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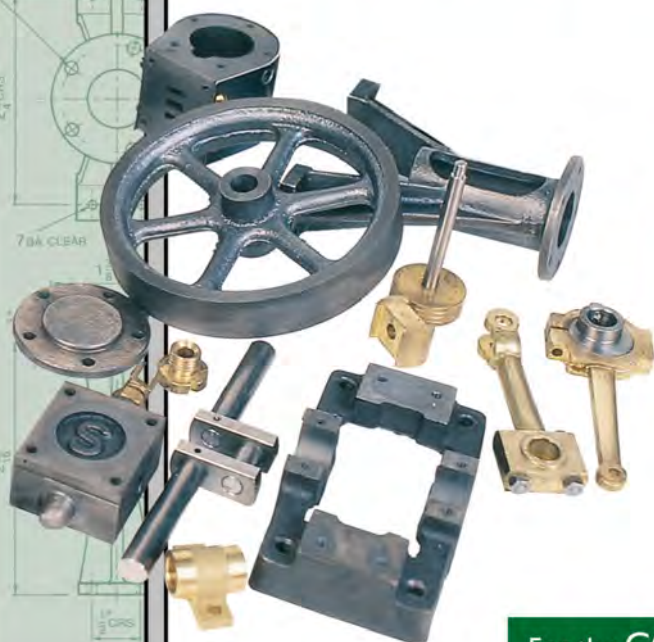
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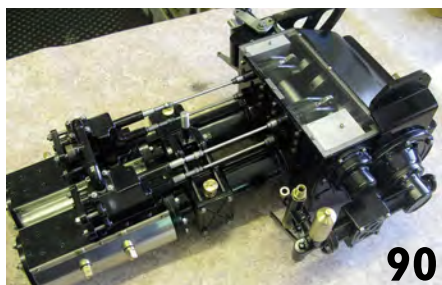
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EDITORIAL

WELCOME!

As Chris Deith announced in last month's magazine, I have great pleasure in introducing myself as the new publisher of Engineering in Miniature magazine. For those of you who are not familiar with Warners Group Publications, we publish a number of magazines covering many subjects, but those most relevant to EIM are BRM (British Railway Modelling), Narrow Gauge World, Garden Rail and Traction magazines.

I would like to take this opportunity to thank Chris, Avril and the TEE Publishing team for trusting us with their title and to ensure readers that we'll continue to work closely with Chris and Avril to support their many shows and exhibitions.

We have many ideas on how to further improve Engineering in Miniature and hope to start implementing these in the coming months. In the meantime, if you have any comments (good and bad) I would genuinely love to hear from you. My email address is stevec@warnersgroup.co.uk

Anyway, that's enough from me. I'll now pass you on to the editor Martin Evans...

Steve Cole
Publisher

Firstly I should like to thank Chris Deith and his small but perfectly formed team at TEE Publishing for taking me on a year or so ago as a 'rookie' editor and providing so much help and encouragement as I gradually got to grips with this new and rather frightening activity. It is a testament to Chris's vast experience and professionalism that the process has proved to be almost entirely painless. I should also like to thank Chris Rayward, our editor emeritus, for his constant help and encouragement over the last year or so.

This month sees the 200th anniversary of the granting of a patent to the Rev. Robert Stirling for a "heat economiser" now known more generally as the "Stirling Engine". We are marking this anniversary with an article about the Stirling Engine by Graham Sheard, which you can find in the pages of this magazine. The Midlands Model Engineering Exhibition, at The Fosse next month, will also mark the anniversary with a special display commemorating Stirling and his engine.

We are always interested to hear your views on any topic relating to model engineering, to hear about your latest project (especially if you would like to write an article or two about it!) and to learn especially what you would like to see in the magazine. We are, after all, here only to promote and provide for your interests.

Martin Evans
Editor

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The front cover shows our contributor Graham Sadler driving his 3" Atkinson Uniflow Tractor at the MSRVS rally at Tewkesbury in late June.

Graham was awarded Best Finished Model at Harrogate 2014.

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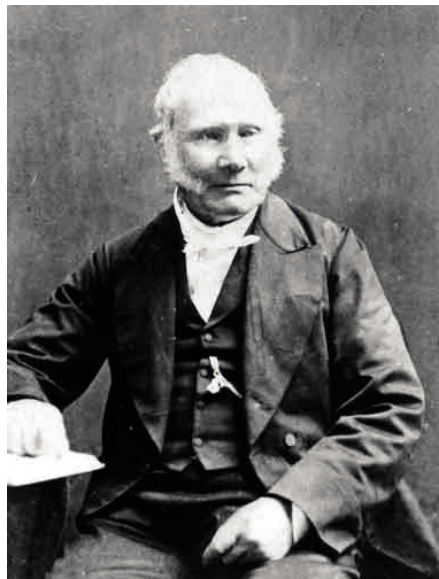
The Stirling Engine – A Bicentenary

