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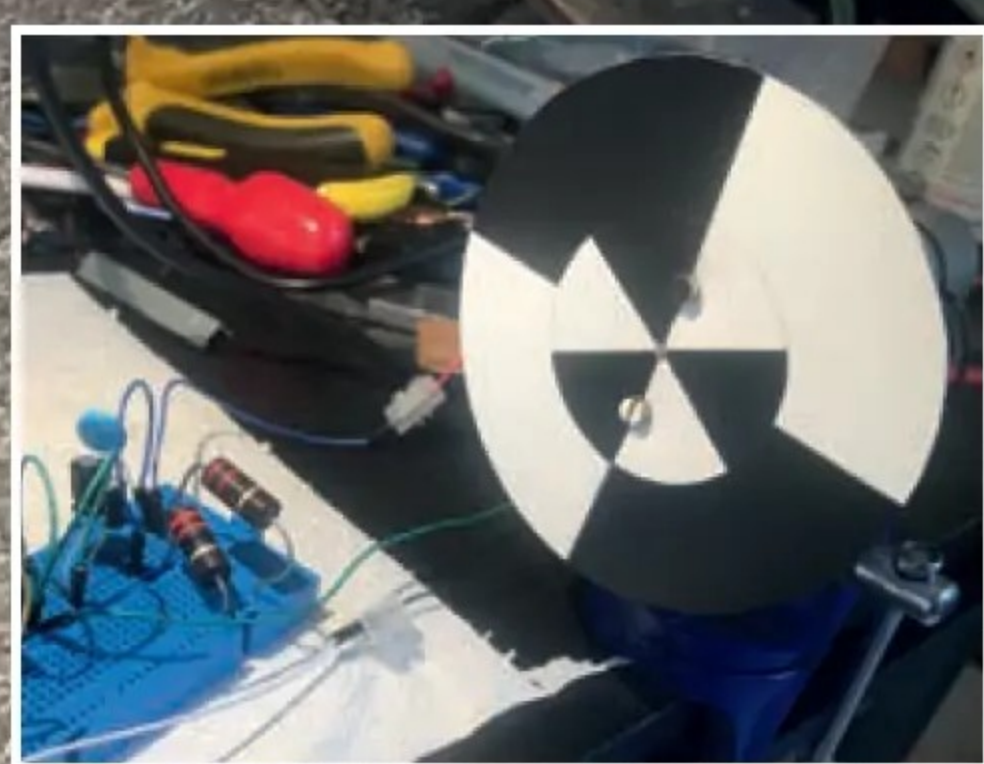
THE LEADING MAGAZINE FOR HOBBY ENGINEERS AND MODEL MAKERS

www.model-engineer.co.uk

Volume: 235, Issue: 4778, July 2026

Making a Steam Tram

INSIDE A WOODEN LOCOMOTIVE.

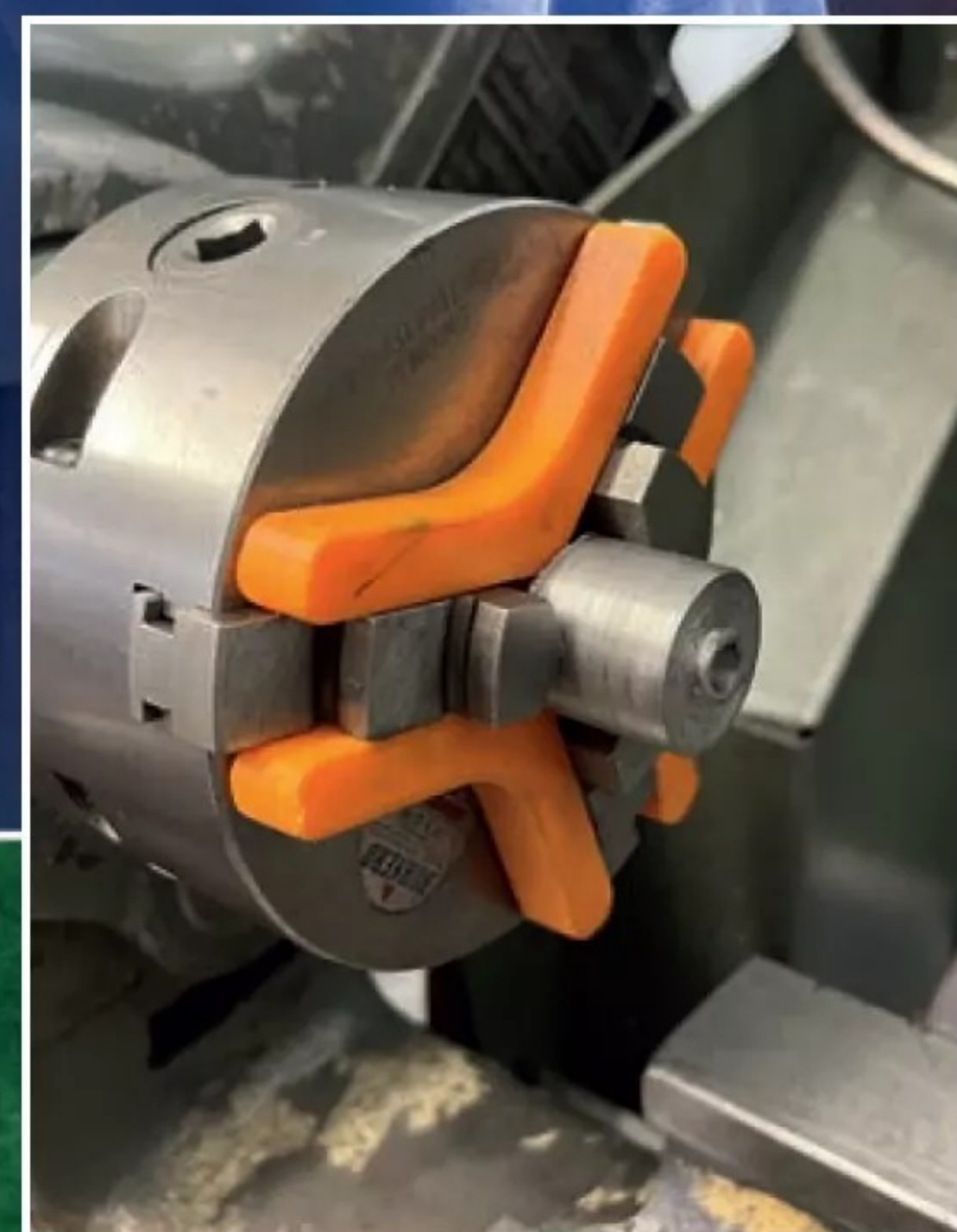


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Illustrator: Grahame Chambers
Publisher: Tim Hartley

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Kelsey Media Ltd, Media Centre,
Morton Way, Horncastle, Lincs LN9 6JR.

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Email: neil.wyatt@kelsey.co.uk
©2026 Kelsey Media Ltd.
ISSN: 0033-8923

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Sales & Distribution Manager: Carl Smith
Publishing Director: Dan Savage
Published by: Kelsey Media Ltd, Media Centre,
Morton Way, Horncastle, Lincs LN9 6JR

SUBSCRIPTIONS

Full subscription rates (see inside for offers):
12 months, 12 issues, inc. post & packing - UK
£71.40. Export rates are also available, see
www.classicmagazines.co.uk for more details.
UK subscriptions are zero-rated for the purpose
of Value Added Tax.

Enquiries: cs@kelsey.co.uk

PRINT AND DISTRIBUTION

Printed by: Acorn Web Offset Ltd,
Normanton, West Yorkshire.
Distribution by: Frontline Distribution Solutions
2 East Poultry Avenue, London, EC1A 9PT

EDITORIAL CONTRIBUTIONS

Accepted photographs and articles
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we cannot use will be returned if
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envelope, and recorded delivery must
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19 June 2026
The next issue will be on sale
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SMOKE RINGS

A FINAL VOYAGE

My father, John Wyatt, passed
away near the end of 2024 at
the age of 92. He never saw
himself as a model engineer,
with his main interests being radio
control aircraft and ships, although he
did run a Unimat SL. A former Royal
Engineers' Dispatch Rider, two years of
National Service gave him a lifetime of
anecdotes! He spent most of his work-
ing life running a business selling and
renting electrical goods. He could fix
anything, until microchips came along!

It's been a long, sometimes heart-
breaking, journey for my two brothers
and me dealing with what he left behind.
We've some things to friends of his and
been able to donate some of his books.
The biggest challenge has been his 1:48
scale model of HMS Warspite, which is
13' 6" long, so not a small model.

I'm delighted to report that, thanks to
the kindness of a volunteer with a huge
trailer, HMS Warspite has successfully
crossed the UK and is now with the Kent Battle of Britain Museum. A running but
partially complete model of a Town Class cruiser went along with it.

The photo shows, Sue Brocklehurst, daughter of John King the ex-Leading
Stoker on HMS Warspite, with the model. He was one of the two survivors from
the engine room whilst thirty-five of his friends and colleagues were killed around
him when the Warspite was badly damaged in May 1941. He took over twenty years
to die from illnesses brought on by the injuries he sustained that day.

Dad would have been over the moon to know that Warspite has found a
welcome home and made this historic link.



Neil Wyatt
Editor

Neil

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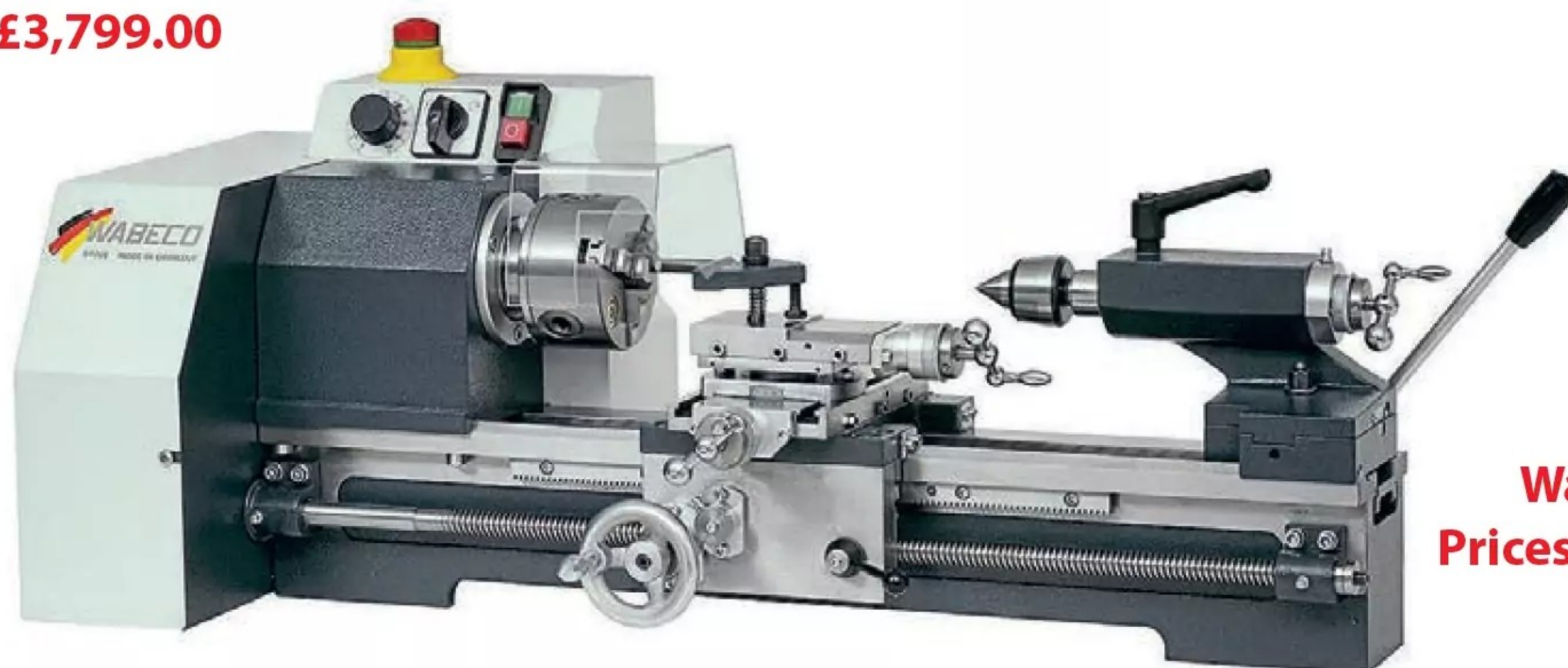
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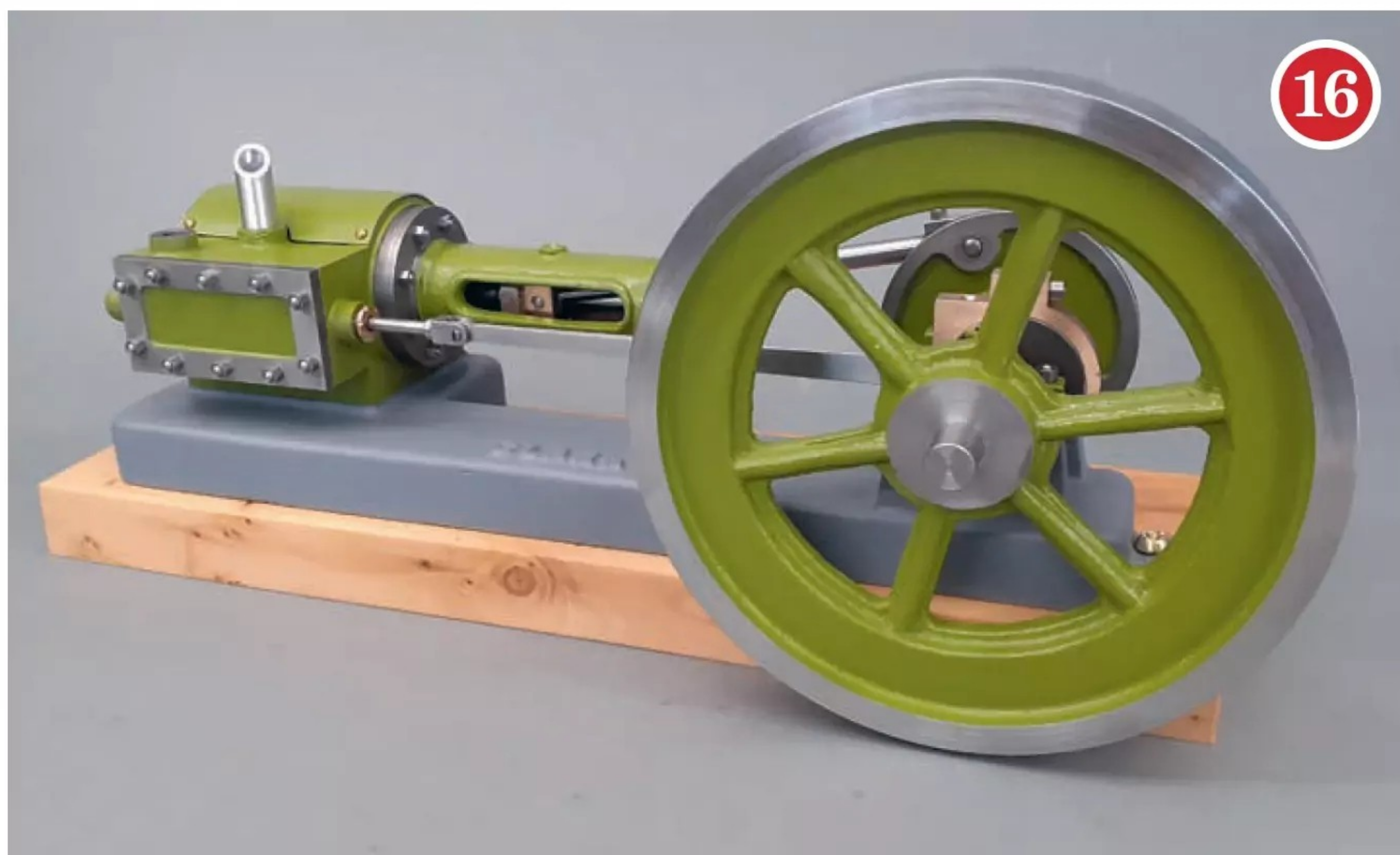
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Extra Content!

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

You can also see a video of Jason Ballamy's engine running using this QRcode.



Hot topics on the forum include:

Printed 3D metal better than a Casting – started by JasonB.
Is this the next big revolution for model engineering?

Dual use Jacot tool – started by Peter Cook 6.
A useful tool for turning small diameters, based on a 2013 MEW article.

24cc DIESEL ENGINE FROM SOLID - started by dean clarke 2.
A build log for a very big compression ignition engine.

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



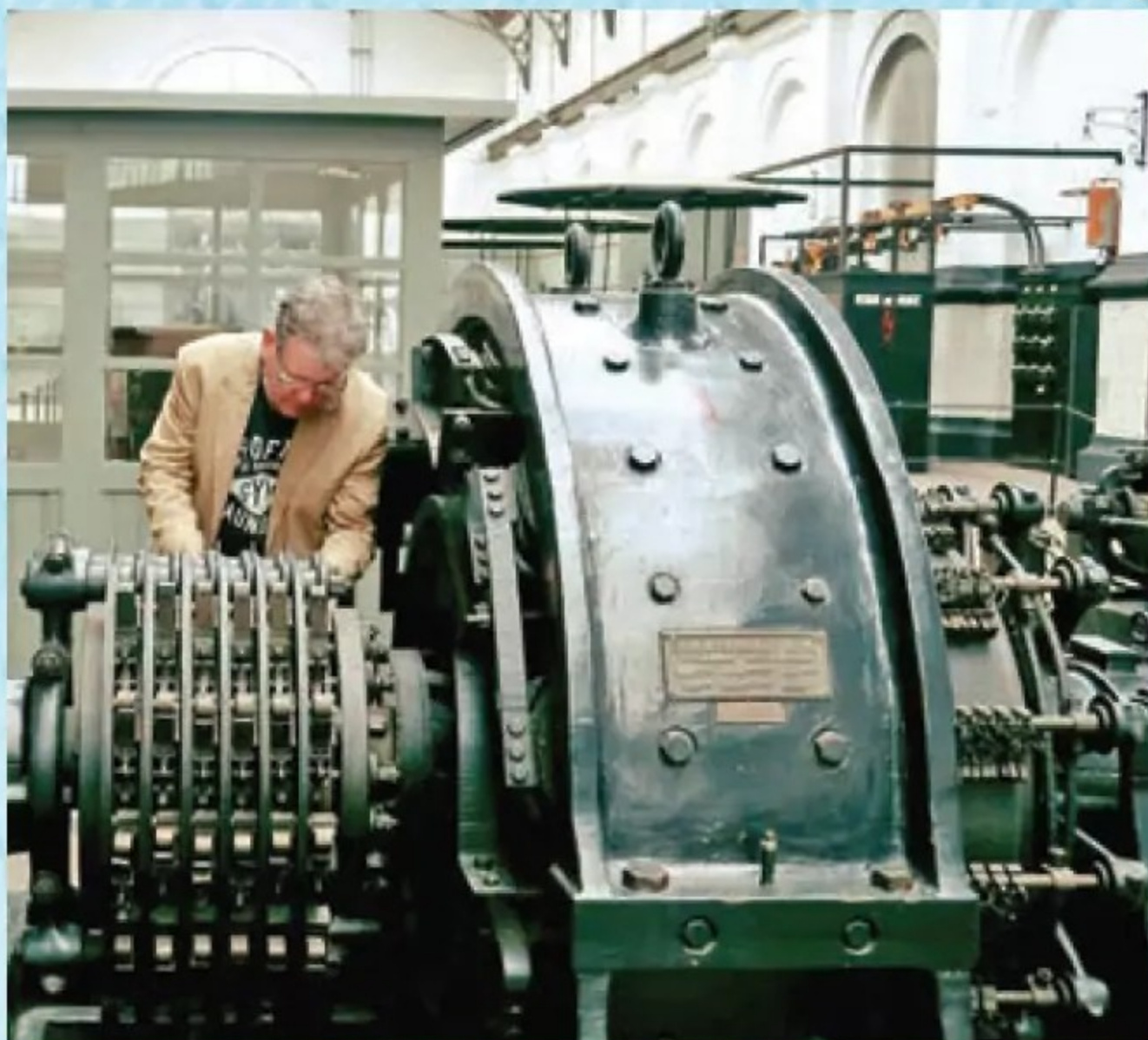
Our cover features Graeme Monk's charming 5" gauge LNER C53 tram getting up steam on the track. See page 44 for more details of this unusual build.

Next Issue



In our next issue, Roger Backhouse visits the Bolton Steam Museum.

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Early Developments In Hydrostatic Transmissions

Mike Tilby describes some important mechanisms that seem to be rather neglected.

PART 1

These articles were initially triggered by an earlier article that appeared in *The Journal* published by The Society of Model and Experimental Engineers (www.sm-ee.co.uk) by fellow SMEE member, Roger Backhouse, **ref. 1**. That article is entitled *Yorkshire hydraulic - a Hudswell Clarke world first* and it describes a miniature railway at Scarborough. As explained in Roger's article, when first built by Hudswell Clarke in 1931, the steam outline locomotives on that railway were powered by diesel engines fitted with hydraulic torque converters. In the previous year Hudswell Clarke had completed what is said to be the world's first commercial diesel-powered railway locomotive, *Junin*, which had a mechanical drive and was fitted with a fluid coupling. In 1932 the LMS railway built the experimental but unsuccessful diesel shunter number 1831 which was fitted with a hydrostatic transmission made by Haslam and Newton. Thus, the Scarborough railway had the UK's and possibly the world's first truly successful diesel hydraulic locomotives.

Roger's article made me realise how little I really understood about the various types of torque converters and fluid couplings. During what started as a brief exploration of the subject, my interest grew and I became rather carried away with it. I've written these articles in the hope that perhaps a few others will also find the topic of interest. However, learning about a subject purely by reading in isolation has its limitations and I hope that people more knowledgeable about this topic will correct the mistakes that are undoubtedly lurking in these pages. The present short series deals with the early years of hydraulic power transmission and focusses on hydrostatic transmissions, a term which is explained below in a description of some general principles. If our editor feels it appropriate, future articles could go on to describe the fascinating (well fascinating to me anyway) hydrostatic transmission mechanisms in railway locomotives,

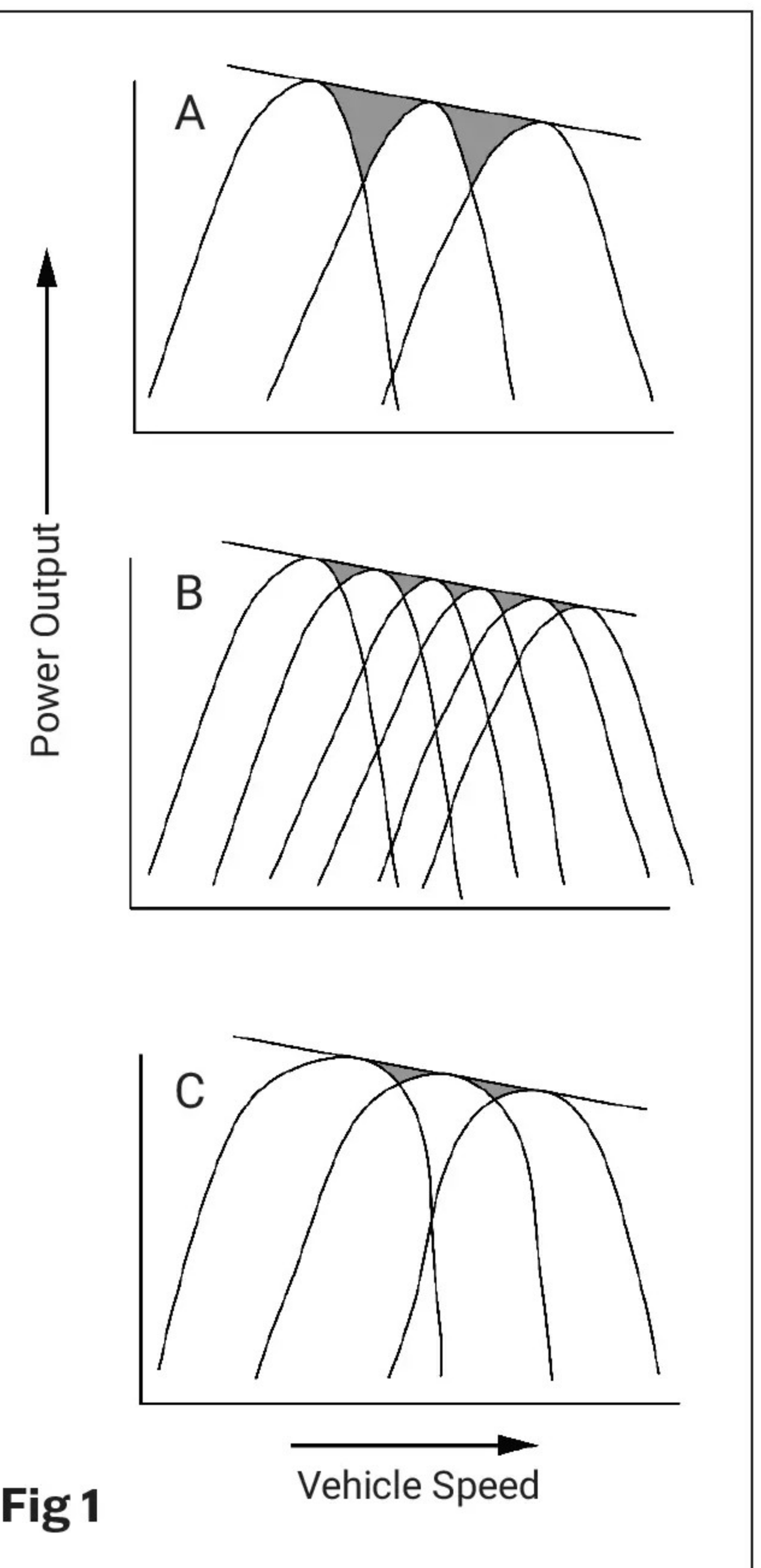
control systems for hydrostatic transmissions and then the important topic of hydrodynamic fluid couplings and torque converters.

Hopefully some knowledge of the background to development of hydraulic power transmission will make it easier to understand the types of transmissions, torque converters and fluid couplings that have been installed in locomotives and road vehicles and how those devices were developed. So this article starts with some general background and some details of early designs for hydraulically powered motors.

TORQUE CONVERTERS

Torque converters are most commonly discussed in relation to power transmission in internal combustion powered vehicles although they are widely used in other situations. The purpose of such devices is often to convert the high rpm output of some sort of prime mover such as an IC engine or turbine, to a lower rpm with a proportionate increase in torque. In that sense a mechanical gear box is a torque converter, but the term is mostly used to describe devices that are based on the use of liquid to transfer power between input and output shafts. Furthermore, it is normally the case that torque converters allow the ratio of input to output speed and torque to be changed gradually and smoothly. This is in contrast to a conventional gear box although certain types of mechanical drives can also provide smooth variation in speed ratio. In general, hydraulic torque converters give less efficient transmission of power compared to a gear-change box (roughly 80-85% versus 95%), however, they have significant benefits.

Generally, the power available for driving a vehicle varies with the rpm of its IC engine. So, for any particular gear ratio, power is maximum at the road (or rail) speed where the engine runs at its optimum rpm. Since a gear-change box changes speed ratio in large steps a graph of available power



against vehicle speed shows marked dips where engine rpm is sub-optimal, **fig. 1A**. The dips are made smaller by increasing the number of gear changes, **fig. 1B**, but use of a torque converter can avoid the dips altogether. In practice hydraulic torque converters are often used in conjunction with a gear-change box. In that situation the converter broadens the peaks in graphs of power versus speed and so the power dips are reduced without increasing the number of gear-changes, **fig. 1C**.

As explained below, the numerous designs of torque converters based on fluids can be divided into the two key categories of hydrostatic and hydrodynamic. These days hydrostatic torque converters are generally called hydrostatic transmissions or hydrostatic drives, and they often completely replace a mechanical gear

box. Also, they provide the means to transmit power to relatively remote parts of a machine or installation. In more recent times the term 'torque converter' is generally used to describe a hydrodynamic device.

HYDROSTATIC VERSUS HYDRODYNAMIC

Hydrostatic transmissions include some form of pump that pressurises the fluid. The pressurised fluid then drives, via direct pressure, some form of hydraulic motor before being returned to the pump. Hydrodynamic torque converters also include a pump, but its job is to accelerate the fluid to a high velocity. The fluid then passes through a turbine-type motor before returning to the pump. Of course both types of transmission rely on flow of a fluid but in the hydrostatic type, power is transferred to the output shaft via the static pressure of the fluid whereas in the hydrodynamic machine it is the kinetic energy of the high velocity fluid that transmits the power.

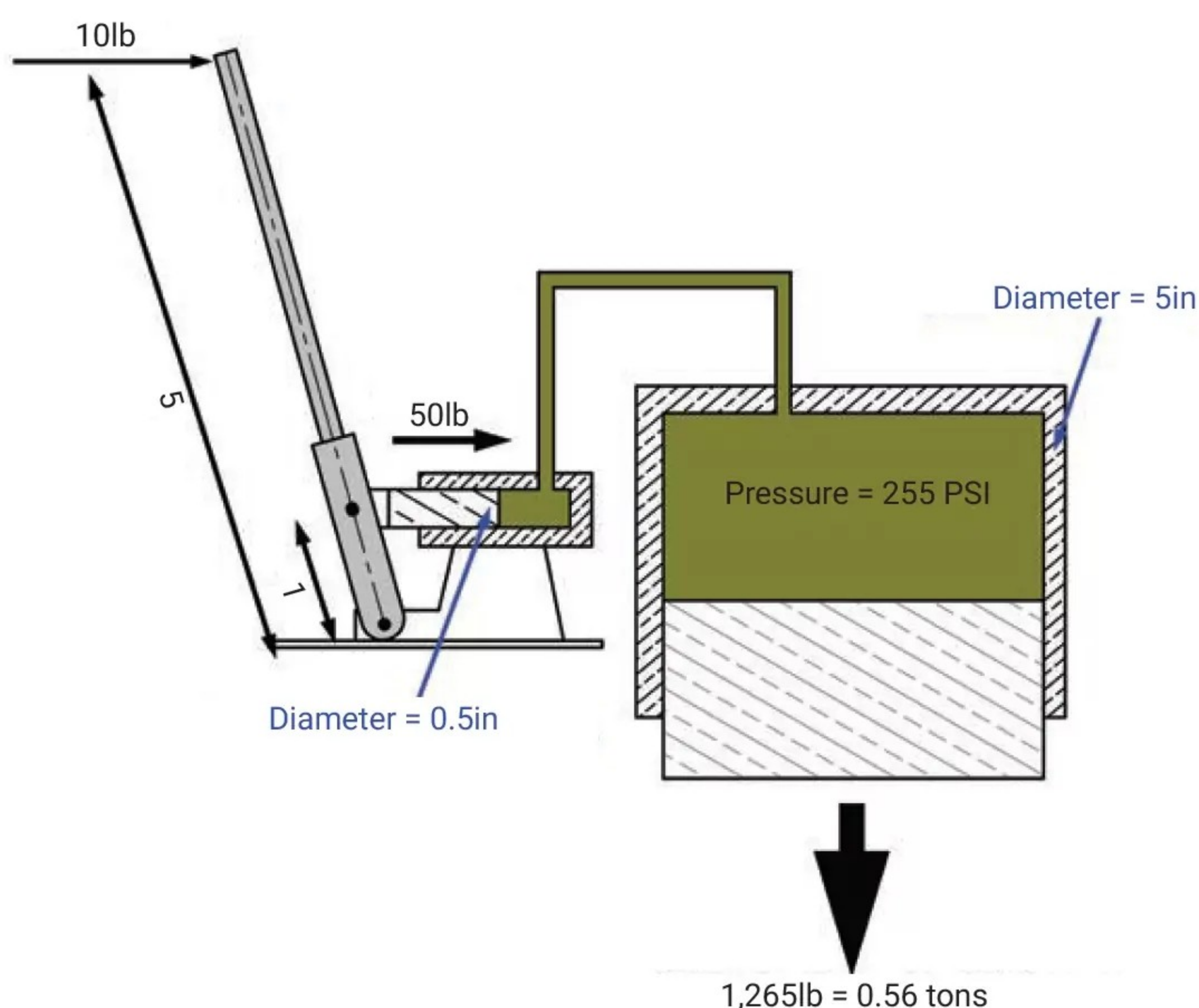
Fluid couplings, otherwise known as fluid flywheels or fluid clutches are hydrodynamic devices which differ from torque converters in that they do not give any change of speed or torque

Development of hydrostatic

BOX 1: HYDRAULIC VERSUS MECHANICAL MAGNIFICATION OF FORCE

In this example the 5:1 mechanical lever gives a 5-fold increase in force. That force acting on the small ram gives 255 psi pressure in the hydraulic fluid. That pressure acting on an area 100 times larger than the small ram gives a force 100-fold larger than the force acting on the ram. A high ratio can be achieved more easily and more flexibly by hydraulic than by mechanical means.

NB: The increases are of the force and not the work done since each increase in force is accompanied by an equal-fold decrease in distance moved and work = force × distance over which the force acts.



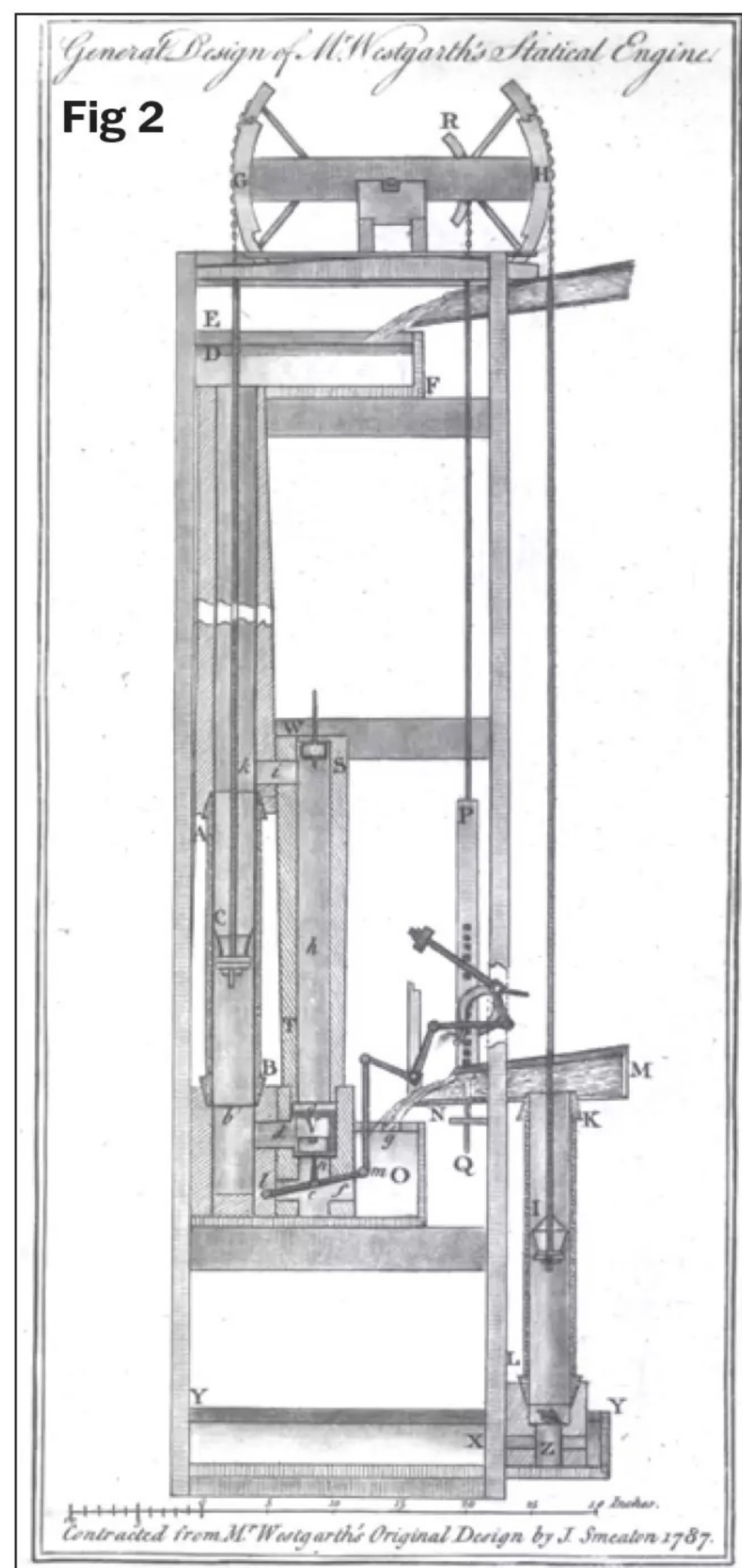
transmissions and hydrodynamic torque converters took place at about the same time. These initial articles will describe the hydrostatic type where the working principles are probably easier to grasp and are more easily adapted for use in models. The design and use of fluid couplings and hydrodynamic torque converters will be described in a possible later series, as explained above.

EARLY HYDROSTATIC POWER

By the time hydrostatic transmissions were first invented, high pressure hydraulic power had been in use for many years. A widely known early use of hydraulic principles to amplify an applied force was famously invented in 1795 by Joseph Bramah for his press. In that machine, a relatively modest force acting on a piston in the small cylinder of a pump was magnified by arranging for the pressurised water that it generated to act on a piston with a much larger diameter. The same principle is often employed in hydrostatic transmissions. (Anyone not

familiar with this principle might wish to look at **Box 1**).

Possibly less well known is that, for several decades before Bramah invented his press, hydrostatic power had been used to drive pumps for draining mines. Water under high pressure was obtained by piping it from natural sources at high levels and was used to drive various types of reciprocating mechanism, many of which superficially resembled Newcomen-type beam engines, **fig. 2**. Most of these pumps were in the mining regions of central Europe where the mountainous landscape provided ample water supplies at high elevations. Suitable water sources were less common in the British Isles but in the 1760s several hydraulic engines were built in the lead mining regions in Northumberland and elsewhere by a Mr William Westgarth. His pumps operated reliably and much more cheaply than coal-fired engines since, in those pre-railway days, coal was expensive to buy and to transport. The famous engineer John Smeaton thought very highly of Mr. Westgarth's engines **ref. 2**.

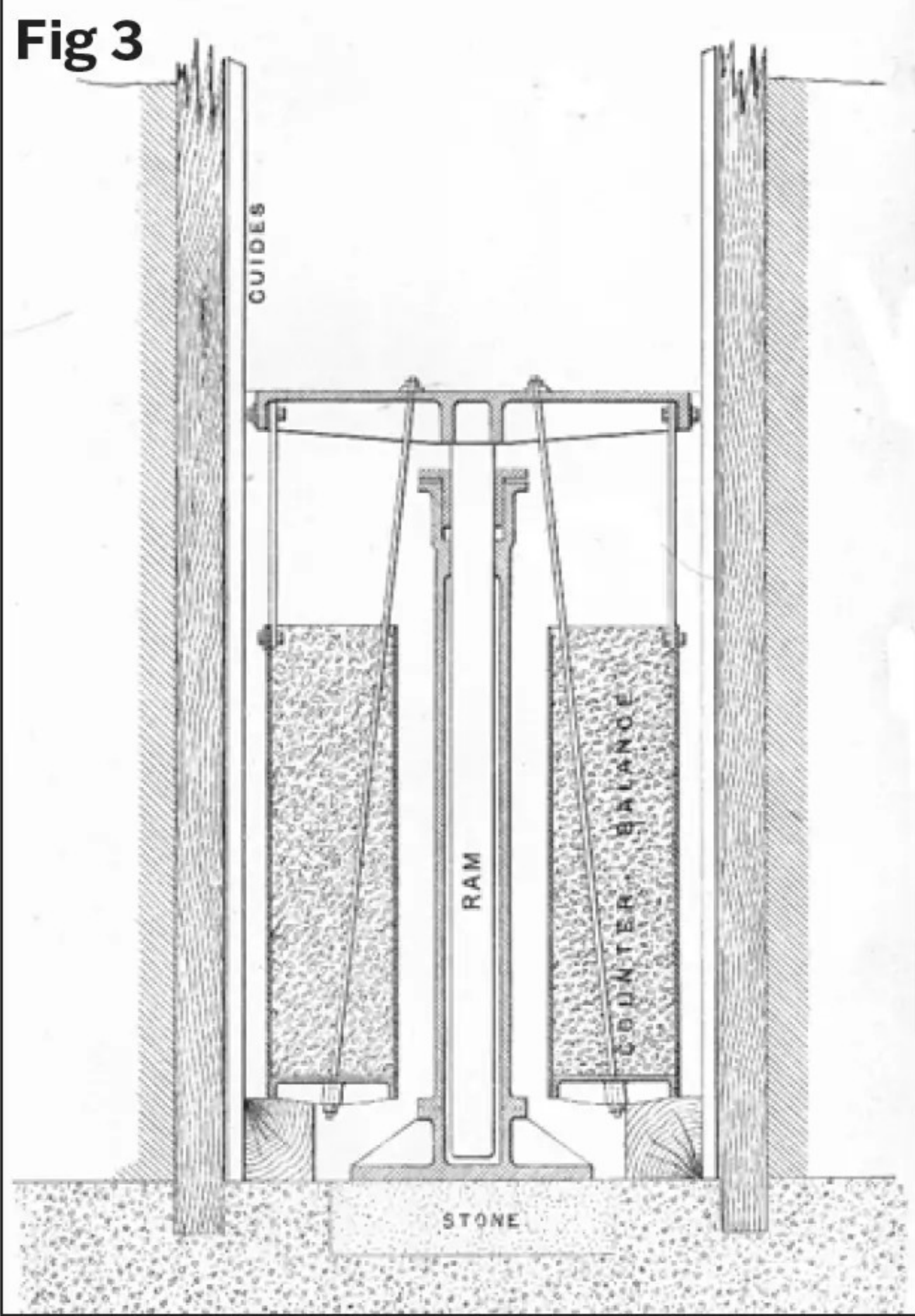


In 1812 Bramah proposed that pipes carrying water at high pressure could be used to distribute power, but it was not until the 1840s that the principle was put into widespread practice through the work of Lord Armstrong. He invented many mechanisms by which high pressure water could drive diverse types of machinery such as lifts, dockside cranes and moveable bridges. As a demonstration of his technology Armstrong erected a quayside crane in Newcastle upon Tyne. This worked very well and consequently Armstrong's hydraulic cranes were installed in the railway goods yard at Manors and then at the larger Forth goods depot, both in Newcastle upon Tyne. These machines were manufactured at Armstrong's large works at Elswick in Newcastle upon Tyne. Initially they were powered by water from the local water company's pipes which were at about 140 psi and supplied from a high-level reservoir.

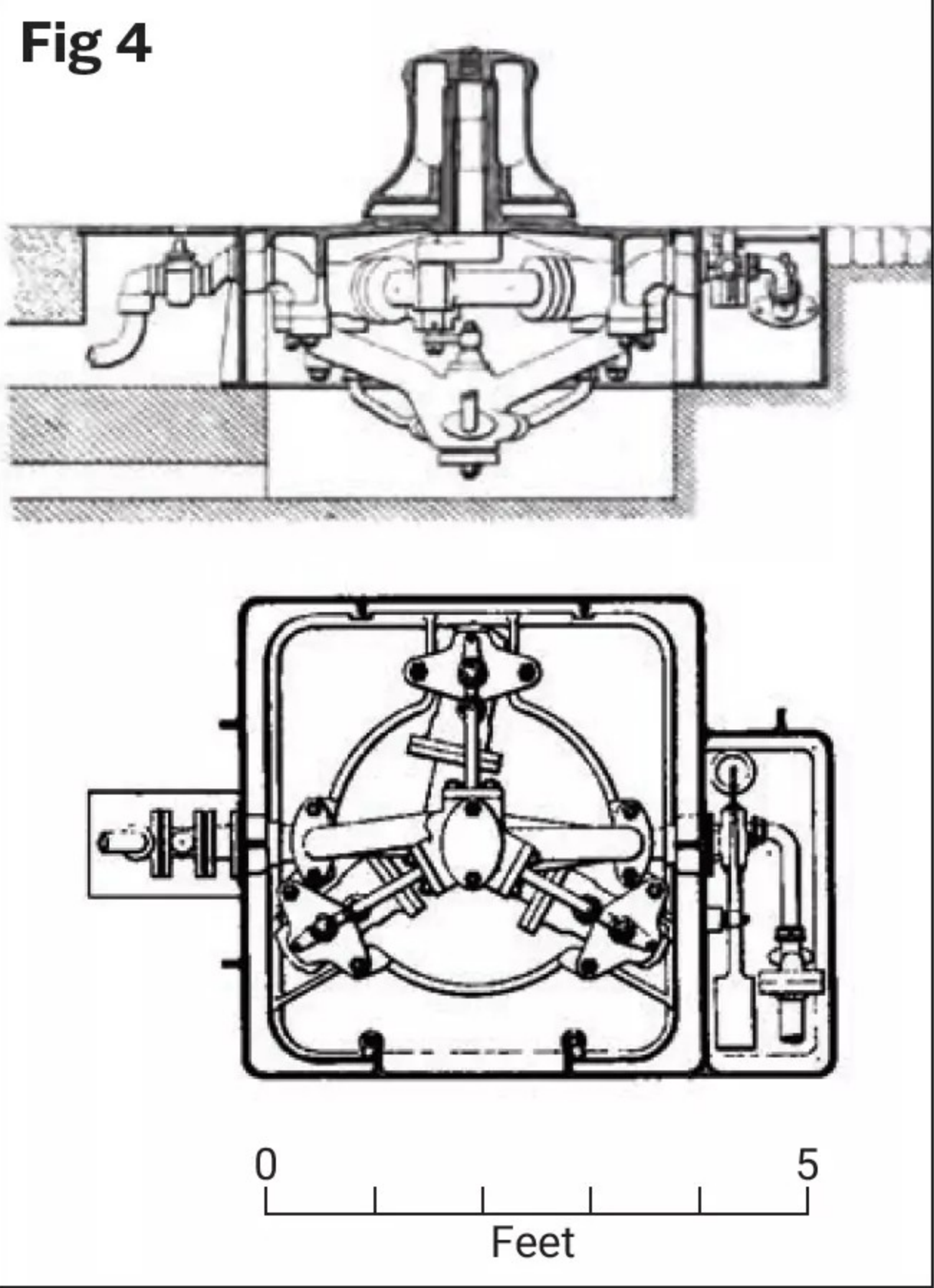
Subsequently, water for powering machines generally came from self-contained installations of pumping machinery or from special public networks of pipes carrying high pressure water to many establishments. In London, for example, the 'Hydraulic Power Company' installed many miles of under-street pipes that supplied, at its peak, many thousands of machines of various types.

HYDRAULIC MOTORS

Of particular relevance to hydrostatic transmissions in vehicles was the



invention of hydraulically powered motors to generate rotary motion. An early example of these is the three-cylinder oscillating engine, **photo 1**, that still turns the Newcastle swing bridge which was designed and built by Lord Armstrong and his company between 1873 and 1876. Weighing about 1,300 tons, it was once the largest swing bridge in the world. Another of Lord Armstrong's inventions was the hydraulic accumulator, **fig. 3**, in which a heavy weight pressed down on a piston in a vertical hydraulic cylinder. By storing water at high pressure it accommodated rapid variations in demand.



Many large railway goods yards had their own hydraulic power installations to drive cranes and numerous small capstans for moving wagons. The short videos in Ref. 4 show these in use at the LMS depot at Camden in London in the 1930s. The accumulator that was part of the installation at Kings Cross has been preserved (See Ref. 5). The capstans were operated by foot-controlled valves and had three radial cylinders with pistons acting on a single crank (**Fig. 4, photos 2 and 3**). Various other types of hydraulic motor have been developed such as gear and rotary vane types but those based on reciprocating pistons have been most favoured for hydrostatic transmissions so, initially, we'll focus on those.

The next part in this five-part series will point out key design differences between steam and hydraulic engines and then describe an early design for a variable speed hydrostatic drive. A possible later series will describe in detail, the hydraulic transmission used in the well-known experimental LMS diesel shunting locomotive 1831.

To be continued

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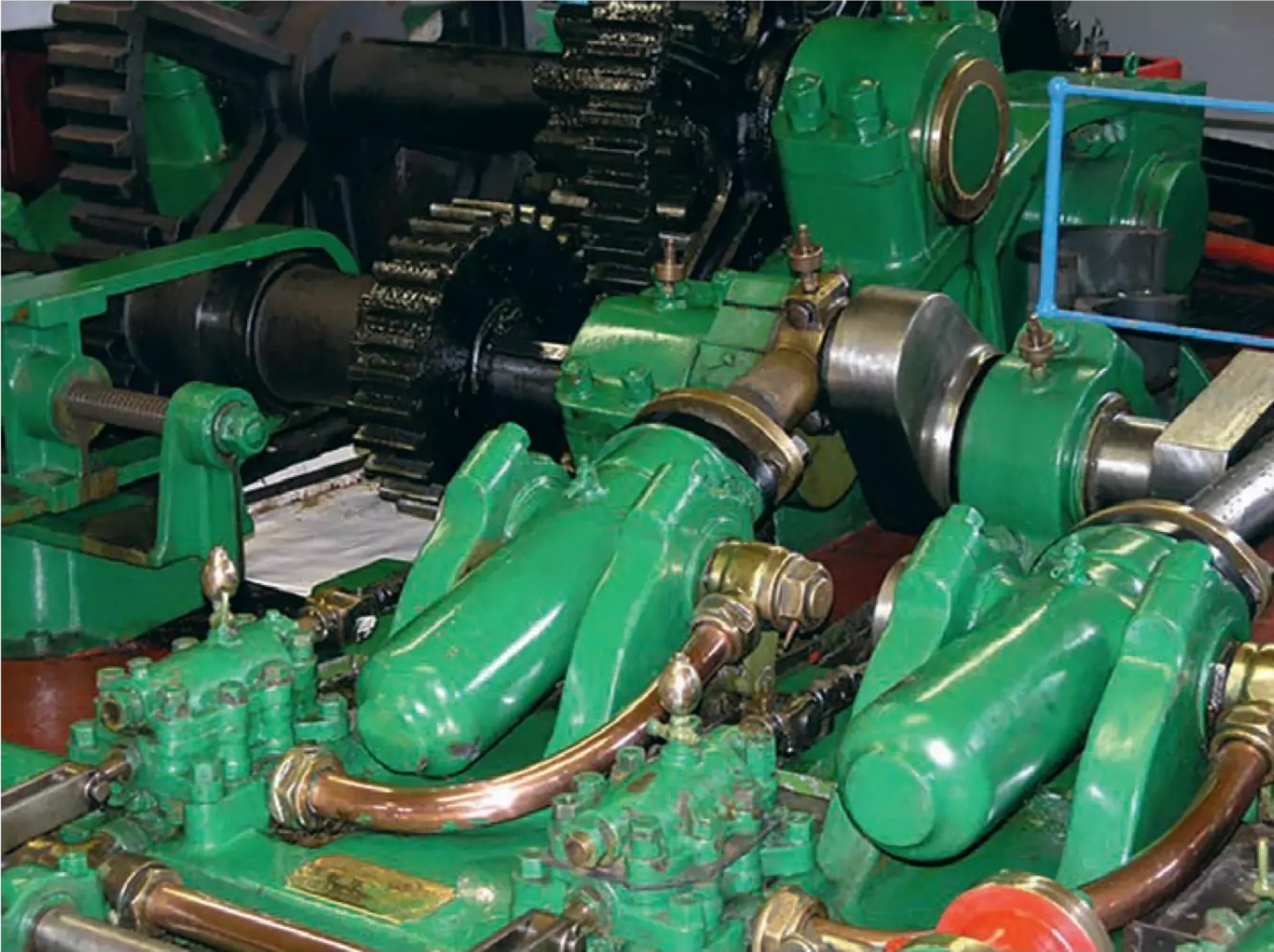


Photo 1: Hydraulic motors of the swing bridge over the river Tyne at Newcastle, built at Lord Armstrong's works 1873 - 1876. Photo: Donald Brydon, CCbySA2.



Photo 2: A 1 ton 'turn-over' hydraulic capstan, manufactured 1850.

and hand power lifting and pressing machinery. Spon (London) 120pp.

4. Two very short video clips showing the use of capstans in the LMS goods yard at Camden, London about 1932. Close up of capstan

operation: <https://www.youtube.com/watch?v=O2nfxANhkPQ> and several capstans: <https://www.youtube.com/watch?v=xtt9xNklx1k>

5. Article showing a photo of the Kings Cross accumulator:

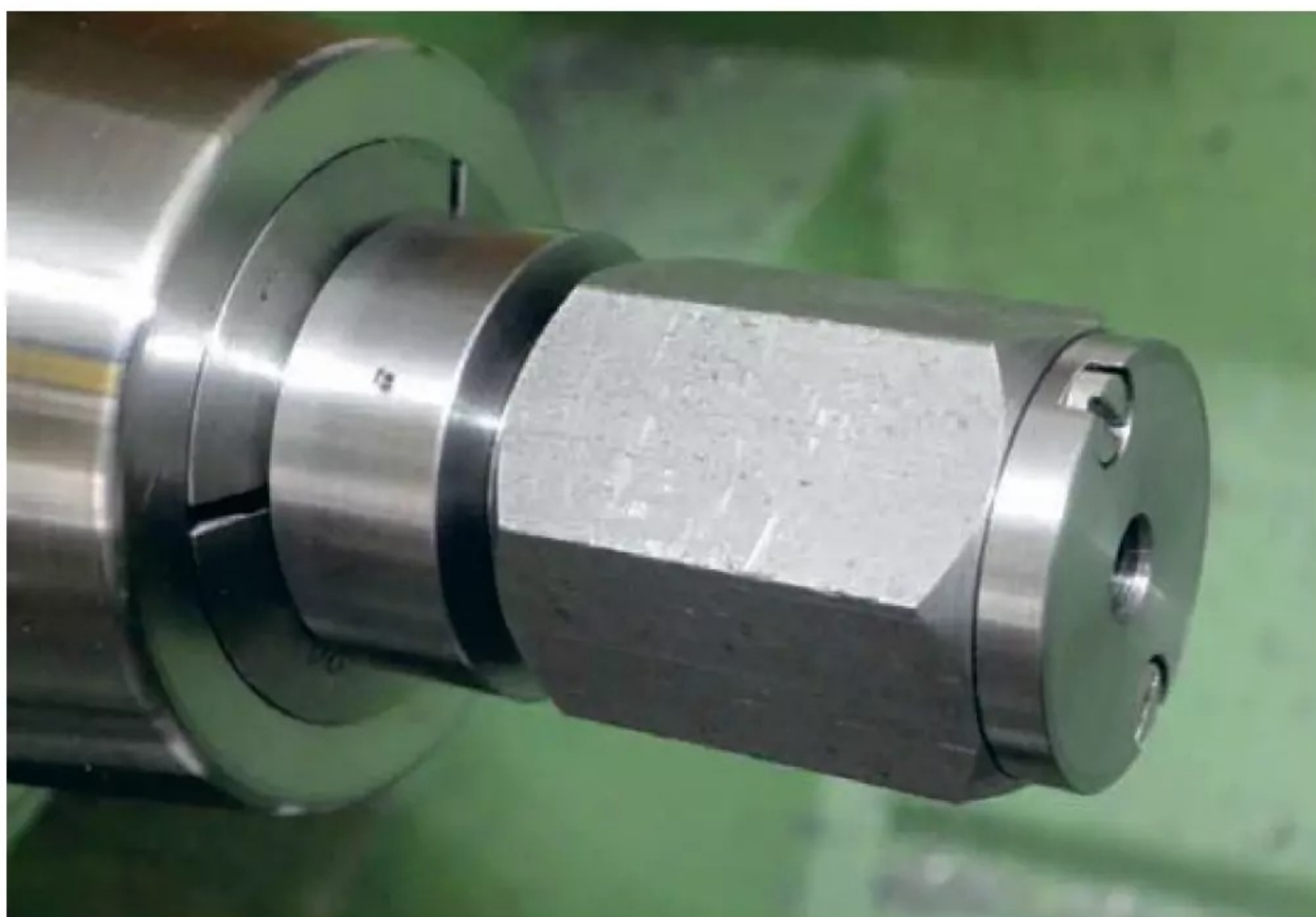


Photo 3: The machine is now in the Armstrong and Aviation Artefacts Museum at Bamburgh Castle, Northumberland.

<https://londonist.com/2015/05/first-look-inside-the-guardians-new-cultural-space-at-kings-cross>

6. Robinson, H. (1904). *Hydraulic power and hydraulic machinery*. Charles Griffin & Co Ltd, London 226p.

THE BRADFORD CUP AND STEVENSON TROPHY 2026



Entries for the Stevenson Trophy do not need to be as complex as last year's CNC Mill; in 2018 John Ashton won with this simple but elegant screw modification fixture.

We would like to remind readers of these two competitions. Full details and competition rules were published in issue 4777. The deadline for entries to either competition is 26 July 2026.

The Bradford Cup, is awarded to the author of the best article or series in *Model Engineer/Model Engineer & Workshop*. Articles that appeared in Issue

4762, March 2025 to 4773, February 2026, are eligible for this year's competition.

Entries to the **Stevenson Trophy** for practical workshop equipment are open to all *Model Engineers Workshop* readers and *Model Engineer* forum members, who may enter their own work.

To make a nomination for the Bradford Cup or enter the Stevenson Trophy, please send the name of the author and the article in question to neil.wyatt@kelsey.co.uk by 25 August 2025.

Details of the entries for both competitions and a link to the online votes will appear in the October issue (out in mid-September) so that the trophies can be awarded at the Midlands Model Engineering Exhibition.

The Rob Roy Rally 2025

To accompany the announcement of this year's meeting for owners of Martin Evan's Rob Roy design, **Rex Hanman** looks back at last year's event.



Photo 1 Paul Wootton still going strong, photo Martin Attewell.



Photo 2 Trevor Wootton with a happy engine.

After a dozen dry Rob Roy rallies, with a dire weather forecast, and heavy rain on the M5, it looked like it was going to be unlucky number 13 when the latest gathering took place on the 20 September 2025. Amazingly, apart from a light drizzle early on, it remained dry at the Bromsgrove Society's lovely track site.

Once again, the author arrived to find Paul Wootton storming round the circuit, **photo 1**, I swear he hasn't stopped since two years ago!

This year there was a good turnout of eleven Rob Roys, with complete engines and some still under construction. Amongst the regular faces was Trevor Wootton who came with Simon Mahon. Simon brought a locomotive that hadn't been steamed for 38 years. Originally built by Steve Faherty, it featured a small brass plaque inside the cab proclaiming it to have been exhibited at the 1982 Model Engineering Exhibition. Trevor and Simon soon had it running up and down in the steaming bays. It didn't seem to object, all three had happy smiles on their faces, **photo 2**.

From the host club, stalwarts included Dave Palmer with his CR liveried example, and Chairman Pete Maybury, who had added the rather nice touch of miniature lamps on the

cab sides, **photo 3**.

Ian Horsfield was, of course, in attendance with his still unpainted but otherwise beautiful engine. In previous years Ian has struggled to get this



Photo 3 Pete Maybury's lamps were a nice touch.



Photo 4 Ian Horsfield's fourth lap.

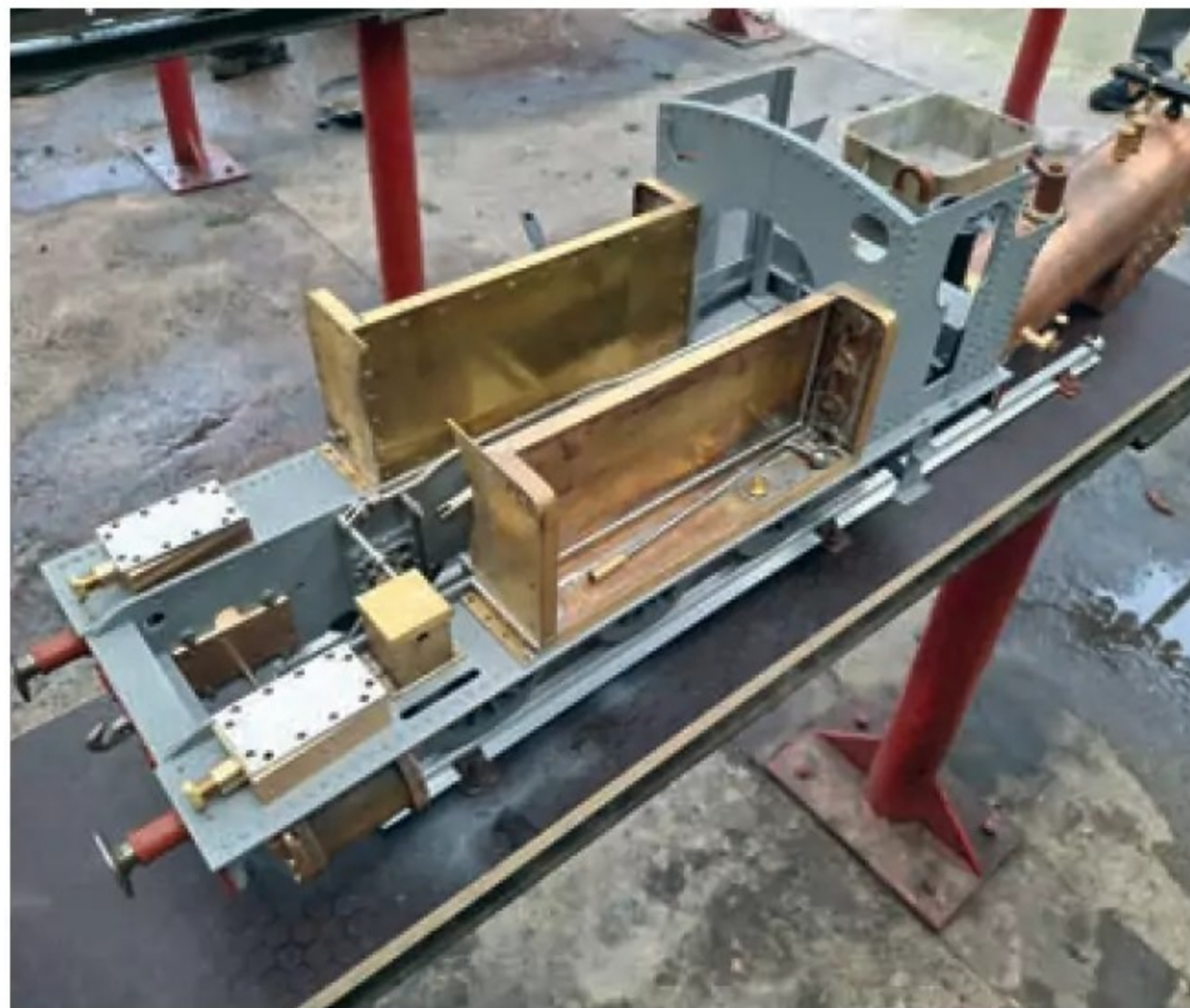


Photo 5 Peter Fairhurst's future masterpiece.



