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662



ISSUE IN THIS ISSUE IN THIS ISSUE IN THIS ISSUE IN THIS ISSUE

Vol.223 No.4624 25 October - 7 November 2019

624 SMOKE RINGS

News, views and comment on the world of model engineering.

625 BRASS, STEEL AND FIRE

Diane Carney attends the opening of a special exhibition at the National Railway Museum.

627 GARRETT 4CD TRACTOR

Chris Gunn paints and lines the wheels of his 6 inch tractor.

630 LATHES AND MORE FOR BEGINNERS

Graham Sadler completes his set of faceplates by making a set of work mounting plates.

632 STEAM TURBINES LARGE AND MINIATURE

Mike Tilby explores the technology, history and modelling of steam turbines.

638 MUNCASTER'S 'SIMPLE' ENTABLATURE ENGINE

Jason Ballamy brings a Muncaster design up to date to present an interesting engine suitable for beginners.

641 A NEW GWR PANNIER

Doug Hewson embarks on a mission to improve LBSC's half century old GWR Pannier Tank design.

644 SHOWCASE

Brian Muggleton's compound condensing marine engine.

645 7¼ INCH GAUGE SOCIETY AGM

John Arrowsmith reports from Newport MES on the society's AGM.

649 FOUR BAR LINKAGE HINGES

Nick Feast is inspired by his Skoda motor car to use a clever hinge arrangement for the cab roof on his Q1.

652 POSTBAG

654 BEAM COMPASS

Stewart Hart describes a useful but simply made marking out tool.

656 THE ELUSIVE WIMSHURST MACHINE

Alan Pickering weighs up the positives and negatives of having his very own Wimshurst machine.

658 MAKING AND USING WAX CHUCKS

Tony Bird demonstrates a few examples of the use of a wax chuck.

660 FIVE INCH GAUGE GARDEN RAILWAY DESIGN AND CONSTRUCTION

Stephen Wessel aims to achieve solid and stable foundations for his garden railway.

662 THE BARCLAY WELL TANKS OF THE GREAT WAR

Terence Holland describes and constructs two appealing, century old locomotives.

665 SIEG SX2 PLUS MILLER CNC CONVERSION

Graham Sadler explains how he converted his Sieg milling machine to CNC operation.

668 CLUB NEWS

Geoff Theasby compiles the latest from model engineering clubs around the world.

671 DIARY



ON THE COVER...

Chris Binks, the National Railway Museum's conservation assistant, attends to a working model of Mark Seguin's first locomotive, which was introduced to France at the St. Etienne-Lyon Railway in 1829 and was the first steam locomotive made in France (photograph by Charlotte Graham reproduced by kind permission of the National Railway Museum).

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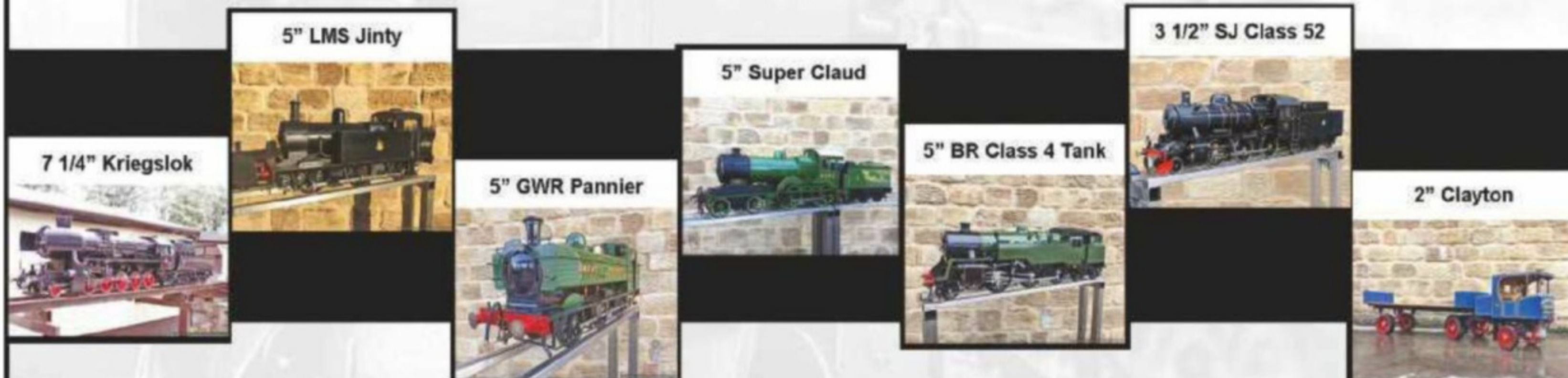
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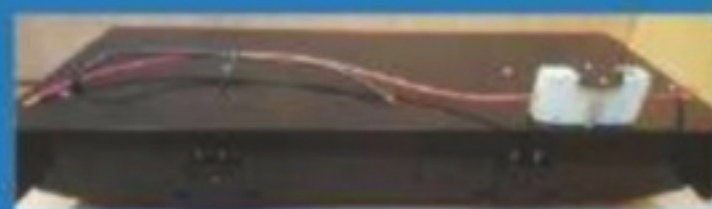
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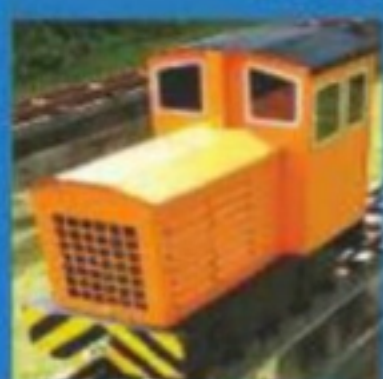
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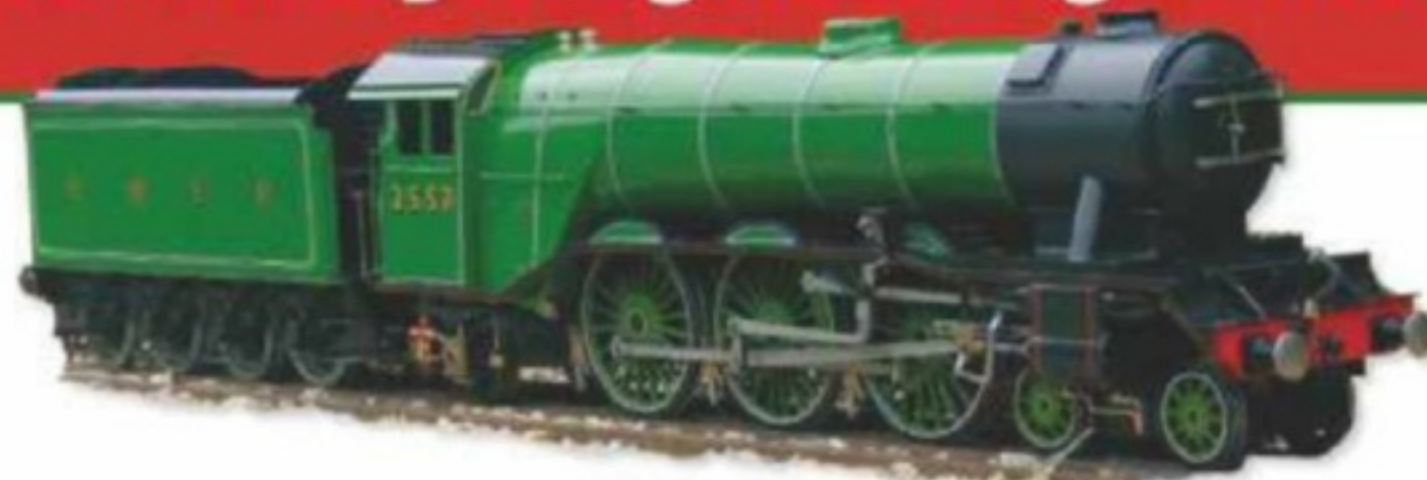


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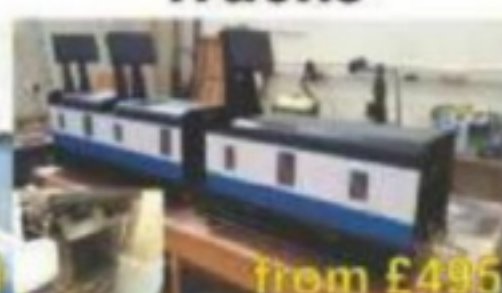
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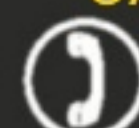


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Crebbin Reunion

A model locomotive, the driver and a passenger have been reunited after 61 years.

In 1958 the young Ann Hatherill (née Carter) drove the locomotive *Conversion* at the Model Engineer Exhibition. Her passengers included Diane (known as Dee) and Philip Crebbin, whose grandfather Jim Crebbin built the engine.

Now a barrister in Hong Kong, Dee Crebbin met Ann Hatherill and SMEE members with the engine *Conversion* recently. Dee remembers the 1958 exhibition and recalls wearing a green and white gingham dress!

Ann is now SMEE's Archivist and says "I was introduced to James Crebbin by my father, Bill Carter, before I was old enough to join SM&EE. Unfortunately, he died two years before I joined in 1952. His loco *Cosmo Bonsor*, which he gifted to the society in 1948, was not run after he died, however *Conversion*, which he left to the society, was run at Model Engineer Exhibitions for many more years. I drove it a number of times. It coped with all loads, was a very free steamer and rarely slipped on starting.

"The occasion I remember best was when my special passengers were James's daughter-in-law Mary and his



MARTIN EVANS
Editor



DIANE CARNEY
Assistant Editor



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Designer



Ann Carter (now Hatherill) drives *Conversion* with passengers Philip and Diane Crebbin (photograph reproduced by courtesy of the Society of Model and Experimental Engineers).

grandchildren Philip and Diane. At that time, 1958, I was 21 years old and Diane (known as Dee) was 10. I never imagined that many years later Dee and I would be able to meet again with the loco *Conversion*."

Jim Crebbin's engine, *Cosmo Bonsor*, is on display at the *Brass, Steam and Fire* exhibition, opened at the National Railway Museum, York, on Thursday 26th September. Diane was there and reports on the exhibition in this issue.

Jim Crebbin's life and locomotives feature in a new SMEE publication linked to the exhibition. *The remarkable Jim Crebbin and his experimental locomotives* by Roger Backhouse describes how a Bank of England clerk overcame parental discouragement and no formal engineering training to become one of the leading model engineers in the first half of the 20th century. Besides details of Jim Crebbin's surprising life this book includes details of his locomotive and model boat experiments.

One of very few model engineers to try locomotive compounding, Jim Crebbin advised G.J. Churchward on introducing the de Glehn compounds on the GWR. Other friends and contacts included Sir Nigel Gresley, Karl Golsdorf, Professor Edouard Sauvage. W.J. Bassett-Lowke, the conductor Sir Henry Wood and Colonel Ricardo, the original for Toad of Toad Hall!

In extensive travel abroad he was an ambassador for model engineering, encouraging newcomers to the hobby.

SMEE Chairman Alan Wragg adds "At SMEE we're very pleased to support the Railway Museum exhibition. Jim Crebbin was a SMEE founder who contributed much to our growth and activities besides being very much in our tradition of experimental engineering. He was always keen to encourage beginners and SMEE aims to continue that tradition with our training courses and other support."

Book information

The remarkable Jim Crebbin and his experimental locomotives by Roger Backhouse, published by SMEE 25th September 2019. 82pp. £14. ISBN 97815272 45327.

Order from booksales@sm-ee.co.uk or by post from SMEE, Marshall House, 28 Wanless Road, London SE24 0HW. Price £14 plus £2 UK post and packing. Cheques etc. payable to 'Society of Model and Experimental Engineers'.

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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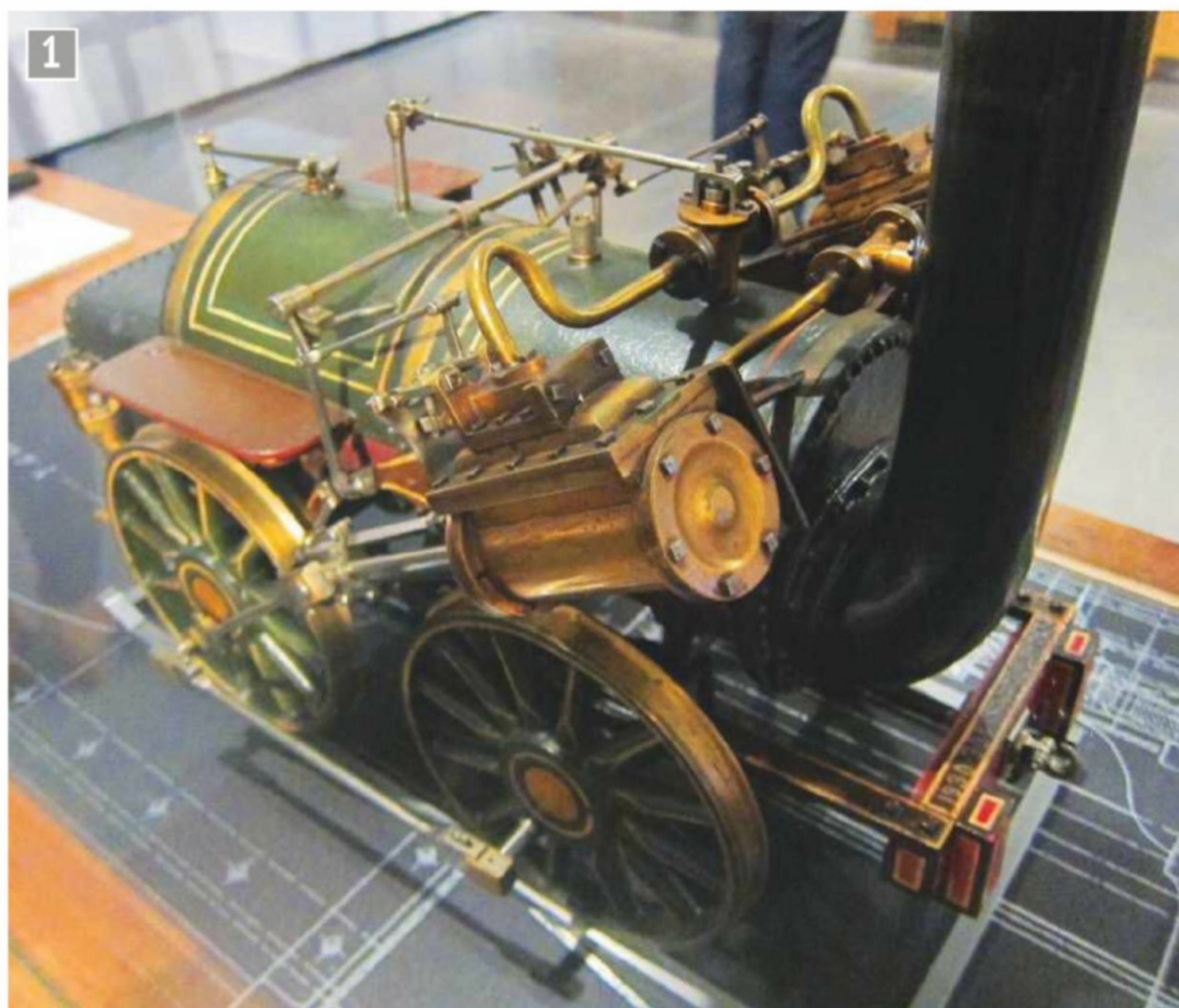


Ann Hatherill and Dee Crebbin reunited with *Conversion* on 19th September 2019 (photograph reproduced by courtesy of the Society of Model and Experimental Engineers).

Diane Carney attends the opening of a special exhibition of historic railway models.



'There are few leisure occupations better calculated to train the hand, eye and mind all at one and the same time.'
(J. Pocock.)



Believed to be Edward Fletcher's model of Invicta; c. 1830.

Brass, Steel and Fire

A Special Exhibition at the NRM

Brass Steel and Fire runs until 13 April, 2020 in the Gallery, Station Hall, National Railway Museum, York. Free entry. Roger Backhouse will be bringing us an in-depth report as part of his *Engineer's Day Out* series in due course.

I was delighted to accept an invitation from the NRM to attend the opening of a new exhibition dedicated, rather refreshingly, to model engineering. Unlike some other exhibitions that may have included models in a supporting role, here they really are the star of the show. To coincide with the unveiling of Stephenson's *Rocket* which has now settled in its permanent home in York, the team at the Museum has brought together a fascinating collection of very early models - almost exclusively locomotives - in order to illustrate two things: firstly the purpose and function

of model engineering and secondly, the pure joy in the making of mechanical models. I would say it is this second aspect that shines through strongest as one walks around the room but, to look firstly at the concept of engineering models, one is invited to consider the reason for their production.

In the first half of the 19th century pioneers were striving for attention as, following the success of *Rocket* at the Rainhill Trials, steam 'locomotion' began development and a model was able to demonstrate ideas without, or prior to, the obvious expense of full-size

production. An apprentice to Robert Stephenson at the time, Edward Fletcher's mind was immersed in what would be built next (after *Rocket*) and he is believed to have experimented with a model of *Invicta* (**photo 1**) which he constructed whilst the 'big engine' was under manufacture in order to understand better how it worked. This model is on display here.

Going even further back in time there is a model, believed to have been made by a clockmaker in about 1810, to put William Hedley's experimental ideas to the test (**photo 2**). Hedley was the

first to recognise that fitting two cylinders to a locomotive both doubled the power and balanced the machine. One has to close one's eyes to try to imagine a time when that was an untried idea! Thankfully these models serve to help us. It is true to say that their survival gives us a much more complete picture of the history of railway development for they often 'fill in the gaps', so to speak.

Several others serve to illustrate the pure fascination with the new technology; an unknown maker produced a model of *Rocket* having never seen it! It is assumed that he heard people talk of it and, going by verbal description alone, set to, to make it in miniature form, completing the undisclosed detail to his own taste where necessary ... and what a beautiful thing it is to see (**photo 3**). Take a moment to think of that 'workshop' (a kitchen table, most likely) and that little model taking shape by candlelight, 190 years ago.

From these early works of art sprang a pastime that has endured through time. In his speech to mark the opening of this exhibition, broadcaster Tim Dunn emphasised the simple, unending pleasure that 'making' has brought to women and men for generations, be it constructing



A clockmaker's model demonstrating William Hedley's idea for a two-cylinder locomotive; c. 1810.



A model of *Rocket* possibly made based on a verbal description only.

miniature buildings, dolls, machines, clothing, farm implements, entire railways ... the list is endless of course. It is understood that very often pleasure in the making is far greater than admiring of the result; something with which many readers will identify. The pudding doesn't always have to be eaten ...!

Without a doubt this exhibition aims to celebrate the uniqueness of every hand-made engineering model that has been fashioned

since the very first. It may, arguably, inspire more of the visiting public to have a go at model making than do our conventional model engineering exhibitions, if only because these models are often simply made, sometimes imperfect or even crude, but always aesthetically pleasing. Some of them were made to prove a principle but most, such as one made *from memory* by a retired engine driver on the Bristol and Exeter Railway, were created out of love for the

machine and perhaps a desire to have a go at improving the look of it (**photo 4**).

If I were to be critical, the exhibition has a fairly meaningless title (unless I've missed something?), the information provided is rather 'simplistic' and the lighting isn't brilliant (my usual gripe at any exhibition) but magnifying glasses are provided. It is, however, a rather special display of historically significant models that is definitely worth seeing. It goes without saying that it's easy to spend the whole day at the NRM, especially if it's been a while since you were there.

My apologies for the quality of the photographs; all the models are, understandably, enclosed in Perspex boxes. The collection has been gathered from a number of sources including the NRM's own collection, The Science Museum in London, our friends at the SMEE, other museums and private collections. *Rocket* can be viewed adjacent to the exhibition (in an even darker corner!).

Congratulations to the NRM for putting this collection together. It may be many years before the like is seen again.



Swift; c. 1862: made by a retired Bristol and Exeter Railway Driver, probably from memory!

ME

Garrett 4CD Tractor PART 62

in 6 inch scale

Chris Gunn
paints and
lines the
wheels.



Continued from p.507
M.E. 4622, 27 September 2019

Drawings, castings and
machining services are
available from A. N.
Engineering: Email:
a.nutting@hotmail.co.uk

This article has been written to guide the builder through the construction of the 6 inch scale Garrett 4CD tractor designed by Chris d'Alquen. The writer has previously built a 4 inch scale Garrett and a 6 inch scale Foden wagon so has the benefit of considerable experience in larger scale modelling. Most machining can be done in the average home workshop but the supplier from whom the castings and drawings are currently available is able to provide a machining service for the largest items if required.



Wheels

The wheels had been sandblasted and primed using Plasticote primer as soon as they came back from having the tyres vulcanised on. I masked off the new tyres with insulating tape for durability and, not long after priming, I sprayed these red again using Plasticote rattle cans. **Photograph 520** shows the rear wheels after priming.

I elected to use this paint as I had used it for my small

Garrett and it has stood up well. Spraying is the only way in my opinion to paint the wheels to get into all the nooks and crannies. It was a good job I did this when I did as Plasticote and its competitors have been removed from the shelves, for our safety, presumably. One can still get rattle cans with solvent based cellulose paint from car accessory shops, so I wonder why it was necessary to remove the Plasticote from the shelves. **Photograph 521**

shows the top coat drying off indoors. I must point out that I sprayed these outside, not in the utility room, as that would have been a step too far. Once the wheels were done I cut some discs from a scrap thick polythene bag and taped this over the wheels to protect them and keep the dust out.

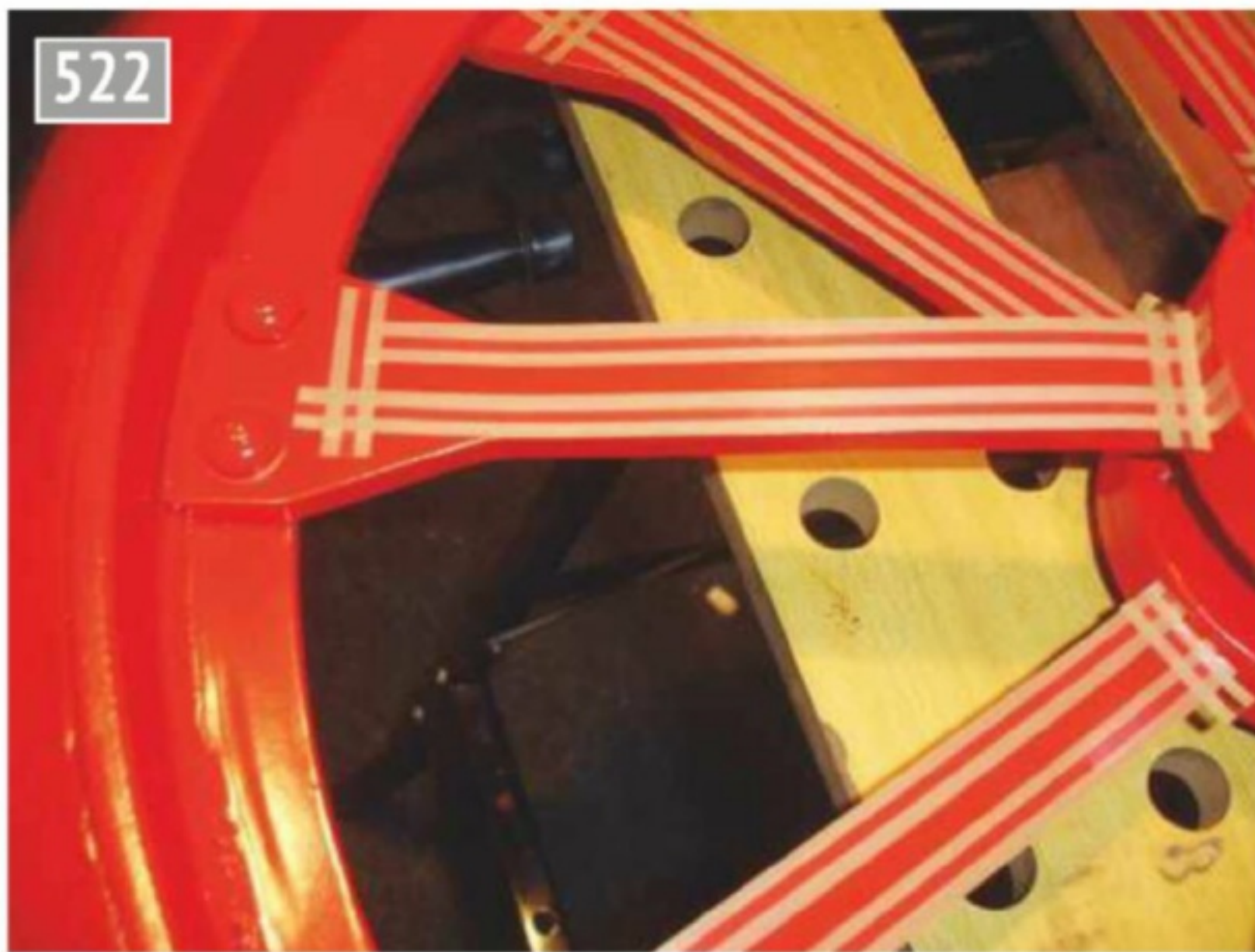
I came back to the wheels to line them after the initial air test of the engine. I started on the front wheels as they are easiest. I would also start with the inside of the wheels,



Sandblasted and primed rear wheels.



Rear wheels drying.



522

A masked spoke.



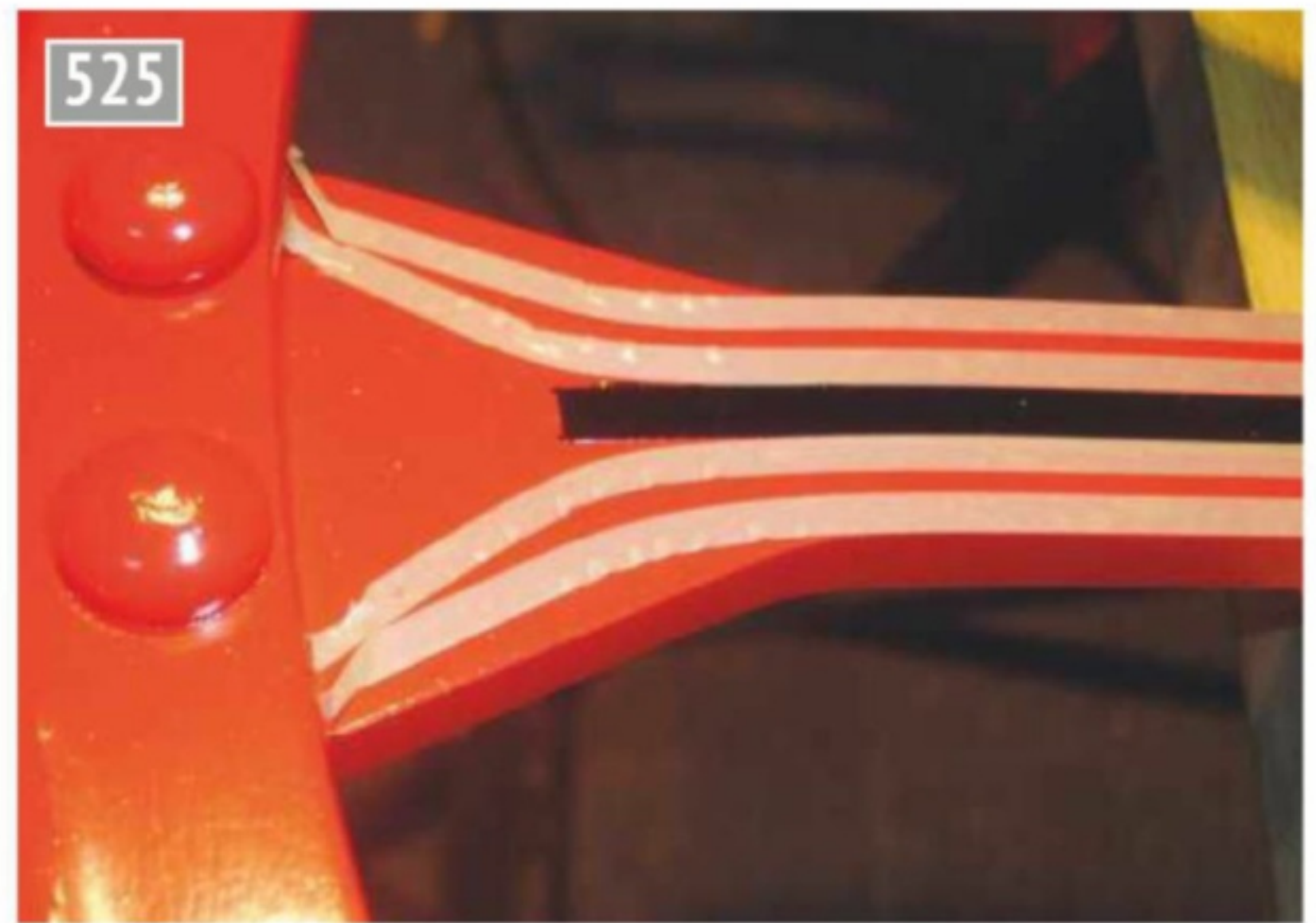
523

Some painted spokes.



524

Black lines complete.



525

Masking tape for flares.



526

Flared lines.



527

Flared lines - improved.

as these are less visible, and I already knew I would get better as I progressed. My best efforts would then be on the outside of the wheel.

I made a pin and bolted it to a piece of ply, then set up a Workmate to hold the wheel, so I could spin it on the pin. I planned to line the wheels in

a similar manner to a full-size engine I had seen. This meant I needed to put a wide black line down the centre of the spokes, then add some narrow yellow stripes and flare out the ends of these at the spade end of the spoke. I had a picture of the full-size wheel I intended to replicate and I was able to

scale the picture and work out the width of the lines.

I was able to use the Craftmaster $\frac{3}{32}$ inch wide striping tape to mask the lines. I used the tape to its full width to mask the edges of the black lines, which was a bit of a waste as I only used one edge but I found it stopped the

paint creeping under where other masking tapes did not.

Photograph 522 shows one of the masked front wheel spokes.

I used Craftmaster lining paint and followed the instructions, which indicated that the paint should be applied, allowed to dry for



A finished front wheel.

20 minutes, and then the masking tape could be pulled off with a pair of tweezers before the paint was fully set so the paint did not chip away as it would if left to dry. I made sure I pulled the tape away in line with the edge so it did not smear. I tried to ensure each spoke had its 20 minutes drying time.

Photograph 523 shows some painted spokes and **photo 524** shows the results.

Once the black lines had fully dried out, after another session in front of the radiator, I set about masking the spokes for the outer yellow lines which I wanted to finish in a flared line coming down to a point. Using the tape to produce a thin line means that the tape, with cover strip, is positioned where required and in this case I had arranged it so that the edge of the tape would be aligned with the edges of the black line, giving a $\frac{3}{32}$ inch gap between the black and yellow lines and a similar gap between the edge of the spoke and the line.

Once the tape is positioned, the upper carrier tape is removed leaving the two masking tapes in position exactly the right distance apart. Once this was done, I put a small strip of tape across the hub end of the tapes to mask off the end of the line. The other end of the line was also left overlong, as I needed to move the tape to create the curve.

In order to create the curves on the ends of the spokes, I had to give the ends a bigger bend than on the front axle so the tendency to crinkle on the edge of the curve would be greater. I reasoned that when the lining out was done back in the good old days, it would also be done by eye and careful study of some pictures of full-size engines showed they were not perfect. **Photograph 525** shows what happens to the tape. This was taken at a very early stage I should add, and **photo 526** shows the results after painting where the bleeding of the paint under the cockles can be seen.



A finished rear wheel.

I got better results if I burnished the tape down with the smooth, domed end of my scalpel just before painting and, although there was a cockle here and there, I got results I felt were acceptable and any bleeding cannot be seen from a normal viewing distance.

Photograph 527 shows a better-looking example after burnishing the tape.

As already stated, all the inside spokes were done first, so I had 20 spokes to practise on before I did the outside facing spokes. **Photograph 528** shows a finished front wheel.

The rear wheels were dealt with in the same way but

everything about this task was more difficult. The wheels are too heavy for me to lift, so I had to rig up a block and tackle to get them flat on top of the workbench. Then there are more spokes on the back wheels and some sharper bends on the spokes too. However, the results turned out well and my technique was much improved after finishing the 40 spokes. **Photograph 529** shows a completed rear wheel and **photo 530** shows the wheels fitted to the engine after painting 96 spokes, as well as my protective cover on the front wheel.

●To be continued.



Lined wheels fitted.

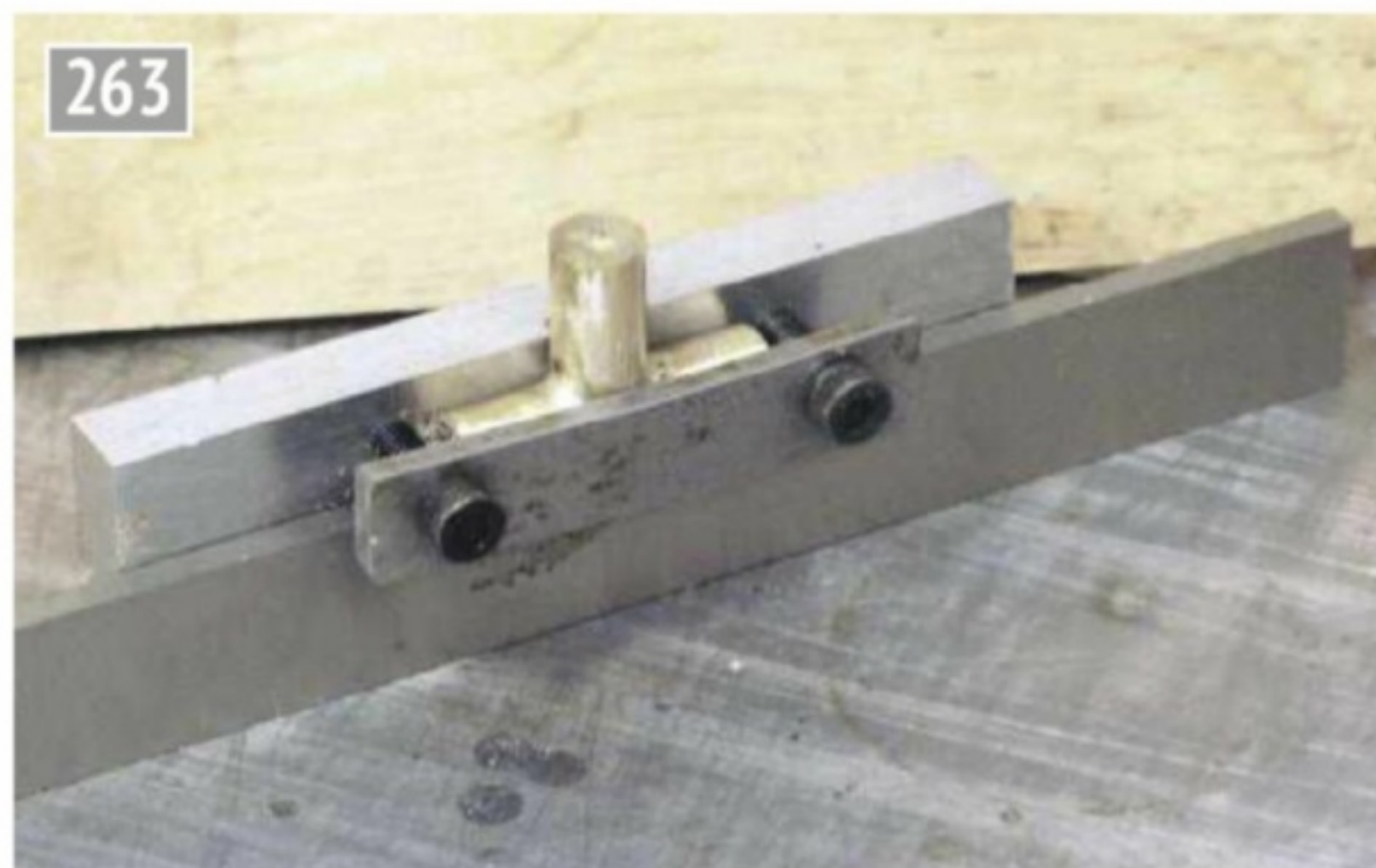
Lathes and More

PART 51

Graham Sadler makes a set of mounting plates for his faceplate.



