3D PRINTER FILAMENT DRYER REVIEW

MODEL ENGINEER & WORKSHOP

EST. 1898

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MIDLANDS GARDEN RAIL SHOW

LOCOMOTIVES IN THE SMALLER GAUGES.

I BUILT A CNC MILL

DAVE SANDERSON'S PRIZEWINNING PROJECT

FOURUNNER

DAVID FOULTON'S INNOVATIVE FOUR-CYLINDER OSCILLATOR.

INSIDE this packed issue:

TOOL & CUTTER GRINDER – MORE DETAILED PLANS · GETTING THE MOST FROM ALIBRE ATOM 3D · EXPERIMENTS FIRING WITH ECOAL · PISTON FOR THE CLARKSON HORIZONTAL ENGINE · UNDERSTANDING TAPERS · INSIDE THE RAHMI M. KOÇ MUSEUM IN ISTANBUL · BUILDING A LOCOMOTIVE FROM A KIT · DESIGNING AROUND SOUND – THE WORK OF AN ACOUSTICIAN · CRINOLINES FOR A 5" GAUGE LOCOMOTIVE · PROBLEMS SOLVING – A CHALLENGING REPAIR

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SMOKE RINGS

THE SOUTH WEST MINIATURE ENGINEERING SHOW

Just in case any readers aren't aware of it, there's a new show coming in May this year. The South West Miniature Engineering show will run on the 14 and 15 May at Newton Abbot Racecourse, TQ12 3AF. This event will involve at least nine clubs and is in some was a 'spiritual successor' to the much-missed Bristol shows. Everything related to our hobby from 3D printing to a live steam ride on railway is promised, together with trade stands and a selection of related interests groups. More details can be found at **www.swemes.co.uk**.

ON THE EDITOR'S BENCH

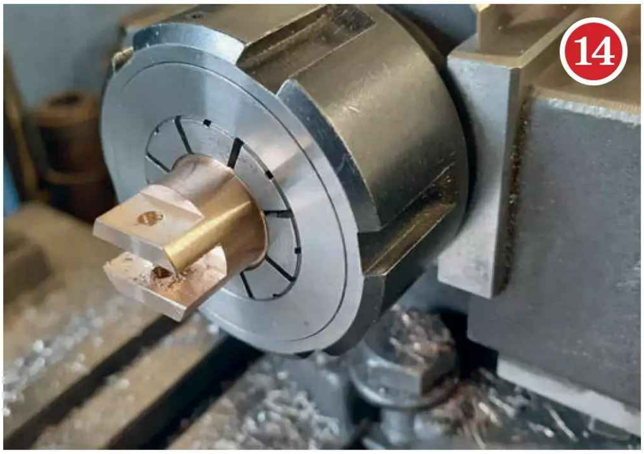
I can't resist sharing a photograph of my *Presflo* wagon on 3 ½" gauge, which is now mechanically complete, although it needs some serious weathering to match my shunter. Personally, I'd call it 'stand-off scale' as it won't bear inspection by Inspector Meticulous and his rivet counters, but I'm pleased with it. The wagon is entirely 3D printed aside from the wheels and a total of ten springs and uses a few techniques I suspect haven't been used elsewhere and several less innovative ideas that could all be of use to anyone wanting to make their own goods wagons, so I will be sharing these soon.

Another opportunity to make practical use of 3D printing combined with other skills was replacing the battered hood for my fish tank. Years of modifications for different filters, brittle plastic and gradual rust had made it not just tatty but unserviceable. I made a nice wooden hood from 8mm ply with a lift up flap. Instead of normal hinges I made some 3D printed ones that could hold it in an open position or let it lift off in a single motion. I also printed clips for the light fitting. Finally the two slots for the external filter's pipes looked untidy so I printed a large shroud, about ten inches long that covers all these ugly bits.

Neil

Neil Wyatt
Editor

Contents


14


34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INSIDE this packed issue:
GET MORE OUT OF YOUR WORKSHOP WITH ME&W


50

Regulars

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Extra Content!

There's lots of extra content to be found online to support past articles in Model Engineer & Workshop.

Visit the www.model-engineer.co.uk forum for extra content including the piston fit for Jason Ballamy's Clarkson horizontal engine.

Hot topics on the forum include:

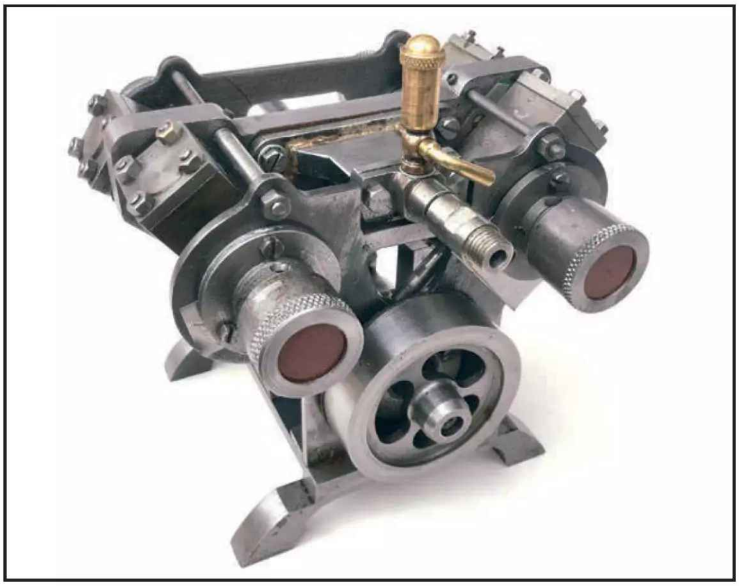
Emco Compact 5 started by Clive Birch.
Some useful discussion for owners of these rather nice lathes.

Plug in Solar started by Vic.
Plug in solar will become legal in the UK later this year.
What does it have to offer us?

All things Beaver Mill started by Robert James 3.
This thread for these big old mills has come back to life with discussion of fitting an x-axis power feed.

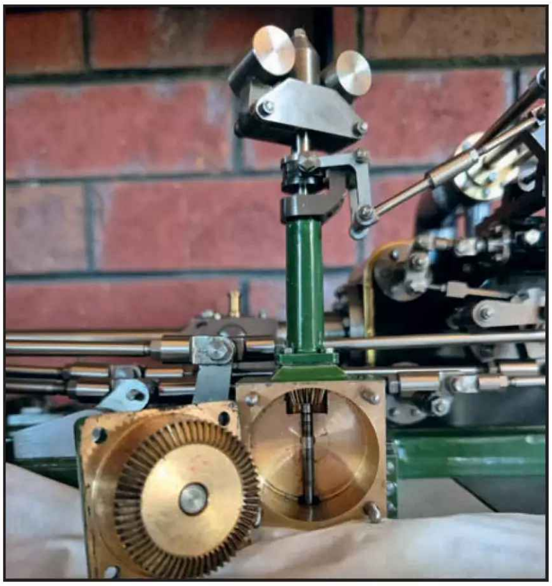
Come and have a Chat! As well as plenty of engineering and hobby related discussion, we are happy for forum members to use it to share advice and support. Come and join us – it's free to all readers!

On the Cover



Our cover features the ambitious Fourunner four-cylinder hybrid uniflow oscillating engine designed by David Foulton. Find out more on Page 40.

Next Issue



In our next issue, Davis Thomas explains how he fitted a Hartnell governor to his Corliss mill engine.

An overall view of the Halesfield stand.

Midlands Garden Rail Show 2026

John Arrowsmith reports from a rail show dedicated to the 'middle sized' gauges.

The Midlands Garden Rail Show was held at the Warwickshire Event Centre Leamington Spa over the weekend of the 28 February to 1 March. It was a bright sunny morning when I arrived although the car park was a bit sticky in places after heavy overnight rain, but it was a pleasant morning and by 9.15 am the queue was already starting to form for the 10.00 am opening.

There was an impressive range of layouts in the centre, although I felt perhaps a couple fewer than last year, but this was more than made up for with the quality of those displayed. They were accompanied by a wide selection of specialist suppliers who had a vast range of products on show. Visitors were met by diverse displays as they entered. The **Halesfield Traction Maintenance Depot** was an impressively made layout in O gauge, covering a modern traction depot with motive power and equipment on display at one end to an equally well-made goods exchange setting at the other with various motive power including some steam locomotives. It was also fully signalled and fitted with the modern high level lighting towers which did make for a splendid eye catching layout, **photo 1**. This layout contrasted nicely with the **National 2 ½" Gauge Association** who showed the Association's models together with examples of available patterns and castings, **photo 2**. Of course this gauge is also that used by the **Gauge 3 Society** who specialise in the scenic side of things and make a really splendid contribution to the overall railway environment, **photo 3**. The scenic side of this gauge was brought to the show with the **Blackgang** layout which is loosely based on Bembridge on the Isle of Wight. Much of the stock and locomotives are based on authentic I.O.W examples. Some of the

On the 2½" Gauge display was this excellent Midland 4-4-0 and train.

An example of a 4-4-0 LSWR locomotive on the Gauge 3 display.

This fine example of a Bedford bus at a level crossing on the Isle of Wight railway.

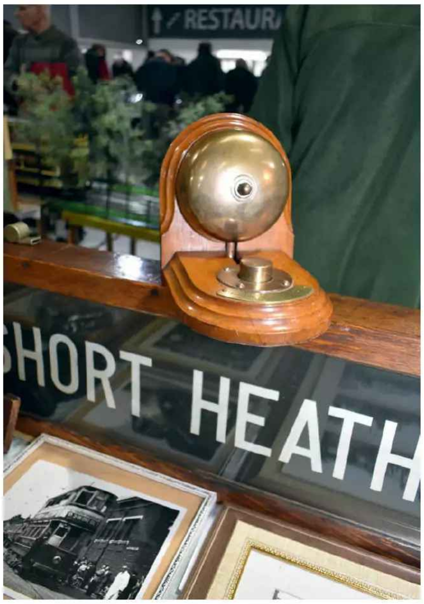
Coronation pacific *City of London* powers past the Carding Road Signal Box.

The coaling stage on the Lough MPD layout.

LMS Jubilee *Anson* waits with Great Central 4-4-0 No 192 for their next turn of duty on Carding Road.

A superb group of scratch built trams on the Streetly Road system.

A grimy 9F waits patiently on shed at Lough.



One of only four known to remain, is this bell from Tram No. 596.

Bromsgrove Society of Model Engineers had a large comprehensive display.

The 3D Printing set up on the Bromsgrove display.

The display by the Coventry Model Engineering Society.

This little loop of track had small locomotives operating all day.

rail side features were excellent, the little Bedford bus at the rail crossing for example was a delightful little presentation on its own, **photo 4**.

Another excellent layout presentation was by the **Midland Group** of the **G1MRA.** *Carding Road* is the new Gauge 1 portable standard gauge layout which is loosely based on the Midlands area, and it provided some spirited running at times with a wide variety of motive power. A powerful LMS Coronation Pacific *City of London* number 46245 was an impressive sight in its splendid LMS livery, **photo 5**. A nice contrast in locomotive styles was on one of the storage lines where an LMS Jubilee engine was posed nicely against a Great Central Atlantic, **photo 6**. A regular attendee layout at the show is the **Lough Motive Power Depot.** This presents an attractive shed scene based on the track layout of Slough on the Windsor Branch combining both steam and diesel traction. The atmosphere creates that dark, smoky, dirty atmosphere so reminiscent of BR sheds of the late fifties/early sixties, **photos 7** and **8**.

A delightful layout showing off a typical Tram system in Birmingham particularly the **Streetly Road Short Heath** area was superbly built and operated very smoothly, **photo 9**. In 1/16 scale the trams were running on hand made track which is 2 5/8" gauge that equates to the actual 3ft 6" gauge of the full-size trams. All was expertly built by David Gould including all the electrics like the transformer, control gear and overhead collection system. The current keeper of this layout is Geoff Simmonds who is an absolute fount of knowledge about these trams and their origins. It was almost a family affair, as all the people involved now had all worked on the Birmingham tram system. This superb model was accompanied by an excellent selection of memorabilia dating from the early 1900's. Geoff was able to tell me the history of most of the artefacts on show here and was delighted to tell me that most of them originated before the Titanic sailed. The Bell for example is one of only 4 known to be in existence and came from tram No.596, **photo 10**.

Two Model engineering clubs displayed their interests in the smaller gauges with some excellent model making on show. The **Bromsgrove Society of Model Engineers** had

This excellent example of an L&B 2-6-2 tank locomotive was on the Coventry MES display.

Scenery on the G Scale demonstration layout.

Busy roads, rail and Metro line at Loft City.

various models on show including one small example which had real tea as a load on a couple of wagons, **photo 11.** What really attracted a lot of visitors, was the 3D Printing demonstration and the many examples of rolling stock produced by this method, **photo 12.** A well laid out display by the **Coventry Model Engineering Society, photo 13,** had a good selection of models on show including stationary engines and a small oval of track with a little 0-4-0 loco and wagon trundling round, **photo 14**. A nice example of an L&B 2-6-2 tank locomotive LEW with a short goods train caught the eye, **photo 15**, (I'm not sure I fancy their beer – Ed.)

In complete contrast to the fine scale models on the ME club stands, the **G Scale Display Layout** in 45 mm gauge had a typical colourful all action display stand showing what can be achieved in quite a small space with the gauge. A range of both European and British outline models were in continuous action against a background of scenic buildings and railway infrastructure, **photo 16**. Adjacent to this layout was another very large and colourful G scale layout, the **Loft City Central Railway** and this had just about everything a layout could have. I think the only modern life feature it didn't have was an airfield, **photo 17**. However, the remainder of this busy presentation more than made up for that. Fast trains, slow goods, an urban metro type of system. A waterfront with an industrial area at one end and a leisure area the other all skilfully joined together. It kept the young visitors fully adsorbed for ages.

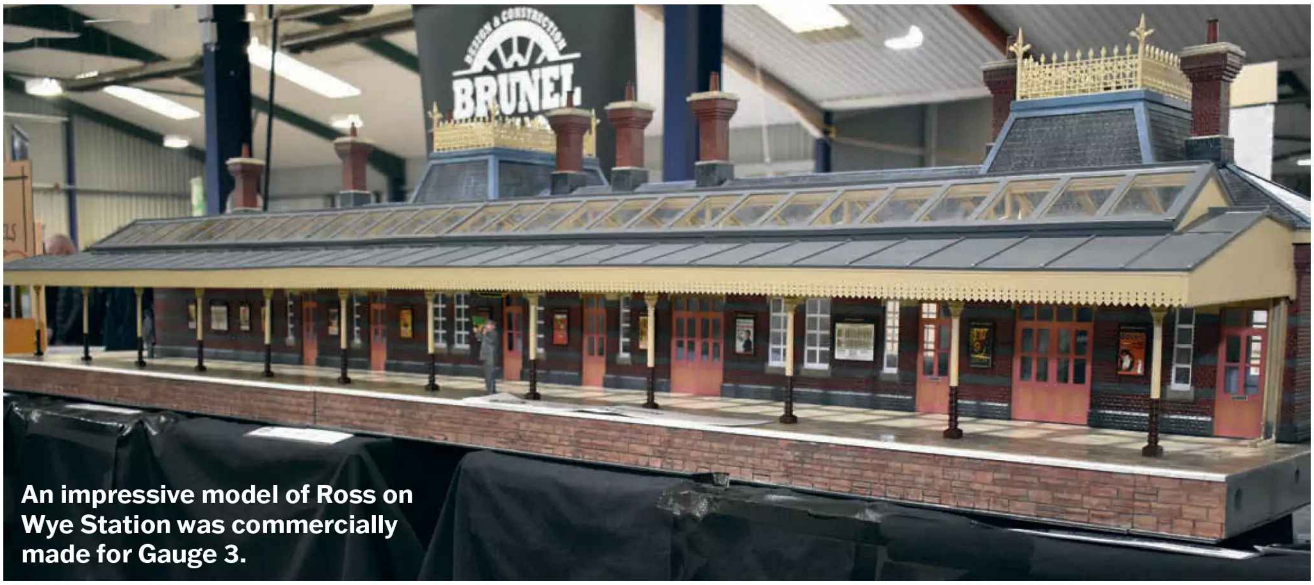
The Modular layout of the **Association of 16 mm Narrow Gauge Modellers** had a fine new layout on show with again plenty of activity, live steam locomotives bustling round the track with assorted goods trains and passenger stock, excellent scenic details. The fine scenery made for a good railway image and plenty of scope for interesting trains, **photo 18**.

Plenty of activity on the 16mm Narrow Gauge layout.

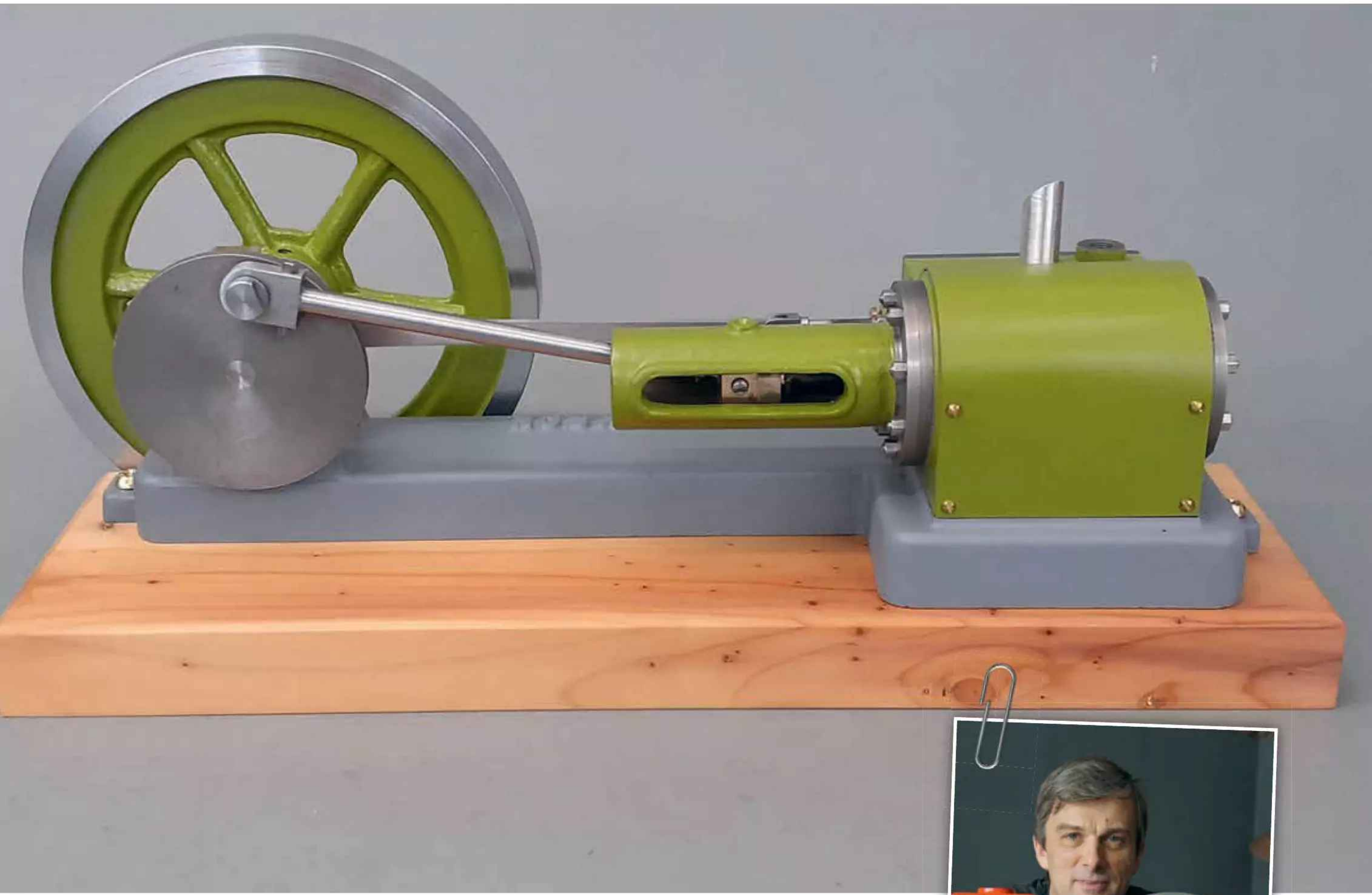
The Gauge 2, 0-6-6-0 tank locomotive has a long goods train in tow on the Vintage layout.

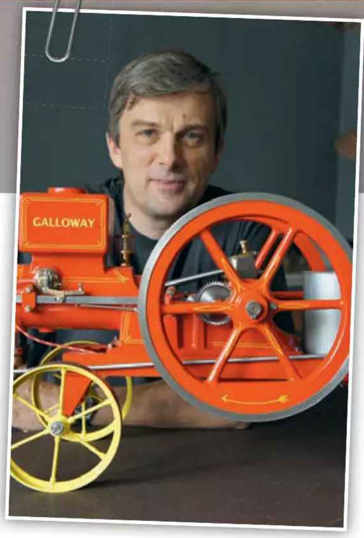
The Gauge 1 Vintage Train Group had their usual large layout showing the model railway set up of days long gone. It also included a unique circuit of Gauge 2 track and rolling stock. Most of the rolling stock is pre WW1 but it still looked in good condition and performed very well, **photo 19.** I must also mention a superb example of the station building of Ross on Wye. A commercial build for a private client it has been built for a Gauge 3 railway and looked a fine piece of work, **photo 20**.

Finally, I must thank the organisers for an excellent show with a good number of trade stands mixing well with some superb layout presentations. It seemed to me that the show was well attended with plenty of activities for everyone to enjoy.



An impressive model of Ross on Wye Station was commercially made for Gauge 3.





The Clarkson 24x38 Horizontal PART 3

In a series aimed at beginners, Jason Ballamy details the making of a stationary steam engine.

VALVE CHEST

Start by milling equal amounts off each face to arrive at the 11mm finished thickness then transfer to the 4-jaw chuck and set the inlet boss to run true so the boss can be faced also face the top edge of the chest as well as cleaning up the outer diameter of the boss, **photo 27**. At the same setting the steam entry can be drilled and the hole opened up and tapped for your steam or air connection, I have shown M4 x 0.5mm metric fine but as with the exhaust use a thread to suit any fittings or pipe you intend to use.

Back to the mill and machine the underside to bring the chest to its final height of 26mm. Mark out the centre position on both ends and punch their position. The punch marks can then be set to run true and the domed end

Photo 27: Machining top edge of valve chest.

Photo 28: Turning domed end of valve chest.

Photo 29: Long centre and 2.5mm drills for guide hole.

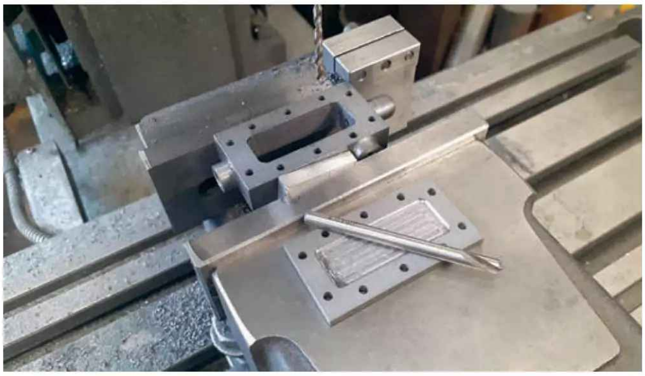


Photo 30: Chest and cover stud holes drilled.

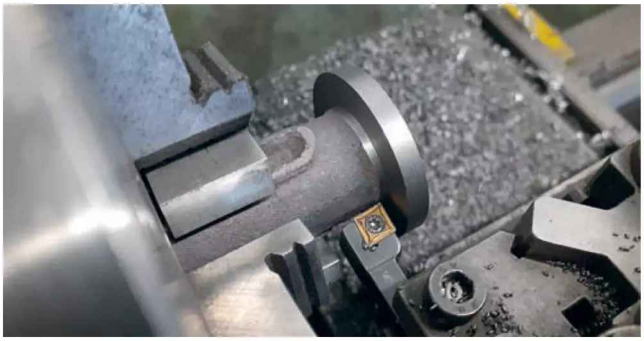


Photo 31: Left hand tool used to clean up surface for nuts.

Photo 32: Flange faced and trunk guide bored.

Photo 33: Chamfering end of trunk guide.

turned, **photo 28**. Before doing the gland end, clean up the inside of the cavity to ensure the drill for the rod end guide has a flat surface to start on then the boss and end of the chest can be faced to length. Spot drill, drill 2.8mm and ream 3mm for the valve rod and then partly open up the hole to 5.3mm and tap M6x0.75 for the gland. Using a long series centre drill start the guide hole at the opposite end of the chest and drill out to 2.5mm which is likely to require a long series drill**, photo 29.**

VALVE CHEST COVER.

This just needs milling all over, start with the two long edges then use those to hold it while the faces are machined and then finally the ends.

As the hole pattern in the cover and valve chest are the same it is worth using a vice stop so that they can all be done at the same time. Locate the centre in both directions, zero the hand wheels or DRO and set out the 2.5mm holes from there, **photo 30.**

TRUNK GUIDE

Set this up in the 4-jaw with the flange facing outwards far enough from the jaws so you can access both faces of the flange, some packing will be needed over the cast slots. Get it running as true as possible with a dti on the outside of the trunk not the flange so that the wall thickness of the guide ends up as even as possible. Using a left-hand tool face off the flange so that the nuts have something to sit against, photo **31**. Then change to a right-hand tool to do the 37mm diameter and then the other face of the flange can be faced until the flange is 2.5mm thick. Change to a boring bar and bore the guide out to 16mm diameter not forgetting to add a small chamfer to the corner, **photo 32**.

Transfer the 4-jaw to the mill with the casting still in it so the flange can then have the eight 2.5mm diameter holes added. Locate centre and then spot and drill the hole pattern. With the other end of the casting facing upwards in the vice mill it down to final length, this is more secure than trying to do it in the lathe. Also use a countersink bit to cut a large chamfer to ensure that the conrod does not hit the end of the guide, **photo 33**.

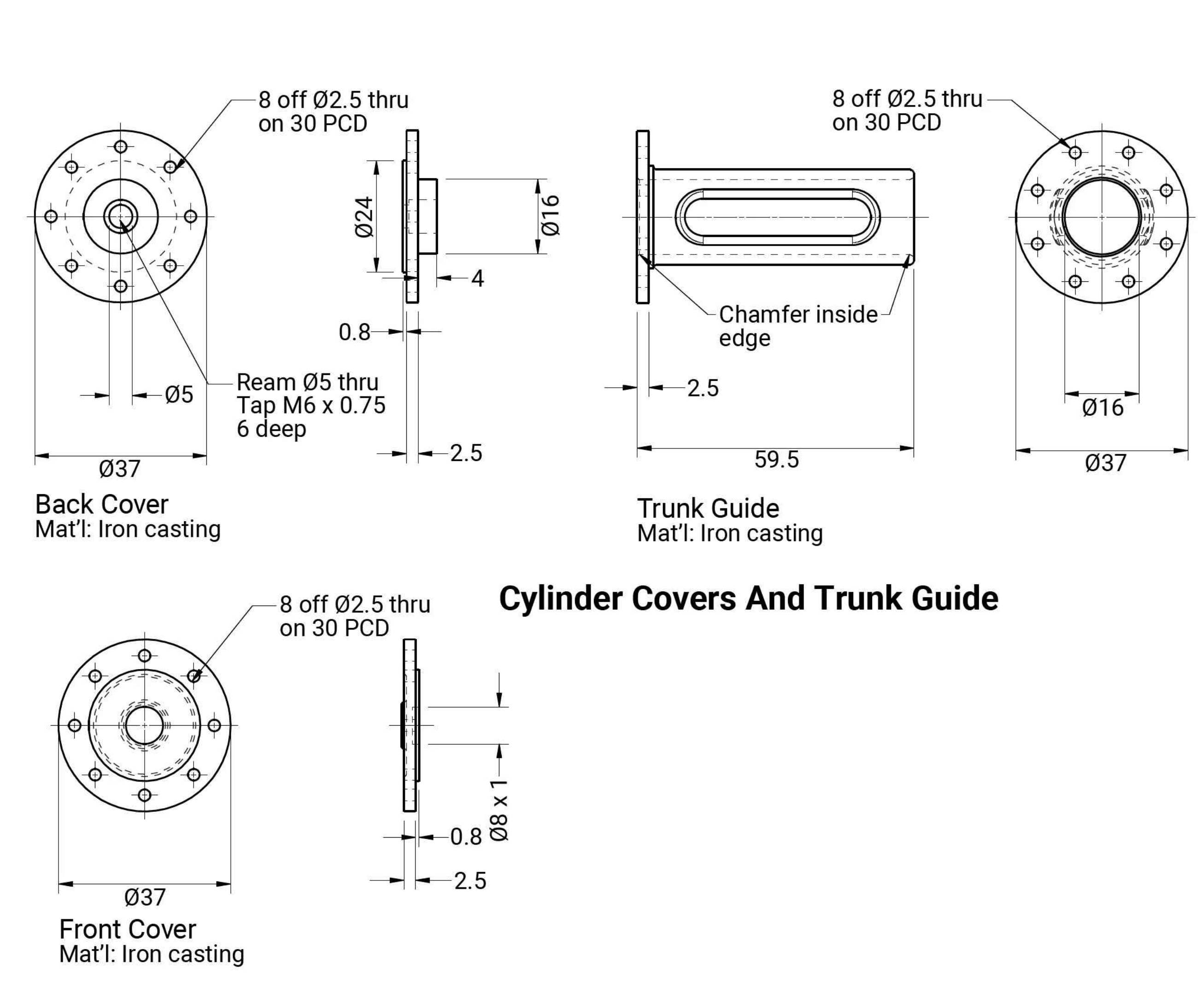


Fig 7

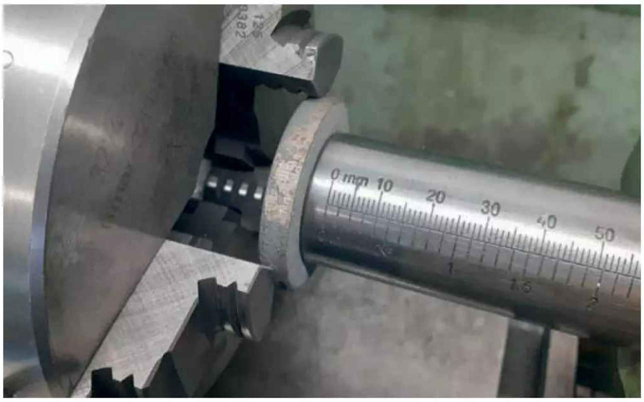


Photo 34: Positioning end cover with aid of tailstock.

Photo 35: Cover turned, drilled and gland being tapped.

To lap the bore for the conrod turn a piece of hardwood to a close fit and then apply a mix of oil and 600 grit silicon carbide powder and slide the casting back and forth along the lap as it rotates in the lathe, cover the bed to keep the grinding paste off.

