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THE MAGAZINE FOR MODEL ENGINEERS

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RESURRECTING A VINTAGE DUKW

Modern technology transforms a 1947 model

BEHIND THE SCENES... We visit a Newcomen Pumping Engine

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AUGUST 2017 Volume 39 Number 2

FRONT COVER

Our front cover shows C. Bramley's nicely made threshing machine which took pride of place on the Pickering Society's stand at the Doncaster exhibition. *Photograph: John Arrowsmith*

EDITORIAL

THE MIDLANDS SHOW

Sitting here, as we are, in the middle of our glorious British summer, Pimm's, perhaps, in hand, (well, sometimes – it's grey and raining outside as I write this) we don't really want to be reminded of the inevitable approach of autumn. All the same, now is the time to reach for your diary and reserve the date for the Midlands Model Engineering Exhibition. This will take place, as usual, at The Fosse, near Leamington Spa, and the dates this year are October 19th to October 22nd. You can find out more at www.midlandsmodelengineering.co.uk

BRISTOL SHOW

If you can't wait until October there is of course the Bristol Model Engineering Exhibition, which is another very highly regarded show. This takes place this month, on the 18th, 19th and 20th of August, at the Thornbury Leisure Centre. You can find out more about this at www.bristolmodelengineers.co.uk

GLOUCESTER VINTAGE AND COUNTRY EXTRAVAGANZA

If you are interested in vintage vehicles, or if you just fancy a great day out, why not visit the Gloucester Vintage and Country Extravaganza? This takes place on the 4th, 5th and 6th of August at the South Cerney Airfield, Cirencester. The show is widely regarded as one of the biggest and best Steam, Vintage and Countryside events in the UK and attracts thousands of exhibitors and visitors from across the county, actively raising thousands of pounds for both national and regional charities each year.

It would be impossible to list here all the attractions at this show, which include a display of nearly 700 classic cars. a funfair, Punch and Judy, steam train rides, dancing tractors, 120 historic military vehicles, busses, motorbikes, steam engines (model and full size), caravans – you name it, it will be there! To top it all there will be a Battle of Britain Memorial Flight Dakota fly-past (on Saturday and Sunday) and the Jump4Heroes parachute display team will drop in every day.

Further information is available at www.glosvintageextravaganza.co.uk

AND FINALLY...

...now is the time to say 'goodbye'. My rather brief tenure, as it turns out, as editor of your magazine has now, sadly, come to an end. As the poet Tennyson reminds us: 'The old order changeth, yielding place to new' and accordingly, from next month, you will have a new editor. He will no doubt bring a new perspective and energy to Engineering in Miniature and I wish him, and the magazine, and all of you the very best for the future.

Martin Evans
Editor

The September issue will be on sale on August 17th

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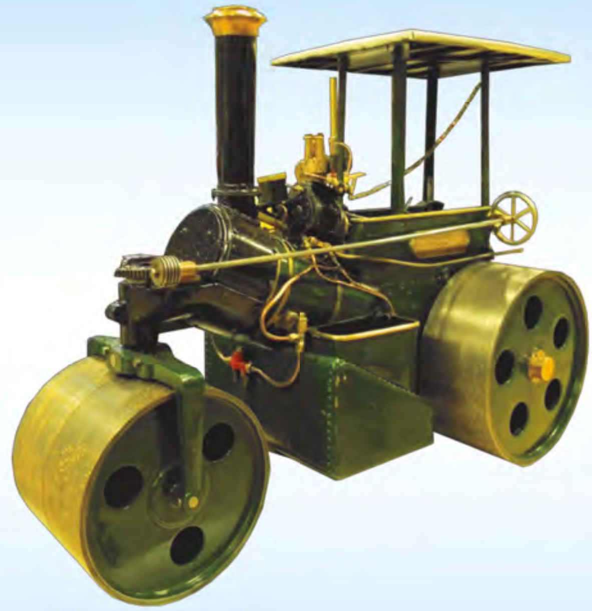

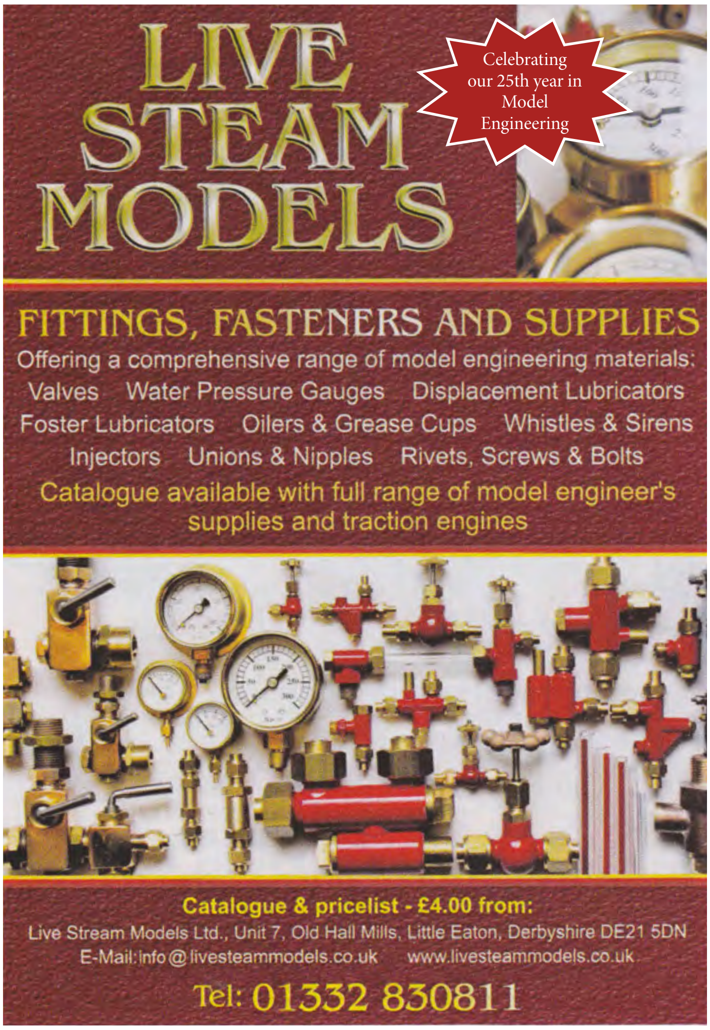
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Resurrecting an Old DUKW

Philip Bellamy relates how an old DUKW, vintage 1947, was restored to working order using modern technology

BY **PHILIP BELLAMY**

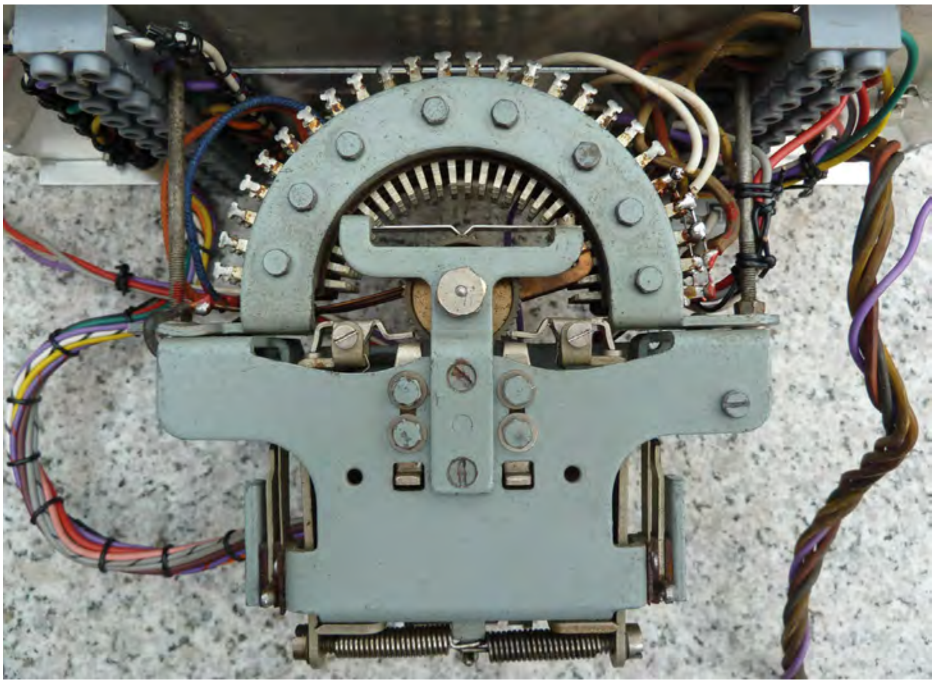
In 1947 there started a greater interest in radio controlled models, so a Radio Controlled Models Society was formed. The Society was centered around four main groups, namely, London, Birmingham, Manchester and Newcastle. Soon after this occurred a competition was started between certainly two of the groups, namely London and Manchester. The idea was to produce a vehicle that would fit in an enclosure that was 3' long x 18" x 18".

The London group decided to make a model of a DUKW, which would be road worthy as well as being able to float and travel in water. The project was organised by George Chapman and Peter Cummins. Just after the war there were several shops selling government surplus materials, especially electric motors, some being for 12 volts but very many for 27 volts, most of the latter being made in the USA.

The person behind most of the machining and construction of the DUKW was Peter Cummins, who took the responsibility for the technical side. Naturally, in 1947 and 1948 there were no semiconductors, so all the electronics were designed around electronic valves, with the usual resistors, inductors and capacitors. The London group had monthly meetings at a hotel. The problem that I had was to get to these meetings in term time as I was at a boarding school some way from London, which meant a train ride of about one hour. Generally I managed to get to some eight meetings each year.

There was no problem with providing the lower voltages for the motors, steering system and the like, but one also needed a higher voltage for the radio valves. This was achieved with the aid of a rotary converter, which consisted of a 24 volt motor at one end and a 300 volt generator at the other. The supply for all items was a set of 12 Exide 2 volt accumulators, these being fitted equally each side of the main valve control unit between the wheel arches.

Peter Cummins with the DUKW in 1948.



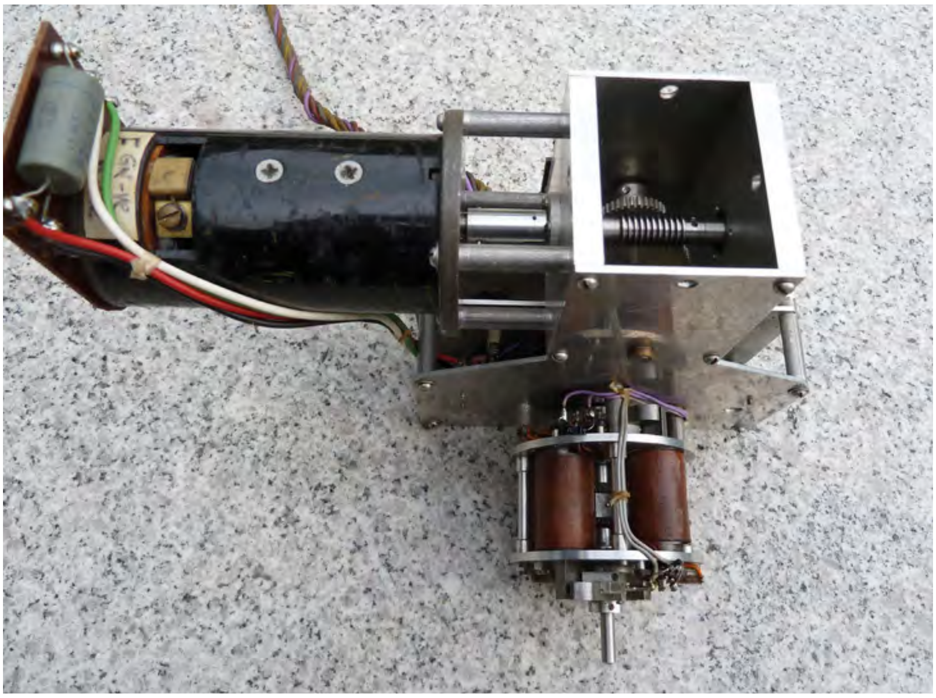
ABOVE
The original speed controller using a uniselector.

ABOVE
The 2-way ratchet system for steering.

BELOW
The steering motor and gearbox.

There were just five functions to operate, namely forward and reverse, right and left, or port and starboard if you prefer, and also a hooter. Each function was activated through a valve operated relay. The speed control was such that there were basically two forward speeds and one reverse, these being selected by a telephone type bidirectional uniselector. Naturally, as the motor was of the wound field type, to change the direction of rotation only the armature polarity was changed.

The steering was operated by a servo which, via some cords to the rear of the vehicle, also operated the two rudders. The steering moved by about 0.5˚ in steps and this was achieved in the following way.



There were two magnetic circuits with ratchets at each end of a shaft, which could then turn the shaft in either direction. On the end of this shaft was a disc with two semi-circular sections. Contacts were made to this disc so that a well geared motor could then turn in each direction, not only turning the contacts but also the front wheels. Naturally the rudders turned at the same time.

The drive to the wheels was from two motors, one at the front and the other at the rear. The front wheels needed to turn, and were also sprung, so the drive from the forward motor went through similar gears as the rear but there were flexible shafts between these gears and the wheels themselves. The drive to the two propellers was from two separate 24 volt motors.

The transmitter consisted of five switched oscillators, each with a different frequency, the outputs being fed into a modulator and then to the final RF oscillator output. The frequency chosen for the output happened to be same frequency that was often used for the telemetry of guided missiles and was also that allowed for radio controlled models, namely 465Mhz. There were not many radio valves that would operate at this frequency reliably. One type of valve which was known as ‘acorn’ family was a triode number 955, but a better valve was the RL18. The former was used in the receiver circuit and the latter in the transmitter circuit, the reason being that the ‘acorn’ valve had a lower heater current. Generally, although disc sealed triodes were used for telemetry applications, the mechanical construction required to use these devices reliably was not really practicable for this application with the DUKW. Peter Cummins, as well as myself, normally used this high frequency, as generally no-one else used it, so we did not get any interference from other users, whose models were normally using the 27MHz frequency.

We still used valve circuits later on in the hobby as high frequency transistors were not available. However I arranged with a company called ‘Hivac’ that they would modify one of their miniature all glass triode valves so that, instead of the anode coming out through the base with all the other connections, they would make a small series with the anode wire coming out at the remote end, thus reducing the capacitance between the anode and the other connections, such as heater, cathode and grid. Using this modified valve I was able to design a co-axial oscillator for the transmitter and a super regenerative receiver.

There was one major problem with the DUKW in its original state and that was that it was very heavy so that, when on the water, there was only between 3⁄16" and ¼" freeboard. After a while I was able to get some silver-zinc accumulators, as used in missiles, which were a little smaller and much lighter, but sadly it did little to increase the freeboard.

The London group of the Radio Controlled Models Society were declared winner of the competition with the Manchester group.

In 1951/2 the Radio Controlled Models Society changed its name to the International Radio Controlled Models Society due to some interest by overseas members in joining the Society. I was a member from the early days until 1961 when I came to Switzerland. Sadly the Society disintegrated soon afterwards.

With the introduction of semiconductors, then integrated circuits, Peter Cummins and I decided to rebuild the DUKW in 1968/9. We decided to simplify the operation and to make it more reliable, even though with the first version the only real problems were the occasional replacement of the radio valves.

The front drive motor was removed together with the flexible shafts to the wheels but the pulse steering system was retained. The rudders were removed as was the cord drive system from the steering actuator. The two motors and propshafts were also removed, as we did not see the need to sail it on water. We still kept the uniselector for the speed control.

Unfortunately its further life, while it was still in England, led to some serious problems as one person who borrowed the DUKW kept it in his garden shed, where the roof leaked. This caused considerable damage to the tin plate used to make the hull on a brass angle frame.

When returned to Peter Cummins in this state it was virtually never run again.

About 1980 Peter asked me if I would take over the safe keeping of the DUKW, which I naturally did. I bought four 6 volt lead acid accumulators and ran the DUKW a few times here in Switzerland.

However, last year I decided that the DUKW should have a rebuild, using modern systems, which would be much simpler, so that other people could run the model easily. I decided to carry out a complete rebuild, taking everything apart, so that it was reduced to just the basic hull. The first thing was to knock out all the dents as well as possible and repair the rusted part of the hull. Fortunately I have a complete set of tools, as used by a silversmith, which were bought before I went on a silversmiths course. The time taken to repair the hull was considerable, as it was very difficult to get either the hammer or the anvil inside the hull. The reason for all these tools was so that I could better make locomotive parts such as steam domes and safety valve covers some years ago.

The bare hull was then prepared for painting, first with two coats of undercoat then three coats of final colour. After this the drive system with the rear wheels, as well as the front wheels, was mounted and aligned. I decided that a modern servo would be used for steering the front wheels. The rear wheels were again driven through gears from the original motor.

ABOVE
The repainted DUKW, without so many dents. The new RCMS shield can be seen at the front.

Rather than using the original uniselector I decided to use a modern speed controller, but this meant that the field winding of the motor needed to be supplied via a bridge rectifier, so that when the armature voltage was reversed the field was nevertheless always driven in the same direction.

The radio link was changed to a modern 2.4GHz control system, working with just two channels, one for steering and the other for speed control, which is now continuous from neutral to either full speed forward or reverse.

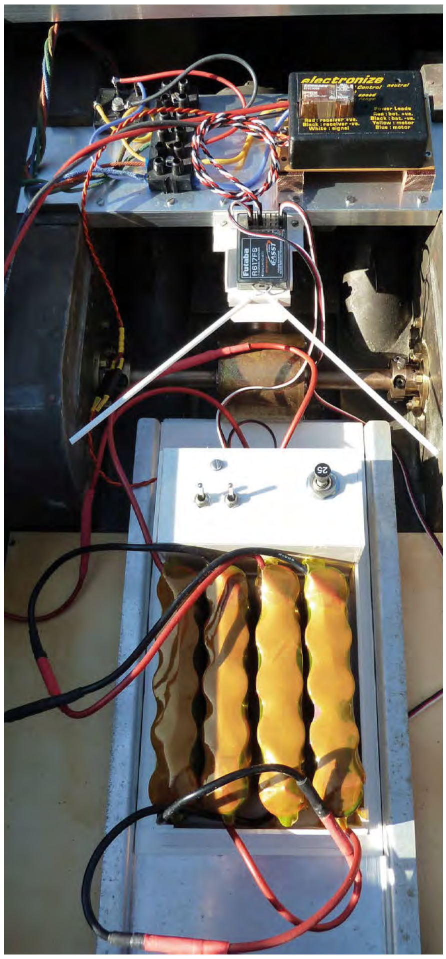
As I still have a few of the original RCMS triangular transfers I was able to get copies made for the side of the DUKW.

The power supply is twofold; there is a small 6 volt supply, namely 5-off 1.2V NiMH accumulators and 4 sets of 5 NiMH cells of 5000mA for the 24 volt motors. There are three switches; the first is a power switch for the main supply, the second is a switch for the 6 volt supply to the receiver and steering servo and, finally, the third switch is to switch on the operation of the speed controller.

I have run the DUKW several times, which has been quite a big attraction for many people. My next task is to make a video on a CD, showing it in operation, as well as detailed photos. ■

BELOW
The control system from 1989/9 – the middle box is for the 465 MHz receiver.

BELOW – The new complete replacement control system. The 2.4GHz receiver and speed controller can be seen at the rear (top of the picture).



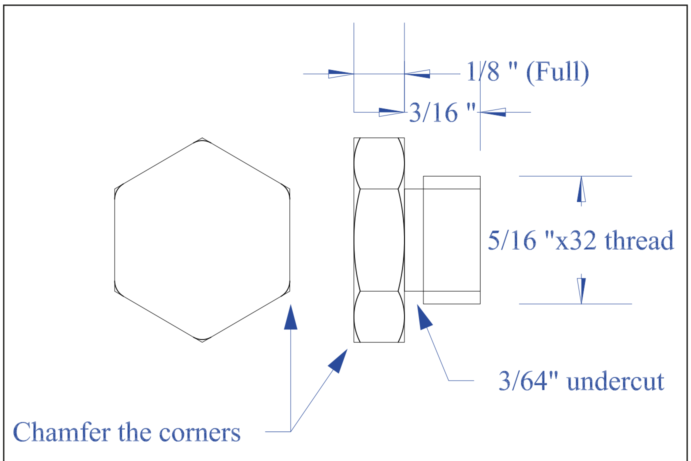
Building the LNWR Coal Engine in 5" Gauge

Hotspur describes the lubricating oil pump drive eccentric and the pipe rail

PART 18 – CONCLUDED FROM PAGE 22 JULY 2017

THE LO TANK FILLER/LEVEL PLUG

I was not able to describe the filler/level plug to complete the lubricator tank last time so a sketch for what is needed is included here. There is nothing very special about it but the 5⁄16" x 32 thread should be made using a tailstock die holder and it would benefit from a small undercut against the hexagon head to allow the die to complete the thread properly.



L. O. TANK FILLER/LEVEL PLUG
7⁄16" A/F BRONZE HEX

PUMP DRIVE ECCENTRIC AND THE STRAP CASTING

When I was thinking how I would make this part I looked carefully at just how little space there was for the eccentric and its operating arm and decided that the original eccentric sheave I have given is probably too wide. The load that will actually be imposed by the lubricator is quite nominal and the eccentric sheave itself can be reduced in width to just 5⁄16" wide with a strap groove of 3⁄16" width, instead of ¼" as originally specified. To move the centre of the strap towards the tank, I also added a recess in the bore on the tank side of the strap to accept the outside diameter of the sheave. These small changes will just move the drive arrangement slightly to the left and ensure it does not contact the brake cylinder flange.

