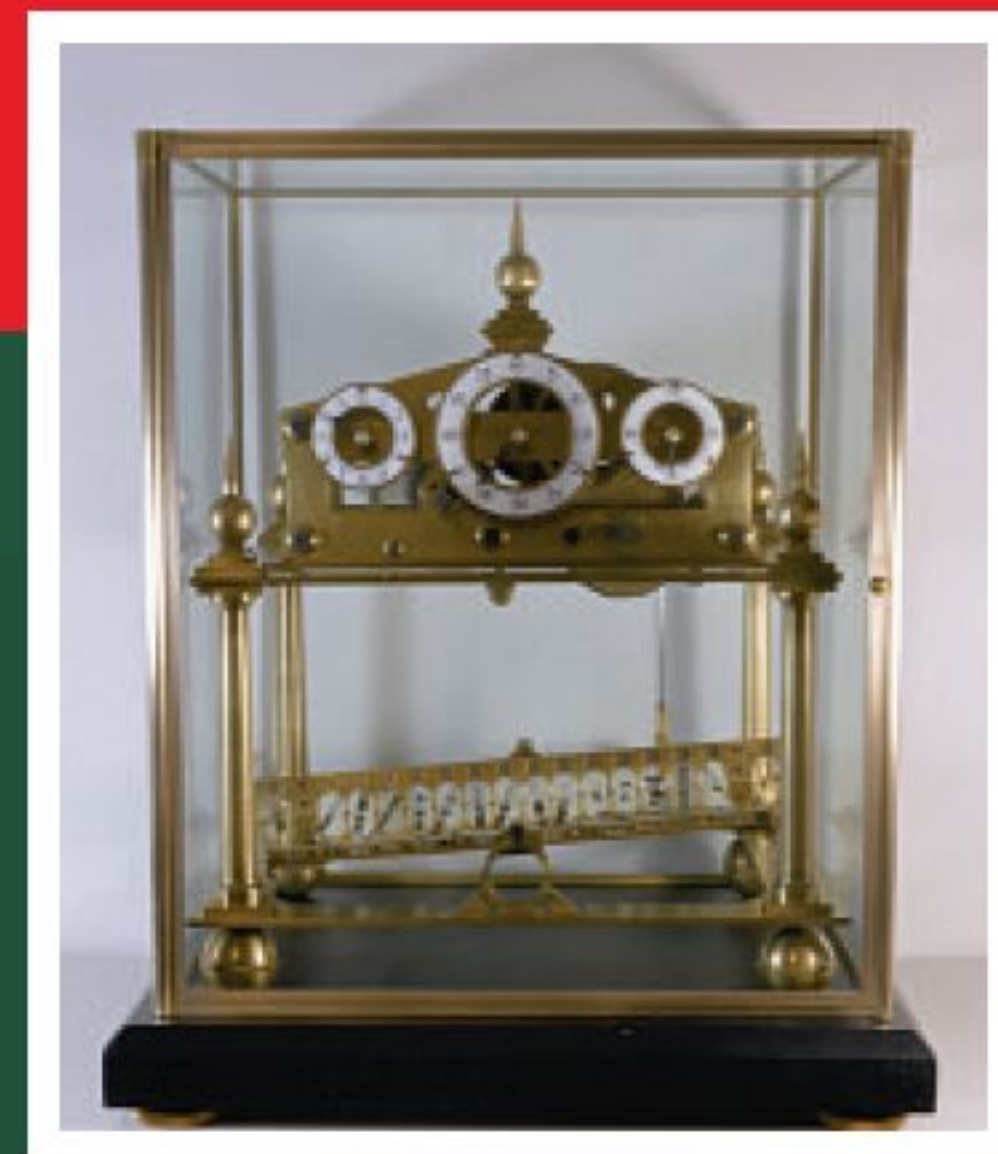


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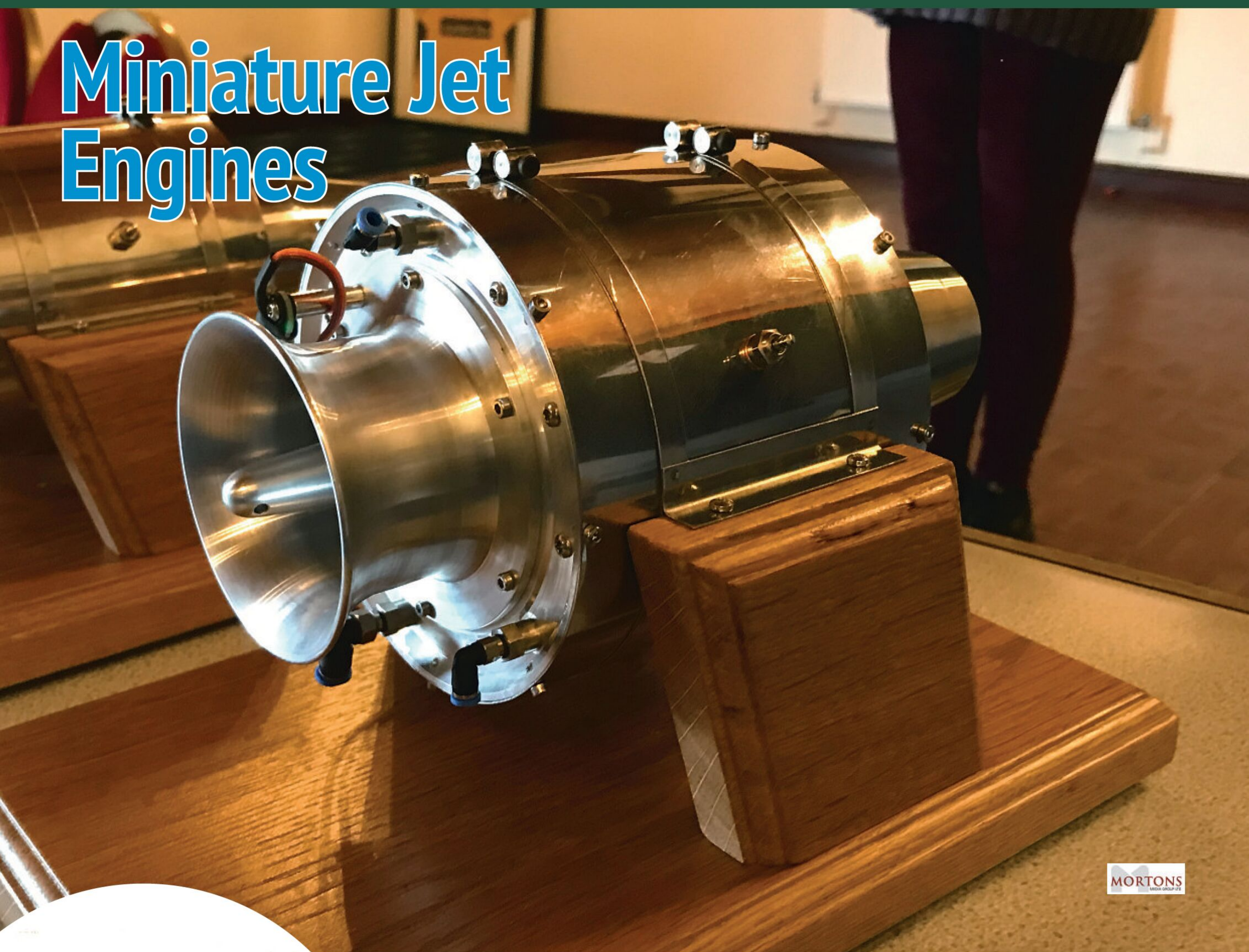


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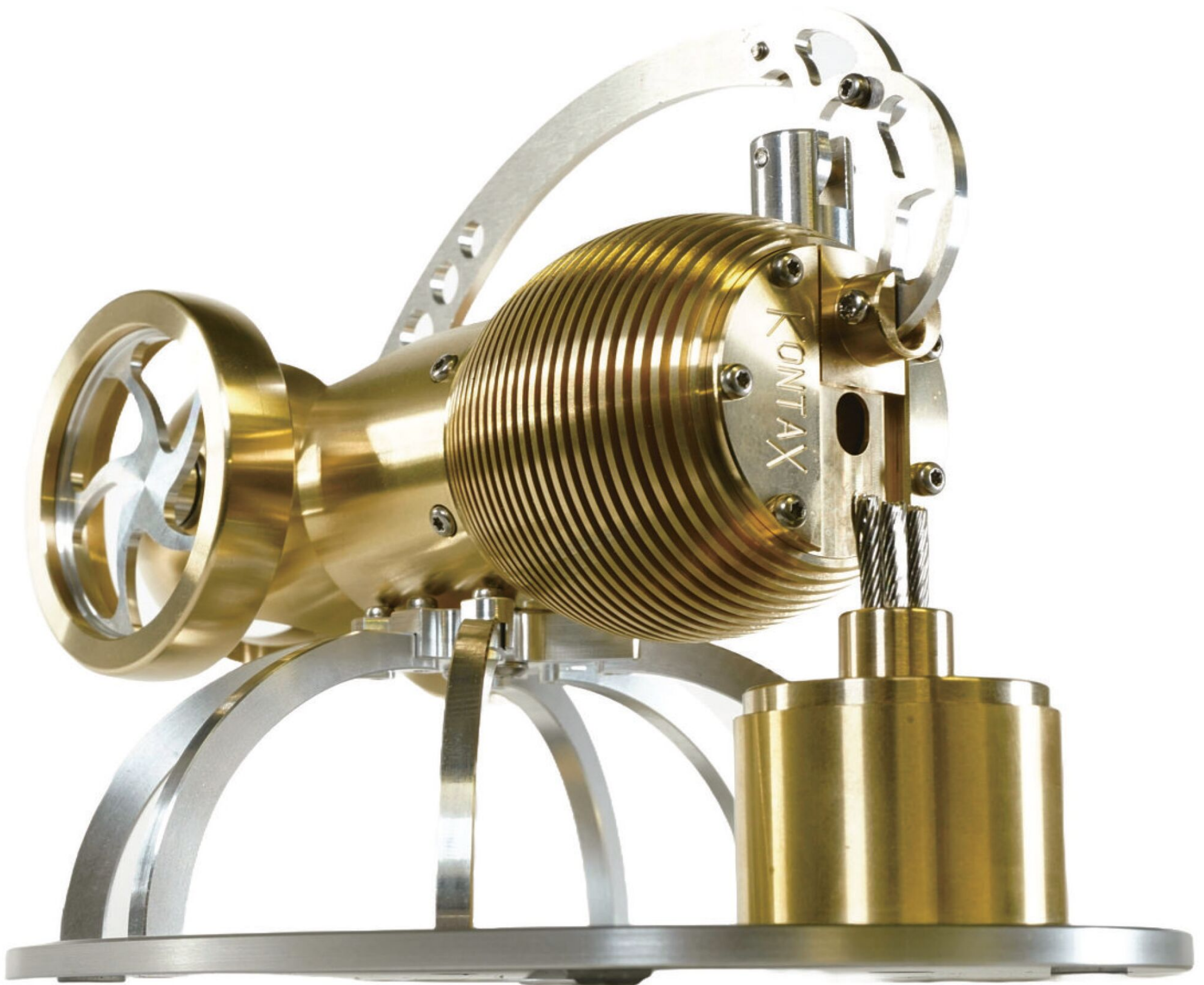


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Editor: Martin R. Evans
MEeditor@mortons.co.uk
Deputy editor: Diane Carney
Designer: Druck Media Pvt. Ltd.
Club News: Geoff Theasby
Illustrator: Grahame Chambers
Publisher: Steve O'Hara

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A: Talk Media, The Granary, Downs Court,
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Investment Manager: Karen Davies
karen@talk-media.uk

PUBLISHING

Sales and distribution manager: Carl Smith
Marketing manager: Charlotte Park
Commercial director: Nigel Hole
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ON THE COVER...

An early miniature working jet engine developed by Jerry Jackman and his team in the 1970s (photo by Tim Coles).

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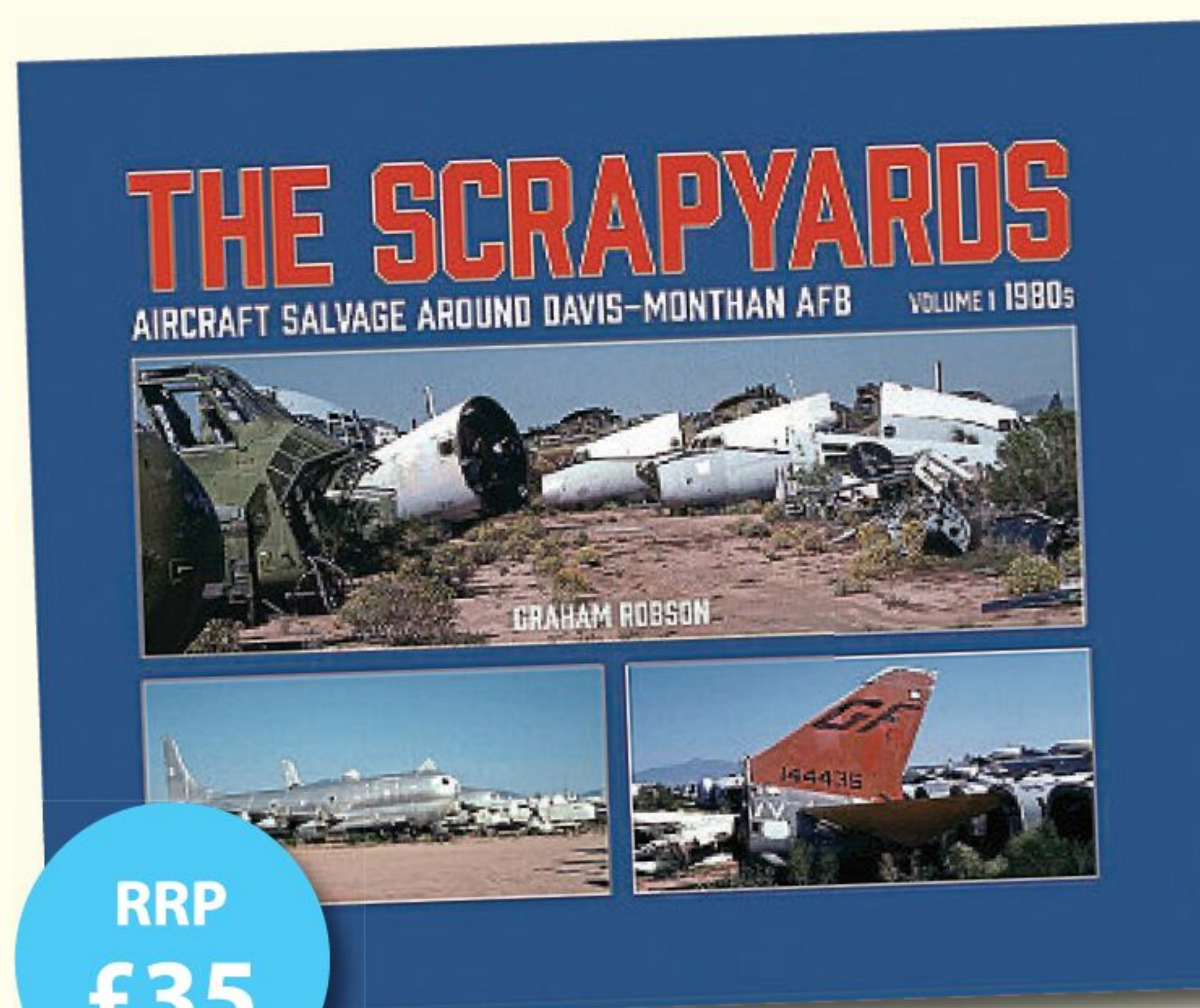


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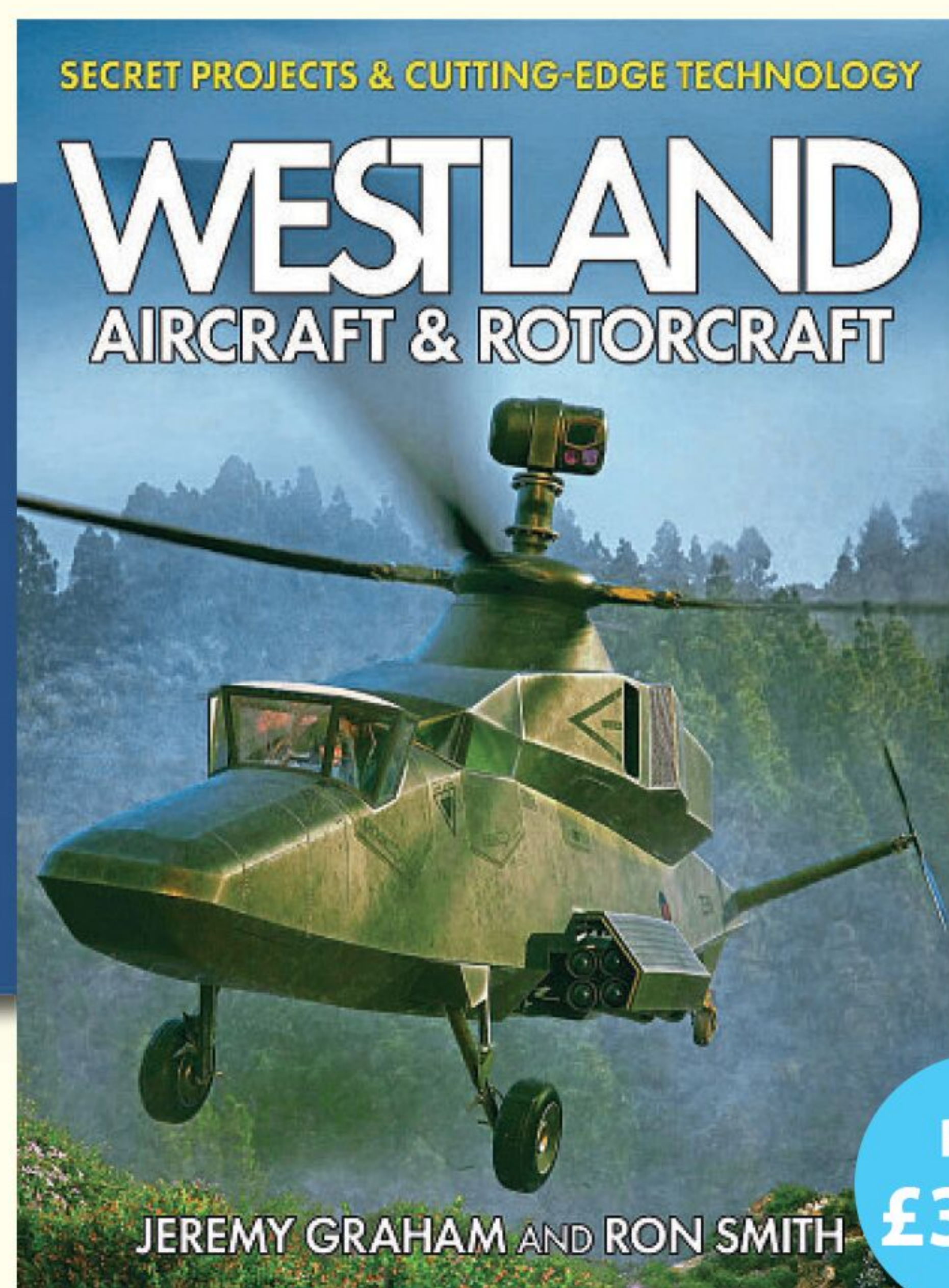
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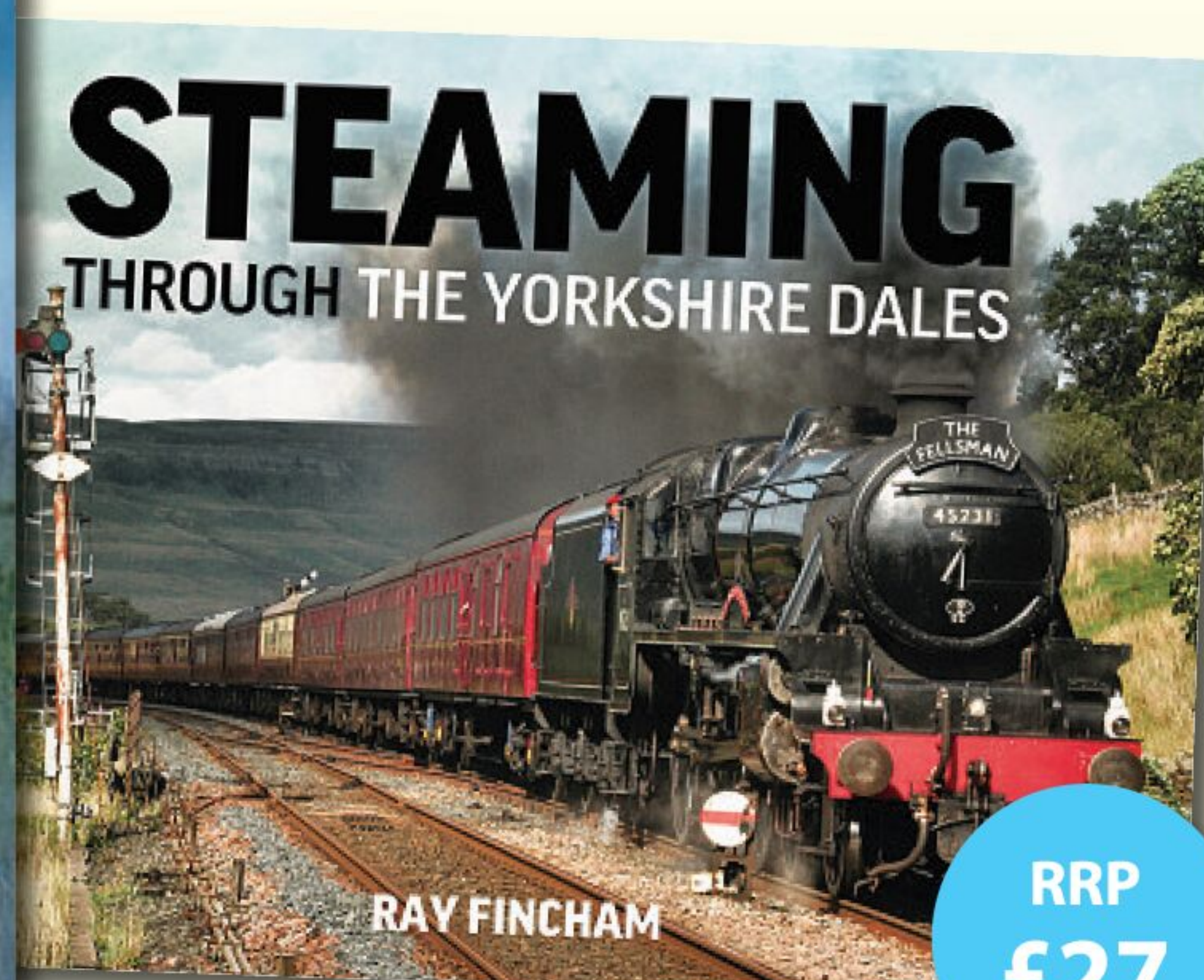
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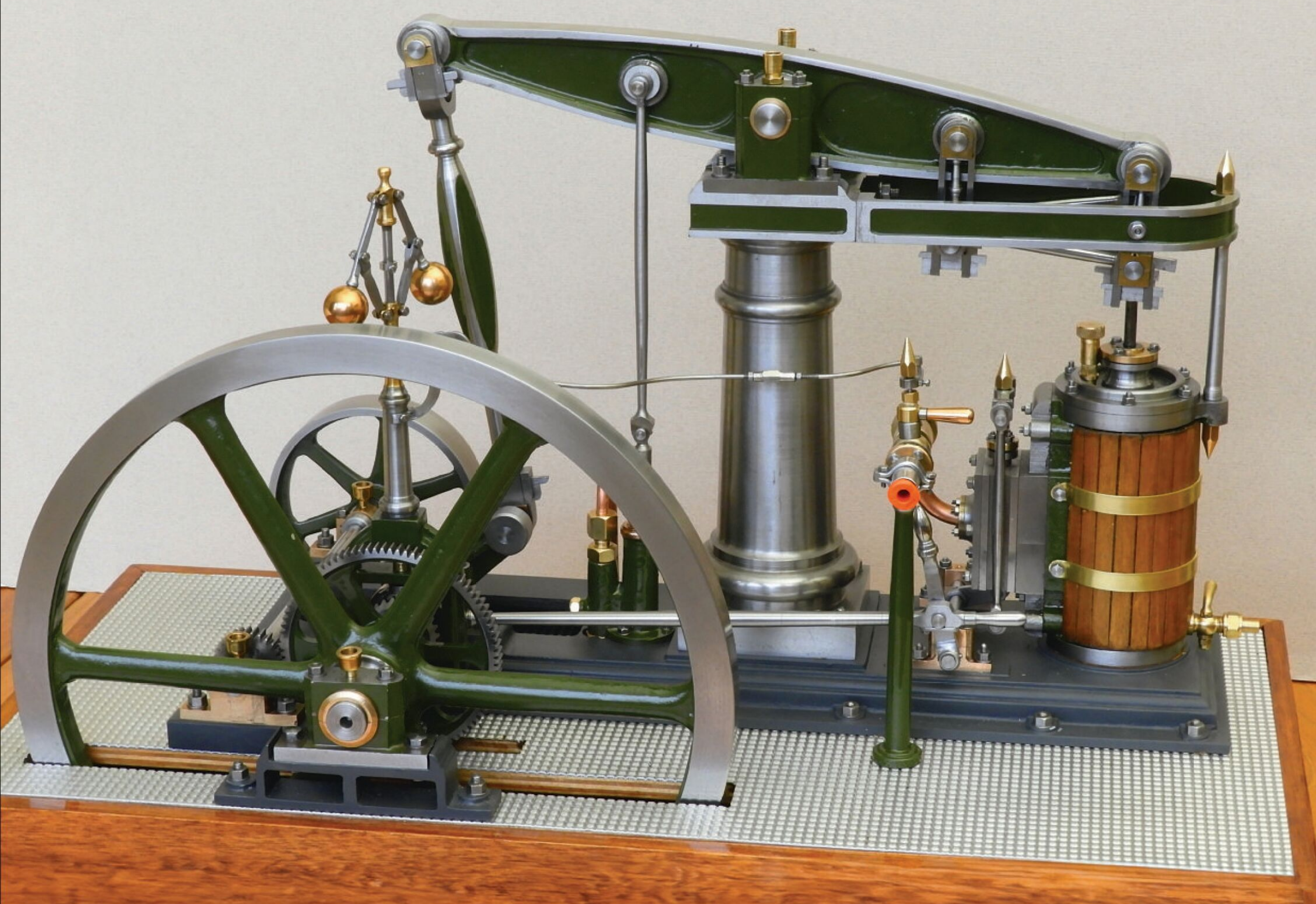
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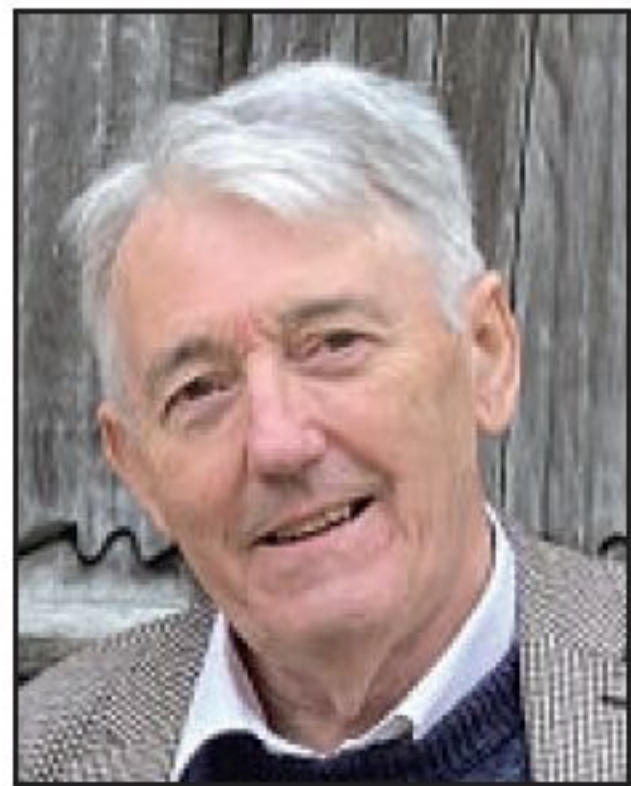


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MARTIN EVANS
Editor



DIANE CARNEY
Assistant Editor

Bournemouth Centenary

I have been informed that the Bournemouth and District Society of Model Engineers celebrates its centenary this year. The formation of the society was announced in a letter to the editor of this magazine on March 13th 1924. The Society website (littledownrailway.org.uk/bdsme) provides a very interesting history of the club, describing its first track at Southbourne, then the move to the Civil Service sports ground and, about a decade later, to Kings Park. This track eventually became unavailable, with the expansion of the football club, and the Society made its final move to their Littledown Park site in 2004. It's interesting to note that the move to the Civil Service site was facilitated by one D.E. 'Laurie' Lawrence, a former editor of *Model Engineer*, who worked at the time for Post Office Telephones.

Further exploration reveals an interesting little twist in the history. In the December 14th 1944 issue, Percival Marshall announced the formation of a new club at Bournemouth. A week later (we were a weekly magazine then), he wrote:

Since writing my note about the formation of a new society at Bournemouth, I have learned that the previous Bournemouth Society, whose activities were suspended in 1940, has come to life again. A friendly approach by the old members to the new body has resulted in the very



Bournemouth & District SME



Three youngsters from the Mortimer family ride the B&DSME track at Southbourne in 1948 behind Falcon.

desirable amalgamation of both membership and interests, and with this additional strength, the combined society may look forward to a long and successful career.

And so it has proved - my congratulations to the club!

Cock-up Corner

It looks like this could become a regular feature and this time it's a major item!

Firstly, I have been taken to task for claiming that Benjamin Franklin 'coined' the word battery to refer to Voltaic piles or Leyden jars. Well, of course, I am aware of the use of the word in a military context so perhaps a better choice of word

might have been 'adopted'. That'll teach me to be a little more precise in my use of English. Secondly, I'm told the motor car featured in Club News (M.E.4742 again) and labelled as a 'Raleigh' is in fact a 'Riley'. It's good to know that at least some readers of this journal are awake and alert!

A rather more serious issue arose in the first art of the series on the Admiralty clock case by Adrian Garner (M.E.4742, May 3). This was entirely my fault so my apologies to Adrian. When compiling the table listing articles about regulator clocks I managed to transcribe the data incorrectly (I blame an interruption by the man from Porlock...). The simplest thing to do is to reproduce the correct version of the table, so here it is.

In Roger Backhouse's article on Hunslet's Scootacar (also M.E.4742), the designer is named as Harold Brown. He was in fact Henry. He was sometimes referred to as 'Harry', which of course is a 'dual use' abbreviation for either Harold or Henry, hence the confusion.

Cue for a song – 'You say Riley, I say Raleigh, Raleigh, Riley, Henry, Harry ...'.

More exciting episodes of 'Cock-up Corner' are promised in future issues.

Table 1

Gravity Escapement Clock	Claude B. Reeve	Model Engineer	26 May 1960 to 21 July 1960
A Weight Driven Regulator Timepiece	Claude B. Reeve	Model Engineer	6 May 1966 to 7 October 1966
A Watchmaker's Workshop Regulator	Alan Timmins	Horological Journal	March 1981 to March 1983
An English Regulator, Machined and Constructed	John Wilding	Timecraft	November 1981 to October 1982
A Regulator Clock	Peter Heinmann	Model Engineer	12 February 1999 to 24 September 1999
Month-going Regulator Clock	Peter Heinmann	Model Engineer	28 November 2002 to 11 July 2003
Making a Regulator to a New Design	John Reynolds	Horological Journal	January 2015 to February 2016

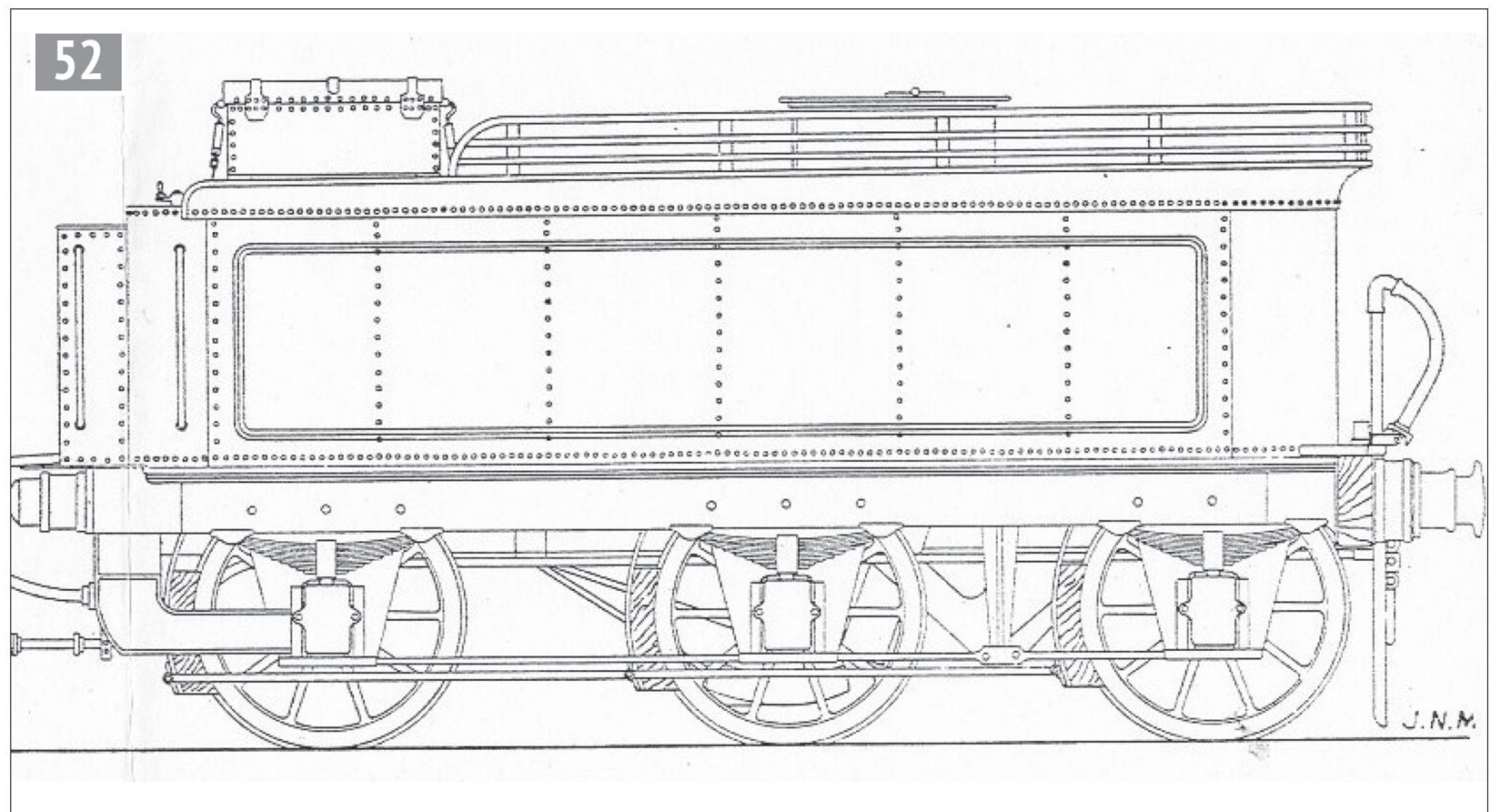
Martin Evans can be contacted on the mobile number or email below and would be delighted to receive your contributions, in the form of items of correspondence, comment or articles.
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BUILDING 3020 *CORNWALL* in 5 Inch Gauge PART 7

Jim Clark
builds the
famous
LNWR 2-2-2 – the first
locomotive earmarked
for preservation.



Continued from p.712
M.E.4743 May 17



Side elevation drawing of the tender for Cornwall (source: Locomotives I have Known, J.N. Maskelyne pp.86-87).

The tender

Someone said to me many years ago that when building a locomotive, be sure to build the tender first, otherwise you will be tempted not to bother with it once you have completed the locomotive itself. I must admit to falling into this trap myself somewhat, as once *Cornwall* was completed to this stage, it took a back seat, or rather back bench, for over a year before I

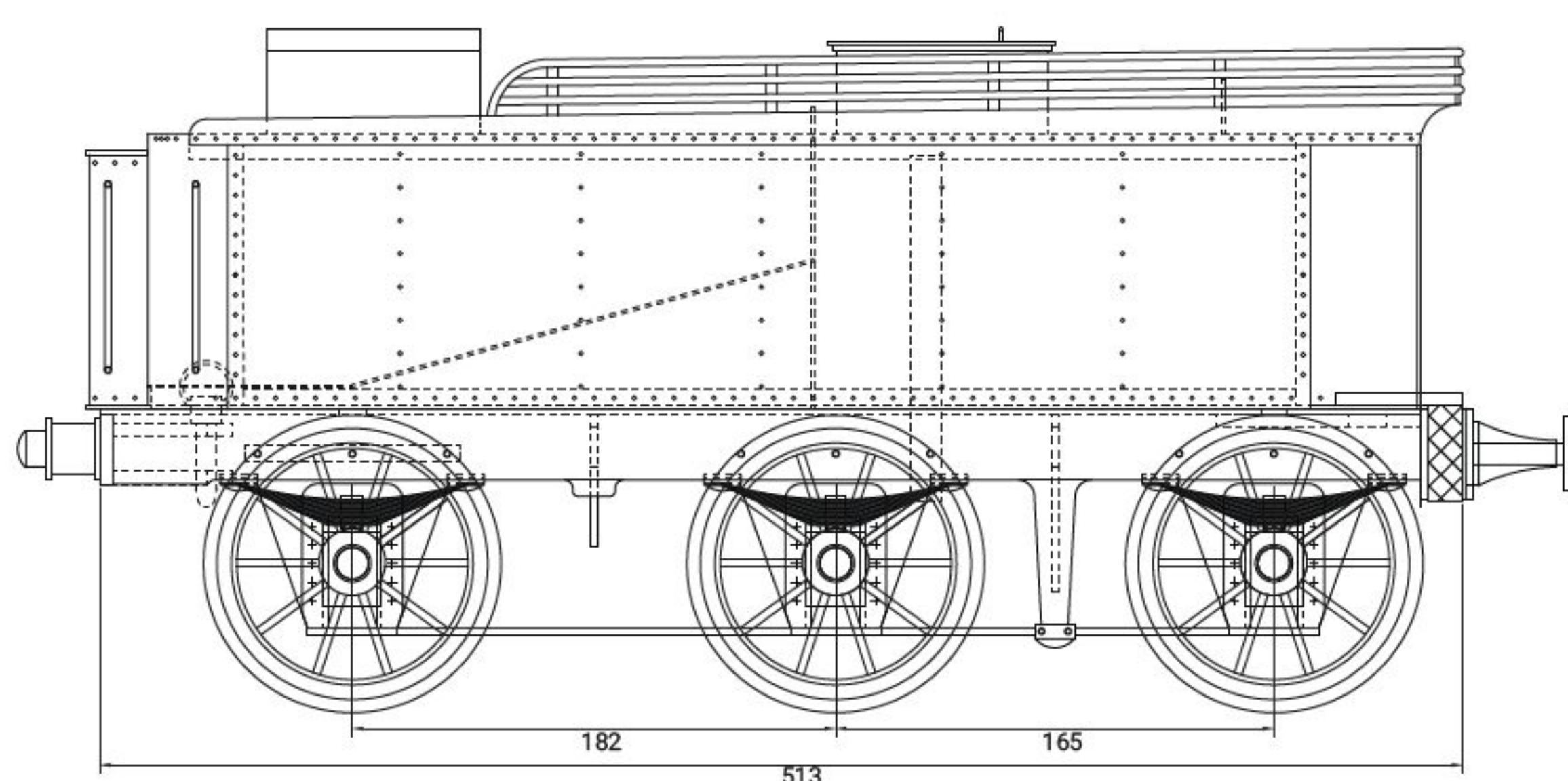
got sufficiently re-enthused to finish it.

The first hurdle to overcome was completing the design drawings, which had stalled. There are plenty of good side and front views of the locomotive, but not many of its current tender, and none taken from above, so it was hard to know how the internal details of the tender were actually laid out.

In the end, I followed the outline in J.N. Maskelyne's book (**photo 52**), with details added from the selection of photographs that I did have. The internal detail I assumed from similar tender designs, and from what would be practical, both for the model and on the full-size original.

Figures 19 and 20 show my own elevation drawings of the tender, which is noted

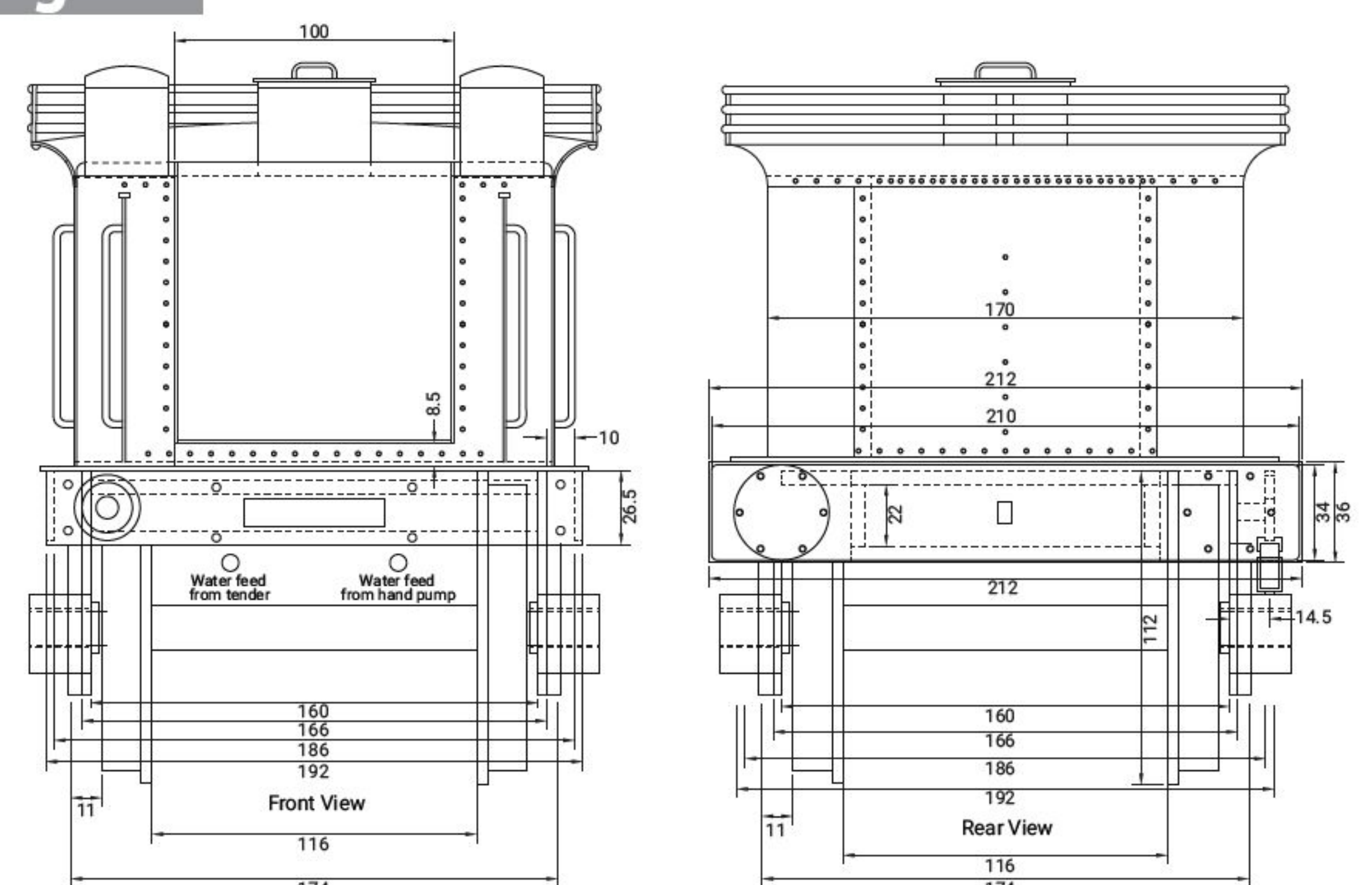
Fig 19



L&NWR Standard 1800 Gallon Tender in 5" Gauge
Overall dimensions: 520mm long x 235mm wide x 250mm high
Weight (empty): 12kg

Tender side elevation as drawn up.

Fig 20



Tender end elevations.