BACK COVER

Start by cleaning up the cast chucking spigot, to help set the casting true in the chuck it can be held against the nose of the tailstock barrel as the chuck is tightened, **photo 34**. Then holding by the spigot it can be faced and turned to 37mm diameter before forming the 16mm spigot, use the trunk guide to gauge the fit which should allow the guide to be pushed on by hand but not slide off under its own weight. At the same setting the hole for the piston rod

Photo 36: Shallow spigot turned on reverse side.

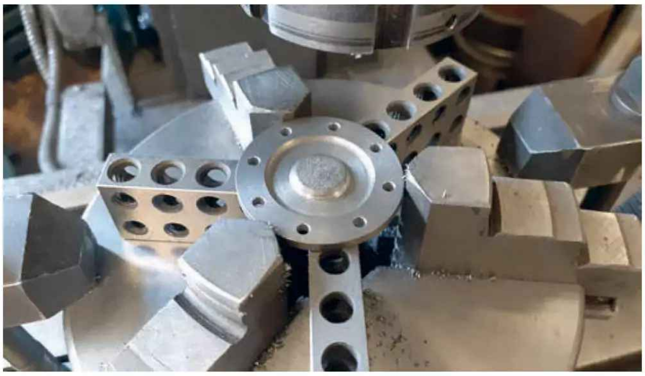


Photo 37: Drilling end cover holes on PCD.

can be spotted, drilled 4.8 and reamed 5mm then open up the hole with a 7.3mm drill and tap M8x0.75, **photo 35**.

If you have soft jaws, make use of them to hold the cover with the inner face outermost, if not spend some time getting it to run both true axially and also with no wobble. Face to 3.3mm thick then take off a further 0.8mm to form the cylinder locating spigot, again use the cylinder to gauge the final size, **photo 36**.

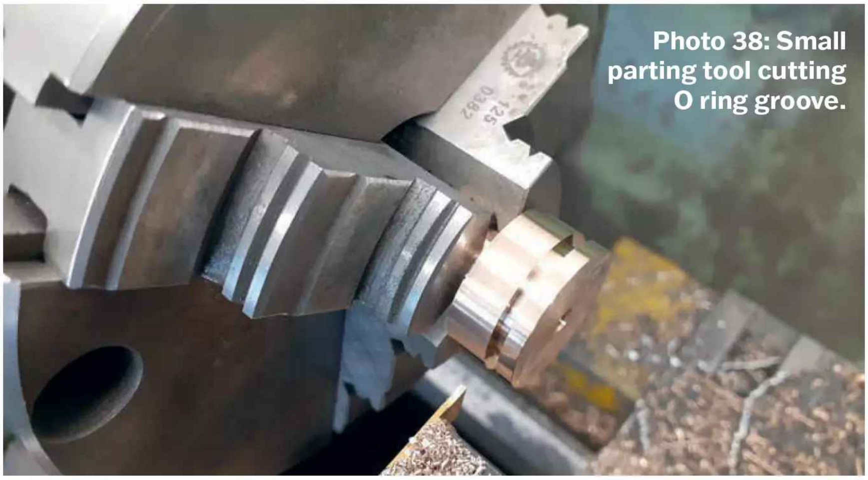
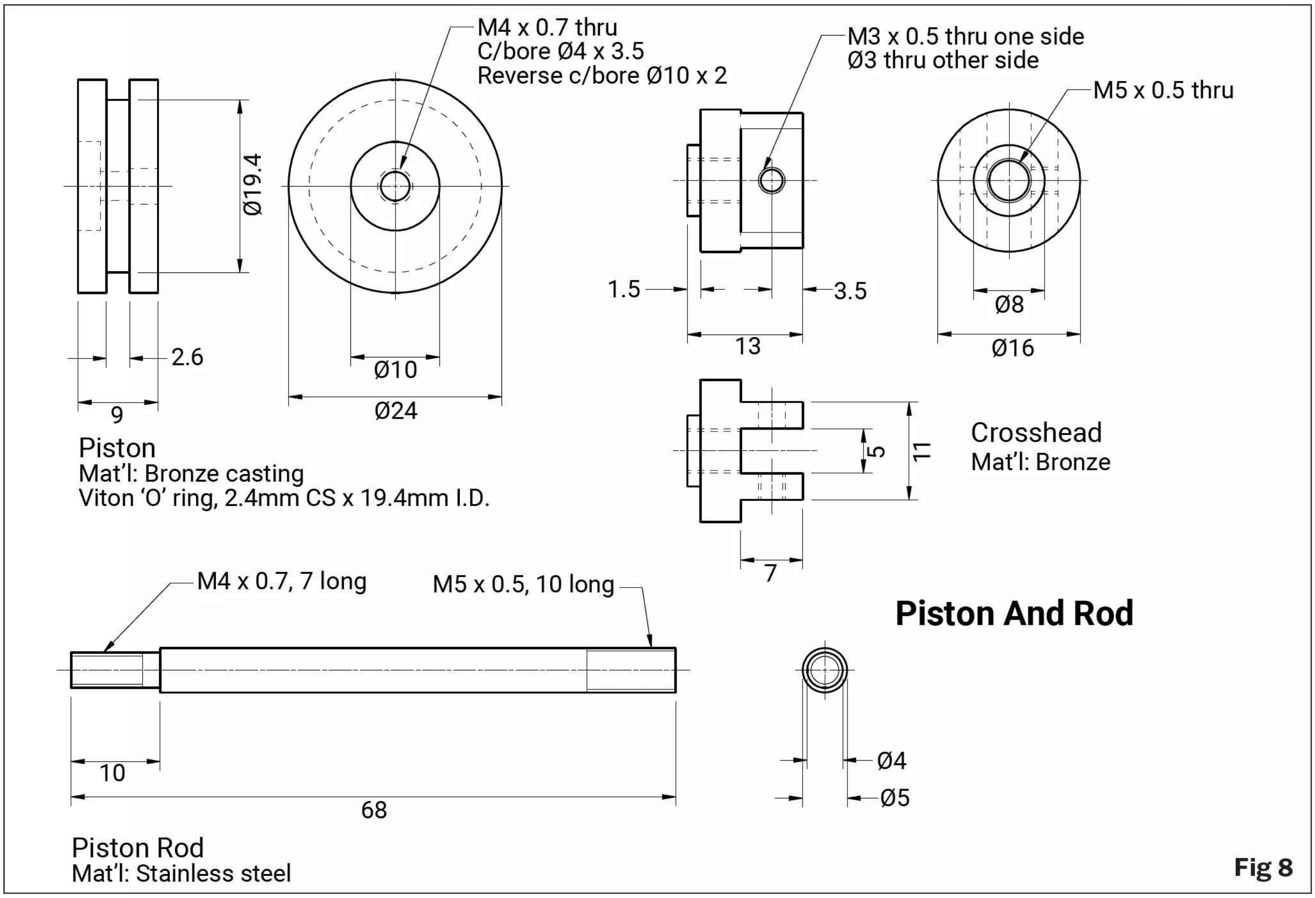


Photo 38: Small parting tool cutting O ring groove.

FRONT COVER

This can be machined in much the same way as the back cover. The cast recess can be left as is or cleaned up



with a small round nosed tool. With both covers turned set them up on the mill, locate centre and then drill the eight 2.5mm holes in both, **photo 37**.

PISTON

After cleaning up the chucking spigot, hold it that to face the end and bring the diameter down to just oversize, say 24.2mm. Then spot drill 3.3mm and open up to 5mm for a depth of 3.5mm before tapping M4. Using a thin sharp parting tool cut the O-ring groove to width and to the finished diameter of 19.4mm, tailstock support is worth using here as you are only holding by the small chucking spigot, **photo 38**. Lastly turn the casting around and face off to final length and bore the recess for the lock nut, which can be done by plunging in with a milling cutter.

PISTON ROD

Face the end of a piece of 5mm diameter stainless steel and thread M5x0.5mm. Set the other end to run as true a possible in either a collet, 4-jaw or make a split bush then face and turn a 10mm length to 4mm diameter then thread that M4 for a length of 7mm.

Without disturbing the position of the rod screw the piston and its lock nut on tightly, they should never be unscrewed from now on which maintains concentricity. Using a sharp tool and shallow cuts bring the piston down to its final diameter once again using the cylinder to gauge fit which should be a free sliding fit but with the minimum of clearance, **photo 39**. The piston and rod should drop freely when the port is open but descend slowly when it is covered (this is without the ring fitted) see the video at tinyurl.com/2s4e7xne, or use the QRcode.

Photo 39: Turning piston to final size on its rod.

Photo 40: Milling crosshead slot and sides.

Photo 41: Cross drilling & Tapping Crosshead.

CROSSHEAD

Start by turning and facing a piece of bronze to overall size, then drill and tap M4x0.5 at least 13mm deep. If you have a collet block, make use of that to hold the crosshead end up so that the central slot and two side flats can be milled, **photo 40**. Then with it on its side drill right through 2.5mm, open the upper hole out to 3mm and tap the lower one M3, **photo 41**. Cut the part off from the parent bar then back into the lathe to face the end and form the small spigot for a thin M5x0.5 locknut to bear against.

to be continued

The Sunlu Filadryer set to 55° C.

Review: Sunlu Filadryer S1 Plus

As 3D printing technology advances, the demands placed on filament quality increase, Stub Mandrel reviews this device from Sunlu that promises more consistent performance from trickier to print filaments.

If you have been 3D printing using fused filament deposition (FFD) for some time, it's likely that on more than one occasion you've come across the effects of humidity on your filaments. All 3D printing filament is hygroscopic to some extent, absorbing moisture from the air, especially when the humidity levels are high. Some filaments that are already challenging to print such as TPU, and especially PETG and Nylon (polyacetal), can absorb enough moisture that they will fizzle when melted in the extruder. Performing a text extrusion instead of a clean thread emerging, instead you may see a rash of tiny bubbles or even see wisps of steam condensing below the nozzle, **photo 1**. This is a sign of seriously damp filament. Lower levels of moisture may not be so obvious, but the expansion of steam in the extruder upsets finely tuned settings and reduces the strength and quality of prints with poor surface finishes and excessive stringing.

Even PLA, one of the most reliable of filaments, is not immune to moisture. It can absorb enough to become brittle enough to snap spontaneously under tension, even when the printer is not in use.

In the past I've relied on basic approaches to drying filament – for PLA storing reels in a warm airing cupboard (if you still have one) or leaving them on top of a radiator for a day or two can be sufficient. Nylon and TPU are more demanding – storage with a chemical dehumidifier or silica gel can help, and I have even used a very low oven to dry nylon, but take care as even at the lowest setting you are close to the filament's transition temperature and you could ruin the filament.

Once some people started using vegetable dehydrators as a makeshift solution, it was inevitable that bespoke filament dryers would make an appearance. The basic ones are charged with silica gel, but the most popular type uses a built-in heater.

After a challenging encounter with some Nylon 66, I decided to buy a proper dryer. I went with a machine from Sunlu (a Vietnamese company specialising in 3D printing consumables) as I'm familiar with their filaments (and UV resins) as being reliable. Billed as a '3D printing Mate' the Sunlu FilaDryer S1 Plus is a solution that not only dries filament, it can keep it dry whilst you are printing. It's worth a good search online as prices (and delivery) costs vary – from under £25 to well over £30. This is their entry level product, other versions hold multiple spools, for example.

It came well-packaged in a box with a separate 24V supply inside the dryer, some (very) short lengths of clear tubing and a couple of leaflets. The device itself is a clamshell box with a transparent lid, see header photo, the lower half contains a low powered heater (maximum power is 48W) and (from the sound it makes) a tiny fan to circulate air inside the box. It has a nice clean appearance with a light up display. The power supply has a reasonable length of mains and low-voltage leads, about a metre of each.


Photo 1: Test extrusions (0.4mm diameter) with Nylon 66, before (below) and after drying.

Photo 2: Spools are supported on these rods so they can rotate freely.

Photo 4: Two buttons access the various functions. An assortment of single, multiple long and short presses takes a little getting used to.

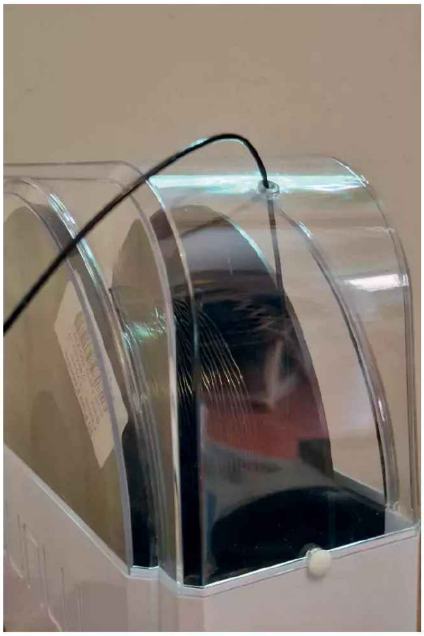


Photo 3: If required, filament can be kept in the dryer and fed out of one of two holes.

There are two very free running rods, **photo 2**, that support a reel of filament and two holes in the box so you can keep a reel inside and dry(ing) with the filament exiting via one of two holes and running direct to your printer, **photo 3**. As my printer is in a warm, dry place, I haven't needed to keep filament in the dryer whilst printing.

There is a small white silicone plug for the unused hole – I nearly lost this as it was just loose in the packaging. The tiny clear tubes appear to be to act as 'grommets' for the filament, but their use isn't explained.

A display on the front of the box has two buttons, **photo 4**, that provides a somewhat non-intuitive control interface. Fortunately it there are relatively few functions and the leaflet explains them well. As well as switch on and off, you can set the temperature between 35-55C (different filaments need different temperatures). There is also a timer for 1-99 hours, and you may switch the display between temperature and humidity, **photo 5**.

Photo 5: The display is, however, clear and easy to read.

Once I'd got the hang of the buttons, I found it quite easy to use. Set to 55° with half a roll of TPU and a few metres of Nylon 66 inside the humidity dropped from around 65% to 18% over several hours, although I left it overnight to make sure the filament was truly dry before using it. A test extrusion gave what I hoped for – a neat, clean and regular thread of nylon – the difference is quite obvious, see photo 1. The resulting print was excellent, **photo 6**. I also had good results with TPU dried in the Filadryer.

One thing I found was that reducing the set temperature rapidly caused it to show an 'overheated' error – presumably a safety measure because it was several degrees hotter than the set temperature. I just switched it off, let it cool and it was working normally again.

Some dryers go much hotter, but 55° C will dry a reel of Nylon in 24 hours which is plenty for my needs. Sunlu also so several other, larger, filament dryers, but as I generally print in PLA and only need specialist filaments from time to time, I think this relatively modest solution is ideal for my needs. ●

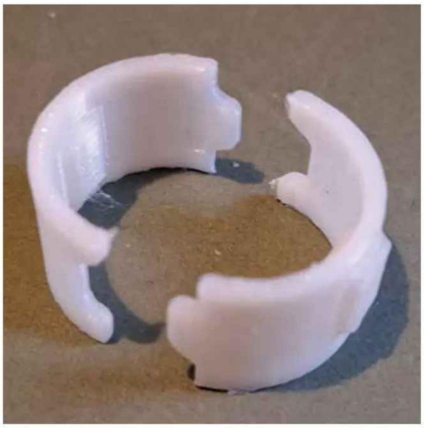


Photo 6: The proof of the pudding is in the printing, the few 'tufts' of stringing seem unavoidable with Nylon, otherwise a perfect print.

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POSTBAG

The Editor welcomes letters for these columns, but they must be brief. Photographs are invited which illustrate points of interest raised by the writer

PostBag is one of the most popular sections of the magazine - readers want to hear from you! Drop us a line sharing your advice, questions or opinions. Why not send us a picture of your latest workshop creation, or that strange tool you found in a boot sale? Email your contributions to neil.wyatt@kelsey.co.uk.

ISLE OF MAN LOCOMOTIVES

Dear Neil, I noticed the query regarding Isle of Man steam locos. About 45 years ago I spent quite a few hours measuring up Peveril, unfortunately not in service, and built my 5-inch version. She went down to the 1983 Model Engineer exhibition and attracted the attention of Don Young the editor of Locomotives large and Small. A good magazine sadly to disappear after about sixty issues, after Don's fight with cancer. I wrote a couple of articles for him in issues 17 and 19. They were not however detailed as LBSC would have done them and more in line with photos of the full size and comments on my foot plate 'treats'. David Bellamy and Max called to see me. They have ordered a boiler from a lady in the south west of England. I did see some work done by her at an exhibition which looked very good. They also brought up a wooden crate with various bits and pieces they had purchased, but there is a lot to make. I do think though there may be a better way than building from scratch, and I'm interested in opinions. That is try and find a part built loco without a boiler that someone has 'given up on'. Unfortunately this happens quite a lot. often due to the builder having moved on to the next world. Ted Jollife (the former editor of ME) who used to spend quite a few holidays over here reckoned that only one in every five got finished. My own loco has been in several IMLECS. Ashdowne Models were keen to take *Peveril* after I built it, and supply drawings and castings. I don't know how many were built and they later went out of business. My patterns and tracings went with them. However, all was not lost, Jim Woods from New Zealand built a lovely loco and then supplied drawings and castings and quite a few have been built. Jimmy has retired and so no longer provides castings and drawings. I'm going to see if he knows of any unfinished engines and will let David and Max know.

Mike Casey, Isle of Man

SILVER CREST KIT BUILD

Hello Neil, I have just been reading an interesting article in the current edition of Model Engineer & Workshop. The article is entitled *The Silver Crest BR Class 1500* and is written by Mark Thatcher.

I know Mark from May 1998 for some 18 months during which time we and seventy others battled with the construction of the first Winson kit, a 5" Britannia. Mark quickly set up a monthly news sheet which was a great help in building the Winson model. He also arranged several get togethers where fellow builders shared their experiences in the many and varied tasks involved in constructing such a model. He clearly spent a great deal of time in building the engine.

Whilst Mark wasn't a born engineer he, and many others, put a great deal of work into the build and I am sure he learned a great deal from this experience. I know I and many others did!

I remember him as a guy who was very determined to achieve the completion of a 5" Britannia, put a great deal of effort into doing so and learned a great deal in so doing.

Barrie Purslow, by email

VIBRATION

Dear Neil, Rhys Owen's article is superb. It's relatively hard to find this material and Rhys presents it clearly and concisely. He might like to remember a thought about sound levels. A string orchestra of 50 (the string section of a symphony orchestra) is only twice as loud as a string quartet – not 10 times. Sensors in nature and beyond tend to be roughly linear, sound detection is logarithmic. Why?

Hunters need ultra-sensitive sound to detect their prey, especially at night. A broken twig, the feint swish of grass against coat, breathing. To quote Harold Macmillan with a twist 'Evolution my boy, evolution'.

Patrick Hendra, by email

Thanks Patrick. I was a bit nervous about the level of this article, but I know there are a proportion of readers who enjoy getting to grips with technical subjects, and the subsequent parts are much less 'mathematical' - Neil.

How I Built a CNC Mill

Dave Sanderson shares his adventures in machine tool manufacture, making his Stevenson Trophy winning CNC milling machine.

First, a bit of history; CNC has been an on and off thing for me for many years. Some time ago (2008) I converted a Proxxon MF-70 to make some small parts. But the day job at that time was computers and embedded control software, and I actually enjoyed hand cranking to make things, so it got little use and ended up gathering dust on a shelf.

Fast forward to 2020 and I wanted to get more into the modern world - CNC opens up possibilities for making things which are much more complex without the need for complex manual setups.

As the late John Stevenson used to say, it also enables you to gain brownie points by being inside with 'She Who Must Be Obeyed' when doing the designing and CAM portion.

The Proxxon, whilst a fair initial step, was not up to the jobs I had in mind. Specifically, it does not have enough Y travel (only 46mm), and the spindle is not really up to the job of milling steels and harder metals.

Looking at the various small mills available that I could convert I came to the conclusion that it would be better to build one that met my actual requirements.

Photo 1: Dave Sanderson (right) receives the Stevenson Trophy from ME&W editor, Neil Wyatt.

DECIDING ON THE REQUIREMENTS

For travel a 150mm cube would cover most of the things I am planning, and would make the mill small enough to fit into the somewhat full garage. I was planning to make small parts in hard to machine metals (stainless steel, titanium etc.) with small cutters. For this stability and a low run out high-speed spindle seemed to be the main requirement. Fortunately, I already had an ER16 spindle unit from a previous project. This is inverter driven, with a usable range of about 6000-24000 rpm.

Basic size parameters decided, my thoughts turned to the configuration of the axes.

There are a couple of main milling machine configurations - XY table and a Z column as the majority of small hobby mills are, or a gantry where Y is on the base and XZ are on the gantry, which is somewhat like the majority of small CNC routers.

There are advantages and disadvantages to each, and I'm not sure that there is a clear winner.

After reading Moore's *Foundations of Mechanical Accuracy*, looking at many mainstream CNC machines, jig borers and manual mills, I decided that a two column gantry over a Y-only table would be the right set of compromises for me.

THE MECHANICS

The foundation of my machine, and the determining factor in its overall size, is a Cast Iron surface plate. This was bought on eBay in quite poor condition. Doing some basic checking showed that the plate was worn hollow, with the centre about 0.07mm lower than the edges. **Photograph 2** shows the areas that touched when tested on my surface plate, circled in black felt pen.

I am fortunate to have a very large manual milling machine, so initial flattening involved a 100mm face mill, followed by hand scraping. Whilst setup on the big mill I also milled the edges to provide a reference for the Y-axis direction.

For the table, I considered fabricating one, but then I came across WDS Components. They supply various components for industry, including CNC machining fixtures. They sold a T-slotted cast iron fixture plate that had the same T-slot size as my current mill, and was the right size to fit on the surface plate base. As supplied, this was blank on the back, so I machined pockets to take the Linear bearing carriages and the block to hold the ball nut, **photo 3**.

With the size of the base and table fixed, I now turned to CAD to design the main structure of the machine. I planned to use box and channel sections for the structure but joining them to the foundation in an elegant and structurally sound manner proved trickier than expected. Fortunately

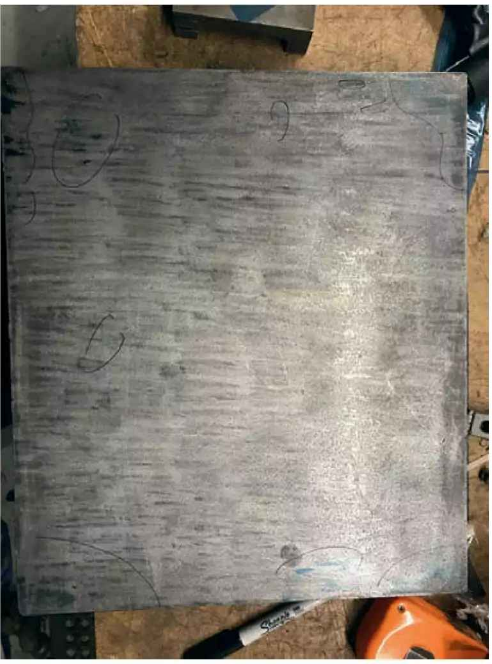


Photo 2: Base plate as received.

Photo 3: Table underside.

at this point the machine was mostly virtual, so changes were a mouse click away.

I planned to have the spindle fixed to the X-rails, and the whole gantry move in Z – rather like a jig borer. I even got as far as mounting the rails to the vertical columns before changing my mind.

As the build progressed, I realised that there was a possibility of the actual gantry crashing into the part when machining pockets. To resolve this I changed to a Y only table, with X on a fixed height gantry and Z on the X axis slider.

To tie the columns together and to the base I settled on an open box like structure. This was mocked up in plywood, **photo 4.** I find it's very easy to overlook something vital in CAD, especially things like 'is that a reasonable size' and 'have I got the fasteners in stupid places that will be inaccessible'.

With the structure sized, I converted the rough CAD model into something

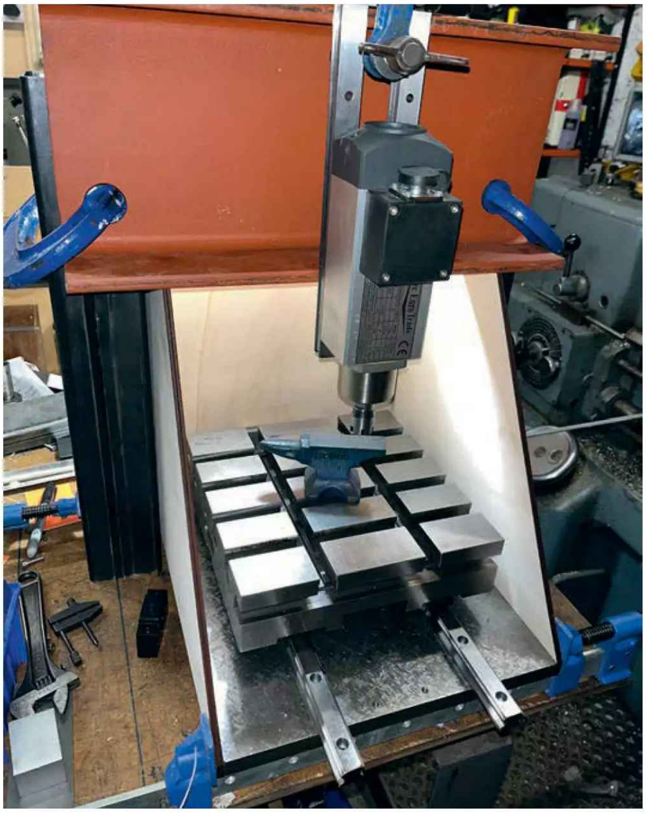


Photo 4: Plywood mockup.

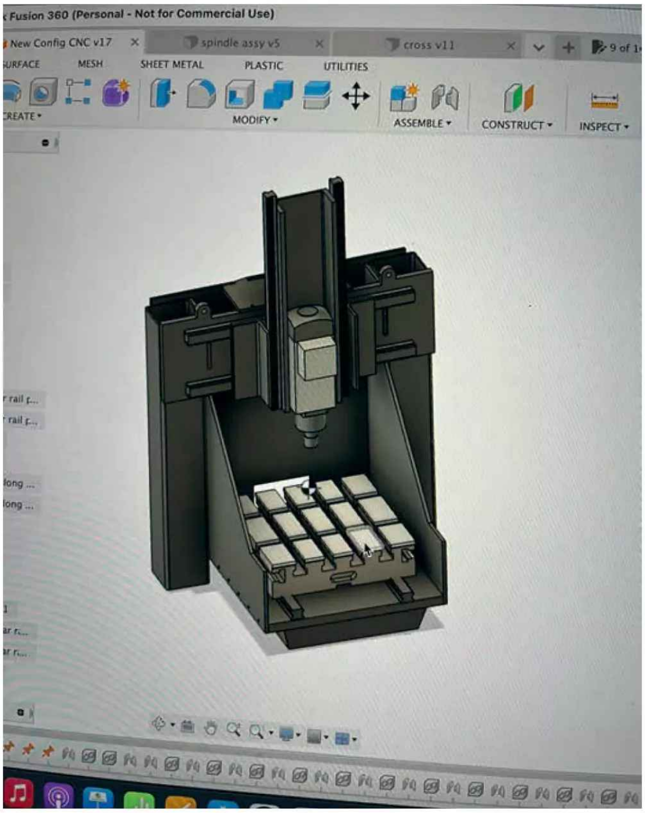


Photo 5: CAD model.

Photo 6: Assembly on TOS FNK25 Mill.

Photo 9: XZ saddle.

more accurate, **photo 5**. I then exported some DXF files and ordered some laser cut steel. The majority of the plates are 6mm thick, with the gantry front plate 12mm thick. All are hot rolled S275JR steel.

I designed the structure to bolt to the sides of the surface plate, and also tie the columns together. Each part has tabs and slots to provide an easy way to lock them together during the assembly. The plates are bolted to the surface plate and the columns. I assembled the plates around the base, **photo 6**, then match drilled through to ensure that the holes and threads would align. Building a new machine tool is made much easier if you already have a lot of machine tools!

In the spirit of 'about that big' engineering I thought a 12mm plate spanning 400mm would be stiff enough for the X Axis. It turned out that this was not the case, with the plate actually surprisingly bendy. Linear rails

Photo 7: Gantry stiffening weldment.

Photo 10: 3D printed fan housing and baffle.

are not necessarily very straight and rely on the support structure to hold them in alignment. With the Y axis rails the surface plate provides sufficient structure.

Clearly this meant that the gantry needed additional stiffening. This was provided by creating a 50mm deep weldment from hot rolled angle, **photo 7.** Weldments are not known for their straightness, so post weld surface grinding was needed, **photo 8**.

The XZ saddle went through several design iterations. Initially it was going to be created from some flat and angle steel, but this looked too flimsy and was complicated to create. I briefly considered milling the saddle from a single large block of cast iron. This was discounted on cost - the initial block needed was huge and turning most of that into swarf did not appeal. So I

Photo 8: Surface ground weldment.

Photo 11: Cable chain to the Z-axis.

looked for 'saddle shaped' alternatives, or ways to make them.

Hemmingway kits sell a small surface plate casting. After a couple of emails to check the overall thicknesses and sizes it was apparent that I could make the saddle from a couple of these with a little machining, which they need anyway- as they are supplied as a raw casting.

The castings were pleasant to work with, and after milling I scraped the surfaces for alignment and size. The 'quill' runs between the side cheeks of the X saddle, so its width (plus the rails and cars) set the overall size, **photo 9**.

ELECTRONICS AND CONTROLLER

The mill is a 3-axis machine, so it has three steppers. I bought steppers that are possibly a little oversized for the job, which may limit the top speed of travel. However they will move each axis pretty fast (3,500mm/min) and given the short travels the ultimate top speed is not a huge concern. At 3,500mm/min the machine will run out of travel in about 3 seconds.

Photo 12: Alignment method for initial Y rail.

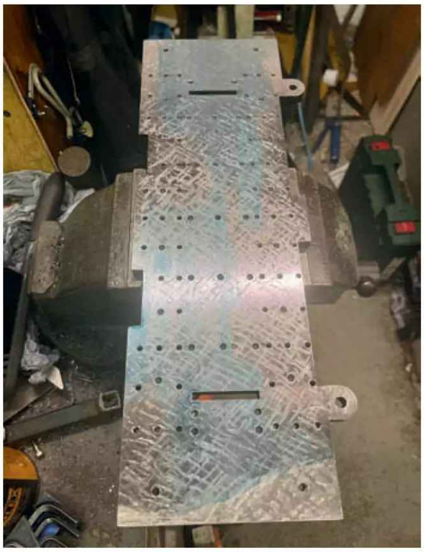


Photo 13: Gantry plate with blue showing the warp.

As the motors are 5A at 48V and each has its own power supply. Also in the electronics enclosure are two power supplies for the controller, and the VFD (and filters) for the spindle.

Given the proximity of the electronics to the mill, I arranged four cooling fans to pull air up from the bottom and blow it out of the top rear. This should prevent swarf and other nasties ending up inside the box. A little bit of CAD and 3d printing created a baffled vent for the exhaust air, **photo 10**.

I considered using GRBL (a CNC motion controller running under Windows) for the controller, and even purchased an Arduino based control unit, however, I would then have ended up with a laptop or computer and screen as well as the stepper drives and such like. I used the Arduino and an old netbook during the initial build, but I wasn't convinced by its usability.