My drawing is given here showing the strap and operating rod with the revised sizes for the eccentric itself. The completed parts are so small in section that the order of construction had to be carefully considered. I already have an eccentric strap from my Lady of the Lake design that will do the task but the cleaning up of the bronze casting and drilling for the holding screws needs to be followed by the boring operation before the majority of material is removed from the strap. This is to minimise the degree of distortion that will come from holding the thin cast sections in a 4-jaw chuck.

So my drawing shows the intended finished size after the machining and handwork has been carried out. Begin by filing down the profile of the casting to bring the flanges square all round and locally remove the excess bronze around the clamping holes. At the same time the curved surfaces of the casting can be fettled to ensure they are square for the subsequent holding

BELOW – PHOTOGRAPH 1
The eccentric strap casting has been squared up and is being initially faced for the split operation.

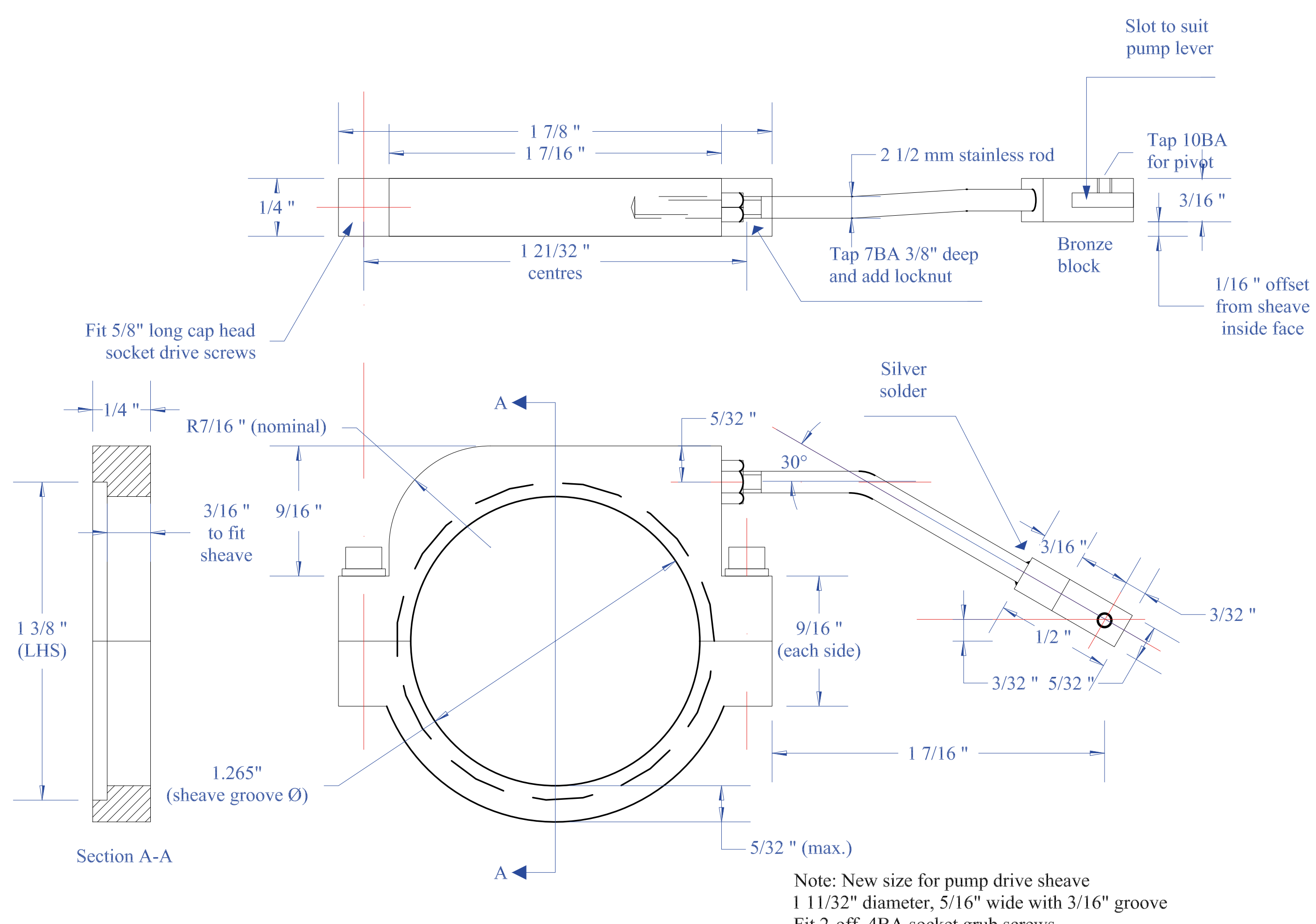
BELOW – PHOTOGRAPH 2
Making the cuts along the split line by hand. Clamp the casting horizontally to assist the straightness of the cuts.

operations. Set up the casting so that the shoulders for the fastenings are level then drill through from the side specified with a No. 43 drill as the tapping size for 6BA (normally I would use a No. 44 drill but bronze tends to be 'cheesy' and needs a bit more clearance for the thread form). Without moving the casting, counter-drill with a No. 33 drill just half way through the material to the intended split line and tap the thread.

Now the casting can be split with a fine saw and the edges cleaned up to be flat mating surfaces and the two screws fitted to hold them together again. Simple 6BA bolts can be used initially, but I have used 6BA socket cap heads screws with washers under their heads as these are easier to fit later when the parts are being assembled to the eccentric on the axle. Using a drive socket is much easier than even a tube spanner. Leave the excess thickness of material around the intended eccentric opening at this stage to give rigidity for holding purposes but it will be quickly seen that the casting is easily squeezed so be careful and do not overtighten the chuck jaws.

We can now put the casting into a 4-jaw chuck. I have a conveniently small chuck with a narrow step between the jaws and initially it is not necessary to use packing to prevent the casting being marked as it will be filed down significantly later. However, two blocks can be used to allow the lathe tool to make a full sweep and this needs checking to avoid any mishaps. Bring the casting to a width of ¼" by machining both sides and take off equal amounts either side of the clamping bolts. Now the casting can be set up to machine the bore of the strap to suit the size of the eccentric and here you will need a digital Vernier. Anticipate the size of the bore expanding slightly when the casting is released from the chuck. Note that one side of the strap is also recessed to sit over the edge of the eccentric sheave nearest to the pump tank and I hope my pictures of the assembly will show which side this is.

ABOVE – PHOTOGRAPH 3
The re-assembled eccentric strap being machined to thickness and ready for boring out. Note that here the bolt holes are farther apart than for the final assembly.



L. O. PUMP DRIVE ECCENTRIC STRAP AND LINK (BRONZE AND ST. STL)

The next operation is to check the fit of the strap over the eccentric and maybe a little de-burring and dressing with a fine file is needed to enhance the fit in the groove. After that the most strenuous task is to remove the unwanted material from the two halves of the straps; keep in mind that the screw heads need to be facing upwards so they are accessible underneath the locomotive for ease of assembly.

THE PUMP OPERATING LEVER

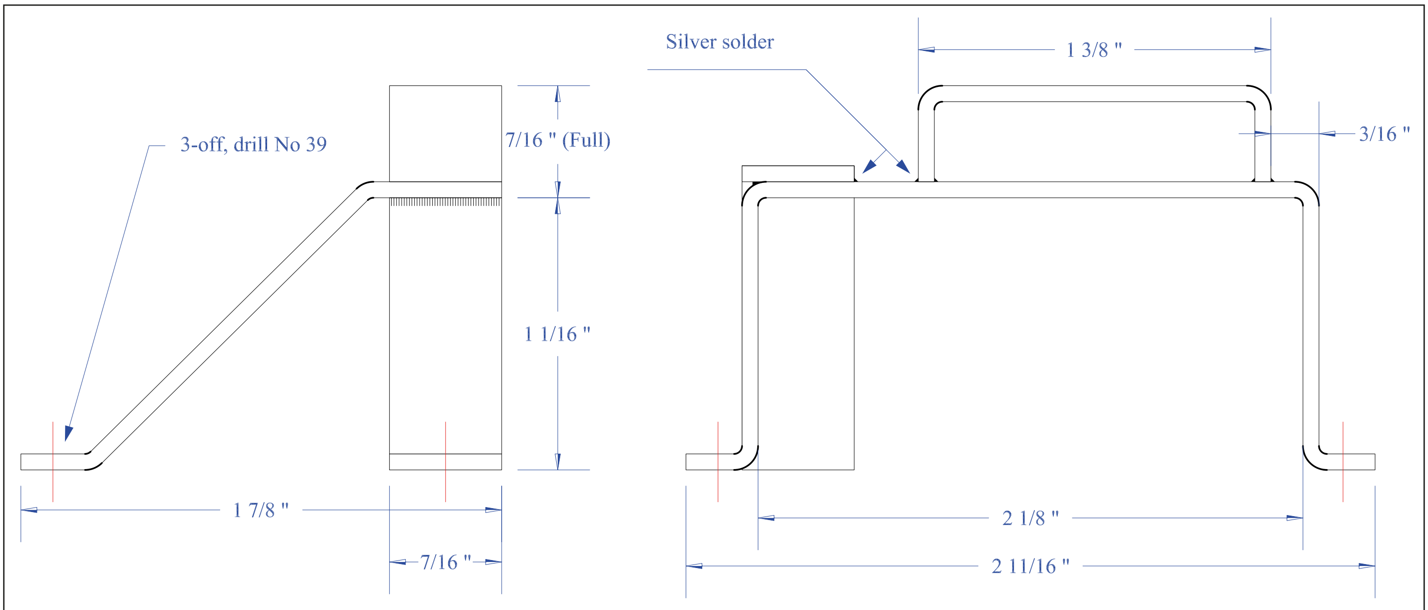
The last operation is to drill the strap for the 7BA thread for the operating rod and then thread a short length of 2½mm stainless steel rod to suit. The outer end of the pump lever is fitted with a small piece of bronze which is slit to give a slot a full 0.050" wide for the arm. The block is drilled with a clearance hole on the outside for the 10BA pivot bolt and threaded on the inside before silver soldering the block to the arm. My drawing shows the likely best shape for the arm to ensure the eccentric strap does not contact the steam brake cylinder during its operation. I found the movement of the lever was sufficient for both pawls to register across the teeth on the ratchet wheel but by chance the length of the operating rod did make a difference and adjusting the rod by screwing in the thread another turn did the trick.

ABOVE – PHOTOGRAPH 4
The completed pump drive eccentric strap with the operating arm attached; note the recess in one side to move the parts towards the tank and gain more clearance. Here new bolt holes have been added at the designed pitch.

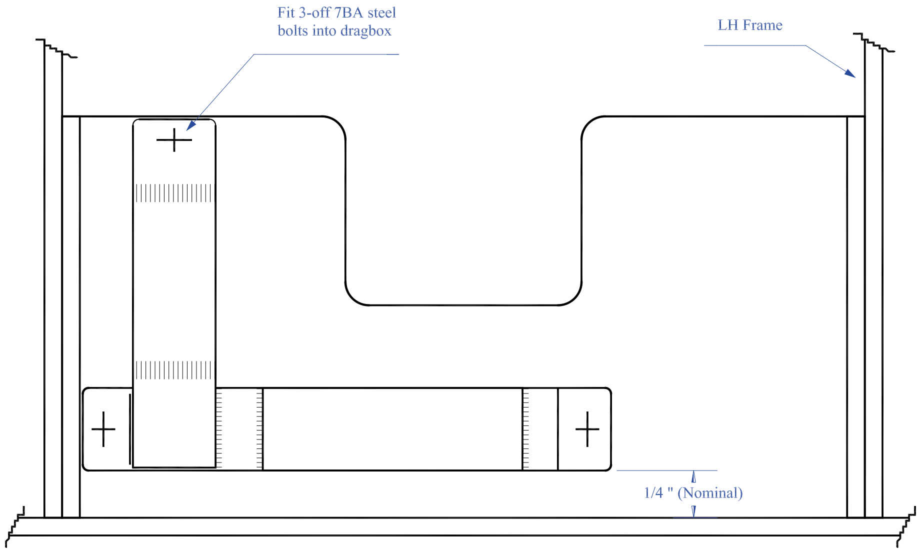
THE PIPE RAIL

The last part to be fabricated and attached underneath the right hand side of the dragbox is the rail to support the pipes coming from the tender. There is nothing very complicated about this item and I formed mine from strips of 1⁄16" thick steel strip before silver soldering the parts together. Note that the loop provided to locate the pipe fittings is shown as more than ⅜" deep to allow the pipe union some easy movement sideways after connection to the tender, which has a similar arrangement. I am not expecting the locomotive to have more than a pressure feed pipe from the tender hand pump and one water feed to an injector.

PHOTOGRAPH 5 AND 6 – Two views of the pipe rail frame parts set up for silver soldering.

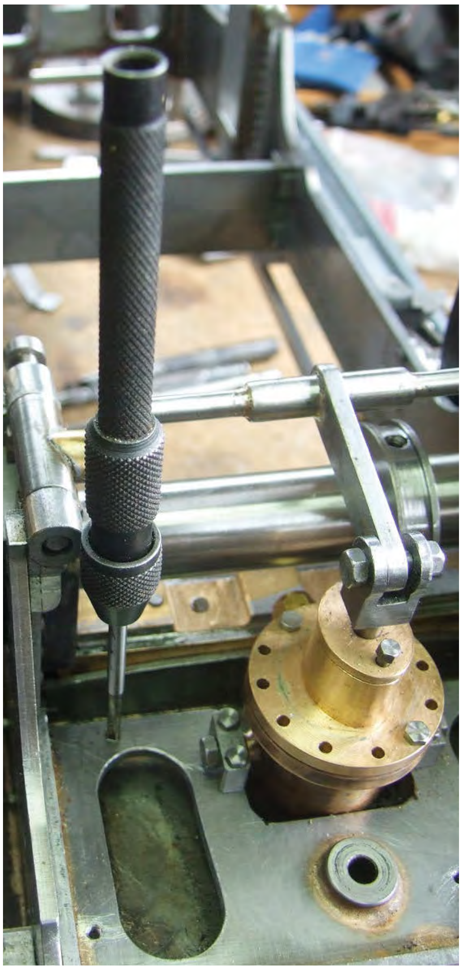


PIPE RAIL FABRICATION (1⁄16" x 7⁄16" MS)



VIEW UNDERNEATH DRAG BOX
SHOWING LOCATION OF PIPE RAIL

LEFT
PHOTOGRAPH 7
The front fixing hole in the dragbox was awkward to drill so a pin-vice chuck in a hand brace was used to gain access.



LEFT
PHOTOGRAPH 8
Similarly, the tapping of the holes in the underside of the dragbox was carried out with the tap held in a pin-vice.

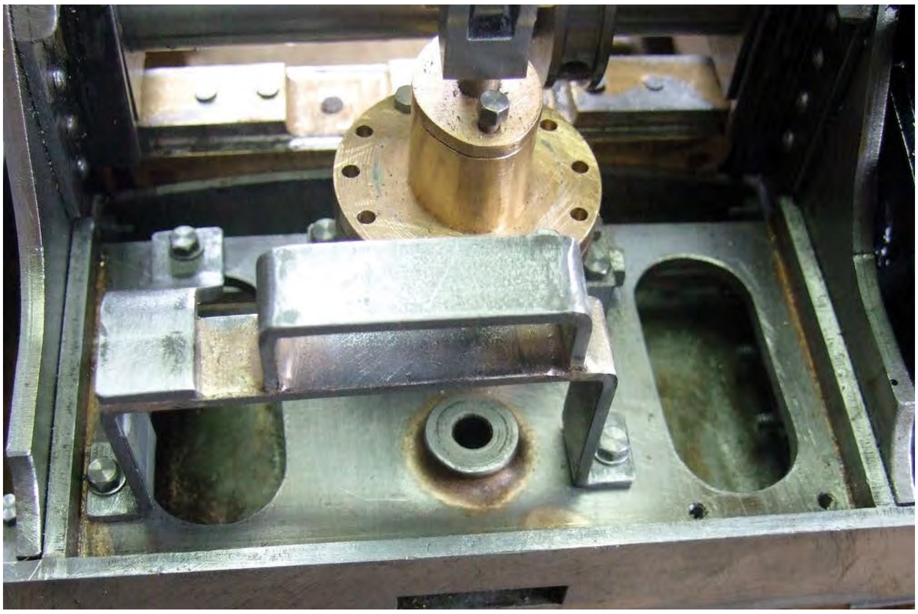
BELOW
PHOTOGRAPH 9
The final assembly of the pipe rail with some room left in front for an injector.

Each of the three flanged legs was then drilled No. 39 and three matching holes were drilled with a No. 48 drill into the lower plate of the dragbox and tapped 7BA, just like the fixings for the LO pump tank. I drilled these holes without dismantling the dragbox as I am quite used to making such drillings by hand. However, the access for one of the hole positions was difficult, so I used a pin drill chuck and held this in my hand brace so there was sufficient clearance, and my picture shows what I mean.

After making these parts I dismantled the additions behind the rear axle to prime and paint the chassis and the other steel items. For re-assembly the order has to be the brake cylinder first, then the pipe rail and finally the LO pump and drive.

This has been an interesting project and I am encouraged that several model engineers are now undertaking the build of the locomotive. Anyone wishing to keep up with what I am doing can look at my website at: www.hotspurdesigns.net or reach me on email at: hotspurmodels@outlook.com

Good luck to you all. ■



Elsecar Heritage Centre

Malcolm takes us on a brief tour of the Newcomen pumping engine at the Elsecar Heritage Centre

BY **MALCOLM HIGH**

Elsecar Heritage Centre is located just south of Barnsley and can easily be accessed from junction 36 of the M1. Run by the local council, it is home to a number of interesting buildings, a standard gauge railway and a Newcomen engine, believed to be the oldest steam engine still in its original location.

Elsecar New Colliery was sunk in 1795 to the Barnsley seam at a depth of one hundred and twenty feet. Although relatively shallow the mine suffered from flooding and the 4th Earl of Fitzwilliam ordered a Newcomen beam engine to be built to extract the water. This allowed the mine to be deepened to access the Parkgate seam at a depth of one thousand feet. The engine ran continuously until 1923 when it was replaced by electric pumps. The only major alterations to the engine were made in 1836 with the addition of parallel link motion and a cast iron beam. Restoration of the cylinder was carried out by the NCB in 1983; it was still considered useful as a back up to the pumps. Major conservation work was done between 2011 and 2014 when a hydraulic system was installed to allow the engine to move once more.

Our tour started outside where a very informative guide gave us the history of the engine and the mine. Moving inside, the engine was then run for a few minutes; this allowed the motion work to be seen in operation, and very simple it is too. The engine runs at approximately half the speed it would have when operational. From there, access was allowed to the upper floors; normally this is fenced off and is only available on operational days. The steps are very steep and narrow.

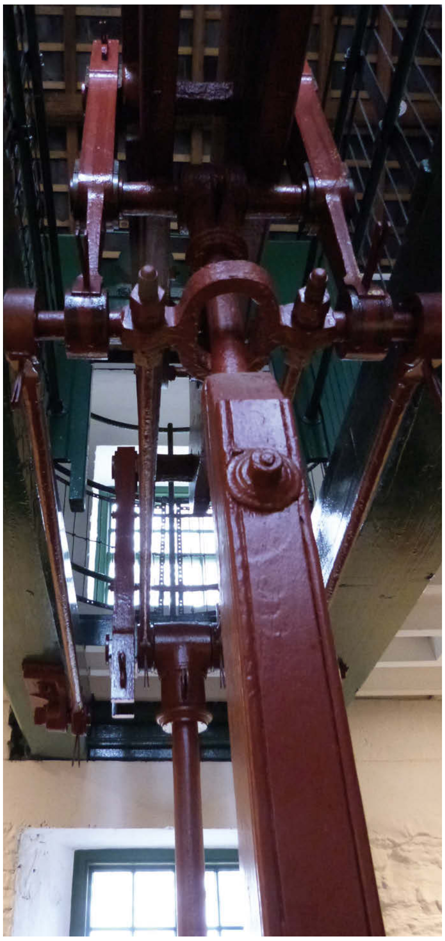
On the first floor the top of the cylinder and the piston can be seen. Again, the engine was run so the piston can be seen going up and down in the cylinder. On the top floor you are level with the main beam and the parallel motion can be observed at close quarters.

Considering the machine tools available in 1795 some of the components must have taken days to make. How they managed to lift the main beam into place without a large crane or any form of motive power other than brute strength and a few horses is a mystery.

ABOVE
The Newcomen engine at Elsecar Heritage Centre.

The Elsecar Heritage Railway is located between the main centre and the Newcomen engine. Volunteers run the railway most Sundays from Rockingham station along the Dearne and Dove canal to its terminus next to the canal basin at Hemingfield. There are a variety of industrial locomotives, both steam and diesel.

The main centre is on the site of the former ironworks built by John and William Darwin & Co in 1795. The ruins of the buildings can still be seen today. The present buildings were built in 1850 to service the colliery and the extensive Fitzwilliam estate. Ornate ironwork is still visible on the exterior of the buildings. The workshops were taken over in 1947 by



ABOVE
Some of the old workshop buildings where the 16mm Yorkshire group hold their annual exhibition.

LEFT
The parallel motion work.

BELOW
The cylinder and valve gear on the Newcomen engine.

the National Coal Board. With the closure of the mines they were purchased by Barnsley Council in 1988 after having been listed as being buildings of special interest by the Department of the Environment in 1986.

The restoration work has been done very sympathetically so the buildings still have a very old feel to them. There are a number of cafes, antique centres and craft shops in the old workshops, many of which add to the charm. The main hall is used for special events and it is here the 16mm Yorkshire group have their exhibition. The next one is over the weekend of 23rd and 24th September 2017. This is an excellent show, popular with all ages. There are a number of running tracks in operation with a good selection of traders.