Continued from p.593
M.E. 4623, 11 October 2019



Remote setting a Tee piece square to the lathe axis using a parallel.

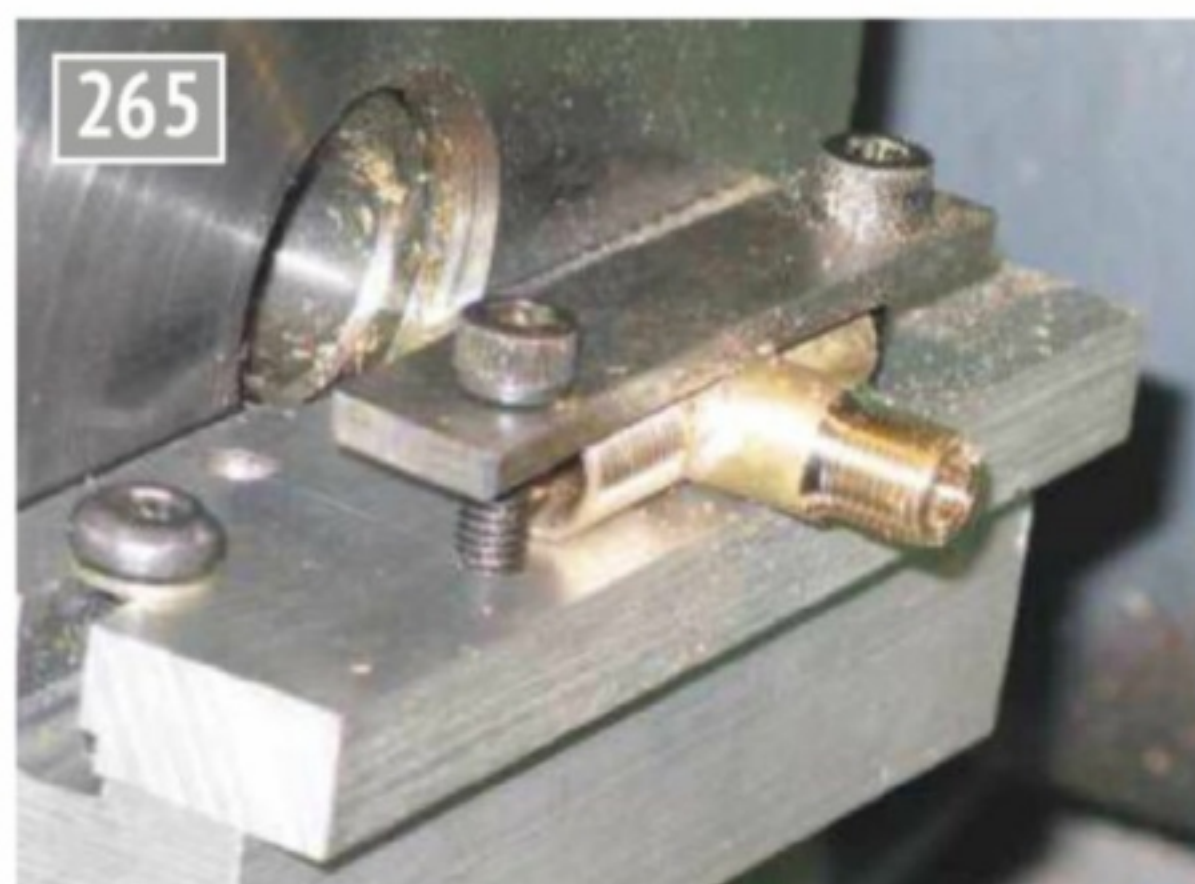
The possibilities for use are endless! An example of work is a simple Tee-piece made from $\frac{3}{8}$ inch diameter brass. It had the short leg soldered on then the through hole was drilled and the thread formed before cutting off from the parent material. Setting of work on the top plate is achieved off the machine making it very straightforward (photos 263, 264 and 265). It is firstly loosely clamped in place, then set on a parallel on the surface plate and the clamps tightened. The Tee is therefore aligned square with

the lathe axis before it even meets the faceplate. Okay, the parallel can be used *in situ* on the faceplate, but how many hands have you got? Along with visibility and space being tight, it's not easy. The angle bar is set to the correct height below the centreline of the lathe setting pin plus $\frac{3}{16}$ inch - a drill was used here. Fit the plate and just nip the fixing screws. This is where the tenon slot comes into play; you don't need to think about that aspect of alignment. Next, a stub of $\frac{3}{8}$ inch diameter material is put in the drill chuck (I have a good store

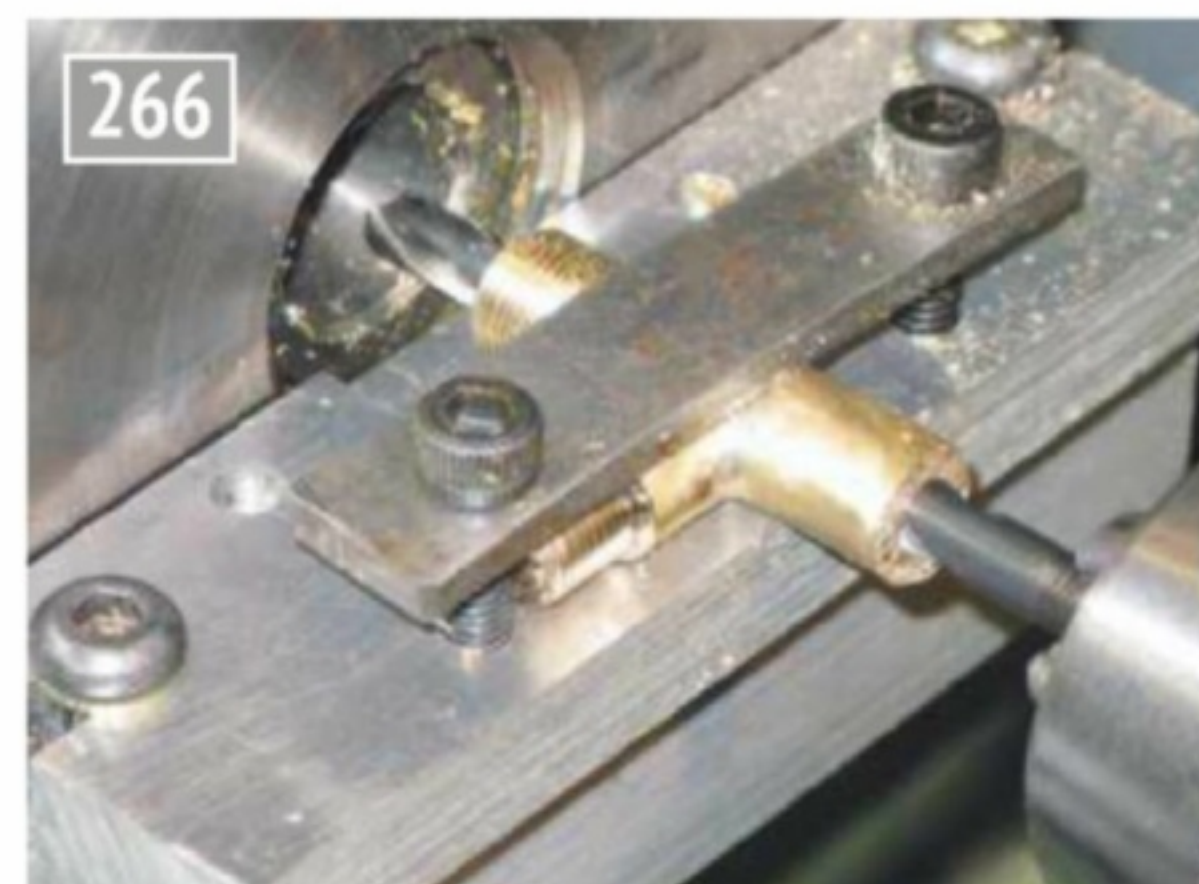


Using a drill to set the centre of the Tee to the lathe axis, rotated for clarity in the photo.

of a lot of these in different lengths and diameters). Now it's possible just to feel for the correct position across the lathe and the top plate screws are tightened. A DTI here could be used but we already know the height above the centreline is correct so touch down on the top, note the setting, rotate the work 90 degrees and push the Tee gently until the same setting is achieved on the DTI, it not being necessary to rotate and check any more (but I bet a lottery winning ticket you do!). It just depends on the



The Tee in position and machined.



Setting true with a drill for the third end.

level of accuracy needed for the component; drilling and threading is then completed. The process for the long part ends is slightly different. This time a drill is inserted into the hole along the length drilled and the top clamps are tightened (**photo 266**).

For boring the batch of cylinders (**photo 267**) the height from port face to cylinder centre was set on the angle bar and it will be seen that there are two pieces of angle loosely screwed to the top plate. All that had to be done was to use a drill to gauge the 'front to back' position against a piece of 8mm diameter bar in the tailstock. The outside diameter of the cylinder was 20mm diameter so we have $20\text{mm outside diameter} - 8\text{ (pin)} = 12$; divide by 2 to get the radius; result is 6mm. This is the off-set so use a drill this size to set the position of the stop. The top plate and angle stops are then tightened (using a tiny square to set them true to the faceplate).

As it turned out, the angle at the front served no function other than holding the clamp bar up. A spring would have done the same. You will note that the 2BA studs here look big and secure (**photo 268**). To face the other end, the cylinders were mounted on an expanding mandrel with the saddle locked for consistent sizing. Later, the centre hole for the trunion was drilled and tapped after giving the port face a lick over with the tool (**photo 269**). Note the stop behind the cylinder used to ensure all were faced off to the same dimension. All the cylinders were produced without any marking out of any form.

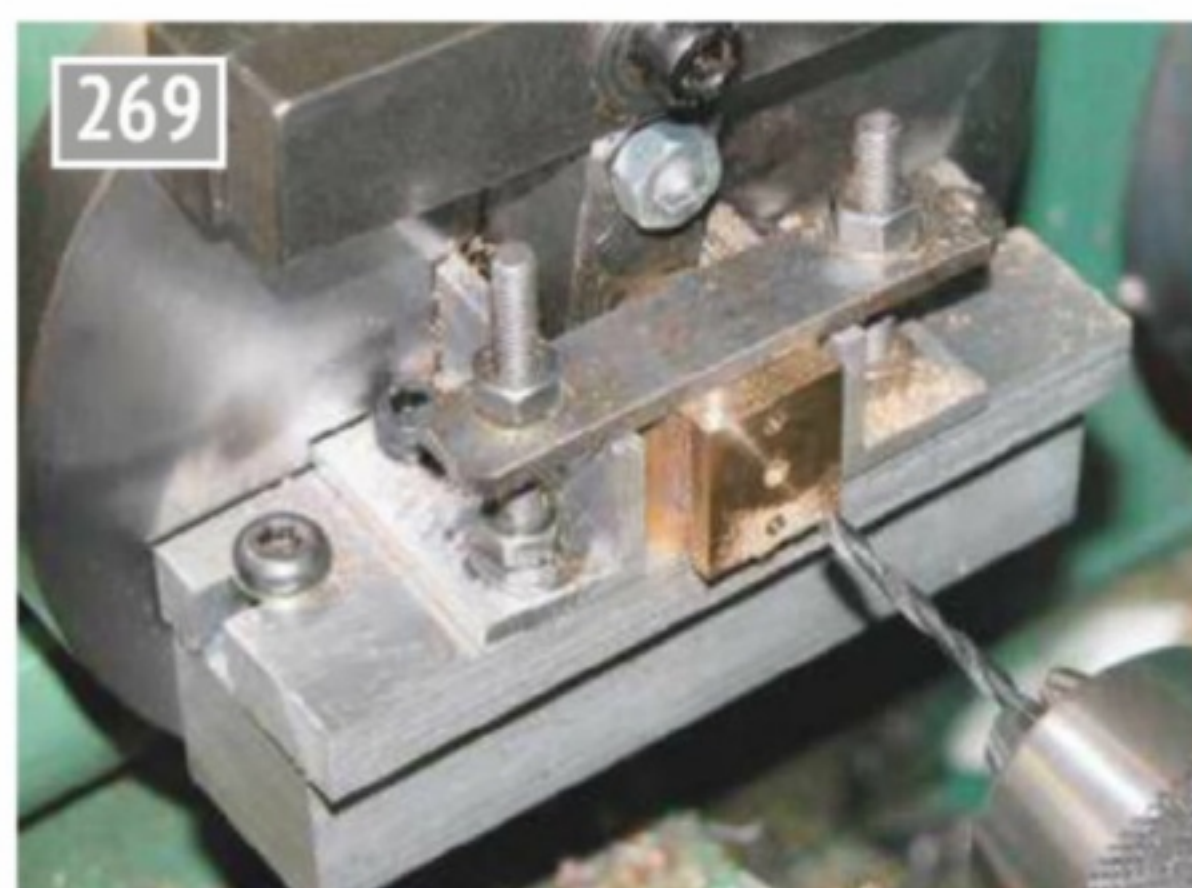
The cube referred to at the start was positioned 12 times during machining yet it was set up with the DTI just once. In **photo 270** the cube is being machined; the block at the top is for a light pinch screw to hold all in place while the main front clamp is tightened. **Photograph 271** shows the cube before final separation.



267 Setting the side location stop to position a cylinder. Each one of the batch will fit straight into the jig and be accurately positioned. I used a bar in the tailstock here as it is a fixed diameter; the setting pin is used only with top plate positioning.



268 Boring and facing the cylinder.



269 Facing the port face and drilling the trunion hole. Note the balance weights and the back stop.



270 Machining the cube, I machined the block true 10 years before I got to this stage! (It looked in focus on the camera).

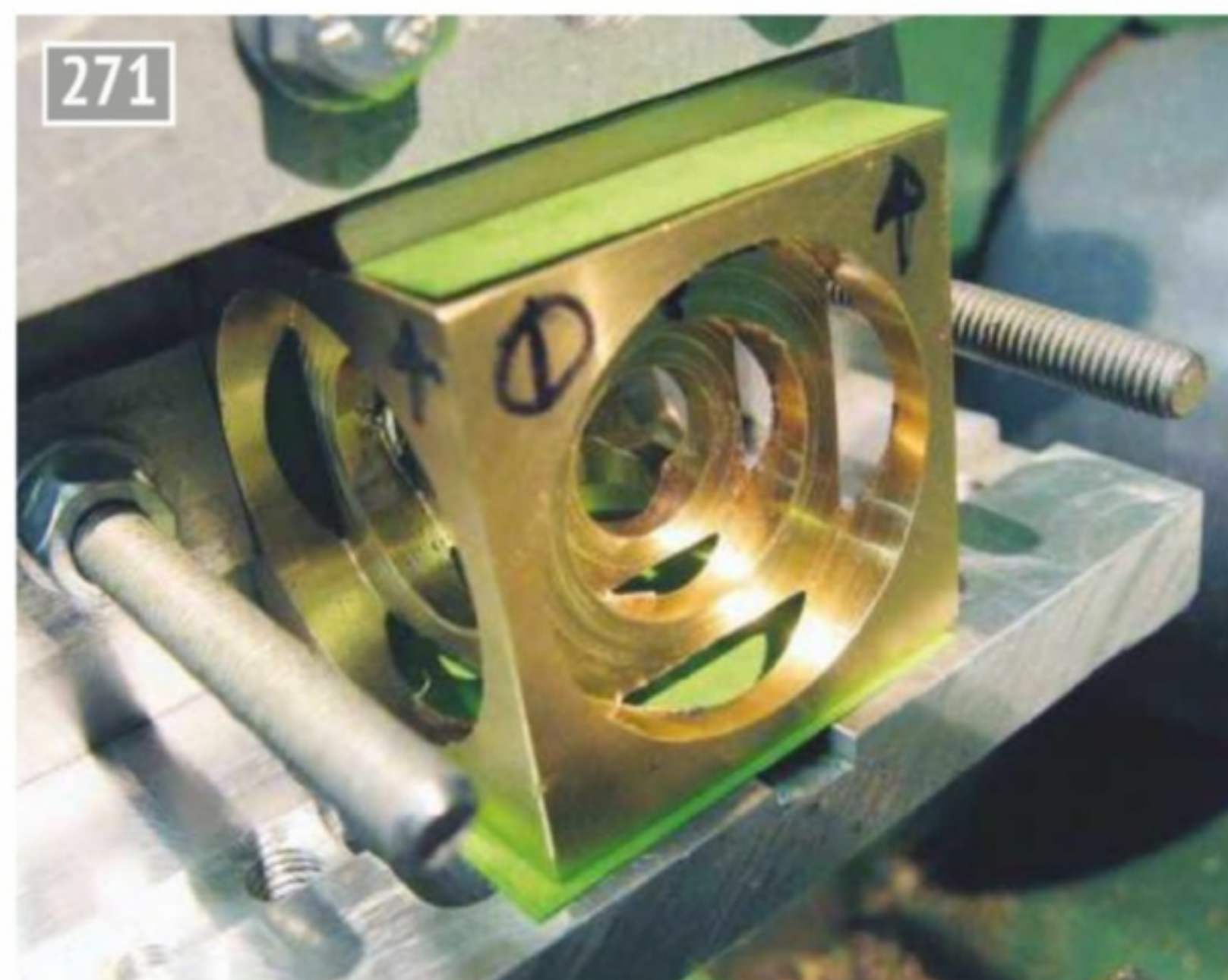
I can honestly say that I have used the kit many times and each time it has proven to have been well worth the effort, making a number of tasks very quick and easy. I do so like the process of working out simple solutions; that's the main fun of this fascinating pastime! Note here that the photos will show some differences between my kit and the drawings - the latter should be adhered to and you benefit from my hindsight.

This issue brings the main part of this series to a conclusion. However, there are a few elements I will cover in the future as stand-alone articles about lathe work and other workshop activities. Some of these I have already hinted at within the series. We have covered a lot of ground starting with the extremely basic and moving to more complex yet valuable workshop and machining techniques. All the tools I have illustrated are in constant use within my workshop, the exception being

I no longer use the method detailed for sharpening milling cutters, having acquired a tool and cutter grinder. Even with this machine, though, I find the sharpening of HSS lathe tools - except screw cutting tools - easier on my grinding rest. Don't be put off with the thought, or consequences,

of making mistakes as these happen to all of us and should be taken as learning experiences - if you can remember them! If you have any questions about the series or are uncertain about any of the topics covered please contact me via the editor.

ME



271 The internals before finally finishing the bores to separate the cubes. Note the side positioning stops and the top clamping bar.

Steam Turbines

Large and Miniature

PART 19

Design details for model turbines - stages and nozzles

Mike Tilby
explores the
technology,
history and
modelling of
steam turbines.



Continued from p.531
M.E. 4622, 27 September 2019

So far, these articles have attempted to explain an important area of engineering that seems to be poorly understood by many non-specialists, namely the history and principles of steam turbines. This provides important background information for the discussion of how model steam turbines might best be designed. The merits of the various design options for model turbines were described last time (M.E.4622, 27th September) and the focus of the articles now turns to more practical information regarding design and construction of such a model.

However, I must stress once more that only a small fraction of the information comes from my own experience of building model turbines. Instead much of the advice is based on principles that have evolved for designing full-sized turbines, with additional information coming from past descriptions of experiments by model engineers. The only prior source of guidance about model steam turbine design (ref 55) is well over 100 years old, pre-dates important developments in turbine engineering and lacks data from tests on actual model turbines. Therefore, it seems to me that almost any sort of up to date summary would be useful.

Previously I explained why my personal choice is to attempt to build a pressure-compounded impulse turbine, generally referred to as a Rateau turbine.

This venture is clearly very experimental and may well end in disappointment. Other people who are tempted to make a turbine may decide to keep things more simple and less risky. In that case, a single stage bladed impulse turbine would seem to be a good option since several successful models of this type have been made before. However, as we shall see, to make the blades could well require the construction of some sort of accessory for the lathe or milling machine or perhaps the use of a suitable CNC machine tool.

If it was desired to keep workshop methods as simple as possible, then a Stumpf-type turbine might be the best option, especially since guidance for making a simple turbine of this type was provided by Mr E. T. Westbury (ref 56). However, ease of construction probably comes at the price of performance since, as discussed last time, the simple Stumpf type rotor is likely to be less efficient than a bladed De Laval-type turbine. Both of these are well tried designs, unlike the multi-stage design which, of course, I hope will turn out to give the best efficiency.

This and subsequent articles will deal with design details for single as well as multi-stage turbines and will also discuss design of Stumpf-type turbines. The main aim is to provide information that might assist someone in designing and making a turbine to their own specification.

If anyone were contemplating having a go at a model De Laval turbine they could do worse than follow the examples built by Messrs. Chaddock, Elkin and Bamford that have been mentioned in these articles. However, those models were built and tested over 60 years ago and a number of potential design improvements have come to light over the intervening years. These will be discussed in the present and following instalments, starting with the subject of nozzles.

Nozzle type

As described in part 4, if the outlet pressure for a nozzle is higher than the critical pressure, then the pressure drop is so low that insufficient energy becomes available for the steam to be accelerated above the speed of sound (Mach 1). Therefore, a simple convergent nozzle will allow the steam to attain its maximum possible velocity. However, if the outlet pressure is less than the critical pressure then available energy could, in theory, accelerate the steam to super-sonic velocities. As described previously, the only way such velocities could be achieved is to use a convergent-divergent (C-D) nozzle. The snag is that there are reasons to think that, in miniature sizes, C-D nozzles have extremely low efficiencies (see part 12). In other words, the velocity attained by steam is much lower than expected and so it does not attain the velocity necessary for the available

thermal energy to be available as kinetic energy.

The critical pressure is generally assumed to be 58% of the inlet pressure (i.e. the pressure ratio is 0.58) although, when superheated steam is used, the value decreases to 55% of the inlet pressure. The ratio of 0.58 was first discovered by experiment and has also been calculated from theoretical principles. However, the experiments and basic theory relate to nozzles of much larger diameters than are used in model turbines. In miniature nozzles the slower moving steam that is near to the nozzle wall and that experiences strong frictional effects (i.e. the boundary layer) encompasses a very large fraction of the total flowing steam (i.e. the Reynold's number is lower - see article 11).

Therefore, it might be expected that predictions based on larger nozzles may not be completely accurate on a miniature scale. This could explain why tests carried out by model engineers Messrs. Elkin, Southworth, Hall and Jones indicated very low efficiency of miniature C-D nozzles and also why the highest steam velocities were attained using simple convergent nozzles rather than various designs of C-D nozzle (see part 12). Also, in this regard, it is noteworthy that the successful steam turbine locomotives built by Werner Jeggli have simple nozzles (ref 57).

So, it may well be that simple convergent nozzles will be the best choice for model turbines working at moderate steam pressures, even under conditions where basic theory indicates that CD nozzles should be used. However, this is far from certain and Mr Elkin (ref 58) reported results of tests that indicated the highest steam velocity was obtained with C-D nozzles in which the divergent sections were slightly longer than was predicted by theory. Because of uncertainty over this topic, anyone building a

single stage turbine might do well to design the casing such that it will be easy to try out nozzles of different lengths and various degrees of final divergence.

Regardless of the uncertainty about miniature C-D nozzle efficiency, there seems little doubt that:

- 1 - Simple nozzles can be more efficient than C-D nozzles, if used under the right conditions.
- 2 - Steam velocities attained in simple nozzles cannot exceed Mach 1.

In other words, the best chance of obtaining good nozzle efficiency is to use simple convergent type nozzles with outlet pressures at least 58% of the inlet pressures. In addition to the issue of efficiency, simple nozzles have the advantage of being shorter than C-D nozzles, which is particularly useful in a multi-stage turbine. Also, they are easier to design and easier to make. These aspects are discussed below.

Number of stages

As explained last time, having more than one pressure stage would give several advantages:

- 1 - Pressure drops per stage would be smaller and this makes it possible to achieve good nozzle efficiency with simple nozzles, as just discussed.
- 2 - The avoidance of very high steam velocities means that optimum blade speeds can be attained at achievable rotor rpm.
- 3 - Lower steam velocity and lower rpm reduce several types of frictional loss.

However, these potential benefits would be at least partly off-set by additional losses due to the increased number of rotor discs and high-speed shaft seals. These would cause additional disc friction, fannage and mechanical friction. These losses are all too difficult to calculate for a model turbine

and so, it seems to me, that the only way to find out if a multistage model turbine can actually show improved efficiency is to have a go at making one and testing it.

In order to get a feel for how increasing the number of pressure stages might influence turbine design, some very approximate simplified calculations have been carried out for a turbine supplied with steam at 60 psig (75 psia) and 100°F superheat, exhausting to the atmosphere. In these calculations it is assumed that there is no friction and so the results are not meant to indicate real achievable efficiencies but are simply to give a rough idea of the effects of changing the number of stages. **Figure 68A** shows how, as the number of

stages is increased, the heat drop per stage decreases. In other words, in each stage, per pound of steam, less thermal energy is available for conversion to kinetic energy. This is echoed by reduction in the maximum attainable steam velocity per stage, as plotted on the same graph.

The shaded parts of the graphs in fig 68 indicate that if only 1 or 2 stages are used, the pressure drop across each nozzle is to less than 58% of its inlet pressure and so complete conversion of enthalpy to kinetic energy in the steam cannot be achieved in simple convergent nozzles. With 3 stages, the pressure ratio per stage approximates to 0.58 (see Table 9). **Note:** as described in part 4, when calculating the pressure ratio

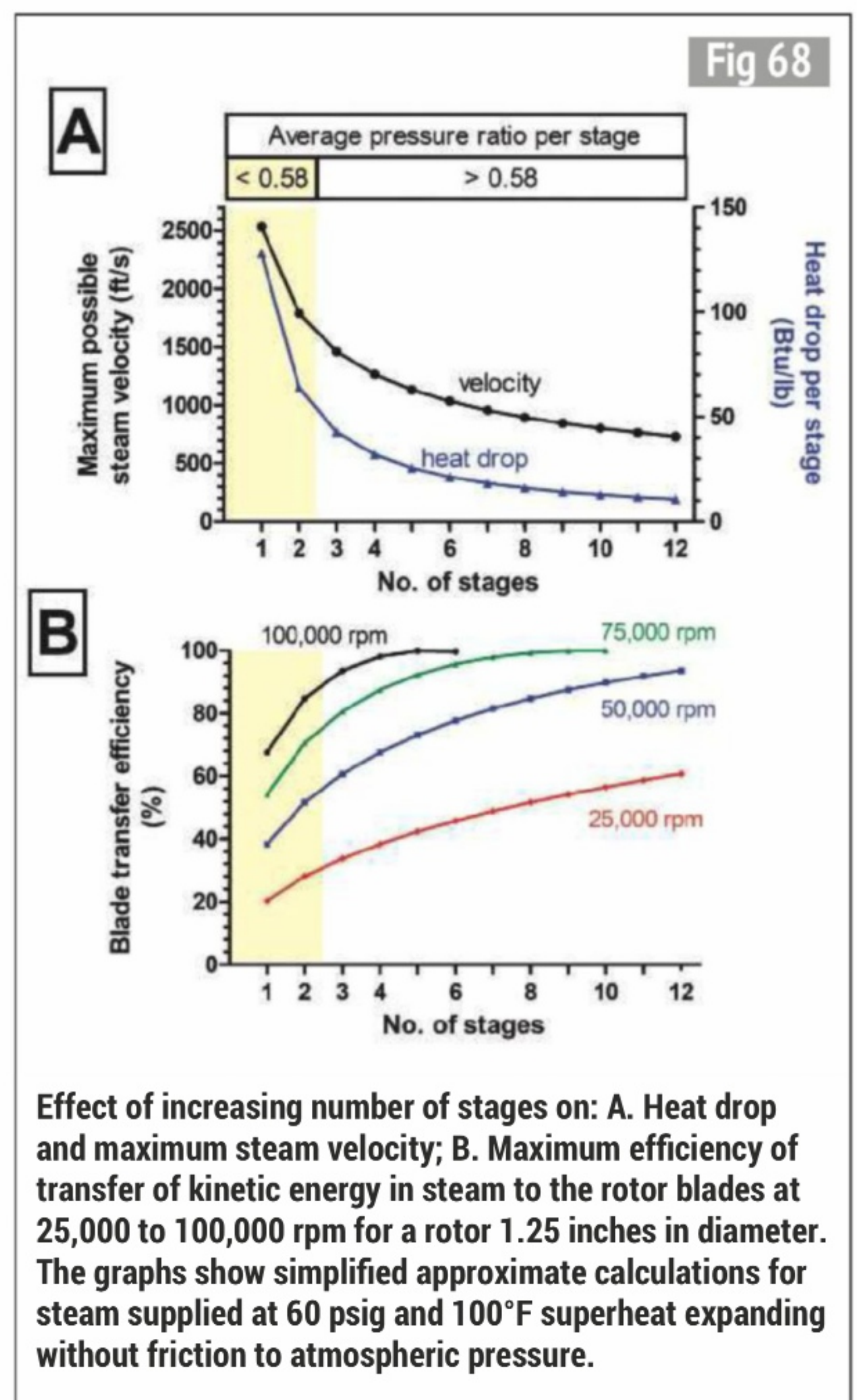


Table 9. Expansion of steam from 75 psia down to atmospheric pressure over 3 stages.				
These approximate calculations assume ideal frictionless conditions and the pressures are chosen to give equal heat drops per stage. In a real turbine the actual heat drops would be different due to the heating effects of friction.				
Stage	Nozzle Inlet Pressure (psia)	Specific Enthalpy (btu/lb)	Pressure Ratio	Heat Drop (btu/lb)
1	75	1235	0.63	43
2	47	1192	0.57	43
3	27	1149	0.56	43
Exhaust	15	1106	-	-

it is essential to use absolute pressure rather than gauge pressure.

In an impulse turbine, the ratio of steam velocity to blade velocity affects the efficiency of energy transfer from steam to rotor. For present purposes this will be called the blade transfer efficiency. Maximum transfer efficiency is attained when the blade velocity is about half the steam velocity (see part 6). The effect that changing the number of stages has on this efficiency will depend on the diameter and rpm of the rotor. For these simplified calculations, a rotor 1.25 inches in diameter was assumed to spin at 25, 50, 75 or 100 thousand rpm. Figure 68B shows how, as the number of stages is increased, the decreasing steam velocity results in theoretical improvement in the transfer efficiency for each of the rpm values. The results also show that the improvement in efficiency is most marked when increasing from a single stage to just 3 or 4 stages.

Lastly, the results show that if the rotor speed is low, then a very large number of additional stages are required in order to achieve an efficiency that is comparable to what can be attained by just a few stages at a higher rpm. So it seems likely that, for any chosen steam pressure and rotor size, any benefit to be gained by adopting a lower rpm combined with more than 4 stages would be wiped out by

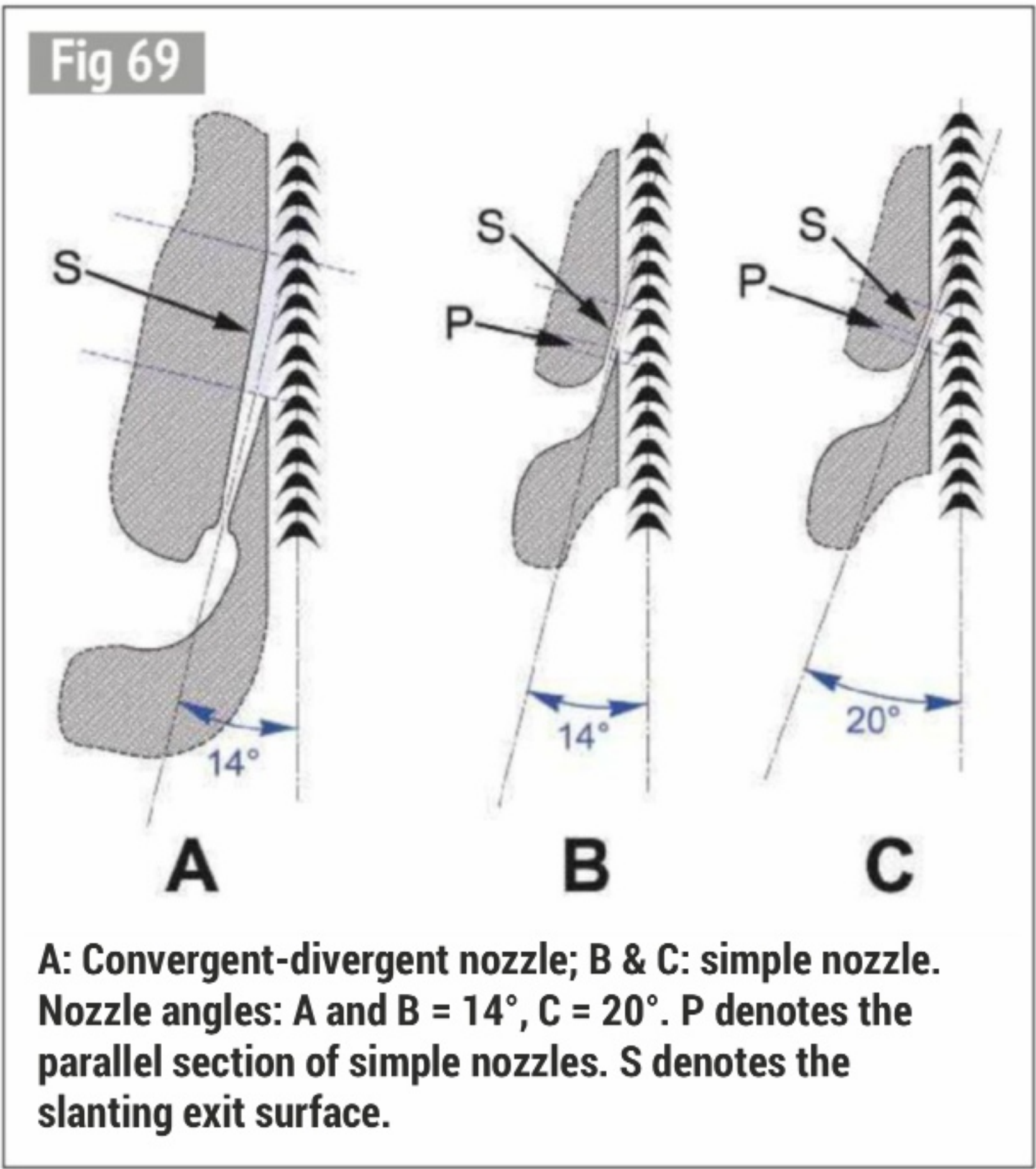
the increased losses caused by the extra stages.

Because of the above considerations, my first attempt at a multi-stage turbine is based on 3 or 4 stages and its speed will hopefully be at least 50,000 rpm. This should give optimum nozzle efficiency using simple convergent nozzles and a good ratio of blade to steam velocity at moderate rpm whilst keeping the number of stages to a minimum.

Nozzle angle

The nozzles fitted to bladed impulse turbines are generally designed to be positioned as close as possible to the sides of the blades since this gives best efficiency. This generally involves having a sloping end to the nozzle (**S** in fig 69). This causes increased friction in the steam and also causes the direction of the jet to change slightly.