John Stevenson had shown me an all-in-one controller unit many years ago, on one of his CNC retrofit jobs. The memory of that unit prompted me to go looking at what was available. I settled on the DDCS Expert controller – it has a dedicated screen and IO with isolation and a decent set of buttons for the user interface. Overall it feels like a good step up from the somewhat cobbled together feel of the various GRBL senders on old laptops that I have used previously.

I had learnt that good homing and travel limit was essential from the Proton – so I included inductive switches on each end of all the axis. The controller will also drive A and B axes in the future should I figure out how to make them.

Cable management on this mill is fairly simple. As the X and Y-axis are separated, their electronics (motors and limit switches) do not move. The Z-axis limit switches, and motor control wires are routed in a cable chain along the back of the X-axis, **photo 11**.

ALIGNMENT

As mentioned earlier I created a reference edge on the surface plate to allow me to get the first rail on the Y-axis straight. This was done using an indicator and magnetic base on a carriage on the rail, referencing off the

Photo 14: Carbide scraper for steel.

Photo 15: Stand and electronics enclosure.

edge. Linear rails are not necessarily straight and are designed to be pushed into an alignment feature on the machine. Typically this is a stepped edge on the base surface. As I had only flat scraped surfaces, I did not have the required edge, so the rails are aligned using countersunk socket head cap screws (SHCS), which wedge a round bar into the rail side. By adjusting the opposing screws a powerful and controllable alignment force can be created, **photo 12**.

Once one rail was straight the next had to be both parallel to it, and the correct centre distance away. This was achieved by setting the second rail just tightened down and using the mating cars as a gage. Again the use of countersunk SHCS allowed the necessary small, controlled adjustments.

As well as aligning the rails the lead screws also need to align to the motion - a diagonal lead screw will bend, as well as not actually traveling the expected distance. Alignment of the screws was carried out by referencing to the now set rails, using the screw to drive the nut along whilst carrying the DTI.

The rails for the X and Z-axis were aligned using a similar process. To setup the Z rails I first had to align the spindle mounting to the surface plate. To do this I set up the quill channel on the surface plate on a three-point support and adjusted it until parallel. Then I could use the surface plate as the reference for both side rails, which ensures that they are both straight and the same distance from the spindle.

During the alignment of the X rails I discovered the gantry was not actually flat - even though the weldment was hot rolled plate it is not precision ground, and it varied in thickness by around 0.05mm, **photo 13**.

The gantry assembly is too big to fit on my surface grinder, so I resorted to hand scraping the steel plate. This requires a modification to the normal scraper geometry, **photo 14**, and is a lot harder than scraping cast iron, but it is doable. A good video on this is here: youtu.be/FgxjiEBhKvM. As a bonus the finish on the surface looks nice.

Once each axis is straight then all that remains is to align the axes to be orthogonal to each other. The Y axis, as a single axis forms the basis for starting this process.

The XZ axis alignment for squareness was carried out as part of the building of the saddle / quill assembly, such that the only 'on machine' alignments needed were for the X axis to be set at a parallel height over the Y - forming the XY plane with its travels at right angles, and the Z axis to be trammed to the XY plane.

As part of the build I had made a reference square (a variation on this: www.conradhoffman.com/refsquare.htm) using a piece of 50x75 hot rolled box section. This was a very useful tool, but its short edge was not conducive to setting up to measure over travels, so I purchased a granite reference square.

The design has adjustments for XY plane and Z axis tram. These are threaded so that the axis can be assembled and then aligned before finally locking the positions.

ENCLOSURE AND STAND

Using small carbide cutters at high speed will create quite a mess - the swarf is like little needles, and I planned to use flood coolant to wash away the chips and prevent recutting - vital for extending the life of small cutters.

The enclosure and stand are built into a rolling tool chest unit, with the electronics cabinet hanging off the side, **photo 15**. I wanted to have dedicated storage for this mill, as well as the ability to move it around if needed (my garage is somewhat crowded).

I happened to have a large aluminium extrusion that I could use to reinforce the top level of the toolchest. This was bonded into place, and then I milled a shallow angle on a large piece of alloy plate. This sits under the base of the enclosure, and then the mill sits on top of it. The angle ensures that the coolant drains into the front channel effectively, washing the swarf to the front of the enclosure to aid cleanup.

The solid back plate of the mill's design meant that the enclosure only really needed to cover the sides and front area. A large sheet of DiBond (a composite of aluminium sheets around a polyethylene core) was partially routed through to produce square flanged corners, and the front doors are part of an Ex-Post Office counter screen. The glass is laminated and so should provide good protection against the inevitable flying debris which sometime results from machining.

The flood coolant tank lives on the bottom of the tool chest, with the pump control conveniently mounted on the opposite side to the controller screen, **photo 16**.

RESULTS AND FUTURE WORK

The finished mill works very well, with good surface finishes and will be a great addition to my toolroom. This watch case shaped object, **photo 17,** shows

Photo 16: The finished mill.

Photo 17: Watch case and CAD design.

the type of projects I am aiming for, now I just have to get to grips with the CAM side of things.

The design is capable of having the void spaces filled, which would increase the mass and damping of the structure. It doesn't currently seem to need this.

The enclosure, whilst it does contain the mess well, is not perfect. There is a small leak somewhere, and the doors fit a little too tightly. I would also like to add some lighting.

Setups are currently done with the traditional Rizla fag paper and a bit of careful jogging. The controller is capable of probing, so I should really learn how that works and make the probe unit.

Readers' Tips

We have £30 in gift vouchers courtesy of engineering suppliers Chester Machine Tools for each month's 'Top Tip'. Email your workshop tips to **neil.wyatt@kelsey.co.uk** marking them 'Readers Tips', and you could be a winner. Try to keep your tip to no more than 400 words and a picture or drawing. Don't forget to include your address! Every month we'll choose a winner for the *Tip of the Month* will win **£30 in gift vouchers from Chester Machine Tools.** Visit **www.chesterhobbystore.com** to plan how to spend yours!

HOLDING CUTTERS IN A LATHE

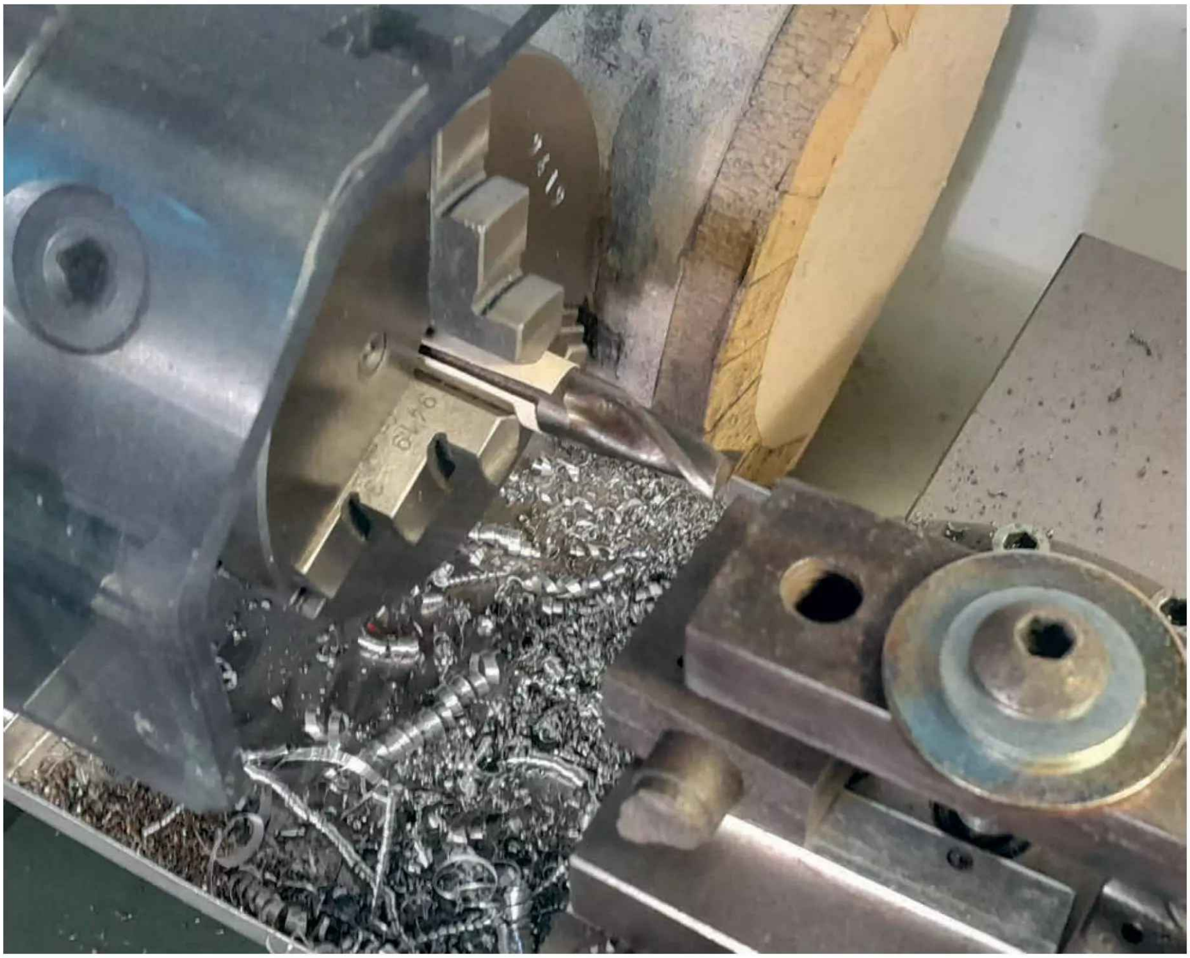
Our tip winner this month is Baz Butcher, whose say his tip is "an old one but maybe not everyone knows or just forgets".

If you try to grip a super hard endmill in the hard lathe chuck jaws to do some milling with the vertical slide it is likely to slip as there is no grip with hard smooth surfaces. Just wrap one turn of paper around the bit; however make sure it is not glossy paper that has less 'give' and not newspaper which has coarse fibres that might compress unevenly.

The plain brown envelope your tax demand comes in will do fine.

This also helps with drill bits in cheap keyless chucks. Pre-form the paper by rolling around a pencil.

The photos are of an endmill in a Hobbymat lathe flattening the side of a 10V valve chest casting and a flycutter machining the valve face of the cylinder. It shows a gap in paper to avoid double layer under any jaw. It also helps with flycutter where less care is needed to avoid scrunching the paper. I should have also put paper under the cylinder to add grip but got away with it.

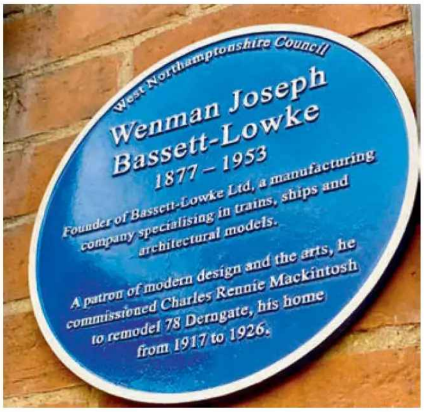


Please note that the first prize of Chester Vouchers is **only available to UK readers.** You can make multiple entries, but we reserve the right not to award repeat prizes to the same person in order to encourage new entrants. All prizes are at the discretion of the Editor.

On the Wire

News from the world of engineering

Blue Plaque celebrates pioneer Model Engineer



In March this year, 78 Derngate, Northampton received a 'Blue Plaque'. This plaque represents the importance of W.J. Bassett-Lowke's vision to use Charles Rennie Mackintosh to remodel his terrace house in Northampton. It also represents his life as a model engineer, businessman and champion of modern architecture and his involvement in developing the civic life of Northampton.

W.J. Bassett-Lowke started his world-wide business in 1898, his first advert was in the July issue of the newly established magazine *Model Engineer* and the help he received from his friendship with our founding Editor, Percival Marshall, helped the fledgling company on its way.

On the 21st of March a ribbon cutting ceremony was held on the doorsteps of 78 Derngate, with the ribbon being cut by Rob Kendall the Chairman of the Friends of 78 Derngate. Attending were volunteers and the committee of the Friends. We are thrilled to have this plaque located next to the iconic front door of 78 Derngate.

It has been a busy time recently for 78 Derngate, they now have Museum status, an extension to 82 Derngate has increased the gallery and shop space and land that was purchased at the rear of 82 has been planted up and looks lovely in the spring sunshine. The museum is open February to December – Tuesday to Sunday. See their website for opening times. www.78derngate.org.uk.

2026 Dreaming Spires Rally

The City of Oxford SME are holding their annual 'Dreaming Spires Rally' form the 24 to 26 of July this year at Cutteslow Park Miniature railway, which will be open for visiting engines throughout the weekend.

Tracks will be available from 12pm Friday until 4pm Sunday. These cover 7 ¼", 5" and 3 ½" gauges as well as a 16mm scale railway with 32mm and 45mm gauges. There are also hard pathways suitable for model road vehicles.

Facilities include free parking, secure overnight storage, steaming facilities and camping and caravan pitches.

To book or for further information contact Denis Mulford on 07850 062932 or denis.mulford@btinternet.com.

If your hobby includes any aspects of engineering, the **ME&W** will have much to interest you in its pages. Bigger than either of its predecessors it has the space to cover all aspects of model engineering from traditional live steam models to gas turbines, from clocks to toolmaking We look in depth at the skills you need to get the most out of your hobby: using maintaining and improving lathes, mills and other workshop machines such as 3D printers and CNC. We also cover the widest range of workshop activities – traditional ones like casting, brazing and welding to modern skills like using embedded electronics. Finally, we keep you up to date with what's happening in the world of hobby engineering with our event reports, news features and reviews.

Neil Wyatt

Editor

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The Rahmi M. Koç Museum of Istanbul.

The Van Osch Collection joins the Rahmi M. Koç Museum of Istanbul

Bruno Cianci updates us on the latest exciting developments at this remarkable museum of engineering in Türkiye.

Established in 1994, the Rahmi M. Koç Museum of Istanbul stands as a testament to the transformative power of the Industrial Revolution. Nestled along the historic shores of the Golden Horn, the museum is not merely a repository of 16,500 industrial-related artifacts (including hundreds of miniature engines, items of railwayana, full scale trains, steam tractors and the likes), but a sanctuary for the mechanical marvels that shaped the modern world.

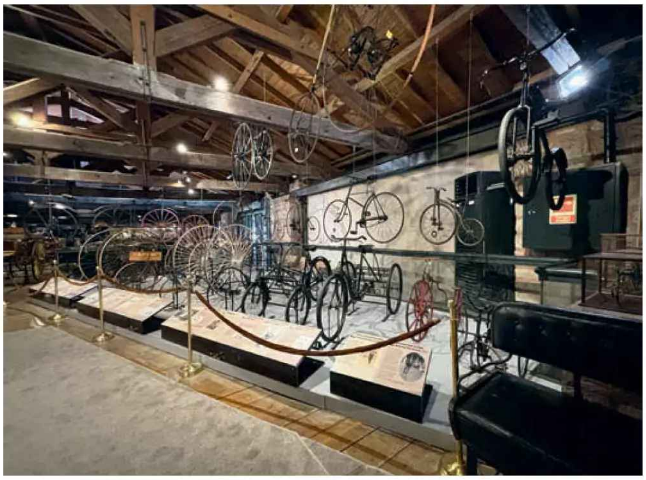
At the heart of this industrial cathedral lies a newly dedicated area, literally custom built over the last few months, featuring a remarkable acquisition: the Van Osch Collection from the Netherlands, integrated into a gallery – located in the so-called 'Tersane' ('Shipyard') —that celebrates the golden age of steam and stationary engineering.

THE VISION OF RAHMI M. KOÇ

The existence of this museum and its themed galleries is inextricably linked to the personal passion of Rahmi M. Koç, one of Turkey's most prominent industrialists and philanthropists. His fascination with 'how things work' has led to the curation of one of the world's finest technical collections. For Rahmi M. Koç (b. 1930), these machines are not just cold steel and iron: they are symbols of human hard work, ingenuity, and the rhythmic heartbeat of progress. His particular affection for the 'Age of Steam' is evident in the meticulous restoration of every piston, flywheel, and brass fitting on display. The atmosphere of the gallery is thick with this reverence—a blend of nostalgic elegance and the raw, oily scent of preserved machinery that transports visitors to a time when steam was the lifeblood of global industry.

THE VAN OSCH COLLECTION

The highlight of this recently opened gallery is the collection formerly housed at the Van Osch Museum in the Netherlands. These objects, acquired in 2024, represent some of the most sophisticated working scale models and stationary engines in existence.



Photos 1 & 2: A twenty-item collection, formerly owned by Mr. Daniel Ward, comprising: Johnson Hobby Horse (1818); Michaux Velocipede (1869); Xtra-Ordinary (1878); Sawyer Quadricycle (1851); Coventry Rotary (1884); Cheylesmore Style Tricycle (1881); Lloyd Quadrant Tandem Tricycle No.15 (1885); Starley Royal Salvo Tricycle (1881); Lloyd Brothers Quadrant Tricycle (1884); Front Steer tricycle (1895); Ladies' Tricycle (1895); Child's Tricyle (1880); Child's Trike (1880); Ariel ordinary Bicycle (1875); Kangaroo (1884); Singer Safety Bicycle (1886); Child's Ordinary (1880); Crypto FD Safety No.3 (Bantam, 1894); Transitional Velocipede (1875); American Star Bicycle (1889).

Photo 3: A wood and glass case containing, from right to left: ¼ full size working scale model of a 6HP general purpose agricultural traction engine built in 1901 by the company Charles Burrell & Sons at St. Nicholas Works in Thetford, England; ¼ full size working scale model of the last 7HP general purpose traction engine built by W.M. Allchin Ltd. Globe Works in 1922, Northampton, England.

Photo 4: This fairground organ, named *'Bartje'*, was produced in 2004 by the Netherlands-based company NBC. It combines the classic European fairground organ design with modern construction techniques. Operating through a mechanical system that imitates the multi-voiced sound of a real orchestra, it represents a contemporary example of traditional fairground culture. Used at fairs, amusement parks, and travelling entertainment venues to provide musical performance. Its powerful sound accompanies dancing, public entertainment, and helps create a festive atmosphere.

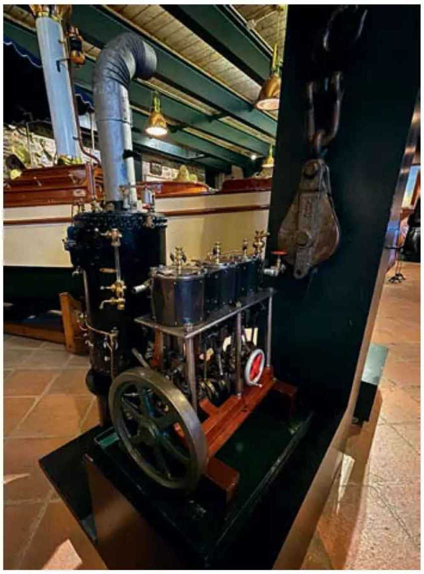


Photo 5: **Three-cylinder steam engine & vertical steam boiler, manufactured in Holland circa 1970-80.**

Photo 6: A wood and glass case with some examples of the exceptional models held by the museum.

Photo 7: Single cylinder steam pump with Scotch Crank (circa 1920).

Photo 8: Robey & Co., Lincoln, England (circa 1920). Output: 3-4HP, 200 rpm, weight: 600 kg. Robey's 'Globe Works' was said to be the first factory in the UK lit by electricity and an electrical plant supplied by Robey lit Lincoln Cathedral to celebrate both the Golden and Diamond Jubilees of Queen Victoria.

Central to the Van Osch legacy are two models of Charles Burrell & Sons engines, **photo 3**. Based in Thetford, England, Burrell was a world-renowned manufacturer of traction engines, known for their robustness and distinctive design. 'Sam' (Burrell Steam Locomotive Model No: 4092) is a magnificent 1/2 scale working model of a steam road locomotive. Built by the Van Osch Museum in 2014, it stands nearly two meters tall and captures the intricate complexity of its full-sized counterpart. 'Niek' (Burrell Steam Traction Engine Model No: 1856) is a 1/4 scale working model completed in 2008. It serves as a tribute to the 'showman's engines', and agricultural pullers that were once common sights on European country roads.

Another former Van Osch Collection masterpiece is the 'Isa', a 1/3 scale working model of a Marshall & Sons portable steam engine. The 'Isa' model, built in 1997, demonstrates the 'portable' nature of steam power—engines that could be towed to a site to power threshing machines or sawmills.

ECHOES OF THE FAIR-GROUND: THE 'BARTJE' ORGAN

Beyond pure industrial utility, the gallery captures the cultural spirit of the era with the 'Bartje' Fairground Organ, the 'soundtracks' of 19th and early 20th-century entertainment. Produced in 2004 by the Dutch company NBC, this very piece is a contemporary marvel manufactured using traditional techniques. On weekend days the visitors of the Rahmi M Koç Museum (which exceed 400,000 per year) are given the chance to listen to a playlist of 13 songs. 'Bartje' uses a mechanical system to mimic a full orchestra, designed to create a festive atmosphere in amusement parks. Standing 3.5 meters high, its presence in the gallery provides a whimsical counterpoint to the more sombre agricultural engines.

MASTERY IN MINIATURE

The gallery also features an array of stationary engines and instructional models that highlight various engineering philosophies across Europe and the United States. Among these are items produced

Photo 9: **Single cylinder steam engine manufactured in Holland between 1970-1980. It was produced to demonstrate the working principles of single-cylinder steam engines.**

Photo 10: Petters Limited, Yeovil, England (circa 1930); stationary engine (petrol or oil-fuelled), 1.5HP, 750 rpm. Application: water pump, generator or light industrial drive. This 1.5HP engine is renowned for its durability and reliability. It has been commonly used from the early to middle of the 20th century.

Photo 11: 2-Stroke 'M' type stationary engine (petrol or oil-fuelled) by Petters Limited, Yeovil (circa 1936), 5HP, 600 rpm.

by international engineering giants such as Ladislav Benz, a premier manufacturer in Brno, Petters Limited, a major British engine manufacturer based in Yeovil, and the U.S.-based Amanco. The Ladislav Benz on display is a 6HP stationary engine from 1948 (Serial No: B39) representing the pinnacle of post-war agricultural support. The gallery displays the Petter 'Universal', produced around 1930 and affectionately known as the 'Apple Top' due to its spherical water hopper. Amanco is represented by a 1916 'Chore Boy' style engine from the Associated Manufacturers Company of Iowa. These 'hit-and-miss' engines were the workhorses of American farms, used for everything from pumping water to grinding grain.

ATMOSPHERE AND SIGNIFICANCE

Walking through this area of the Rahmi M. Koç Museum is a sensory journey. The 'A-frame' beam engine models (circa 1840) with their Watt-type regulators stand in silent elegance, while the triple expansion marine engine models hint at the massive power required to cross oceans.

The gallery, and the museum as a whole, succeeds in making engineering techniques accessible. For instance, the model Fowell-Box Patent Engine, which won a Gold Medal in London in 1999, was built by Brian Hutchings from old photographs and measurements, proving that the art of model engineering is a form of historical preservation in itself.

Last but not least, the gallery utilizes wall space to display unique pieces like the Otto Lilienthal wall-mounted steam pump model (circa 1882). Lilienthal, though famous for his pioneering work in aviation, was also an accomplished engineer of small steam engines. Beside it sits a 1916 model of a Witte Engine Works gas engine, illustrating the transition from steam to internal combustion.

AN INSPIRING VENUE

The Rahmi M. Koç Museum's dedication to these collections ensures that the genius of the 19th and 20th centuries is not forgotten. The integration of the Van Osch collection brings a specific Dutch flair for precision and model-making to Istanbul, building another bridge between European industrial

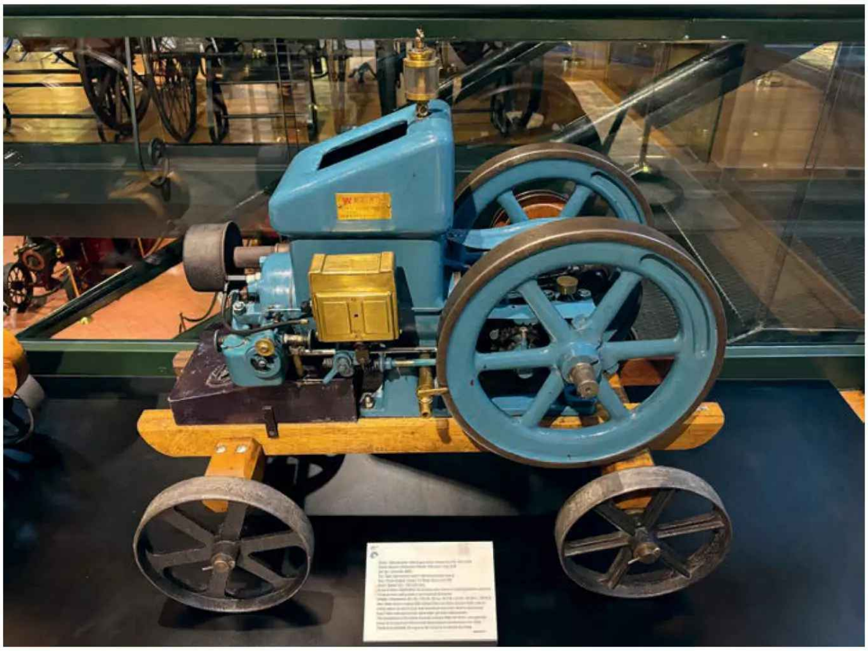


Photo 12: Witte Engine Works, Kansas City, MO (circa 1938); Internal combustion engine, 3-5HP; 850-1200 rpm. Application: pumping water, cutting wood or running small generators.

Photo 13: Langensiepen & Co., Magdeburg, Germany (circa 1898) Diesel engine. During the day this machine powered a mill in a factory, and when the factory closed in the evening, the flat drive belt was placed around the pulley of a generator to illuminate the houses next to the factory itself.

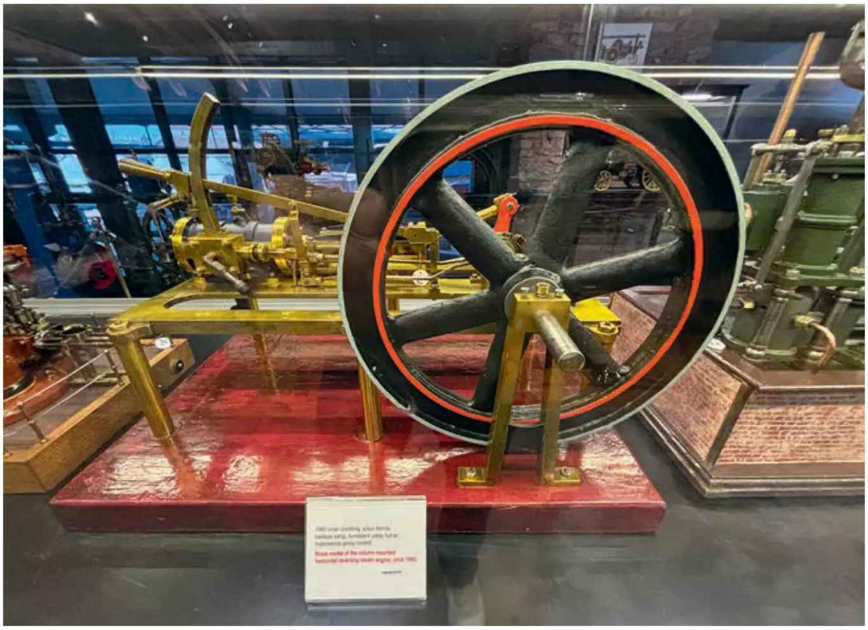


Photo 14: Brass model of a column mounted horizontal reversing steam engine, circa 1880.

heritages. Under the watchful eye and patronage of Rahmi M. Koç, these items continue to educate and inspire, reminding every visitor that the foundations of our digital world were laid in iron, brass, and steam.

You may find out more about the museum at www.rmk-museum.org.tr.

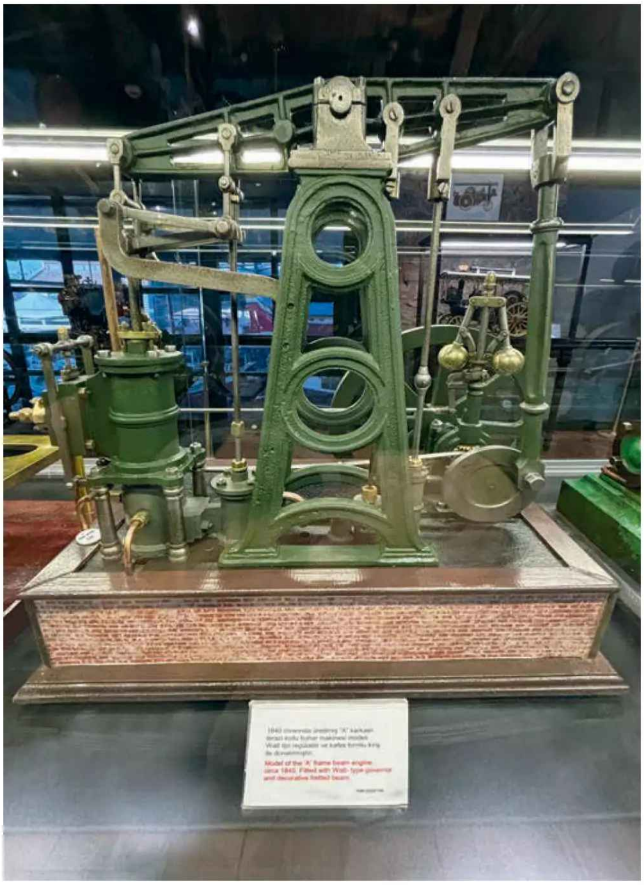


Photo 15: Model of the 'A' frame beam engine (circa 1840). Fitted with Watt-type governor and decorative fretted beam.

Photo 16: 2 HK 2002-Stroke-Cycle, 2-Cylinder, Opposed- Piston Diesel Engine manufactured by Junkers Motorenbau GMBH, Dessau, Germany (1928). 185HP, 4300 cc, 300 rpm.

Fourunner

Steven Foulton describes his father, David Foulton's, experiments with an unusual model steam engine.

The article *Optimising the Oscillator* by Mr. David Fulton, which appeared in *Model Engineer* issue No. 4713, (24th March 2023) led to some enquiries regarding his four-cylinder engine, *Fourunner*, pictured on page 431. I'm sad to say that Mr. Fulton, my father, **photo 1,** died before the article was published. It seems a pity, though, to let his unusual designs go forgotten when they may well hold some interest. This is why I wanted to write about his models, but since I'm no engineer I apologise if my explanations are fairly basic.

Among many papers stuffed in a filing cabinet in my father's study were his technical notes and drawings. To see them, along with his workshop photographs, please scan the QR code shown nearby. This will take you to a folder with all the files and photo references on the featured engine. Please bear in mind that some dimensions given in his notes do not correspond to the finished model! The figures provided in the 'Fourunner Dimensions' PDF, which you will find in the 'Documents' folder are as measured from the engine.