The centre itself is free to enter and has a large car park, which is also free. For special events additional parking is arranged across the road. With such a variety of activities to choose from the centre is a popular family attraction. Details of events, running days and opening times can be found on their web site, which is very informative: www.elsecar-heritage.com ■

BELOW
0-4-0 'Birkenhead' built by George Stevenson and Hawthornes Ltd in 1948 setting off with the first run of the day.

Workshop Woes

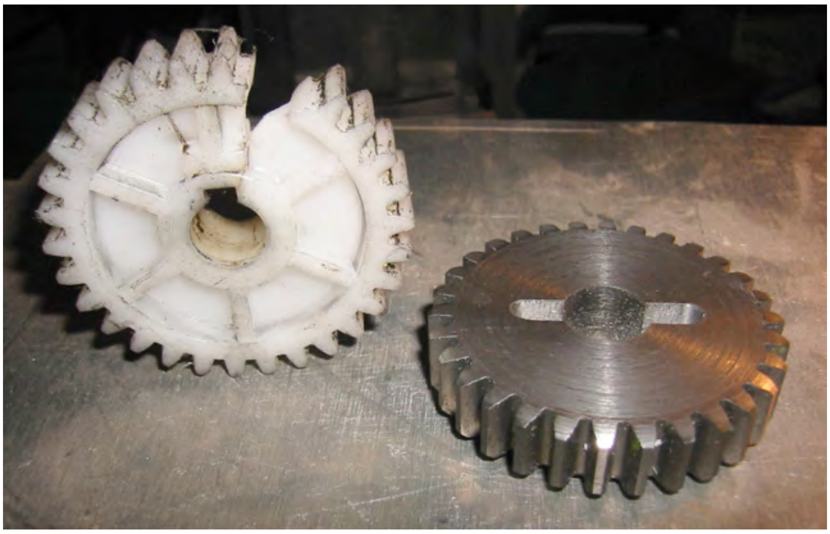
Jan-Eric goes through the mill

BY **JAN-ERIC NYSTRÖM**

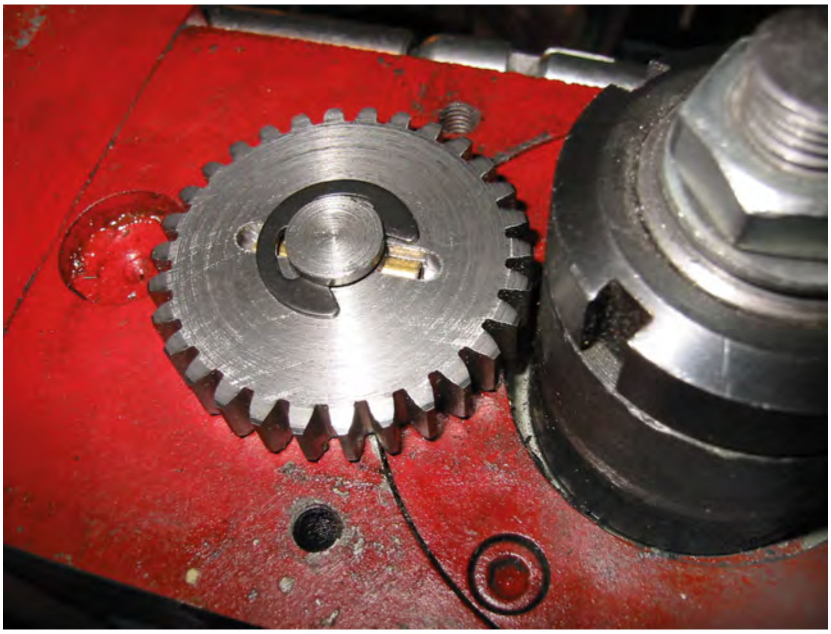
Some years ago, when I started planning my second Live Steam locomotive, I decided I needed a mill. All the milling work for the first locomotive had been done on my lathe and that was quite a hassle sometimes, having to mount the vertical slide onto the lathe, and not being able to quickly switch from turning to milling and back. So, looking at what was available, as well as the limited budget and how little workshop space I had, I settled on a small vertical table-top mill of Asian manufacture.

This type of mill has a dovetailed column, which is a definite plus. I've seen identical, or at least very similar 'mini-mills', advertised in British magazines and on the internet for around £800 or so under various brand names and in various colours – it appears to be a pretty common mill type.

Buying this little machine from a supplier in Finland was cheaper than ordering it from the UK, due to high international shipping charges - even though the mill is small, it's pretty heavy. I expected it to be a tool suitable for my purposes i.e. making parts for my Live Steam engines. Sure, like many other Asian tools, there was a need for adjusting the gib strips and other moving parts to minimize slop and backlash but, after that, I was pretty satisfied with its performance, until...



RIGHT PHOTOGRAPH 1 A cracked plastic gear wheel and its replacement. Note the different keyways.



RIGHT PHOTOGRAPH 2 The replacement in position. A hollow brass pin provides a break-off safety feature.

CRASH!

While boring out an axle box of cast iron I suddenly heard a loud bang from inside the mill, which stopped abruptly – with the motor still spinning! The tool had dug into the cast iron, causing a plastic gear wheel to crack (photograph 1).

Fortunately, the importer of the mill had a few of these gear wheels in stock, and they weren't all that expensive, so, expecting some future dig-ins, I bought a handful of spares, thinking that I'd be all set for the foreseeable future...

Alas, that was not to be. The mill showed a tendency to dig in whenever I milled anything substantial. This might have been due to some of my work exceeding the capabilities of the mill, or taking too deep cuts, but also because a small mill like this is not very rigidly built. Any flexing will increase the risk of a dig-in.

Even though the mill has a dovetailed column, the vertical feed is not very well designed – the fine-feed wheel uses reduction gearing to operate the rack-and-pinion main feed, which is not as accurate as a direct screw feed. There is some definite slop in the mechanism and this was probably the main cause of the dig-ins. So, this meant I quickly ran out of the spare gear wheels!

With the last one installed, I decided I needed to do something about it. Fortunately, a local supplier of industrial components had a large selection of steel gears in stock, and I found an exact replacement for the plastic gear. Milling a slot in the new gear, as seen in photograph 1, meant that I didn't have to make a keyway. By turning a clip ring groove and drilling a hole in the mill's axle, I could secure the gear to the axle with a hollow brass pin (photograph 2). I assumed this pin would break well before any other damage would occur if the mill was stressed too far. How wrong I was!

MORE DAMAGE

A small mill like this really isn't suitable for all of the work involved in building a 1.5" scale steam locomotive but, since I had nothing else, it would have to carry out all the tasks I required it to do. I tried to be careful but when boring holes of more than an inch in diameter in cast iron or steel, with a vertical feed that is a bit sloppy due to the original design and the less-than-stellar workmanship (this is a cheap mill), you can't really help it, if the tool digs in. I did break a few of my hollow brass pins, with no other damages, so I assumed everything was OK – for a while, until I heard another crash, this time much louder, with a clinkety-clank addition. The mill spindle had again stopped, the motor spinning wildly...

This time, the brass pin was not broken so I had to dig a bit deeper into the innards of the mill to find the cause. Inside the gearbox, I found two double gear wheels, keyed to the axle with ordinary key slots. But – both wheels were made of plastic! This really surprised me; I could understand one easily accessible plastic wheel as being a security measure – but the entire gearbox being plastic!!??!!

The two gear pairs were beyond repair. The larger one had a sheared keyway and broken teeth while the small one was totally smashed – see photograph 3. The supplier/importer of the mill did not have any spares in stock and new gears would take an eternity to arrive if ordered (or, at least it would seem like an eternity to me, with all my building projects half-way!).

THE REMEDY

Back to the supplier of steel gears! In their catalogue I found four suitable gears, not quite identical to the originals (they had a slightly different pitch, or module), but with a suitable choice of gear teeth numbers, and the distance between the axles would still be the same, to a tolerance of just a few hundredths of a millimeter. The gearing ratio with these wheels would also be a bit different, but only by 10% or so.

The reason for the special double gears is that this mill has a two-speed gearbox. One of the double gears can be slid on its axle by moving a lever, giving a different gear ratio when it connects again to the other gear. The axle has a very long key to transfer the torque; the keyway in the gearwheel is always in contact with the key as it slides along.

Some lathe work later, I had modified the four simple steel gears I had purchased into two replacement gear pairs, seen on the right in photograph 3. The bosses on the steel gears were turned to shape and securely attached to each other using countersunk screws and Loctite, thus copying the shape of the original plastic gear pairs as closely as possible.

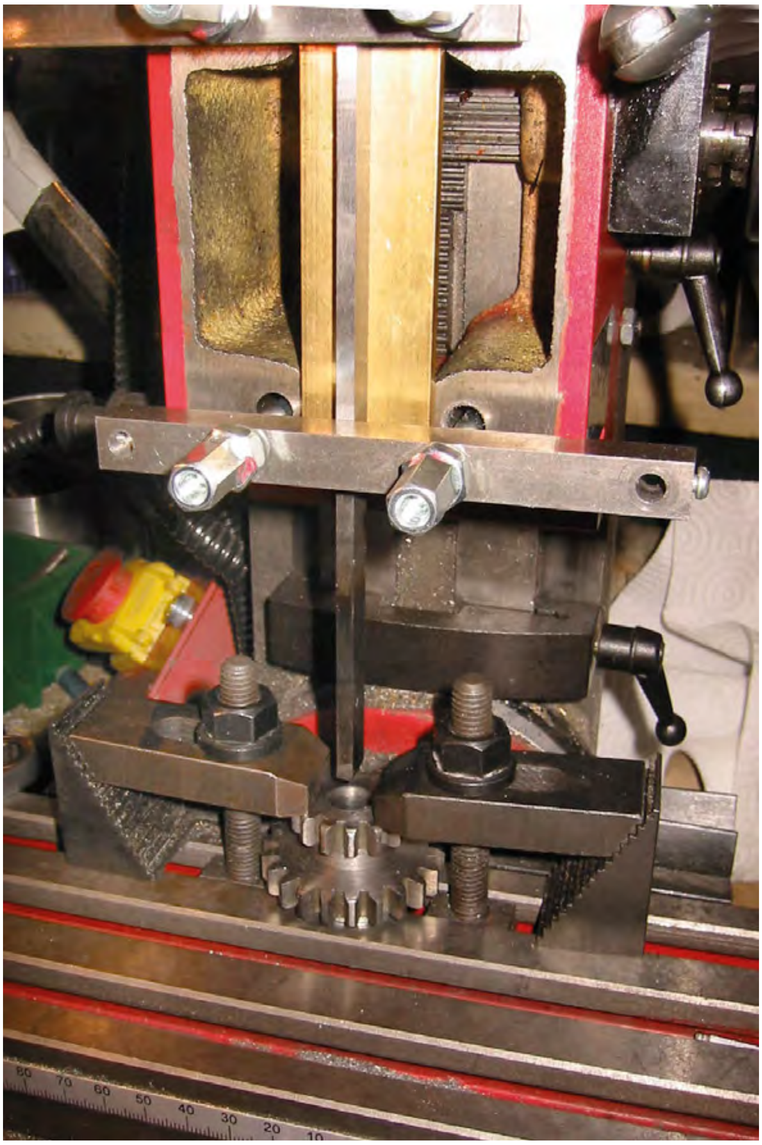
There was still one important feature missing, though – the keyways! How do you gouge out an internal keyway? In industry, it can be done with a shaper or a special broach. It is not impossible for an amateur to fabricate a keyway broach – you can get some ideas of the right shape from a machinist's handbook or from http://en.wikipedia.org/wiki/Broach_(metalworking) – but I didn't have the patience to make such a special tool for just two keyways. It is also possible to use the carriage on a lathe as a shaper, but I noticed I had an even simpler solution to the problem staring right in my eyes; the disassembled mill!

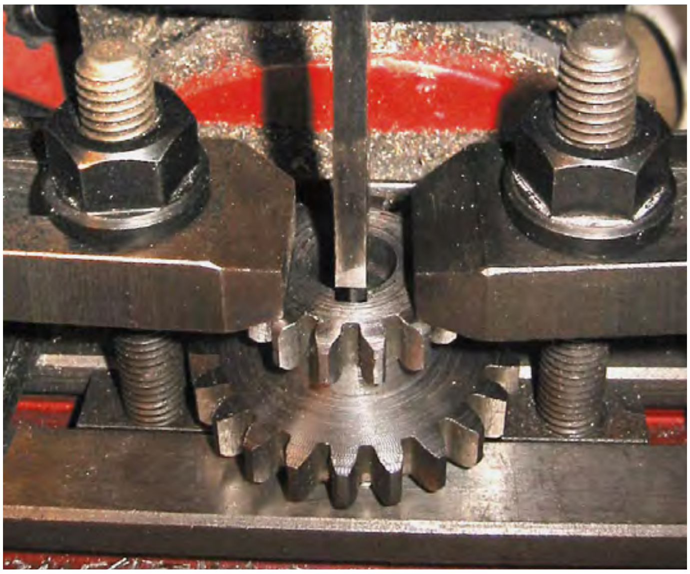
The mill head, on its dovetail column, could be racked up and down, while the mill table provided a precise feed. It was an easy job to take a long piece of gauge plate (a rectangular, hardening steel material, similar to 'drill rod' or 'silver steel'), shape the end of it, heat, harden and temper it, and Presto! – I had a keyway cutter!

Attaching this quite rigid piece of steel to the mill (using existing bolt holes in the mill head and a few pieces of brass and steel for clamping), I had a makeshift shaper (photograph 4). Racking the mill head up and down, and feeding a couple of thou before every downstroke, I could quickly gouge out the keyways in the two gear pairs (photograph 5).

ABOVE
PHOTOGRAPH 3
Smashed plastic gearbox parts and their replacements, fabricated from standard, stock steel gears.

BELOW
PHOTOGRAPH 4
Using the disassembled mill as a shaper.





LEFT – PHOTOGRAPH 5 – A close-up of the cutting of the keyway.

ABOVE – PHOTOGRAPH 6
The cooling fan in the motor had worked itself loose – this required another repair job.

PROBLEM SOLVED?

Now I thought I was finally done... No, not quite, it turned out – this little mill really talked back to me! Boring yet another cast iron axle box (so far, at this writing, I've done 44!), I suddenly heard a different, alarming noise from the mill; this time, a loud rattle. It was time to diagnose a new, different problem. It turned out that, contrary to the old adage, it was not any stuff hitting the fan, but the fan itself hitting the inside of the motor cover...

The half-horsepower motor powering the mill has an internal fan to keep it cool. This fan was only press-fitted onto the axle, and with all the heavy work the mill had done, the fan had worked itself off its seat (photograph 6).

This necessitated an almost complete disassembly of the motor; I had to extract the brushes, remove the rotor, and pull off the bearing from the axle in order to re-attach the fan, by 'riveting' it to its seat – yes, simply with a hammer and a centre punch.

Finally, the mill was in a condition that I would have expected it to be from the start, i.e. having steel gears, a breakaway pin for safety, and a fan that wouldn't work itself loose. Phew – quite a few hours were frittered away on these shortcomings! But hey, who counts hours – this is a hobby, right?

Fortunately, there have been no further problems, even though I've used the repaired (you could almost say re-built) mill for several years now – knock on wood! If you have, or intend to buy a mill like mine it may be a good idea to check the availability of spare gears, and whether your particular unit has plastic or metal gears. From what I've heard, this type of mill is made by several factories in Asia and some may have better specifications than others. In any case, you now know that it is possible to re-build a plastic gear box into a steel one! ■

PRODUCT REVIEW

EXPO THIN COMBINATION SPANNERS

Code 780-90. £14.95 RRP

This set of small spanners from Expo is highly useful. It has a good range of sizes with different sizes at each end. These have a real advantage over standard open ended ring combination spanners in that they are very thin yet at the same time strong. In a situation where a locknut has been used it is actually possible to get a spanner on both nuts, which is a complete impossibility with the usual thicker standard versions – see photograph for comparison, with an M4 nut, between the Expo example and standard spanner.

The thin width is also of great advantage in some situations and I have found that they are the only tool I have which enables me to see what is going on when adjusting the gib locknuts on my Sieg Miller. The space is tight and the standard open ended spanner is double the height of the nut making observation almost impossible, but not so with these. In addition, when a through nut and bolt is being fitted, one does not have to resort to using pliers or buying a second set to have two of each size.

Normally, with a ring open ended combination, both ends have the same size. Not so with this Expo set where the ring is one size up/down on the open end. They have a satin finish and are pleasant to handle. The spanners really come into their own for the smaller sizes of fixings, their short length being great for all nuts under M6.

The set contains 3.2/4/5/5.5/6/7/8/9 and 10. Sizes 4 – 9mm have both an open ended and a ring spanner.

Graham Sadler

The EIM Steam Plant – The Engine

Martin Gearing completes the manufacture of the parts of the engine by making the piston, crank and connecting rod

BY **MARTIN GEARING – PART 9 –** CONTINUED FROM PAGE 17 JULY 2017

CRANK DISK – ITEM E18

Ø1 ½" x 1" Stainless 303
Refer to – Drawing E18

The material supplied is in the form of bright bar, allowing the use of a self-centring chuck, and may be held with 3mm protruding set against suitable thickness packing to ensure the sawn face runs reasonably true. See photograph E52.

NOTE – Remove the packing!

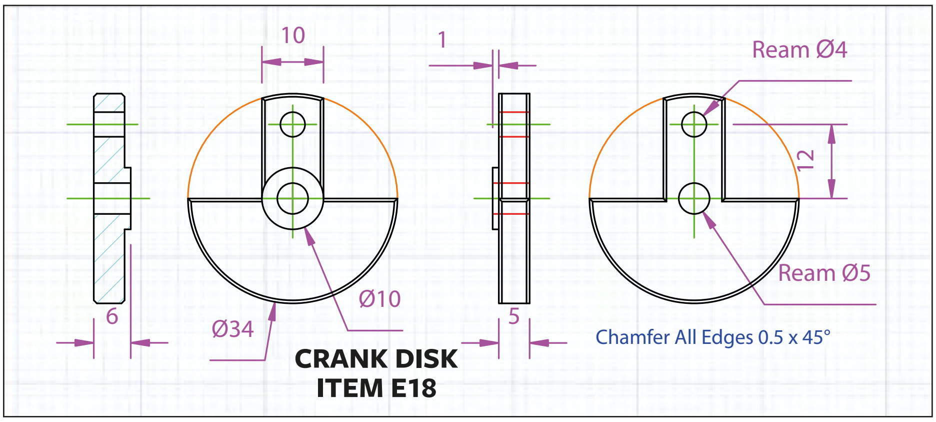
Face off and turn around. The blank now needs to be set against packing as near as possible to 4mm less than the distance between the back of the chuck and outward face of the chuck jaw, before the chuck is tightened.

NOTE – Remove the packing!

Face off to 6mm thickness and then, using a sharp right hand knife tool turn the Ø10 x1mm centre boss.

Transfer it to the milling machine and hold on suitable parallels sufficient to bring it near to the top of the vice jaws.

Centre the machine spindle between the two jaws on the Y-axis. Clamp the slide. Centre the machine spindle to the centre of the disc on the X-axis. Zero the X-axis feed dial and clamp the slide. Centre drill, drill Ø4.8mm and ream Ø5mm. Move 12mm on the X-axis and clamp the slide. Centre drill, drill Ø3.8mm and ream Ø4mm. Remove from the vice and lightly deburr both sides of the holes. See photograph E53.



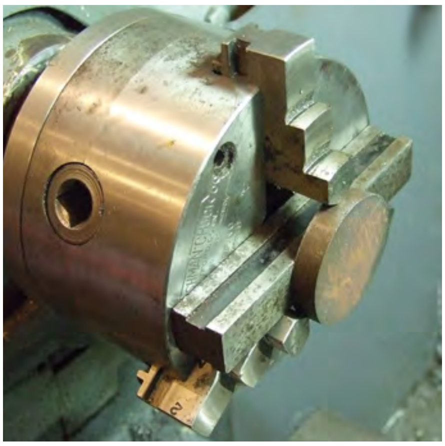
Transfer the disc to the lathe and carefully grip in a self-centring chuck with the Ø10 x1mm centre boss facing outwards, setting against parallels to ensure that the face runs true. Hold the chamfered end of the crankshaft lightly in the tailstock drill chuck and apply a drop of Loctite retainer to the central Ø5mm reamed hole and a drop on the end of the crankshaft.

Move the tailstock chuck forward until the shaft enters the hole and rotate the lathe spindle by hand a couple of turns to ensure the retainer is evenly distributed. If you insert one of the parallels used in setting up so that it lays across the centre of the disc it will act as a stop to prevent the shaft going too far through the disc. Do not move the assembly until the retainer has cured. See photograph E54.

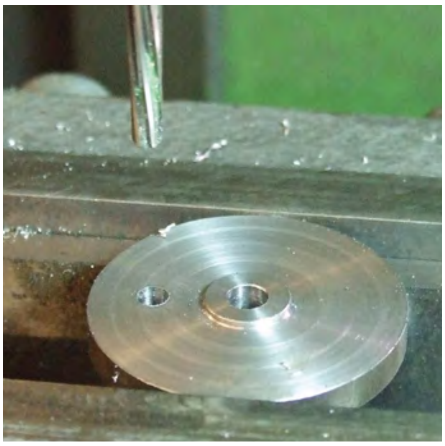
After a suitable time, I would say an hour at least, remove the assembly and install the crankpin after applying a drop of retainer to the hole and end of the crankpin before inserting the pin, rotating it as you do so, making sure that you stop when it becomes flush to the back surface. Hold lightly in the tailstock chuck on the crankshaft and leave to cure.

After a suitable time hold the crankshaft, ideally in a collet or accurate self-centring chuck, then use a sharp right hand knife tool – taking cuts of no more than 0.2mm depth – to reduce the outside to Ø34mm. Chamfer both outer edges 0.5 x 45˚, paying particular attention not to damage the rotating crankpin with the tool. See photograph E55.