Nozzle angle is generally measured as the angle between the axis of the nozzle at its outlet and the plane of the turbine wheel (fig 69). The smaller that angle, the more the steam will tend to directly generate torque on the rotor. However, as the angle is made progressively smaller further increases in torque become less significant while the sloping end of the nozzle becomes very long and that increases frictional loss in the steam jet. In full sized turbines the angle is generally in the range 12 degrees to 20

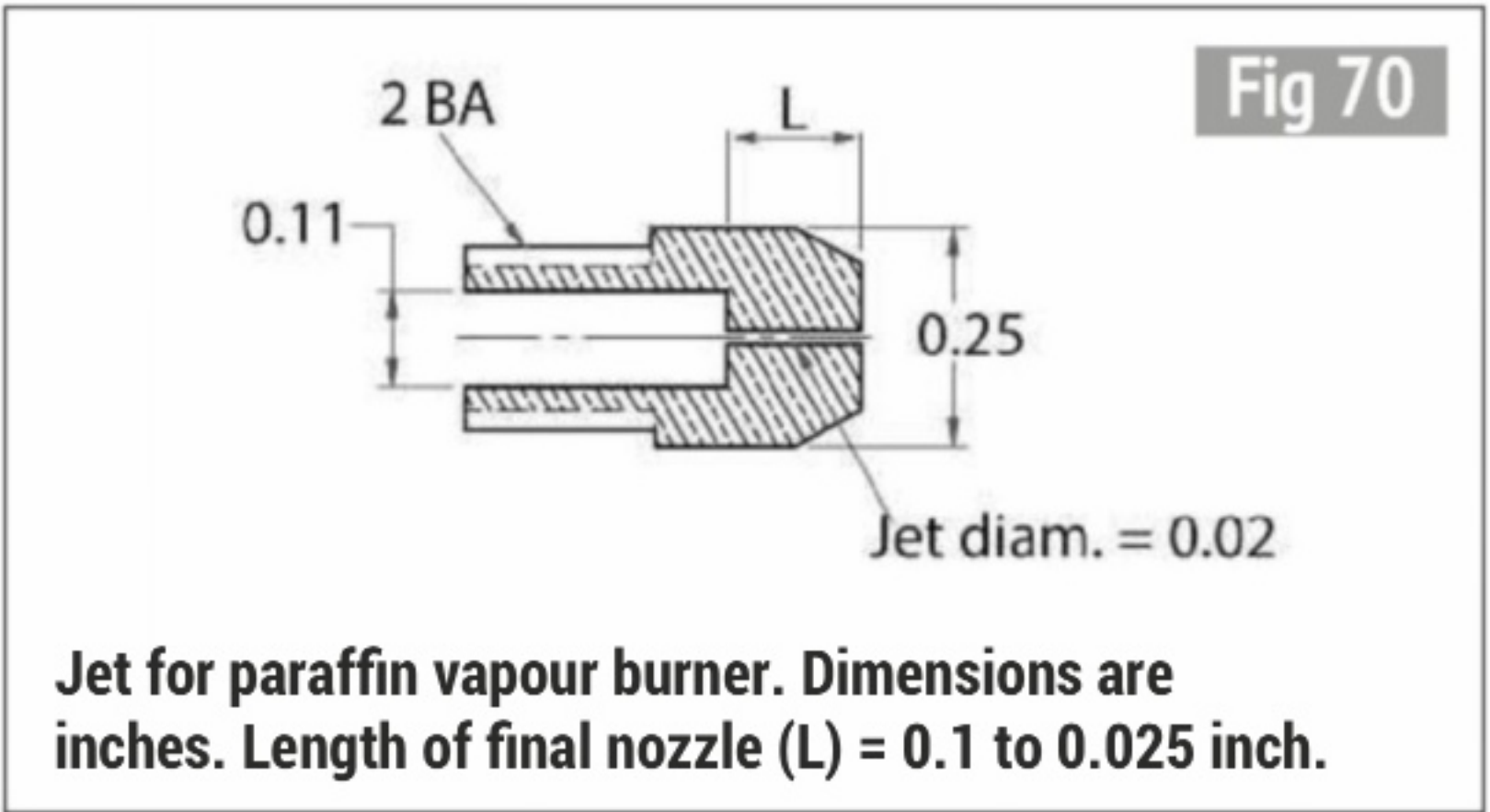


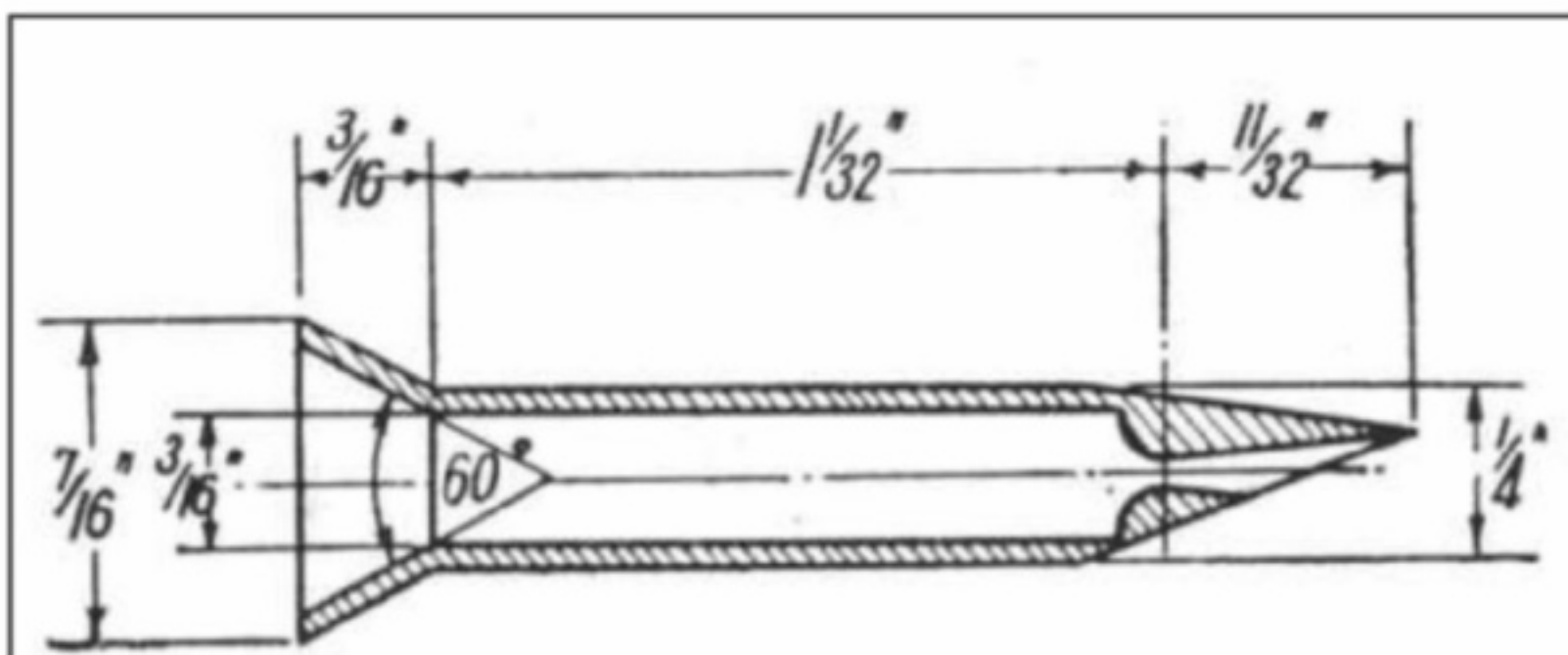
degrees and the upper part of this range seems sensible for model turbines.

Nozzle shape

The exact shape of the entry region of simple convergent nozzles and C-D nozzles does not seem to be very critical. A key feature is to have a smoothly curved entry rather than a sharp edge. Any sharp corner could cause unwanted disturbances in the flow pattern, thereby increasing losses due to pressure changes and turbulence. The rate at which the bore tapers down to the throat does not seem to matter very much but that section should be made as short as possible in order to minimise frictional loss as the steam accelerates.

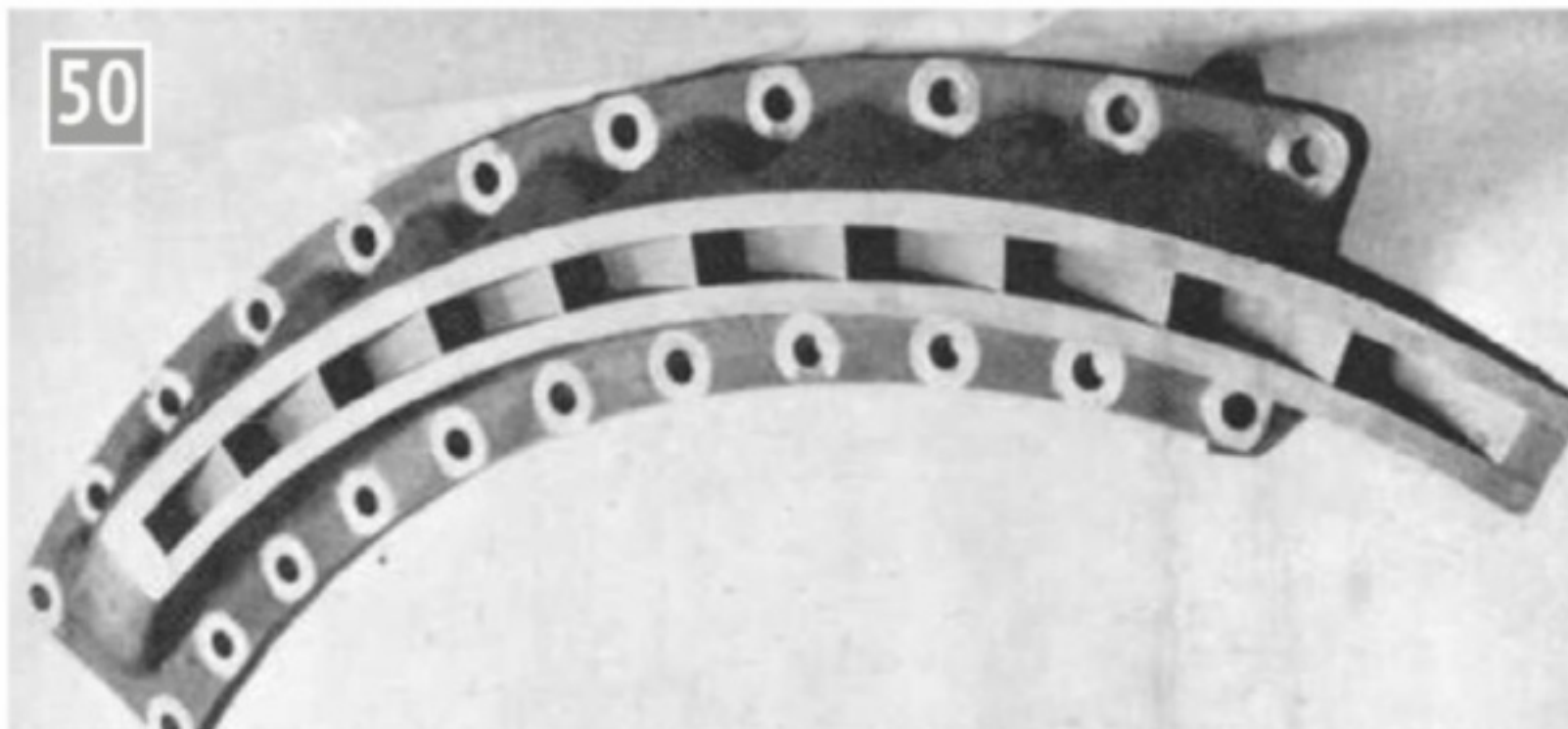
The impact that increased length of a small nozzle can have on velocity of gas flow was brought home to me when experimenting with home-made nozzles for gas and paraffin burners. These were of the form shown in fig 70 and changing the length of the final bore from 100 thou to 50 and then 25 thou made very obvious improvements in the behaviour of the burner. However, in practical matters everything is a compromise and to help the steam to exit in a parallel jet, the nozzle outlet of simple nozzles in full size turbines was usually made to have a short parallel section (**P** in figs 69B and 69C) just before the start of the slanting end. It has been thought that an appropriate length for this





A convergent-divergent type nozzle made by Mr. Jim Bamford (ref 60).

Fig 71



Cast nozzle block for a Rateau turbine.

parallel section is to make it equal to the width of the nozzle outlet.

The marked increase in frictional loss with increase in length of a fine nozzle could explain why miniature C-D nozzles appear to give lower steam velocities than predicted by basic theory. Divergent sections are relatively long and narrow so, even if steam did attain a supersonic velocity just after the throat of a C-D nozzle, friction in the divergent section would be very high. Another problem is that, for maximum efficiency, the divergent section needs to be designed properly (see part 12). However, for reasons to be explained in the next article, it is difficult to predict the optimum design for miniature C-D nozzles.

Nozzle construction

In full-size single stage De Laval turbines the nozzles have been circular in cross-section. The main reason for this was ease of manufacture. However, a drawback of a rounded shape is that the steam jet does not fully fill the rectangular channels between the blades on the rotor. This results in increased entrainment of dead (i.e. stationary) steam which

decreases efficiency.

These De Laval nozzles are generally inserted into suitable holes in the casing (see fig 22 in part 6). Since model turbines have mostly consisted of a single high-pressure impulse stage, the nozzles have generally been of the C-D type and similarly have had circular cross-sections and have been straight. An example is the nozzle made by Mr. Bamford (fig 71). Manufacture of these nozzles has used methods akin to those used for making injector nozzles, with specially made D-bit type reamers of appropriate size and profiles, one for each end of the nozzle. Similar methods should be satisfactory for simple

convergent nozzles although it could be difficult to ensure the length of the parallel section is correct.

In reaction stages of Parsons-type turbines the nozzles have been formed by stationary blades designed and made by the same methods as used for the rotor blades. (These will be described in a later article.) However, different construction methods were developed for making nozzles that fitted into the thin diaphragms that separate the pressure stages of Rateau and Curtis turbines. The internal shapes of these nozzles needed to be complex and to have very smooth surfaces.

Some nozzles were made as a cast block (photo 50) but the internal surfaces were difficult to make sufficiently smooth to ensure efficient steam flow. Some manufacturers made the curved divisions that separate the individual nozzle channels by bending pieces of smooth sheet steel to the desired shape. These pieces were then held accurately in position in sand cores which were placed inside a mould for casting the outside part of the nozzle block. In the finished block the ends of the smooth plates were embedded in the cast iron body.

This method was also used to make diaphragms with complete rings of nozzles, similar to that shown in photo 51. I have seen a large diaphragm made by GEC using that method. It was about 8 feet in diameter with a very large number of blades and the quality of the finished job

was very impressive. Other manufacturers developed ways to make the nozzle blocks by assembling fully machined components (fig 72).

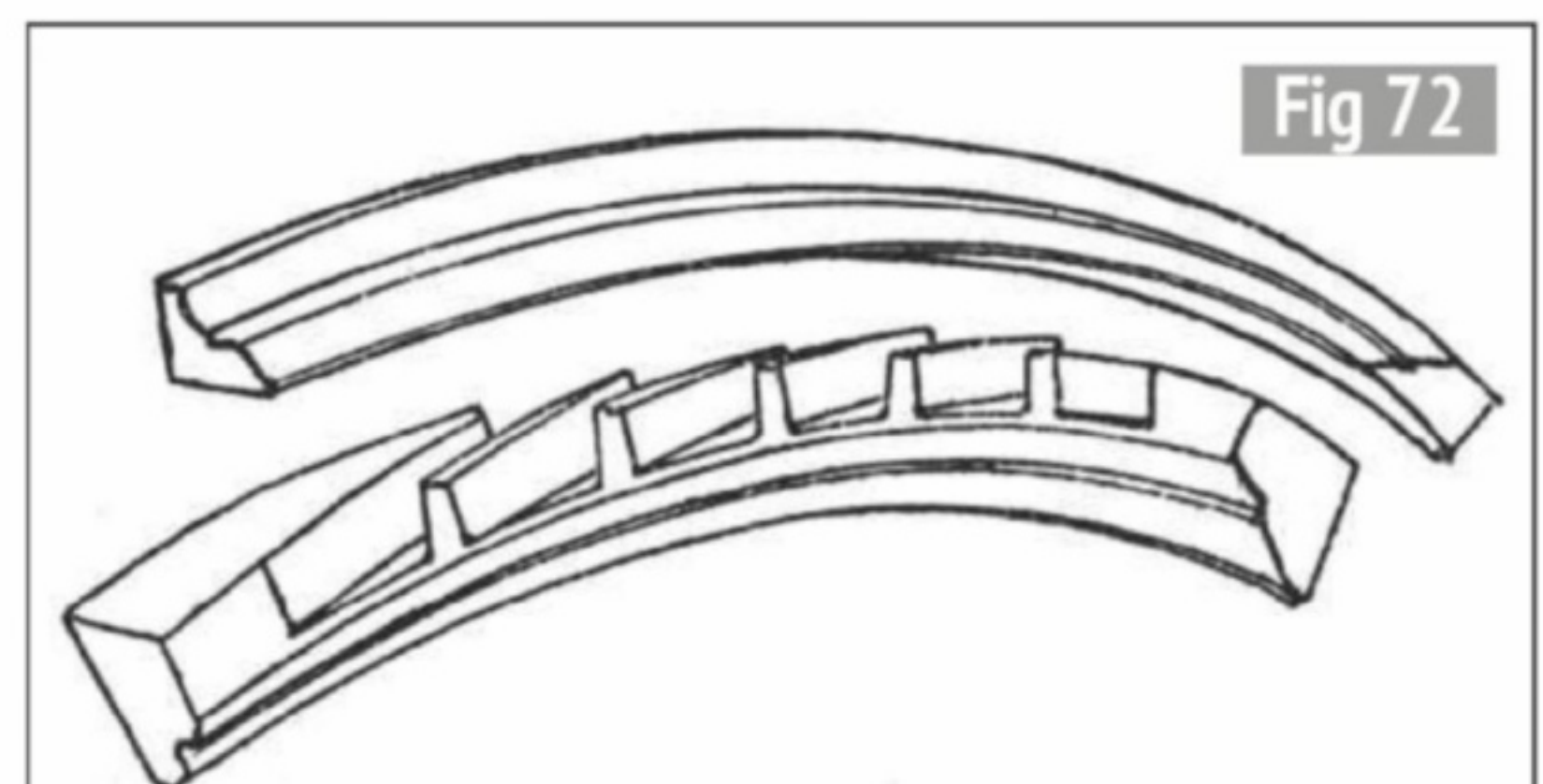
In the world of models, an interesting built-up method of nozzle construction was described by Pierre Bender (ref 59). His C-D nozzles were made by milling a suitably shaped cavity in a flat surface and clamping a flat plate against this (photo 52). This enabled him to ensure the internal surfaces of the nozzle were well polished. Another very ingenious method to fabricate nozzles of rectangular cross-section was described by Werner Jeggli (ref 57).

In De Laval turbines with more than one nozzle, the nozzles were often widely spaced around the casing (see photograph 14 in part 6) but there appears to be an advantage if nozzles can be arranged to be closely adjacent. When nozzles are adjacent to each other a continuous momentum of steam flowing through the rotor blades is maintained as they pass the nozzles.

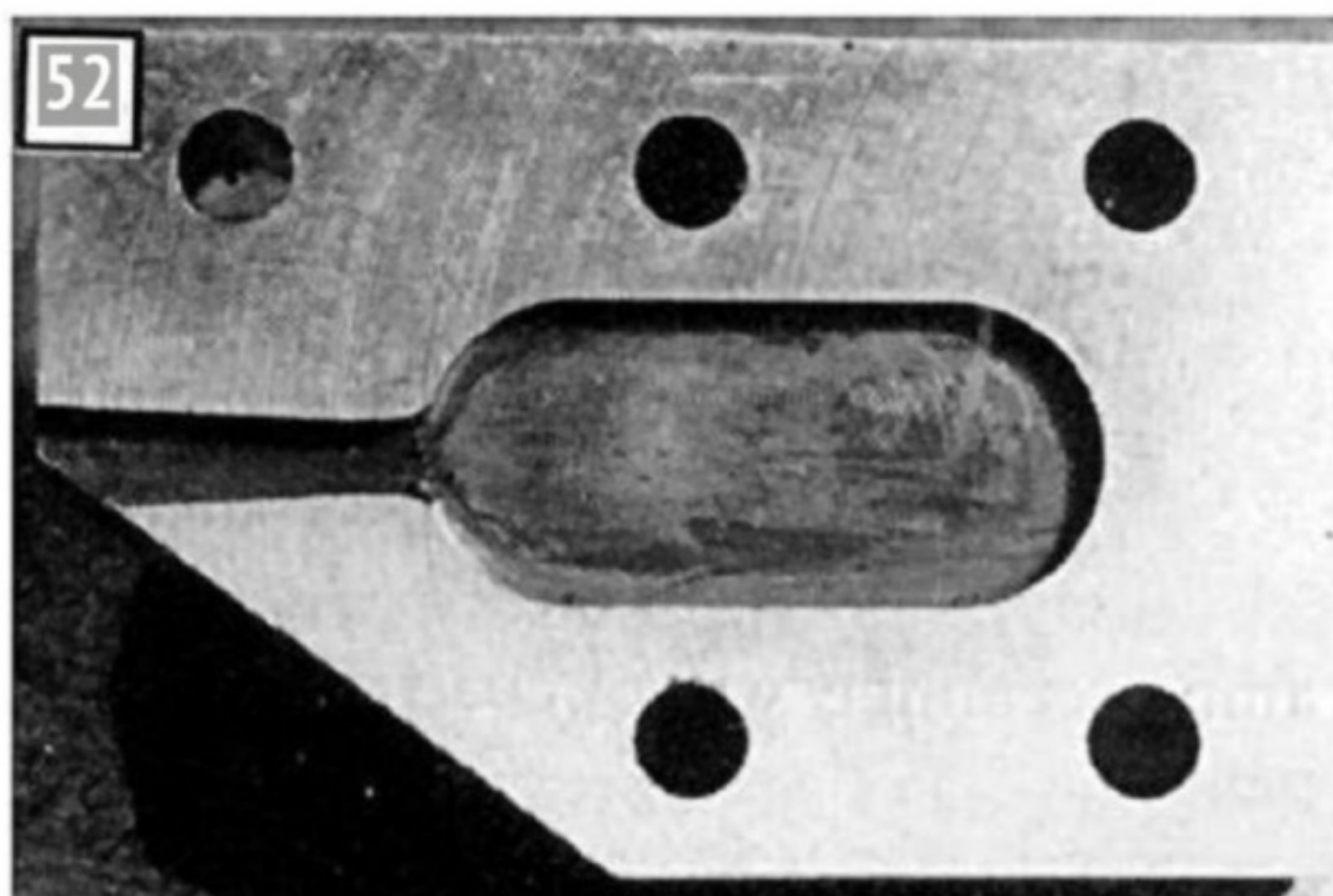
When nozzles are widely spaced, as blades move in front of each nozzle, the steam jet initially impinges on a body of steam that is stationary relative to the rotor, and so some of the kinetic energy in the jet is wasted in turbulence as it impacts against and imparts momentum to the stationary steam. In the first stage of Rateau and Curtis type turbines, several nozzles were usually arranged in blocks (see photos 50 and



Large diaphragm disc consisting of sheet steel guides embedded in a cast iron body.



Fabricated nozzle block made by Brown-Boveri.



Fabricated nozzle made by Pierre Bender (ref 59).

51) and each block would be supplied with steam from its own admission valve.

For my model turbine I have devised the fabricated nozzle design shown in **fig 73** and **photo 53**. As in full-sized nozzles, this allows the manufacture of a curved duct leading to a nozzle with a rectangular cross-section and a well-defined parallel exit section. Also, several nozzles can be spaced fairly closely together (photo 53B).

The nozzles are milled into the edges of diaphragm discs. The example shown in photo 53 is for the first stage. This disc is thicker so as to accommodate radial passageways that conduct steam from control valves to the nozzles which are either single or in a small group. These diaphragm discs have a tapered periphery which closely matches the internal bore of a brass ring that forms the fourth side of the nozzle passage.

The nozzles shown in photo 53 are 27 thou wide and 30 thou deep at the outlet. They were cut with a 0.5mm diameter carbide end mill at 20,000 rpm using a home-made micro-milling contraption that I shall mention further when discussing the manufacture of model turbine blades. The taper of the diaphragm periphery is necessary to attain a good seal with the ring but I hope it will also have a beneficial effect on the steam flow since it will tend to direct the steam jet towards the centre line of the rotor and away from the ends of the blades.

Material for nozzles

Mr Westbury advised making nozzles out of stainless steel in order to resist the abrasive action of superheated steam. In part 4 of his series of articles he wrote: 'Those who have had experience with full-size turbines will need no reminding of how super-heated steam will literally eat away solid metal when moving at high velocity as in a turbine jet.' (ref 56). This advice puzzles me because it is generally accepted that in full-size turbines it is water droplets in high velocity wet steam that cause damage to turbine components.

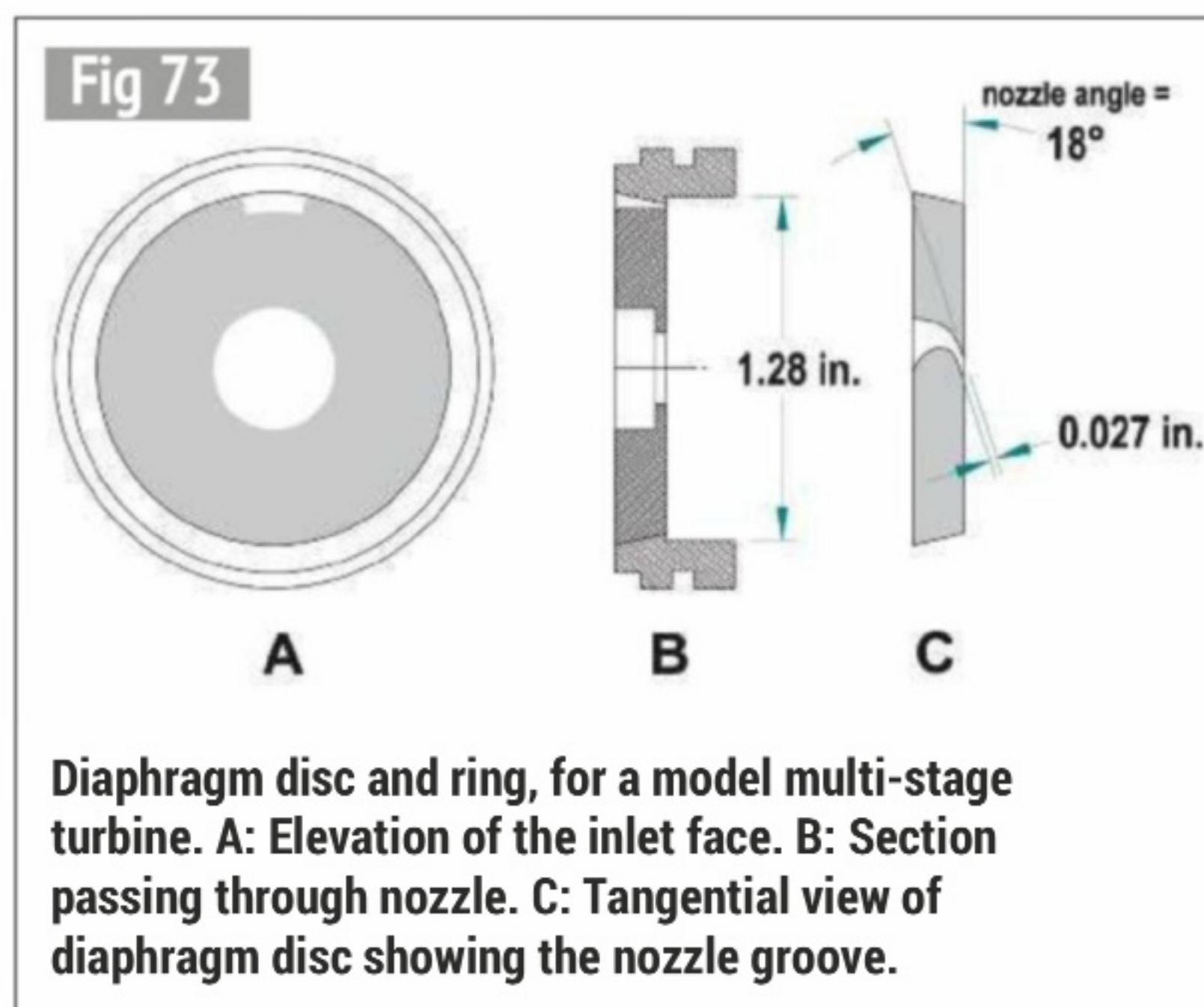
In the early decades of turbine development blades used to be made from materials such as copper and brass. In ships and power stations such turbines operated on super-heated



Diaphragm similar to the one shown in fig 9. A: Periphery of the disc showing the milled nozzle groove. B: Outlet face of diaphragm showing nozzle outlets.

steam almost continuously for months and even years on end without erosion of the fixed or moving high pressure blades. In fact, in both full-size and model turbines, nozzles have often been made from brass and, of course, brass is a much easier material in which to make fine holes.

●To be continued.



Diaphragm disc and ring, for a model multi-stage turbine. A: Elevation of the inlet face. B: Section passing through nozzle. C: Tangential view of diaphragm disc showing the nozzle groove.

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Muncaster's 'Simple' Entablature Engine PART 7

Jason Ballamy presents a rarely modelled engine suitable for a beginner.



Continued from p.566
M.E. 4623, 11 October 2019

Oil cups (fig 15)

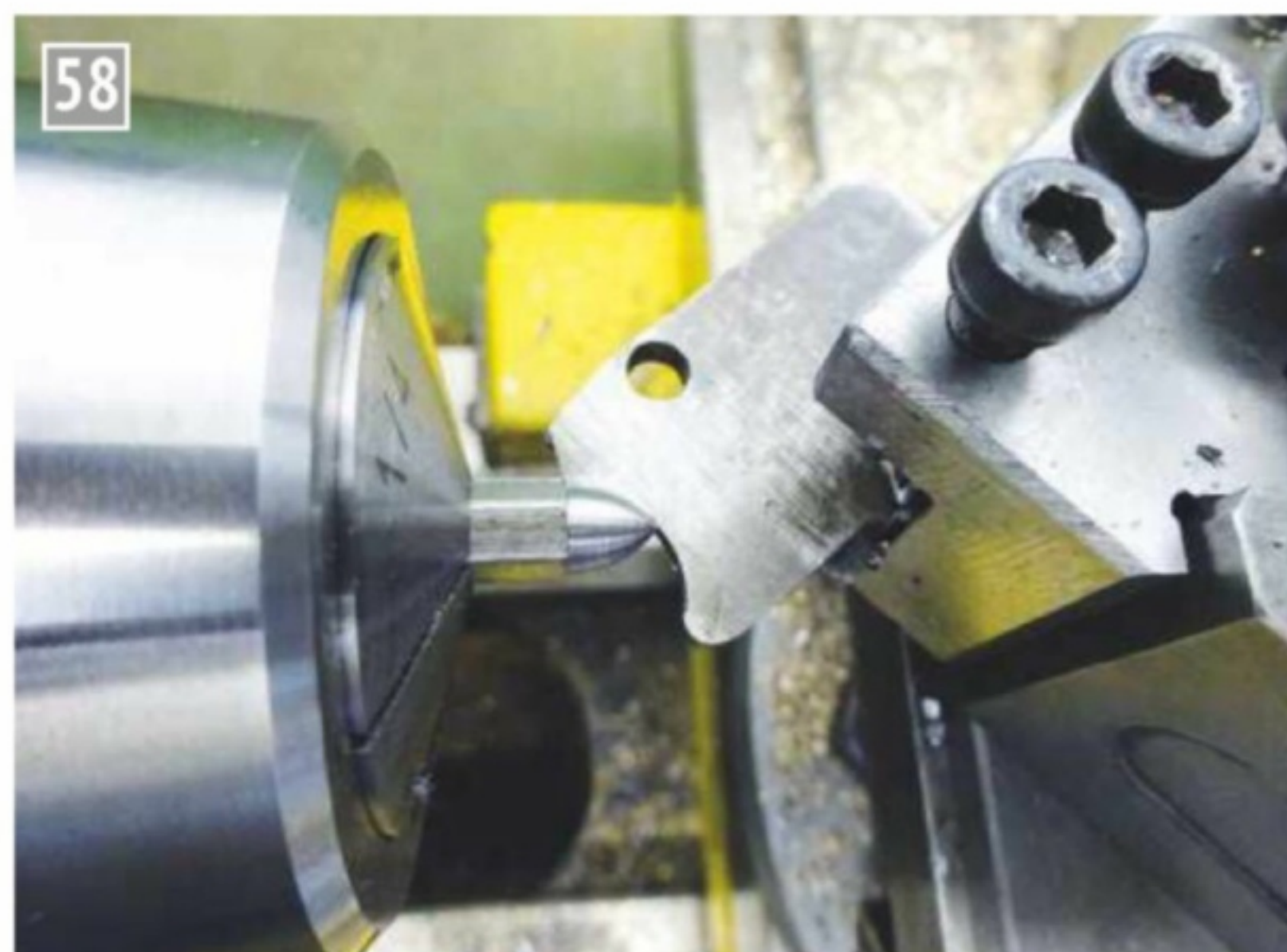
Start with some 6mm diameter brass, face off, reduce a length to 4mm and thread, (you can add a small undercut so that the flange pulls down tight onto the boss) and drill the hole. Use the mill to form the 5mm hex section. Then it's back into the lathe with a very small round nose tool to cut the waist and turn the outside of the cup to 5mm. A small file or form tool can be used to blend the outside diameter into the waist before parting off. Tap a suitable hole in some scrap and screw the cup into it. Open up with (say) a 3.5mm drill then use a 4mm diameter bull nose milling cutter to finish the inside - if you don't have one of these cutters then just a 4mm drill will do.

Acorn nuts (fig 15)

Start by forming the decorative 'acorn' shape. I reused a form tool from another job that had been made from suitably hardened gauge plate but you could grind an HSS one or simply rough turn and finish with a file (**photo 58**). If starting with hex stock then part off before drilling and tapping to suit the thread you used on your column tops; if using round stock mill the hex first.

Exhaust pipe (fig 15)

It is not easy to put a tight radius bend into tubing so I milled a 2mm radius out of the corner of a bit of brass then drilled two angled holes with a 4mm ball nose cutter to form the inner passage (**photo 59**). Two short tubes were then soldered into this block (**photo 60**) and when cool the outside



Form tool shaping acorn nut.