ENGINEERING BACKGROUND

David Fulton was the archetypical engineer with professorial balding head and Fred Dibnah style oily flat cap. There was always a Mickey Mouse mug of tea on the work bench with many an iron filing or lathe swarf to be found in the bottom of it.

He would never have written about himself, but here's just a little. He was born in Newcastle-Upon-Tyne in Northeast England, at a place called Newburn, in 1935. In 1957 he gained an engineering apprenticeship at the engine workshop of Swan Hunter's shipbuilding yard on the river Tyne. After that, he went to sea for a few years as a merchant marine engineer and quickly got used to the weevils in his porridge.

Returning home in the sixties, he became a writer of technical publications for the crane manufacturer, Coles Cranes. In the mid-seventies David was a salesman for *Encyclopaedia Britannica*, but in 1977 he opened a second-hand tool shop and ran this business until he retired in 2006. (Occasionally he had a tool stand at Doncaster and Harrogate model engineer exhibitions).

David also had an interest in cine films and projectors (collecting mainly Disney animation), and from time-to-time he would invite families over for a 'film show'. He enjoyed jigsaw puzzles and making paper model cut-outs. Religiously, though, he was one of Jehovah's Witnesses. So, at the ripe old age of 87, he'd wander the High Street surprising passers-by with a word or two about the Kingdom of God. His wife died in 1988, and he remained a widower until his death in November 2022.

Photo 1: David and Steven.

Photo 2: The original Fourunner (end plate removed) incorporated a rudimentary reversing mechanism.

FORWARD ONLY

First, let me explain that David's initial Fourunner design was for two-way running. The inlet passages in the port block supplied steam to *both* fixed ports, with only a 'uniflow' slot in the cylinder wall at the bottom of the stroke for exhaust. (This is different from **fig. 1**, which has only one inlet port per cylinder, the other being an exhaust) Using thin plates between the cylinders and port block he could close off one port and open another, thereby altering the engine's running direction. David had them swinging on the pivots and were adjustable using small turnbuckles and levers attached to the top of the block, see **photos 2** and **3**.

Here is his own description of Fourunner: "This is an interesting engine to watch in motion, the four cylinders bobbing in sequence, to the sound of a pleasant purr from the exhaust. Speeds are adjustable with a proper regulator from tick-over to 2,000 rpm." This was described fully in David's article, *Steam Regulator* in *Model Engineer* issue 4666, 4-17 June, 2021, and provides graduated control.

"The original concept was for a reversing engine using moveable plate valves in conjunction with a simple

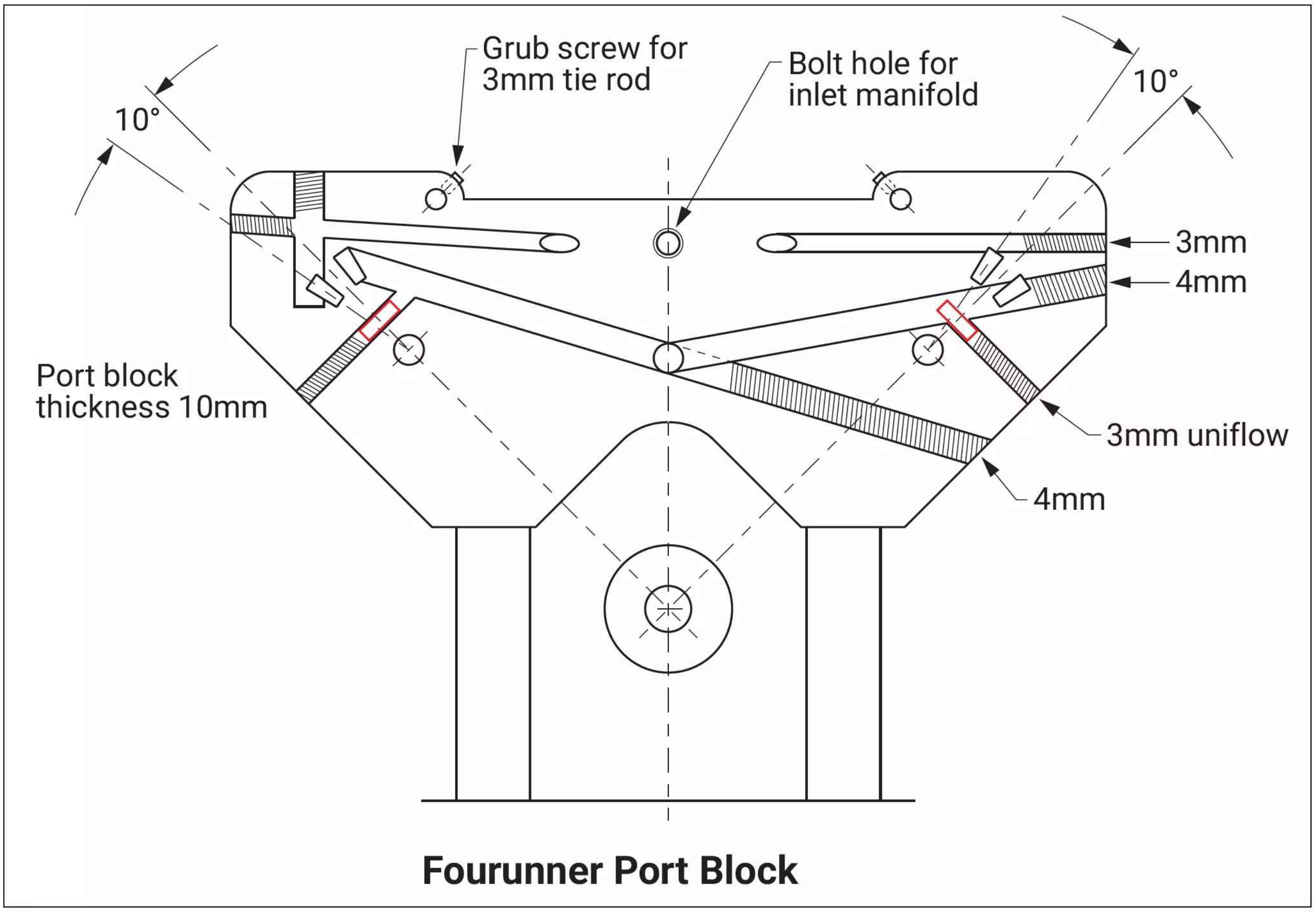


Fig. 1 Port block template No.2 (without reverse) showing a labyrinth of internal passages. These are drilled from the edge and then sealed off with a bolt. Inlet and exhaust port positions are the same on both sides of the block.

uniflow exhaust. This worked, but back pressure on the exhaust stroke was such that efficiency was significantly reduced. Conversion to 'forward only' solved the problem but required an awkward-looking route to one of the inlet passages."

Here, David means that the far-left port in fig. 1 required two drillings (from the side and top) to make the supply passage reach it. "However," he continues, "running is unaffected by this and torque is remarkably good, especially at faster speeds. Also, ports don't have to be spaced equally each side of the centre-line as they must in a reversing engine."

PRINCIPAL DEPARTURES

"Oscillating engines are nothing new, including four-cylinder ones. They have been around for a long time, ranging in size from those which drove the giant paddle wheels of I. K. Brunel's *Great Eastern* to Mamod engines and similar steam toys. What this design has to offer is a few features aimed at increasing efficiency, plus a wider range of speeds and a different kind of appearance. The principal departures from usual practice are:

1. Offset big ends allow the cylinders to be opposite one another rather than staggered, reducing overall length.
2. Guides on the piston rods take the oscillating load rather than the pistons themselves, reducing piston/cylinder wear.
3. Trunnions on both sides of the cylinders. This avoids the usual cylinder overhang that can permit cylinders to tilt under load, with consequent wear on pivots and steam leakage.
4. No pipework. All passages are internal and short in length.
5. Independent adjustment of contact pressure at the interface between cylinder and fixed ports. Adjustable while running, optimum balance can be set for friction commensurate with steam tightness.
6. Narrow profile inlet ports permitting adequate steam admission without the often wasteful steam events of wider ports.

"Oscillating engines have the advantage of simple mechanical working. Operation of inlet and exhaust is controlled by the swing of the crankshaft, hence no need for crossheads, eccentrics or slide valves. There is a small penalty with this simplicity, in that port timing is non-adjustable while running.

"Despite the above limitation the oscillator works well and is considerably less complicated than most fixed-cylinder engines."

Photo 3: Types of moveable port plates. The right plate (with one aperture) was for two-way running with an earlier design of port block. The plate on the left is for one-way running to establish optimum port positions.

Photo 4: Port block, side A.

PORTING

David's engine still incorporates port plates, but ones which are fixed—screwed onto the port block with a gasket in between, **photo 4 and 5**. The use of a plate is convenient in that if a mistake is made either in the size of a port or its position, the entire port block does not have to be re-made. With regard to his use of moveable ones, he explains:

"Experiments with various adjustable port plates have established what seem to be optimum inlet and exhaust angles, as well as port widths that give maximum steam/air efficiency (for which I make sincere apology to such undeniable experts of engineering design as the late K. N. Harris). But these are not necessary unless the builder wants to conduct his own experiments."

Here, David is referring to Harris' book *Model Stationary and Marine Steam Engines*, (chapter 1, page 8, second edition, 1964, ISBN 0–85344–072–7). Harris says that the area of the cylinder port should be one third of the area on the port block swept by the cylinder.

In his article David argued that in a non-reversing engine the fixed port openings do not have to be the same size, nor, as mentioned previously, do they have to be equidistant from the cylinder oscillation centreline. He wrote that it is better to have wider exhaust ports in relation to the inlet. Obviously steam/air crossover must be avoided, hence Fourunner's ports have wedge shaped, narrow openings. Harris agrees that ports should, to quote, "have *straight* sides so as to obtain a quick and complete opening to steam and exhaust," (whereas in most model engines they are round). The accompanying sketch on page 8 in his book shows a wedge-shaped area.

Having conducted several experiments on Fourunner, David concluded, "Best running was obtained with inlet ports close to the centreline". Fourunner's cylinder ports are 2.5mm wide (at the top end of the wedge) by 5mm long. The fixed exhaust ports are slightly wider (2.8mm), while the inlets are very narrow, only 1.6mm (approx. 1/16") by 5mm. This is another break with convention, which has it that fixed ports should be larger than moving ones.

Despite his alterations, David retained Fourunner's uniflow exhaust. Harris comments on the advantage of such a port. He says, "A number of experiments I made some years ago indicate that this auxiliary exhaust port very definitely serves to pep up the engine performance at high speeds, whilst at the same time it adds no moving parts whatever." (Harris explains the reason for this efficiency in chapter 8, page 47).

However, David's uniflow design may raise a few eyebrows. His port block shows two 3mm passages drilled from the edges, which connect the uniflow slots (fig. 1, shown in red) to the main 4mm exhaust passage. Since one passage must serve two cylinders, exhausted steam (or air) will pass straight through to the other cylinder on the opposite side the block, where it will emerge out of the piston guide vents. This makes it appear that supply steam is leaking from between the moving faces when, in fact, it is simply exhaust vapour. I'm not sure if this arrangement was intentional because it seems to negate the benefits of a uniflow system which, as Harris outlines in his book, is designed to avoid heat loss in cylinder walls from cooled steam.

Photo 5: Port block, side B.

Photo 6: Assembled crankshaft.

CRANKSHAFT CONUNDRUMS

On a notepad headed *The Cranky Crankshaft* David wrote, "Aside from machining out of the solid, there are three ways to fabricate a crankshaft: a) Loctite and pin it, b) force fit the components, c) silver solder the whole thing. Sadly, each of these has its own problems. In the case of (a) there is a high probability that the air gap needed for retaining compound to penetrate the joint will produce an out-of-line result. Further, experience has shown that the strength of such a Loctite joint can be hugely variable no matter how much care is taken.

Force fitting is most likely to give a true running shaft. The problem is that nearly all ground steel rod is undersize; hence a force fit cannot be obtained in a reamed hole of the same nominal diameter. The solution — to turn one's own crankpins and journals 1 ½" thou oversize and achieve the accuracy and surface finish of ground stock — is asking a lot of a garage workshop model engineer. Besides this, pressing together a multiple-throw crankshaft is a fearsome jigging operation.

Silver soldering will give an extremely rigid job that won't come apart but presents the same problem as Loctite; leave enough space for the solder to penetrate and you'll have a strong but wobbly shaft."

David went with the first option. But as he says, building it from bits and pieces makes it difficult to avoid misalignments. He found, for example, that the faces of the webs were not truly square with the holes. So, to ensure straight drilling and correct alignment on centres (9mm apart) he drilled the webs together as a pack of four on the milling machine table. Since two of the webs have a larger diameter hole, he used a packing piece in the middle of this sandwich and drilled the larger hole last.

The centre section of the shaft has a diameter of 11mm. This is drilled through to accept a ¼" bar, 5 ¼" long, which can later be cut away between the webs, leaving the ends for journals. The centre piece has ends turned down to 5/16" which are retained into the central webs using Loctite 638.

First, the drillings in the webs are checked for accuracy by placing them in the lathe with a length of ¼" bar fitted into the hole. The bar will exaggerate any deviation from trueness, which is measured by a height gauge placed on the lathe bed.

The rest of the crankshaft is assembled with Loctite and clamped between two vee blocks, checking for correct alignment with a dial gauge. The result is shown in **photo 6**. David wrote, "A solution may be to make all the webs the same width, closing the vice on four webs simultaneously during assembly." This is possible because the crankshaft offset is 180°. Of course, it would require accurate machining of the edges in relation to the shaft holes. After curing, the joints were drilled to secure them with taper pins.

Next time I will commence with a description of the pistons and cylinders.

To be continued

Club Diary

Please send your events for Club Diary to meweditor@mortons.co.uk

2026

EVERY SUNDAY

Urmston & District MES
Public Running every Sunday Contact: secretary@udmes.co.uk

Warrington MES
Running day. Contact : contact@wdmes.org.uk

Wakefield SMEE.
Public running day. Contact Denis Halstead 01924 457690

APRIL

18 Brighton & Hove SM&LE
Hove Park Railway public open day. www.hovepark.com

19 Stafford & District MES
Steam up, County Showground, Stafford, 10:00 am. See www.sdmes.co.uk or Facebook.

19 Bradford Model Engineering Society
Public running day. Members from 11:30 am, public from 1:30 pm to 16:00, whatever the weather, Northcliff. Contact: Russ Coppin, 07815 048999.

26 Worthing & District SME
Public running day, Field Place. 1:30-4:30. www.worthingmodelengineers.co.uk.

MAY

3, 4, 24, 25 Bristol SMEE
Public Running day, Ashton.

4, 25 Brighton & Hove SM&LE
Hove Park Railway public open day. www.hovepark.com

6 Leeds SMEE
Jack Salter - What I Did last Summer. Darrington Golf Club, 7pm.

9 Bromsgrove SME
Bromsgrove SME will be hosting the Polly Rally. Contact Richard Taylor 01905 779688.

10, 24 Worthing & District SME
Public running day, Field Place. 1:30-4:30. www.worthingmodelengineers.co.uk.

17 Bradford Model Engineering Society
Public running day. Members from 11:30 am, public from 1:30 pm to 16:00, whatever the weather, Northcliff. Contact: Russ Coppin, 07815 048999.

23-24 Bradford Model Engineering Society
Event at Bradford Industrial Museum

JUNE

5-7 Cardiff Model Engineering Society
34th Welsh Locomotive Rally Heath Park, rally@cardiffmes.com.

6, 20 Brighton & Hove SM&LE
Hove Park Railway public open day. www.hovepark.com

7, 14, 28 Bristol SMEE
Public Running day, Ashton.

10 Saint Albans and District MES.
Puffing Field, depending on weather. Alternate July

13-14 Rugby Model Engineering Society.
Sweet Pea Rally, To be held at Rainsbrook Valley Railway.

14, 28 Worthing & District SME
Public running day, Field Place. 1:30-4:30. www.worthingmodelengineers.co.uk.

20-21 South Cheshire Model Engineering Society
LittleLEC annual locomotive efficiency competition, Willaston, near Nantwich. littleLEC@gmes.org.uk.

21 Bradford Model Engineering Society
Public running day. Members from 11:30 am, public from 1:30 pm to 16:00, whatever the weather, Northcliff. Contact: Russ Coppin, 07815 048999.

JULY

4 Bromsgrove SME
Bromsgrove SME will be hosting a Moden Traction Open Day. All gauges welcome 5", 3.5", 2.5", Gauge 1 and 16mm. Contact Doug Collins 07585 524836.

4, 18 Brighton & Hove SM&LE
Hove Park Railway public open day. www.hovepark.com

5, 26 Bristol SMEE
Public Running day, Ashton.

12, 26 Worthing & District SME
Public running day, Field Place. 1:30-4:30. www.worthingmodelengineers.co.uk.

24-26 City of Oxford SMEE
Dreaming Spires Rally at Cutteslowe Park Miniature Railway. Open for visiting engines throughout the weekend. Contact 07850 062932 or denis.mulford@btinternet.com to book or for further information.

8 Saint Albans and District MES.
Puffing Field, depending on weather. Alternate July.

18 Nottingham SMEE
Miniature Diesel Locomotive Gala. For enthusiasts of both battery and petrol-powered diesel locomotive models in 7¼, 5-inch and 3½-inch gauge. You must book in advance with Rob Buxton – buxton845@gmail.co.uk or 07837 272650.

19 Gauge 1 North
Live steam on the Ridings track, traders and society stands North, Agriculture and Business Centre, Bakewell. Contact: secretary@gauge1north.org.uk

19 Bradford Model Engineering Society
Public running day. Members from 11:30 am, public from 1:30 pm to 16:00, whatever the weather, Northcliff. Contact: Russ Coppin, 07815 048999.

AUGUST

1, 15, 31 Brighton & Hove SM&LE
Hove Park Railway public open day. www.hovepark.com

2, 30, 31 Bristol SMEE
Public Running day, Ashton.

16 Bradford Model Engineering Society
Public running day. Members from 11:30 am, public from 1:30 pm to 16:00, whatever the weather, Northcliff. Contact: Russ Coppin, 07815 048999.

SEPTEMBER

5 Bromsgrove SME
Bromsgrove SME will be hosting the Rob Roy Rally plus other 3.5" friends all welcome. Contact Doug Collins 07585 524836.

12, 26 Brighton & Hove SM&LE
Hove Park Railway public open day. www.hovepark.com

13 Bradford Model Engineering Society
Public running day. Members from 11:30 am, public from 1:30 pm to 16:00, whatever the weather, Northcliff. Contact: Russ Coppin, 07815 048999.

13, 20 Bristol SMEE
Public Running day, Ashton.

26-27 St Albans and District Model Engineering Society
The BIG St Albans Model Show.

OCTOBER

3 (TBC) Bradford Model Engineering Society
Visitors Day. BMES welcomes members and their locomotives from other societies to Northcliff for breakfast & lunchtime butties. Let Russell know in advance, please: Russ Coppin, 07815 048999.

10, 24 Brighton & Hove SM&LE
Hove Park Railway public open day. www.hovepark.com

Vibration, Sound and Noise

Rhys Owen concludes his exploration of the phenomenon of 'vibration' and turns to the application of the mathematics to some practical issues.

PART 3

The phenomena of resonance and the coincidence effect lowering the sound reduction index, mentioned in the previous issue, are illustrated in **fig. 11.**

Even a small aperture in the insulating partition will mar the insulation performance of that partition. For example, some years ago, following building works in a school, a sound insulation test found that the insulation performance of the wall separating two classrooms was inadequate. Lifting the ceiling tiles showed a pipe that passed through a hole in the common wall. Closer inspection showed that there was no caulking around the pipe so that sound could freely pass from one room to the other via the spaces above the ceilings and the – quite small – uncaulked gap, **fig. 12**.

A small aperture has a big effect!

This is a classic example of what is called 'flanking transmission', that is, transmission of sound energy around an insulating partition. This may occur via open windows and via the spaces between doors and floors.

By now you may be wondering how the insulation provided by a partition can be tested.

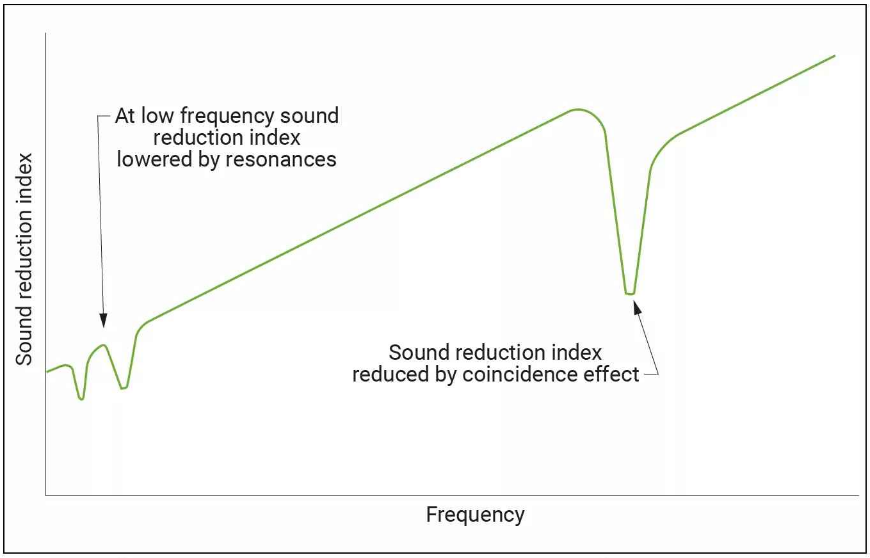


Figure 11 Sound reduction index plotted against frequency

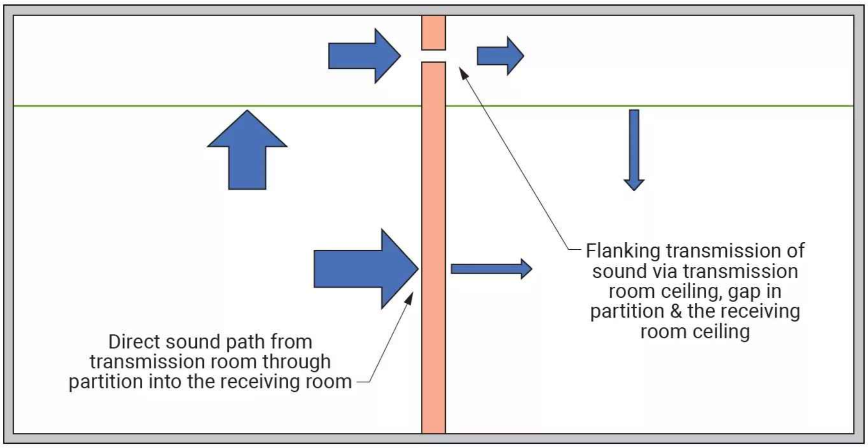


Figure 12 Example of flanking transmission

SOUND INSULATION TEST

A sound insulation test of the insulation provided by a partition requires the use of a sound source (this is a special loudspeaker) and a sound level meter.

The sound source is designed to emit a constant sound power over a broad spectrum of frequencies. Frequently it is shaped like a dodecahedron so that the sound field it forms in a room is as diffuse as possible. Note that the sound source has to be very loud to minimise the effect that extraneous noises will have on the test. It is also essential to ensure that there are no flanking paths of noise transmission such as open windows. A typical sound source is shown in **photo 1**.

The principle of the test is that the sound pressure level in the room with the sound source operating within it is measured either with the sound level meter located in a number of different positions or with measurements taken in 'sweeps' around the room. The aim is to establish a value for the sound pressure level in the 'source room'. Ear protection must be worn!

With the sound source still operating in the source room, the sound level meter is taken to the 'receiving room' on the other side of the partition and the sound pressure level is measured there in the same manner.

When the sound source is not operating, measurements must also be taken of the background sound pressure levels in the receiving room to ensure that the levels measured in that room during the test are not affected by the background noise or, if these levels are high, to allow for the measured levels to be corrected to take account of the background

Sound source. Photo: Antonio Taddei.

levels (this precaution is not usually necessary in the source room as the sound source noise is very loud).

It is now possible to determine the level difference between the two rooms. However, the level difference between the sound pressure levels in the two rooms is not the end of the story because the amount of sound energy absorbed by the receiving room will affect the sound pressure level that is measured within it. Accordingly, the sound source is transferred to the receiving room, switched on so that a diffuse sound field is established in that room and then switched off. During this procedure the sound pressure level in the receiving room is measured to establish the length of time it takes for the sound pressure level to fall by 60 dB (extrapolation may be necessary if a complete fall of 60 dB cannot be achieved). This time is called the Reverberation Time and, as we shall see, it is a good indicator of the amount of sound energy that the receiving room absorbs. **Photograph 2** shows an acoustician measuring the reverberation time within a corridor.

Calculations using these reverberation times allow the level differences at each frequency band (usually octave bands) to be normalised so that the sound reduction established may be determined as a property of the partition rather than as a simple level difference (although this assumes that any flanking transmission around the partition is negligible).

Sound reduction indices thus established (preferably under laboratory conditions) can be used to predict sound pressure levels. For example, if it is required to predict the sound contribution within a room adjoining another room with a noisy machine within it then this can be done if the performance of the partition can be determined.

While on the subject of room absorption, it is worth pointing out that when a sound source is in a room or other enclosed space then the sound pressure level that is measured (or the sound that is heard) consists partly of sound that is transmitted directly from the source to the receiver and partly of sound reflected from the surfaces of that room or enclosed space. In other words, at any given point in the room the sound pressure level is composed of a component of direct sound and a component of reverberant sound. Clearly, at a point close to the source the dominant component will be direct sound and at the boundaries of the space the dominant component will be reverberant sound.

Reverberation time measurement. Photo: Antonio Taddei.

NOISE BARRIERS

In certain situations sound propagation can be controlled by noise barriers and examples of these can be found close to roads and railways. The attenuation provided by a barrier is determined by the sound frequency and the path difference between the direct path (source to receiver) and the indirect path (source to top of barrier plus the distance from the top of the barrier to the receiver). Provided that the receiver is in the shadow zone of the barrier (i.e. it cannot be seen from the source position) then the greater the path difference, the greater the attenuation provided by the barrier. However, this depends on the frequency of the sound (low frequency sound waves go round corners more easily than high frequency waves). Moreover, it is important that the barrier provides sufficient insulation so that the contribution of sound passing through the barrier itself is negligible!

The following illustrations show how the path difference is established (the calculations of this are a good example of Pythagoras' theorem being put to practical use!). **Figure 13** is the case where the receiver is in the shadow zone of the barrier (i.e. there is no line of sight between source and receiver). The case in **fig. 14** is where the receiver is in the illuminated zone of the barrier (i.e. there is a line of sight between source and receiver).

Provided that the sound energy transmitted through the barrier is negligible, the attenuation provided by the barrier may be established using the difference between the direct and the indirect paths.

Low frequency noise is less attenuated by a barrier than is the case for high frequency noise.

Even where the receiver is in the illuminated zone there will still be some attenuation (because the barrier will still obstruct part of the wavefront's propagation).

ISOLATION

We have already dealt with isolation with respect to the transmission of vibration energy. Since sound is a form of vibration, isolation is one means of preventing its transmission so we should avoid having connections between, say, the two leaves of

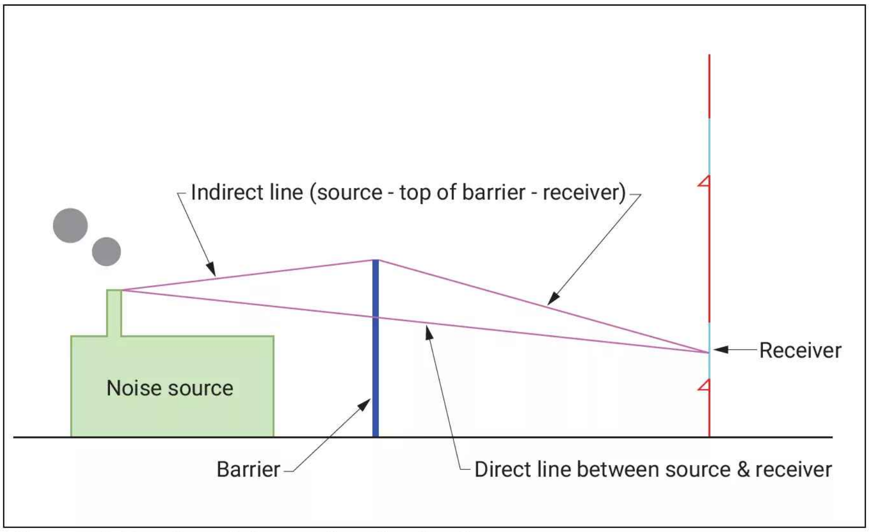


Figure 13 Barrier with receiver in shadow zone

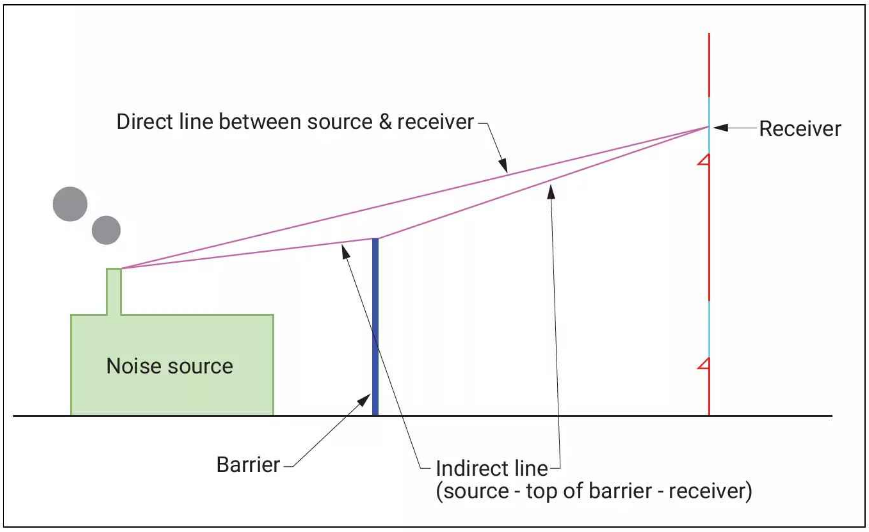


Figure 14 Barrier with receiver in illuminated zone

a double wall. If a connection is unavoidable, we should make the connection out of resilient material. This is why pipes and ducts are often connected using resilient materials.

ABSORPTION

When a sound wave impinges on a surface such as a wall some of its energy will be reflected back and the remaining energy will be absorbed by the material. Air conditioning system silencers typically incorporate large amounts of absorptive material to remove sound energy from the air flow. However, the selection of such silencers must be made with care as the silencer may itself cause noise because of turbulence within it or because it makes the air handling equipment work harder (and more noisily).

Here is an example that concerns absorption:

EXAMPLE 3

Before the staff and students walk into a new school a whole army of engineers will have contributed to that school's design. For example, structural engineers ensure that the roof will stay up, building services engineers design the heating and ventilation systems, electrical engineers design the power system and so on.

This army of engineers includes acousticians who look at the noise issues affecting the school. These include:

- sound transfer between rooms (e.g. the voice of a teacher in one room disturbing the lesson in another room);
- sound transfer from outside sources (e.g. road traffic) to the inside of the school;
- noise from building services both inside and outside (e.g. noise from air conditioning);
- confidentiality (e.g. ensuring that a conversation in the head teacher's office is not intelligible in an adjoining room), and;
- room reverberation times (loosely, this means how echoey the room is).