by **Graham Sheard**

Have you ever had a bright idea, an invention that would be labour saving, of benefit to humanity, potentially profitable and, having produced it, only to find it overcome by problems beyond your control? This year, 2016, is the bicentenary of Robert Stirling's patent that introduced to the world an economical, silent and almost maintenance free prime mover that required, when running, the minimum of attention. The patent, applied for on 7th September 1816, is for 'improvements for diminishing the consumption of fuel', or fuel efficiency in modern parlance. So, rather than for the engine that now bears his name, Stirling's patent was for an economiser.

The engine itself is simple enough; a fixed mass of air is alternately heated and cooled with the resulting pressure variation used to drive a mechanism to do useful work. The economiser, or regenerator as it is now known, sits between the hot and cold ends, absorbs the heat as the air travels to the cold end and gives it up on the way back.

Robert Stirling was quite a remarkable man, a clergyman but also an engineer in a family of engineers. His grandfather was an agricultural engineer and his brother, James, followed him in building air engines. Four of his sons became engineers, except one who followed him into the ministry. His daughters were both practical. His most famous son, Patrick, produced the Great Northern Railway Stirling Single, a locomotive ahead of its time and perhaps the most elegant steam locomotive of all time. A thorough biography has been written by Bob Sier.



The Reverend Robert Stirling DD

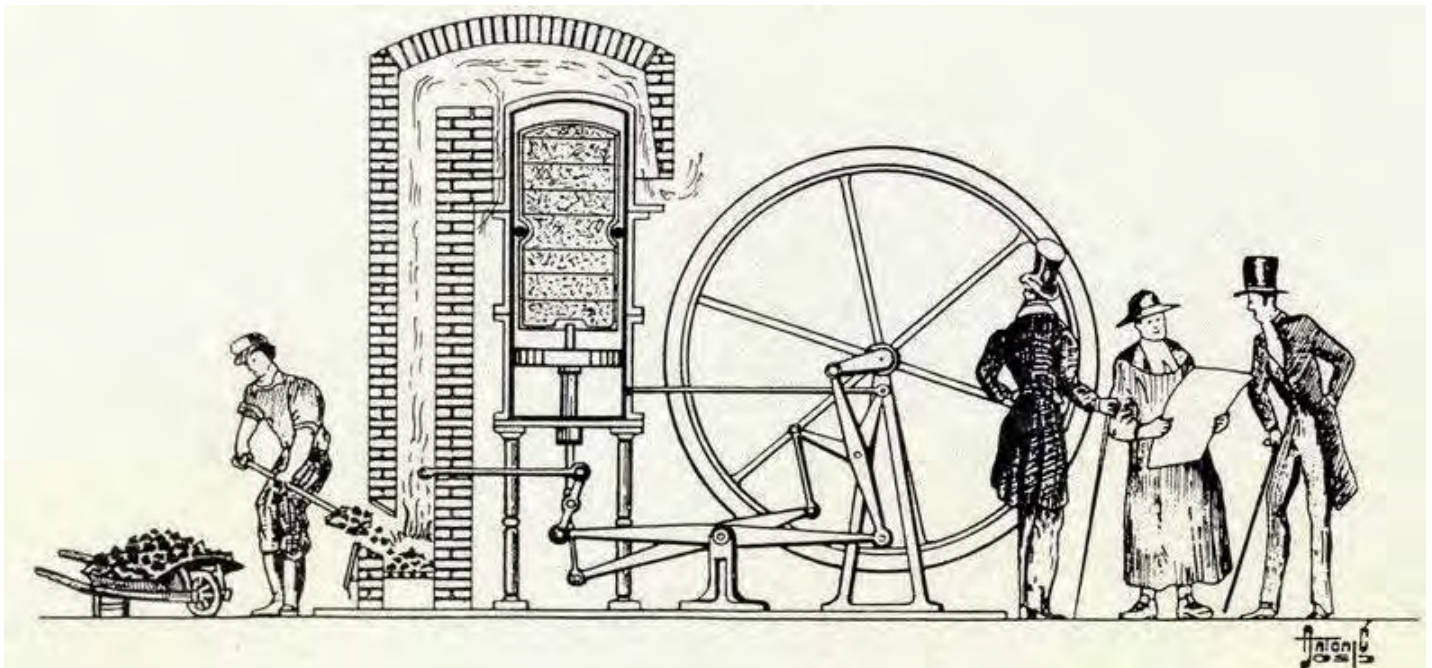
Robert's brother James found that more power could be obtained by pressurising the engines and erected two engines at the Dundee Foundry. The first provided 21hp and the second in 1842 of 45hp replaced it. This ran continuously for 2 years, 9 months before the air vessel burnt through. This was because of the cast iron of which it was made. Had Bessemer steel been available the engine would have survived much longer. Two further repairs were made. There were no deaths or injuries despite the engine being pressurised – only a little black smoke. This is to be compared with the many fatalities caused by the explosions of high pressure steam boilers at the time.