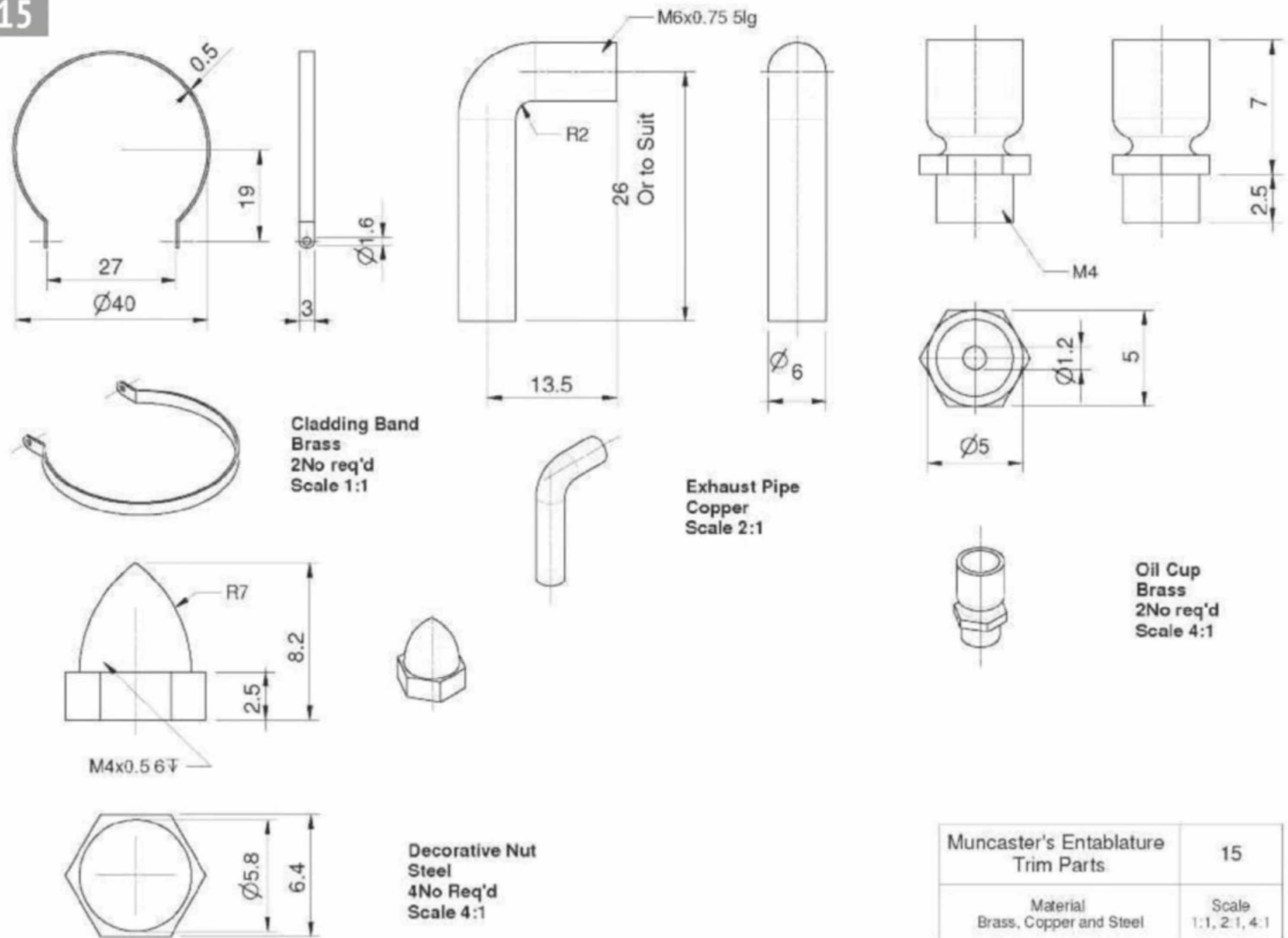
Drilling pipe 'bend' with bull nose slot drill.

was filed down until it looked like a single bent pipe. The short end can then be threaded to fit the cylinder.

Cledding and bands (fig 15)

The cylinder can be finished with some wooden cledding, about 5mm wide and 0.75-1mm thick looks about right. You can buy ready cut planks or make your own from thin

sheet. Start by cutting 22 pieces a little over length then, applying wood glue to just the backs, stick them to some cotton - an old sheet or hanky will do just fine. While the glue is drying make a card template to go around the cylinder from one side of the valve block to the other including a hole for the exhaust. This can then be transferred to your sheet of

Fig 15

Muncaster's Entablature Trim Parts	15
Material Brass, Copper and Steel	Scale 1:1, 2:1, 4:1

planks for cutting to shape. You should now be able to carefully bend the sheet of planks around the cylinder and have then sit flush below the overhanging top cover.

To retain the planks two bands can be bent up from 3mm wide thin brass and the holes in the bands ends transferred to the sides of the cylinder so that can be drilled and tapped M1.6.

The only work that now remains is to make up a batch of studs if you have not been doing it as you go along. Don't be tempted to use bolts or screws after having spent all this time making this barstock engine look like a traditional one, the only exception being some round head brass screws for the banding.

Trial assembly and timing

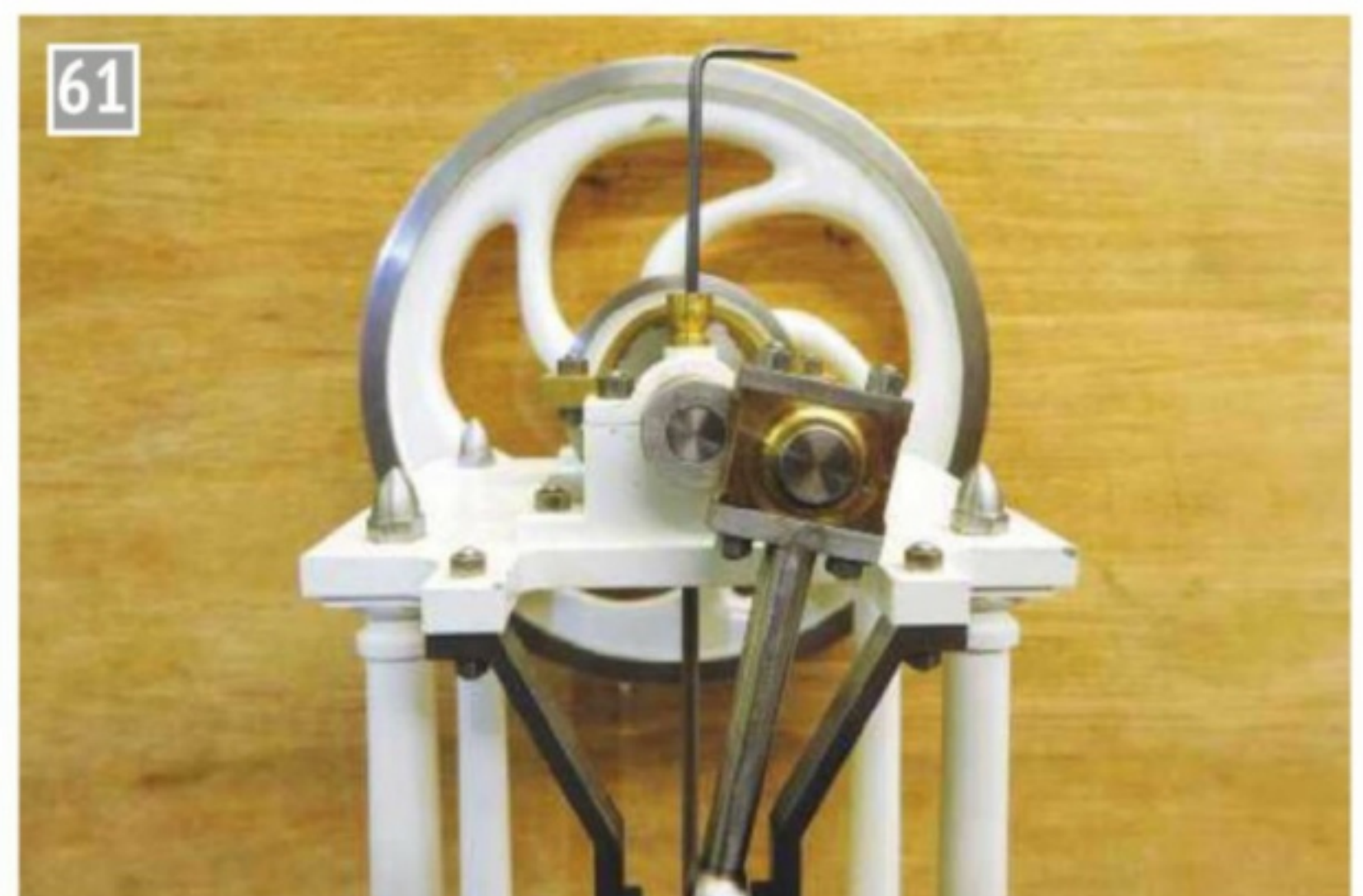
I like to get an engine running before applying paint, this way if you end up having to take things apart and reassemble

a few times you don't risk damage to the paintwork. If your machining has been done to a good standard there is no need to seal any joints or fit piston rings at this stage. Just assemble from the bottom up checking that the engine turns over freely as each part is added rather than putting it all together then trying to trace back to find the cause of a tight spot.

For running on air I find that having the eccentric lead the crank by about 100 degrees works well. The easiest way to set this is to put your Allen key into the eccentric and have it stand vertically upwards at 12 o'clock which, if made according to the drawing, will also put the maximum throw of the eccentric at the top. Now, holding the key upright while looking from the cylinder side of the engine, rotate the crank until the web is pointing to just past 3 o'clock and nip up the grub screw (**photo 61**). This will



Exhaust parts soldered together.



Setting timing angle.

I like to get an engine running before applying paint, this way if you end up having to take things apart and reassemble a few times you don't risk damage to the paintwork.

now be set for anti-clockwise running when viewed from this direction.

All that is left now is to add a little oil to the moving parts and apply some air. If the engine does not self start give the flywheel a light flick in the right direction.

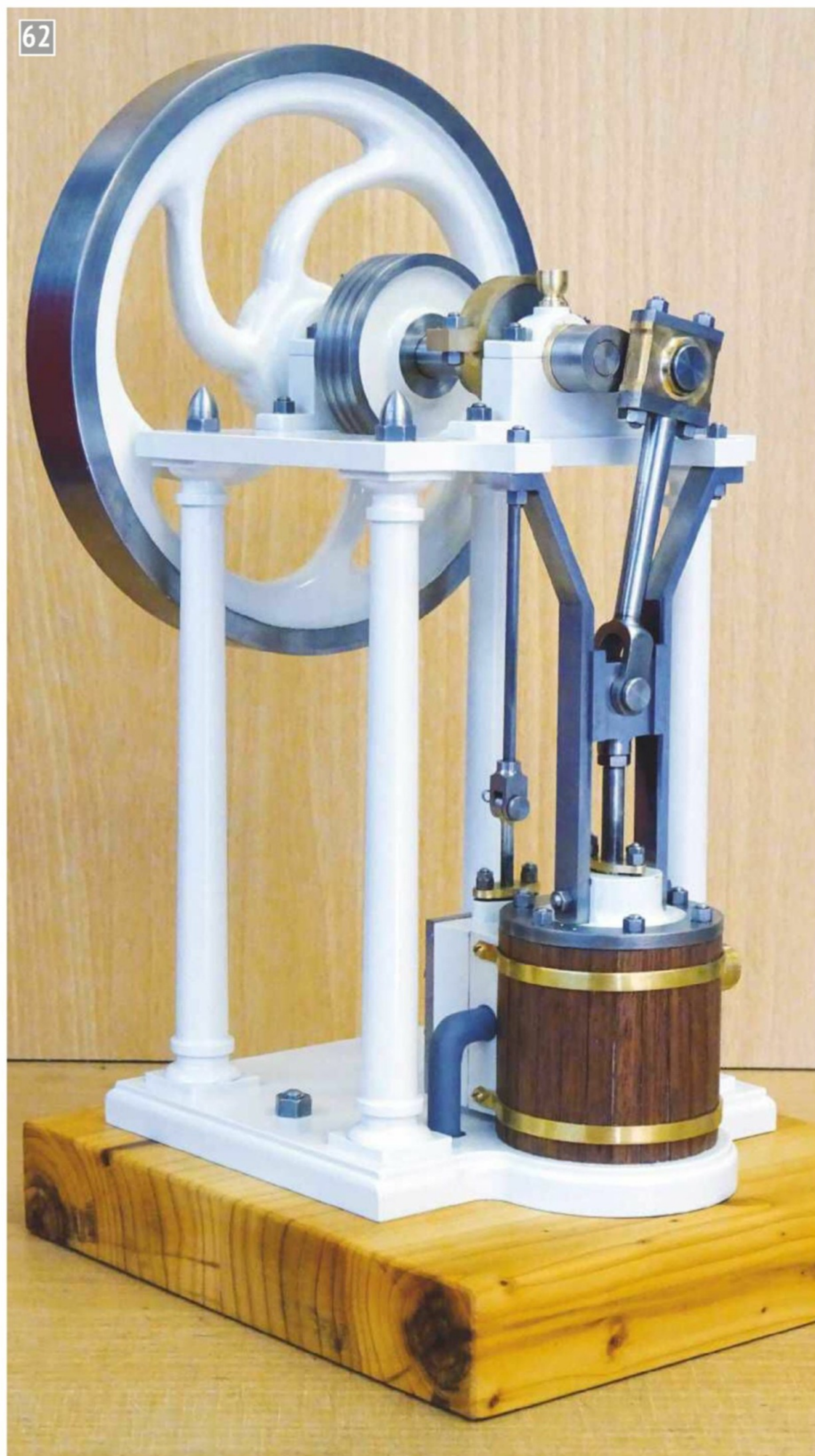
Painting and final assembly

Take the engine apart and give it a good wipe over with thinners, mask up anywhere you don't want painted and then prime and add the colour coat. On smaller engines like this I tend to use spray cans as it is hardly worth getting the airbrush out for such small areas. In this instance I used Audi 'Amalfi White' which makes a nice change from the usual dark greens and reds.

For final assembly I use a very light smear of liquid gasket which is much like a silicone sealant as it does not add any thickness to the joints. A couple of turns of graphite yarn can be placed onto the gland recesses and then they can be tightened down with nuts and locknuts and the piston ring if any fitted. I opted for a simple yew base so as not to draw attention away from the engine and stained the cleading to match, which brings this engine build to a close (**photo 62**).

ME

Additional content and discussion about this build can be found at www.model-engineer.co.uk/forums/postings.asp?th=139596



Complete engine.

A New GWR Pannier PART 11

Doug Hewson decides that LBSC's well-known GWR pannier tank design needs a make-over.



I think the next job on the Pannier Tank is to make the slide bars and cross heads (fig 15). In photo 88 I have shown the upper slide bars on 7754 at Llangollen. There is not that much to see really. However, you can see the tops of the slide bars nicely and that is what matters here. In fact, photo 89 also shows a good photograph of one of the crossheads which is what I want to talk about first.

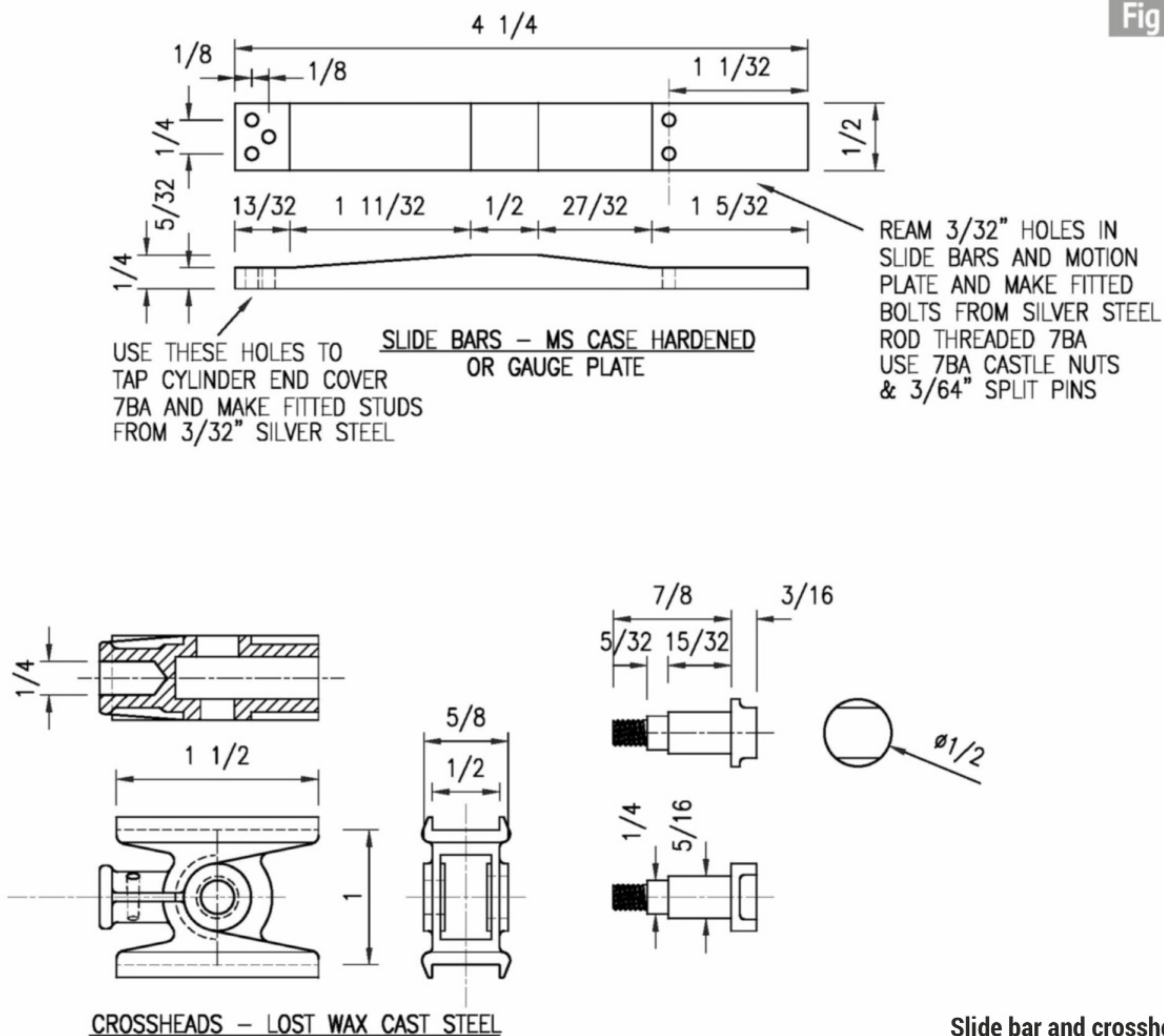
I have had lost wax castings made for the cross heads (photo 90) and they are in



Slide bars belonging to 7754 at Llangollen.

Continued from p.511
M.E. 4622, 27 September 2019

Fig 15





89 Crosshead on 7754 – note, con. rod is missing.

free cutting stainless steel so any polish you put on them should stay polished. They are cast in pairs so they can be machined in one setting. They have also been made so that you can either machine them to the correct size or take a bit more off to leave a bit of space for a white metal lining to the slides. To do this I just

put an old toolmakers clamp across the end and poured them full of white metal and then machined them to size in one piece. Once you have done this you can then part them off and bore them $\frac{15}{32}$ inch and then ream them $\frac{1}{4}$ inch for the piston rods.

For the gudgeon pins they need drilling out on the outer



90 Crossheads, as supplied, as lost wax stainless castings.

side $\frac{1}{4}$ inch and then on the inner side they need reaming to $\frac{5}{16}$ inch for the little end of the connecting rod. They will also need a little skim off the outsides to give the $\frac{5}{8}$ inch width. You can give them a nice bit of polish to finish them off. To make the gudgeon pins you will need some half inch free cutting bright bar. Turn down a

$\frac{1}{4}$ inch to $\frac{3}{16}$ inch diameter and then a further $\frac{1}{4}$ inch and then another $\frac{15}{32}$ inch or very slightly under, so that the nut tightens up properly and then part off at $1\frac{1}{16}$ inch long. Make a couple of these of course and then you can do something with the heads to get a spanner on them. Finish them off by case hardening them.

Fig 16

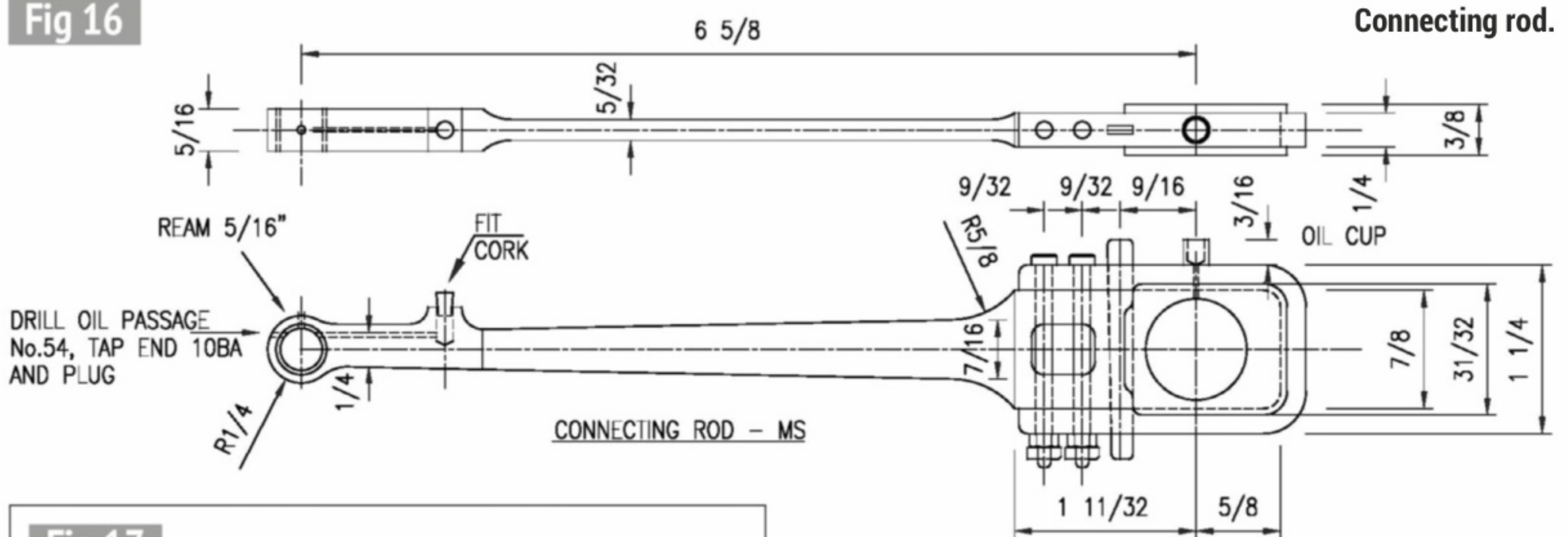
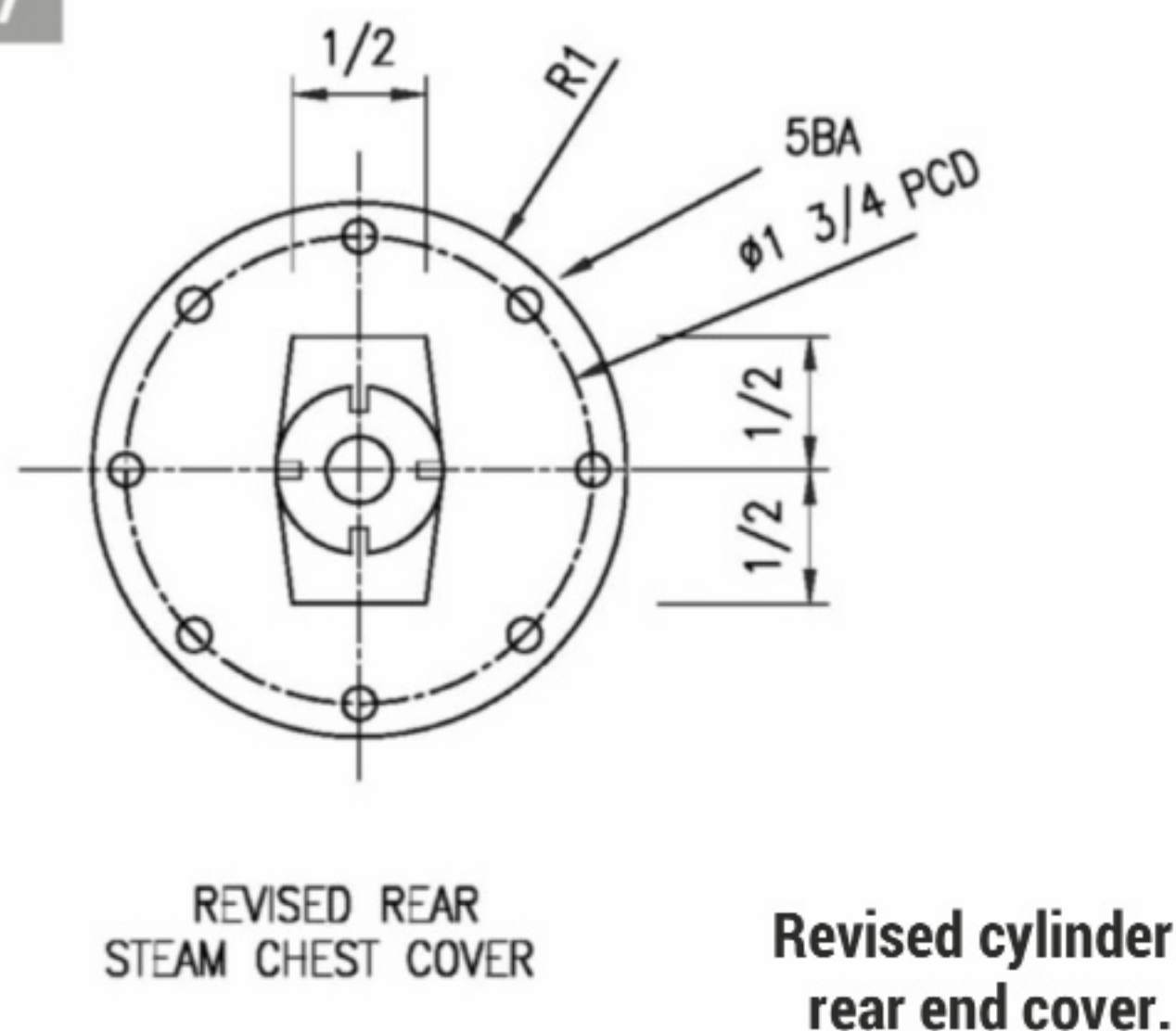
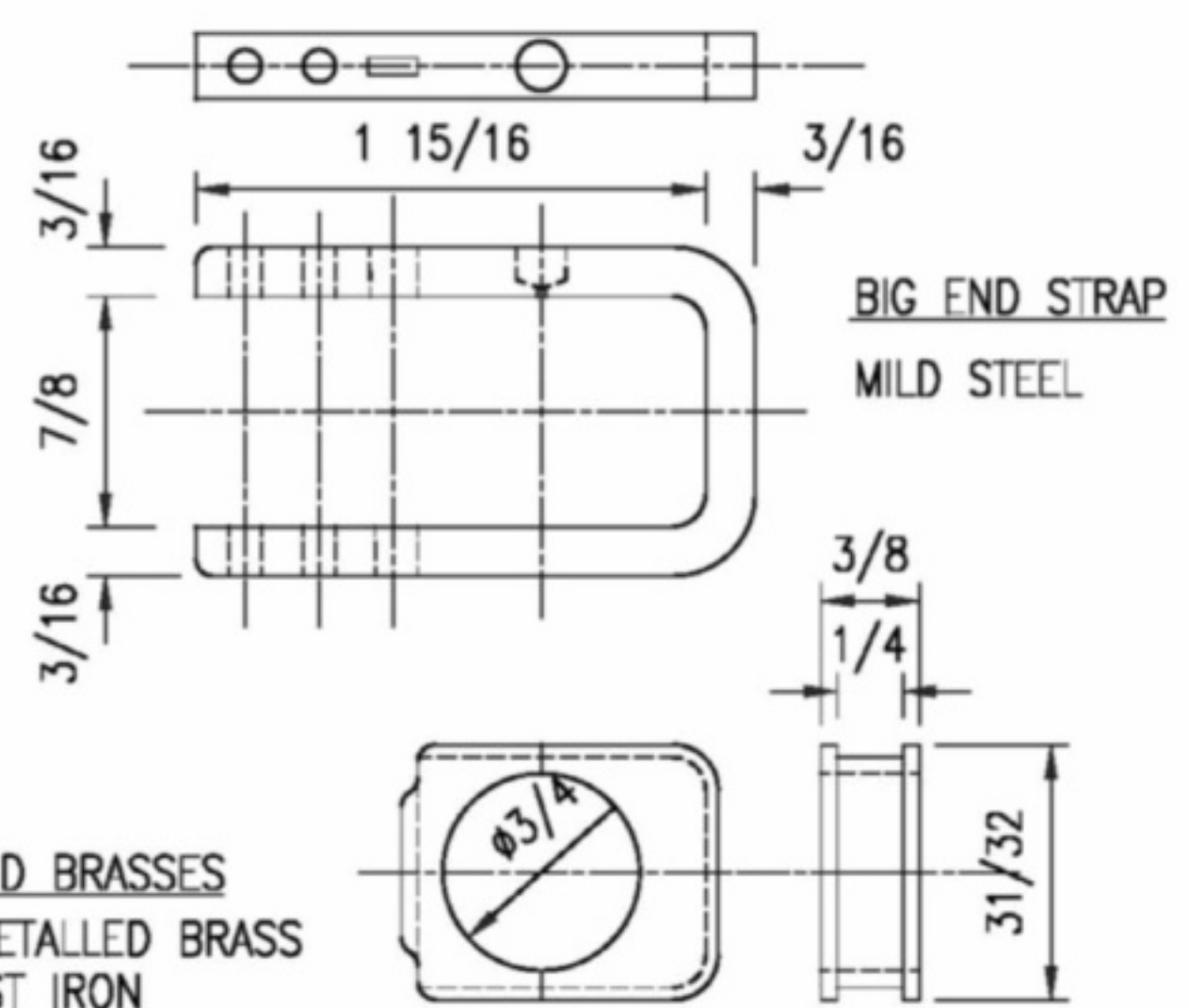


Fig 17



Revised cylinder rear end cover.



The slide bars are made from a piece of $\frac{1}{2}$ by $\frac{1}{4}$ inch mild steel bar. If you can buy some 'gauge plate' then all the better as it will be a lot harder wearing. The bars just need milling away to the shape shown and drilling. I have shown three bolts in the cylinder ends of the bars, as that is the way the full-size ones are fixed and just in case you are after a gold medal for your engine, though two will do, I suppose. Ream the holes in the bars $\frac{3}{32}$ inch for the fixing bolts. If you have made your slide bars from mild steel then I would definitely recommend that you case harden them.

You can make your own reamers for this purpose and I am still using mine which I made when building *Tich* in the 1950s! Just grind the end on a piece of $\frac{3}{32}$ inch silver steel rod to an angle of about 60

degrees, cut it off at about 2 inches long and then harden and temper it. It will work fine and then you can put it in a little drawer with your other reamers.

When making the studs, make them long enough so that you can get a split pin in both ends and then drill them No. 54 for a $\frac{3}{64}$ inch split pin in each end. I hope that you haven't made your cylinder end covers yet as I have just had to alter them very slightly to suit the slide bar width. I have attached a new drawing for these (fig 16).

I have also had to amend the connecting rod drawing (fig 17) slightly as I didn't think to put an oil box on it so I was ticked off by one of our club members. Anyway, once you have made the coupling rod I think the con. rod should be much easier for you. However, as you will also have noticed

I have altered the little end as it now also has an oil box on it which it didn't have on the old design. It is made to stick out the back of the crosshead so that you do not have to tip the engine upside down to oil it. Hopefully you will find this an improvement.

Now, there is definitely a problem with the valve gear. I emailed Don Ashton to ask him what he thought of the *Pansy* valve gear and I received a three word reply: 'Not a lot' was his answer.

For a start, it is all upside down with having the steam chests below the cylinders so that did not help. I then asked him if he would like to elaborate a little so then I received a six page report on that! He said that the worst thing was that with it all being upside down he could not get it all corrected. However, what he did say was the valve events were 45% out

in reverse gear and 42% out in forward gear.

Now, if you follow Don's new design you can get it much better. In fact, you can get it so that it is only 7% out in either gear with a couple of very simple alterations. The lifting arm on the weighshaft needs extending by $\frac{3}{8}$ inch and then the lifting links need to be made 2.41 inches long rather than the $2\frac{3}{8}$ inches that I think they were. Frank Osgerby of our society altered his and his exhaust now sounds like shots from a gun, especially when he has a good train on. Furthermore, he can now notch it up to within a hair's breadth of mid gear.

●To be continued.

NEXT TIME

We'll look at the rest of the valve gear.

SHOWCASE

1923 Compound Condensing Marine Engine

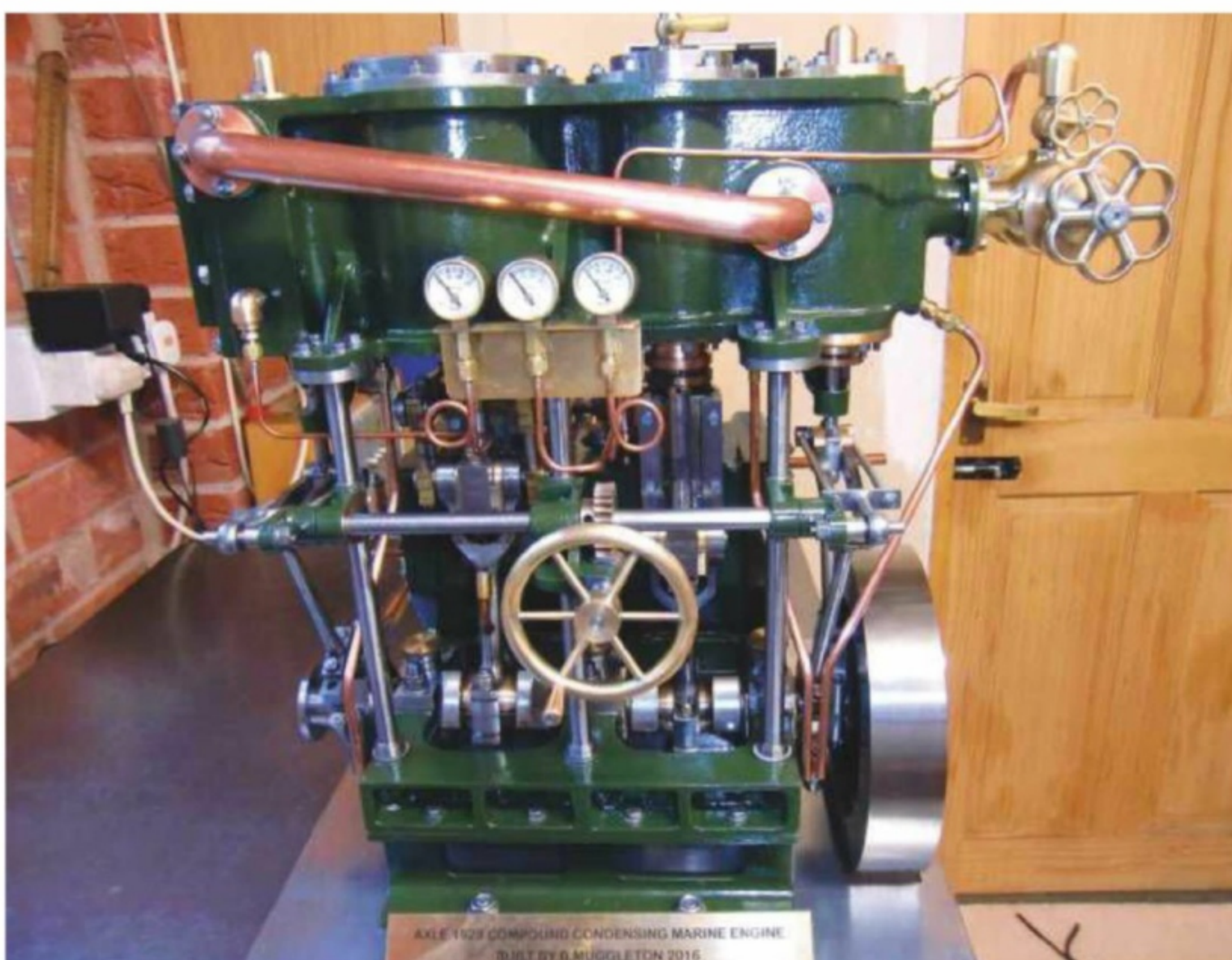
This engine came to be after I purchased a box of steam bits on eBay in 2015. In the box was a casting for a two cylinder bed plate. It was a very good quality iron casting.

By chance I saw an engine on a USA website with the same bed plate and that site put me in touch with another company in the USA that was producing patterns and castings for this engine.

I purchased a set of iron and gunmetal castings of very high quality. Armed with these castings and a set of drawings from *Model Engineer* magazine dated March 1923 (M.E. 1141) and with help from a guy in the UK who was also building this engine I set to with its construction.

I managed to complete the engine over the next two years. I have built many engines over the last 20 years and I think this is my best effort to date.

Brian Muggleton



If you would like to see your model in the 'Showcase' please send a photograph and a brief description to the editor.