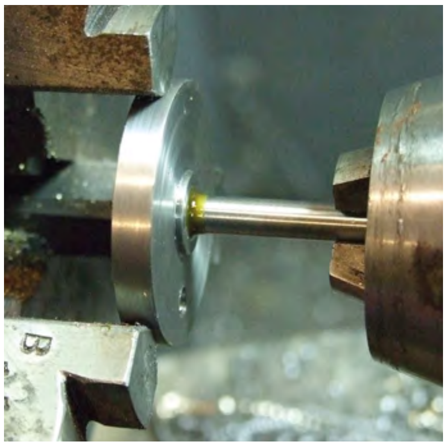
BELOW – PHOTOGRAPH E52
Crank disc – 1st stage. Setting crank disc blank to run true.

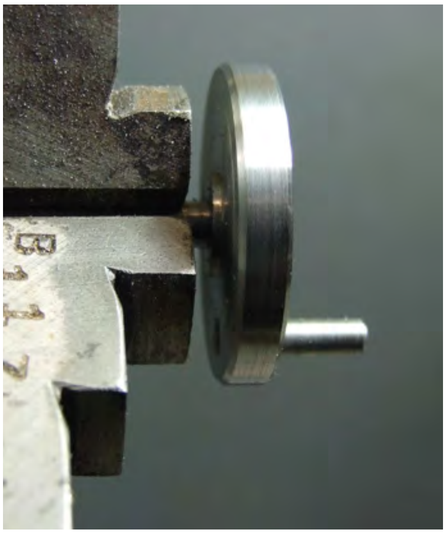


BELOW – PHOTOGRAPH E53
Crank disc – 2nd stage. Reaming holes for crankshaft and crankpin.

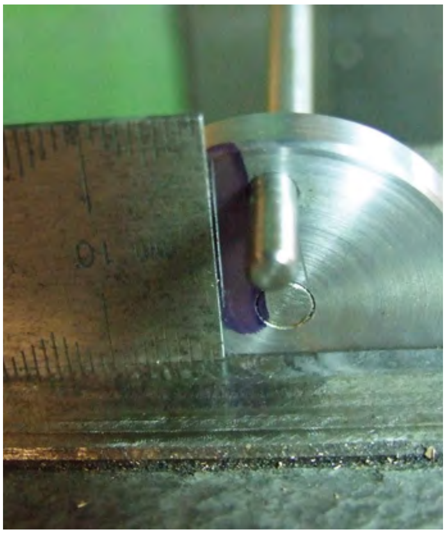


BELOW – PHOTOGRAPH E54
Crank disc – 3rd stage. Location of crankshaft whilst retainer cures.

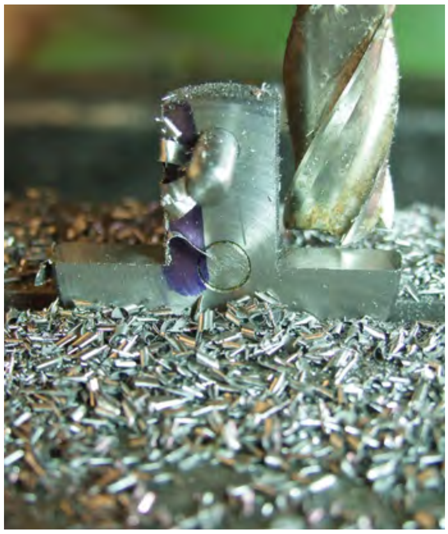




ABOVE – PHOTOGRAPH E55
Crank disc – 4th stage. Outside diameter and chamfers machined.



ABOVE – PHOTOGRAPH E57
Crank disc – 6th stage. Setting crank disc shaft and pin centres vertical to vice jaw.



ABOVE – PHOTOGRAPH E58
Crank disc – 7th stage. Crank disc webs machined.

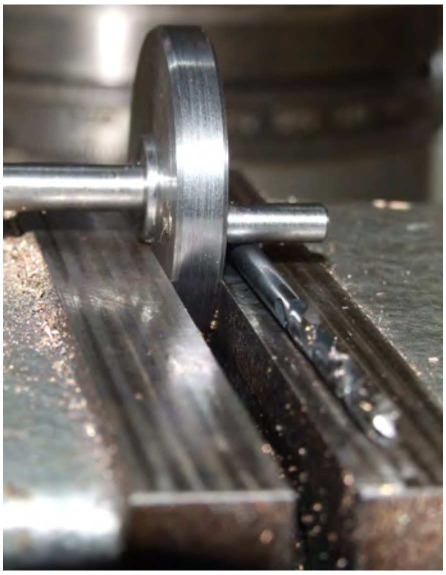
Mark the area between the crankpin and the middle of the disc with a permanent felt tip marker. Hold the crank disc lightly in the milling vice with the bottom edge of the Ø10 boss resting on the top of the fixed jaw and the crankpin resting on the un-damaged shank of a Ø3mm drill laid between the crankpin and the top surface of the moving jaw. Tighten the vice.

See photograph E56.

Using a sharp fine scriber, scribe a line from the outside edge of the disk where the crankpin is located to just short of this centre. Slacken the jaw sufficiently to allow the disc to rotate about the Ø10mm boss and line up the scribed line with the end of a steel rule resting on the top of the vice jaw. This will have the effect of aligning the centre line between the crankshaft and crank pin to 90° from the horizontal surface of the vice jaw.

See photograph E57.

BELOW – PHOTOGRAPH E56
Crank disc – 5th stage. Setting crank disc shaft and pin centres parallel to vice jaw.



Now follow the procedure below:

- Zero the spindle to the centre of the crankpin on the X-axis.
- Zero the feed X-axis dial.
- Using a sharp, preferably Ø12mm or larger, end mill, touch the end onto the top edge of the crank disc.
- Zero the Z-axis feed dial.
- Move the work on the X-axis 5mm + half the diameter of the cutter being used to one side of the crankpin (zero) and clamp the X-axis slide.
- Run the cutter clear of the disc – keep in mind that the work needs to be fed AGAINST the cutter rotation to prevent grabbing caused by climb milling which usually results in the destruction of the workpiece or cutter and sometimes both. (Don't ask how I know this!)
- Feed up on the Z-axis 1mm. Then slowly feed the disc 1mm past the cutter on the Y-axis until the cutter clears the work, returning back to the start. Repeat in 1 mm steps on the Z-axis until the 17mm dimension is reached.
- When the full depth of 17mm depth is achieved lower the work on the Z-axis to zero.
- Move the work on the Z-axis 5mm + half the diameter of the cutter being used to the other side of the crankpin (zero) and clamp the Z-axis slide.
- Repeat machining away the second side of the crank disc. NOTE – This time after increasing the depth on the Z-axis you will be feeding the work past the cutter in the opposite direction to satisfy the requirement of the work being fed AGAINST the cutter rotation.

See photograph E58.

- Remove the work and, with a fine file, produce a 0.5 x 45° chamfer on the flat edges to match that on the outside diameter.

Finally insert the crankshaft into the bearing block and fit the flywheel. Install the securing M4 grub screw very carefully, stopping as soon as you sense it touch the crankshaft. Loosen the grub screw by at least two turns, and remove the flywheel. You should see on the crankshaft a very faint 'witness' mark where the grub screw touched the shaft. If not repeat tightening the grub screw a little more than before but not so tight as to raise a burr that will make the flywheel difficult to remove, damaging the fit. Using a fine file you need to produce a flat in the shaft about 0.5mm deep approximately 2.5mm either side of the 'witness' mark. This is to allow the flywheel to be removed after the grub screw has been tightened as any burr raised by the end of the screw will be below the diameter of the shaft.

See photograph E59.

BELOW – PHOTOGRAPH E59
Crank disc – 8th stage. Flat for flywheel securing screw.

BIG END – ITEM E19

Ø1/2" x 1" LG2
Refer to – Drawing E19

INITIAL MACHINING

The material supplied requires preparation using the same process used to produce the rectangular blanks for the main engine components.

Initially set the material on a parallel in the vice sufficient to bring the top surface about 4mm above the vice jaws and take a cut along the length 2.2mm deep. This will be your first datum, which is placed against the fixed jaw, and the second datum is then machined to a depth sufficient to just lose any trace of the diameter where the two flat surfaces meet.

From these two surfaces produce the square 8 x 8mm dimensions. If the 8mm square section is then located on a parallel so that one end is clear of the vice jaw ends, the side of the end mill may be used to square the end.

Remove it from the vice, mark a distance 12.5mm from the faced end, and saw apart. Return to the mill and bring to 12mm length.

Clamp in the vice on suitable parallels to bring the end about 5mm above the vice jaws. Check that the blank is vertical – because of the size I found using the end of a 12" steel rule was easiest, and double checking from both sides to make sure the blank was vertical.

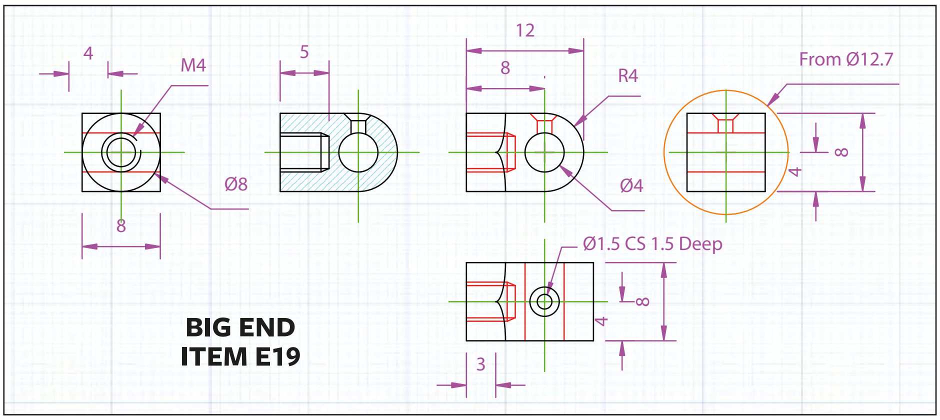
Zero the spindle to the centre of the blank on both the X and Y axis and clamp the slides.

Centre drill, drill Ø3.3 x 5mm deep and tap M4.

See photograph E60.

Turn the block onto one side. Hold on a suitable parallel to bring the blank just above the vice jaws and align the spindle to the centre of the vice jaws on the Y-axis, and to the threaded end of the blank on the X-axis and zero the X-axis feed dial. Move the spindle 8mm further on and lock the slide.

Centre drill, drill Ø3.8 x 5mm and ream Ø4mm.



Turn the block 90˚ and align the spindle to the threaded end and zero the X-axis feed dial. Move the spindle 8mm further on and lock the slide.

Using a centre drill with a 1.5mm pilot, drill into the reamed hole continuing so as to form a 1.5mm deep countersink with the 60˚ section. This forms the oil hole.

See photograph E61.

Remove the work from the vice and, holding firmly the piston rod with suitable protection to prevent marking, screw on the big end until tight.

Holding the piston rod ideally in a collet chuck – or true running self-centring chuck with protection between the jaws and the rod – use a tool with the tip ground to a radius of approximately 3mm to machine the Ø8 x 3mm as indicated. Machining will be speeded up by using an end stop between the right-hand end of the saddle and the tailstock.

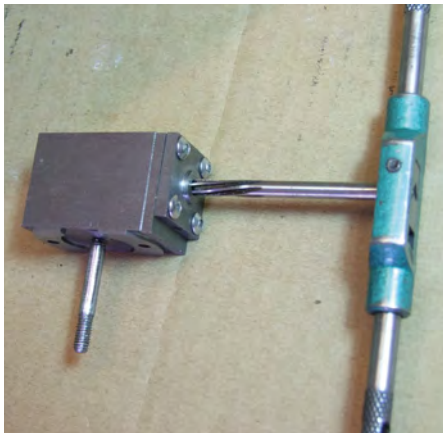
See photograph E62.

Assemble the main bearing and port block to the base. Install the crankshaft into the main bearing block. Assemble the rod end cover followed by the gland cover and secure with four M3 bolts. Check that the piston rod passes freely through the assembly and covers and, if necessary, run a Ø4 reamer through to ease any misalignment of the assembled covers.

See photograph E63.

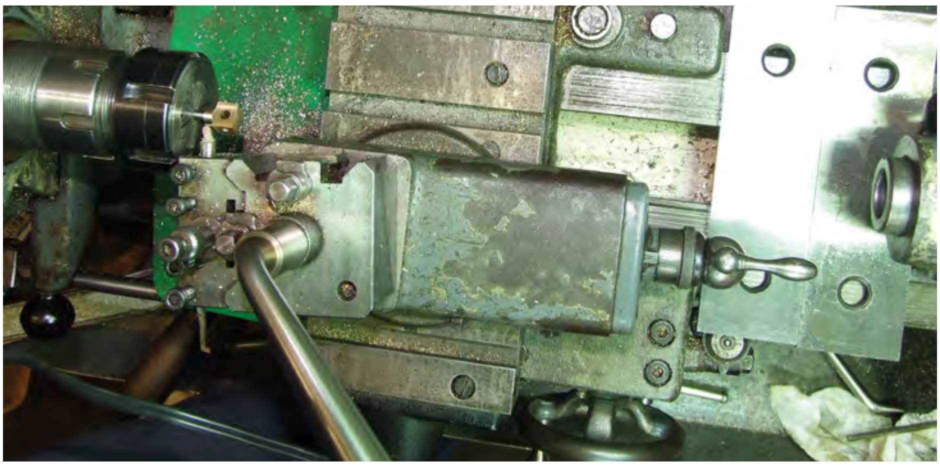
BELOW – PHOTOGRAPH E61
The oil hole completed in the big end.

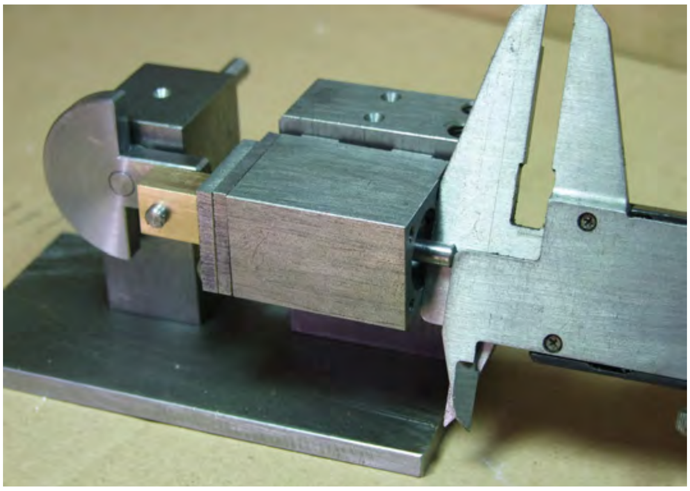
BELOW – PHOTOGRAPH E63
Checking the alignment of the gland diameter on the covers when assembled.



BELOW – PHOTOGRAPH E60
Threading the big end for the piston rod.

BELOW – PHOTOGRAPH E62
Turning the big end profile.





LEFT – PHOTOGRAPH E64
Measuring the piston rod protrusion.

BELOW – PHOTOGRAPH E65
Filing buttons for big end.

BRINGING THE PISTON ROD TO LENGTH

Assemble the Main Bearing and Port Block to the base, cutting the countersunk screws to length if required, then install the Crankshaft to the Bearing Block. Pass the assembled big end and piston rod through the end covers of the cylinder block and carefully locate the cylinder pivot bolt into the port block Ø4mm reamed hole and the big end onto the crankpin. Push the cylinder block into full contact with the port block, which will be made easier by rotating the crankshaft. Rotate the crank disc so that the crankpin is at its closest to the gland cover. This position is called the 'top dead centre', or TDC for short, and results in the piston being at its limit of travel and closest to the top cylinder cover. It is necessary to measure how much of the piston rod protrudes out of the end of the cylinder block and calculate how much needs to be removed so that the piston when fitted doesn't hit the cylinder cover. This is an important dimension and I recommend that you check it more than once to ensure that it is absolutely correct.

See photograph E64.

To this dimension add 1mm, and note it down. Remove this amount from the plain end of the Piston Rod by holding the rod, preferably in a collet chuck, or self-centring chuck (protect the rod surface from damage) with 5mm protruding. After referencing the tool against the end of the Piston Rod, zero the top slide feed dial, and lock the saddle before machining away the amount calculated, taking small facing cuts. Remove the sharp edge produced and put to one side.

FILING THE BIG END PROFILE

As the rod is screwed into the big end it is easy to handle and a convenient time to file the radius on the plain end as detailed. To assist in producing an even radius I suggest that the small investment in time required to make two buttons is time well spent.

Take a short length of Ø8 steel (Ø8 x 4" free cutting stainless 303 is included in the metal pack) and hold in a self-centring chuck with 15mm protruding. Turn Ø4 x 3.5mm long. Remove any burrs. Check that it is a snug fit in the big end. Part off 7.5mm long. Repeat the process making two buttons in total.

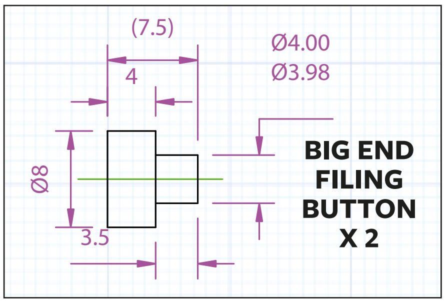
See photograph E65.

Fit one in each side of the reamed crankpin hole and, holding the sandwich between the jaws of a bench vice, carefully file away the corners until the file just touches the surface of the buttons. Filing radii can be done in one of two ways and is often referred to as 'banana' filing. 1) Starting with the tip of the file you roll around the radius as the file advances – your hand traces the path of a banana with the inside of its curve sitting on the part being radiused. 2) Starting with tip of the file at the top of the radius you lower the handle as you advance – your hands trace a path the shape of a banana with the outside of its curve sitting on the part being radiused. Of the two methods I prefer the latter but it is really down to personal choice.

See photograph E66.

After removing any burrs that may have been created by filing the radii, remove the big end from the piston rod taking care not to damage the surface of the rod, and put the big end to one side.

BELOW – PHOTOGRAPH E66
Filing the profile with buttons installed.



PISTON – ITEM E20

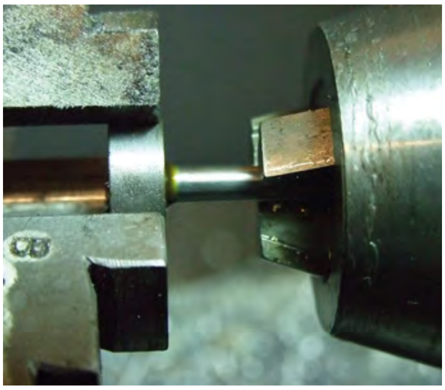
Ø1" x 1" Cast Iron
Refer to – Drawing E20

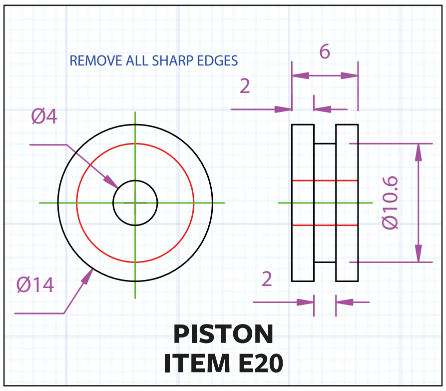
This is the last part to be made before the engine can be assembled.

Hold the cast-iron bar in a four jaw chuck with at least 15mm protruding, centre using the loose tool method and remember to have a final check that all four jaws are tightened before machining. Face off, centre drill, drill Ø3.8 x 30 (or through), ream Ø4. Rough out to Ø15mm. Now take great care in the following setting up. Position a parting tool with its right-hand edge 6mm away from the face and clamp the saddle. Part off a 6mm wide piston blank. Remove any burrs that parting off may have created at the edge of the reamed hole. Check that the plain end of the piston rod fits through the reamed hole, passing the reamer through the hole again if there is any resistance.

Hold the piston blank in a self-centring chuck and grip the piston rod lightly (to prevent marking the rod) in the tail stock drill chuck with the plain end protruding. Put a drop of retainer into the reamed hole of the piston and a drop of retainer on the end of the piston rod. Pulling the chuck around by hand, advance the piston rod using the tailstock feed hand-wheel until the rod is seen to protrude through the piston. Using a tool blank or parallel pressed against the back surface of the piston, carefully withdraw the piston rod until its end is exactly flush with the back face of the piston. Leave at least one hour to cure.

See photograph E67.





ABOVE – PHOTOGRAPH E67 – Locating the piston rod whilst the retainer cures.

When cured, remove the piston and rod assembly from the chucks (wiping away any excess liquid retainer) and hold the piston rod – ideally in a collet chuck or true running self-centring chuck – with protection between the jaws and the rod, with about 5mm gap between the chuck and rear face of the piston. Using a sharp right-hand knife tool, bring the piston diameter to Ø14.1mm and then take cuts of 0.01mm depth, taking two passes after each cut is added before checking to see if the cylinder will fit onto the piston. Although a little slow, by this method there is no risk of creating more than 0.02mm clearance and having to scrap the piston. Check each time that both ends of the cylinder block are able to fit over the piston without any suggestion of stiffness.

Grind a parting tool to a width of 2mm or less (but note the actual width) and, with the front cutting edge ground square to the tool's length into the tool post, adjust the tool-post to bring the tool square to the work.

Carefully align the right-hand side of the tool with the end face of the piston, using a tool blank to give a reference surface. Zero the top slide feed screw dial in the forward direction, taking account of backlash, and clamp the saddle.

See photograph E68.