Photo 6 Warwick Jackson poses with his recent acquisition, photo Martin Attewell.



Photo 7 Bob Dunn (rear left) and his 3 1/2" Ivatt joined some of the proud owners, Alan Hartley, Bob Griffiths, Trevor Wootton, the author, Simon Mahon, and front row, Peter Fairhurst, Ian Horsfield and Paul Wootton, photo Martin Attewell.

model to perform, but this was his year. As he passed the steaming area, he declared it was his fourth lap, **photo 4**. I think he got his maths wrong, he had probably done more than that.

Bob Griffiths, formerly of the Bromsgrove club, returned with his black engine proudly carrying its Rob Roy nameplates. Alan Hartley from Burton on Trent arrived with his almost complete example. Currently lacking a chimney, it looked to be otherwise finished. Alan described it as a "work in progress".

Peter Fairhurst from Melton Mowbray also had a part-built project with a nice Western Steam boiler. His well-made rolling chassis, with yet unfinished side tanks, will be a fine example in the future, **photo 5**. Like the author, Peter had chosen to fit the hand pump in the right-hand tank. This tank is larger than the left hand one

which is narrower to accommodate the reach rod behind it. Additionally, it is more accessible to a right-handed driver, who doesn't have to reach over the safety valves to operate it.

Star of the show must go to Warwick Jackson, who visited from Bridgenorth. He recently purchased the loco at an auction and knows almost nothing of its pedigree. Whoever built it made an excellent job of it. The painting and lining make it worthy of any exhibition, **photo 6**.

There was, of course, the traditional line up of those present, **photo 7**.

In total there were thirty two visitors from six counties at this years 'Rob Roy and Friends' event, **photo 8**.

The first Rob Roy rallies were held at the Andover club. Over the years their raised track has deteriorated, but major renovations are currently under way. With this in mind, next year's assembly will be held at Bromsgrove SMEE in Worcestershire.

As always, thanks to the Ian Horsfield and the members of the host club for their welcome and fine lunch. 🍷



Photo 8 There was much to discuss in the steaming bays.

This Year's Loco Rallies



Rob Roy Engine RALLY 2026

**Join us on Saturday
5th September
10.30am until 4pm**

Meet other enthusiasts

All Rob Roy locomotives, whether part-built, fully running or in project stage are welcome.

No RobRoy? no problem

Other 3.5 inch locomotives also most welcome on the day!

Interested in attending?

Contact: Ian Horsfield on 07857 336425

Bromsgrove Society of Model Engineers
Avoncroft Museum of Historic Buildings
Bromsgrove, Worcestershire B60 4JR.

DREAMING SPIRES RALLY

24-26 July at City of Oxford Society of Model Engineers. For live steam from 16mm garden railway gauges up to 7 1/4". To book or for further information, contact denis.mulford@btinternet.com

INTERNATIONAL MODEL LOCOMOTIVE EFFICIENCY COMPETITION - IMLEC

7-9 August at Sheppey Miniature Engineering and Model Society. Typically larger locomotives with classes for both 3 1/2" and 5" gauge. Contact: smemsmail@talktalk.net

SWEET PEA RALLY

13-14 August at Rugby Model Engineering Society. Celebrate the popular Sweet Pea and related miniature locomotive designs. For further details contact rmes@gmx.co.uk

ROB ROY ENGINE RALLY

5 September at Bromsgrove Society of Model Engineers. All Rob Roy locos from part built to running welcome, plus other 3 1/2" designs. Contact Ian Horsfield, 07857 336425.

LBSC MEMORIAL RALLY - CURLY BOWL

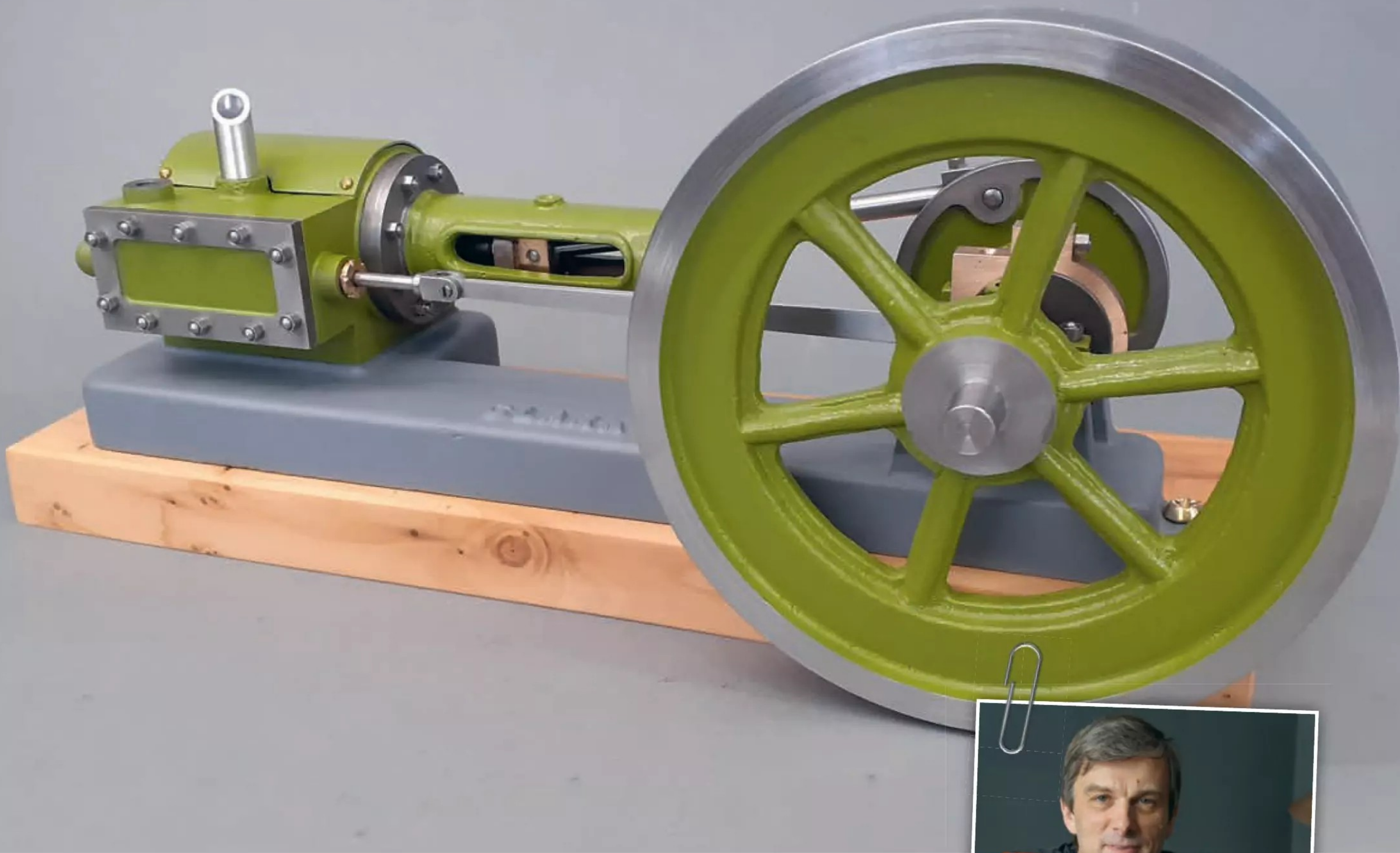
13 September at Reading Model Engineering Society. The event is open to any LBSC design/derived locomotive of 2 1/2", 3 1/2" and 5" gauges that have not won the trophy before. For more information and entry requests please email Steve on lbscrally@gmail.com

SMALL LOCOMOTIVE EFFICIENCY COMPETITION - LITTLELEC

20-21 June at South Cheshire Model Engineering Society. LittleLEC is an annual locomotive efficiency competition for drivers of small locomotives weighing less than 50lb dry. For more details at www.littlelec.co.uk

MINIATURE DIESEL LOCOMOTIVE GALA 2026

18 July at Nottingham Society of Model & Experimental Engineers. A miniature diesel locomotive event for 7 1/4 inch, 5 inch & 3 1/2 inch gauge locos, plus a miniature electric road vehicles display. Contact buxton845@gmail.com



The Clarkson 24x38 Horizontal

PART 5

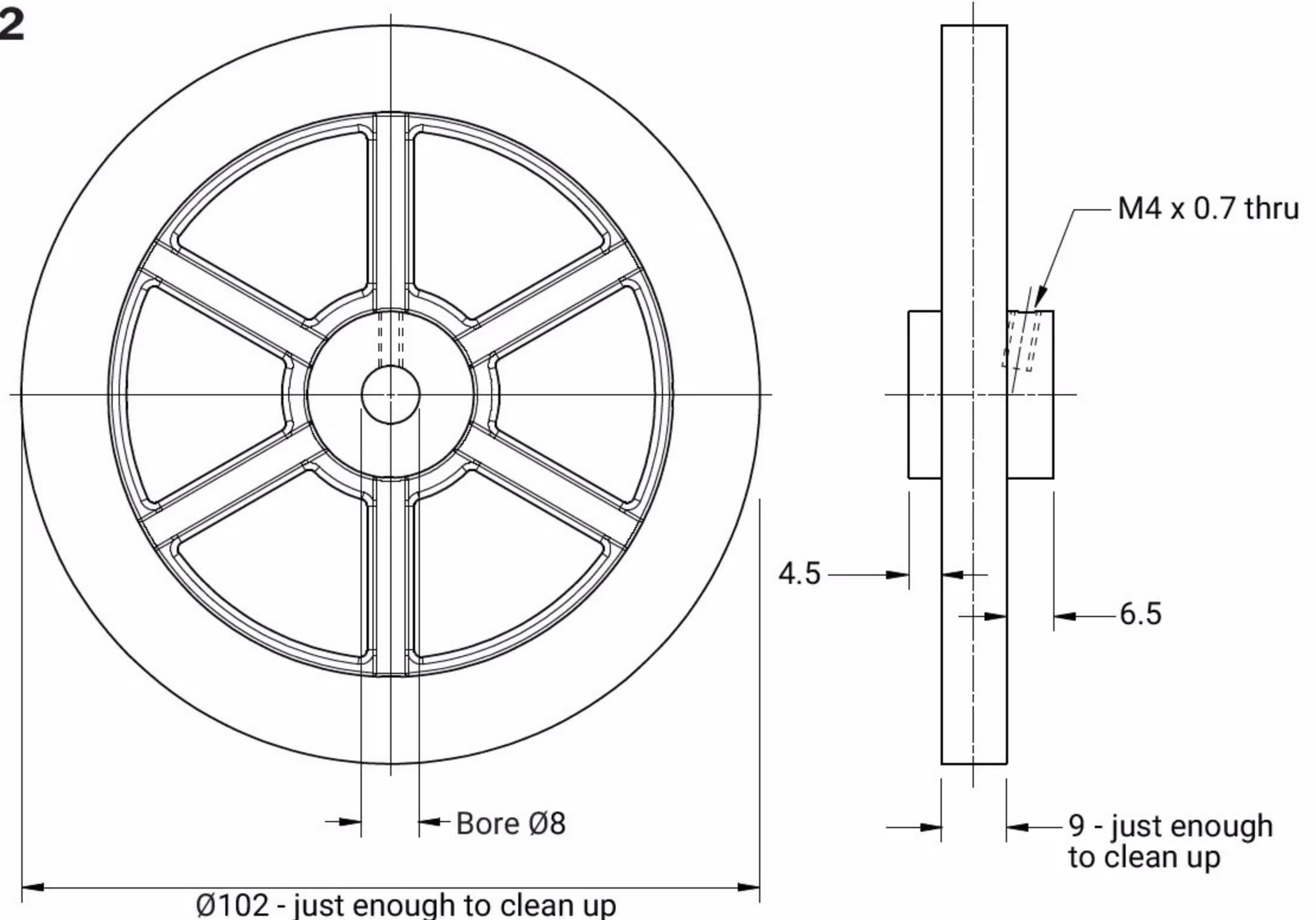
In his series aimed at beginners, **Jason Ballamy** completes this simple steam engine, using castings available from **Blackgates Engineering**.



FLYWHEEL

This is intended to have a painted rim so only needs the minimal amount of clean up in the lathe. If you are the type that likes a bright rim, then to avoid removing too much mass from the existing flywheel I will cover the fitting of an additional rim at the end of this series of articles. I was able to hold the casting by expanding the 3-jaw chuck against the inside of the rim, which is ideal as it allows the outer diameter (OD) and side to be machined without chuck jaws getting in the way. The OD is likely to need the most machining, but the side just needs enough to partly clean it up. Without disturbing the casting in the chuck, face the hub, drill to 7.5mm and then finally bore to size aiming for a firm push fit on the crankshaft which should eliminate the

Fig 12



Flywheel
Mat'l: Iron casting



Photo 57: Flywheel turned and bored

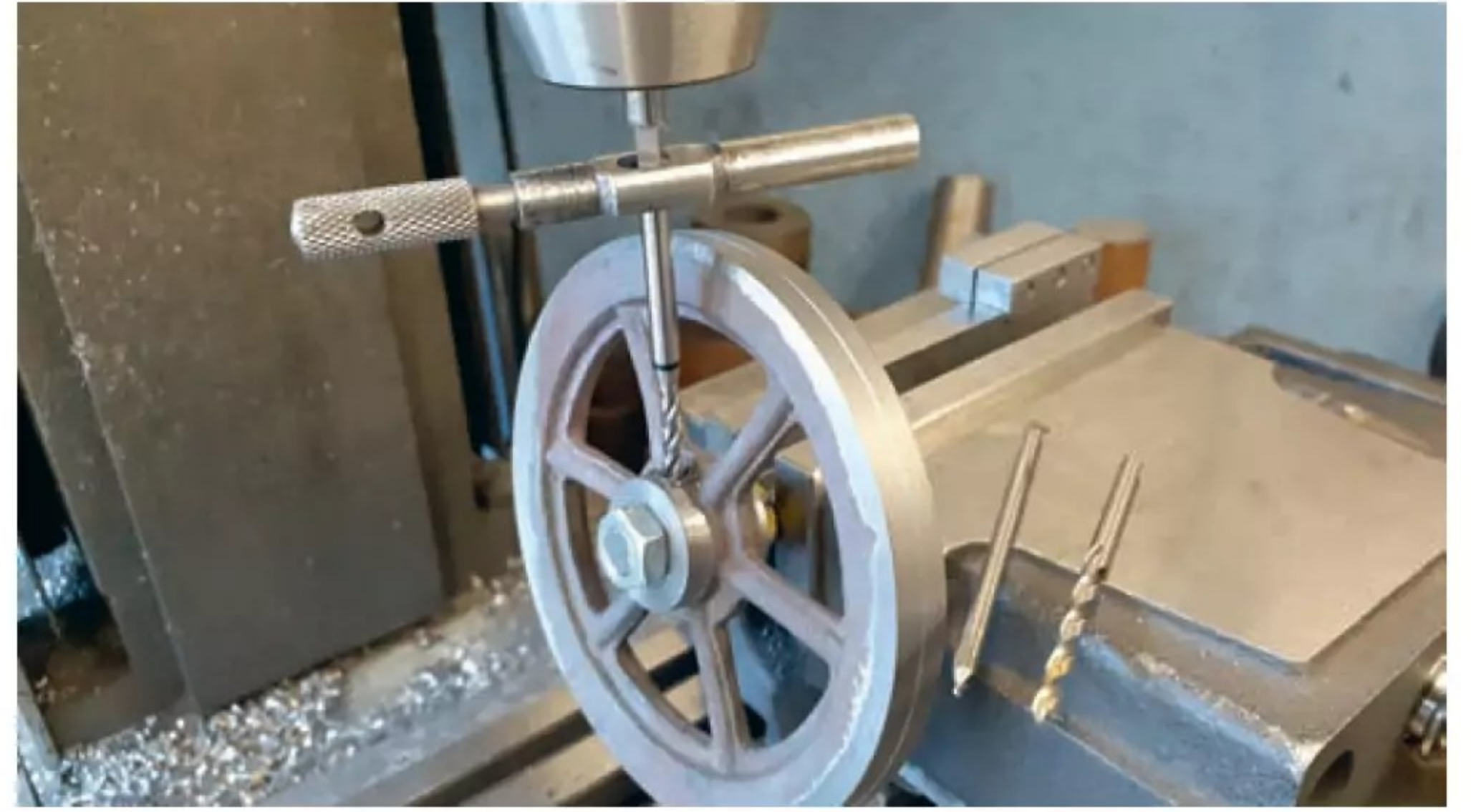


Photo 58: Tapping flywheel for grub screw

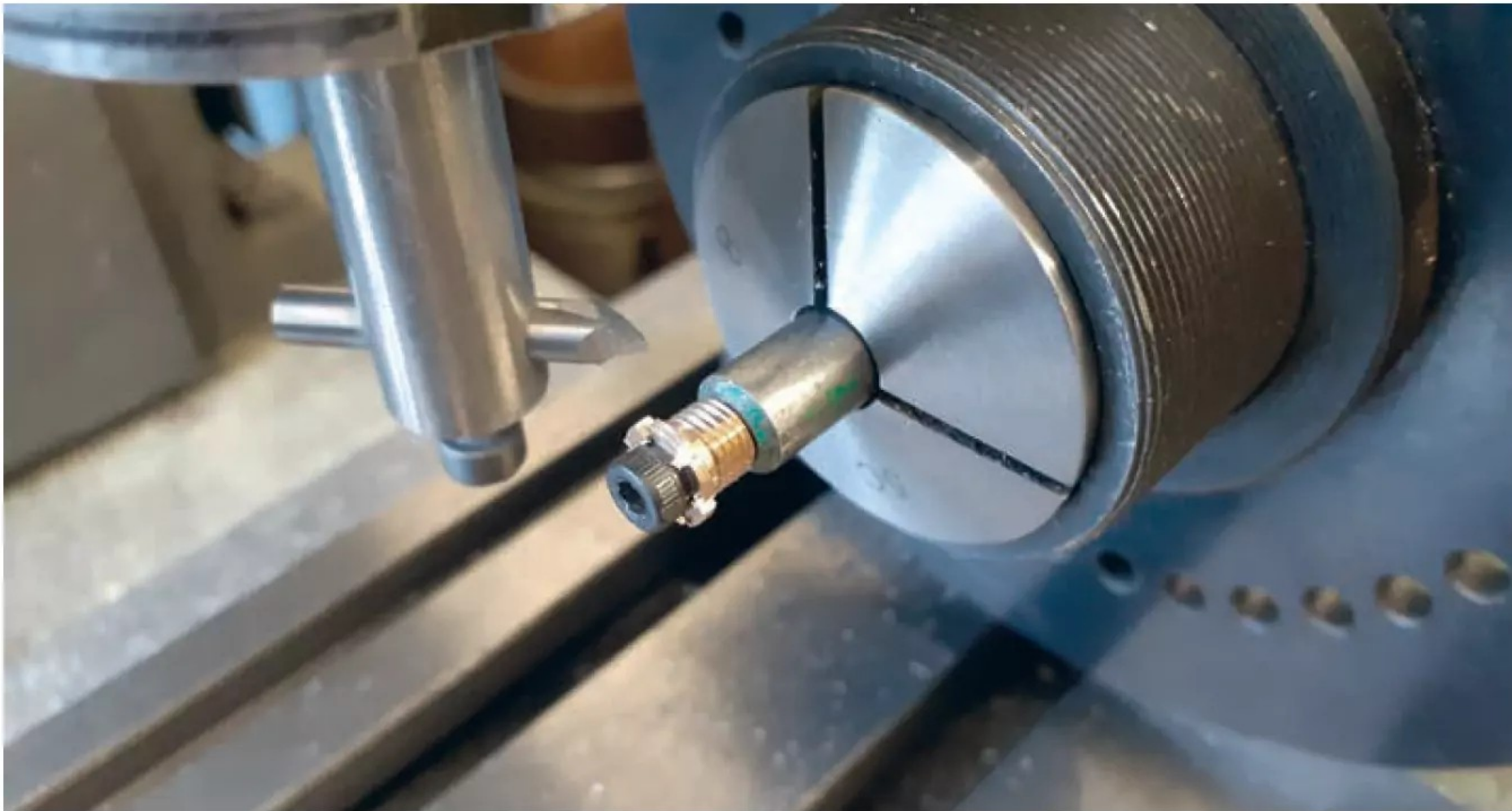


Photo 59: Cutting gland slots with single point tool

parts to gauge the fit, thread the ends and then saw off. Face the other end then the screwdriver slots can be added either with a slitting saw or a junior hacksaw cut carefully placed across the ends will do.

PISTON AND VALVE ROD GLANDS

Again two similar parts. Face the end, turn the 8mm and 5mm spigots and thread accordingly before drilling and reaming. The slots can be cut with a small homemade single point tool or a very small end mill before being parted off, **photo 59**.

CLADDING

I chose to use some 0.5mm thick aluminium sheet as it is easy to bend and cut. Start by bending over a suitable piece of rod, 30-32mm will be about right allowing for spring back and then file the clearance around the exhaust boss etc. Mark out the position of the screw holes and clamp to the cylinder casting drilling through the cladding and into the casting 1.2mm before opening up the hole in the cladding to 1.6mm. Tap the hole using the mill's spindle to help guide the tap before moving onto the next position, **photo 60**.

ADDITIONAL EXTRAS

Before moving on to painting and assembly there were a few additions that I made to the basic engine, just for personal taste. Some or all can be incorporated as other builder wish.

FLYWHEEL RIM

I was not keen on the shape of the supplied flywheel so decided to add an additional wider 'tyre'. To facilitate this when turning the OD of the casting I reduced half the width of the OD by 0.5mm to create a step for the additional rim to locate against. The rim was

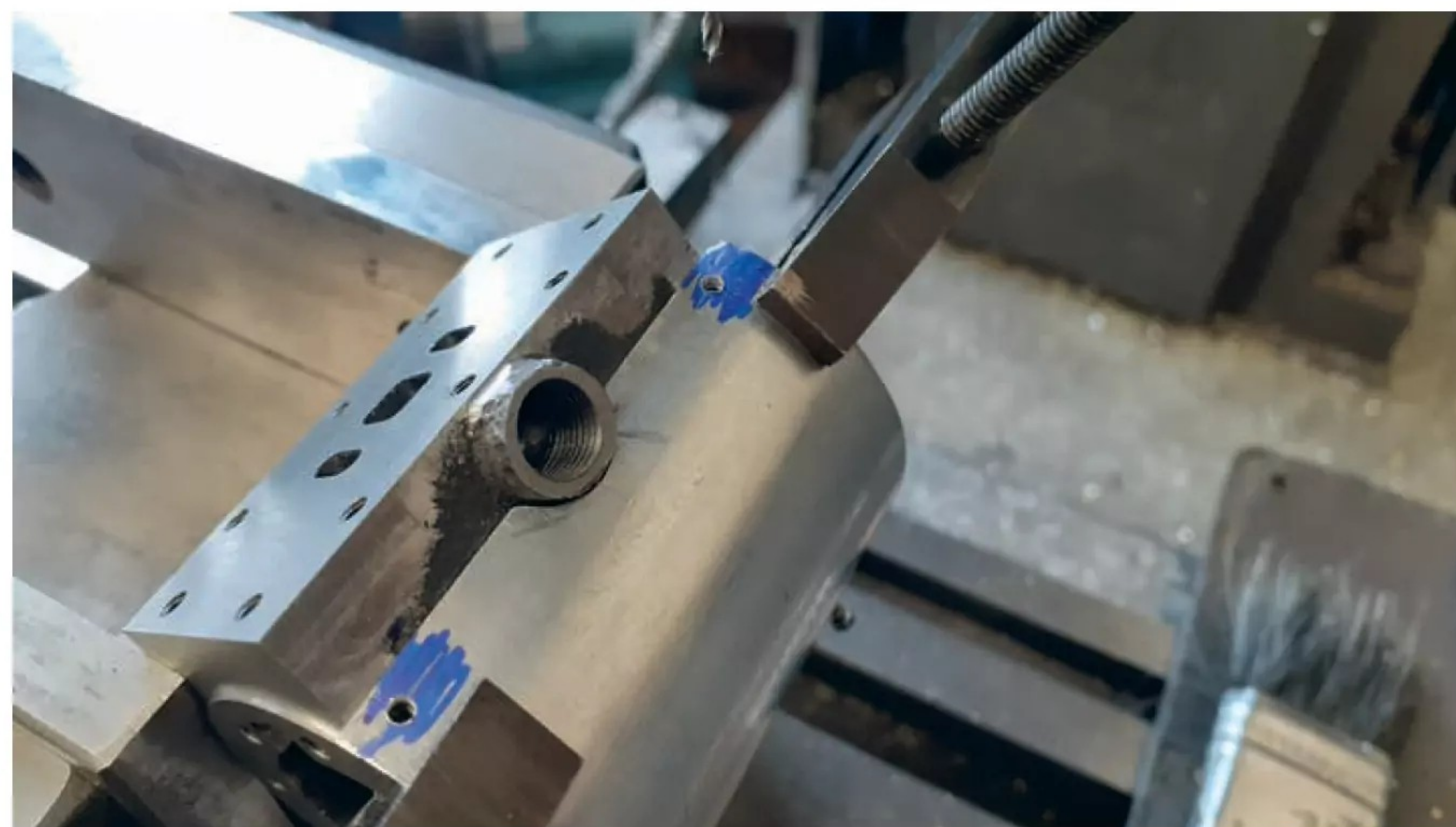


Photo 60: Drilling cladding clamped to cylinder

chance of wobble, **photo 57**. Turn the casting the other way round and get it running true then skim the other side of the rim and face the hub.

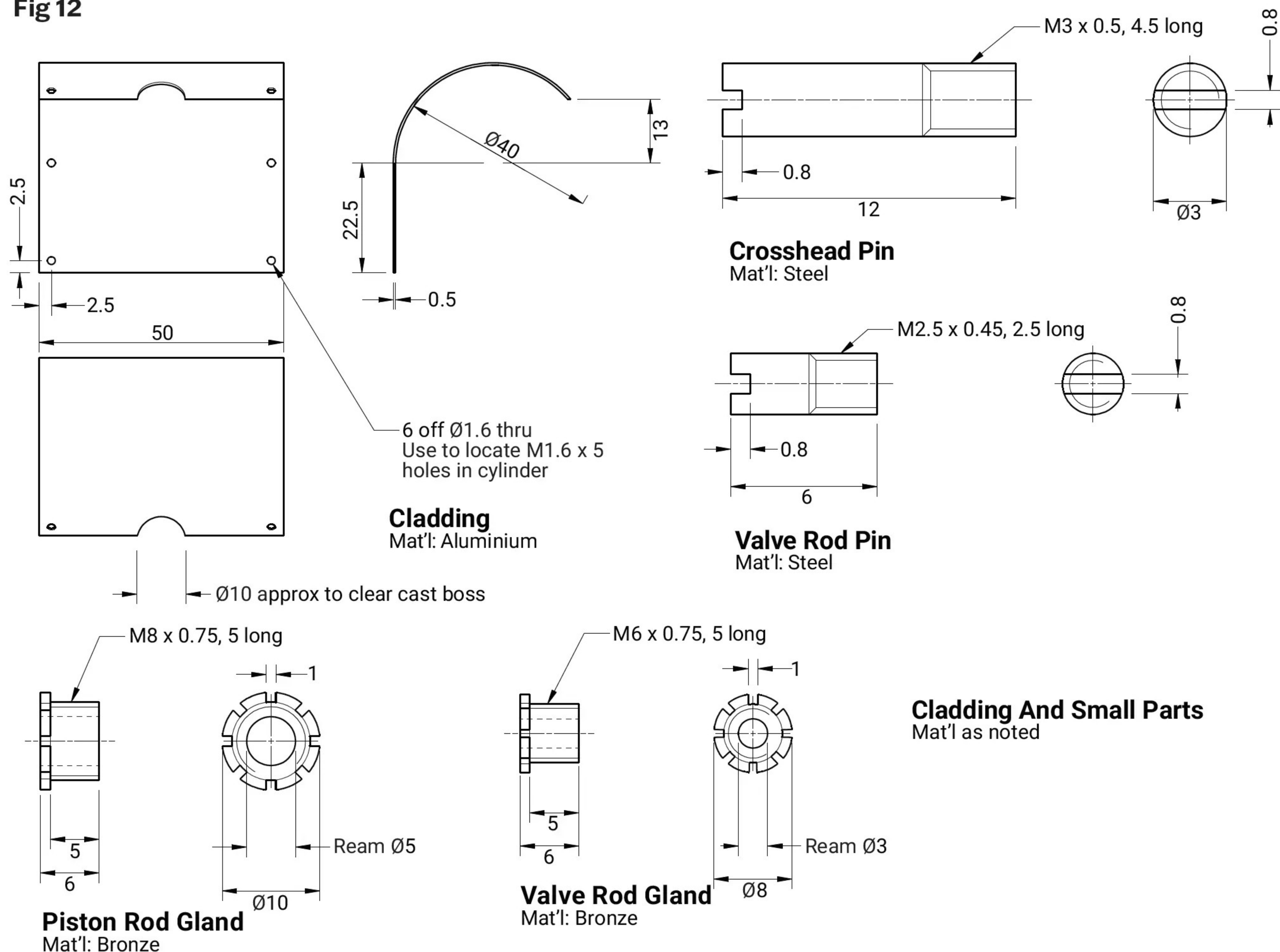
To drill and tap the angled grub screw hole put a sacrificial nut and bolt through the hole, hold the bolt at an angle in the mill vice and then spot, drill 3.3 and tap M4, you may need long series drills for this or they can be extended by drilling their shank diameter into, say, a piece of 6mm

diameter bar and Loctiting the drill into place. A bit of heat will get the drill back out afterwards if you don't have a spare drill bit to keep in the extension for future use, **photo 58**.

CROSSHEAD AND VALVE ROD PINS

These are essentially the same to make, turn some bar down to the required diameter using the mating

Fig 12



machined all over from a piece 115mm OD x 100mm ID thick wall steel tube with a matching step to the ID, **photo 61**.

The rim can be fixed to the flywheel casting with Loctite and once set add a small fillet of body filler to the internal corners where they meet so that it looks like it was all one cast item.

VALVE CHEST COVER RECESS

The valve chest cover as per original is quite a bland flat surface, but the addition of a recessed central area will add some interest and colour. With a 3mm diameter milling cutter preferably one that has a corner radius to leave a small fillet cut the 1mm deep recess to the dimensions shown. A flat ended cutter would do if you don't have a radius one, **photo 62**.

CRANK DISC RECESS

In a similar way to the chest cover a recess can be cut into the crankshaft side of the disc crank to not only add interest but also add some counter balance for smoother running. A rotary



Photo 61: Turning flywheel rim from thick wall tube

table is really needed and a slightly larger 6mm diameter cutter having a 1mm corner radius is the right size cutter for the job, **photo 63**.

TRUNK GUIDE OILER

The last item I added was a small boss

and oiling point mid-way along the top of the trunk guide. Drill a 1.2mm oil hole and then plunge part way in with a 6mm milling cutter. A short length of 6mm rod with a countersunk hole can be stuck into the recess with Loctite and then a fillet of body filler will complete the job, **photo 64**



Photo 62: Milling chest valve cover recess



Photo 63: Milling crank disc recess



Photo 64: Adding oiler boss to trunkguide



Photo 65: Preparing castings for paint



Photo 66: Painted parts and paints used



Photo 67: All the parts ready to assemble

PREP AND PAINTING

Now is the time to make up the various studs that will be needed to replace the temporary cap head screws used during the build. I also use 'small hex' metric fixings which typically have a one size smaller hexagon A/F dimension which look better on a period model than the larger ISO sizes.

Any surface imperfections that were not removed at the initial casting clean up stages can be dealt with and holes & recesses filled with body filler to make them good, **photo 65**.

Clean all parts to be painted with thinners and mask surfaces that are not to be painted, plug holes with bits

of screwed up masking tape and then mount the parts so they can be held for painting. I make use of the handles of cheap artist's bristle brushes sliding parts onto the tapered handles until tight. Other small parts can be stuck to blocks of wood with double sided tape or hung on wire.

Prime the bare metal with the colour to suit the top coat and inspect the surface as imperfections don't always show up until primed and remedy anything that is needed. The final colour coats can be added, I went with a light grey for the bed casting and an apple green for the remaining parts, both with a matt finish, **photos 66** and **67**.

ASSEMBLY

Once dry the engine can be assembled checking for free rotation and movement as each subsequent part is added. A liquid gasket can be used on the cylinder end covers, valve chest and it's cover. Just apply a very thin amount and leave any that squeezes out to set then it can just be rubbed off with your finger.

The position of the nut on the valve rod should be adjusted so that equal amounts of exposed inlet port are seen at each end of travel as the engine is turned over by hand. To time the engine use can be made of the eccentric's grub screw hole that was

Fig 13

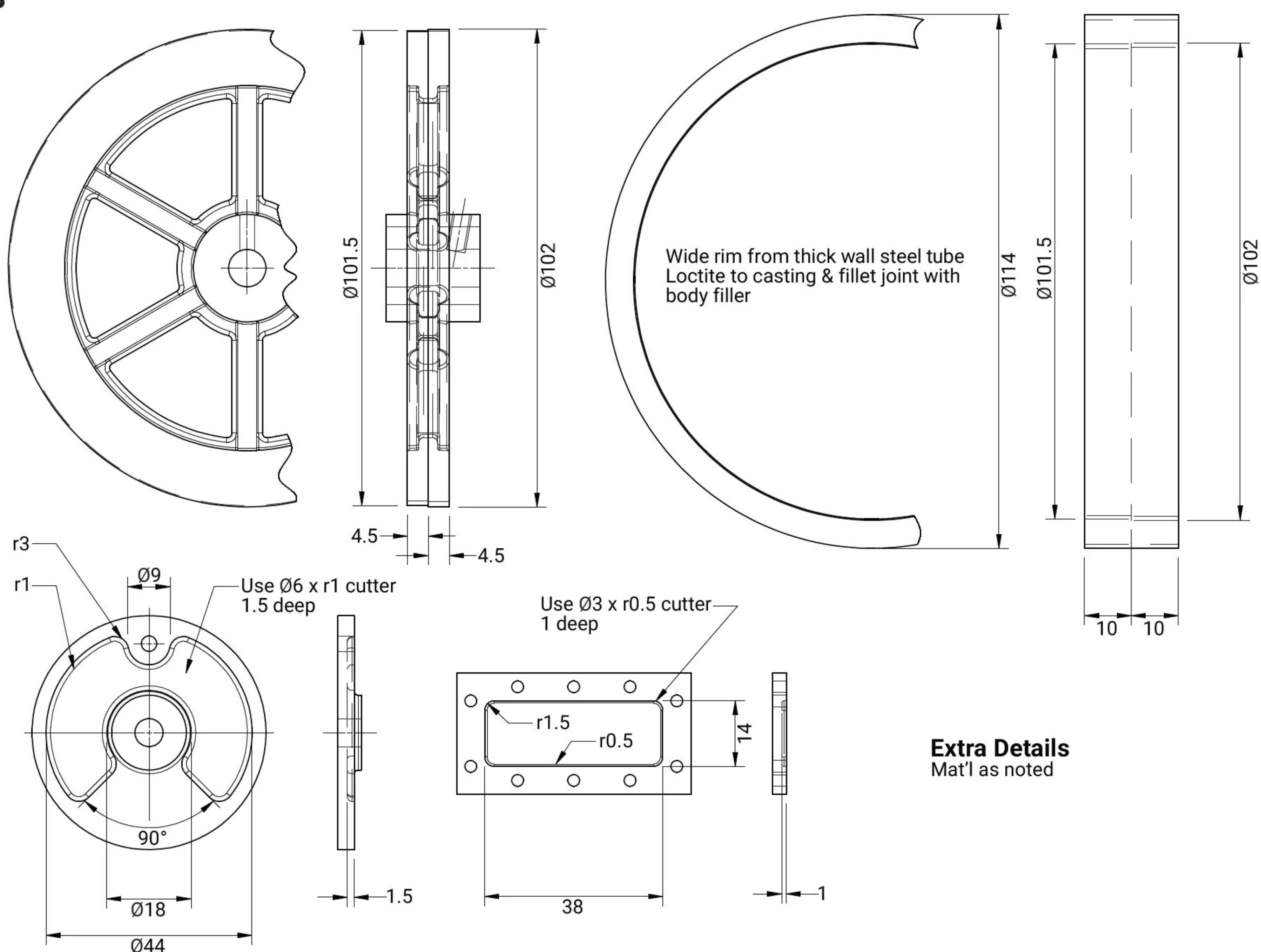


Photo 68: Setting the timing

placed to line up with the maximum throw of the eccentric. Looking from the crank side and with an Allen key in the grub screw pointing up vertically at the 12 o'clock position rotate the crank until the pin is at the 4 o'clock position and tighten the grub screw, **photo 68**. This should give a good starting point for the timing which can be further tweaked depending if you intend to run on air or steam.

Apply a light oil, I use a 'clock oil' to all the moving surfaces as well as

a drop or two into the valve chest via the steam connection. Then connect an air supply of around 10psi and flick the top of the flywheel away from the cylinder and the engine should start to run. Speed can be adjusted by restricting or opening up the supply, but pressure can stay the same, **photo 69** shows the completed engine and **Video**, tinyurl.com/y2w6yrm5 shows the engine running on a 10psi air supply.

The castings for this engine are available from Blackgates Engineering. 🇬🇧

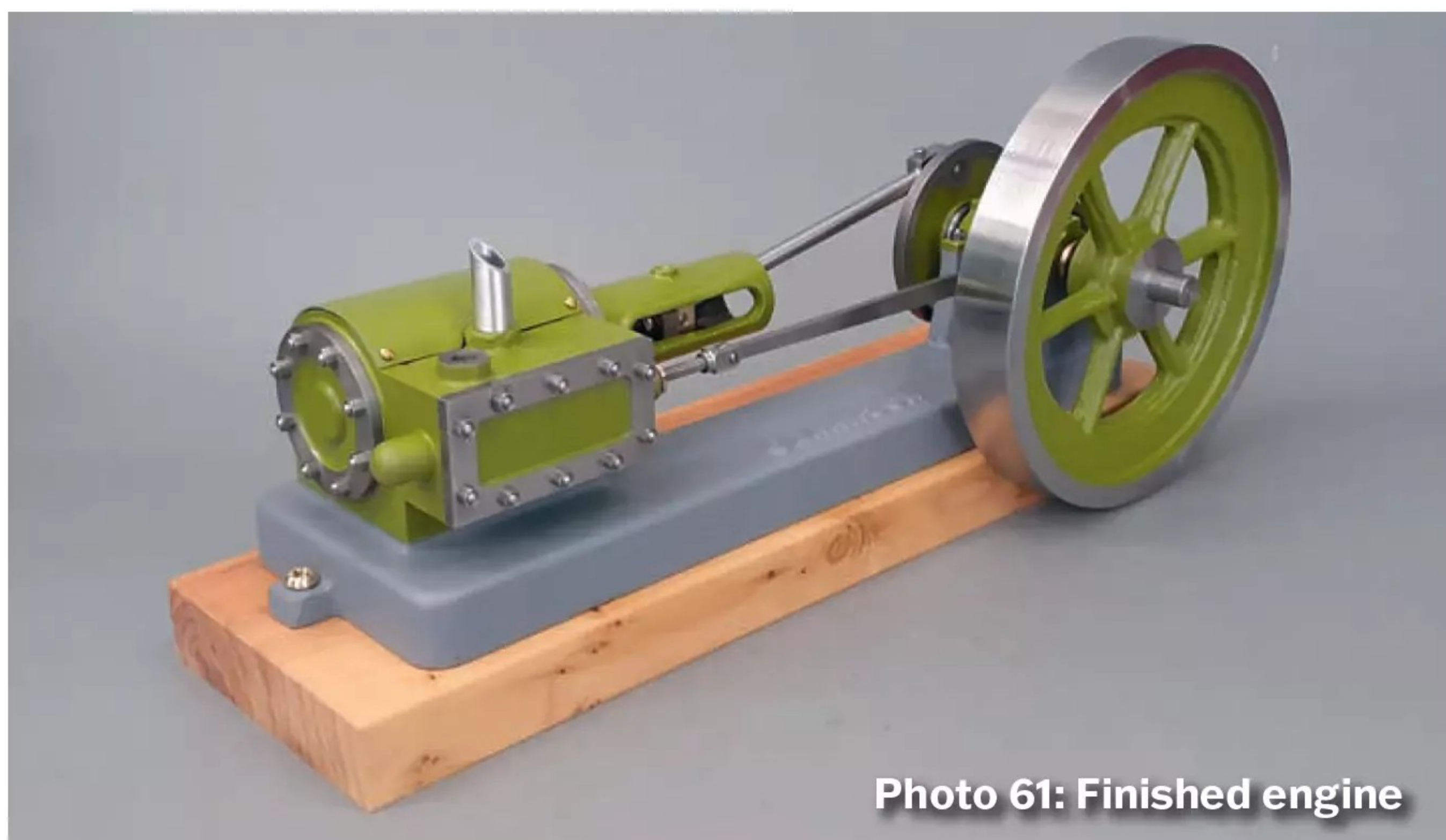


Photo 61: Finished engine



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Summary Specification



Length approx 77"

- | | | | |
|---|--------------------------------|---|------------------------|
| • Coal-fired | • Available in choice of names | • Piston valves | • Length 77" |
| • Sprung axle boxes with needle roller bearings | • Painted and ready-to run | • Mechanical drain cocks | • Width 10" |
| • Two safety valves | • Stainless steel motion | • Mechanical lubricator | • Height 14" |
| • Silver soldered copper boiler | • 2 Outside Cylinders | • Reverser in cab | • Weight approx 120kgs |
| • Etched brass body with rivet detail | • Walschaerts valve gear | • Boiler feed by axle pump, and hand pump | |

The 5" Gauge Britannia Model

This coal-fired live steam model is built to a near exact scale and is an excellent representation of the full size locomotive. The kit model is supplied with the regular BR1 tender and you can select the name and number of your choice. The copper boiler is silver soldered, hydraulically tested to twice working pressure, and supplied with a shell test boiler certificate. Every model benefits from a full 5 year warranty.

The manufacture of the kit version of this model is presently scheduled for completion December 2026.

High quality kit models are expensive to manufacture and the cost of raw materials is spiralling ever higher on a weekly basis. However, once you have paid your deposit your price is guaranteed. We are pleased to offer this kit at the fantastic value-for-money price of just £13,995.00 + p&p. The model can be supplied built and ready-to-run for an extra £1,000.00.

Save £195. We are pleased to offer free UK delivery for any order received within 28 days.

Delivery and Payment

The order book for the 5" gauge Britannia kit is now open and we are happy to accept your order reservation for a deposit of just £1,995.00.



We will then request a stage payment of £5,000.00 in August 2026 as the manufacture progresses, a further payment of £5,000.00 in October and a final payment of £2,000.00 on completion of batch presently scheduled for December this year.

Please send, without obligation, my free 5" gauge Britannia colour brochure.

Name: _____

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The Silver Crest BR Class 1500

PART **4**

Mark Thatcher continues his build of a 5" Gauge Live Steam BR Class 1500 loco kit from Silver Crest Models, this time concentrating on the cylinders, reversing gear and the smokebox

I am pleased to be making good progress with this kit, and it is progress that I can actually see. I never imagined that when I undertook this project that I would find it so fulfilling and it was very satisfying to have created a rolling chassis that actually worked last time. When I started this build, I had no idea what a learning curve this kit would present, but I have to say, despite a few niggles here and there, plus my own inability to hold a nut spinner straight, most components have gone together well and so far, I have not stripped one thread either!

To start off, I thought it was worth having a size comparison between this 5" gauge model and a 16mm (SM32) live steam loco in a scale that I am much more familiar with working on, **photo 1**. I am beginning to realise that doubling the length, width and height of anything, quadruples its volume and my Accucraft Groudle Glen Sealion loco was positively dwarfed by the 1500.

Kit four comprises the reversing gear assembly, plus the majority of the steam fittings, pipework and the steam injector. All the pipework was packed into a single box, and upon opening

it, it looked like a pile of spaghetti and most of these parts were totally alien to me.

The CAD/CAM for this kit, **photo 2**, looked fairly straightforward. However, all the pipework detail is omitted from the underside of this diagram. I would have liked to have had a similar image showing the underside but had to make do with what I had and would try to figure things out from there.

Whilst there were numerous build photographs of where all the pipework was located, these photos were fairly meaningless to me. Also, as some of the shots were so close up, I had no

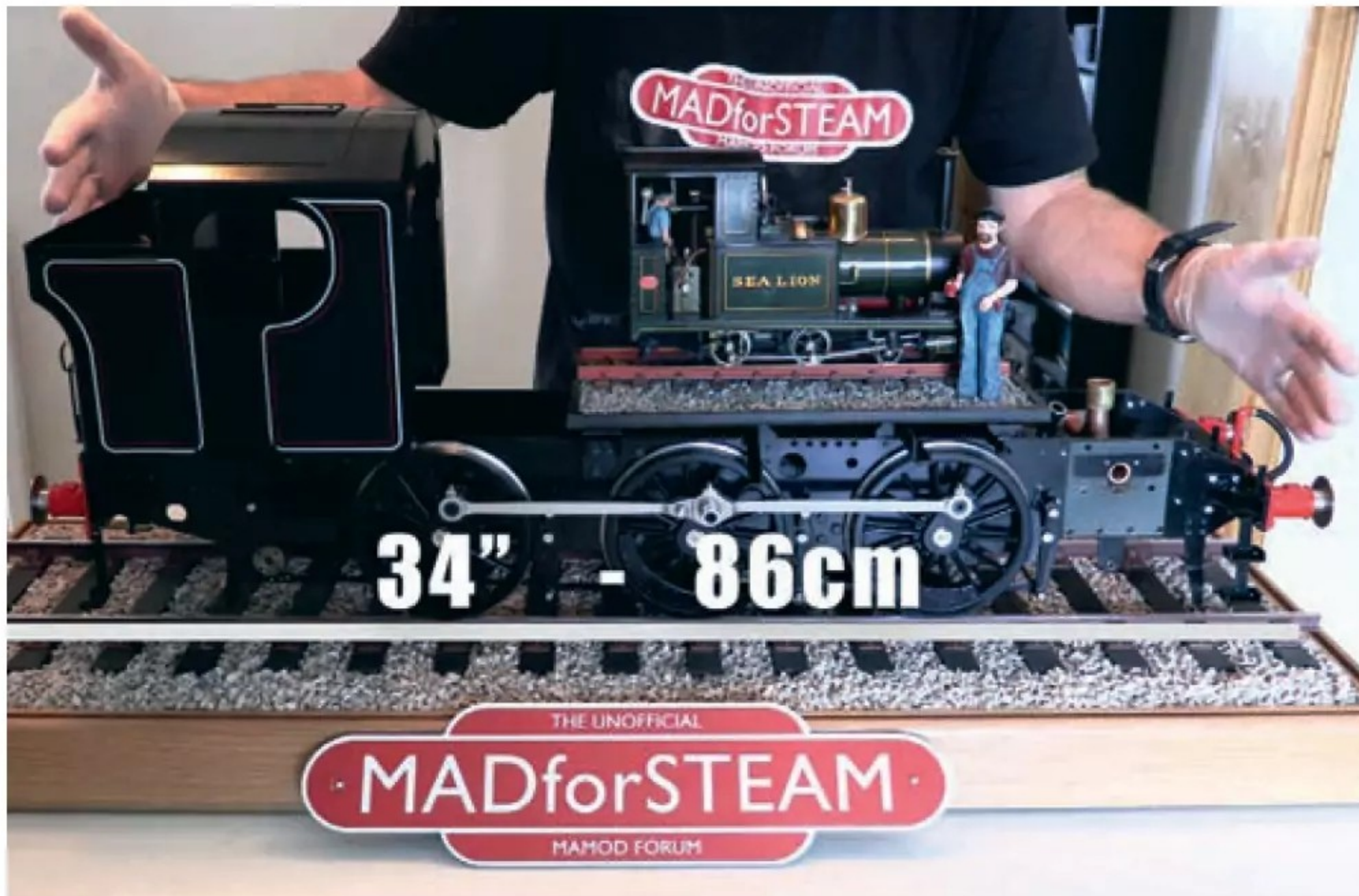


Photo 1: Size comparison with a 16mm (SM32) loco.

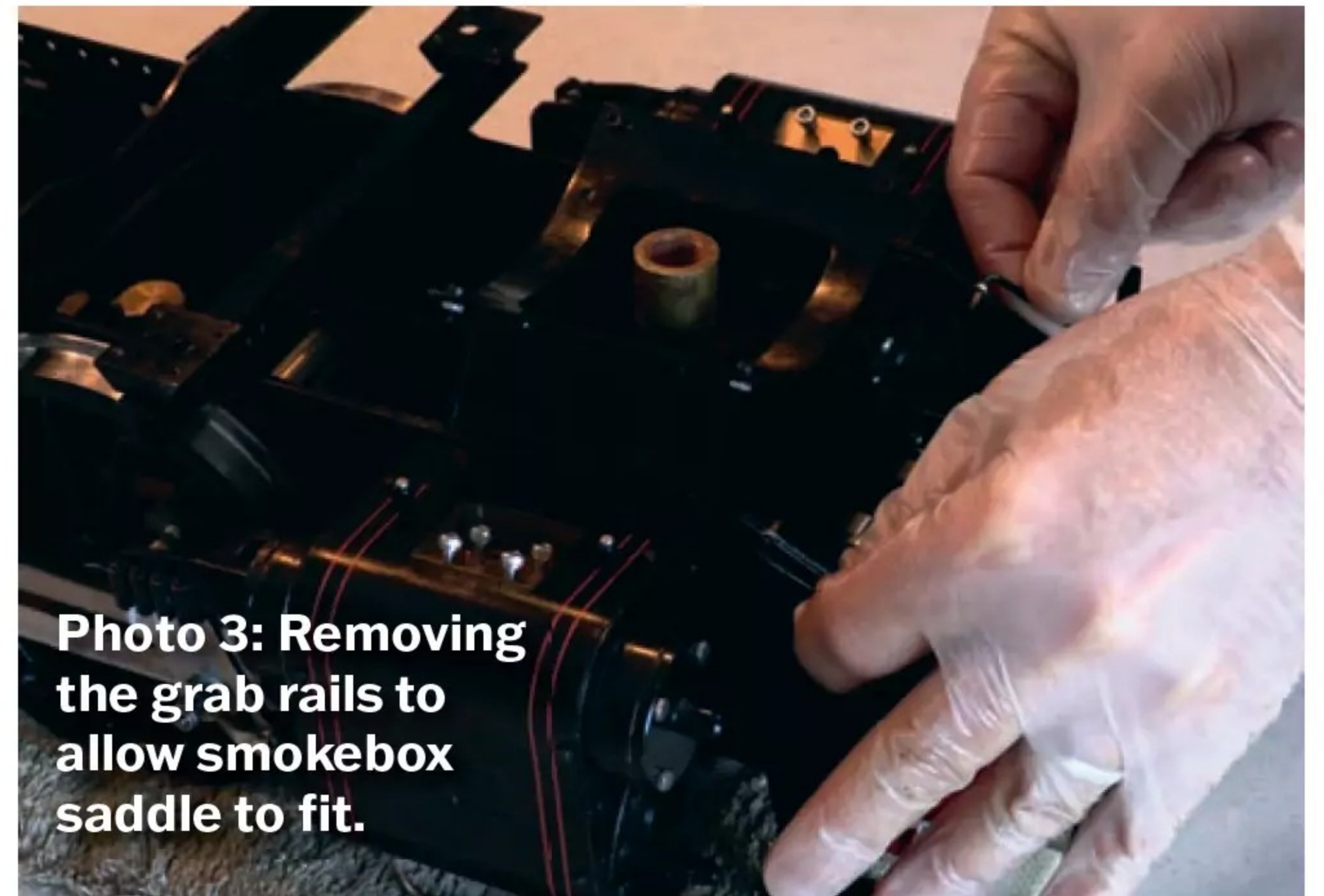


Photo 3: Removing the grab rails to allow smokebox saddle to fit.

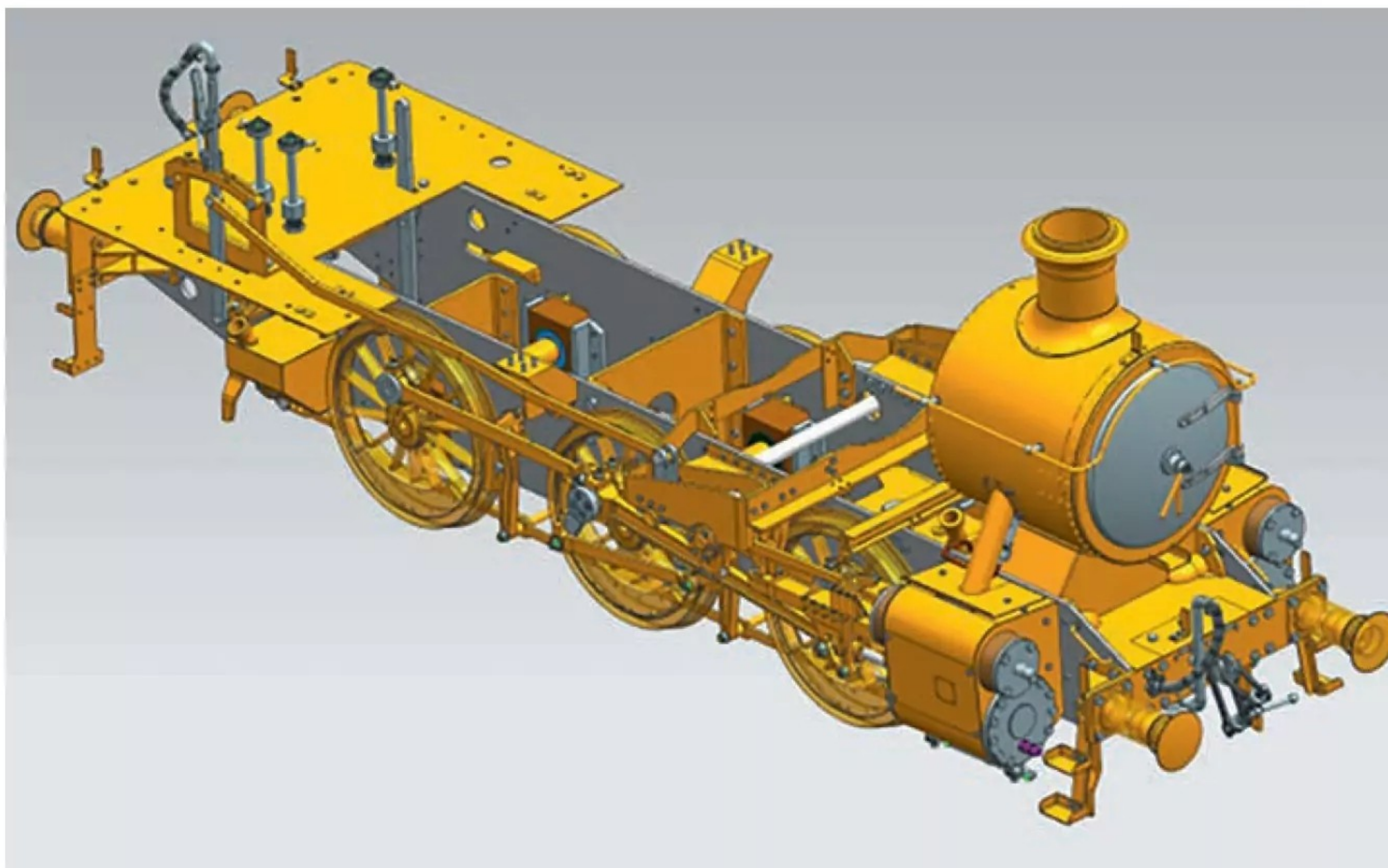


Photo 2: CAD for kit four.

frame of reference and could not even figure out which way up the chassis was sometimes. This was exacerbated by the fact that the instructions simply said “fit the pipework...” I eventually figured out where all the pipes went, and they will only fit between two nipples one way round. If you think about bending pipes to fit, then you are using the wrong pipe.

I did discuss this with Silver Crest and Mike Pavie; the designer of the loco and I shall cover their responses later on. But before I get too far ahead of myself, and also before I could progress with this kit, I needed to finally secure that errant smokebox saddle.

SMOKEBOX SADDLE FINAL FIT

Those of you who read the story on kit three will be aware of the issues I faced with the smokebox saddle last time, and whilst I tried my best to show you where the tight spots were, I thought it may be wise to complete the picture

by showing you the final fit. It would be impossible for me to have refitted this component had I not removed the two grab rails, **photo 3**, that were located on the angled leading edges of the frames, and also now I knew that the saddle was handed, so once these rails were removed, the saddle dropped in between the frames easily and without any force, **photo 4**. The offending grab handles were then refixed in place.

REVERSING GEAR

The reversing gear assembly was another of the partially factory-built assemblies in this kit. The reversing cranks came pre-installed into their respective frames. These gear frames bolted to the outer side on each face of the frames and I needed to then slide the weigh shaft laterally through these

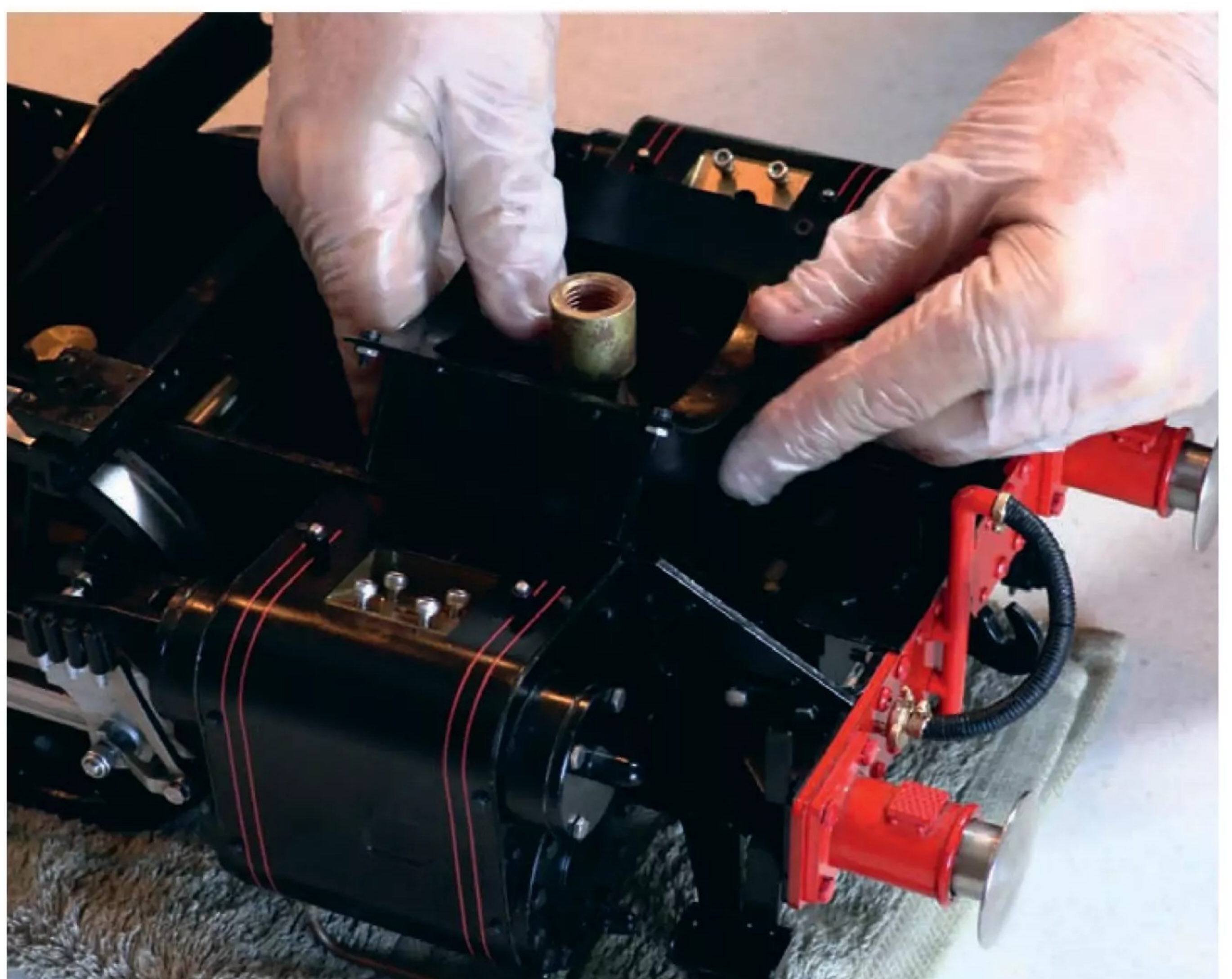


Photo 4: Dropping smokebox saddle into place – finally!.