Let's look at the last of these. The reverberation time of a room is the time required for a sound in that room to reduce by 60 decibels. If the reverberation time is too short, the room will sound 'dead'. On the other hand, where the room has many hard surfaces the sound waves 'bounce around' more and this increases the reverberation time. If the reverberation time is too long it becomes difficult for a student to understand what the teacher is saying.

On television, when people are being interviewed when they are at home, sometimes their voices cause annoyance because they are speaking in a small room with many hard surfaces - surfaces that reflect, rather than absorb, sound waves. Once I attended what would have been an interesting lecture that was spoiled because the room in which it was given was full of hard surfaces and it required intense concentration to understand the speaker because 'reflected words' could be heard at the same time as 'direct words' (if you see what I mean!).

Where a room is furnished with absorbent materials the reverberation is decreased because these materials absorb more of the sound waves' energy so that the sound waves reverberate (bounce around) less.

There are two ways we can establish the reverberation time of a classroom:

- If the classroom is already built, we can measure the sound directly using a sound source and a sound level meter. The sound source is usually a special loudspeaker (as is used for a sound insulation test) but firing a starting pistol or bursting a balloon can also create the necessary sound (persons doing this work must use ear protection!).
- We can calculate the reverberation time using a formula. The formula uses the room dimensions and takes account of what the walls, floor and furniture are made of.

When an acoustician examines the design or layout of a room, he or she usually refers to official guidelines. In the UK the relevant document is Building Bulletin 93 *Acoustic Design of Schools: Performance Standards* (BB93). Depending on the use to which the room will be put, BB93 recommends a suitable reverberation time. For a new classroom BB93 recommends a reverberation time of less than or equal to 0.6 seconds for frequencies around 1000Hz. There is a little more to it than this, but for simplicity we shall look only at the 1000Hz frequency.

Every sort of material found in a classroom absorbs sound to a certain extent. These materials will have been measured in a laboratory, and these laboratory measurements establish the proportion of each wave's energy that is absorbed at each reflection or 'bounce'. This proportion is the material's absorption coefficient. The absorption coefficient of an open window is 1, because an open window does not reflect noise back into a room but absorbs all the acoustic energy of a sound wave. If the absorption coefficient of the material is 0.1 this means that when a sound wave hits the material only one-tenth of the wave's energy is absorbed. The other nine-tenths are reflected back into the room.

So, if we have a very reverberant room, adding more absorbent materials such as soft fabrics within it will decrease the reverberation.

For example, swimming pools are full of hard surfaces such as tiles. Moreover, the surface of the water in the pool reflects sound waves so is also acoustically 'hard'. When people make a lot of noise in the pool these surfaces reflect the sound waves and make the acoustic environment annoying. One solution is to hang acoustic baffles from the ceiling to absorb sound and reduce the reverberation time. This solution is also used in some concert halls, notably London's Albert Hall.

Over a century ago Professor Wallace Clement Sabine of Harvard University was asked to improve the acoustics of a lecture theatre. After some experimentation he derived the following mathematical formula, which is still used today:

$$T = 0.161\frac{V}{A}$$

In the above equation:

- T is the reverberation time (in seconds);
- V is the volume of the room (in cubic metres);
- A is the absorptive area of the room (in Sabins).

The Sabin unit is named after Professor Sabine. One Sabin is the absorption provided by one square metre of perfectly absorptive surface

So, 10 square metres of material that has an absorption coefficient of 0.1 has an absorption A of (10 x 0.1=) 1 Sabin. In mathematical terms:

$$Acoustic\ absorption\ of\ element = S_1 \propto_1 = 10 \times 0.1 = 1\ Sabin$$

We establish the total absorption of the room by looking at all the elements making up the room and applying the following formula to calculate the absorptive area of the whole room:

$$A = S_1\alpha_1 + S_2\alpha_2 + \cdots + S_n\alpha_n$$

Where:

- A is the absorption area of the room.
- S_i is the area of a building element.
- α_i is that element's absorption coefficient.
- n is the number of surfaces making up the total surface A.

So, if we have the necessary data, we can calculate the reverberation time of the room using Professor Sabine's formula.

Suppose we have a classroom that has a length of 8m, a breadth of 7m and a height of 4m. The volume V is:

$$V = lbh = 8 \times 7 \times 4 = 224m^3$$

Here are the details of the surface materials, areas and absorption coefficients:

From the above, the absorptive area of the room is **13.76** Sabins.

We now have both the volume ($V = 224m^3$) and the absorptive area (A = 13.76 Sabins).

These values are put into Sabine's equation:

$$T = 0.161\frac{V}{A}$$

$$= 0.161 \times \frac{224}{13.76}$$

$$= 2.71\ seconds$$

Clearly the BB93 criterion is not met (remember, BB93 recommends $T \leq 0.6s$ for a classroom).

To reduce the reverberation time more absorptive material needs to be incorporated into the design of the room. By looking up data relating to materials we find that 'acoustic tiles fixed direct on ceiling with small airspace' have an absorption coefficient of 0.6 so we can repeat the calculation using this material on the ceiling instead of "suspended plaster or plasterboard".

The Sabine equation calculation is repeated using the new values giving a reverberation time value of T = 0.84 seconds.

This value is much closer to the reverberation time target of 0.6 seconds or less. There are several ways in which the absorption can be increased. For example, we can put acoustic tiles on one of the smaller walls instead of plaster.

Putting the new values into Sabine's equation we get a reverberation time of 0.61 seconds.

In this case the criterion is met (0.61 seconds rounds down to 0.6 seconds). However, there are practical matters to be considered. For example, having soft acoustic tiles within reach of children might not be a good idea so the top 1.6m of the one long wall and the two short walls could be clad in this material (recollect that the other long wall is made of glass). This would give a reverberation time value of 0.59 seconds and the acoustic tiles would be high up and thus out of reach.

People themselves provide some absorption and an estimate of this can be made.

Once the acoustician has found a solution for all the acoustic requirements in a school a report is written (this will usually include a marked up drawing that shows the architect and builder what is required).

Acousticians are not the most well-known members of the engineering profession, so I hope that the foregoing has lifted the veil on our activities. ●

Element	Area (S)	Absorption Coefficient (α)	Absorption (A)	Material
Glass wall	32	0.04	1.28	Glass
Long wall (less door)	30	0.08	2.4	Plaster on solid wall
Door (in long wall)	2	0	0	Wood (no data, assumed perfectly reflective)
Short wall 1	28	0.08	2.24	Plaster on solid wall
Short wall 2	28	0.08	2.24	Plaster on solid wall
Ceiling	56	0.05	2.8	Suspended plaster or plasterboard ceiling (large airspace)
Floor	56	0.05	2.8	Composition flooring
Total	**232**		**13.76**	

The Silver Crest BR Class 1500

PART 2

Mark Thatcher builds a 5" Gauge Live Steam BR Class 1500 loco kit from Silver Crest Models. This month he completes the rolling chassis.

Welcome back. Last time I got to the point that I had a square and true chassis, but in this build, I will add the wheelsets, brake hangar assembly, mechanical lubricator, driving wheels and the cranks to connect them together. The plan was to end up with a working rolling chassis. Let's see how it went shall we?

Here are the main components of this kit, **photo 1**. The brake hangar assembly is pretty-much preassembled, and the wheels are also pinned in place onto the axles. There are two eccentric rods also locked into place on two of the axles to save me the hardship of making sure they line up once I identified where these eccentrics were located. Likewise, the mechanical lubricator was pre-built with the small actuator pivot pre-installed.

Photo 1: Main components in kit 2.

Before I started the build of this kit, I wanted to do a test run of fitting one of the side tanks, to see for myself where things went and how they looked. Another reason for this is I wanted to take the model to a model engineering show to illustrate the build as far as I had got with it. The kit is available in in either BR black, BR lined black or GWR green, the latter has now sold out. I am really pleased I went for the lined black version, **photo 2**, as I think it adds a

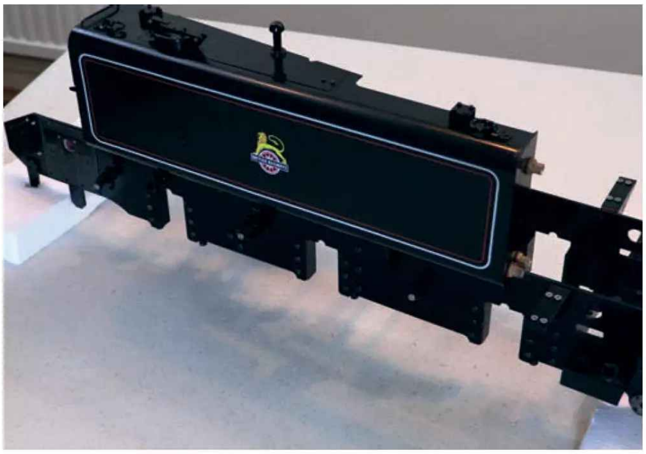


Photo 2: Example of the lined BR scheme.

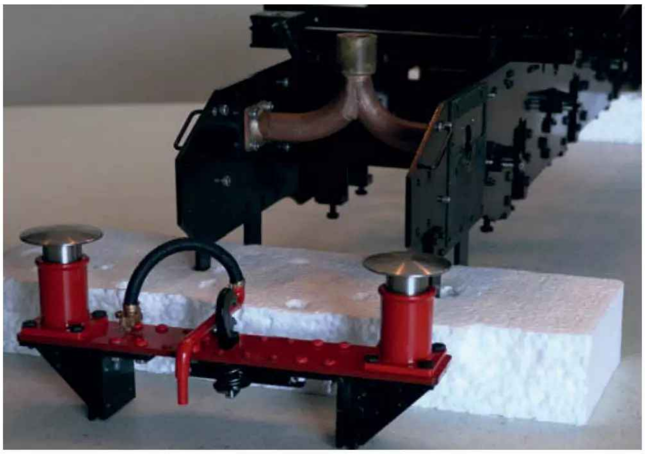


Photo 3: Buffer beam.

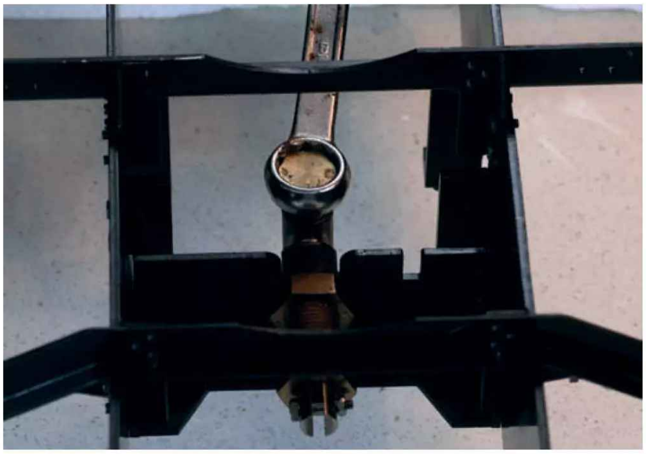


Photo 4: Tightening axle water pump banjo.

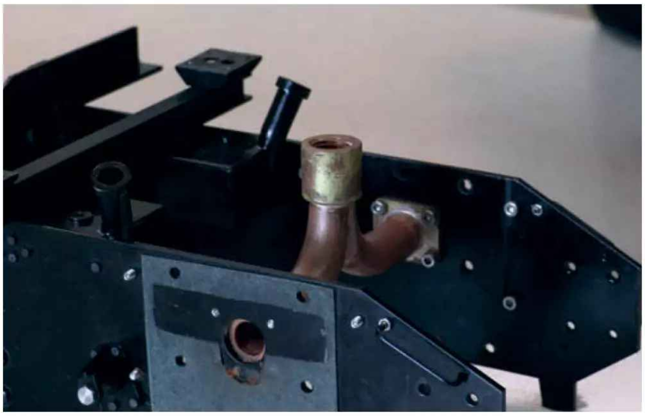


Photo 5: The sandbox will need to be removed before fitting the smokebox saddle.

nice level of detail and colour to what would otherwise be a predominantly black and workmanlike locomotive.

Whilst the instructions suggested I fitted both buffer beam assemblies, **photo 3**, at this point I elected not to for two reasons. Firstly, I did not want my ham-fisted attempts using various spanners and nut spinners to slip and damage the buffer beam red paint (even though these are stove-enamelled), and secondly, I could see that the limited space between the frames would be further reduced when these were in place. So, they were put aside to be added later on in the build process.

If you read my previous article, I noted that the inlet and outlet pipes were already attached to the crank-driven water axle pump. I did not see any reason for this, particularly as these pipes will need to be removed and reinstalled and indeed may need removal further on down the line for servicing and for access to the pump itself. Unfortunately, these were fixed in place by the factory using gasket sealer. This as well as the addition of the boiler and upper frame supports made removal a challenge, but I just about managed to get a 16mm ring spanner over the banjo bolts to remove these pipes using the frame spacer and the frame itself for leverage. **Photograph 4** illustrates it is just about doable and you can see a way in to get to the bolts to loosen them off.

The second mistake I made was to fit the two front sandboxes that I mentioned in my previous article, **photo 5**. Just to remind you – don't do this yet! These are fitted to the inside of the frames. They were mentioned in the parts list for this stage, and shown on the corresponding CAD diagram, but not mentioned in the build instructions for this stage. So, I put two and two together and fitted them anyway – whoops! These don't need to be fitted until after the smoke box saddle drops in between the frames later on. I left these in place for now, as at least I knew where they were located, but made a mental note to remove them again later.

This may be a bit of a Marmite moment, but having some stainless-steel domed Allen bolts in stock I swapped out the standard bolts supplied in the kit for them, **photo 6**.

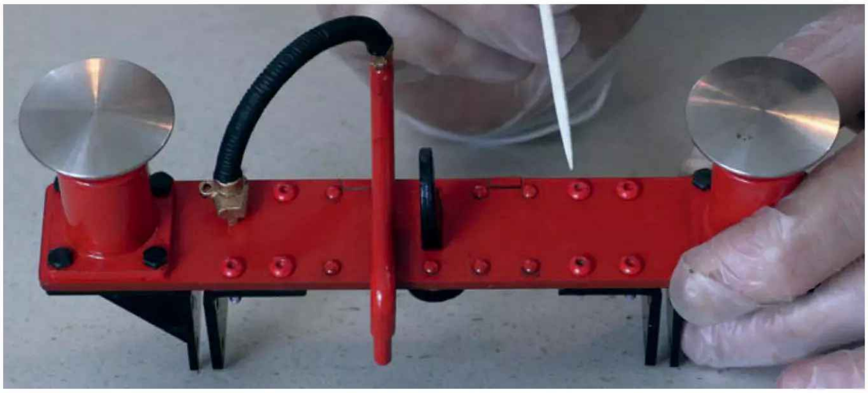


Photo 6: Domed head Allen bolts...

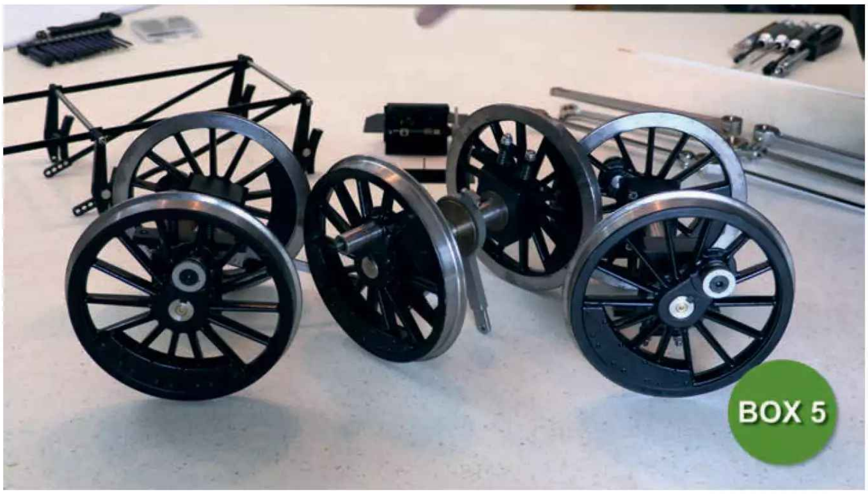


Photo 7: The three wheelsets.


Photo 8: Brake hanger assembly.


Photo 9: Connecting rods.

I think they improve the finished look of the buffer beams, but you may not agree with this modification as they are not prototypical. In any case, the bolts supplied in the kit should work just fine.

Looking more closely at the wheelsets, **photo 7**, you can see that two of the axles have cranks attached. One is for the axle driven water pump; the other crank is eccentric and connects to the mechanical lubricator. Also, all the crank pins have been fitted, and any bolts and bearings have been pre-installed in these. I think this is good for two reasons: out of the box(es), you know where all the fixings go, rather than having to hunt through numerous bags of separately supplied fittings. Secondly: you know the kit is complete as it left the factory. (The factory knows this too!) So, there should not be an issue with any missing small parts.

The brakes and brake hanger assembly is also complete, **photo 8**, and ready to be bolted on, much like many other sub-assemblies in this kit. I guessed that the two rods hanging down would later connect to a lateral rod to the underside of the cab floor, which will allow manual control of the brakes, although I also suspected I would be relying more on the steam brake to stop this little beast!

There is a very good reason for me to show you the main connecting rods here, **photo 9,** as this alludes to a common theme in this kit. Some of the parts are handed, and some have a top and bottom face too. For example, the oiling points on the cranks need to point upwards and the two top rods are laid out with the visible face you see that will face inwards. These two factors helped guide me as to which crank went were as they were handed. Many other parts were too and will fit slightly better on one side or the other of the loco.

The mechanical lubricator is fitted to the inside face of the front buffer beam, **photo 10**. To check everything fitted neatly between the frames, once again I reinstalled the front buffer beam. If you have half the gear and no idea like me, you can manage to bolt the lubricator on the wrong way around. The clue was in the shape of the lubricator cover. There is a slight curve to the front of the cover plate, and this fitted pointing forward towards the buffer beam. If you install the lubricator the wrong way round, then the cover plate will not fit snugly as the lubricator's cut out for the top cover won't match its profile. Then when you come to install the lubricator pipework, the nipples on the lubricator will be the wrong way round too.

With the frame upended I then started to fit each of the three wheelsets, starting at the front of the loco, **photo 11**. This foremost wheelset had an eccentric axle crank for the mechanical lubricator already installed, but being eccentric and off-centre, unlike some of the other parts, this assembly would only fit into the horn blocks one way. Note also the fixings are screwed in place into the crank pins and not loose in a bag somewhere for me to lose!

The crank for the mechanical lubricator was secured to it with a small bolt which is only partially threaded to enable smooth movement of the lubricator actuator arm. To the left of **photo 12** you can see the banjo bolt for the steam brake cylinder which

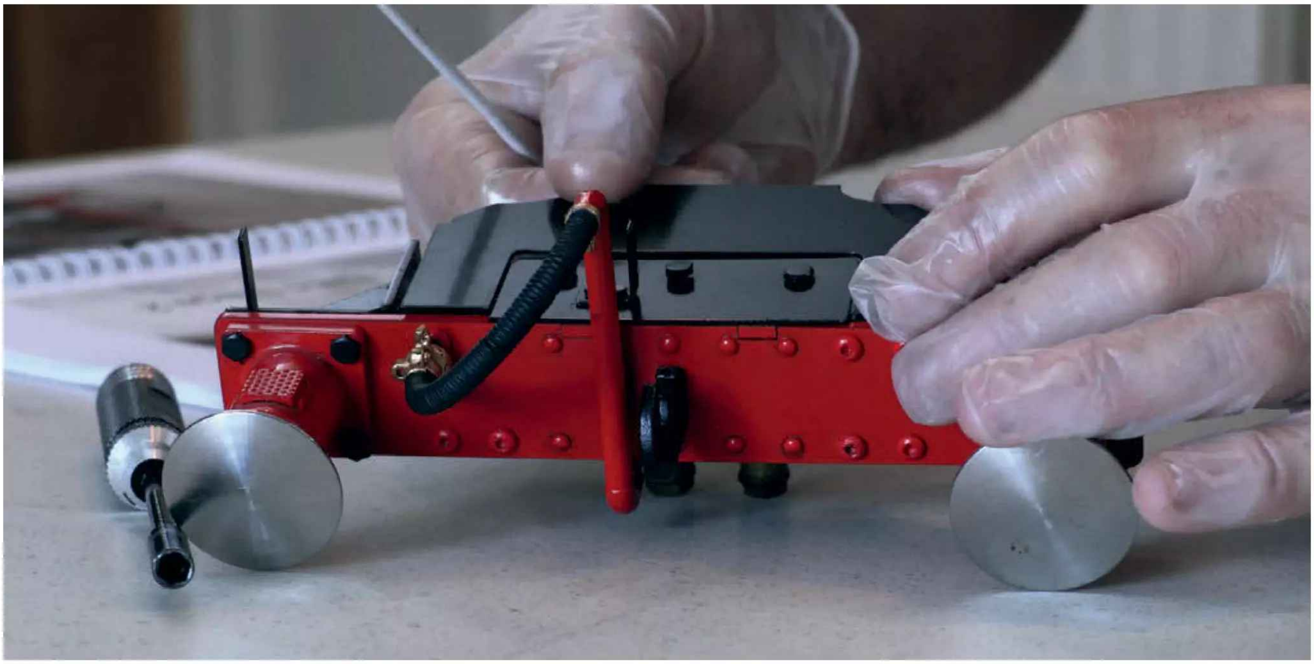


Photo 10: Fitting mechanical lubricator.

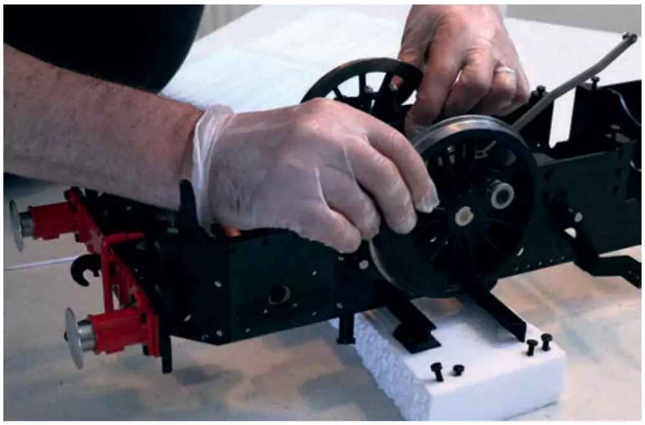


Photo 11: Fitting front wheelset.

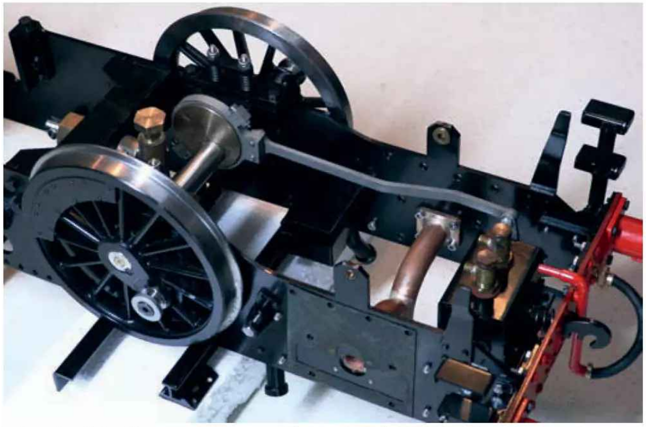


Photo 12: Arrangement for driving lubricator.

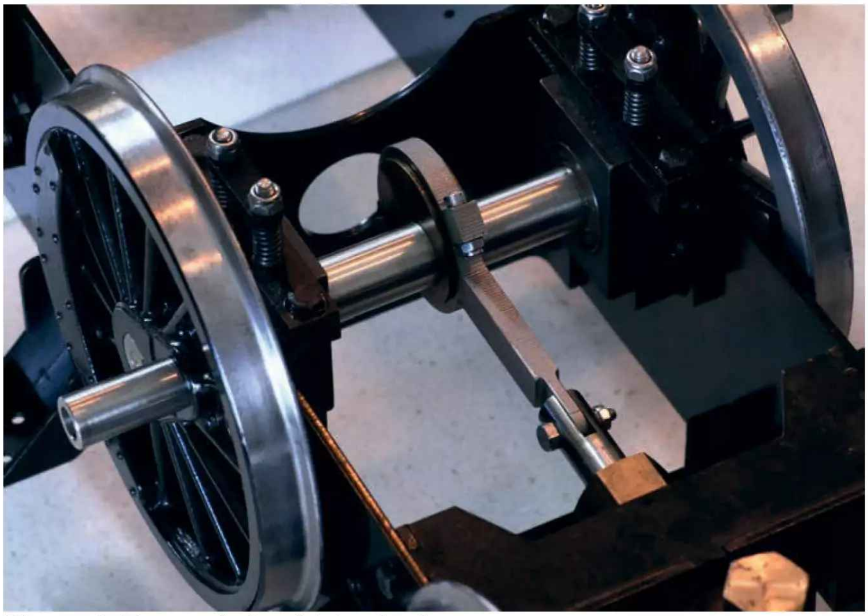


Photo 13: Eccentric for driving brake vacuum pump.

I partially refitted after taking its associated pipework off, so I did not misplace the bolt.

The middle of the three axles was fitted next. Unlike the front wheelset and axle box arrangement this sub-assembly can go either way round as the crank on this axle sits centrally, **photo 13**. I noticed that initially there was some binding between the piston on the crank and the brake cylinder, but once I reversed the axle, all was fine. So why do some parts fit better in one orientation than the other? Spoiler alert: this kit is derived from the ready to run model, which after testing has been taken apart and re-packaged as a kit of parts. These are mass-produced models and as such, whilst the tolerances are close, they won't be as precise as a similar build from a model engineer who has hand-fettled each component. But neither do these kits cost three to four times as much and

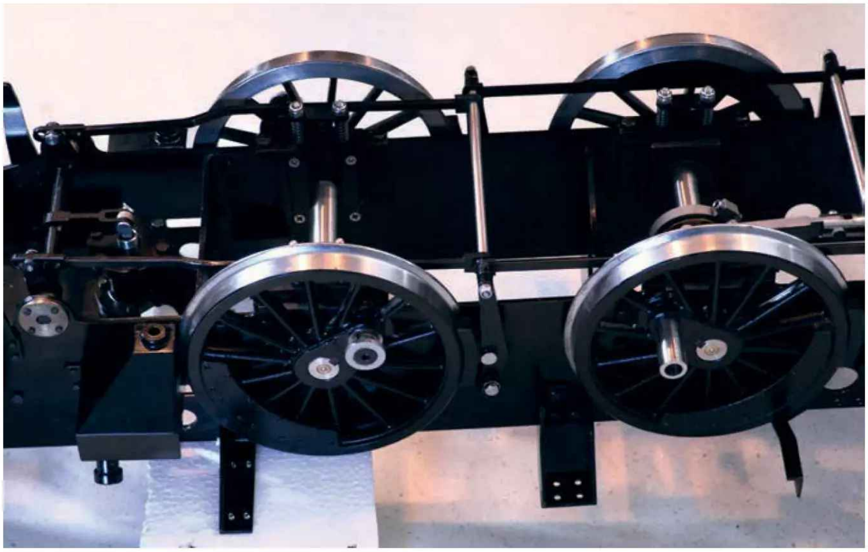


Photo 14: Brake assembly fitted.

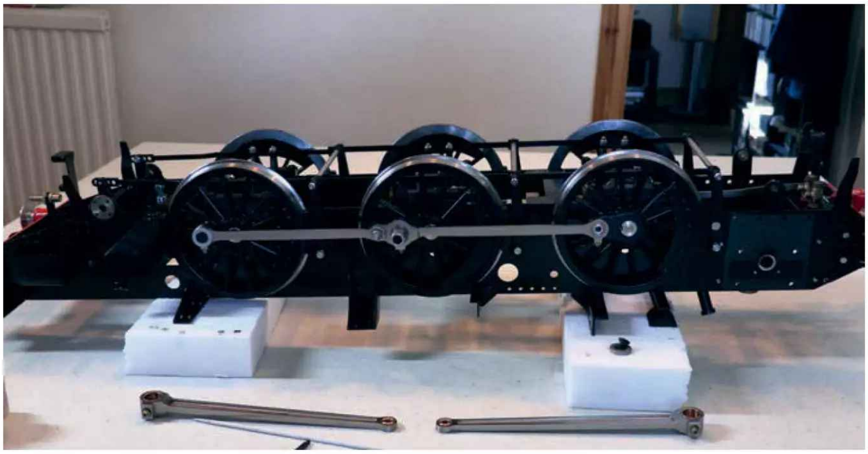


Photo 15: Connecting rods fitted.

they take around 25 hours, not 25 years to build. I guess it is horses for courses.

As you can see, I was totally wrong about my guess that the two long rods of the brake hangar assembly sit somewhere under the footplate. They are actually located to the front of the loco, **photo 14**, and a balance rod passes through these to connect the brake hangars and brakes to the steam brake cylinder. I have to say, for an amateur like me, so far, I have gleaned a lot of knowledge about how steam engines work during this build that I could have never achieved by buying a fully built model, even if my nomenclature still leaves a little to be desired! Please feel free to correct me.

As all the wheels were already pinned to the axles and I got the orientation of the middle axle correct, then I knew the connecting rods had to fit exactly, which they did, **photo 15**. After all, this kit came apart at the Bowande factory so it should fit back together here. Also quartering the wheelsets was not a challenge either, although I suspect once I have added the cylinders, gear frames and the weigh shaft to connect the two together later on in the build, that valve timing would be an issue and may be challenging too. We shall see!

I have to say for an amateur like me and within only a handful of hours, this build was a mightily satisfying experience, and I ended up with a rolling chassis that actually worked, **photo 16**. Out of the box, so far, the kit of parts has reassembled pretty-well. But I would urge you to take your time when fitting what appear to be identical parts to either side of the model as only the slightest difference in the tolerances of this kit will make one part fit better than the other.

SO, AM I A QUALIFIED MODEL ENGINEER YET?

Er… no, I am not! I don't think I will ever be. I don't have the skills, tools, nor the time to learn how to use them. But this kit suits me as I am time-poor and can achieve what is, so far, a passable result with very little input, yet I also am learning 'on the job' so-to-speak. For instance, before this venture, I did not know ball-ended Allen keys or crow's feet spanners even existed. Both have been a boon to me during this build.

I know all I am doing is really putting back together something that someone else has taken apart, but if it is good enough for James May to do this in his *Reassembler* series, then it is good enough for me. Perhaps this process, in itself, may lead onto bigger and better things for me in the future.

Next time I will add the reverser frames, cylinders and smokebox saddle, amongst other components. If you would like a more detailed insight into the building of this kit, then you can dip into my series of build videos on YouTube. Just search for my channel's name: **MADforSTEAM** and you will find them.

Also, if you would like to contact me personally, I can be reached on the Unofficial Mamod & Other Steam forum. You will need to join then you can PM me, but it is free to join and a great forum to be a part of in any case. So, until next time, happy steaming!