Move the tool 2mm towards the chuck using the top slide and zero the feed screw dial. With the work turning at approximately 200rpm or less, carefully bring the tool into contact with the outside diameter of the piston and zero the cross slide feed screw dial. Feed in slowly using the cross slide 1.7mm (3.4 mm on a Ø dial). Back out the tool and advance it towards the chuck 2mm less the previously noted tool width using the compound slide, if the tool had a width of less than 2mm. This will produce a groove 2mm wide with a core diameter of 10.6mm as required for the efficient operation of the piston ring. Very carefully remove the sharp edges from the four corners at the edges on the outside diameter of the piston.

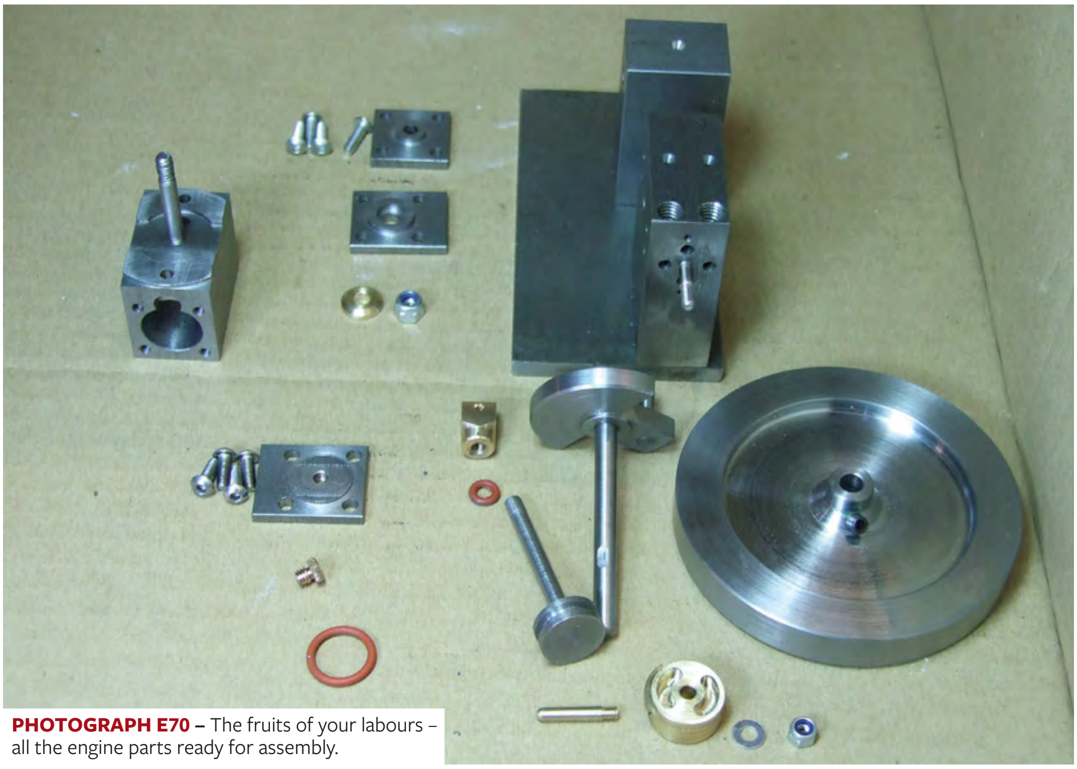
See photograph E69.

Next time we will assemble and test the engine. See photograph E70 for a picture of what you should have produced!

« TO BE CONTINUED »

ABOVE – PHOTOGRAPH E68
Setting right hand side of grooving tool exactly flush with piston end face.

BELOW – PHOTOGRAPH E69
Piston 'O'-ring groove complete.



PHOTOGRAPH E70 – The fruits of your labours – all the engine parts ready for assembly.

BUILD NOTES

Tolerances for all parts in the article – unless stated otherwise:

- **Non-functional (ie parts not a fit or a match): ±0.1mm**
- **Functional (ie parts having to match): ±0.02mm**

All drawing labels start with the reference letter E.

BOOK REVIEW

GEARING OF LATHES FOR SCREWCUTTING

BY BRIAN WOOD

Published by the Crowood Press
Price £14.99. Pages: 160
ISBN 978-1-78500-250-2

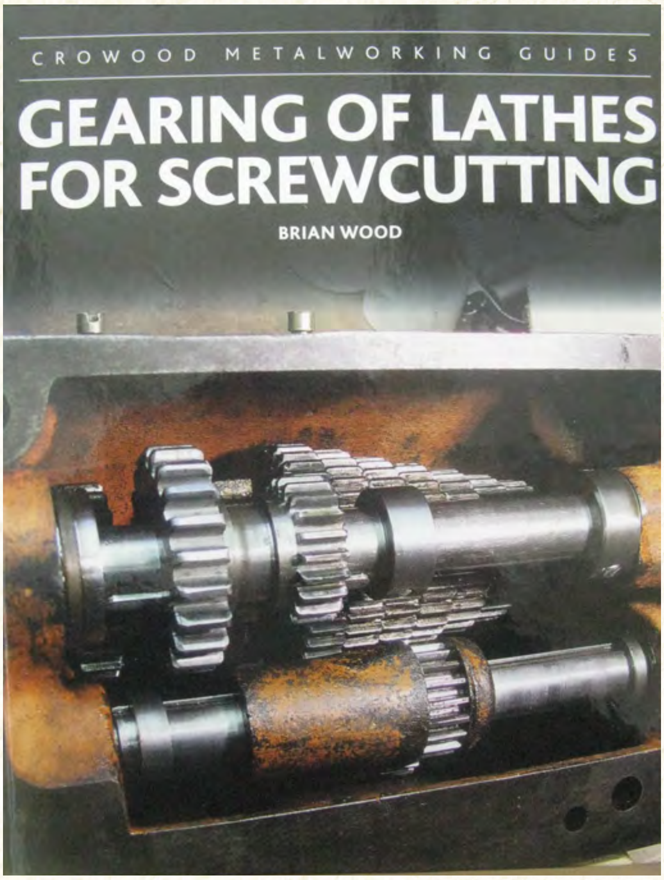
Brian Wood is a well-known writer in several of 'our' engineering magazines on matters of workshop matters and especially screwcutting. This outstanding book will most probably become the definitive work on the subject for the home workshop user. The title of the book suggests it's just for screwcutting but it goes a lot further giving realistic methods for producing worms of DP or module standards and a whole range of perhaps little used specialist threads.

He concentrates on very simple means of obtaining the correct gearing arrangement mainly for the lathe fitted with a gearbox, although there are details for the user of mini lathes and plain lathes without gearboxes.

Brian begins with a brief history of the development of the Norton Quick Change box and introduces something of the scope of his interest in the subject. He then goes on to look in detail at the main types of lathe used by the amateur in his home workshop. Individual chapters cover firstly the ubiquitous Myford 7 series lathes, with a separate chapter dedicated to owners of lathes with the David Machin gearbox (now a Hemmingway kit). This is followed by individual chapters covering the other main lathe types, the problems and limitations of them and detailed tables of the possible range of pitches possible within his stated tolerance range. Although I am personally a Myford user, these chapters were of considerable interest (I have used several of them throughout my career) as they give background to the machines and their limitations by initial design. Machines covered are Southbend and its many clones, typically Boxford, Smart and Brown Sabel lathes, and the Australian Hercus, Smart and Brown Tool Room Lathes, Raglan 5" and 5½", Holbrook Model B toolroom lathe and the strangely rare Covmac 13" and 17" lathes, of which he states there are only six known examples.

At the end of each chapter there are extensive tables giving, on the whole, remarkably easy methods of producing not only simple metric coarse and fine threads with great accuracy but, in addition, BA, module pitches, Lowenhert pitches, Small Arms Factory Enfield pitches, and Holtzapffel pitches and a small range of imperial pitches not normally found within the standard Norton box. Often, these threads can be obtained with the use of a single input gear and an associated setting of the gearbox – the Southbend chapter, for instance, contains 15 pages of tables.

For the Myford user Brian covers in depth the problems associated with limitations of the gearbox input, making the range of gears used very tight, but he has however designed an incredibly simple and hidden from view modification to the gearbox input banjo clamping arrangement which will allow change wheels of up to 66 to be used for the input (used on 16DP worm pitches giving a quoted error of +3 microns!). Most users, perhaps, will be interested mainly in producing metric pitch threads, and for this only 6 input change wheels will be needed for metric coarse from M1 to M42 and for metric fine from M2 to M20. The maximum pitch error for the full range for the English gearbox is 0.007mm (for M30) but at the same time it shows 16 metric pitches with an error of one micron or less! So, with M6 x 1mm for example, for a screw of 1000 mm length the pitch error will be just 1 mm short, but most threads would only need to be perhaps a maximum of 10mm length so the error hardly exists (0.01mm or half a thou).



Brian finally deals with alternative approximate gearing, going to great lengths considering meshing of gears, and the effect of π. He then discusses the significance of the errors generated within his simple systems within gear trains especially when creating worms.

For most users, much of the book will hardly ever be used (but you never know!) while the ability to achieve a massive range of accurate pitches will be invaluable to all Model Engineers at some point in their modelling careers. This book is an essential work of reference. ■

Graham Sadler

TRACKING DOWN A BLACK 5

The Hanscomb family once owned a 7¼" gauge *Black Five* locomotive, number 5432, which they called 'Black V Magic' and which they used to run at the Vale of Aylesbury Model Engineers club track at the Buckinghamshire Railway Centre, Quainton Road. It was then sold through Station Road Steam. They are now keen to discover the current whereabouts of this locomotive. Its rolling chassis was made by David Underhill (ex Rode Woodland Railway) and subsequently completed by Malcolm Armstrong in Stafford. Anyone who can provide any information about 5432 is invited to contact the editor.

The Doncaster Model Engineering and Modelling Exhibition

John shares his impressions of the various club stands at the Doncaster show

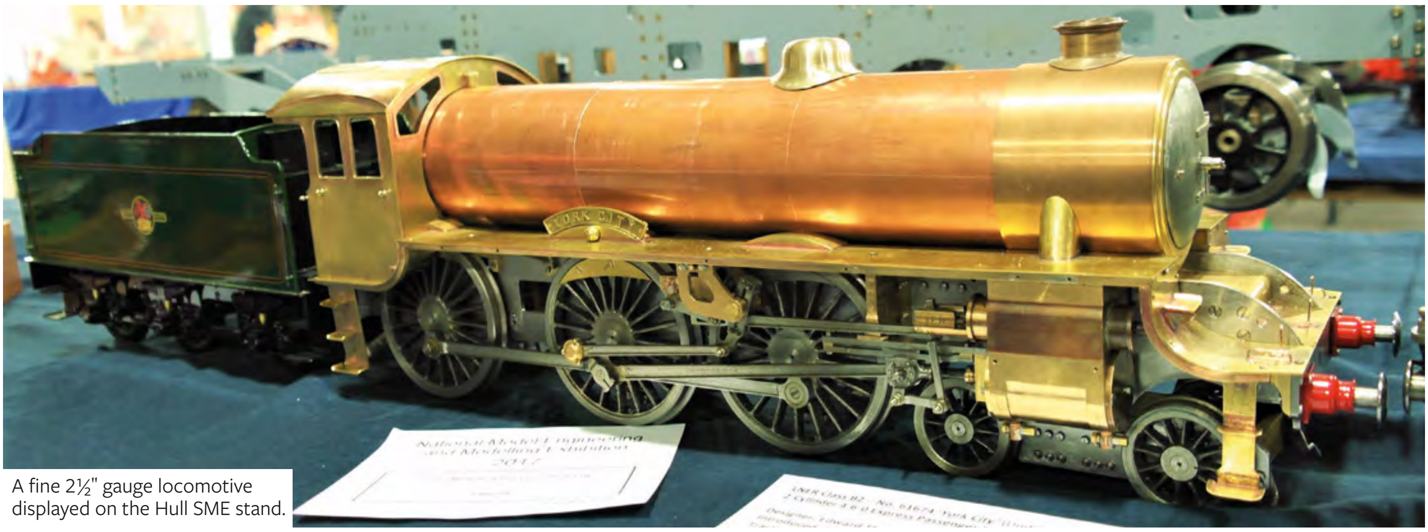
BY **JOHN ARROWSMITH** – CONTINUED FROM PAGE 9 JULY 2017

Having covered the competition side of the exhibition I need to try and describe the tremendous selection of models on display on all the club stands. There were 45 clubs in attendance complemented by over 50 traders. This is a significant event which had a large percentage of railway locomotives. The winner of the Best Club Stand was the Hull & District SMEE so what better place to start. The 18 cylinder radial engine under construction by Steve Tracey looks to be a very complicated piece of work and is displaying some excellent workmanship. A very useful locomotive stand and cradle complete

BELOW – An 18 cylinder radial engine was part of the Hull & District SME display.

ABOVE – This large Garrett was part of the 7¼" Gauge Society display.

BELOW – A superb example of a Metropolitan Railway luggage van, part of the GL5 display.



A fine 2½" gauge locomotive displayed on the Hull SME stand.

ABOVE – On the PEEMS display was this colourful threshing machine.

LEFT – This complicated grab assembly was part of the 7¼" gauge Booth steam crane.

with a 16mm locomotive chassis was another fine piece of work. I was pleased to see a 2½" gauge LNER B2 4-6-0 locomotive on the stand as this gauge and this prototype are not often seen. This model by T Barnes was an impressive piece of work and when complete will be a real credit to the builder. All these models complemented by a wide range of other fine model engineering exhibits made for a great display.

As visitors entered the exhibition they were greeted with displays by the 7¼" gauge Society and the GL5 Association who both provided examples of what can be achieved in these scales. It was good to see the 5" gauge chassis of an LNER B1 locomotive on the York City & District SME stand as this is being built by Crispin Cousins, who readers may remember won the Junior section at Harrogate a few years ago as well as Class 14 at the Midlands exhibition. Crispin is obviously moving up through the gears, so to speak in the model engineering world, so look out for this model being a strong competitor in future exhibitions. Among the wide range of first rate models on display, the 7¼" gauge Booth steam crane and grab featured prominently and was demonstrated from time to time by its builder Richard Gibbon. A very well made Lyre skeleton clock by D. Lawson was another fine example.

On the Tyneside SMEE display I liked the line-up of locomotives showing a wide range of prototypes under construction. The line of five started with a BR STD Class 5, an LNER K3, GWR Manor, LNER V2 and a GNR H4. Excellent workmanship provided an opportunity for visitors to see 'the workings' at close quarters. A new design of Orenstein & Koppel locomotive under construction by Brian Nicholls showed great attention to detail and some top quality machining skills.

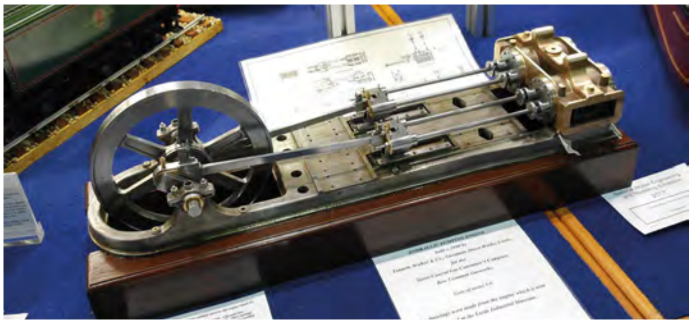
The Pickering Experimental Engineering Model Society always provide a large comprehensive display of models, and this was no exception with their selection ranging from Mike Sayer's superb 1/3rd scale 4.5L supercharged Bentley engine, right down to a humble finger plate. Centrepiece of the stand was a well-made threshing engine by C Bramley and the little Gardner 'O' stationary engine by M Doran added a touch of colour as did the 12000rpm drill head built by R Gretton.

The very professional display by the Bradford SME demonstrated the wide range of skills and workmanship within the club. From an oscilloscope to larger scale model boats, this display covered most model engineering disciplines. The model of a Tannet Walker pumping engine (circa1890) was a rare prototype and well-made example.

LEFT – A lovely Lyre clock shown on the York City display.

RIGHT – A Tannet Walker pumping engine from the Bradford SME.

BELOW – From the Tyneside MES came this range of locomotives, both under construction and complete.



ABOVE – The superb workmanship being displayed on this 5" gauge A4 was part of the Southport display.

A new display by the Model Steam Road Vehicle Society added a wide range of traction engines and steam road vehicles to the show. A large well filled display by the Southport Society contained a wide range of excellent models with the 5" gauge A4 locomotive under construction attracting a lot of attention because of the superb work being done around the very difficult front end. In addition, a magnificent 7¼" gauge GWR King chassis under construction by Will Naylor was a constant talking point.

The exhibition also contained a good selection of radio controlled road vehicles, model boats and aircraft with the Durham Truck and Construction Club and the Kirklees and Redcar Model Boat Clubs providing comprehensive and colourful displays. The Large Model Association had some impressive aircraft models on show ranging from a Piper Pawnee to a Lancaster bomber. In contrast to these large models the Gauge 1 Model Railway Association and the Yorkshire Group of the 16mm Narrow Gauge Modellers both provided plenty of operations and a wide variety of stock to keep the visitors entertained. Both the Chesterfield and Sale Area Model Engineering clubs displays included a wide range of locomotives combined with good selections of other models which showed off the interests of members. The 5" gauge Duchess on the Sale stand and the Deltic from Chesterfield were impressive models.

Another well presented stand was by the Keighley & District MES where Vic Crossman showed off a number of his first rate 5" gauge wagons. Among a number of stationary engines the little horizontal engine by P Wilson was a well-made model.

A regular contributor to this exhibition is the Society of Model and Experimental Engineers(SMEE) and again their well-presented stand included some excellent examples of model engineering. Hubert Stum's Lanz tractor was an exceptional model. The Stockport tram system designed and built by Greg Marsden from the Grimsby & Cleethorpes Club attracted a lot of attention with its range of trams working over the layout. On their main display the 7¼" gauge Britannia tender under construction by G Dumbleton was subject to many inspections by the visitors.

There was a selection of large models on the Doncaster SME display with a 7¼" gauge Class 20 Diesel locomotive as their centrepiece, alongside an even bigger Hunslet. From the Leeds Society came a good representative collection of well-made models. Included was a very well made Murdoch and Aitkin steeple engine together with a nicely made example in 5" gauge of an LMS guards van.

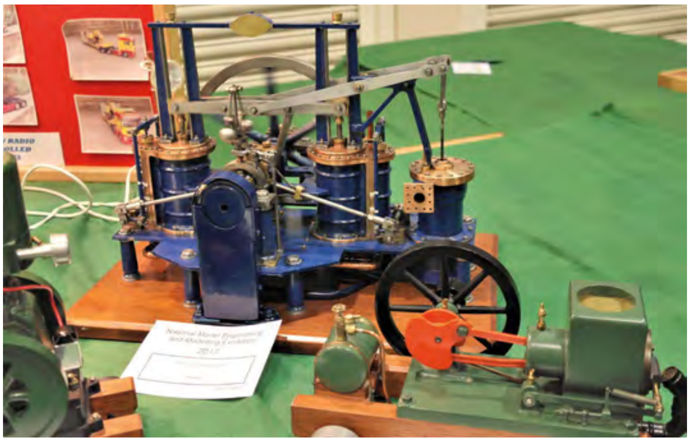
In concluding my notes I should apologise to all those clubs and individuals who greatly contributed to this exhibition and whom I haven't mentioned – it's not that you were not important, it's just that space is not available to cover all your fine efforts. You were greatly appreciated by both the organisers and the many visitors. I would like to thank Gavin and Lew Rex for their help and hospitality – you organised a great show gentlemen. ■

ABOVE – Part of the large road system built by the Durham Truck & Construction Club.

ABOVE – These large aircraft formed the Large Model Association display.

ABOVE – One of the wide variety of narrow gauge locomotives on the 16mm Narrow Gauge Modellers' layout.

BELOW – Lots of fine locomotives from Sale Area MES.



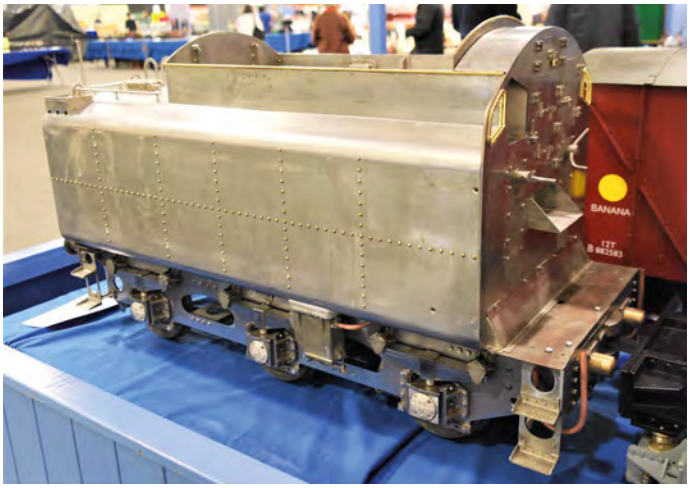
ABOVE – This attractive horizontal engine was part of the Keighley & District MES stand.

ABOVE – A well made 5" gauge 'Deltic' from the Chesterfield Society.

ABOVE – Hubert Stumm displayed his Lanz tractor on the SMEE stand.

BELOW – A colourful array of boats and marine craft on the Kirklees display.

ABOVE
An authentic looking LMS guards van from Leeds.



ABOVE – Geoff Dumbleton is building this superb Britannia tender in 5" gauge.

ABOVE – A4 'Mallard' has just come off the turntable on the Gauge 1 Model Railway Association layout.

BELOW – An attractive 4" scale Burrell traction engine ticking over nicely outside.