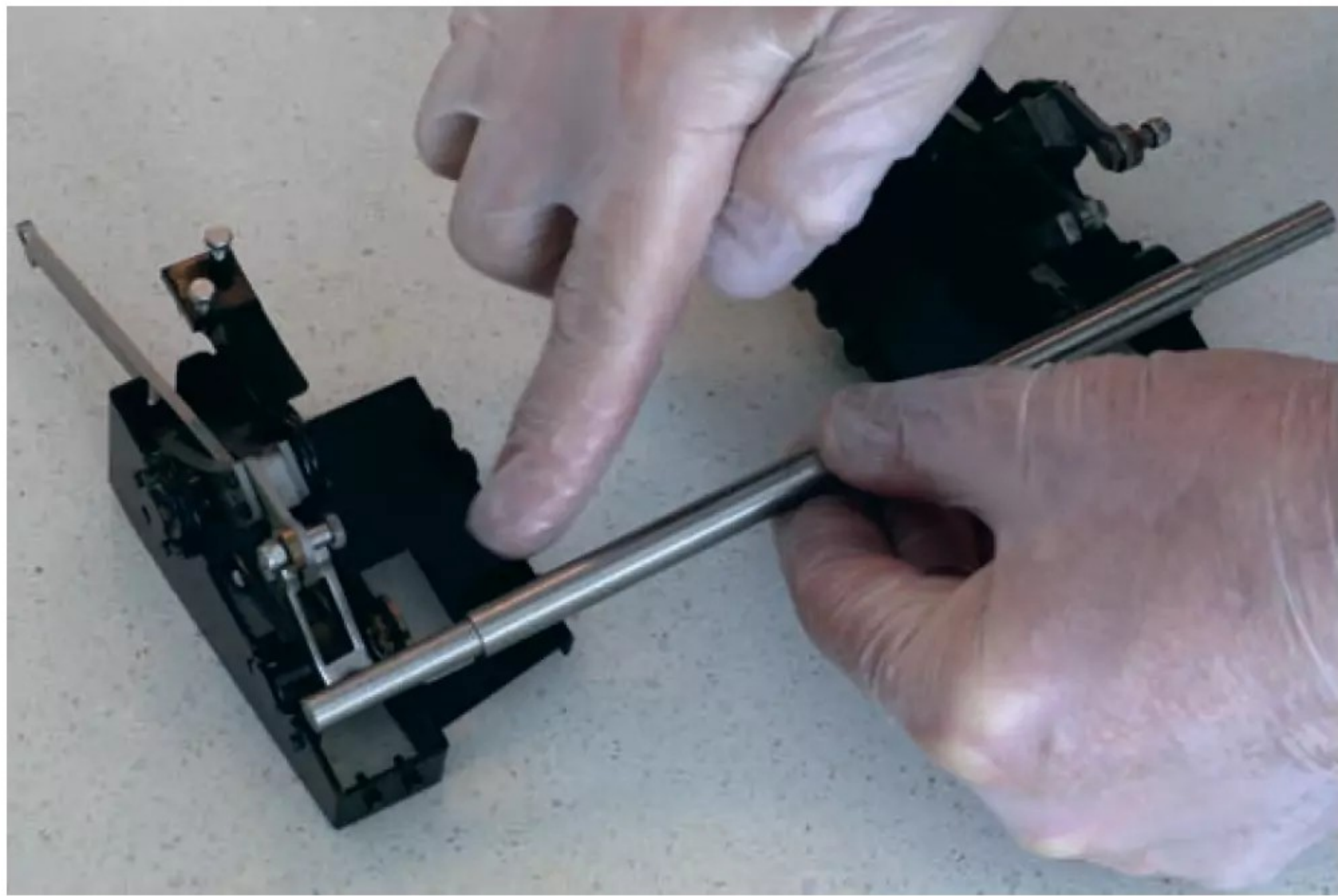


Photo 5: The reverser weigh shaft rod.



Photo 6: Fitting one of the gear frames.

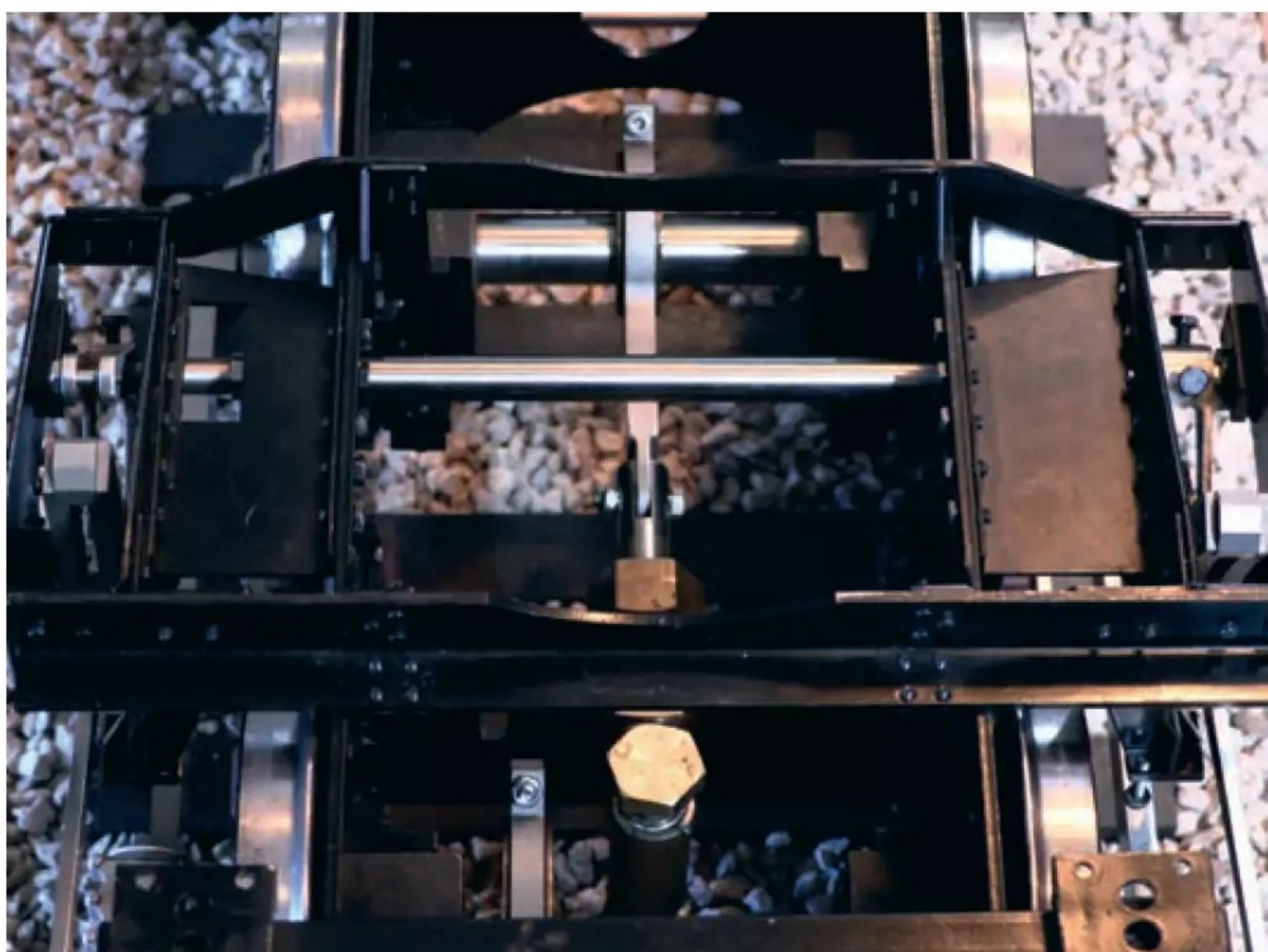


Photo 7: Completed gear frame & weigh shaft assembly.

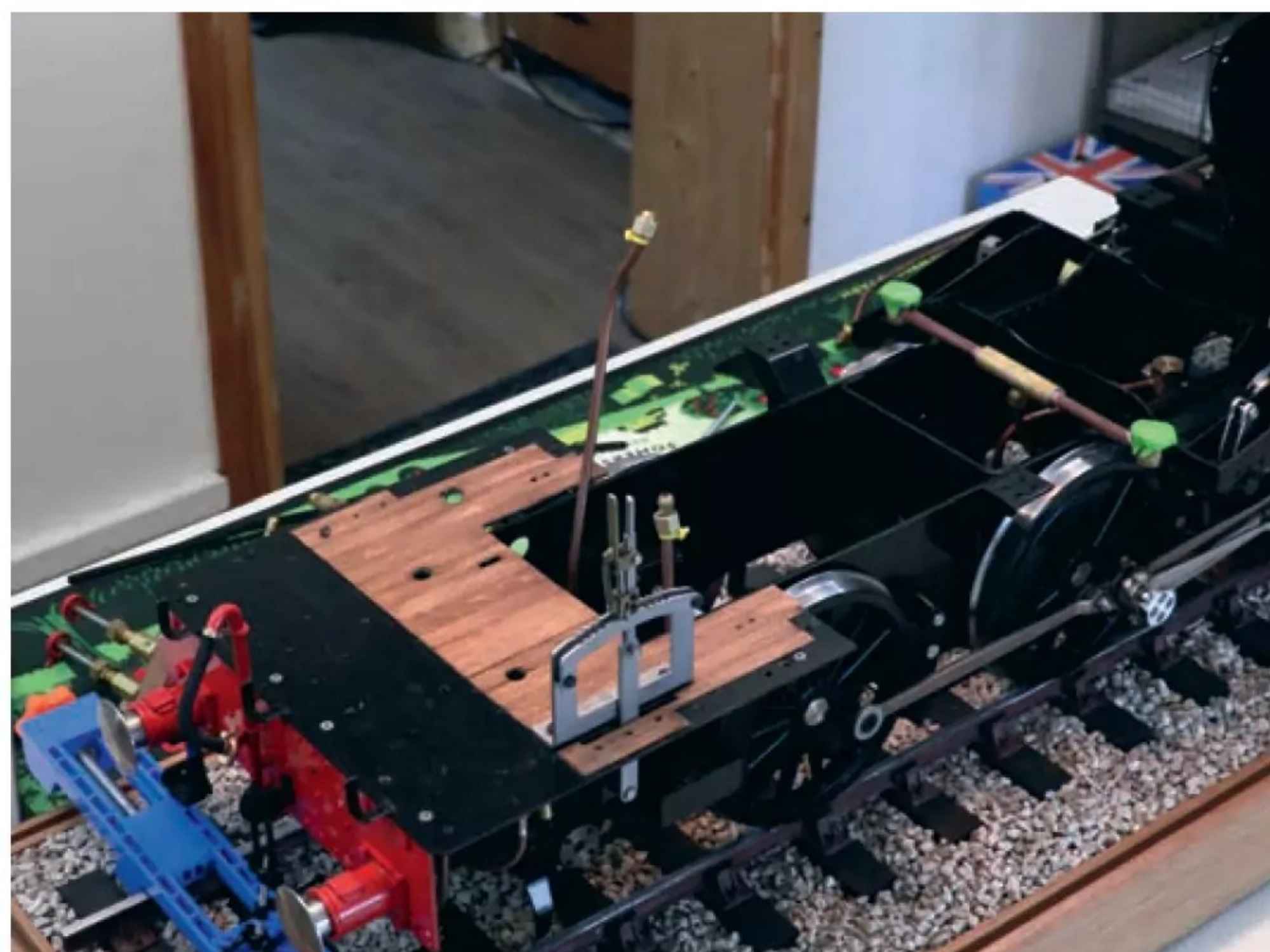


Photo 8: Test fit of the cab floor.

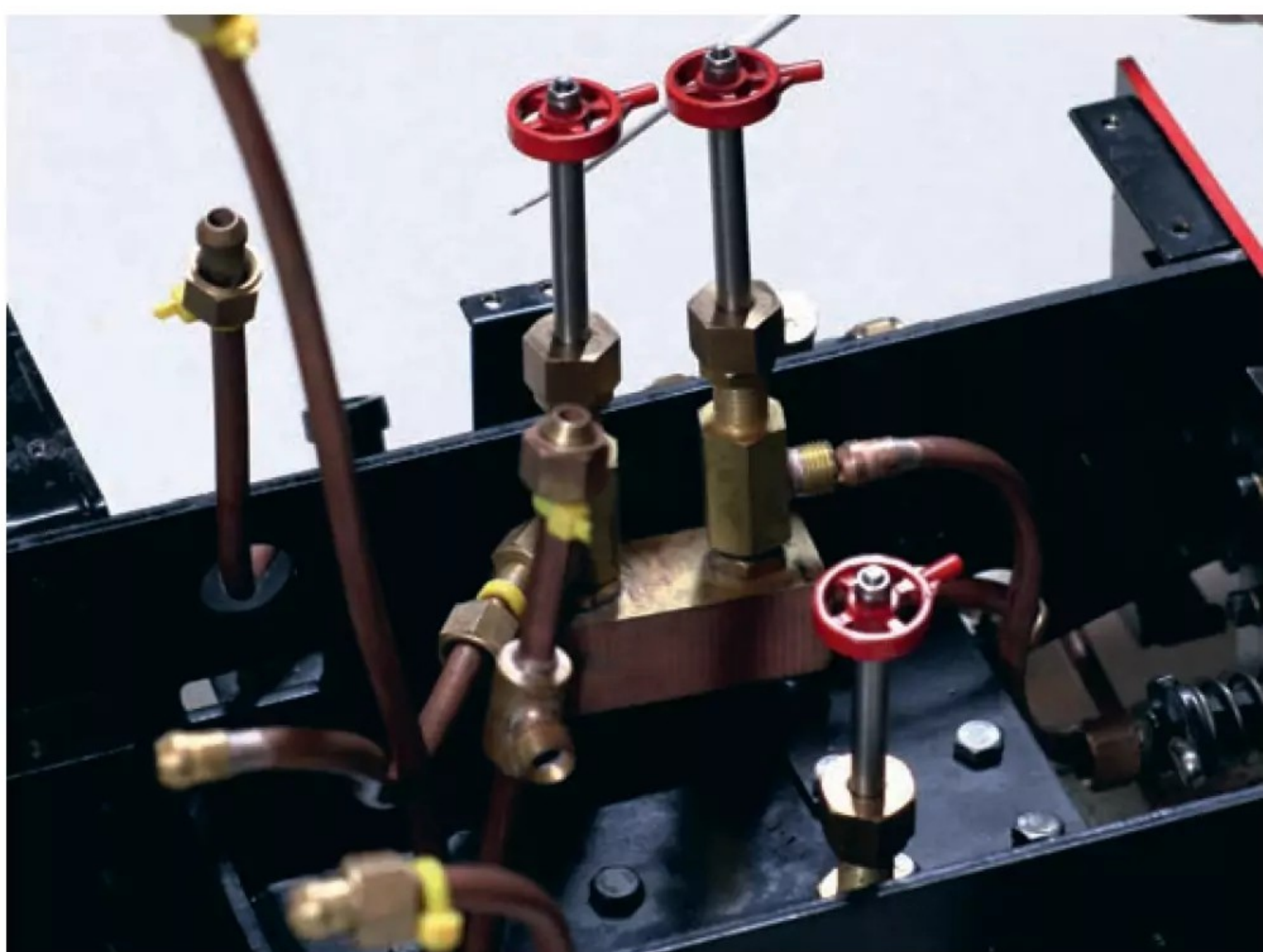


Photo 9: Fitting the reversing lever assembly.

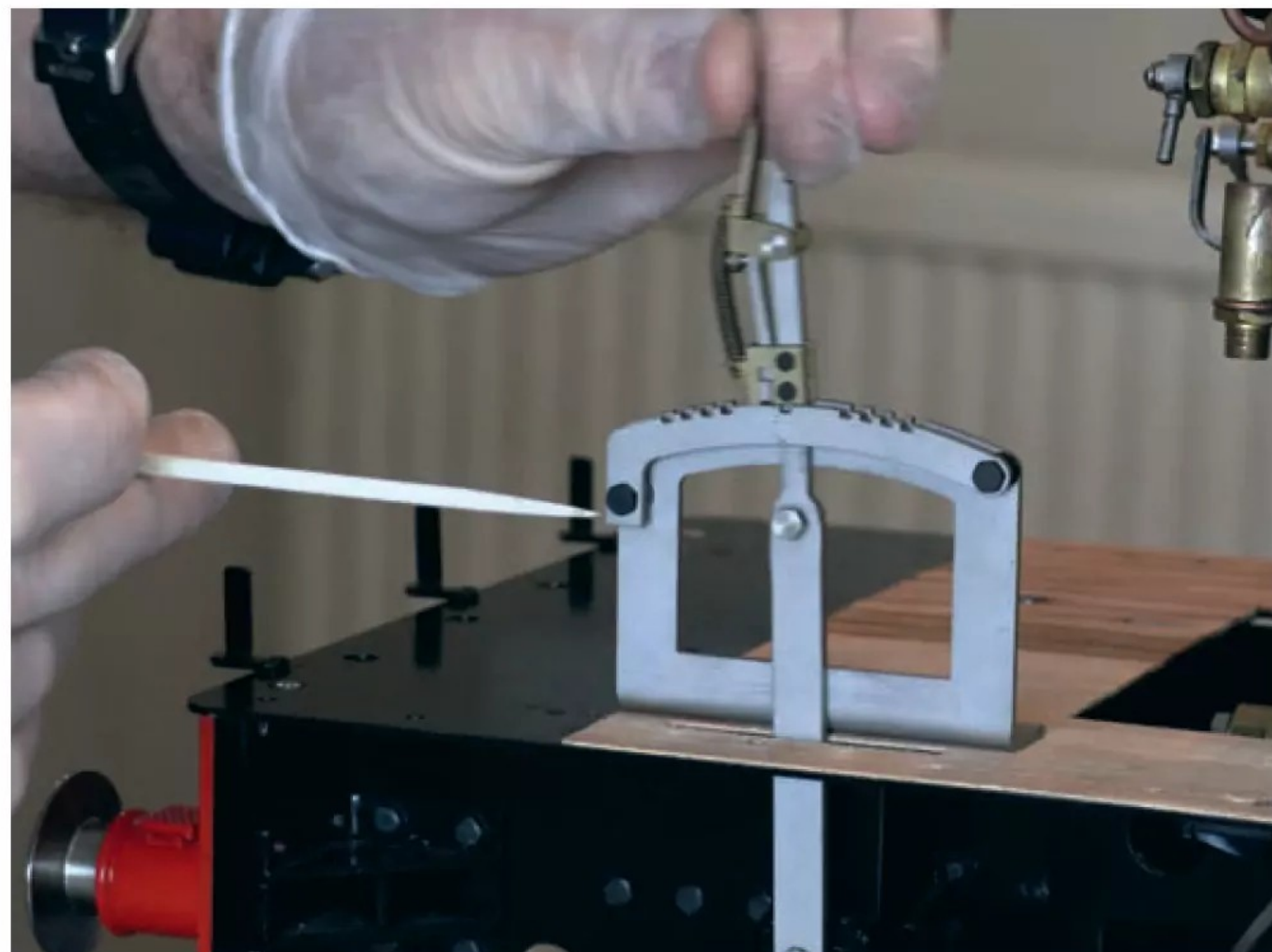


Photo 10: The steam fittings that protrude through the cab floor.

and the gear frame assemblies to tie all of these components together, **photo 5**, the plan being that I would tighten up Allen grub screws on the gear cranks themselves, so that when the gear reversing rod was fitted later, both reversers would be synchronised for notching up and down the gearing.

Each gear frame was secured to two of the lateral support stretchers that I had fitted previously, being secured by 3mm bolts into tapped threaded holes in these stretchers, **photo 6**. Tapped threaded holes and generally the lack of nuts holding components into place were becoming very much

de rigour with this kit. Now I am not experienced enough to have an opinion as to whether this is a good or bad construction method but thought I should mention it in any case. You will get an idea of how the final reversing assembly should look in **photo 7**, and I am pleased to say the whole

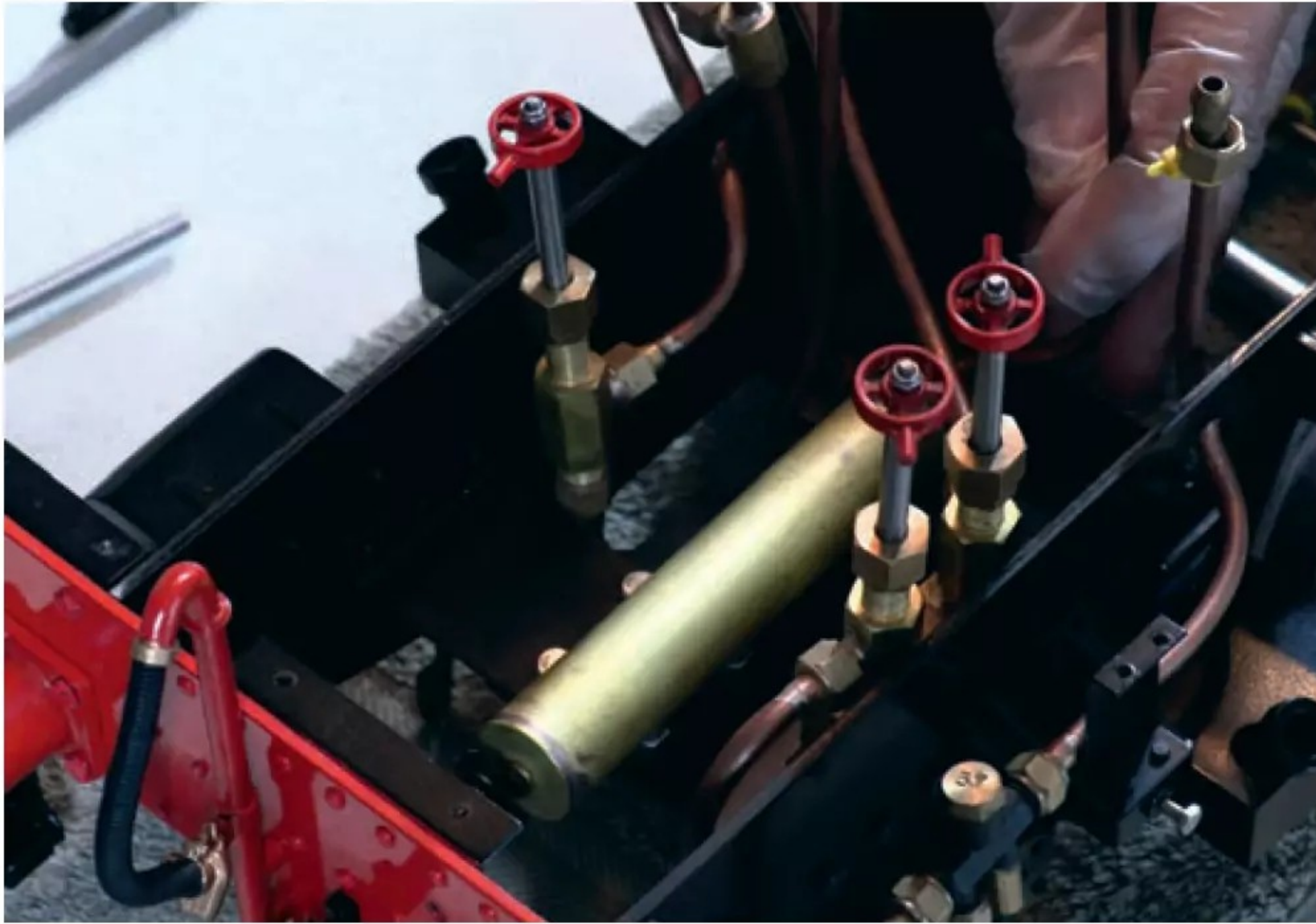


Photo 11: Fitting the steam whistle.

ensemble went together very well with no tolerance issues or binding tight spots and the resulting fore and aft movement of the gear assembly was super-smooth.

FOOTPLATE, STEAM FITTINGS & PIPEWORK

The next job was to loosely test-fit the footplate. I decided that one of my few embellishments was to use 1/12th scale sticky-backed flooring, suitable for doll's houses to add a bit of realism. This was to bite me in the bum later on as during its first run on steam, some lit coal fell onto this flooring which spontaneously ignited! After a quick dash for a fire extinguisher, no real harm was done, but now I have a scorched wooden footplate. Hey – it adds a bit of realism I guess, and at least this is evidence to the fact that this loco has actually been fired up. A big shout out must go to *Coach & Wagon Works* here, as this company is where I get all my paints, stains and adhesives from.

The footplate was simply secured with some countersunk posidrive screws to the frames at the rear, some 5mm bolts to the front and six 5mm Allen bolts from underneath, **photo 8**, and if you are going to add a wooden floor you will need to cut this away from around the reversing lever and also where the cab will eventually locate over and onto the original floor. The reversing lever was attached to the footplate with two bolts, and note this test fit of it, **photo 9**, did not account of the let-in needed so the reverser sat flush onto the metal cab floor. If I had not done this, the width of the wooden floor was enough to raise the reverser up only very slightly, but also enough to cause this to bind when the reversing reach rod had been added.

Once I had test-fitted the floor, out it came again, as there were certain pipes and fittings that needed to

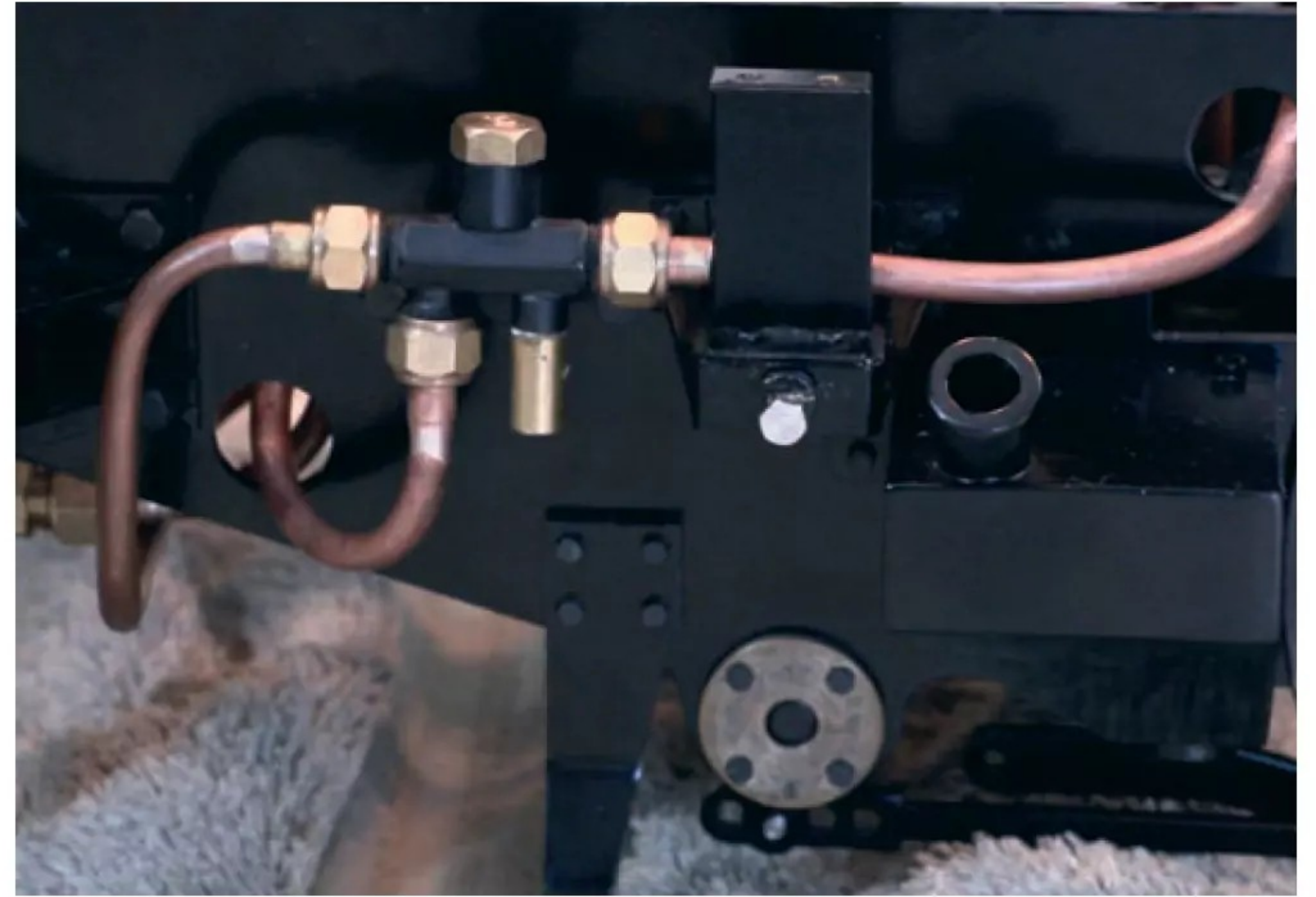


Photo 12: Water balance pipe.

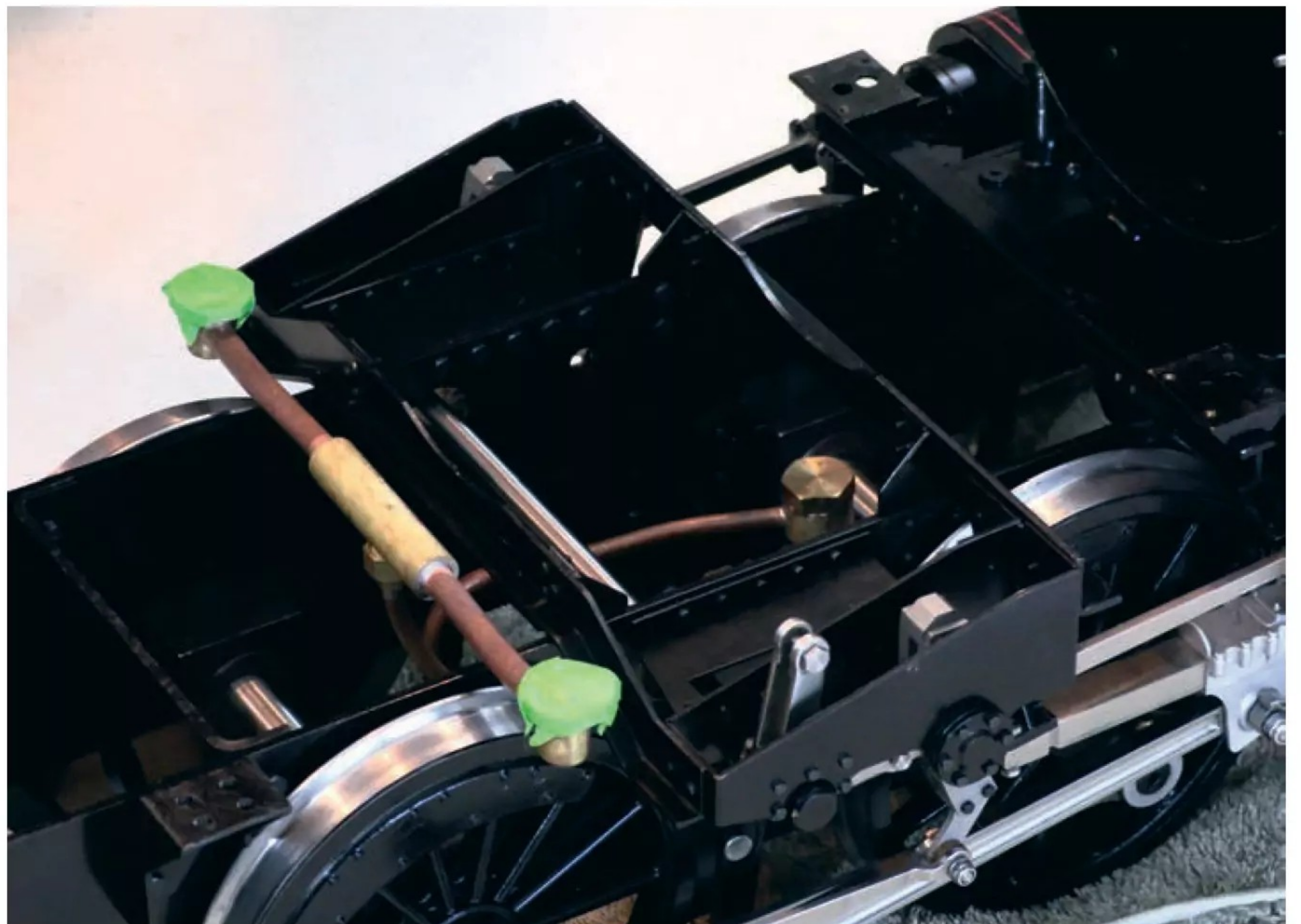


Photo 13: Location of the steam injector.

be added. These sat under the cab floor, but their unions and controls needed to be pushed up and through the apertures in it. In particular, I needed to install the double water valve assembly. This was bolted to a bracket set between the frames. You can see in **photo 10** that I have used a trick of holding the banjo nuts in place on the end of the pipes with zip lock cable ties, and this stopped them sliding down the pipework into the deep depths of the chassis. This would have made it awkward for me to fish them out when I was ready to screw them into their respective unions. After all the relevant pipework was connected to these assemblies that would eventually be covered by the footplate, I bolted the whistle into place, **photo 11**, which was secured to the inside of the rear buffer beam.

It was easier to fit the steam injector valve at this point too, as access to

this and its associated pipework would be quite tight once the footplate was added permanently. The build photos showed the pipe to this running in front of the rear tank support bracket, although I found it a much neater job to route this pipe behind the bracket, **photo 12**. An eagle-eyed viewer on my YouTube video series of this build noticed small limescale deposits had already formed on the injector and suggested a good soak in vinegar was needed to remove this. At least it proves it had been tested as working by the factory prior to despatch! Once this was completed, I could go ahead and refit the footplate properly for the last time and this area of the build was complete.

The final piece of pipework I needed to add was the water balance pipe which will connect to the two water tanks later on, **photo 13**. I could see this being challenging when it needed

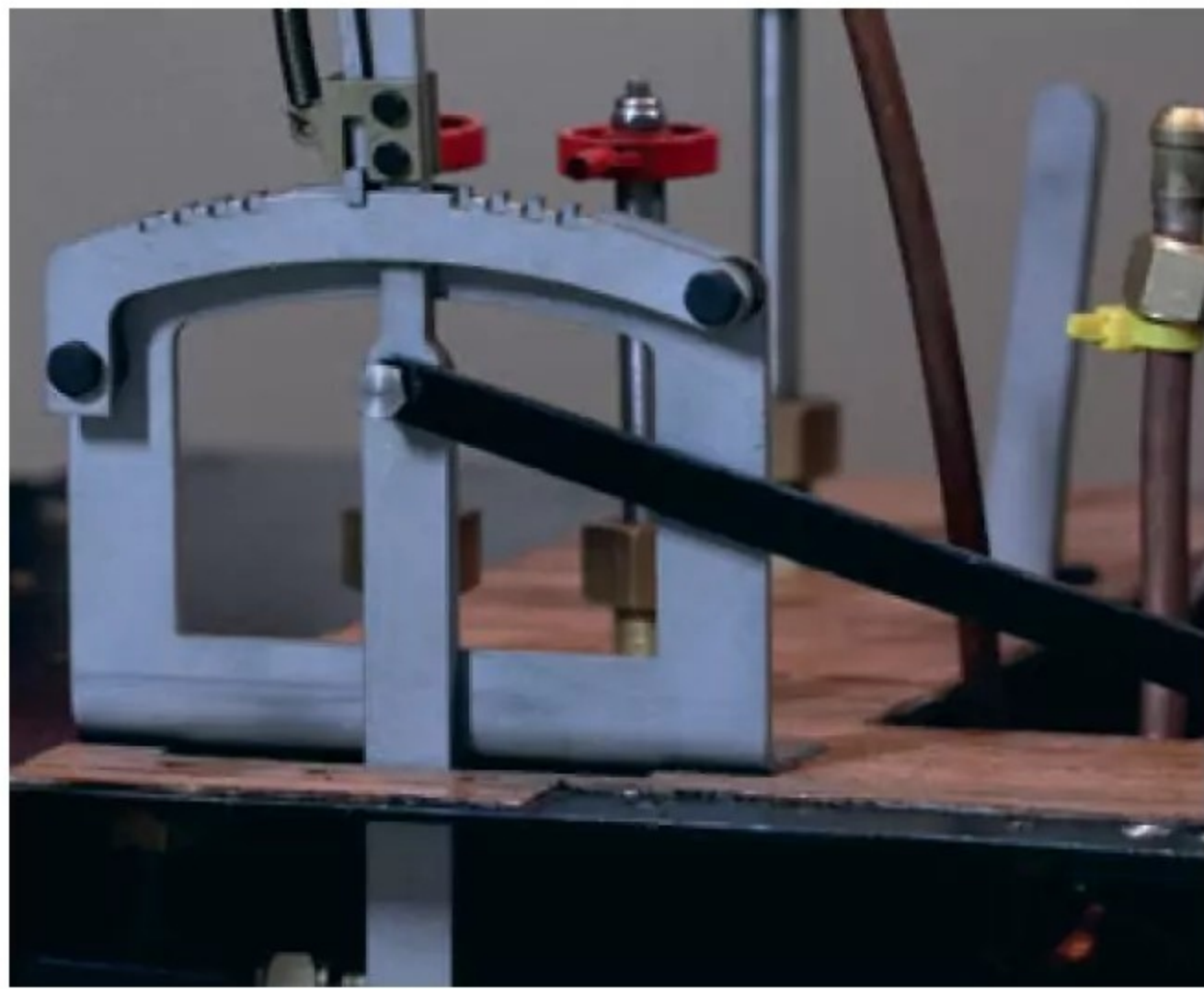


Photo 14: Connecting the reverser reach rod.

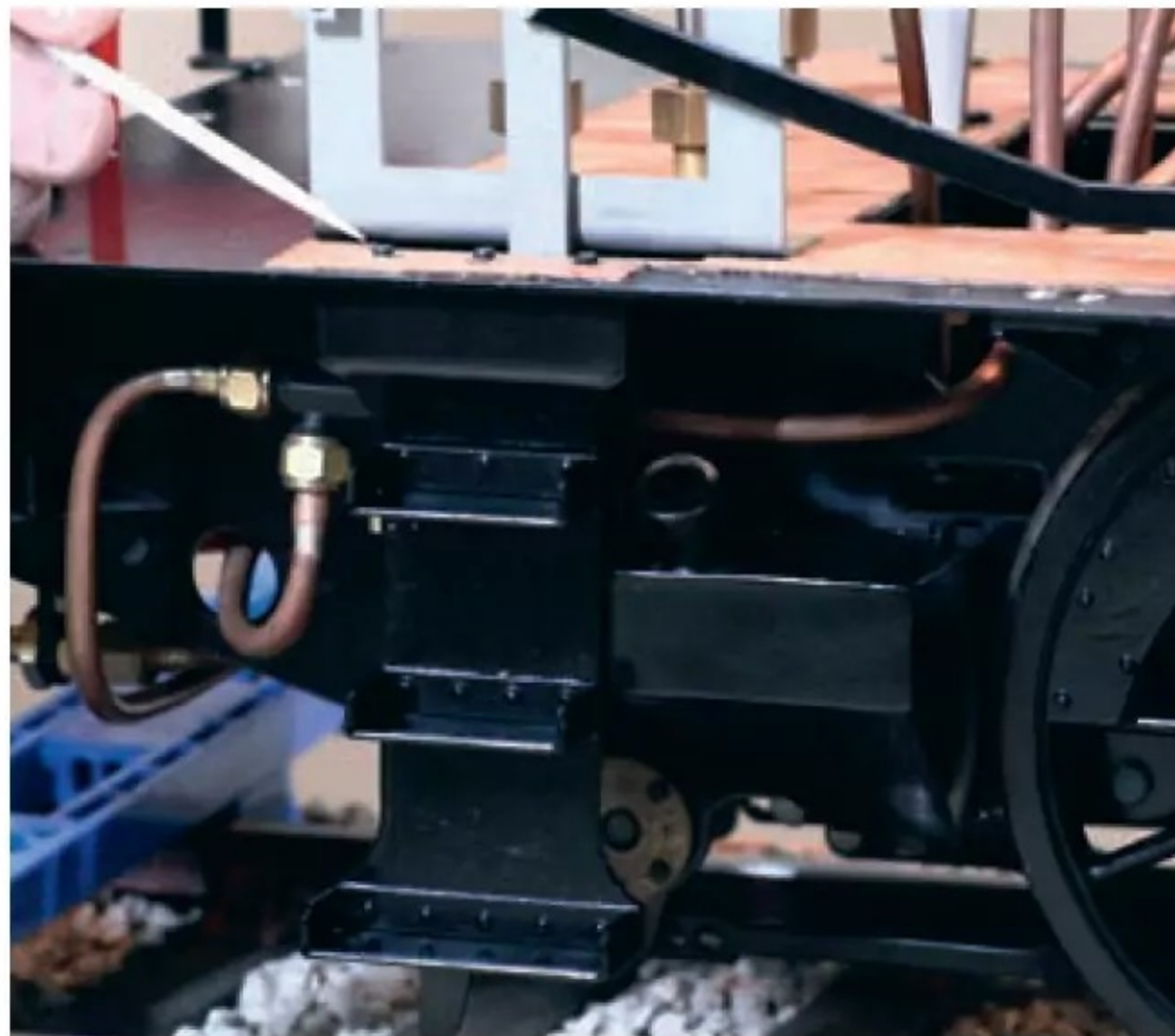


Photo 15: Fitting the rear steps.



Photo 16: Bolting in the smokebox.



Photo 17: A selection of pre-painted body parts.



Photo 18: Etched brass running number plate & lining decals.

to be connected to the underside of the water tanks. Remember, I have said all these pipes had already been preinstalled on the ready-to-run model, prior to the strip down in the factory to create this kit. The outlet pipe goes directly down from the two inlet pipes, so could be fitted either way around. However, in the pipe bending process this component was not completely symmetrical, so would clearly fit better one way round. The only problem was I had no reference as to which was the right way – so had to guess. I know if I guessed wrong, I would have to make small adjustments to get the outlet feeds to line up with the underside of the tanks. Spoiler alert: I got it wrong. Two small O rings were attached to the top of these pipes, which would offer a watertight seal. I held these in place with tape so I did not lose them and also invested in a cheap box of Rolson O rings which covered all the sizes of the O rings used in this kit and provided me with ample spares.

PESKY PIPEWORK

With all of the awkward-to-fit pipework completed, I breathed a sigh of relief as I was now on the home straight. I did mention earlier I spoke to both Silver Crest and Mike Pavie about this and was met with two differing opinions. Mike felt that fitting the

pipework would pose no challenges to more experienced model engineers and did not want to patronise them by explaining in detail where each pipe went. On the other hand, Silver Crest felt that more explanation was required for this process as they thought many of their target customers were just like me, with limited comprehension of how a live steam loco works. Now, I am only the oily rag at the end of the food chain in this respect and can't really comment on the above, but from my personal perspective, I would have liked my hand to have been held more tightly during this procedure.

It was nice to round this kit off with two very simple tasks, as a reward for all my hard work. The reversing reach rod, **photo 14**, was attached between the reversing lever, located in the cab and the reverser bracket assembly. As the threads did not extend all the way down the length of the bolts, it would be impossible to over-tighten these, which would have stopped the reversing lever from moving. The rear steps were bolted down through the top of the footplate and held in place by 3 x 3mm bolts on each side, **photo 15**. The smokebox could now be fitted onto the saddle. This is held in place by four similarly sized 3mm bolts, but this was one of the rare occasions that nuts were used to secure these, **photo 16**. The bolts were inserted from inside

the smokebox, through and out the other side of the smokebox saddle and then retained with the nuts. Not the prettiest of solutions, but then I could not get a ring spanner inside the smokebox to hold the bolts whilst I used an Allen nut spinner to tighten up the nuts. As it was, I needed to use a flexible shaft on my nut spinner as the curvature of the smokebox made it quite tricky to access these.

PRE-PAINTED BODYWORK

Overall, I was very pleased with my efforts on the build of this stage. In hindsight, the pipework was the most challenging part of this build, but from here on in I was on a downhill slope and it looked like there was lots more fun to be had adding the boiler, boiler wrapper, and the side tanks, **photo17**, and I could see this would increase the size of this loco dramatically. I took a moment to more closely examine these pre-painted body components. I liked what I saw. I went for the lined black version rather than the plain black variant and the lining transfers stood up well to a close-up shot, **photo18**.

The etched brass plates were supplied but these needed to be fitted. Rather than risking drizzling glue down the cab sides I used Gorilla Glue double-sided sticky tape which I have found to be very strong, yet with care and a plastic spatula, I would still be able to prise these off without damaging the paintwork in the future should I wish to re-number the loco.

Next time I will be doubling the weight of this loco, which is barely a one-person lift already, as I will add the boiler and associated back head fittings, and seal around any gaps between this and the smokebox to make it airtight. If you wish to dip into my YouTube series of build videos, just search for my channel's name: **MADforSTEAM** and you will find them. Until next time, happy steaming!

RPM Measurement Without A (Proper) Tachometer

Rod Angel explored different ways of checking the RPM of a governed electrical motor.



Unlike most workshops that have featured in this magazine, mine is set up for electrical and electronic engineering rather than mechanical engineering. OK, to be absolutely honest, it's set up for amateur radio – but on this occasion I was building a unit that would use a small 12v motor.

After fifty-something years of tinkering with such projects, I have a reasonably well stocked 'junk box', and it didn't take long to find a suitable part in there. The chosen item was a rather nicely made motor of German origin which, a long time ago, had been salvaged from an old cassette tape drive. Despite decades of neglect in my junk box, it ran beautifully.

An interesting feature of this little motor was a miniature centrifugal switch, which was built into a hub on the back end of the motor shaft, **photo 1**. The significance of that only became apparent later, but initial examination of it inevitably led to



Photo 1: Motor with built-in centrifugal switch.

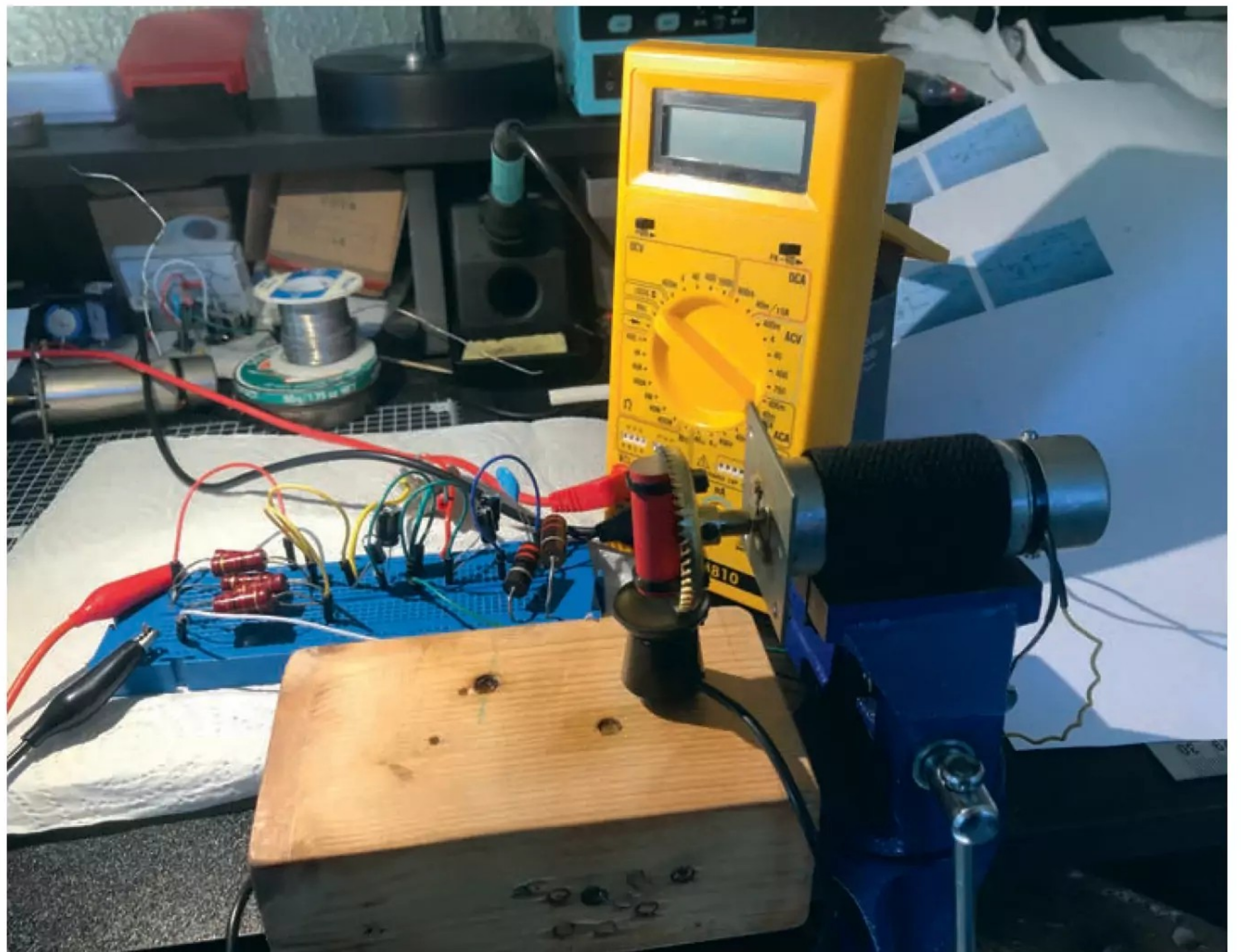


Photo 2: My first DIY tachogenerator.

thoughts about rotation speed, which was obviously going to be a key input to my project design. So, how fast was it spinning?

I do understand that tachometers – both the contact and non-contact types – are common tools, and that every self-respecting model engineer probably has at least three of them in their tool cabinet. But I don't have any; and I needed to know how fast my motor was running. So began a process of improvisation, which rapidly grew arms and legs, and soon became something of a science project in its own right.

Some of the spin-off from that (sorry, no pun intended) might find application elsewhere so, for what it's worth, I'll now share with you the techniques that emerged from my unplanned research.

THE ALL-PURPOSE METER

My first, and simplest, DIY tachometer was based on a digital multi-meter (DMM). This is probably the most used piece of test equipment that I possess and, despite being now rather elderly, it has a kHz range. Armed with this, I only needed to convert mechanical rotation into a voltage. Of course, devices which do that are commonly known as generators, and they usually have magnets and coils. So, a small bar magnet and a telephone pick-up coil were the next things to be rescued from my junk box. The general arrangement is shown in **photo 2**. Aficionados may recognise the Meccano crown wheel, now modified to fit on a 6mm shaft.

The bar magnet is simply tie-wrapped to the wheel, using four

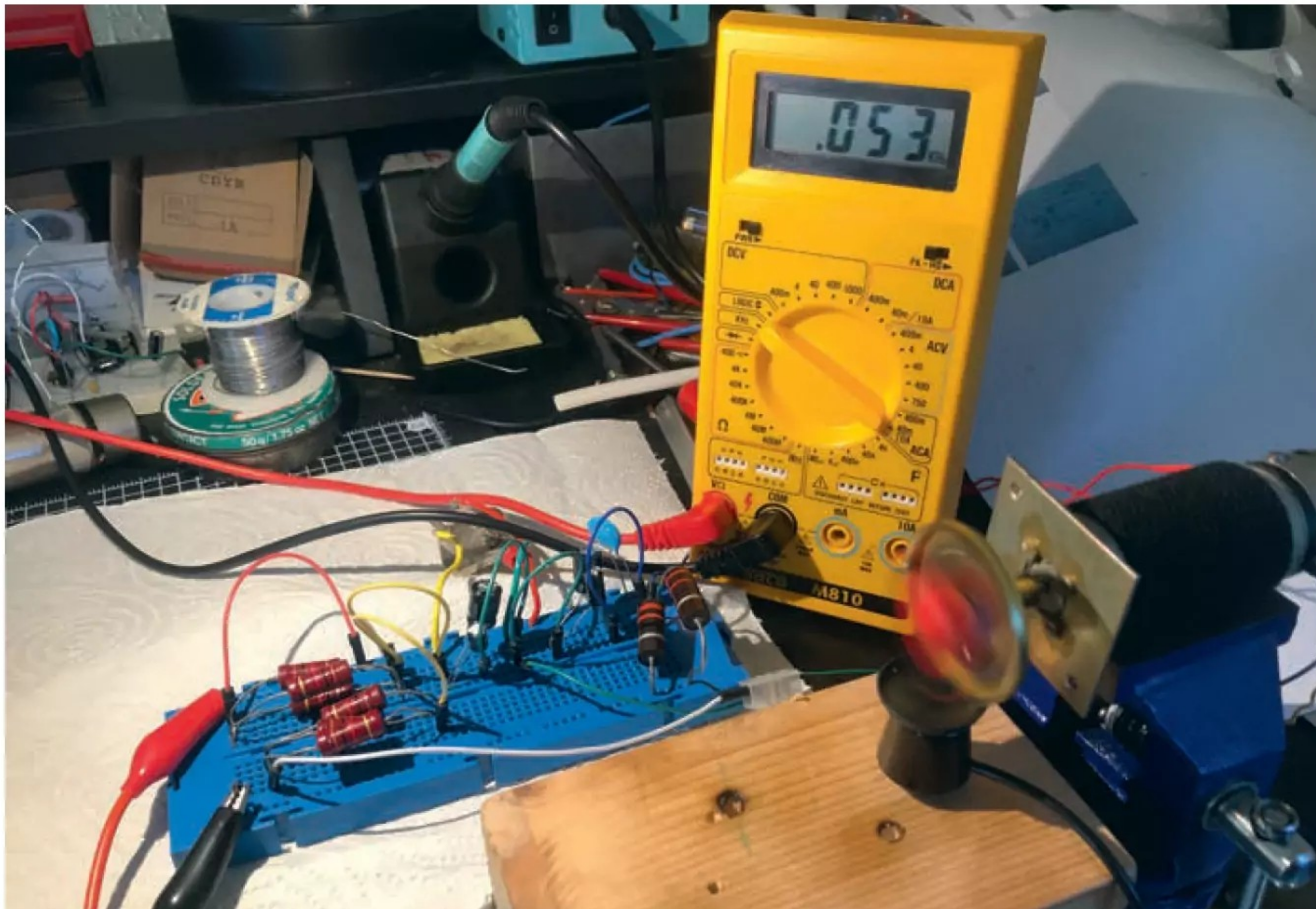


Photo 3: DMM displaying detected rotation rate in kHz (thousands of revs per second).

of its original holes – and because you can never be sure about the strength of tie wraps, I always don safety glasses before connecting electrical power to the motor. The pick-up coil is held in place with Blu Tack, but double-sided sticky tape should work just as well. The output from the pick-up coil is fed directly into the DMM. And that’s it.

Photograph 3 shows the magnet spinning, and the DMM displaying the detected frequency: 0.053kHz. This equates to 53Hz, indicating that the motor shaft is turning at 53 cycles (or revolutions) per second. Multiplying that figure by sixty gives the number of revolutions per minute: 3180 rpm.

This number was quite a bit higher than what I’d expected, and I immediately doubted the accuracy of my homebrew tachometer. In fact, I had a perfectly good result – and, with hindsight, I probably should have seen that because there were other clues. Nevertheless, at the time I was unsure, and so I set about finding ways to either verify or disprove this first measurement.

USING AN OSCILLOSCOPE

The first test was to replace the DMM with an oscilloscope. **Photograph 4** shows the ‘scope display with the motor running and the pick-up coil connected directly to one input channel. The waveform is really ugly, but the period of the cycle (revolution) is clear enough. The time scale (x-axis) is 5ms per graticule division. It can be seen that identical points on successive cycles are about 3.8 divisions apart,

making the period of the cycle about 19ms or 0.019s – which is pretty close to 1/53 of a second, and therefore in good agreement with the DMM measurement of 53Hz.

OPTICAL DISC

The result from the ‘scope test was encouraging, but I still wanted proof of the indicated result; and ideally more precision. I resolved to try a different approach. The use of a strobe light to ‘stop’ a moving optical pattern is a well-established technique. Readers of a certain age may remember using a

strobe gun to check engine timing after replacing the points in a distributor. Others may have tweaked the speed of a gramophone turntable to an accurate 33rpm using its built-in (mains frequency) strobe light and stripes on the turntable edge. In practice, the fine-tuning of timing or speed to a known datum is easy enough, but determination of an unknown speed is more difficult.

For this I made the optical disc shown in **photo 5**. This has three main elements:

1. An outer ring with alternate black and white quadrants;
2. An inner disc with alternate black and white sextants;
3. Two mounting bolts (one with a black head, the other with a white head) positioned symmetrically about the centre point, on a diameter line which is common to both inner and outer patterns.

The rest of this article describes the use of that disc to prove rotation speed, and the construction and assembly of a simple test rig to support the measurement process.

RPM MEASUREMENT BY STROBE

Before we go any further, a quick health warning: This technique involves flashing lights. In a small minority of the population, the sight of a flashing light can trigger an epileptic fit. So, no-one who is known to suffer from epilepsy should be present when a strobe light is in use.

Even for the vast majority of us

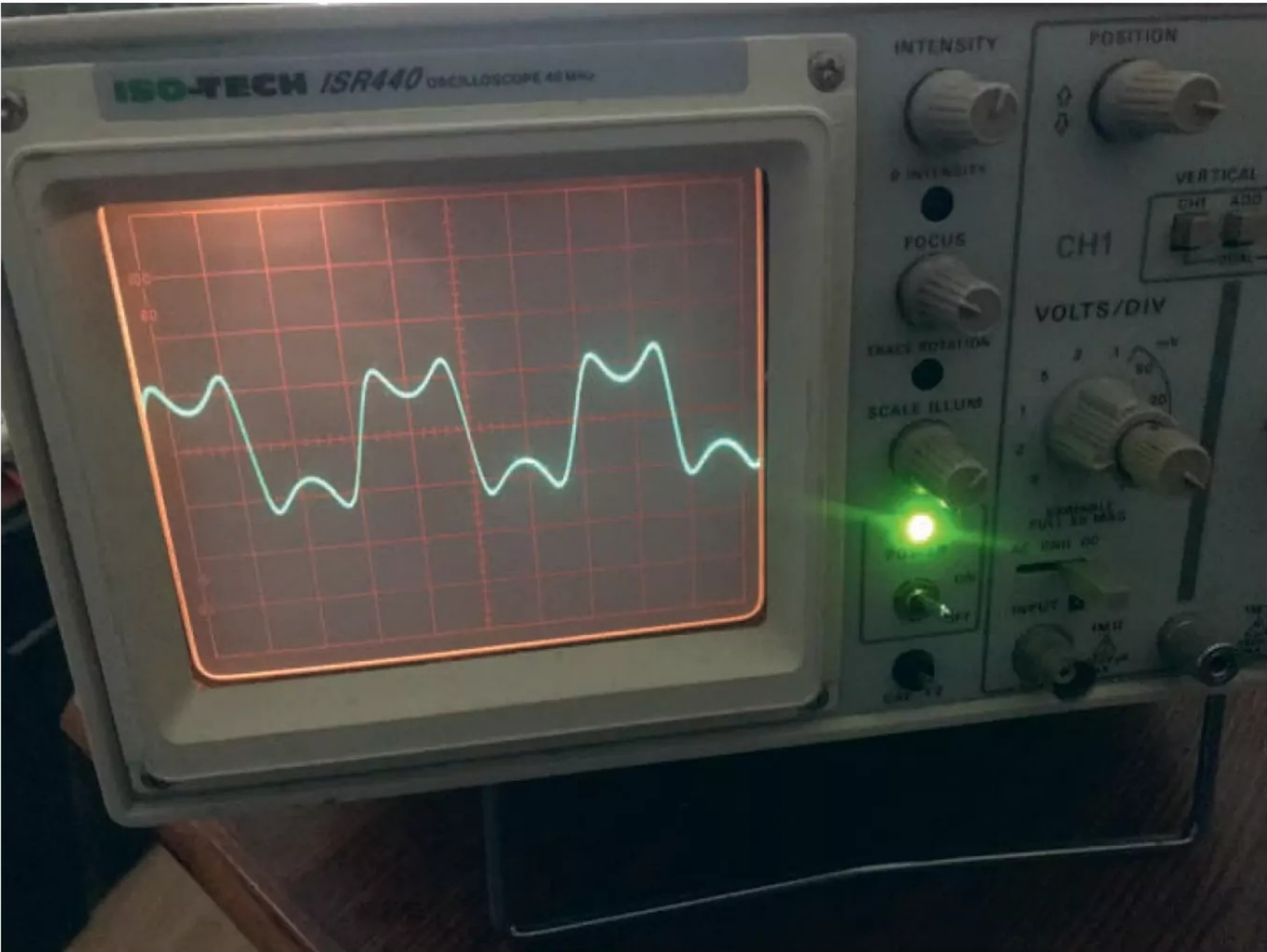


Photo 4: Oscilloscope trace of the DIY tachogenerator output signal.

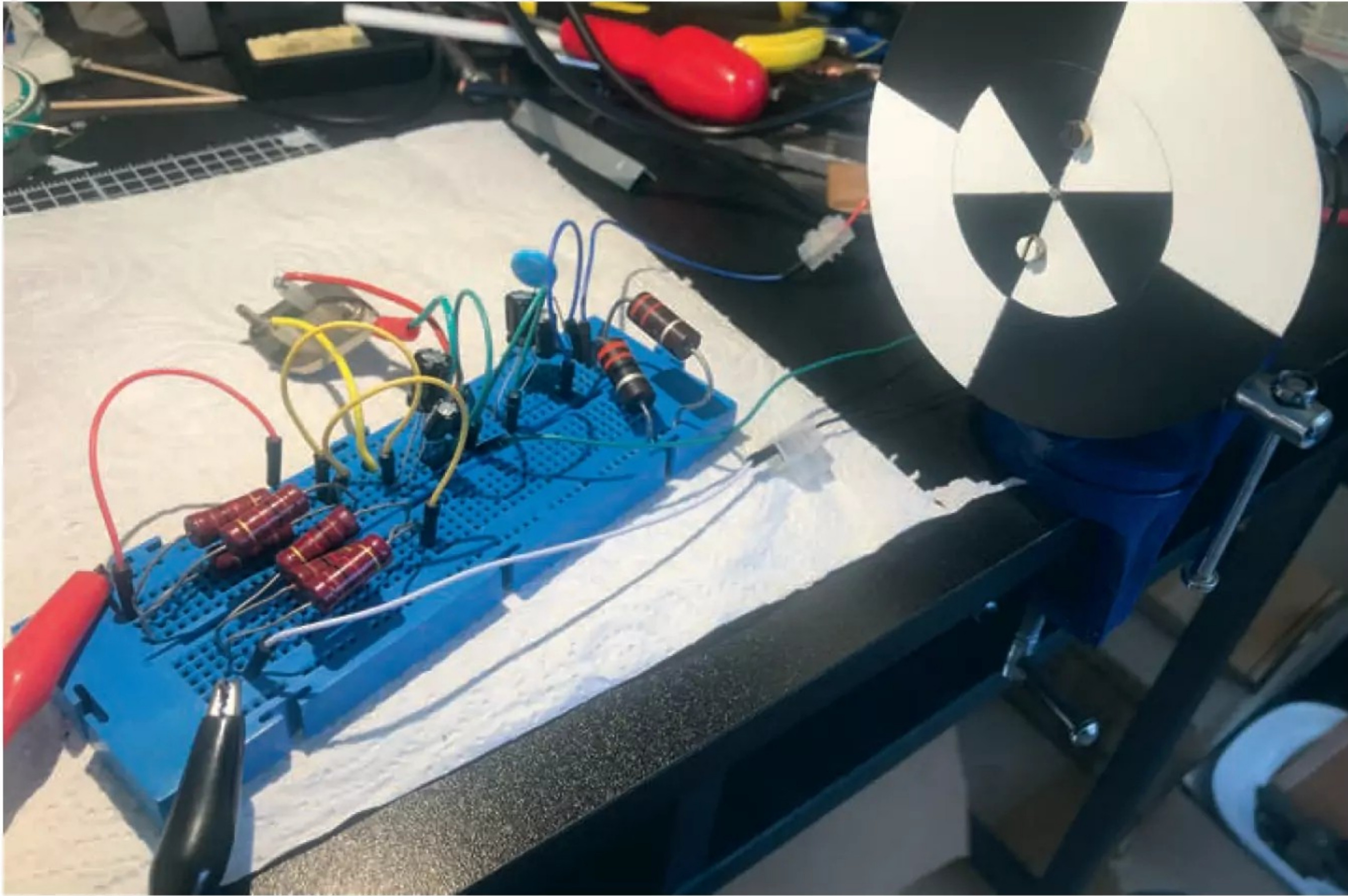


Photo 5: Optical disc (right) and breadboard recreation of the analogue speed governor (left).

who are not susceptible in that way, a light flashing at a few Hz can be quite unpleasant to look at. Most people will not want to dwell on the early stages of this measurement process – but, happily, there is no need to do that.