To be continued

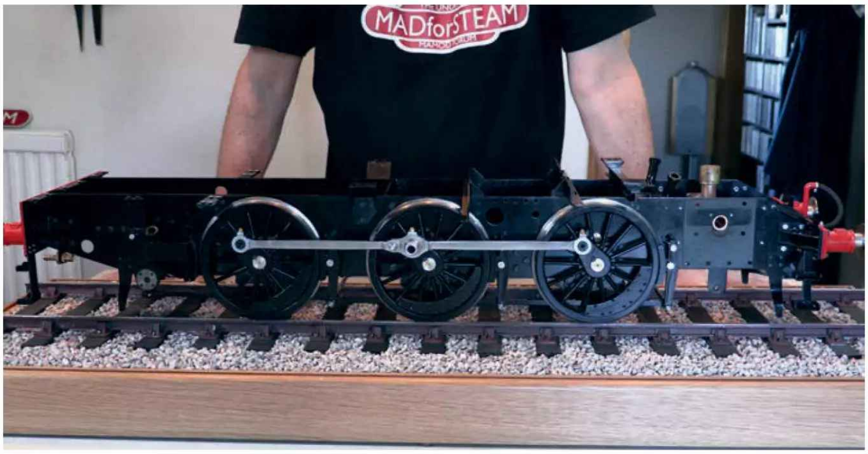


Photo 16: A complete rolling chassis.

Beginning CAD With Alibre Atom 3D

Rob Footitt shares some tips and tricks to help you progress faster with learning 3D CAD.

After teaching Alibre for many years, I've found that there are a few common issues that often crop up, for both new and more experienced users. Over two short articles, I'm sharing a compilation of tips and useful shortcuts that you may find helpful. I've split these up into separate categories so you can jump to what is most relevant for you.

GENERAL APPROACH

Part or Assembly?

When starting out with 3D CAD, it can often be difficult to know if you should create something as a single part or create multiple parts and then combine them together in an assembly. As a starting point, I suggest thinking of how the item you are modelling would be manufactured. If the item is made as a single piece (for example an injection moulded cover, a casting and so on), then this can be modelled as a part, **fig. 1**. If on the other hand it would be made from multiple bits (even if these are then permanently joined together such as a welded frame), it's best to model the individual pieces and then combine these together in the assembly workspace, **fig. 2**, reflecting the real-world manufacturing steps.

Managing the 3D View

When 3D modelling, you tend to move the camera around a lot, and when starting out it can be easy to get lost (especially with more complex models). A handy tip is to make sure the 'view cube' is enabled, **fig. 3**, (found under the View section of the ribbon in the Part and Assembly workspaces). If you need to reset the view, click on a face or corner of the view cube and Alibre will orient the software to the chosen view, zoom out and centre the model on screen, **fig. 4**.

Options for Visual Impairments

All versions of Alibre and Atom 3D offer a wide range of customisations to make the interface more readable. These include the ability to increase the size of the icons and text in the design explorer, change the thickness and size of reference planes, sketch nodes and constraints and the ability to fully

Figure 1 Example part.

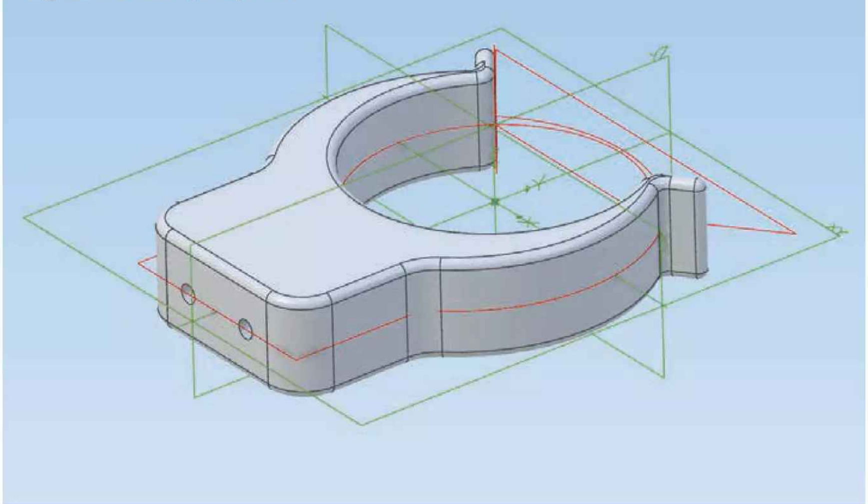
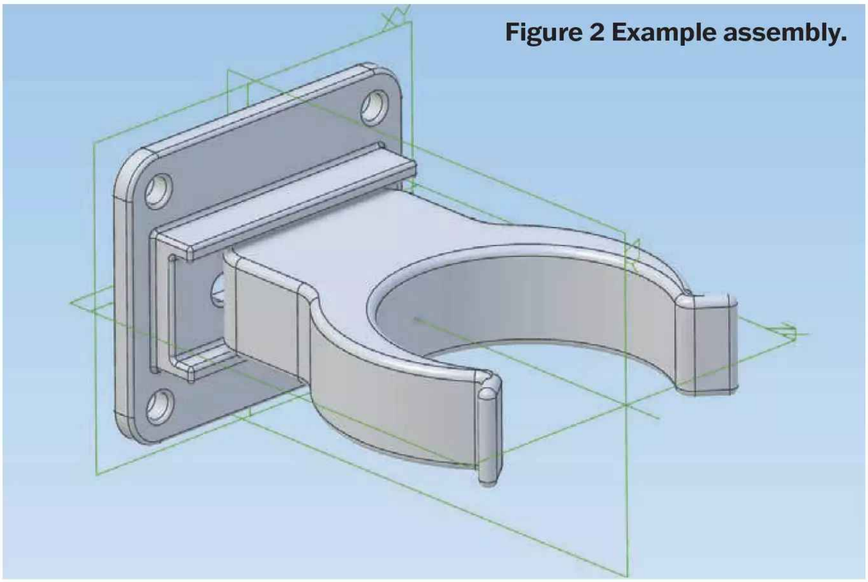


Figure 2 Example assembly.



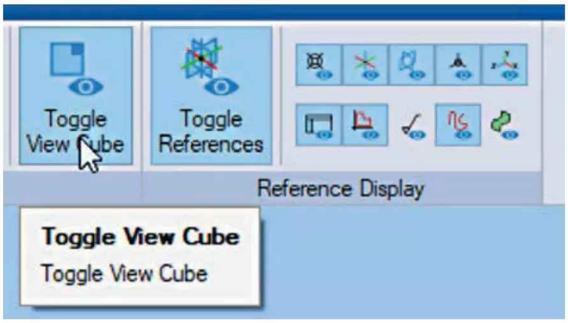


Figure 3 Toggle view cube.

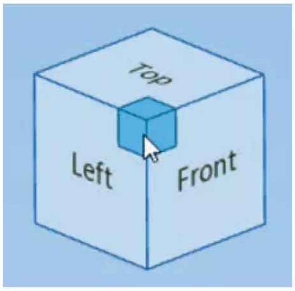


Figure 4 Using the view cube to reset the view.

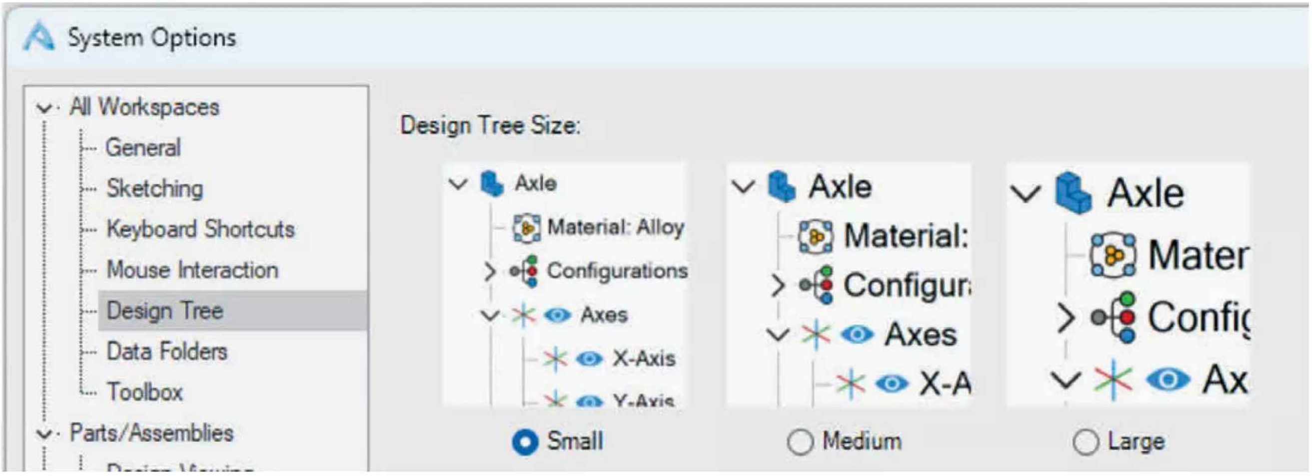


Figure 5 Design tree size options.

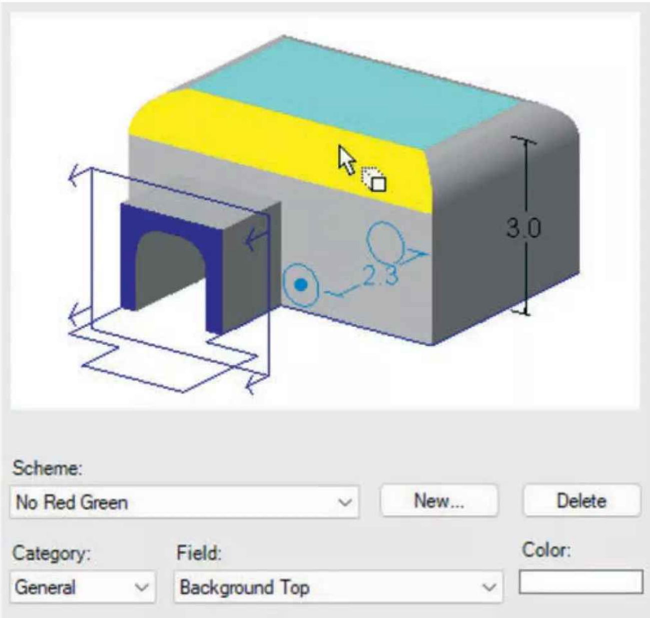


Figure 6 Colour scheme options.

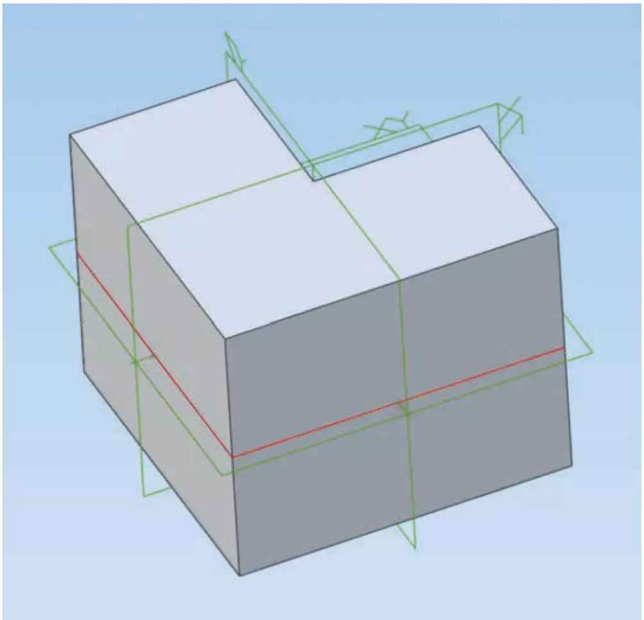


Figure 7 Centred Model.

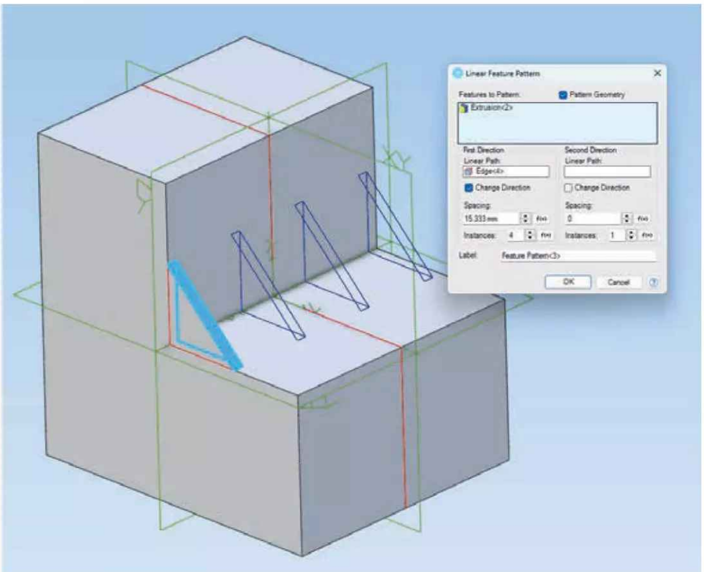


Figure 8 Pattern tool.

customise the colours used in the main workspace. These options mean the software can be made easier to read if you have less than perfect vision, or if you have difficult with certain colours, **figs 5** and **6**.

PART MODELLING

Centre your models

As a rule of thumb, I recommend creating your part models around the origin point Alibre provides, as this results in there being planes running through the centre of your part (where the shape of the part allows), **fig. 7**. The advantage to modelling parts in this way is that it allows you to use tools such as mirror or pattern without having to manually create a reference plane beforehand. It can also make life easier when working in an assembly.

Be Lazy!

A common mistake I've seen beginners make is to manually model repeated features. Where you have a common feature (for example a support rib), I would instead suggest creating the first instance of the feature and then use commands such as mirror or

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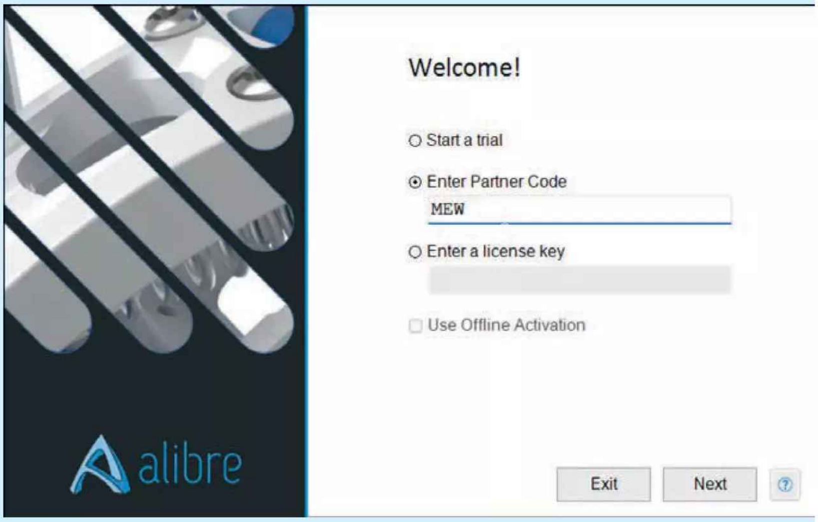
To claim the six month license, please go to https://www.alibre.com/get-a-trial-of-alibre-atom3d/ and fill in the form to request a download link.

Once you have downloaded and installed the software, fill in your details on the Welcome page and click NEXT.

On the next screen, click on the 'Enter Partner Code' radio button, then enter the code MEW as shown and click Next.

This will activate the software for six months.

Please note if you have had a trial of Alibre in the past, the partner code will not work. If this is the case, please contact Alibre at the following email address to request a temporary license key: support@alibre.com



pattern (or a combination of both) to repeat the feature to the required locations. This makes life much easier if you need to adjust the feature, as you will only need to edit the first instance and all the copies will update to match, **fig. 8**.

Shell Command

When working on a thin-walled design (e.g. a plastic cover), it's generally easier to create the outside shape as a solid piece first, then use the shell command to make it thin walled, **fig. 9**. The Shell command can also be used on closed volumes to make them hollow, which is handy to save material when 3D printing for example (where the printer slicer will otherwise fill the empty void with a sparse support structure, it can save you material).

Next month we will look at more tips to help you improve your sketching skills.

To Be Continued

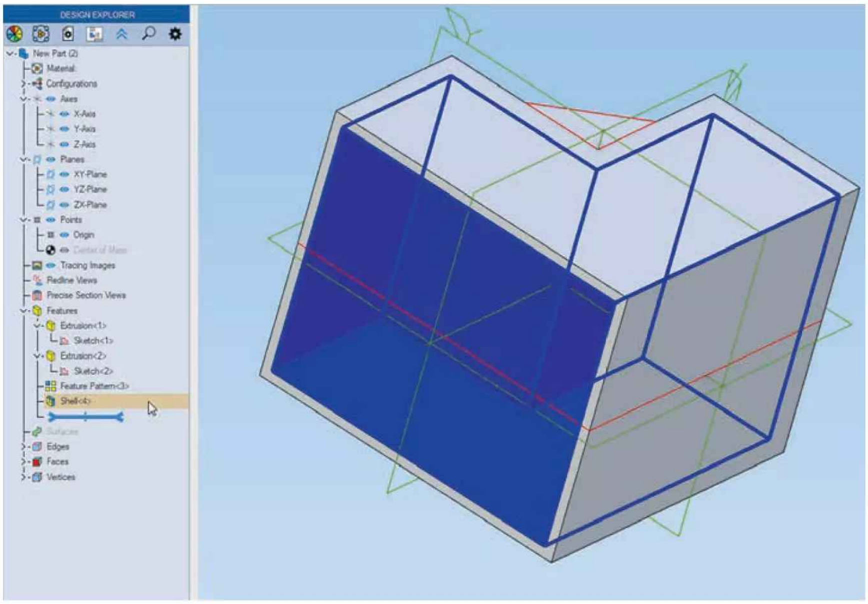


Figure 9 Shell Function.

Photo 1: Channel flange and tilt mechanism.

Under the Top Repair

Howard Jennings got the call to make an unusual repair.

The inevitable, intractable question of what to give my daughter for her birthday had arisen. Stumped as usual, I gave her a call at her home 200 miles away, where she lives with her family, to see what Amazon (or another online retailer) might be able to gladden her heart with. However, in a break with tradition, this year she had an idea for something much more interesting. She told me about a table, just a fairly inexpensive laptop table that IKEA named 'Dave' when they sold them, but one that she had liked very much and that had languished, unused and often in the way, since her then toddler broke it several years before. My daughter's husband had recently 3D-printed a replacement for the tilt block mechanism, which had fixed the table for all of half an hour before breaking in almost exactly the same place as the first one. Clearly the table was not designed for a house with children!

So after a bit of online research and much questioning to find out what this table is all about, I asked for the remaining bits and pieces of the tilt mechanism to be posted to me. In true Scandinavian style the IKEA Dave table is quite simple, with a rounded triangular top and a Y-shaped plastic foot connected by a steel tube. A telescopic tube fits into the top of the steel tube attached to the foot; this has a tapering slot along its length allowing a clamp screw to be used to set the table height. The telescopic tube is bent to about an 80° angle at the top and has a solid bar in a drilling across its open end. This bar slides into slots in two plastic plates which are connected together and sprung to form a tilt block. **Photograph 1** tells its own story: one of the plastic plates is set up to show how the tilt block works; the other is lying to the side, its pivot point broken. The device allows the table top to be angled either flat or at around 20° in one action.

HOW TO FIX IT

The key to the repair is the internal width of the channel between plastic flanges on the mount that attaches the whole mechanism to the underside of the table top (henceforth to be called the channel flange). The internal width turned out to be 45 mm. How unfortunate (or other expletives) - the 40 mm square steel section I had had my eye on for this job, **photo 2**, looked to be just too small. Oh what a jolly nuisance! I beat a hasty retreat to the teapot for a bit of a think.

Photo 2: Steel section doesn't quite fit.

Photo 3: Brass off cut.

I pondered fabricating a 45mm square section from some 50mm square section I have. The 50mm piece is much heavier - 3mm wall thickness as opposed to less than 1.5.mm on the 40mm section - so there would be the possibility to cut the width down and weld it back together. But then there would be the heat distortion and the weld beads, making the post-machining somewhat fiddly. On top of this my measurements indicated that even a 45 by 50mm section wouldn't allow the pivot point to be drilled through and the slots for the tube cross pin to be incorporated with adequate metal. At the end of the day I wasn't keen on a result that would look more at home as part of a ship either!

So I turned my attention to how to make the 40 mm square section steel work. I started to remake the channel flange 40mm wide in steel. I dropped that idea when my daughter reminded me that my still-young granddaughters would likely be playing under the table at some point: the less steel for their heads to bang into, the better. So as it would be a rather fiddly operation anyway, I dismissed that idea. My solution came from the semi-scrap bin: an offcut of solid brass was waiting for its final destiny, **photo 3**.

Photo 5: Drilling the 8 mm slots.

I had considered welding extra steel onto the 40mm² section to allow the pivot point to be drilled through. This would be fiddly welding, making it hard to achieve a decent job. But the brass was just crying out for silver soldering onto the steel section. That way I would get a neat joint and easy machining for the next stage. So off I trotted with a workable repair strategy.

The brass was prepared; skimmed up into a neat bar. Then the 40mm square steel section was cleaned, squared up and cut back for about 2mm on opposing sides at one end so that it formed two 'ears'. The brass then had a 2mm deep slot machined along its length, ready to accept the two steel ears. I cut the brass bar into two generous lengths using the original black plastic components as a guide. Then the brass and steel were clamped together, heated with a propane torch and silver soldered; an easy, neat joint. Then on to machining the slots and the pivot.

A small confession here: it wasn't my idea to write up this job for the good people of MEW. My daughter suggested it, but only after I was well on with the job, so some of the photos are set up retrospectively.

After the silver soldering, the pivot unit was checked for fit with the channel flange. My setting of the slot machining in the brass and machining of the ears had worked: it fitted and there looked to be little distortion.

The next stage was to drill and tap holes in the steel to screw on the plastic plate from the original mechanism, (the only one that still had its pivot point). A spacer plate was drilled at the same time, to allow

Photo 4: Pivot block with plastic slot plate attached.

Photo 6: Machining across to break into the drillings and form the slots.

the original plastic plate to sit square against the side of the soon-to-be pivot block (**photo 4** - just imagine that the pivot block had yet to be machined!) In **photo 5** you can see how the 8mm slots were formed: drilled straight through with an 8mm drill using the plastic slot plate as a guide. Then, **photo 6**, machining straight across the pivot block to form the slots, again using the plastic slot plate as a guide. The slots were finished with a slot drill and a bit of filing. Note the pivots on the original plastic pivot block were 3 mm screws: these were 'upgraded' to a 5mm pin straight across.

IT'S NOT QUITE AS SIMPLE AS THAT.

I had reached what I thought was the final assembly stage: the new pivot block was inserted and the tilt mechanism worked. All that was

Photo 8: Soap dispenser.

needed was a bit of machining to open up the gap between the two now slotted brass plates to allow the steel tube to pass and the cross pin to fully engage with the slots. A couple of big snags then emerged.

Firstly: I thought I could leave the steel section as it was with no modification at all, because I had incorporated a more generous pivot position. **Photograph 7** tells the story; the pivot needed more clearance than the original plastic one had. Oh well, very straightforward to fix that: cut two triangular sections from the sides of the 40mm square steel section, using the plastic slot plate as a guide. Then bend the remaining lip to close the triangle and weld it. A bit of filing and dressing; job's a good'n. Now all looked to be working OK.

Then my euphoria was crushed. I was enthusiastically showing the result to my daughter over WhatsApp and she (ever one for details) asked about the spring return. Hmmm, I thought. I had half-known about it but thought I could ignore it/get away without it. But oh no I couldn't: there was too much risk of the pivot slipping out of the slots and the table suddenly dropping, with obvious consequences for whatever was on it. Oh right, yes. But how to provide a spring return? Back to the teapot and a lot of thinking.

The original pivot blocks had thin leaves of plastic cast on that worked as leaf springs pushing against the channel flange mounting. I seriously considered buying some steel leaf springs from eBay. But time was short; we had a visit planned to see my daughter and her family and there just wasn't enough time to fit this type of spring, even if I could order the right size and type first time. A coil spring was the answer, but it wasn't clear how to fit one so that it wouldn't just ping out and appear on the carpet during use.

Now I have had some success repurposing springs from ordinary handwash dispenser bottles, **photo 8**. I used one inside my 4-way tool post ratchet mechanism in an emergency; I expected it to throw in the towel within weeks but it's still going strong years later. I tried holding one of these springs in a suitable position to return the pivot block: it showed every sign of being ideal. The question was how to mount it with no chance of it popping out?

The answer was staring me in the face: **photo 9** shows how the spring is retained inside the dispenser, around the central tube. There was enough

Photo 7: Pivot block angle clearance incorporated.

Photo 9: The spring as you find it.

Photo 10: Drilling the channel flange for the spring pin.

space inside the pivot block for a steel pin, acting as a permanent guide, to have ample clearance. So straight back to the workshop I went and on examination of the back of the channel flange it looked like a straightforward drilling through to the new pivot block would be a great place to install the spring. Measurements confirmed this; **photo 10** shows the drilling setup. I used the stiffening rib of the channel flange as a guide. An M6 nut made a simple spacer/centraliser for the eventual spring guide pin. All that was needed was to mark the top and bottom travel of the pin as the pivot block was moved. A brief encounter with a slot drill on the top of the pivot block enabled the pin to remain perpendicular to the channel flange, constraining the spring, **photo 11**. Phew! Problem solved, easy in the end - the teapot strategy works! A spray with some old silver car paint and the job was finished.

So the present was presented in person and the table rapidly reassembled, **photo 12**, taking its place in family life as a laptop stand, side table, den support, shield from the ice queen and in various other guises. Most importantly, my daughter was very happy to have her beloved table back in much more durable form! Later that year her husband had extensive ligament repair surgery to his ankle,

Photo 12: Table restored.

and I spied the table on many video calls, supporting his laptop in front of the sofa as he worked from home whilst his leg was immobilised for weeks. It's still going strong!

Job done!

Photo 11: Spring in position with a steel pin and short slot in the pivot block.

The BR Standard 2-6-0 Class 4 Tender Engine

Doug Hewson addresses the boiler cleading.

PART 27

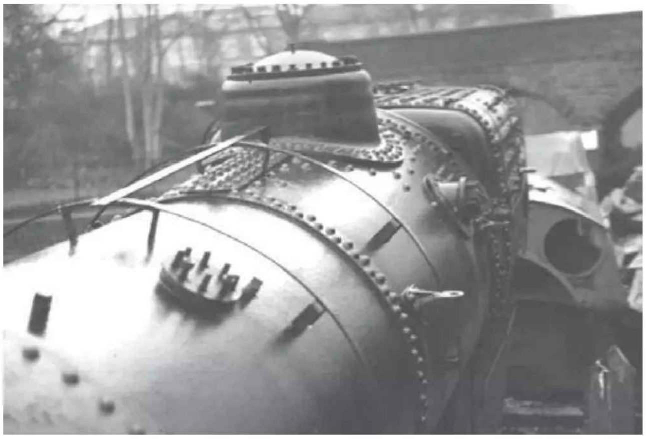


Photo 261: The crinolines on the boiler of 80002 and it is fairly obvious how much lagging you can get in there beneath the crinolines (similar boiler).

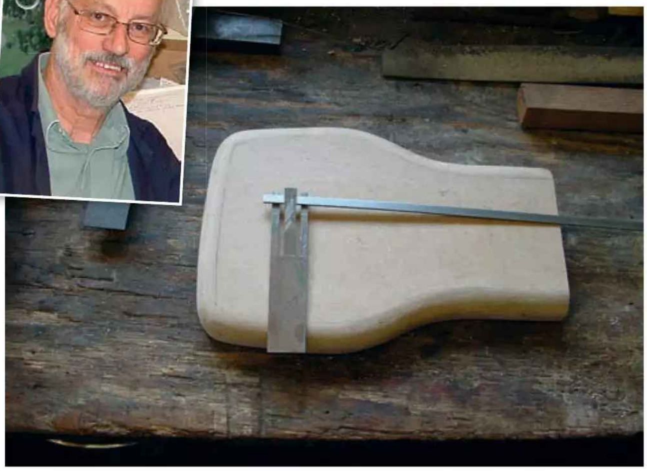


Photo 262: The little jig I made for putting the double bends in the crinolines.

Photo 263: Another picture of the jig I made, and it just needs a quick squeeze in the vice to finish the job off.

For the drawings of the crinolines, you will need to refer to the boiler drawing as they were shown that drawn on that drawing.

Now you may wonder why a loco this size requires a crinoline, and you have probably never seen one described before in these pages. However, there are several good reasons why we need one in this case, the first being the shape of the boiler. With it having a parallel section and a tapered section it means there is no straight line from the firebox to the smokebox, and we need to form one to shape the cleading. I suppose normally one would wrap the boiler with insulation, wrap the cleading sheet around and then try to tighten the boiler bands up onto the soft padding. The first photo is of 80002 on the Keighly and Worth Valley Railway which, at the time was undergoing an overhaul and I thought it would illustrate the job in hand very nicely, **photo 261**.

With a proper crinoline there is a solid framework on which to clamp the boiler bands. You will notice from the general arrangement of the boiler that the framework of crinolines requires a number of joggles where the strips cross to give a flush surface. The first thing I did was to make a little tool to make these crimps as it saves no end of time in the long run. In fact, all it consists of is a strip of 16swg steel plate about 3" long and an inch wide with two slots cut in it. The piece of strip to be crimped can then be woven through the three fingers and this is then just wound up tight in the vice. This will make the double crimp to form a cross though some of the strips will require just a single crimp and these can be made using the same little tool but only threading the strip through one of the slots. **Photographs 262** and **263** show the jig for putting the kink in the crinoline which couldn't be simpler. You will note that a lot of the crinolines are directly beneath the boiler bands

Photo 264: Another thing which I had to do was to silver solder a square of the same material on to the strip.

and there the bands can be tightened down nicely.

I started the crinolines by using some commercial 1/4" x 1/16" bright drawn mild steel but this was very unfriendly to use. It then occurred to me that we keep a stock of 6mm x 16swg in CR4 steel and this proved perfect for the job as it bends very easily, making it very nice to work. I began by making the oval surround to fit around the safety valve bushes. This was cut from a piece of 16swg steel plate. From this oval to the front of the firebox is a single strip with a double crimp in it to accommodate the front firebox band so the first thing to do is to put a single crimp in one end and then put a little bend at right angles and this will form a step to support the safety valve surround. The step requires filing down so that when the surround rests on the joggle the top surface is 3/16" above the firebox top. At the other end you need to press in the double crimp for the front firebox band and the centre of this needs to be 9/16" back from the front edge of the firebox wrapper. You then need to bend the strip to a right angle again and cut it off and file it so that the small length at the front band is also 3/16" above the firebox top. You will now find that there is a 1/16" gap beneath the joggle and this wants making up by silver soldering a short length of the same strip to the underside of the joggle so that it sits solidly on the firebox top as we will require this for a datum point for the long strip along the top of the boiler which forms the top of the taper.