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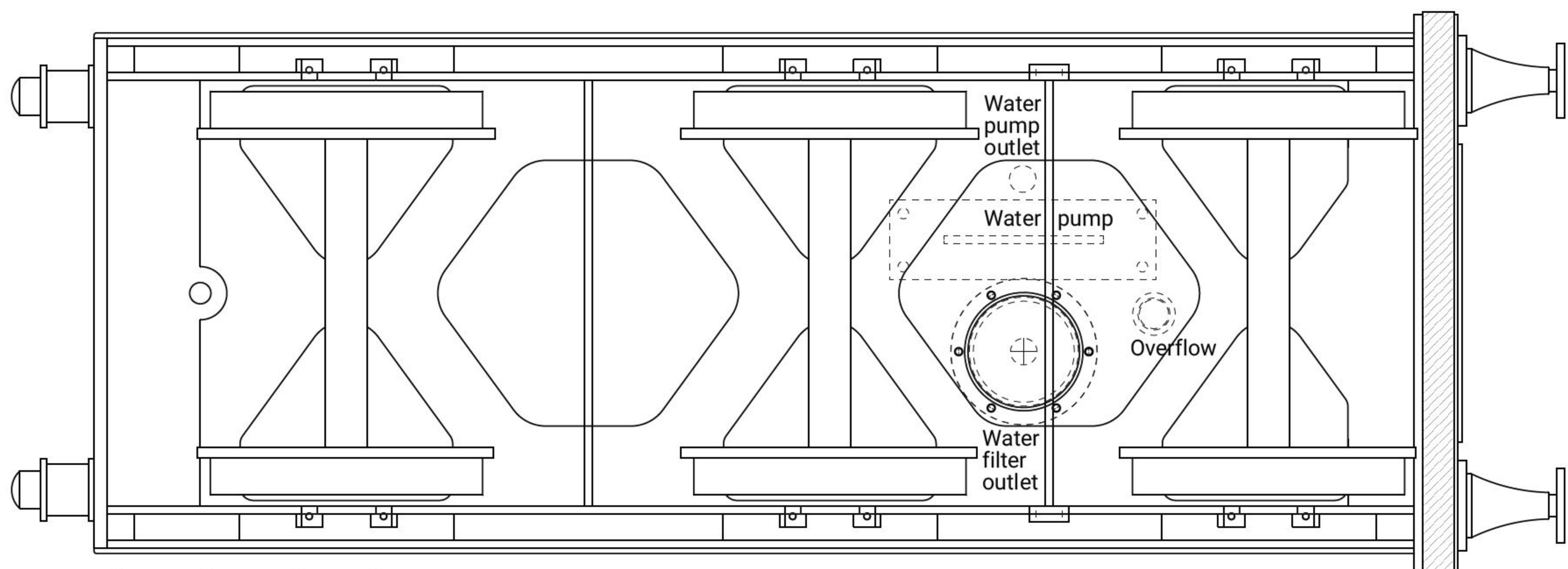


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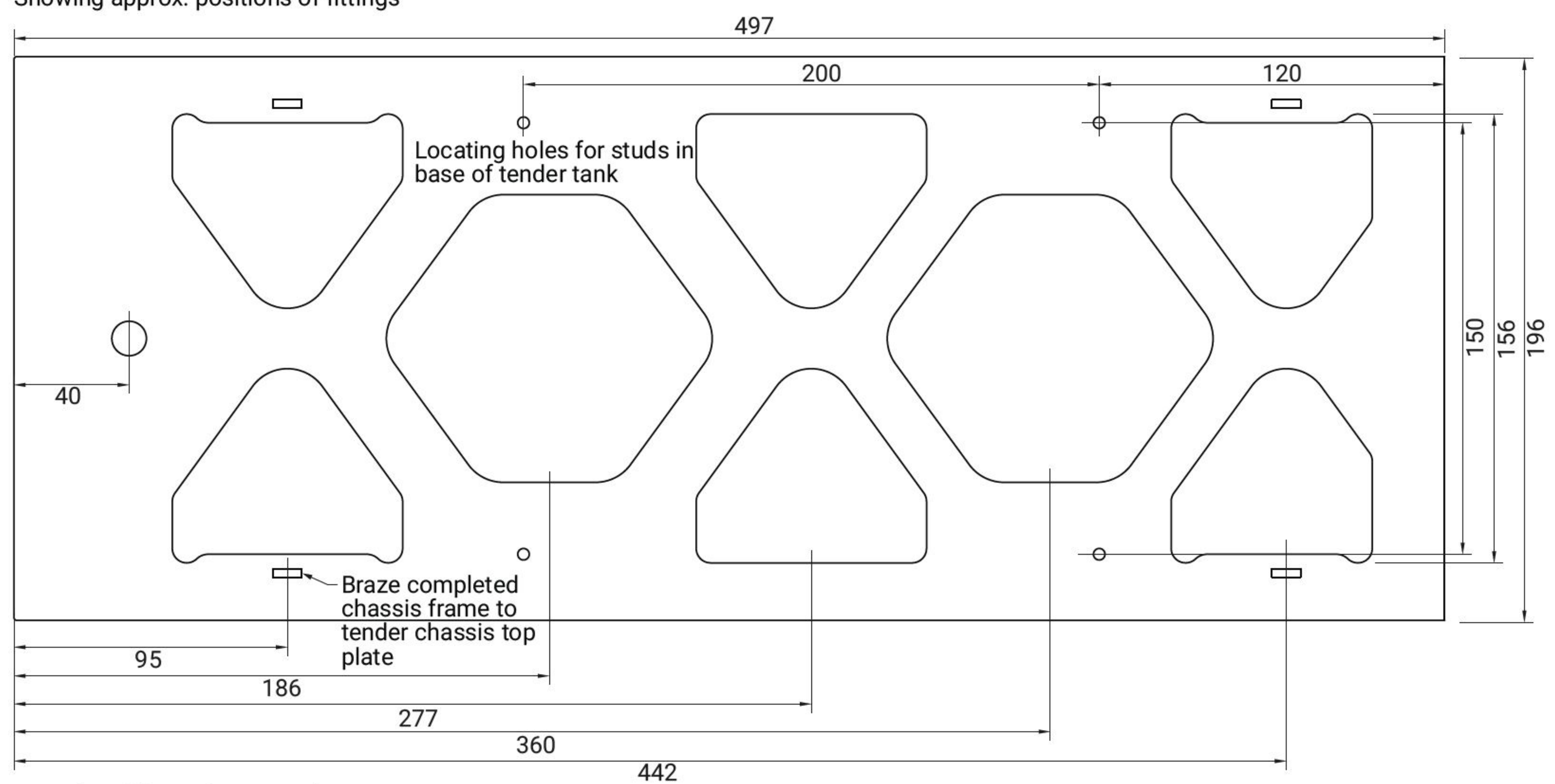
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Fig 21



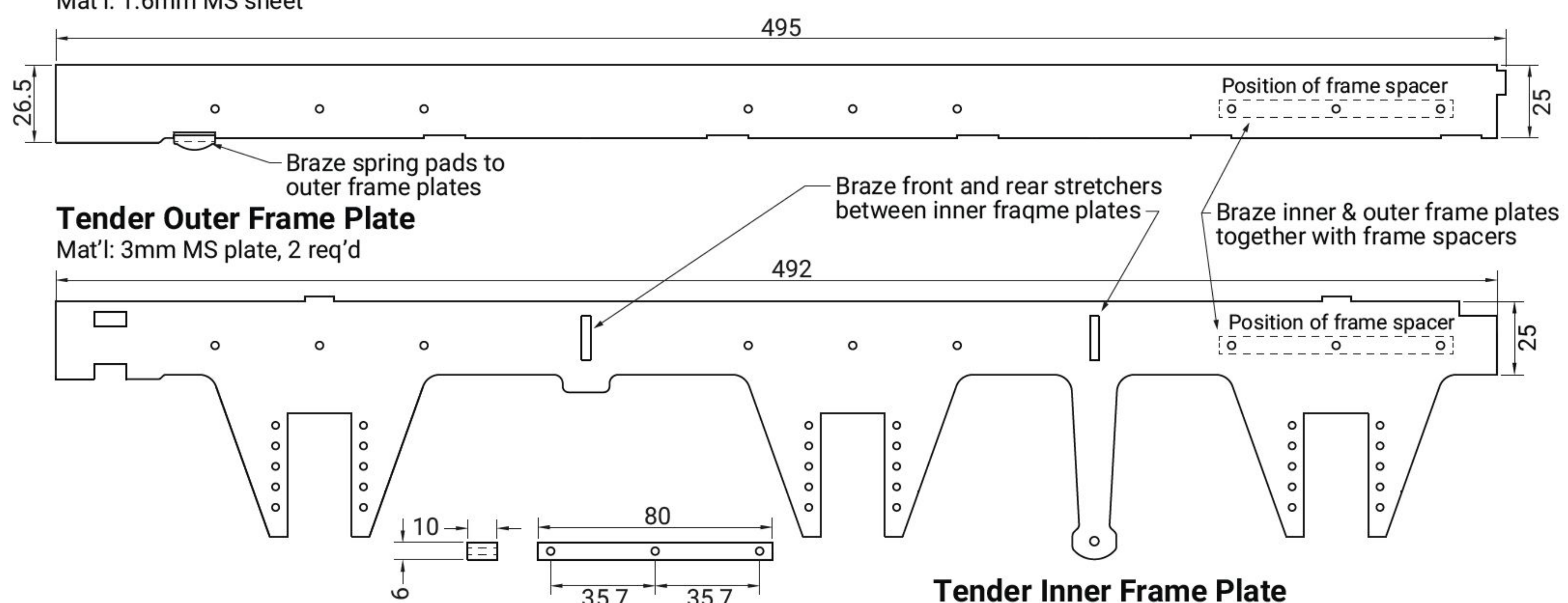
View Underneath Tender

Showing approx. positions of fittings



Tender Chassis Top Plate

Mat'l: 1.6mm MS sheet



Tender Outer Frame Plate

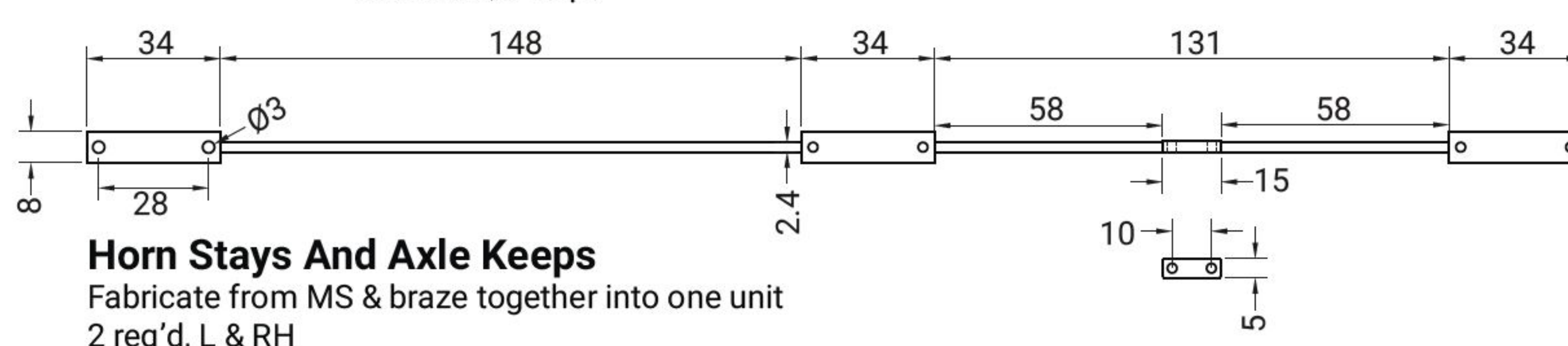
Mat'l: 3mm MS plate, 2 req'd

Tender Inner Frame Plate

Mat'l: 3mm MS plate, 2 req'd

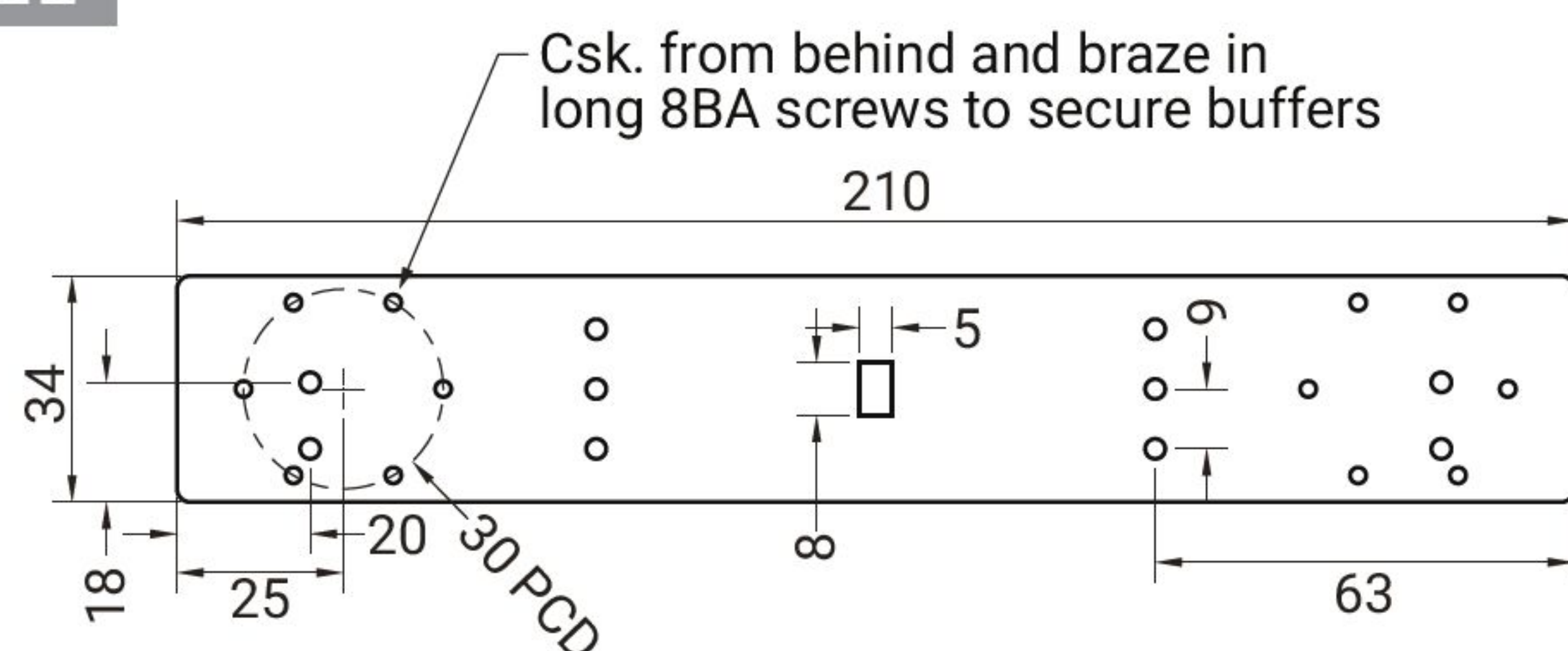
Frame Plate Spacer

Mat'l: MS, 6 req'd

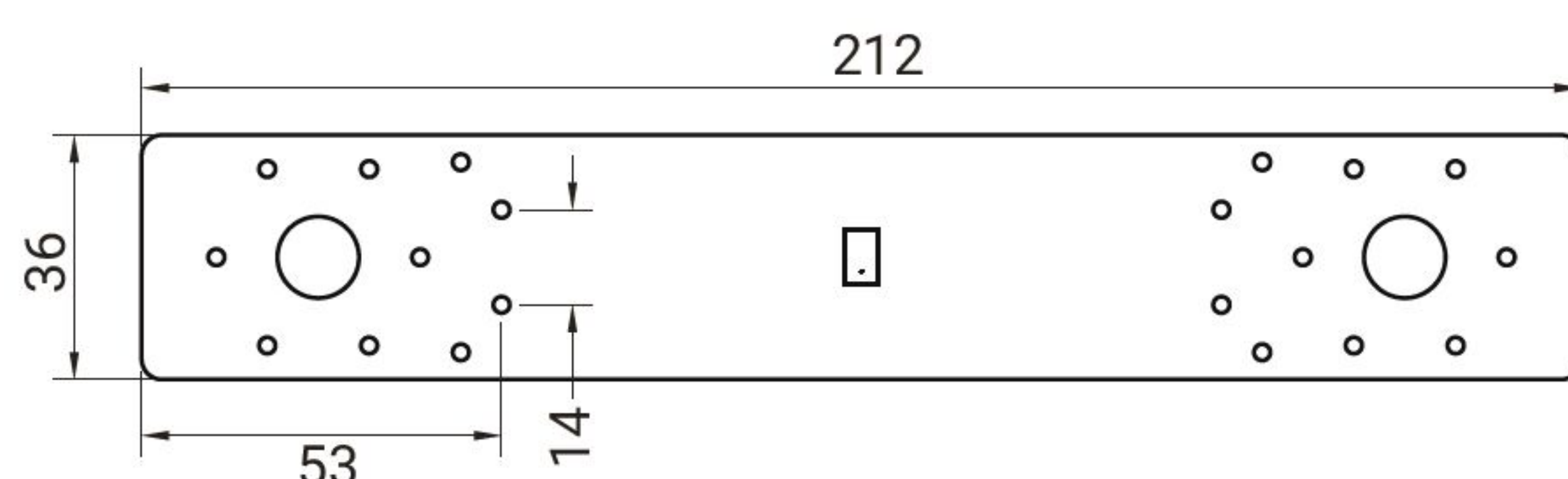
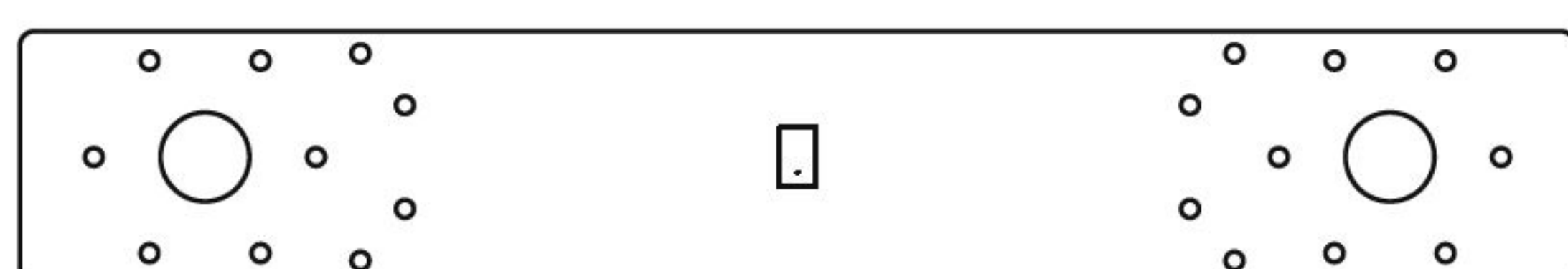


Horn Stays And Axle Keeps

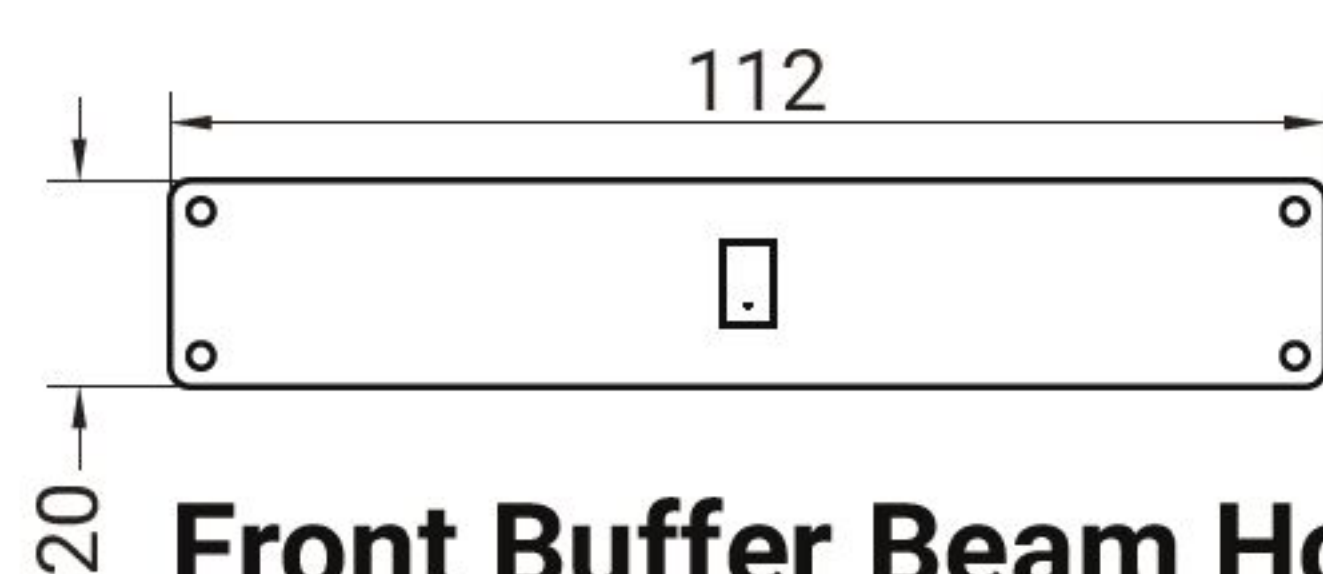
Fabricate from MS & braze together into one unit
2 req'd, L & RH

Fig 22**Front Buffer Beam Inner**

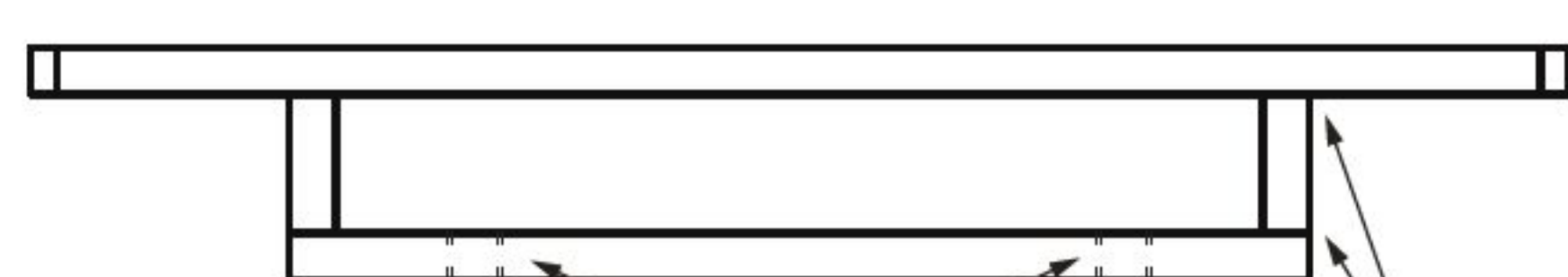
Mat'l: 3mm MS plate

**Front Buffer Centre**Mat'l: 12mm close grain hardwood
Varnish or clear coat**Front Buffer Beam Outer**

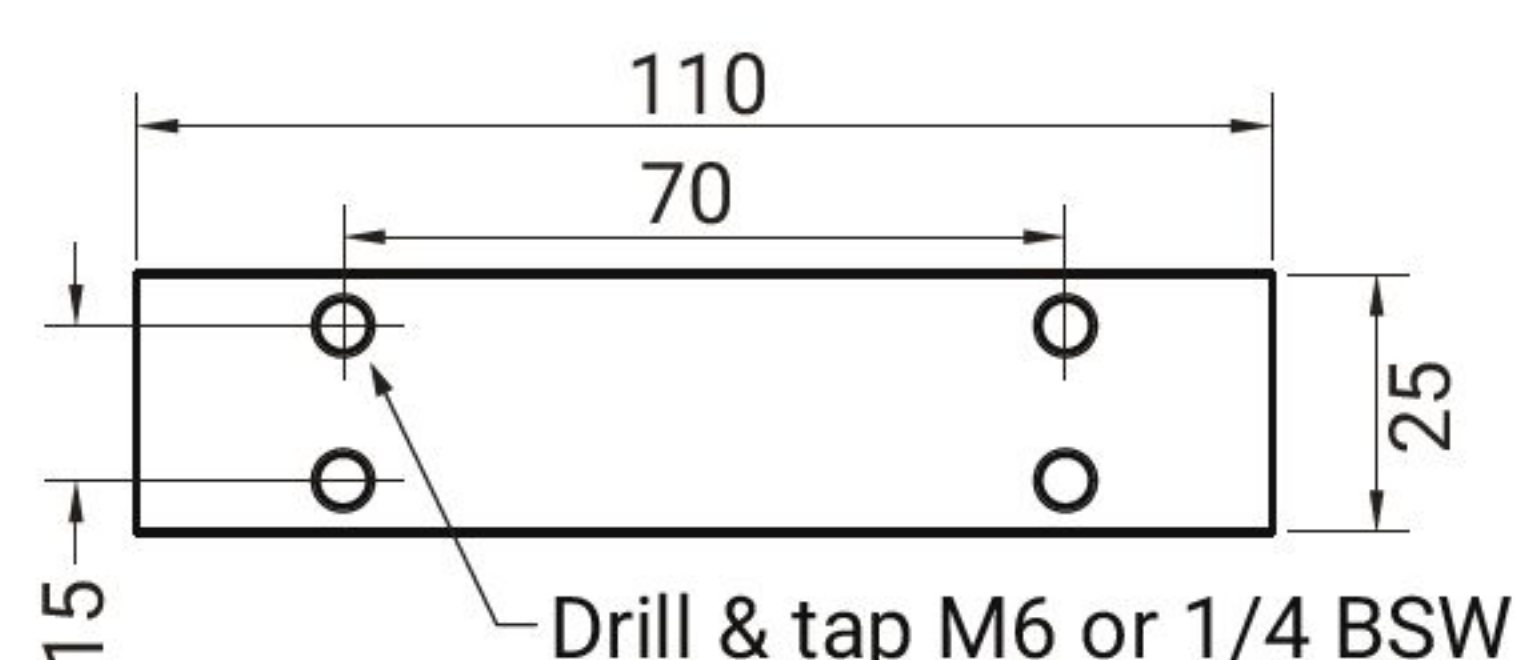
Mat'l: 1.6mm MS

**Front Buffer Beam Hook Plate**

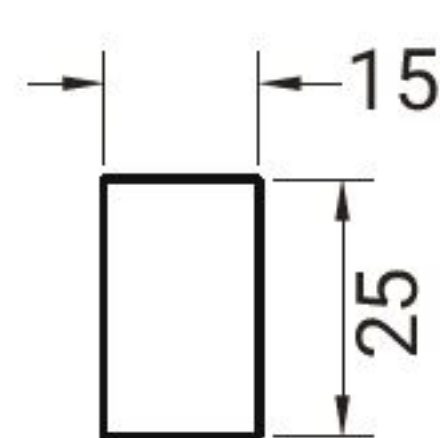
Mat'l: 1.6mm MS

**Rear Buffer Drag Box**

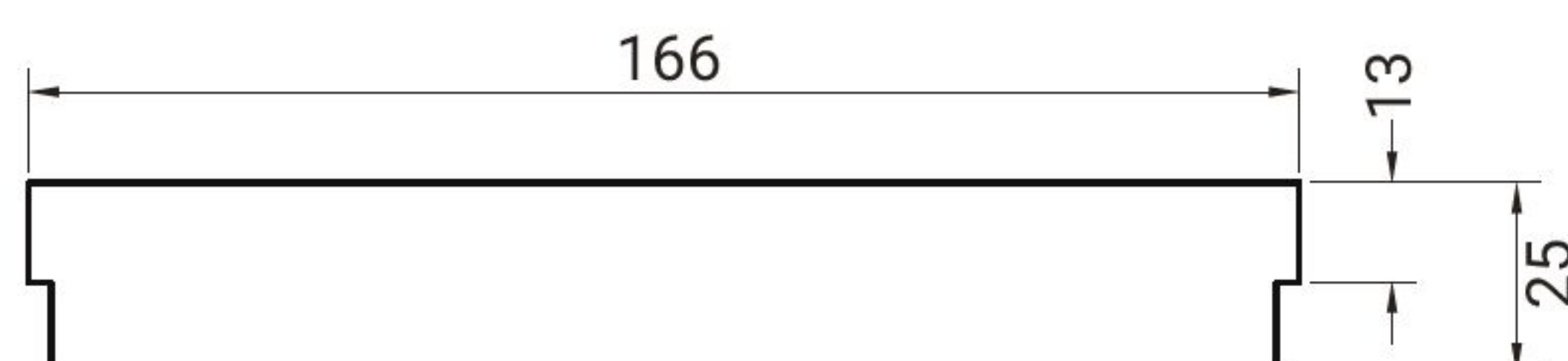
Mat'l: Fabricated 5mm MS plate

**Drag Box Base**

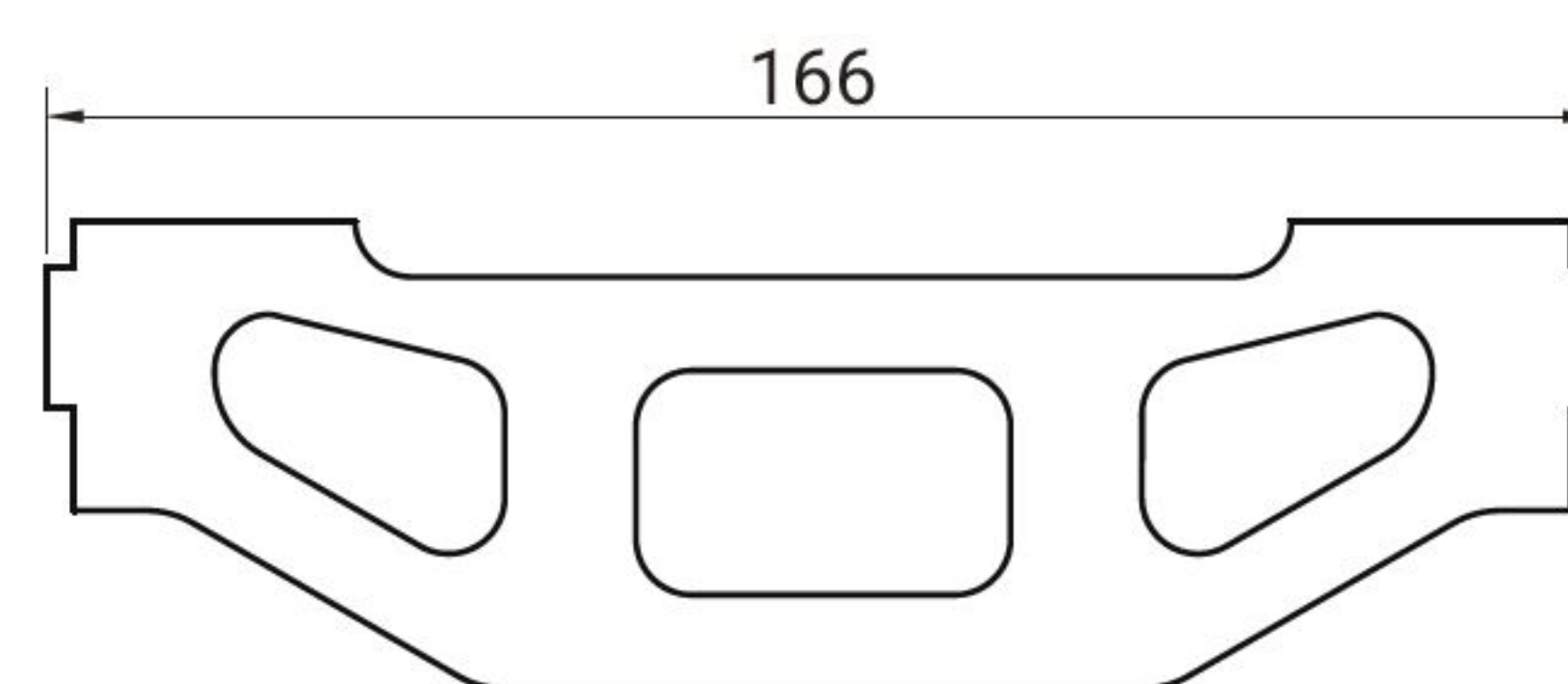
Mat'l: 5mm MS plate

**Drag Box Sides**

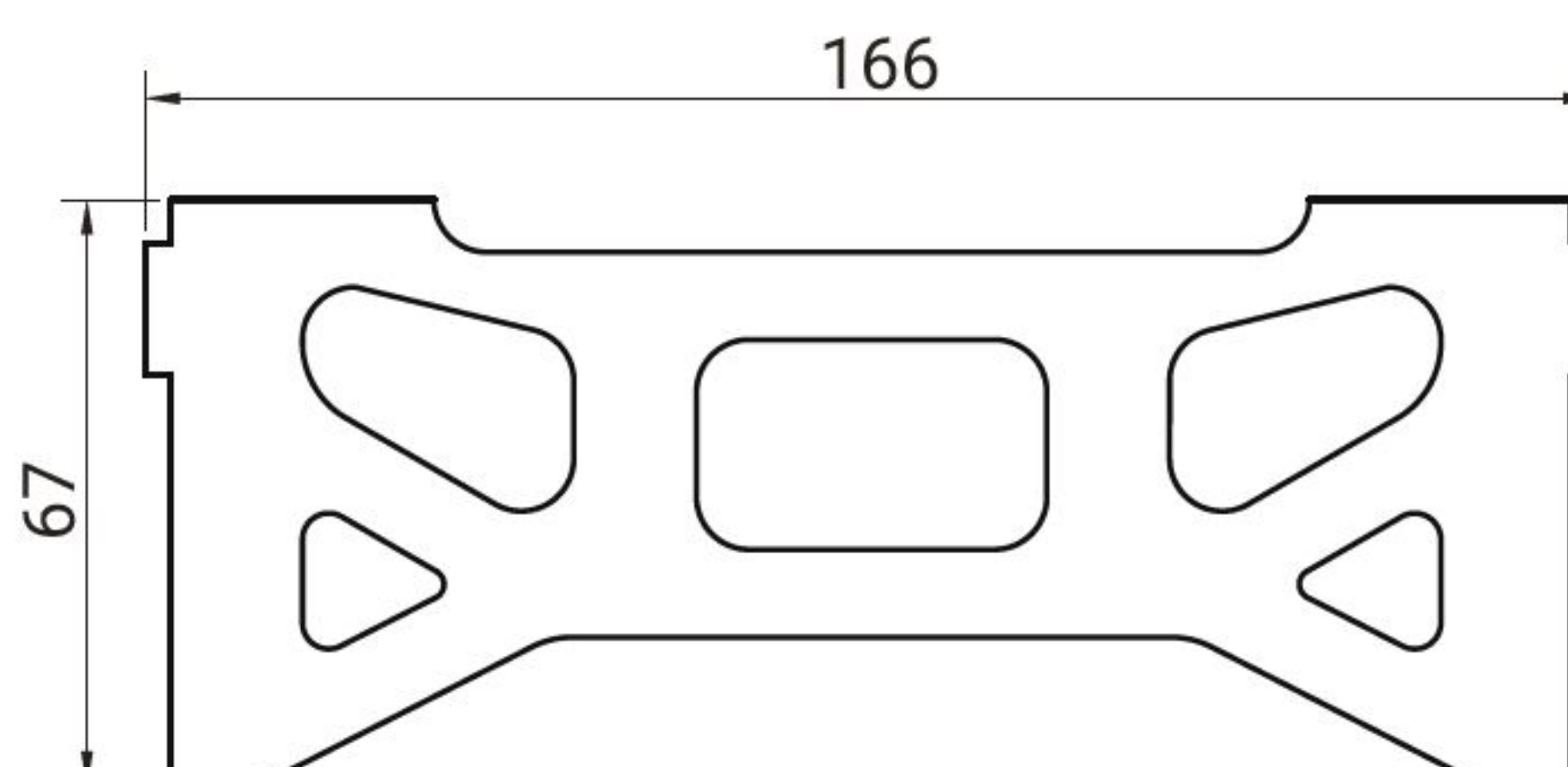
Mat'l: 5mm MS plate

**Rear Buffer Beam Stretcher**

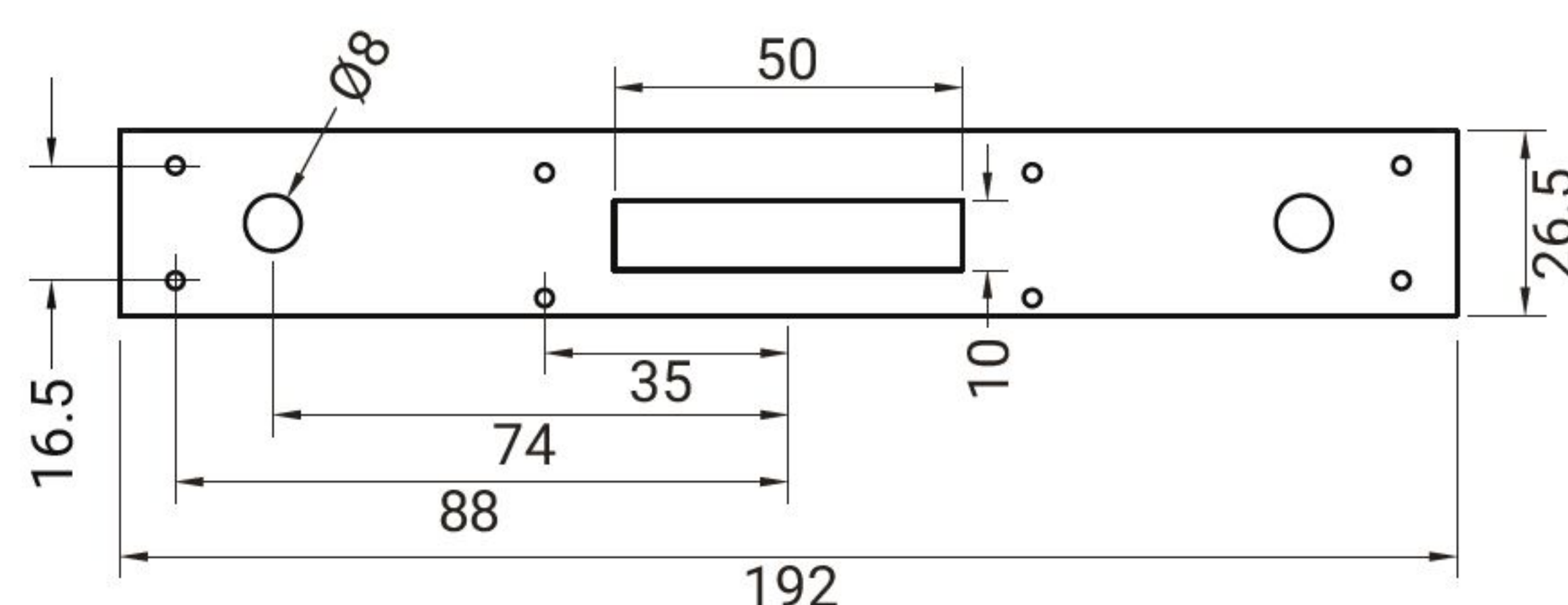
Mat'l: 5mm MS plate

**Front Stretcher**

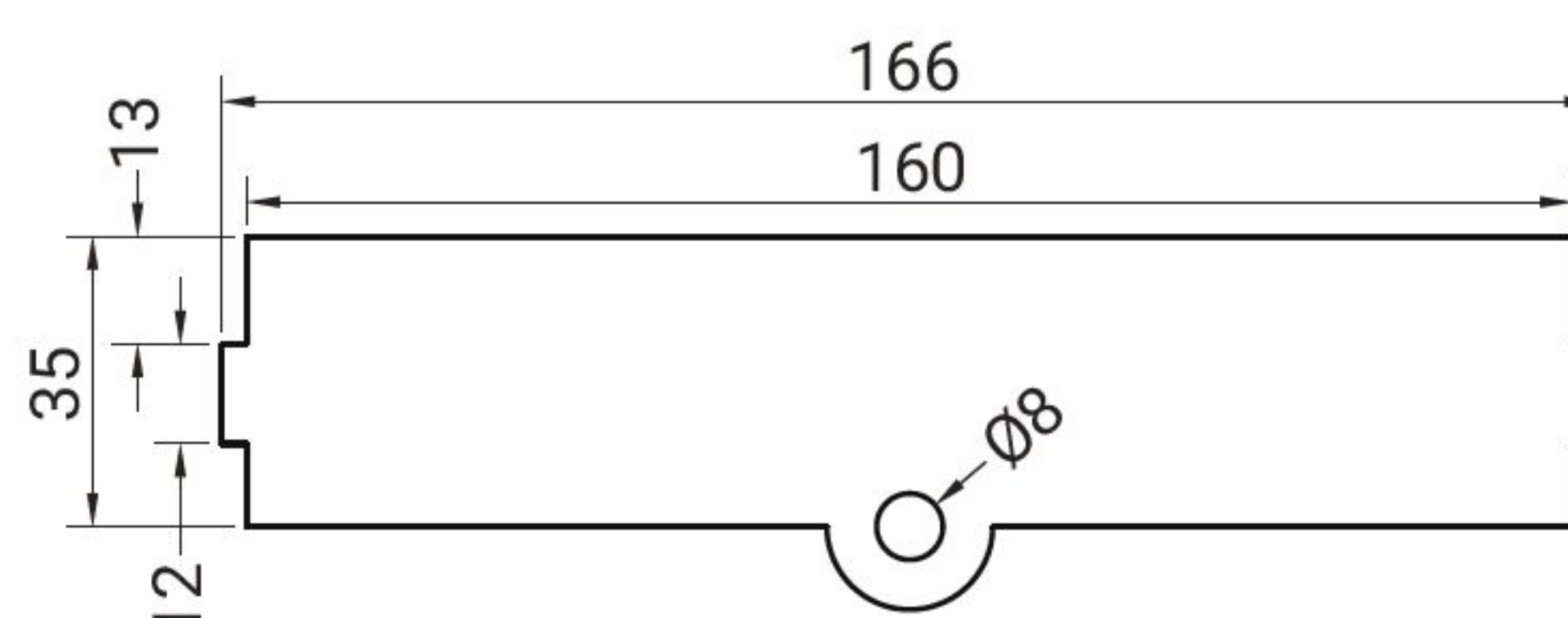
Mat'l: 3mm MS plate

**Rear Stretcher**

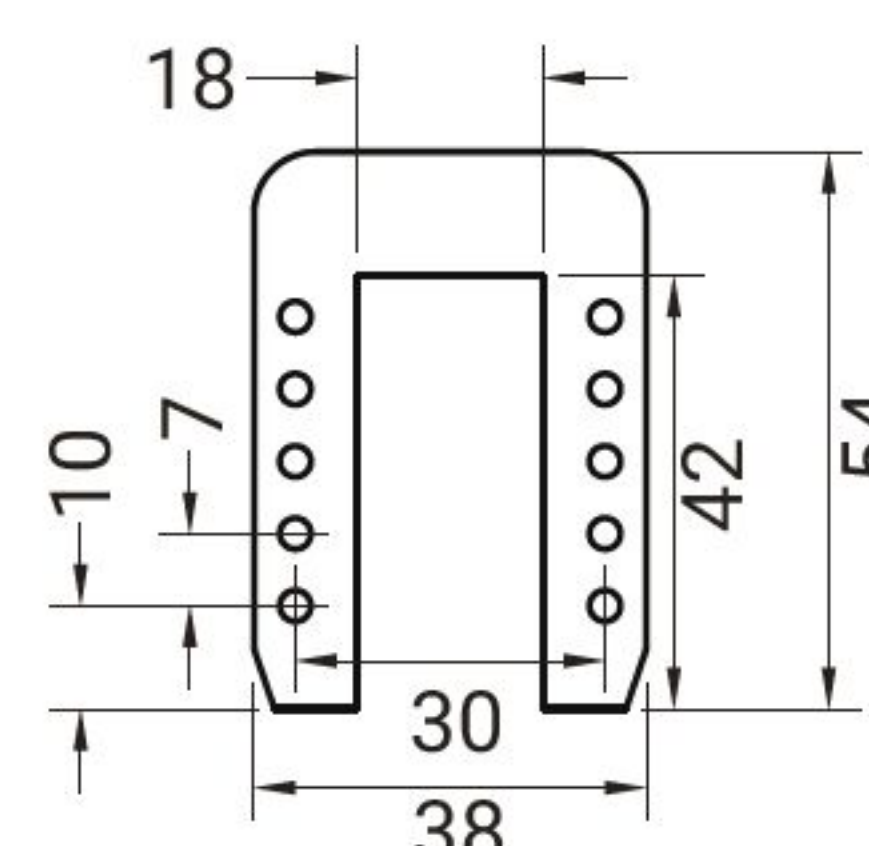
Mat'l: 3mm MS plate

**Front Buffer Beam**

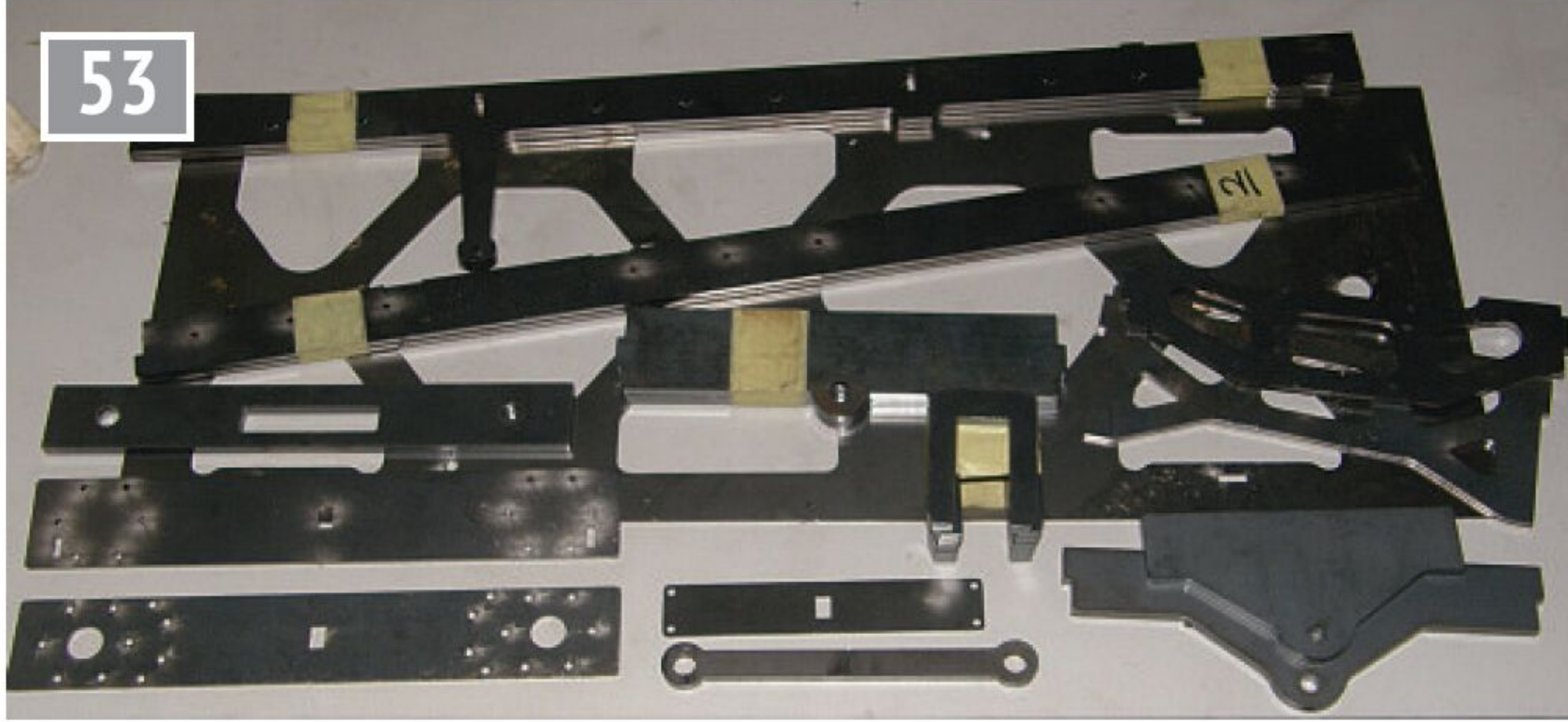
Mat'l: 5mm MS plate, 1 req'd

**Front Buffer Beam Stretchers**

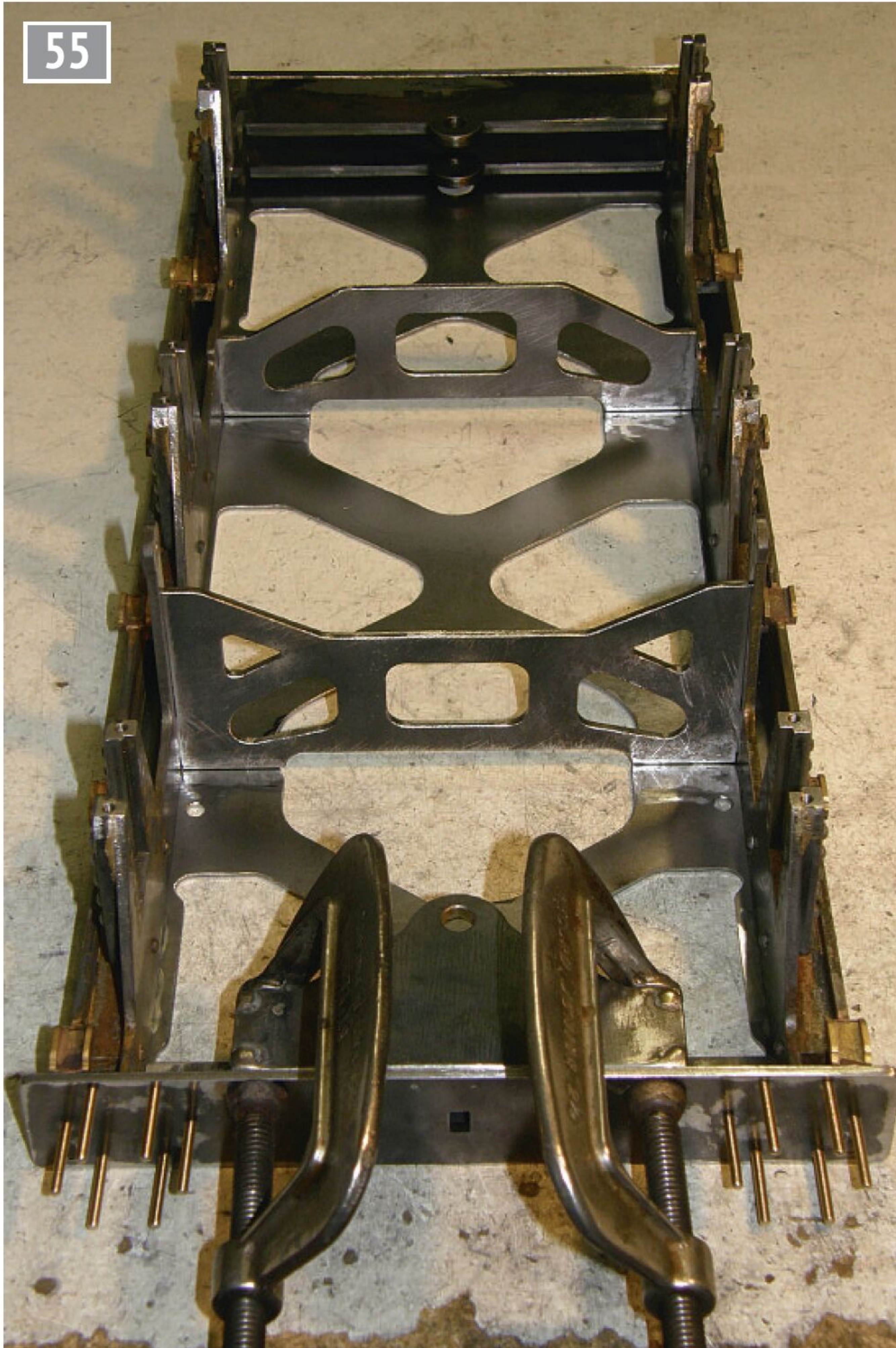
Mat'l: 5mm MS plate, 2 req'd

**Tender Horns**

Mat'l: 5mm MS plate, 6 req'd



Once again, the steel chassis components went out for laser cutting and soon a kit of parts arrived.



The frame clamped up for brazing.

in J.N. Maskelyne's book as a 'standard 1,800 gallon L&NWR tender', and which was introduced to the L&NWR by Francis Webb in 1874. These tenders were widely used with other locomotives of the period, but this particular tender would only have been paired with *Cornwall* relatively recently, since it entered preservation.

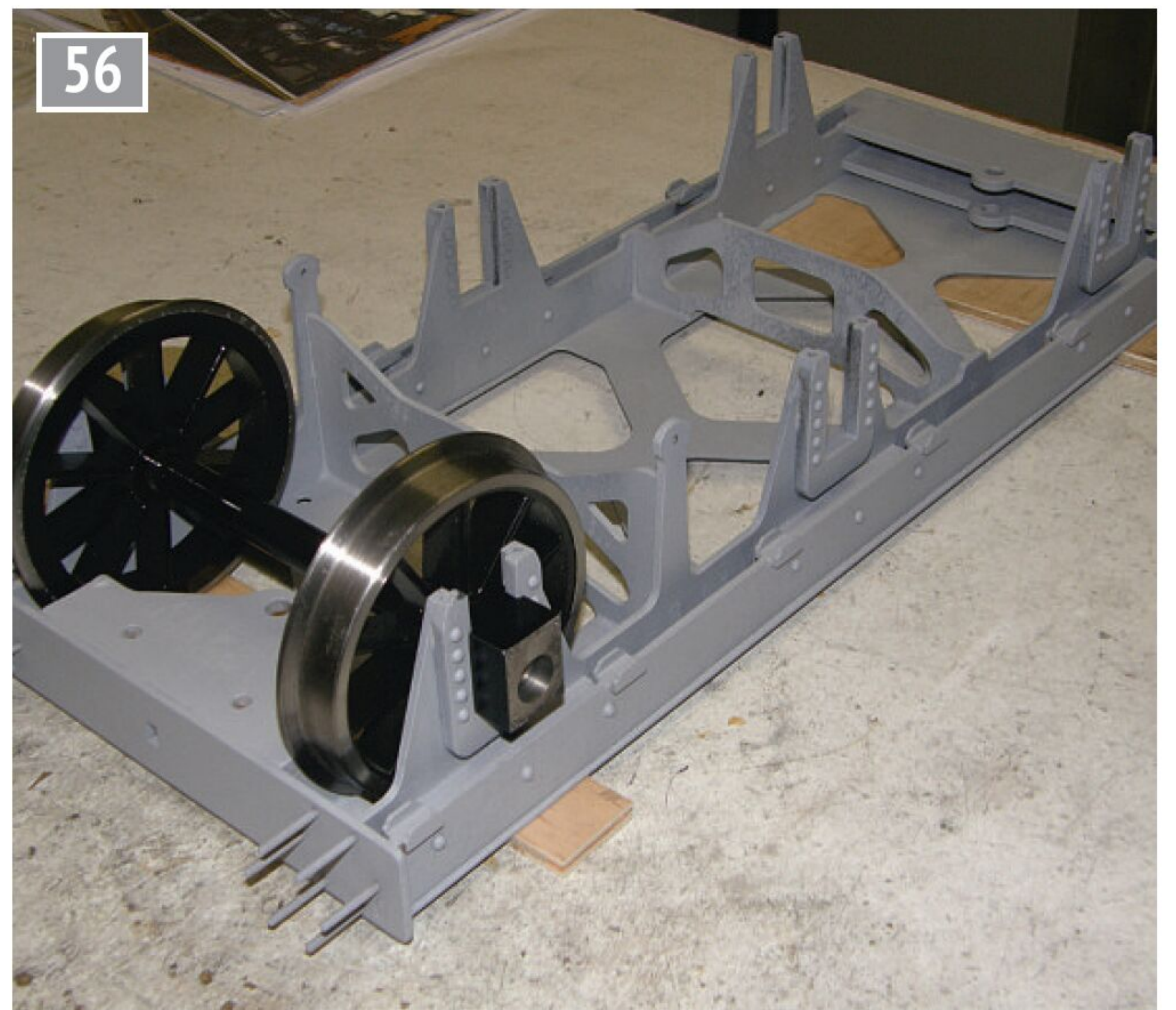
These standard tenders included a hand-lowered water

scoop, to take advantage of the water troughs introduced by John Ramsbottom and used on the L&NWR to allow long-haul running without stops. However, that is one detail that I decided not to include in the model tender, complex enough as it is!

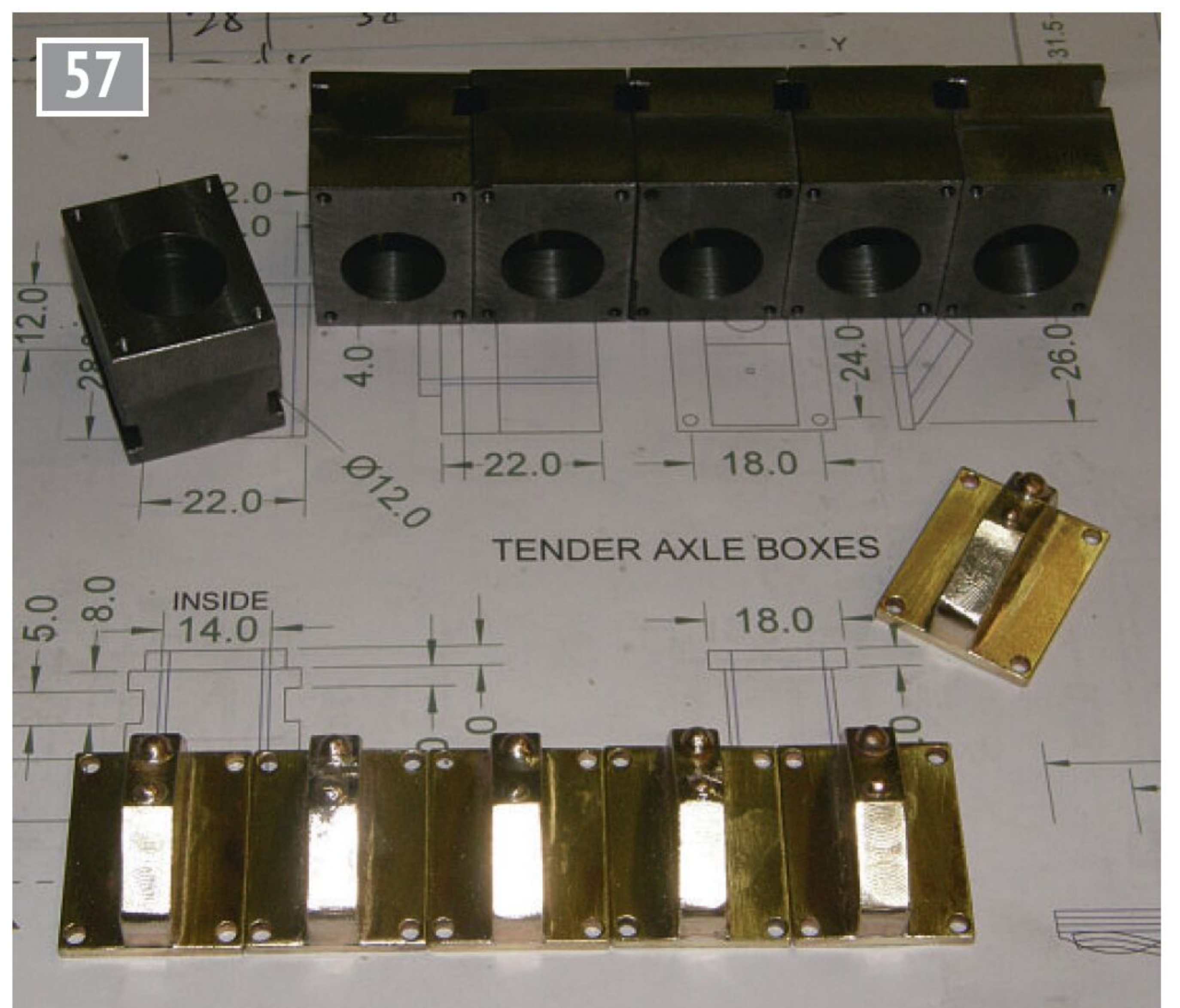
I made the tender in two parts – a complete underframe chassis, with a separate tender body sitting on top. This makes for a strong and robust chassis,



Assembling the axle hornblocks.