Building a Panther Tank

Chris discusses the motor and the final drive system for his Panther tank

BY CHRIS MEYER – CONTINUED FROM PAGE 36 JULY 2017

DRIVE MOTORS AND REDUCTION UNIT

After running the tank over a period of time I felt reasonably happy with the suspension, final drives and the steering differential but some of the other components needed a rethink or even a re-make. The main motor seemed a bit down on power and it did not like pushing the vehicle in top gear, on even a slight incline. I could not use a larger motor due to space constraints and I really did not want to draw more current from the batteries if I could avoid it. So, I had to cast about for a more efficient motor.

A friend suggested trying a motor and reduction unit from a battery operated drill, so I purchased a new one that was not too expensive and stripped it down to have a look at the gear system.

It contained a double epicyclic unit which had a total reduction of 36 to 1. In the specification of the drill, the no load output speed was stated as 550rpm, meaning the motor would be running at 19,800rpm. Using a single stage of the gear would give a reduction of 6 to 1, which was OK. To keep the overall length as short as possible I cut the annular ring gear in half, using a flexible grinding wheel. I machined an aluminium housing, into which the ring gear was fitted. The cover also had a housing for two spur gears which, as before, dropped the output to match the level of the propellor shaft rear universal joint. The gears were keyed to the upper and lower shafts.

To return to the epicyclic gear, I wanted to use the three second stage gears as they were sintered steel, whereas the first stage had nylon gears fitted on the original drill unit. I knocked up a brass chuck to hold the gears in the lathe to bore and ream them to take two oilite bearings each. I made a flanged shaft with three ⅛" pins on which the gears fitted. The shaft ran in a rear oil seal and a ball race at each end. The lower shaft had the same arrangement, except the oil seal and race were in the front housing

ABOVE PHOTOGRAPH 30 The front of the motor, showing the housing for the two spur gears that drop the output to the level of the of the propellor shaft.

cover, which also held a flanged ring that bolted to the engine bulkhead. This was actually the front engine mounting on the full size vehicle (FSV).

My friend kindly gave me a 9.6V motor from an earlier drill; the later motors run on higher voltages. I was a little dubious about using this motor, at first, as its diameter was only 36mm, compared with the 51mm of the motor previously used.

I made a rear fitting which was cemented to a lower mounting with two angled rubber blocks between them. This fitting clamped around the brush housing and was bolted on two U shaped brackets screwed to the belly plate in the same position as in the FSV. The front mounting also had a rubber cushion between the inner and the outer ring, which as I had mentioned, bolted to the engine bulkhead. Up to now I had used a one piece prop shaft, using two universal joints from an earlier project, but I decided to make four new universal joints of the correct diameter fitted to front and rear shafts with sliding joints. The FSV had a power take off (PTO) fitted in the chassis, directly under the turret, which also had a rotating slip ring supplying current for lighting etc. I wanted to make a representation of the PTO to which the two propellor shafts would be attached.

Before that, I carried out some more tests to see how the latest motor and reduction unit performed. I was pleasantly surprised at the hill climbing ability, with it stopping and starting on a 35° incline quite easily – low gear of course. Apart from buying a new Johnson fan cooled motor which had a slightly longer armature but with the same diameter housing, I was happy with the new drive unit.

ABOVE
PHOTOGRAPH 31 AND 32
The epicyclic gear ring and the rear of the spur gear housing, showing the three spur gears which engage with it.

ABOVE
PHOTOGRAPH 33
The motor unit, complete with mounting and the assembled epicyclic unit, with the propellor shaft and universal joint fitted.

MAIN GEARBOX

The new gearbox and propellor shafts were the next components to be dealt with. The gearbox would still have two speeds – high and low – controlled by a sliding dog clutch.

On the FSV, the main clutch housing was offset well to the left meaning that the front propellor shaft, running from the PTO to the input flange, was at quite an angle. The gearbox and steering unit was set over to the right a small amount, so I copied this on my own chassis. I also made a new saddle clamp which went around the clutch housing 'nose' just ahead of the input flange with the clamp bolted to the crossmember in the correct position.

This then gave me an exact distance between the rear face of the steering unit and the front face of the clutch housing – clearly it was going to be a tight squeeze getting the new gearbox installed. As I had decided to use a decent electronic speed controller by this time the friction clutch was redundant but, apart from removing the withdrawal forks and thrust race, it was left in place.

After a lot of sketching, and then drawing at twice size, I figured I could fit the three shafts, six ball races, one oil seal, three pinions, three spur gears, the three piece dog clutch and the shift mechanism in the gearbox. The basic set up had the input shaft and pinion on the left of the first spur within which the high gear dog is pinned, with a pinion fitted on the rear. This assembly had bronze bushes as did the low speed dog pinned in the third spur gear at the front, all running on the main shaft with the grooved central dog sliding on a long square key, and the gear change brass fork fitted in the groove. The fork was fixed to a horizontal shaft with two stop collars to limit the side movement. A vertical spindle has a lever engaging a pin fitted in the fork and a link at the top connects to the gear change actuator – more about this further on.

The front bearing housing has an extended lip which accurately locates the gearbox in the steering unit. The output bevel is locked on the front of the main shaft. Above the rear pinion the second spur gear is locked to the layshaft with the third pinion pinned on the front end meshing with the low speed spur gear.

The total gear reduction from the motor unit to the steering output shafts is 26.4 to 1 (high ratio) or 54.84 to 1 (low ratio). When the final drives are included you get 193 to 1 (high ratio) or 402 to 1 (low ratio) at the sprockets.

PROPELLOR SHAFT AND UNIVERSAL JOINTS

To make copies of the full size universal joints at 1/12th scale, strong enough to take the increased torque from the new motor and reduction gear, proved to be quite a challenge – for me anyway.

I had a lot of close up photographs of the universal joints and had been able to take measurements of the real things.

I started on the fork ends first, machining as much as possible, then filing to achieve the right shape. I had to make sure, when drilling and reaming the two .156" holes into which the bearing caps were fitted, that they were both exactly on

BELOW
PHOTOGRAPH 34
The new gearbox, split to show the internal arrangement.

the centre line of the joint. On the FSV these caps contained needle rollers but I fitted thin wall bronze bearings in the caps.

The 'X' or cruciform shaped pieces have four .093" diameter bearing trunnions which fit in the caps. It was just possible to get the cruciforms fitted in the fork ends before the caps were fitted. To make the trunnions, I mounted a short length of ½" diameter EN8 steel rod in a dividing head and centre drilled rows of holes at 90˚ to each other, also milling each side of the centre holes to the depth of the trunnions. A 0.075" hole was drilled in the centre of the rod before parting off eight discs – four trunnions were actually required but I was allowing for machining errors etc.

It was then a matter of turning between centres, after making a fixture with its own small centre and a projecting pin driving one arm of the trunnion at a time. At the tailstock end another small silver steel centre was used in order to make room for the turning tool. I drilled 0.025" lubricating holes in each trunnion pin, breaking through to the centre hole.

An assembly jig was made to hold two forks in line, with the trunnion in between, enabling the bearing caps to be fitted using Loctite retainer. I was pleased with the results, the joints running pretty true when I checked them on the lathe.

On the FSV, each of the two propellor shafts has a splined sliding section. I really did not want to make another small spline broach so I used two keys at 180˚ fitted to a reduced diameter shaft ahead of the spline. I did take the trouble to make a four tooth cutter with angled sides, which produced a reasonable copy of the full size spline. The shorter section has two internal keyways cut inside.

ABOVE PHOTOGRAPH 35
The contents of the gearbox.

BELOW LEFT PHOTOGRAPH 36
The motor unit mounted at the rear of the tank chassis.

BELOW RIGHT PHOTOGRAPH 37
The power take off unit, situated directly under the turret.

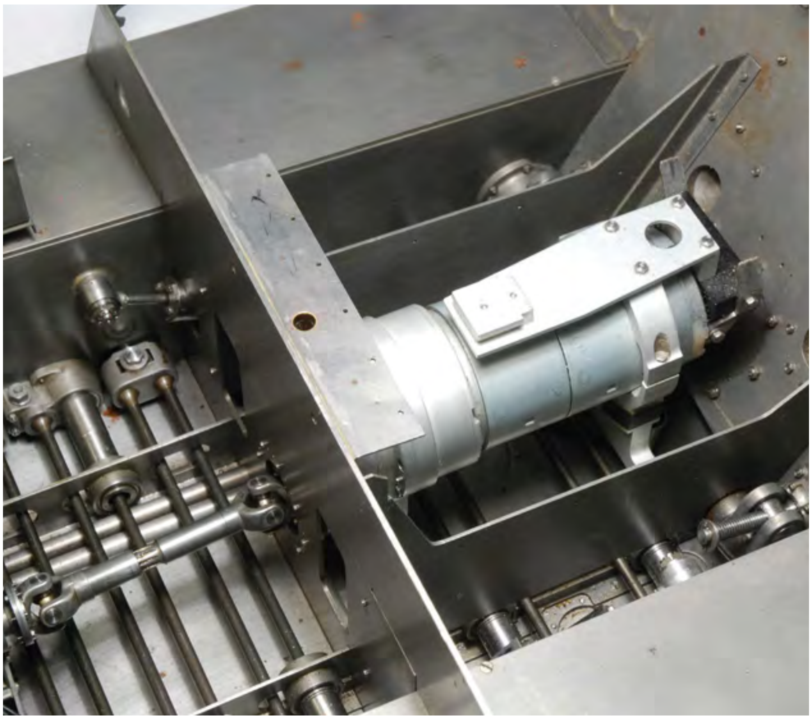
FINAL DRIVE COUPLINGS

I had been running the model using temporary final drive couplings until I found out more about the actual Panther units. These consisted of a short internal splined flanged sleeve bolted through the track brake housing onto the final drive flange, with a short splined shaft fitted in this sleeve. A longer internal splined sleeve was able to slide inwards to engage a splined fitting, locked to the steering unit output shaft.

I am afraid this seems such a long winded description of what in reality was fairly straightforward. The end result was that it only needed the long sleeve to be pushed up to the outer sleeve to give enough clearance to install or remove the gearbox and steering unit. When the sleeve is slid back into engagement two or three small bolts are fitted to stop the sleeve sliding out again when running.

To copy all this, as far as possible, required a spline broach to be made from silver steel, which was a bit of a pain. I used mild steel for the sleeves and case hardened them. The shafts were machined from EN8, hardened and tempered. At least the shafts fitted inside the sleeves without slopping about, which was quite satisfying. I fitted three 14BA bolts into the sleeves to locate them. Up to then I had not bothered about making copies of the track brakes but once I had made the PTO and the two new propellor shafts, plus the 'proper' final drive couplings, I had to have a go.

The track brakes on the FSV were quite a prominent feature, looking at inside shots, or better still seeing the full size things, as I have done.



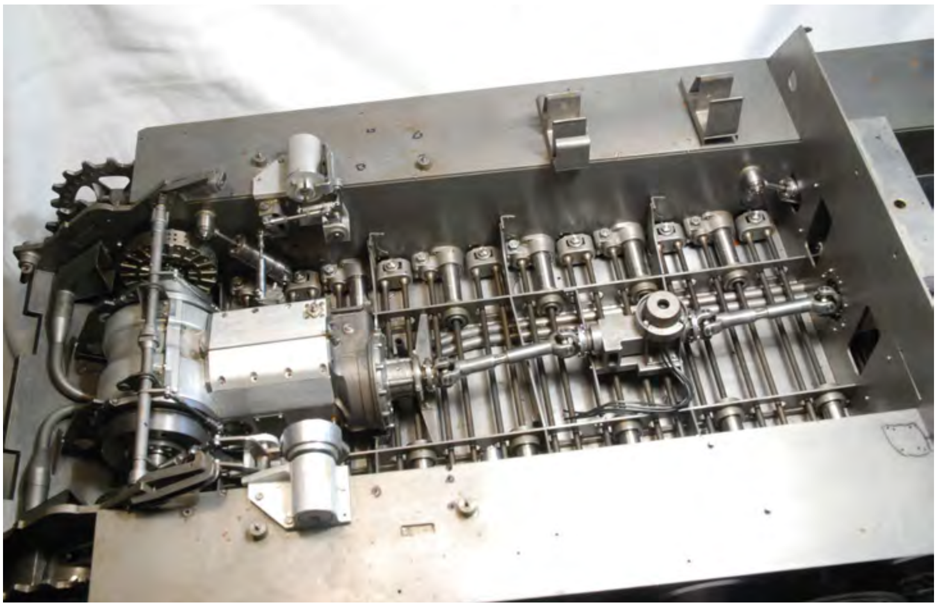
The housings, which are in two halves, held together with 18 bolts, are ribbed and have six air cooling holes in the front face and pairs of smaller holes around the periphery. The outside diameter is about 22", which on mine work out to be 1.835". Originally, I was going to fit shoes in these, so that skid turns could be achieved, but decided against this as it was going to be very difficult to separate the different steering controls, and the heavy extra loading on the rather fragile differential pinions was undesirable.

On the FSV these brakes, which were very powerful twin disc units, normally had sheet steel covers over them, with a 'nose', actually a tapered rectangular tube, running to the front, each connecting to one of the two air pipes running to the rear of the vehicle. After spending a lot of time making copies of the two housings, with the ribs soldered into shallow grooves in the faces and all the holes drilled, I mounted them in the lathe to skim them over. Mine still require the 18 bolts to be fitted to look correct.

I did not want to hide all my work so I have left them uncovered but with the nose pieces in place. I had actually made the two air pipes quite a while back, because the cross members that fit between the bearing longitudinal members are soft soldered to the pipes, and they are held in position with screws fitted through the belly plate. The pipe units are split into four sections with short pipes inside joining them. This was done to make a tricky job a bit easier as the pipes had to be bent in certain places, bending up at 35˚, then to the front where each turned at 90˚ – one left, one right. The rear pair curved round a large access hole in the belly plate and ended in a collector with a single larger diameter tube which was just behind the motor mounting.

On the FSV this pipe ran up and to the left, fitting into the fan box, thereby sucking the hot air from the brakes, and also the clutch and gearbox, connected by smaller pipes, to the two main ones. I have not yet made these pipes but will do so before long. The rear of the clutch housing shows two flanged holes to which the pipes will be connected – hopefully!

« TO BE CONTINUED »



ABOVE – PHOTOGRAPH 38
A view of the two propellor shafts and the power take off unit, with the forward shaft entering the clutch and gearbox.

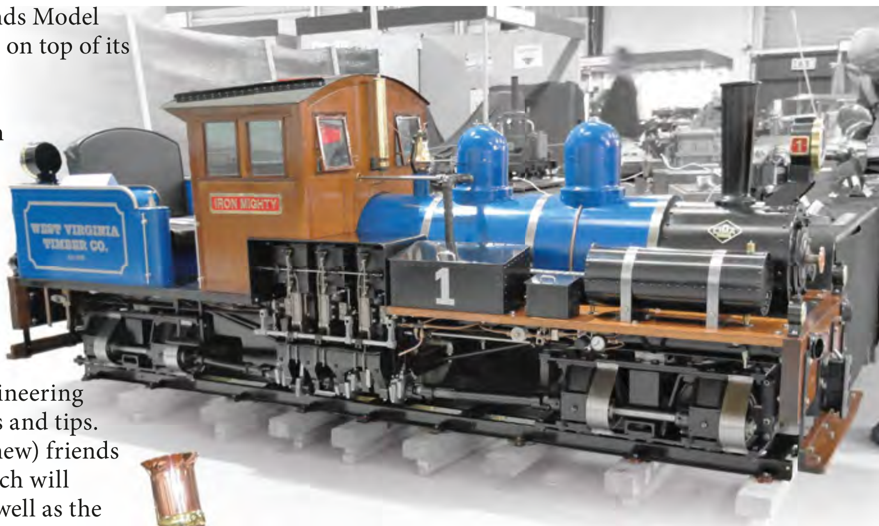
ABOVE – PHOTOGRAPH 40
Final drive unit.

BELOW – PHOTOGRAPH 39
One of the track brake housings, attached to the back of the final drive.

BELOW – PHOTOGRAPH 41
A view of one of the track brake housings and its associated nose piece, connected to the air pipe which takes hot air from the brakes to the rear of the vehicle.

More than Just an Exhibition

With more than 1,000 models on display, The Midlands Model Engineering Exhibition is one of the 'must-visit' shows of the year. Here's what to expect in 2017



In celebration of its 40th Anniversary, this year's Midlands Model Engineering Exhibition is promising special attractions on top of its 1,000+ models on display, further reinforcing this as one of the UK's premier modelling events.

The show was originally launched in 1978 by Chris Deith (former owner of this very magazine) with his company, Meridienne Exhibitions, continuing to run this exhibition, plus many others including The London Modelling Engineering Exhibition at Alexandra Palace and the Midlands Garden Rail and Large Scale Show at The Fosse.

This year's exhibition will include over 1,000 models including the chance for YOU to be part of the show by entering your work into any of the 16 competitions and display classes. There will also be over 50 leading model engineering stockists and over 40 clubs and societies sharing experiences and tips. It really offers an unmissable opportunity to meet old (and new) friends and fellow model engineers. There's also an outside area which will include the 'Fosse Way Steamers' with their daily parade as well as the 5" gauge passenger carrying track.

The show will take place on Thursday, October 19th through to Sunday, October 22nd. It's open from 10am to 5pm on Thursday to Saturday and 10am to 4pm on the Sunday. The show takes place at the Warwickshire Exhibition Centre, Fosse Way, Near Leamington Spa, CV31 1XN.

There's a mass of further information on the show's website where you'll be able to book tickets and see a full list of suppliers and club/societies attending the event. You can also download the competition entry form. Go to *www.midlandsmodelengineering.co.uk*

The Atkinson Steam Wagon

Graham discusses the manufacture of the camshaft

BY **GRAHAM SADLER** – CONTINUED FROM PAGE 14 JULY 2017

I have changed the camshaft from my original design to get better usage of the cutoffs. My shortest was 50% but the engine didn't like it unless on flat tarmac and consequently was rarely used. I did actually measure the cutoff before making the new camshaft; it came in at 40% so no wonder it was struggling. At the same time, as the engine has a clutch, having the warming cam for all valves open was also rarely used but now I am thinking that this cam was in the wrong position, situated at the end beyond the reverse cam (a mistake during assembly), resulting in the followers often having to climb over the reverse cam to get to the warming cam. In addition, reverse was very fierce and needed restricting.

So the new design has the cutoffs set at 80%, 67% and 55% with a lift of 2mm rather than the original 2.5mm and the reverse is at 70% with a lift of 1.5mm.

The reversing lever is pulled towards you to go forward with maximum cut off and away for reverse – the wrong way round. In this position it is much easier to see which notch on the quadrant you are in when driving. Unlike a rail locomotive, a road steam lorry does very little work in reverse so the lever is more convenient this way; however you may decide to do things the other way round to make things more 'correct' so the order of the cams in this case would have to be in the reverse order to my drawings.

I am giving you two methods of manufacture; totally built up with individual cams or the cam groups can be made as a single unit, still with a fabricated core, which is a very interesting bit of machining. The individual cam route is far easier, and is how I made my first shaft, but assembly was a bit stressful due to the speed at which the Loctite sets so I am making the cams as a solid group and if ever I make another camshaft it will most certainly be done this way and not from individual cams. The biggest problem with individual cams is in making the transition angles on the cams which aids lateral movement of the shaft. It's very difficult to do them without rounding the edges, and of course because the cams are made from hardened silver steel this task cannot be undertaken after assembly when all the positions are fully fixed - added to which I am not good with very small work unlike some of you out there.

MAKING THE INITIAL COMPONENTS FOR THE CORE AND BEARING JOURNAL (BOTH CONSTRUCTION METHODS)

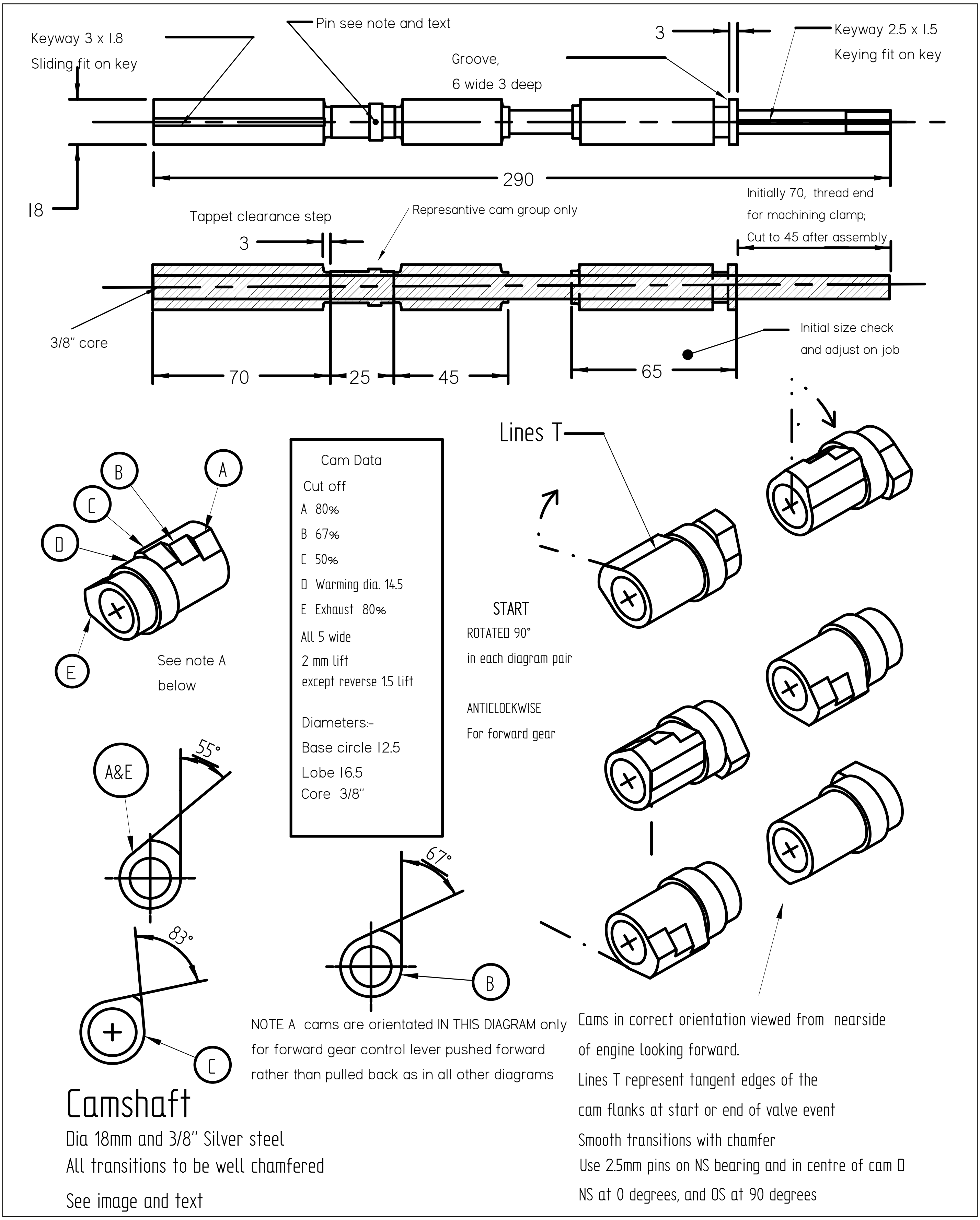
The best way to do this is to cut the 18mm silver steel into the required lengths then set them true in the 4-jaw. The concentricity is quite important so don't trust the 3-jaw here. Ream the ⅜" bore for the central core, which should be over-length, with a temporary screw thread on the offside end along with a centre for usage on the dividing head. Make the offside bearing at least 5mm over-length for now. For the keyways the one in the core shaft on the offside is intended to be a tight fit for the lubricator eccentric while the one in the nearside bearing should be a sliding fit on the key bonded in the gear carrier. This is extended for the full length of the bearing to help the flow of oil to the bearing. Assemble the nearside permanently onto the core with high strength Loctite and fit the pin.