The basic principle here is much the same as any other measurement by strobe: We are aiming to synchronise the flashing of the light with the rotation of the disc, and thereby to make the optical pattern appear stationary. What makes this different from other applications is that we do not need any a priori knowledge of the rotation speed which is to be measured. We just vary the flash rate until we find a frequency that does actually synchronise with the mechanical rotation of the disc. At that point, the black and white pattern will appear to stop. The means to control flash rate is discussed in a later section.

Finding a flash rate (frequency) that ‘stops’ the disc is a key step; but it is not, by itself, a foolproof measurement of rotation speed – because any whole number of revolutions between flashes will ‘stop’ the disc. The final piece in this particular jig-saw is to progressively increase the flash rate until there is just one complete rotation between successive flashes. How do we know when we have arrived at that point? By continuing beyond it and observing that the disc pattern cannot then be stopped. Clearly that is a potentially infinite process, so we need a method of bounding it.

In the design suggested here, the second and third harmonics of rotation rate can readily be identified by stopping different parts of the pattern separately. So, if we call the true rotation rate R , a flash rate of $3R$

will stop the inner disc, but not the outer ring. Similarly, a flash rate of $2R$ will stop the outer ring, but not the inner disc. In these cases, the disc does not complete a whole revolution between flashes but does rotate enough to realign the symmetrical segments of one or other pattern, so that only the one pattern appears stationary.

There is one final nuance. Since a flash rate of $3R$ stops the inner disc (which will then have rotated $1/3$ of a revolution between flashes), a flash rate of $1.5R$ must also stop this part of the pattern – because the disc will then have rotated $2/3$ of a revolution between flashes.

Observation of the mounting bolts adds supporting evidence. With a flash rate of R , we see two bolt heads, one black and one white. At $2R$ we still see two bolt heads, but both are now white. At $1.5R$ and $3R$ we see six bolts, whose heads appear to be either half grey and half white, or half grey and half black.

MEASUREMENT PROCEDURE

Whilst detailed analysis of stopped or partially-stopped patterns may be of academic interest, the practical application of all this to a useful tool calls for rapid convergence to an unambiguous measurement of rotation speed. With that in mind, the following procedure is recommended. Observations are most easily made in a dimly lit room.

Start by illuminating the disc at a slow flash rate; below 10Hz . Increase flash rate in increments of 1Hz until the pattern shows signs of slowing down. Reduce the frequency increment to 0.1Hz . Home onto a stopping frequency using progressively smaller and smaller frequency increments. When the complete pattern is stationary, check that one bolt head looks black and the other looks white. If it does, note the frequency – which we’ll now call F_1 .

Increase flash rate to $3F_1$, and repeat the process of homing in with smaller and smaller frequency increments. Check for indications of $1.5R$ or $3R$. If the whole pattern can be stopped at about $3F_1$, note the exact frequency – we’ll call that one F_2 .

Increase flash rate to $3F_2$, and then iterate the process of homing

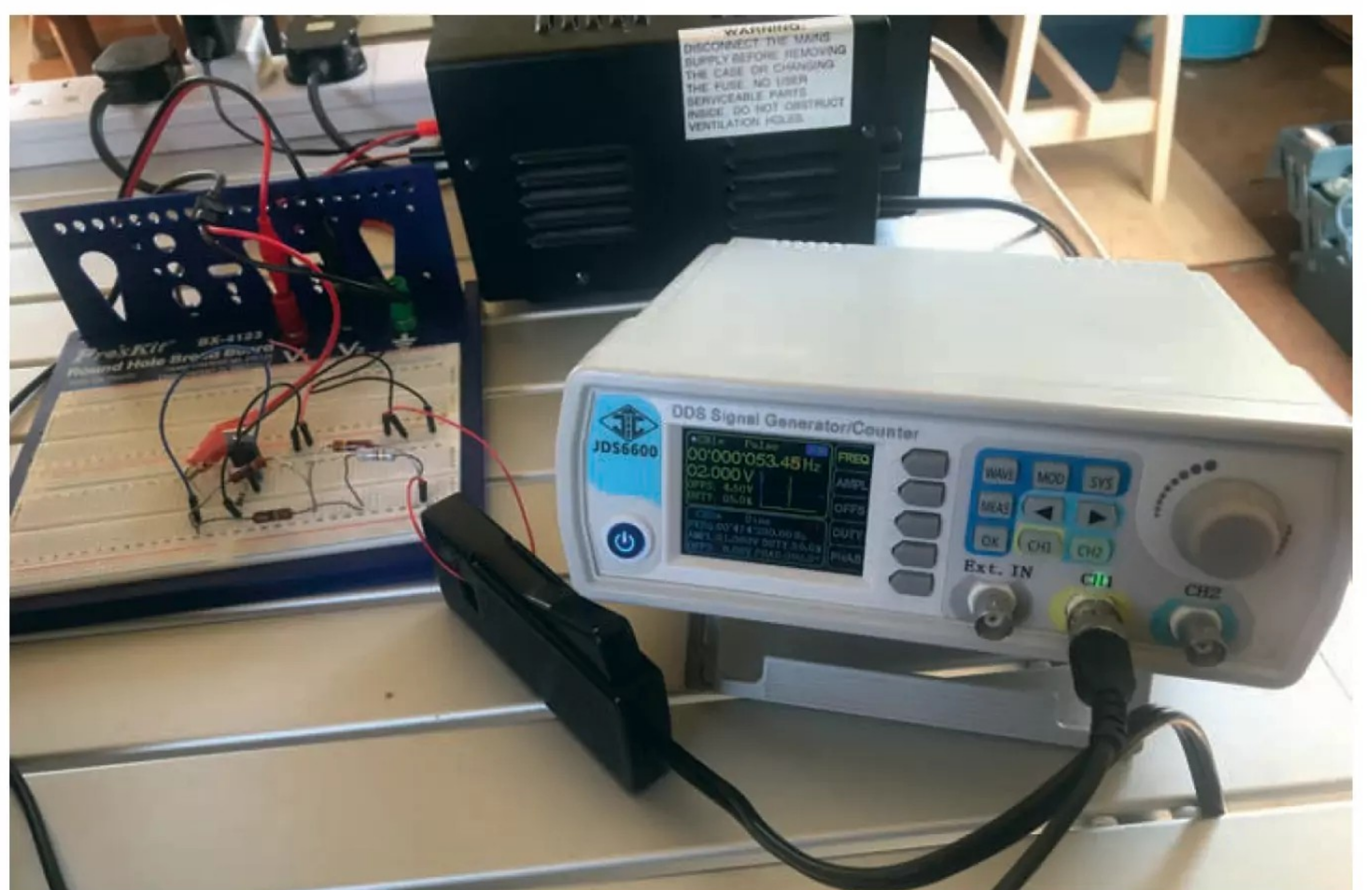


Photo 6: Breadboard prototype of the strobe trigger drive (left), and signal generator (right). The black object between the two is the inductive coupling clamp which picks up the trigger signal.

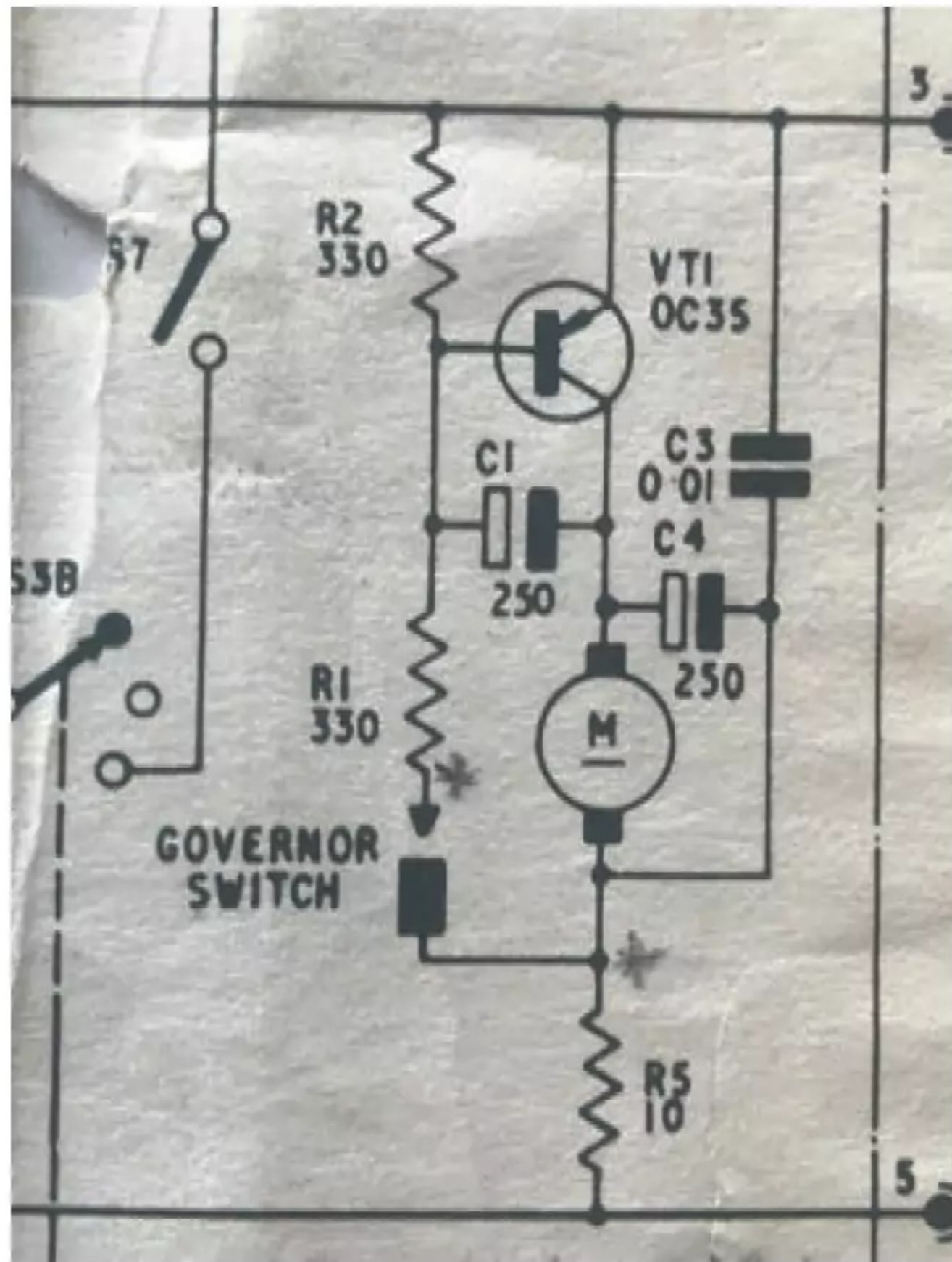


Photo 7: Extract from the 1980 equipment manual (originally published in 1970) showing the motor speed governor circuit.

in and checking for harmonics until an indication of either 1.5R or 3R is suspected. Check for each by reducing the last flash rate, first by 1/3 and then by 2/3. The whole pattern should stop at one of these points. When it does, the flash rate will be R. This can be verified by setting the flash rate first to 2R and then to 3R, and confirming that the expected effects can actually be observed.

DRIVING THE STROBE

The ideal strobe light is the kind used to check the spark timing of a petrol engine – or indeed any other that uses a Xenon tube as its light source and has an accessible trigger input. These devices emit very short bright flashes (pulse durations measured in microseconds) which make the edges of a stopped pattern nice and sharp. If such a tool is not available it is possible to flash an LED, either with an adaptation of the strobe gun driver circuit presented here or (more simply) by downloading a tachometer app to your smart phone. The downside of LED strobes is that the flash duration is orders of magnitude longer (milliseconds); and that makes edges fuzzy and patterns blurred.

A garage mechanic's strobe gun is connected directly across the car battery, and I have mimicked that arrangement with a lead acid battery in the workshop. The trigger input comes from an inductive coupling, which would normally be clamped over a spark plug lead. My 'spark plug lead' is a wire carrying the drain current of

a power MOSFET. A signal generator, set to give short pulses at the desired frequency, is connected to the MOSFET gate. With a suitable resistor forming the drain circuit load, current pulses of about 0.5A can easily be generated, and these are more than enough to trigger the strobe. Photo 6 shows a breadboard prototype of the trigger drive, the inductive clamp, and the signal generator.

Figure 1 is the circuit diagram of this arrangement.

Care is needed to ensure that the load resistor has a high enough power rating. I used a network of four 5W resistors, and these still get very warm at the higher flash rates.

If a LED strobe is to be driven, it and its ballast resistor can replace the drain load resistor.

MOTOR SPEED GOVERNOR

At the beginning of this piece, we saw the miniature centrifugal switch, which appears to have been a standard feature on this type of motor. I return to it now only because strobe speed measurement, as described above, gave an unexpected insight into its operation.

The original equipment manual (last updated in April 1980) included a full circuit diagram of the cassette tape drive unit, and a small part of that is reproduced here at **photo 7**. This shows a simple closed-loop speed controller, which uses analogue techniques. The specification called for a constant running speed (of the cassette tape) with power supply voltages in the range 10v to 16v. The motor running speed was obviously related to tape speed by a mechanical gear ratio, but I don't have that bit.

Once again, I had my doubts; and once again they proved to be groundless. I recreated the original governor circuit in breadboard form, even including the specified Germanium PNP power transistor (another treasure from the Angel junk box). This can all be seen in photo 5. And sure enough, this very simple

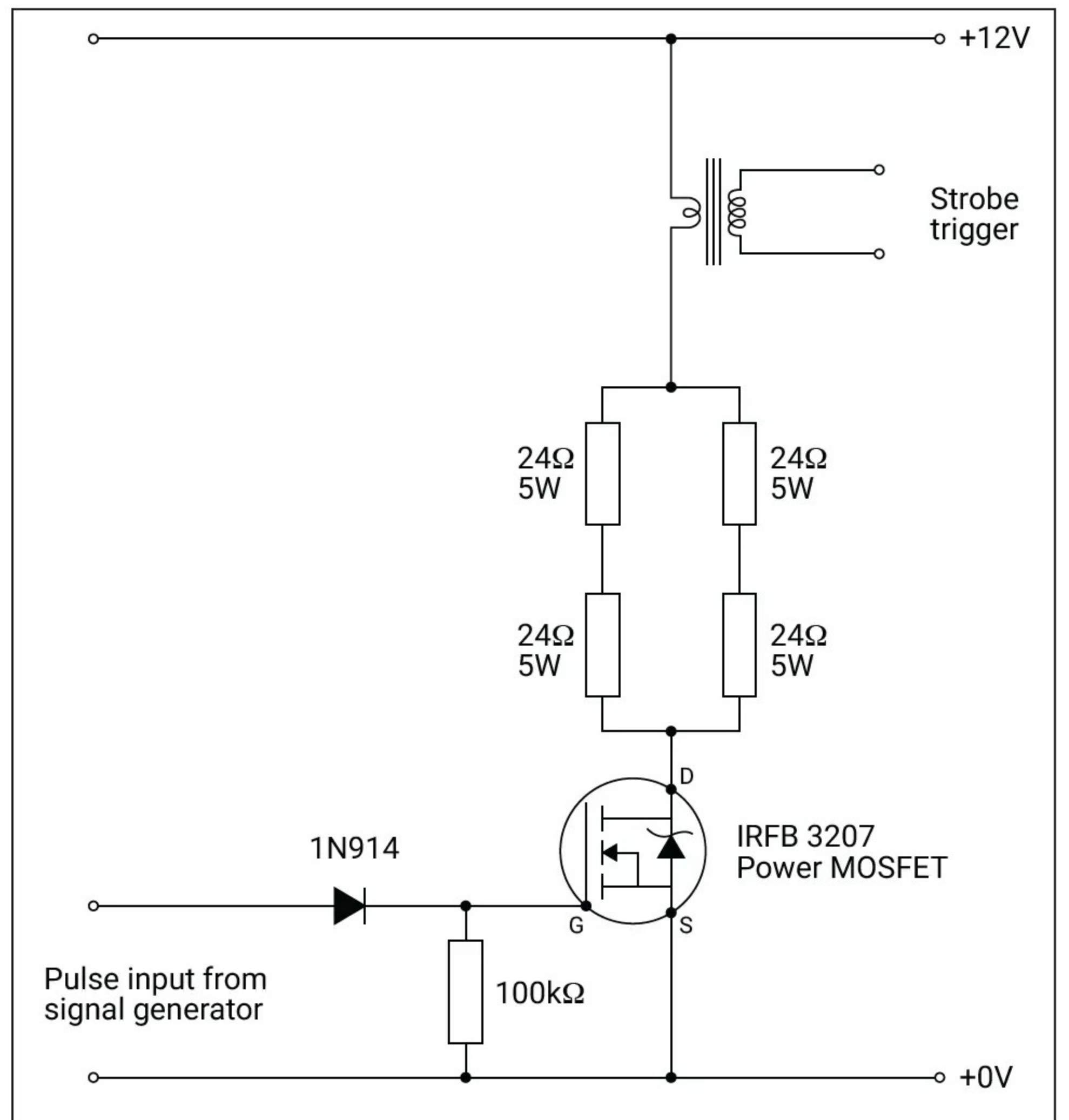


Fig 1: Circuit diagram of the strobe trigger drive.

governor did exactly what it said on the tin. It coped equally well with representative loads, which I simulated by gently pressing an old toothbrush onto the spinning motor shaft.

In the midst of all this scrutiny, an emergent characteristic caught my eye. With a stable power supply voltage, and no mechanical load applied, the notionally-stopped disc pattern could be seen rocking gently backwards and forwards. After reflecting on this observation for a while, I am drawn to the conclusion that this indicates the centrifugal switch opening and closing, as the motor speed hunts around its design point. The rpm excursions were apparently insignificant in the original application, and they certainly do not show up on either a DMM or a 'scope, but they are visible on the optical disc. I guess that means the strobe light method is quite sensitive.

CONCLUSION

A variety of 'proper' tachometers is available for use in the workshop; but if you don't happen to have one when you need it, all may not be lost. Some very simple improvisations are possible, and these may well give adequate results.

If greater precision is required, the combination of a strobe light and a DIY optical disc will enable close scrutiny of rotation speed. With this set up, no a priori knowledge of rotation speed is assumed (or needed). A straightforward and logical test routine converges rapidly onto the true speed and enables error checking thereafter. 🌀

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 or 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.

A SOUND lathe-work principle is to machine as much as possible of a component at a single chucking in order to preserve alignment between faces and concentricity on diameters and to save time in resetting.

Many chucks do not hold really truly, particularly after a period of use, and there are components whose slenderness or fragility renders their rechucking a problem. Often, of course, a second set-up is inevitable and consideration must then be given to ensuring truth, avoiding distortion, and performing the work with the minimum of trouble.

A diameter, bore, or face on material gripped and machined in the chuck is obviously true until the material is moved, so that any such feature employed for alignment will result in a component being true on a second set-up.

Stub mandrels, as at *A*, machined from material held in the chuck, provide for the true setting up of bushes, sleeves, small wheels and pulleys, previously finished in the bore either by accurate boring in the lathe or drilling and reaming. Friction drive is sufficient for light cuts, and a mandrel can be turned with a slight taper, or a taper produced by a Swiss file and/or abrasive cloth. Pushing a component on by hand is sufficient and in some cases, a smear of oil is advisable to prevent seizing. If the

component is tight a clamp or protected-jaw pliers may be needed for removal.

Using a nut and washer, a component can be gripped on a mandrel; and when overhang is considerable support can be given from the tailstock. Mandrels may also be run between centres-but, naturally, more time is needed for making them. For ordinary stub mandrels scraps and off-cuts of most common materials can be used—mild steel, brass, aluminium alloy; and they can be given a reference dot mark to No 1 jaw for rechucking when necessary—or set up in an independent chuck.

A problem may arise when a large diameter must be turned with the component on a mandrel, since a friction grip, or even a mounting with a nut on the end of the mandrel, will not ensure a slip-free drive. In

the case of wheels or pulleys with spokes or holes, a solution is to employ a driving bar bolted to the mandrel and shaped and “set” as required to pass between spokes or through a hole. The mandrel should be partly finished, the bar fitted, then removed while the locating diameter and face are machined. Again support from the tailstock may be necessary in use, as at *B*.

On more elaborate mandrels to run between centres an expanding sleeve or opposed cones may be used in the bores of components, as at *C*—the cone type somewhat wanting in accuracy. For the expanding sleeve the mandrel is tapered and the sleeve slit lengthwise to be displaced by a nut. A second nut at the large end is advisable when the mandrel taper is slight—to free the sleeve by screwing back against it.

Provided with threads externally or internally stub mandrels in the chuck afford means of setting up screwed components, as at *D*, for operations on the outer ends—turning, facing, threading, etc. To ensure truth, threads on the mandrels should be screwcut or cut with dies or taps from the tailstock.

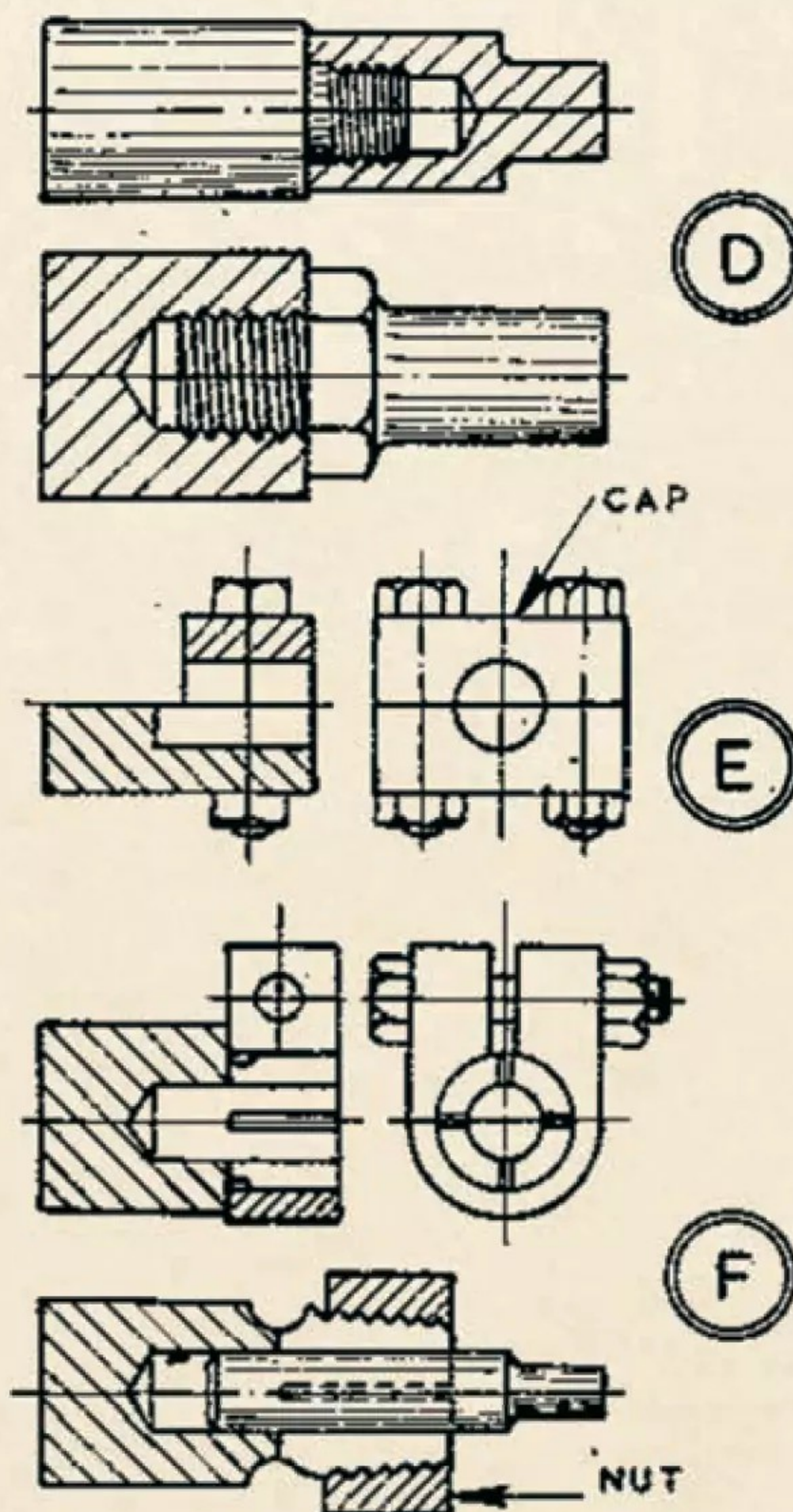
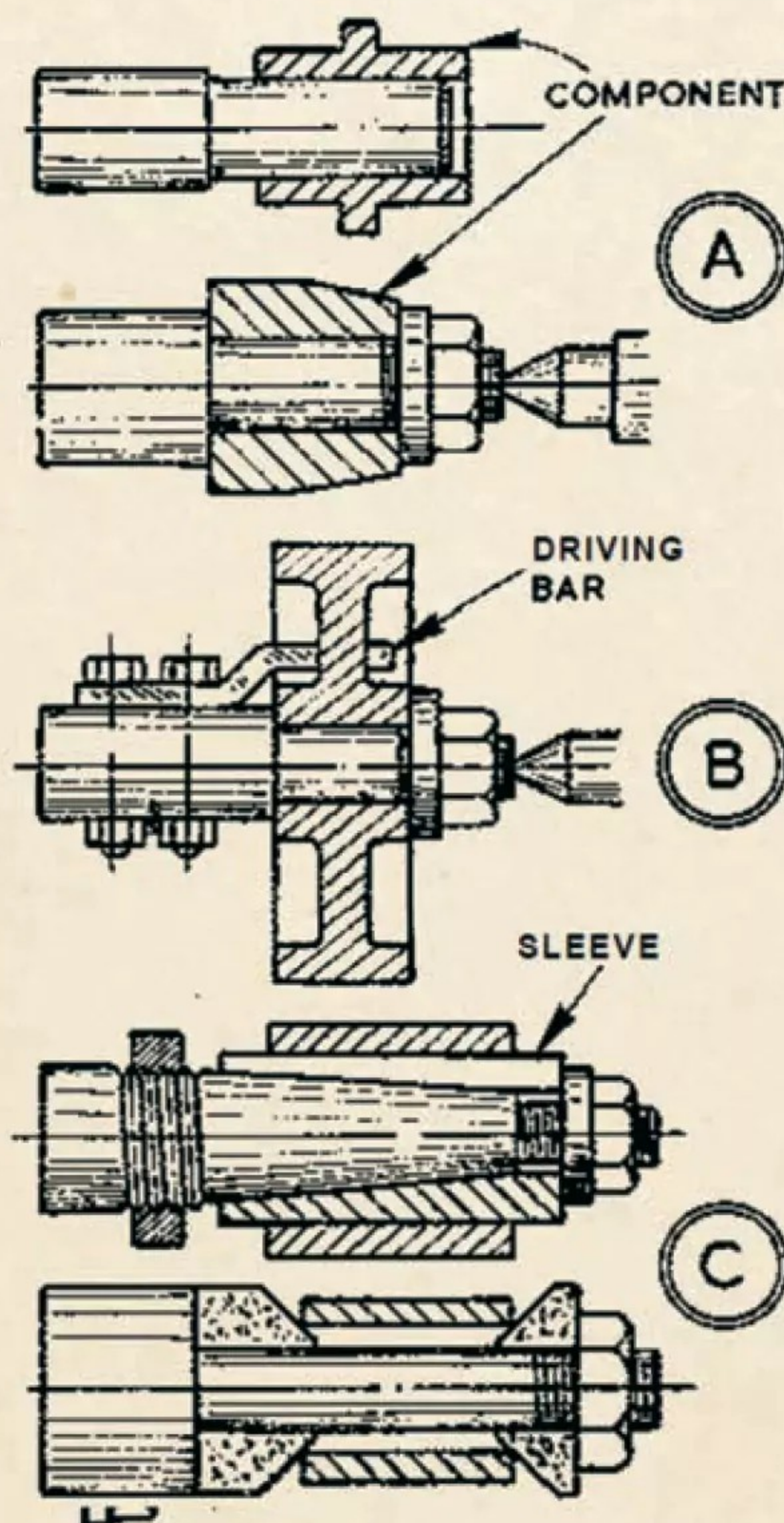
Spindle-type components or those with shanks for location can be set up in various sorts of clamping or contracting mandrels or collets. A simple and effective type can be made from flat stock, as at *E*, by bolting on a cap and setting in an independent chuck for drilling and boring—the cap then being eased on the joint face for a grip to be obtained on the shank of the component.

Collets to contract and hold components can be as at *F*. For the clamping type the stub mandrel is bored, turned, and a small undercut made at the shoulder. Without removing from the chuck the end is slit lengthwise with a fine saw. For closing, a clamp as shown is better than a collar with a screw. The type with a nut can have a taper thread by not running the die on fully, while the nut can be undersize from not passing the tap right through

Beginner's Workshop

By GEOMETER

Second operation set-ups



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Neil Wyatt

Editor

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3D Printing in the Home Workshop

Alan Bryan explains how a 3D printer can change your life, or at least, your hobby.

Working as a consultant car design engineer in the motor industry, meant that quite often I rarely saw what I had actually designed 'in the metal' until about four years after my involvement in the project had ended and I came across the car that I'd had a hand in designing a showroom. I worked mainly in Europe on a contract basis and my tenure at the motor manufacturer, on those projects, often finished well prior to the vehicle going into production. Indeed, sometimes I never saw it all. Either because the engineering program that I had been retained for was cancelled, or what was eventually produced was nothing like I had committed several hundred hours of work to. Programs often change direction part way through the design cycle. Prototype vehicles are often partially or completely restyled and/or reportioned part way through the program and that would completely change the engineering done to that date. I was often introduced to engineering projects at the beginning of the design cycle and sometimes, due to market research by the manufacturer, the market sector that the vehicle was aimed at might change as the program progressed. Occasionally, the project experienced a hiatus and my involvement would cease. Usually, by the time that work recommenced, you'd find me working somewhere else, possibly in another part of the world and by the time that it reached production I might not recognise it. Although I really enjoyed my profession, it was always the inability to see things through to the physical product that I found to be less than satisfactory.

I first came across 3D Printing's ancestor in the form of Stereo Lithography in 1990 when working at Chrysler's Design Centre in Auburn Hills in Michigan USA. I recall that the program was so data hungry that the several hundred CATIA CAD design stations, which Chrysler had at the Tech-Centre, slowed down noticeably when the department decided to 'run a print.' I realised then that each design office could eventually have a means of

producing the physical form of a virtual 3D design directly from the design engineer's computer. I'm retired now but aware that variations of 3D Printing are used these days to prototype design programs in industry. The technology has expanded to encompass printing with many varied materials, including metal, so it's not just plastics and resins that are deposited to manufacture production parts. The construction industry is also using the technology to construct buildings. The medical industry too. Additive manufacturing is the collective name for it now and it's really still in its infancy as a manufacturing method.

For the purposes of this article though, I'll stay on the subject of additive manufacturing with plastic materials, which is sufficiently fascinating in itself. Since I first came across the process, it hasn't just been professional engineers who have taken advantage of the technology. Today, there are many manufacturers selling 3D Printers possessing a variety of specifications and capacities to hobbyists across the world. For example, our own editor, has a 3D resin printer and has written about it previously in these pages. Therefore, I guess it was



inevitable that just over a year ago at the time of writing, I invested in a Creality K1C 3D printer, **photos 1** and **2**. I use 3D CAD to solid-model 90% of my projects and, since buying my printer, I have been able to realise my virtual designs and inventions into 3D form to the benefit of my workshop, and also to my home as well.

Why that make and model of printer you may ask? Well, inevitably it all came down to price in the end but firstly I wanted a fully enclosed machine. It was going to live in my workshop, which is hardly a laboratory in terms of its cleanliness, so I wanted to ensure that its working volume could be kept dust and grit free. Secondly, I needed a machine with as big a build volume as possible and I think I achieved that from amongst the enclosed machines available at the time which were available at the price that I was



Photo 1: The printer on delivery day, just after unboxing.



Photo 2: The printing space.

prepared to pay. Shortly after I bought it, the Creality K1 Max was announced, albeit at a price above my then applicable ceiling. In the year since its introduction the price of the K1 Max has inevitably reduced considerably and the K1, which is still available, has dropped considerably below what I paid for mine. Frustrating, but par for the course with tech items. Development is relentless and there's always the 'just introduced latest version' of everything available now or coming along shortly.

My version of the K1 is the K1C which was advertised as being compatible with carbon-fibre reinforced filament. I chose that version because the extruder and nozzle etc. are steel in order to meet the performance demands placed on them by the more abrasive filament that the machine is capable of printing. I figured that the working life of those parts would be longer, and I've been proved right on that front. I have printed with carbon-fibre PLA but to be honest haven't noted any improved performance over normal PLA which is my usual material of choice in the parts that I've made from it.

Almost everything that I build in my workshop is designed in 3D CAD as a virtual solid object and I can now realise each project quickly in solid form if I choose to. Indeed, within a few hours after finishing a virtual model, I can have a prototype of the physical item sitting on my workbench. Therefore it was logical for me to consider whether or not 3D printing can have a place in the manufacturing process. Either as a part of the finished product or alternatively as part of the tooling necessary for me to construct it. To date I have modelled and printed, tools, jigs, machine components and storage systems for my workshop and also parts to improve the installation of home infrastructure items. What isn't there to like about that?

Hopefully, I've whetted your appetite for information and you're itching to know more. Therefore, without further ado, I'd like to tell you what I've actually been doing with the latest addition to my workshop, which I recently described to my six-year-old granddaughter has the robot on my workbench. She was impressed by that and wanted to know a bit more about it. Perhaps I've sowed the seed for a future engineer...

VICE JAW PROTECTORS

These were my first printed components, **photo 3**. Since then I've tried making these from PLA, which I use for the majority of my prints and also from Carbon Reinforced PLA. I use them



Photo 3: Printed jaw protectors for the 6-inch vice.

on both my vices and I've embedded circular magnets into each jaw to retain them in place, **photo 4**. They don't last long unless I'm clamping even-surfaced items in the vices because they delaminate under intense pressure. If you try to grip a casting tightly for instance, they are useless and will break up due to the uneven clamping loads. They are extremely useful though for holding machined items or flat parts and do prevent the jaws from marking vulnerable workpieces.

LATHE CHUCK SPIDERS.

These, **photos 5** and **6**, really are game changers when you've got a

circular workpiece or a short length of bar that is too short to sit squarely in the chuck jaws. You need to align it more precisely prior to commencing machining but how do you ensure that it's gripped in the jaws squarely? Wouldn't it be easier to do the job if the chuck jaws were shorter and you could sit it against the body of the chuck to square it up?

What do you do? The obvious answer is to provide a stop for it to sit against by inserting packing between the workpiece and the body of the chuck or perhaps a more complicated device inserted into the lathe spindle. Have you made a spindle back-stop though? How do you prevent packing from



Photo 4: Embedded magnets.



Photo 5: Front view screen grab of a Myford chuck spider.



Photo 6: Rear view.

flying out of the chuck and impaling your eyeball the moment that you switch the machine on? What you need is a chuck spider, or rather a set of them of different thicknesses. One, or several stacked, provide sufficient thickness to enable items of varying length to sit squarely in the jaws with a minimum of only about 3mm gripped. I modelled a set for each of my lathes and printed off a couple for each machine. The thinking is that I will print these as I need one rather than running off a complete set now.

In use they have proved to be excellent. They aren't exactly robust items, but then they don't need to be. Their only function is to enable the back face of the item in the chuck to sit against something to stop it from being clamped with its axis tilted to the lathe's centreline.

The ones that I have made to date have several disadvantages though for the following reasons: -

1. The chuck won't be able to grip small diameter workpieces because the jaws won't close fully due to the mass of the centre part which joins all three retainer legs together. Remove that and the spider isn't retained, nor does it have anything for the part to seat against.



Photo 7: Myford chuck spider in use.

2. The centre part of the spider prevents through drilling of larger holes.

The centre part is there to join all six legs of the spider together and I have minimised it to the absolute minimum that I consider appropriate for retaining the integrity of the part. To do away with it will mean that it will no longer function because the workpiece will have nothing for the part to interface with. The minimum diameter that can be gripped in my Myford Super 7's Grip-Tru Chuck is 9mm when using a spider and there's not much in the middle holding the arms together. Overall, I don't consider 9mm minimum to be a problem, certainly not yet anyway. If it proves to be, it can be worked around by using a small diameter split bush to grip the smaller diameter part instead of using the spider.

Regarding through drilling, the centre hole is 4mm diameter which permits a hole of that size to be drilled as a maximum. Therefore if a larger diameter part requires a drilled hole through it larger than 4mm I will simply remodel the spider to suit the outside diameter part and print a special one

to permit the hole to be drilled. A 14mm thick spider represents a fraction of an hour to print and uses approximately 23 grams of filament. I have models stored, ready to print, of spiders from 2mm upwards. **Photograph 7** shows a spider in use.

My Colchester Master 2500 Lathe has a 3-jaw chuck more than twice the diameter of the Myford's whilst the jaws are also wider by the same factor. That all conspires to increase the minimum diameter that can be gripped when using one. However my previous remark about making and using a split bush still applies. Either that or switch to machining that part to the Myford instead and use a spider to do it.

MACHINING BALL ENDED HANDLES – ANGLE SETTING AIDS FOR THE MYFORD TOP SLIDE.

I'm building a Quorn Universal Tool and Cutter Grinder. I bought the castings in the 1980's from the now defunct Model Engineering Services Ltd and for years it sat under the bench waiting to be commenced. Finally though, I am

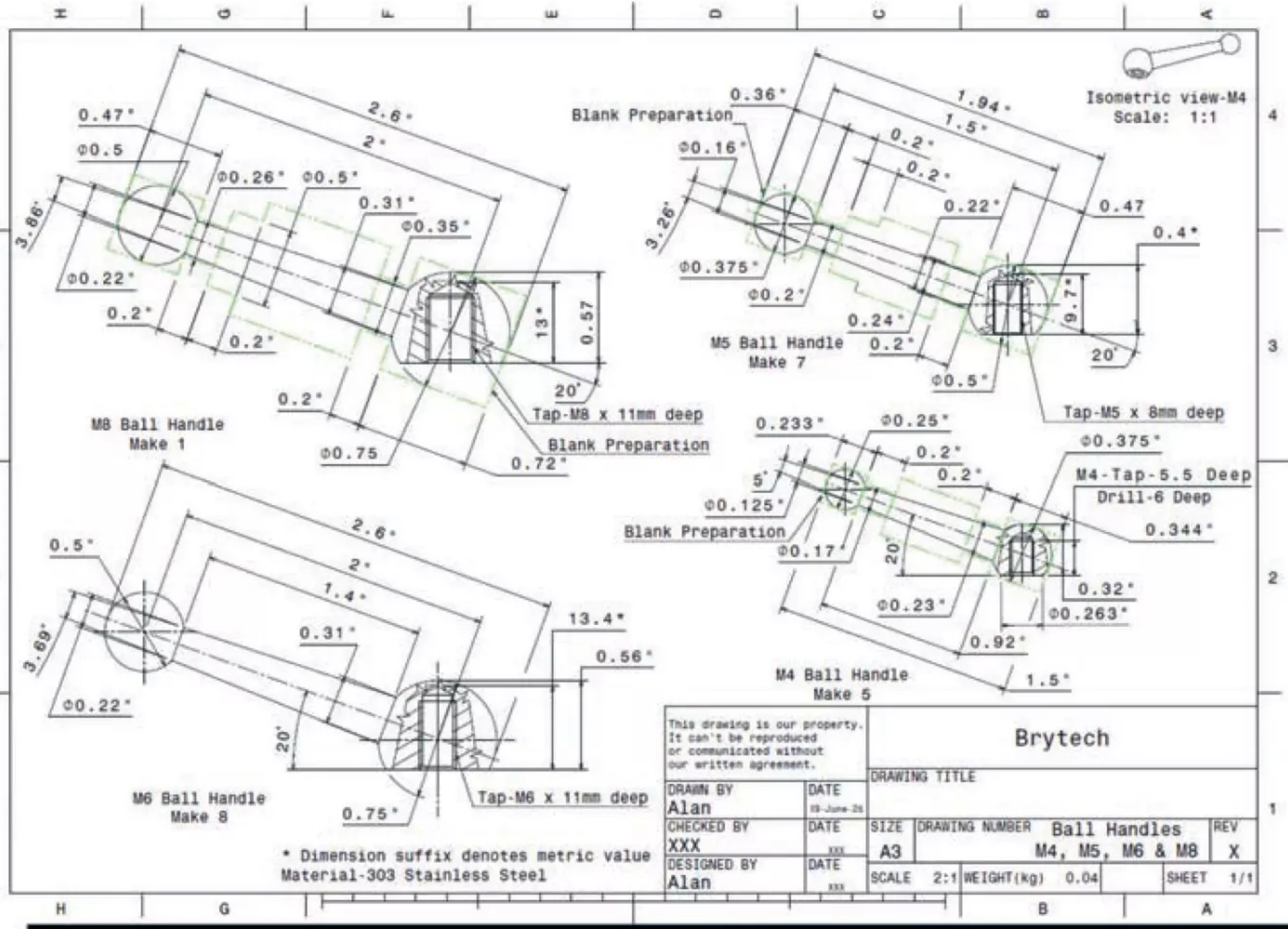


Photo 8: This is my drawing of all three sizes of ball ended handles that I made.

now in retirement, getting stuck into it. As I usually do, I've modelled the whole machine in CAD. I've also redesigned several key features of the machine, and I will use 3D Printing to manufacture some of the parts.

When the late Professor Dennis Chaddock designed the Quorn, he specified two sizes of ball ended handles on all locking axis of the machine to eliminate the need for spanners and Allen Keys to adjust things. I am aware that several modern constructions of the machine have seen the use of the 'Bristol' locking handle in place of the ball ended items but to me a Quorn isn't a Quorn without the shiny ball ended bits plastered all over it. For assorted reasons, I decided to use three sizes of ball handle for my machine with four different threads: M4, M5, M6 and M8, see **photo 8**.

The principal features of a double ball handle are the two spherical ends and the tapered section between them. The late Prof's now universally accepted sequence to machine a ball handle is as follows: -

1. Machine a dumbbell (shown in green on my drawing) with the ends to the diameter of the largest ball.
2. Part off each blank to its finished length
3. Grip the dumbbell in the chuck or an ER32 collet on the parallel centre section and reduce one end to the diameter of the smallest ball.
4. With the unmachined centre section held in the chuck or the collet, form the ball on each end of the blank. The Prof used form tools, but

- I designed and made a ball turning attachment based on a small, cheap boring head and used that.
5. Change to a 3 Jaw chuck and grip the large end of the ball ended blank by using a special split collet. Support the small ball with a female rotating tailstock centre.
6. The tapered section between the balls can then be machined between chuck and centre by using either the top slide or a taper turning attachment. Both devices must be set to a specific angle dependant on the size of the ball handle.

That all went swimmingly until I got to the taper turning stage. I machined the balls on the Colchester Master because I don't have to bend so far when using the Colchester and my back aches less as result. The balls took a while to machine.

As an aside-the Myford 7 series was designed in the 1950's and I guess that we were shorter then! Mine dates from 1960 and sits on a Myford industrial stand with the Myford raising blocks but it's still too low for comfort. Maybe I'll get around to raising the stand somehow sometime, but I doubt that 3D printing will help me with it. I wasn't looking forward to the potential discomfort of using it.

Anyway, despite that I decided to do all the rest of the turning on the Myford Super 7. I don't have a taper turning attachment for either lathe and the angle for each size had a unique taper, so I needed to be able to quickly set the top slide to produce three different angles, 1.63 degrees, 1.93 degrees and

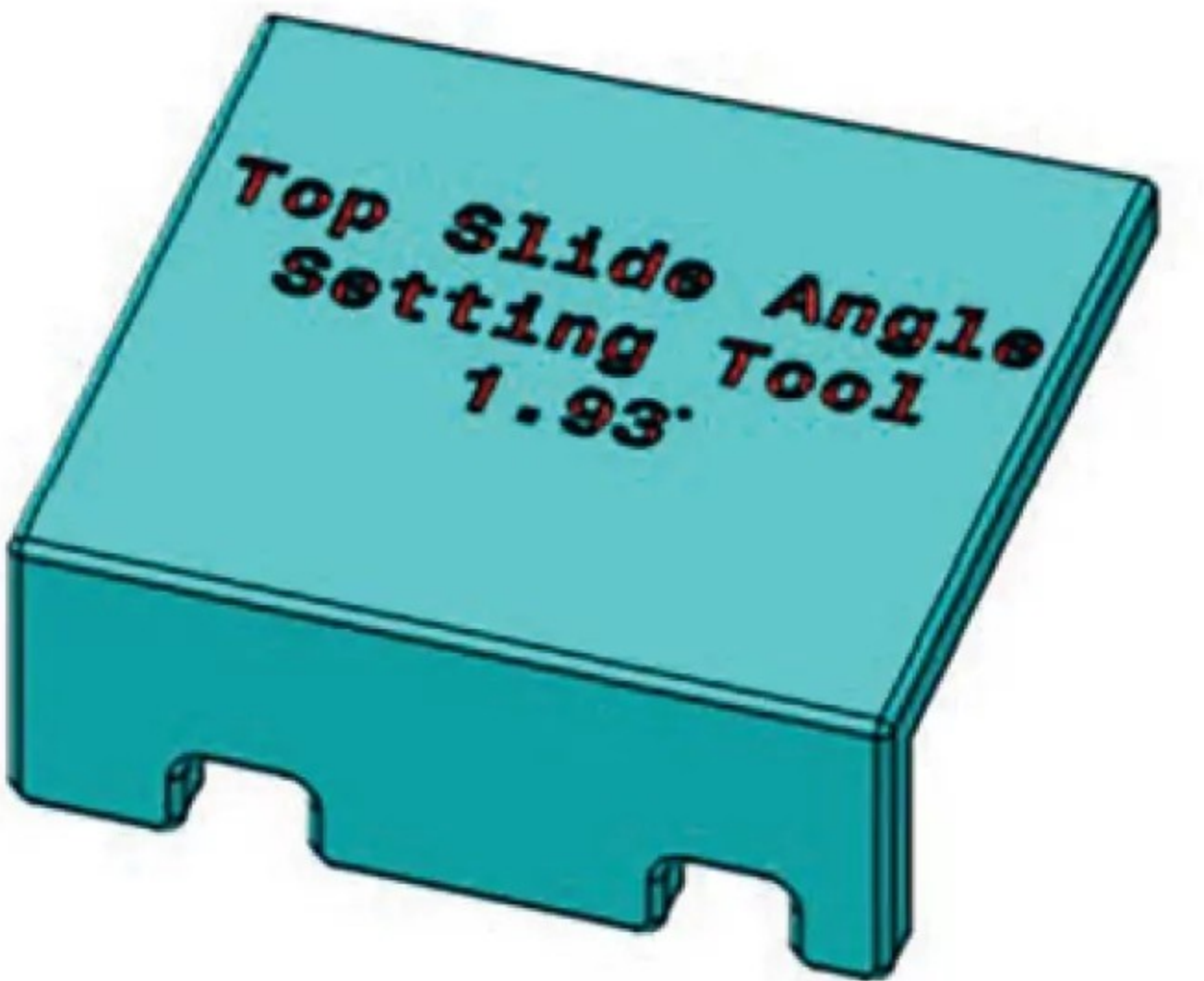


Photo 9: Screen grab of the angle setting aid for Myford Top Slide.

2.5 degrees. I wasn't going to be able to set those angles accurately from the graduated top-slide base with my failing eyesight. I needed something to refer to that was more convenient to use than a precariously balanced protractor.

I have sine bar, which I made as an apprenticeship project, and a set of imperial slip gauge blocks but holding all those bits in place, flipped over horizontally to clock along, was seemingly impossible to set up. I needed a reference surface on the top slide parallel to the slideway to clock along to set the angle correctly. On older Super 7s like mine there's only one machined external surface accessible, but it is closer to the operator than to the lathe axis so it's not easy to set a DTI up to read against. I therefore decided to attempt to design, **photo 9**, and 3D Print a set of adaptors that would allow me to clock along them, **photos 10** and **11**. I intended to locate it against the



Photo 10: Aid in place prior to setting the correct angle.

machined surface that the gib screws pass through and be held there by magnets, **photo 12**.

It took a few experimental attempts to print the parts as usable items, but I got there in the end. 3D printers don't always produce smooth surfaces, so the smoothness and truth of the reference surface needed to be improved. How the part is orientated on the bed when printing, always has an impact on the finish and the strength of the moulding and can also affect its propensity to shrink. It can also have an impact on the amount of filament consumed because a particular orientation will require numerous areas to be supported during the print process and those supports can consume a significant amount of material which finishes in the bin at the end. Therefore, several different orientations of the print on the printer bed were used to eliminate as much of the inevitable surface roughness as much as possible. My prototypes required some hand finishing with a file on the reference surface but not much else. Plus, the time taken to do the job was considerably quicker than fabricating or machining a fixture. To identify each setting aid I modelled the



Photo 11: How the aid fits over the gib screws.

text into the moulding which made finding the correct one much simpler. Thus my 3D Printer saved me much time

and established a procedure to use for future projects should it be required.

To Be Continued

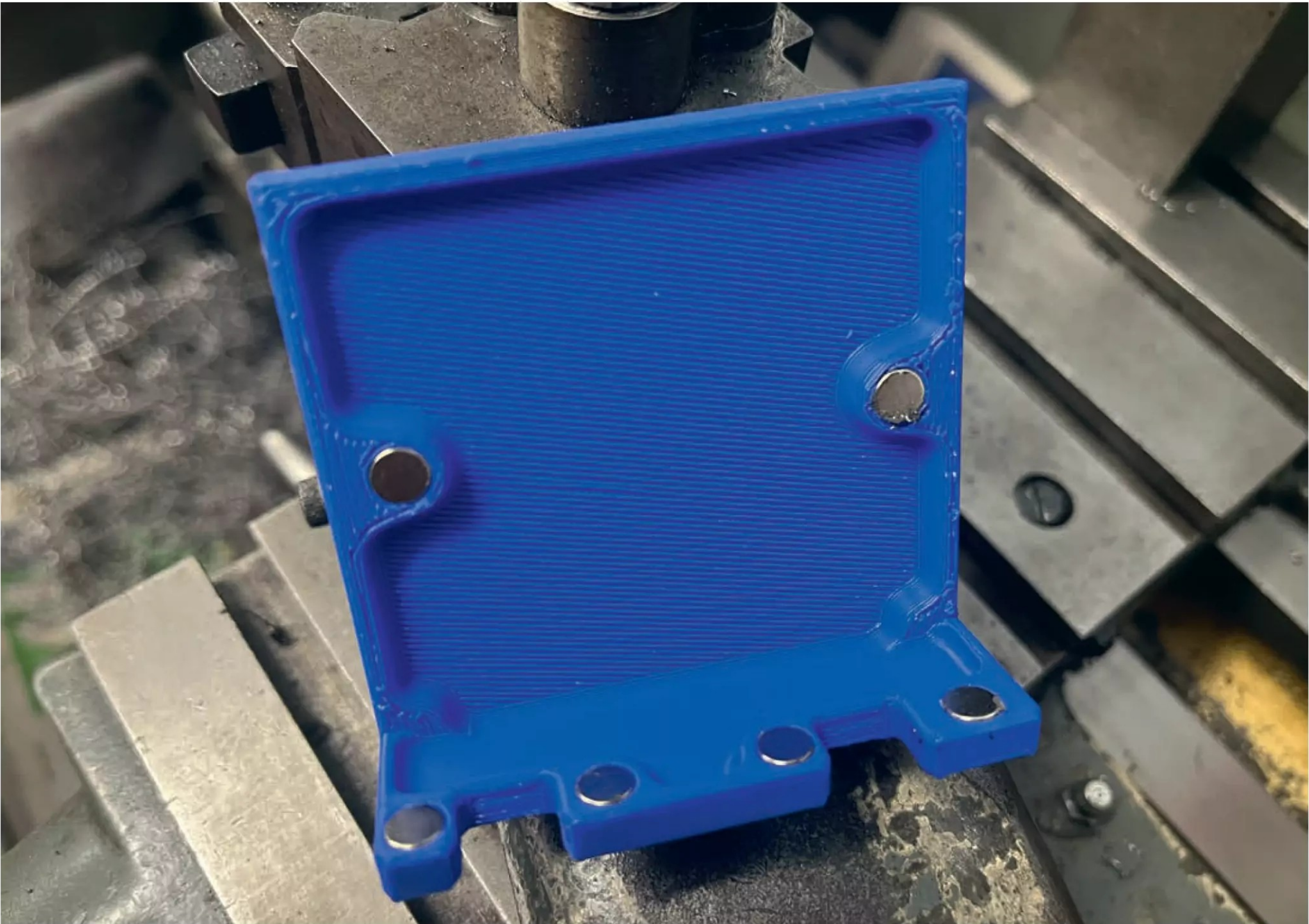


Photo 12: Shows the embedded magnets used to retain it on the top slide.

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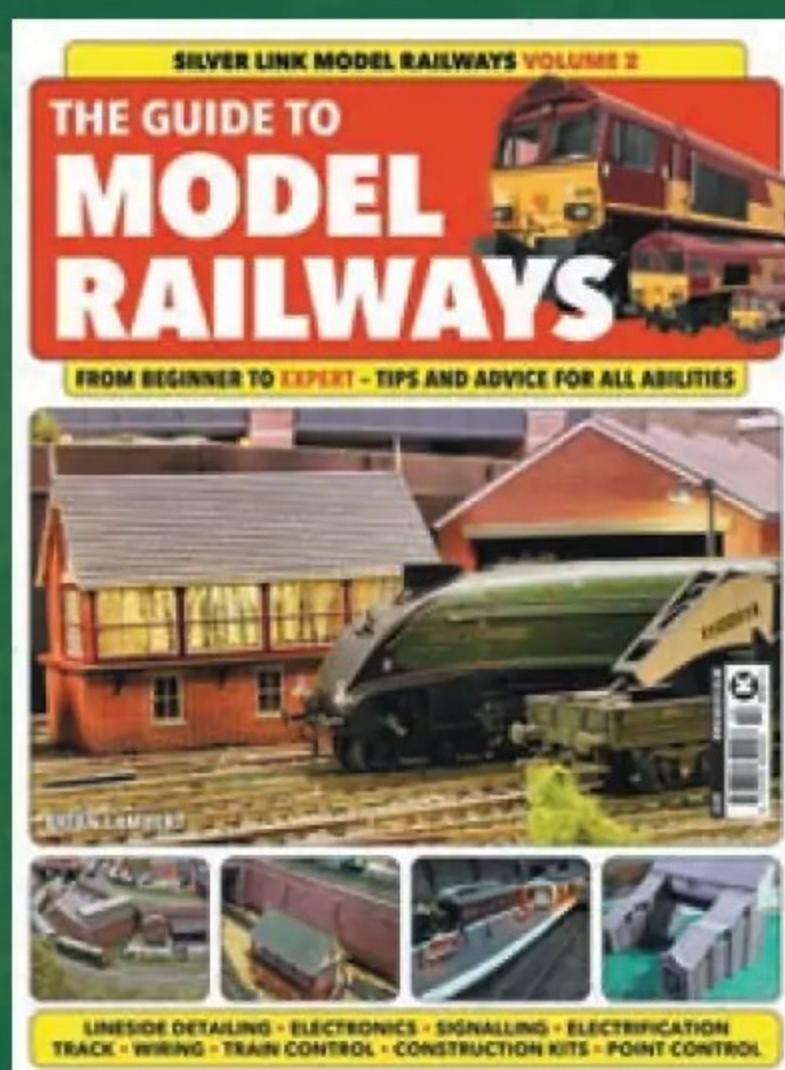
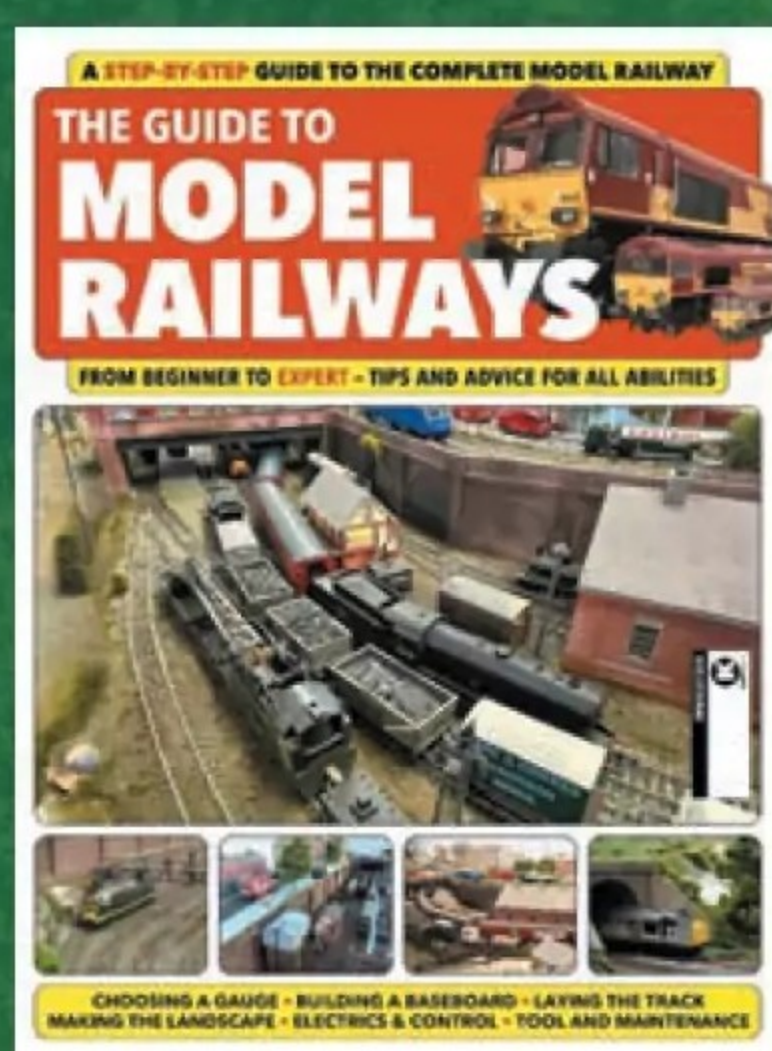
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SCAN ME





Photo 13: Turning down the opposite end.

A Garden Harrow

PART 2

Will Doggett completes the heavy duty harrow inspired by Monty Don's.



Photo 14: Batch of tines before bending.



Photo 15: V-block and press tool.



Photo 16: Press tool.



Photo 17: Mark for bending point.

After the tapers were cut, the ends were rounded with a file. The tines were then turned around and remounted in the chuck, and I took a very light cut to reduce the end that is to go in the frame this is to a push fit. **Photograph 13** shows a very fine cut being taken and **photo 14** shows batch production. The next operation is to set the tines at the required angle this angle was taken from the photo on the internet so it is a bit of a stab in the dark – it looks to be about 30 degrees. This was done with the aid of a V block in the press, that I had made some time ago (*Model Engineers' Workshop*, Issue 285) and a round tool that was made for use on the press to push the metal into the V block. **Photograph 15** shows the setup, **photo 16** shows the tool used. I then marked a line on the tine about half way up this was used to position the tine for bending, the line can be seen in **photo 17**. I brought the ram down to push the tine into the V block at the right height. **Photograph 18** shows the first tine being bent and **photo 19** shows the first tine after bending. I then marked the ram on the press so that the bend could be repeated to the same angle on the other fourteen tines, **photo 20**.

ASSEMBLING

It was time to assemble the tines to the base, the first few fitted the base but some of the subsequent ones were too tight to go in to the holes. On investigation (I will not go into the method) but I found the problem was me when turning the ends. I didn't notice that the indexing wheel was loose, so the sizes were getting bigger as I turned them and to compound this, I did not check them, I assumed they were the right size. As they say assumption is the mother of all.

The first step was to file the ends to the correct size to fit the holes that



Photo 18: Bending the first tine.



Photo 19: Tine after bending.



Photo 20: Mark to keep bends the same depth.



Photo 21: Filing oversize spigot.



Photo 22: Opening up hole with round file.



Photo 23: Clamping to keep tines aligned.



Photo 24: The rusty water pipe.



Photo 25: Cleaned up and tapered.

are already drilled as they are at the maximum size possible with my drills at 7.5mm, without being over size for the tines. To achieve this each tine was put in a toolmaker's vice held in the bench vice and filed round with the aid of a vernier to size them as they are filed; the setup is shown in **photo 21**. with the file that I used on the top of the vice. This method was not as

straightforward as I had hoped, part of the tine was ok but they were not round to fit the hole to my satisfaction the only solution was to open up the holes with a round file and fit each one individually to its own hole this was a lot easier than I thought it would be. **Photograph 22** shows the last hole being opened up with the file. After all the tines were fitted, they were

clamped in their positions with some small angle to keep them square to the frame and ready to be welded, **photo 23** shows the clamping up.