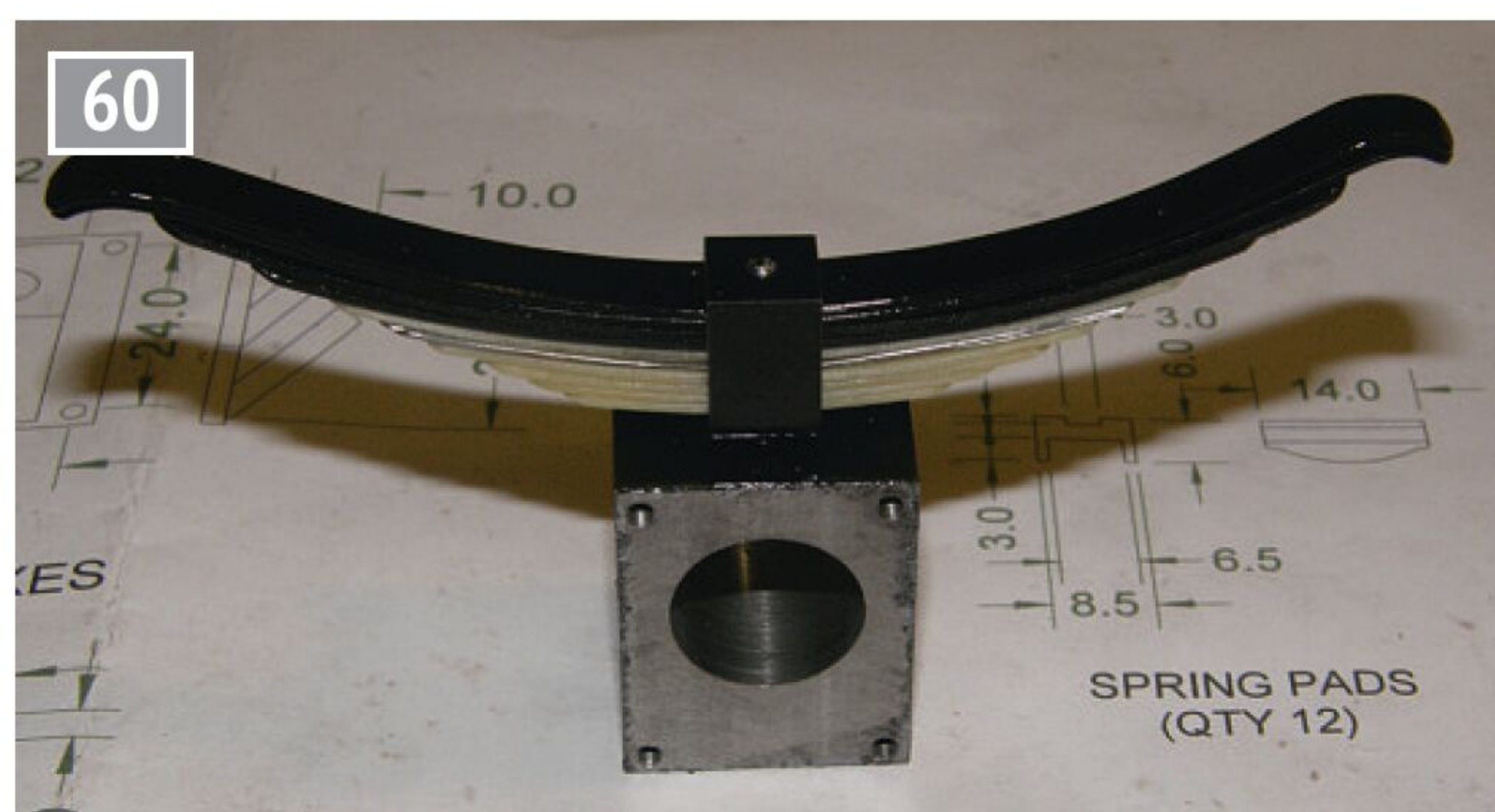
Frame complete, testing a wheel and axle set for correct fit in the hornblocks.



The axle boxes and covers.



The buffers and wooden rear buffer beam.



Here is a completed spring on its axle box.

all in steel, with the more delicate tank parts all in brass sheet sitting above it (figs 21 and 22).

While waiting for the laser cutting (photo 53), I busied myself making up the various chassis fittings, such as buffers, axle boxes and suspension springs. These were all fitted to the completed chassis frame later on, once that was completed (photos 54 to 58).

Tender springs

Exterior leaf suspension springs are a prominent feature of the tender, as can be seen in the side elevation drawing. So, I decided to make working scale springs, rather than using dummy spring shapes with a coil spring hidden inside, as is often done on models. This did add some new complexity and

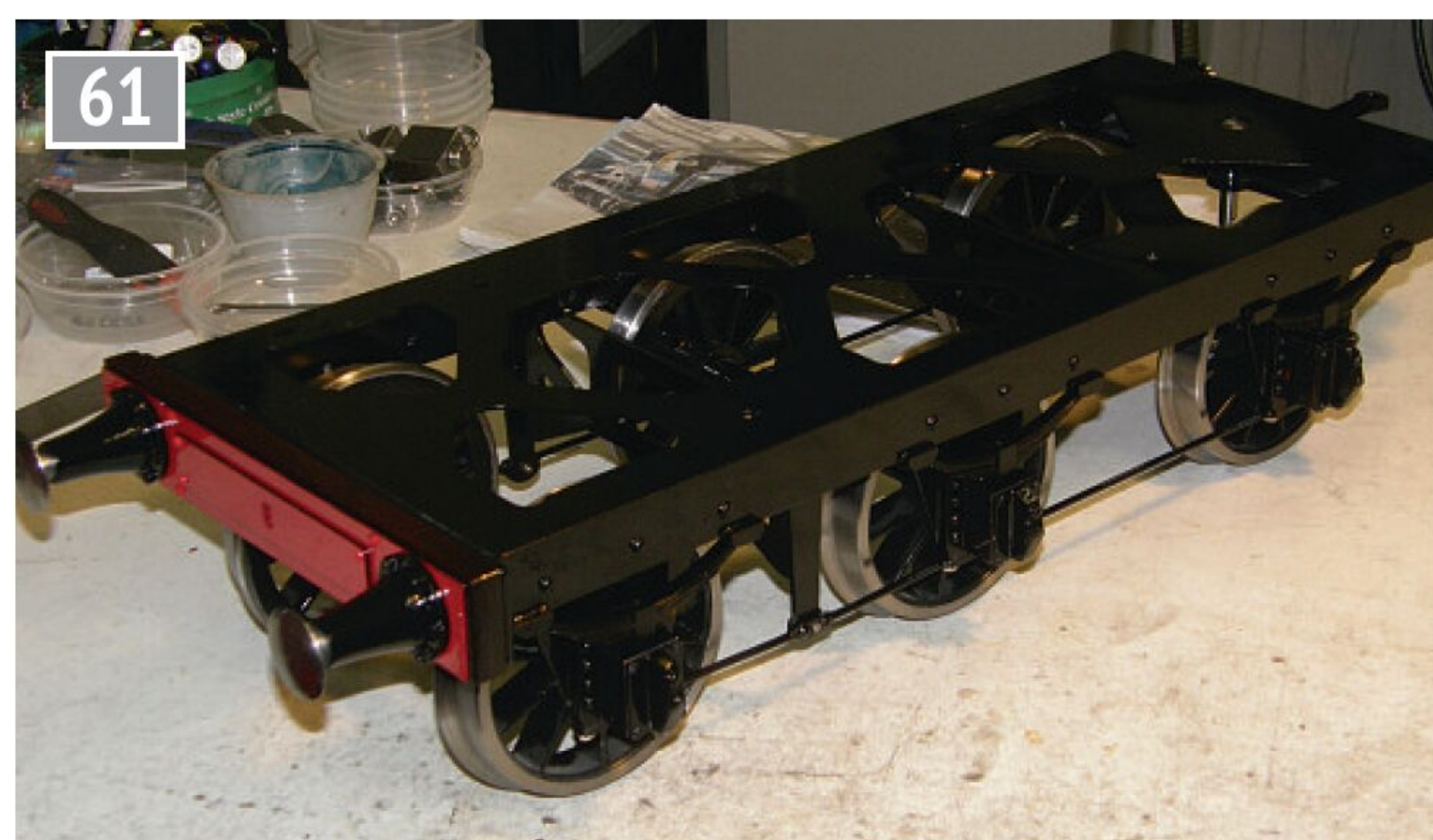
challenges but that's what it's all about!

I estimated that the sprung part of the tender (excluding unsprung parts such as wheels and axles) would weigh somewhere around 10-12kg. I calculated the volume of the water space to be around 6 litres so, when full of water, the total sprung weight will rise by another 6kg to about 16 to 18kg. Incidentally, the model water capacity compares well with the original tender; the volume scales down by the scale factor cubed, so 1,800 gallons in full size reduces to 1.35 gallons at 1/11 scale, or 6.2 litres.

As there are six wheels, the loading per wheel will be in the range of 2kg to 3kg. This worked out that I would need somewhere around 3mm of spring travel per 1.5kg load.



Component parts for the working leaf springs.



The springs mounted up on the completed tender chassis.

There is a total of 6mm travel in the springs and we want the axles sitting in the middle of their travel range when unladen and not bottoming out when the tender is full of water.

Fellow NDMES club member Phil Hartley kindly supplied me with a sheet of 0.8mm thick spring steel. I had no real way of estimating the spring force of this steel sheet for a given width/length, so I just went ahead and cut off some 6mm wide strips which I bent up to the required shape. The two longest spring leaves which are in contact with the slipper plates under the chassis obviously do most of the work, and some rough tests I did with a digital scale showed that these two spring strips alone would give a deflection in the order of 2-3mm with a 1.3kg weight applied.

Fortuitously this was just about right!

Phil also gave me some similar thickness Tufnol sheet. This is very flexible and is suitable for making dummy spring leaves which can be inserted into the spring stack without adding any actual spring force. I followed the top two steel leaves with three Tufnol ones, then a steel one, then more Tufnol strips to complete the stack.

One trick I learned: before cutting the Tufnol strips to finished length I coiled them inside a round tin can and heated it gently with a hot air gun – when cool and removed from the can, the Tufnol strips retained the curved shape they need for the spring stack (figs 59 to 61).

●To be continued.

Congreve Clock

Ian Beilby
explains
how to
get the best out of a
notoriously tricky clock.



I am sure most readers of *Model Engineer* are well aware of the infamous Congreve Clock, a clock which, love it or hate it, has a reputation and fascination like no other.

Without a doubt it has its many critics. As a clock, even when working at its best, it is a notoriously bad timekeeper, so much so that many people totally disregard it as a timepiece at all. In fact I have heard many serious clock collectors say it isn't really

a clock, but an engineering novelty, like a clockwork toy.

To many owners, and even some repairers, it can be a nightmare to repair or manage to make it run. And yet, despite its bad reputation, it is captivating to watch and has an attraction more than any other clock that I know of.

It hypnotises all ages, from children as young as four to adults in their eighties.

The visual attraction of the ball continuously zig-zagging backwards and forwards is

mesmerising and holds the viewers' attention whenever a Congreve clock is put on display.

There is no doubt that they are difficult clocks to make and adjust, the fusée movement and framework are a challenge, let alone the tilting table which is a totally alien concept to a clockmaker.

This is probably the reason that for many years most Congreve clocks were made by model engineers, well known for overcoming a challenge and tackling difficult projects, employing many engineering techniques unfamiliar to a clockmaker.

The clocks beguilement did create a limited commercial market and some notable firms of clockmakers did start to produce them; however they were not made in great quantities and as such were quite expensive.

Irrespective of the maker or manufacturer, these clocks are still difficult to set up correctly. In operation they rely on gravity, perfect adjustment and being absolutely level in all directions; any slight deviation will result in the clock stopping. It requires a great deal of patience, understanding and observation to set these clocks up correctly.

Quite recently Congreve clocks have started to be manufactured in Asia and exported to America and Europe, and they are now more commonly seen than in the past.

The majority of these newer clocks are bought via the internet and quite a few secondhand Congreve clocks are now appearing regularly in sale rooms and online auctions.

I was recently asked to look at the Congreve clock shown in **photo 1** which had been recently bought in England on



A Congreve clock in its vital glass case.



Underside view of the tilting table.

eBay. The clock would appear to be possibly 10 or 15 years old. It was not running but was advertised as having been working in the past. The new owner had tried to sort out the problems but encountered difficulties and wondered if it was possible for me to look at the clock, clean it and adjust the movement in order to get it running.

This is not the first time that I have been asked to work on these clocks and I have worked on both commercially made examples and individual clocks made by model engineers. The clocks I have worked on have all been well made and the usual problems that I have encountered have more to do with the adjustment and setting up of the table than faults with the movement or components. As many of these clocks are a favourite with model engineers, I thought it may be of interest to readers who have perhaps made or are thinking of making a Congreve clock to look at some of the problems and adjustments that need to be made in order to get the best out of these most interesting of clocks.

Gravity

Most mechanical clocks rely on gravity to operate correctly, especially pendulum clocks driven by weights and springs. Congreve clocks are the same only perhaps slightly more so. The Congreve clock relies entirely on the force of gravity to give impetus and momentum to the steel ball as

it zig-zags along its track on the table.

Pendulum clocks have to be level and the pendulum put in beat in order to operate correctly. The regular impulse and swing of the pendulum controls the release of the escape wheel and wheel train over an accurate and measured period of time. With a Congreve clock the same principles apply, only here, the tilting table is the equivalent of the pendulum which must tilt twice a minute in order to release the locking wheel, letting the wheel train operate and the hands move forward.

Unlike a conventional clock, the wheel train of a Congreve clock is not constantly driving the escapement and hands; only when the table tilts and the locking wheel is released does the movement wheel train advance and drive the three hands together at thirty second intervals.

The tilting and unlocking of the table is dependent on the steel ball consistently traversing the table from left to right and back again and operating the table release levers as it does so. The movement plays no part in driving the ball; the ball relies solely on the angle of the table and gravity for its impetus.

In order for the ball to run continuously, the table must be level. This is one of the prime requisites of a Congreve clock. If the table is even slightly out of level it will impede the travel of the ball - the ball will slow down, lose momentum



Support bracket and pivot screw.

and eventually stop. The clock must also be perfectly stable and be placed on a solid table or work surface which is not prone to vibration or movement of any kind. If the table or work surface is situated on a wooden or carpeted floor, any surrounding movement can easily upset the stability of the clock. As important as it is for the clock to be level, certain other mechanical adjustments must also be understood and made when assembling and adjusting a Congreve clock in order for the clock to work correctly and to help in pinpointing and solving any possible problems that may arise later on. I list below some of the important checks and adjustments that should be made when working on a Congreve clock. These adjustments apply to both a newly constructed clock as well as a Congreve clock that has just been dismantled, cleaned and serviced.

Checking the flatness of the table

If the tilting table is fabricated, the surface of the table should be checked diagonally for flatness with a steel rule. Any curvature of the surface should be removed by adjusting the diagonal steel stress rods fitted on the underside of the table. The stress rods run in brackets and are threaded at both ends; small nuts are screwed onto the ends of the rods and these are adjusted in order to compress or release the appropriate stress rod

until the surface of the table is perfectly flat, corner to corner. The surface of the table must be flat otherwise the ball will not run evenly along the track. The diagonal stress rods on the underside of a fabricated table can be seen in **photo 2**.

The table should tilt freely and positively in both directions

The table should be free, but must not have too much lateral play between the table brackets and the table support pillars.

Assuming the table has been checked for wear to the pivot screws and bearings, the pivot screws should be adjusted so there is very little play or end-shake between the table brackets and the table support pillars. The pivot screws are adjustable and usually provided with locking nuts which should be tightened when the optimum position of the table has been achieved. One of the table support brackets and pivot screws is shown in **photo 3**.

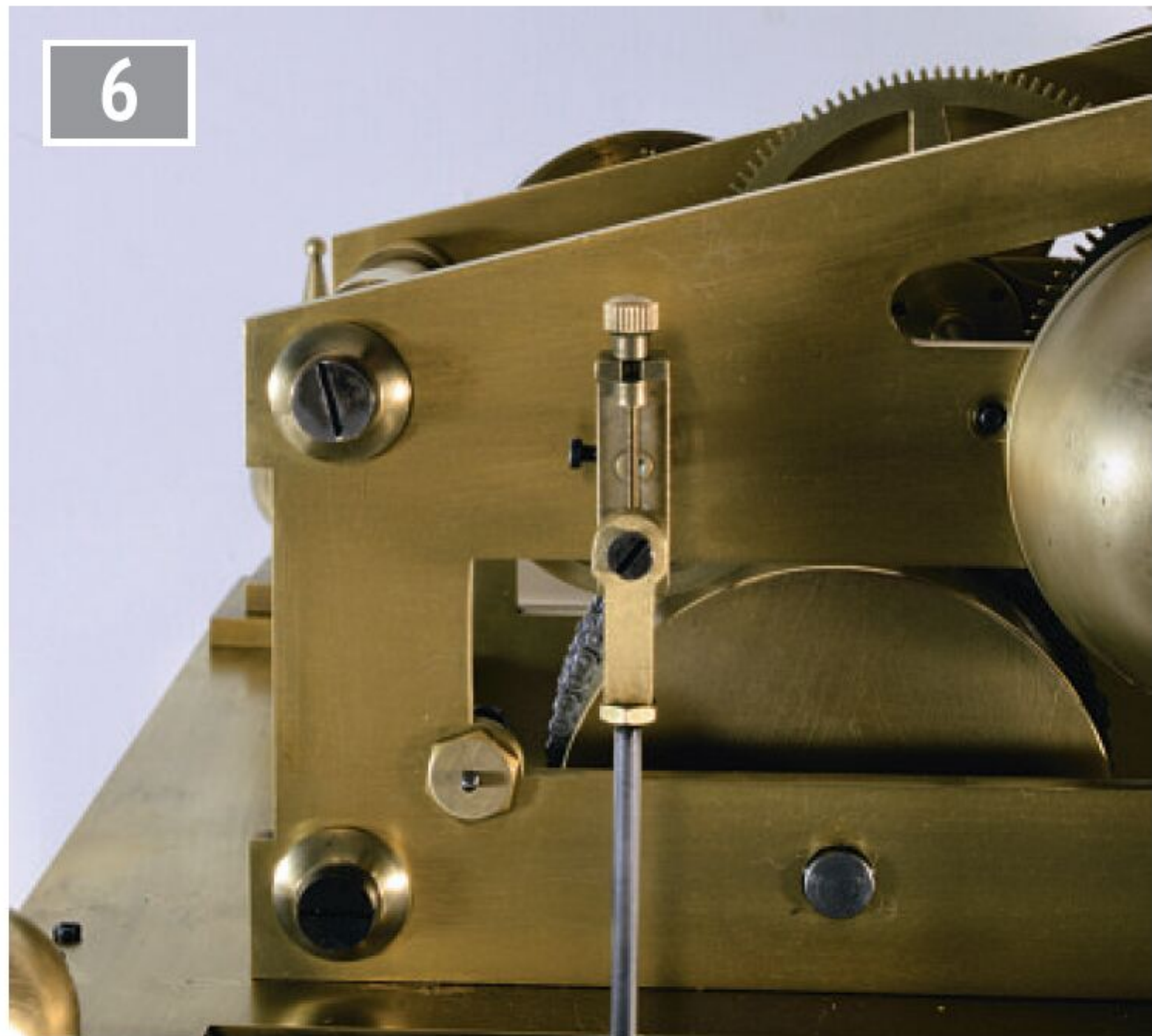
The table must be checked for balance

The table connecting rod is attached to the rotating crank and the lower table bracket. These components are permanently attached to the table and add extra weight to one side of the table. If the table is not equally balanced the movement will require more effort to lift one side of the table than the other.

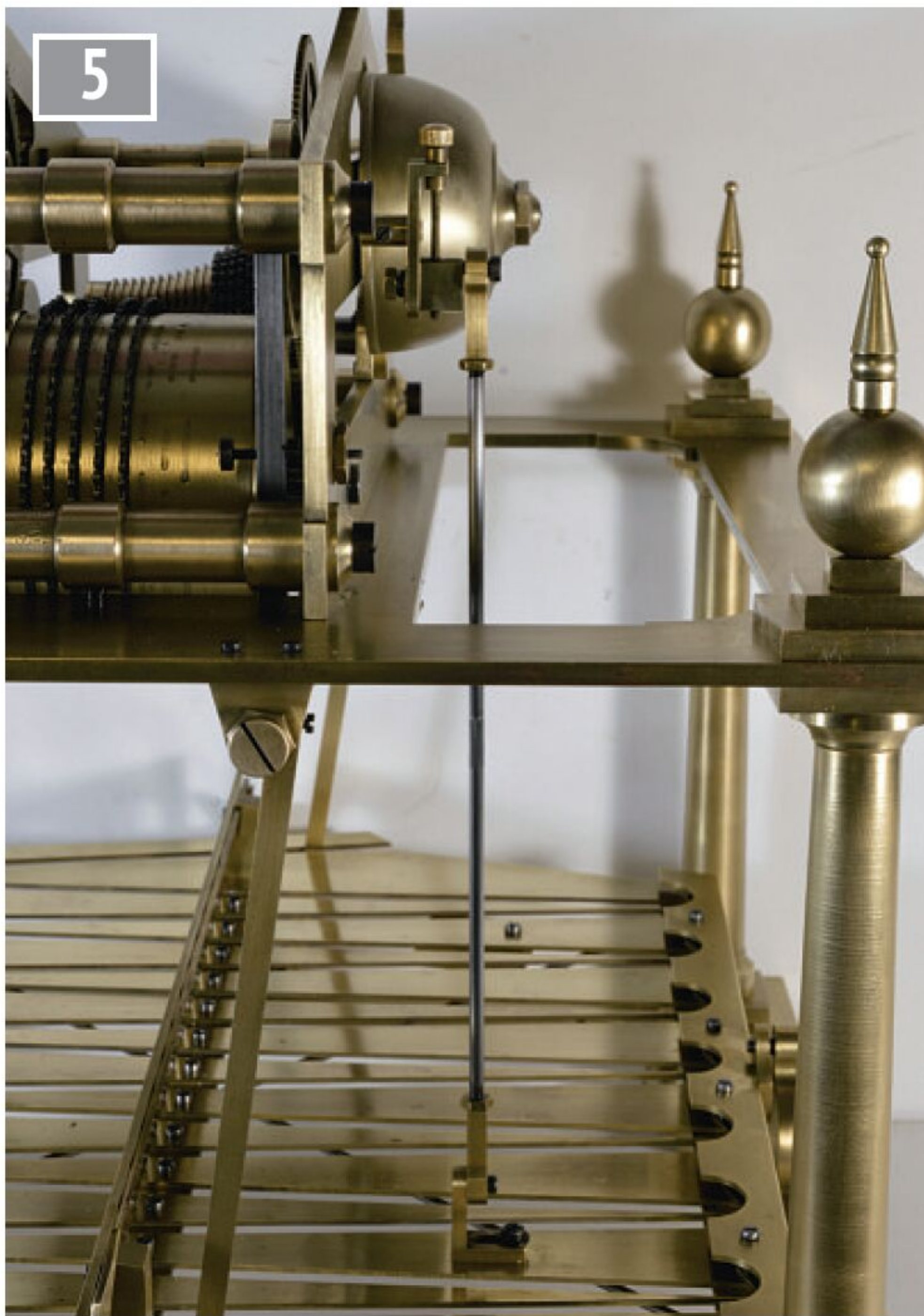
A counterweight has to be provided on the opposite underside of the table in



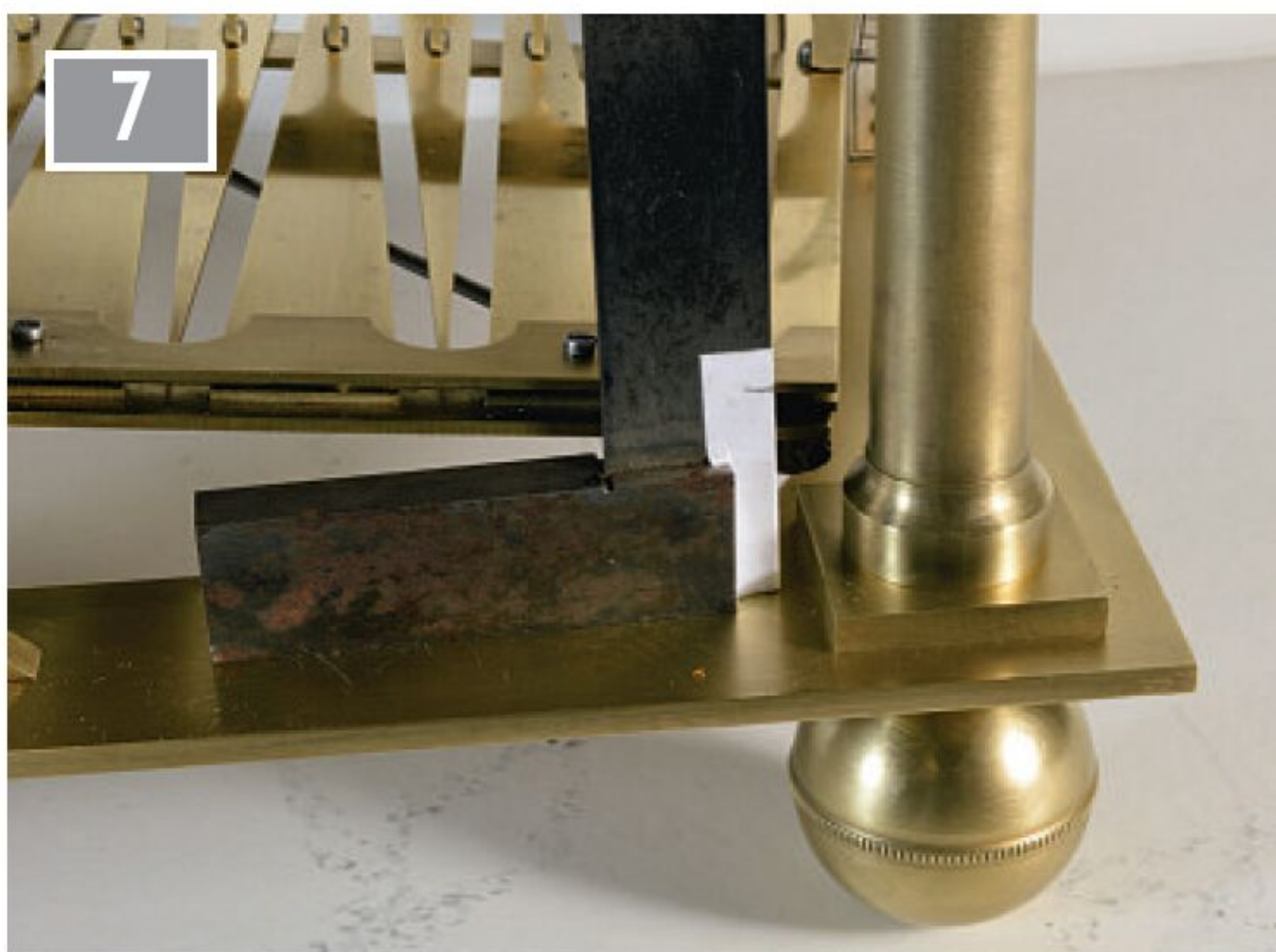
Table counterweight.



Rotating crank, with adjustment.



Connecting rod for tilting the table.



Checking the position of the top corner of the table.

order to balance the table. With the counterweight in place the movement should lift both sides of the table at the same speed. If, when the locking wheel is released, the movement is slower when lifting one side of the table than the other, the balance of the table should be carefully checked.

The connecting rod should first be removed from the rotating crank and left connected to the table. The table should then be checked for balance. This may lead to some experimentation with the counterweight, which if correct should be sufficient to balance both sides of the table equally.

The connecting rod assembly should also be checked to ensure the crank is able to

rotate freely. When assembled, and with the locking wheel locked, the rotating crank and the connecting rod must be positioned vertically and parallel to the rear movement plate in order for the crank to freely rotate.

The table counterweight attached to the underside of the table can be seen in **photo 4**, the connecting rod assembly in **photo 5** and the rotating crank in **photo 6**. In photo 4 you can see this counterweight has been drilled-out in order to achieve the optimum weight.

The table must tilt by the same amount in both directions

In order for the ball to travel at the same speed when

running both left and right, the table must tilt the same amount in both directions. This is achieved by adjusting the length of the table connecting rod.

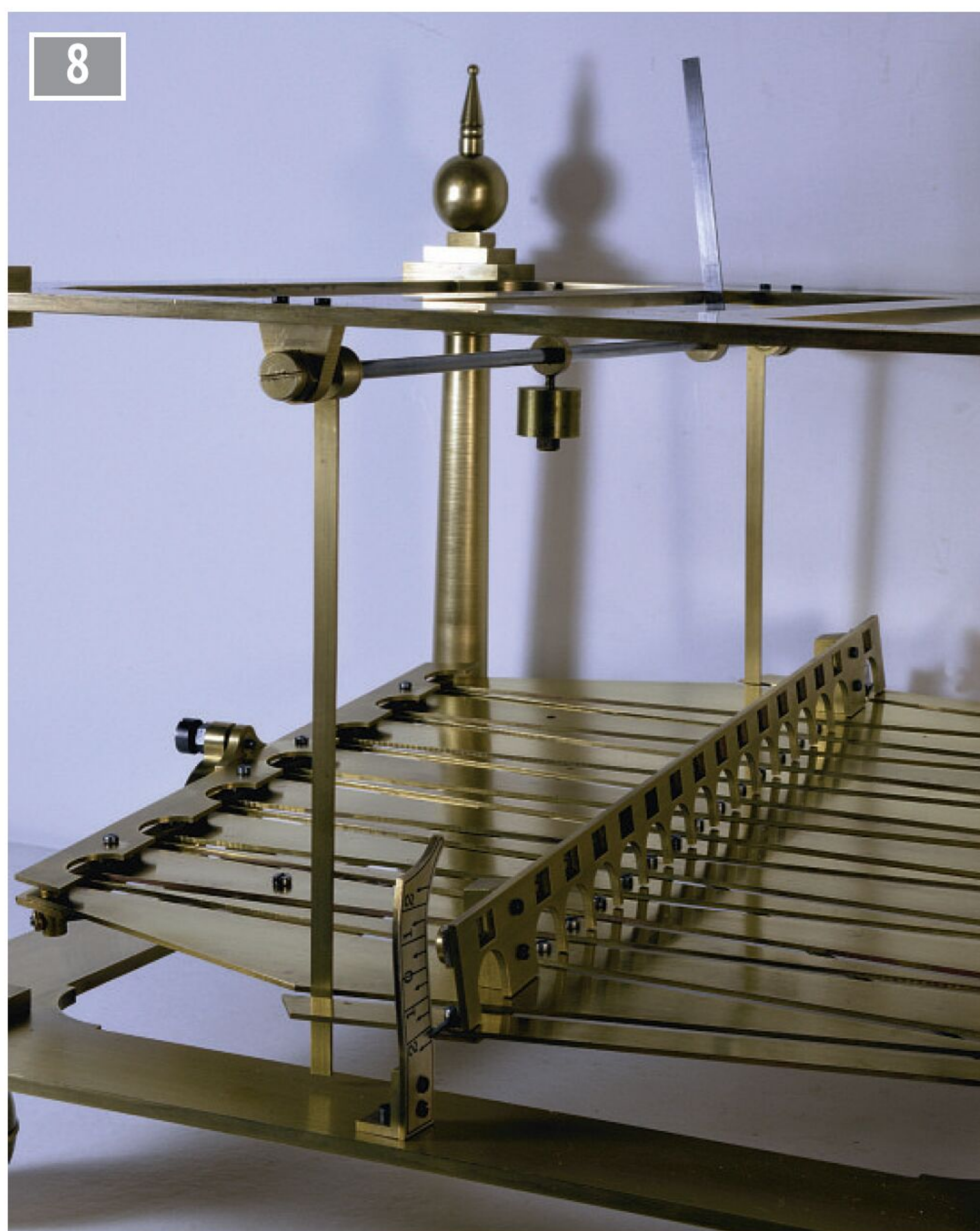
The connecting rod is threaded at both ends and screwed into the rotating crank and lower bracket; the rod should be screwed in or out of the components and adjusted until the tilt of the table is found to be equal in both directions. This can be checked with the use of a steel rule or by placing a small engineer's square on the bottom plate and marking the distance between the top corner of the tilted table and the bottom plate. When the connecting rod is adjusted correctly, the measurements

and tilt on both sides of the table should be the same. **Photograph 7** shows a small engineer's square mounted on the base plate and the position of the top of the tilted table marked on the blade.

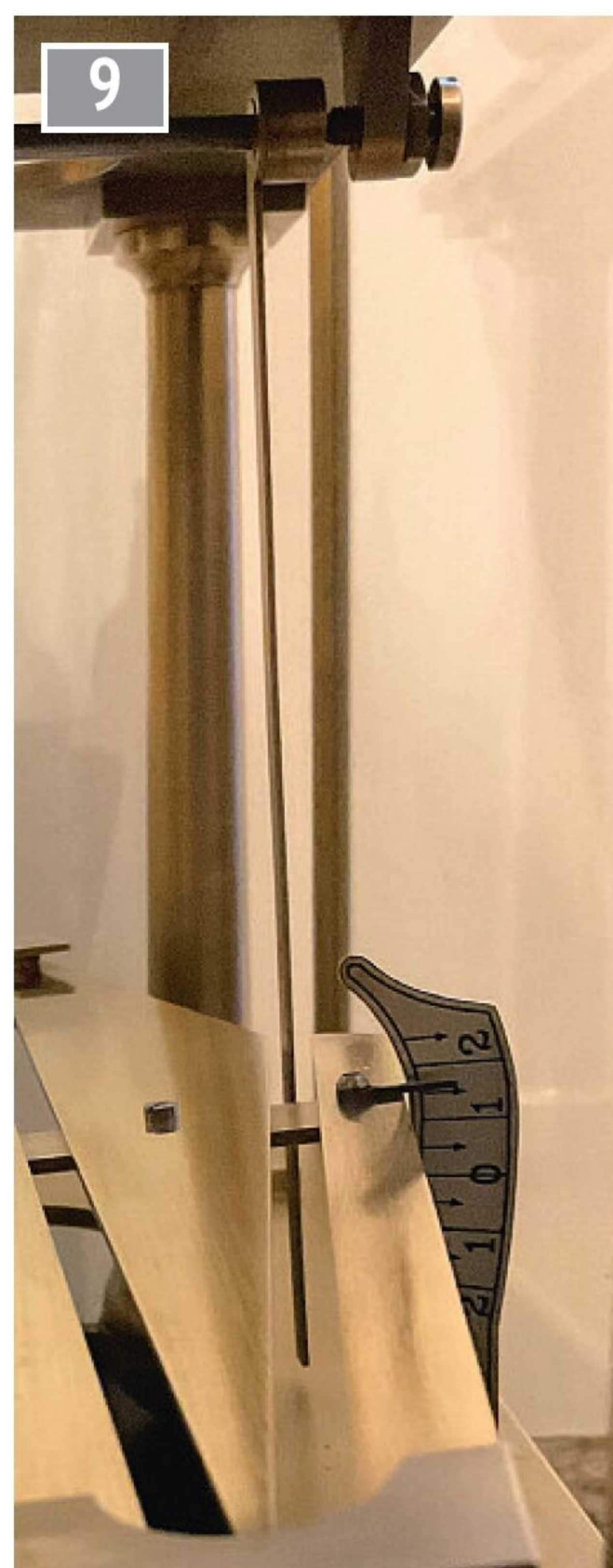
Adjusting the table release work

The table release work consists of a pivoted steel arbor running under the length of the top plate with two adjustable brass release levers operating in the ends of the track, a counterweight and a vertical steel locking detent which engages with the radial pins on the locking wheel. The brass release levers should be adjusted and set to hang downwards, with the levers positioned carefully in the middle of the track at a slight angle forward. At the same setting, the vertical steel locking detent should be set to engage with a pin on the locking wheel. The counterweight should then be set at an approximate angle of 30 degrees to horizontal. The purpose of the counterweight is to return the release levers and locking detent to their original position immediately after being struck by the ball and the tilting of the table. The levers and counterweight should be adjusted so the locking wheel is only allowed to make half a turn before being re-arrested by the locking detent. The counterweight must not be too heavy and prevent the ball from activating the release levers, or too light, and slow the return of the locking lever.

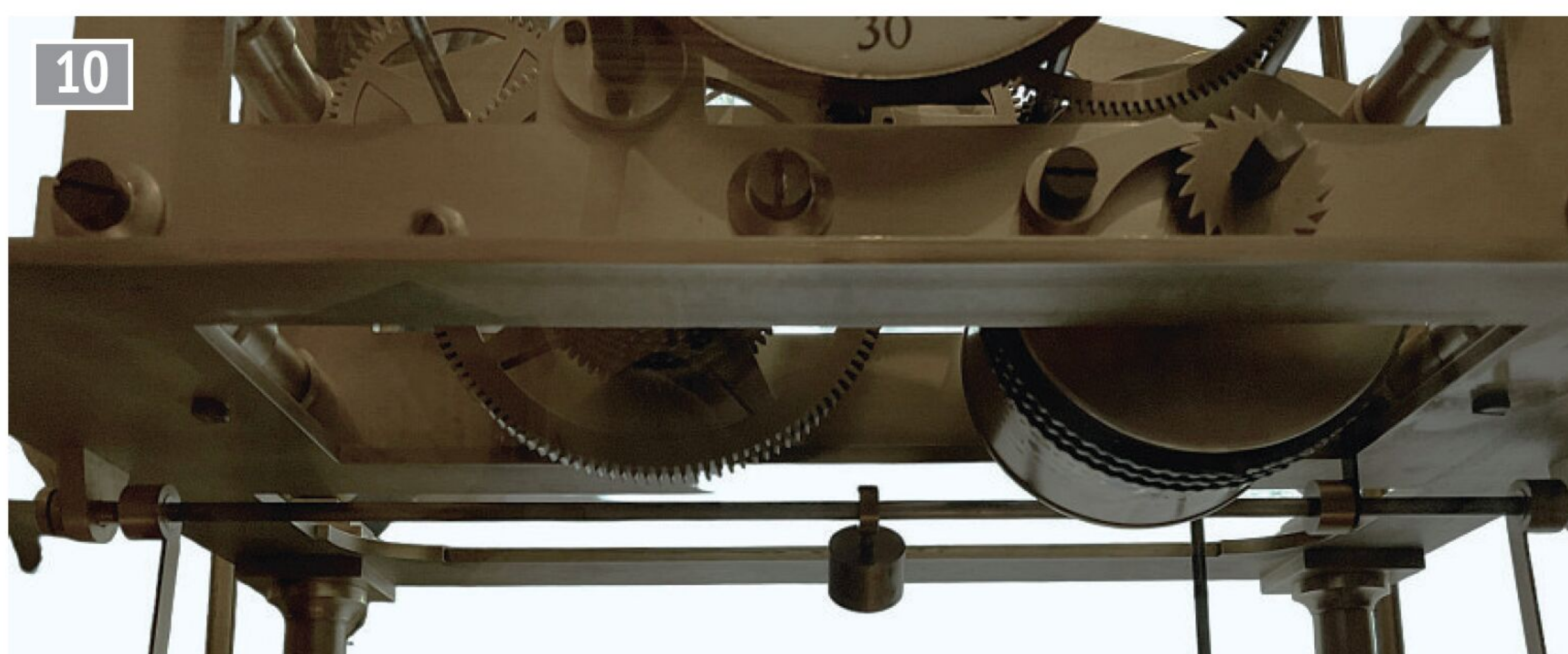
The position of the release levers in the track should be carefully determined to ensure they are set in the middle of the track and do not engage with the sides of the track whilst at rest, or whilst the table tilts. **Photograph 8** shows the table release assembly fitted to the frame before adjustment and before the movement was attached to the top plate. **Photograph 9** shows the amount of desirable clearance of one of the release levers located at the end of



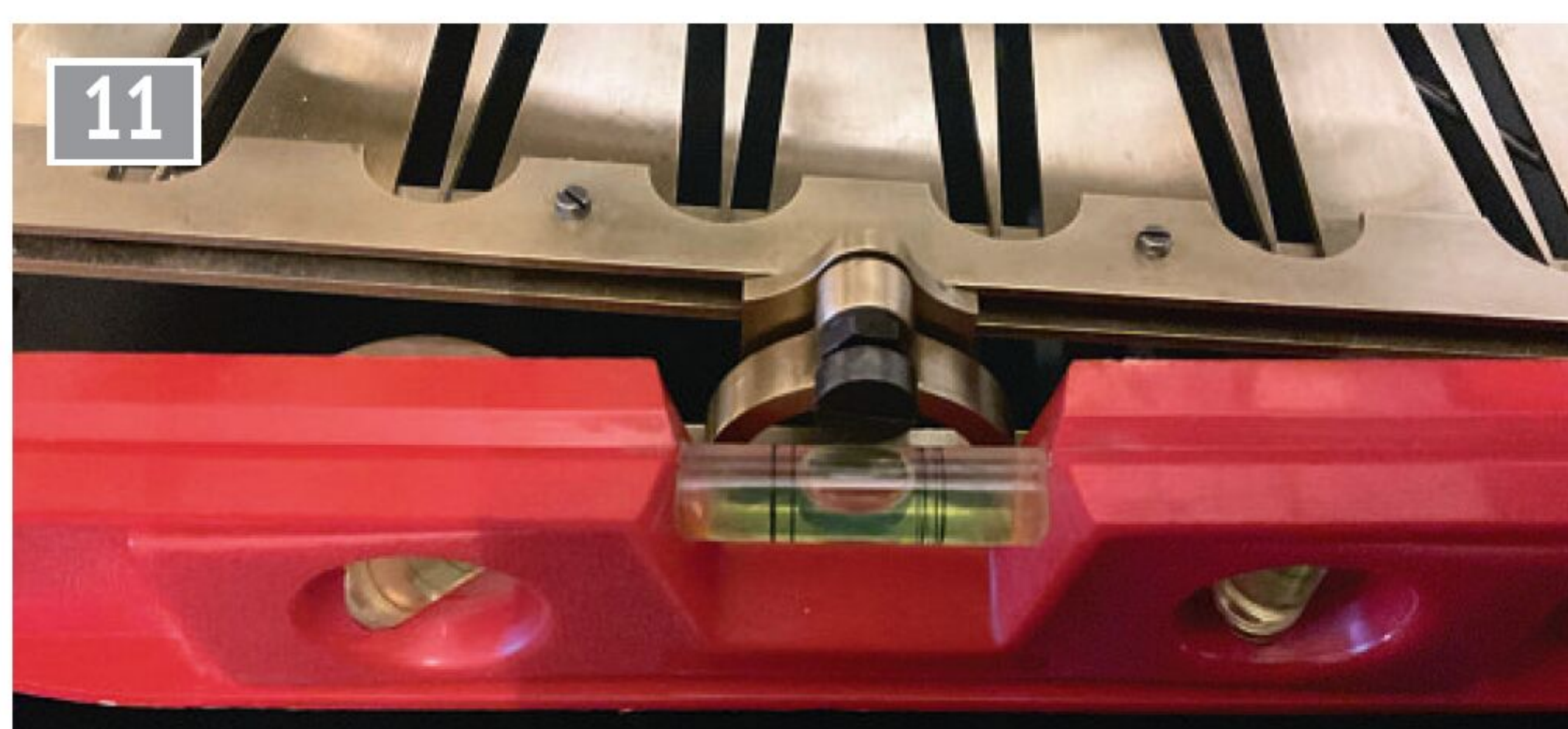
Release levers.



Ensuring the release lever is central to the track.



Counterweight for resetting the levers.



Levelling the clock.

the track and **photo 10** the angle and position of the counterweight used to re-set the levers.

Final checks, levelling and timekeeping

Having checked and made all the adjustments to the various

components mentioned above, the action of the wheel train and table should be checked and the frame of the clock adjusted and levelled.

The movement should be fully wound and the table release work checked. It should be found that when the release levers are activated, the locking detent immediately releases the locking wheel and the table tilts once only. After activation, the levers should immediately return and in doing so lock the train once more. The locking wheel should be seen to rotate

quickly and positively with no hesitation or sluggishness. Any hesitation of the wheel train or speed in the tilting of the table should be investigated and the cause remedied before proceeding further.

With respect to this issue, it should be noted that most Congreve clocks are fitted with a fusée. A fusée is a device which evens the torque of the mainspring as it unwinds in the barrel. The mainspring should be 'set up' or given a preload when the movement is assembled. The preload is not always the same on all movements, as a lot depends on the size of spring and several other factors, but the preload should be sufficient so that even when the fusée is nearly unwound and most of the line is transferred from the fusée to the barrel, there should still be sufficient power to drive the movement and tilt the table. If the preload is not sufficient it can result in the movement gradually losing power and both the turning of the locking wheel and tilting of the table becoming sluggish. The preload should be checked to see that it is sufficient and the movement still has enough power to tilt the table as the clock runs down.

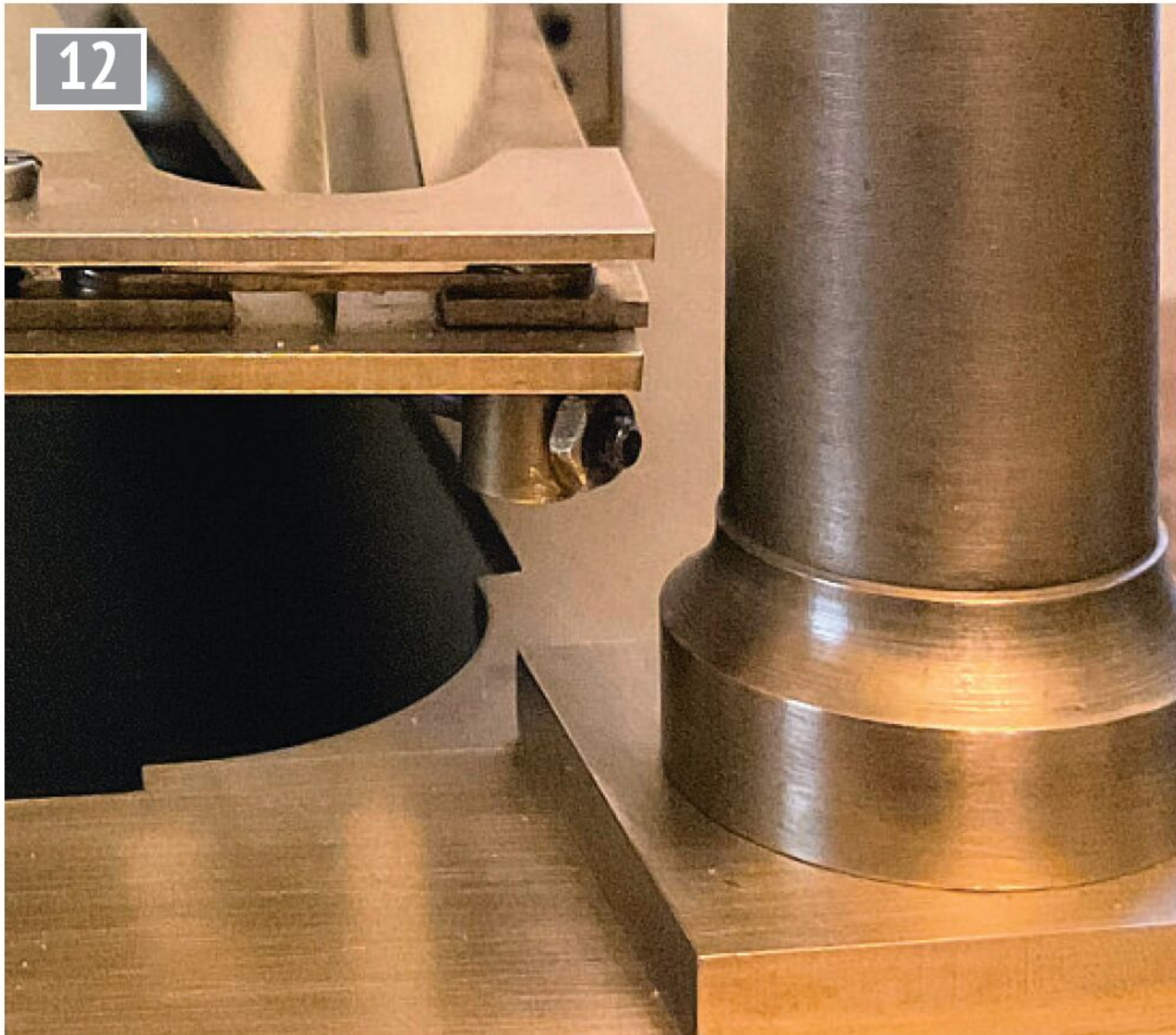
The table should be checked in both directions and the table should tilt with the same speed and by the same amount each time.

When happy with the performance of the table, wheel-work and release work, the clock frame can then be levelled.

Congreve clocks are always provided with adjustable ball feet which are attached to finely threaded steel studding, allowing even quite small adjustments to be made when levelling the clock.

Initially, the frame should be adjusted until it is perfectly level. A spirit level should be placed on the bottom plate of the frame as shown in **photo 11** and adjustments made to the feet until the clock frame is level, both front to back and left to right.

Even if the frame is level, it does not always follow that



The angle of the table determines the speed of the clock.

the table will be level within the frame; sometimes errors in the machining of a component or the assembly of the frame can lead to minor discrepancies which can render the table or its fittings slightly out of level with reference to the frame. Although it is possible to check the if the table is level by placing a small spirit level on the table itself. I personally find a better way is to level the frame and then roll the ball on the table and watch and listen to the action of the ball as it runs. You can quickly both hear and see any changes in speed, indicating a further adjustment needs to be made to the feet of the clock in order to render the table level. If this is the case, the appropriate foot or feet are then adjusted until the table is level and the error corrected. Usually only very slight adjustments to the feet are necessary in order to make a substantial difference to the running of the ball. When correct the ball should be seen to operate the release levers and run continuously at the same speed in both directions.

Any unevenness in the running of the ball on the straight is usually due to the table not being level. However, if the ball stops running or slows after entering a turn, the ball should be carefully observed as it enters the turn. The ball should be seen to

enter the turn smoothly and rotate around the full inner circumference of the turn with no reduction in speed. The ball should not catch on the edge at the entry of the turn and momentarily be thrown off the track. Equally, the edge of the turn should not be too wide or worn, resulting in the ball making contact too far at the back of the turn, losing impetus and speed.

Once the table is level and the ball is running correctly, increasing or decreasing the angle of the table is the only variable means of adjusting the speed of the ball and the timekeeping of the clock.

Initially, the crank adjustment screw should be adjusted so the low top corner of the tilted table is roughly one and a quarter inch from the surface of the bottom plate as seen in **photo 12**. The ball can then be set in motion on the table and a record of the timekeeping made. If the clock is losing time, the angle should be increased to make the table tilt at a greater angle and increase the speed of the ball; conversely the angle should be decreased if the ball is running too fast and the clock gaining in time. The crank adjustment screw only requires a small amount of regulation to make a noticeable difference to the tilt of the table and the speed of the ball.



Counting off the seconds.

Ball size

The ball on this clock is 12mm in diameter and works well. The size and weight of the ball is important as it can affect the operation of the table. If the ball is too light it can have difficulty in operating the table release levers; too heavy and the movement may require more power to lift the table and slow the speed of the locking wheel and the tilting of the table.

Lubrication

The movement pivots should be oiled with a quality medium grade clock oil excepting those of the fusée arbor and the bearings of the barrel on the barrel arbor, which will benefit from a slightly thicker grade of oil. The fusée arbor and barrel bearings take the main power of the mainspring and will naturally be subject to more wear. The table pivots and the two radial pins on the locking wheel should also be lightly oiled. These are the only items that require lubrication. The table release levers do not require any lubrication and on no account should any oil be applied to the track or ball.