On the strip down of the engine I found damage to the ends of the lower two tappets. This was probably caused by over travel of the shaft, or perhaps contact with the full diameter ends, so to remove this problem the 18mm diameter portions of the shaft are now reduced to base circle diameter for 2mm on each face abutting onto the cam groups. In the comparison photograph (photograph 1) between old and new camshaft the pieces will not appear to be the same length but they are – it's this reduced abutment face making things look out of position.

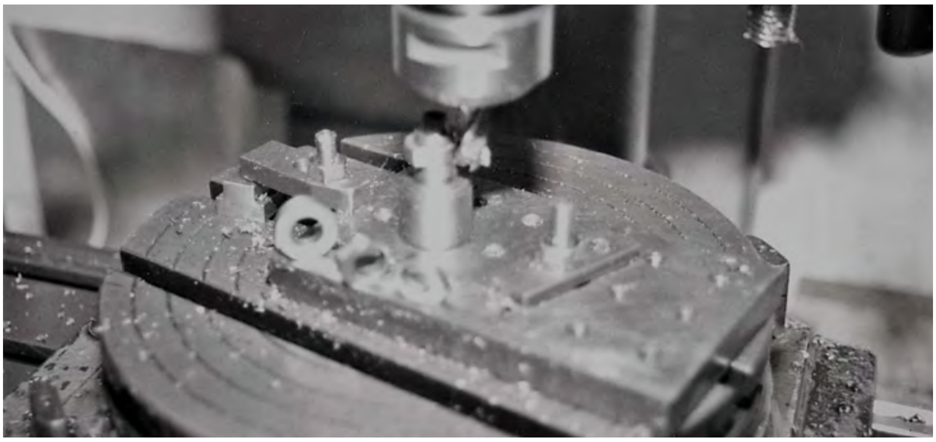
MACHINING INDIVIDUAL CAMS

If you wish to make the machining easier, then go for individual cams and Loctite them onto the core, although I can categorically state that having used both methods I would never use this route again. Assembly is far more difficult and the cams are just crude compared

PHOTOGRAPH 1 – Comparison of the old and new camshafts.



CAM TYPE	REQUIRED ANGLE	CUTOFF %	NEARSIDE START ANGLE	NEARSIDE FINISH ANGLE	OFFSIDE START ANGLE	OFFSIDE FINISH ANGLE
Forward	55	80	235	0	325	270
Forward	67	67	247	0	337	270
Forward	83	55	263	0	353	270
Reverse	55	80	325	90	55	180



ABOVE – PHOTOGRAPH 2
Milling individual cams.

with the machined version. However, if you decide to go down this route, the machining is dead easy. Prepare the discs 5mm wide and 17mm diameter reamed ⅜". It will be wise to make a couple of spares to practise the machining on. The faces must be parallel and flat so either use soft jaws or an expanding mandrel for facing the second side to width after parting off, unless of course your parting off is perfect…

Prepare a mounting mandrel from about 20mm diameter steel with a ⅜" spigot 4.5mm long tapped M6 for a clamping bolt. Centre the dividing head or rotary table under the miller spindle and centre the arbor and zero the dials on the feed screws and the rotary table. With the spindle centred on the divider, we use the Y axis for cutting the cam flanks and base circle, with the X axis used to set the dimensions. The blank disc is mounted onto the vertical arbor.

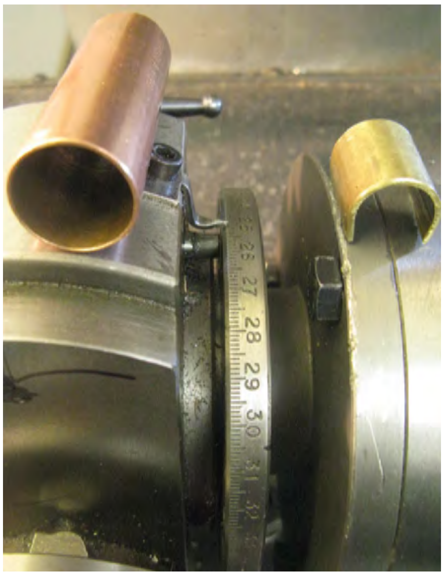
The spindle is centred on the spigot and the dials or DRO readings are zeroed. The spindle is moved 8.25mm to the right plus half the diameter of the cutter you will be using, and also taken forwards towards you. Mount the blank and set the rotary table to zero, and feed in to the centre. Lock the slides then rotate the table for the included angle for the cam you are making. Finally feed away from you to mill the other flank. Lift the cutter, bring it forward and return the rotary table to zero. Use the X axis to set for the pre-finishing cut at 6.5mm (giving a diameter of 13mm), mill it again and check the size for the finishing cut to bring the base circle to the required 12.5mm and repeat the finishing cut. This is the way I did my first camshaft. The photograph is poor but shows the setup (photograph 2). Note here that the cutter is on the right of the work to get conventional, not climb, milling. The cam is now profiled to the correct angle, which for the full cam will be to get an included angle of 55˚ and a base circle diameter of 12.5mm, so rotate the table until it is at 360˚ - 55˚ = 305˚ then feed away again. Cam finished. It's as easy as that. Now just do the rest of them!

ASSEMBLY OF 'LOOSE' CAMSHAFT

In order to file the transitions assemble the cams on the shaft without adhesive and orientate (details of how below). Aim for a 45º chamfer which of course will be tapered (see photographs). Polish with fine abrasive. They are then hardened and given a tiny bit of tempering just to reduce the brittleness so it only needs pale straw (210˚C).

Assembly after final polishing is complex – take care not to round any edges where the cams mate. I set mine on V-blocks clamped to the surface plate. A square ended block was machined and stood on the surface plate. Loctite was then applied and the first nearside forward cams and the warming cam were aligned with this block which was pressed down and forward onto the cams causing them to rotate into the same plane. Finally they were secured in place by tightening the nut on the end, which will need a bit of scrap tube spacer cut to length to clamp the cams, and left to cure. To add the reverse cam a parallel packing piece was machined to the exact gap size between the surface plate and the flat inlet face of the forward cams, thus setting them parallel to the plate.

BELOW – PHOTOGRAPH 3
Making things easier with the dividing head.



The reverse cam is then set vertical when the nearside of the shaft is on your left by using a small engineer's square on what is the front of the shaft. With the cam pointing down the spacer and square combine to ensure the correct 90˚ displacement. Next the central spacer is bonded and cured. Set the nearside cams on the left again vertical at the front with the engineer's square and then the machined spacer may be used to position the offside forward cams so they are at 90º to the nearside cams. The offside reverse cam is set using the spacer again with the engineer's square at the back of the shaft, and the reverse cam again points downwards. I'm glad I made notes on this important aspect when the shaft was made. It took a lot of experimenting dry with double sided tape to hold things together to work all this out then visually test the shaft in situ – I said it wasn't easy! As I write these notes again I have the shaft next to me and have visually tested it again so it is correct.

SINGLE CAM GROUP MACHINING

Machining the solid cam is a lot more involved but a lot of fun. Prepare the cam blank pieces to length – 25mm reamed ⅜" and turned to 16.7mm diameter – as it's easier to turn than mill! Assemble them onto the core and check the size of the central spacer to give the correct overall spacing of 70mm between the cam embryos and adjust it.

Set up the dividing head on the miller – but first a tip. When doing this sort of rotary milling I add a small strip of bent brass (actually from a bit of tube) which holds the handle out and stops the detent engaging in the division plate. As a tremendous amount of handle turning is required, a bit of 22mm copper water pipe tube is pushed over the handle to provide a rotating handle. You will also need the cut piece of tube to hold the detent plunger out. This makes it so much easier to turn the handle and one is not constantly pulling it out from the division plate (photograph 3). Also, note the marker reminder about the direction to turn the handle!

At this stage only use the assembled core. Using the loosening dodge on the 3-jaw chuck to get the shaft absolutely concentric with the head axis or if your head can take a 4-jaw use this.

Establishing the datum position for the milling is next. While it would seem that the end of the nearside bearing can be used, this will tend to be difficult later, so I set this face at an exact distance of 1.5" from the face of the chuck, and made this the lengthwise datum. Do check that the cutter chosen to form the cams can do its work without the miller chuck fouling with the dividing head chuck. As I had made the original camshaft to imperial dimensions this new one had to be the same so I set the datum using a depth micrometer but in a metric world this would be best at 40mm from the face of the chuck. Use the edge finder on the chuck body and also to set the spindle over the centreline of the shaft.

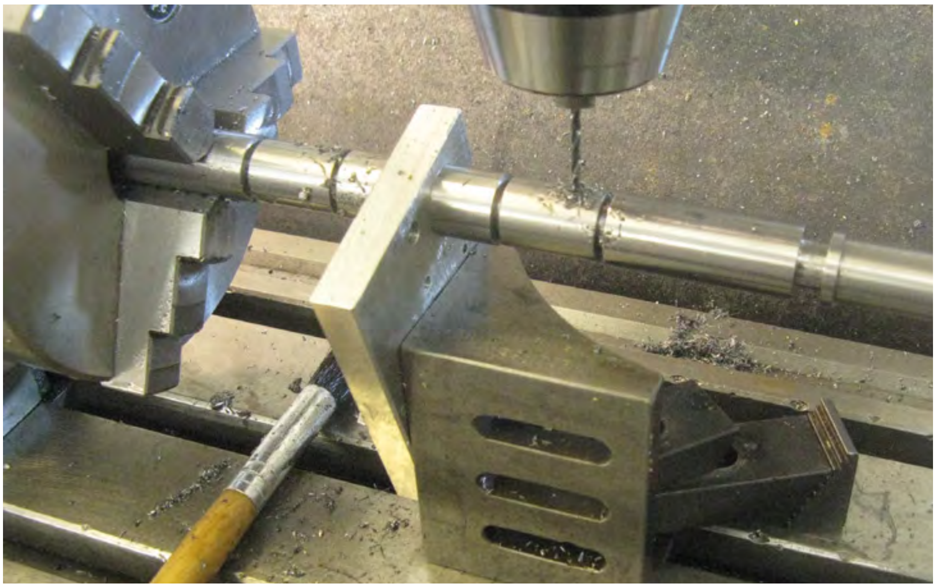
Zero the dials and the DRO – do not forget the dials as if you leave the machine and turn it off the setting could be lost. Want a laugh on me here? I have had my Bridgeport for 12 years and I fitted a DRO as soon as I got it so the table dials are not used very often, but when I did use them things didn't quite go according to plan and I could never understand why. After zero setting I moved the table and happened to look at the dial – it was way out! Gulp, the DRO is packing up, need to check it, so out with the 4" slip gauge to test things. The DRO reading was perfect but the table dial didn't read zero as it should have. I'm confused and alarmed. Switching to metric gave an error of 1.6mm…. hang on… divide this by 4 gives an error of 0.4mm per inch – it should be 25.4 so the penny dropped. I have Imperial screws on the Y and Z axis, but the X axis has a metric 5mm pitch screw not the 5 tpi as it should have had!! As my gran would have said, "Well I never!". No wonder things went wrong whenever I used the dials as they are 15.7 thou per inch out.

All the pieces are dry assembled in place and locked with a nut on the end of the temporarily over-length central core.

To make the setup more rigid for the milling, bore an 18mm piece of scrap 10mm aluminium plate and bolt loosely onto an angle plate and slide this onto the central bearing. Support the outer end with the tailstock and then check that there is no movement of the support block when the shaft is rotated. When satisfied, bolt the angle plate down and secure the support plate – see photograph 4, which shows the drilling of the cross pin alignment holes.

Set the dividing head degree scale, if yours has one, to zero. If it is devoid of one of these, turn a disc of thin plastic or ply and mount it somehow, marking out all the angles on it. Set the head to zero and drill for the 2.5mm pin in the centre of the warming cam on the nearside, which is close to the chuck. Rotate the shaft 90˚ and drill the second pin hole in the offside cam. I suggest making these holes at a definite dimension from the nearside so that if ever you feel it is needed, a new cam can be made and fitted directly to the shaft removing the need for a completely new shaft. Test the drilling with a bit of scrap silver steel and aim to get a very snug fit on the pin.

Do not fit full- or even over-length pins here, but make it 12mm long as, when the warming cam is machined, the pin will completely disappear and will be difficult to locate to punch out. This way, the pin is too short and will easy to find (says he who found this out the hard way!) then replace with longer ones on final assembly.



ABOVE – PHOTOGRAPH 4
Central support and cross drilling cam fixing pins.

To machine the cams there are two ways. Use a 5mm carbide slot drill or, if you have one, do as the writer did by using a right angle drive on the miller with a 5mm side and face cutter. The result of this method is that all the cutting lines go round the cam, not across it as would be found with the end mill, making a neater job with less hand finishing. Whatever you use, move the table in the X direction to put the edge of the cutter co-planar with the reference face of the dividing head chuck. I will refer to the stepped side and the flat side – study of the drawings will make this clear.

MACHINING THE REFERENCE FLATS

Before you start, sketch a diagram indicating all the distances from the reference face of the chuck to the start and end if each cam, or the centre if you are using a cutter of the same diameter. As the required cam width of my cams had to be 3⁄16" wide or 0.1875" the numbers seemed completely random. When using metric it's a 5mm wide cam and adding five on to each dimension is so easy in comparison to the imperial version.

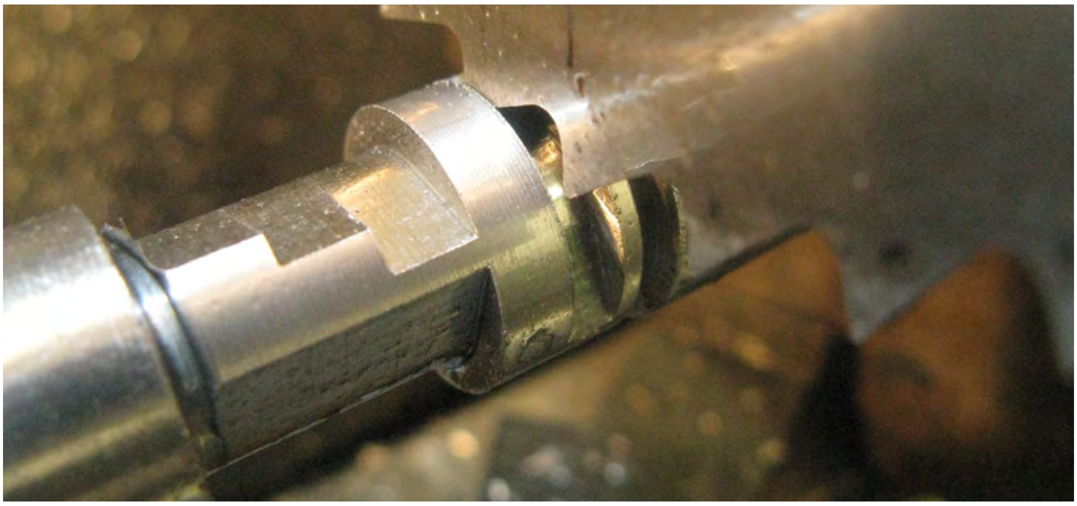
In order to keep an eye on what is happening machine some roughing out of basic flats on the forward cams to give a visual indication of what's going on. Set the dividing head to zero. Touch down on the blank, bring the cutter to the front and add a cut of 2mm. Cut fully across the shaft and cut a flat for the common flank flat side of the nearside cam a maximum of 14.5mm wide. Rotate 180˚ and rough out the stepped side flat. We can now measure the size of the cam, which should be 12.7mm. Adjust the Z axis to leave 0.1mm oversize and re-machine the 180˚ angle, then rotate back to the zero and re-machine the first face. Then do the shorter cut which will be the base circle at 90˚, leaving what will be the stepped side at full diameter. This is repeated for the offside forward cams, with a starting angle of 90˚ and finishing at 270˚ with 180˚ for the base circle shorter face.

Now we are ready for the finishing cuts. Add enough cut to finish at 12.5mm diameter for the base circle of the cam. Return the dividing head to zero and set the X position for the first cam on the nearside which is closest to the dividing head chuck. We will now cut what will be the step side first as when using a dividing head with a chuck screwed onto the mandrel we should always rotate clockwise when viewed from the chuck and from the front to finish the cut on the flat side. This ensures any cutting force tends to tighten not loosen the chuck. So, set the cutter well to the front of the shaft with the already roughed out face to zero. Ensure the short base circle flat vertical at the front of the shaft is facing you, then rotate the dividing head to 180˚ plus the included angle of 55˚ ie 235˚.

Start the miller and feed from the front, over the previously established Y axis to the centre. Then rotary cut, in my case turning the head hand wheel anti-clockwise to zero then feed away until the cutting stops. That's the first cam done!

Return the spindle to the front and move the X axis. Refer to the table which lists all the angles to get the start of the next cam. To save confusion, I did all the forward cams first on both ends of the shaft, but it all seemed straight-forward once the details and procedures had been worked out.

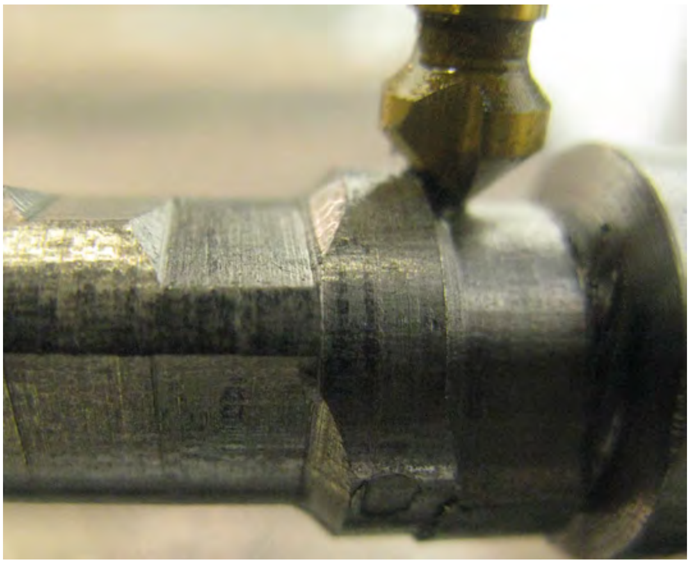
This is the time to machine the reverse cam. Again be careful and study the drawings to see what is required. Photograph 5 shows the reverse cam being cut and also the embryo warming cam. This latter cam will only need a small lift – 1mm is quite enough and it is of course circular. The final machining of the cams is to cut the angled transitional edges. This is to make the lateral sliding of the shaft much easier while notching up or down. I used a tiny countersink bit for this and it did a good job (photograph 6). Here the



LEFT – PHOTOGRAPH 5
Cutting the reverse cam behind the warming cam. Step and flat sides are now obvious.

BELOW LEFT – PHOTOGRAPH 6
Cutting the transfer chamfers.

BELOW – PHOTOGRAPH 7
Polishing.



cutting oil and strong lighting makes the finish look poor – it wasn't! In the bench vice carefully round the top of the lobes with a dead smooth file (photograph 7). The rounding won't do anything to the events, as this is determined by the lobe/base circle tangent but makes things easier for the cam followers. The location pin makes a great handle during this task. Now it's out with the emery tape, starting with 120 grit and working up to 800. Finish with Scotchbrite and the final result will be highly shiny and very pleasing. Photograph 8 shows the finished cams.

Harden the cams then temper to about 210°C or a yellow colour. I use the domestic oven for such tasks. Set it going then come back a while later to quench. It's a lot less stressful than doing it with a flame. The shaft can be tried in situ to determine the exact position of the actuating groove on the offside, which is then machined. The easiest way to do this is to remove the bearing from the shaft assembly to the lathe.