THE HANDLE

The handle was going to be steel tube, but I decided against this, so now it is going to be a wooden handle as are



Photo 26: End crushed in the vice.

most rakes. The method of attaching the handle to the frame is something to sort-out there were several ideas I thought of but felt the best idea was to turn the frame to handle piece from a piece of mild steel 32mm round by 150mm long, drilling a hole for the handle in one end and tapering down to about 10mm on the other end that is going to be welded to the frame. However, his method does waste a lot of metal drilling the hole. An alternative to this was using a piece of tube that fits the wooden handle and putting a taper to the end of the tube and welding the taper to the base. The easiest way is to put a taper on the tube is to squash the end. The piece of tube was found in the garden shed when I was having a clean it up, it is a piece of 1-inch-thick wall water pipe, I think. I cut a 6-inch piece from it, **photo 24**. It was very rusty, so the tube was put in the lathe chuck and skimmed to remove most of the rust. I then turned a 2-degree angle on the end. **Photograph 25** shows the roughly cleaned finish and the taper. The reason for the taper on one end was to reduce the wall thickness so that the handle support could be squashed down to roughly the base thickness and also make it easier to bend in the vice, as at full thickness it would be nearly impossible to bend without a lot of heat. The tapered end of the tube was then put in the heavy bench vice and squeezed down to size. The end is shown in **photo 26**, it is a bit ragged, but this would be covered by the welding when it is welded to base. If the welding doesn't cover the end, it could be tidied up with filler before painting for cosmetic reasons.

WELDING

The base was taken outside to weld as I don't like welding in the workshop. The front row of the tines were welded

first then the clamps and angle were removed and refitted to the back row to hold the other row of tines in position, then these were welded. To complete the welding the steel handle part was welded to the base at about a 30 degree angle. The welding complete is shown in **photo 27**, the underside of the harrow is shown. It is now time to clean up the welding with an angle grinder and wire brush ready for painting. The paint I am using to spray the base is from an aerosol can, it is meant for steel and requires no undercoat I got it from Lidl some time ago. I gave the base two coats of the paint and it look ok. **Photograph 28** shows the working end of the harrow after it was painted.

CONCLUSION

I have clay soil like Monty has, the only way I have found to overcome the

very wet in winter and dry conditions in summer is dig over the soil in the autumn and leave it rough dug with large clods. The frost breaks it down so that in spring it is fine soil the other thing to do is put plenty of garden compost on the soil before digging it over in the autumn. In that way I have something resembling workable soil. I only put garden compost on soil that will not have root crops in the following summer, as this encourages roots to fork with the added nutrients from the compost. With the new harrow getting a fine seed bed is a lot easier than before with a normal single headed rake as there are double the tines to work the soil in one movement of the normal rake. As to whether it worth making it? I think it was, as it performs better than I expected it to, so I am very pleased with my effort in making the harrow as we now know it. 🌱



Photo 27: Welding complete.



Photo 28: The finished harrow.

The completed tram engine.



A 5" gauge Steam Tram

Graeme Monk took on the challenge of building a working steam locomotive with dual controls all inside a wooden body.

I've always been interested in the history of the 'wooden wonders' or 'sheds on wheels'. During the research I discovered that two versions of this tram. The first was designed by Thomas Worsdell of the Great Eastern Railway in 1883 to run on the Wisbech and Upwell Tramway and classified G15, later reclassified Y6 when the LNER took ownership of them.

These were an 0-4-0 configuration with inside cylinders and Stevenson's valve gear with lots of unique design features with wooden bodies, speed governors, steam from the safety valves directed back into the water tanks, and the water tanks themselves form the running boards. Plus being a tram this was one of the few British

locos to be fitted with a whistle and a bell, everything was designed to control as much noise pollution as possible.

When Worsdell left the GER, he was replaced by James Holden who redesigned the steam tram. Now with a larger boiler, 0-6-0 configuration, with outside cylinders and one of the earliest British locos to use Walschaerts valve gear, classified C53 until the LNER took ownership of them and reclassified them to J70. The only way you can tell the difference between the two locos when they are both fitted with side skirts and cow catchers is the C53 has an obvious cutout in the tanks as part of the footsteps into the cabs and the pipe on the roof directing the

steam from the safety valves is at an angle, **photo 1**.

The engines were used on the Wisbech & Upwell Tramway in Cambridgeshire and Norfolk, as well as for dock shunting in Ipswich and Great Yarmouth. Both locos were designed to be driven from both ends, giving the driver a clear view of the road ahead, and in this case, I really do mean road, the tramway ran on the main road and alongside canals. Though it did carry passengers it was mainly used for transporting fruit.

Incidentally, this loco apparently inspired the Rev. W. Awdrey to write the character of Toby the tram engine.

I have seen so many of both types in 5-inch gauge but always electric, which



Photo 1: The unpainted chassis and boiler, cutouts for the steps declare it to be a C53.



Photo 2: The stretched boiler does not instantly give away its *Tich* origins.

got me to thinking, why hasn't anyone built a live steam version?

The only examples of a live steam tram are either tank engines with a fake body on, or a 7 1/4 inch loco that used a traction engine boiler and chain driven valve gear.

I was trying to find a locomotive that I could use the casting to make a tram locomotive and in the original *Tich*

book a loco had a body shell over it to make it look like a tram.

I wanted to take this a step further, so I got in touch with the Great Eastern Railway Society who were extremely helpful and provided me with drawings and transcripts from footplate crews.

A *Tich* chassis is close but a tad on the short side so, I designed a stretched set of frames to get the scale right,

photo 2. So a *Tich* it is then, this is perfect for the 0-4-0 G15 in size but with outside cylinders this wouldn't be right. So I made a creative decision, everything is hidden up by the skirts so from outside it would look right, but for the fellow spotters out there I going to say this is a "what if" loco, What if Holden took over while a G15 was under construction, and refitted it with outside cylinders Walschaerts valve gear. Well at least that's how I was going to justify it. This solves the problem of not having the inside cylinders, but the first challenge was the smokebox.

I had to make my own casting in some cases, so I started with the smokebox. This has a half door as a normal full-size door would hit the front of the loco wooden body. To sweep the tubes both the smokebox and the wooden doors would have to be open.

This was my first attempt at making my own castings, I used bronze swarf of which there was a fair bit after machining the cylinders, pistons, valve chests etc. I looked into how much shrinkage occurs with bronze and made a rough wooden pattern, I also gave myself a bit more material as I knew the castings wouldn't be amazing, fully expecting to find blowholes etc.

I must have appeased Hephaestus, as after I turned the castings down to size I only had a few small inclusions, which since they would be on the inside where no one would see them, I thought would be good enough. Plus It took me all day to make one casting, really didn't want to break my back moving everything outside again.

BOILER

This was to all intents and purposes a *Tich* boiler, **photos 3** and **4**, but with a few differences. The boiler needed to be longer than a standard large boiler, so the barrel, tubes and stays were two inches longer. This was a gamble as stretching the tubes, although it



Photo 3: Smokebox plate.



Photo 4: Backhead.



Photo 5: A dome over the firebox makes inspection easier.



Photo 6: Firebox stays.

increases boiler volume, can result in breathing issues. The tube diameter wasn't increased so the gases now have further to travel.

Also the steam dome on the full size is right above the crown of the firebox, meaning not only is the steam collected at the hottest part of the boiler, but when silver soldering the girder stays are a dream to solder in, having miles of clearance. It also made it easy for the boiler testers at my club to do the building inspections, **photos 5 and 6**.

All the steam fittings are fed from the steam dome, which seems to work incredibly well. This also feeds both pressure gauges as there's one either end. As for water feeds, I kept it simple, one injector, axle pump, and hand pump.

Again there are problems here to consider, the injector is hidden under the skirt so you can't see if it's working,

you have to rely on sound and gauges. The bypass is in the tank with no way to see inside, again to test this it's either watch the gauges or put a finger on the check valve to see if it's cooling down.

For the hand pump, I had two choices, either to hide it in one of the tanks, or mount it on the footplate. I decided on the latter as even though it does spoil the aesthetics somewhat, being a live steam loco I like to have the reassurance that should the injector or axle pump fail, I had one safe way of getting water in. Besides it's mostly hidden by the body work.

After I spent about a week playing with the timing, I got the chassis to run on hardly any psi at all. I used the old trick of putting a hose on the exhaust and listening to the other end far away from the air compressor to hear if each beat was even. I also used my phone and laptop to watch the wheel position to watch for dead spots. I grant you this is extreme but wanted to try it and it really did work well.

Next problem was the water tanks, I want to replicate the tanks making up the footplate, but my decision to use outside cylinders and valve gear meant my water capacity would be woefully small. For a while I considered a small well tank to try and help this, but it wouldn't make a big difference, so just like the full size, water was going to be an issue.

On the G15 the water fillers are in the front cab doors, on the C53 they are in middle and filled through the windows. So sticking with the G15 I realised I can increase the water capacity with as many balancing pipes as possible.

So I made each filler connect to the tanks on the left and right side, along with each other and a central pipe which feeds the axle pump. All this does help but a lap around my local track and the tanks would be empty. I attached an isolation valve that means I can feed water to the loco from a separate tank/tender which I would need to feed a small injector too.

DRIVING CONTROLS

This although, apparently simple turned out to be quite tricky to get right, two 3/16th rods run the length of the right-hand side of the boiler and



Photo 7: Regulator and reverser rods run the full length of the boiler.

the smoke box. One for the regulator and the other for the reverser, **photo 7**. The regulator used a left hand 1/4 BSW thread as I needed a fairly coarse thread, otherwise when the linkage for the other end went in only a small movement would be required to open the regulator. Fortunately I have a very patient father who has worked in engineering all his life and he taught me, be it the hard way of learning, to think ahead. Trying to play out all the steps and what knock-on effect it would have, helped me greatly. Not only did the back of the boiler with a bracket on it to take the controls have to line up with the smoke box, but the boiler also had to be level, and the rods had to miss the check valve in the side of the boiler and line up with the reverser arms. So a lot to think about.

Then there's the linkage to connect the regulator to the front. Now here I went off the drawings slightly to get a better performance. The first link arm had to miss the firebox door, but I didn't need a massive movement from the front regulator. So using the lever principle I first made a test arm with a series of holes to work out how long my lever arm needed to be to give me the right amount of movement.

Once I was happy with controls, I made finished components and taper pinned everything together. I used taper pins for two reasons. One it pulls everything together tight, but I also needed a way to take it all apart for maintenance without fighting lock nuts or Loctite.

To be continued

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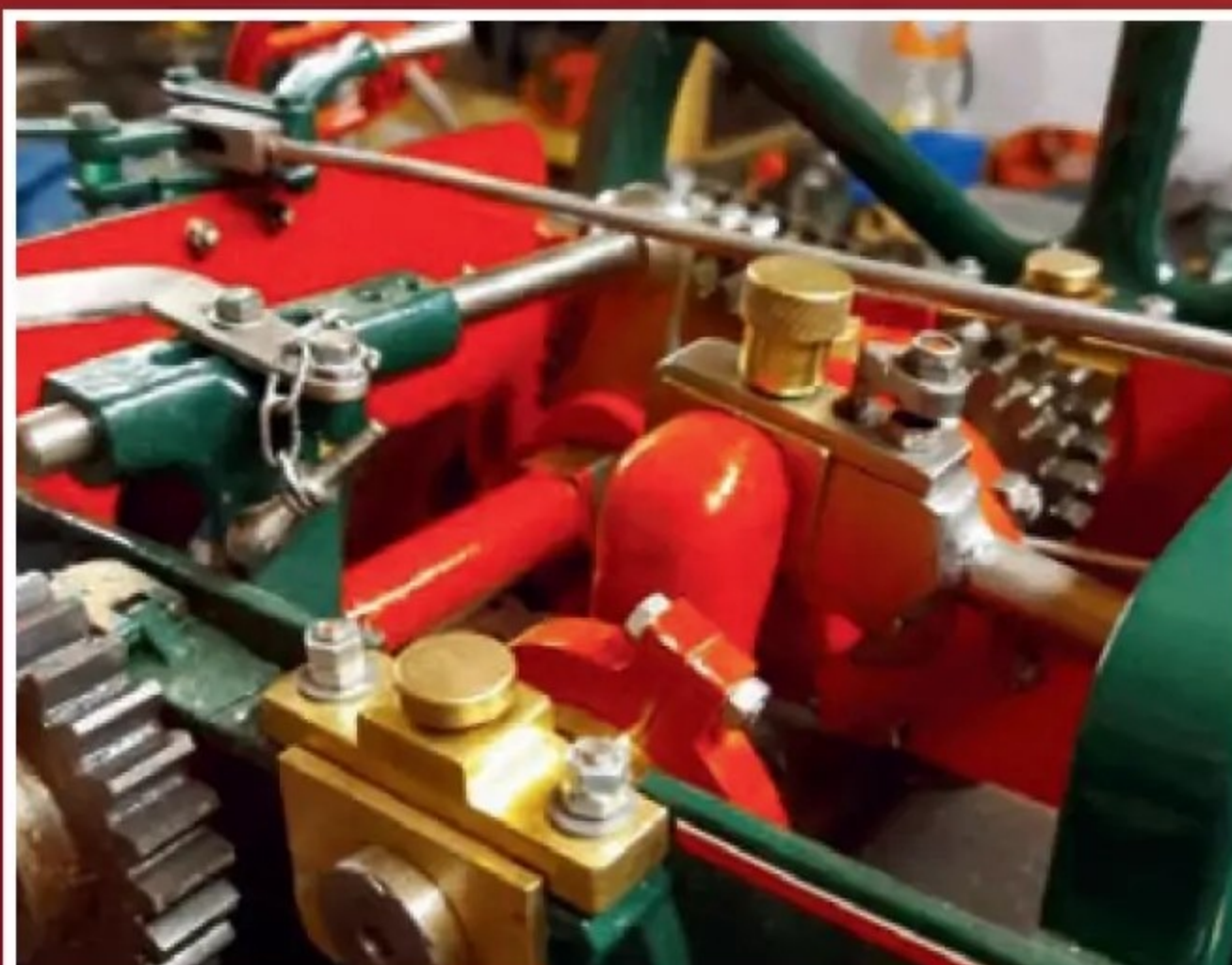




Photo 1: Travel box.

Improvements to a Pannier Tank

Gerald Martyn returns with details of additions made to his 3½" gauge model featured in his award winning series.

I hope you found some interest in my series on building my 1366 Pannier Tank. Even if you're not building it then the notes on some of my ways and some new ways of doing things may have been food for thought (my new boiler method certainly was!). Back in the beginning (*ME* No 4752, 20 Sept 2024) I said that my plan was to design and build a basic and runnable version of the engine, then follow-up with some enhancements for those who wish for something more detailed. Now is the time to explore these 'improvements', but I'll start with some notes about parts that I, myself, left unfinished at the end of that series, and some comments on how things can go wrong at the track.

The first thing to do, after a few trips to the track wrapped in blankets in the back of the car, was to make a storage and travel box. I made this from plywood, panel pins and glue, nylon webbing carrying straps, some hinges

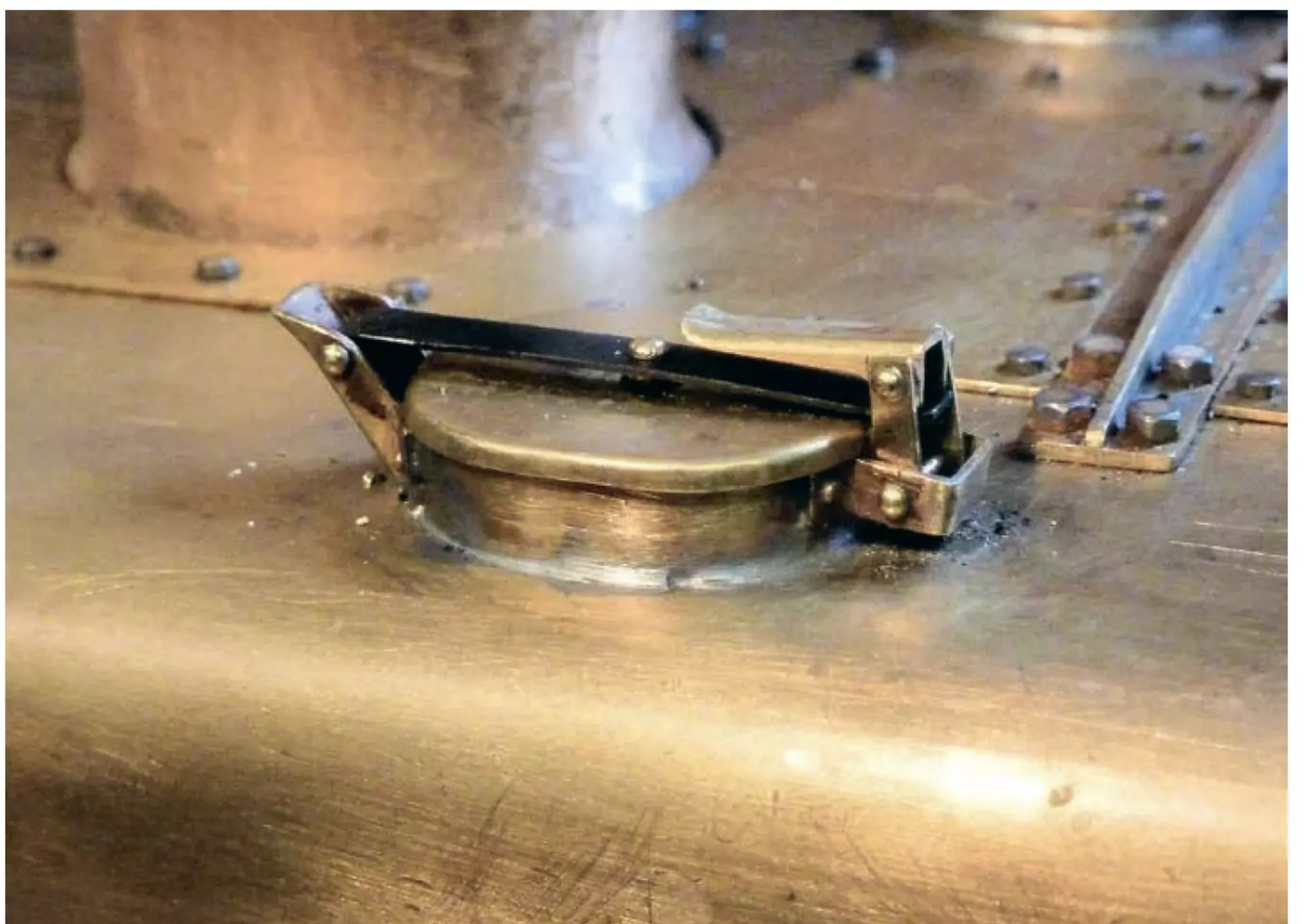


Photo 2: Tank filler toggle latch.

and fittings and finished it off with a few coats of varnish. Carpet strips inside protect the model. Unless you plan to drop it from a great height the joints don't need any particular reinforcing as the webbing wraps under the thick plywood base and take all the weight, **photo 1**. The model can now be carried easily and at an all-in weight of 39 lb does not strain the ageing muscles.

Back in the workshop there were a few details needing completion after the rush to get the engine ready for testing. Firstly, the tank filler lids toggle latches. These are made from brass sheet and 3/64" rivets for pivots with 12BA threads and nuts to stop them falling out. The spring strips needed a bit of tweaking to get the latches to work correctly and then were hardened and tempered to dark blue before re-fitting. The result is shown in **photo 2**. It's always satisfying to get these little details working as they should. The brackets for the lifting rings were made from two short lengths of the 1mm thick diy store brass angle silver soldered back-to-back then cut up and shaped. Rings can be made from mild steel rod and blackened in a flame for a durable dark finish. The prototype tank vents were split into two pieces with a flanged joint just below half-height. My original published drawing was a bit light on detail, and I'll offer something a bit better now, **fig1**. The two finished



Photo 3: Tank vents in the hand.

vents are shown in **photo 3** and one in position in **photo 4**. Note that the lower flange is a bonded-on part, a special washer if you like, to cover the thread run out and ensure full thread engagement in the 1.2mm tank skin. An alternative way would be to include the flange in the machined part but make the thread as a stud into a tapped hole. The 14BA flange bolts are for show only and held in with Loctite (no threaded holes). Be warned; they're very small and when dropped on the floor are gone forever!

Having now finished everything above it was time for another trip to the track. Oh dear, everything went wrong! Have you noticed that people always want to chat while you're trying to prepare for a run? Such distractions can lead to problems, the first of which

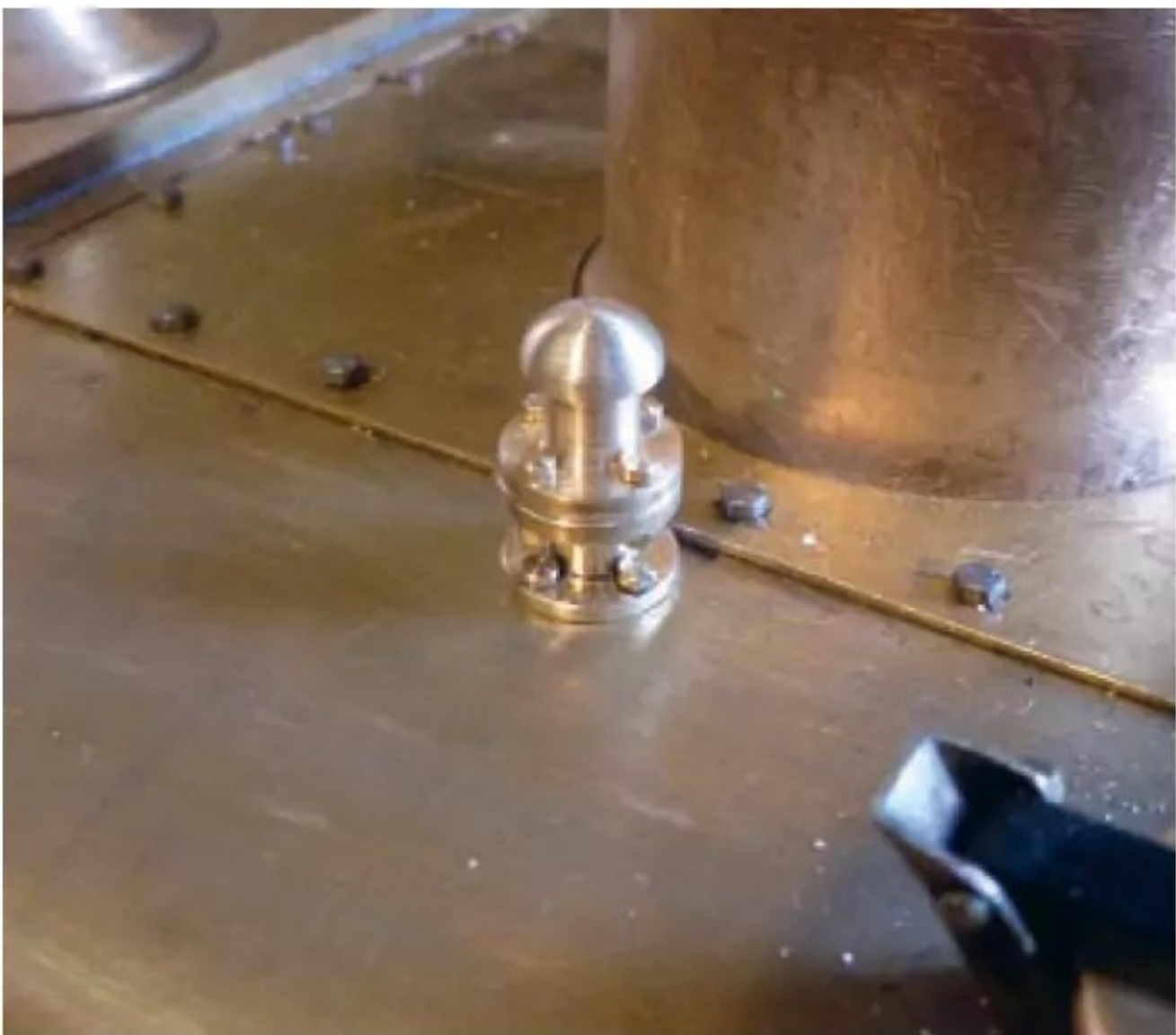


Photo 4: And one in position.

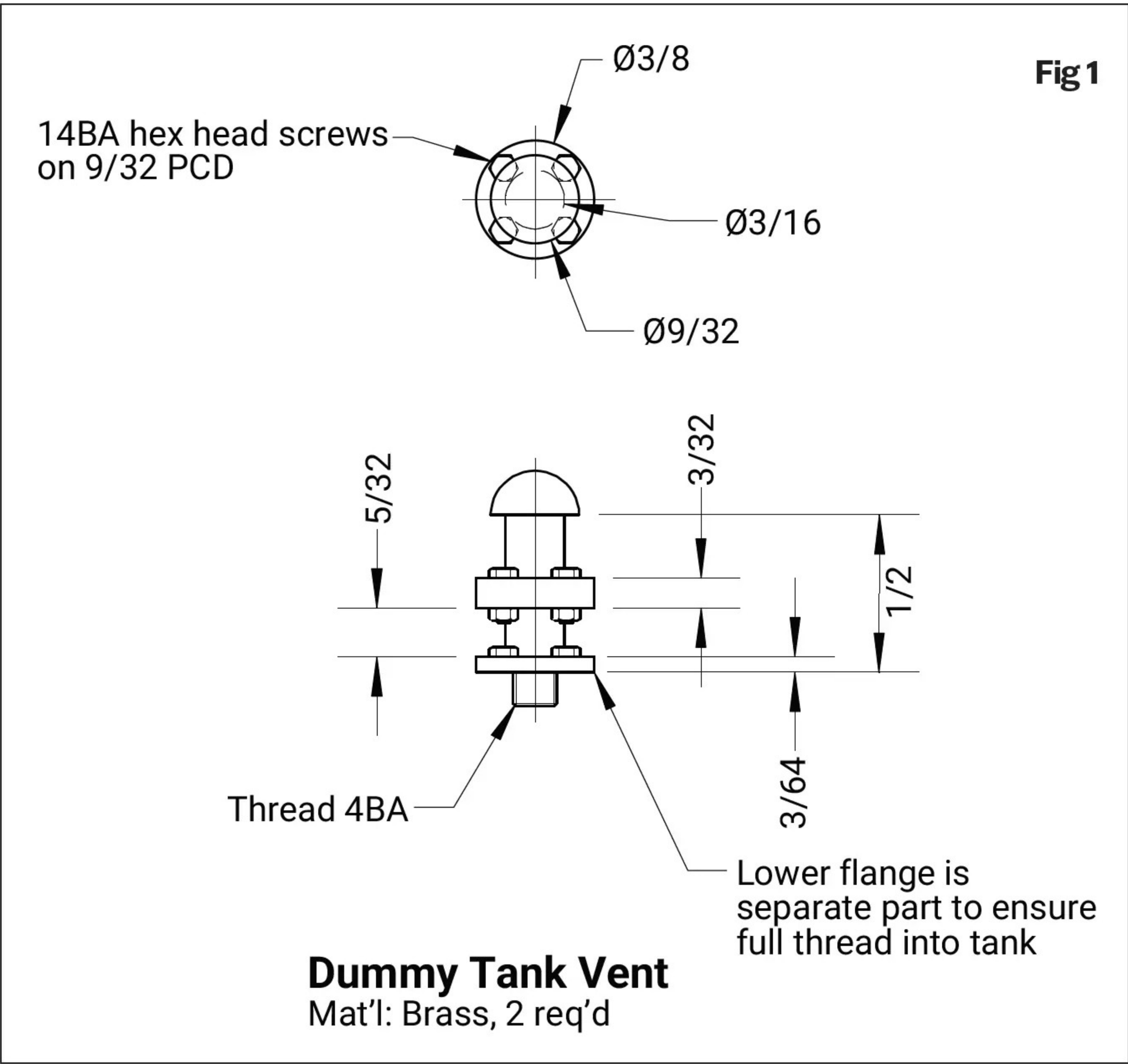


Photo 5: Checking the backhead.

was lighting the fire before putting any water in the boiler. Not a good thing to do, especially with soft solder caulked stays. Fortunately, I realised in time and shut down the blower fan. The next interruption was during oiling-up, so the more remote parts of the valve gear got missed. I realised this a short way round the track, but had to complete the (half mile, remember) circuit before it could be put right. It was a cold but sunny day and up the back straight the sun on the steam cloud obscured, well, everything. All the coal missed the firehole and went onto the footplate instead of where it would do any good, and a stop for a blow-up was needed. This takes me back to the first mistake of the day which was selecting anthracite grains. I find half of them roll off the shovel, half of what's left get blown straight up the chimney and those that end up in the right place pack down and block the air flow. The reason for trying grains was that the anthracite beans we get these days seem to have a high ash content which blocks a small grate. Experiments with e-coal mixes look now look promising.

Back home, and after cleaning down, I put my cheap borescope (previously mentioned way back during the boiler build) through the firehole to have a good look at the stays just in case. All was well, with nicely domed caulking covered with fine ash and no sign of any melting, **photo 5**. Phew! Next time; on with the job.

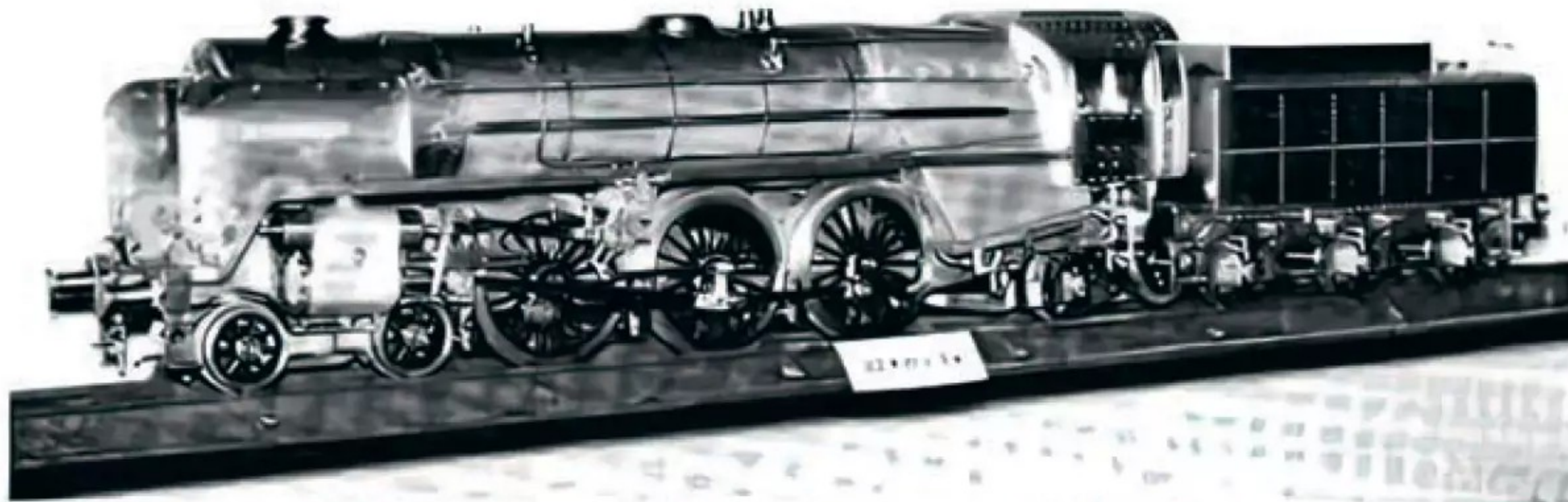
To be continued



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.



Mr W. R. Skuse's 3½ in. gauge "Britannia" - winner of the LBSC Memorial Bowl.
Below: The 5 in. gauge "Speedy" built by N. Rossiter was placed second.

WALTER SKUSE

Dear Neil, I am currently doing some research concerning the Ramsgate and District Model Engineering Club, founded in 1947. One of the founder members was a Walter Skuse who produced several very fine model locomotives.

Do you know if there is a list of winners of the LBSC Curly Bowl over the years - especially 1970-1990. Walter is supposed to have had a win with at least one engine, his 3.1/2" gauge Britannia. Any help much appreciated, and a picture of the winning Brit or the man with one of his locomotives would be the icing on the cake.

I am in conversation via Messenger with a man from New Zealand who purchased a Walter Skuse built LNER L1 tank engine. Interestingly the L1 is not mentioned in anything I can find thus far on Walter Skuse.

Peter Wilson, by email.

Model Engineer issue 3388, 6 March 1970 has a report of the Model Engineer Exhibition 1970 and LBSC Memorial Bowl Competition. This includes a photo of Walter Skuse's 3 1/2" gauge *Brittania*. It seems his model was to a high standard though it faced little competition. Does a reader know the whereabouts of this model today? Thanks also to Steve Eaton who's looking into the history of the competition - Neil.

PERFORATED GRATES - QUESTION

Dear Neil, I enjoyed reading about the success of perforated (rosebud) grates as described by Matt Jeffery in the most recent ME&W. However no details as to the type of taper used was given. Would it be possible to have a little more detail regarding this as I am sure this would be of interest to many readers?

Malcolm Metcalfe, by email.

ROSEBUD GRATES

Hi Neil, there was an article in ME about Rosebud grates ME No 4702 p587. At Chelmsford CSME we have a Sweetpea with a rosebud grate that at the moment uses Welsh steam coal. Also my brother-in-law in Australia has a rosebud grate in his 16 ft steam launch that has a water tube boiler.

Robert Walker, United Kingdom

PERFORATED GRATES - RESPONSE

Dear Neil, in reply to the enquiry about the taper tool I used for my grates. The diameter at the shank end is 0.500" the diameter at the small end, being 3 flutes, is difficult to measure but appears to be 0.285" ,the length over the flutes appears to be 0.780". That gives me a taper of approximately 15 degrees, I hope my maths are correct (please check them as I am 83 yrs old and things are a bit rusty now). I got the taper reamer from Manhattan Supply Co. (MSC) about 5 yrs ago, but most mail order tool shops should sell them. When I bought mine they were \$15 plus postage, now I believe they are nearer \$30 or so, its Chinese and does the job if you keep coolant on it

Matt Jeffery, Pennsylvania, USA.

FILAMENT DRYER

Dear Neil, Stub Mandrel's review of the Sunlu Filadryer S1 Plus in *Model Engineer and Workshop* 4776 was very interesting and very useful. So much so that I went out and purchased one for 54 AUD. I have been printing directly from the dryer with it running. I printed a *Benchy* in PLA and the improvement in detail and finish, with practically no stringing and a smaller seam, is immediately noticeable. The instructions that come with the unit are poor, so go to YouTube. On the display SV means Set Value and PV Present Value. I have no empirical evidence to support it, but I have a feeling that preheating the filament helps in some way. Also support seems much easier to detach. Thanks very much Stub.

Robert Walker, Australia

Funnily enough, I've been looking into your last point recently, it seems dry filament is less likely to over extrude, and this helps ensure models are not forced too tightly against the support - Neil.



STAN BRAY'S BRUNELL

Hello Neil, I am currently preparing an article about a steam engine—specifically, a model of the machine *Brunell*. If I'm right, this engine was in the Model Engineer 3787, October, 1986. Do you have an issue of this or photos of the machine? I am certain that this beautiful machine must not be allowed to fade into oblivion!

Helmut Harhaus, Germany

It was a design by the late Stan Bray, and was described over eight issues. The castings were available from Brunell Models for many years. Does anyone know if castings are still available, or have a photograph of a completed model? - Neil.

RONNY KARLSSON

Dear Neil, I write with sorrow to tell you that my father, Ronny Karlsson, passed away on 13 April 2026, two days after his 79th birthday. He had been a subscriber to Model Engineer since the 1970s and kept every issue from that day to this, half a century of the magazine, lined up on his shelves. Ronny was a Swedish engineer who spent his career as a broadcast camera engineer at Sveriges Television (the Swedish public broadcaster, where his work reached millions of viewers through programmes such as Allsång på Skansen, the Nobel Prize banquets, twenty-five Vasalopp ski races, and four Olympic Games). His real work, though, was at his bench. He designed his own model aircraft and competed with them in



Sweden and abroad; the engines were his own design too, from making the wax cast to chrome the aluminium cast and all machined by hand from raw stock to finished article. For several years his engines

were held to be among the finest in the world, until the international engine competition could keep up! (even the formula 1 team engines did not match the compression that his engine had), one single man with a internal drive to make something better and faster. He also built an early drone, which he demonstrated to the King of Sweden and to SAAB Aerospace. He was an inventor in the old, careful, hands-on sense, exactly the kind of reader I imagine Model Engineer has always hoped to have. I include a photograph of him with one of his model aircraft (SE-243), together with King Carl XVI Gustaf of Sweden. He gave Model Engineer fifty years of his close attention.
Niklas Karlsson, Sweden.



ST SWITHIN’S DAY

Hi Neil, I was having a fiddle with AI and came up with the attached. Do with it as you wish!
Humphrey Park, by email

3D PRINTED PRESS TOOLING

Hi Neil, I’ve just seen your follow up on Smoke Rings (ME&W 4777) in regard to the FDM press tooling. To expand a bit, the metal blanks were laser cut as 1/8” steel donuts with a wedge removed according to a formula based on finished diameters and degree of spiral. These were manually ‘twisted’ a little to help initially sit in the die. A piece of tube was machined to fit in the central hole and this kept everything aligned. The model used a fairly close infill, just a guess really at 50%. I’d not allowed for a degree of spring-back so a little manual help was beneficial

post pressing. Commercial FDM tooling is often ‘annealed’ to just below the deposition temperature to improve the inter layer adhesion, but this requires heat treat oven with precise control. This so called annealing improves the Z axis strength; in my press dies that isn’t a great concern both parts being under compression. The final results were multiple and closely identical elements of the spiral ‘auger’ and an interesting exercise in 3D modelling, slicing and printing the forming dies.
Paul Zeusche, Washington State, USA.

Model Engineers' Workshop Article Index

DATA to June 2012
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The spreadsheet based index compiled and hosted by Colin Usher at www.colinusher.info has been an invaluable resource for hobby and model engineers for many years. Unfortunately, as of July 2012, Colin has no longer been able to update the index.

I am pleased to say that, with Colin's agreement I have taken on the task of keeping the index up to date. I will supply Colin with the updated files to maintain the continuity of his site, but this page will be the 'official' home of the index for the foreseeable future.

Notwithstanding my personal involvement with Model Engineers' Workshop magazine, this is a voluntary activity and the index is not derived in any way with MEWS/MEWS Ltd. This index is offered as a free service to hobby engineers for personal use only, and it is not intended for commercial use. No liability can be accepted for any errors or omissions or any consequential loss arising from use of the index. If you have any comments on the index, or find any errors or omissions in it, please use the contact email net@colinusher.info to let me know.

How to navigate this index

This document is divided into two sections. The first is ordered by issue number and the second is ordered by the contributor's name (where known). If you know the issue number, click on the small triangle nearest the first listed bookmark. For example, if you want to go to the page for issue 5, go to the bookmark 0001-0020 and click on the small triangle to the left to open it up. Then click on Issue 5. If you want to see the article list ordered by author click on the lower section. This is organised in a similar way but approximately by name.

Alternatively, you can use the word / phrase search box.

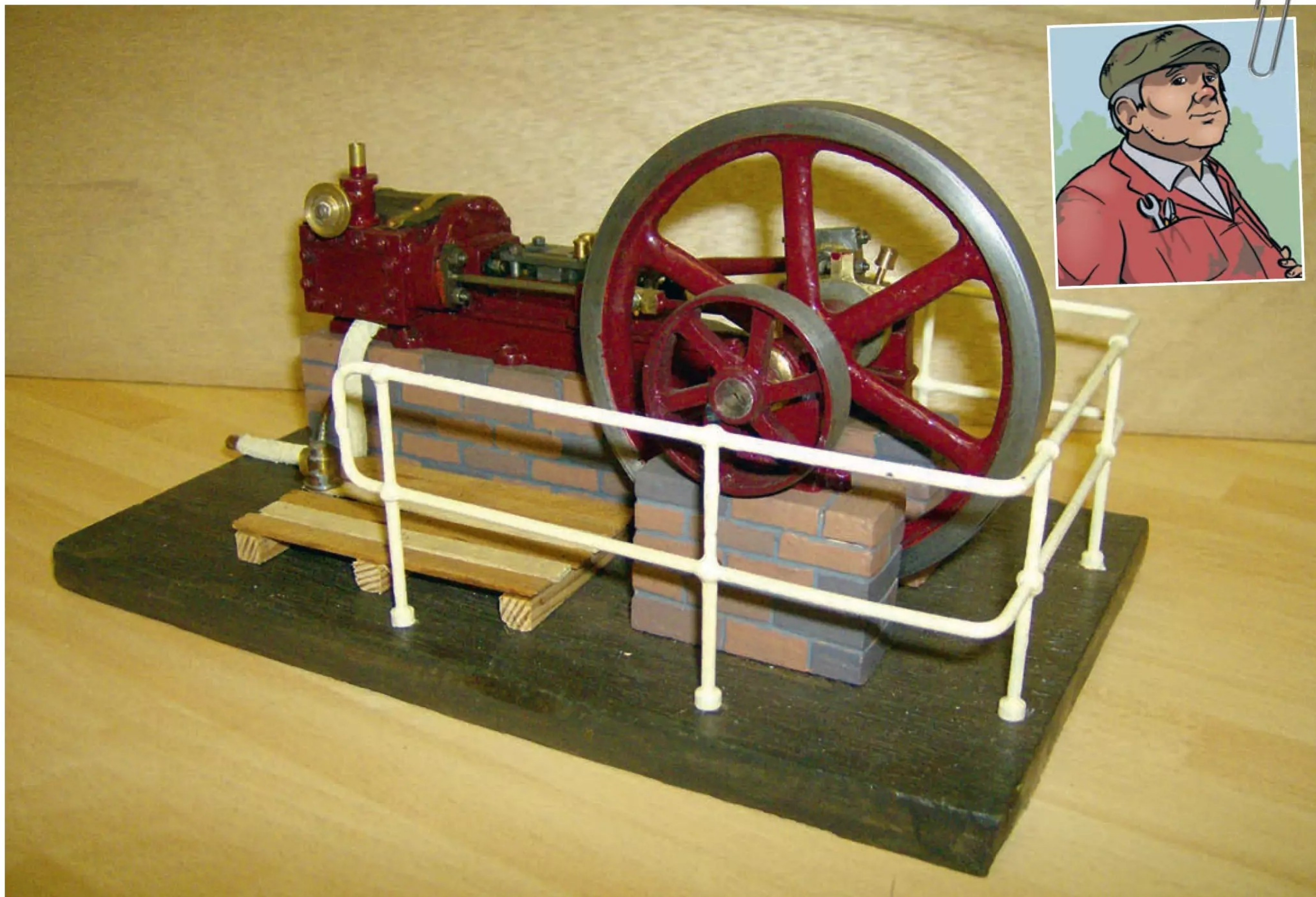
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ONLINE INDEXES

David Frith prepares the indexes for Model Engineer & Workshop. The latest copy can be downloaded on from the Forum at www.model-engineer.co.uk – just select Forums and then the Model Engineers' Workshop topic. Alternatively scan the adjacent QR code.

If you prefer the paper indexes, don't worry, David continues to produce these as well.

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Buxton

Stub Mandrel makes a model of an old brewery steam engine with an unusual bedplate.

In 2008, I visited Abbey Pumping Station, **photo 1**, a museum dedicated largely to stationary steam engines, many of which can be seen in action at regular 'steam days'. It sits, rather incongruously, cheek-by-jowl with the National Space Centre, **photo 2**.

One of the engines which caught my eye was a modest sized horizontal engine, built around an unusual cast bedplate, **photo 3**. Built by Buxton and Thornley of Burton upon Trent, it probably served its working life providing power in a brewery as that was their specialisation. Incidentally you can also find one of their engines at Clay Mills pumping station north of Burton, this is also horizontal, single-cylinder engine, dating from 1889. It that drives an open-frame Crompton dynamo and is considered the oldest working, steam-driven generating set in the UK. This engine has a very similar cast bed, I cannot find my photos of it, but found an excellent shot by Chris Allen on Wikipedia, **photo 4**.



Photo 1: Abbey Pumping Station.



Photo 2: National Space Centre.

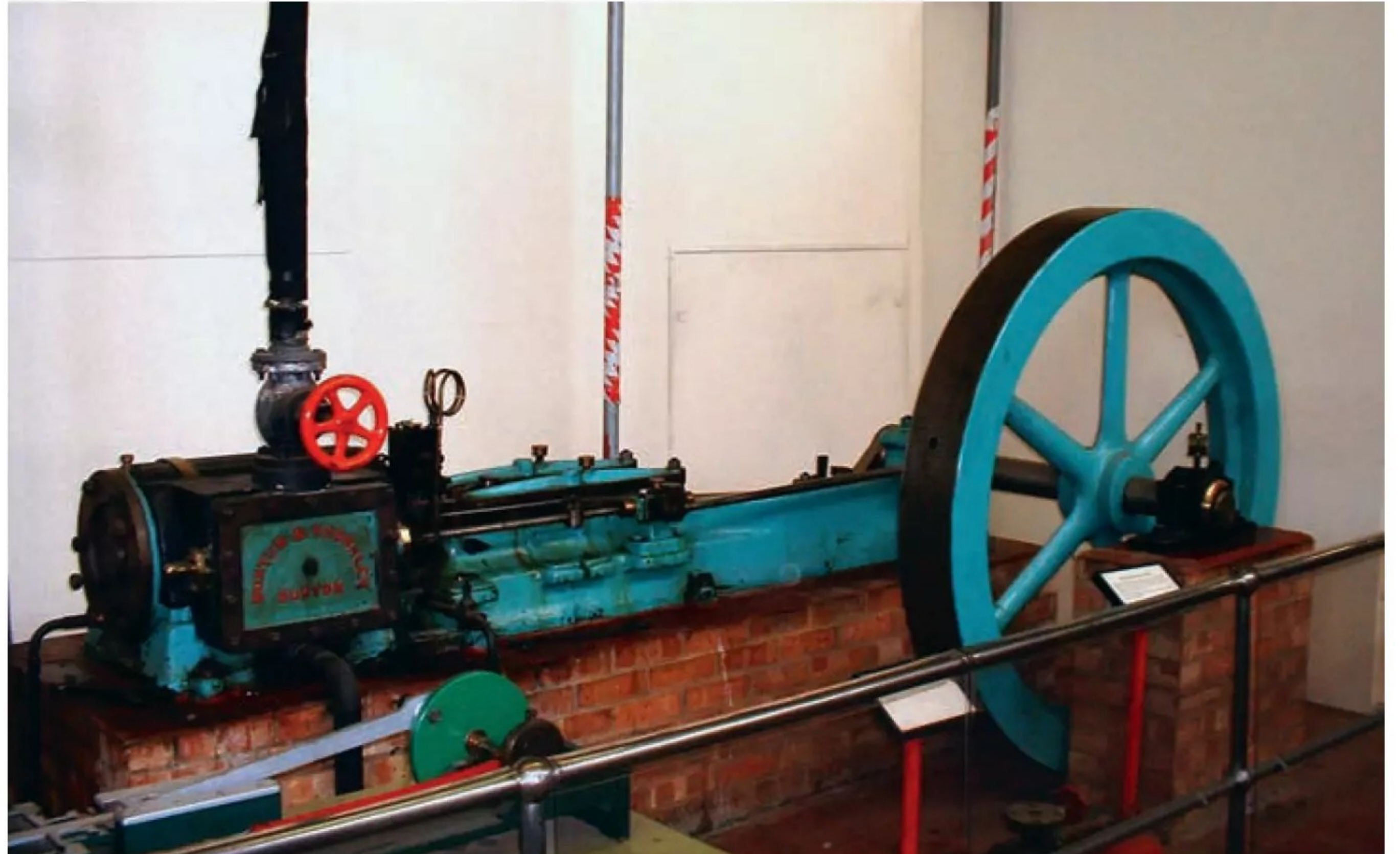


Photo 3: Buxton and Thornlea steam engine at Abbey Pumping Station.

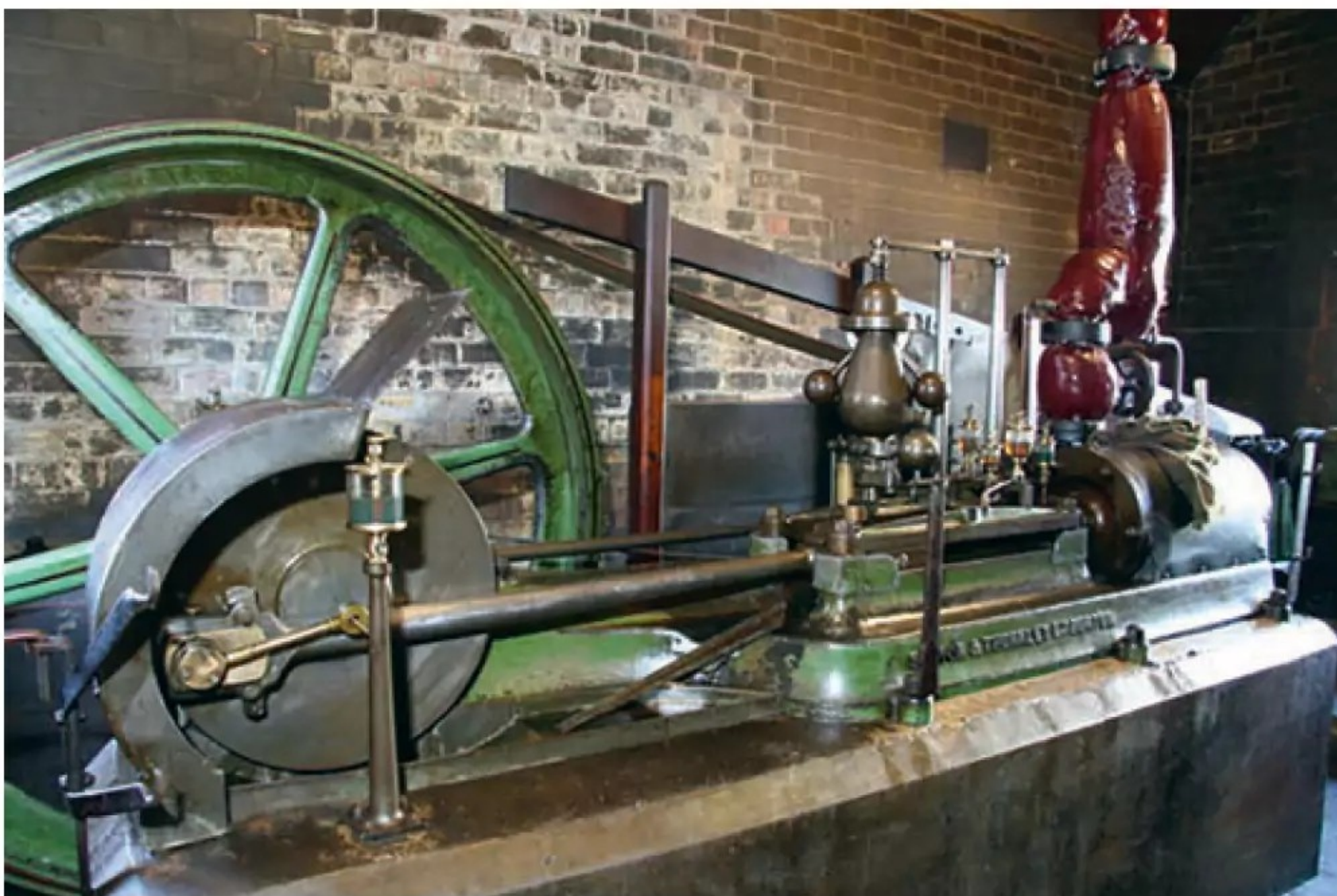


Photo 4: Buxton & Thornley steam engine driving 1889 open frame dynamo at Clay Mills. Chris Allen, CC-BY-SA 2.



Photo 5: The original's flywheel.



Photo 6: Basic cylinder machined from cast iron bar.

Returning home, I realised that the flywheel on the Abbey Pumping Station engine was a fairly good match for a cast one that I had bought from College Engineering at an exhibition, **photo 5**. Although I didn't have any accurate measurements of the original, I decided that model 'inspired' by the Buxton and Thornlea engine would be a good way to make use of this casting. The flywheel ended up at just under 3 3/4" diameter and the original is about 5' diameter, so the model is around 1/16 scale.

THE CYLINDER

I already had a small cylinder, machined from cast-iron bar, **photo 6**. This was originally intended for another engine, but I had decided to use a cast cylinder for that instead. The making of the cylinder was detailed in *Model Engineers' Workshop*, issue 298, November 2020, **photo 7**. At that time I

Machining a cylinder from the solid

Stub Mandrel describes an approach to milling a complex shape

A few years ago, I unearthed some dimensions and a sketch of an old colliery winding engine. It was an unusual, but straightforward subject, and I decided it would make a great subject for a model. One of the first components I made was the cylinder, which I machined from the solid, that is from a length of cast iron bar instead of a casting. For various reasons, nothing to do with the success of that cylinder, I ended up making a pattern and getting a casting made, but I thought that readers may be interested in how I went about producing that first cylinder.

The cylinder in question has a rather nice shape, being fairly tall and having angled sides that taper into the valve face. This shape lends itself to being machined reasonably easily.

I used Corel Draw, a vector drawing programme, rather than full CAD, to produce my drawings. One of the advantages of using the computer is being able to move things around to see if they fit, in this case I was able to see that there was plenty of room for the cylinder, including the valve face. In a 'continuous' cast mechanical bar, this was obtained from College Engineering and machined beautifully with no hard spots (unlike square



Cast iron bar set up in lathe

section bar which I find may have had some) and very little 'slag'. An accuracy of roughly 1/16" would leave a machining allowance all around the casting. I set the bar in my 4-jaw chuck using the tip of a tool in the toolpost and a 1/16" drill to gauge the offset. Greater accuracy was not needed.



Initial milling cylinder 1



Initial milling cylinder 2

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Model Engineers' Workshop

Photo 7: Machining the cylinder in MEW 268.

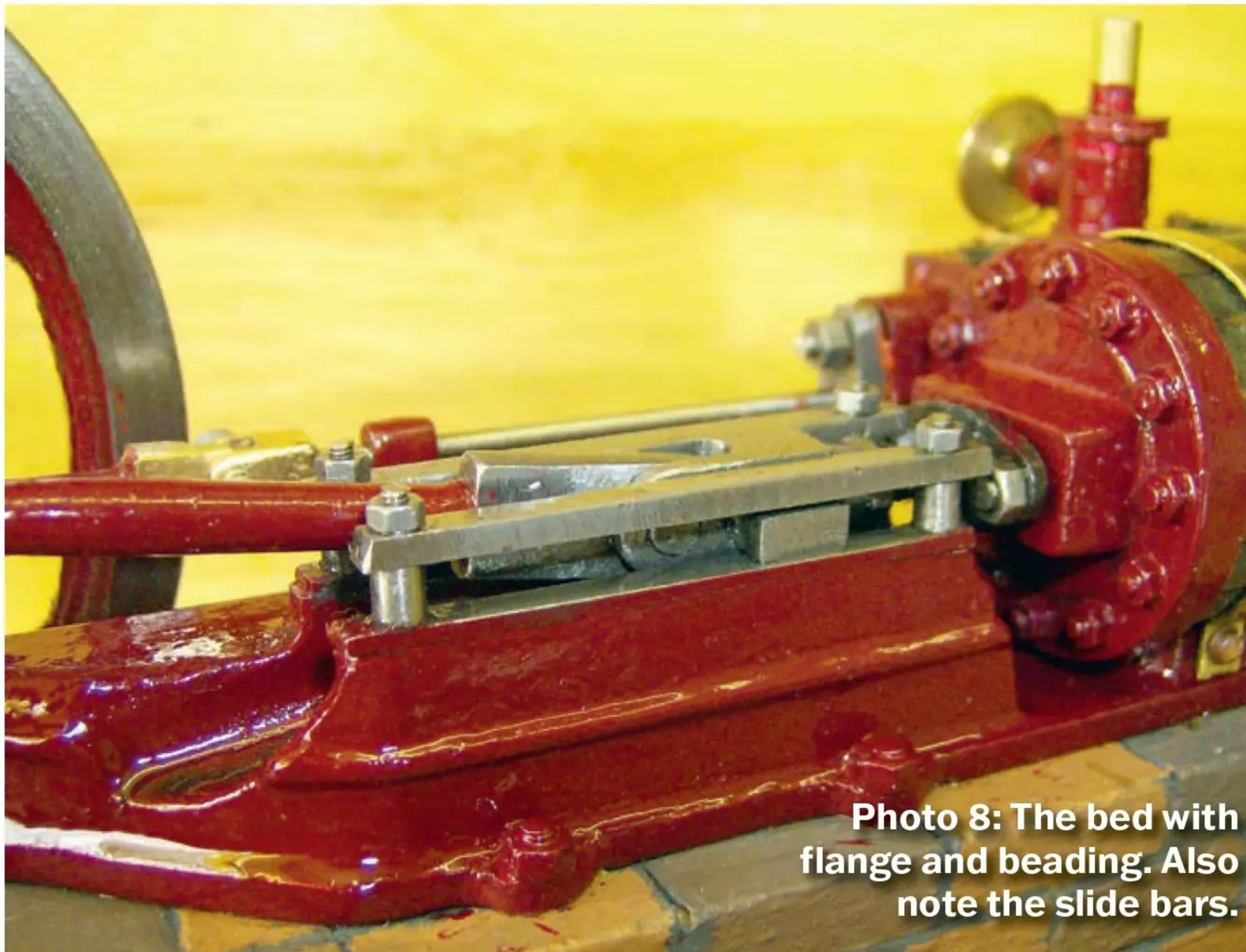


Photo 8: The bed with flange and beading. Also note the slide bars.

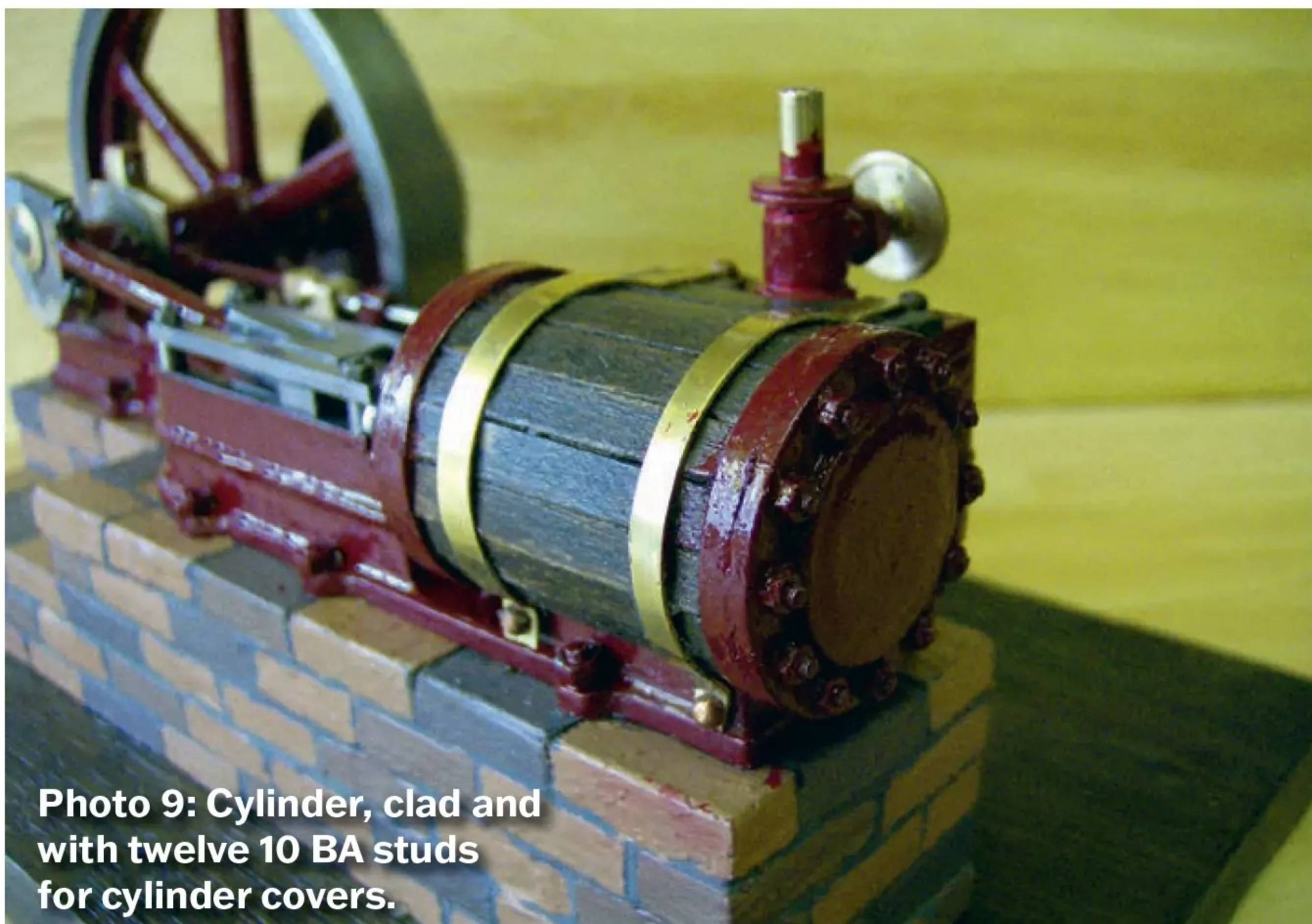


Photo 9: Cylinder, clad and with twelve 10 BA studs for cylinder covers.