Cleaning of the ball and table

The cleanliness of the ball and table is also important. Over the weeks and months of running, even if the clock is enclosed in a glass case, the table will attract dust which will transfer onto the surface of the ball. Over a period of time this will accumulate and eventually slow the running of the ball in the track. The table and ball should be regularly cleaned with a lint-free cloth, preferably

every two or three weeks. On no account should any polishing materials be applied to either the table or ball as this could build up and have to be removed at a later date. The table and ball are shown in **photo 13**.

The Congreve clock is a notoriously poor timekeeper and you certainly don't buy or make a Congreve clock if you want an accurate timepiece. The clocks can be difficult to adjust, one alteration invariably leads to another, but if the mechanism is understood, adjusted and set up correctly, and the clock placed on a solid and substantial flat surface, there is no reason why it should not run perfectly well. Depending on your hearing, they can be quite noisy in a quiet room. The endless motion of the ball and the noise of the table as it tilts is quite noticeable. They are, however, undeniably fascinating to watch. Like a skeleton clock, you can see all of the mechanism in action, making it visually easy for even the novice to understand and grasp the principles employed in the clock's construction and operation. They are a wonderful show piece and always of interest to those who see them. If made by an individual model engineer or clockmaker they are certainly a challenging project and incorporate a lot of combined clockmaking and engineering skills. The work and effort is, however, well worthwhile, the clock providing a longstanding testament and legacy to the skills of the maker.

ME

Part 12:

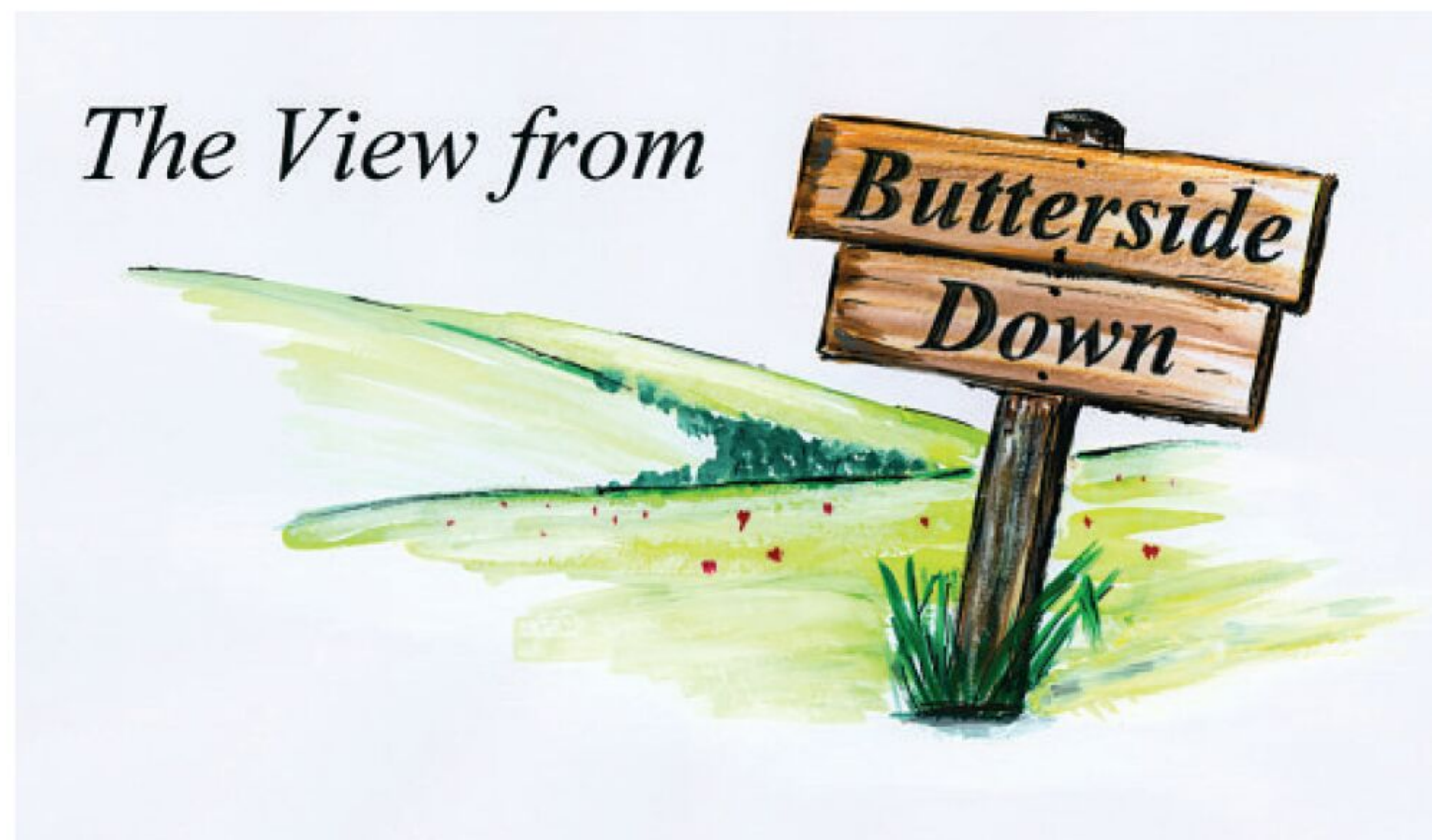
Hauling the Toys - Part 2

Steve Goodbody takes a random walk through model engineering.



Continued from p690
M.E.4743 May 17

The View from



When we left our colonial correspondent, he had just arrived home with a new trailer, six feet long and ten feet wide in its stockinged feet, with a hinged and ribbed ramp at its rear and was preparing to convert it into something that would comfortably haul both a traction engine with its driving trailer and a steam locomotive with its attendant train, albeit not at the same time.

The Wind in the Willows

To kick this episode off, let's have a look at that important aspect of any trailer - its entrance - for without a well thought out entrance you won't be able to load your trailer and if you can't load it then you are the proud owner of nothing more than a fresh-air transporter with wheels. Having lived through the excitement of a couple of tornados and several hurricanes over the years, including Superstorm Sandy, the author can categorically confirm that fresh air doesn't need a wheeled transporter, it can happily shift itself from A to B without any help from you or me and can do so far faster than we can safely drive. Trust me on this (photo 35).

Conflicting needs

While I generally try to avoid stating the blindingly obvious, it is a simple fact that traction engines and steam railway locomotives, while sharing some basic similarities, are not the same. In essence, it all comes down to the wheels, doesn't it? A traction engine likes a nice flat surface - the ground is ideal in all respects - while a railway locomotive prefers rails and strongly dislikes the ground. Are you with me so far? I thought so.

Having piqued your interest with these astonishing insights, let's consider what this means in the context of the author's

transportation trailer, with its ribbed and hinged ramp doubling as the entrance gate, to pick a non-random example.

Now, if you are a weighty traction engine and want to gain access to the bed of a transportation trailer, then what you really desire is a nice, smooth, solid loading ramp - none of those uncomfortable ribs, thank you very much - which is long enough to provide a gentle slope to the ground and give the winch - a necessary component in the struggle against gravity - a fighting chance of getting the beast to the top of the hill without destroying itself in the process or stalling itself into submission. Let's face it, that would be embarrassing for all concerned, wouldn't it?

However, when you're driving this contraption along the highway, with the gate raised in its vertical position, then you really don't want a solid wall sticking up in the air like a mainsail and providing - as it would - the aerodynamic slipperiness of a garden shed and generating the unenviable fuel economy of a Chieftain



Superstorm Sandy's aftermath proves to the author's young family that fresh air needs no help in moving rapidly from A to B.



The plywood ramp attached to the rear gate, folded and ready for deployment.



With the first part unfolded, the ramp does not quite reach the ground.



With the side-by-side lowest portions unhinged, the ramp meets the ground and gives flexibility to cope with uneven surfaces.



With the gate raised, the folded ramp encloses the rear of the trailer while leaving its aerodynamics unaffected.

tank. No, that would be no good at all.

Conversely, while a smooth and solid ramp is all well and good for a traction engine, what if you are transporting a railway locomotive? In that case, in order to successfully transfer your precious cargo from trailer to railway, an entirely different item is probably needed; a bridge, which is sufficiently long and suitably strong to span the trailer's lowered ramp, which is getting in the way, and to interconnect the trailer with the turntable (or traverser, or whatever loading and unloading arrangement exists at the railway destination, but I'll use 'turntable' as the catch-all example and ask that you mentally modify the detail to match other situations) and support the weight of the locomotive as it is wheeled across the chasm. However, the

trouble with bridges is that they tend to be a fixed length and this means that the trailer must be accurately positioned a very specific distance away from the turntable at the start. But how to judge that distance as you reverse the trailer towards its destination? If the trailer's gate is left in its raised position, then the cargo area is hidden from view and the correct distance is impossible to judge. If the gate is lowered, then it drags along the ground and makes a real mess of things.

And so, to summarise, what I ideally needed was a nice, long, smooth ramp permanently attached to the trailer's ribbed gate for the traction engine, a sturdy bridge to span the ramp for the railway paraphernalia, some way to accurately judge the distance behind the trailer while reversing towards the turntable and

nothing more than the original aerodynamically-ribbed gate pointing towards the sky when travelling along the highway. And the solutions to these apparently conflicting goals must not consume valuable payload space and, to throw another criterion into the overflowing mix, the transition from railway duty to traction engine haulage to highway motoring and vice-versa must be quick and, preferably, require no tools at all to accomplish. Straightforward, eh? Ho hum.

Conflict resolution

Now I must admit that this is the sort of challenge I enjoy: a set of apparently conflicting goals, a decent constraint or two and a blank sheet of paper on which to begin.

Clearly, the ramp for the traction engine was the first

problem to overcome, for not only was the transportation of *Ruby Swann* a more pressing issue than the then-incomplete *Jennifer Ann*, but, I reasoned, the dimensions and details of the railway bridge would probably be dependent on the eventual length of *Ruby Swann's* ramp and, hence, the distance it would need to span. One spring morning, with sketchbook at the ready, I lowered the new trailer's aerodynamically ideal gate to the ground and began to ponder the burning question; how to convert the ribbed ramp into a smooth version, extending all the way to the ground when in the lowered position but leaving nothing to impede the airflow with the ramp raised.

While I could certainly make a removable ramp, stored within the trailer alongside the

traction engine when driving along the road, such a ramp would be a real nuisance – something to be removed and stored elsewhere when the trailer was filled with railway equipment. Furthermore, even when transporting *Jennifer Ann* and her wagons, a smooth ramp would be a much safer means of accessing the cargo space – those blasted ribs had already attempted to twist my ankle on several occasions, once successfully, and I wasn't a fan of their incessant menace. No, I didn't want a removable ramp, I wanted one that was always ready for use, regardless of what was inside the trailer and could be deployed in an instant. There had to be a better solution than a removable ramp.

I looked at that ribbed gate for a long time, making sketch after sketch after sketch, each one scribbled out in turn as either too complicated or too space-intensive or both. And then it finally hit me, a solution so obvious in hindsight but so long in coming. Hinges! What if I built a plywood ramp, with one half permanently attached to the ribs on the bottom portion of the gate and the other half hinged to unfold upon and cover the remainder of the gate when in its lowered position? I measured the gate for what seemed like the hundredth time - no, that won't quite work for, if hinged in half the plywood would still be higher than the walls of the trailer when the gate was raised, creating a sail when driving along the road, even if only a small one. How could I get around that? With hinges now at the forefront of my mind, the answer finally hit me: why not a double-hinged ramp? The more I thought about it, the more I liked the idea for, with two sets of hinges, not only could the entire ramp be folded up to be no higher than the rest of the trailer when the gate was raised for towing, but the hinged portion at the base of the ramp could be split in half width-wise to provide greater flexibility for loading and unloading *Ruby Swann* on

uneven ground (**photos 36, 37 and 38**). Furthermore, with the entire hinged ramp system permanently attached to the ribbed gate, it would always be available, would consume very little payload space and the neatly folded assembly would completely block the rear of the trailer when the gate was raised, protecting the contents from rearward damage and prying eyes; an added bonus (**photo 39**).

One problem down.

A bridge just far enough

With *Ruby Swann's* traction engine ramp now resolved and working remarkably well, I turned my attention to the challenge of getting railway locomotive *Jennifer Ann* and her eventual train of passenger wagons into and out of the trailer and across the chasm formed by the ramp when in its open position. Once again, more head scratching and more sketches were the order of the day.

After a while, having determined that a bridge consisting of two angle-iron rails set 7¼ inches apart by spacers would be the simplest solution, I realised it must be at least seven feet long in order to span the open gate and would therefore have to be stored lengthwise in the trailer's payload area when not in use, consuming far more payload space than I was willing to sacrifice. No, something different was needed. After a few more sketches, it occurred to me that it might be possible to make a more compact version in the form of two half-bridges, each made from square steel tubes of different sizes, one half arranged to slip inside the other in the manner of a slide trombone for assembly. If so, then, with each half roughly five feet long and allowing for an eighteen-inch overlap, a sturdy eight-foot-long bridge would result, yet, with the two halves separated and stored crosswise at the rear of the trailer when unused, it would occupy little payload space during transit.

While I certainly liked the idea in principle, I really didn't expect it to be a practical solution for, as much as I may wish for mutually compatible off-the-shelf materials, tubing or otherwise, in my experience such things rarely happen in practice. Imagine my surprise when, upon consulting the appropriate material specifications from my usual metal supplier - and despite all rational expectations to the contrary - the tables suggested that this may indeed be possible. Scarcely believing my luck, I ordered appropriate lengths of 1½ inch and 1¼ inch square section tube, one-eighth of an inch wall thickness in each case and crossed my fingers in hopeful anticipation.

Interference fits

The next weekend, with the packages arrived, opened, inspected and each tube roughly dressed to remove the cut-end burrs, I tentatively offered the smaller tube to the larger and, of course, it did not fit. Opening the measuring-tool drawer and extracting my trusty pair of Vernier callipers, I carefully measured the outside of the smaller tube and the inside of its larger brother and compared the results. Strangely, the figures exactly matched the published specifications, suggesting that the smaller tube should have neatly fitted into the larger without a problem. Taking the two tubes, I made another unsuccessful attempt to slot them together. What was going on?

Now I'm sure that you're well ahead of me, experienced Reader, and the answer to you is obvious, but I had to examine those tubes several times before the penny finally dropped. But drop it eventually did, as I realised that the tubes, which I had incorrectly assumed were manufactured as solid, square-sectioned extrusions, were actually fabricated from steel plate, folded into the correct shape, with the ends continuously butt-welded along their length. And sure enough, running along

the inside of each tube was a weld bead, perhaps fifteen thou' high, which prevented the smaller tube from fitting inside the larger. So near ... yet so far.

I must admit that this annoyed me, for nowhere in the stockist's drawings, specifications or pictures had there been mention of an internally-protruding seam weld. But, having already purchased the materials the facts were plain to see, so it was either back to the drawing board or find some way to make those tubes fit together. *Caveat Emptor*, dear Reader.

Now those of you in possession of a decent milling machine, with plenty of X-axis travel and a surfeit of surrounding space to swing long lengths of square steel tube, are presumably wondering what the problem was. Surely, a shallow slot, perhaps twenty thou' deep and eighteen inches long, milled along one face of each smaller tube in the appropriate location, would provide clearance for the larger tube's internal weld bead, allow it to enter the hole and resolve the situation in one fell swoop? And while you would of course be correct, logical Reader, you are perhaps forgetting that I do not possess such a milling machine and rely upon the small vertical slide of my diminutive Edwardian round-bed lathe when performing the necessary duty. And eighteen-inch-long slots are rarely milled into five-foot long lengths of hefty steel tube using such machines.

But there we are and there I was and, believe it or not and after considering and rejecting a few other options, that is exactly what transpired; so with the round-bed lathe's saddle tilted at roughly thirty degrees to provide sufficient rearward clearance for the lengthy steel tube dangling in mid-air from the vertical slide and with the cross-slide providing its whopping two inches of X-axis milling travel between set-ups, eventually the job was finished. Finally, both smaller square tubes slid neatly into their larger brothers, each missing

➤

the latter's weld beads all the way and providing an ideal basis for a two-part railway loading bridge or, alternatively, a very unusual trombone. Whichever may take my fancy (photos 40 and 41).

The finishing touch

With the roughly eight-foot-long loading and unloading bridge finished, painted a bright *don't-trip-over-me-when-you're-not-paying-attention* shade of red and dis-assembled into its two main component parts, these were each attached to the folded traction engine ramp using dome headed carriage bolts and wing nuts so that, while hidden away within the trailer when the gate was raised (photo 42), the railway bridge was cunningly revealed and readily deployable without need of tools once the gate was lowered (photo 43).

And finally, with the folding traction engine ramp complete and the two-part railway bridge ready for eventual use, that left only one remaining problem to resolve: with the gate raised and the railway bridge hidden inside, how to ensure that the trailer was correctly positioned and properly distanced from the turntable, so that the bridge would safely span the gap without an endless and frustrating succession of gate up/gate down trial-and-error reversing attempts?

Gone fishin'

For a change, the solution to this conundrum really didn't take much pondering; I soon realised that what was needed was a tell-tale pole of the right length whose end would, when attached to the rear of the trailer, hover over the end of the turntable when

the trailer was the appropriate distance away. Realising that the desired distance may change from track-to-track however and not wanting to regularly manoeuvre an unwieldy eight-foot-long pole in the vicinity of easily scratched

models, I decided that the pole should, like the bridge itself, also comprise two shorter and interconnecting parts. Retiring to the workshop, an hour later I returned with two copper tubes, one a sliding fit within the other, an adjustable



The railway bridge in its two-part pre-assembled format.



The eight-foot railway bridge, assembled in slide trombone fashion.



The railway bridge, attached to the folded ramp and hidden within the trailer during transportation.



With the gate lowered, the railway bridge's components are revealed.



A tell-tale pole takes the guesswork out of the reversing process.



45 Ignoring comments about unicorns, the author attaches one half of the adjustable tell-tale pole to the trailer's rear end, ready for reversing towards the turntable. The second half of the pole, lying on the ground beside his right foot, slides into the first to be secured by a simple knurled thumbscrew (photo: Helen Munro).



46 With the trailer positioned the correct distance from the turntable thanks to the tell-tale pole, the assembled railway bridge is laid in place (photo: Helen Munro).



47 Jennifer Ann having crossed the void, the author removes the railway bridge while breathing a sigh of relief (photo: Helen Munro).

brass stop-collar upon the smaller tube to allow the length to be set and adjusted as necessary, a threaded insert silver-soldered into one end of the larger tube to allow it to be affixed to the rear of the trailer for reversing, a knurled screw to hold the two tubes together when assembled and a thin chain dangling from the farthest end to clearly indicate the remaining distance to the turntable.

And, despite the inevitable laughter and disparaging

comments during its initial trial at the club track – the words 'fishing' and 'unicorn' featured prominently if I recall correctly (photo 44) – the fact remains that, no more than ten minutes after attaching the tell-tale pole to the rear of the trailer, Jennifer Ann and her attendant driving wagon were sitting sedately upon the turntable on the other side of the chasm (photos 45 to 48).

That showed 'em!

●To be continued.



48 Ten minutes after first attaching the tell-tale pole to the rear of the trailer, Jennifer Ann and her driving wagon sit safely on the turntable, ready for action (photo: Helen Munro).

SMEE News

The Rolls Royce L Engine

Martin Kyte
has the
latest from
the Society of Model and
Experimental Engineers.



detail, a power plant he spent most of his life involved with, and a very enjoyable and informative afternoon it was. As an aside Matthew's son is part of the Red Bull Racing team and coincidentally, in the light of the subsequent lecture, the conversation over lunch dwelt for a while on the developments in automotive technology brought about by the changing rules of Formula One. The relevance of this will become apparent.

I don't intend to give a blow by blow account of Matthew's talk but hope to highlight some of the things that stood out for me. I am not an internal combustion engine aficionado but belonging to SMEE does expose you to areas outside your own immediate interest, which both widens your horizons and sends your mind off in interesting

and sometimes surprising directions, which I like.

So, a brief outline of the L engine may be as follows. It is a V8 with a central camshaft directly above the crankshaft. Cylinders are 90 degrees apart with inlet valves on the inside of the 'V' and the exhaust ports on the outside. It has a deep skirted 'Y' block crankcase providing strong support for the main bearings and the initial design was a semicircular cylinder head housing the valves which were actuated via rockers and pushrods from the camshaft. High silicon aluminium was used for the heads and crankcase and maximum length waisted studs were used for cylinder block and main bearing retention. These were ground to length and tightened to go/no-go gauges to obtain the correct torque. Unified threads were

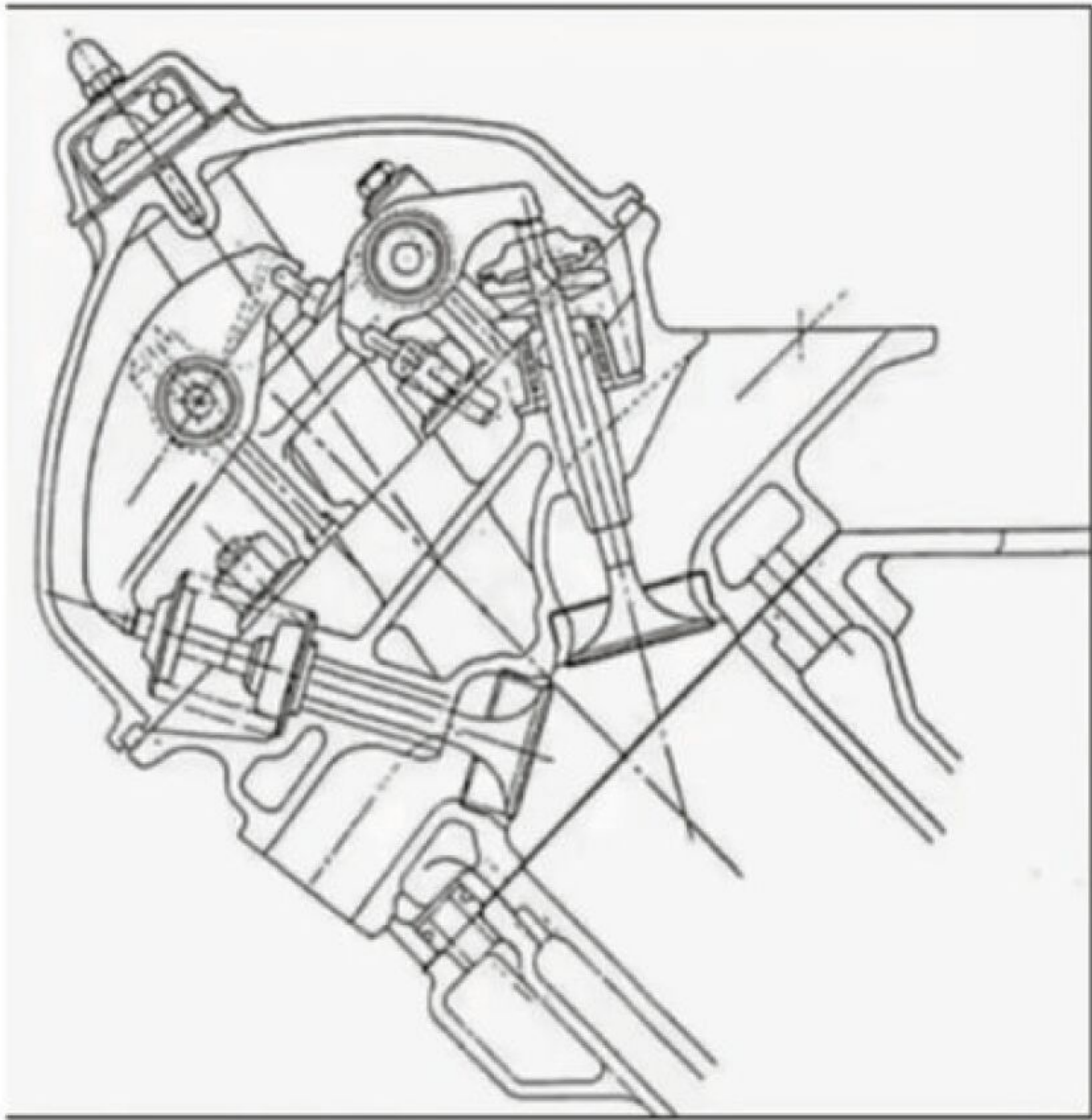
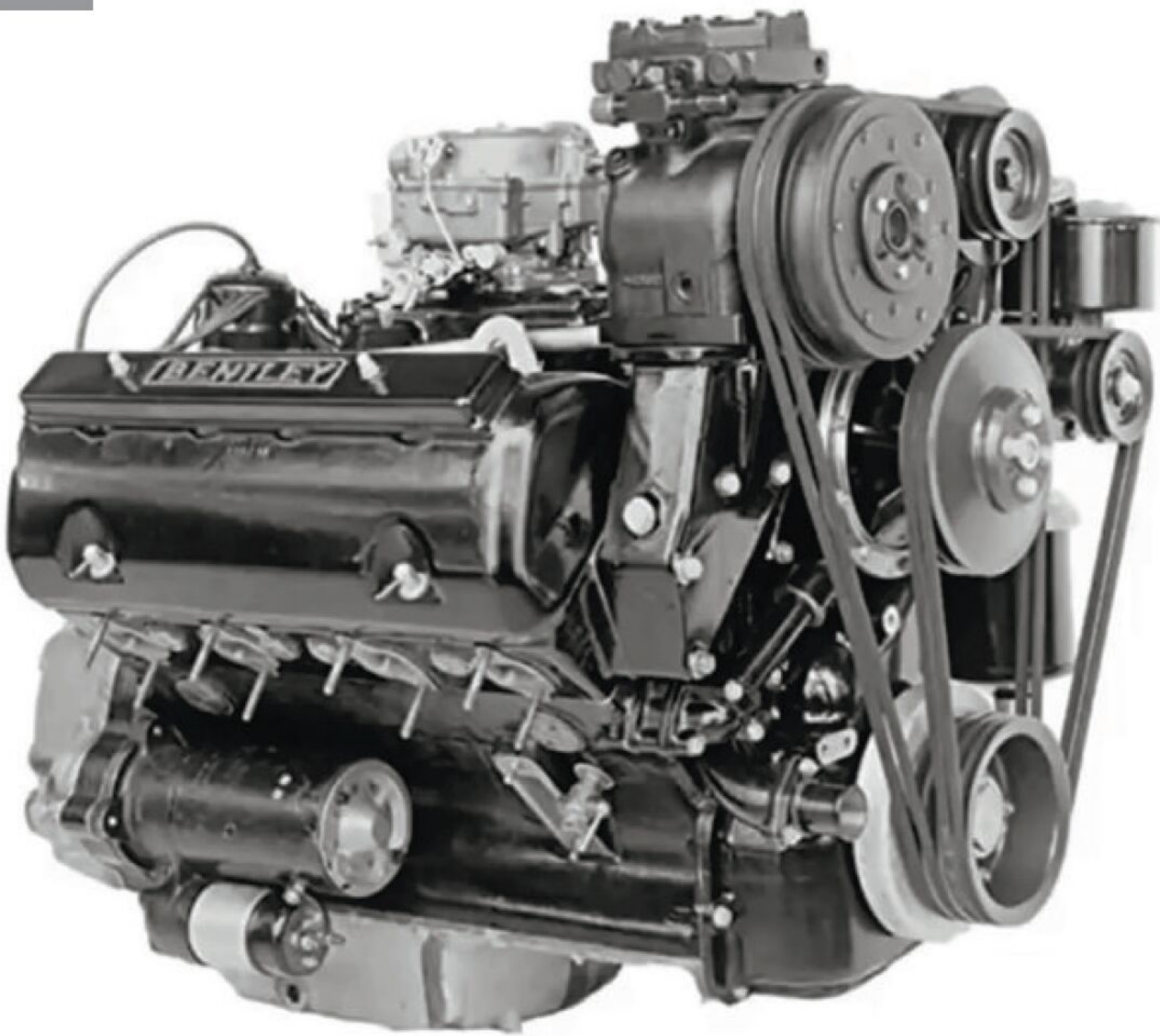


SMEE

Welcome to another catch up on SMEE activities and I do hope you find my musings informative and thought provoking. A while back I wrote about a talk given by Matthew Waterhouse to our Engine Builders Group on the history of engine development by Rolls-Royce at Crewe. Matthew promised us a part two, covering the RR L engine in

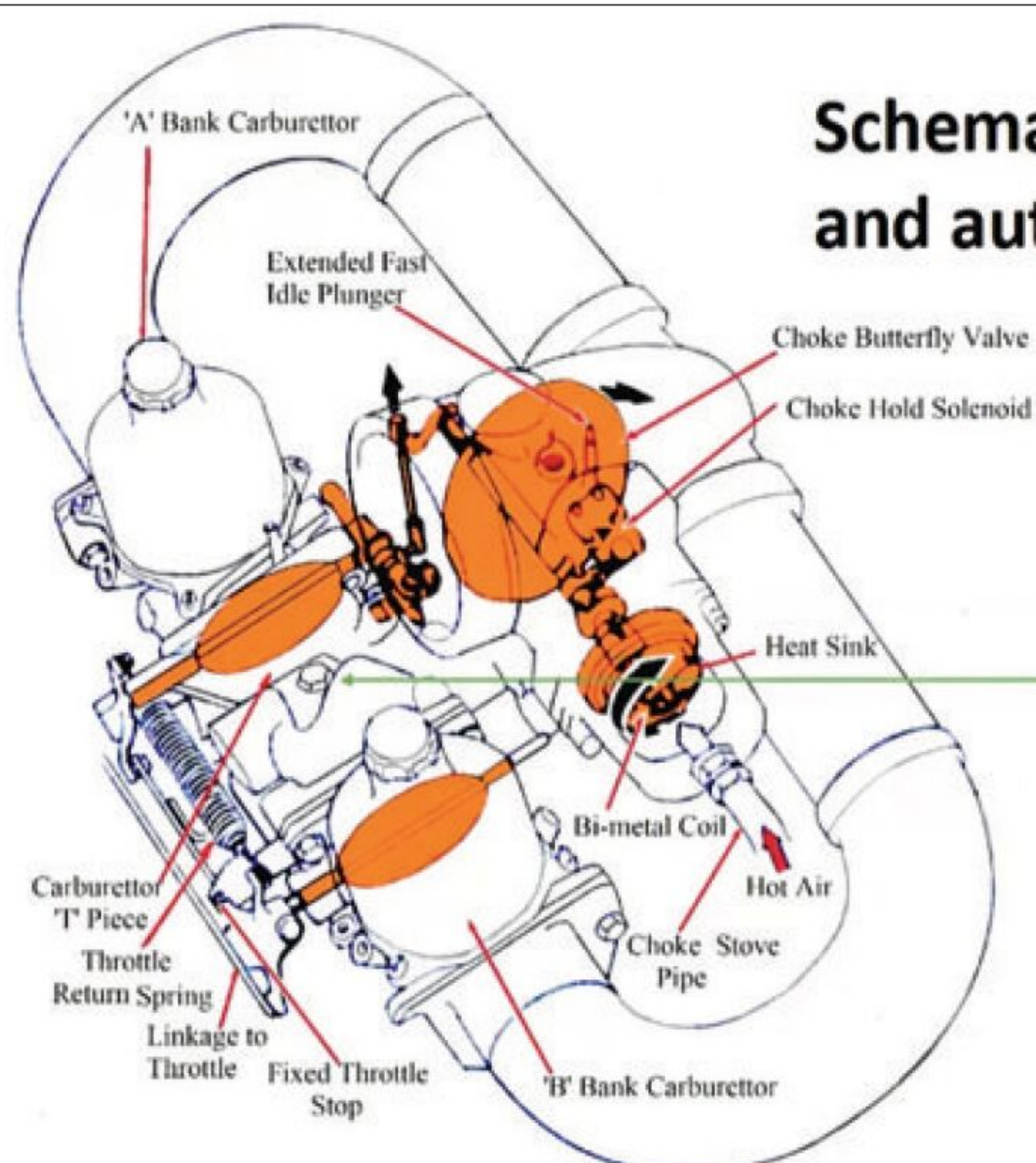
1

The Wide Engine – 5.2 litres



The Rolls Royce L engine.

2



Schematic view of the throttle and automatic choke system.

All retained by a single bolt with some dowels to keep position

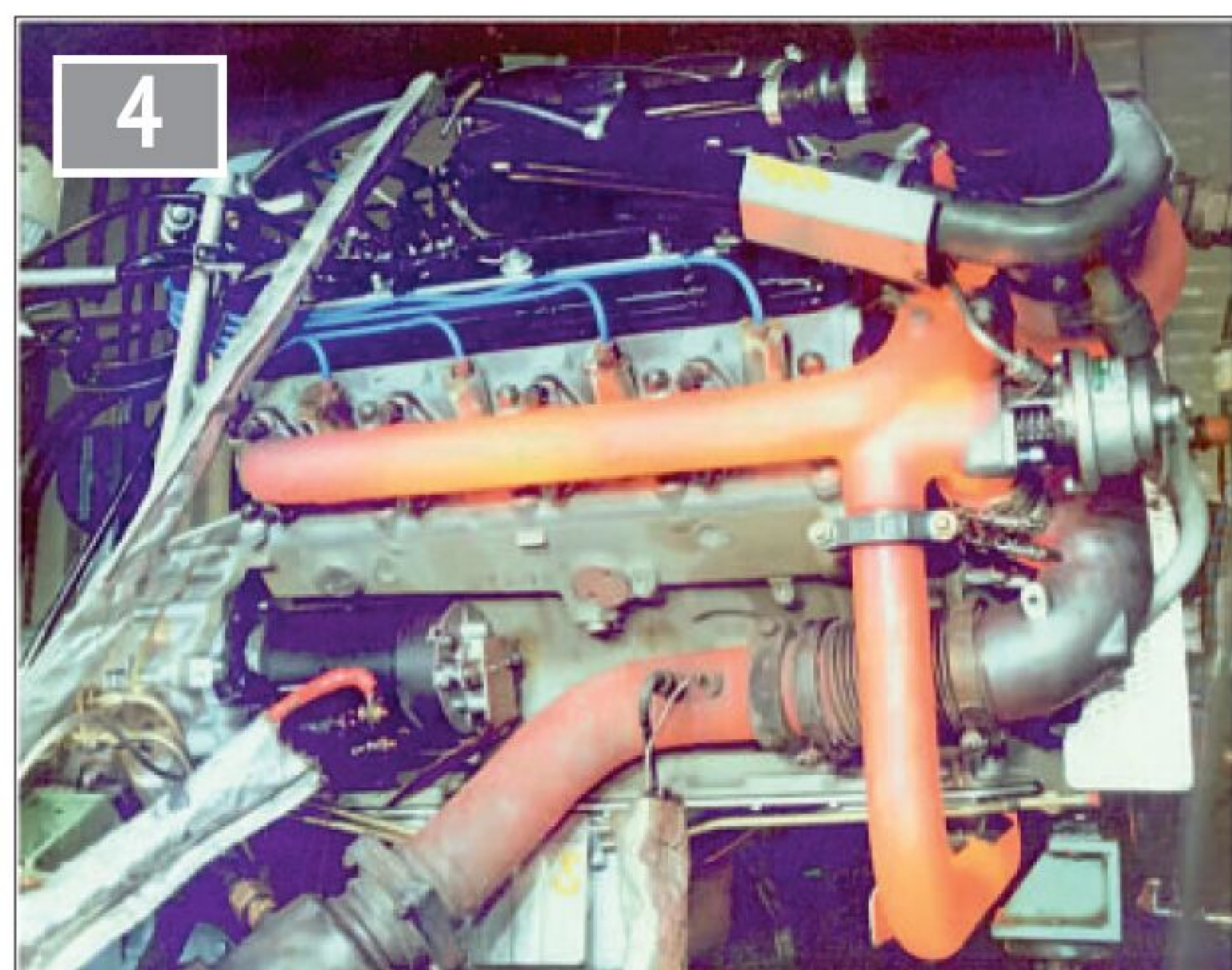
Throttle and choke.

3



The 'smog house'.

4



**L410D
Turbo
Engine
On test**

Red hot engine under test.

employed throughout and the crankshaft was lubricated from both ends.

The initial design resulted in an engine which functioned well but was difficult to squeeze into the engine bays of the S2 and S3 cars. A rework was carried out resulting in a narrower engine and a much better fit (see **photo 1**). In order to shift the cylinder head inboard a wedge-shaped combustion chamber with short exhaust ports was added. This turned out to have long lasting benefits for

emissions as well as allowing exhaust gasses to be vented swiftly without the transfer of too much heat into the water jacket and was retained for almost the entire life of the engine.

A neat design for the carburettor and choke assembly complete with all the relevant ducting is shown in **photo 2**, which is fitted by a single bolt and a number of locating dowels, allowing the entire thing to be removed without disturbance to any of its components.

This brings us to somewhere around the end of the first 20 years of the engine with all the initial teething problems sorted out, the usual refinements done and the engine in full scale production.

The sales environment then started to change. Various countries began to tighten up their emission laws, the most significant being America but eventually Europe too. So, in order to continue to sell to these countries, virtually all the development effort on the engine for the next 20 years was spent in meeting the changing emissions targets whilst retaining or improving the power output. In order to do this an emissions testing lab - the 'smog house' - was constructed (**photo 3**).

To give you an idea of the challenge, the emissions standards for America between 1968 and 1982 required an overall reduction in hydrocarbons, carbon monoxide and nitrogen oxides of 7.1 to 0.41, 72 to 3.4 and 4 to 0.7 gram/mile respectively, representing a cutting of emissions by between 95% and 82% across these three pollutants. Some of the innovations to achieve this included direct air injection into the exhaust system in order to provide sufficient oxygen to the catalyser to clear excess hydrocarbons, some of the hot exhaust was reintroduced to the inlet

which reduced combustion temperature and thus nitrous oxides and a device called an evap. loss canister which collected all potential sources of evaporated hydrocarbons and trapped them in an active carbon filter which was periodically purged.

As you can imagine there was a steady move from naturally aspirated fuel systems employing carburettors through an almost bewildering range of injection systems and turbo charger arrangements which brought an increase in power output from less than 180bhp for the earlier arrangements to 400bhp in the late 1990's. Many of you will recall a similar story of the increase in power of the Merlin during the war years.

I include this last image of a turbo charged engine on test with the entire exhaust system glowing red hot (**photo 4**).

So, my take away from the afternoon was the notion of development being driven by external factors. Whether these were artificial constraints such as race rules to constructors in Formula 1, economic factors, environmental regulations, public demand or direct competition, my thought is that it doesn't matter what it is just so long as it exists. I have a feeling that engineering development works better in a constrained and in some sense pressured environment, almost like evolutionary pressures work in Darwinian selection. We should then see more innovation going on when the stakes are high and it's a case of change or die. I wonder what you think?

I should mention that Matthew is currently helping to edit and publish a book about engine production at the Crewe factory since 1938. The author is Matthew's colleague George Ray, and the book promises to be an interesting read so you should look out for it.

As usual details of SMEE including membership can be found on our website at www.sm-ee.co.uk

Engineering Surface Flatness

PART 1

Neil Raine discusses the meaning, measurement and methods of achieving flatness.



Introduction

The ability to produce flat surfaces on metal and other materials is a prerequisite for the mechanical engineer. Precise surface flatness is highly valued for many reasons within the various disciplines of manufacturing and engineering. Among these, it enables precise movement and rigidity in a mechanical system that subsequently reduces the complications of inefficiency and wear. The eminent British engineer Joseph Whitworth recognised the importance of precise surface flatness early in the nineteenth century, towards the end of the Industrial Revolution. Together with the method of using three comparative plates (the three-plate method) Whitworth had learned the technique of hand scraping metal to precise surface flatness during an apprenticeship

under Henry Maudslay ([ref 1](#)). When used in combination, hand scraping and the three-plate method enabled metal surfaces to be prepared to a precision of flatness that had previously been unobtainable. It represented a momentous turning point in engineering precision that suddenly improved by an order of magnitude. The insight of Joseph Whitworth about the property of flatness is described in the following quotation from a lecture that was given in Glasgow, 1856:

Due latitude must be allowed to the expression 'true surface'. Absolute truth is confessedly unobtainable. Moreover, it would be possible to aim at a degree of perfection beyond the necessity of the particular case, the difficulty of attaining which would more than counterbalance its advantage. But it is certain that the

progress hitherto made falls far short of this practical limit, and that considerations of economy alone would carry improvement many degrees higher ([ref 2](#)).

The three-plate method is very well known and is described elsewhere ([ref 3](#)). Briefly, three metal plates are scraped flat and compared with each other sequentially by using engineer's blue to identify the accuracy of mating between them. This information is then used to progressively improve surface flatness by scraping in - a time-consuming process. Using three rather than two plates prevents the production of one convex and one concave surface on matching plates. The sequence of comparison between the three plates is very important.

Nowadays, it is to great advantage that precisely flat or highly true surfaces are found in all manner of components and machines as well as the sophisticated machine tools that create them ([photos 1 to 6](#)). The property of surface flatness is vital for articulating parts but it is also important when joining non-moving components too. The additional challenge to the engineer is that a flat surface is often required in combination with other geometric properties such as the achievement of precise angles and producing components of uniform thickness. In addition to manufacturing precise surface flatness there is also the need to accurately assess and measure it principally for two reasons; to evaluate the quality of the manufacturing process and to determine the



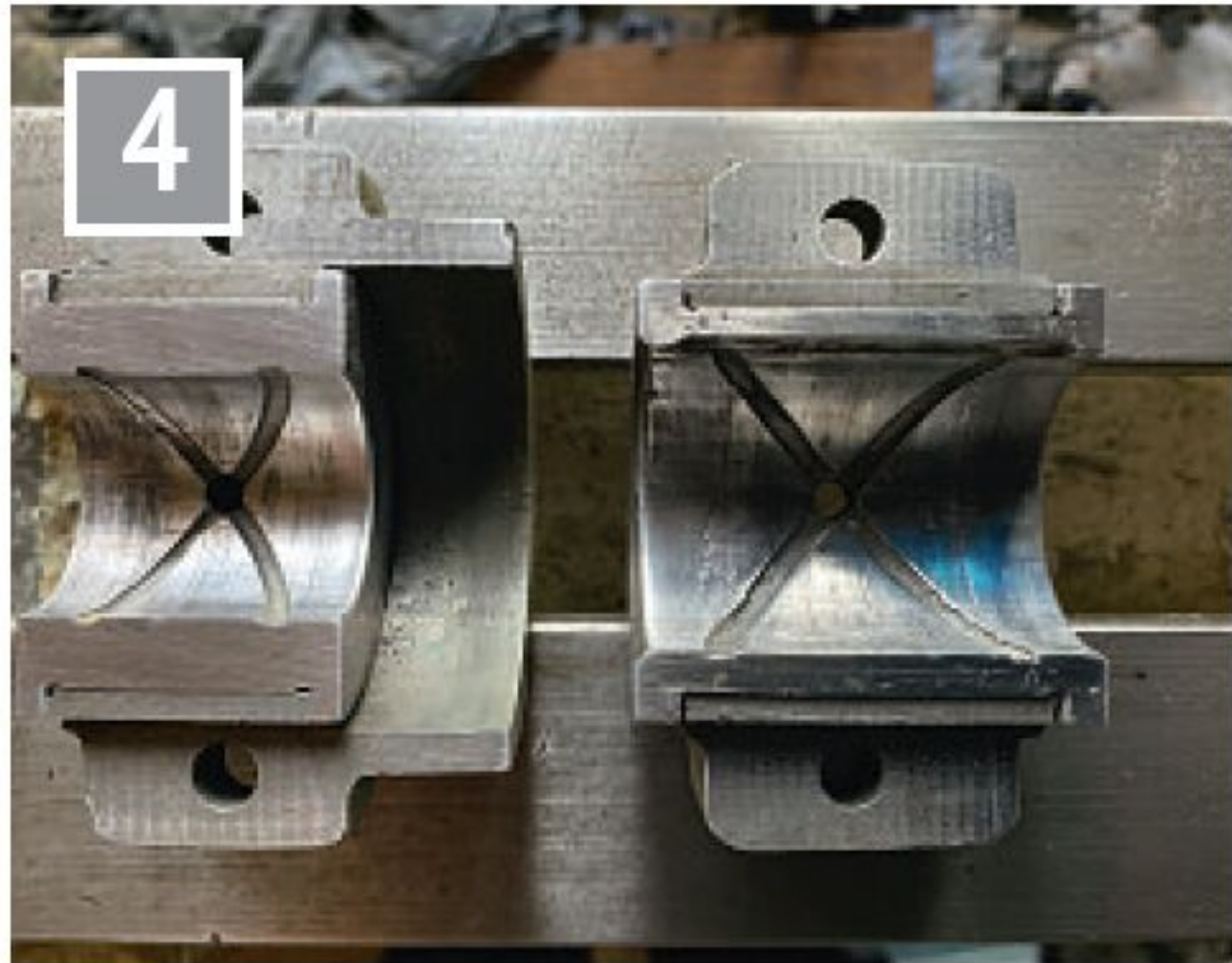
Drill press table.



Lathe saddle.



Myford lathe bed.



Headstock bearing housings.



Machine vice.

condition of a component(s) throughout the operating lifetime of the machine.

Although surface flatness is an essential feature of vintage and modern machines, some details about the property can easily be overlooked or under-appreciated. Therefore, the purpose of this article is to investigate the property of precise surface flatness, how it can be achieved and how it is assessed or measured.

Definition and description of surface flatness

The three-dimensional surface of an object can be likened to a landscape that possesses high points, low points and undulation, to varying degrees. The shape of a surface is referred to as the surface topography or the surface landscape. In contrast to these, the term surface profile is used to describe a two-dimensional cross-section (**fig 1**).

Absolute or perfect flatness is a description of the surface geometry of an object when all of its matter is perfectly aligned in three dimensions, simultaneously, in one plane. This condition is described well by the following definition:

plane (n) A surface of which it is true that, if any two points on the surface be taken, the straight line joining them will lie entirely on the surface (**ref 4**).

When a surface is not perfectly flat, then it must possess the opposing property of roughness, to varying degrees. Alternative words used to describe the surface topography of an object include evenness, regular, planar, levelled, uniform, undulating, irregular, uneven and pitted. Mechanical engineering, particularly, has tended to

adopt the terms flat, flatness and surface flatness to best describe the property that is so highly valued and sought through the process(s) of manufacture. Precise flatness can be regarded as the gold standard against which the engineered surface is compared. In reality it is rare, or likely impossible, to manufacture the surface of a component to achieve absolute flatness, certainly at the atomic level. Therefore, it can be said that engineers strive to get as close as possible to the property of flatness within the confines of skill, tools and machinery, sensitivity of measurement and the material. Each of these categories possesses unique limitations.

The property of flatness occurs in one plane. It is a unique feature that is entirely distinct from other geometric properties such as; smoothness, thickness or parallelism and levelness. For example, flat surfaces are smooth but smooth

surfaces are not necessarily flat. Furthermore, whereas straightness is a two-dimensional component, flatness is a three-dimensional feature. Because surface flatness is independent of the other properties mentioned, it has traditionally been difficult to quantify objectively and assessment of it was, and still is, mostly done by comparison, as shall be seen.

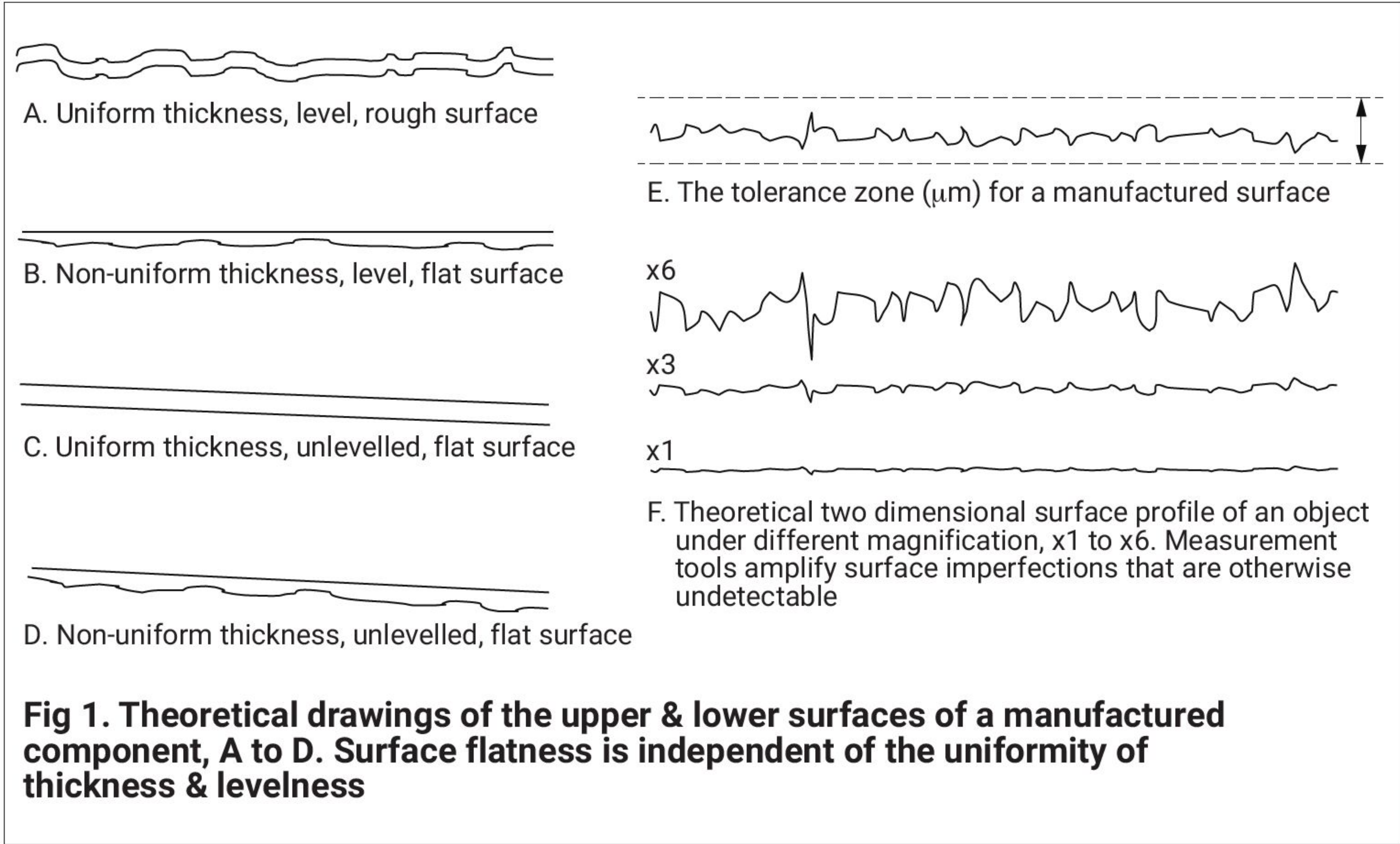
The value of surface flatness in engineering

In order to initially propagate the benefit of precise surface flatness throughout the industrial revolution, it was first essential that the machine tools used in manufacturing, mostly the lathe and the planer or shaper, were of the highest order of precision. From the following extract, it seems clear that success of the company Joseph Whitworth (Machine Tools) Ltd. was built on this philosophy.

The extensive class of machinery, denominated engine

tools, affords an important application of the subject. Here every consideration combines to afford accuracy. It is implied in the very name of the planing engine. The express purpose of that machine is to produce true surfaces, and it is itself constructed of slides, according to the truth of which will be that of the work performed. When it is considered that the lathe and the planing engine are used in the making of all other machines, and are continually re-producing surfaces, similar to their own, it will manifestly appear of the first importance, that they should themselves be perfect models. (It is plain that, in machines intended to be used in reproducing other machines, errors in surface are of the utmost consequence, for the original defects are propagated in an aggravated form.)

In the many different branches of engineering, there are numerous examples where the surface topography of a manufactured component(s) or structure influences important parameters such as wear, fatigue (**ref 5**), rigidity and corrosion. In most instances, but not all, the manufacturing process aims to minimise surface roughness to improve performance parameters. An example of the benefit of precise surface flatness is found in letter sent to Joseph Whitworth in 1840.