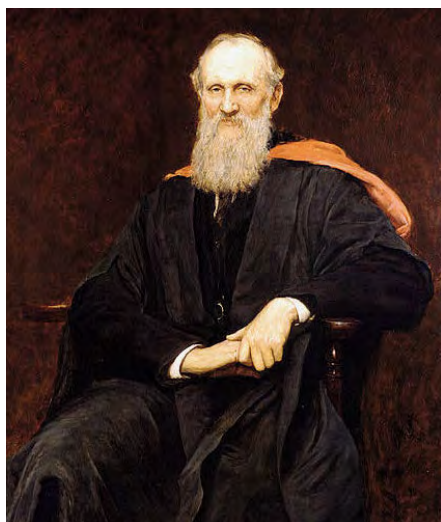


The Edinburgh Engine

Of particular note, of the small engines built by Robert Stirling, are the two he presented to each of Glasgow and Edinburgh universities. At Edinburgh the engine was used by William Thompson for lectures and research. Thompson used the engine to develop his theory of thermodynamics and was later ennobled as Lord Kelvin. You

The engine described in the patent of 1816.





Lord Kelvin

may have heard of him. Thompson also discovered that if you input mechanical energy you can pump heat out. This type of engine has been widely used for cryogenic cooling. An excellent book about the Glasgow and Edinburgh engines has been put together by James Rizzo: 'Robert Stirling's models of the Air Engine' with full details for modelling these historical machines.

The engine became popular in a variety of forms of domestic motor, from pumping water to grinding coffee. The most widespread were the Heinrici and Robinson engines both of which have proved popular subjects for modellers. Arnold and Horace Robinson around 1886 developed a squat Stirling engine with the regenerator integral with the displacer.

Louis Heinrici's 1876 popular domestic motor was made in various sizes from 1/100 to 1/2hp. Technically this was a hot air engine as there is no dedicated regenerator. Several museums have working examples of these and other versions.

AK Rider in 1842 developed another version, a compression engine in which both pistons are open and contribute to the output power. These were used extensively for pumping artesian wells. They were manufactured in England by Hayward-Tyler and two examples may be found working at Hereford Water Works museum.

As electric motors became more widely available there was less need for these small domestic motors, but a need was found for an electricity generator that would supply the power needed

Philips Stirling engine with electrical generator.



The Great Northern Railway Stirling Single, designed by Robert Stirling's son, Patrick.

for valve radios. The Stirling engine, not producing the electrical noise of an internal combustion engine, and being acoustically quiet, was ideal.

NV Philips developed a useful portable generator that fulfilled these requirements. Unfortunately some fool developed the transistor and the bottom fell out of the market. So, it's been 200 years and the engine is hardly ubiquitous.

The work by Philips inspired others to find niche applications for this versatile engine, cryogenic cooling being a success. As an external combustion type it could use any heat source and solar energy has been found particularly effective but the varying price of oil means cost margins are close. Nuclear power also has been used and with the low loading and low maintenance the engine can be used in space vehicles.

Air Independent Propulsion systems are used in submarines producing no detectable waste and no noise.

Central heating systems have been developed by Whispergen and Microgen which provide both the domestic electricity and heating. Generators using wood pellets and various other materials for fuel have been developed.

Great advances in materials technology have overcome the problems of early development. Stainless steel is often used for the hot end and exotic gasses, notably helium, can be used instead of air showing a great improvement in power.

Using solar energy: Solo Stirling engine on solar concentrator.



Pressurisation has to be used to generate significant power and this will usually involve enclosing the crankcase. For modellers most of the attraction of these engines is with the variety of mechanisms used to extract power and provide the ninety degree phase shift. Consequently many engines on display are little more than toys producing barely enough power to turn over. However there is still a place for the amateur to make a significant contribution to development. A freestyle engine can be built from the remnants of the scrap box but great technical skill is demanded to produce a really good engine.

Despite the setbacks there is still a lot of interest in these engines both on a commercial and an amateur basis. There may yet be found a use in energy storage systems. We just have to leap over the lead held by the internal combustion engine.