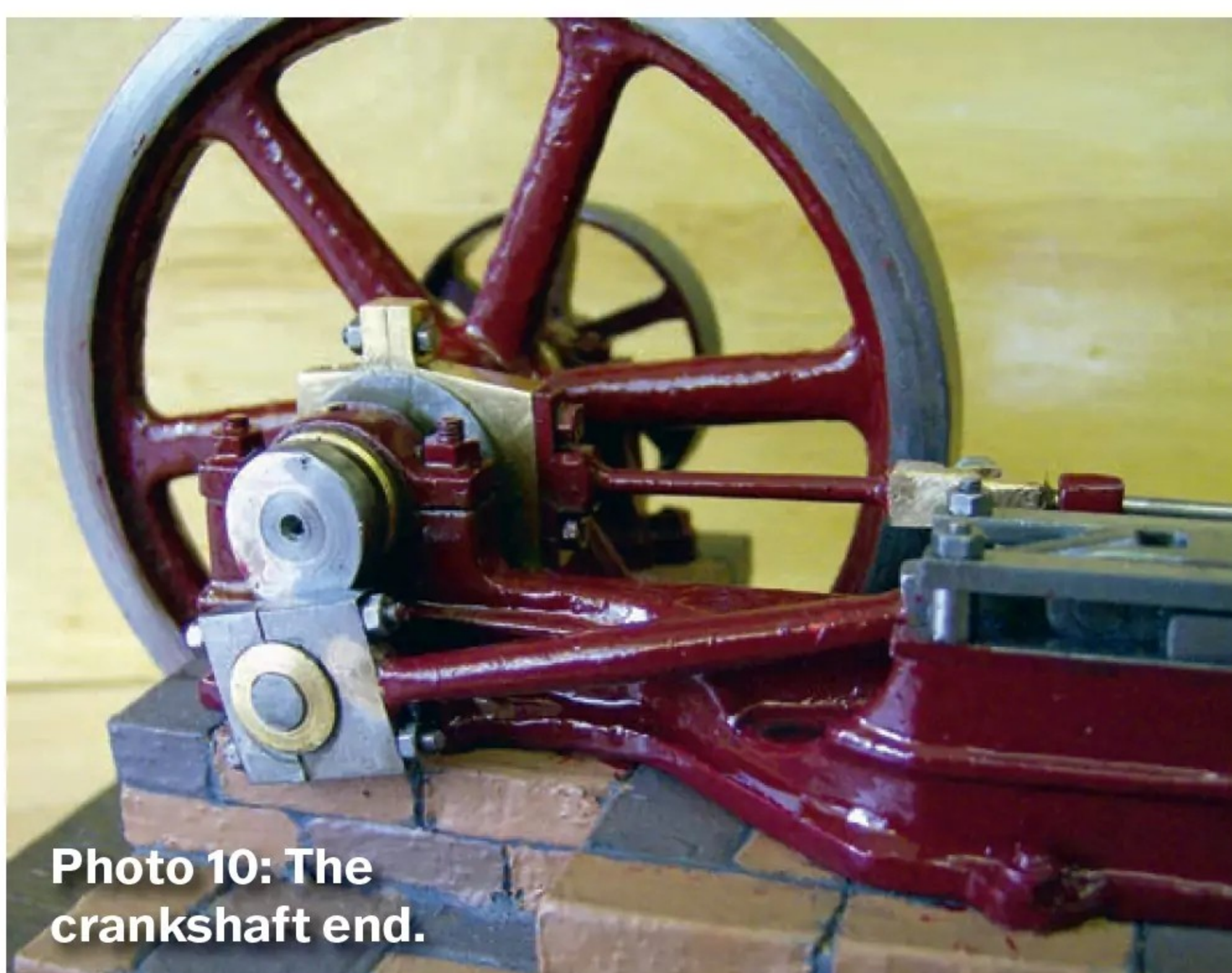


Photo 10: The crankshaft end.



Photo 11: Valve rod guide on 'shelf', 'lubricators' not yet fitted to the slide bar.

said the making of the engine bed was another story. I ended that story with tapping for the end covers and steam chest. You'll see that I went for twelve 10BA screws for end caps, valve chest and valve gland; tapping thirty-eight 10BA holes was a bit nerve wracking, I made a simple top-hat shaped guide to help avoid breaking the tap and help keep the holes straight.

THE BEDPLATE

I didn't try to replicate the original cast bed perfectly, I just wanted to capture its rather unusual shape (notably my engine is rather shorter). I started by drawing its plan profile on a piece of paper, which I glued onto a 1" aluminium bar, and roughed out the overall shape. All around the base is a narrow flange with 'ears' for holding down bolts. I roughed out the flange to a full width, then simulated the slight draft on the 'casting' by running around the outside with a home-made single flute taper milling cutter with a groove in it. This had to be used very slowly. The 'beading' around the centre line of the engine bed is half round brass, **photo 8**. The flange was reduced in width, except around the ears which were filed to shape by eye.

The overall contours of the base come from gently blending together three main elements. The cylinder is supported by a block, with a concave upper surface bored to match the cylinder's out diameter, **photo 9**. The cylinder's flanges overhang each end, requiring a cross groove (which I made a bit deep) before the next section that has two raised mounts for the slide bars. I machined these as one, then ran a 5/16" endmill along the centre to create the space for the little end to move in, see photo 6. The final, narrower section supports the inboard flywheel bearing, **photo 10**.

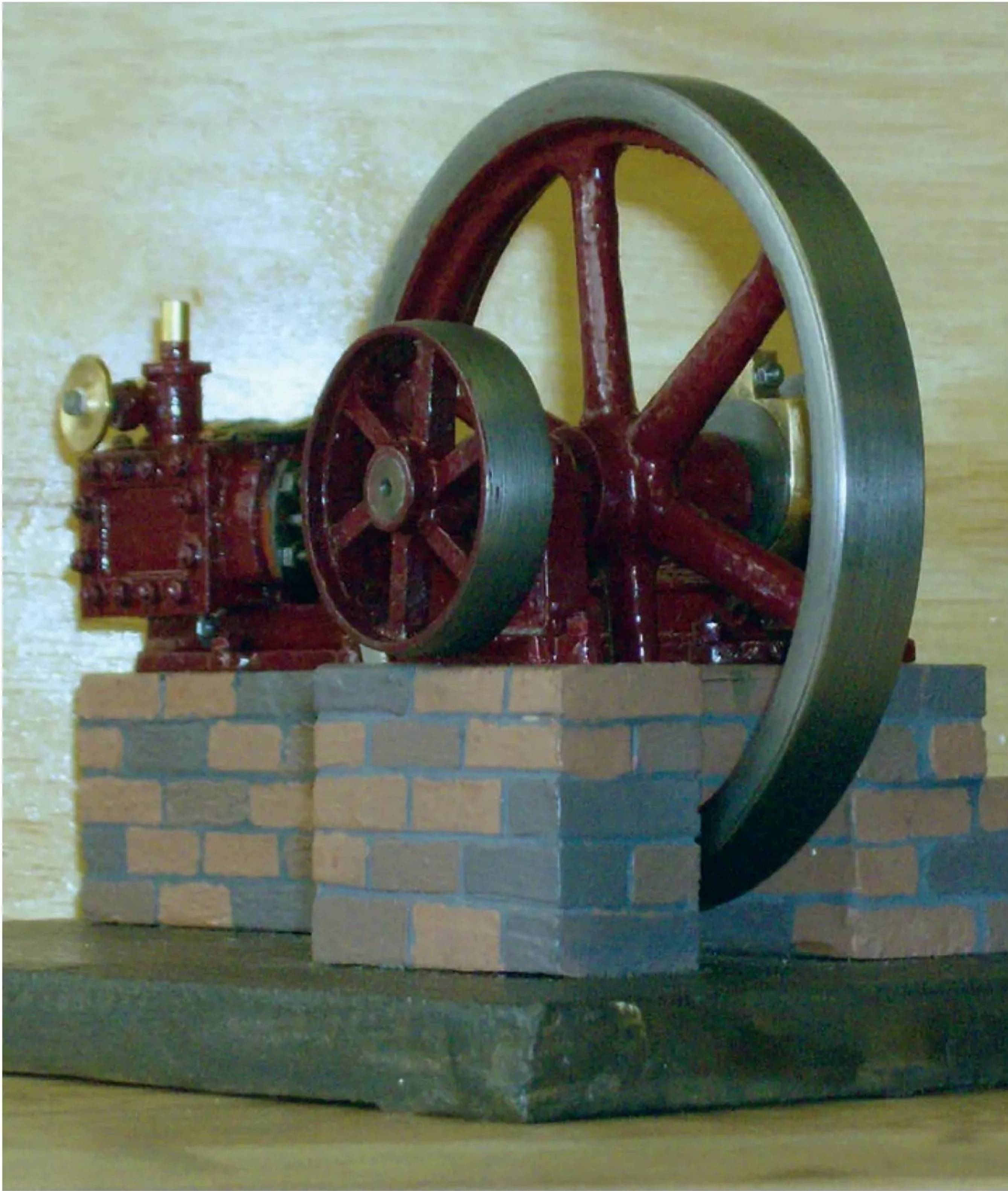


Photo 12: The outboard end of the crankshaft is supported on an outboard pillar, as with the original.

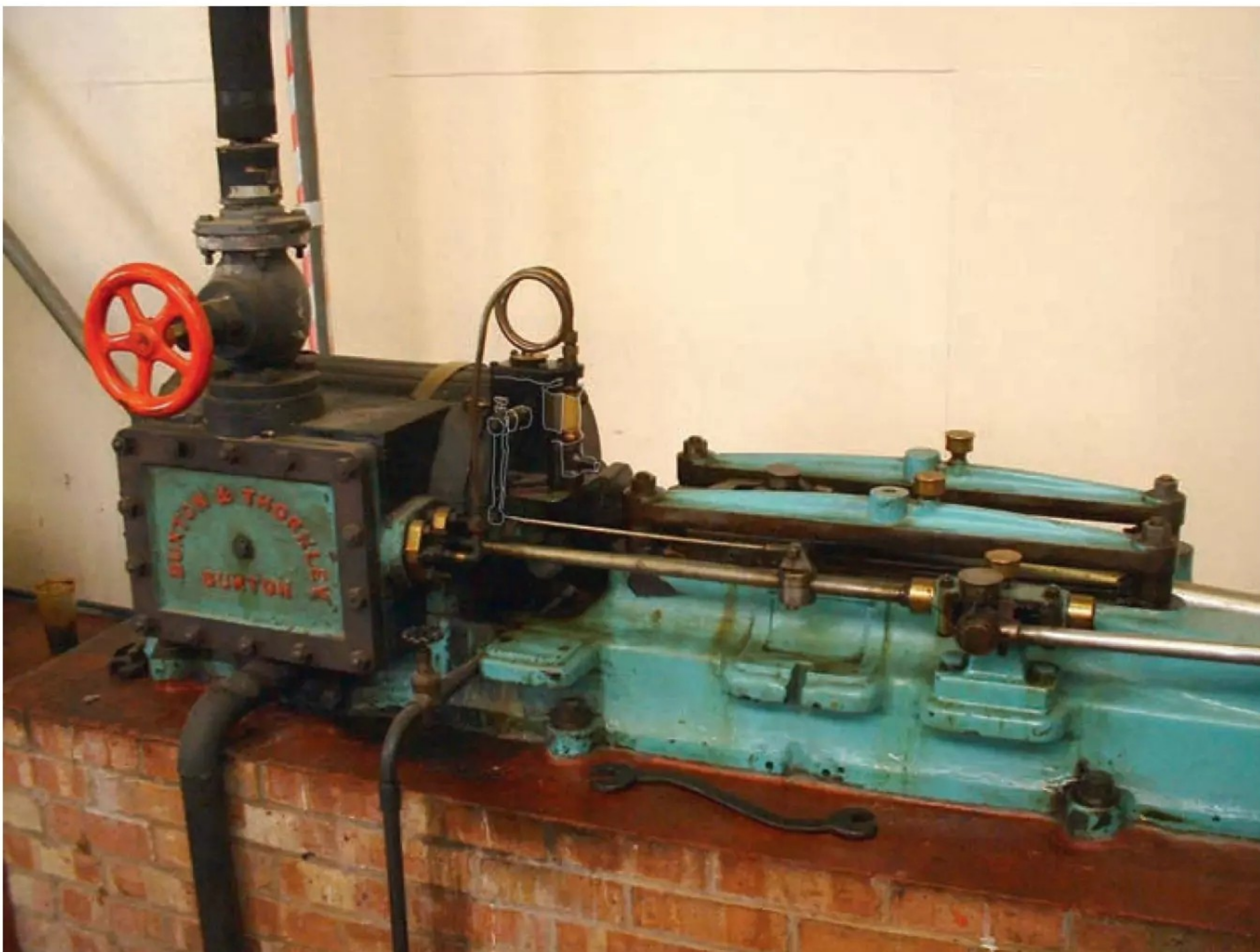


Photo 13: Cylinder end of the full size engine, the lubricator detail is rather dark so I outlined it in white.

The original engine has a few cast-on 'shelves' that must have supported various ancillary equipment, perhaps a governor. I milled out a slot and fitted a piece of aluminium sheet to represent just one, to support a small pillar to guide the valve rod, **photo 11**. This was a simplification of the original arrangement, although it works well for a lightly loaded model.

The 'shelf' was fitted in place using two-part epoxy, this was also used to locate the cylinder – the means of attachment is not visible on the original, and it may be cast as one with the base.

Once the cylinder was fixed in position, its centre height was known and the mounting pads for the slide bar and crankshaft bearing could be machined flat. A 'pillar' for the outboard crankshaft bearing was machined up to match, **photo 12**.

There's nothing special to say about the pistons and valves, they follow usual practice for both, the piston has a Viton o-ring. The crosshead guides are from steel strip with short tubular spacers. The cross head was quite a long job requiring a good fit between the slide bars for its 'ears'. Although the general shape was machined, the slot and ears required careful work hand finishing with small files.

The valve rod link is filed from brass with a turned pin secured with a microscopic wire through the end, bent from a guitar's e-string.

The big end and crankshaft bearings have split outers, but the inner bronze bearings are single piece. The eccentric strap was a mixture of machining and handwork. I did do some preliminary sketches for the cylinder lubricator, **photo 13**, which is driven from the valve rod on the original, but decided it was too fiddly.

The pulley was an 'interesting' exercise in carving out an unusual shape from cast iron bar, but I find such work curiously satisfying.

OTHER DETAILS

I didn't feel obliged to follow the original paint scheme, although the greeny blue colour was quite appealing. I have a big soft spot for the old Humbrol gloss crimson enamel, number 20. Although I find acrylics much more pleasant to use, for anything that's going to have to cope with steam and oil, enamels are far superior.

The cylinder was clad with stained hardwood strips, glued in place with brass bands. The tiny brass rivets are purely decorative to represent screws. The steam inlet valve is non-functional and just has the central

Photo 14: The base,
before adding railings.

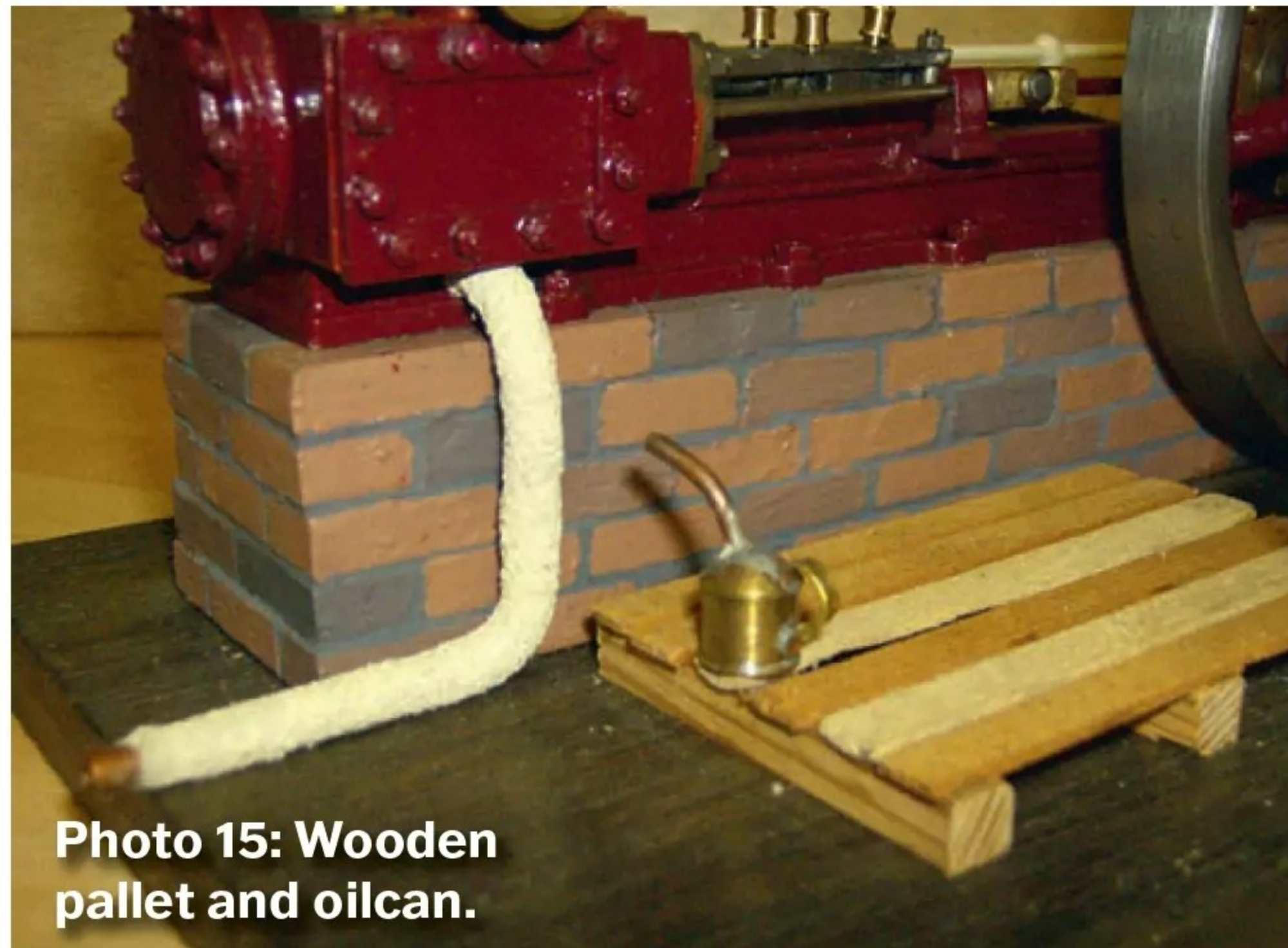


Photo 15: Wooden
pallet and oilcan.

pipe soft soldered through its body. The insulation on the exhaust pipe is closely wrapped string painted with white enamel paint.

The various 'lubricators' are also non-functional, they were turned from brass rod with small pegs left on the bottom when parting off. Such things are entirely optional on a semi-scale model, but these are the sort of details that you will see on most full engines and help to give a little more interest.

The plinths for the bed and outboard bearing are just pieces of wood, grooved and painted, **photo 14**. Not my finest piece of work but intended to be unobtrusive rather than the focus of the

model. Some random plywood gave the base, the railing pillars are from steel rod with the round sockets produced using a form tool, drilled and then TIG welding rod bent to shape for the rails.

The small wooden platform was just from some random stripwood, and the fabricated oil can is a body turned from solid with details in brass tube and strip – it was a fun exercise in soft soldering, **photo 15**.

PAINTING AND RUNNING

As the engine is not a strict scale model, I didn't feel bound to copy the greenish-blue paint job, instead I

went with a nice deep maroon enamel whose consistency made a good job of covering up flaws and leaving a casting-like surface finish, **photo 16**. That's my excuse, anyway.

I set the eccentric to give a small amount of advance, and the finished engine runs nicely on both steam and air. I didn't fit a real lubricator, so for steam I put a drop or two of steam oil into a silicone tube and use this to supply low pressure steam. The engine runs happily off the steam outlet of my cappuccino machine – this is a great way to test small steam engines if you only want them to run for a few minutes to 'prove' that they work. ●

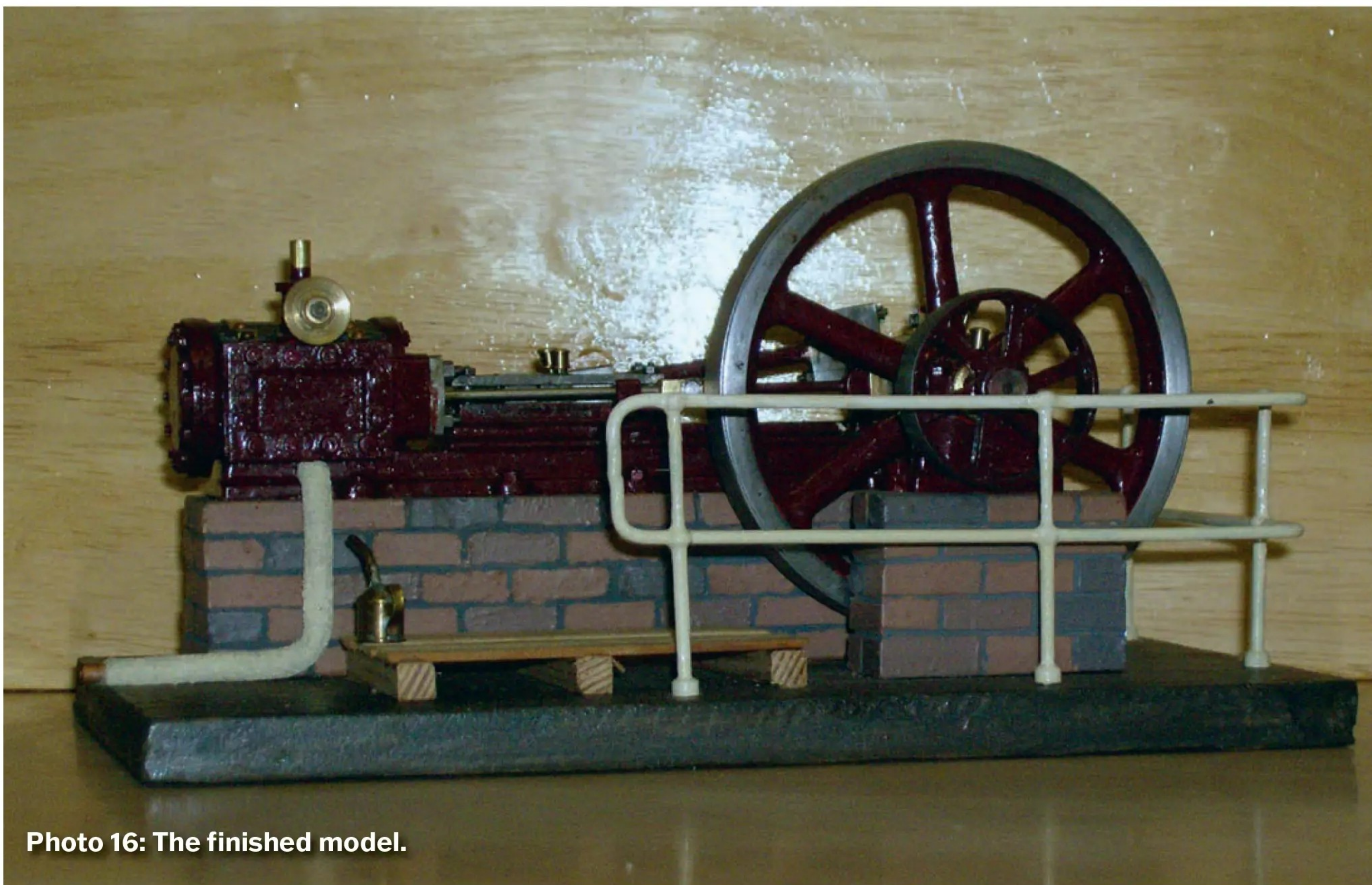


Photo 16: The finished model.

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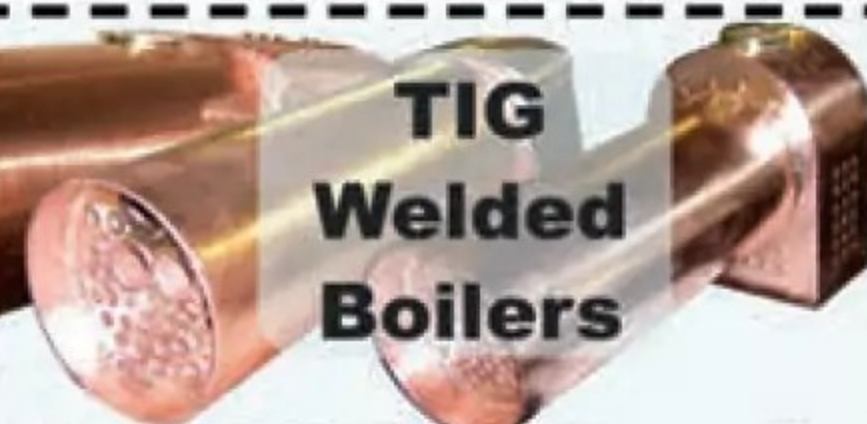
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Readers' Tips



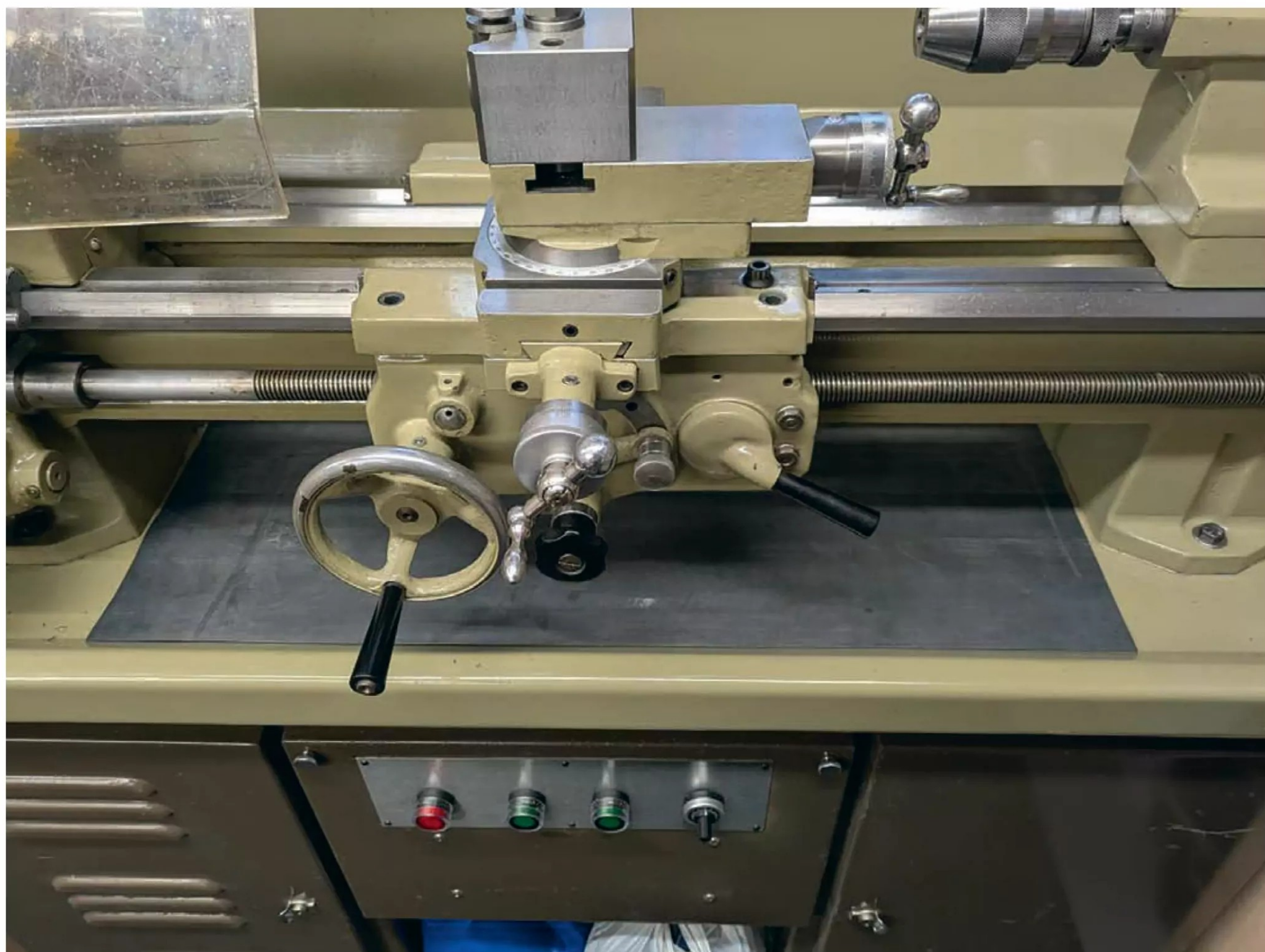
We have £30 in gift vouchers courtesy of engineering suppliers Chester Machine Tools for each month's 'Top Tip'. Email your workshop tips to neil.wyatt@kelsey.co.uk marking them 'Readers Tips', and you could be a winner. Try to keep your tip to no more than 400 words and a picture or drawing. Don't forget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

A NEATER SWARF TRAY

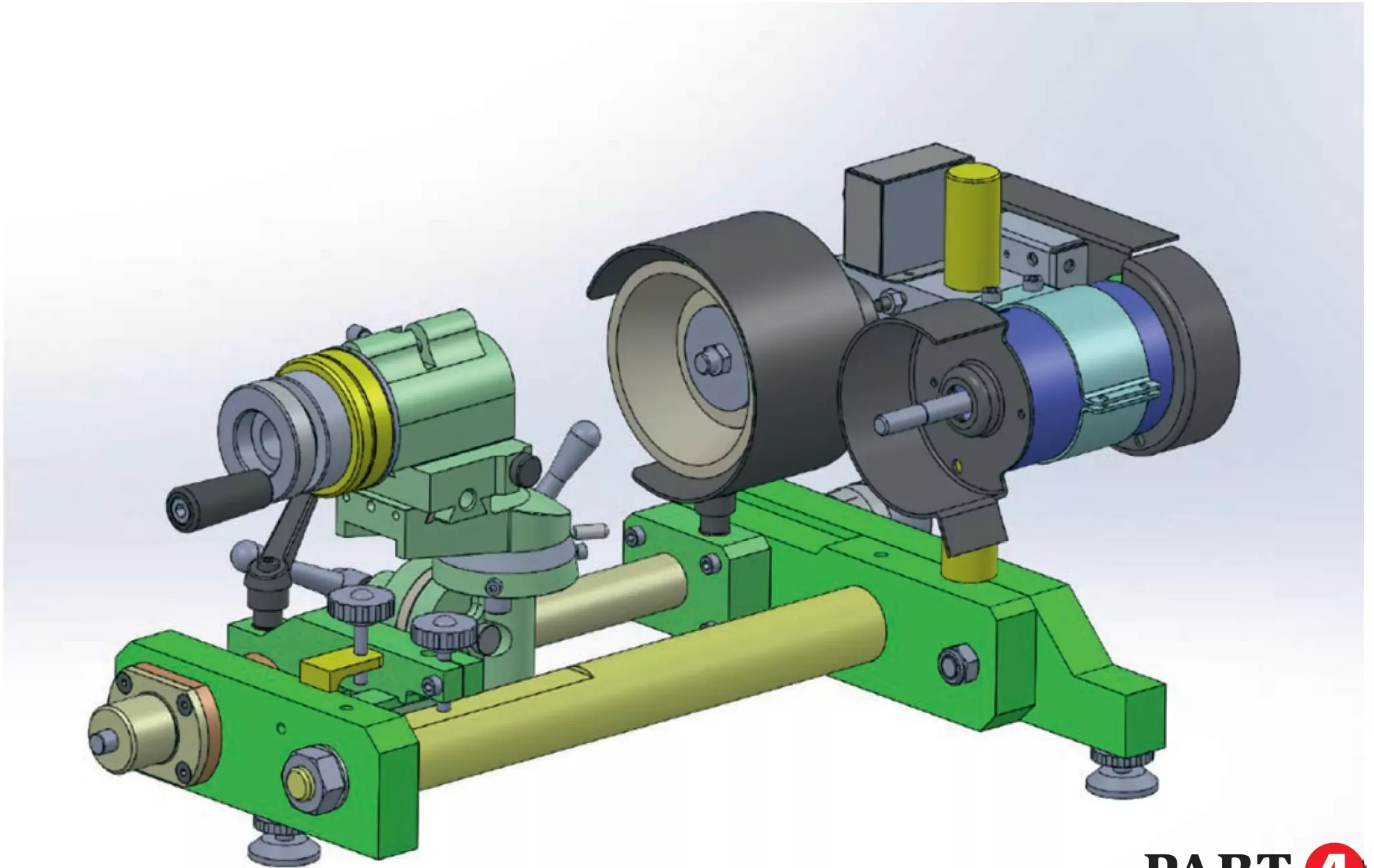
Our tip winner this month is Matt Taylor, with a tip for helping keep the swarf tray tidy.

Here's my 'tip'. It's one of those things that is so simple you'll wonder why you didn't think of it earlier! It took me twenty plus years to realise. It not something I see other people doing either, so I'm probably not alone.

What is it? Well, it's just a mat. I cut a piece of rubber (leftover from a rubber roof) to fit in the bottom of my lathe's coolant tray. It protects the paint from damage caused by dropped items and also it collects a large amount of swarf! The mat can then be removed along with the swarf, folded and poured into the bin for easy cleanup. It seems so obvious now, huh? No doubt you've all been doing this for years.



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.



PART 4

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.

We continue after the silver soldering of the two parts; **photos 27** and **28** were omitted from the last instalment. The side plate was roughly cut with a disc in an angle grinder and an undersize hole cut in the centre with a hole saw. It was

then bored to the correct size on the mill, **photo 29**.

The bore of the support tube was bored for a clearance fit with the outer housing of the grinding spindle. The support tube and side plate silver soldered together, and the outside diameter of the plate then turned to the

correct diameter, **photo 30**.

A piece of pipe was used as a former for bending the outside wall of the guard and for holding the assembly while welding. (Note: I chose silver soldering as the best option for the initial fabrication but TIG welding for this operation to minimize distortion).



27



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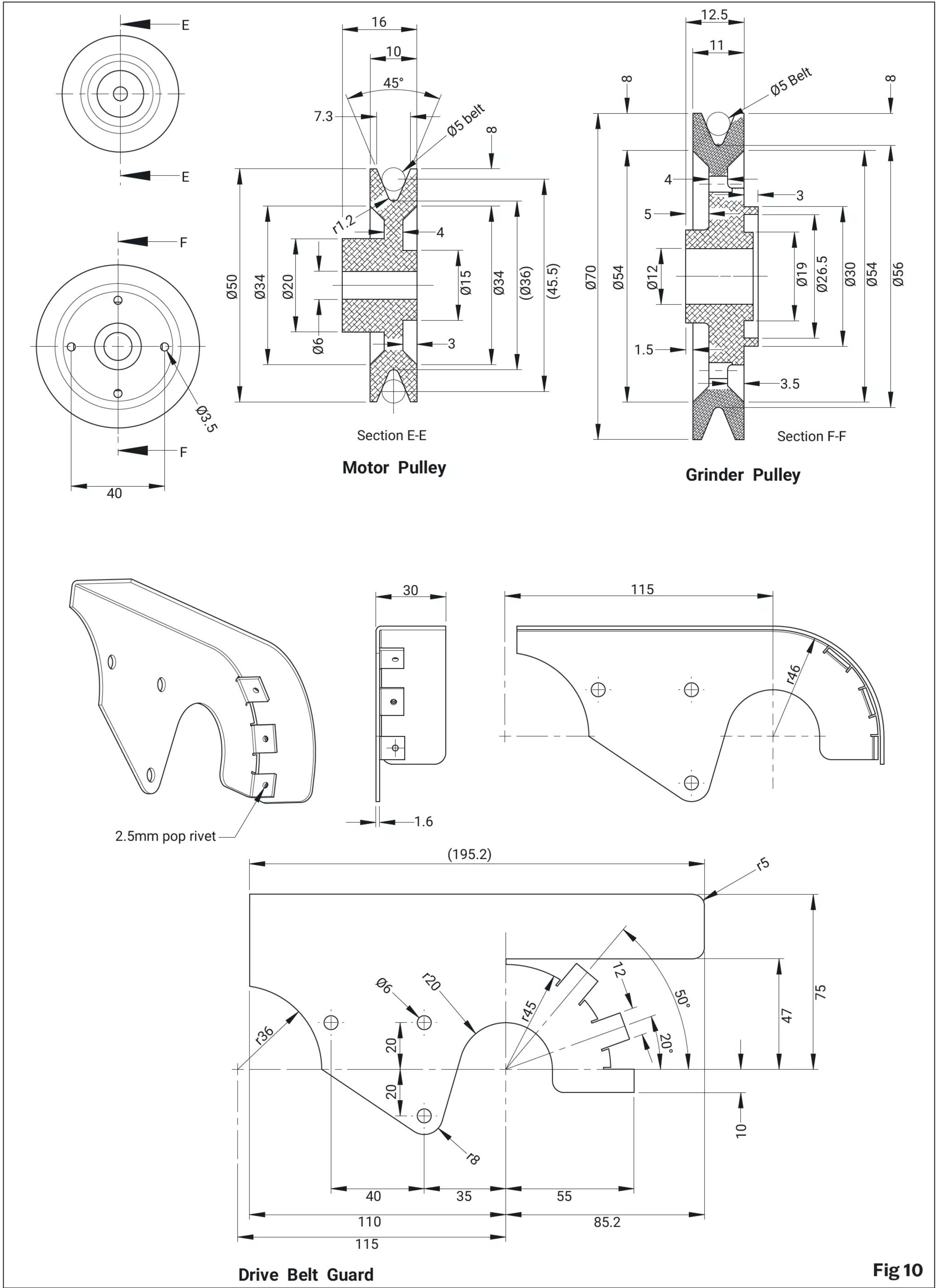


Fig 11

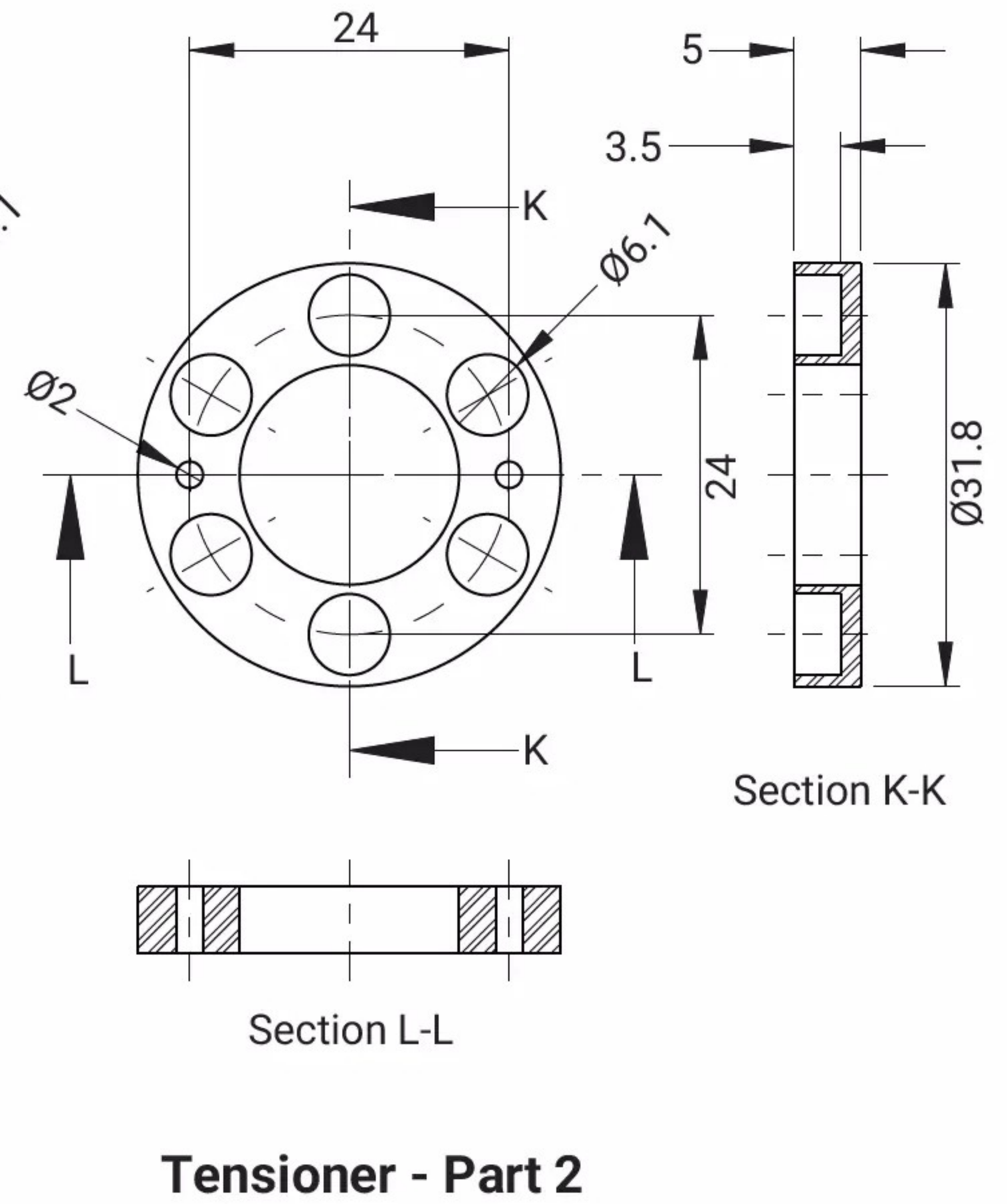
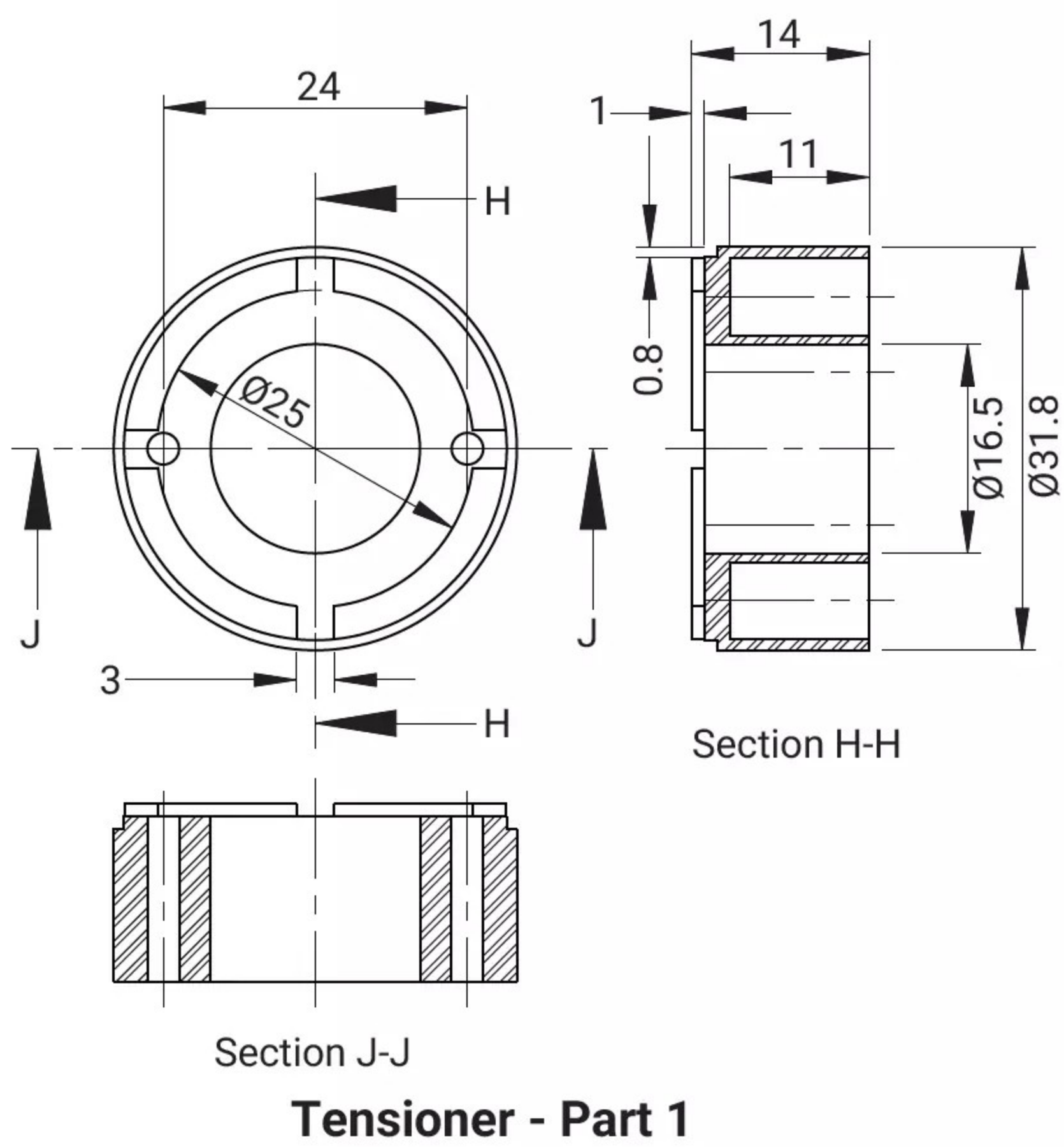
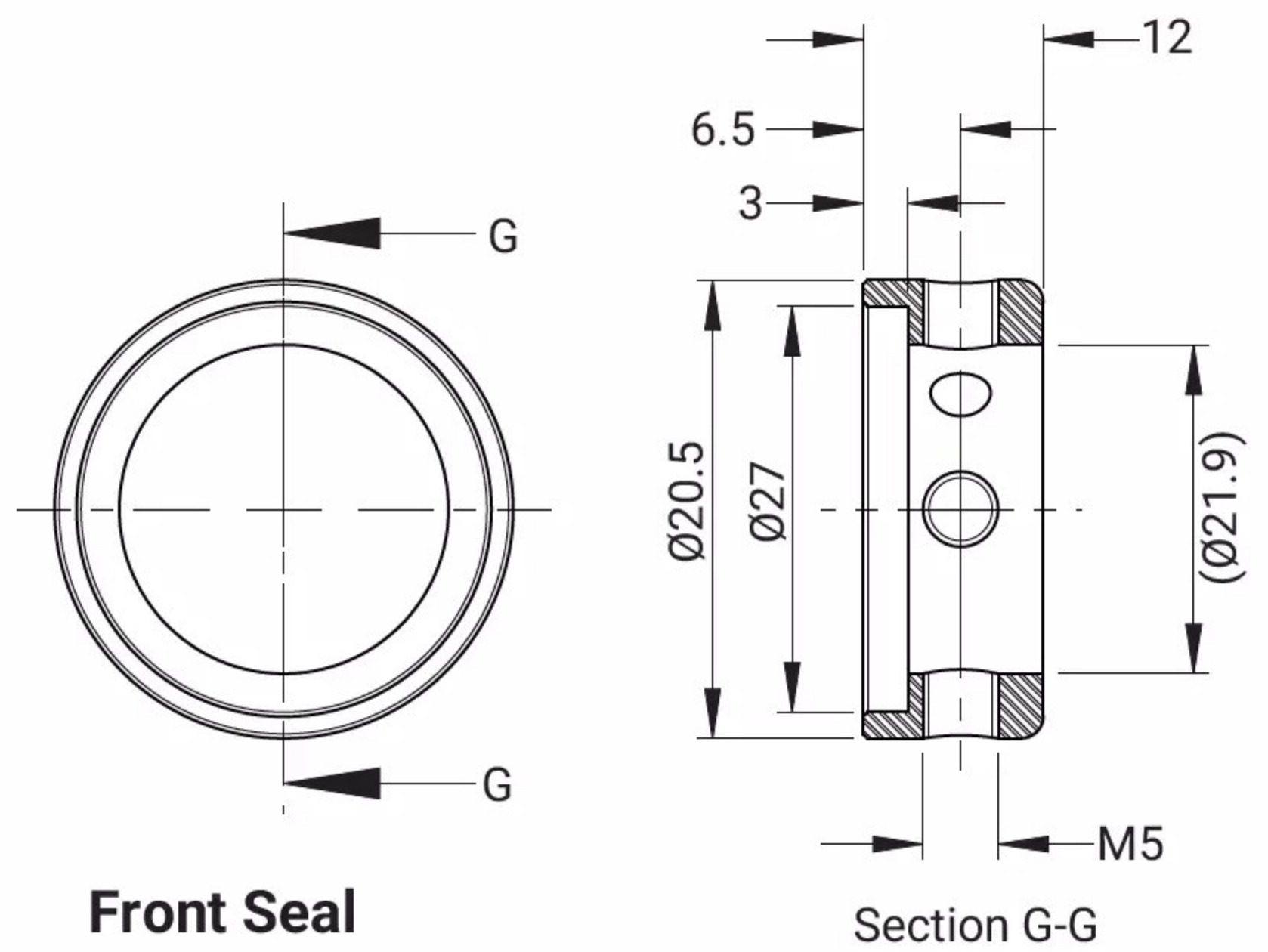
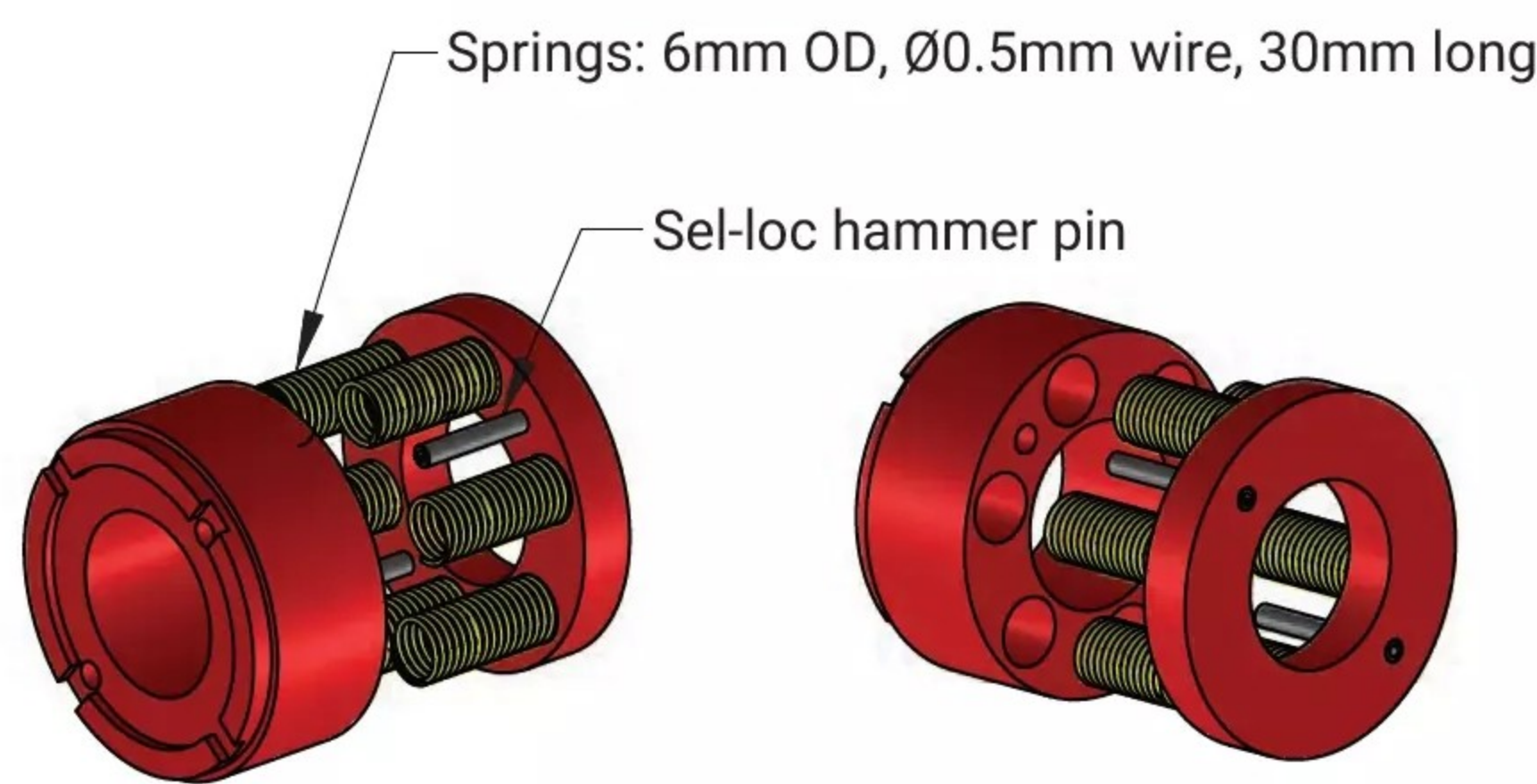
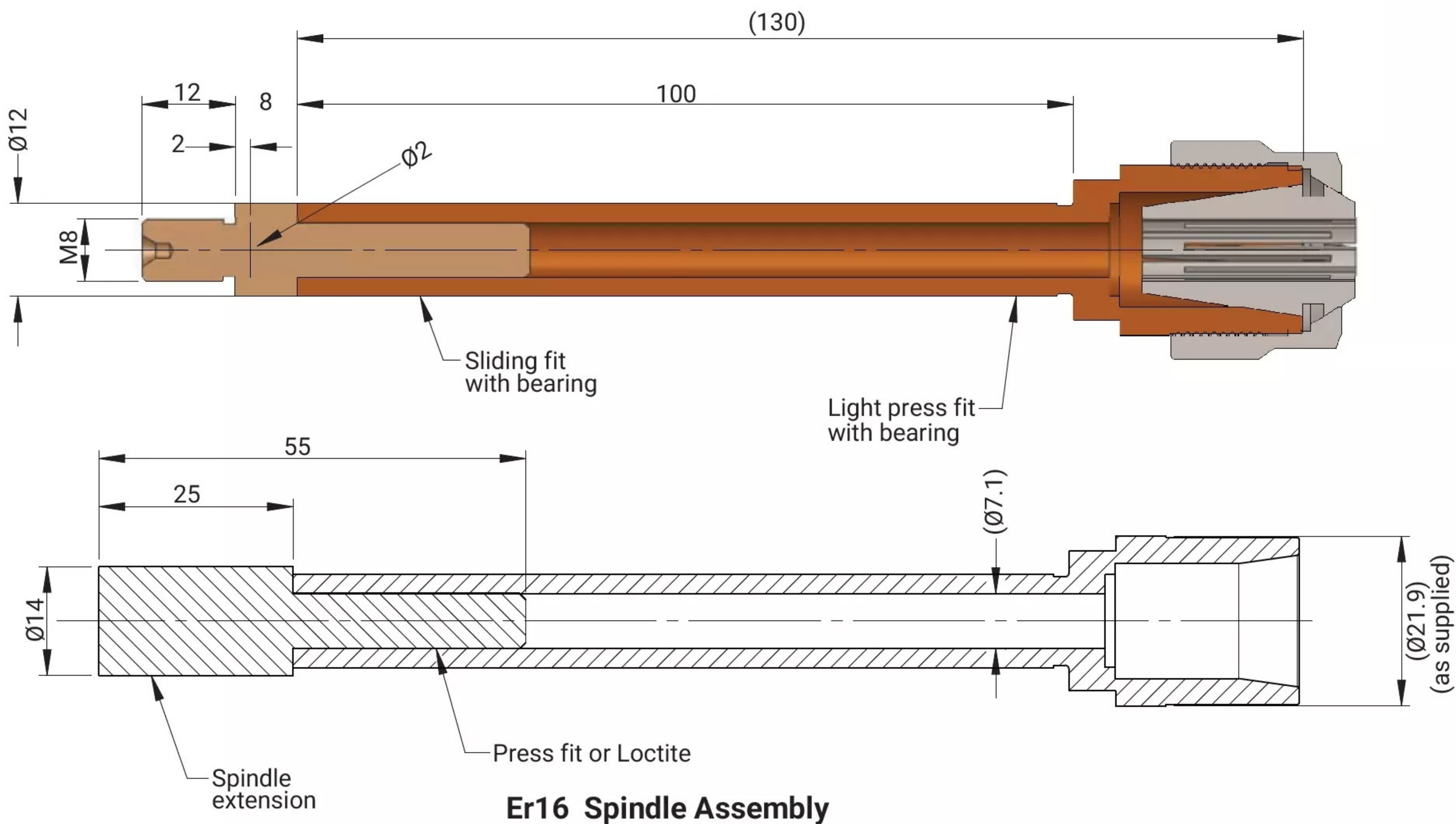
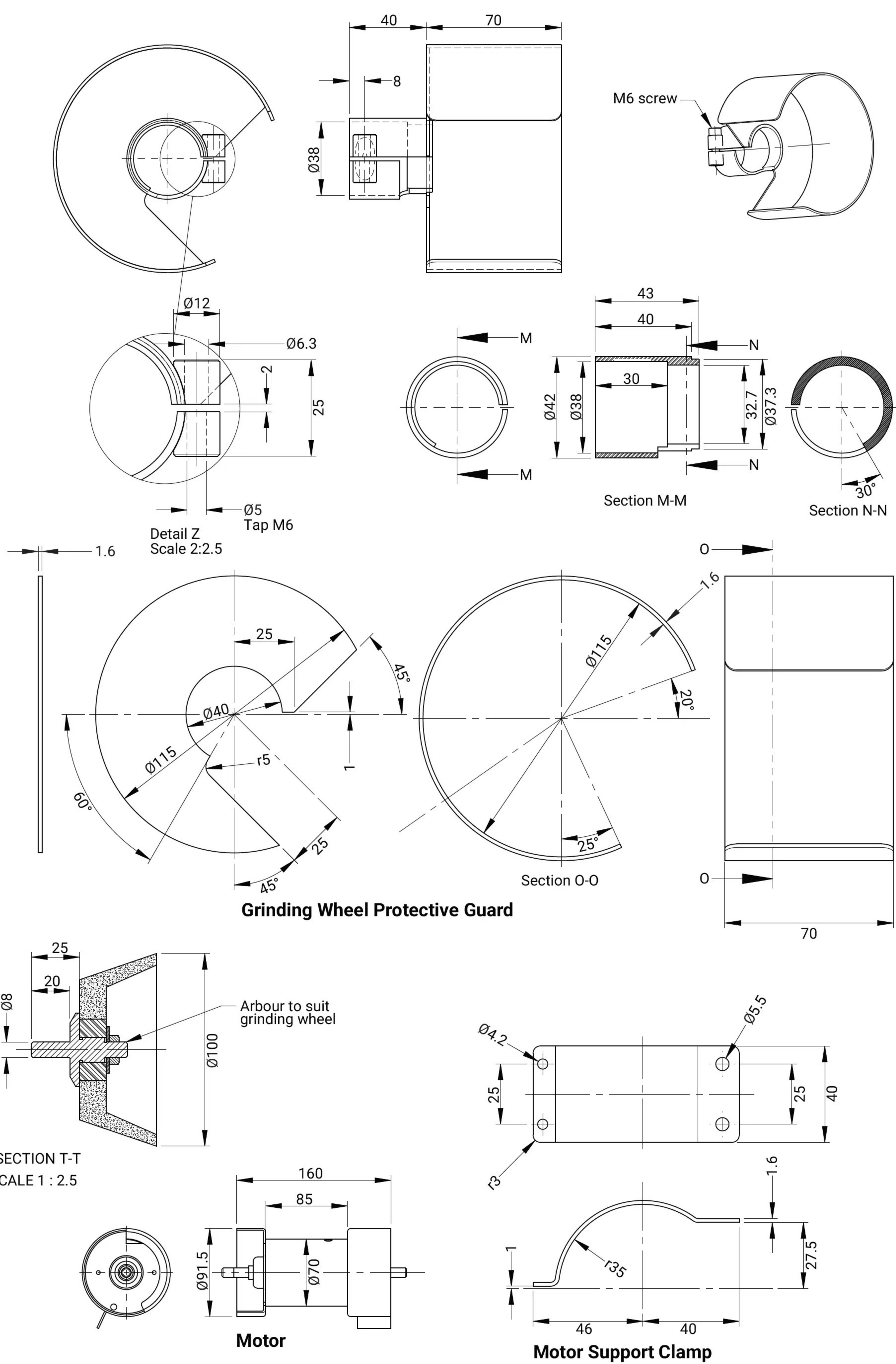


Fig 12



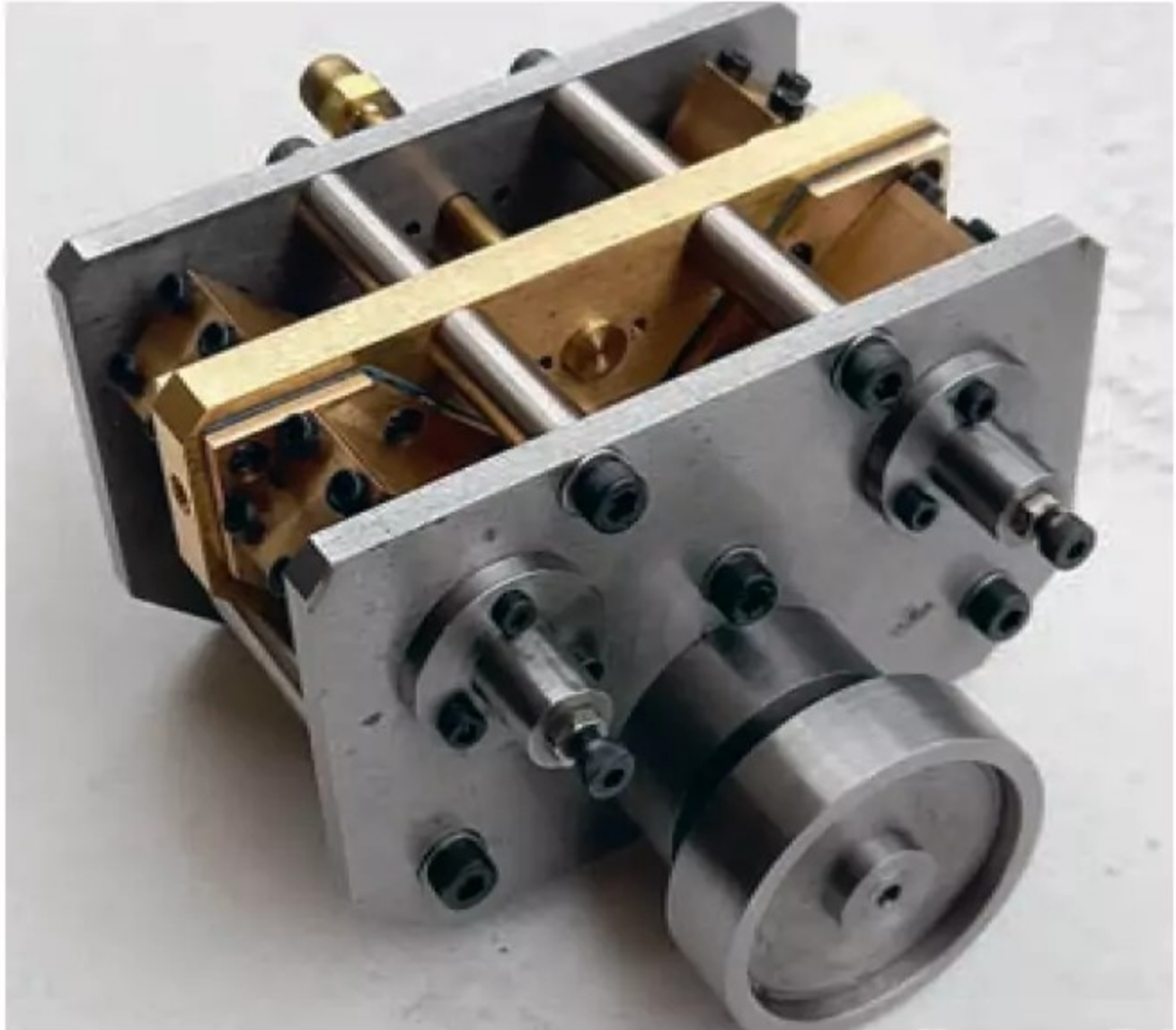


A cut was then made thru the support tube and clamp bar and the remaining plates also cut to finished shape, **photo 31**.
The final assembly was pickled in vinegar to remove solder flux and clean the guard, **photo 32**. Only part of the assembly was submersed with the tube on the bottom and why this is only the clean part. The vinegar used has been previously used and was a dirty brown colour but still works OK. Available in the cleaning section of supermarkets.
The final drawings for this project will appear in our next issue.
<to be continued>

Look out for your next issue of Model Engineer & Workshop

Number 4779
August 2026

On sale
July 17
2026



Peter Stuart shares his updated design for Fourrunner Mk. 2.