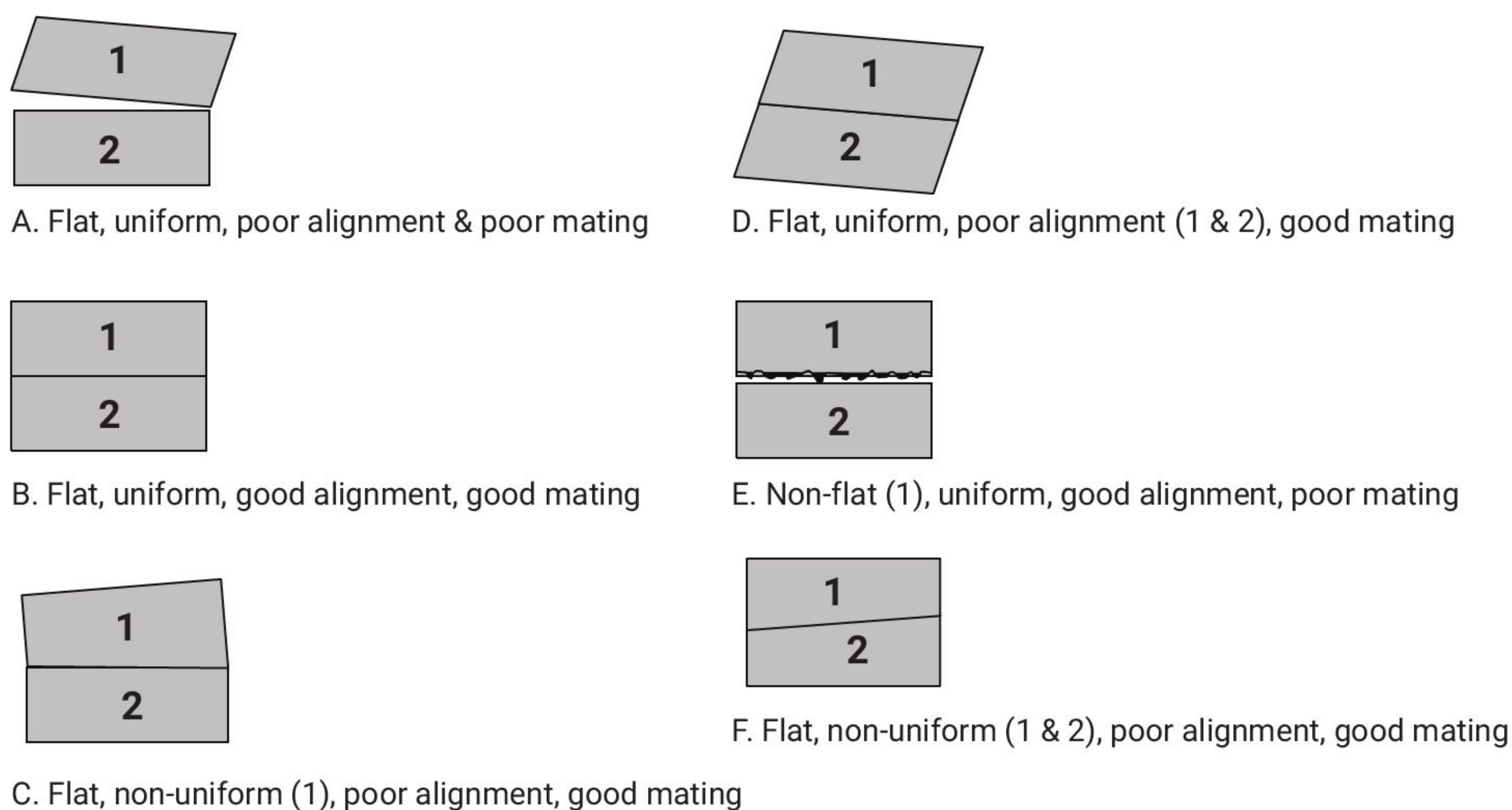


Fig 2. Mating surfaces. Different possible geometry & orientation between mated surfaces, part 1 (top) & part 2 (bottom). Although components can be well mated this does not guarantee correct alignment for the intended mechanical movement e.g. horizontal sliding

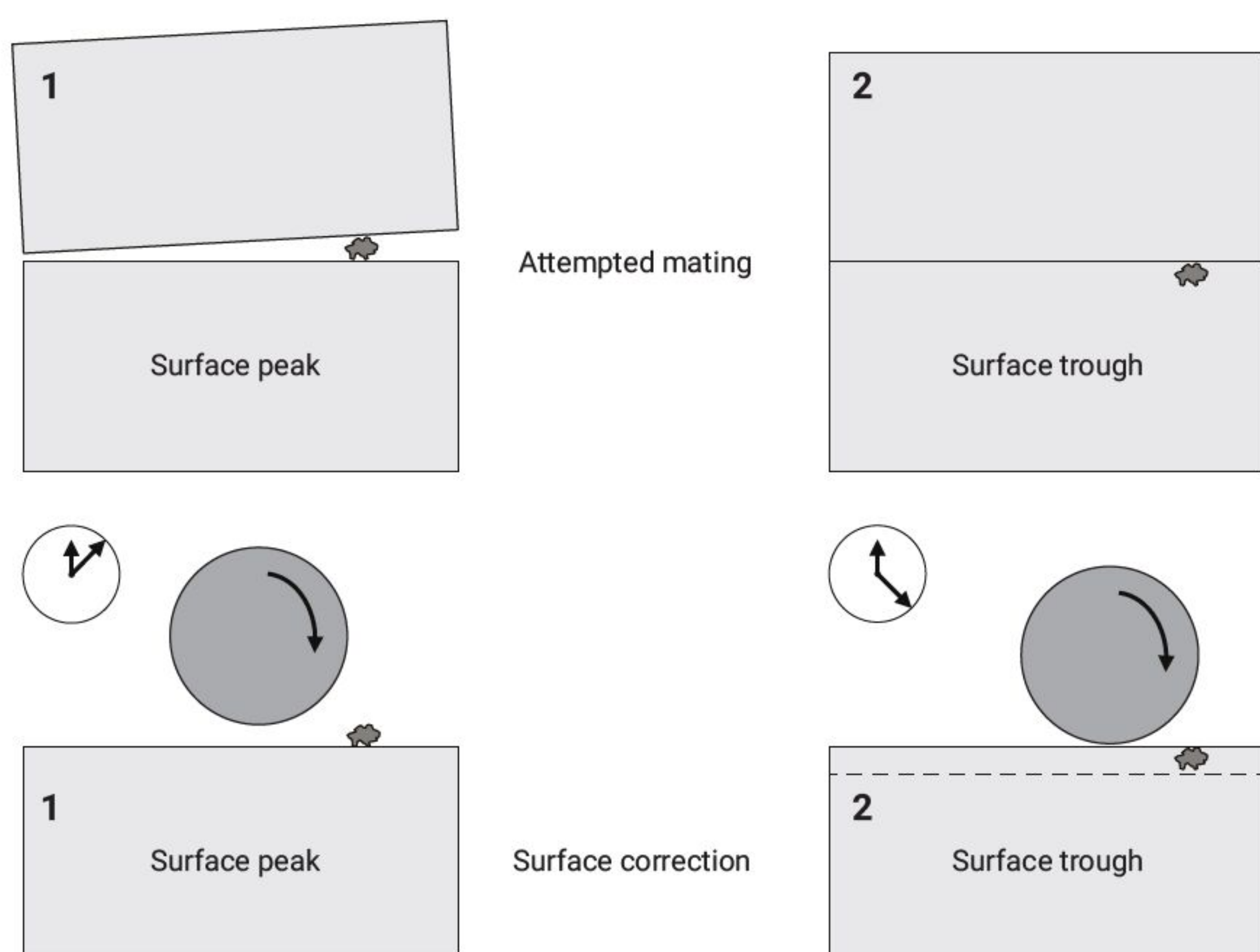


Fig 3. The two types of surface imperfection, positive-peak (1) & negative-trough (2). Shown only on the lower component of a mated pair. The type of imperfection affects the mating between surfaces, the volume of material that must be removed to regain surface flatness & the working time

Mr. Dewrance, Superintendent of the Locomotive Department of the Liverpool and Manchester Railway, in a letter to Mr. Whitworth, dated 23rd December, 1840, says:

'In answer to yours of the 20th inst. respecting the difference of the slide valves got up with emery, and those that are scraped or got up according to your plan, the difference is as follows: - I have this day taken out a pair of valves got up with emery that have been in constant wear five months, and I find them grooved in the usual way. The deepest grooves are one-eighth of an inch

deep, and the whole surface, which is eight inches broad, is one-sixteenth hollow, or out of truth. Those that were scraped are perfectly true, and likely to work five months longer'.

In a typical model engineer's workshop, machined flat surfaces are to be found in many different locations including the surface of a drill press table (photo 1) and a milling machine table, the dovetail of a lathe saddle (photo 2), all faces of a lathe's bed bars (photo 3), the mating surface of a lathe tailstock assembly, the mating surfaces of a bearing housing (photo 4),

the jaws of a vice (photo 5) and the anvil of a micrometer. Although flatness is frequently manufactured onto the exterior surface(s) of a component where interaction with another component takes place, machines will often possess flat surfaces deep within them too. Inside the metal casting of an engine block, for instance, the bearings at either end of the crankshaft are seated onto flat surfaces in order to align them accurately and to retain and stabilise them.

The high surface area of contact between flat sliding surfaces, or slide ways, provides excellent stability and enables predictable and repeatable movement between components. Other advantages of flat surfaces include the precise orientation between non-moving parts and the formation of dependable seals. The seal between two fixed flat surfaces, such as the cylinder head and engine block of an internal combustion engine, is aided using a compressible gasket, as it is in many other situations. The join between flat mating surfaces in a combustion engine is essential to separate the internal compartment from atmospheric pressure, enable the compression of gases and separate different

internal compartments such as the oil galleries and the water galleries. Should the sealing gasket fail, there are immediate consequences including the mixing of engine oil and the water used for cooling.

Using the example of an engineering machine tool, e.g. a lathe or milling machine, it is expected the accuracy of the fit of a machine's mating surfaces is optimal when it leaves the factory. This assumption will clearly depend upon the inclusion of certain stages of production, the quality of the machine's manufacture and the company quality control practice. Even with a brand-new machine straight from the factory, it is likely that some improvement to the mating surfaces can still be made. This might sound surprising and it does not imply that a factory new machine will perform badly. Rather, the implication is that fine honing of flat mating surfaces by the owner of the machine shall improve precision further.

Mating surfaces

Flat surfaces that interact are called mating surfaces, whether there is movement between the components or not. When there is linear motion between flat surfaces, the assembly is described as a slideway. Some examples of slideways from machine tools include the lathe bed and saddle and the table of a milling machine. However, there is a trade-off for the benefits surface flatness brings to machine operation. Because there is a positive relationship between precise surface flatness and the surface area of contact between moving mating surfaces (fig 2), friction between them is comparatively high. Although friction can be managed to an extent using lubricants, there are ultimately consequences of it including heat-production and wear, particularly erosive wear.

The accuracy of the fit of flat mating surfaces is important as it impacts how effectively the machine will perform. In machine tools, optimally mated

surfaces are essential for good rigidity of the components in the machining system. To cut hard materials such as metal, the component of rigidity is critical. To put it another way, enabling rigidity within the machine will reduce the likelihood of vibration that is an enemy of the machinist.

When two components associate, factors other than surface flatness influence the intended mechanical action. As shown in fig 2, the uniformity of material thickness and the alignment between components also influence the intended interaction and movement. This again emphasises the independent feature of surface flatness that, although essential, is not solely responsible for ensuring optimal machine operation. The examples shown in fig 2 also highlight sources of potential error when manufacturing mated components that represent additional challenges to the engineer.

Indicator pigments have been utilised in the manufacturing industry, motor mechanics workshops and professional engineering and home workshops for many decades. Early indicator compounds were not blue but were made by mixing red ochre pigment with oil. Nowadays, and for many decades, the product commonly known as engineer's blue has become the norm. There are two main uses for engineer's blue: the layout marking of components before machining and to assess the fit of machined mating surfaces. Although the permanent felt tip ink pen is now commonly used for marking out work, this cannot replace engineer's blue to assess the compatibility of mating surfaces. Engineer's blue is a simple, reliable and quick method to assess the accuracy of fit between machined mating surfaces. It is commonly used to assess the fit of slide ways and the interaction between gear wheels. The method relies on the contact transfer of

blue dye from one surface to another. Any indication the dye has transferred represents a region of contact between moving components, a bearing point. When the indicator is used to prepare a flat surface it represents a high spot. Although engineers blue is a valuable tool, it is not an assessment of surface flatness. It aids only in assessment of the precision of association between two surfaces - it is an indicator. Theoretically, there could be a perfect interaction between two worn components, neither of which is particularly flat.

Bearing points

When two flat surfaces are brought together, contact is made at a number of locations across the surface. These points of contact are called bearing points because it is upon these points that the load bears down and that support is given from below. The more positions on a surface there are in exactly the same plane, the closer the surface is to being flat.

The esteemed engineer Joseph Whitworth described the concept of bearing points in a lecture that advocated the technique of hand scraping a metal surface towards precise flatness:

It is required in a plane surface, for mechanical purposes, that all the bearing points should be in the same plane, - that they should be at equal distances from one another, - and that they should be sufficiently numerous for the particular application intended. Where surfaces remain fixed together, the bearing points may without disadvantages be fewer in number, and, consequently, wider apart; but, in the case of sliding surfaces, the points should be numerous and close together.*

*Presumably by joining with a fixing such as a bolt or rivet, or by welding.

Before surfaces are fully prepared to be flat, the number of bearing points between them will be low (fig 3). As shall be discussed later,

some surface imperfections will directly interfere with the mating between components and others will not. When the surface imperfections are proud of the surface and the surface is then prepared by grinding or by scraping, the number of bearing points shall increase. This is because additional points of contacts, bearing points, are established by reducing the gap between the two surfaces. In other words, as the height of surface imperfections, preliminary bearing points, is lowered more points of contact come into play. The factors of stability and rigidity, that are so vital to machine tool performance, are related to the accurate mating between surfaces, i.e. the effective bearing points.

Assessment of surface flatness

Flatness is a description or attribute of a surface and is, itself, not measured. The same can be said for the opposite condition of surface roughness. Flatness is a property that is assigned to a surface when it meets the specified requirement of the engineer or manufacturer. Rather, it is the surface topography of an object that is measured or, more accurately, the distances that define the undulations in the surface. The simplest way to quantify surface irregularity (roughness) is to measure the highest point

(peak) and the lowest point (trough) on the surface of the component and express this as a range on a measurement scale. This is not an accurate expression, though, as extreme outlying measurements will greatly influence the result. Collecting a high number of data points from the surface of the material will always provide a more reliable measure of surface topography from which flatness may be qualified. As shall be seen, this can be done in two dimensions or three dimensions.

To quantify an acceptable deviation from surface flatness, the manufacturer will often specify a tolerance zone. A tolerance zone is represented by two parallel planes that are separated by a specified distance. The distance of the tolerance zone equals the maximum accepted variation of surface undulation or the deviation from absolute flatness. The surface of the component must fit within the specified tolerance zone to satisfy quality control. To use an analogy, a tolerance zone can be likened to a letter box and the surface of the component must be manufactured to a dimension(s) to fit within its boundaries. When a surface meets the required standard, it is designated to possess the property of flatness.

●To be continued.

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Ref 3 www.youtube.com/watch?v=rHmsQEAx16o

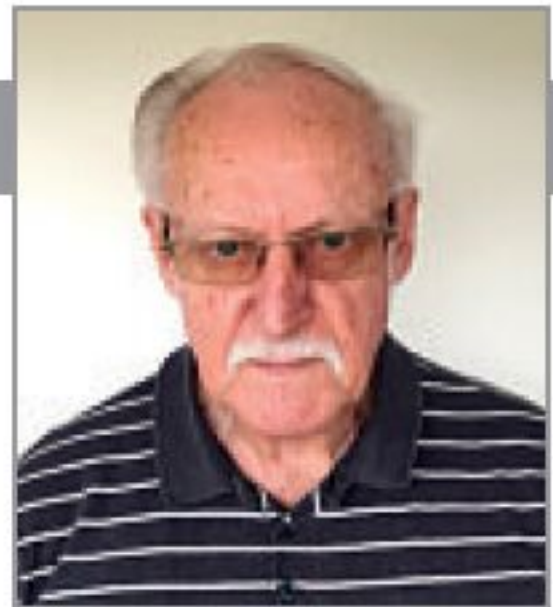
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A Twin Tandem Compound Steam Engine

PART 5

Graeme Quayle presents his own design for a compound winding engine.



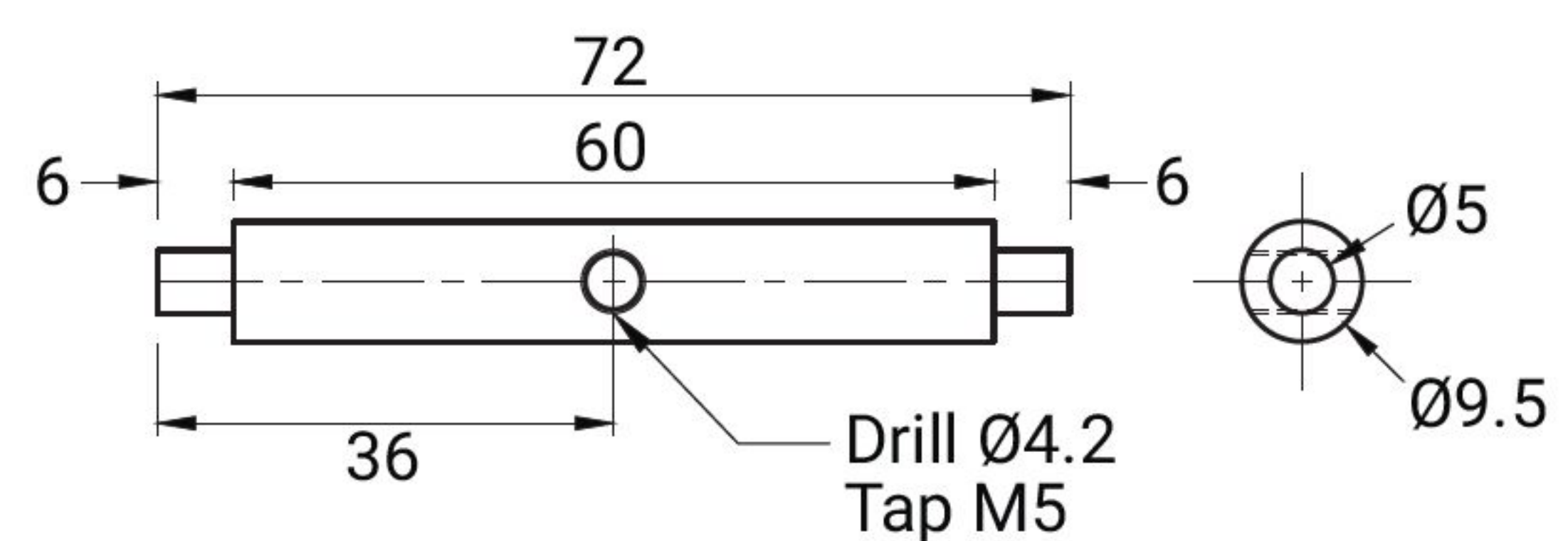
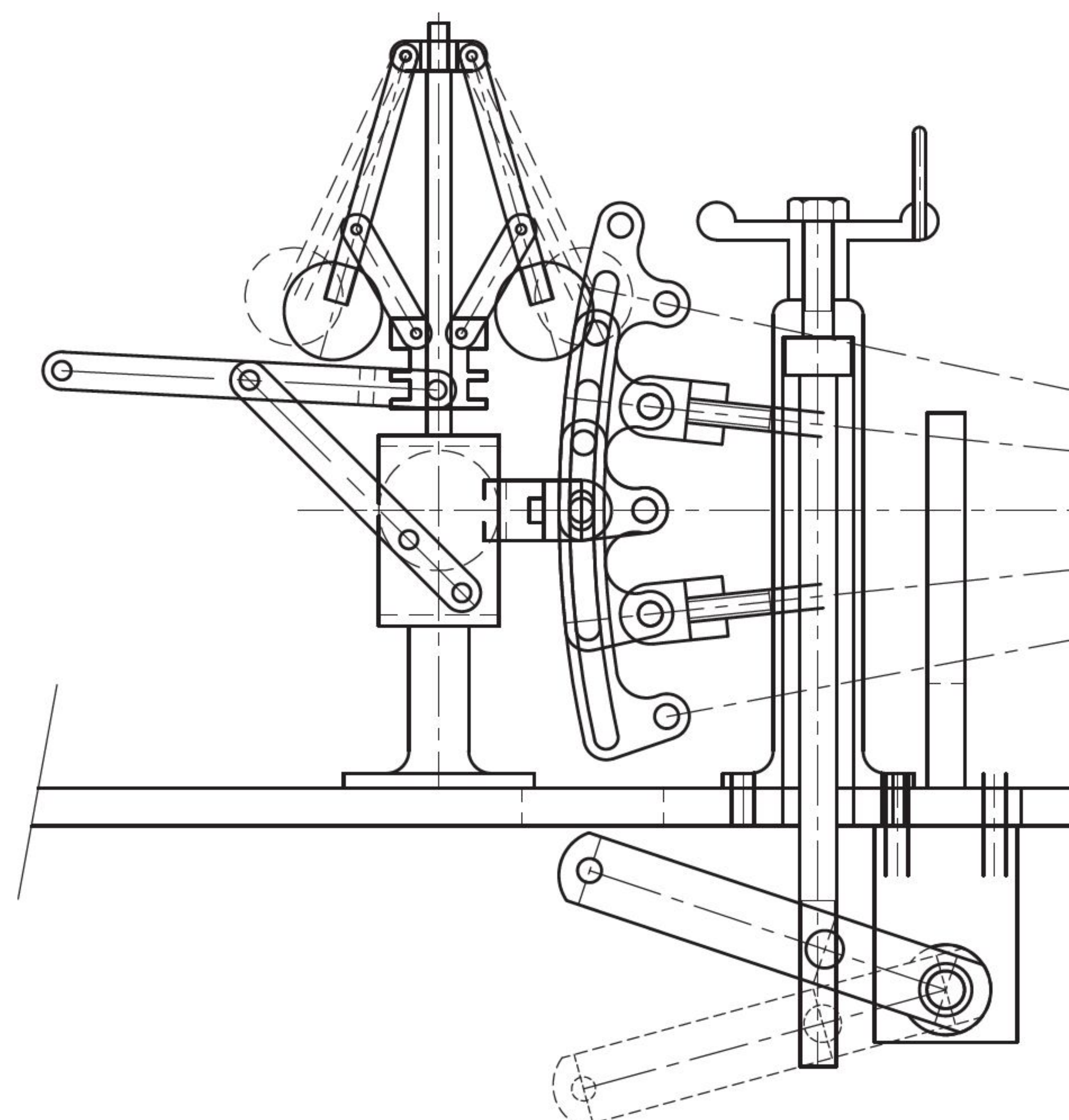
Continued from p.699
M.E.4743 May 17

We continue with the making of the cylinder's parts for the TTCSE model steam engine (fig 10, part 4, M.E.4743, May 17th).

The crossheads are machined from 20 mm diameter mild steel – on the drawing (fig 10) I have omitted to dimension the width of the flats which are 14 mm. If the 10 mm diameter boss is machined on the end of the piece of steel then this will guide you to the correct depth of the flats. The flats should be machined and the cross hole for the bush drilled and reamed at this setting. Then with the bar clocked to run true in your four-jaw chuck, finish turning the two crossheads. Note that the threads in the crossheads and the threads on the piston rods are 40 tpi Imperial ones which can be thread cut and finished to size with those dies. It is important to use the ¼ inch x 40 thread on the piston rod as the dies must be able to slide over the 5 mm diameter section of the piston rods without marking these sections. The bushes should be turned to a press fit in the crossheads and the oil hole drilled.

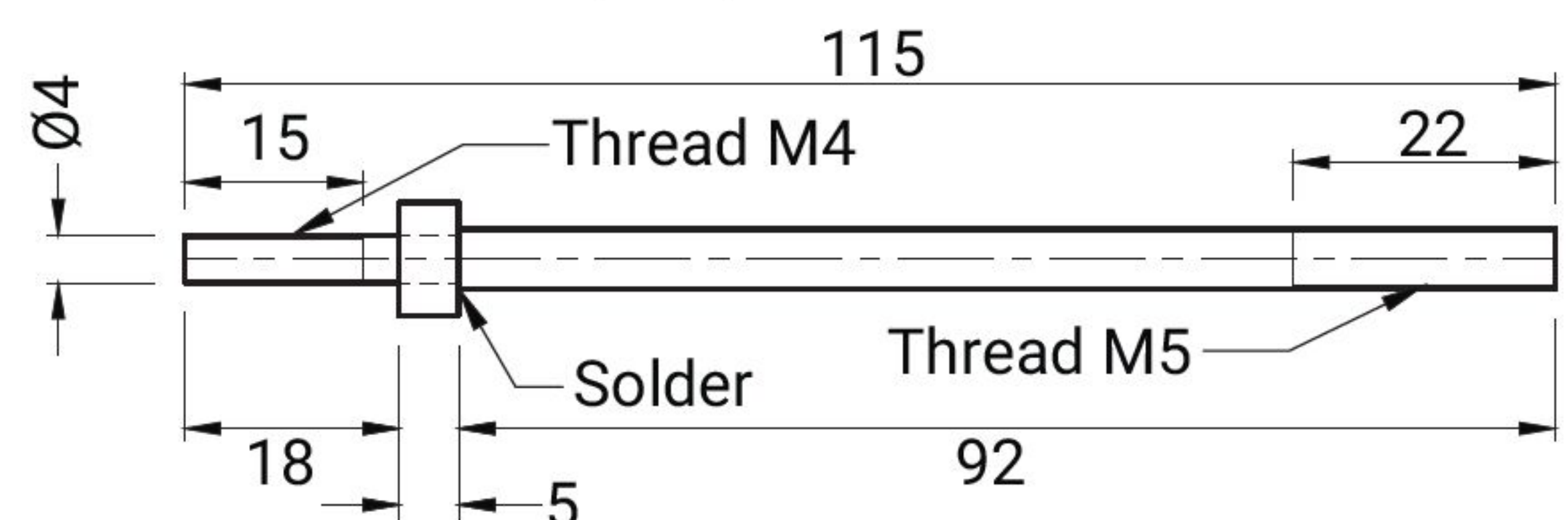
The connecting rods need to end up at the same length so, to achieve this, the parts that require the most work, the yokes, should be done first. These can be made as a pair, end on end with the radiused end out. Drill the 10 mm diameter holes each end and, by holding this blank with stub mandrel in your rotary table, the end radius can be done. In your four-jaw chuck machine the 8 mm diameter flat and drill for the screw. Of course,

Fig 11



Reverser Lifting Link

Mat'l: Ø9.5 (3/8") M.S, 1 off



Reverser Lifting Screw

Mat'l: Ø5 & Ø9.5 (3/8") M.S, 1 off

Reverser/ tail rod parts.

the countersinking cannot be done yet. Back in the mill to slot between the two holes and cross drill and thread for the crosshead pins. Separate them into individual parts, radius the fork ends and countersink the screw holes. Obviously check at this stage that the crossheads fit to the yokes. Then make the crosshead pins. These should not project more than the 1 mm each side.

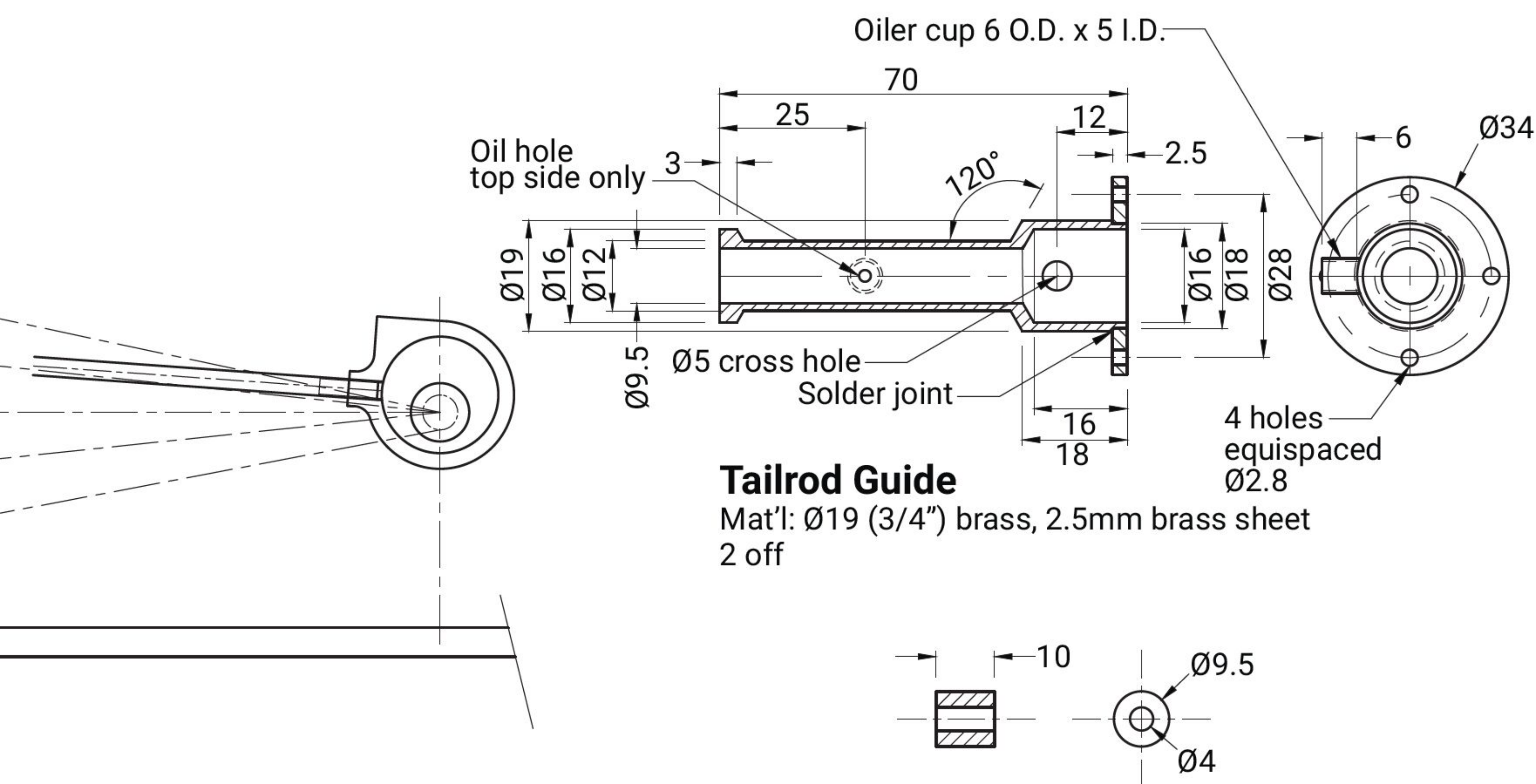
Back to the connecting rod parts - make the steel round ends. Don't at this stage make the bronze bush. Continue to make the 8 mm diameter shank and with the stud and countersunk screw assemble the three parts making sure to line up the boss and yoke correctly. Also check the center distances, then silver solder together and clean up.

Now make the bronze bush

for the crank pin end. There will probably be a need to file the corners of the yokes for them to clear the bores of the trunk guides when they are connected to the crank throws and being turned around.

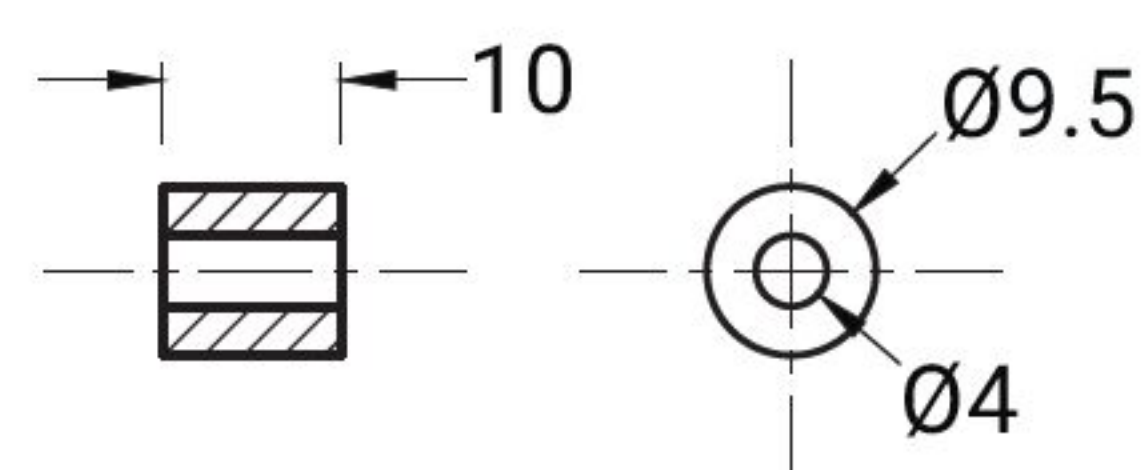
After I had done the initial design of the engine, I decided to add tail rod guides. You may have wondered what the four countersunk M2.5 holes in the low-pressure end covers

are for. The tail rod guides and the bobbins are shown on **fig 11**. They are straight forward lathe and drill parts soldered together. The faces of the guides need to be faced off true to the 9.5 mm bores. A couple of parts that are not shown are the 5/32 inch x 40 tpi nuts to hold the bobbins to the piston rods. A piece of ¼ inch hex brass bar is fine for these.



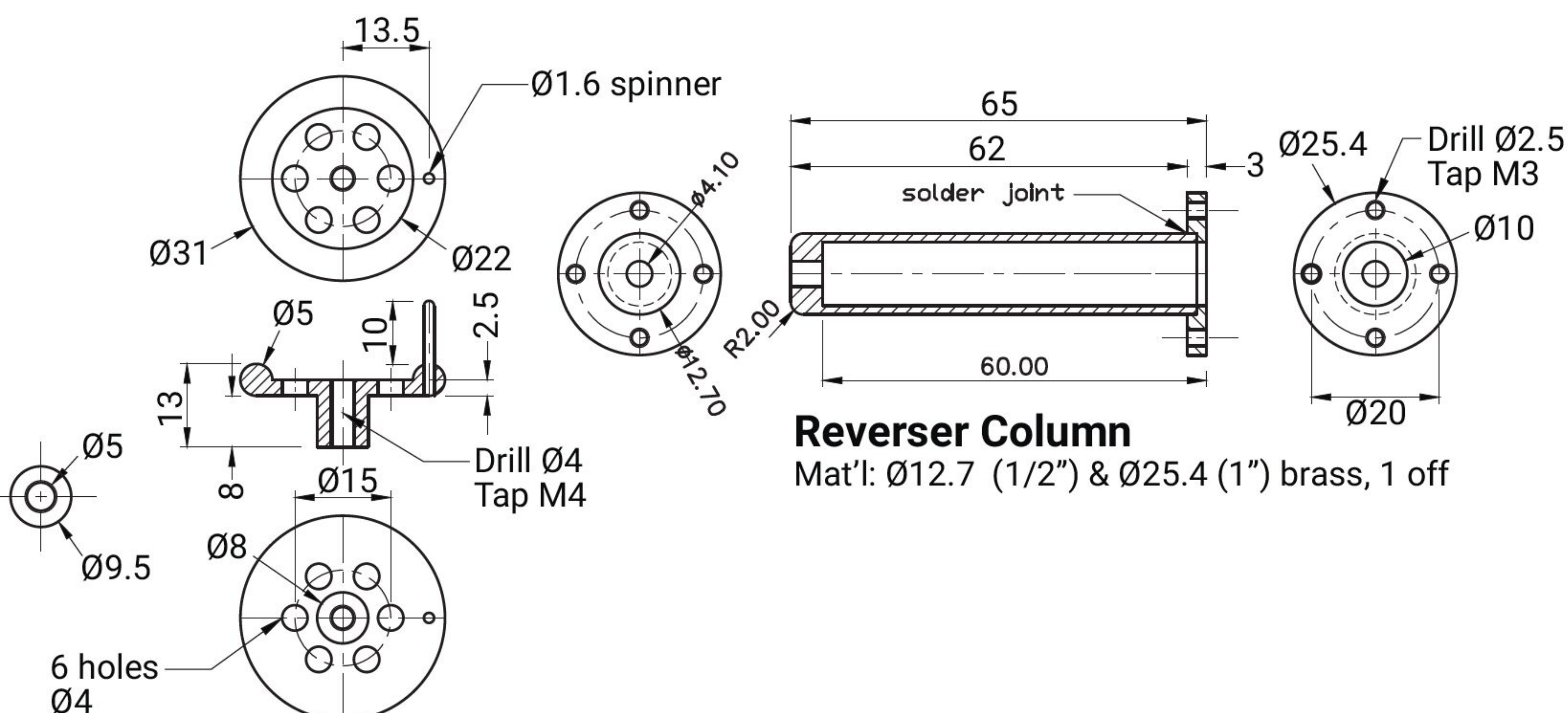
Tailrod Guide

Mat'l: Ø19 (3/4") brass, 2.5mm brass sheet
2 off



Tailrod Bobbin

Mat'l: Ø9.5 (3/8") M.S, 2 off

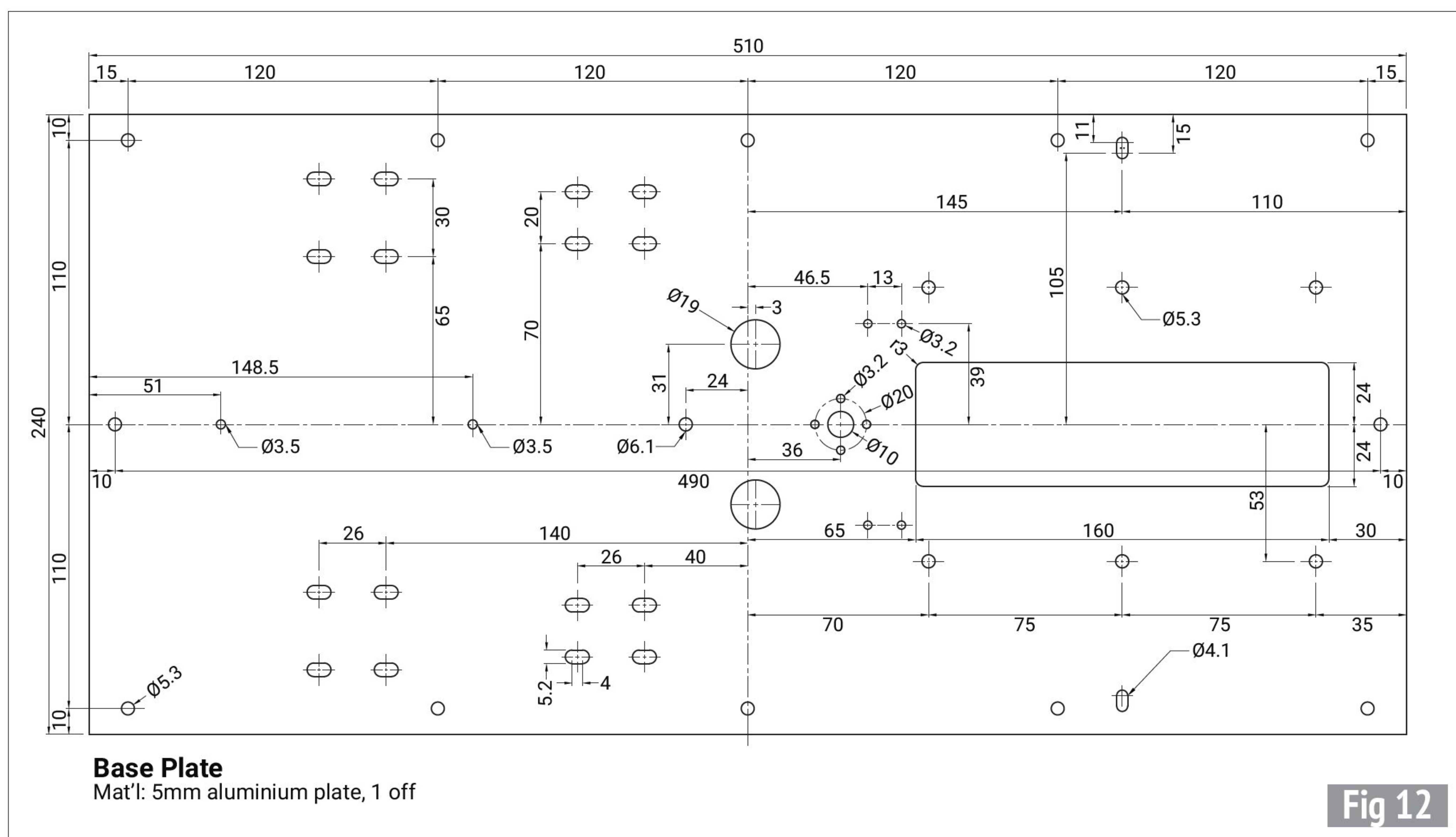


Reverser Column

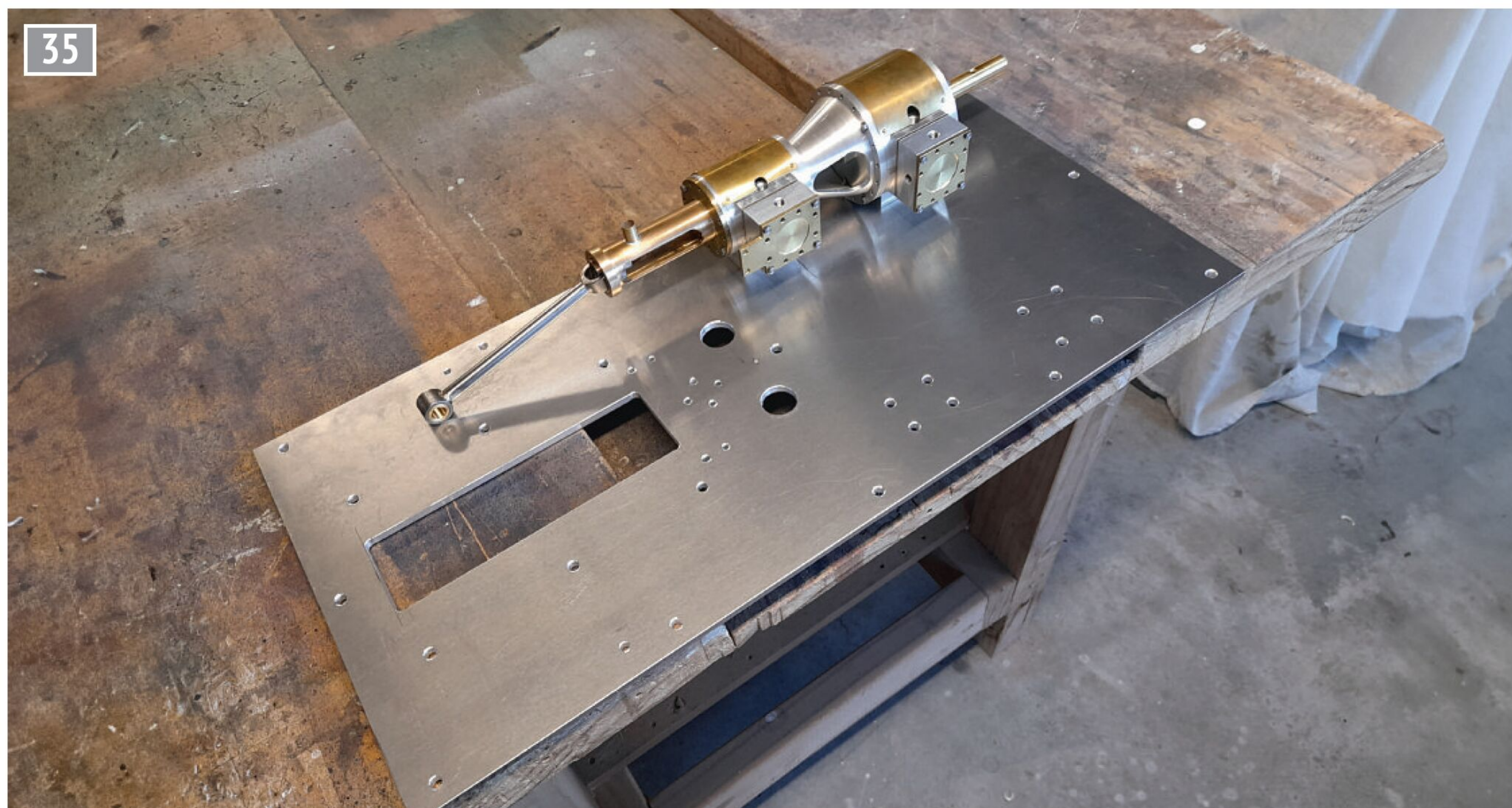
Mat'l: Ø12.7 (1/2") & Ø25.4 (1") brass, 1 off

Reverser Handwheel

Mat'l: Ø31.75 (1 1/4") brass, 1 off



Base plate.



Aluminium base plate with one cylinder assembly.

That's all the main cylinder parts barring the valve gear. We will leave them for the moment as I think that you will want to get on with a base assembly to start mounting things onto it.

The main base is a piece of 5 mm aluminium plate

which no doubt you will have to purchase from a supplier (**fig 12**). To ensure that this is as flat as possible ask them to saw it, not guillotine it. Do mark out everything before doing any drilling. The cutting out of the flywheel slot is not

critical as far as size goes but the positioning of the slots and holes in the middle of the plate is. Only the 12 perimeter holes of 5.3 mm are not critical. You may wish to alter the wood mounting to another type of mounting, bearing in mind

the 5 mm plate has to be 50 mm above the base to give clearance to the flywheel and the reversing gear (**photo 35**).

● To be continued.

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Tel. 01246 277357. Chesterfield.

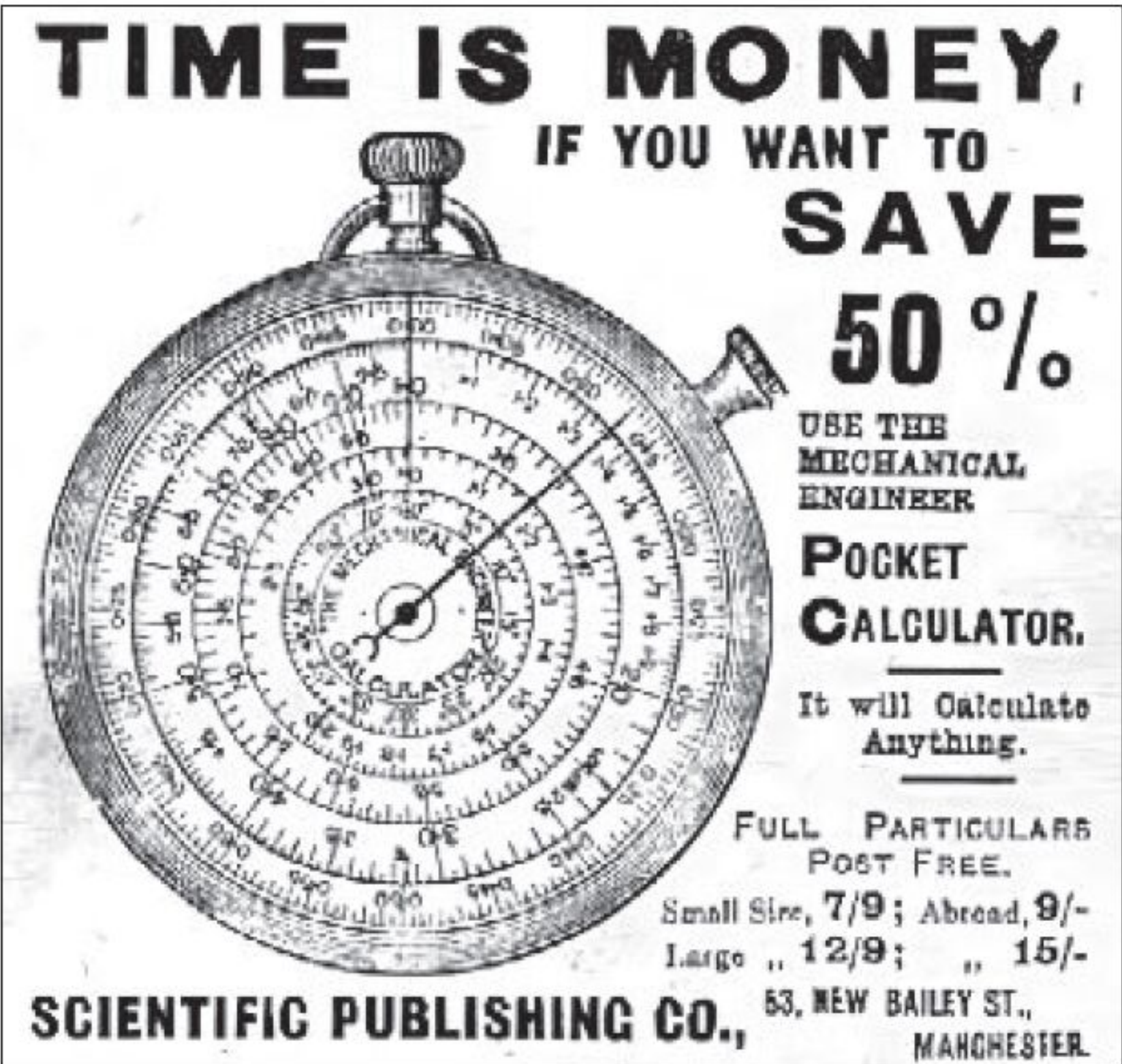
- Mk.1 Clarkson tool & cutter grinder. 3 phase, slides all in good condition. Very little tooling, hence, £400, or very near offer.
Tel. 01865 820827. Abingdon.

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- Stuart Steam Boiler Feed Pump, factory built, unused, also part machined set of castings for same, stand alignment machined by Stuart Turner, £250 the two.
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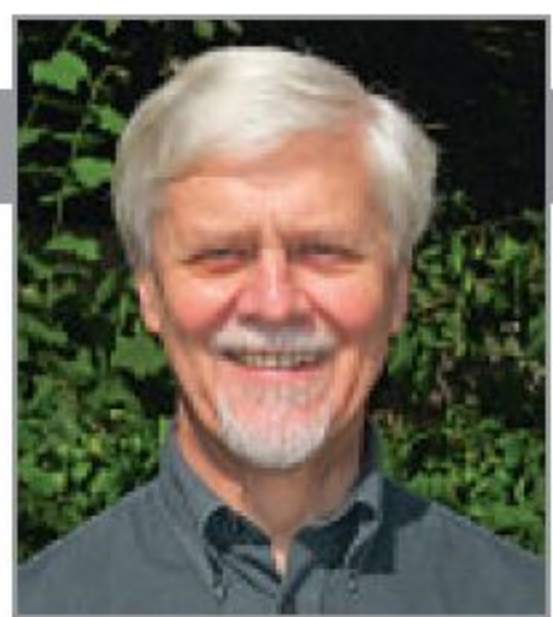
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An Admiralty Case for a Regulator

PART 3

Adrian Garner makes a simple but good-looking case for a regulator timepiece.



Continued from p.708
M.E.4743 May 17

Veneering

My case is veneered with rather expensive Rosewood but there are cheaper options. The quantity needed will depend on how the figuring of the veneer chosen looks and thus the need, or not, to book match, that is to arrange the grain to be a mirror image on each side of the case. In any event buy more than you think you will need as some is always wasted.

I have tried various gluing methods but on balance I would now recommend using old fashioned hot glue as this allows adjustment (correction!) in what is fundamentally a fiddly and messy business.

Most veneer needs to be prepared by flattening. Fill an old spray bottle of the type used for window cleaning products etc. with a mix of 6 parts by volume of water, 3 parts isopropanol and 1 part glycerine. The isopropanol can be obtained on the internet whilst the glycerine is probably cheapest from the local pharmacy (used to soothe sore throats) rather than the supermarket (baking). Spray the veneer on both sides until very wet and then sandwich between blotting paper and two flat boards. Clamp tight. Change the blotting paper each day for three days and the veneer should remain flat. Keep

between the boards when not being used.

Before starting to veneer make a note of the position of the four threaded brass inserts in the sides used to secure the handles. These will be covered by the veneer and will need to be opened up once the veneer is dry.

Commence with the hood and door. Cut sections of veneer oversize for each section with a sharp knife or preferably a veneer saw. The saw needs many light strokes but avoids the problem of a knife which can try to follow the grain (**photo 17**).