Next time I shall conclude by describing the assembly and testing of the camshaft. I shall also offer a few suggestions for improvements in the light of my own experiences with the engine.

« TO BE CONCLUDED »

BELOW – PHOTOGRAPH 8
Finished cams.

CLUB NEWSROUND

BY **JOHN ARROWSMITH**

Following on from my note in the June issue about a new miniature railway line being planned in Cornwall comes news of another one at Mount Edgecombe House and Country Park. It is proposed that the new 5" gauge line which is scheduled to be inaugurated on the 27th May will run throughout the venue with, hopefully, volunteers running it. So – if there are any model engineers in this area looking for a new challenge then perhaps this could be the place for you!

There are a number of good events taking place this month including the Mainline Rally at the Ryedale Club in Gilling supported by the Lindsey Model Club and GL5 over the weekend of the 26th /28th August. This event is a must for anyone who is interested in operating 5" gauge fine scale standard gauge locomotives and rolling stock. There is also the excellent Bristol Model Engineering Exhibition at the Thornbury Leisure Centre over the weekend of the 18th/20th August to look forward to and the Canterbury & DSME Trains and Traction Rally will be held on the 12th/13th of the month. I spent a lovely day at the Oswestry Society club track during the NAME Narrow Gauge IMLEC event in May and my notes on this will follow in a future issue but a locomotive there reminded me that the Midland Model Engineering show is on the horizon in October and that if you are thinking of entering one of the competition classes now is the time to do so.

In the spring edition of the Colchester SMEE newsletter they report on the proposed building of a station canopy in front of the club house with an additional one over the steaming bays. If these proposals are implemented then members there will have good protection during wet weather conditions. The club house has benefitted from a makeover with new kitchen units and tops and a larger serving hatch. Director Geoff King comments on the decline in the making of models from scratch, coupled with the magazines still publishing old designs without including any new features or fittings. He comments that people seem to be buying locomotives from the trade and when something goes wrong they do not have the skills to repair them. It is a growing problem for many clubs and, like Geoff, I don't know what the answer is. (If readers have any comments on this please drop a line to EIM so that we can see how others feel.) The club has started its driver training evenings again which hopefully will provide the necessary guidance and experience to operate safely on the track. Andy Hope has retired as Chairman and, in recognition of his contribution to the club, has been made an honorary member of CSMEE.

The Derby SMEE is hosting an event at their Morley Hayes track site that I have not heard of before but which sounds very interesting. It is called the NIGGLES Rally and will be held over the weekend of the 5th/6th August. NIGGLES stands for the Narrow Industrial Gauge Ground Level Engine Society and the informal event is for narrow gauge profile locomotives and rolling stock only. It is not open to the public and running will be restricted to known attendees only, so if you would like to attend this novel event get in touch with the event organiser NAMEWebsiteEditor@gmail.com for more information. I can tell you that there is a limited amount of caravan and motor home space available.

Chairman Nick Harrison reports in the Spring edition of the Nottingham SMEE magazine about the excellent visitors' days they have had and the high take up of locomotives using all their tracks. On one day alone they had 45 different locomotives operating which gave a great deal of pleasure to all those attending and as everything went off smoothly it is also a great compliment to the members who maintain the facilities. The club enjoyed a day out at the Rugeley Power Station club when they could run on the track which is destined to be closed by the end of the summer following the closure of the power station. Eight locomotives attended and a most enjoyable time was had by all.

At the Portsmouth MES members are getting concerned about their dwindling membership. They are predicting that they may not last another ten years because of the aging membership and the difficulty they experience in recruiting members of any age. This problem is beginning to show itself at many clubs but it is not an easy one to resolve. It would seem that anything that involves more than two thumbs to make something happen is not of interest any more. If anyone has any thoughts on this we would love to hear from you. They have a really nice set up in Bransbury Park so it really would be a pity to see all their hard work coming to an end in this way. If there are any readers in the Portsmouth area who think they could help them get in touch, you will be sure of a warm

BELOW
Water being taken in the middle of the night.

BELOW – Richard Gibbon drives through the tape at the start of the 24-hour non-stop run at York.

ABOVE
The happy group of members and the hospice staff on the completion of the marathon run.

welcome. The membership fees are very reasonable so that should not be an obstacle to joining.

There has been a lot of work going on at the Southampton SME with all the new ground works and track re-alignment being undertaken. A new raised track trolley storage tunnel and swing bridge is to be built and installed to provide easier access to the running line for locomotives and trolleys. Alongside this new tunnel a new ground level siding is also being built to enable disabled passengers to board a special new carriage which will enable them to enjoy the train rides. The work started in March and, with the use of a mechanical digger and dump truck, they moved about 30 tons of soil from one part of their site to another and completed all the shuttering and reinforcement ready for the concrete. A few days later and the concrete was poured so that when dried out the track work and building could begin. In his news letter notes, Chairman David Goyder pays tribute to all the members who helped with this work which will be of great benefit to the club when it is all finally completed. A new member to the club describes how his father always wanted to own a model of a GWR King class locomotive so in his 80's he set out to learn CAD drawing, produced all the scale drawings he needed and then proceeded to build the engine. It is now 80% complete but the gentleman cannot finish it and the family are looking for someone to finish off the building work to the same exacting standards as the original builder intended. It is their aim to see the locomotive run in all its glory.

Members at the Taunton Society are under serious pressure as they come to terms with being asked to vacate their track at Creech Village. Apparently, the parish council are being very awkward about the situation and will only talk to the club through their solicitors. They have given the club notice to quit by September 30th but have then proposed a new 5-year lease, on a smaller area of ground which is no use to them for a railway, as well as increasing the rent. Talk about being between a rock and a hard place! What are these councillors trying to achieve? At the other site in Vivary Park they were hoping to get a new 5-year lease which would include a new building and for which the council would lay the foundations as well as water and electrical services. However, at the same time they propose to introduce parking charges for the park and for which the club would get no dispensation on the 3-hour parking limit, which obviously is no use to them particularly on working and operating days. I hope these disputes can be resolved for the members' sake and that the Taunton Society can continue to operate.

At the York City and District SME a 24 hour non-stop marathon run was organised earlier in the year to raise funds for the Martin House Hospice in Boston Spa. Seven members took part in driving the locomotive which was a 37-year old 7¼" gauge Kerr Stuart Wren to the Ken Swan design. For this 24-hour run the ash pan was made to be dropped on the move. However, clinker became a problem and the engine was stopped for 1½ minutes. For this stop the judge made them drive for an additional 4 minutes at the end. The details of the run were impressive, with the locomotive using about 8kg of coal, 200 litres of water and 200cc of lube oil. It did 257 laps of the Dringhouses track which equates to about 72 miles. Richard Gibbon, who organised the event, told me that at the end of the 24 hours non-stop running the locomotive was in perfect condition which is more than could be said for the drivers. I won't tell you how he described them but it begins with a 'b' and ends in a 'd'. They raised a magnificent £4000 for the hospice, who were present when the locomotive and crew finished this marathon run. Congratulations from all at EIM in achieving this wonderful sum for such a worthy cause. ■

BELOW
A smoke box full of ash after 24 hours of running.

YOUNG ENGINEERS

BY **JOHN ARROWSMITH**

This month I include another short article by a young man who started his model engineering experience as a 12-year old at the Hereford Society. When Daniel Bell first joined the club he had no practical engineering knowledge at all but in 12 months he has not only learnt the basics but he is now progressing onto simple 3D design work as well. He and his dad have put together these notes to explain how it all started.

Daniel has always been interested in engineering; he loved to watch engineering videos rather than cartoons and the like. We visited HSME on several occasions and he enjoyed this so much he wanted to join in. He then joined as a Young Engineer in April 2016 when he turned 12. For his first project he decided to make a trailer for his Mamod steam lorry similar to the one he has with his traction engine – this would be based on the existing one but would not be a copy. When Daniel started I don't think he realised how much thought and work goes into engineering and the making of models and engines. He has had to think ahead on what he wanted to achieve and get advice on how this could be done but is thoroughly enjoying it.

Firstly, he had some time with Bob to learn about technical drawings and then to 'getting his hands dirty'. His practical work started by learning to use a saw and to cut the flat bar to length for the two end pieces – we did find some bits to practise with – and then filed the cuts flat.

This was followed by drilling holes to make the curved sections of the ends, the hole for the centre bar, and then more sawing and filing to cut the sections out fully. Subsequently, Daniel learnt how to set up and use a mill to machine the edges smooth and to cut a slot in the bottom of the ends to allow clearance for the axles. The centre bar (between the ends) was cut from a length of aluminium tube and the two axles were cut from a length of 5mm stainless steel bar. We then bought some cast aluminium wheels that needed finishing so that involved learning how to use the lathe, along with the safety aspects of course. This involved setting the wheels in the lathe chuck so that they ran true, drilling the centre hole to suit the diameter of the axle bar, and then turning the wheels to give a better finish and to run true on the axle.

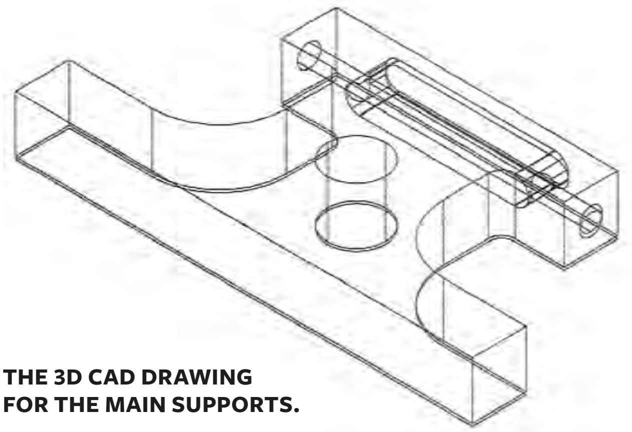
ABOVE
Daniel with the assembled components.

BELOW
The wheels before and after machining the outside rim.

The next question was how to modify the front axle so that it could steer and after some discussions it was decided to use the relatively simple method of cutting straight across one of the ends above the axle and allowing it to rotate on a bolt so a design was scribbled out to work to. It was decided to go with a 2BA bolt so Daniel found the hole size and the diameter required for the bolt from the relevant chart, turned a piece of bronze bar to create the bolt then used a 2BA die to cut the thread. He then drilled a hole in the trailer ends and tapped these 2BA, countersinking to a suitable depth so that the bolt would clamp the centre bar but allow the axle to steer once completed. A grub screw was used to hold the centre bar in the non-steering end block. This all went together very well.

Daniel has now started learning to use TurboCad which has a 3D ability so has the task of drawing the bits he has made so far. This will hopefully stand him in good stead for the future as technology moves on.

This is an ongoing project with several things still to finish but Daniel is really enjoying the work with the machines and with the help and experience of the senior and junior members at the Hereford club he is making good progress. The next project will be a 1½" – 1ft scale battery powered steam outline lorry that he can drive at various events etc. ■



THE 3D CAD DRAWING FOR THE MAIN SUPPORTS.

Frames and wheels for the new wagon.

AUGUST DIARY

- **1 2 3** Bromsgrove SME. Public running at Avoncroft Museum 11:30 – 15:00 every week.
- **1** Romney Marsh MES. Track meeting at Rolfe Lane 10:00 onwards.
- **2** Bedford SME. Public running at Summerfields Miniature Railway 10:30 – 16:00.
- **2** Bradford MES. Steam Up at Northcliffe from 19:30.
- **2** City of Oxford SME. Public running in Cutteslowe Park 13:00 – 16:30 every Wednesday.
- **4 5 6** Whitby Traction Engine Rally, Hawsker Lane, Whitby YO22 4JR
- **4** Chesterfield MES. Public running at Hady 11:00 – 15:00 every Friday.
- **4** Torbay Steam Fare at Churston TQ5 0LJ from 10:00.
- **5 6** Burnley & Pendle MR. Public running at Thompson Park noon – 16:00 every weekend.
- **5 6** Crowborough Light Railway. Public running 14:00 – 17:00 every weekend.
- **5 6** East Herts MR. Public running 11:00 – 17:00 Great Amwell SG12 9RP every Sunday.
- **5 6** Merthyr Tydfil DMES. Public running Cyfartha Park 12:30 – 16:30 every weekend.
- **5 6** Model Engineers Society of Northern Ireland. Public running 14:00 – 17:00 Ulster Folk Museum every weekend.
- **5 6** NIGGLES Rally at Derby SME. Contact editor@gmail.com for more information or to book in.
- **5 6** North Wilts MES. Public running at Coate Water Park 11:00 – 17:00.
- **5 6** Sussex MLS. Public running at Beechurst Railway 14:00 – 17:00 every weekend and Wednesday.
- **5** Bridgend MR. Public running at Parc Slip Nature Reserve noon – 16:00.
- **5** City of Newport MES. Public running at Gleblands Park 13:00 – 17:00.
- **5** Dublin SME. Public running in Marlay Park 14:30 – 17:00 every Saturday.
- **5** Ickenham & DSME. Public running noon – 17:30.
- **5** North Wales MES. Public running at West Shore MR noon – 16:00 every Saturday.
- **5** South Durham MES. Portable track at Locomotion NRM Shildon 10:00 – 17:00.
- **5** Wakefield SMEE. Open Day at Thornes Park Miniature Railway WF2 8TW from 10:00 onwards. Contact sales@blackgates.co.uk for more information or to book in.
- **5** West Wilts SME. Track Day 10:00 – 16:00.
- **6** Ashmanhough Light Railway. Open day and public running 14:00 – 17:00.
- **6** Basingstoke MES. Public running at Viables Craft Centre 11:00 – 16:00.
- **6** Bournemouth SME. Public running at Littledown Park 11:00 – 15:30.
- **6** Bristol SME. Public running at Ashton Court noon – 17:00.
- **6** Chelmsford City MR. Public running at Meteor Way 14:00 – 16:30 every Sunday.
- **6** Chingford SME. Public running Ridgeway Park 14:00 – 17:30 every Sunday.
- **6** City of Sunderland MES. Public running from 13:30 Roker Park.
- **6** Crawley MES. Public running Goffs Park Light Railway 14:00 – 17:00 every Sunday.
- **6** Doncaster MES. Public running Thorne Park Railway 11:00 – 15:00.
- **6** Esk Valley MES. Vogrie Park Railway 14:00 – 17:00 every Sunday.
- **6** Frimley Lodge MR. Public running Sturt Road GU16 6HY 11:00 – 17:00.
- **6** Fylde SME. Public running at Marsh Mill Railway, Thornton Cleveleys.
- **6** Gravesend MMES. Public running at Cascades Leisure Centre 14:00 – 17:00.
- **6** Grimsby & Cleethorpes MES. Public running Waltham Mill noon – 16:00.
- **6** Harrow & Wembley SME. Public running in Roxbourne Park 14:30 – 17:00.
- **6** Kinver & West Midlands MES. Public running 14:00 – 16:30 every Sunday.
- **6** Lancaster & Morecombe MES. Public running at Cinderbarrow 10:30 – 15:45 every Sunday.
- **6** Leicester SME. Public running in Abbey Park 13:00 – 17:00 every Sunday.
- **6** Lincoln MES. Public running at North Scarle 09:00 – noon.
- **6** Malden DSME. Public running Thames Ditton Miniature Railway 14:00 – 17:00.
- **6** Mid Cheshire MES. Public running at Sandiway Wood CW8 2EB noon – 16:00.
- **6** Milton Keynes MES. Public running at Caldecotte MR 13:00 – 17:00 every Sunday.
- **6** Mold MES. Public running at Celyn Wood Northop 11:00 – 15:00.
- **6** Moorlands Railway Charity Day 14:00 – 17:00 between Whitby & Scarborough.
- **6** National 2½" Gauge Association Rally at the Sutton Coldfield SME at Belleny Green 10:30 – 16:00.
- **6** North London SME. Public running at Colney Heath AL4 0NJ 14:00 – 17:00.
- **6** North Norfolk MEC. Public running at Holt Station from 11:00.
- **6** North Staffs MES. Public running at Brampton Park 14:00 – 16:30 every Sunday.
- **6** Northampton SME. Public running at Delapre Park 14:00 – 17:00.
- **6** Norwich MES. Public running at Eaton Park 13:00 – 17:00.
- **6** Polegate MEC. Public running at Daly Recreation Ground 14:00 – 17:00 every Sunday.
- **6** Portsmouth MES. Public running Bransbury Park 14:00 – 17:00 every Sunday.
- **6** Plymouth Miniature Steam. Public running at Goodwin Park 14:00 – 16:30.
- **6** Reading SME. Public running in Prospect Park noon – 17:00.
- **6** Ribble Valley Live Steamers. Public running at Clitheroe from noon.
- **6** Rochdale SME. Public running in Springfield Park from noon every Sunday.
- **6** Rotherham DMES. Public running at Rosehill Victoria Park 12:30 – 16:30 every Sunday.
- **6** Ryedale SME. Public running at Gilling 12:30 – 16:30.
- **6** Saffron Walden & DSME. Public running adjacent to Audley End Railway from 10:00 every weekend.
- **6** Sale Area MES. Public running at Walton Park M33 4AQ noon – 16.30.
- **6** Sheffield SMEE. Public running at Abbeydale Park MR S17 3LB 13:00 – 17:00.
- **6** Southport MEC. Public running in Victoria Park 11:30 – 16:30 most Sundays.
- **6** Spenborough MEE. Public running in Royds Park 13:00 – 16:00 every Sunday.
- **6** Valley Road MES. Public running at Floralands Farm Park from noon.
- **6** Vale of Aylesbury MES. Public running at Quainton from 11:00 every Sunday.
- **6** West Cumbria Guild MES. Public running Curwen Park 13:30 – 15:30.
- **6** West Huntspill MES. Public running at New Road 14:00 – 16:30 every Sunday.
- **6** West Riding SMLS. Public running at Freedom House Tingley 13:30 – 16:30 every Sunday.
- **6** Wrexham SME. Open Day at Gresford LL12 8UA noon – 15:30.
- **6** Wirral MES. Public running at Royden Park 13:00 – 16:00.
- **6** Wolverhampton DMES. Public running at Baggeridge Park 13:00 – 17:00 every Sunday.
- **12 13** Astle Park Traction Engine Rally. Astle Park, Cheshire SK11 9AD.
- **12 13** Avonvale MES. Public running at Dunnington 11:00 – 16:00.
- **12 13** Canterbury & DMES. Trains & Traction Weekend 10:00 – 16:00 each day.
- **12 13** Leyland SME. Model Engineers Open Weekend + Traction Attraction from 10:00 Worden Park.
- **12** Brighton & Hove MR. Public running at Hove Park 13:30 – 16:30.
- **12** Westland & Yeovil DMES. Running Day at Westland Leisure Centre 11:00 – 16:30.
- **13** Bracknell Railway Society. Public running at Jocks Lane 14:00 – 16:30.
- **13** Brighouse and Halifax MES. Public running in Ravensprings Park 13:30 – 17:00.
- **13** Cambridge MES. Public running at Fulbrook Road 13:30 – 17:30.
- **13** Coventry MES. Public running at Ryton Pools Railway Steam Special 13:00 – 16:00.
- **13** Hereford SME. Public running at Broomy Hill noon – 16:30.
- **13** Welling & DMES. Public running at Falconwood 14:00 – 17:00.
- **13** Worthing SME. Public running at Field Place Durrington 14:00 – 17:00.
- **15** Nottingham SME. Evening talk and demonstration on Powder Coating with Brian Parker 19:30.
- **18 19 20** Bristol Model Engineering Exhibition, Thornbury Leisure Centre from 10:00 each day.
- **19 20** Belfast & County Down Railway 26th Birthday weekend, Drumawhey Junction Railway.
- **20** Guildford MES. Open afternoon, Teddy Bears Picnic, Stoke Park 10:00 – 17:00.
- **20** Huddersfield SME. Public running in Greenhead Park 11:00 – 16:00.
- **20** Ipswich MES. Summer Open Day at Foxhall Road from 11:00.
- **20** Northolt MRC. Public running at Northolt Community Centre 14:00 – 17:00.
- **20** North West Leicester SME. Public running at Hermitage Leisure Centre 13:00 – 16:00.
- **20** Pinewood (Wokingham) MR. Public running at Pinewood Leisure Centre 13:30 – 16:00.
- **20** Rugby SME. Public running at Rainsbrook Valley Railway 14:00 – 17:00.
- **27** Evergreens MR. Public running Open Day at Stickney 10:30 – 16:00.
- **27** High Wycombe MEC. Public running at Holmer Green from 11:00 – 17:00.
- **27** Phoenix MES. Public running at Telford Steam Railway.11:00 – 16:00.
- **27 28** Cardiff MES. Public running at Heath Park 13:00 – 17:00 each day.
- **27 28** Claymills Pumping Station Bank Holiday Steaming from 11:00.
- **27 28** City of Oxford SME. Public running at Cutteslowe Park from 13:30 – 17:00.
- **27 28** Millerbeck Light Railway Open day from 10:00.
- **27 28** Nottingham SMEE. Public running at Ruddington from 11:00 each day.
- **27 28** Papplewick Pumping Station Open Days with 7¼" gauge railway in operation 11:00 – 16:00.
- **26 27 28** Ryedale SME Mainline Rally at Gilling from 09:00 each day.
- **27 28** Shrewsbury Steam Rally at Onslow Park from 10:00 each day.
- **28** Sutton Coldfield MES. Public running at Bellany Green 10:00 – 15:00.
- **28** Surrey SME. Public running at Mill Lane Leatherhead 11:00 – 16:00.

Details for inclusion in this diary must be received at least EIGHT weeks prior to publication. Please ensure that full information is given, including the full address of where every event is being held. Whilst every possible care is taken in compiling this diary, we cannot accept responsibility for any errors or omissions.

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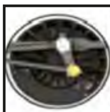
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