Roger Backhouse visits the Bolton Steam Museum.



Mitch Barnes looks into engraving and describes the development of an air powered engraver.

Contents subject to change



To pre-order your next copy of ME&W visit www.classicmagazines.co.uk or call 01507 529 529

A Steam Mower



An interesting post caught my eye on the www.model-engineer.co.uk forum recently, by forum member Richard who has been asked to restore an unusual Atco 14-inch mower, converted to be powered by an oscillating steam engine. The mower was purchased from Auction by Clive Gravett, Curator of The Museum of Gardening. It's based in the South Downs Heritage Centre, Hassocks, BN6 9LY. The Museum is also linked to the Budding Foundation Charity through Clive. Clive is also now the Chairman of The Old Lawnmower Club. There's more information on the forum in the thread 'Steam Powered Lawn Mower'. Hopefully we'll be hearing more about the restoration of this fascinating machine.

A New British Scale Model Kit Manufacturer takes Off



A new British precision scale model manufacturer, DB Modelling Kits (DBMK), has launched its first product - the Sea Fury kit - marking the first debut from a mainstream plastic model kit brand in over five decades. Developed in collaboration with Navy Wings, a UK charity dedicated to preserving and flying historic Royal Navy aircraft, the kit has been created using advanced LiDAR laser scanning of the charity's restored Sea Fury plane, enabling an exceptional level of accuracy and detail. Navy Wings maintains a unique collection of

airworthy aircraft and plays a central role in keeping the Royal Navy's aviation heritage alive. The launch was marked at RNAS Yeovilton, home to Navy Wings' working aircraft collection, where guests were able to see the aircraft that inspired the model up close. Founded in 2021 DBMK manufacture their kits in the UK at Plastech Tooling and Moulding Ltd in Newhaven, East Sussex. Scale modelling remains a popular and enduring hobby in the UK, blending engineering, history and craftsmanship. Enthusiasts often spend significant time recreating real-world subjects with precision, with advances in digital design and manufacturing raising expectations around accuracy and realism. Despite its long heritage, the scale modelling market remains dominated by a small number of established manufacturers, making new entrants like DBMK relatively rare.

Disposing of a Workshop



As Editor, I am often contacted by people faced with the sad task of disposing of a loved one's workshop. In the last month several people have been in touch, and as you'll see from Smoke Rings I have first-hand experience of this. It's now over ten years since Model Engineers' Workshop carried an article by Roger Backhouse on this difficult topic, you can find it at www.model-engineer.co.uk/819/disposing-of-a-workshop or use the QRcode. I still share this article with people and many of them have got back in touch to say they found it helpful.

I strongly recommend taking a look at this article and having a think about the future of your workshop; the best time to think of these issues is many years in advance.

A Packaging Coating from Birch Bark

A novel wood bark-based packaging coating material was pilot-produced in a Finnish research project. In the COCOBIN project, coordinated by the University of Oulu, coating materials are being developed from suberin, a natural compound found, for example, in birch bark. In plants, suberin acts as a protective layer and prevents the loss of water.

The material can be applied to fibre-based packaging materials such as paper or paperboard as a moisture barrier, as well as in other products requiring durable and functional surfaces. One key application area is food packaging, where the role of the coating is to prevent moisture from passing through the packaging material and to protect the product. "Current coating materials are typically fossil-based and can present challenges for recycling. Suberin-based coatings can offer an alternative while achieving comparable performance," says Rajesh Koppolu, Senior Scientist on the project.

The starting point was birch bark, from which suberin was extracted as a

moist material, then dried and further processed into a fine powder. This enabled it to be mixed into a uniform coating formulation. From this powder, a water-based coating was prepared, where suberin particles are evenly distributed in the liquid. Additional components were included to help the coating spread evenly and to achieve the desired functional properties. The formulation is based on approximately one and a half years of research and development work. The work demonstrates the feasibility of the concept at semi-pilot scale. The trials showed that the coating can be processed in a similar way to conventional coatings and that production is feasible beyond laboratory scale. The coated materials are now being analysed to better understand their properties, performance in different applications. Suberin can be extracted from birch outer bark, which has traditionally been used for energy production in Finland. With new applications, it has the potential to become a higher-value side stream for forest-based industry.



Workshop Design Challenges

Here are a few ideas for articles about shop-made workshop tools. If you are interested in designing/making and documenting one of these tools for the magazine, please contact the editor, neil.wyatt@kelsey.co.uk, or if you have other creative ideas, please share those.

A Fractal vice – the type with several moving jaws that adapts to unevenly shaped workpieces.

A device for bending music/piano wire or metal rods. Bonus points for something handheld that could be used

in hard to reach areas. An example could be bending a control rod already threaded through a tube or hole. A device to help with marking out a line that bisects any angle, without having to measure the original angle.

An accurate device to gauge an internal bore that can then be used to take a micrometer measurement from (something easier to use than the normal T-shaped devices).

Alternatively an accessory that could be used to modify a digital caliper for this purpose.

Useful accessories using Stanley knife blades etc. in holders – miniature guillotine or a balsa stripper for example.

A vacuum forming tool, possibly using one of the easily available rechargeable pumps for camp beds/inflatable toys.

A multi-position clamp/handle for holding small parts for close hand work, painting, finishing etc.

Please don't take this as suggesting we are not interested in articles on other subjects - suggestions for other articles are always welcome.

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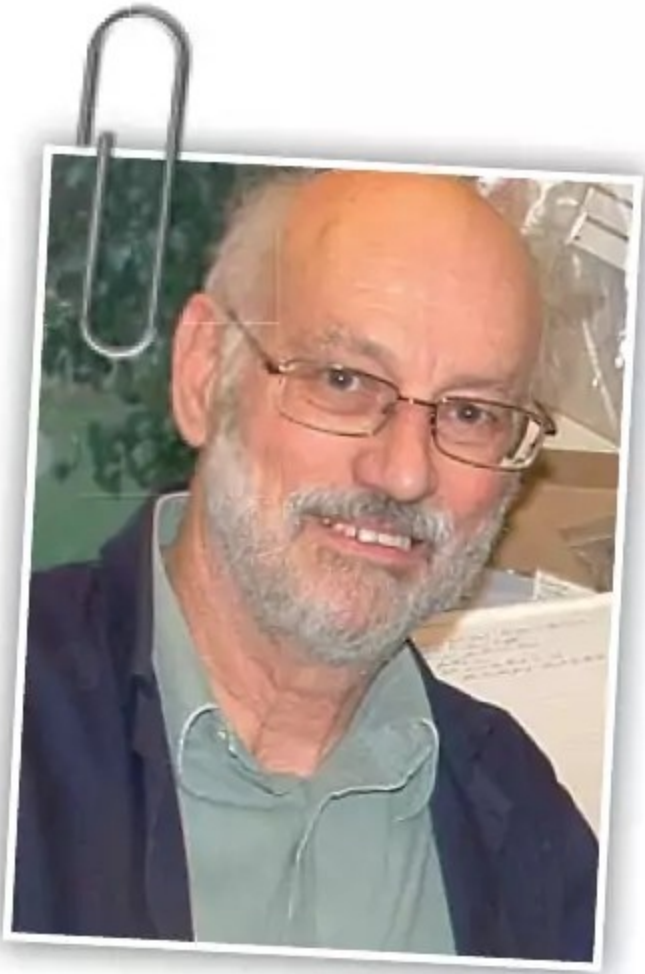
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The BR Standard 2-6-0 Class 4 Tender Engine



This month **Doug Hewson** describes the Rocking Fire Grate and Hopper Ash Pan.

PART 29

This was another thing I picked up from an acquaintance who I met at the Derby Club when we had a joint visit to their track. I took my Y4 and about half a dozen wagons; have wagons, will travel! We had a lovely day there but at the end of the day, it began drizzling. I went to the loco shed to drop my fire and on the adjacent bay there was a chap who was rocking something in the cab of his USA S160. I went across to have a word with him as asked the obvious question, does your engine have a rocking grate in there, to which he answered, yes! He had come from Sheffield Society and told me that his grate has been in there for ten years and it had never caused him a problem. I thought, right I will have some of that. The first job was to make a pattern to have the fire bars lost wax cast. Of course, this pattern needed all the correct draw on it, and it was made exactly the same as that on the full-size engine. I did wonder at the time how to replace the bars, but funnily enough they are still



Photo 279: Ash pan door trunnions.

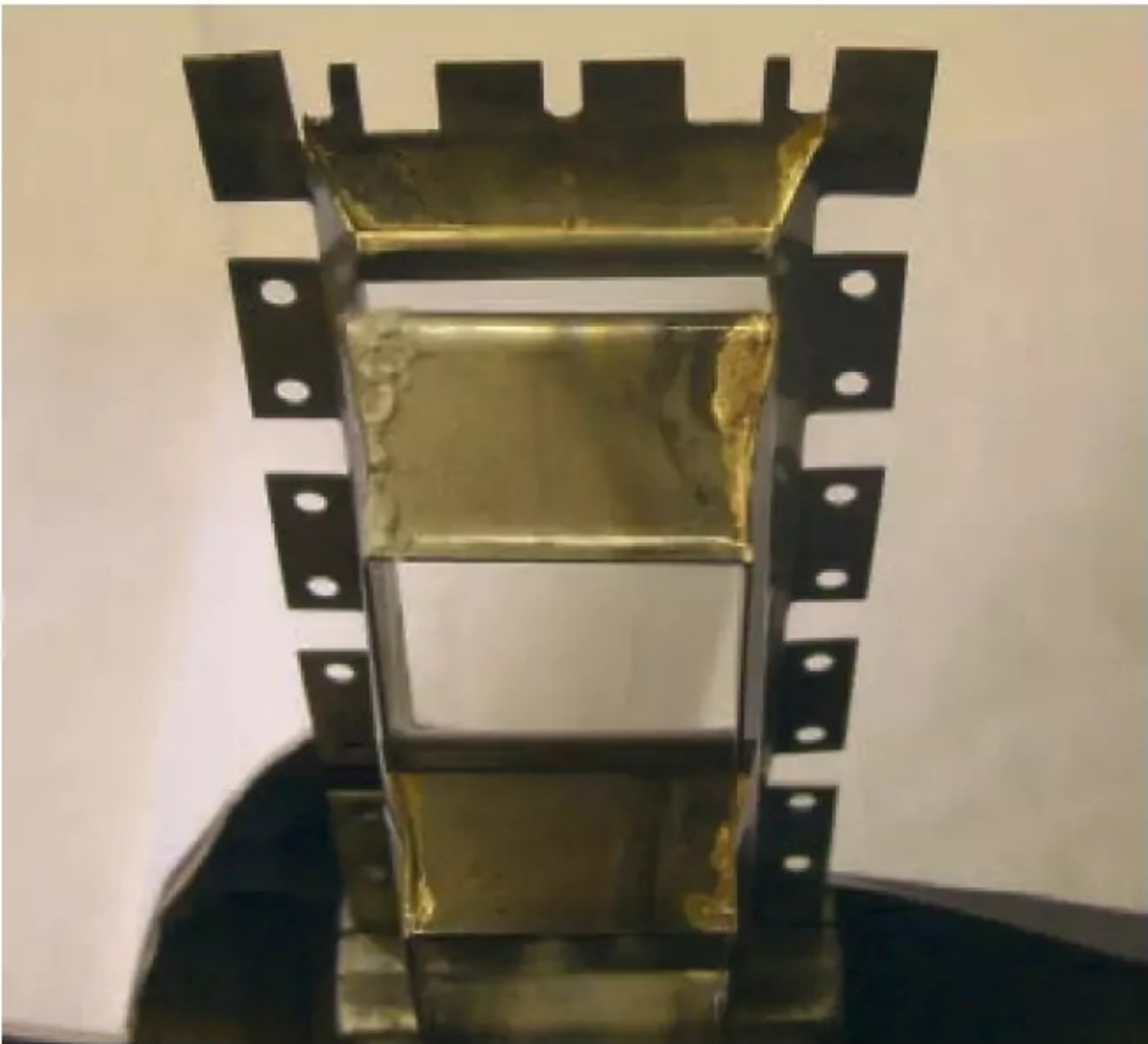


Photo 280: Fabrication of ash pan sides.

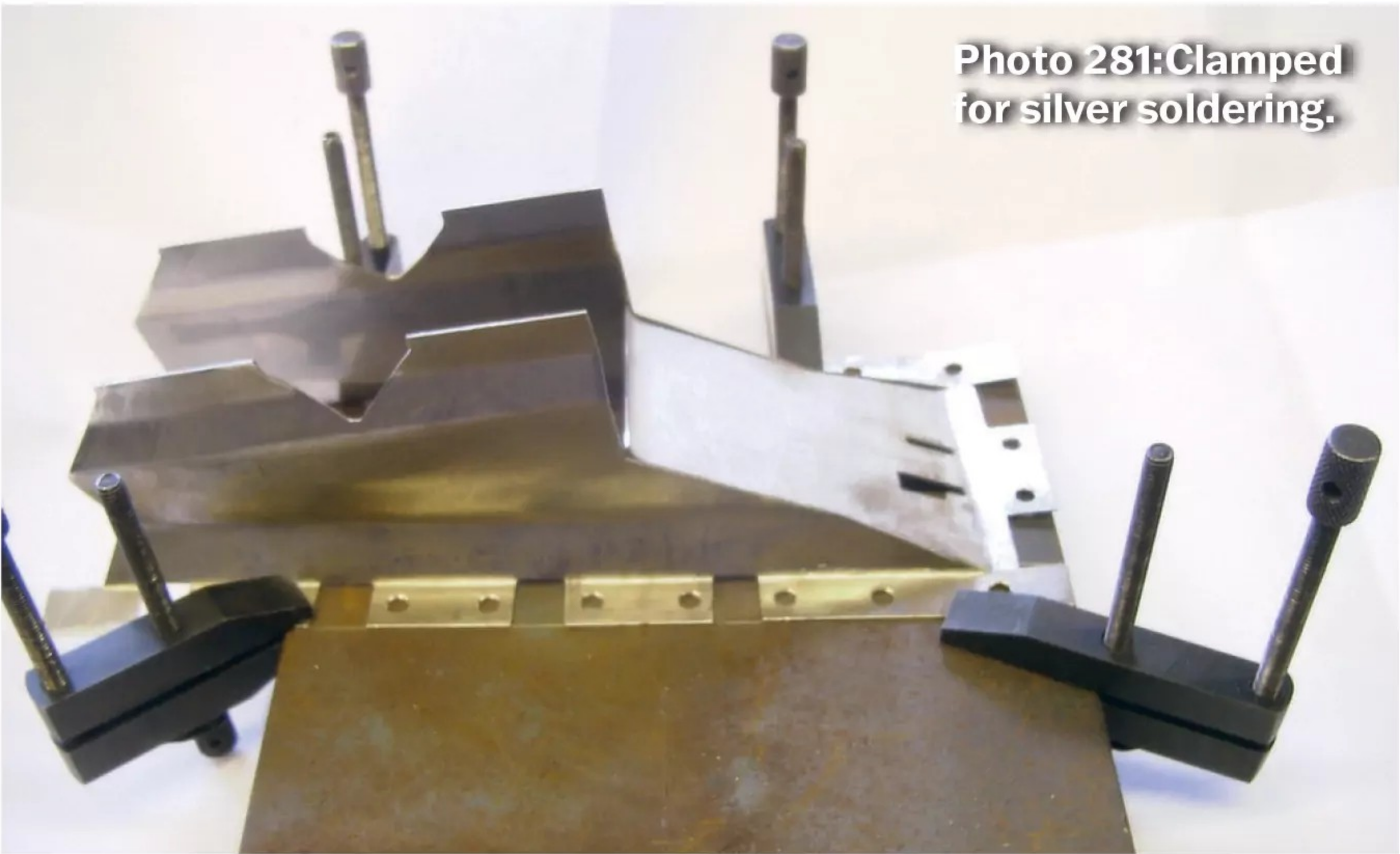
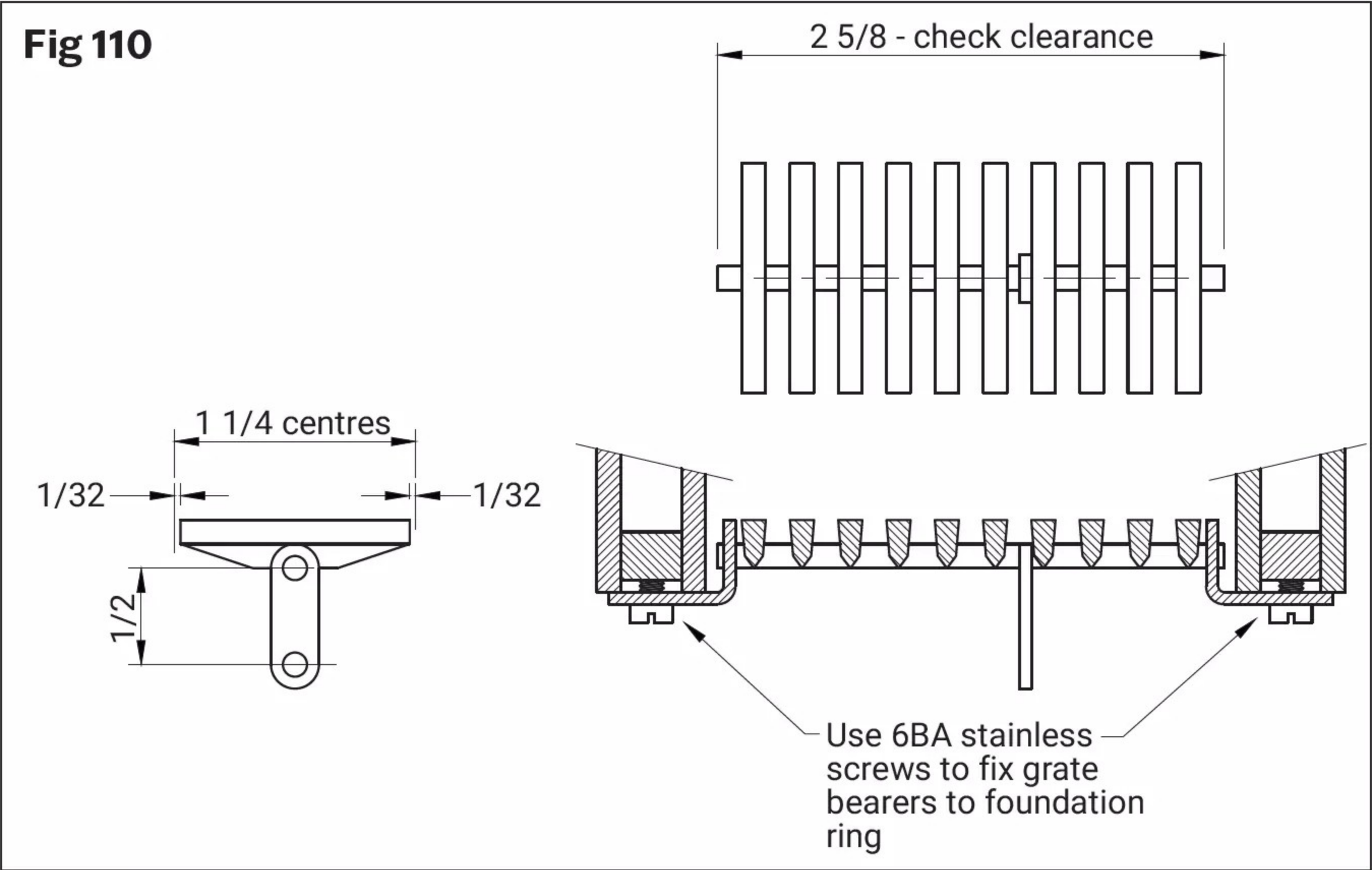


Photo 281: Clamped for silver soldering.

as good as new. I made the whole ash pan out of 18swg stainless steel and it took silver solder very nicely.

The first job was to acquire a piece of 1/4 plate about a foot square to use as a building frame. I had of course, done all the drawings for said fire grate ages ago. I cut all of the plates out with my trusty jig saw and that only took half a day or so. The worst thing was the noise of course. Fortunately, my wife was out teaching at the

time! I soon had the edges filed up. **Photograph 279** shows the trunnions which eventually supported the ash pan doors. **Photograph 280** shows my silver soldering before the ash pan was cleaned up also you will see the staggered gaps along the sides of the ash pan where the cutouts are and these are there to fit the stainless angles in which support the fire bars themselves. Following on from there you will see in **photo 281**, there is my ash



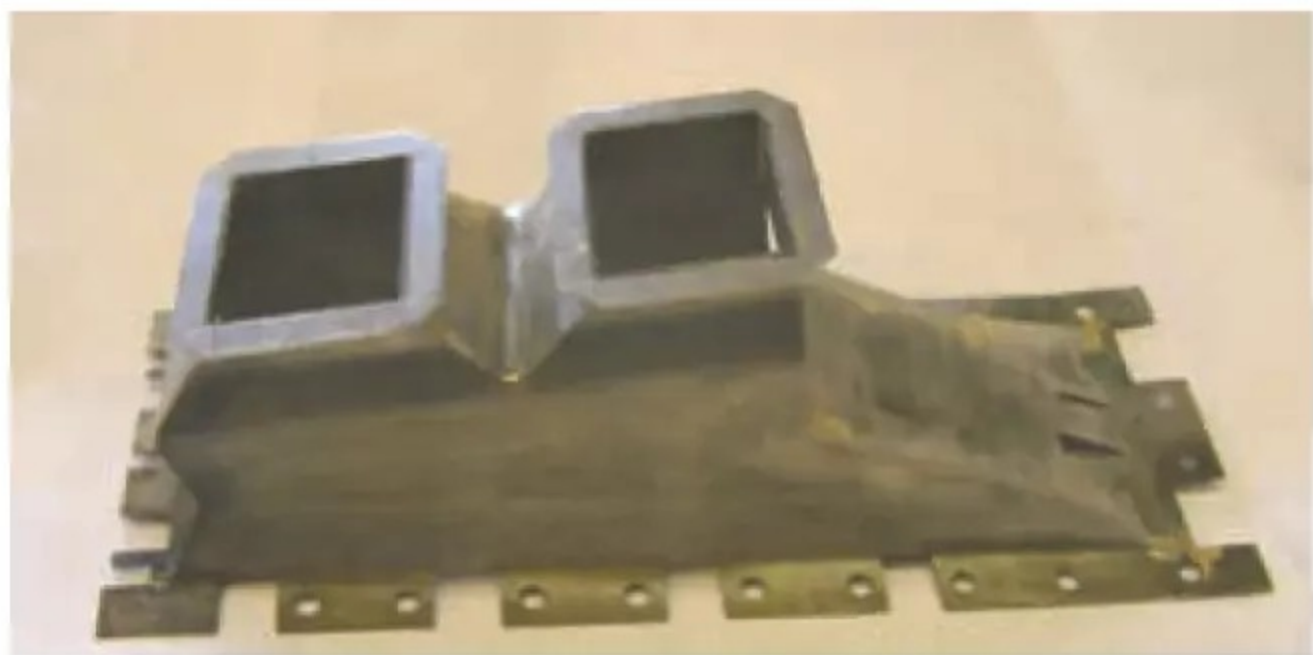
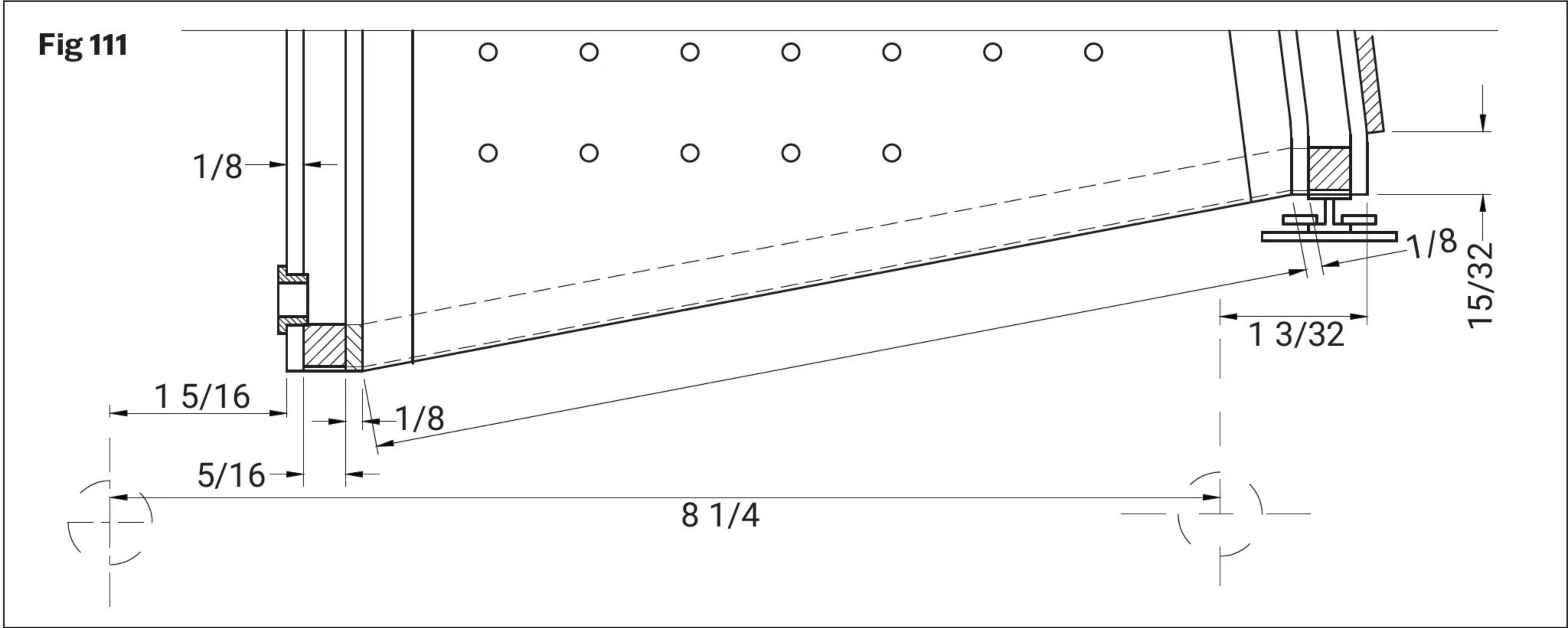


Photo 282: After brazing.

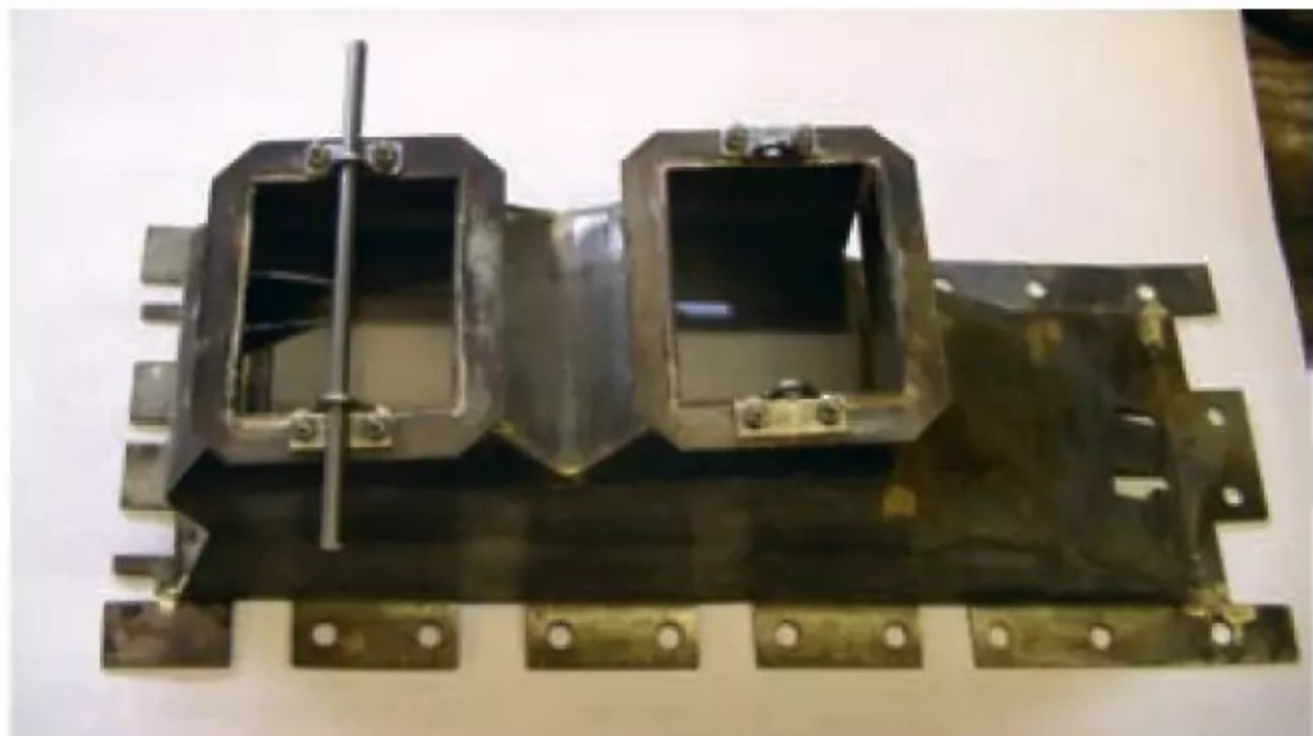


Photo 283: With trunnions fitted.

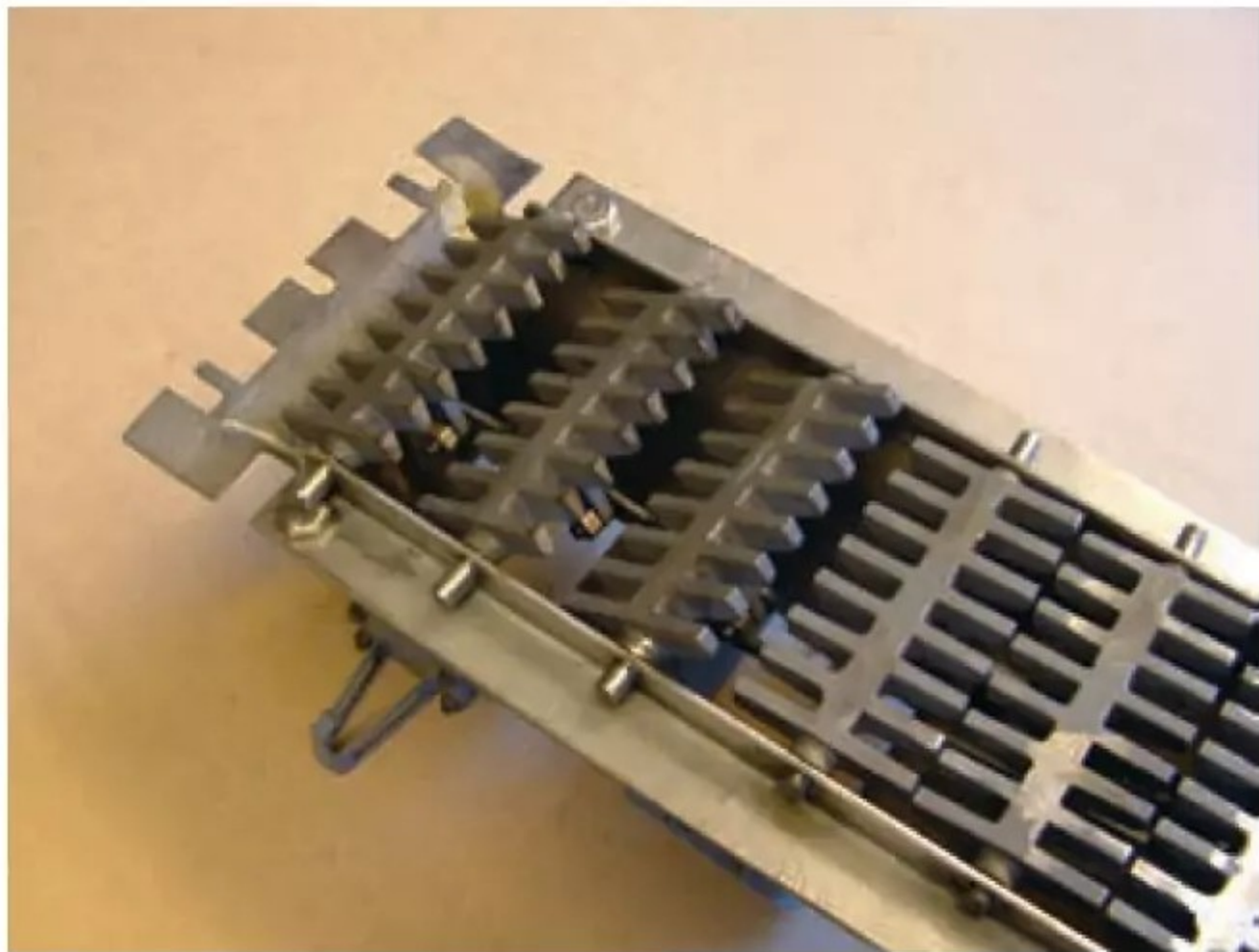


Photo 286: With front section open.

pan with lots of toolmakers clamps on it holding the bits and pieces together whilst I was silver soldering the back end together. **Photograph 282** shows the basics all complete and **photo 283** shows the ash pan trunnions bolted on with a 1/8 rod used to check the alignment.

Photograph 284 is a casting from the patterns which I made for having them cast in stainless steel.

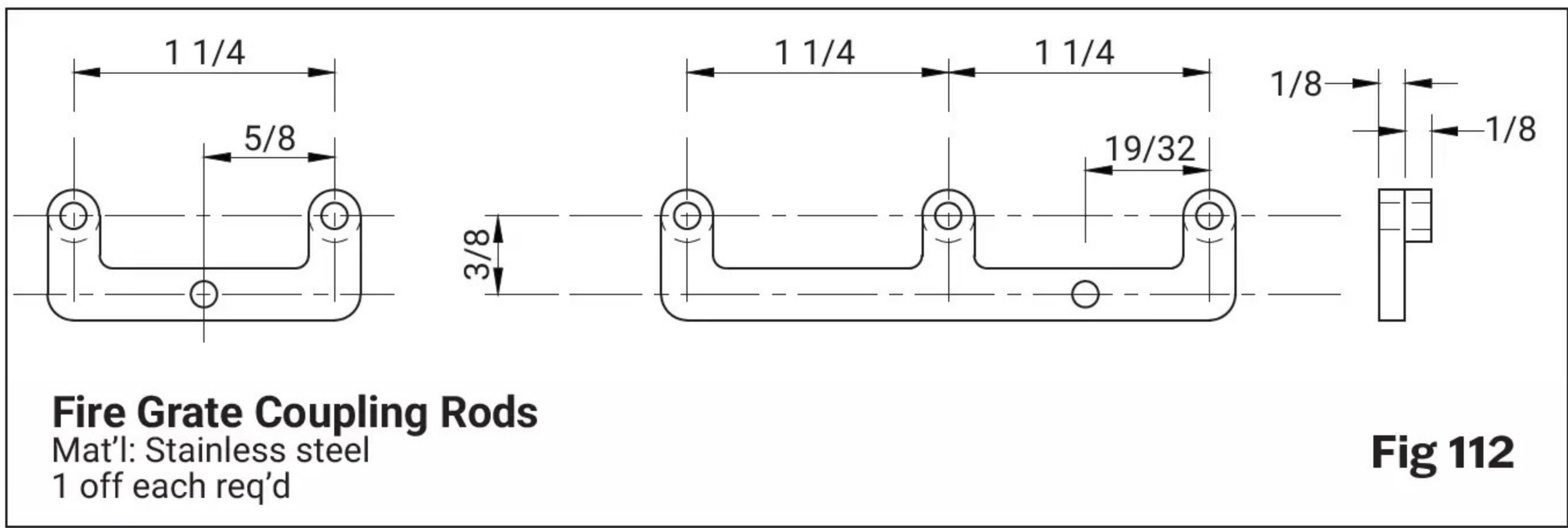


Fig 112



Photo 284: Stainless steel grate casting.



Photo 285: Assembled grate in closed position.

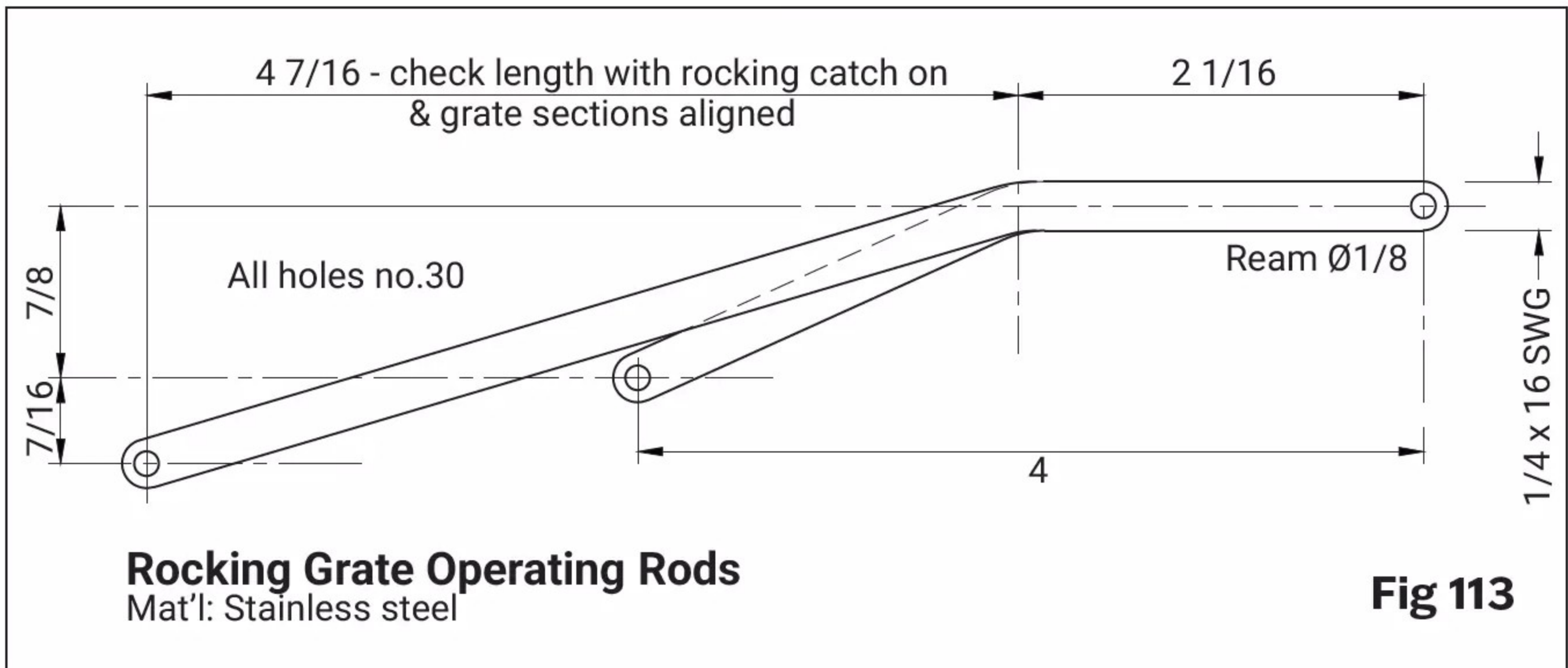


Fig 113

Photograph 285 shows the grate assembled in the ash pan with the six fire bars mounted on a couple of angles which I folded up from stainless steel to carry the grate sections, except in your case there are only five sections plus three separate fire bars

so you may have the buy a small piece of fire bar section from Blackgates. **Photograph 286** shows the three front fire bars on the open position. Now, this brings me to another point. It means that if you are on a long shift, and you need to clear some clinker for

Fig 114

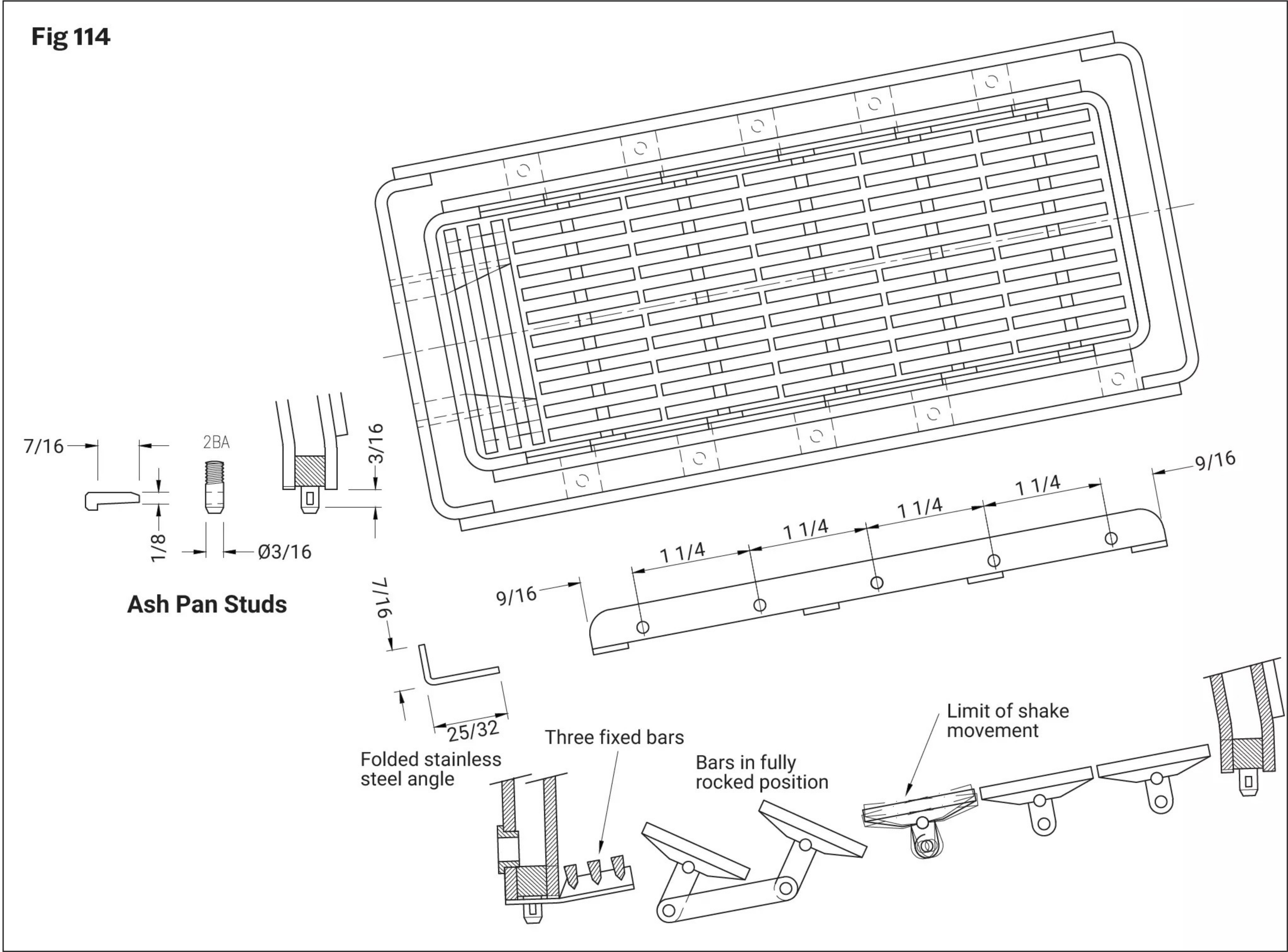
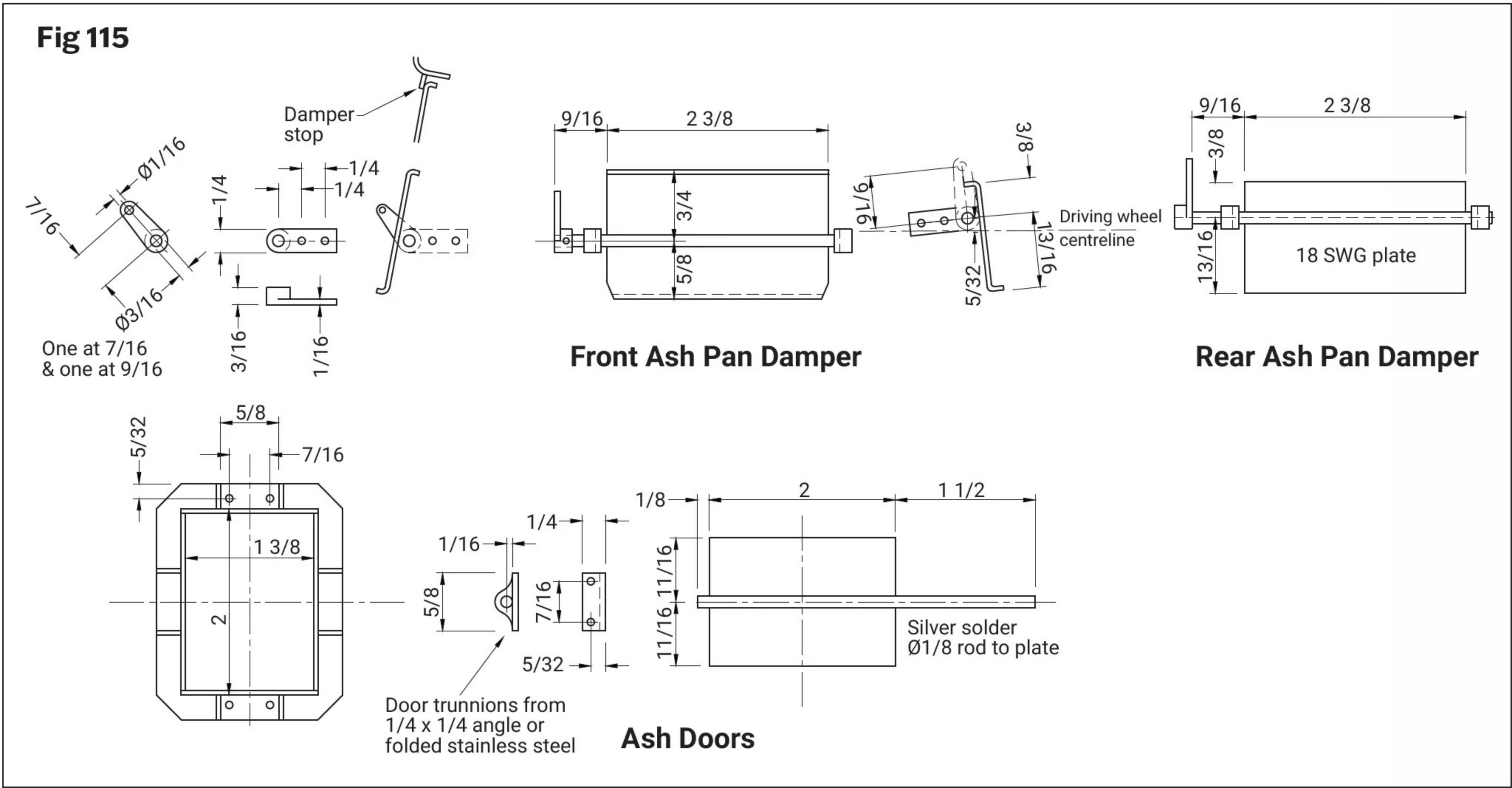


Fig 115



the grate, you can rake all the fire to the rear of the grate, open the front fire bars and drop the clinker into the ash pan, making sure that the doors are

open and then spread the fire out again and rebuild it. The chaps who have my engine in their custody think that is a brilliant feature. **Photograph 287**

shows the rear end of my firebox with the operating links for the fire grate visible and part of other gear there. Now, there is some black gunge oozing

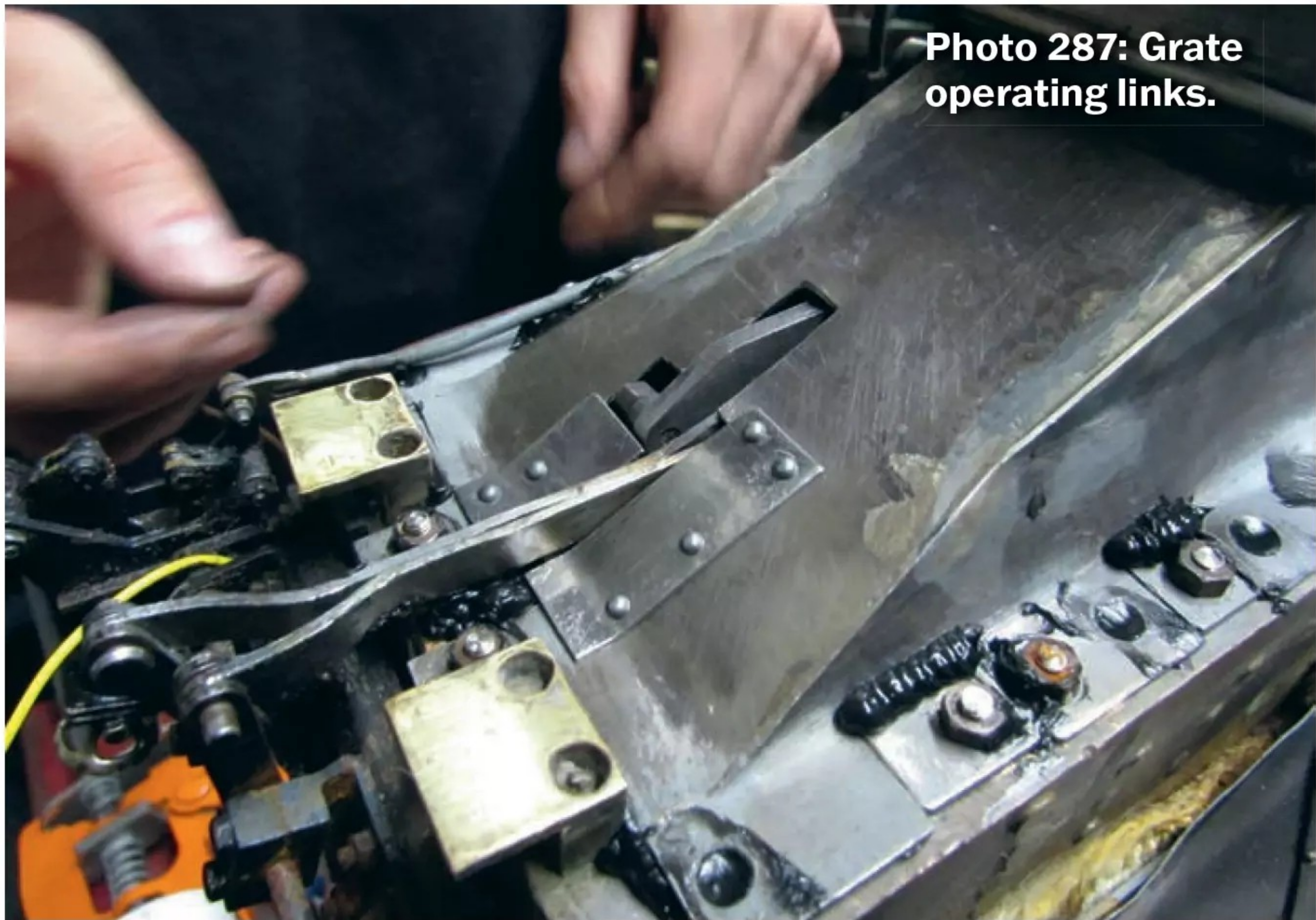


Photo 287: Grate operating links.

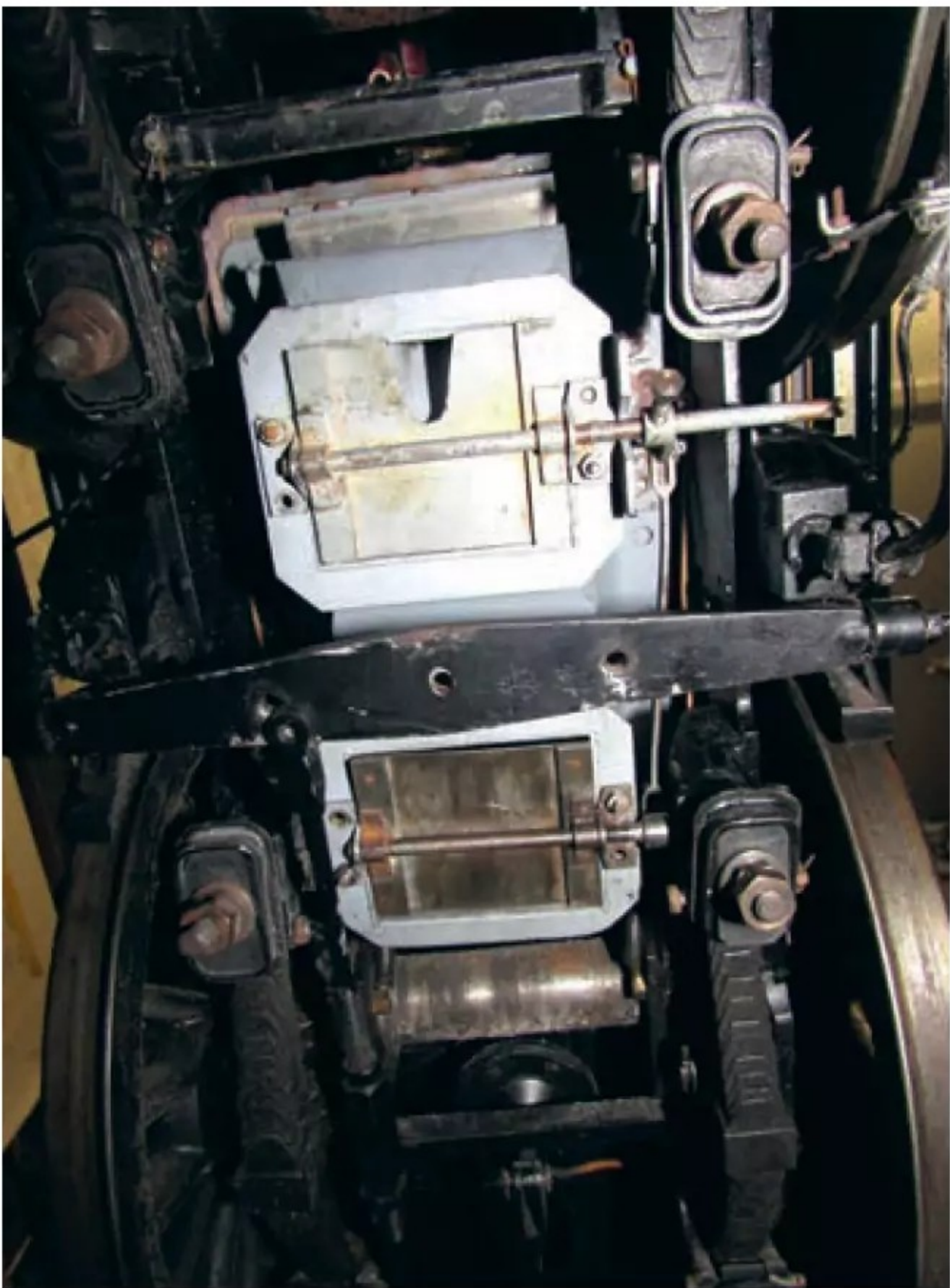


Photo 288: Ashpan doors.

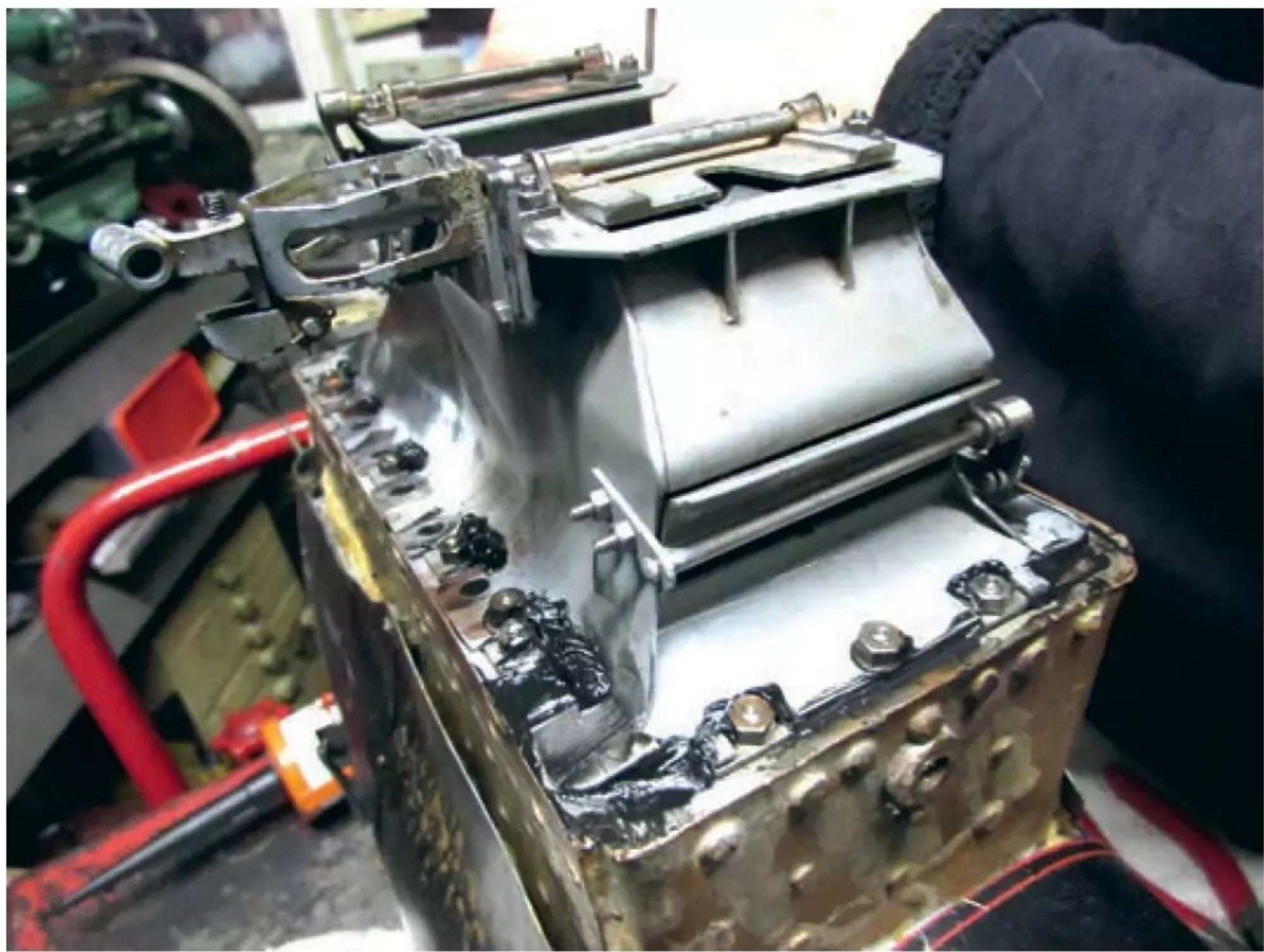


Photo 289: High temperature sealant for the ashpan.

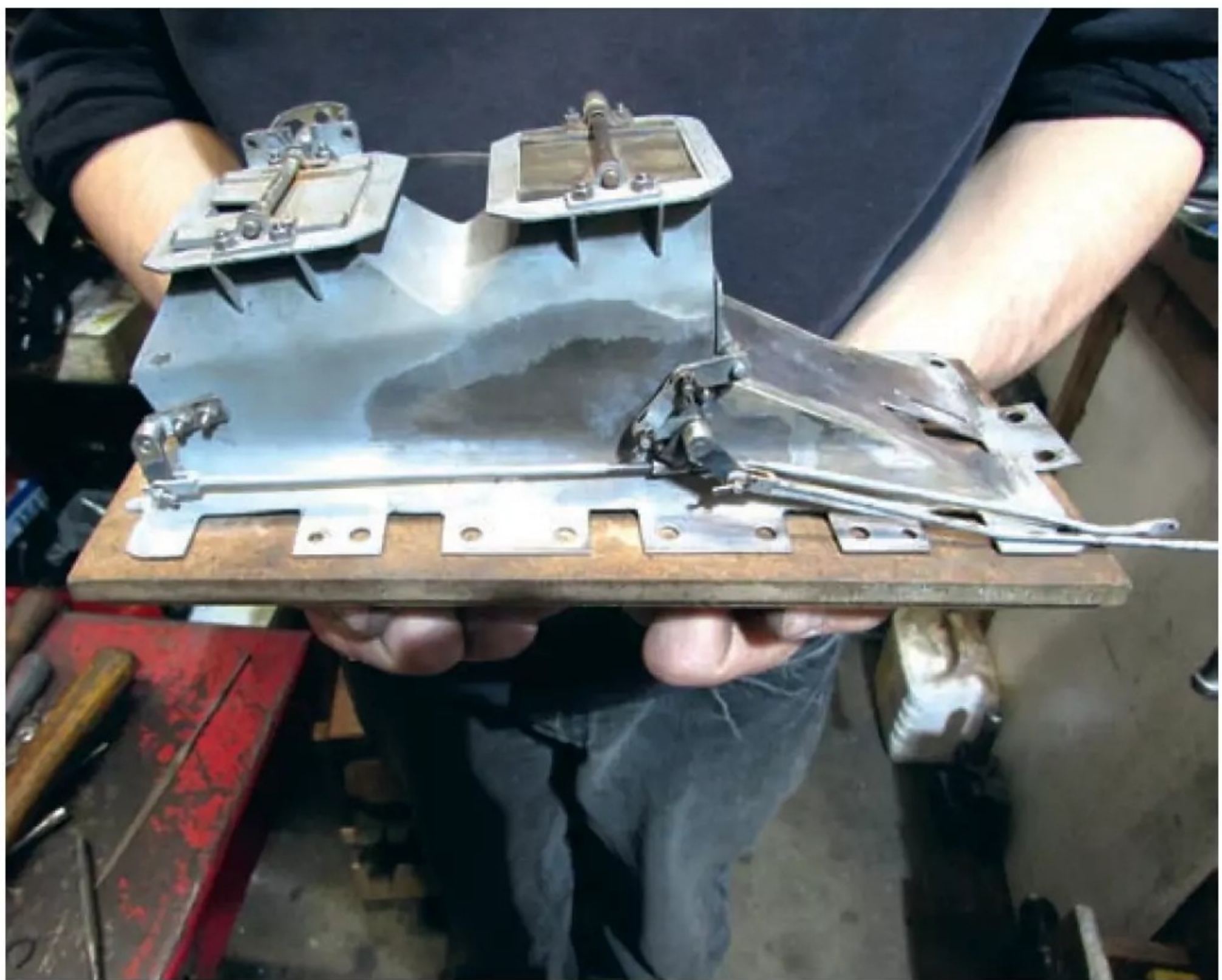


Photo 290: Ashpan showing damper controls.