Apply the glue to the frame, place the veneer and squeeze flat with a veneer hammer. Do not worry if there are areas where it does not fully adhere. Just use a domestic iron to warm the offending area and clamp flat for about five minutes. Leave for twenty four hours to fully set, trim back the excess and then sand the edges smooth (**photo 18**).

There are a lot of small areas to cover so do not hurry. Do the side edges first so that the edge of the veneer is then covered by the front sections.

The large area on the back of the case needs to be handled differently. The solution seems to be water:

- 1) Cut the sections of veneer oversize whilst dry.
- 2) Using a wet cloth, dampen the case rear.
- 3) Dampen the veneer. It will curl but do not worry. The case rear and veneer do need to be wet.
- 4) Apply an even and slightly generous layer of glue to the case rear.



Cutting strips of veneer for the cross bars of the sides using a veneer saw.

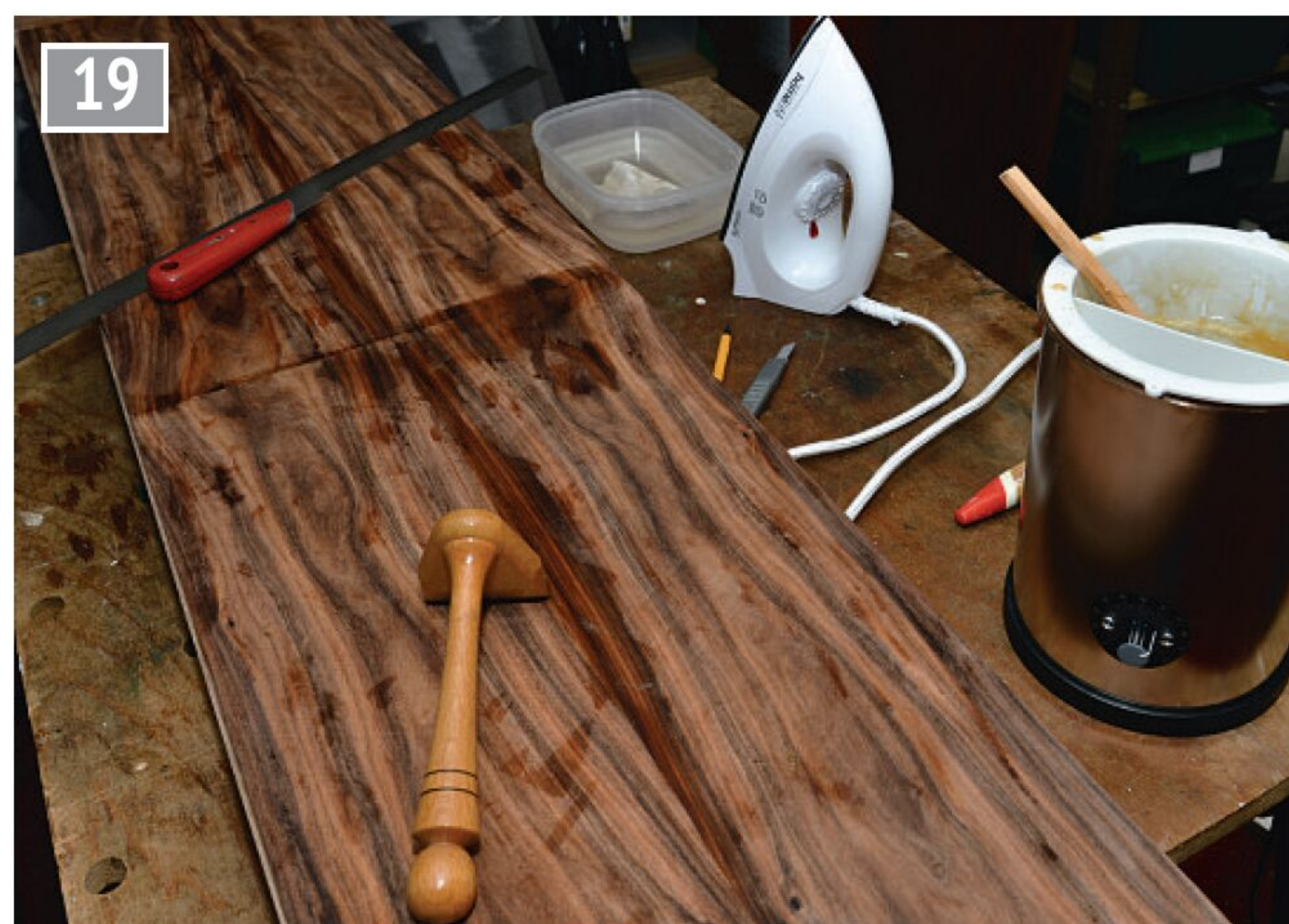


Where the veneer forms bubbles heat from an iron is applied and the area is clamped for about five minutes.



Mitred Ebony edging being glued in place after the veneer is dry.

- 5) Position the veneer and try flattening with a veneer hammer – it will not flatten but should stick enough to stay in place.
 - 6) Thoroughly wet the front of the veneer with the wet cloth. It will now go flat. Yes, all appears wet!
 - 7) Use the veneer hammer to squeeze and flatten (**photo 19**). Do not press so hard that the glue is all squeezed away.
 - 8) Along the edges where the veneers are being book matched, the veneers should be overlapped. Using a sharp knife and straight edge they can be cut together using multiple light strokes.
 - 9) Reheat with an electric iron where needed and, if dry, dampen with the wet cloth, and flatten with the veneer hammer.
- After leaving all to thoroughly dry out for a day or two, glue on the mitred ebony strips as edging ornamentation (**photo 20**). I mounted brass handles, hinges and catches to the door and hood - the type



Book matching the veneer on the back. It is a wet and messy process but all dries out.



Ebony handles and brass catches. The former were cut from some spare stock and fitted via a short dowel to the door side whilst the latter are commercial items.

with a sprung ball (**photo 21**) - and also glued two rounded ebony handles to the edge of the door to ease opening. To ensure these were secure I drilled both the ebony and door for small location dowels.

Assuming all fits correctly, remove the brass work so that the veneer can be lightly scraped and then sanded. The choice of finishing is yours but there is no doubt French polish seems appropriate. The reader is referred to the many articles and YouTube videos on that subject. Once polished leave for at least a couple of weeks and then apply either Black Bison or bees wax with 000 wire wool, wiping along the grain, not across the grain. After allowing to dry this can be buffed with a duster leaving a smooth but not too shiny sheen.

The last task is to put back the brass work and glaze the case. I coated my polished brass work for the case with Renaissance wax to reduce tarnishing due to handling. To keep the weight of the hood down I opted for 2mm glass for the sides and 3mm thick glass for the door. The glass panels need to be cut about 2mm short of the height of the recesses and just wide enough so that when slotted into the deeper of the routed groves they can just be fitted into place. They are then slid back across and secured at the top and bottom by beading. Narrow strips of leather can be added if they are too loose in the groves.

ME

My First Steaming Experience

Chris Rayward recalls the acquisition of his first steam locomotive.



Not long after my wife and I bought our first house in North-East Northamptonshire in 1970, we went on holiday to Scotland and found some wonderful landscapes with railways and bridges over rivers that gave us thoughts towards the possibility of building a live steam railway in our garden. On our return, some elementary surveying was carried out and, with a minimum radius of 30 feet, we found that a length of 5 inch gauge track of around 150 feet would fit into the garden without encroaching on the decorative areas. It would require a slope up and down

at both ends with gradients of about 1 in 60. **Figure 1** is the diagram of the track layout in our back garden.

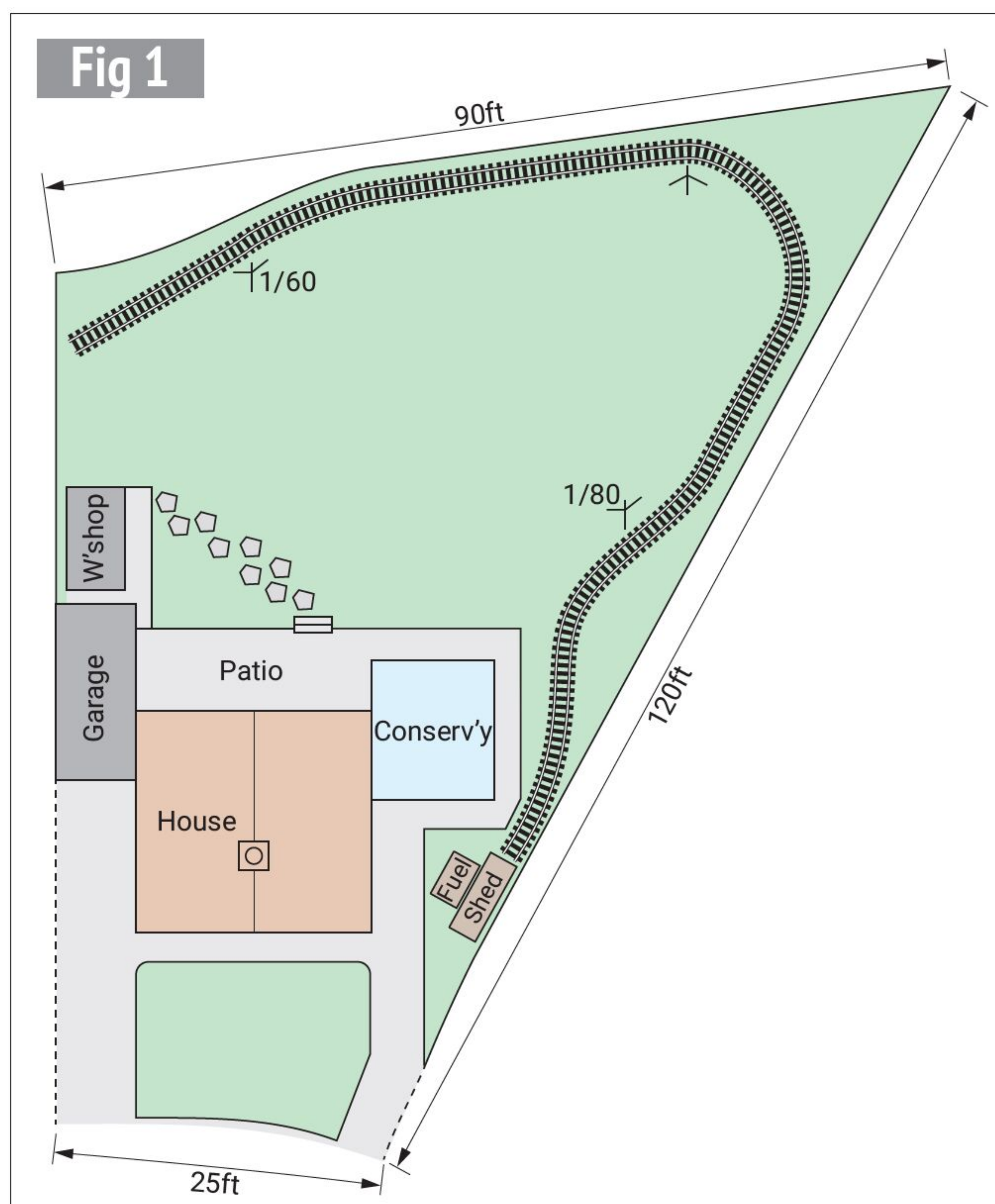
The track was to be laid on a concrete base strip for most of its length and, where the slope of the land fell away, a kind neighbour gave me some old wooden house beams that would serve as supports on cast-in-situ concrete pillars at the lower end by the workshop so the initial steaming and fire disposal would be at nearly waist height. **Photographs 1** and **2** are two views of the installation nearing completion at this end of the track.

The track took around three years to build and of course we had to have an engine, so looking around the advertisements in the magazines, I found an example of a Fowler 3F 0-6-0 tank engine (a 'Jinty', no less!) for sale by a Mr S. Whitmore of the Derby SME. This was an appealing opportunity as, many years previously when at home in Somerset, I had cycled up to the station at Binegar on the old S&D line over the Mendips from Bath to Bournemouth. Here I had chatted to the station staff and seen the odd goods train coming up the long grade towards the Masbury summit where a Jinty banker had ceased its task and was permitted to work wrong line back to the station to cross to the right line on the double slip points. Once the required tablet exchange had taken place, the driver asked me if I would like a ride back down to Radstock. What a chance; so I put my bike up on the bunker and off we went. I had never realised

just how uncomfortable a locomotive could be as we bucked from side to side all the way back down the hills. The experience was wonderful but the only drawback was that I had to cycle many miles back to our village just north of Wells – happy days!

We phoned the model builder and made an appointment to go and see the engine. The locomotive had the necessary certificate to the rules at that time and after subjecting the boiler to a high-speed fire-lighting and steam-raising period, he gave us a demonstration run on their club track. It absolutely flew around the circuit and the performance seemed to be satisfactory. The engine had been constructed to the Pansy chassis specification with all the required water pumps and lubrication arrangements needed, which worked well.

Once there was sufficient track to try the locomotive back at home, it became clear that the trial warm up experience when the engine had been purchased had hidden two issues that I was not happy with. I could not get the boiler to raise steam with the small electric blower I was using, as the volume of steam through the blower jets was draining the boiler of steam faster than the fire could generate it, and I could not get more than 30 psi on the pressure gauge. This explained the very severe method used to fire up the engine for the test. A check in the smoke box revealed that there were four holes in the blower housing and, although the direction of the jets seemed



The layout of the track in our back garden.



Two views of the lower end of the track leading to the workshop, where the track was laid on discarded house timbers.

to be alright, they were too large! I estimated that the blower holes had been drilled at least 1/32 inch diameter so I was faced with either dismantling the smokebox to rebuild the assembly, or just blocking one off to try again. A stainless taper pin was cut down and tapped in one of the holes and I tried to steam the engine again. It worked and soon I was able to try the locomotive up and down our short length of line.

Alas, here the second issue revealed itself as it would not start and run slowly in either direction and the engine was returned to the workshop for a closer examination. Clearly the demonstration at high speed had masked the slow

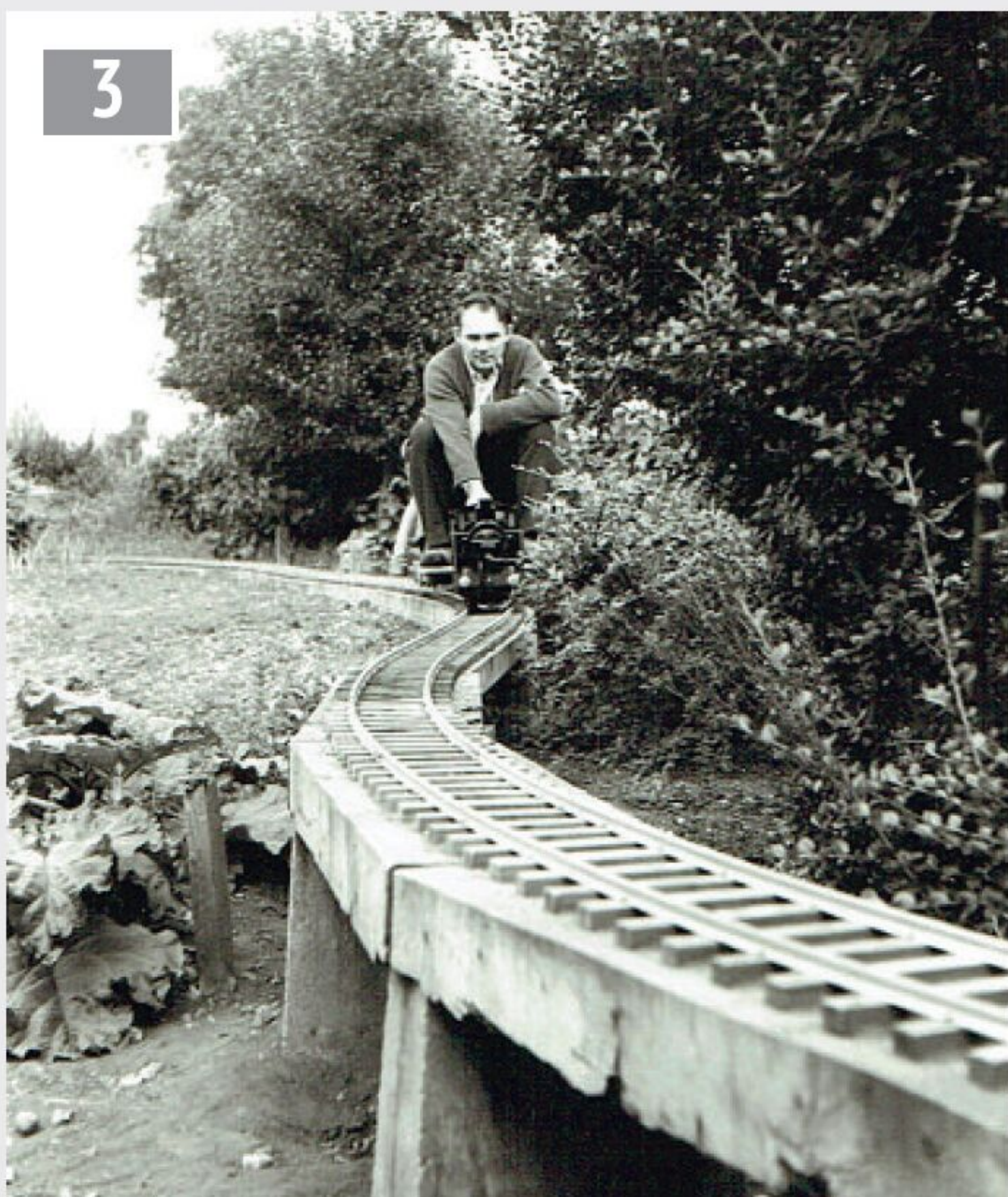
speed difficulty and I had not thought to test it out for myself. I removed the coupling rods and, with suitable precautions to protect the paintwork, the locomotive was laid on its side on the bench. I then made a circular disc from stout cardboard marked out in degrees to fit over the driving wheel. Those of you who are familiar with the 'Pansy' design will know that the steam chest is underneath the cylinders so it was a simple matter to remove the cover and observe the movement of the valves against the rotation of the crank axle with the reverser set in full gear for both backwards and forwards running.

This was done for both cylinders and the resulting

information was astounding. I was aiming to see if the valve gear movement would open the inlet ports to steam at or just before the TDC position for each piston when set to run in each direction. They were all nowhere near correct and the travel of the valves was only just sufficient to give a reasonable steam path at starting. It is not usual for a Stephenson's valve gear to provide the full port opening as constructed (about 2/3 opening is satisfactory) and once I had adjusted each of the valve spindle drive nuts to give equal valve movement in each direction, I could set the external clevis to supply the line-to-line opening required. Thankfully, I deduced that

there was nothing wrong with the timing of the eccentrics themselves as any adjustment to these would have needed a major strip down. The steam chest cover was replaced and there was just one additional task to tackle.

I could see that our model locomotive was a reasonable representation of the prototype Jinty, but the quality of the machining of the coupling rods was poor and I decided to mill the flutes myself and finish them to what I believe is a sensible finish for a model. With each rod set up on my milling machine table, I was able to use a small woodruff key cutter to clean up the flutes and using a small file and progressively finer emery paper, a satin finish was achieved. I am not a fan of shiny surfaces anywhere on the moving parts and what I had produced represented the finish on the full-size engine. Once re-assembled it was back out to the track for a test run. I could not have been more delighted with the engine's performance in its new state and once the track had been completed, a slow start could be achieved in both directions with a loaded trolley behind and regular rhythmic puffs of steam signalling a well-set valve gear. By this time we had two small children and it was a delight to see their faces as they rode on the passenger trolley. Having heard the whistles, other dads with small children came from around us and there was much enjoyment. **Photographs 3 and 4** show me driving the



The writer pictured on the locomotive a) approaching the terminus by the shed and b) running down towards the top end by the fence adjacent to the field behind us.

5



My younger brother at the controls as the engine rounds the curve of our garden track at the top of the climb from the shed. To aid stability without any passengers, a bag of house coal was placed behind the driver.

6



The Fowler 3F cleaned and stored on its shelf. Although not very detailed, the proportions were correct and it gave a great deal of pleasure.

locomotive at two places on the track.

Photograph 5 shows my younger brother driving the engine on the full length of track around our back garden. The passenger trolley had two six-wheeled bogies with ball races, the front one having conventional brake shoes on all six wheels, and the whole unit ran very smoothly.

Subsequently, the locomotive performed at the Stamford MES Club track that we had built at the Witham on the Hill school and then at other well-known venues; in particular we visited the Oxford track and made the longer journey down to the first Ascot track at the Heatherdown School which was laid out for all three of the usual gauges and where the

Jinty covered six laps of the $\frac{5}{8}$ mile long track. The station was the terminus and from here the line was straight and had a slight climb. After about 200 yards of course I had to start firing as well as keeping an eye on the water level and this was different to anything else I had experienced because the Jinty had a deep firebox and did not usually require attention on the

shorter circuits. About half way round after the bottom curve there was a steady climb up to the top of the track through a tunnel where I was able to use full regulator and the fire looked to be close to white heat. Then it was back down to the station and onto a large turntable where I could stay aboard so that both the engine and trolley could be turned ready for the next circuit. **Photograph 6** shows the locomotive after the refinements were made as described above.

Once back on our garden line the engine was even better than before as the valves had by now been thoroughly bedded in. Time moves on and we had to move house and leave the Stamford club behind. The track was taken up but never re-laid and the Jinty has gone to a delighted new owner. Our family has moved away too and I do not play trains anymore as my satisfaction comes from the designing and building of new prototypes. I also know that to get down onto a ground level track trolley to fire and control an engine would not be possible with advancing years.

ME

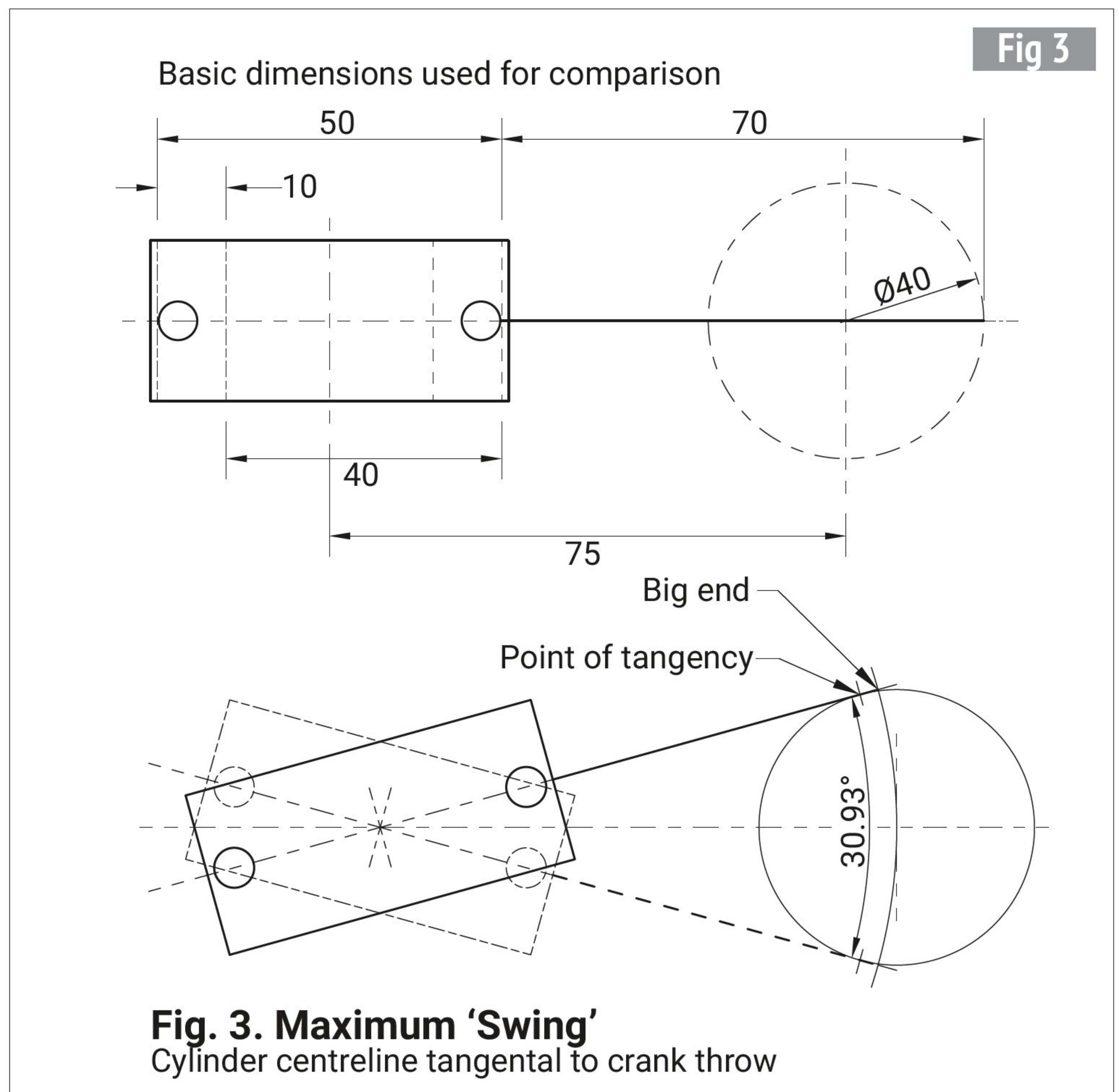
Oscillating Engine Design

PART 2

Martin Gearing explores different approaches to the design of oscillators.



Continued from p.681
M.E.4743 May 17



Maximum angular swing.

Advantage of tangential laying out to increase port area

One other aspect of the oscillating engine often overlooked when seeking to achieve the maximum performance, is that a note has to be made of the exact point of maximum cylinder 'swing' on the fixed port block. This was discussed by E.T. Westbury (ref 7) when he wrote

a series on the appreciation of the Muncaster steam engine models which states when discussing the port location and timing of the classic Muncaster designed inverted single acting oscillating engine that '...both the size and position of the holes in the stationary port block are dependent on their radius from the trunnion centre, in conjunction with the maximum distance of swing at

extreme cylinder angularity – which, incidentally, is NOT the same thing as half the piston stroke'. Or, put another way, the maximum **angular swing** of the cylinder coincides with the cylinder centreline becoming **tangential to the crankshaft throw circle (fig 3)**, NOT to the point at 90 degrees to the centreline of the engine. This is so often suggested for the port layout and, unfortunately

Fig 4

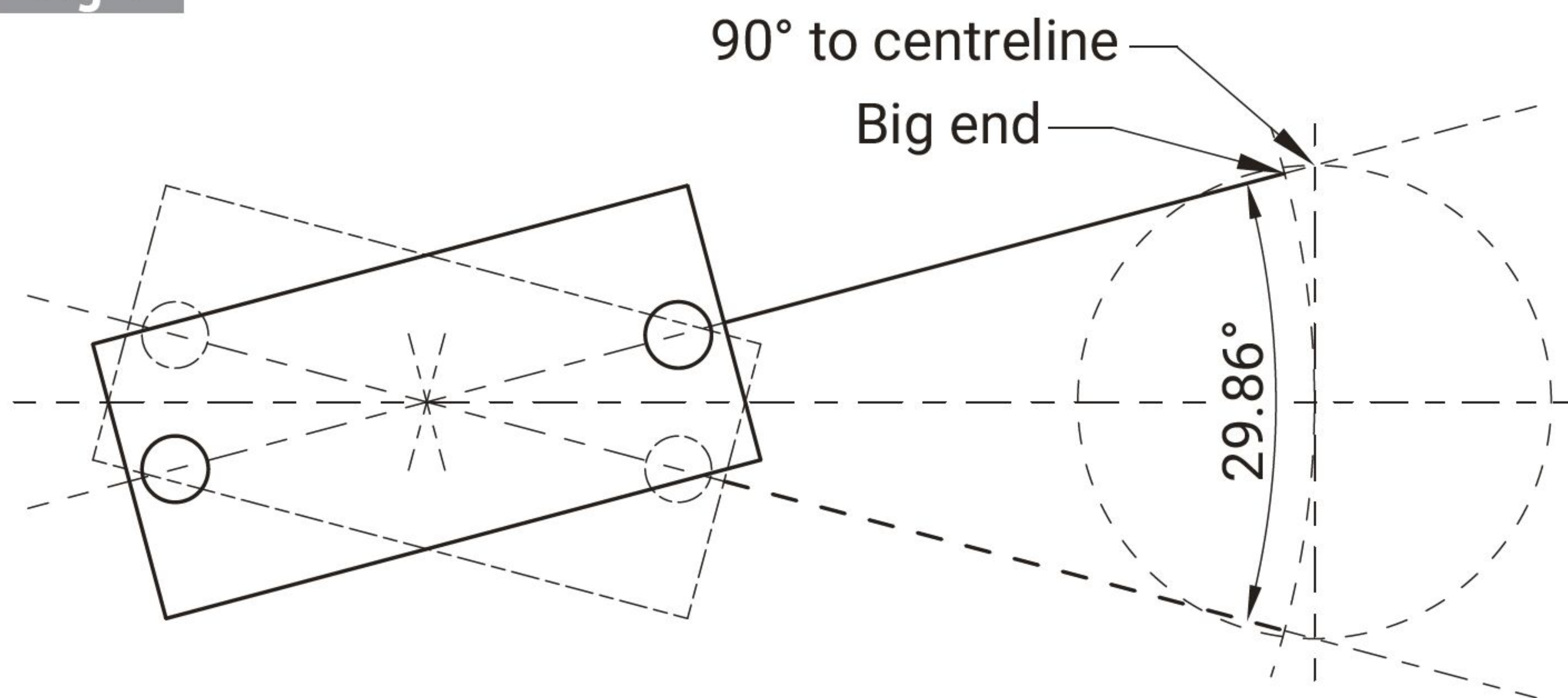


Fig. 4. 'Swing' Of Cylinder Marginalised
(Due to setting out 90° to crankshaft)

How setting at 90 degrees gives less than maximum swing.

Fig 5

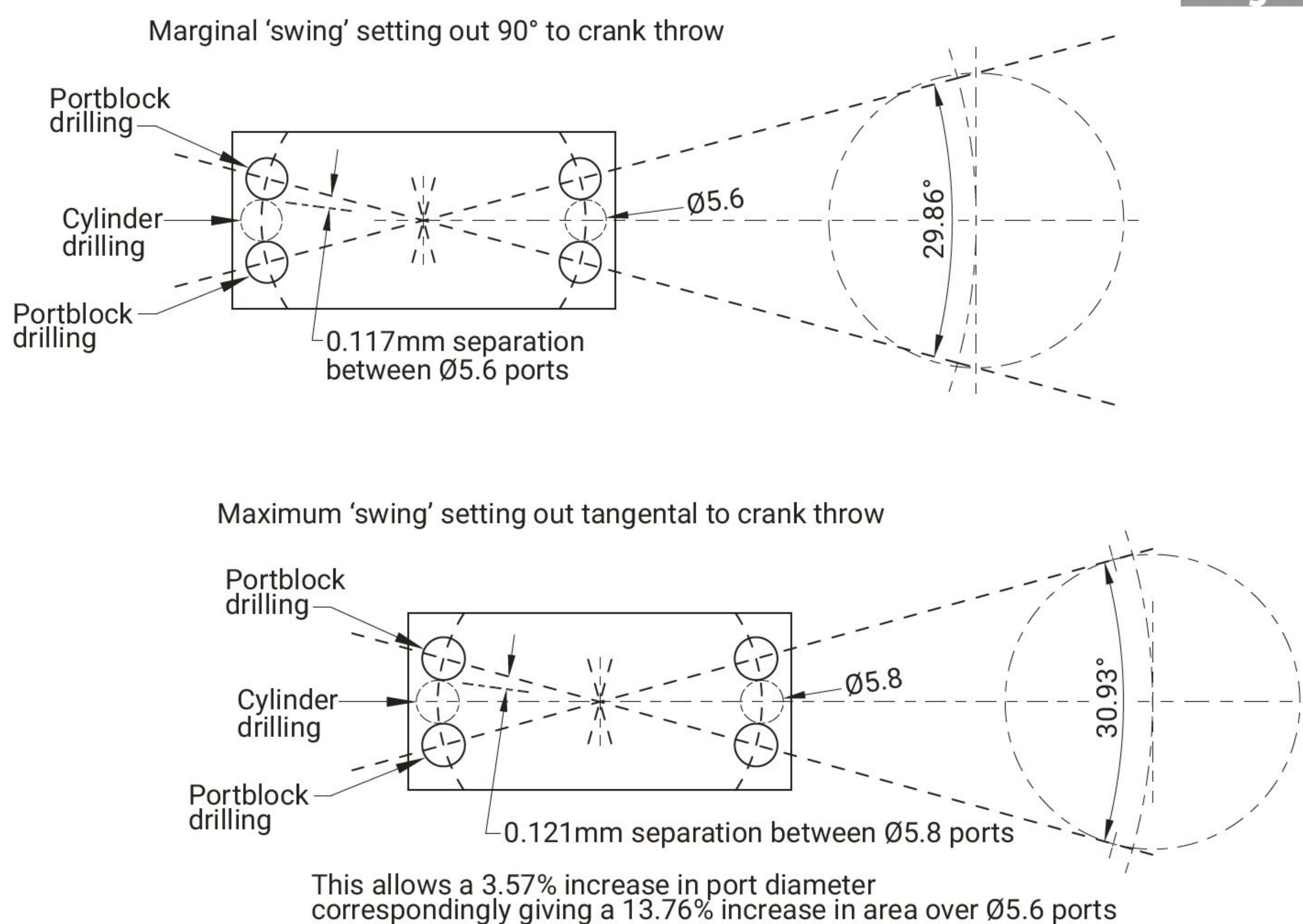
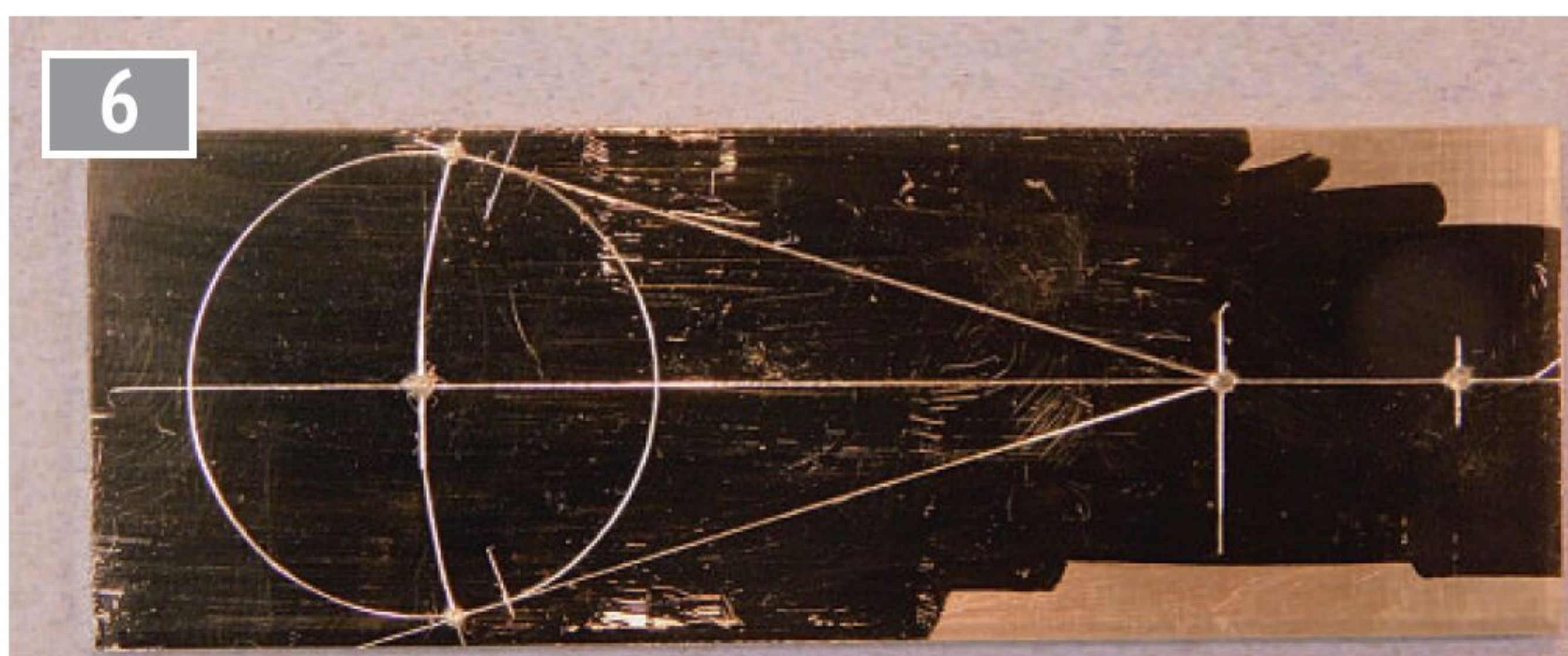


Fig. 5. Comparison Of Two Methods

Comparison of 90 degree and tangential geometries.

6



Marking out the guide plate for the tangential method.

shown in figure 1 of David Fulton's article (**fig 4**). By way of comparison, **fig 5** shows the improvement on port size gained by using the tangential method of laying out.

It can be seen that the diameter of the port drilling can be increased from 5.6 mm diameter if laying out at 90 degrees to 5.8 mm diameter

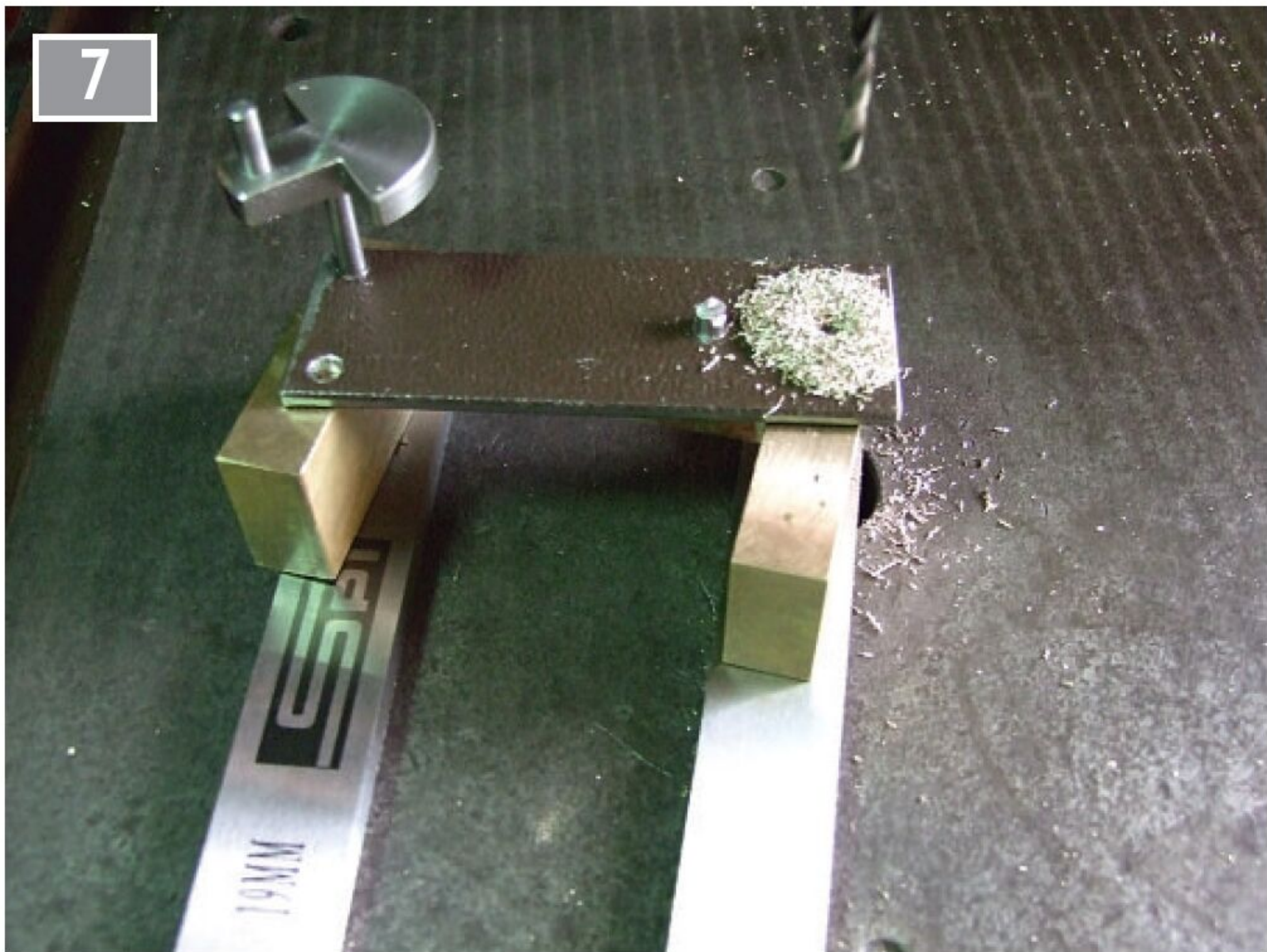
when using the tangential method, and provides over 13% increase in port area. These diameters provide a reasonable minimum separating land between the inlet and exhaust drillings on the fixed face when the cylinder port drilling is located between them at either of the dead centres, all using the same radial centre line.

The drilling of the ports tangentially is simply done with the aid of a length of not less than 3mm thick flat steel strip coated with marker pen, following these steps:

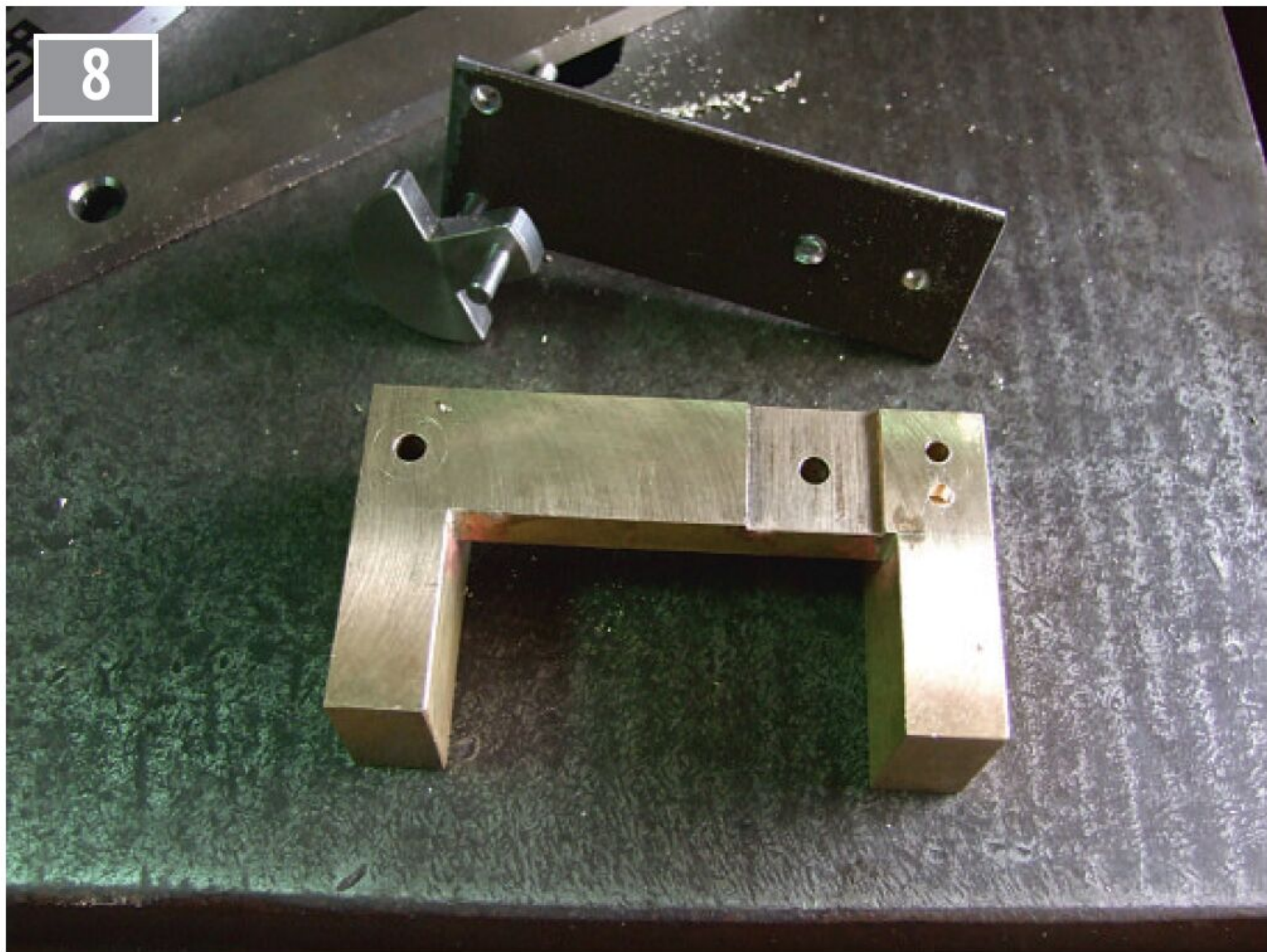
- * Scribe a centre line.
- * Mark the centre of the cylinder pivot point, crankshaft centre and the centre of the single cylinder port for single acting (or two ports for double acting).
- * Lightly centre punch these points before scribing a circle to the radius of the crankshaft throw.
- * Use a straight edge to carefully scribe a line precisely through the cylinder pivot point and tangent to the crank throw circle either side of the centre line.
- * Scribe a radius from the cylinder pivot point through the crankshaft centre across the strip.

Note: This will cross the two tangents line a small distance along from the actual tangential point of contact (see fig 3 and photo 6).

- * Lightly centre punch the two points where the radius crosses the two tangent lines.
- * Drill and ream the two holes at the crankshaft end the same size as the crankshaft.
- * Drill and ream the cylinder pivot point to suit the cylinder pivot used.
- * Drill and ream the port or ports to the size chosen.
- * Locate the drill guide plate onto the port face using a suitable stub of silver steel passed through the cylinder pivot hole in the guide and engine frame.
- * Align the drill guide by passing the crankshaft



Drilling the ports using a guide plate.



Both ports drilled.

- through one of the crankshaft end holes and the crankshaft hole in the frame.
- * Drill the port/s into the engine frame guided by the hole in the guide plate (**photo 7**).
 - * Move the guide plate to the second crank position and repeat drilling the second port/s in the engine frame (**photo 8**).
- The easiest way to maximise performance on an oscillating/wobbler engine design, was covered in a further article by Westbury in an article for the *Junior Model Engineer*, in which he discussed ways of increasing the PORT AREA to maximise power, giving examples of LENTICULAR and SECTOR SHAPED PORTS (**ref 8**), and as used in David Fulton's *Forerunner* (see ref 1 in part 1, M.E.4743, May 17).
- Practically, the port face may have its dimension increased slightly, whilst keeping all the other dimensions unchanged, as in the example shown in **fig 6**, where it can be seen that by using ports in the form of a round ended sector it is possible to produce a sizeable increase in the port area, quickly forming the ends of the profile by drilling.

Recapping

In combining/considering these three suggestions when creating a design, it is possible to create a simply/quickly constructed oscillating/wobbler engine that operates in a reasonably economic manner.

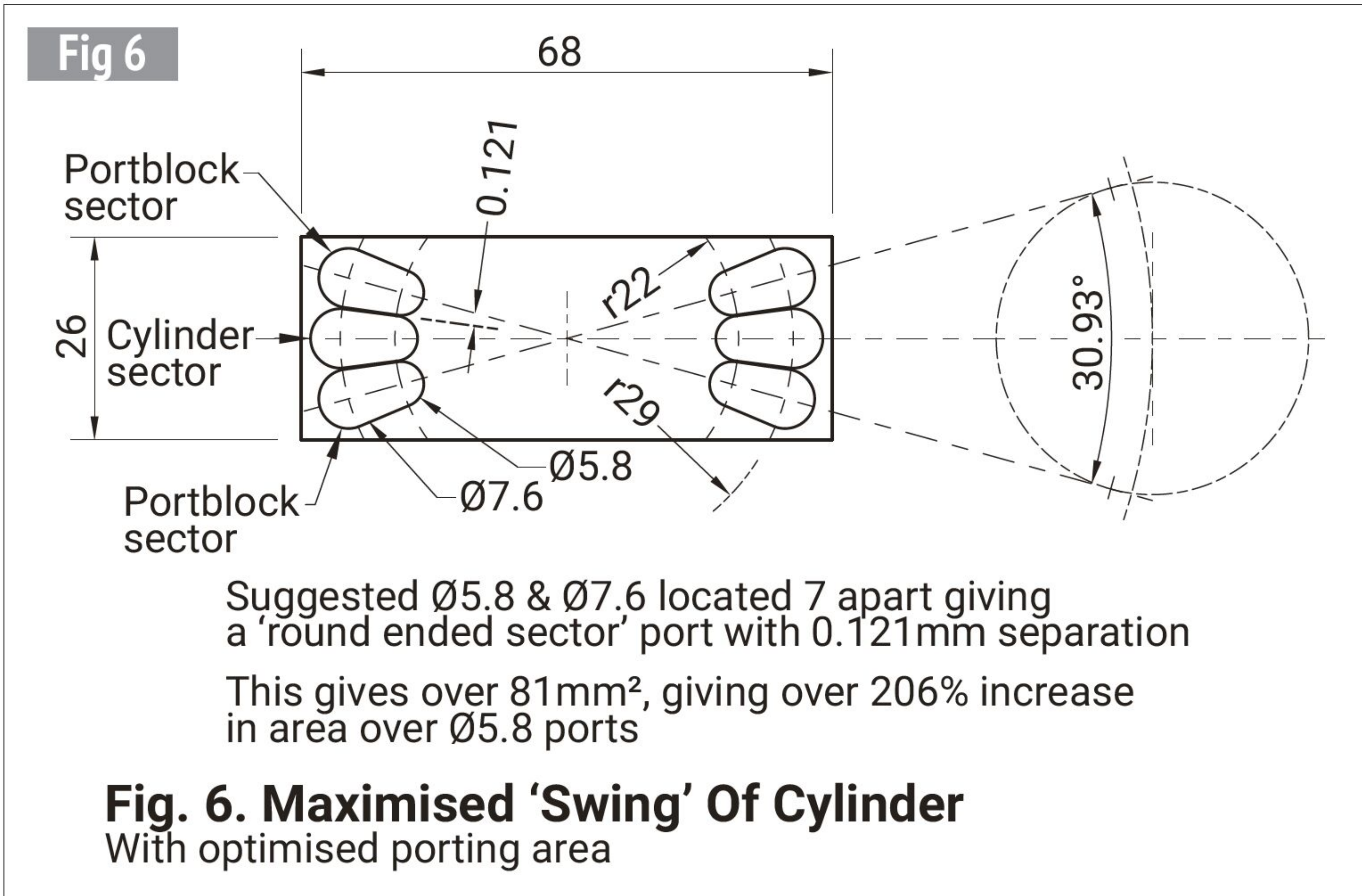
These are:

- * By laying out the port position on the fixed port face ensuring that their profile centres (either drilled round hole or an alternative profile) are exactly on a line between the cylinder pivot centre and point tangential to the circle drawn at the crankshaft radius.

- * Incorporating the design used in the Green Twin design of engine, of the circular milled portion in the fixed trunnion but amended by the attachment of the suggested circular port plate, removing the need for problematic port drilling. This has the added bonus of being able to have the size and shape of the porting changed without the need for a complete new fixed trunnion.
- * Using a thrust washer on the pivot stud secured with either a Nyloc (or similar) or conventional pair of locknuts.

My thanks must go to George Ray for his assistance in providing information for me about Gordon Howell in general and *Wapiti* in particular, ably assisted by Reg Wilkinson (aka 'Wilkie') and Roger Green. All three are members of Andover MES and together knew Gordon personally.

ME



Optimising the port area.

REFERENCES

- Ref 7** Edgar T. Westbury, *Utility Steam Engines*, Model Engineer, 20th Oct 1949.
- Ref 8** Edgar T. Westbury, *Junior Model Engineer*, Model Engineer, 7th July 1967.