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The Mayor of Newport takes the train from the station.

7¼ Inch Gauge Society AGM

John Arrowsmith visits the City of Newport SME to attend the 7¼ Inch Gauge Society AGM and rally.



This annual event is one of the highlights of the railway model engineer's year in terms of the number of large locomotives that are present, the number of members and friends who attend and the wide range of

locations where it is held. This year, after many years of hard work by the members, the City of Newport Society of Model Engineers hosted the rally an AGM at their large site at Glebelands on the outskirts of the city. Despite still having

a large amount of work to do to complete their site, the Newport members had made a tremendous effort to ensure the rally and the important AGM meeting were held in a way that embraced all that is good in the model engineering world.

Their site has some really innovative features for moving heavy locomotives from vehicles to the steaming bays and for turning them into the correct running position and this really helps everyone, especially the visitors.

When I arrived, the site was just coming to life and the steaming bays were a hive of activity with locomotives from far and wide being prepared for the day's activity. When I say far and wide I mean it - there were visitors from Belgium, Holland, Cambridgeshire, North Wales, Yorkshire, Kent and many



A much quicker way of putting the soil around the tree - the Mayor of Newport shows how to do the planting.



Bob Whitfield's superb Shay locomotive waiting for its turn on the track.



Colin Edmundson poses with his 'Shed of the Year' while his breakfast cooks on the stove.



Winner of the Brian Reading award was Ian Dixon with his superb example of an American 'Mikado' locomotive.



Mat Rainer, winner of the Charles Simpson award, with his 2-6-0 BR Std Class 2 and goods train.



Wally Sykes from the Hereford SME with his latest Bo-Bo locomotive.



Peter King with his 0-6-0 'Romulus' Sophie B comes off the girder bridge.



Ivan Hewlet with his GWR Railcar and train crosses the girder bridge.

other parts of the country, so it was really a good mix of people, locomotives and rolling stock, all anticipating a good weekend.

The hosts were busy organising the special train

for the visit of the Mayor and Mayoress of the City of Newport, Councillor William J. Routley and Ms Alison Robbins. This was headed by a 'Romulus' locomotive driven by Nick

Burton, a member from the Northampton Society, which duly departed the station followed by a cavalcade of visiting locomotives. Part way round the circuit a stop was made so that the

mayor could formally plant a commemorative tree. The area was already prepared with a silver spade and a container of soil available for the mayor to complete the ceremony. He gave a short, amusing



A rare example of a Bassett-Lowke 0-6-0 tank engine owned by Kevin West.



The vertical boilered De-Winton driven by Lynne Leak leaves the station.



Paul Pavior with his superb 3 cylinder A4 gets away from the station.



An unusual version of a 'Lion' locomotive.



This fine 4 inch scale Burrell was gently steaming away all day.

address to the assembled members and guests and then proceeded to plant the tree with a couple of shovels of soil. Then he gave the spade to the lady mayoress to hold, while to the surprise and amusement of his audience

he tipped the remaining soil from the container into the hole. The mayor then rejoined the train to complete a circuit of the track and get the whole weekend off to a great start.

The day continued as all AGM events do with a wide

range of locomotives enjoying track time along with lots of good-natured banter between old and new friends. All this of course was leading up to the important part of the day, the AGM meeting itself. This went off smoothly with

over 80 delegates attending and all the usual meeting business being completed without delay or problems. The meeting decided that there will be a greater promotion of the Proficiency Scheme following the HSE's



The splendid fully adjustable turntable designed by Eddie Atree and built by the Newport members.



The versatile cable operated traverser, again designed and built by the Newport members.



Claude Magdelyns, Vice President of the Petit Train a Vapeur de Forest from Belgium, takes a turn round the track.



A visitor from Holland, Rosie Bongers, running with the locomotive and train she has built on the track she brought from Holland for the rally.

requirements for greater training at all miniature railways. I hope this element can be explained in detail in another article so that all clubs can understand how it might affect their operations. All the officers elected at the meeting will be detailed in the Society's journal available to all members. Details of a new loan scheme to help fund AGM's at clubs was outlined and well received.

There is always a presentation element of the day and this year the Brian Reading Award for the best locomotive at the meeting was made to Ian Dixon for his superb example of an American 'Mikado' 2-8-2 locomotive. Ian told me it took him 6 years of work to complete the model and his philosophy for this was to do

something each day, be it 10 minutes or all day. That way the project is always moving forward - seems like good thinking to me.

The Charles Simpson Award for services to the 7¼ Inch Gauge Society went to Mat Rainer for all his work with the Proficiency Scheme

and an award to the Young Engineer of the Year was made to Robert Woolsey from the Bedford SME.

All in all, a very successful weekend for both the 7¼ Inch Gauge Society and the hosts, the City of Newport Society, who must be thanked for all their hard work and hospitality

over the weekend - you did a great job and everyone appreciated all your efforts. Next year's AGM meeting will be held at the Echills Wood Railway on the 18th, 19th and 20th September.

ME

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Four Bar Linkage Hinges PART 2

Nick Feast explains how he used an ingenious mechanism to improve access to the cab of his locomotive.



Continued from p.575
M.E. 4623, 11 October 2019



With the ventilator open it is possible to keep an eye on the water level and pressure gauge, just out of sight on the lower right side of the backhead.



With the roof up, all controls are easily accessible. I have experimented with 'butterfly' firehole doors, as on the full size Bulleid Pacifics.

Photograph 7 shows the roof ventilator slid back to allow the water and pressure gauges to be seen when on the move. This may be all that is required for a lap of the track if an axle pump is fitted and you have mastered the bypass valve. On a few occasions I have completed the one third of a mile lap at my club track without firing or touching any of the controls on the locomotive after the first twenty yards of getting the train moving. A few touches of the train brake to keep speed down on the downhill bits were all that was needed.

As the train gradually slows on the 1/100 uphill gradient there is a great temptation to make adjustments but if all is left alone you should get a revealing demonstration of what a unique and effective self-regulating machine the miniature steam locomotive can be. Lower speeds bring a sharper blast at the chimney and more steam is



From this angle the way the hinge operation allows the roof to clear the steam turret, which is very close to the top of the cab front, can be seen.

automatically produced to cope with the extra load.

However, on this locomotive there is no axle pump, so the injectors will be needed.

Photograph 8 shows the roof fully open. Everything is easily accessible, with no risk of a loose roof panel disappearing into the trackside scenery!

Photograph 9 shows the view

from the front. The turret and manifold are mighty close to the top of the cab, as on many later designs of main line steam engine. No problem for this hinge as it lifts the roof up and back to provide the necessary clearance.

Incidentally, the locomotive is '02C 34', the numbering being my prediction of how an



On the L class it was possible to fit the frame of the hinge to the cab sides as these are flat.

0-6-4 locomotive would have been identified under Bulleid's unique numbering system. 0-2-C is the wheel arrangement and 34 is the running number. We could speculate that the BR number would have been 33134; these machines would surely have been useful enough to have lasted to the end of steam.

Photograph 10 shows another locomotive I have fitted with this design of hinge, a 3½ inch gauge SE&CR L class 4-4-0, a more traditional design which contrasts somewhat with the high boilered Q1. The challenge on this locomotive was to keep the authentic appearance of a model designed to follow the full-size prototype as closely as possible but still be a 'drivable' proposition on the track.

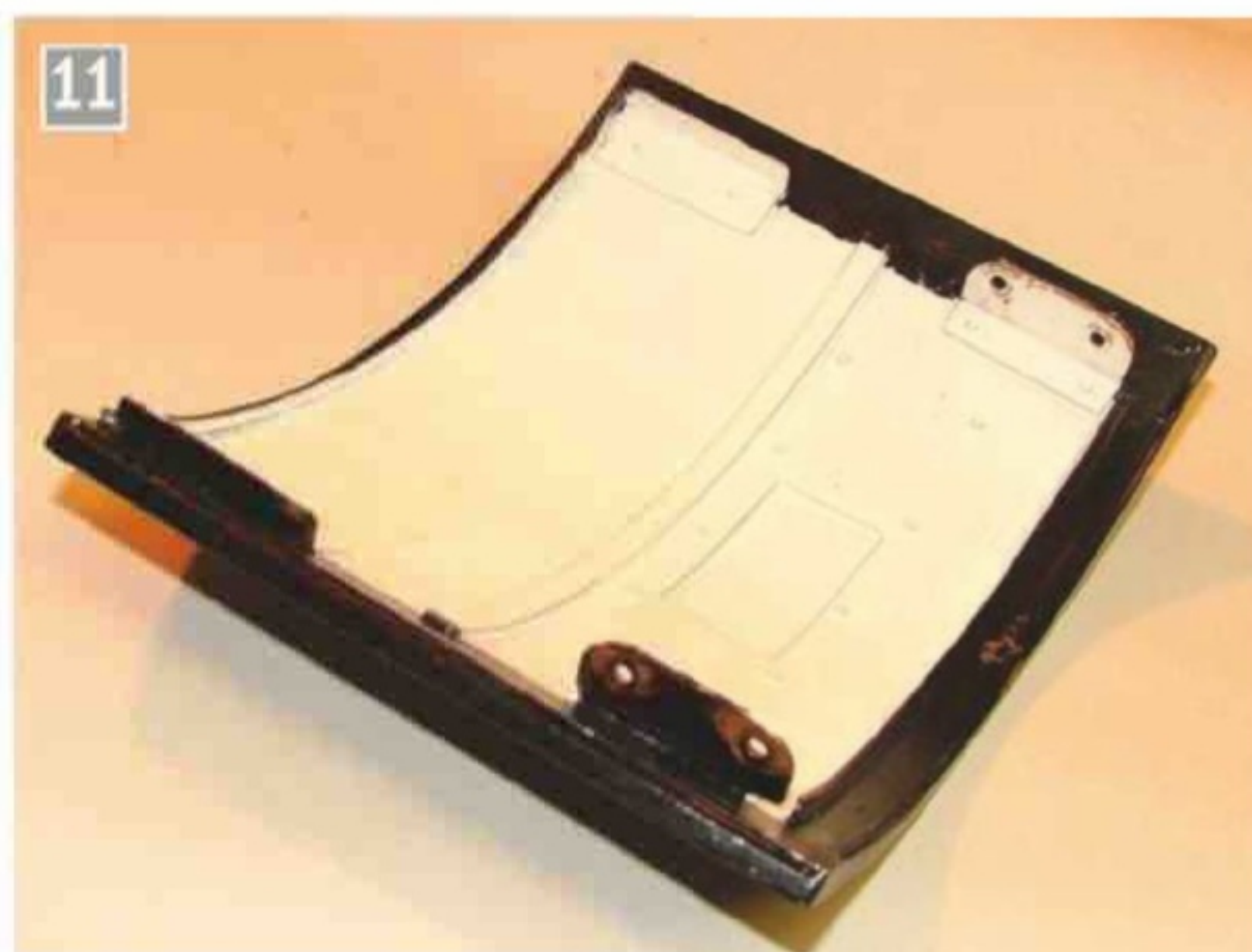
The model was started by a retired locomotive designer from Bagnalls, the industrial locomotive manufacturer in Stafford. It was an admirable attempt to produce a locomotive, which has rarely been reproduced in any gauge in the past, and was Harry Wainright's final design for the SE&CR. It was introduced in 1914, just prior to the start of the First World War, and the locomotive shown here when completed will be number 773, one of ten engines manufactured by Borsig of Berlin. These were shipped to Ashford in kit form and assembled by a group of Borsig

engineers on site. They finished the job just weeks before the outbreak of war; no doubt some were soon to perish in the conflict. The remaining 12 engines in the class were constructed in Manchester by Beyer Peacock and were virtually identical.

It was an up to the minute design, with 9 inch diameter piston valves directly above the cylinders having just over 5 inch travel. Boiler pressure was 160psi and superheaters were fitted from new. The SE&CR network was in the front line when war started and so these engines would have been put to work straight away on troop and ambulance trains. Although Maunsell built more powerful 4-4-0 designs later in Southern Railway days, the last of the L class lasted until 1961, having served the railway well during two world wars with few design modifications during that time.

The countersunk holes on the inside of the hinge bars, visible in the photograph, are mistakes as the countersinks for the fixing screws need to be on the outside only.

The roof is shown removed in **photo 11**, showing the small bracket at the front with the fixing holes for the hinge bars. The small brackets at the rear end are to align the roof with the cab sides when shut. The white paint is not the final colour. Interior cab surfaces above a certain



Small brackets were riveted to the cab roof for the upper hinge pivots at the front and the guide pieces at the back.

level were painted cream and the exact shade is yet to be decided. Perhaps readers have information to pass on? Restored locomotives I have seen are a creamy yellow colour, although around this time interior cab surfaces were specified to be 'grained light oak'. This would be a version of 'scumbling', which I remember seeing on the panelling on the doors in my grandparents' house.

I made the mistake of buying very expensive 'dragged' pattern wallpaper for the living room at home some years ago. The fine vertical lines looked good from a distance of around six inches away but any further away it just looked like plain coloured paper! I feel a wood grain effect on a one sixteenth scale would fail in the same way so I'll be giving that detail a miss!



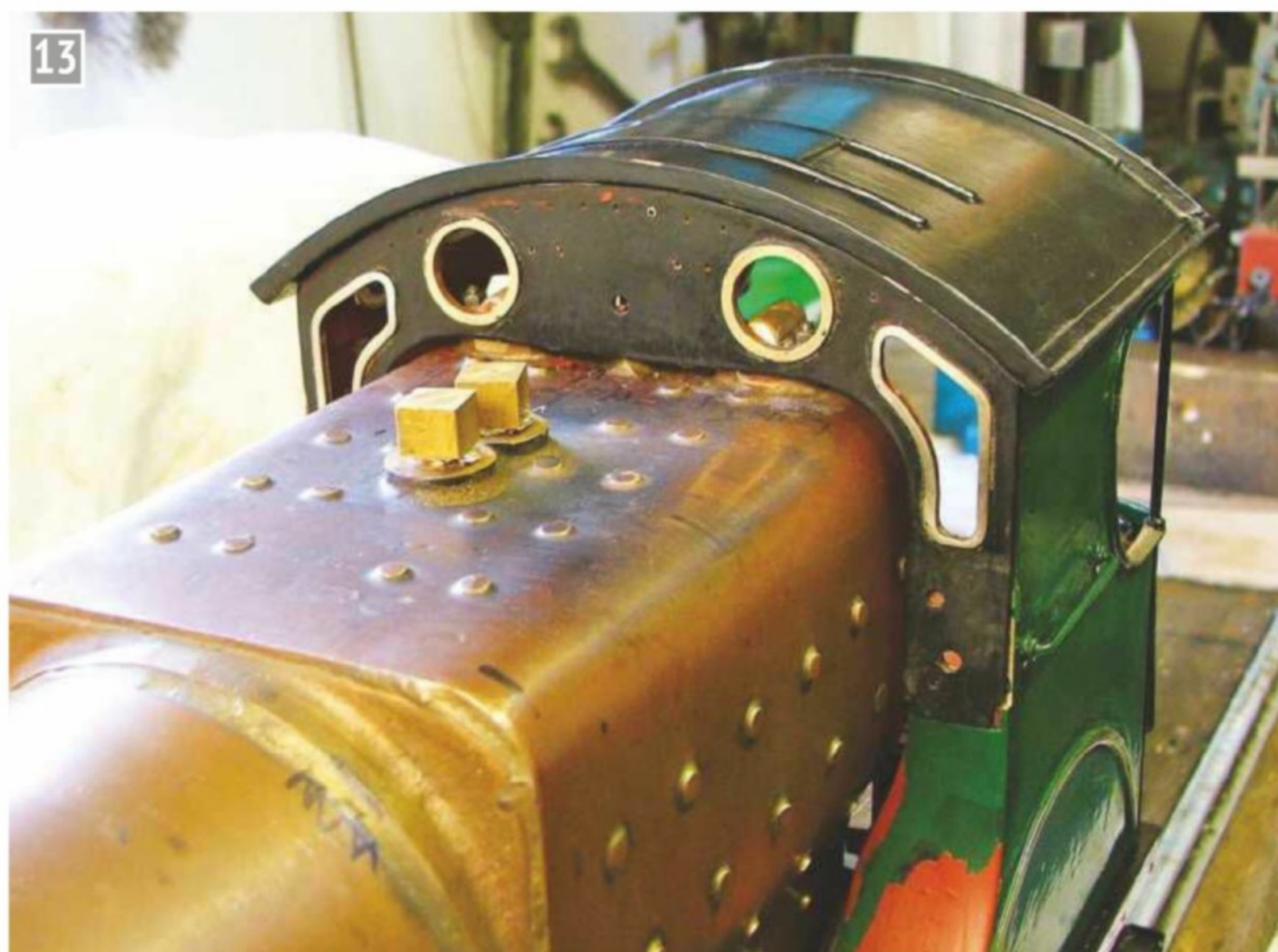
Once painted the hinge will be inconspicuous in the closed position.

Photograph 12 shows the view from 'platform' level - once painted in the correct colour to match the rest of the cab I think these fittings will be inconspicuous enough.

Photograph 13 shows how the roof sits down nicely onto the spectacle plate and cab side sheets. The frames for the round lookouts were a simple turning job but the lower frames were bent up out of OO gauge nickel silver rail. Polycarbonate 'glass' will be added in due course, probably after final painting.

Photograph 14 shows the roof in the raised position and, in the side view in **photo 15**, the position of the raised roof relative to the spectacle plate can be seen. There is just enough clearance for the roof to lift without taking the paint off. This was more by luck than calculation - I didn't make many drawings to prove the geometry, I used the trial and error method and fortunately the hinges were 'spot on' first time.

Obviously, the roof can be made to 'stay put' in the raised position by tightening the



The roof detail is correct for a Borsig-built L class. The Beyer Peacock locomotives had a different ventilator arrangement.

fastenings, so it's probably best not to lubricate them at all to allow friction to do the job.

I have spent some time refining other parts of the Q1 design over the last few

years and I hope to get these developments written up and approved by the editor in due course (pre-approved! - Ed.). These are the results of experience running my engines

on passenger hauling duty and hopefully will be of use to those who want to build engines that work!

ME



Roof raised, ample access to the controls. The locomotive is correctly built with right hand drive but incorrect in having a screw reverser. A steam reverser was standard on the SECR on almost all classes.



It would have been possible to make a sliding roof on this locomotive but the roof is then prone to being dropped and damaged as it is then fully detachable.

VMC Inverter

Dear Martin,

I was interested to read Peter Russell's article (M.E. 4617, 1st August 2019) about his fitting of an inverter to a VMC.

All he says without doubt covers the improvement in functionality of the machine, as the original choice of step pulley sizes obviously had no regard or understanding of geometric progression for the selection of speeds, needlessly making quite a useful machine a pain to use seriously.

What I must say, based on personal experience, is that his choice of the inverter location is waiting for an expensive disaster unless he only machines non-conductive materials.

After putting up with running my VMC for several years at less than ideal speeds because of the aforementioned pulley/speed issue, I fitted an inverter and positioned it to the rear of the machine out of harm's way - so I thought.

All was well and the machine became a pleasure to use, until one day an explosion accompanied by the sound of a 12 bore shotgun preceded all the power going off. As the VMC and lights were the only items being used, I isolated the VMC and reset the power supply RCD and further checking confirmed that the inverter no longer functioned.

As it was still in warranty, I sent it back but quickly was informed that the fault was caused by a fragment of brass swarf shorting across tracks on an internal PCB and so the problem was not a warranty issue as it had been caused by the installation/me.

Given that I'd been fly cutting some brass at the time I had to accept that the location I'd chosen (high up to the right of the motor) was in fact not sufficiently out of harm's way and I suppose that the inverter's cooling fan had assisted a chip, that perhaps had glanced off the side of the column, to enter through the

vent slots and on to destroy the electronics.

I would therefore recommend that as a minimum Peter (or anyone) installs the inverter on the back of the cast base column and fits a remote control. However, that still might allow chips to ricochet off the wall, to be drawn into the vent resulting in an expensive heart stopping 'Poof/Bang'.

My solution was to fit the inverter inside an enclosure with suitable regard to protected vents and make a remote so that all the functions are easily accessible at the front of the machine. This solution has so far been able to endure all that has been 'thrown' at it.

Regards, Martin Gearing
(Southampton)

Steam Turbines

Dear Martin,

I have been following Mike Tilby's very learned articles on steam turbines with interest, and I am pleased to see his current comparison with gas turbines. Could I however, correct some of the data, and add some more detail?

Mike refers to the Wren 50 turboprop engine - it is in fact the Wren MW54 engine, the number referring to the diameter of the gas generator turbine disc in mm, and the letters referring to Mike Murphy and John Wright, the designers. The engine best idles at 40,000rpm and is rated to 160,000rpm at full power. The power turbine is rated to 45,000rpm and, in the turboprop version, drives a gearbox with a reduction of 5.6:1, to rotate a 22 inch diameter propeller at 8,000rpm (photo 1).



Wren MW54 turbo-prop engine.

I understand the combustion chamber is rated at 18kW, with a mechanical equivalent of roughly 25BHP. Of this, approximately 18BHP is delivered to the compressor wheel, and the rest is available to do work, hence 7BHP. The flow rate at full speed is given as 200 litres per second, which is a mass flow of around 240g/sec.

The Wren MW54 was not a great success, mainly because it turned out to be too big for most model aircraft applications and it was followed by the more successful MW44. Many of these shaft power turbines are used in model helicopters, with appropriate gearbox design configuration.

Wren turbines is in permanent liquidation, although Wren products are still fully supported by Turbine Solutions Ltd. The loss of Wren is a tragedy. The directors were brilliant successors to the British team, led by the late Jerry Jackman, who first flew a micro-turbine in March of 1983. The market for small turbines is now dominated by foreign companies, notably Jet-Cat in Germany and AMT in The Netherlands. Various turboshaft configurations are available, but be warned, they are expensive!

Incidentally, the hoverboard on which the very talented French gentleman recently flew the channel used six of the largest microturbines, each delivering about 50lb of thrust. How he controlled the board is, apparently, a French military secret!

Readers of ME are probably well aware that my working model of the gas turbine mechanical locomotive GT3

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is powered by a Wren MW54 engine. The drive train drops the power turbine speed by 100:1 and this seems to work out well. The available shaft power is far more than is needed for a 5 inch gauge locomotive and so I limit the gas generator to 120,000rpm. When hauling two or three adults, the gas generator goes up to about 100,000rpm and the inter-turbine temperature is a comfortably cool 450°C. The model has been demonstrated on a rolling road at many exhibitions and on the track at a number of clubs. It has featured on the cover of *Model Engineer* no fewer than three times! Readers may be interested to know that your editor had a hand in building this model, deftly making a neat job of my rats-nest wiring!

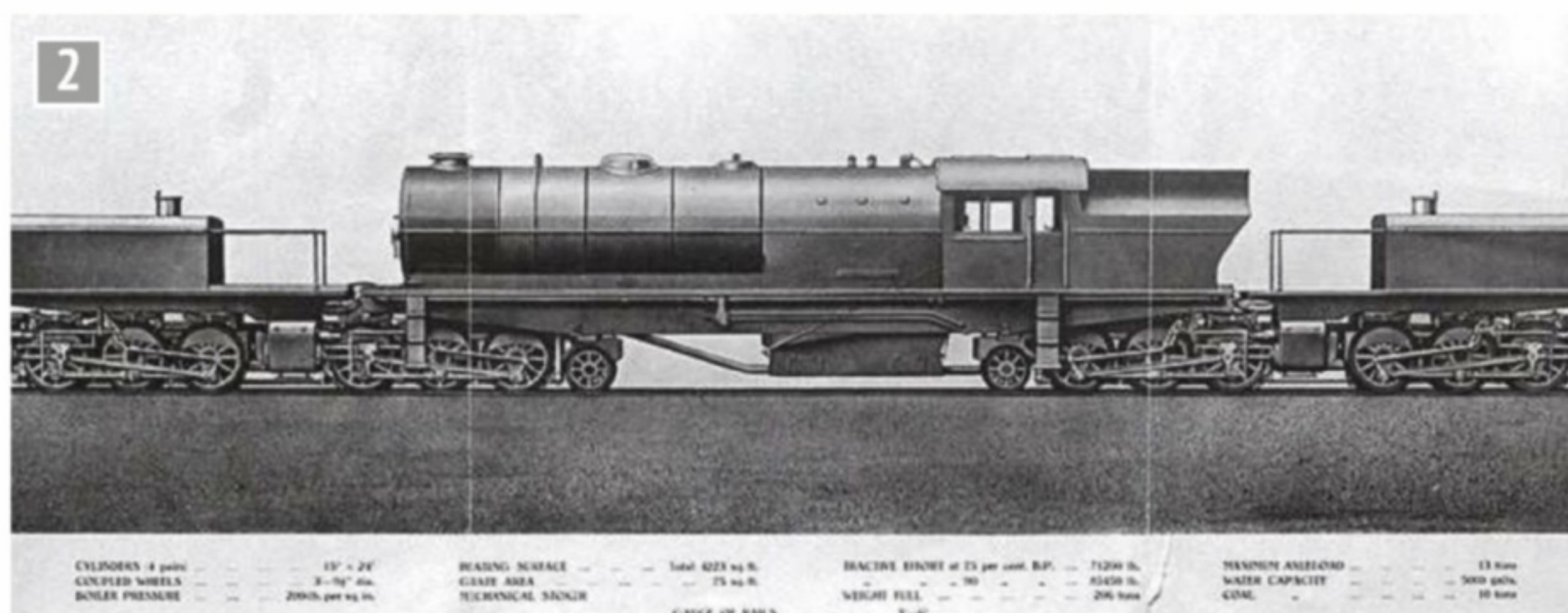
Anyone keen to know more about microturbines and perhaps considering building one should refer to the website of the Gas Turbine Builders Association. The chairman of the GTBA, James Hill, is currently completing a set of four gas turbines of various sizes. These have been designed specifically for the home builder, with the critical compressor and turbine wheels available commercially. Turboshaft versions may follow in due course.

Best wishes, Tim Coles
(Secretary to the Gas Turbine Builders Association)

Huge Boy

Dear Martin,
I would like to make a few points concerning your editorial piece 'How Big?' (M.E. 4620) and the article 'The Henry Ford Museum of American Innovation' (M.E. 4614).

The locomotive pictured in photographs 7 and 8 in the latter article is indeed an Allegheny 2-6-6-6, C&O Class H8. These were Mallet-type locomotives with a hinged front engine unit and a six-wheel trailing bogie under the firebox which allowed them a more efficient combustion chamber than the *Big Boy*.



Beyer Peacock 'Super-Garratt'.

Duplexes were manufactured with a number of different wheel arrangements, all with rigid frames and having 4 cylinders. Variations of wheel arrangement were:

4-4-4-4
6-4-4-6
4-6-4-4
4-4-6-4

The last three wheel arrangements had the second set of cylinders mounted underneath the cab by the firebox. Of note were the Q2 Class 4-4-6-4 goods locomotives, one example producing 8000HP at 57mph on the Altoona dynamometer.

The T1 Class 4-4-4-4 of 1946 were very successful for passenger work pulling eleven 80 ton cars at 100mph. Number 6110 of this class was tested in Altoona and produced 6100HP at 15% cutoff. The B&Os 4-4-4-4 duplex of 1937 had a water tube firebox, the rear cylinders were at the back and had clean British styling. It was a very attractive locomotive in my opinion. (Can somebody please build one in 7½ inch gauge!)

There were four so-called triplex locomotives manufactured around 1914 to 1916; all were Mallet-type with the extra engine unit stuck underneath the tender. All suffered from lack of steam and were scrapped relatively quickly.

Returning to your Smoke Rings article asking how big can a locomotive be - there are numerous ways of defining this. The *Big Boy* produced

135,000lb of tractive effort but the N&W Class Y-6b produced 166,000lb of tractive effort working simple and 132,000lb working compound.

As has been mentioned, the Q2 produced 8000HP, the T1s 6100HP and the *Big Boy* 6300HP with C&O H8 Class weighing in at 7498HP. It could be argued that the H8 Class was heavier and produced more HP and was physically larger than the *Big Boy*, but the *Big Boy* wins on the size of the boiler and the tractive effort. I don't think there is a simple answer to the question raised. It all depends on what you define as 'big'. For instance, the question of the largest diameter cylinders ever used can be definitively answered. The Virginian Railroads 2-10-10-2 of 1918 had low-pressure cylinders 48 inches in diameter.

I hope these points are of interest to you.

Regards, Chris Baker

Dear Martin,
I refer to your remarks in Smoke Rings (M.E. 4620 30th August).

In 1925 Beyer-Peacock patented a hybrid Mallet-Garratt which they named 'Super-Garratt' (patent No. 230,888). One of the proposed designs was possibly in collaboration with ALCO (American Locomotive Co.). It would have been a 2-6-6-2 + 2-6-6-2, with an estimated weight of 460 tons. It carried 13,300 gallons of water and 16 tons of coal (photo 2). The boiler was 10ft diameter and the overall length 142ft. It's

on pages 182 and 183 of 'Beyer Peacock, Locomotive builders to the world' by R. L. Hills and D. Patrick (ISBN 0903839 41-5). It was intended for South Africa on the 3 foot 6 inch gauge according to Donald Binns, 'Articulated Locomotives of the World' (Bradford Barton ISBN 085153 201 2).

Dr Hills was a curator of the North Western Museum of Science and Industry, now the Science and Industry Museum, Manchester. The museum obtained all the negatives and records when Beyer Peacock stopped building locomotives. When the museum was still on Grosvenor St., I used to pass it on my way home from school and would sometimes stop and go round. On one such visit, I was doing research for a school paper when I got into conversation with Dr. Hills who showed me the collection, which was still being catalogued. The basement storage rooms were a veritable Aladdin's cave of treasures, with several model locomotives and boxes of glass slide negatives of locomotives going right back to the start of Beyer Peacock.

Anatole Mallet (pronounced 'Mall-ay') (1837-1919) was a Swiss engineer, whose original design envisaged a compound locomotive with the rear cylinders getting HP steam and the front cylinders the LP steam. In the USA Mallets are not usually compounds and his name is usually pronounced 'Mall-et'.

Victor Croasdale
(Spring Valley, Illinois)

Beam Compass

PART 2

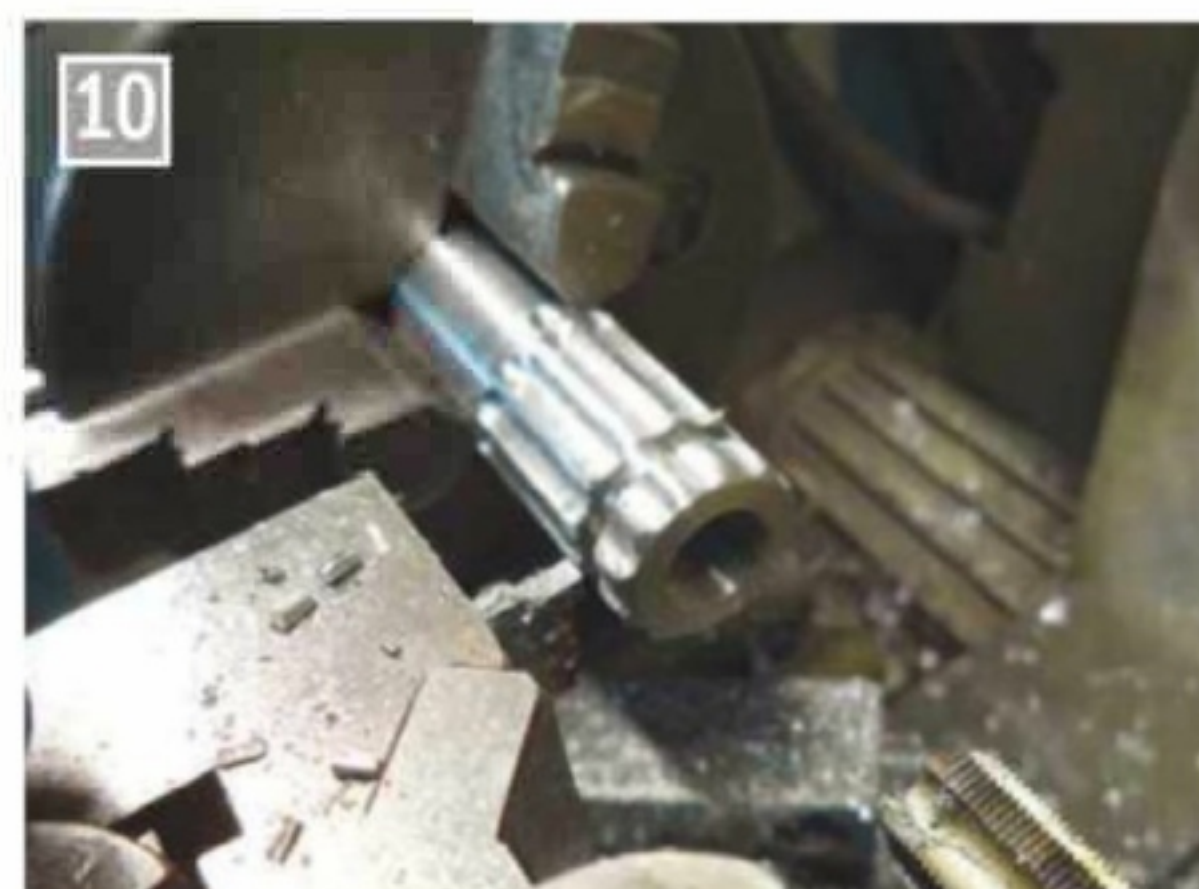
Stewart Hart describes a useful but simply made marking out tool.



Continued from p.503
M.E. 4622, 27 September 2019



Cutting the finger grips.



Tap and part off.

I made the locking rings (part 3) and the adjusting ring (part 8) from 1 inch diameter aluminium turned down to 22mm diameter for a length of at least 40mm to make all four rings. These rings would normally be

knurled but instead of knurling I decided to mill 12 finger grips along the length of the bar with a ¼ inch bull nosed slot drill using the spin indexer. The bar was then loaded back into the lathe, the smaller M3 hole for the adjusting

ring drilled and tapped first, some neat chamfers added and then parted off to length. Then I drilled and tapped the locking rings ½ inch x 32ME, chamfered them and parted them off to length (**photos 9 and 10**).

Here's another little trick for putting the chamfers on the rings. Make yourself a form tool, use it to chamfer the front then, before you part off, chamfer the back. At the same time, you will be chamfering the front of the next ring - this way you won't have the problem of trying to chuck the thin part for chamfering the back (**photo 11**).

You can make the beams (part 5) any length. I made mine 300mm and, when they



Chamfering tool.



Thread the beam M5.

are screwed together, I can draw 1m diameter circles, although I doubt very much I'll ever need to draw a circle that size. All you have to do is turn and thread one end M5 and drill and tap the other M5. The second beam only needs the male thread (**photo 12**).

The centre pointer (part 9) is made from 3mm silver steel, hardened and tempered. Grind the points by spinning in the lathe and using a hand held 'Dremel' (**photo 13**). I've drawn two different types of points - the tapered point is for use on metal parts and the small stepped point is for use on paper.