The little strip which fits at the back of the safety valve surround to the manifold bush now becomes a simple job and the strip from the manifold bush which drops over the back head can now be made with a nice curve, in fact, I bent mine round a piece of 20mm bright bar and left the lower leg long to be trimmed off later when we get round to doing the back head.

We can now start fitting the bands around the firebox and the first thing I did was to screw the safety valve surround to the strips fore and aft with 8BA countersunk steel screws which were tapped into the strips. However, nothing would stay tight for long so I then decided it would be best to silver solder this lot together to give me something a little more rigid with which to set out the rest of the framework.

I started with the front strip for the wrapper and apart from the two top corners which were just pulled around a piece of 1" BMS bar, the rest was formed just with thumb and finger to follow the curves of the outer wrapper so that the band was 3/16" proud all the way round. In other words, there was a 1/8" gap between it and the firebox wrapper. To keep the complete firebox crinoline in position I drilled a No. 34 hole in the front and rear ends of the top centre longitudinal strips and tapped a couple of 6BA holes in the firebox outer wrapper plate. These holes were only 1/8" deep and had just enough thread to hold things firm.

The holes were of course directly above the flanges of the throatplate and backhead, so they did not go into the water space. The frame was also held in position at the sides by tapping 10BA holes into a couple of the protruding ends of side stays. Well, this all may sound very tedious but all that I have described so far took me just about an hour. I then transferred my attentions to the boiler and for this you require a 2 ft. rule or some other good straight edge as the top strip for the boiler needs to end up as a dead straight line between the front of the firebox and the top of the smokebox, leaving an allowance for the thickness of the cleading material which should finish flush with the outside of the smokebox.

To form the boiler crinoline, I started by rolling four rings and this time it was from the 1/4" x 1/16" steel strip as I had already rolled those before I discovered the difficulty in working it for the rest of the framework. The next job was to make the little joggled strip which fits between the firebox and the rear of the dome bush and rested the back ring on this to give me a datum point for the straight line required from here to the front end. The next strip to form was the continuation strip from the front of the dome to the back of the smokebox.

First of all, the positions of the two central boiler bands were marked on the boiler with French chalk and the two joggles formed into the strip at these two points. The front and rear ends of the strip were then bent down to form props which sit on the boiler and filed to give a nice straight line from one end to the other. When the front crinoline ring is mounted on this strip the outer surface of it should be at such a height that when the cleading is wrapped round it will finish flush with the outer diameter of the smokebox. The two little 'U' shaped pieces were then formed over a piece of 5/16" BMS bar and silver soldered to the underside of the two crimps where the middle rings fit, **photo 264**, and the rings were then each fixed with an 8BA countersunk screw to the long strip. These two stools then need filing so that when they sit on the boiler the strip is in a nice straight line from end to end. The next job was to fit the two side strips and once you have completed the top one this should cause no problems except to say that you need to constantly check to see that all four rings form a straight line from one end to the other. Once the side strips are screwed into place the boiler was stood on its end so that I could pull the rings right around the boiler, form a joggle in one end so that the other overlaps and this was then fixed with a single 8BA screw.

I found that the boiler crinoline was quite firm just like this so there were no tappings made into the boiler to fix it. You should now find that you have a nice rigid framework, **photo 265**, in fact, more rigid than that on the full size loco as that does not have any side strips along the boiler. The crinoline for the back plate cleading, **photo 266**, was an interesting exercise. You need to mount your fire hole door frame and the damper pedestal in place to make sure that where you fix the crinoline does not foul the two above. I failed in this simple precautionary measure and when I decided to mount the fire hole doors for the photo I then realised the fixing to the bottom pad had somehow strayed into the path of the oncoming fire hole doors. I started with the right hand side piece up to the level of the continuous blow down valve boss (Which you will see is missing from y boiler!). Using the CR4 steel strip you will find it bends quite nicely edgewise just by using a pair of pliers and thumb pressure. The bends are obviously not too onerous of course. I am intending to make a dummy continuous blow down pad blanked off with a flange on my loco, as they were in later life. The strip to fit around the recess for this was made by cutting out a semi circle of 18swg steel plate and this was then silver soldered in to place. The blow down flange will be hung off the back of this with a couple of countersunk screws later. The strip then continued above passing between the mounting stubs for the pressure gauges and then a separate piece was silver soldered virtually at right angles to pass across the top of the back head. At the left side an additional piece was fashioned to fit between the regulator bracket and brake valve studs. To fix the lower ends in position I simply tapped a couple of 8BA holes into the double plate on which the rocking grate levers are mounted. When complete all this lot needs stripping off and painting. The space can then be packed with the lagging of your choice ready for the cleading sheets to go on. I know a lot of builders favour Kaowool, but if you can't find any contact your local supplier and you should find something suitable. I went to ARCO in Hull and explained what I required and they came up with a sheet insulation material which looks like a coarse woven hessian. It is actually a mineral fibre which is used for forming curtains around welders to prevent glare and goes under the trade name of Weldaguard. On the brochure which I was handed it shows a sheet of this material folded into a channel with molten metal being poured down it. However, I presume that our usual suppliers will have something on the shelf. We have now used this material successfully on two other locos and the price was not outrageous.

To be continued.

Photo 265: The oval which I made to fit around the safety valves which I silver soldered to the strips fore and aft and also the plate which I formed using the MDF block seen in photo 262.

Photo 266: The crinolines now completed with a few more bits added including the base for adding the backplate cleading later.

These articles by Geometer (Ian Bradley) were written about seventy years ago. While they contain much good advice, they also contain references to things that may be out of date or describe practices or materials that we would not use today either because much better ways are available of for safety reasons. These articles are offered for their historic interest and because they may inspire more modern approaches as well as reminding us how our hobby was practiced in the past.

Beginner's Workshop

Some facts about TAPERS

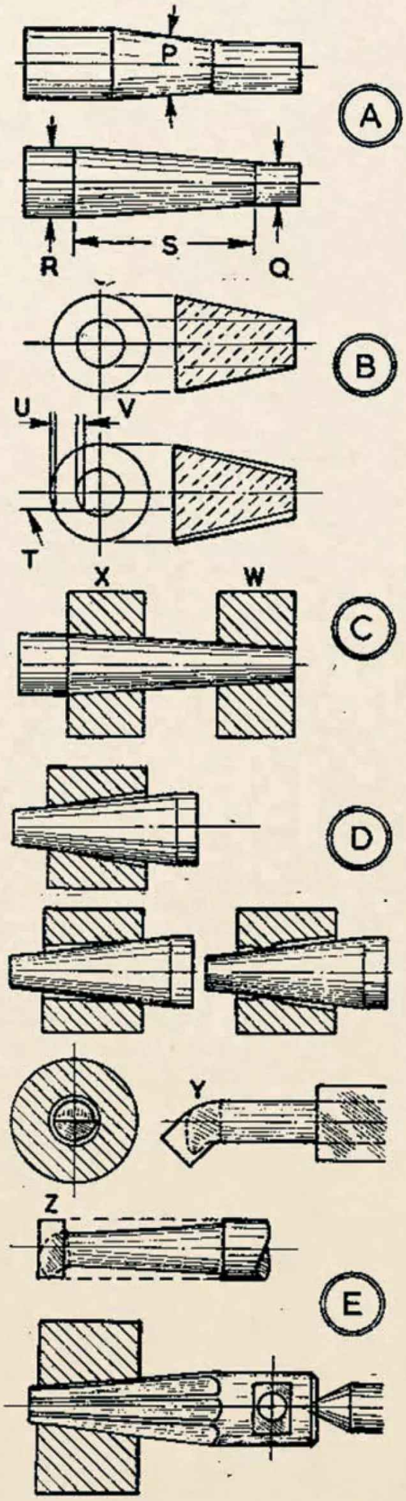
By GEOMETER

APART from many other uses a taper is often the means of securing a flywheel, a sprocket, a gear or pulley to a shaft-either with or without a key. For such purposes, a taper is usually mechanically more satisfactory than a plain interference fit between shaft and bore, a sliding fit with a drive-in key, or a sliding fit with a locating shoulder and, a nut for holding.

The angle of a taper has a considerable influence the grip exerted when components are pulled together ; and the smaller the angle, 'or the less the change in diameter for unit length, the more powerful the hold.

A taper may be dimensioned or designated in two common ways, *A.* The angle, *P,* may be given irrespective of the size of the shaft, which may be convenient when the angle is a whole degree, such as 5 deg., or whole degree and a simple fraction, such as 6) deg. Alternatively, the smaller and larger diameters, Q and *R,* may be given and the distance, S, between them. In such an event, the taper may also be given as so much per foot or per inch as the case may be.

On a lathe, a fairly-quick taper is machined by setting the topslide at an angle and using this for machining; while a slow or gradual taper longer than can be machined from the topslide is produced by setting over the tailstock, or using a set-over centre



when the work is mounted between centres. Again, on lathes so equipped, a taper turning attachment may be used to control movement of the cross-slide, leaving the work in longitudinal alignment with the lathe bed.

Some experiments are virtually always necessary in setting up for machining a taper, since no graduation -particularly of the topslide-is sufficiently accurate. Moreover, it is important for the tool to be at centre height, otherwise, variations in shape and angle occur, *B.* When the tool is at centre height it lies on the horizontal centre line of the shaft, where the slide angle is the same as the taper. If the tool is dropped, however, to' plane, T, the effect on the larger diameter, U, is much less than on the smaller diameter, V.

GOOD-FITTING TAPERS

In obtaining well-fitting tapers, size, angle and finish, both externally and internally, are extremely important. If one has the choice when fitting two parts on a " one-off" job the shaft is better finished last, as it is the more easily adjusted for size to secure longitudinal location, and the simpler to provide with a good finish, or on which to correct small inaccuracies, from careful use of a fine (Swiss) file and/or abrasive cloth.

Variations in longitudinal location with size are shown at C, where the component moves from W to X as the bore is increased.

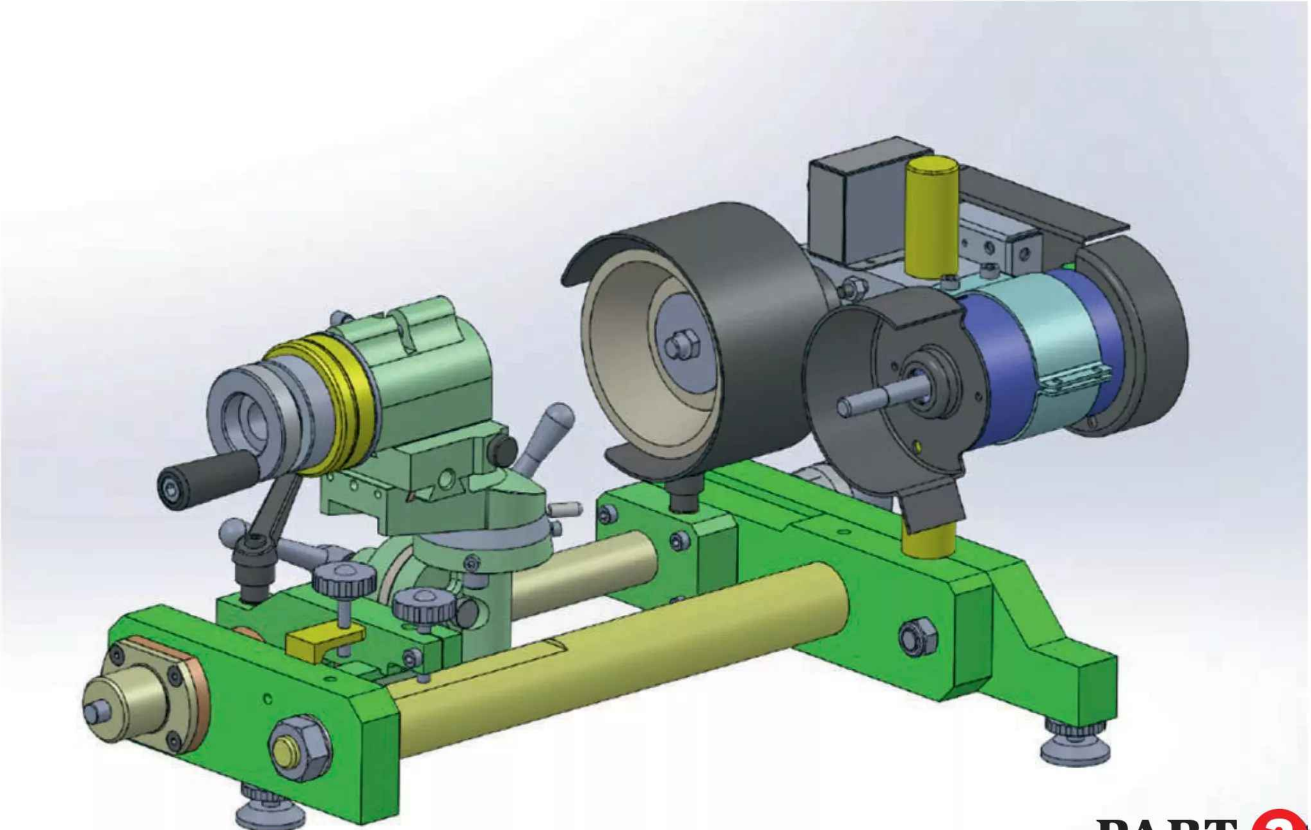
If there is no choice in procedure, as when fitting a new sprocket to an existing shaft, the taper is picked up on the topslide with the shaft in the lathe and a mandrel turned to the same taper, but smaller. This is used for preliminary testing, though the final testing should be with the shaft itself.

Illustrations, *D,* show some ways in which an internal taper can be faulty The bore may be large on the outside or inside, when on entering the mandrel and " feeling," slackness can be noticed. Pushing in the mandrel and twisting also shows where the taper is touching.

When the taper is faulty, the topslide requires m-adjustment. Finish is important, since if the mandrel rides on ridges the fitting will be poor though the angle may be correct. Slight correction and improvement follows from grinding the parts together, but too much reliance should not be placed on this.

For small bores, silver-steel tools, E, can be made by bending as Y or turning to leave a diameter, Z, both of which can be filed to shape, then hardened and tempered.

Of course, with a taper reamer available, or made from silver steel sizing and finishing are simplified. ❑



PART 2

A Tool and Cutter Grinder

Paul Lousick has designed this tool and cutter grinder around a readily available cutter holder. It offers a great deal of flexibility while being relatively straight forward to construct.

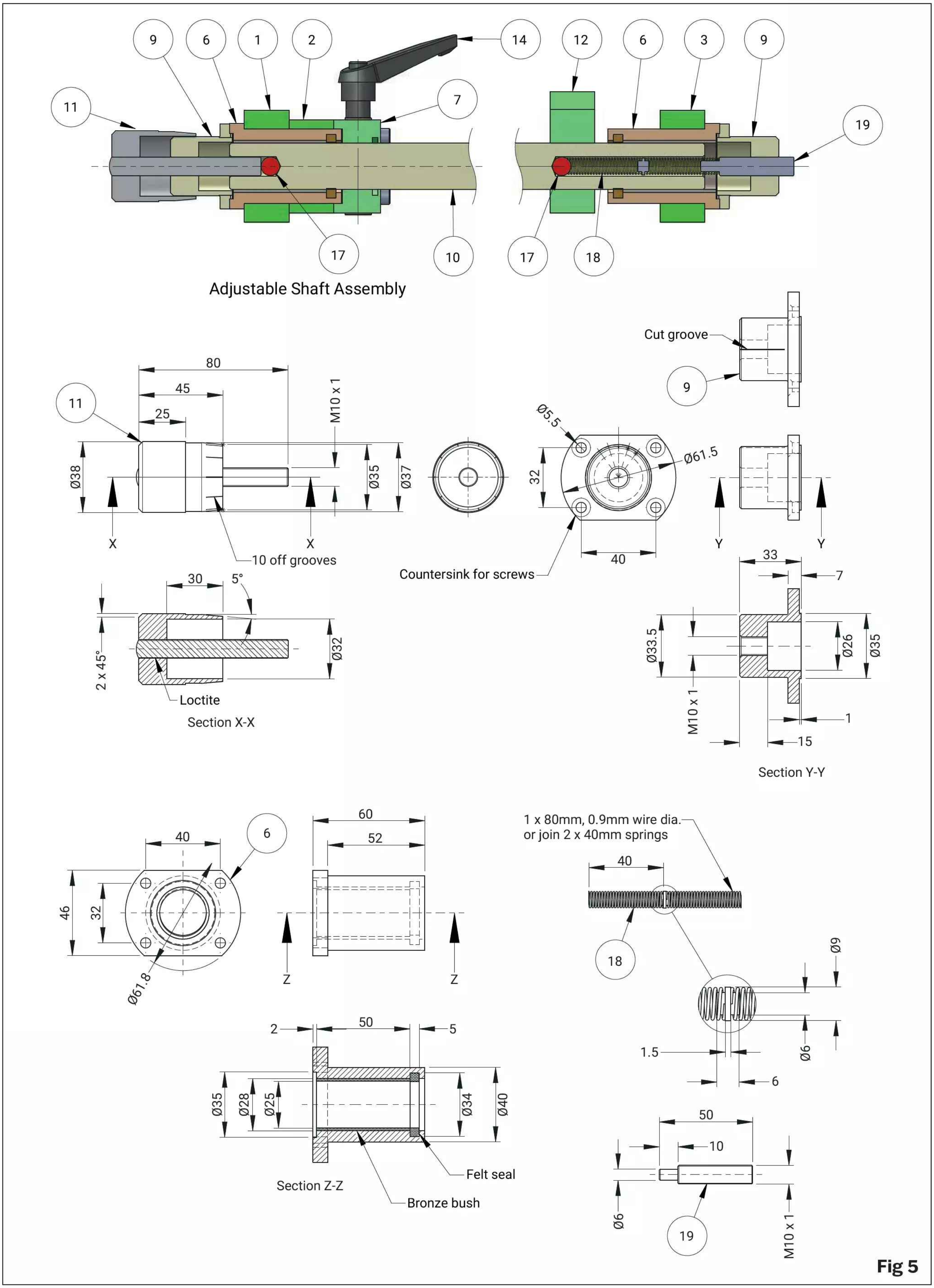
This series has about a dozen groups of drawings which will appear slightly out of synchronisation with the text in order to keep each instalment a reasonable length. We continue from last month's installment with further machining of the stop arm.

A step on the end of the arm was machined and a hole for shaft clamp drilled thru. The opposite end was then machined for an adjusting screw that limits the rotation of the shaft and cutting tool, **photo 10**. A similar hole was made for the shaft locking housing, **photo 11**.

The clamp pin is used to stop any rotation of the shaft and should be made from brass or bronze so it does not damage the shaft. I did not have either and made mine from copper.

The clamp pin was initially made with a head on the top end and the bottom end tapped for M8 thread. A bolt was then used to clamp the pin securely in the stop arm *(and lock housing)* while the radius was cut in the side, **photo 12**.

10



Adjustable Shaft Assembly
11
9
6
1
2
14
7
12
3
19
17
10
18
80
45
25
M10 x 1
Ø38
Ø35
Ø37
X
10 off grooves
Ø5.5
Ø61.5
32
40
Countersink for screws
Cut groove
Y
30
5°
2 x 45°
Ø32
Loctite
Section X-X
33
7
Ø33.5
Ø26
Ø35
1
15
Section Y-Y
60
52
46
Ø61.8
Z
1 x 80mm, 0.9mm wire dia.
or join 2 x 40mm springs
Ø9
Ø6
1.5
2
50
5
Ø28
Ø25
Ø34
Ø40
Felt seal
Section Z-Z
Bronze bush
10
M10 x 1

Fig 5

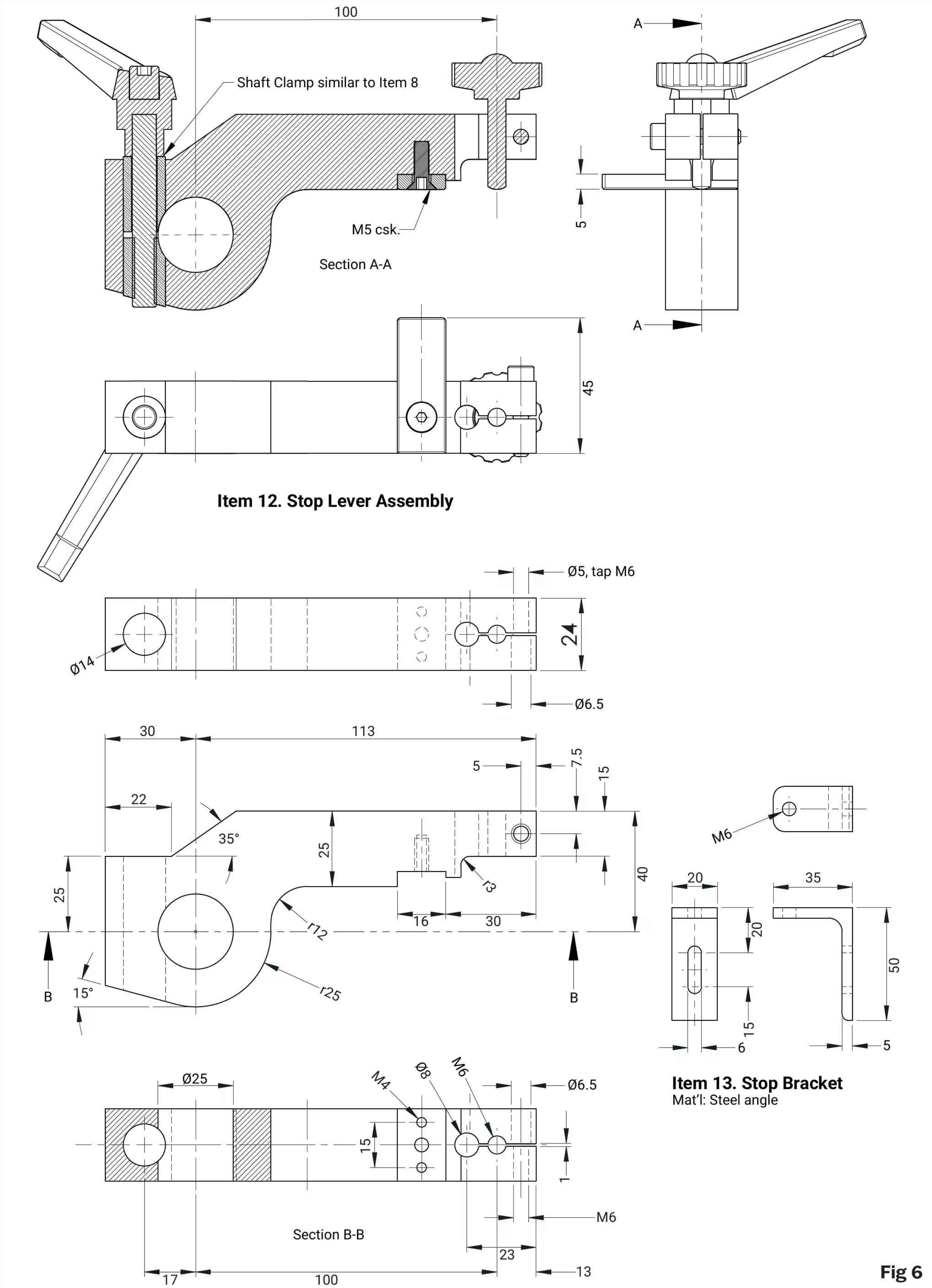
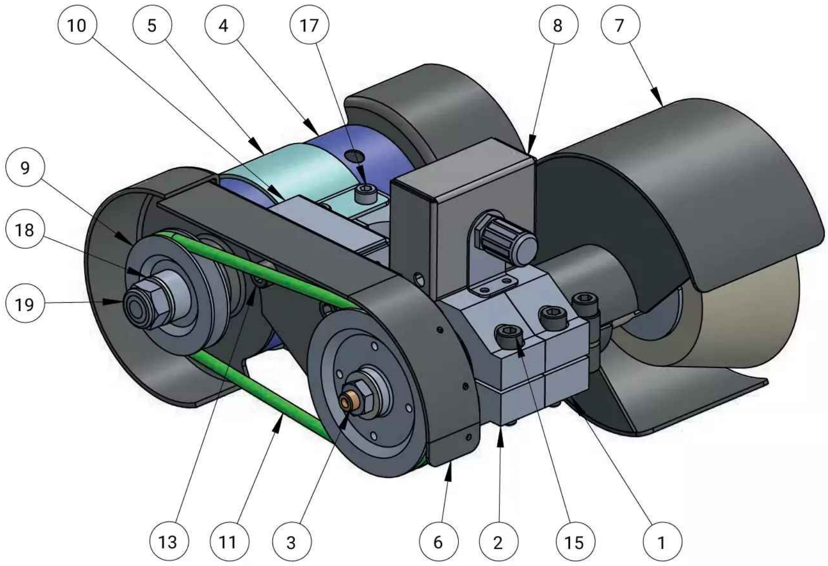
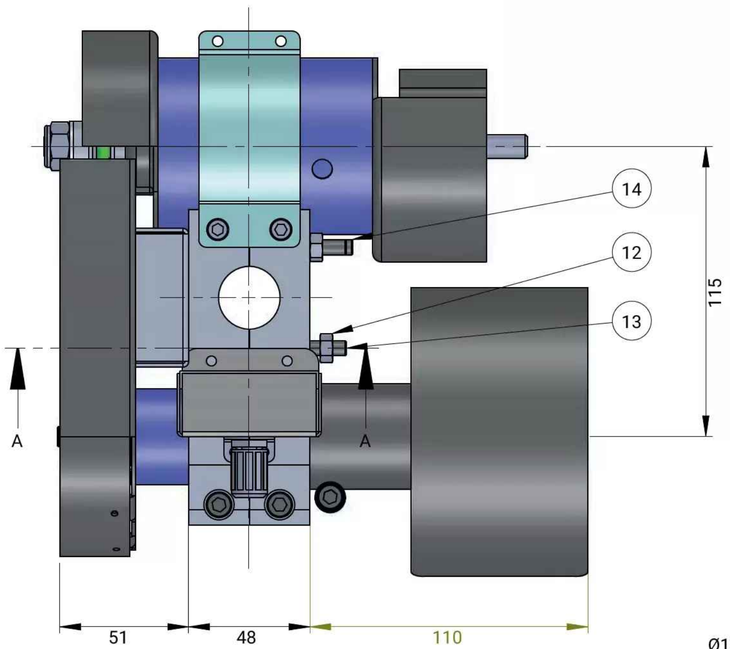

100
Shaft Clamp similar to Item 8
A
M5 csk.
Section A-A
5
45
Item 12. Stop Lever Assembly
Ø5, tap M6
Ø14
24
Ø6.5
30
113
5
7.5
15
22
35°
25
40
r3
16
30
r12
r25
B
15°
M6
20
35
20
50
15
6
5
Item 13. Stop Bracket
Mat'l: Steel angle
Ø25
M4
Ø8
M6
Ø6.5
15
1
M6
Section B-B
23
13
17
100

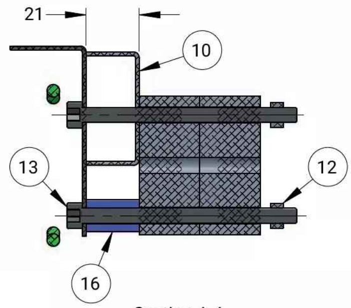
Fig 6



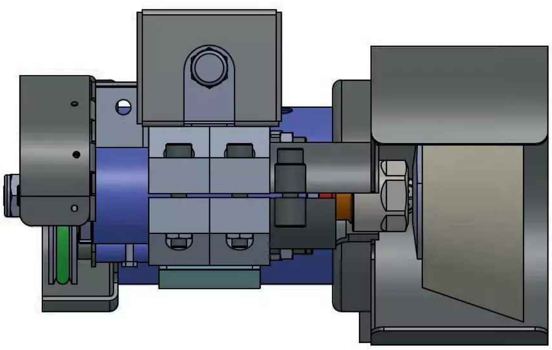
Item	Part Number	Qty
1	Base RH	1
2	Base LH	1
3	Spindle Assy	1
4	Motor	1
5	Motor Clamp	2
6	Belt Guard	1
7	Grinder Guard Assy	1
8	Motor Speed Switch	1
9	Pulley typ. 22	1
10	Cable cover	1
11	Drive Belt	1
12	M6 Hex Nut	6
13	M6 Capscrew	3
14	M6 Capscrew	1
15	M6 Capscrew	2
16	Spacer	1
17	M5 Cap x 12	2
18	Washer 10	1
19	M10 Nylock nut	1

Grinder Motor & Spindle Assembly





Section A-A



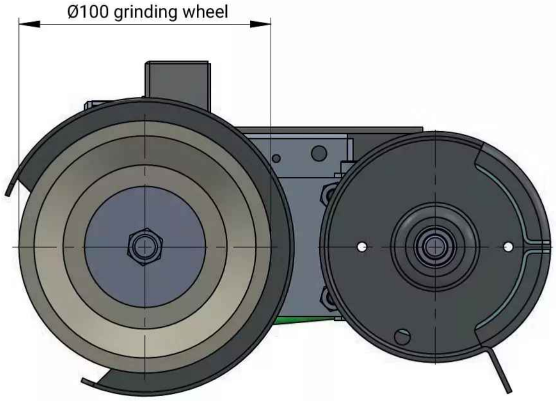
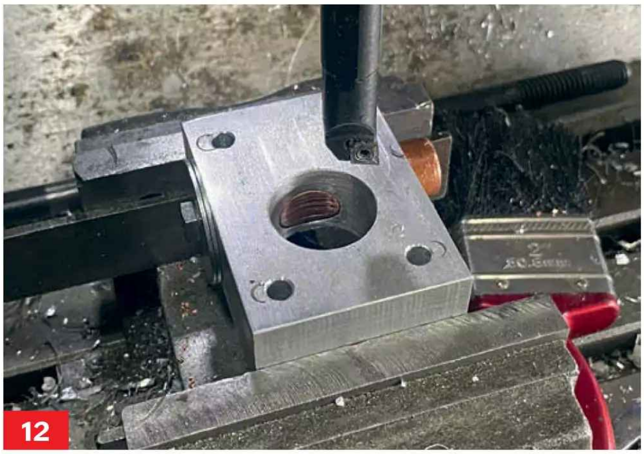


Fig 7


11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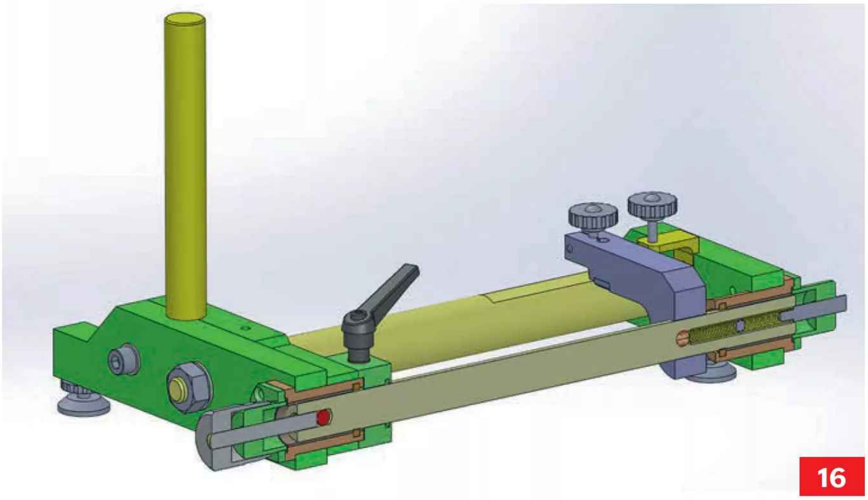
13


14


15


16

After the radius was machined on the side of the pin, the head was removed and the pin cut in half. The hole in the top end enlarged to 8.5 mm for a clearance fit with the screw that is used pull the two halves together and clamp the shaft, **photo 13**.