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Martin R. Evans,
The Editor, *Model Engineer*,
Mortons Media Group Ltd, Media Centre, Morton Way, Horncastle, Lincs LN9 6JR
F. 01507 371066
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Thixotropic Metals

Dear Martin,

In addition to Mr Theasby's interesting metals (ahem!) (M.E.4740, April 5), I would like to point out that the opposite behaviour of 'Potty Putty' is rheopectic - it relaxes and flows when in a relaxed state (a little like me) but when hit is very hard and can even shatter (also like me). I believe that it was tried in expansion joints such as motorway bridges.

And thank you to David Rollinson and his articles on American Locomotives - I now know, after all these years, what goes on inside a spark arrestor!

Regards,

Mike Joseph
(Chipperfield)

EKP Supplies

Dear Martin,

I found the account of your visit EKP Supplies most interesting (M.E.4734, January 12).

I think the machine that you were being shown in photo no. 10 is what is known as a single sliding head automatic lathe. You are quite right in saying they are quite a complicated machine to set up initially but once up and running they can make a very large number of the same thing quite cheaply. I remember many years ago when I was in my teens/early 20's (I am now 76) that when I was attending Hackney Technical College next to Hackney Downs station in the workshop they did actually have one of these but we never actually saw it in use.

Another similar type of machine has multiple spindles, usually six spindles all running at the same time which index round and at the end of each cycle a part is complete. My own experience of this type of machine is having used, both as an operator and setter operator, the Herbert no. 0 capstan and the Herbert no. 2D manual capstan lathes.

With the no. 2D and also the Herbert no. 4 capstans we would normally use them with collet chucks on bar work, either round or hexagonal. We could also put a back stop in the spindle to do a second operation so that all the parts would be the same.

Occasionally we would put a three-jaw chuck onto the spindle instead of the collet and often we would have a set of soft jaws that we would bore out for a particular size, again to do a second operation.

The other thing I was interested in was the photograph in Geoff Theasby's club news of the steam powered Land Rover. I know this is a bit outside of what we would class as model engineering, but it would no doubt make a good article to describe how it actually works and how the drive is taken from the steam engine to the gearbox and transmission, perhaps in not too much technical detail but I found it quite interesting having read about it in Club News.

Yours sincerely,

J.E. Kirby
(London)

Boiler Safety

Dear Martin,

There's nothing like a periodic ding-dong about boiler safety (oh, there certainly isn't! - Ed.)!

I agree with much of what *Luker* says in his comments in the letters page (M.E.4741 April 19) but will throw in a few more points. Also, I would like to thank him for his kind comments about my work in his article *Linings for the Backyard Foundry Furnace* in the same issue.

The UK boiler testing code just covers testing and unlike the Australian code does not give any design rules. This leaves these matters to the designer and allows experimentation and innovation - a good thing in my view. So long as the boiler passes the test then it's good to use. A negative aspect is the complexity of

the form which has to be filled out each time. I think it's the most complicated thing I've ever seen, to record what is essentially a simple test, and it invites mistakes. I also wonder how many people have given up on steam because of the annual tyranny of boiler testing or inspection and how many testers have given up because of the over-complex form they have to use. I agree with *Luker* that for small boilers all this may be overkill. I guess it has come about as models have become larger and more and more clubs become involved in commercial passenger hauling. I've been lucky with my club (Pembrokeshire MES); we don't do it. Just run for fun is our way and with a half mile of track and 1-in-30 gradients that's what we do (end of advert). Is there an answer to this in a less complex regime for small/medium copper boilers, or would that be a further complication?

Where I do not agree with *Luker* is his concern about metal fatigue (cracking and failure under repeated load less than the ultimate) in copper boilers caused by excessive testing. I'm afraid this is now going to get a bit technical and I must apologise for not explaining all the terms in this fairly short letter. I'll think about something longer when my current project and write-up (which our editor is waiting for) is complete. Firstly, I'd like to ask *Luker* if the finite element analysis he mentions was a linear, fully elastic, one. If it was then I don't believe it can tell us accurately about the stresses and strains in an annealed copper boiler. Copper has a very low proof strength (the point where elastic stretching starts to become plastic and permanent) and once this is exceeded at one of the many stress concentrations in a boiler then a linear analysis will not be correct. A non-linear iterative analysis would be required to get anywhere near the truth, and this would be very computer intensive unless things have changed since I retired.

Our boilers are conservatively designed partly because the assembly is too complicated to analyse in all its parts. As a maximum nominal stress I use the annealed copper proof stress with a small (aircraft industry) safety factor of 1.125, to be met at shell test pressure. This gives a margin of 4 or more to the tensile failure stress and ensures that the inevitable distortions during the first test are barely measurable. When I've had cause to do so I've found that other available boiler designs are not too far from my own assumptions. There will be lots of points in the boiler where stress concentrations occur and we have no real way of analysing these at home, but custom and practice shows that they can generally be ignored. As *Luker* says, the first test can actually help strengthen the boiler as the metal yields at these points causing redistribution of the internal stresses and work hardening. For a stress engineer working on the ultimate case allowing a bit of plastic yielding like this can get you out of a problem. Another benefit is that a residual compressive stress will be built in when the pressure (or load) is removed and this can benefit the fatigue life. This is sometimes known as coxing and is why a static ultimate test specimen must never be subsequently used for a fatigue test.

So far as the actual fatigue strength of copper is concerned then I had to do some searching around to find out as it's not an area I've considered a problem before, either in my aircraft industry career or as a model engineer. I discovered a fairly recent paper reviewing fatigue data for copper and this gives a fatigue endurance limit alternating stress at 10¹⁰ cycles of around 50MPa, or 7250 psi, at zero mean stress. Our cycle for the 1.5 times pressure re-test would be, on my designs, 3000 +/- 3000psi for sheet copper, so even when corrected for mean stress gives plenty of margin for plain sections because that's a lot more cycles than if

we add together every test on every boiler than has ever been made.

Coming on to the local stress concentrations then things are more difficult. As mentioned, yielding, work hardening and stress redistribution occur and so the actual mean and alternating stresses under test are hard to determine. Looking at the problem from the other end, if I consider the repeat pressure test we do here in the UK then it is carried out every four years. That's 25 cycles in a century - if the rest of the model has not worn out of course. This is far too few cycles to show on a normal alternating stress - life (S-N) plot because nobody sensible would design anything with such a short life. At 10⁴ cycles (10,000) the paper by Jiménez-Ruiz et al.* gives an alternating stress at zero mean of around 130MPa (21750psi) and corrected for mean stress would give us 113MPa (16300psi). So a stress concentration factor of 2.1, an easily achievable value in a structure, would be allowable until well after we're all pushing up daisies. In the same paper mentioned there are test results giving strain-life data for plastic strain testing. At 25 cycles the strain to failure at zero mean is around +/-10%. That's a pretty big figure for an engineering material, but it's nothing for copper which can stretch by 50% before failure, so probably good news. Then we would also need to consider whether a fatigue crack could propagate in a catastrophic manner through an assembly, the bulk of which is a very tolerant plastic material, before showing some form of observable leak.

So what does all this mean? To be honest I don't know for sure but I don't, myself, believe metal fatigue caused by our UK testing regime is likely to lead to a catastrophic copper boiler failure. Metal fatigue is (or was in my working days a few years back now), if you like, the last bastion of semi-empirical engineering. There are so many variables such as

base material, surface finish, machining method, residual stress (deliberate or otherwise), interface conditions and fretting etc. etc. that it is very hard to calculate a definitive safe life for a structure, finite element analysis notwithstanding. Coupon tests in such documents as the ESDU data sheets or your own proprietary tests can be used to estimate a life, but the only definitive way is to test the finished structure, otherwise possibly prohibitive safety factors would be required. Could we do this? A whole boiler maybe, if anybody has the time, but coupons would be less work. Make a small specimen with joints and stays and pump it up a few times. First and once only to shell test pressure then, say, to working pressure 100 times (representing 25 runs per year) followed by one to re-test pressure, and repeat this sequence until failure. Anybody willing?

Best regards,

Gerald Martyn
(St Davids)

* *A Comprehensive Review of Fatigue Strength in Pure Copper Metals (DHP, OF, ETP)*, Eduardo Jiménez-Ruiz, Rubén Lostado-Lorza, and Carlos Berlanga-Labari, Metals 2024, Published: 15 April 2024

Dear Martin,

When I read *Luker's* article designed to encourage more people into model engineering (M.E.4738, March 8) I was most heartened to see a modern realistic approach. However, I just knew that when he criticised the current approach to boiler safety there would be a reaction and so it has proved.

I think that *Luker* is correct in that the current regime is not necessarily looking for the right problems and has the potential to be life shortening boilers. I was involved with helping to translate an article by Wim Merks on stress analysis of a boiler by the FEM method

published in *Model Engineer* (M.E.4660 et seq.). That work showed that the typical 2x hydraulic test was imposing considerably higher stresses over a much wider area than normal operation. *Luker* makes a good point about low cycle fatigue being an issue with copper boilers. As an aside, the 2x hydraulic test for steel boilers quoted in the UK Boiler Test Code 2018 (Section 7.6) is in direct conflict with the requirements of BS2790 for steel boilers. I have designed my own steel boiler and gained approval from a notified body and can tell you that subjecting a steel boiler to 2x hydraulic test has the potential to over-strain it which would be sufficient reason to take the vessel out of service.

In my view a significant but unrecognised problem is accepting boiler designs where the only criterion in assessing the design is that it be a 'recognised design...' (UK Boiler Test Code 2018, Section 5.1). I would very much doubt that design calculations for designs by the likes of Greenly, LBSC, Evans, Young, Walshaw etc. are available or have ever been reviewed by a third party. In my view, that lack of design verification of so many popular designs is a bigger issue than the hobby cares to admit. It is a damning indictment of UK boiler safety that the Australian code has become the de facto design code over here.

On the subject of design calculations, a colleague who studies such things assures me that we have gone from factors of safety of around 4 in LBSC designs up to around 8 in current designs. That obviously has an impact on material build cost but is it really necessary? The UK Code then excludes stainless steel boilers which would be cheaper in material cost. Is there really any good reason for this exclusion? If so, what is it?

The UK Boiler Test Code makes considerable demands on boiler testers, requiring knowledge and experience which those without formal engineering training are

unlikely to have. Further, as rules are tightened up further, such as moving to 7 year lagging off inspections including ultrasonic measurements, the workload on testers is becoming ever greater. It is also placing ever more work on engine owners in dismantling and rebuilding engines. What evidence is there that 10 year inspections are missing safety critical defects?

I fully agree with *Luker* that proving of gauge glass, safety valve and pressure gauge response and verifying two working means of water feed are essential parts of lighting up a steam engine - not a once a year party trick. If those conditions are not satisfied each and every time, drop the fire and fix it - simple. I know of one club that requires extended spindles on safety valves in lieu of easing levers so that stuck seats on safety valves can be proved not to be a problem.

Responses talking of 'explosions' and 'bombs' are alarmist, ill-informed and a crude effort to close down discussion. Yes, we need safety but that has to be underpinned by a quantitative knowledge of the risks weighed against the work and cost of testing. If there is any collection of incident reports or review of boiler stress and design literature or consideration of feedback from grass roots boiler testers then the UK Code authors have done an excellent job in hiding it from the wider hobby.

A proportional response, transparency and openness is the way forward. Testing must respond to real risks, not exaggerated doomsday scenarios. Please leave scare tactics to the tabloid press.

Martin Johnson (retired chartered mechanical engineer)

Precision Engineering

Hi Martin,

I was reading Roger Backhouse's book review in which he mentions the book *Exactly: How Precision*

Engineers Created the Modern World (M.E.4711, February 24 2023). Having read this book, I thought I would alert readers to two rather glaring omissions. I was astounded to discover that nowhere was there a single reference to Joseph Clement, Babbage's erstwhile on-call mechanic. Clement is widely acknowledged as a pioneer in implementing precision techniques for the mass production of finely engineered devices, included the earliest experiments in die-casting employed to mass produce the difference engine's multitude of indexing dials. Babbage was a mathematical genius with a talent for engineering invention but commercially un-astute with their early close collaboration eventually dissolving into a rancorous and somewhat acrimonious 'parting of the ways'. One of the earliest precision lathes that he had built for Babbage is on display in the London Science Museum (www.computerhistory.org/babbage/josephclement). There was once an original piece of Babbage's difference engine here in New Zealand that, unfortunately, got auctioned off to an Australian purchaser.

The second (incredible) omission was the complete absence of any mention of the seminal event of the 20th century - the dropping of the atomic fission bomb on Japan. The 'Fat Man' implosion weapon required a massive leap in electronic circuit technique in order to achieve a level of timing precision heretofore unknown. It was an astonishing achievement... which makes it all the more incomprehensible that Winchester left it out of the



Joseph Clement

book given that he devoted a large amount of page space to the evolution of precision time-keeping, with whole chapters delving into the transition to electronic time-keeping. Inexplicable!

Reader's should not be deterred by my pithy criticism as the book is still a good read but do bear these two notable omissions in mind.

Kind regards,

Andre Rousseau
(New Zealand)

Parting Off

Dear Martin,

It is about time to put to rest the long-standing vilification of the top slide as a host for parting off tools. The top slide can be locked securely by screws bearing on the gib strip. This has worked for me for decades. Secondly, since the top slide can be rotated it is easy to set the tool straight using the face of a chuck as the reference.

You will note that the tool in the illustration above has a back rake of about 45 degrees and its cutting edge is angled slightly. When I had to part off disks from 3 inch diameter aluminium I thought it might be wise to consult Dr Chapman's three volumes named *Workshop Technology*. The steep back rake was advised and worked a treat in conjunction with a carefully sharpened tool edge. The angle on the tool edge ensures that the item being parted off has only a minimal pip.

Lastly it also needs to be noted that the parting tool blade provided by Myford-Dickson tapers towards its bottom. This is useful in preventing binding when parting off normally but when the aluminium tool is in up to its gullet it must jam. The cure is to retract the tool and slice a little off each side of the cut, repeating as necessary as the tool goes deeper. In fact, when doing almost all parting off I give myself initial leeway to widen the cut with the final cut being in the correct position.



Writing the above reminded me of an article or letter in *Model Engineer* long ago pointing out the utility of knife tools for working the copper-based alloys. A knife tool would be a tool having large side clearance and a side rake approaching 40-45 degrees. The writer expressed dismay at the increasing use of carbide tooling not really suited for copper-based alloys and similar materials.

Best regards,

John Bauer
(Ontario, Canada)

Thunderbirds

Dear Martin,

I regularly watched Thunderbirds in my youth and marvelled at the skill of the model-makers and puppeteers. I was into radio-controlled model boats at the time with a neighbour of mine and a couple of his friends. One of our group was Nick Procopedes, a cameraman working in the Thunderbirds studio on Slough Trading Estate. I think my enduring love of this series (and Meccano!) eventually led me to take up model engineering as a hobby!

Henk-Jan de Ruiter's article on Thunderbirds (M.E.4741, April 19) recalled some happy memories of the series and there was a recent TV documentary on ITVX entitled *Century 21, Slough*, which follows former employees of the film studios visiting their old workplace before it was demolished in 2017. It is a very interesting programme and I am sure that many of your readers would also be interested to see it.

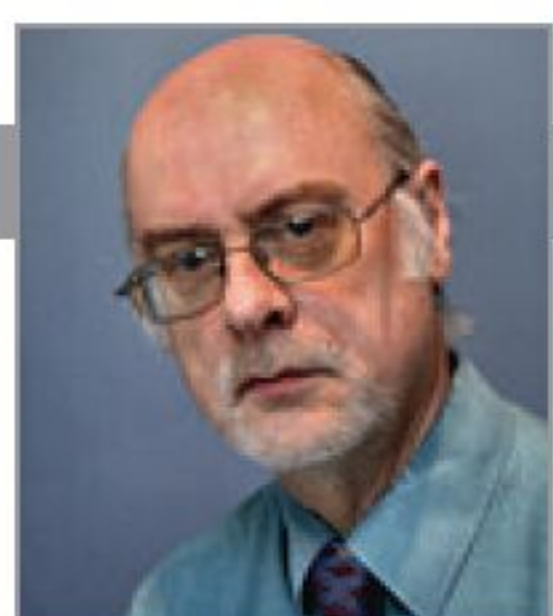
Kind regards,

David Greenaway

Miniature Gas Turbines – An Introduction

PART 1

Tim Coles
takes us
through the
basics of model turbine
design.



A modern gas turbine system.

Introduction

Sixty years ago, I was a 'Keil Kraft kid', building tow line gliders, small free flight and control line models, with bold ventures into single channel radio control. At that time, there was talk about model gas turbines, or jet engines as we knew them, and I'm sure I'm not alone in having experimented with making turbine wheels from aluminium sheet, or from baked bean tin lids and razor blades. However, we were told, in no uncertain terms, by those who purported to know better, that there was

no prospect of making small gas turbines; it was simply a physical impossibility, in the same way that scientists insisted that bumble bees can't fly – but they forgot to tell the bumble bees.

Forceful as they were, these opinions failed to discourage the interest in small jet engines and several individuals and groups carried on trying to develop working engines. Early miniature gas turbines featured components that today seem outlandish, including plywood compressor wheels bound with carbon fibre tow,

but real practical progress came with the introduction of commercial turbochargers for the automotive industry. Apart from better all-round understanding of high-speed turbomachinery, a supply of small but efficient centrifugal compressor wheels became available (**photo 1**).

Among early model gas turbine developers were Thomas Kamps in Germany and Kurt Schreckling in Austria, whose books on the subject are well-known, but it was a British team led by Jerry Jackman who first developed a miniature



An early miniature working jet engine.



Centrifugal compressor wheel.

working jet engine during the 1970's, culminating in it being used to power the first 'real' jet powered model in March of 1983. Their 'Barjay' aircraft was fitted with a propane fuelled engine producing about nine pounds of thrust at 85,000 rpm - an engine which set out the basic design for miniature gas turbines which has been used in virtually all engines since then (**photo 2**).

The first commercial gas turbine was the French-built JPX T240 unit, again propane fuelled, and with about nine pounds of thrust at 120,000 rpm (**photo 3**). This engine was quite cumbersome to operate, with the need to handle the propane fuel, compressed air start and basic control unit, but it proved the potential of

the technology. Nowadays, the design, manufacture, and the control electronics have been refined to make miniature gas turbines a practical work-a-day propulsion system for model aircraft, albeit at a fairly high cost.

I should perhaps mention the units used to quantify thrust at this stage. Being of an age, I like pounds as a measure of engine thrust, a liking shared by our American friends, while our continental cousins use kilograms. Real jet nerds, however, prefer to use newtons, which are actually units of force, but in terms of our gas turbines there are roughly 10 newtons to the kilogram, or roughly 5 newtons to the pound. Those same nerds also use absolute units



The JPX 240 unit.

when referring to pressure and temperature, so you will see, for example, degrees Kelvin used in thermodynamic calculations.

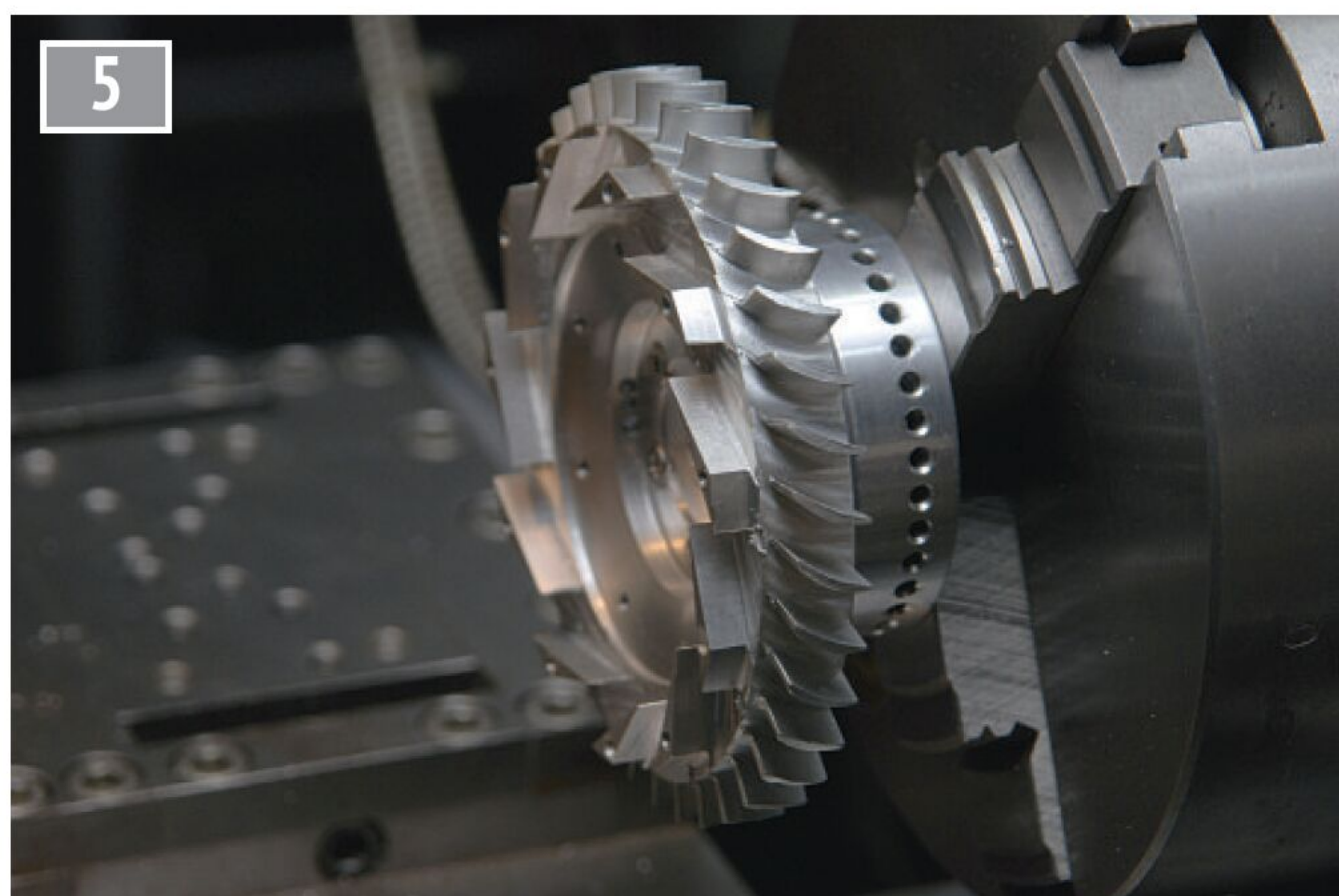
Most miniature gas turbines are used in model aircraft and, as such, are termed 'turbojets'. The term turbojet refers to the simplest gas turbine design, where all the air induced passes through the combustion chamber and out through the turbine. This is unlike the turbofans of modern airliners in which only a proportion of the air acted upon passes through the core of the engine. The basic gas turbine, large or small, can be fitted with an extra turbine or turbine wheels, in order to extract shaft power which can drive propellers in aircraft and rotors in helicopters, or provide shaft power for other applications such as power generation. Such prime movers are, not surprisingly, known as turboshafts.

Back to basics

So, how does a gas turbine, little or large, actually work, to produce the thrust needed to drive an aircraft through the

air? Consider a cylinder full of compressed air at around 40 psi. There is a hole in one end of the cylinder and air rushes out. How fast? About 200 to 300 metres per second, getting on for the speed of sound. How much does air weigh? About 1¼ kg per cubic metre. Newton's law tells us that sending some mass moving fast in one direction produces an equal and opposite force in the other direction - in the case of our cylinder, a thrust in the opposite direction to the air expelled.

So now we need to top up the compressed air. Let's open the other end of the cylinder and put some sort of fan arrangement on the front to do that. Then, of course, we need to drive that fan, so how about another fan in the jet exhaust and connect the two fans with a shaft to provide that power? Well, that isn't going to work; we need to add something else. What is that something? Energy - and the most suitable form of energy to achieve what we need is heat, and lots of it. This then makes the air in the cylinder expand enormously, so



Diffuser.

that it leaves the engine faster than it entered. The heat, of course, comes from burning fuel. Now we have a workable jet engine, give or take some very clever engineering and metallurgy!

Miniature gas turbine design

Compressor

As mentioned, our engines are all pretty much based on the layout produced by Jerry Jackman and his team. We start with a centrifugal compressor wheel at the front, drawing in air and throwing it out radially at high speed (**photo 4**). This component is commonly made from aluminium alloy although higher performance wheels are made from titanium. Both metals can be sourced from turbochargers. The wheel may be cast although these days they are most often CNC machined from solid, and they are then referred to as billet wheels (**photo 4**).

Diffuser

The next component in line is the diffuser, which accepts the high-speed air off the compressor wheel, slowing down the air in divergent channels, which gives us the essential pressure recovery before being turned back in the axial direction and thus pressurising the engine case (**photo 5**). The diffuser is normally CNC machined from aluminium alloy. The highest pressure in the engine is developed in the engine casing,

immediately after the diffuser; thereafter the pressure falls steadily through to the exhaust efflux, which can be below atmospheric pressure in more efficient engines. Miniature gas turbines typically have a surprisingly low pressure ratio of only around 2.5, as compared with full size engines which can reach in excess of 40. The pressure ratio directly affects fuel consumption. However, the higher the pressure ratio the more complex the engine design has to be. High compression ratio also significantly increases the jet efflux noise. The reason engines are built to high pressure ratio at full size is to enable them to fly much greater distances for a given amount of fuel. As model jet aircraft are not designed to fly from London to Hong Kong, we can afford the penalty of the extra fuel weight for the benefit of a significant saving in engine complexity. This makes them inefficient, with high fuel consumption, but we get plenty of thrust from our engines and the complication of trying to improve the pressure ratio is just not worth the effort.

Combustion chamber

Now comes the really clever bit and the part that was probably the most difficult to develop - the combustion chamber. In miniature gas turbines this is in the form of an annular can surrounding the shaft tunnel. A series of very carefully positioned holes allow the compressed air in the casing



Combustion chamber.

through into the chamber. At the front of the chamber, small holes provide the primary air needed for combustion. Further back, holes of increasing size provide secondary and then dilution air, which is heated by the combustion process to expand the whole mass of air enormously, and which then enters the turbine stage at high speed. It is interesting to note that only about 20% of the air passing through the combustion chamber is used for combustion, the rest is effectively the working fluid of the engine. This is true for both miniature and full-size gas turbines.

In a number of designs, a series of tubes is mounted on the back face of the combustion chamber, these tubes reaching towards the front of the chamber. Within each of these there is a fine tube delivering fuel a short way along the tube or 'stick', so that the fuel evaporates and mixes with the air travelling down the tube, ready to burn at the front of the combustion chamber. The fine tubes are connected to a supply manifold, usually on a ring which is fed with fuel under pressure from the fuel pump.

Apart from the primary, the secondary and the dilution air holes in the combustion chamber, there are typically a number of angled holes which add a circumferential element of flow to the burning gases, so that there is a 'doughnut' of flame anchored at the front of the chamber. There is a popular video on YouTube showing a



Nozzle guide vane.

miniature gas turbine with a transparent case, making this doughnut clearly visible.

At the point of combustion, the temperature of the gases approaches 2,000 degrees centigrade but, after the secondary air has been added, the gases have dropped to about 800 degrees.

The combustion chamber is fabricated, usually by spot welding, from thin stainless-steel or Inconel sheet (**photo 6**). The end plates may be spun or pressed to form flanges which overlap the rolled outer and inner combustor walls.

Nozzle Guide Vane

The next component after the combustion chamber is the nozzle guide vane, or NGV (**photo 7**). This item receives the hot gasses from the combustion chamber and turns them to the optimum angle to impinge on the turbine. The gases are hot and so the NGV needs to be heat resistant, which is why it is often produced as a casting in a nickel-chromium alloy known as Inconel, this alloy being strong at high temperature. Because the NGV is not under any centrifugal stress it can be fabricated or cast in stainless steel. Stainless and nickel alloys have a remarkably similar melting point; however, the nickel alloys retain torsional strength at significantly higher temperatures than stainless, hence their use for the turbine.

This article first appeared in the British Model Flying Association newsletter.

● To be continued.

LNER B1 Locomotive

PART 46 – SANDING GEAR

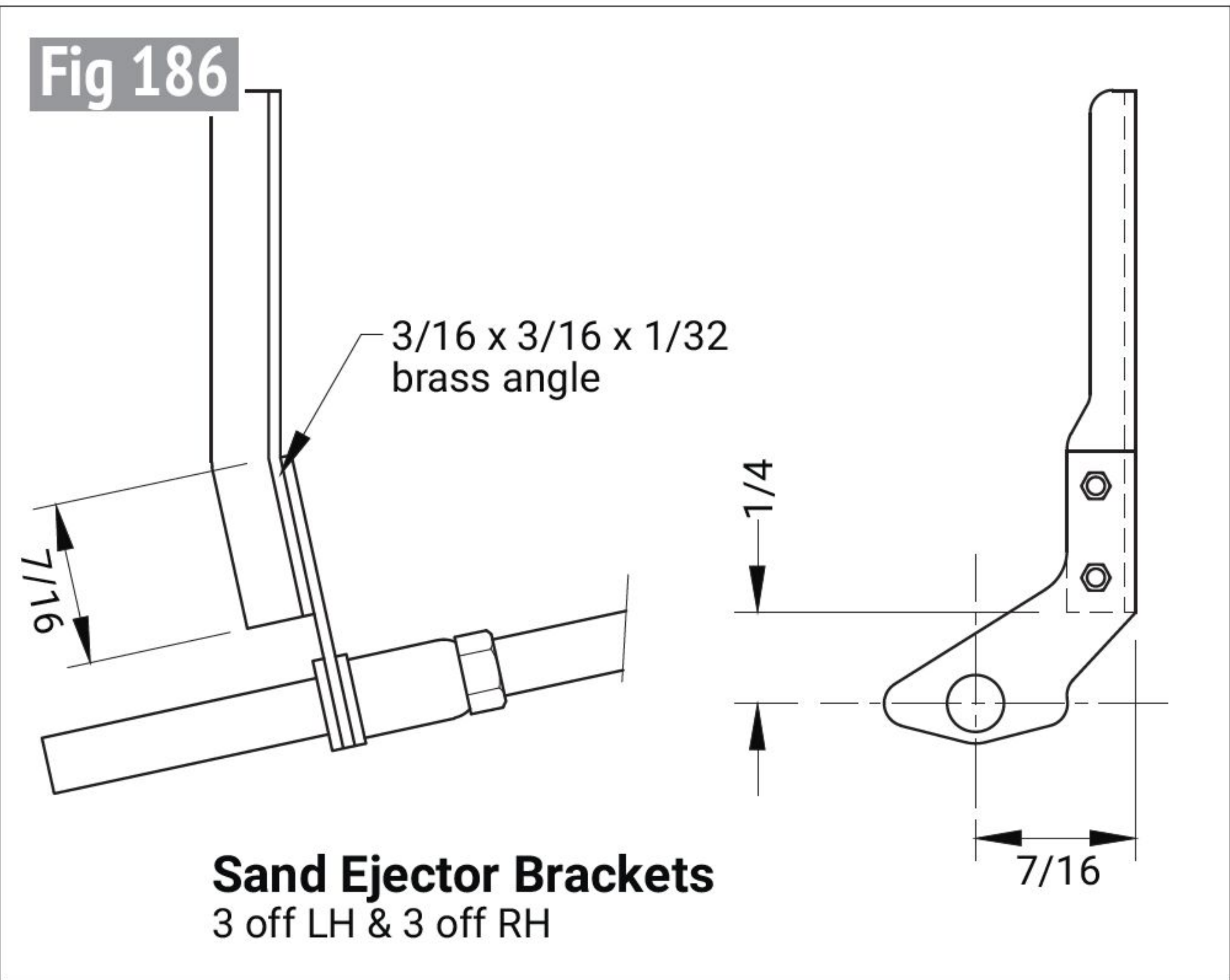
Doug Hewson presents an authentic 5 inch gauge version of Thompson's B1 locomotive.



Continued from p.685,
M.E.4743, May 17

I have to admit that I had almost forgotten about this - shame on me. I have produced castings for all the components that you will need and everything can be made to work for very little effort. There are only a few small drillings to do. I have made them all work on my 4MT. However, one thing it is as well to be aware of is that this may mean sand blowing into the valve gear and other places where it isn't needed! Needless to say, that I have never tried mine for that very reason. As with most engines with six driving wheels there is one set for the front of the leading wheels and a set either side of the main driving wheel.

The sanding valve is identical to the cylinder drain cock valve on my 4MT so there is also a casting available for that. These are all available from The Steam Workshop and you will require three sets as they come in pairs. The valve needs machining in a slightly different way from the drain cock valve as on my 4MT. All this requires is to make the little disc valve with a No. 50 hole in it such that you have to push it forwards for the front sanders and backwards for the



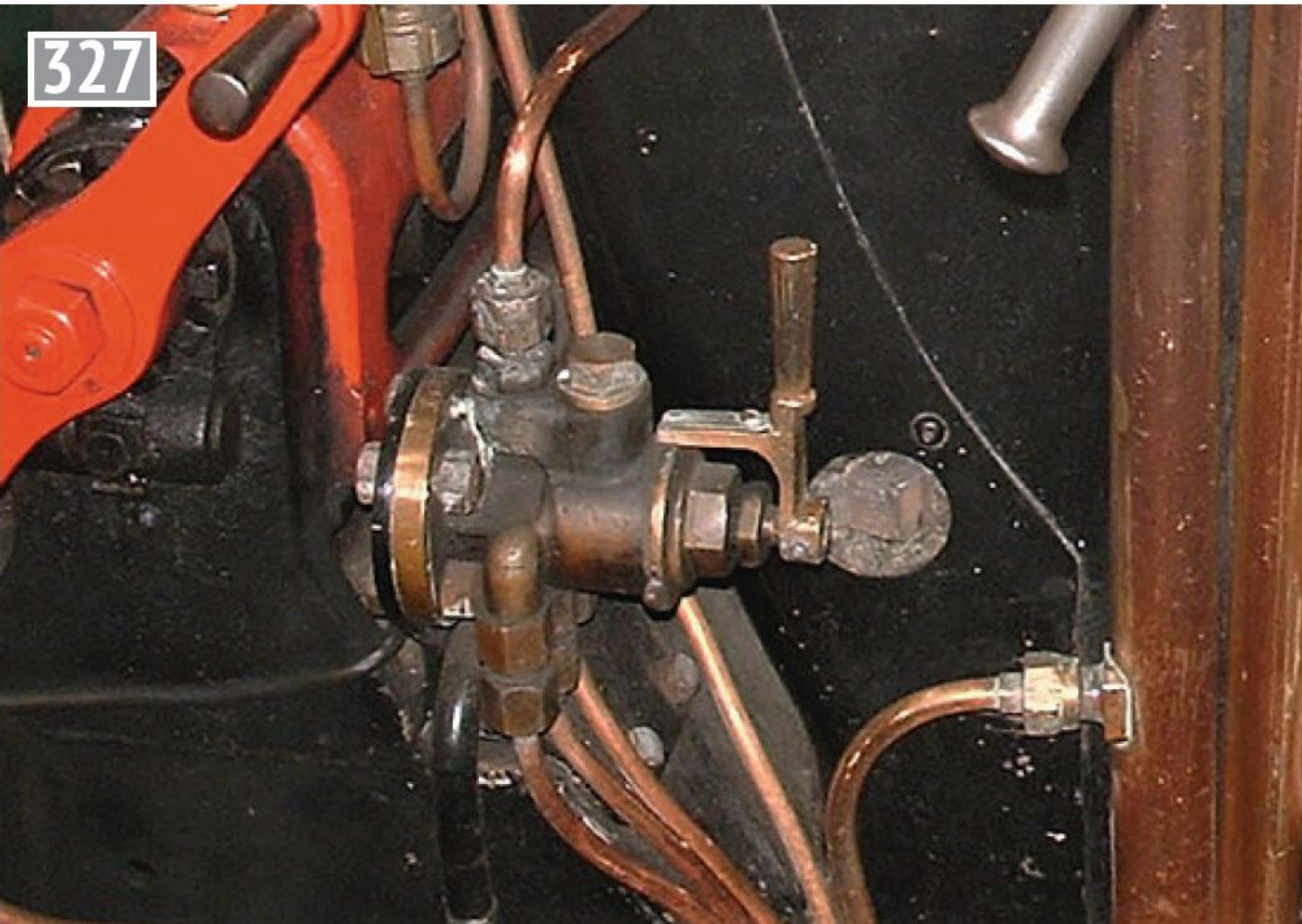
Sand ejector brackets.

rear sanders. I am sure you can understand that.

The first thing you will need to do is to modify the steam valve for the sanding gear. This means first of all removing the dummy unions from the casting and silver soldering some new ones on. Now if I remember rightly this also means making up the unions complete with the threads on them, heating them up quite gently and using some silver solder wire to fix them in place. This is so that you can silver solder them on with no

hindrance to using a die in a holder. I am sure that you will realise what I mean when you get working on the casting.

The handle also needs swapping over as these castings were made for my 4MT so that locomotive has a lever operation with the valve much further forward rather than a brass handle. The handle on the B1 is all part of the casting. The inlet valve for the steam is slightly different and as you will see on the photograph it just requires a simple alteration. The disc



Steam sanding valve.



Rear sand box.

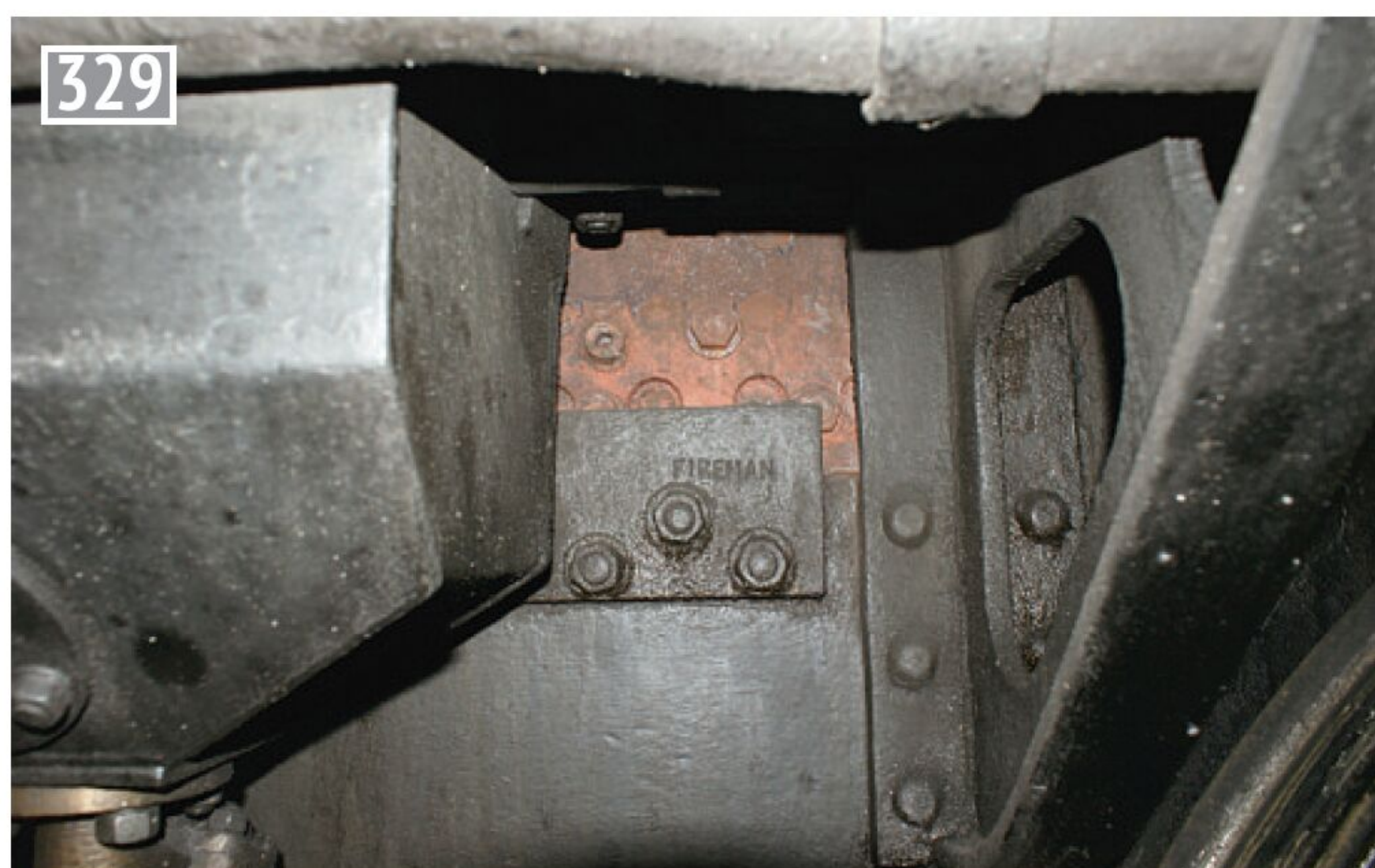
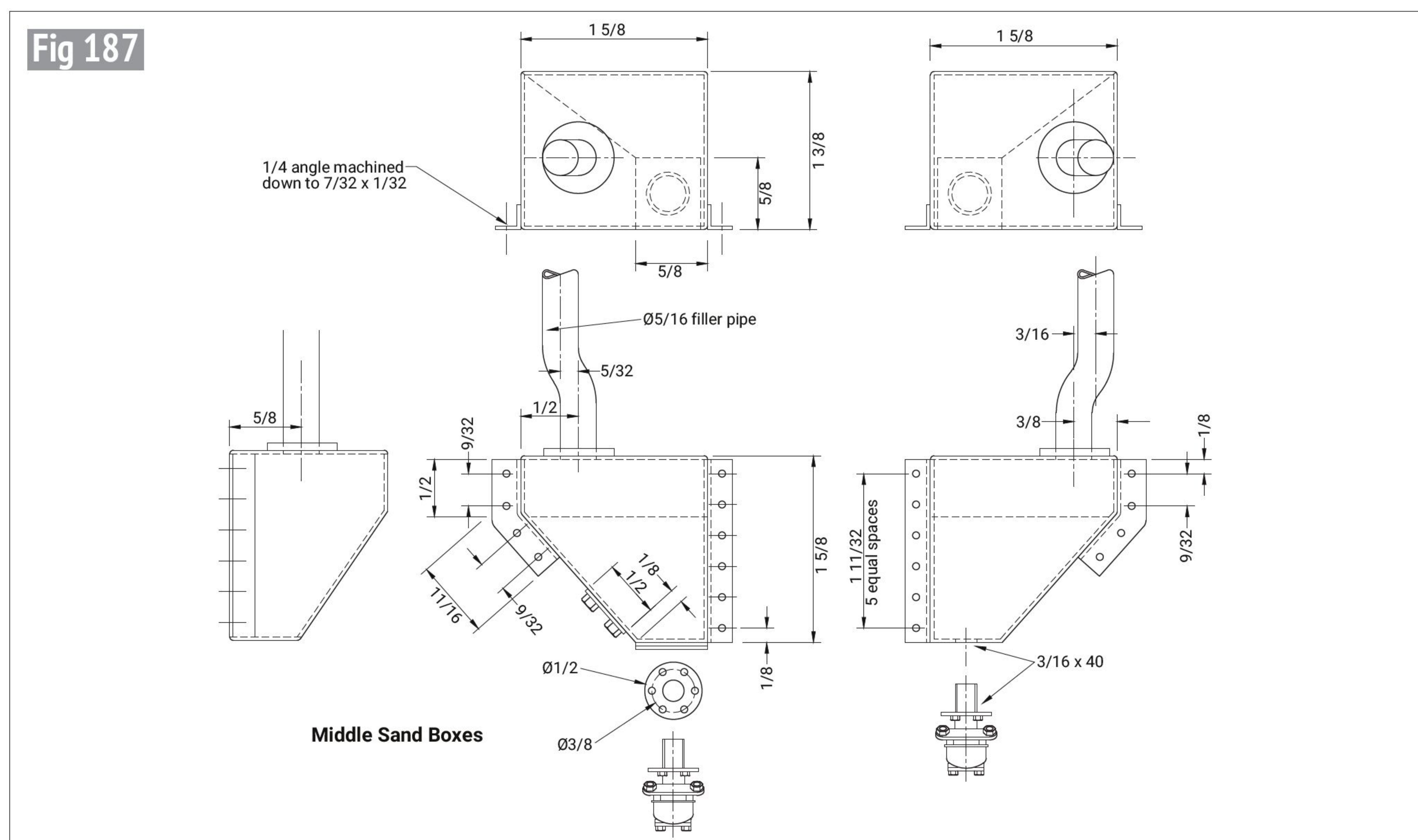


Plate indicating which side the sand box is on.



Filler tube and cap.



Middle sand boxes.

valve, which needs an almost polished face, is a much simpler affair and there is only one hole in the disk but there are three holes in the body of the casting. I have arranged it so that you push the lever forwards for the front sanders and rearwards for the rear sanders (**photo 327**).

I will make a start on the rear sand boxes as these are quite an interesting job. The main body of the boxes of all six sanders is constructed from 18swg steel plate. There is quite a bit of bending to do and to get all the bends in the

plates needs a bit of thought. The rear sand boxes are handed just by the plates which attach them to the frames. These have three 10BA bolts at one side and two at the front of each box. As you may have noticed, I have copied them from 61264 and it would be a very nice touch if you could hard stamp the 'Driver' and 'Fireman' on the fixing plates and then you can show them off to visitors! The driver needs to be on the left-hand side of the engine of course.

I can't think why the designer of these engines chose to fit

the sand traps on the B1s - what I would say - inside out, as it seems a rather strange idea to me, but I am not a locomotive designer! If you look at **photo 328** you will see what I mean. Perhaps it was so that the pipe run can be a little nearer to the frame plates. **Photograph 329** shows the stamped plate so this is obviously the rear right-hand sand box.

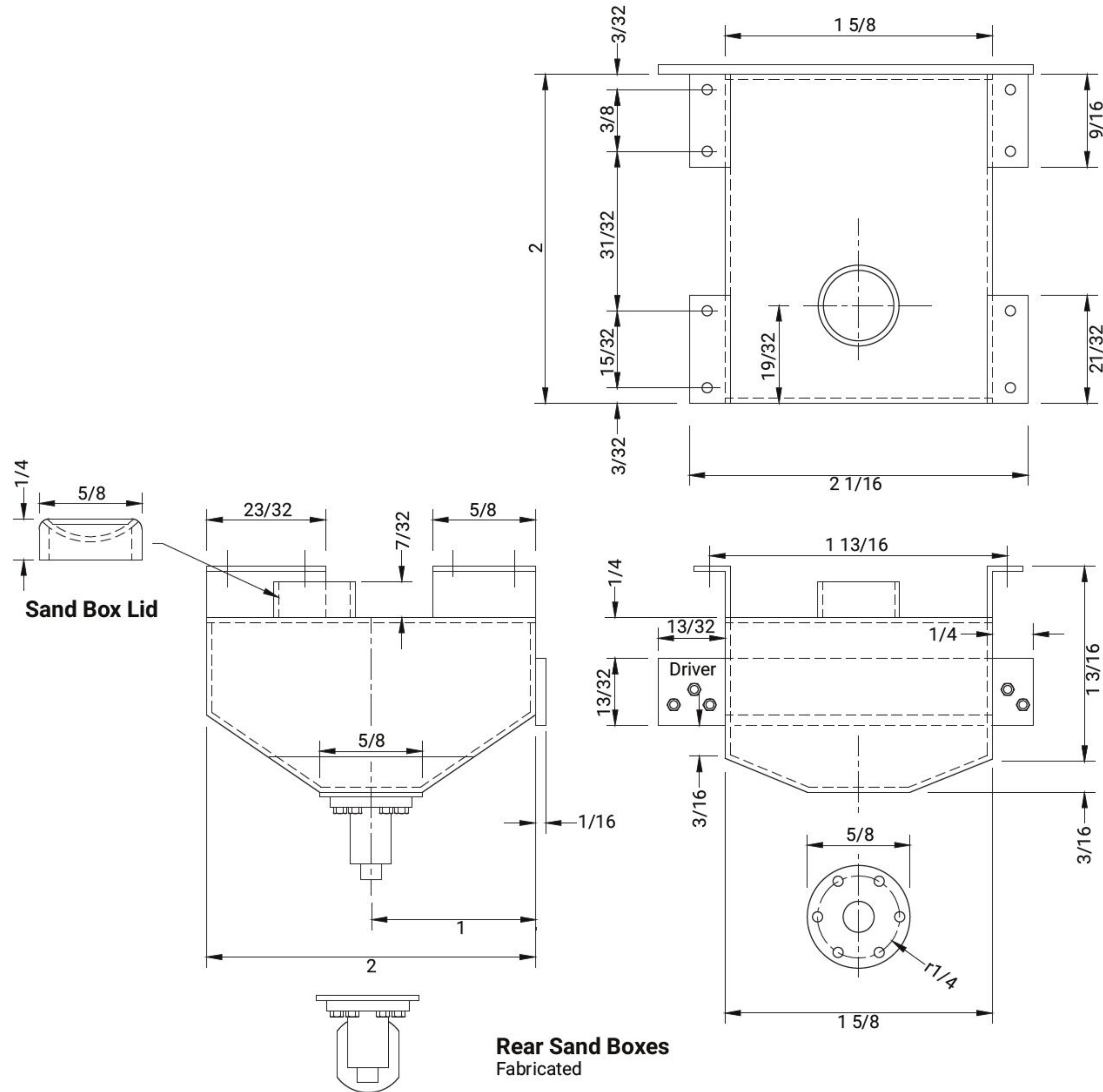
I have designed the sand traps from lots of photographs to get all the detail correct and they are in several pieces so that they can be cleaned out

if you decide to use them. I would make the hand holes in the outside of the rear boxes with an opening in them for the same reason. I bet you thought that making sand boxes was going to be easy! On the tops of the rear boxes are four plates which offer some support to the side platforms. There are also some cast iron covers over the filler tubes and the rear ones should finish more or less level with the platform. The other four have the filler tubes and caps protruding above platform level as in **photo 330**.

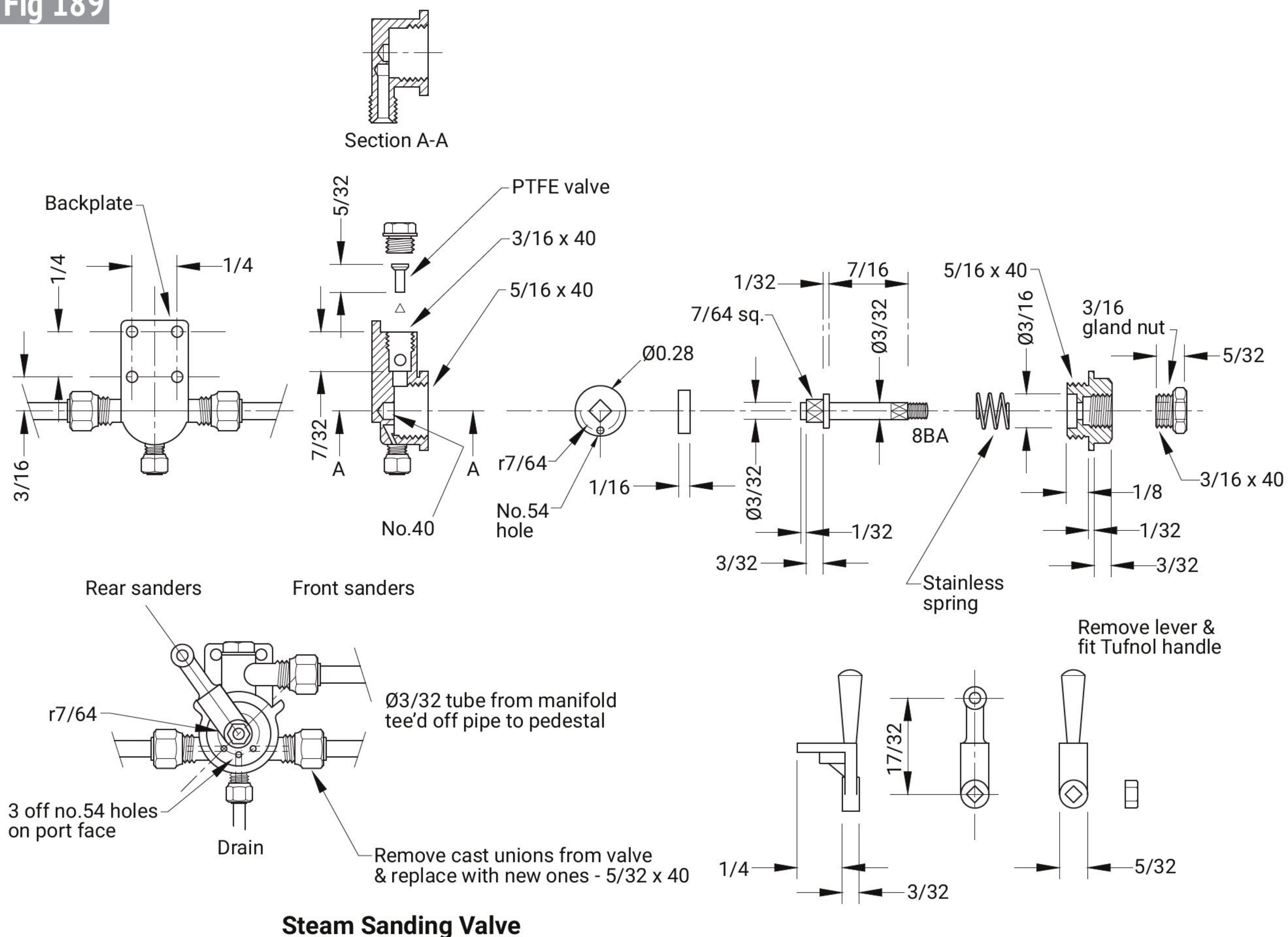


Front four sand boxes.