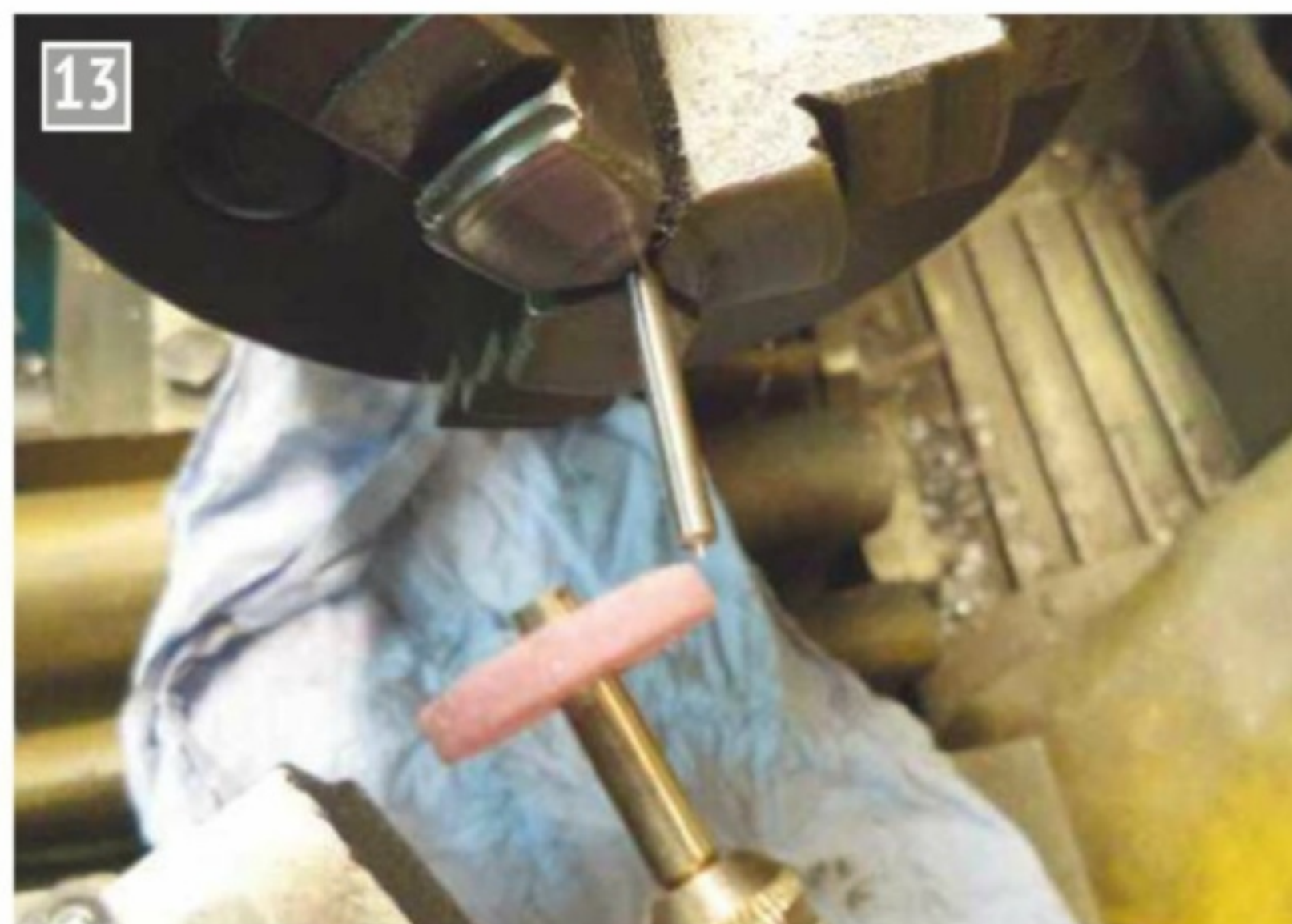
An ordinary pencil can be used on paper but for metal you'll need a scribe (part 1). I made mine from a short length of 9mm diameter brass. It's very simple - drill down the centre 3mm and fix the

hardened and tempered silver steel point with high strength Loctite. Again, sharpen the point with a 'Dremel' (**photo 14**).

The trammel can also be used for cutting out circular gaskets by replacing the scribe with a scalpel (**photo 15**).

The adjusting screw (part 7) is just a length of mild steel M3 studding held in place with thread lock and the centre pointer is held in place with an M3 grub screw. You may have to ease the slot out a bit to enable the adjusting ring to turn smoothly and that's more or less it - job done. Only one thing is missing; a nice little instrument like this deserves a box - nothing too complicated, just glue and screwed (**photo 16**).

When you're working on a long term project like a locomotive, you do get fed up working on the same thing,



Grinding the points with a Dremel.



Scribe.

with the end a long way away so it's nice to get distracted from time to time with a little project like this, with the excuse that it is contributing to the long term objective. I've certainly enjoyed designing and making this trammel and

I'm hoping that I will find it of use. It's a project I would definitely recommend for a beginner to gain experience as it's got lots of basic turning, threading, drilling and hand work.

ME



Trammel with scalpel for cutting out gaskets.



Box.

The Elusive Wimshurst Machine

Alan Pickering

recalls what sparked his interest in electrostatic machinery and influenced him to charge out and get one of his own.



It eluded me for 80+ years and not many interesting things do - everybody should have at least one. They are a wonderful talking point in the lounge, attracting lots of stupid questions like 'is it a rotary ironer'? Well, it's rotary and will certainly iron out wrinkles in a flash given the chance - it can even seek you out to do so. My initial interest goes back a lightyear to school days, around about the age of the wheel.

I unexpectedly passed the 11+ exam to qualify for a technical college engineering course - my passion! Great, but it was what all the other entrants with higher pass marks also wanted. A case of Hobson's choice - a bricklayer or out! I was not consulted, just enrolled, the theory being that the lack of education was the same for every trade, just the practical changed. How true.

The weekly highlight was the woodworking shop or the annual visit to the science lab. and it was here that I first spotted the Wimshurst machine, safely locked behind glass doors. I was told that it was never let out, presumably just in case somebody actually learnt something (learning was

against school policy) never even dreaming that 68 years later I would actually make one.

Anyway, at the tender age of 15 I escaped to begin my self-education. The trowel was useful for planting snowdrops. I never even learnt how a knife and fork worked but was a world expert at cleaning off used bricks. I was blessed with an enquiring mind and a love of the new-fangled electricity and soon started building crystal sets, one valve radios eventually leading to the five valve superheterodyne.

Who could imagine that adding a second additional cat's whisker to the germanium crystal would change the world for ever, ending the domain of the valve (my world) and eventually sending us to the moon. In those days the mere thought of today's technology would have had you certified and the key thrown away. This missed development set science back 20 years.

Many years later model engineering was discovered and life was never the same again (search my history page on Google). Recently I built three large scale Stirling show engines (all of which have graced these hallowed pages)

and was looking for something spectacular for them to drive that didn't require much torque. Dynamos and water pumps have all been done but - wow - not a Wimshurst machine. This ticked all the boxes and must be researched.

I read the 1908 book by R. Marshall and all the excellent explanations/animations on YouTube. I found that each contradicted the other, leaving my brain cell desperate for company. There are pages of higher maths to prove it so somebody knows but can't simply explain at my level of understanding without waffling over the difficult bits, like neutralising rods are supposed to be +ve at one end and -ve at the other - they are simply copper rods, for heaven's sake!

It smacks of Schrodinger's cat, quantum entanglement, the double slit experiment, the pyramids - they are there to be counted yet nobody can. Nobody understands anything if he can't explain it to an ice-cream salesman, he only thinks he knows.

As an ex-electronics classroom teacher in the RAF I can vouch for this truism. These machines are magical, the book on the subject concludes, and I quote: 'The action of these machines is not entirely understood'. I rest my case. Here lies a new can of worm-holes, it scares me, keep away.

The decision is made, I have to have one. As always, my famous junk boxes were consulted (the ones that never let me down) but they failed to produce a washer. Then the penny dropped. These machines are not model



A box'o'bits.



Some bits were in bits.

engineering fodder, but more suitable for the ship or aero modeller. They are all made of plastic-glue-tinfoil-glass-wood-cardboard etc. - in fact anything that can't be either welded or silver-soldered.

There has to be a simpler way. eBay was consulted but only produced expensive antiques and a few Indian or Chinese examples. I stumbled across one from China which seemed to be the best; it looked well made, it had the metal sectors somehow etched into the Plexiglas discs, as opposed to sticky tinfoil, which comes off, and it was the cheapest, with free p/p, from China, around £30-ish, 100% +ve feedback. I was well prepared to risk this loss. Hobson's choice.

I bit on a piece of leather and pressed the 'buy now' button. To my utter amazement it eventually turned up three weeks earlier than expected. However my smile soon disappeared. The over big cardboard box was wet and well damaged but worst of all there was absolutely no packing whatever, all the screws & bits were loose, undone and rattled around like a rattle snake, the base was broken in two places - it was simply a box of bits with a wet Chinese instruction book. Had it been in UK, no way. I tipped all the bits out onto the bench (**photo 1**) and they were all there! After I came down off the ceiling and examined them they were just what I wanted. The broken base was plastic crap (**photo 2**) but as the intention was to rebuild it my way - no problem - all the parts were there. I was very happy especially when I was given an £8 refund with a plea not to leave negative feedback - he said his job was at risk so I happily gave super feedback.

I built it up on an alloy base plate which electrically connects the two Leyden jarouters together, making for a neater job, then screwed it to a mahogany base (**photo 3**). I replaced the two car fan belts that came with it with 3mm round leather thonging, spliced



Front view of the machine.



Rear view of the machine, showing the crossed belt, spark gap and Leyden jars.

and Superglued. As the rear disc rotates anticlockwise its belt has to be given a twist - this causes it to rub against itself causing most of the total machine friction. This was sorted out with two flanged ball races pushing the belts apart (**photo 4**). The two neutralizing bars work most efficiently set at 60 degrees to the horizontal - experiment proved this to be better than the usual 90 degrees. As these machines have a reputation of being touchy I was very careful to get things right and to my amazement it worked first time - five turns produced a 50mm strong blue spark with a loud crack - very, very impressive. With the Leyden jars disconnected many weak multiple sparks were produced - not nearly so impressive.

The next step was to drive it from the big Stirling engine. This proved difficult but it soon resolved itself. You simply accept the many shocks you get as par for the course - most are nothing. The formula (in kilovolts) for the voltage to jump a 50mm gap is given by $kV = 3 \times \text{gap length (in mm)}$ approximately, i.e. 150,000 volts. Okay, this is only micro amps for micro seconds, a bit like an electric fence - one killed my lovely border collie when its wet nose touched a newly installed fence in the field at the bottom of our garden. It's an instant discharge of a high voltage capacitor after all - catch it right and you will spill the coffee. At a show this is an instant attraction, a solicitor's dream come true, 150,000 volts, nosey children, no warnings, no

fence, no first aid, no insurance, safety at work, etc. ... I Googled it to find out that they are banned in schools.

Coincidentally the above formula is used by solicitors to calculate their claims for compensation (in £ sterling) - a similar figure.

It's a bit like a boiler - it stores energy over time then lets it out all at once, like discharging a capacitor. It's good practice to short out the spark gap after use as the jars tend to recover and will surprise you next day. As with all electric shocks it's when they get in the blood stream and cross the heart it's 'bye bye' - especially 240V, it just never knows when enough is enough. I started thinking - these machines are not built for continuous running as they will simply wear out, problem solved. Best locked away like the one at my old school.

In 1907, 7th March, pages 232-235, *Model Engineer* first published an article on the Wimshurst machine. It was invented by James Wimshurst many years earlier, I repeat invented, not developed from something else, so he clearly knew how it worked. He must have been in the same league as Tesla, Faraday, Maxwell etc., all in the days of gas lighting.

The speed of rotation only governs the number of sparks, not the voltage, which is proportional to the space between the sectors; the fewer of them the greater the charge so a larger disc also has the same effect. This proves that the charge lives in the dielectric; if the sectors could

be removed they would have zero charge, only returning to normal when replaced. My machine has a total of 48 sectors. The more segments the easier it excites but the less the charge. I think of it as 48 Schrödinger cats in a row, 24 facing forwards and 24 facing backwards, all being stroked individually, then the charge transferred to its own Leyden jar and being allowed to build up. That's where the neutralising rods come into their own, as they ensure that only like charges fill their own jars. As one disc is a mirror image of the other the rods are able to sort it.

When it's broken down into electron movement I find it too much for my brain cell to cope. I recommend studying Google animations and if you cannot explain it simply, then you don't know. As an ex RAF electronics classroom teacher, I assure you that this is true. They are correctly called influence machines as each sector influences its opposite sector, forcing it to be attracted to it - in fact the discs wobble because of this force.

There are lots of well documented experiments on YouTube to be fascinated by. They are cheap to make and lots of fun. Just in case you understand it, here's a snippet that says you don't - if a plain glass disc is installed between the two discs then it turns it from a DC machine to an AC one.

As an influence machine it's influenced me for many hours - now after all this do you really want one?

Making and Using Wax Chucks

PART 2

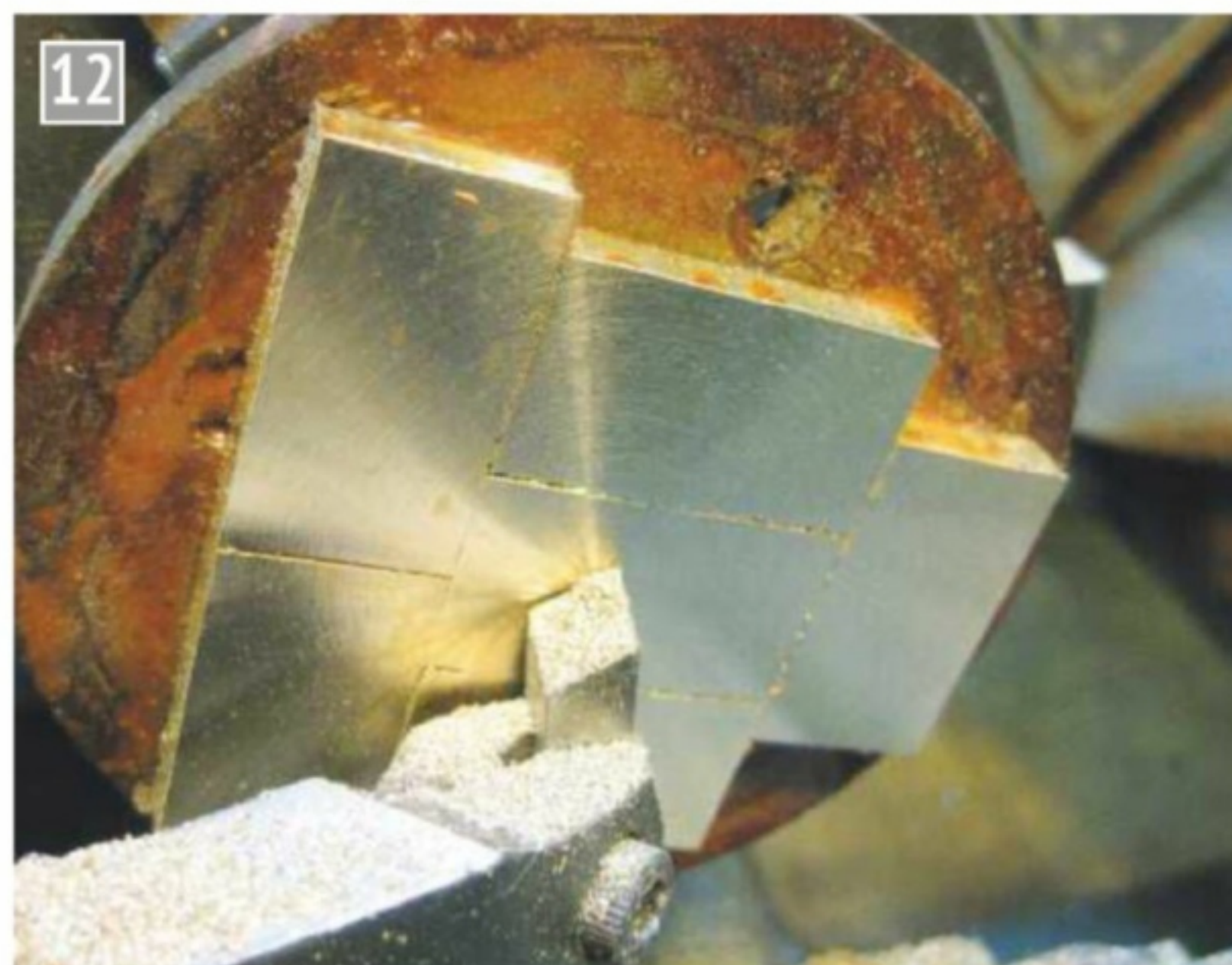
Tony Bird demonstrates an unusual but effective method for work holding.



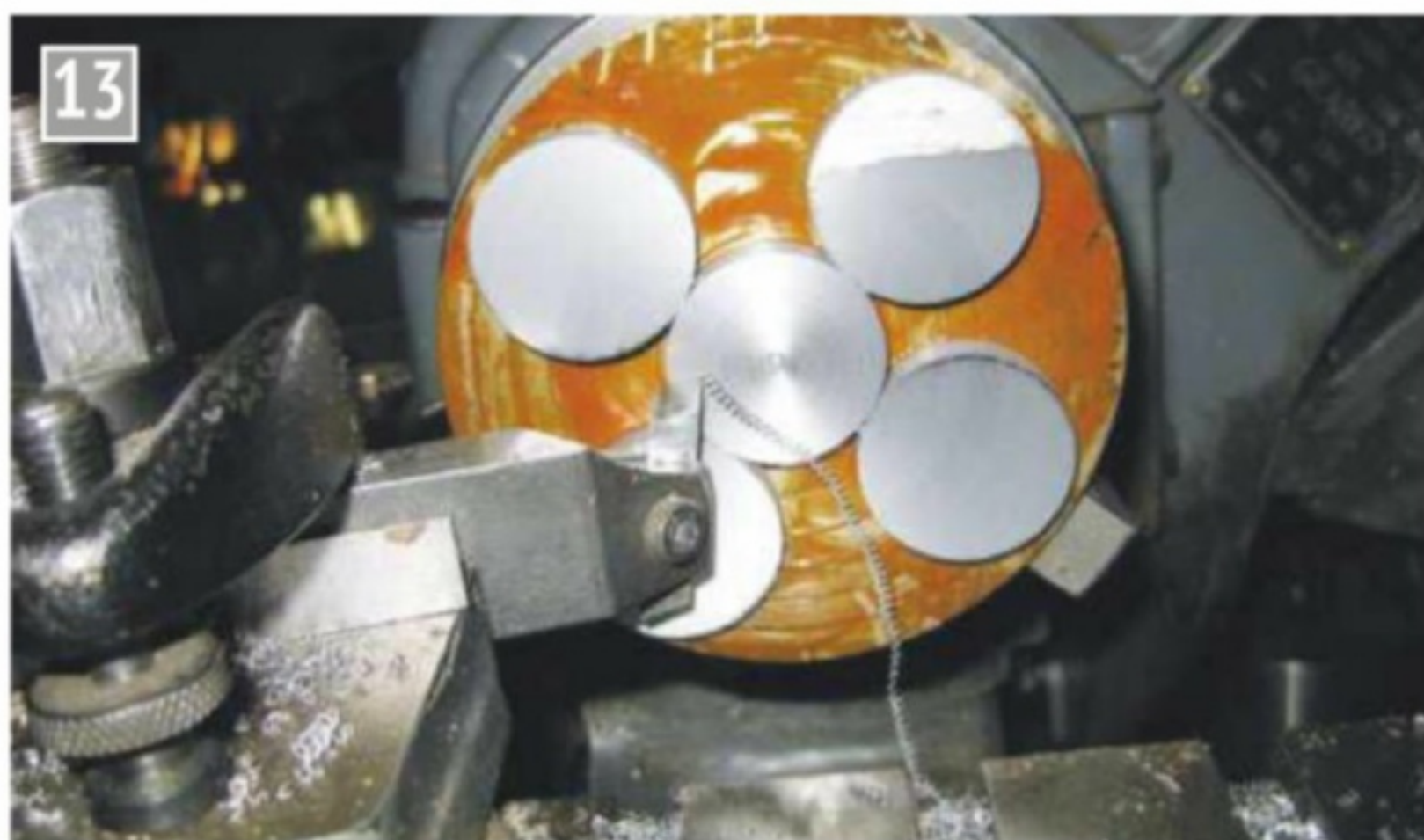
The following photographs show some of the different wax chucks made and some of the jobs they were used for. **Photographs 12 to 15** demonstrate the wax chuck's capacity for multiple machining.

There are many machining jobs that wax chucks can do well but many that it cannot do as well as conventional chucks and of course some that it cannot do at all. There are also various glues that the author has heard of that will do similar jobs maybe as well and possibly better. The author has never tried them as he is used

Continued from p.569
M.E. 4623, 11 October 2019



Thinning 6 brass port blocks.



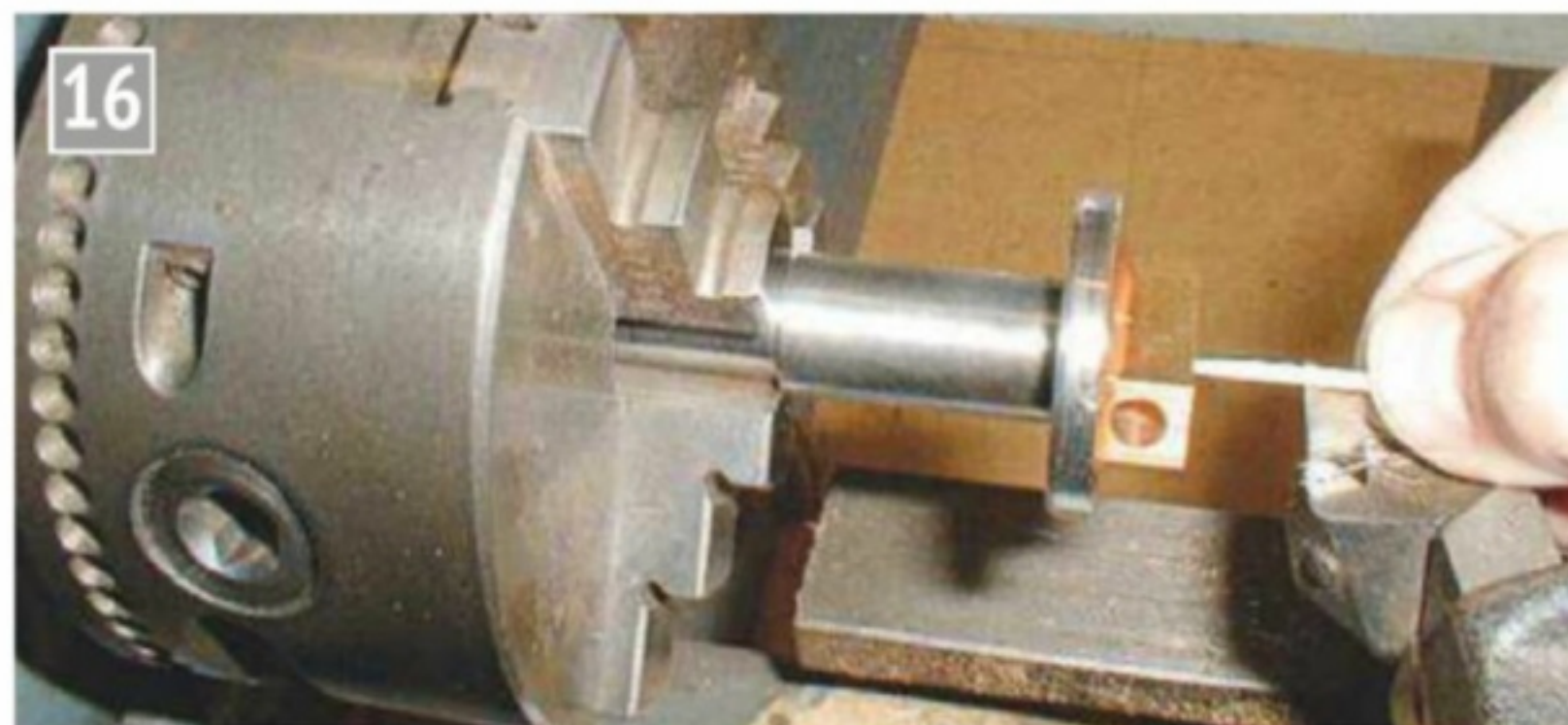
Machining 5 steel flywheel blanks.



Making 4 brass square section rods.



Machining 16 small brass rectangular oscillating cylinder blanks.



Centring one of the cylinder blanks using a wax chuck that can be heated on its back. The centring is being done while the chuck is rotating using a cocktail stick while the shellac is still mastic.

to using shellac, which has the advantage that work can easily be moved while on the chuck and if the work is removed it doesn't have to be cleaned to be put back on again. As long as the work is turned cool with a sharp tool it rarely if ever comes off the chuck and, if it does, it mostly isn't damaged. It is important that the correct shellac is used.

●To be continued.



Turning a relief on the centred oscillating cylinder.



A fly crank mounted on an off-set pin on a wax chuck to drill its crank pin hole.



20

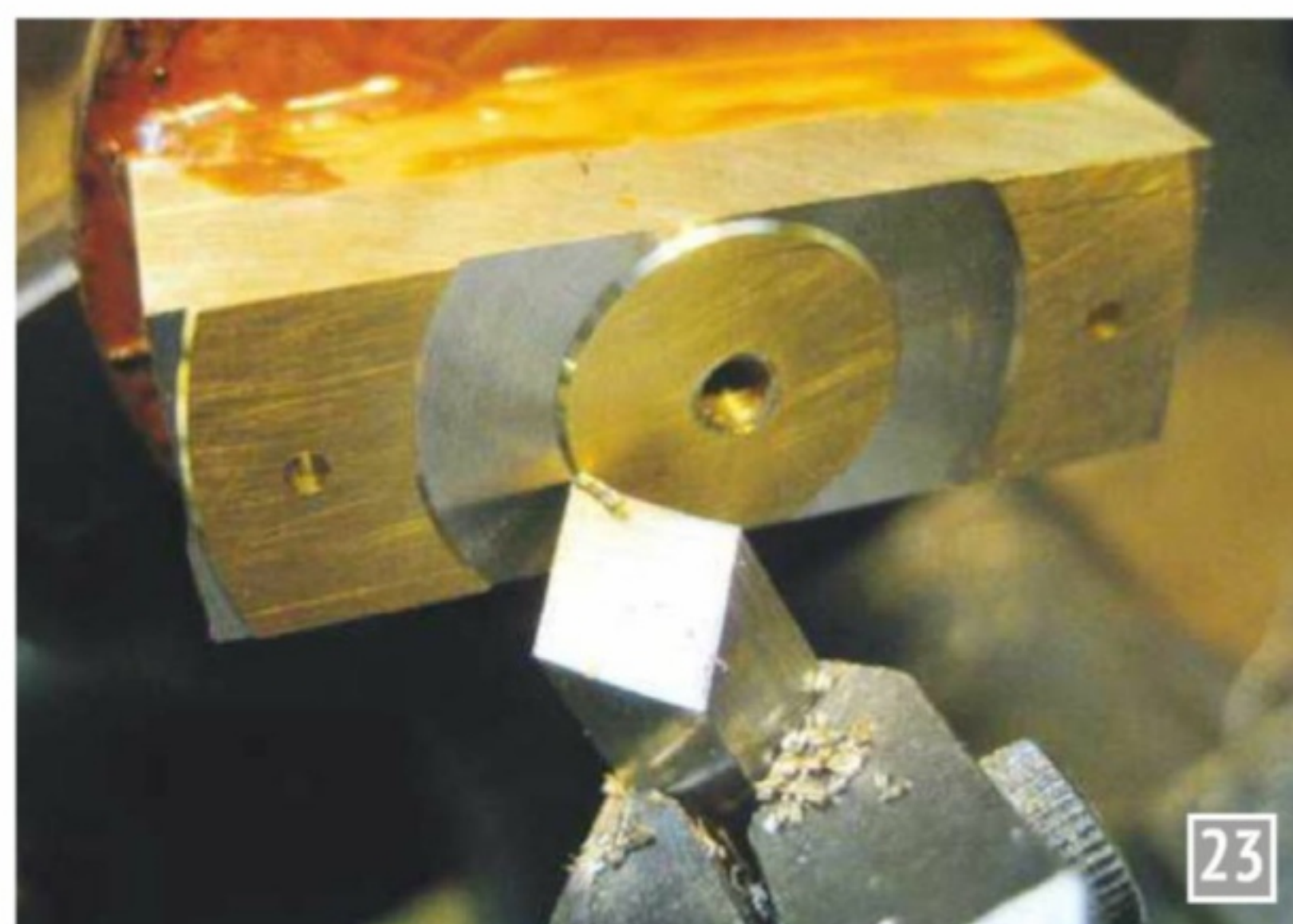


Sequences of making a small crank pin.



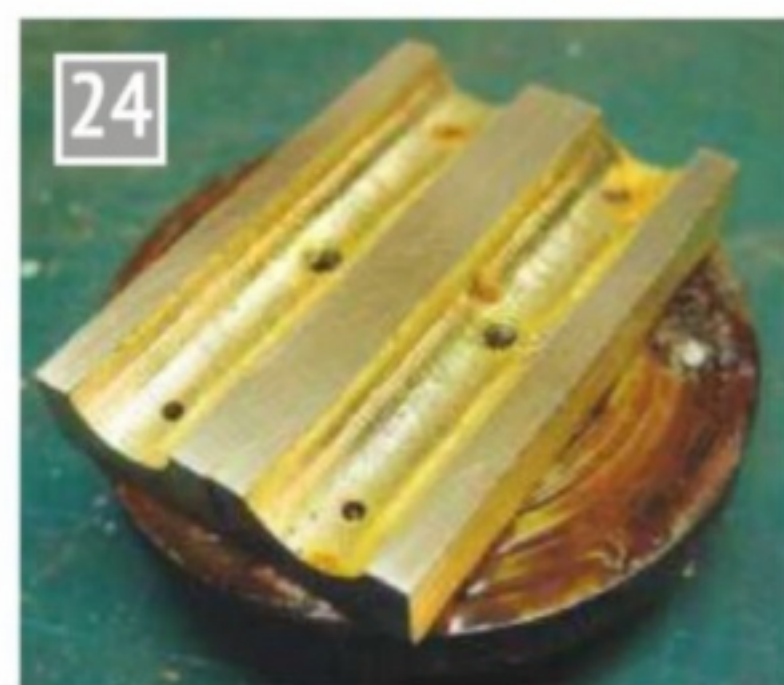
21

Correcting badly machined commercially made Mamod type port blocks.



23

Making a port block for an oscillating engine. A piece of brass square section rod has been drilled through to the diameter of the cylinder, which will be soldered to it. Its fulcrum point has been drilled and used as a centre for mounting on a wax chuck. The ports have also been drilled and the relief is being turned on its port face. This done, the rod will be turned over and similar machining will be done on its opposite side.



The above port block has been sawn down its centre and both parts mounted on a wax chuck to be machined to the same size.



Using a centrally mounted pin; a crank being machined.



26

Five Inch Gauge Garden Railway Design and Construction PART 4

Stephen Wessel considers the best way to achieve a stable and durable track bed for his garden railway.



Continued from p.597
M.E. 4623, 11 October 2019

Strength requirements

It is very difficult to state with certainty what loads might be expected of a miniature railway sleeper. In normal use the weight of a passing train is spread over many of them and acts vertically downwards to be resisted by the underlying ballast. Providing each sleeper is uniformly supported there should be practically no flexural or bending moment involved. However, if a sleeper becomes partly unsupported, perhaps due to washout or burrowing animals, it might have to behave as a beam in which case its flexural strength becomes important (see fig 4 in part 3).

On curves a train exerts a lateral force on the outer rail tending to tip it; this induces a bending moment on each sleeper. These forces are resisted by the fixing screws which, in softwood or plastic will, over time, work loose.

Probably the biggest load a sleeper might have to resist would be impact due to a derailed vehicle. Again, there is much uncertainty about the loading vector. If such events are as rare as they should be on a well maintained railway a few broken sleepers might be easily tolerated. I can say with the benefit of experience

that if the half-rotten softwood objects supporting much of my own rail can resist these loads (and we have narrow gauge type engines of great weight carrying heavy passenger trains) then GFRC would do a much better job all round.

In the full size world vibration of rail and sleeper caused by frequent passing trains is the main issue. It can, if not properly allowed for in design, cause both steel and concrete to crack and limits the life of both. My hunch is that because our tracks do not get such intensive use, vibration is of little importance. This might be another way of saying I have little clue as to how to deal with it in design! In practice the loads on any reasonably well supported sleeper will be very slight in normal use. Trying to calculate them from a mass of very uncertain data would, I feel, lead nowhere. Much better put some to use and see what happens.

Recipes and ingredients

Now please put aside the whole notion of general construction concrete. GFRC is a different material. The most important factor in obtaining high strength is the water/cement ratio. This

should be kept between 0.3 and 0.35. If you try to make ordinary concrete with so little water you would not be able to mould it without hydraulic assistance. (This is how concrete blocks are made.) Two major alterations are required to allow proper mixing and easy placement, namely a much higher proportion of cement to aggregate such as 1: 1.3 and the use of a superplasticiser. There are various other additives that can be used as well. At the end of this series I will detail all these ingredients with a list of suppliers.

The aggregate normally used for this type of concrete is well-graded silica sand. I do use this but have also been getting good results with a local 'all in' carboniferous limestone graded from 3mm to dust (**photo 16**). The local quarry has a pile of it about the size of Mount Everest and you can fill up your trailer for a few quid. Whatever aggregate is chosen should, I believe, be of this sort of size, the usual 10 or 20mm types being quite unsuitable. If it is damp an accurate estimation of water content should be made and allowed for to maintain the correct w/c ratio.

To get GFRC to flow easily into the moulds and compact properly it has to be sufficiently fluid. We are up against a natural scaling problem here: a larger mould could be filled with a stiffer mix, probably forced in under hydraulic rams. The way to increase fluidity however is NOT just to add more water but to add it *with more cement*, so maintaining the correct w/c ratio (**photo 17**). This has the effect of increasing the cement/aggregate ratio. Strength will therefore be maintained or increased while



Washed sharp sand. The larger particles are about 3 - 4mm.



Filling is complete. Note very little bleed water at surface. This shows the water/cement ratio to be about right.

both mixability and fluidity are improved. Adding more superplasticiser also helps. The type of aggregate also influences the fluidity – too much dust means a stiffer mix. Remember that aggregate of any type is always damp or actually wet; it can contain a lot of water which must be measured and subtracted from the theoretical amount required by the cement in order to work out how much to add. I shall have more to say about aggregates later on.

Testing

The standard test for measuring deflection under load and flexural strength is a very simple set-up that can be done in the workshop without recourse to a local university lab. There is much published data on what to expect from various mixes. **Photographs 18 and 19** show my own rig. Downward force at the centre of the sleeper is applied by a nut, amplified by a 10:1 lever and measured with a spring balance. A DTI records the deflection. The sleeper is supported near its ends at a 9 inch spacing. A maximum deflection of 0.015 inch under 110kg was recorded just before failure.

One of my early smaller sleepers was tested after the standard curing period of 28 days. Note that the fibre content was *half* the recommended minimum of 3%.

Concrete is usually tested in compression as this is the type of load to which it is normally subjected. However, I have no worries on that front and see no reason for a specific test. At the time of writing I have singlehandedly made nearly 800 sleepers (of both patterns) and most of them have now experienced both frost and hot weather. Apart from trains, they have been subjected to considerable foot and wheelbarrow traffic. None have suffered in any way. Despite the absence of hold-down screws into the concrete base, the panels have remained quite stable and shown no sign of buckling in the heat. Those laid directly in ballast have a very solid feel, showing no tendency to move about.

●To be continued.

NEXT ISSUE

We'll look at the design of sleeper moulds.



Test rig for flexural strength. Load is applied by a screw attached to the top of the balance (out of shot). It is magnified x 10 by the steel bar. This sleeper broke at 110kg when supported by two rollers placed right at the ends, 9 inches apart.

No.287

MODEL ENGINEERS' WORKSHOP

November's issue, number 287, will have some more great builds:



Mike Cox makes a useful Ring Light.



John Hinckley makes a Travelling Steady.



Pete Barker explains the Myford Wide Guide conversion.

On Sale 1st November

The Barclay Well Tanks of the Great War PART 54

Terence Holland describes and constructs two appealing, century old locomotives.