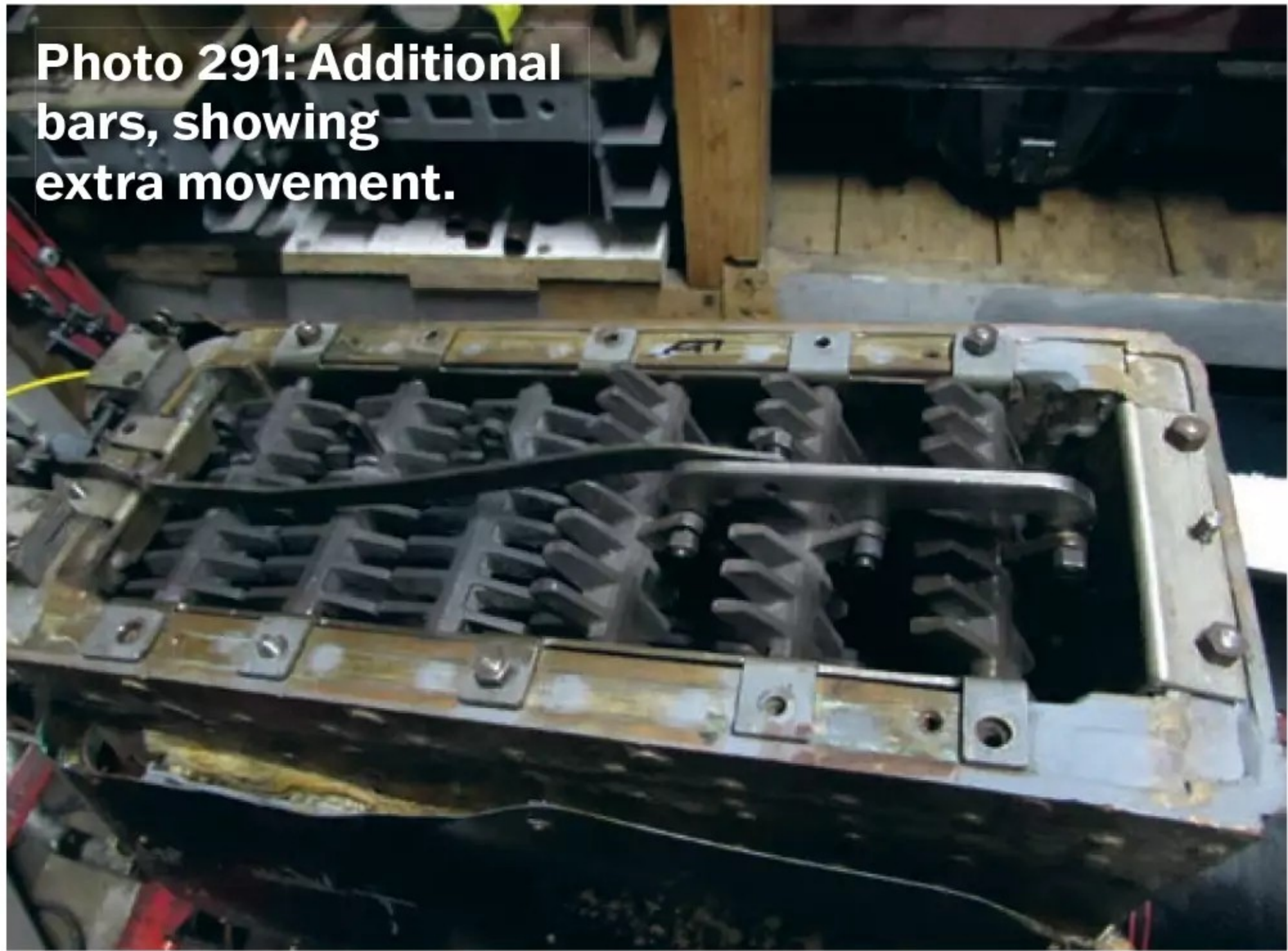


Photo 291: Additional bars, showing extra movement.



Photo 292: Another view of the improved grate operating gear.

from ash pan, and this is due to the fact that the ash pan on my engine has to be sealed as airtight as possible so that it has to be worked using the front

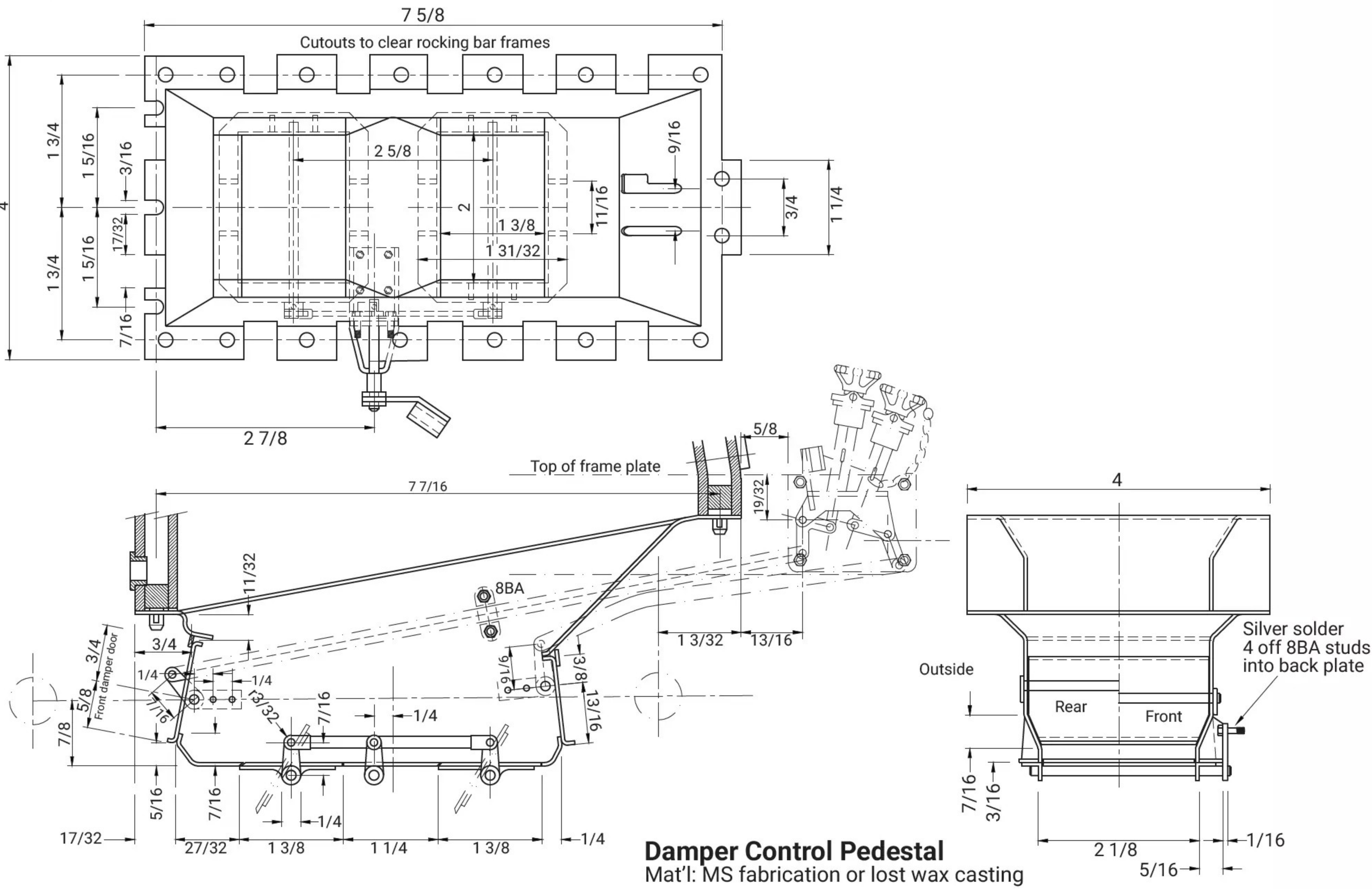
and rear dampers only. For lighting up, the dampers need to be both open and then generally the rear damper should remain closed so

the fire can usually be controlled with only the front damper. **Photograph 288** shows both ashpan doors in place and they too need to be as airtight as

Folded Bracket Screwed To Foundation Ring

Mat'l: Stainless steel

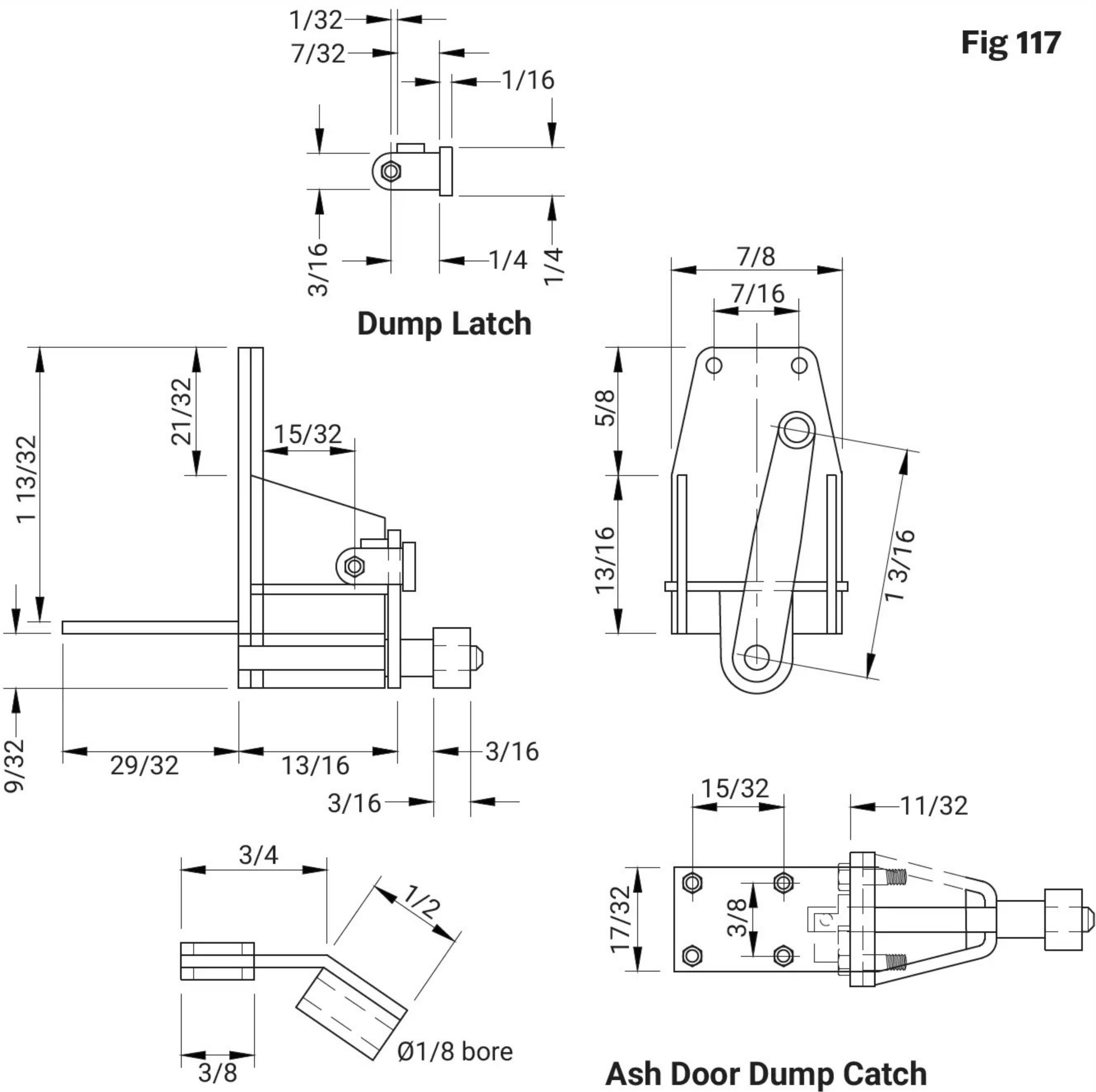
Fig 116



Damper Control Pedestal

Mat'l: MS fabrication or lost wax casting

Fig 117



Dump Latch

Ash Door Dump Catch

possible and **photo 289** shows more gunge being applied before the boiler is re-mounted on the engine and here you can also see the rear damper. **Photograph 290** shows Joe holding up my ashpan to show all the controls for operating the front and rear dampers. One of the problems I had with my engine was the fact that the grate did not have enough clearance to cope with unburnt anthracite beans. A problem at one of the railways I visited was they only had the beans, but my engines were made for Peas. The problem was addressed by Eddie and Joe addressed this problem by adding two additional bars into the operating gear, so I have included the alterations into one of my drawings. **Photographs 291** and **292** show the additional bars. This means that the grate now opens that bit further so a bean should just clear the bars when they are supposed to. Now, I am presently involved in doing a complete re-draw of Don Young's BR Standard Class 2, 2-6-0 as things have now moved on somewhat, so if anyone is interested, in knowing how I am getting along with my drawings, I would be very interested to hear from you. I am on e mail, doug@doughewson.co.uk

To be continued

Club Diary

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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

JUNE

12 Chichester Model Engineers

Public running at Blackberry Lane, Chichester PO19 7FS. 13:00.

13-14 Rugby Model Engineering Society.

Sweet Pea Rally, To be held at Rainsbrook Valley Railway.

14, 28 Bristol SMEE

Public Running day, Ashton.

14 Saint Albans Model Engineering Society

Running sessions at Puffing Field. 1pm start, weather dependent.

14 Guildford Model Engineering Society

Public running days at Stoke Park Railway. Info and times see www.gmes.org.uk.

14, 28 Worthing & District SME

Public running day, Field Place. 1:30-4:30. www.worthingmodelengineers.co.uk.

20 Brighton & Hove SM&LE

Hove Park Railway public open day. www.hovepark.com

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.

28 Stafford Model Engineering Society

Running day at County Showground, Stafford. 10:00-14:00. Further information via www.sdmes.co.uk.

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.

4-5 Guildford Model Engineering Society

Stoke Park Railway Gala 2026. Info and times see www.gmes.org.uk.

4, 18 Brighton & Hove SM&LE

Hove Park Railway public open day. www.hovepark.com

5, 26 Bristol SMEE

Public Running day, Ashton.

8 Saint Albans and District MES.

Puffing Field, depending on weather. Alternate July.

11 Gauge 1 North

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

12 Chichester Model Engineers

Public running at Blackberry Lane, Chichester PO19 7FS. 13:00.

12, 26 Worthing & District SME

Public running day, Field Place. 1:30-4:30. www.worthingmodelengineers.co.uk.

12, 26 Saint Albans Model Engineering Society

Running sessions at Puffing Field. 1pm start, weather dependent.

16 Stafford Model

Engineering Society

Running day at County Showground, Stafford. 10:00-14:00. Further information via www.sdmes.co.uk.

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 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.

19 Guildford Model Engineering Society

Public running days at Stoke Park Railway. Info and times see www.gmes.org.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.

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.

6, 16, 27 Guildford Model Engineering Society

Public running days at Stoke Park Railway. Info and times see www.gmes.org.uk.

9 Chichester Model Engineers

Public running at Blackberry Lane, Chichester PO19 7FS. 13:00.

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.

16, 30 Saint Albans Model Engineering Society

Running sessions at Puffing Field. 1pm start, weather dependent.

23 Stafford Model Engineering Society

Running day at County Showground, Stafford. 10:00-14:00. Further information via www.sdmes.co.uk.

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.

6, 13 Stafford Model Engineering Society

Running day at County Showground, Stafford. 10:00-14:00. Further information via www.sdmes.co.uk.

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 Chichester Model Engineers

Public running at Blackberry Lane, Chichester PO19 7FS. 13:00.

13, 20 Bristol SMEE

Public Running day, Ashton.

13 Saint Albans Model Engineering Society

Running sessions at Puffing Field. 1pm start, weather dependent.

20 Guildford Model Engineering Society

Public running days at Stoke Park Railway. Info and times see www.gmes.org.uk.

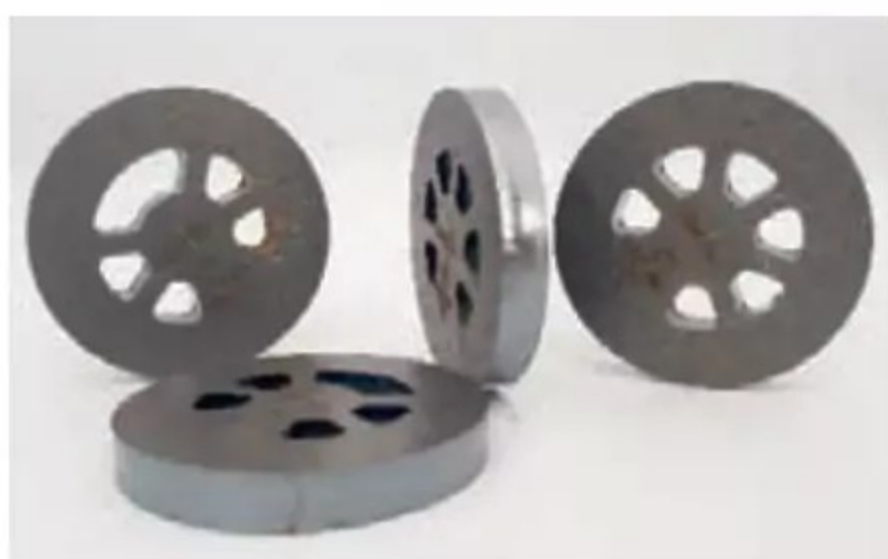


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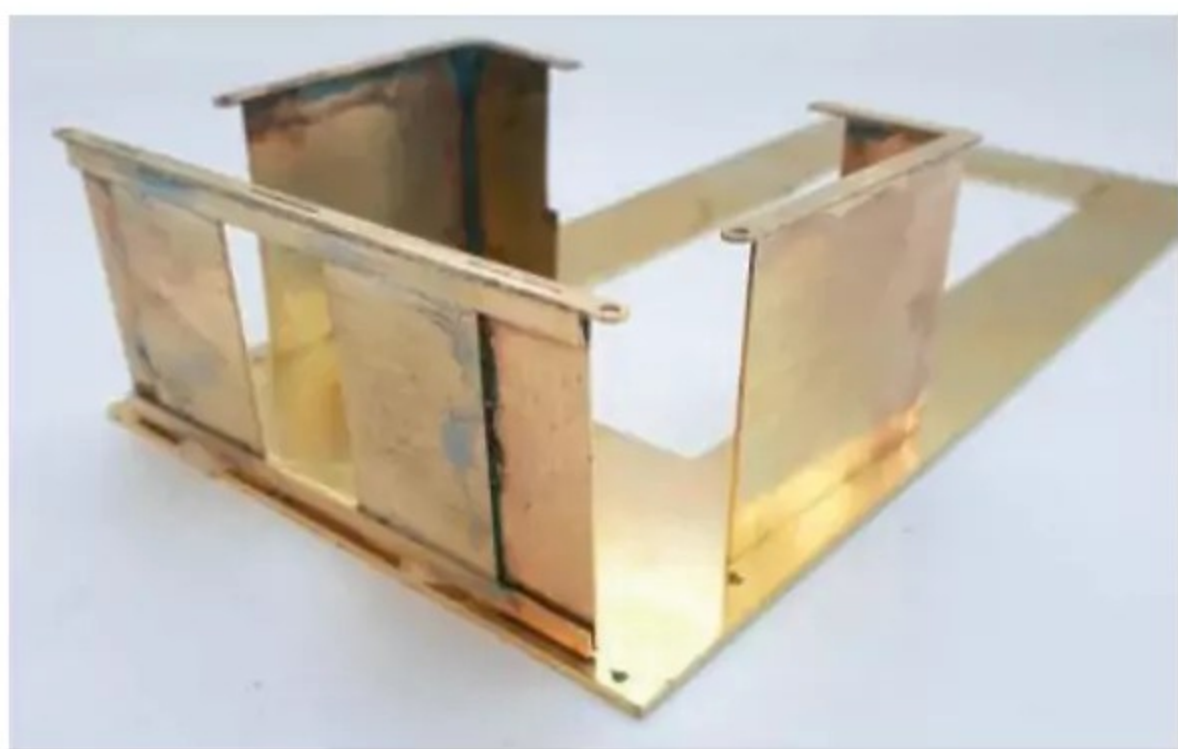
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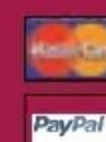


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Illustration created using AI by Becca Cooper - a Camden girl

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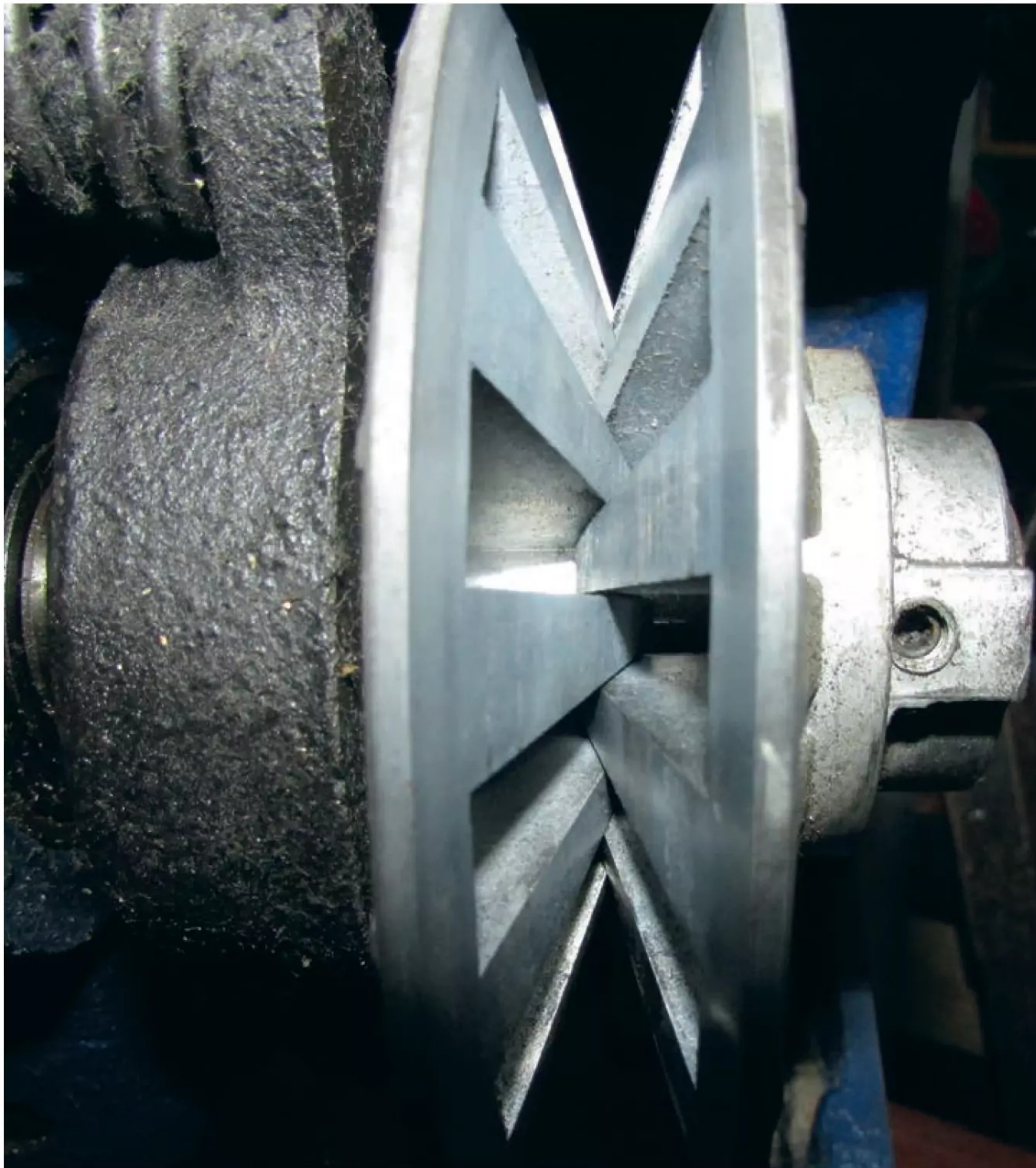


Photo 1: Variable diameter pulley concept

A Mechanical Variable Speed Drive Repair

Eddie Draper (no relation!) repaired and improved the variable speed drive of his Draper wood turning lathe.

A Draper WTL90 wood lathe needed repair. It had lain out of use for an extended period and the variable speed drive was both very stiff to vary and failing to drive at all when set to the higher speed. I had a vague notion that it would be a variable diameter pulley and V belt arrangement that probably just wanted freeing off. Nearly right! Unfortunately, the pulley half that had the weakest

design among the four in the set proved to be suffering from fatigue or intergranular corrosion to the light alloy from which it was cast. It fell apart under manual force when attempting to slide it off its shaft. It would probably have failed very quickly if put into service. Internet searches revealed that spares were available for a Sealey lathe that looked very similar and had the same leading dimensions (o/d and i/d) for



Photo 2: Minimum...

the pulley set, but it claimed 'probable compatibility' with the Draper WTL95, not the WTL90. I have no idea what the difference is, maybe centre height or something. I took the decision to risk the ~£45 and buy a set, the logic being that any mods are likely to be slight and easily effected. No way was I going to spend ages attempting to carve one of these from the solid!

DESIGN CONCEPT.

For anyone not familiar with the concept of a variable speed belt drive, a short summary of its operation follows. The pulleys are arranged with a split around the middle and legs/ribs that can slide between each other. One part is fixed and the other slides. One pulley has a mechanism that controls the sliding half, and its opposite pulley has a spring-loaded sliding half. Good design puts the control pulley on the driven member and the spring-loaded pulley on the driving member, so that the spring load and hence belt friction is greatest when the driving pulley is smallest. It's probably best to provide photos. **Photograph 1** is a pulley minus the belt showing the arrangement. This is the driven (control) pulley, and the thruster is to the left. **Photographs 2 and 3** show the belt position with the pulley set to minimum and maximum diameters. Generally speaking, the speed can only be changed while the drive is rotating, as the belt has to slide up and down the spokes.

Consideration of the photos leads to the realisation that at least one of the pulley halves has no structural support

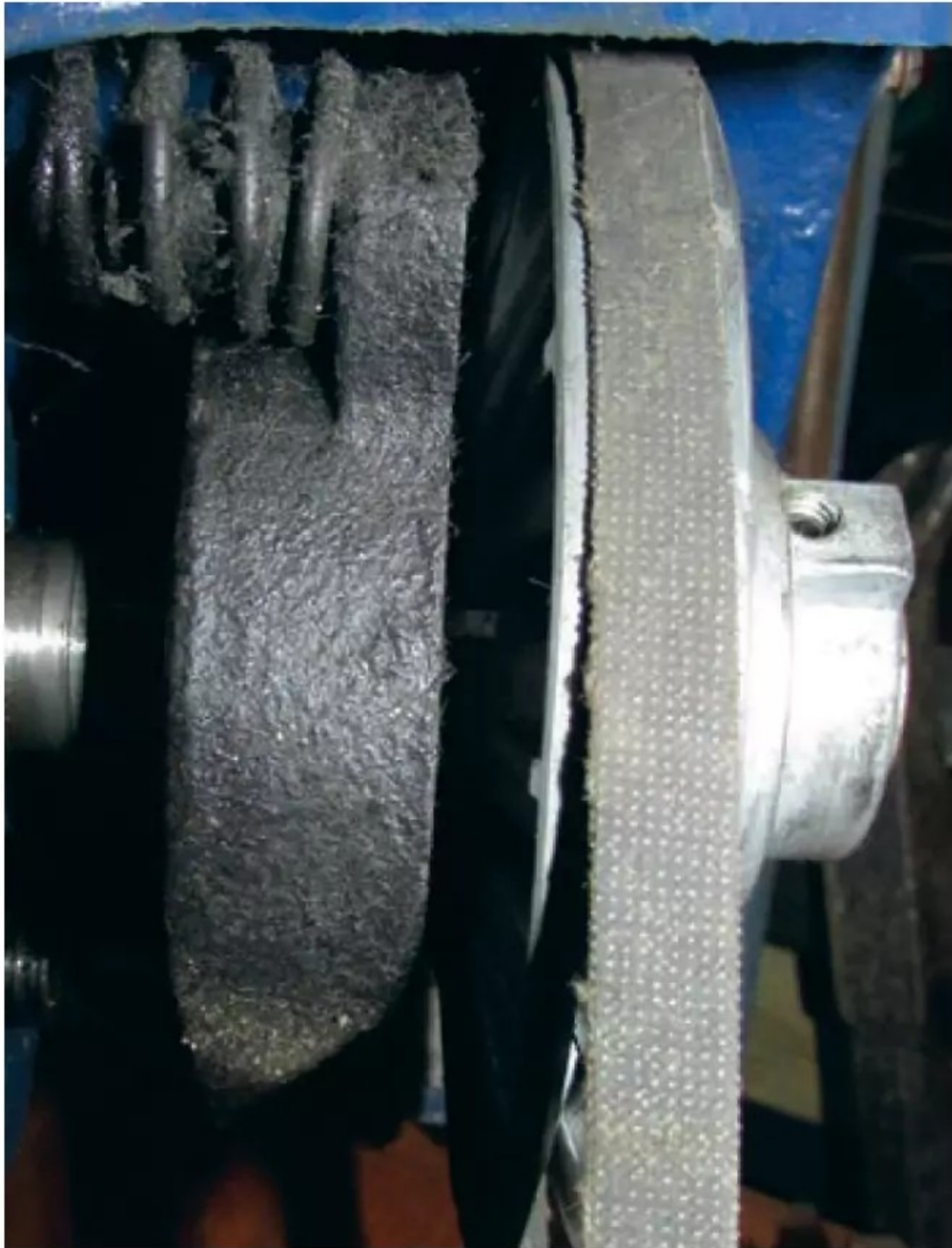


Photo 3: ... and maximum diameter.



Photo 5: Fracture line visible at left, note the hollow centre – no support for spokes.

under the spokes, as the spokes have to pass over either the shaft or the hub of the other half pulley.

STRUCTURAL FAILURE INVESTIGATION.

Here's the damage that had occurred, **photo 4**. This was the fixed half of the motor pulley, and is located inboard of the sliding half.

The pulley half that broke is the one of that pair that is hollow at the centre, i.e. there is no support or bracing under the spokes. The only attachment between the centre boss and the spokes is via the thin backplate, which during operation is subjected to considerable cyclic leverage from the belt trying to force one side apart while also imposing the driving torque, see **photo 5** for the fracture line.



Photo 4: All the parts of the broken pulley half.



Photo 6: Comparison of the hub diameters of the failed and surviving hollow half pulleys.

All four pulley halves in the set are different from each other. **Photograph 6** shows the corresponding fixed half pulley on the output shaft of the drive. It will be noted that the boss of the pulley half has a larger diameter than the broken one that is held adjacent, making

the joint to the spokes better able to withstand the leverage from the belt.

REINFORCEMENT:

The replacement motor shaft pulley pair duly arrived, and it was readily



Photo 7: Determining the angle of the spokes by use of the compound slide. The relatively small size of the pulleys may not have been obvious before this picture.

apparent that the broken half was near enough identical to its replacement (apart from the latter being all in one piece!) The other half of the pair had its length extended. This excess could easily have been machined off, but a trial assembly determined that the excess length was only a guide for the coil spring that loads the assembly. In particular, it was confirmed that the spokes meshed into one another satisfactorily. My life philosophy is that if it's broke, don't just fix it, prevent it from breaking



Photo 8: Completed part. Bonding surfaces have been roughened with abrasive to help the bond.

again. Sometimes surprisingly little improvement is needed to effect a major reduction in the incidence of failures. The reason for the failure is poor attachment of the spokes to the hub in the presence of a significant overturning moment generated by the belt forcing them outwards. It was reasoned that strengthening the root area was the way forward, but how to do it? I settled on a bonded-on collar over the hub with a concave conical section that provided support to the spokes at a large radius. The whole was machined up out of a lump of some sort of aluminium alloy that happened to be lying around (almost any material would have sufficed so

long as it substantially stiffens the assembly) and it was secured in place with a high strength two-pack epoxy adhesive. You can see the method by which I determined the angle of the face of the spokes in **photo 7**, just by adjusting the angle of the compound slide for zero deflection on the DTI, and the finished machined part in **photo 8**, bonded to the pulley half in **photo 9** and assembled to the motor in **photo 10**. The angle read off the compound slide was 71 degrees. The only critical dimensions are the bore of the centre hole and the angle of the dish. I would strongly recommend a mod similar to this even if this pulley half hasn't already broken, should an owner have other cause to dismantle. For those who have a broken one, full compatibility with the advertised Sealey item is confirmed. I leave it to others to determine compatibility of the driven pair. 🌀



Photo 9: Reinforcing collar bonded to the pulley half.

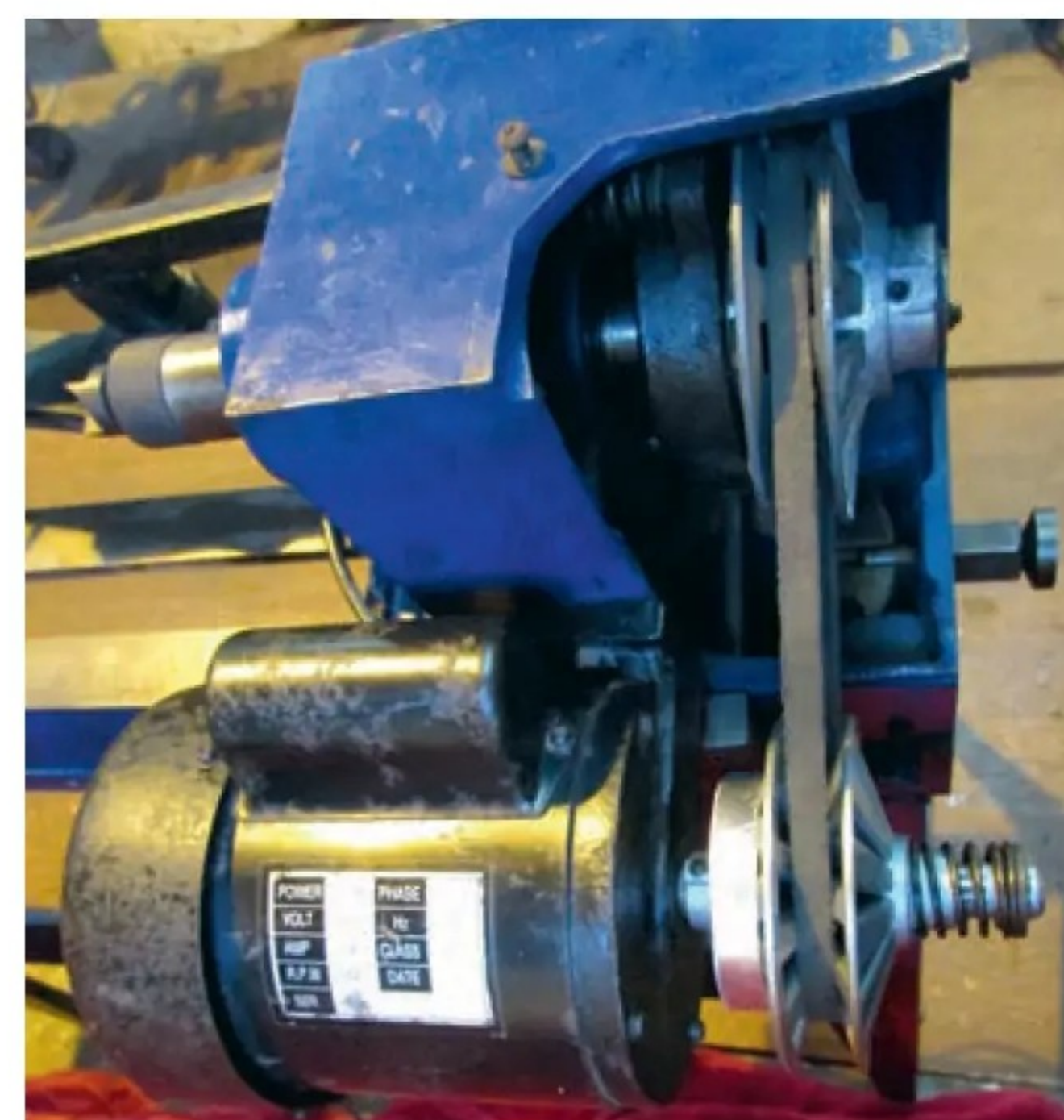


Photo 10: The drive re-assembled.



Club News

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

I am writing this on the 4th of May, and 'I feel the Force', says Sunny Jim. Not the Constabulary, I hasten to add. This gave rise to the thought that each month could be similarly appropriated. So, beginning with next month, *June-know*, (and the Jury is out on this) and you may wonder what that has to do with this *August* publication. At which point I ran out of ideas so apart from the French revolutionaries to have fun with, I am lacking. The refurbished calendar of these idealists had 10 months of 30 days each. Known as 'decades'. The arrangement is an almost exact copy of a calendar used by the ancient Egyptians, who didn't speak French. The day was divided into 10 hours of 100 minutes each, the minutes were further subdivided. Clocks were made to mark this time, but the idea did not catch on, and was abolished by Napoleon I in 1806. In Britain a contemporary wit renamed the months according to names reminiscent of the seven dwarfs, whilst Thomas Carlisle had a more serious view in *The History of the French Revolution* published in 1837. In this issue, Lady Sylvia, a zoo, a patented motor, what do we do with the learned daughter? Otto, scrap, flying a Lancaster, one railway closes and another opens, and Paul Merton. *Raising Steam*, Spring, from the **Steam Apprentice Club**, part of the National Traction Engine Trust, marks the passing of Sylvia Dudley, founder of the SAC and first Chairperson. (The miniature Burrell, *Lady Sylvia* is, of course, named after her) John Darling has written an obituary. Lady S was also involved with the Steam Ploughing Club, and suffered from Parkinson's by her 80th birthday, which makes your Club News editor gulp a little as he was 80 in midsummer and has the same condition. In the archives is a picture of a motor lorry leaving Marshall's works with a large boiler on it. Information on the lorry is requested. It looks to me like a Leyland 'Zoo' from the radiator grille. Harley Plumb, Apprentice of the Year, is pictured helping to clean and prepare Ian Newman's new, half size McLaren road locomotive and is also making his own model in wood. Ivy and Reece Chamberlain have been exploring the locality on *Bill*, their 3-inch gauge Burrell. The current crisis



Photo 1: Industrial locomotive, ICI's Ainsbury.

in the Middle East reminds editor, Jim Huntley, of the Suez crisis in 1956, when, due to a shortage of diesel fuel, steam was the only available power, so, Richard Preston's *Lightning II*, which had been bought for preservation, was put to work in haulage for his family business. She is still owned by the Prestons, and who knows, we may see her in revenue-earning use again soon! www.ntet.co.uk This is the last of the 'interesting' locomotive pictures from cousin David. It shows ICI 0-4-0 Ainsbury, and is dated 1967. no further details known, **photo 1**, (This is an LY&R/LMS Class 21 'Pug', as those of us who have made the Railmaster/Dapol/Airfix kit will recognise - Ed.) *Stephenson Link*, April, from **Chesterfield Model Engineering Society**, Kev Willis opens the proceedings with his completed kit from 'Stirlingkit'. It is a 10th scale model of the power unit used in the Benz Patent-Motorwagen. It runs on liquid fuel and the only concession to modernity is the electronic ignition. John Walker tells a tale of two engines, both designed by Sir John Aspinall, of the Lancashire and Yorkshire Railway, and Mr Walker intends building both in 5-inch gauge, and writing it up for we readers. Bob Bramson's dreams came true on the day when he obtained a driving turn on the RH&D. John also writes on the Malta railway. This opened in 1883 and closed in 1932. Pete Nash updates the Killamarsh situation, and Adrian Lloyd reports on a disastrous noise from his Land Rover whereupon the first, second, third and reverse gears disappeared.

This left 4th only, and he was able to get home by careful abuse of the clutch and fourth. He dealt with the problem by parking the vehicle for the next (mumble, mumble) years, and eventually, as younger daughter had qualified as an engineer, used the situation to his advantage and gave her the aged vehicle. www.cdmes.co.uk Attending an Open Day at South Yorkshire Transport Museum, I took a coffee break, and across the table was a furry beast, that looked like someone's pet toy. I checked this with a nearby lady, who said it was her granddaughter's. When the youngster appeared I learned that its name was Otto, it being an Otter. Parked outside was this immense Scania, Scania, which could have filled the museum on its own, possibly a future inmate of the establishment, **photo 2**.



Photo 2: Scania at the SYTM, a future inmate?



Photo 3: My loco. Photo Deborah Theasby.

SCRAP – Self Contained Rusting Advance Project. After expending countless hours in the garage, constructing a diesel outline railway shunting locomotive, I finally took it to the Sheffield Model Engineers' Abbeydale track for testing. When I began the project, I said I wanted it to haul me round the track at least once, and I would be happy. The first hurdle has been achieved, in that the loco, with batteries in a small trailer, passed! Now to complete the driving trailer, i.e. incorporating a seat and instrumentation, which will be taken round the track again

to achieve Nirvana, **photo 3**. The drawbar revealed itself to be off centre, due to the fact that that my garage track had the 7 ¼ gauge rail on the opposite side to that on the Abbeydale track and I had to hastily make a compensating mounting, using a non-ferrous metal probe, to wit, a 3 mm flat-bladed screwdriver, to create a oppo-skewed (Good word, that...) drawbar in order to give a straight pull. At first, the locomotive cast off the driving chain, and I had to get very serious with its location and alignment, to get it running again. Please note the transverse axle for the front of the

driving trailer. I suspect it may prove to be a difficult task to get right, **photo 4**. At home I have devised a section of raised track, as is customary in the smaller gauges, 5" for the locomotive and 7 ¼" for the trailers, so I can sort it out under artificial conditions, simulating the real track. This enabled me to construct and locate a footrest assembly and find a home for components not fitted elsewhere. I also began a ramp to allow the scooter to go inside the car more easily, as Deborah and I are finding it difficult to lift the beast in and out of the tailgate. I originally considered a hoist, manual or electric, but inspiration on designing and constructing the idea in practice was lacking. I used 50mm channel from Wickes. The length, 5 metres, is such that even my Volvo could not swallow it in one go. The answer, of course, if there are any more such products, is to buy a hacksaw and metal shears, as appropriate, or take them with me, and cut the extrusions down in the car park. The company don't cut material but will deliver. (from 7 am!!) So, I was up at sparrow's cough to receive a shipment of 5 metres of steel. I subsequently established that I need another, but forewarned is forearmed and we could handle it, **photo 5**. **East Somerset Society of Model and Experimental Engineers, Newsletter**, April, relates Roy Proctor's 'flight' in a newly-created 'virtual' Lancaster bomber of the 'Dam Busters' era,



Photo 4: Fiddling with loco. Photo Deborah Theasby.



Photo 5: Scooter ramp preparation.



Photo 6: My Isle of Wight Railway brake van.

www.lancasterflightuk.co.uk. David Hale was asked to build a carriage for the Bala Lake Railway, and he describes this process in an article of good length, essmee.org.uk. *Steam Whistle*, April, from **Sheffield & District Society of Model and Experimental Engineers**, has Editor, Mick Savage, announcing that the Beer Heights Light Railway will not reopen this year. The Severn Beach Miniature Railway would also not

now go ahead, blaming prolonged resistance by South Gloucester planners. However, Clevedon Miniature Railway has been restored by the family who ran it in 1952. and Basildon Miniature Railway has reopened after a process taking six years. Mike Peart relates a grim tale of a man who died after travelling on the on the GWR in an open, though roofed, carriage, despite being very heavily clad for the weather on the day in question,

www.sheffieldmodelengineers.com. **Otago Model Engineers** send their newsletter, *The Sprocket*, its original title of 90 years ago, for this issue only. Editor, James Woods thought he would ask ChatGPT (an AI chatbot, M'lud) what it knew about Otago MES. To this observer 12,000 miles away, it seems a very good response. Mr Woods does not relate his or any other members' reaction, www.omes.org.nz At a recent Sheffield Auction Gallery sale, three unremarkable model steam engines were sold. A Marklin 10mm scale locomotive, of 1910/20, no 281, playworn, with out of scale chimney, and no boiler dome, £80; a prewar stationary steam plant by Mersey Model Company, £50 ; and Capt. Jack Irving's Sunbeam land speed record car of 1926, £70. The original of the latter used two Talbot-Darracq aircraft engines coupled together. It achieved 200 mph in 1928 driven by Henry Segrave. I seem to remember seeing this car at Brooklands MEX a few years ago John Bryant, of **Ottawa Valley Live Steamers and Model Engineers**, wishes to move on the Gauge 1 project. The reasons being, the President wants to leave a legacy, and a ballroom is out of the question. He appends a short paragraph showing the proposed layout and facilities, www.ovlsme.com To mark the 200th anniversary of Matthew Murray's death, the Middleton Railway Trust has arranged a series of three talks at the Middleton Railway in Leeds, to be held in June, July and August this Summer. Admission will be free. middletonrailway.org.uk I recently watched Paul Merton's *Driving Amazing Trains* on Channel 4. He was appreciative of the enthusiasts who make and run these restored trains with such enthusiasm, and displayed very little of his frequently funny and sardonic remarks as on *Have I Got News For You*. Exploring the IoW he encounters the **Isle of Wight Model Engineers'** track at Cowes. As luck would have it, I happen to have a IWR 10-ton guards' van in my collection, **photo 6**. I acquired it with a locomotive from a gentleman, who also offered me a carriage. But, I said, a locomotive towing a solitary brake van looks more convincing than one towing a solitary carriage. My research indicates that the lack of running boards, hand rail placement and no duckets, show that this is a 'Billinton Brake', diagram 81A from the LB&SC railway, and the last one was scrapped in 1947. And finally, my wife says I have the manners of a pig. I made her apologise. Now she says I haven't got the manners of a pig. 🐷

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MISCELLANEOUS

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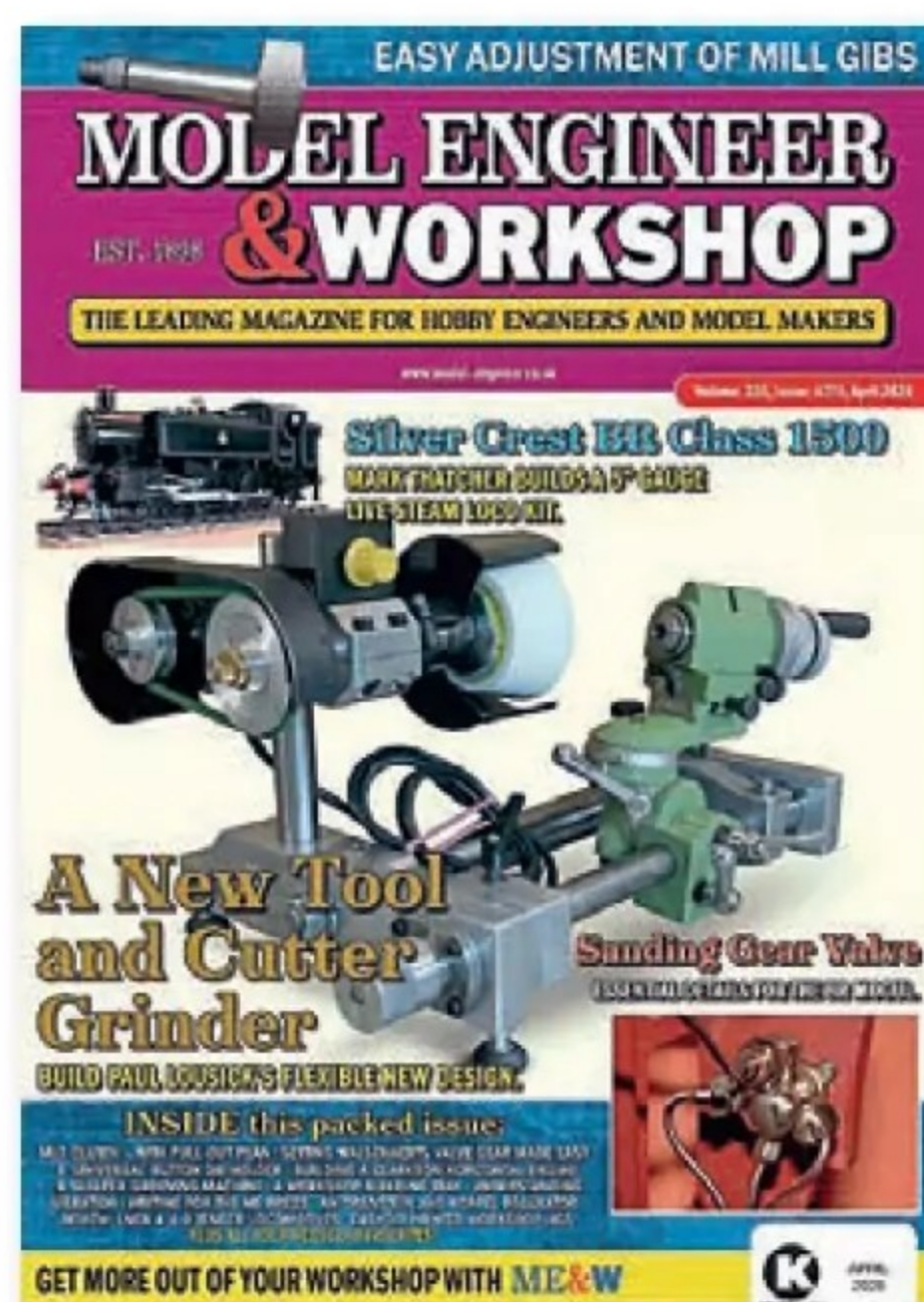
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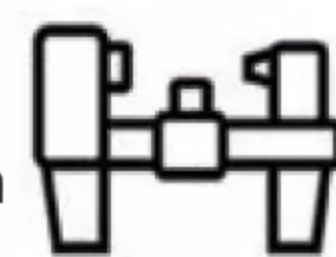
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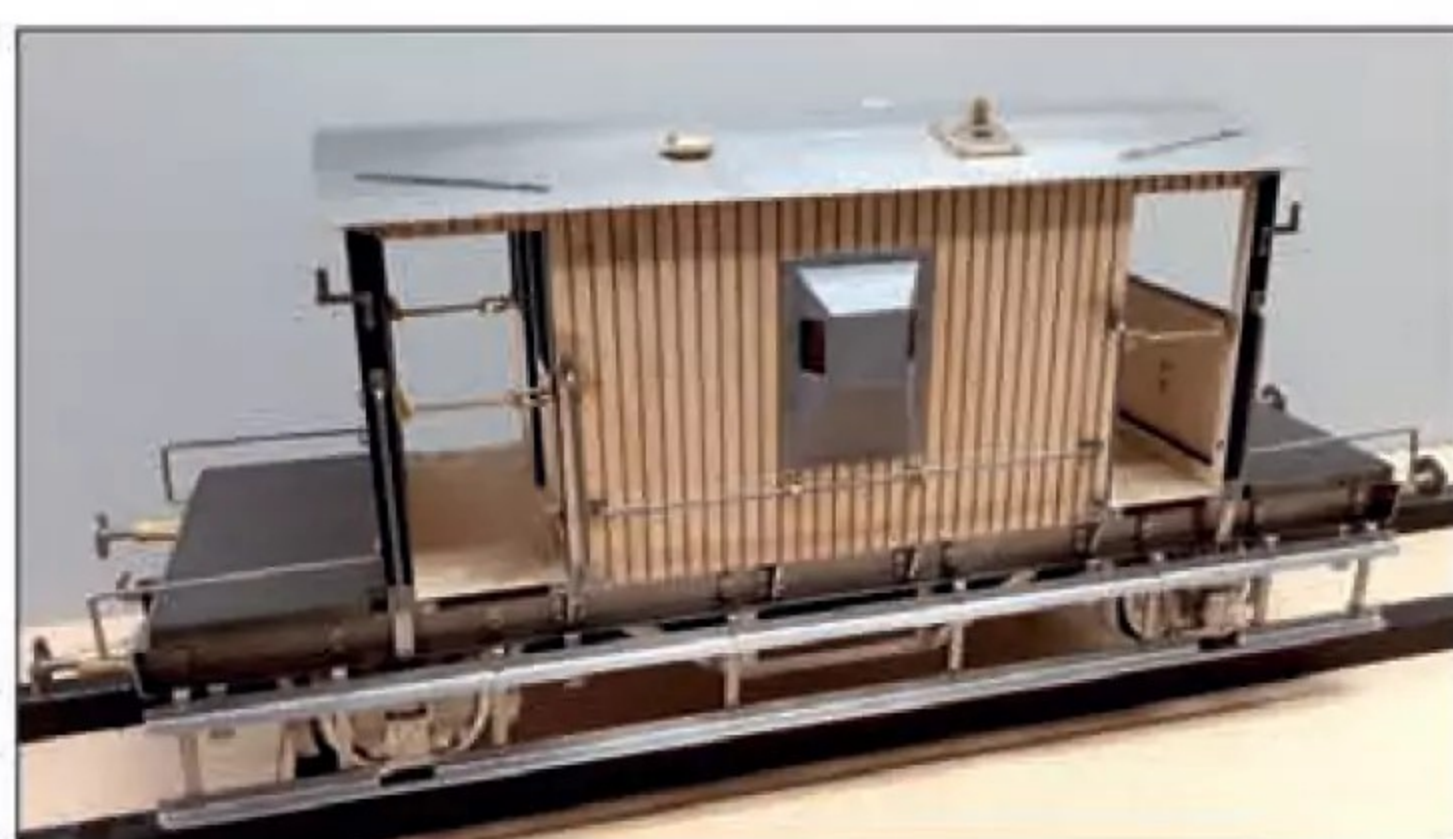
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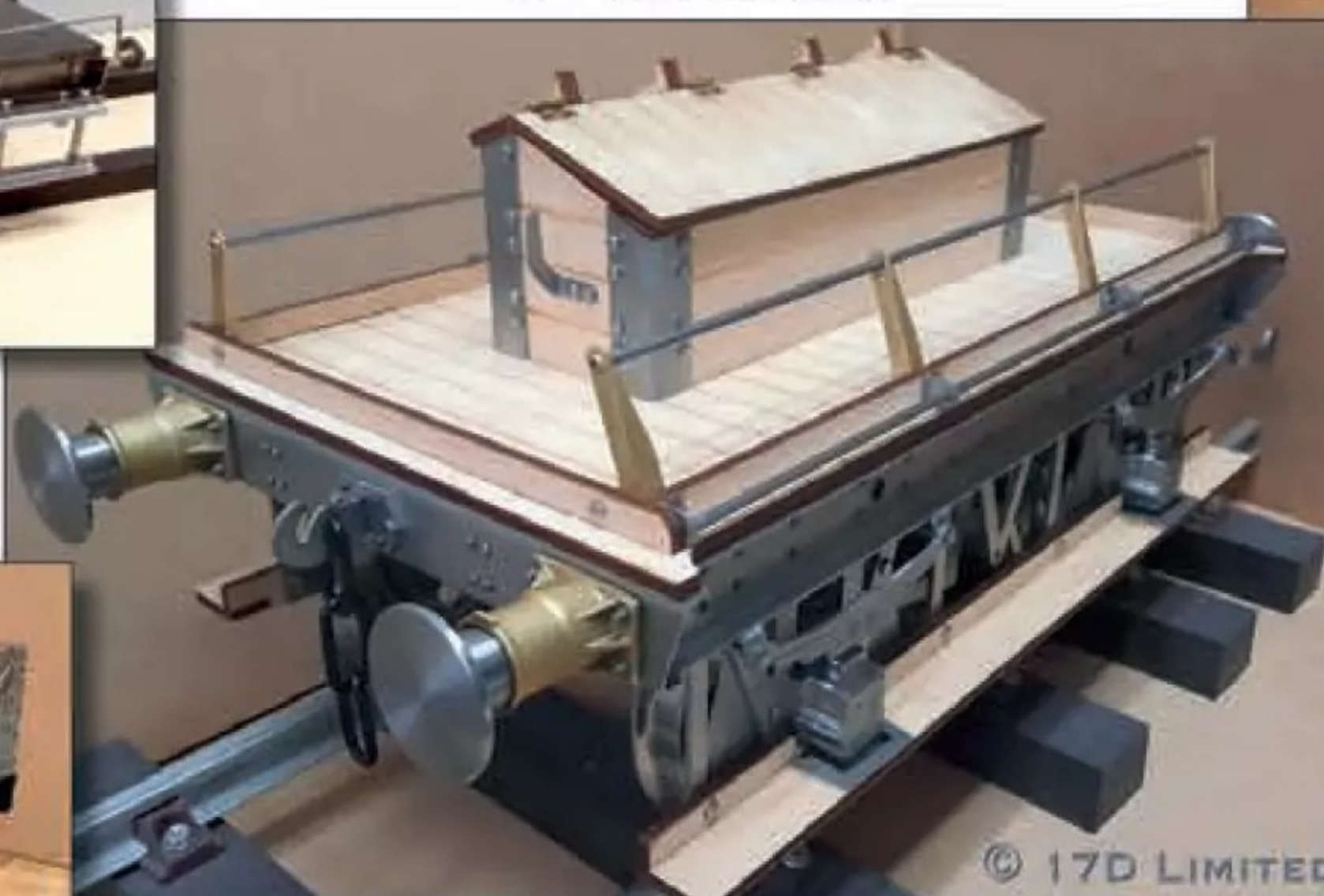


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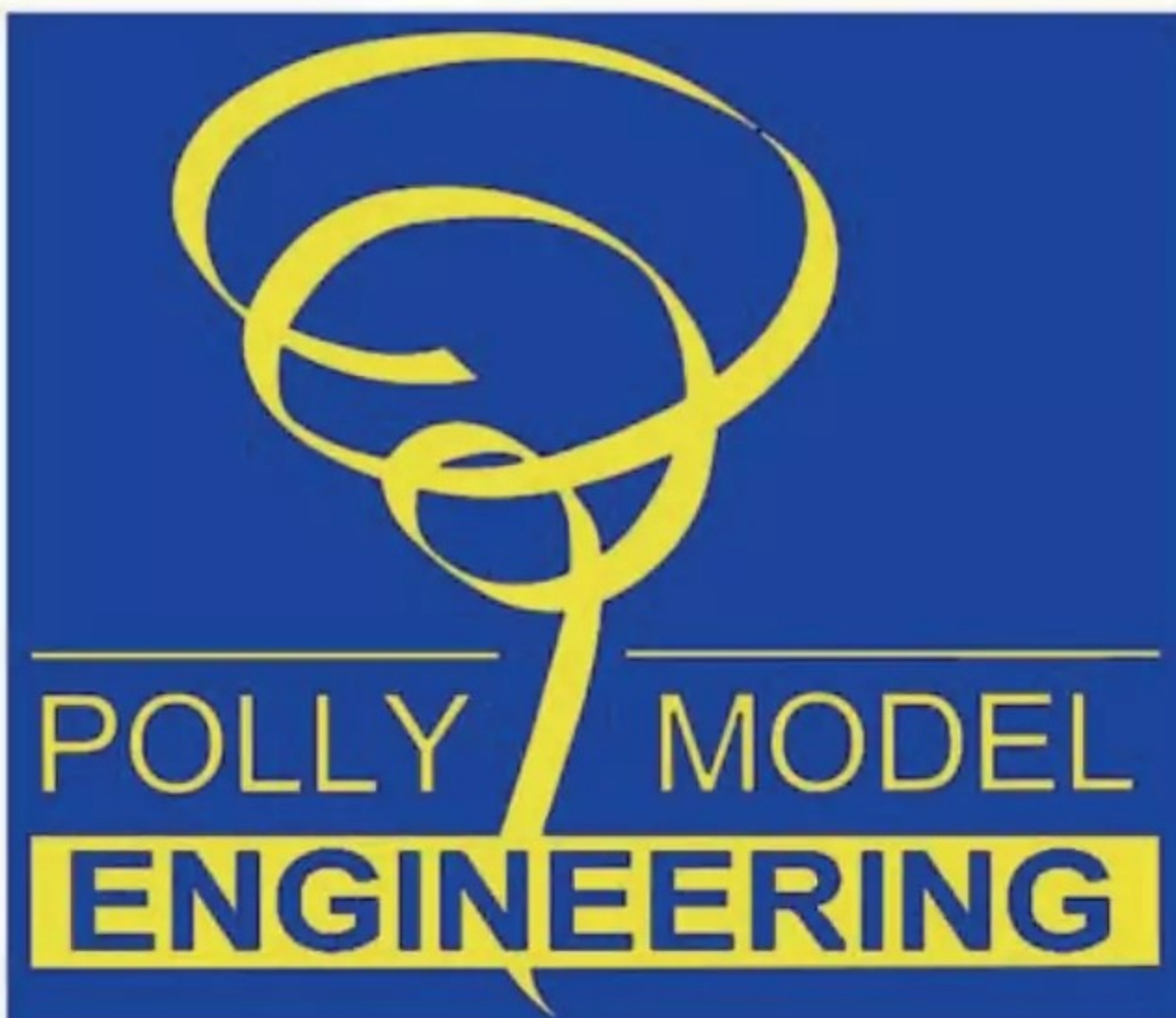
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