Fig 188

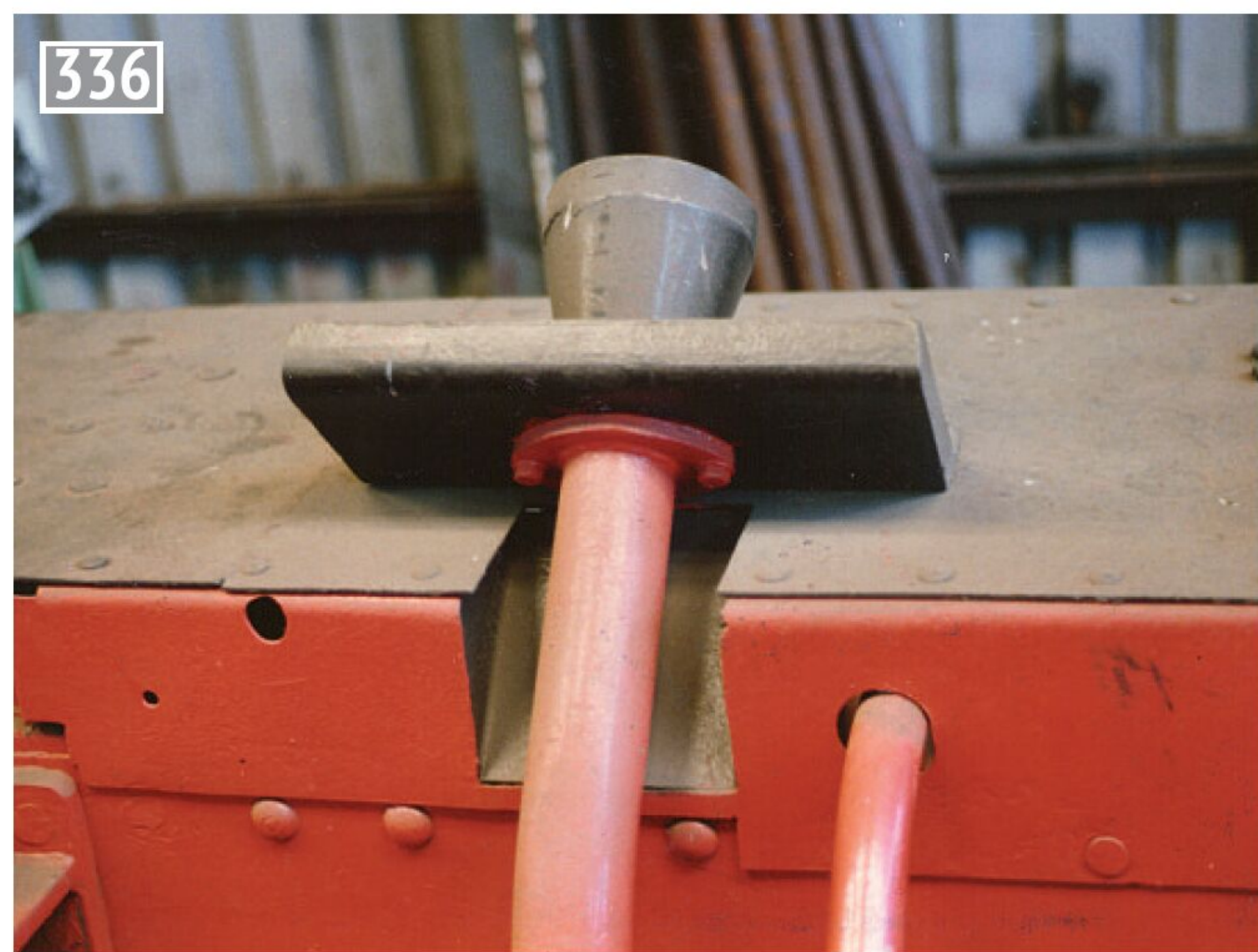


Rear sand boxes.

Fig 189**Steam Sanding Valve***Steam sanding valve.***Sand ejector nozzle.**

For the front four sand boxes there are two pairs. These are all shown in **photos 331 to 334**. In photo 332 you will see a good picture of the sand trap sideways on. I

hope you noticed how all the '10BA' which fix the sand boxes to the frame plates bolts have split pins through them! Photographs 333 and 334 show the bent angles

**Rear view of the sand box fillers.**

are stopped after the two bolts and include the plates covering the hand holes. **Photograph 335** shows the sand ejector and the reducing nozzles on the B1.

Photograph 336 shows the rear view of the sand box fillers. The BR engines do not have the same nozzles fitted.

●To be continued

Geoff Theasby
reports on
the latest news from the
clubs.



Well, unprecedented it may be, but I had enough raw material to sustain me for the whole of this contribution, as opposed to the recent few issues where I subsisted on 'nothing, spread thin.' It may be the answer to my prayers but not one I was expecting. Whilst preparing for the fray, debonair, handsome, well informed, suave; none of these qualities feature in my repertoire as I begin the next chapter in the Life Saga of Club News.

In his issue, a 'Clan', female engineers, solar power, pond life and an Atkinson truck.

Criterion, March, from **High Wycombe Model Engineering Club** is first out of the bag. On the cover is a boat, not often featured in this prominent advert for our hobby. It is an Admiralty salvage tug, built by Eric Hambling and using 'artificial steam'. Editor David Savage has made a Victorian lawn mower. That should keep the astroturf in order... Mike Cox wanted to be a veterinary surgeon but had a career in flying boats and invented the Landing Aid Mk 1. Not only that, but the absence of suitable rail for his models led to his inventing a stud contact system towards the end of WWII.

W. www.hwmecl.org.uk

Debs and I went to the *Hengist* Open Day at CTL Seal in Ecclesfield, North of

Sheffield. I was agreeably surprised how well attended it was, the two locomotives (**photo 1**) (the other being the B17 *Spirit of Sandringham*) were on show, of course, plus lots of stands featuring other projects and fundraising for their particular group. The GCR Grand Unification project was presented by the BBC's Tom Ingall, the broadcaster. This project's progress in the last few years has been very successful. A magnificent five page fold out on heavy card bearing a full, side view of the intended complete locomotive gives the costs for building a real, mainline locomotive in the 21st Century and looks good on my wall. I was impressed by the Sheffield University student rail project, 'Railway Challenge at Sheffield', which has been running for some years now. Projects were often entered in RCAS but never won; it nevertheless provides a good practical training for students of engineering, including a brace of female engineers manning (!) the display (**photo 2**). All this took place within the CTL Seal factory, a modern engineering works with appropriate facilities. Not so the ablutions. Clean and attended by a named individual, but apparently not decorated for several years :-(. I asked Debs to investigate her appropriate provisions and she got lost whilst looking and abandoning the quest, suggesting that the company

employed no women. *Hengist & Horsa*, originally Angles, Saxons or Jutes, who some regard as mythical, were so named as to imply superiority, virility and power, perhaps with Richard Harris playing the part*. The previous evening, we went to the Bring & Buy sale at Sheffield SMEE. I thought it was a little disappointing, but a young member I asked said he thought it 'brilliant', so maybe I'm being curmudgeonly... Amongst the varied and well-stocked stalls, was *Gowrie*, the last locomotive built for North Wales Narrow Gauge Railways by Hunslet and scrapped around 1930. Reputedly, it was not up to the job and a plan was devised 50 years later to construct a new one, rectifying the failings of the original. In style it is a single Fairlie and changes/enhancements will be kept out of sight where possible. As readers will see, the Society was exhibiting a model of *Gowrie* and charging for photographs, as part of the effort. Having paid my editor's 'mite' I present this to my readership (**photo 3**). One display concerned *Duke of Gloucester*, which was restored to the mainline in 1968 - from a wreck, thought to be unrestorable - after 13 years of hard work. Of course it needs maintenance, etc. and hence the fundraising. For your contribution of a 'pony' '£25' (locomotive joke) you will receive a new publication, *Friends of Gowrie*, Newsletter No. 1, an uplifting publication to gladden the heart of narrow gauge travellers. I note amongst the contributors named is one *Mike Lynskey*, whom I remember for his humorous contributions to the Keighley & Worth Valley Railway's *Push & Pull*, some years ago and I recognised the style.

W. www.gowrielocomotivetrust.com

On Track., April, from **Richmond Hill Live Steamers**, is a little late, due to the editor, Eric Motton, visiting the UK, including Stockport SME, who generate all their electrical needs on site and



A Brit. Not a Clan, or a B17, or a single Fairlie.



Female engineers at RCAS

independently of mains power by using solar panels, including the charging of electric locomotive batteries. He visited the East Lancs Railway for their Legends of Steam event. A video found online is about the End of the World train, <https://www.trendelfindelmundo.com.ar/index.html> and another featuring 'Caterpillars', New Zealand's logging locomotives, in https://www.youtube.com/watch?v=MmiAdFvX_88 Plans are afoot to rethink the crowd control for the Richmond Hill 'Doors Open' event, in view of the popularity of last year's event and excessive train rides by a few, thus denying a ride to other passengers queueing patiently. A sinuous queue area was marked out, making space for customers but not encroaching on the road. Limiting the ride tickets to two per visitor also helped reduce congestion. Montreal Live Steamers' 90th Anniversary event takes place on 28-30th June. There are five loops

in their track, so that should keep drivers and visitors happy for the weekend (www.montreallivesteamers.org) The covered accommodation at RHLS uses substantial buildings made from baulks of timber, which appear big enough to service really large locomotives, let alone models. **W.** richmond-hill-live-steamers.tripod.com *Blastpipe*, April, the joint Newsletter from **Hutt Valley and Maidstone MES** is presided over by Claud Poulsen, who modestly submits a one page newsletter. This keeps us up to date and features a small, battery powered shunter of unknown ownership or provenance. **W.** www.hvmes.com **Bradford Model Engineers' Monthly Bulletin**, for April, introduces an innovation from the committee. A collection of 'mugshots' is printed, of all the guiding lights of the society. This will help anyone with questions or topics to discuss, by identifying the dignitaries



Gowrie at the Hengist open day

concerned. Jim Jennings has a small number of acetylene lamps and explains their operation for young members who have never seen one. (I remember my Dad telling me about those and how, if you were running out of light on your way home at night, but too close to home to make a refill necessary, you would open it and spit into the top, which gave enough gas to reach home – Geoff.) A group of horologists meets at Bradford Industrial Museum and they invited BME to a joint meeting to explain what we model engineers 'do'. The attendees were interested in our ideas and our members were able to explain them in somewhat greater detail during the break for tea and tasty comestibles.

W. www.bradfordmes.uk

The Daresbury Gazette, April, courtesy of **Warrington & District Model Engineering Society**, Daresbury, reports that a gap in a fence has been repaired with suitable and matching materials, but an obstacle was the amount of rubble 'landfill' located just below the intended location of the support posts. An oversize hole was dug and a base laid in it. This required a three inch square post for the fence, but Duncan's suggestion of buying a piece of the requisite dimensions was dismissed as silly and a convenient item was located. Being larger than required one end was

reduced to fit, in the manner of producing baby carrots (CN 4743)...

W. www.wdmes.co.uk

The Prospectus, from **Reading Society of Model Engineers**, has chair/editor, John Billard making the amusing typo, of referring to 'pubic' running, at which gathering the profits amounted to more than £1,000. If you ever saw the British 'silent' film, *A home of your own* the last scene will remind you when you see it again. https://www.youtube.com/results?search_query=a+home+of+your+own+ Anyway, back at the ranch, the Society was represented at the Federation of Model Engineering Societies' meeting at Boscombe Down Aviation Museum (which is 'well worth a visit', says John). When the old workshop lathe was being dismantled, this notice was found and reinstated (**photo 4**).

An upcoming meeting will be a talk by Peter Venn, entitled, 'The Desk'. Hmmm, I'll pass on the joke, he has probably heard it several times already. (That doesn't usually stop you! - Ed.) 130 words, okay, John?

W. www.rsme.uk



Recycling.



DIY servicing. (Photo courtesy Deborah Theasby.)



Look ma, no hands... (Photo courtesy of Deborah Theasby.)

The Stephenson Link, issue 2024/2, from **Chesterfield & District Model Engineering Society** has a good picture of Rod Brown and his

Fowler traction engine, taken at Papplewick where there was also a display of miniature submarines and AN ALLIGATOR! Debs and I intend

visiting in the near future. A recent addition is the winding engine from Linby Colliery. Brent Stafford updates his Special Scenic Showmans engine, finding that the safety valves weren't satisfactory when running on air, so he has fitted locomotive types for the moment. A lathe tailstock depth gauge is Ivan Turner's contribution to the science, made from a six inch digital caliper. Adrian continues with his Land Rover, in which he falls for an overdrive gearbox. New, the cost was prohibitive but, spotting a used one in the local paper, he could barely contain his excitement to get on and fit it. Results are revs and noise are down, top speed was up and he also now had 16 forward gears and 4 reverse. This will help him to run away more quickly as his wife still hates it!

W. www.cdmes.co.uk

The spring *Kingpin*, from **Nottingham SMEE** finds Tom Ingall (he gets about, doesn't he?) updating us on the GCR reunification project, which may have some momentous news by the time you read this. Tom says that tens, may be hundreds of thousands of people all around the world have supported this project since it began. See also GCROFFICIAL Youtube channel, now standing at over 14,000 members. John Ollerenshaw writes on the Leek and Rudyard Railway, 10 1/4 inch gauge near Rudyard Lake, relocated from the Isle of Mull. Since leaving Mull in 2011, the locomotive has had several owners and the railway is an interesting visit, including guided shed tours, an excellent café and lots of action (www.rlsr.org) John then writes of the Amerton Farm steam gala, near Stafford; this 2 foot gauge track of about 1 mile in length runs passenger trains clockwise and freight trains anticlockwise. (Don't ask... just don't – Geoff.) (www.amertonrailway.co.uk) A number of random photographs show views of several of the facilities, drivers with their locomotives and members indulging in

site maintenance. The newly decorated café is very smart. John goes on to cover the Statfold Barn Enthusiasts Day, running 16 locomotives on 3 gauges. The opening of a new area is the P10 1/4 gauge Mease Valley Light Railway. Resident is 2-4-2 T *Victoria*, whilst in the carriage shed were frames for an 18 inch gauge Crewe Works NG locomotive of 1867, being built by engineering enthusiasts from Airbus. This project was evicted from its home with only four weeks' notice, therefore being given four weeks' notice to find a new home! One of its companions was an Atkinson truck, PTC440K, with its very trendy wrap-round windscreens. Finally, I bring to my readers attention the new website, www.nsmee.org.uk courtesy of Dave Fisher.

As my gorge sets slowly into astronomical twilight, I must admit that my locomotive had its first outing and did not cover itself with glory. The derailling habit had not gone, it was only in abeyance. However, apart from checking that the wheel spacing is correct, it may be relevant that the Abbeydale track uses proper railway shaped (bull head) rails and my home track is steel bar set on edge. I also had electric problems in that a fully charged battery seemed to be completely drained, but it wasn't. Funnily enough, as a project I thought it was finished, and built into the Wall of Radios, but then this morning it too seemed to have a paucity of the fluid. Here I am getting to grips with the missing Amps (photos 5 and 6).

Note to editors

I very rarely find nothing of interest in any club newsletters, so please don't hold back from submitting a contribution, however uninteresting it may seem to you.

And finally, a lady who injected herself with Marmite later gave birth to Twiglets.

*A man called 'Horse'
**Until we meet again,
(eventually)

ME

Club Diary

2 June 2024 – 8 August 2024

June

2 Guildford MES

Small Model Steam Engine Group, 14:00-17:00.

See www.gmes.org.uk

2 Plymouth Miniature Steam

Public running, 14:00-16:30, Pendeen Crescent, Plymouth, PL6 6RE, Contact:

Rob Hitchcock, 01822 852479

2 Westland and Yeovil MES

Running the track at Yeovil Junction – Steam Train Day and Children's Day.

Contact : Michael Callaghan, 01935 473003

6 Sutton MEC

Bits and Pieces evening 20:00.

Contact: Paul Harding, 0208 254 9749

6 Westland and Yeovil MES

Thursday running afternoon and evening followed by fish and chips. Contact : Michael Callaghan, 01935 473003

7 Rochdale SMEE

General Meeting. Castleton Community Centre, 19:00.

See www.facebook.com/RochdaleModelEngineers

7-9 Cardiff MES

Welsh Rally at Heath Park, Cardiff. Contact : secretary@cardiffmes.co.uk

8 Bradford MES

Meeting: RC Loco Competition and Evening Running. 13:00 onwards, Northcliff. Contact: Russ Coppin, 07815 048999.

9 Bradford MES

The Big Lunch, Northcliff. Contact: Russ Coppin, 07815 048999.

9 Guildford MES

Open day, 14:00-17:00. See www.gmes.org.uk

9 Sutton MEC

Track Day from 13:00. Contact: Paul Harding, 0208 254 9749

15 Bromsgrove SME

Midlands Gauge 1 event, incorporating the Paul Forsyth Memorial event. See www.bromsgrovesme.co.uk

15 Cardiff MES

Steam up and family day at Heath Park, Cardiff. Contact : secretary@cardiffmes.co.uk

16 Bradford MES

Public Running Day. Members from 11:30 am, public from 13:30 to 16:00, whatever the weather, Northcliff. Contact: Russ Coppin, 07815 048999.

16 Plymouth Miniature Steam

Public running, 14:00-16:30, Pendeen Crescent, Plymouth, PL6 6RE, Contact:

Rob Hitchcock, 01822 852479

16 Westland and Yeovil MES

Running the track at Yeovil Junction – Steam Train Day.

Contact : Michael Callaghan, 01935 473003

20 Sutton MEC

Club night – paper aeroplanes.

Contact: Paul Harding, 0208 254 9749

21 Rochdale SMEE

Models Running Night – 17:00 onwards. Springfield Park.

See www.facebook.com/RochdaleModelEngineers

23 Westland and Yeovil MES

Track running day 11 :00.

Contact : Michael Callaghan, 01935 473003

27 Sutton MEC

Afternoon run from 13:00.

Contact: Paul Harding, 0208 254 9749

30 Cardiff MES

Open Day at Heath Park, Cardiff. Contact : secretary@cardiffmes.co.uk

30 Westland and Yeovil MES

Running the track at Yeovil Junction – Pirate Day. Contact : Michael Callaghan, 01935 473003

July

3 Bradford MES

Meeting: Steerage Trophy Competition, 19:30, Wibsey. Contact: Russ Coppin, 07815 048999.

4 Sutton MEC

Bits and Pieces evening 20:00. Contact: Paul Harding, 0208 254 9749

4 Westland and Yeovil MES

Thursday running afternoon and evening followed by fish and chips. Contact : Michael Callaghan, 01935 473003

5 Rochdale SMEE

Members projects/Bits and Pieces. Castleton Community Centre, 19:00.

See www.facebook.com/RochdaleModelEngineers

6 Bromsgrove SME

Modern Traction Open Day

– all gauges are welcomed

– 5, 3½, 2½, Gauge 1 and 16mm. Contact: Doug Collins, 01527 874666. See www.bromsgrovesme.co.uk

6/7 Bournemouth and District MES

Gala Weekend at Littledown Park, Bournemouth. Contact: bdsme.secretary@gmail.com

6/7 Guildford MES

Gala, 10:00-17:00. See www.gmes.org.uk

6 Sutton MEC

Coulsden Fete. Contact: Paul Harding, 0208 254 9749

7 Bradford MES

Rae Day Gala, Northcliff. Contact: Russ Coppin, 07815 048999.

7 Plymouth Miniature Steam

Public running, 14:00-16:30, Pendeen Crescent, Plymouth, PL6 6RE, Contact:

Rob Hitchcock, 01822 852479

14 Sutton MEC

Track Day from 13:00. Contact: Paul Harding, 0208 254 9749

14 Westland and Yeovil MES

Running the track at Yeovil Junction – Steam Train Day and Turntable Day. Contact : Michael Callaghan, 01935 473003

19 Rochdale SMEE

Models Running Night – 17:00 onwards. Springfield Park.

See www.facebook.com/RochdaleModelEngineers

19-21 Southport MEC

International Model Locomotive Efficiency Competition. See southportmodelengineering.club

21 Bradford MES

Public Running Day. Members from 11:30, public from 13:30 to 16:00 whatever the weather, Northcliff. Contact: Russ Coppin, 07815 048999.

21 Guildford MES

Open day, 14:00-17:00. See www.gmes.org.uk

21 Cardiff MES

Open Day at Heath Park, Cardiff. Contact : secretary@cardiffmes.co.uk

21 Plymouth Miniature Steam

Public running, 14:00-16:30, Pendeen Crescent, Plymouth, PL6 6RE, Contact:

Rob Hitchcock, 01822 852479

25 Sutton MEC

Afternoon run from 13:00.

Contact: Paul Harding, 0208 254 9749

27 Cardiff MES

Steam up and family day at Heath Park, Cardiff. Contact : secretary@cardiffmes.co.uk

27 Westland and Yeovil MES

Track running day 11 :00. Contact : Michael Callaghan, 01935 473003

30 Westland and Yeovil MES

Running the track at Yeovil Junction – Diesel Day. Contact : Michael Callaghan, 01935 473003

August

1 Cardiff MES

Members' projects. Contact : secretary@cardiffmes.co.uk

1 Sutton MEC

Bits and Pieces evening 20:00. Contact: Paul Harding, 0208 254 9749

2 Rochdale SMEE

General Meeting. Castleton Community Centre, 19:00. See www.facebook.com/RochdaleModelEngineers

4 Guildford MES

Small Model Steam Engine Group, 14:00-17:00. See www.gmes.org.uk

6 Westland and Yeovil MES

Running the track at Yeovil Junction – Diesel Day. Contact : Michael Callaghan, 01935 473003

7 Bradford MES

Meeting: Evening running & Social, 19:30, Northcliff. Contact Russ Coppin, 07815 048999.

8 Guildford MES

Open day, 10:00-13:00. See www.gmes.org.uk

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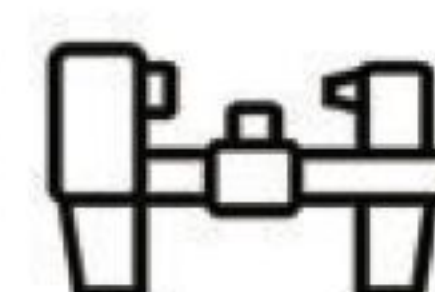


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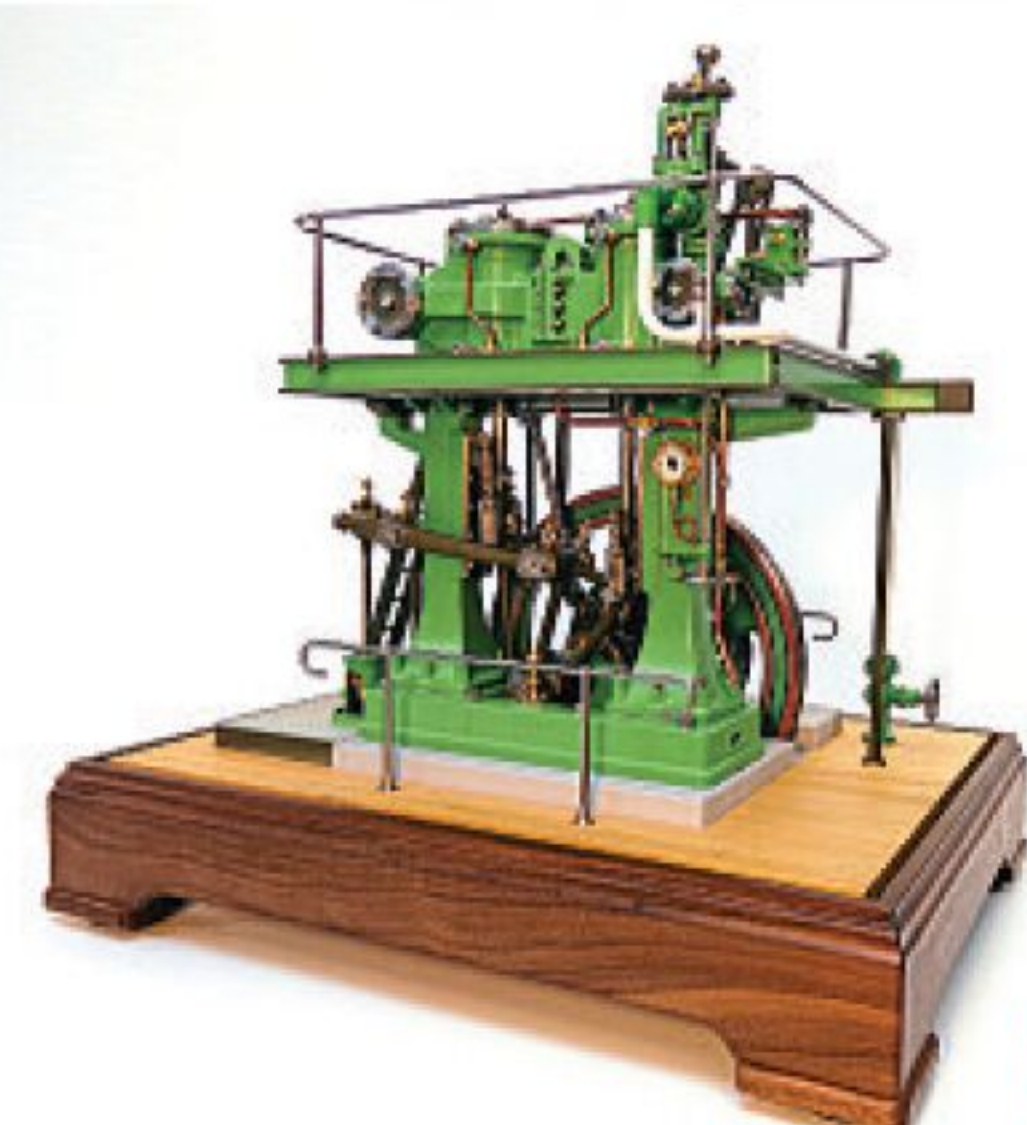
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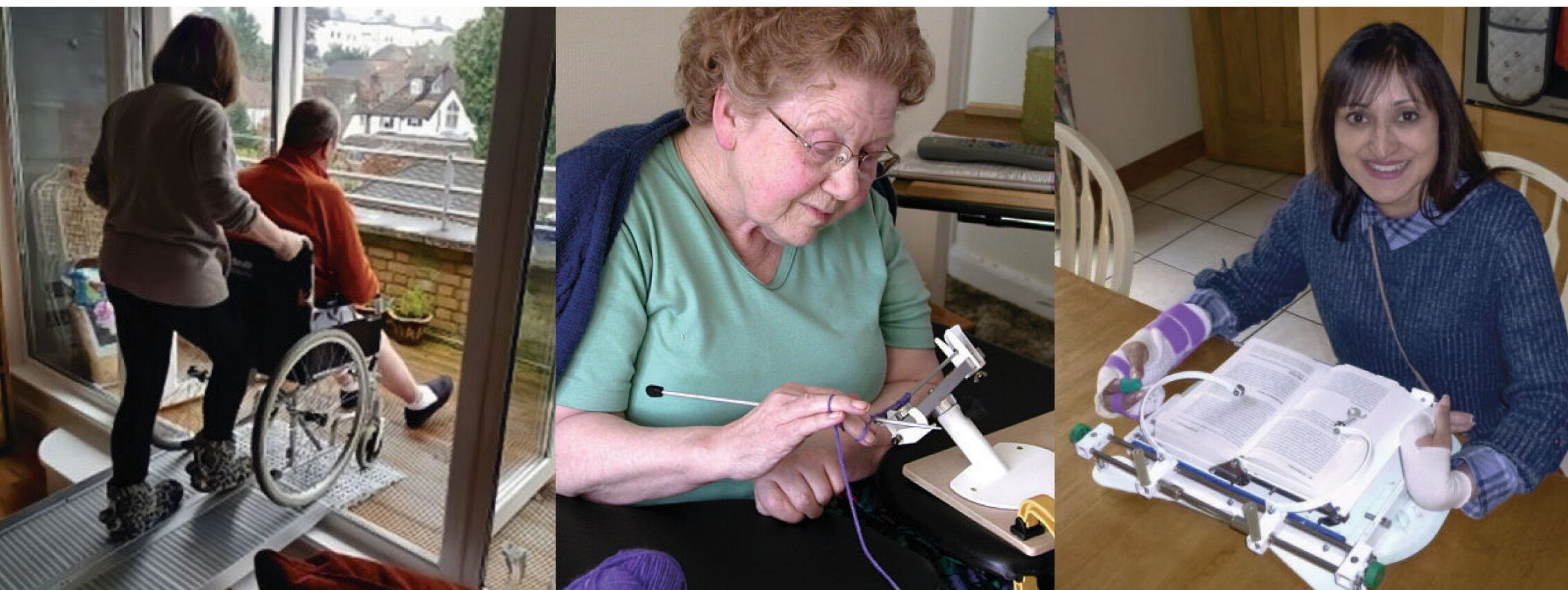


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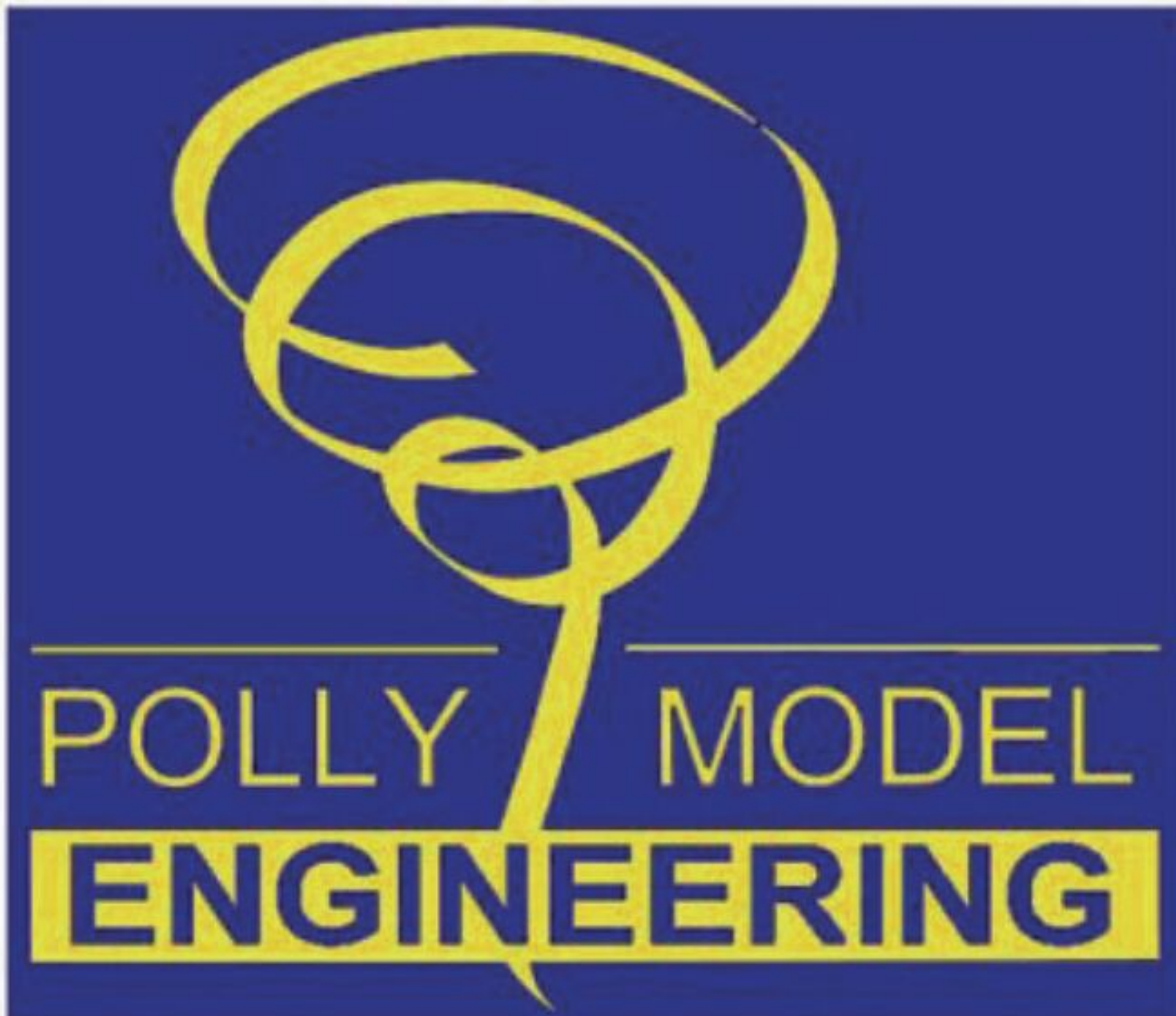
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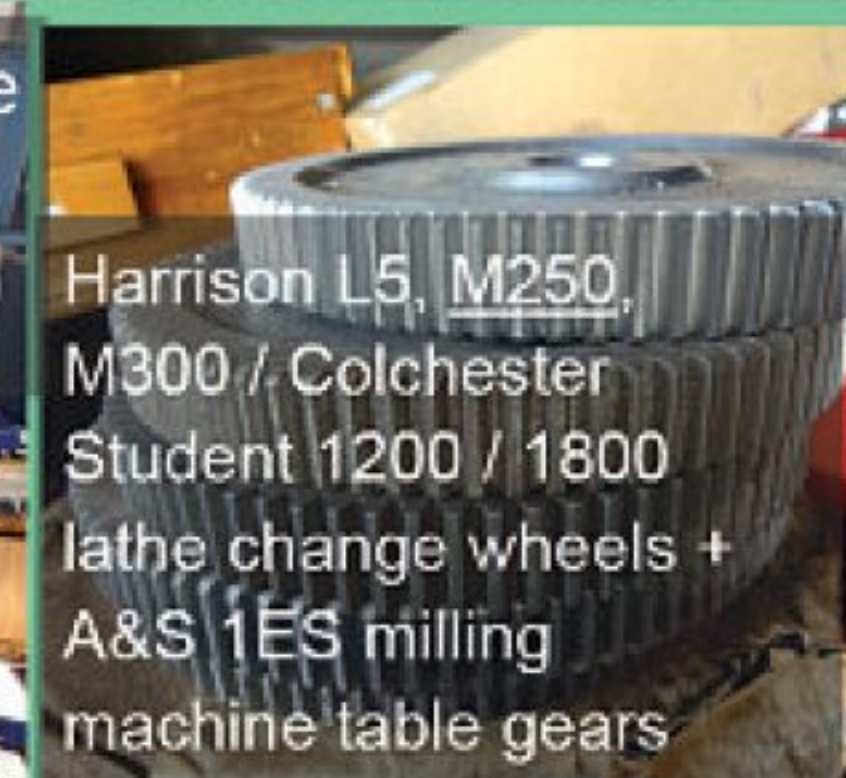
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Elliot 8 8" pedestal grinder 3PH £245



Myford 3/4HP 240V resilient mount motor configured to match a Dewhurst reversing switch already wired + instructions £226



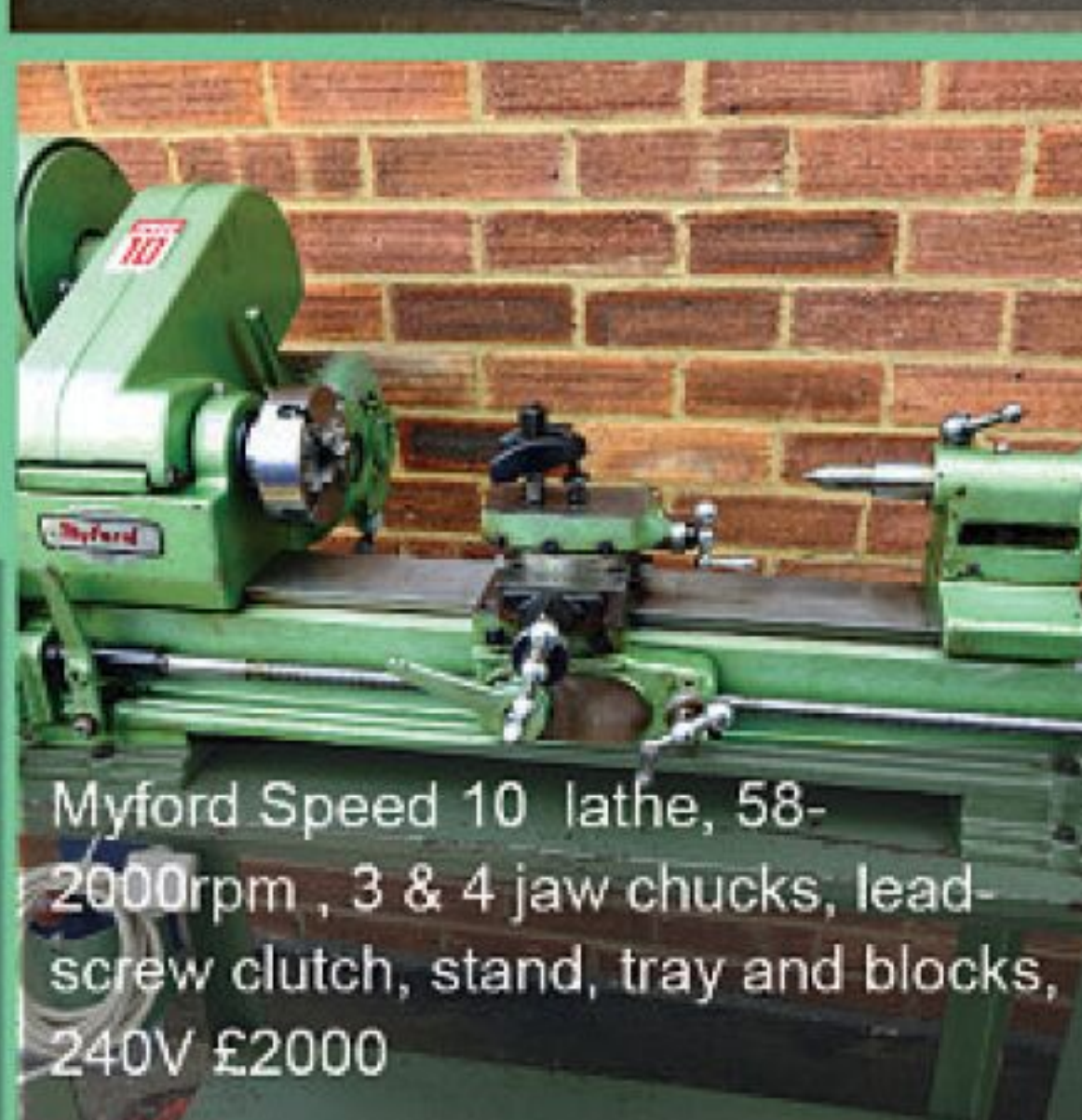
Trugrip collets metric £35 Imperial £30, Marico 2820 £15 each



Wolf-Jahn lathe + collets j+ two tailstocks just in! £3250



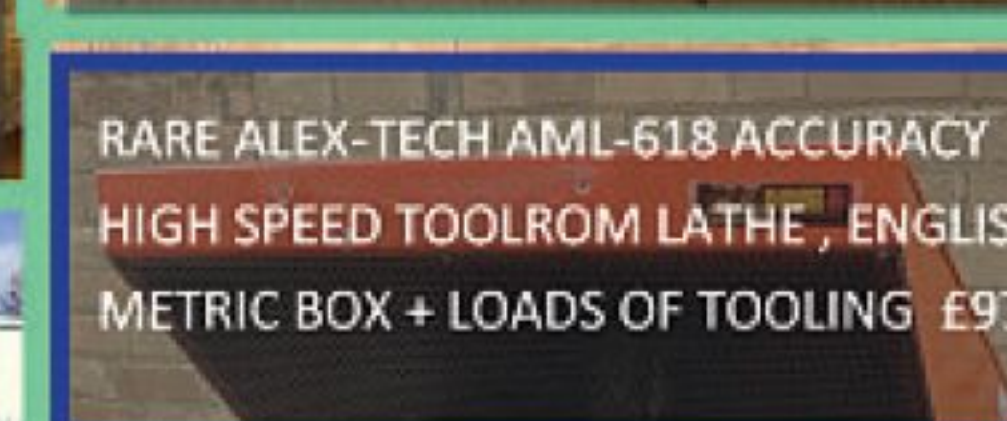
DP / MOD gear cutters
JUST £20 each + MORE JUST ARRIVED!
Hundreds in stock!



Myford Speed 10 lathe, 58-2000rpm, 3 & 4 jaw chucks, lead screw clutch, stand, tray and blocks, 240V £2000



Myford VMB Mill + chucks, stand, 240V £2750



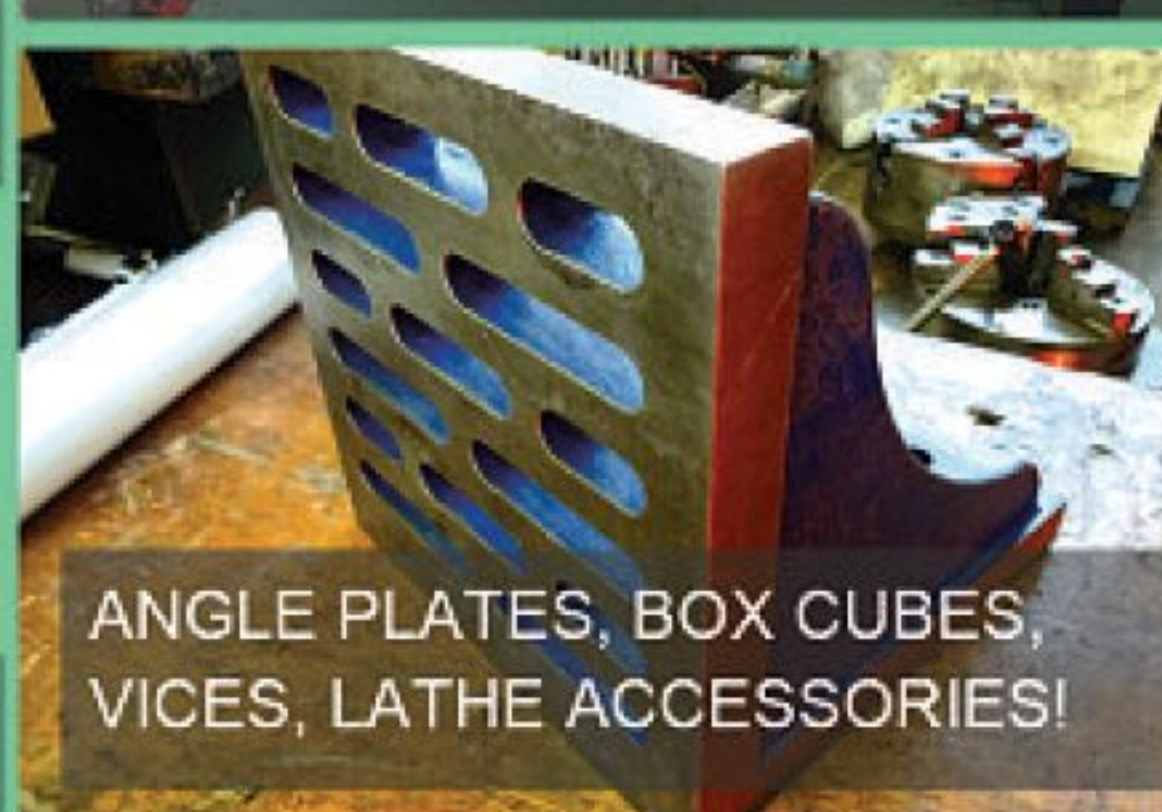
RARE ALEX-TECH AML-618 ACCURACY HIGH SPEED TOOLROOM LATHE, ENGLISH / METRIC BOX + LOADS OF TOOLING £9750



Tripus 240v switch £90



Norton Deep throat No.6DB fly-press 12" throat x 9" height £950
+++ FLYPRESS PUNCHES AVAILABLE



ANGLE PLATES, BOX CUBES, VICES, LATHE ACCESSORIES!



Myford gearbox unused £1000



HME Hearth just arrived from education 3PH / mains gas £500



Crown Windley Brothers 6ft x 4ft cast iron surface table £1425
Granite 5ft x 3ft surface table £1425



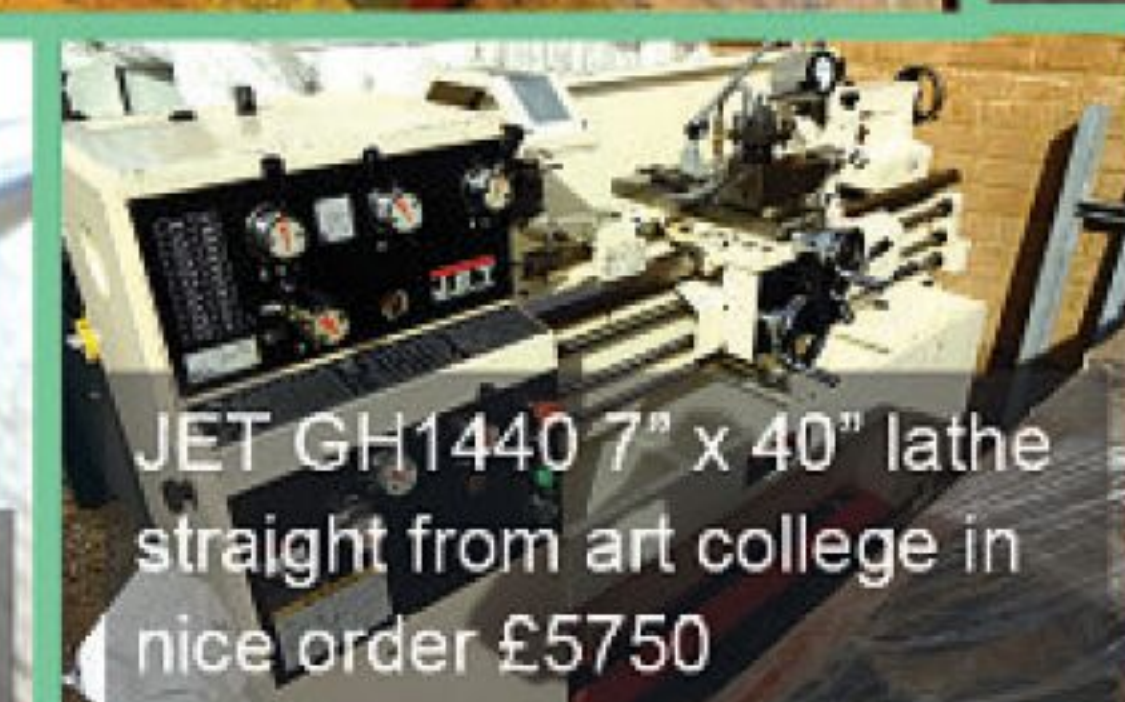
Smart and Brown Sabel lathe £950



Neat cut and soluble cutting oils £10 each



Milling cutters, drill bits, chasers, DOC cutters etc.



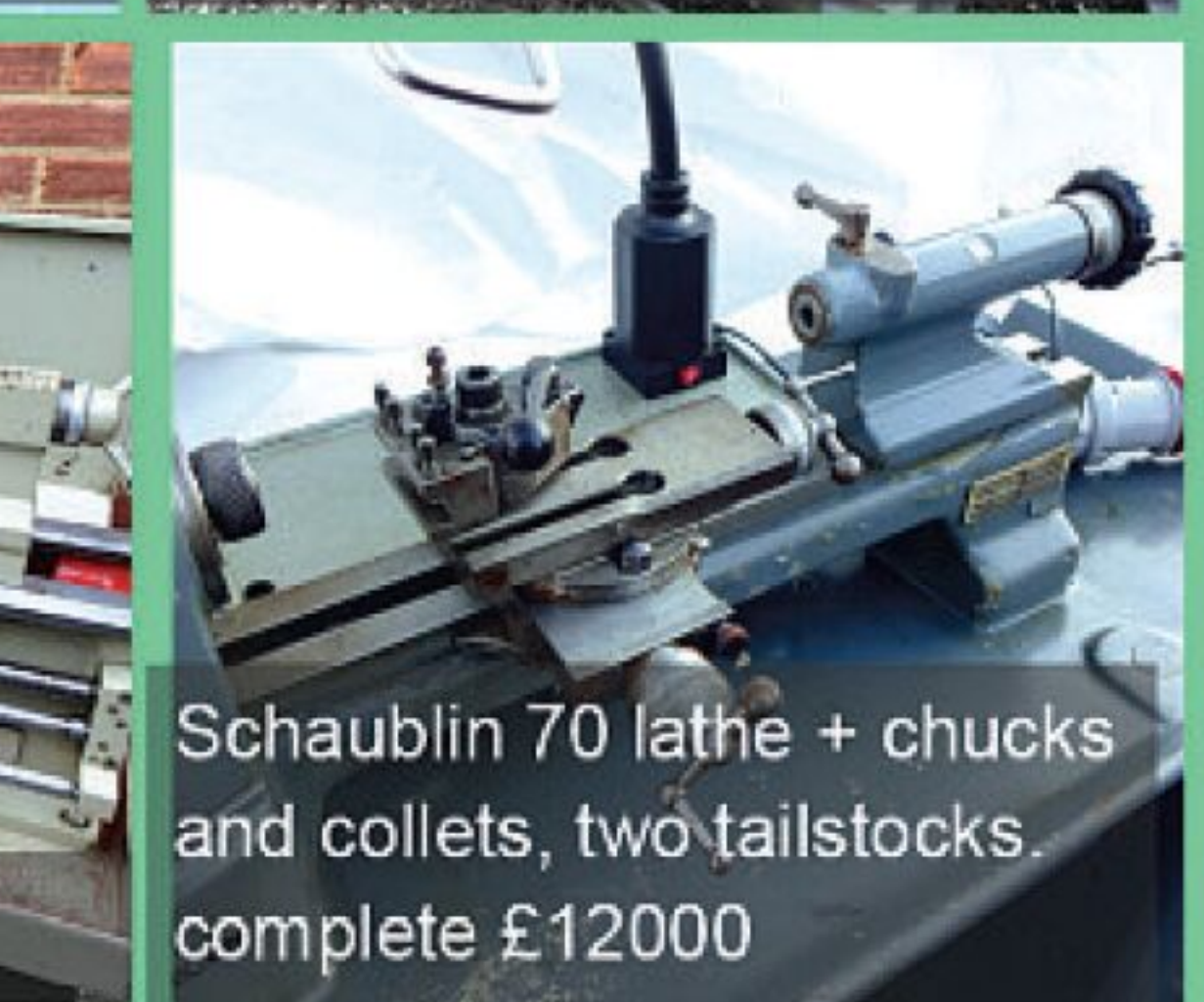
JET GH1440 7" x 40" lathe straight from art college in nice order £5750



Picador Pulleys just arrived from £12.00



Harrison M300 lathe £3950



Schaublin 70 lathe + chucks and collets, two tailstocks, complete £12000

Please phone 0208 300 9070 to check availability.
Distance no problem – Pallets leaving daily! – prices exclusive of VAT
Just a small selection of our current stock photographed!

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