Continued from p.494
M.E. 4622, 27 September 2019

This constructional series addresses Andrew Barclay 0-4-0 and 0-6-0 narrow gauge locomotives supplied for use in the First World War. Built without the use of castings, the 0-4-0 design is described as two versions; as-built for the British Admiralty in 1918 and as rebuilt and currently running on the Talylllyn Railway as their locomotive No.6, *Douglas*. The 0-6-0 engines described were built in 1917 and operated on 60 centimetre gauge track at the Western Front in France. These were small, spartan machines of which only 25 were supplied and none have survived into preservation.

Painting and lining

Here, the world is your oyster (whatever that means - but it isn't so often Shakespeare gets quoted in the *M.E.*!). As you will have gathered by now, my engine has reincarnated in several colours and the only thing that links them all together is that all the liveries



Douglas masquerades as Airservice Constructional Corps No. 1 (Talylllyn archive).

are black, but with coloured panels separated from the black background with yellow lining. Perhaps this is a bit of a simplistic view but if you look closely that's how it is. The basic Talylllyn livery uses yellow lining to create a coloured panel (primarily an olive green) with the black surround mentioned above.

According to researchers on the Talylllyn, the 0-4-0 engines were originally supplied lined out over Barclay standard green (photo 245) and even the edge of the rear slide bar support was lined. This this can be seen in the original black and white photograph of the engine

at Barclay's (photo 246). It's amazing the lengths to which these companies went, even though there was a war on.

There were some *Douglas* fans I knew on the T.R. who reckoned that the two engines at Fawley were painted in a blue/grey RAF livery with RAF roundels! As far as I know no early colour photographs exist, but black and white photos taken at Fawley (ref 5) show no sign of roundels. However, the recent RAF centenary in 2018 saw *Douglas* looking good for her (?) age, painted blue for the celebrations and complete with those elusive red, white and blue roundels (photo 247). Note, however, that the original engine would not have had Talylllyn twin buffers, heavy-duty motion work, running irons and an air pump.

I have to record here that *Douglas* ran for some time in the eighties or nineties, I can't remember which, with the (normally red) regulator handle painted blue. It was all a bit surreptitious and anonymous



Lining on the original engine. (Author's collection.)



Douglas dressed up for the RAF centenary. (Talylllyn archive.)

at the time, but members of the unofficial *Douglas* fan club were suspected of railway heresy!

Painting

Unfortunately, when it comes to painting brass items such as side tanks and cab work, paint and brass don't make good bedfellows. I've tried all sorts of ideas in the past – etching primer, epoxy primer etc. – but in the end the paint easily chips and occasionally peels off. All I do now is give each job a couple of coats of oil-based gloss paint, leave it at that, try not to do too much damage during operation and hope for the best – I don't even bother with undercoat. One technique I have not tried is to etch the brass using a hydrochloric acid/peroxide mix, as mentioned earlier in the series, when addressing the etching of nameplates. This, at least, should provide a textured surface, which is more likely to encourage a bond and retain the paint. For mild steel parts I don't think one can beat an epoxy primer – I noticed during the recent rebuild that epoxy painted surfaces on steel components were still tenaciously retained after decades of service. And, in fact, the primer was so well bonded that it did not respond well to removal using paint stripper.

One important point is that any surfaces to be painted should be grease-free and, therefore, cleaned before any paint is applied. I wash each item with hot washing up water, followed by a wipe over with acetone, or cellulose paint thinners.

Lining

Lining is a different issue, which requires a level of skill not difficult to acquire through practice. In the past I have always used a draughtsman's pen (the sort found in any old-fashioned set of drawing instruments) loaded with oil-based paint, which has been diluted slightly with turps (approximately 10%). Before starting on the job, it makes sense to practise by carrying out some trials on a test piece. Thin the paint until a good flow is obtained but ensuring it is not too thin so it does not run outside of the desired line. Getting it right will result in a line that is significantly raised above the base paint layer. Before starting the central panel should be painted with a couple of coats and allowed to dry.

The main technique to master is that of guiding the pen along an edge using the middle finger, whilst the forefinger and thumb are employed holding the pen. The two blades on the pen should be set by trial and error to 0.020 to 0.035 inch apart using a feeler gauge and this should produce a line about $\frac{1}{32}$ inch wide. Dip the pen in the thinned paint to a depth of about $\frac{1}{2}$ inch (too deep and the pen will 'blob' on the job), wipe the outside of the blades and start drawing the pen along the edge of the job at constant speed and without hesitation. This speed will need to be determined in practise, as it will depend on several factors, not least of which is the thickness of the

paint. At the start of drawing a line it is important to ensure that the pen is in good contact with the base paint so that the lining paint can flow properly. This may need the extreme tip of the pen to be dipped in paint before starting. Any slight imperfections can be touched in later. The semi-circles on each corner are drawn in by hand. Once the lining is in place and dry, the black surrounds can be painted.

Having always carried out lining using this technique, I thought it was about time I tried the proper method; that is, the use of coach lining brushes as used for lining motorcycle tanks etc. It proved very difficult to find lining brushes that were small enough but eventually I located some in the good old US of A. These were 'Drag'n Fly' by Ted Turner. The snag was that by the time they came the job was finished. The sizes ranged from 000 to 5 but only the smallest brush, 000, was suitable. I gave it a fair trial but gave up in the end and, in future, will stick to the draughtsman's pen – I could have saved myself a few bob there if I'd known. It's quite sad really because my great grandfather was a coachbuilder in South Molton, Devon and I bet he could have done it!

Garter crest

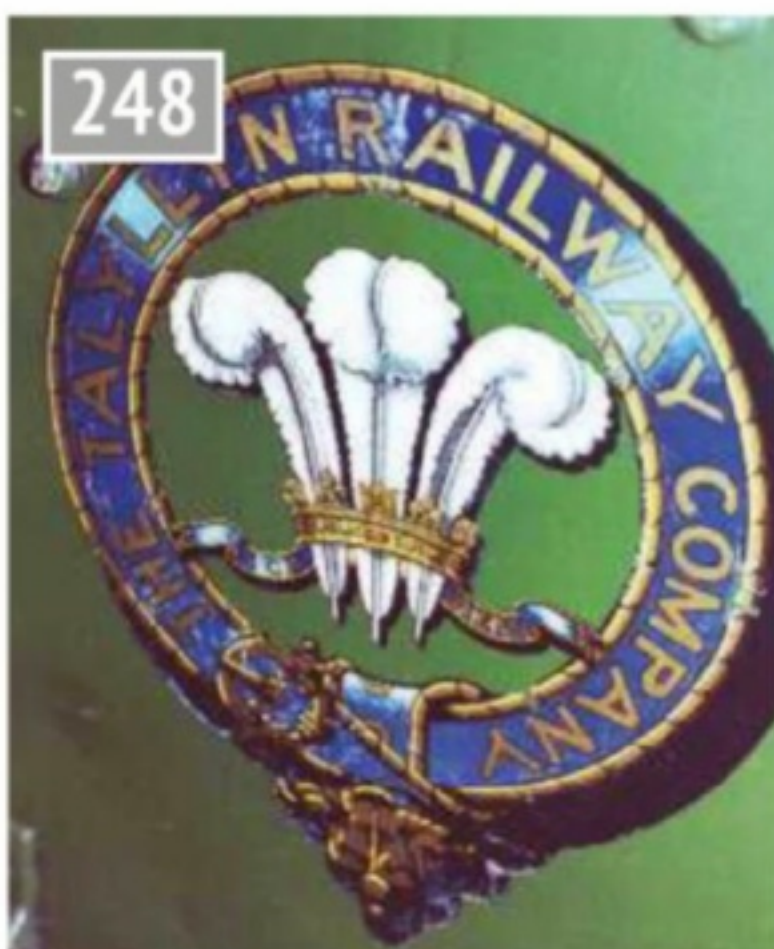
Now herein lies a tale, but don't panic because I don't propose to go into much detail! The use of garter crests on railway stock goes back to the beginnings of the railways in England, but the use of crests etc. has a much longer history.

The use of the coat of arms, or shield, evolved during medieval times, when heraldry became commonplace to identify warriors in battle. However, the subject is very complicated and need not concern us too much here.

Basically, the railway crest consists of a shield surrounded by a garter or belt. The garter was useful in that it provided somewhere to include the name of the railway. The shield often consisted of the personal arms of the company directors or funders but could also be related to the locality served.

The Talylllyn garter crest on locomotive No.6 is shown in **photo 248**. Note that this photo was taken at an oblique angle. The garter identifies The Talylllyn Railway Company, whilst the crest is the heraldic badge of the Prince of Wales, which consists of three white ostrich feathers emerging from a gold coronet. A ribbon below the coronet bears the motto, *Ich dien* – 'I serve'. The crest is often used to symbolise Wales, particularly in Welsh regiments of the British Army. The end result is a perfect logo for the railway, dare I say 'iconic', which can be applied to both locomotives and rolling stock.

Photographs 249 and 250 show the hand painting work in progress and the completed work respectively. In photo 249 the outer annulus has been laid out using a pair of compasses fitted with a draughtsman's pen, dipped in the required oil-based paint – note the small patch of brass showing at the centre where a small centre punch



The Talylllyn garter crest.



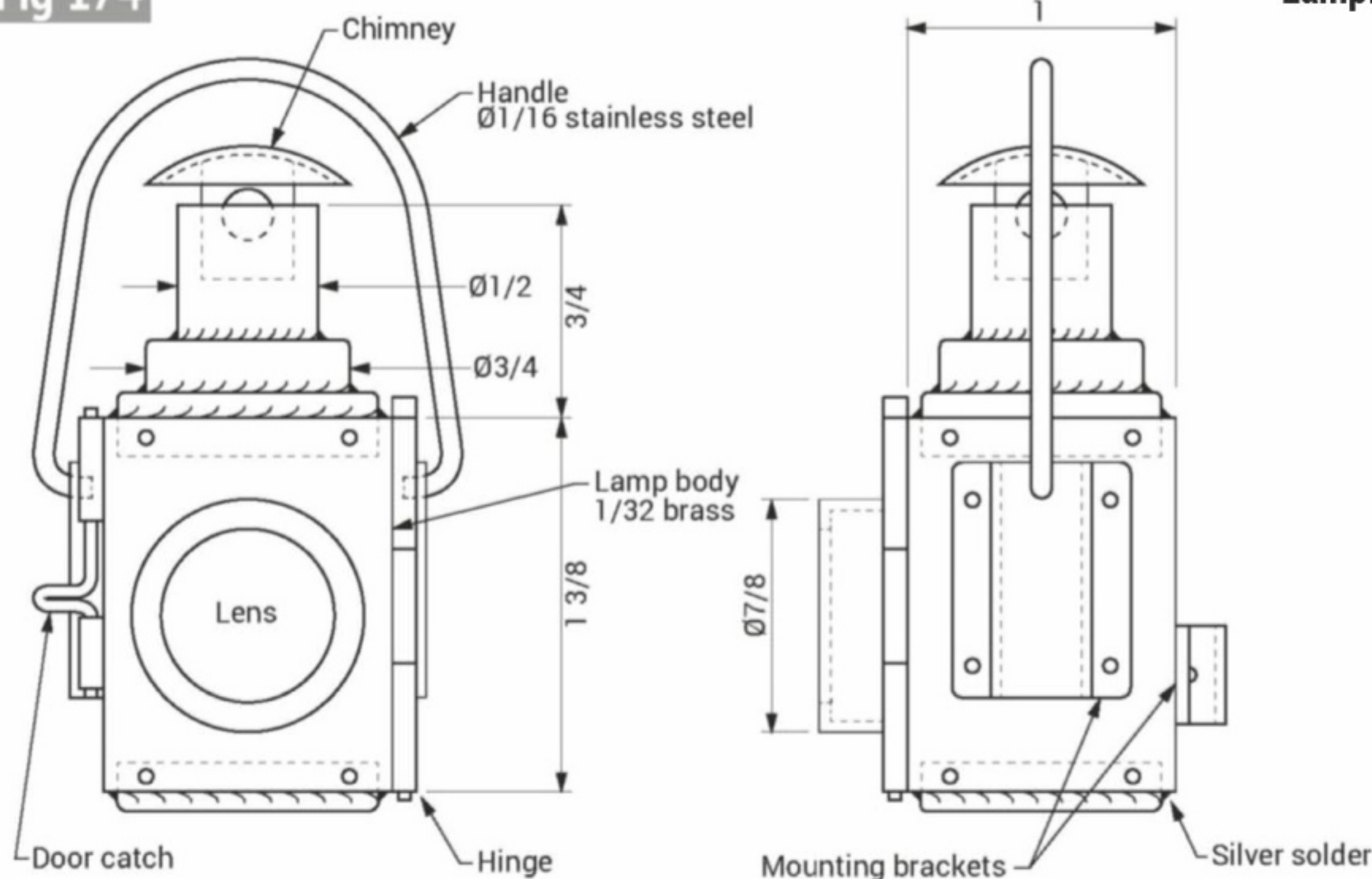
Starting to paint the Talylllyn garter crests.



A completed crest.

Fig 174

Lamp.



was used to provide a location for the compass point. Three concentric circles were then drawn, from the outside black, gold and again gold. The annulus between the gold lines is then filled in by hand with blue paint, using an artist's sable brush, size 0000. This provides a fairly accurate template on which to carry out the rest of the hand-brushed paintwork, working from photo 248.

Hand painting of the transfer in this fashion is in keeping with the principle of 'fabrication without castings'. Add to this making the injectors (ref 37) and the pressure gauge (refs 44 and 45) and just about everything on the locomotive is 'scratch built' in-house. So, when it all goes wrong there's no-one to blame - but also there's no part that can't be repaired or replaced!

Note that the full size T.R. transfers are slightly incorrect in that the bottom of the garter is not well defined. Mine are painted with the correct arrangement of the garter - showing the buckle and strap. This presents a dilemma for the purist; paint the 'correct' buckle detail or reproduce the T.R. transfer.

Front and rear lamps

First a *caveat*; the dimensions of these lamps were measured by me on the Tallylyn many years ago so they may not represent those that are currently in use. The scale lamps shown in photo 241 are made from 1/32 inch thick brass sheet, riveted together with 1/16 inch copper rivets (fig 174). Some silver soldering is required on the front door etc. to fit the hinges.

If a small lens is not available for the front window, a piece of 1/16 inch thick glass will suffice. Fix this in with a circle of spring wire, which is a tight fit inside the front extension against its small flange. The lamp is comprised of quite a few parts, fourteen in all: main body; base; top; door; hinge pin; closing pin; chimney; reflector; paraffin

container; wick holder; lens; handle/mounting brackets; rear mounting bracket and handle. I have not drawn these as individual components so fig 174 is a general arrangement with only a few dimensions. Those parts that are not dimensioned are not critical, but note that the brackets must fit on the mountings on the locomotive etc.

It's handy to have two of these lamps; a white one for the front of the locomotive and a red one to 'bring up the rear' - the red lamp is mounted on the back of the tender when running light engine or, with a train, on the back of the guard's van.

Surprisingly, these lamps do actually work. The tank, not shown on the drawing but made from a 3/8 inch slice

of 1 inch diameter copper tube, holds a teaspoon or so of paraffin and a wick can be made from a piece of soft string. But there is one big snag - after a couple of minutes the lamp gets so hot that its paint starts smoking. It's a good thing it's not an essential piece of kit or it would need water cooling! Consequently, unless you want to see one lit, there is no need to make the internals; the paraffin tank, the wick holder and the silvered reflector that sits behind it all.

The photo of the lamps (photo 251) also shows a few scale accessories that decorate the cab; the fireman's shovel, a brush and a couple of oil cans. There's just about room for them among the pipework. The shovel slots in for storage at the fireman's side, between the boiler's lagging and the coal bunker - just like it does on its big cousin! The dustpan brush may seem a bit incongruous, but it's an essential component of the fireman's 'working tools' and helps keep the footplate clear of coal dust.

That sums up the construction of *Douglas* but before addressing the relatively minor changes that need to be made to produce the original engine, *Airservice Constructional Corps No. 1*, I will deal with the fitting of injectors to all three designs; *Douglas*, *ACC No. 1* and the *WD 0-6-0*. Watch this space! And if I come up with any items that I have forgotten I will attend to those later in the series.

●To be continued.

251



Lamps and other accessories.

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 44. John Walters: 'Miniature Pressure Gauges', *Model Engineer* 4099, July 1999.
 45. Henry Wood: 'Miniature Pressure Gauge', *Model Engineer* 4552, January 2017.

Sieg SX2 Plus Miller CNC Conversion

Graham Sadler discusses workholding in a CNC machine.



Making the sub table

One of the biggest problems with CNC is work holding. The system I used is a combination of ideas from other authors, both in ME and MEW. I will not go into great detail with the construction as the components are all relatively simple.

The first stage is the sub table (**fig 28**). This is basically to Mick Knight's design. At

first, I did wonder why he used separate feet on the ends of the plate but he is quite right about the need for them. With the feet, there is clearance under most of the plate meaning that swarf lodged in the array of tapped holes is easier to remove as it can be pushed downwards. I have a 5mm drill mounted on a handle to make it easy to clear them. It's annoying whenever the end rows are needed as clearing out of the blind holes is far more difficult.

My plate is a little too short but it's made from my last large piece of 20mm plate so I used what I had in stock. The drawings show the correct length.

The first task is to make the feet. Check the mating face is true and, if necessary, fly cut flat. I added three slots but only the outer two are really needed. Attach the feet with countersunk cap screws fitted from the bottom into the sub table. These are fitted into shallow recesses to ensure

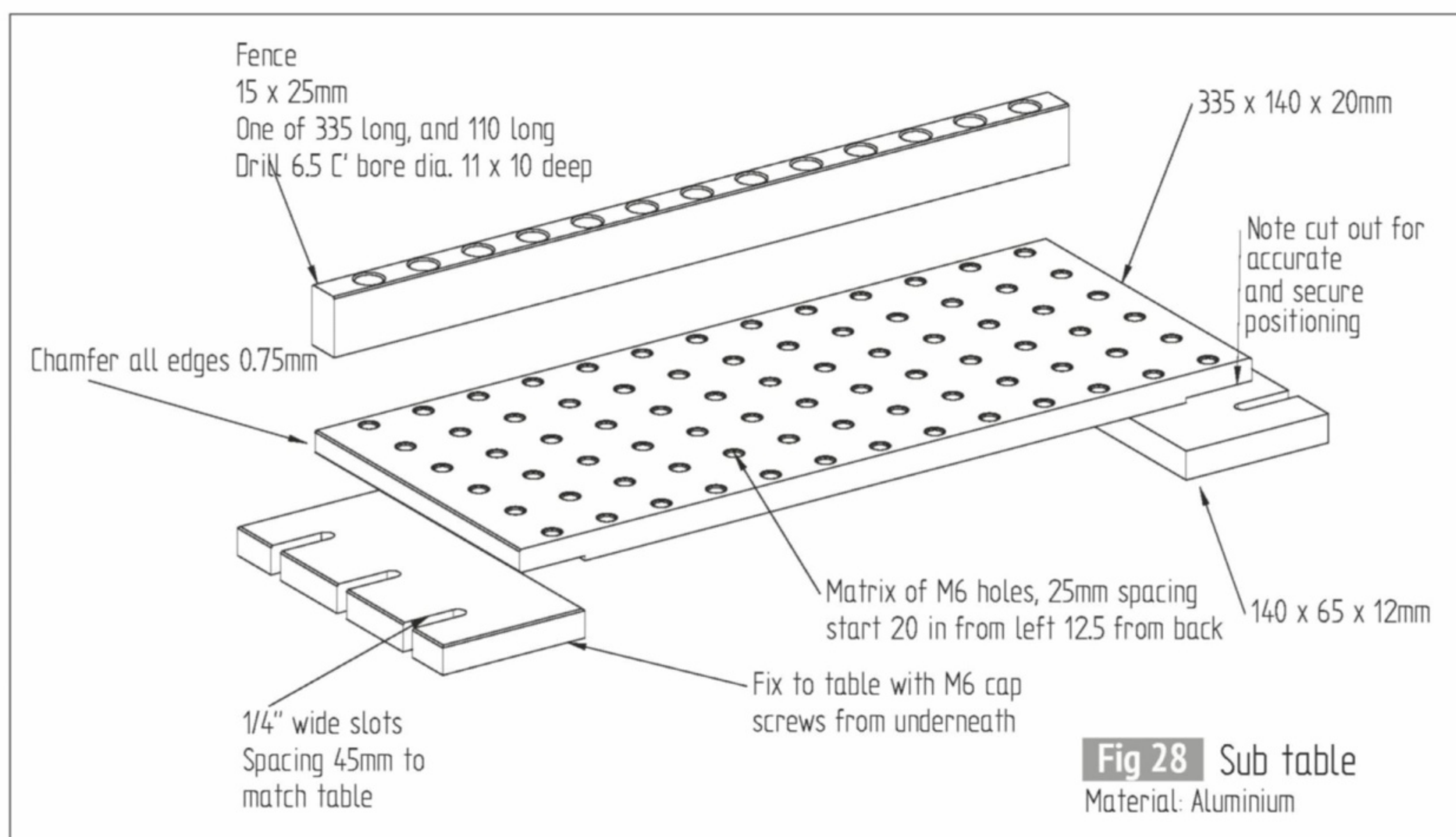
a clean mating of the faces, ensuring no wobble. On the conventional mill, the table is clamped direct onto the miller, feet up, which are then fly cut flat and true.

Invert and clamp down by the feet at the ends. Machine all round the sub table edges, to make it all referenced to itself, moving one clamp at a time so the ends can be finished. The dimension of the table is such that both edges will be perfectly aligned with the long edges of the main table. To position after removal, which doesn't happen often, a parallel is held on the back edge while gently pulling the sub table forward before tightening the mounting bolts. Fly cut the top flat. I used a cutter in the boring head for this (**photo 69**). This ensures that all faces are true and parallel.

Mount the table on the CNC, pushing it hard against a fixed stop so that it can be repositioned whenever it has to be removed. In addition, the back edge should be aligned



Fly cutting the sub base.



with the machine table just to check it for truth. I have wondered about fitting a couple of tabs to the back edge to make this task easier. Re-mounting as stated above is easy. I tested the top of the sub table for truth and found that one corner was a paltry 1.5 thou high, so small it could be ignored. You should check the long edges are also true.

Use an edge finder to set the datum at the back left-hand corner using the offset page in Mach3 to cater for the diameter of the edge finder. The array of holes is at 25mm centres and positioned 12.5mm in from the back long edge and 20mm from the left. The holes were all drilled with a simple CNC program, the bones of which are:

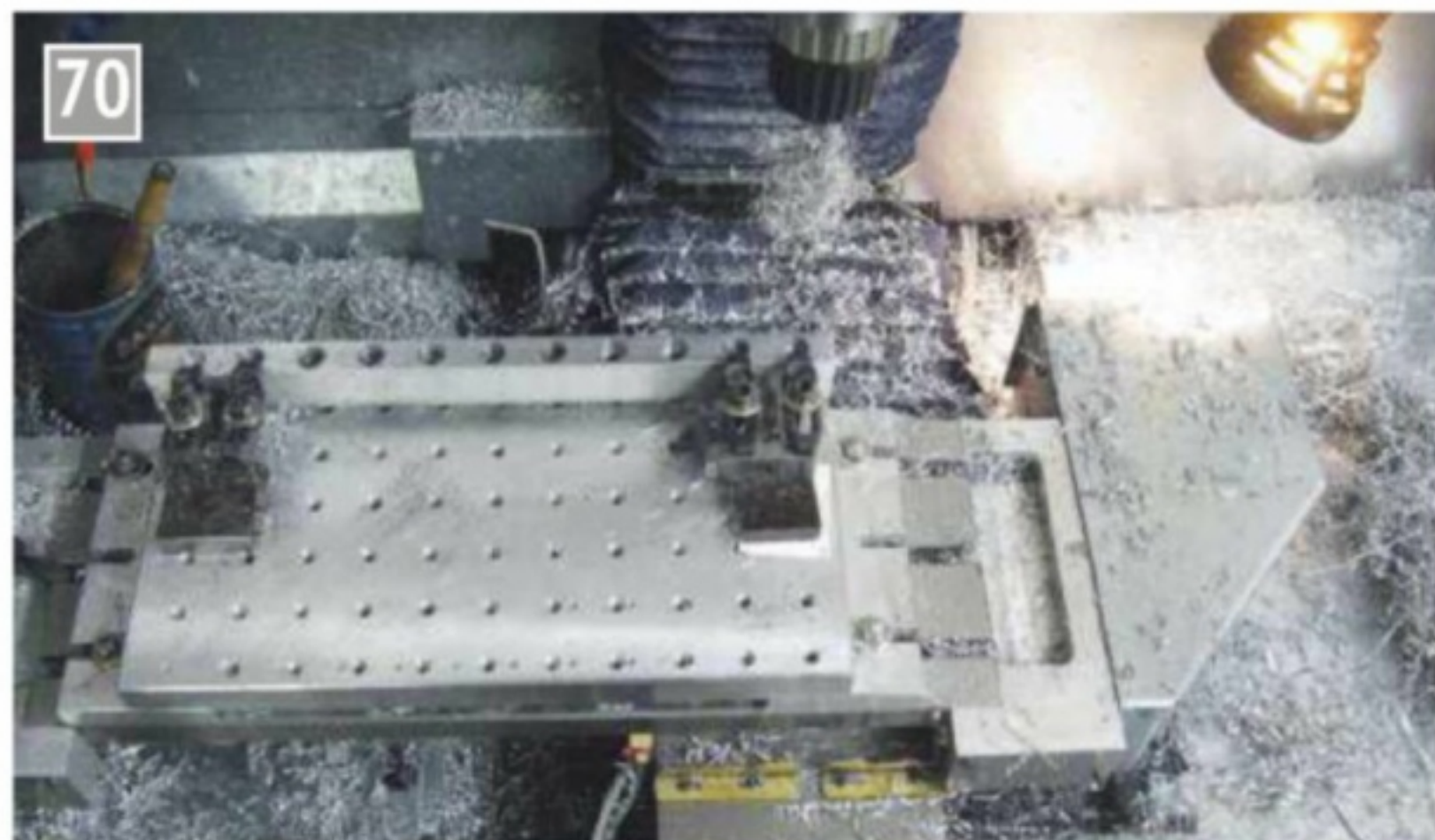
```
Move Y and X 12.5mm
Peck drill to a depth of 17 mm
Move 25mm; repeat in a loop
Return to X 0
Move Y 25mm
Repeat the drilling loop
```

In reality, the Mach 3 wizard for hole array was selected and the holes were centre drilled.

Go back to the wizard to change the tool and switch to the 5mm tapping drill. Tap all the holes (tedious). Use the wizard again to produce a small countersink at the top of the holes.

Using the sub table

Photograph 70 shows the sub plate in action, where the back fence is being drilled. Don't let anybody ever say there's



Drilling the back fence with its counter bore. It has been set true with a DTI and checked that it is true to the back edge of the sub plate and aligned at the left end. Note all the swarf!

no need for containment! It is clamped down and clocked true. Ensure the left end is aligned with the sub table base. A smaller half length fence has also proved useful. They make setting long material very simple, as all that is needed is to use a parallel between the fence and the work.

Most work is mounted on further spacers or a base of aluminium or plywood. Mick Knight, I think, tends to cut into the sub table itself. His also

has a groove cut across it to fit the vice. I wanted to keep the top true and flat. Although it seems there is a lot of height from main table to work top, the setup is quite rigid and, in any case, with CNC machining, cuts tend to be smaller and generate less force than on the conventional mill.

Making the fences

Stage 2 is to make the fences. The long back fence is now clamped down on packing and clocked true. As in photo 70, use the linear hole wizard to space the holes, then counterbore them with either a slot drill or a dedicated tool. The 6.5mm holes have proven to give enough clearance. This fence is now mounted semi-permanently onto the sub table, aligned in the same way as the sub table to the bed. I only use three screws to hold it down but often use longer bolts through into the base-plate.

The vice base

Stage 3 is the vice base. I spent a lot of time selecting a vice.

I wanted one which is ground all over, as it gives a lot of versatility and enables it to be used on its edge. The pin type for me was best and I chose the mine from ArcEuroTrade, as it has a captured pin working in a type of rack meaning that, to adjust the size, it's loosen, tilt the moving jaw, slide to new position and tighten, unlike a true pin. Some designs in which the locking screw and the pin have to be removed and then fiddled back together in the new position yield too much faff! The vice is held down with a block working in a groove in the vice body. This type of vice is excellent as the angled tightening screw grips with a down force thus removing any possibility of jaw lift.

The base plate

The base plate is aluminium 150 x 140 x 12mm. It is machined on all edges to get it square and then a groove is cut into it for the vice to be a push fit into it. Mounting holes are drilled to match the hole array so that, in use, the back edge is

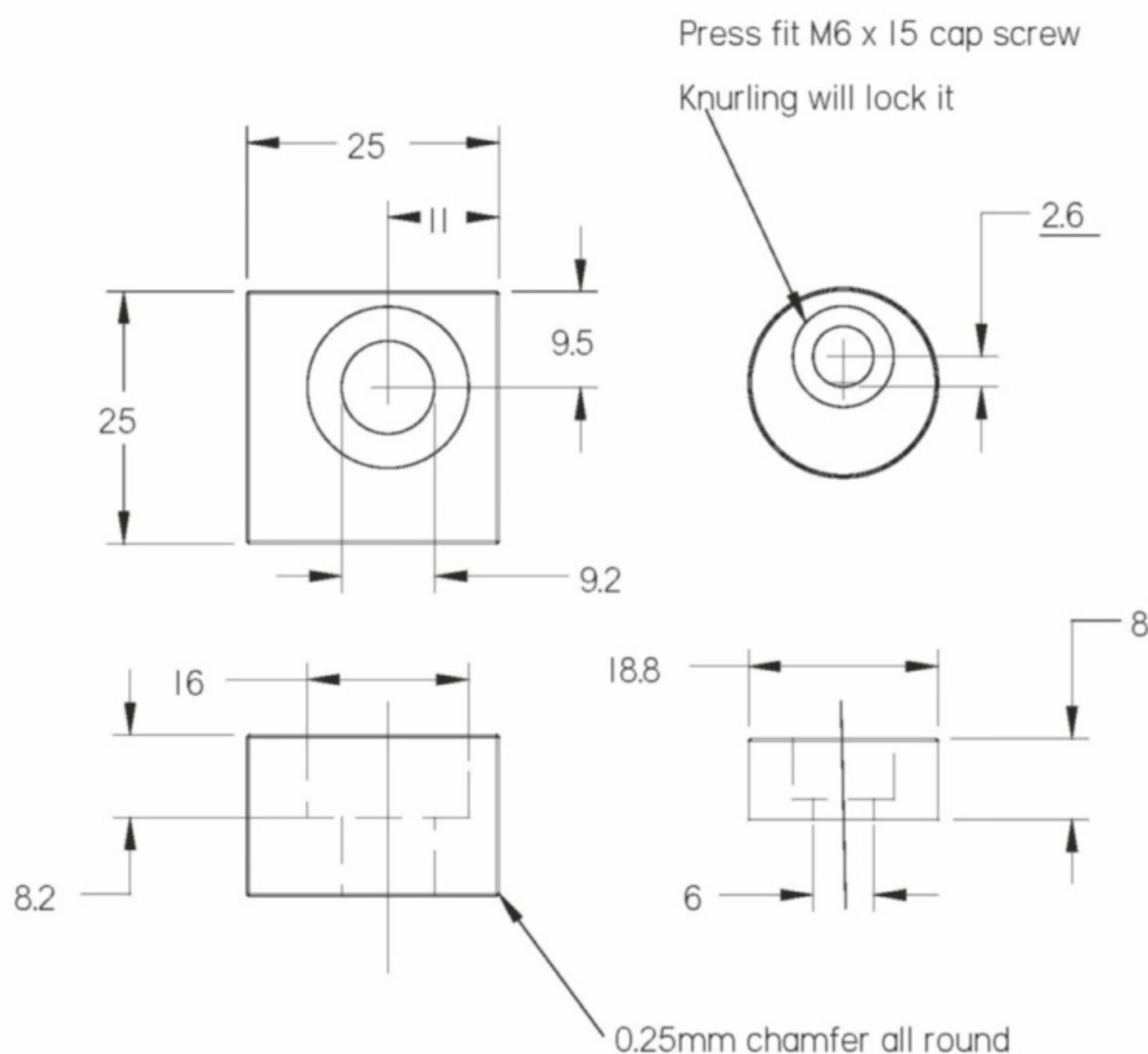


Fig 29 Low profile cam clamp

Material: Steel

pushed hard against the back fence and aligned with the left end of the sub table. The dimensions will also allow the vice to be mounted along the X axis rather than across it in the more conventional position (**photos 71 and 72**). It also makes mounting this small neat vice on the conventional mil easy as the plate is pushed against table 'T' slot blocks.

Lock blocks

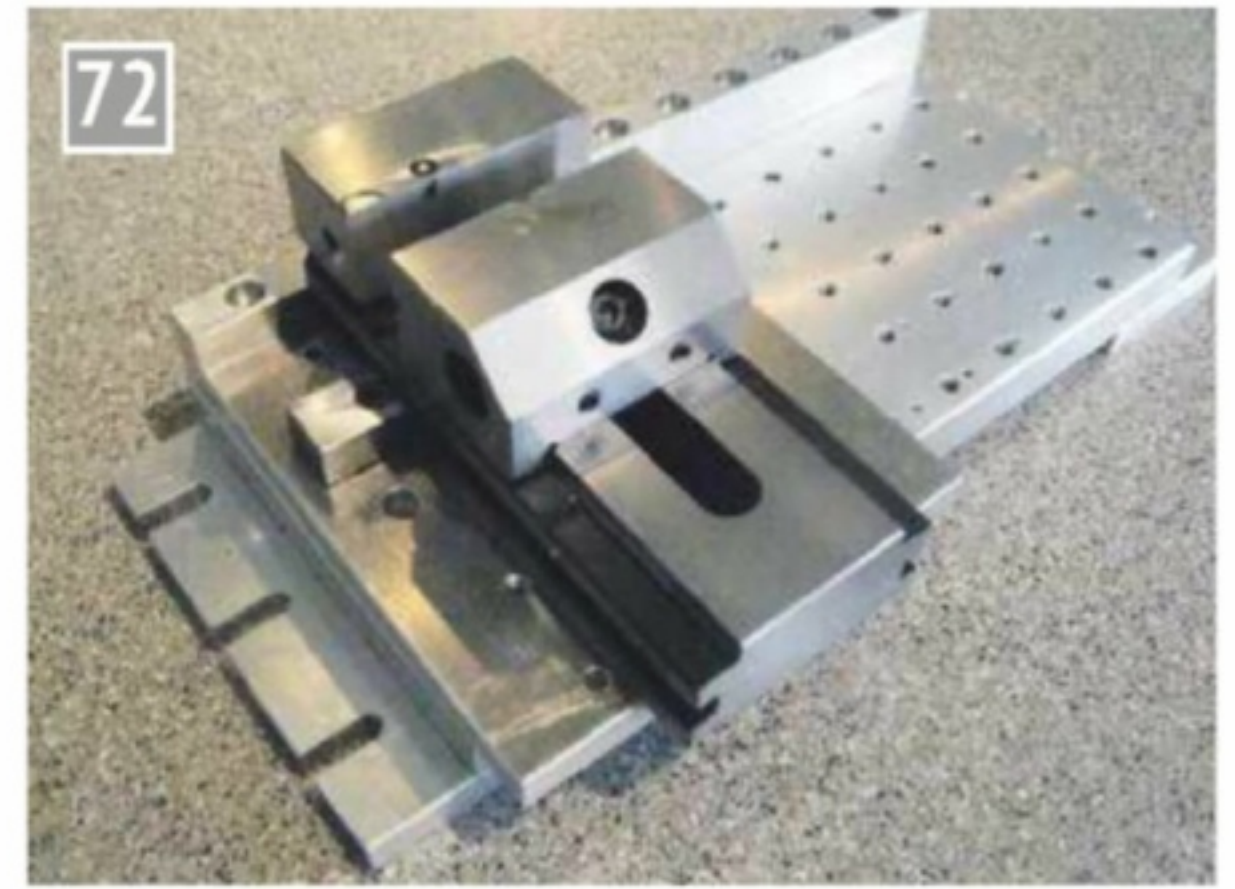
With the vice mounted we can produce the eccentric lock blocks. These are brilliant at providing a secure low-level clamping, especially when linked with the back fence (**fig 29 and photo 73**). The blocks are firstly skimmed on two sawn edges to ensure square flat faces. Mark one end as the datum. These are then gripped in turn in the vice on parallels with the datum at the left of the vice edge. Drill each and then switch to an end mill to mill out the circular pocket.