The shaft end covers were fabricated from plate and round bar and turned to size on the lathe after silver soldering together. Then drill a hole thru and tap an M10x1mm thread 20mm deep. This thread should be a close fit with the adjusting screw.

Then reverse the part to turn the OD of the plate and bore the inside of the round bar, **photo 14**.

I bolted a 4-jaw chuck to the mill table to hold the end covers while I cut the flats on the side of the plate and drill the four mounting holes. This is quicker than mounting the chuck on a rotary table and then bolting it to the mill table), **photo 15**.

Axial movement of the toolholder shaft is made by rotating the dial on the left-hand side. The dial screw has a 1mm pitch thread. One complete rotation will move the toolholder by 1mm. 10 grooves are cut around the periphery of the dial, allowing the shaft to move by 0.1mm increments. More grooves may be added if you require better accuracy. A spring on the opposite end keeps the shaft pressed against the adjusting screw, **photo 16**. If a long spring is not available, a joiner can be used for 2 short springs as shown.

Next time we will move on to the motor and grinding spindle assembly, previewed in **figure 7**.

to be continued

Sweet Pea steaming on Ecoal.

Adventures in Ecoal

Nick Maunder experiments synthetic coal as fuel for miniature locomotives – a potentially less polluting power source.

Personally, I am not here to save the planet - or superglue myself to critical parts of it. My experiments with synthetic coal are purely selfish and primarily for the following reasons:

- The supply of good quality steam coal is dwindling and becoming increasingly expensive. I have seven bags of Foss-y-Fran dry Welsh steam coal left, which is a lifetime supply at my age. However, if I can avoid using it for a couple more years, I can sell it and take the family on a cruise.
- We are all in the same boat insomuch as we have to adapt or give up. There are a few articles out there relating to tests on 15" gauge and upwards but very little relating to miniatures. I hope that by running some tests with miniature locomotives, others might be encouraged to do the same and build on the minimal information available thus far.
- Explaining to Jo public in the queue that we are experimenting with lower carbon alternatives to coal resonates with this generation of young parents and demonstrates our hobby is not just treading water but still evolving.

Photo 1: CPL website.

BACKGROUND

Leading the way to lower carbon, smokeless fuels is CPL Industries, **photo 1**. They have been doing sterling work with the heritage railway sector and, following testing with the Bure Valley Railway, North York Moors and others, have now released several blended fuels including one specifically for the heritage railway sector.

I emailed CPL to enquire if there are any plans to produce Ecoal in smaller sizes (15mm or thereabouts) for the model engineering market. I had a very helpful and supportive response in relation to my experiments with the product, but alas the tooling to produce briquettes in miniature remains prohibitively expensive for now at least.

To be clear, referring to these products as 'synthetic' coal is perhaps a little misleading. There is still a significant content of mineral coal which is blended with other material and then pressed into briquettes. The aim of the game is to create something that burns as much like coal as possible with the lowest possible output of nasties.

The aim of my game is to keep playing trains after the supply of decent steam coal runs out. So will it work?

For the purpose of my trials I have settled on Ecoal 50. This is not specifically for locomotives, in fact is a rather different animal to the heritage blends, containing 50% renewable Biomass made from recycled olive husks that would otherwise go to landfill.

I selected Ecoal because I wanted to go with the product boasting the lowest emissions. Biocoal does not contain sulphur, nitrogen oxides or mercury. Several hours each weekend with a miniature locomotive chimney inches from your nose is likely worse than smoking cigarettes so the cleaner the better. Secondly, it is readily available.

Mostly, I arrived at this particular option as I have used it in my fire at home for the last couple of years so already have some in stock. I noted it lasted for a very long time in the stove and wondered how it would do in a locomotive firebox with a forced flow of air. If the trials are not successful, I can still use it on the fire.

OVERVIEW

Ecoal 50 comes in the form of briquettes roughly the size and shape of a traditional brass doorknob, **photo 2**. Apparently, the hexagonal shape encourages the product to interlock evenly on the fire grate when used whole, **photo 3**.

The product in its current form is widely available in 10 or 25 Kg bags from DIY stores, garage forecourts and the like, as well as your friendly local coal merchant. I found mine closer to home at a timber yard.

For the purposes of miniature engines, the briquettes have to be broken down into pieces of useable size. I found the briquettes break up very cleanly as long as they have been stored in a dry place, **photo 4**. There is definitely less waste on the ground after breaking an equivalent volume of Ecoal than the dry Welsh coal I have used for many years.

I left an open bag of Ecoal 50 out in all weathers for a year and, although it burned just as well it was definitely softer and more prone to crumble when broken up with the hammer. Store it in the dry for best results.

For the purpose of my experiments I used a *Sweet Pea* and a Maxitrak *Pearl*. Both are free steaming locos which I have run on mineral coal for some time, so I have a reasonable starting point as a basis for comparison. The fire grates of each loco are of a reasonable size which allowed me to try different ways of loading the fire. My scamp would have made this rather more fiddly but is on the list to test with if the trial is deemed a success.

The marine boiler of the *Sweet Pea* requires a 'little and often' approach to

Photo 2: Ecoal briquettes.

Photo 3: The hexagonal profile.

Photo 4: After breaking down.

firing which provided a rather different test environment to the locomotive firebox of the *Pearl*.

TEST RUNS

My experiments did not raise much suspicion at the club as I have always brought my own coal with me. I have never been a fan of the club Anthracite which is high in clinker and generally burns like wet asbestos in my *Sweet Pea*. For the first test I used the *Pearl*.

The boiler was lit in the conventional way with charcoal soaked in paraffin and the Ecoal added on top. The fire took as normal and raised steam in comparable time with nothing unusual to report.

I have seen reports from the tests with full size locos the Ecoal takes longer to light, but this was not my experience with a miniature boiler. Possibly the briquettes light more readily when broken down into smaller pieces.

For the first few laps I fired the boiler as I would with mineral coal, occasionally raking the fire before adding fuel. I found the fire was making plenty of steam initially, then burning through fast and leaving the loco low on steam toward the end of the 1/4 mile lap at the Tonbridge track. I tried loading the firebox higher than usual toward the back and around the sides so the fuel could fall inwards as it burned away, and this worked a lot better.

With a few more laps it was clear the fuel burns at a steady, consistent rate before rapidly dropping off and disintegrating in quite a short window of time. The fuel did not last nearly as long as mineral coal when pulling hard with the blower. When forced, it burned intensely but rather more briefly before disintegrating into ash. With a little more work, the loco ran better for having a constant but reduced pull on the blower, steady at all times. Further minor tweaks followed until the gentle but constant pull on the blower found a 'sweet spot' where the boiler made just the right amount of steam to meet demand without the need to pull the fire up at any other time.

I daresay plenty will comment at this point that this is how it should be done anyway. I am not too proud to acknowledge my own driving skills (or lack thereof) as a factor in this experiment.

It was noted on some of the trials with full sized boilers the fuel burns more evenly across the whole grate leaving the back head rather hotter for the operator. This may be the case in full sized practice but at reduced scale I can't say I particularly noticed this. The back head is always hot on a 5" gauge locomotive and was not noticeably more so for using this fuel.

Back at the station, I asked some of the other members "does this coal smell funny to you?" With the response that it didn't smell odd at all.

After a couple of hours running, I took the loco off to see where we were with ash build up. I noted the ash produced was no more abundant than I would expect after running on mineral coal for a similar amount of time despite using more fuel.

I suspect the organic content produces a percentage of lighter ash which blows out through the chimney. I am yet to weigh identical volumes of this ash and coal ash to verify the above. All I can say for now is I was no more sooty than normal.

There was however one significant point to note: There was zero clinker formation. The fuel breaks down into a fine even grit with no suggestion of clinker formation at all. The organic content of the product simply doesn't contain the same cocktail of impurities that fuse together to form clinker. This discovery was a turning point as in turn meant there is really no need to rake the fire. I had done so only on the basis of 'but we always do it that way' without considering quite how differently this product may perform.

The next running session I used the rake only to open and close the firebox door. Combined with the revised use of the blower to a low but constant setting the fuel consumption dropped, steam production became more reliable, and the engine ran happily for three hours, this time making steam more consistently than before.

Confident now that I now understood the basics of how to work with this product, I handed over to another member. Following the advice to run the fire slightly higher, keep the blower low but steady and above all, avoid raking the fire he ran the loco as he otherwise would and, after a few laps the report came back that all was well. The loco steamed well and ran as one would expect.

Next was the turn of the *Sweet Pea*, (see the header photo). This engine has always been fussy about fuel so I was pleasantly surprised at how well it liked the Ecoal.

Armed with the new knowledge from the previous trials I again ran with a slow and steady pull on the blower and avoided raking the fire. The fire on the marine boiler is thinner than a locomotive fire box and I think the propensity of the Ecoal to burn evenly across the grate actually works in its favour here.

At this point I would encourage those with a knowledge of rosebud grates to take up the experiment. Some locos prefer a fire which is hotter at the front or centre of the grate for example. I suspect a well-designed rosebud grate combined with this new fuel could present some really interesting results.

Although there have been some extremely interesting and informative articles written on the subject of rosebud grates, I cannot find a book where all the information has been put together in one place much less compared for validity. If anyone knows of such a book, please let me know. If not, the gauntlet has been thrown down! (We will run a short article on rosebud grates soon – Ed.)

I managed to get a couple of runs in with the sweet pea before the end of the running season. Both times the loco ran well with only a couple of changes to technique as described above.

OBSERVATIONS

Cost wise it is comparable to or cheaper than good quality steam coal - if you can get real steam coal at all. When firing this fuel does not like to be thrashed.

Ecoal is pressed from a mixture of materials so is more physically delicate than mineral coal. It needs a steady, gentle pull from the blower rather than aggressively pulling the fire up for short periods. If pulled too hard with the blower the fuel will burn through quickly and break down faster than mineral coal.

COMBUSTION CHARACTERISTICS.

After some practice I found little benefit in strategically piling deeper at the front, back or centre of the fire with a conventional fire grate at least. I understand on trials with full size boilers this fuel can make life rather warmer for the fireman as the even burn means the backhead runs hotter. For the purposes of the 5" locomotives this has made little discernible difference. I can still burn my fingers on the controls just as effectively.

There were comments from some of the trials on full size locos the fuel took longer to light. This has not been my experience. Initially, I made a habit of reloading the fire while the passengers were getting off the train in the hope of gaining an additional minute or two for the product to light. Later on I switched to reloading the fire after pulling forward to load passengers. The slightly reduced ignition time made little difference. There was only a minor drop off on the pressure gauge when pulling away as one would expect and this quickly recovered as normal.

CLEAN UP

The fire tubes presented no greater build-up of soot than with regular coal. The only comment here is the soot appears to be softer and therefore easier to brush out of the tubes at the end of the day.

Another point I noticed was I normally drive home from the track, clean the engine down, take a shower and can still smell coal when I go to bed. Not so with the Ecoal. There is no lingering sulphur smell in the sinuses.

BOILER LIFE EXPECTANCY

The long-term effects of burning Ecoal on the silver soldered boiler joints is as yet unknown. I am no metallurgist but would speculate the cocktail of combustion products from the burning of mineral coal are more aggressive and likely to erode the solder joints of the boiler faster than the combustion products formed from burning organic material. Only time will tell. Anyone with expertise in this area please contribute.

IN CONCLUSION

By the end of the season the clinker issue with the club stock was becoming a topic of regular conversation and the suggestion was made to make a bucket of the 'new stuff' available for trial on other locos.

As ever the running season ended all too soon so the experiments with other locos will now be in the spring. The committee have made suitably encouraging noises so the treasurer *may* release the twenty quid for a club bag if we all behave.

Thus far I believe we have some promising results and would encourage other clubs to give it a go. For around twenty quid a bag what have you got to lose?

Given the deteriorating quality of available coal, the issue of clinker formation has become a real bugbear for many model engineers already. On this basis alone I would recommend trying a bag and embracing a life without clinker!

From what I have seen so far, I am happy it can be done, however eco coal is not steam coal so don't expect it to behave the same way. With only minor relearning of technique and a little practice, these eco fuels can give you all the steam you need to keep playing trains for the foreseeable future.

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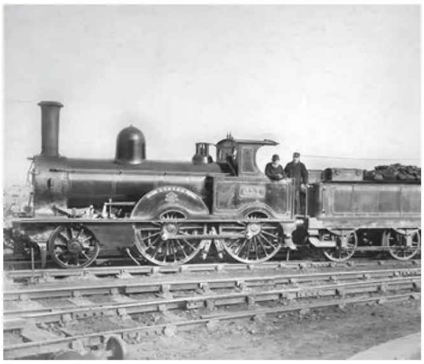
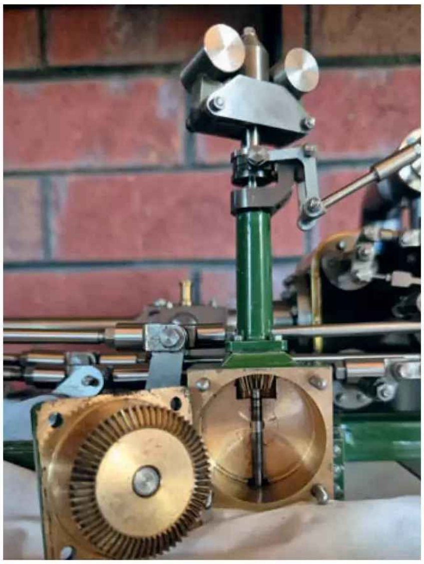


Chris Rayward describes Samson, an L&NWR 2-4-0 tender locomotive in 5" gauge.



David Thomas describes the Hartnell governor for his Mill Engine.

Will Doggett turns his engineering skills to a gardening-related project.

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Club News

Geoff Theasby reports on the latest news from Model Engineering Clubs.

Photo 1 Doug Hewson wagon from GL5 (Picture courtesy of Doug Hewson) 4776

I trust my readers realise that Club News is not a series of stand-alone articles but a continous narrative chopped into 12 items. That being the case, I usually have no problem starting off each one, as in this case, where Debs and I visited an old friend of mine in Leeds whom I had not seen for some years. On our return to civilisation, via the M1, we were overtaken by a white van bearing the legend "Cynwal a Chadw Highway" in the yellow and red chevrons on its rear doors. I suspected that it was an imposter, since Sheffield is far from Gogledd Cymru, and thus the van was out of its Chapter 8 jurisdiction and likely to be the cause of a collision as following traffic might hit it whilst trying to work out what it meant. Anyway, having obtained my friend's address, I looked on Google Maps for an aerial view of the property and its environs in case I could differentiate it from its neighbours by the collection of old motor bike parts on the lawn, as was the case at his old residence, but no. Perhaps being recently married has some connection. I also noted that due to joint problems, he has had his favourite armchair raised by a few inches. I hope he wasn't kept waiting too long for the essential item to be delivered *

There are times when my bed calls invitingly, offering seductive benefits when I should be rising to update the next Club News. I know I should leap from the pit, all bright and cheerful and ready to go. Leap, leap, I say, leap! sounding like Sputnik One. I heave my unwilling carcass to the vertical and set about creating another masterpiece for you, my lovely readers…

In this issue, Reunification, NOT the doctor, fast ladies, odd looking locomotives, Tequila! a nude calendar? and exotic motorbikes.

Kingpin, Spring, from **Nottingham SMEE**, opens with Tom Ingall on the great Reunification (of the Great Central Line) project. The final phase is being worked on, and checking the piggy bank, it is 75% full. Wow! Bob Bramson had a day to remember, in that he got a driving turn on a Romney, Hythe & Dymchurch locomotive. David Aitken has memories of the visit by 60103 to Ruddington, and the old debate about colour, double chimney and 'blinkers' continues… John Ollerenshaw visited the Vale of Rheidol Railway, whose three 2-6-2 locomotives were the last steam powered locomotives to be run by BR, in 1968. The weather was kind, and he had a great day out, free from the famous Welsh 'liquid sunshine'. Norman Smedley wrote about a workshop day, for both men and women. (Good! - Geoff) W. www.nsmee.org.uk

A Talk by Professor Jonathan Aylen, of the Newcomen Society, on Shadow Factories of WWII, should have begun by reference to Rolls-Royce Merlin engine crankshaft manufacture, but the nature of the subject had changed by the time of the meeting. I made reference to this subject in CN 4770 and 4767. The crankshaft story has yet to be given. The above talk was nevertheless very interesting, and Prof Aylen has supplied me with notes, see next month.

Norm Lorton sends *Turnout,* the newsletter of the **Ground Level 5 inch gauge Mainline Association**, featuring a fine model of an all-steel four-wheeled wagon, including the main drawings from Doug Hewson, **photo 1.** There's an article on the building of a coal drop at their track near York. Guy Harding won a first prize at MMEX, with his Metropolitan Railway stores van. W. www.gl5.org.

Welling & District MES Newsletter, February-March issue will certainly stand out when on display as the cover is a striking royal blue. A very fine picture of Mark Evans' SR 2-6-0 N0 1705 *Hither Green,* taken at the Erith exhibition. I note that not many Southern Region locomotives appear on these pages, with the exception of the 'Spam cans'. Tim Ellis is the new editor, and he points out that he is an Editor, not a content generator, so he asks readers to send contributions if they want to see the next issue. The Society was given a room at the Erith event and filled it with many models and displays to attract public and modellers. Tim noted the presence of 'OO' gauge models, which causes him to regard the asking price for the larger models as good value for money. This is followed by an item on Beatrice Shilling, whose simple 'Merlin' engine modification was quickly accepted and solved their problem of cutting out when the aircraft pitched nose down in combat. It worked by restricting the flow of fuel through carburettor under

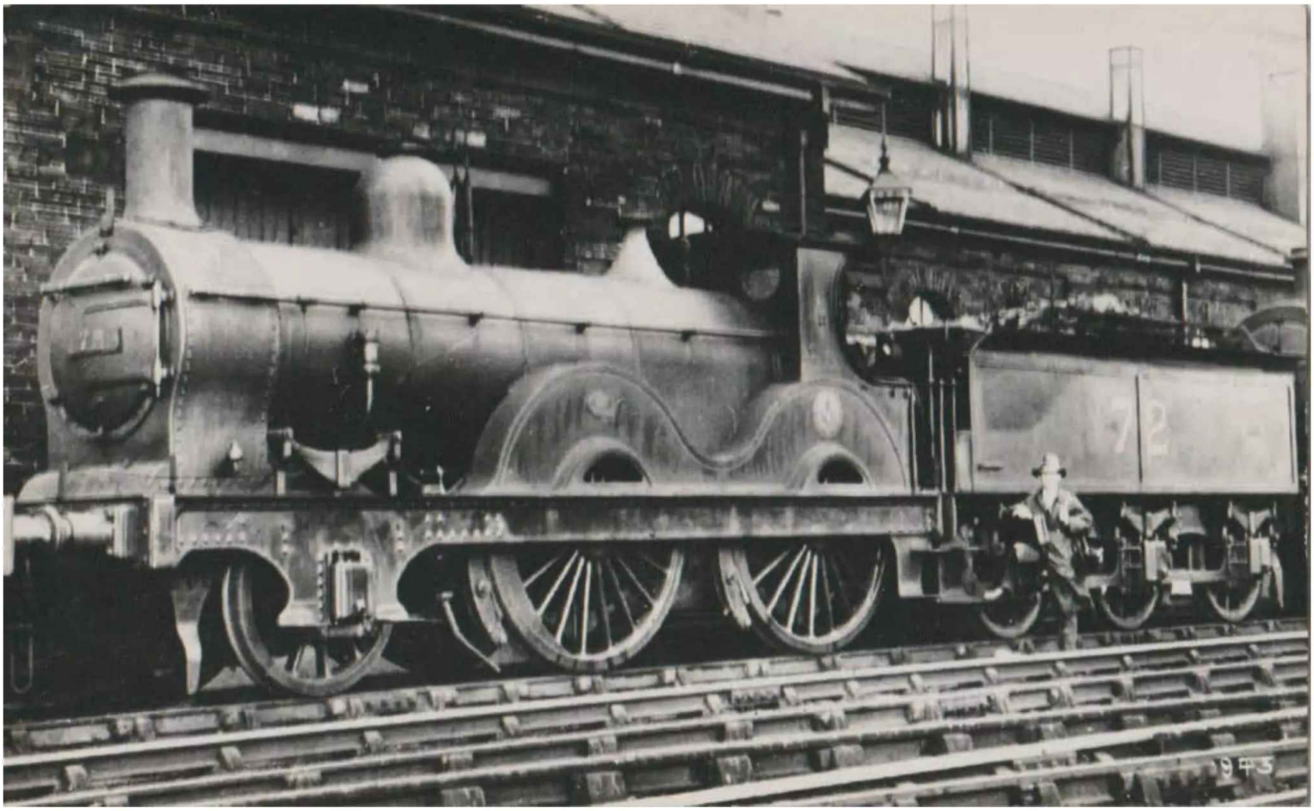
Photo 2 LMS 72 Class 111 (1P) at Hellifield CN4776

negative 'G' conditions. Technical Officer Beatrice Shilling worked in carburettor design and development and to deliver the fastest introduction of this modification, she toured RAF bases on her own motorcyle, a Norton 500cc which she had owned and maintained from the age of 14. Travelling to Brooklands by train, she achieved in excess of 100 mph on the Brooklands track, one of only 3 women to do so. In a piece entitled '*An amateur response to an amateur solution*', Ian Rolfe explained how he mounted a 3-bolt chuck on a 4-bolt backplate with only .01 mm runout. Tim Ellis continued with his fanciful locomotive using 'found materials' in the best tradition of William Heath Robinson himself. The model is now at the Heath Robinson museum, and a video can be seen on YouTube. 5-inch gauge wagons are the subject of another article by Tim, who has been producing a variety of scale wagons on a 3-D printer. An item on explains there were only 13 'Cramptons' in America, and as separate and individual railroads in that country, they tended to develop their own responses to deal with a common problem. This resulted in some very odd-looking locomotives. One such, utilised what appeared to be a garden shed as a cab. It has a dearth of windows, which are rather a necessity on a mobile item. A 'Camelback' loco, known as '*Humphrey*', caused me to spill my drink when I first read the item. W. www.wdmes.co.uk.

Sheffield SMEE *Steam Whistle*, February, opens with an item by Editor, Mick Savage, on cars built in Sheffield, followed by his views on making a project, which he built as an illustration that participants do not need a comprehensively equipped workshop. He built a Stuart No 4 using an old Black and Decker drill in a stand, and an old Myford. With this device he won 2nd prize at a Midlands exhibition. It was later sold by Christies auctioneers in London. Dr Murray Wilson has died, he was well regarded and contributed to the growth of the Society. His career was spent in anaesthetics, and he designed a gas failure alarm for operating theatres, which worked very well. He was also a consultant to the Civil Aviation Authority for sixteen years, on the design of aircraft seating. When asked about the safest seat on a 'plane, he remarked that aircraft do not normally reverse in to obstacles. Bob Potter tells how JBWeld saved his bacon by being involved in the repair of a fishing seat for his cousin. W. www.sheffieldmodelengineers.com. Another historic photo, is of LMS Class 111 (1P) 2-4-0 No 72, taken at Hellifield. The driver standing next to it wears a distinctly non-regulation hat, **photo 2.**

The Prospectus, February, from **Reading Society of Model Engineers**, contains an announcement of the retirement, after 20 years, of John Billard, as Editor. Alec Bray offered a story, *The Signalman*, not the Charles Dickens one, but another mystery for readers' enjoyment. It arrived at the same time as the March Issue. Terry Wood writes about his new 5-inch gauge tram. A previous MEX is reviewed, dating from 1913, their first, The details were found by Jim Brown. The then President, Mr E Hubert Foster, had been involved in the construction of an 18 foot model of a battleship in 1902. More recently, he had built a model railway of several hundred feet in length. W. www.rsme.uk.

East Somerset Society of Model & Experimental Engineers have found an editor for their newsletter, and sent two issues, beginning with the February issue. The second was closely followed by an unnumbered supplement. Further issues will be eight pages long, and he is sure that the Society is not lacking in contributions. However, let us contemplate the present and not dwell on the future. The Society are planning a stand at the Exeter MEX in May (Hmmm, EXMEX…? Is there a locomotive named Tequila, perhaps? That would be appropriate

Photo 3 Horse drawn bus at London Transport Museum 9175

- Geoff). Alan Hutfield was beginning a Fowler TE some twenty years ago, until a house move/enhancements forced it on to the 'back burner'. He has now taken up his model again starting with the front wheels. The Society are making three new carriages, to be ready for the main event in the Summer. The Junior members meeting was attended by eight youngsters, rising to fifteen in February W. *www.essme.org.uk*.

UK Mens Sheds Association, February issue of *Shoulder to Shoulder,* launches a practical guide entitled *Thinking Inside The Box* on adding a 40-foot steel container to their work area or its use as a club room. Several other items cover projects at a number of sheds: minibuses, local theatre advertising boards, and a recording made by North Colchester which is freely available by the expenditure of £1 in coin of the realm, proceeds going to club funds. Wittily entitled, *Better Shed than Dead*, it was written by a member during one evening spent in the company of a bottle of whisky. Everyone involved in the Thinking project found it great fun, and better than a nude calendar. I have a personal thanks to make to Wharfedale Mens Shed in that they assisted me in finding a long lost friend. Thank you. W. www.menssheds.org.uk.

Photograph 3 is a horse bus at London Transport Museum, Covent Garden

Bradford Model Engineering Society's *Monthly Bulletin* says the Society has decided to buy the locomotive *HMS Rodney* from its current owners. Five feet long, it is a great conversation piece to be taken to exhibitions for the publicity value. Martin Birch is building a new Manx tram. He arranged for the Motorman to be 3D scanned, using himself as scale model, suitably posed. JCB has designed a pothole filling machine, known as Pothole Pro. An ingenious answer to an access problem in some houses is a narrow-bodied dumper truck, barely three feet wide. Dominic Scholes built a 1929 Meccano Supermodels steam crane and then set about improving it. Jim Jennings was given a 'Train in a Tin'. It came in a small tin box, 5 x 4 x 2 inches (about OXO tin-sized) locomotive, boxcar, coal wagon and caboose plus track for a 22 x 19-inch oval. The power comes from an AA battery in the loco, upon which it will run for hours. Ade says, "It does what it says on the tin!" W. www.bradfordmes.co.uk.

GMES Newsletter, February, from Guildford Model Engineers society, draws our attention to Alan Millyard videos in YouTube. Alan is a skilled motorcycle enthusiast and engineer. I had a look and what marvellous creations he has made. Well worth a viewing. Peter Shires is building a 'Dragon' Class yacht. Andrew Giffen and Martyn Dix are building a model of 7 ¼ inch gauge Bulleid designed 4-6-2 Canadian Pacific. Nigel Paine delivered a talk on Napier engines, modifications of which were fitted to the English Electric *Deltic* locomotive. These engines were originally designed to power motor torpedo boats and minesweepers in WWI., using diesel fuel to reduce the fire risk. W. www.gmes.org.uk.

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MODELS

Part built Edward Thomas 5" ng loco. chassis, wheels, axles complete, silver soldered boiler complete with recent hydraulic cert. It's too heavy for me to complete. **Email: duncanwebster26@gmail.com. Tel: 07526473230. Warrington Cheshire**.

PARTS AND MATERIALS

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Complete set of Don Young's magazines "Locomotives Large and Small", 59 issues, all "Good" to "As new" condition, total weight approx. 11kg. £125 collection or postage at cost. **Email dah@uwclub.net. Stockport**.

5" gauge loco drawings - "Horwich Crab" by Don Young, 11 sheets + 'LLAS' articles, etc. £25. - "Crampton" by Brian Arridge, 14 sheets + 'EiM' articles, etc. £25. - "Nigel Gresley" by Martin Evans, 12 sheets + 'ME' articles, etc. £25 - "Rail Motor" by Don Young, 8 sheets £15. Each plus postage at cost. **Email dah@uwclub.net. Stockport**.

WANTED

WANTED - As a working memento, an Engines & Electrics coolant pump (3ph), as fitted OEM to Colchester and Cincinnati machines, amongst others, up to 1980's. **Email mrp@ thedrift.net. Tel. 07973 753 836**.

WANTED: Mirror mounts or first surface mirrors (Hilger watts etc). Hello, If anybody has any mirrors, mounts or other related accessories for autocollimators I would be interested to purchase them. **Email: ryan.carter848@gmail. com**.

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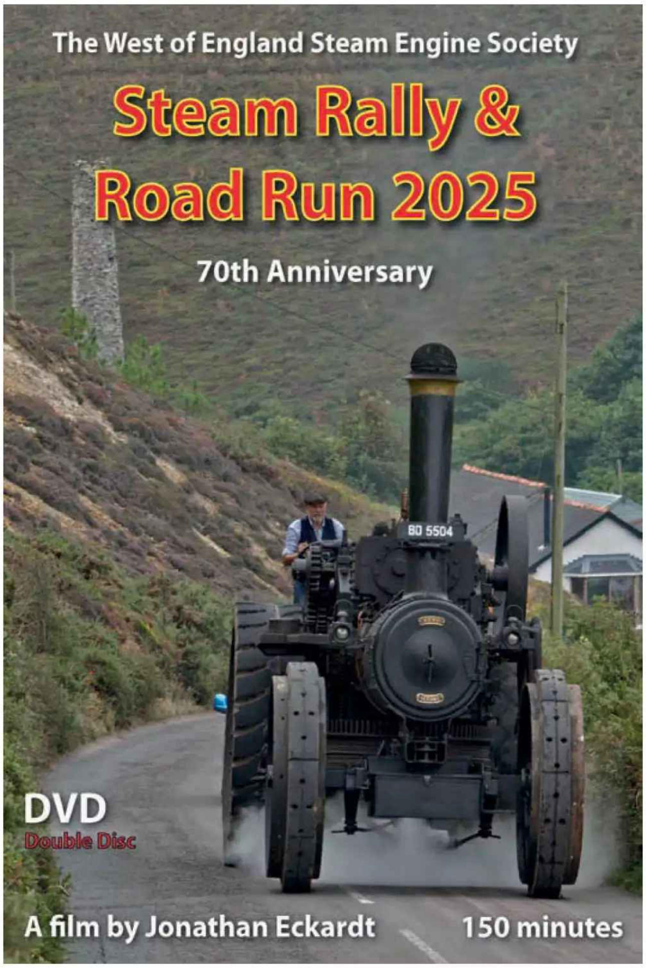

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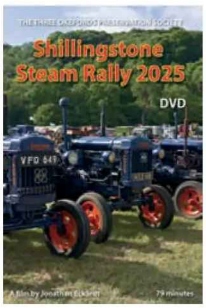

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