The cams are made eccentric by skimming the outside to diameter to size, then setting up the offset in the four jaw chuck for drilling, boring the pocket and parting off. Finish with a chamfer on the end.

The pocket is sized so that when the cap screw is pressed



Machining the seating for the pin vice.



The vice mounted on its own sub plate aligned with the edge of the main sub plate.

in, the straight knurling bites into the eccentric pocket and will lock it in place, so check your own supply. They do not move in use. The position of the hole in the block means that there are four different sizes which can be used, although I have found that most clamping will need thin spacers, as seen in the smoke box drilling example.

There is one important thing to note, when working on duplicated components. If you have to have a break in machining, over several days, it's important to set the machine up for the next session before you finish. Return the machine to X 0, Y 0 and turn off. In the next session, turn on the machine but don't move the slides or REF all! Zero the DRO in the



The eccentric low-profile cam blocks and the mounting pillar used for the radius rods.

current location then all is okay to continue.

● To be continued.

NEXT TIME

We shall look at some worked examples.

● Wrexham

John Arrowsmith chooses a suitably sunny day to visit the Wrexham club on its attractively landscaped site.

● Walschaerts for *Sweet Pea*

Frank Birchall fits Walschaert's valve gear to his *Sweet Pea* locomotive.

● Usk Show Steam Corner

Graham Gardner explores the 'steam corner', originally started by John Haining at the long established Usk show.

● BR2 Aero Engine

Mick Knights finds the right propeller to add the finishing touch to his BR2 aero engine.

Content may be subject to change.



ON SALE 8 NOVEMBER 2019

Geoff Theasby reports on the latest news from the Clubs.



The leader of a local social media group spotted a carved head on a city centre church and published his photo of it. I immediately identified it as being an image of ME! This I had to see and on finding it, took my own photo, with 'hil(hair)ious' results (**photo 1**). As you will see, like Esau, I am an hairy man (Gen 27:11). If readers are in Steel City, go to the West Door of St. Marie's Roman Catholic Cathedral and there I am, on the right, holding up the West Front. I understand that it is representing St. Paul. In respect of this likeness, I wonder what the statues and carvings talk about when everyone has gone home, the priest is writing a homily in his study and there is another long night ahead of them. What do they discuss, when it's All Quiet on the West Front...?

A piece of Chinese electronics contained the following warning on its paperwork: 'Do not exceed xx volts, or there will be alarm'. Here at Theasby Industries, there is quite often alarm in such circumstances; 'Why did that happen/not happen...?' Not only alarm, but also despondency, allied with wailing and gnashing of teeth.

In this issue, Heavy Harry, O Calamity!, 'Yorkshire' fittings? Rare woods, a Topkapi museum, letters, a wind up, generosity, a modest writer, a trip to the USA, A beginner's second place and a 'coup de grass'.



'Stoneface' Theasby, for one night only!

Port Bay Express, September, from **Portarlington Bayside Miniature Railway**, in which Ron Griffiths writes about Heavy Harry, H220, one of three 4-8-4 steam locomotives built to haul the Overland Express to Adelaide. 'He' could haul 550 tons up Islington Bank (10 miles at 1 in 48) at 20 mph. Although a three-cylinder, 'he' had Henschel conjugated gear, as the Gresley design was heavy on maintenance. In service from 1941 to 1956, 'he' is now in the museum at North Williamstown, Melbourne, whilst the other two class members were never finished. The railway passenger monthly totals continue to improve, the current year so far exceeds 10,000 for the first time.

W. www.miniaturerailway.com.au

Bournemouth & District Society of Model Engineers' B&DSME News, August, relates that the Society raised £250 on their Annual Charity Day, for 'Hope for Isobel'. Dick Mantle has been a member for 60 years and shares his reminiscences, which extended to building a *Butch* and three other 5 inch gauge steam locomotives, two electric and a steam lorry. Dick has been elected President for the current year. In the light of this he is listed under his Sunday name, Mr R. Mantle, on the website. Robert Hammond's Open Day raised £330 for church funds.

W. www.littledownrailway.co.uk

Model & Experimental Engineers, Auckland August Newsletter says that Allan Roberts has completed his one-third scale Le Rhone rotary engine. It has electronic ignition, home-made spark plugs and the inlet manifolds appear to be made from 'Yorkshire' fittings, but are actually made by Allan using electro-deposition. 'Oh Calamity!', said Murray Lane, as his 5 inch gauge Heisler fell 600mm off its stand on to the floor. He was trying to lift it onto blocks in order to inspect the motion and running gear. Fortunately, the

only damage was to a small corner of tender paintwork. Graeme Quayle made a firing shovel, a water tank dipstick and a scraper bar for his 2 inch scale Fowler Showman's engine. He also made a substantial display stand for it, in reclaimed Kauri and Rimu woods. Both are large, indigenous and coniferous. They are scarce and protected nowadays.

UK Mens' Sheds Association sent their magazine, *Shoulder to Shoulder*, where everyone is concentrating on ShedFest in Worcester, on 3rd September, at which the winner of Shed of the Year will be announced.

W. www.menssheds.org.uk

Stamford Model Engineering Society's August Newsletter, tells us that Editor Joe Dobson says that there are etched brass fittings for the internals of a 1:72 scale Halifax bomber, to enhance the realism. A photograph of the model shows the flight engineer's station behind the pilot and the navigator's and wireless operator's position in the nose.

Branch Lines, Summer, from **West Riding Small Locomotive Society**, announces the award of a Silver Medal to Richard Byram at the Doncaster exhibition, for his 7¼ inch gauge GWR Dukedog locomotive. The Society are to build a Garden Railway at their site, with 32 and 45 mm gauge tracks, so will be able to run anything LGB, O Gauge and Gauge 1 and 16mm, 10mm and ¾ scale. The 45mm station will be modelled on Wakefield Westgate, as it was between 1890 and 1960. Graham Beal describes his O Gauge layout 'Kirby Stephen', on the famed Settle and Carlisle line. New Treasurer, Stephen Seale, analyses the Society's finances, where they originate and what they are spent on. The Committee has decided to sell the club's 2½ inch gauge locomotive which appears to be of a Tasmanian Railways, Beyer-Garratt, K1 for which sealed bids are invited.

W. www.westridingsmalllocomotivesociety.20m.com

Your scribe was recently confused in that he misidentified a reader as a frequent correspondent to his newspaper. The response was that he wished he were, as he understood that this was a prequalification for a knighthood. 'Aha!' quoth I, 'that explains the otherwise unaccountable non-appearance of a K to my CDM. No letters in the paper!'

To me, this is one of the best looking post war cars, a 1949 Triumph Roadster at the Classic Cars event in Sheffield (photo 2) and a Sheffield Simplex (photo 3).

The Newsletter, September, from **York Model Engineers** starts with Model of the Month, by Editor, Roger Backhouse. This features Mike Waters and some of his clocks. Beginning with a lathe incapable of facing a flat end of bar, he progressed to a Myford and a Boxford and won a First Prize at the Harrogate exhibition. When not making clocks, Mike is part of a group which winds York's public clocks. (A wind-up merchant! - Geoff.) 'Not the Model of the Month' is Roger's kit-built model of a Clyde Puffer, his first kit for many years. 'There's no such thing as a bad model', says Roger, 'Only, some are better than others'. This feature is for the 'others'. President of **Leeds Model Engineers**, Arthur Bellamy, generously bought a Bridgeport mill on the closure of their track at Eggborough and donated it to YME, even paying for its transport. YME Arts critic (Surely, a first for model engineering?), Phil E. Stein, recommends seeing two films to be shown in York, soon: Buster Keaton's *The General* and *Steamboat Bill Jr.* A book on Jim Crebbin and his locomotives has been published. In view of the author's claimed false modesty, I shall refrain from bringing him unrequited fame by naming him. Oh ... and a joke about a very long railway, or something....

W. www.yorkmodelengineers.co.uk



Triumph Roadster in Sheffield (above) and a Sheffield Simplex at the same event (left).

Steam Whistle, August, from **Sheffield & District Society of Model Engineers** reports a good attendance for their Children's Hospital charity day. To date, the Society has raised over £19,000. Pete Nash decided in May to try to visit *Big Boy* in Wyoming, hoping that its scheduled return to the tracks would be on time. The odd date was missed, but they had the thrill of being in Echo Canyon as the train came through. They also visited a hump shunting yard in Nebraska, with two humps (no jokes about 'Bactrain' camels

or sugar, please!) and which is two miles long. (Sheffield's Tinsley yard was also two miles long- Geoff)

W. www.sheffieldmodelengineers.com

Worthing & District Society of Model Engineers, *Newsletter*, autumn, reports that Hon. Treasurer, Dave Baldwin, has resigned and is returning to his native Yorkshire, passing on the missionary work to others. He will return intermittently, bearing supplies of Keighley's hand-crafted pork pies to maintain morale. Lionel Flippance, current IMLEC

champion, stood aside at this year's event in favour of his daughter, Joanne. Despite relatively little training and practice, Joanne came second out of 28, a very creditable effort indeed. Neil Furze writes on his day at Bracknell for LittleLEC, with his *Rob Roy*. John Stoton related his encounter with Chinese penny pinching. (Power tool, not food.) An important part of his woodworking equipment appears to have been made of what was euphemistically-named *Monkey Metal*. Relating his time in the RAF and after, he mentions that the American parent company of his then employer complained that a piece of machinery did not work. Answer - 'you asked for the drawings, not if it worked...' Out shopping with an Eastern European refugee, he bought some Osram light bulbs. His colleague was wary of them, but why? Finally, Mike Wheelwright discusses the 'Hornbys', SR CC3 electric locomotives.

W. www.worthingmodelengineers.co.uk

This Savage traction engine was in steam outside Bradford Industrial Museum's *ModelMania* event where BMES were contributing by running the portable railway. Savage of Kings Lynn are better known to many as the maker of steam centre engines for large fairground rides, such as Gallopers (**photo 4**).

Tim Coles sent *The Cam*, August, from **Cambridge and District Model Engineering Society** which says that Helen Hale's (joint editor with Tim) Class 20 locomotive 60 amp controller has been replaced with a 200 amp version. Although powered only by two, 1 HP motors, the thermal cut-out kept activating. (2 HP is 1.5 kW, at 24 volts they will draw 60 amps at full power, so the small one was only marginally capable – Geoff.) A great photograph of a possibly unique situation appears on page 5, where newlyweds Mr. & Mrs. Garratt are hauled by a Garratt locomotive, driven by a Mr. Garratt who built it (**photo 5**)! Jo DiVanna says that right by the Topkapi palace in Istanbul, in the Sirkeci station, is a small railway museum devoted mainly to the Orient Express and he thoroughly recommends it.

W. www.cambridgemes.co.uk

Ryedale Society of Model Engineers' *Monthly Newssheet* for August, reports that several times during August they had little rain, whilst Swaledale to the West was under cloudbursts. The rain that did fall on Gilling soon



Savage traction engine BMES at BIM Modelmania.

stopped for that day as it warmed up. (The rain in Swale falls mainly in the Dale...? - Geoff.) On an occasion when there was a birthday party in the village hall, use of the proverbial 'shepherd's crook' enticed many of the guests onto the railway. On another day, one couple turned up showing enthusiasm. One of them was a decided signal box enthusiast, having made a model of Grosmont box. So the Gilling box was opened for them to inspect. They gave a donation of £10 to the club on leaving. Daniel Crisp offered to cut the grass, as it

needs constant attention in the summer. He arrived on a full-size International tractor with mowing attachment which made short work of the job. It was revealed that he had *DRIVEN* all the way from Bedale on it in 2½ hours - and the same to return. His palm was accordingly and gratefully greased with coin of the realm. The Gilling Main Line Rally attracted 39 locomotives; everything - shed, steaming bays and running lines - was full. Great! Mike Aherne's 'Fell' locomotive puzzled many (**photo 6**). The following day was so busy

that a supermarket run had to be organised to keep up with demand. A driver on the 'big railway' who attended on the Saturday returned with his friends on the Sunday, as he couldn't believe how good it was and he comes every year. W. www.rsme.org.uk

And finally, a joke from Richmond Hill Live Steamers: 'I have a set of buffers going cheap, its an 'end of line' sale'.

Contact:
geofftheasby@gmail.com



Four 'Garratts' in Cambridge. (Photo courtesy of Julian Garratt.)



Mike Aherne's Fell locomotive at Gilling. (Photo courtesy of Bill Putman.)

OCTOBER

- 23 Bedford MES.** Public running, from 10.30am at Summerfields Miniature Railways. Contact Brian Walton: 07498 869902.
- 24 Cardiff MES.** AGM. Contact Rob Matthews: 02920 255000.
- 24 Sutton MEC.** Afternoon run from noon. Contact Paul Harding 0208 2544749.
- 26 Brandon DSME.** Hallowe'en running day. Contact Mick Wickens: 01842 813707.
- 26 Cardiff MES.** Steam up and family day. Contact Rob Matthews: 02920 255000.
- 26 Romney Marsh MES.** Track meeting, noon onwards. Contact Adrian Parker: 01303 894187.
- 27 Bedford MES.** Public running, from 10.30am at Summerfields Miniature Railways. Contact Brian Walton: 07498 869902.
- 27 North Wiltshire MES.** Public running, Coate Water Country Park, Swindon, 11am-dusk. Contact Ken Parker: 07710 515507.
- 27 Oxford (City of) SME.** Running Day, 1.30-4.30pm. Contact: secretary@cosme.org.uk
- 27 Rochdale SMEE.** Hallowe'en special at Springfield Park, 7.30pm. Contact Rod Hartley 07801 705193.
- 28 Newton Abbot & District MES.** Running day at Lindridge Hill. Contact Ted Head: 07941 504498.
- 29 Romney Marsh MES.** Track meeting, 11am onwards. Contact Adrian Parker: 01303 894187.

- 29 Wigan DMES.** Presentation by Mr John Collier on 'Special Fire Appliance Fleet (GMFRS)'. Contact Kevin Grundy: 07877 634184.
- 31 Sutton MEC.** Talk: 'Development of the de Havilland Mosquito' – Rod Dean. Contact Paul Harding 0208 2544749.

NOVEMBER

- 1 North London SME.** Open discussion. Contact Ian Johnston: 0208 4490693.
- 1 Portsmouth MES.** Club night: 'Slide Show on Railway Life', 7.30pm, Tesco Fratton Community Centre. Contact Roger Doyle: doyle.roger@sky.com
- 1 Rochdale SMEE.** Members' projects and problems, 7.30pm at Castleton Community Centre. Contact Rod Hartley 07801 705193.
- 2 Tiverton & District MES.** Dusk running at Rackenford track. Contact Chris Catley: 01884 798370.
- 3 Newton Abbot & District MES.** Running day at Lindridge Hill. Contact Ted Head: 07941 504498.
- 3 North Wiltshire MES.** Public running, Coate Water Country Park, Swindon, 11am-dusk. Contact Ken Parker: 07710 515507.
- 5 Romney Marsh MES.** Bits and pieces/bring and buy, 7.30pm. Contact Adrian Parker: 01303 894187.
- 6 Bradford MES.** Autumn auction (only members may bid), 7.30-10pm, Saltaire Methodist Church. Contact: Russ Coppin, 07815 048999.
- 6 Brandon DSME.** AGM and meeting at The Ram Hotel,

- Brandon, 7.45pm. Contact Mick Wickens: 01842 813707.
- 7 Cardiff MES.** An evening with Tony Bird. Contact Rob Matthews: 02920 255000.
- 7 Leeds SMEE.** Meeting night – Members' hints and tips. Contact Geoff Shackleton: 01977 798138.
- 7 South Lakeland MES.** Meeting in the pavilion, 7.30pm. Contact Adrian Dixon: 01229 869915.
- 7 Sutton MEC.** Bits and pieces. Contact Paul Harding 0208 2544749.
- 8 Tiverton & District MES.** Club meeting at Old Heathcoat Community Centre, Tiverton, 7.30pm. Contact Chris Catley: 01884 798370.
- 10 Newton Abbot & District MES.** Running day at Lindridge Hill. Contact Ted Head: 07941 504498.
- 10 North Wiltshire MES.** Public running, Coate Water Country Park, Swindon, 11am-dusk. Contact Ken Parker: 07710 515507.
- 10 Sutton MEC.** Sunday track day from noon. Contact Paul Harding 0208 2544749.
- 12 Romney Marsh MES.** Members' social afternoon 2pm. Contact Adrian Parker: 01303 894187.
- 14 Cardiff MES.** Members' projects. Contact Rob Matthews: 02920 255000.
- 14 Sutton MEC.** Club night. Contact Paul Harding 0208 2544749.
- 15 Rochdale SMEE.** Talk: 'Steam in Rhodesia and Zambia' – David Thornber, 7.30pm at Castleton Community Centre. Contact Rod Hartley 07801 705193.
- 16 Westland & Yeovil DMES.** Track running

- day 11am – 4.30pm. Contact Bob Perkins: 07984 931993.
- 17 Newton Abbot & District MES.** Running day at Lindridge Hill. Contact Ted Head: 07941 504498.
- 17 North Wiltshire MES.** Public running, Coate Water Country Park, Swindon, 11am-dusk. Contact Ken Parker: 07710 515507.
- 17 Tiverton & District MES.** Running day at Rackenford track. Contact Chris Catley: 01884 798370.
- 19 Romney Marsh MES.** Ron and Mary Hyde in Canada, 7.30pm. Contact Adrian Parker: 01303 894187.
- 20 Bristol SMEE.** Themed topic evening - CAD. Contact Dave Gray: 01275 857746.
- 21 Leeds SMEE.** Meeting night – 'Advanced Steam in Miniature' – Nigel Bennett. Contact Geoff Shackleton: 01977 798138.
- 21 Sutton MEC.** Club night. Contact Paul Harding 0208 2544749.
- 23 Cardiff MES.** Steam up and family day. Contact Rob Matthews: 02920 255000.
- 24 Newton Abbot & District MES.** Running day at Lindridge Hill. Contact Ted Head: 07941 504498.
- 24 North Wiltshire MES.** Public running, Coate Water Country Park, Swindon, 11am-dusk. Contact Ken Parker: 07710 515507.
- 26 Romney Marsh MES.** Members' social afternoon 2pm. Contact Adrian Parker: 01303 894187.
- 26 Wigan DMES.** Bits and pieces evening. Contact Kevin Grundy: 07877 634184.



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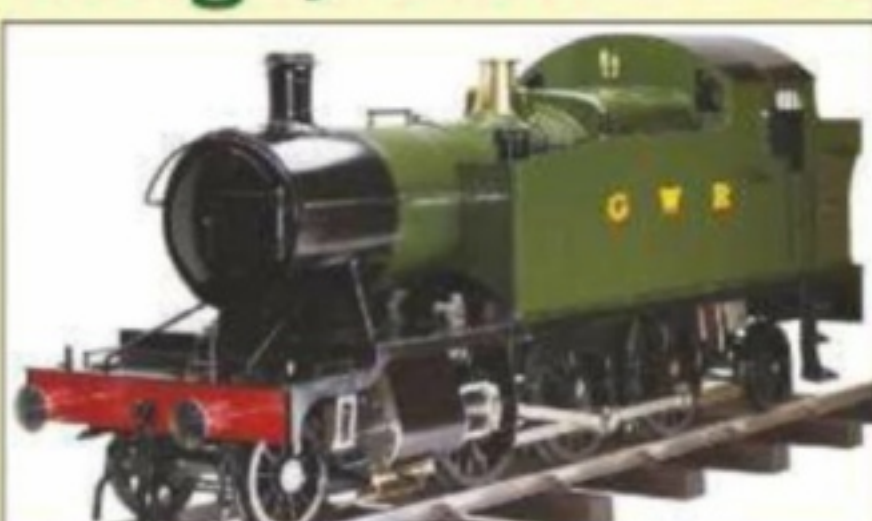


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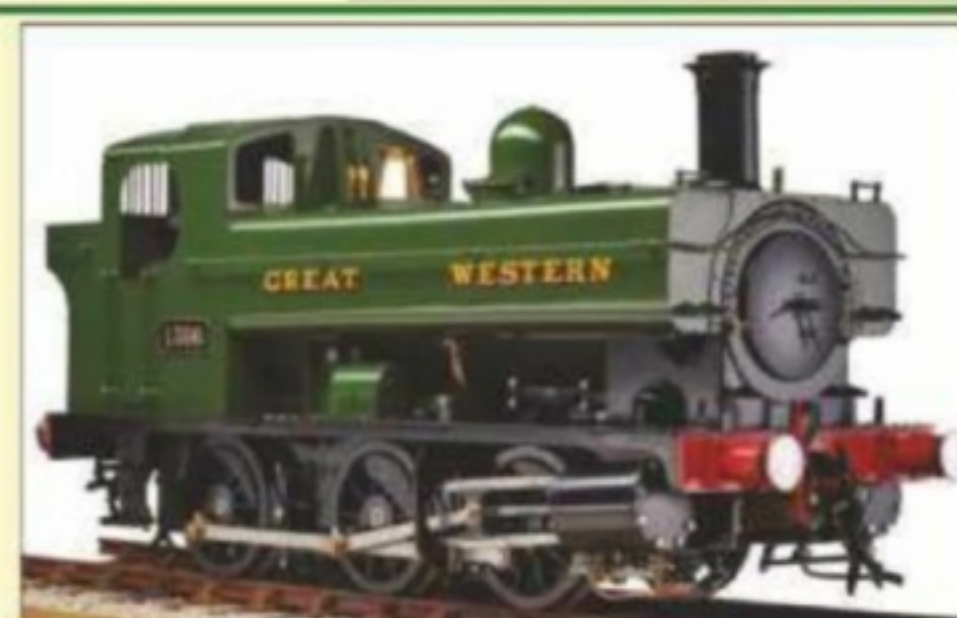
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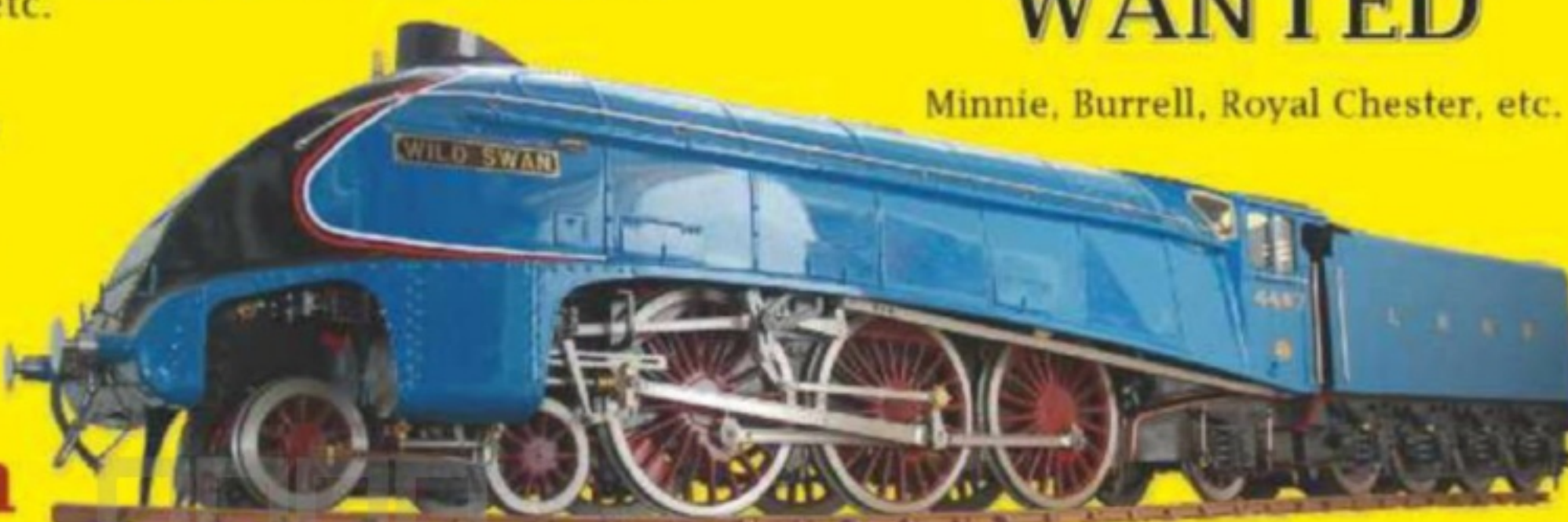
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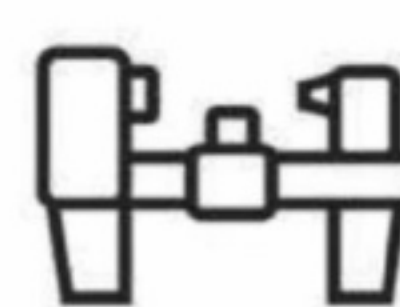
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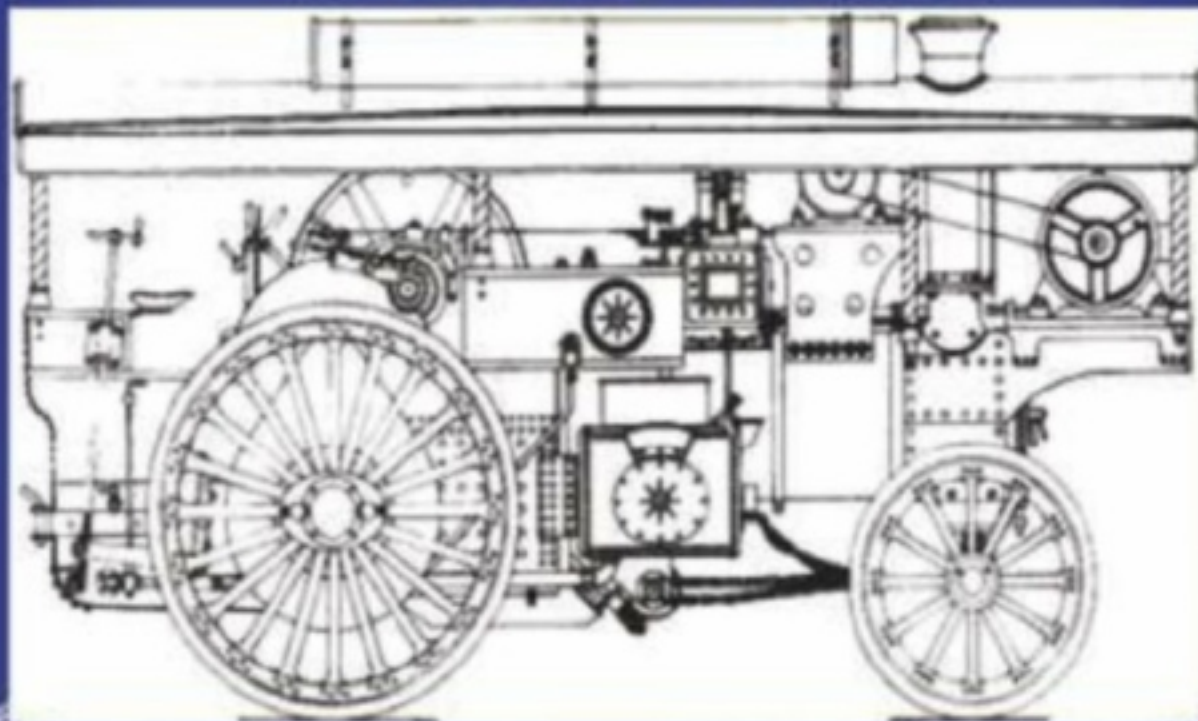
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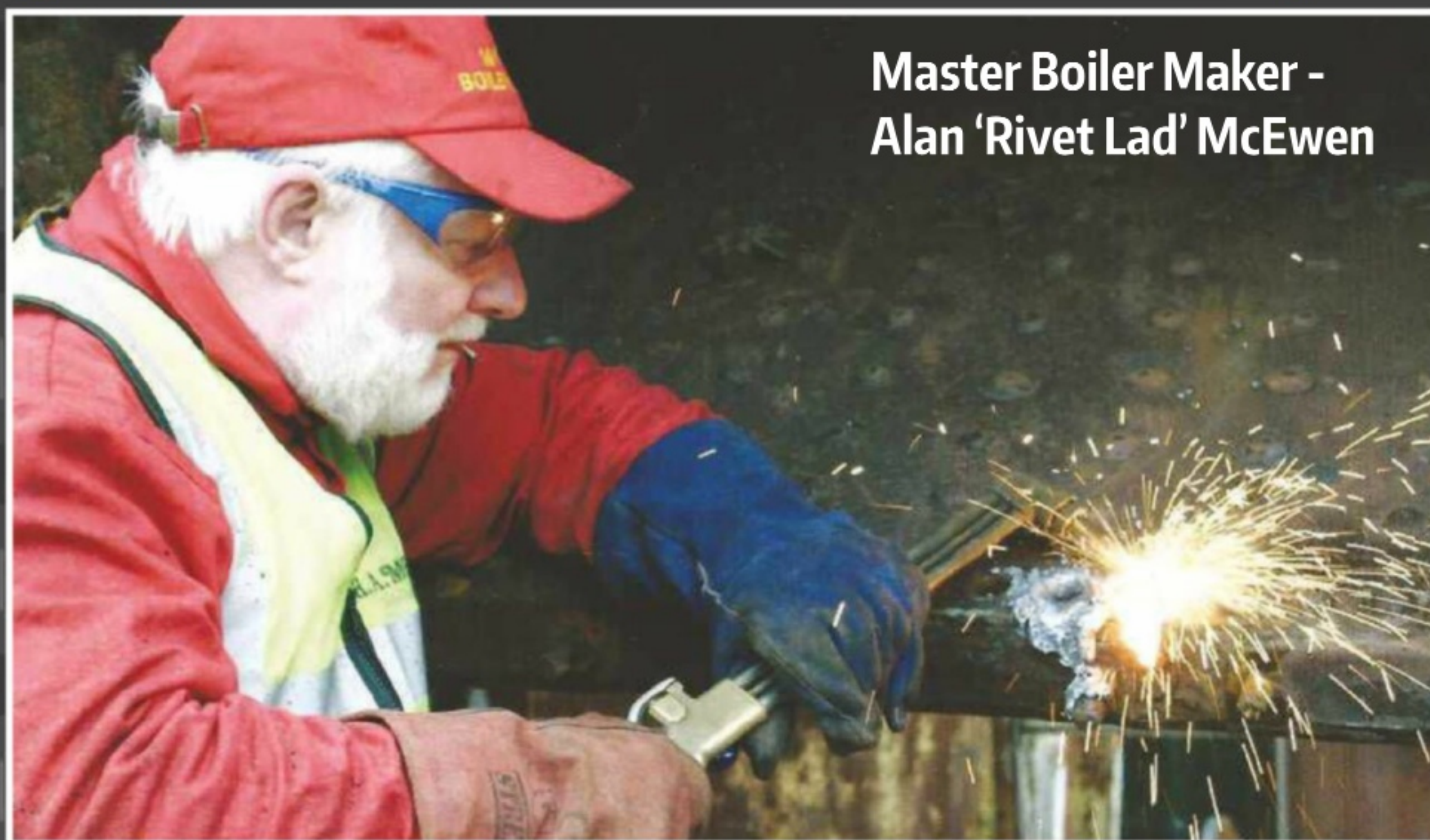


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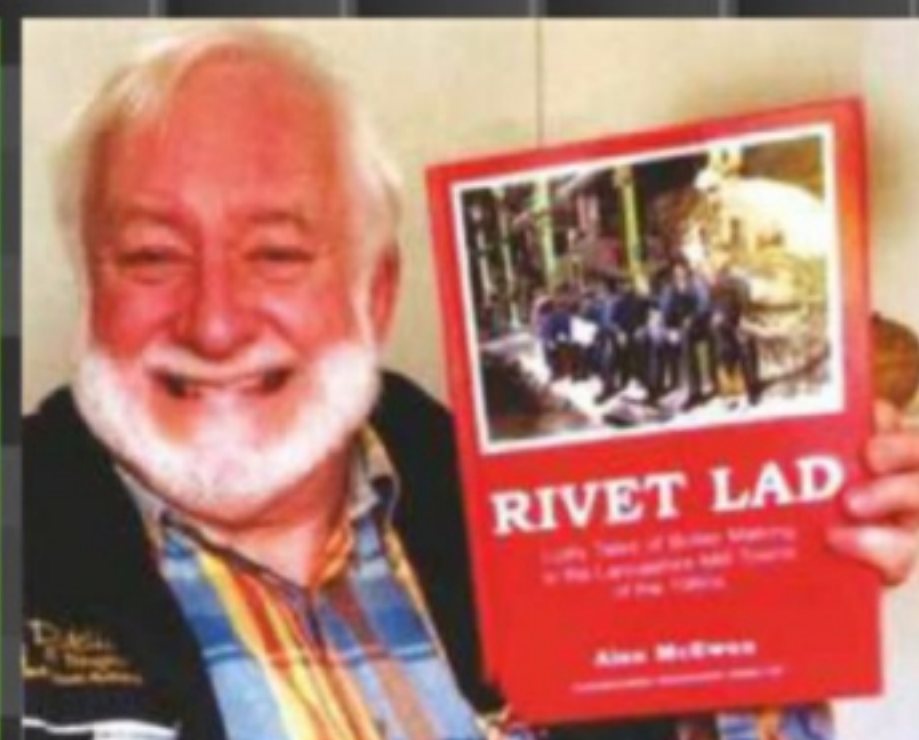
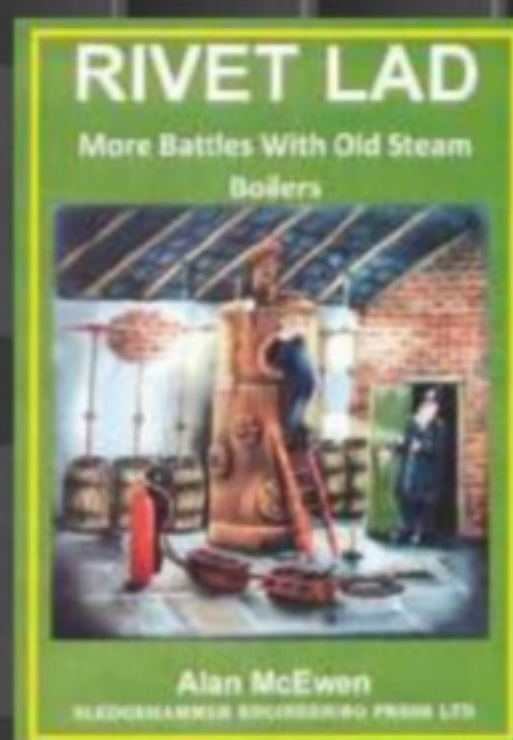
Bringing British industrial history to life



Master Boiler Maker -
Alan 'Rivet Lad' McEwen

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

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



Alan's second RIVET LAD book: **RIVET LAD - More Battles With Old Steam Boilers** was published in September 2018.

Now priced at £20 including postage and packing to UK addresses.

This latest book chronicles Alan's story from leaving Phoenix Boiler Makers and establishing his own firm: H.A. McEwen (Boiler Repairs) on the 4th August 1968. In those early days Alan battled with a great variety of old steam boilers in town and country, where he met some extremely interesting and rather bizarre characters, such as the 'Piggers'. The book is hard back and contains 128 pages of text and numerous amazing photographs.

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