The Reverend Robert Stirling wanted to be remembered for 'tramping around his parish'. Today he is remembered for an engine which may help solve our energy problems. ■

For further reading:

Bob Sier, 'Rev. Robert Stirling DD', ISBN 0 952641704

'Hot Air, Caloric and Stirling Engines', ISBN 0952641712

James Rizzo, 'Stirling Engine Manual' Vol 1 ISBN 9780951936733, Vol 2 ISBN 9780951936795

'Robert Stirling's Models of the Air Engine', ISBN 9780954713195

Roy Darlington, 'Stirling and Hot Air Engines: Designing and Building Experimental Model Stirling Engines', ISBN 9781861266880
Allan J. Organ and Theodor Finkelstein, 'Air Engines: The History, Science, and Reality of the Perfect Engine', ISBN 9780791801710
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Building the L&NWR Coal Engine in 5" Gauge – Part 7

Hotspur describes the construction of the cab front and roof

Continued from page 67, August 2016

To begin with I offer prospective builders a further picture of the inside of a cab side panel. I could not include this last time but it shows the fastening arrangement onto the cab side assembly. I have used a small size 8BA bolt here but for the trial build and alignment cheese head slotted screws were much easier to take in and out.

Cab Front and Roof

I started these two parts by forming the roof as it is far easier to profile the top of the cab front to the roof shape than to do it the other way round. Cut a piece of 20SWG brass to be a full $7\frac{5}{16}$ " long by $3\frac{15}{16}$ " wide and lightly scribe two lines across the width $\frac{1}{2}$ " from each end. Here again, I usually make sure any marks on the sheet are made on the inside where they will not show through the painting. Hold each end in your bench vice along these lines, making sure the sheet is at right angles and push the material gently away from you to make the short reverse curve on the ends of the roof. I have deliberately not specified a radius for these bends, as it would have been almost impossible to create the exact dimension, but a very small bend is needed. Now take the sheet and either roll it through a bending machine or coax it by hand until the large radius curve is created between the two small bends. The height of the curve needs to be just over $\frac{1}{2}$ " when placed on a flat surface. The material is quite soft and this "tweaking" is a simple task. The dimension is given for the height of the arc on the cab side view I included last time.

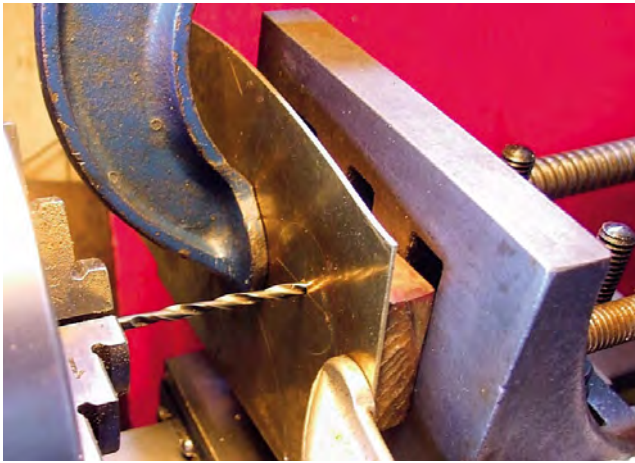
To help ensure the radius was right I made the cab front sheet at the same time. Take a piece of 18SWG brass sheet about 4" wide and slightly wider than the final width required over the side panels and mark out the large radius on the centre line. Set out the large radius with the two blended radii noting that the "curve" is actually horizontal at the very ends. This shaped edge can be easily filed and then used to check that the roof has been formed to the correct profile. My second photograph shows the parts I made nestled together but do not be concerned if there is a little "spring" needed to fit the roof as this will not be a problem on assembly. This front section of the cab is quite straightforward and, with the two side panels in place on the cab side assemblies, measure across the front to establish the width outside the panels and trim the front plate to suit.

Photograph 1 – An inside view of the right-hand cab side panel showing the fixing arrangement.

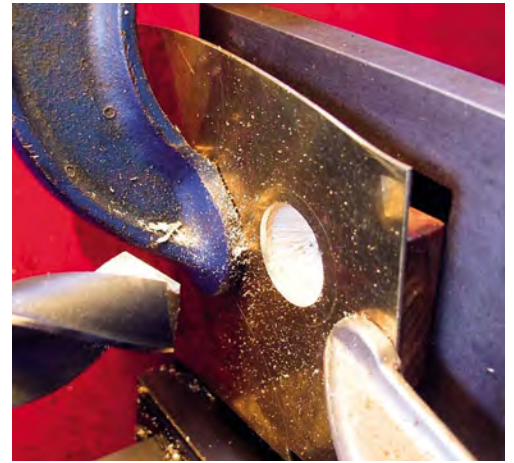


Photograph 2 – The formed roof plate and the profiled cab front shown fitting well together.





Photograph 3 (Left) – The cab front mounted on an angle plate on the lathe saddle to pick up the drilled pilot hole for the window opening.



Photograph 4 (Right) – Using increasing drill sizes to open up the window hole.

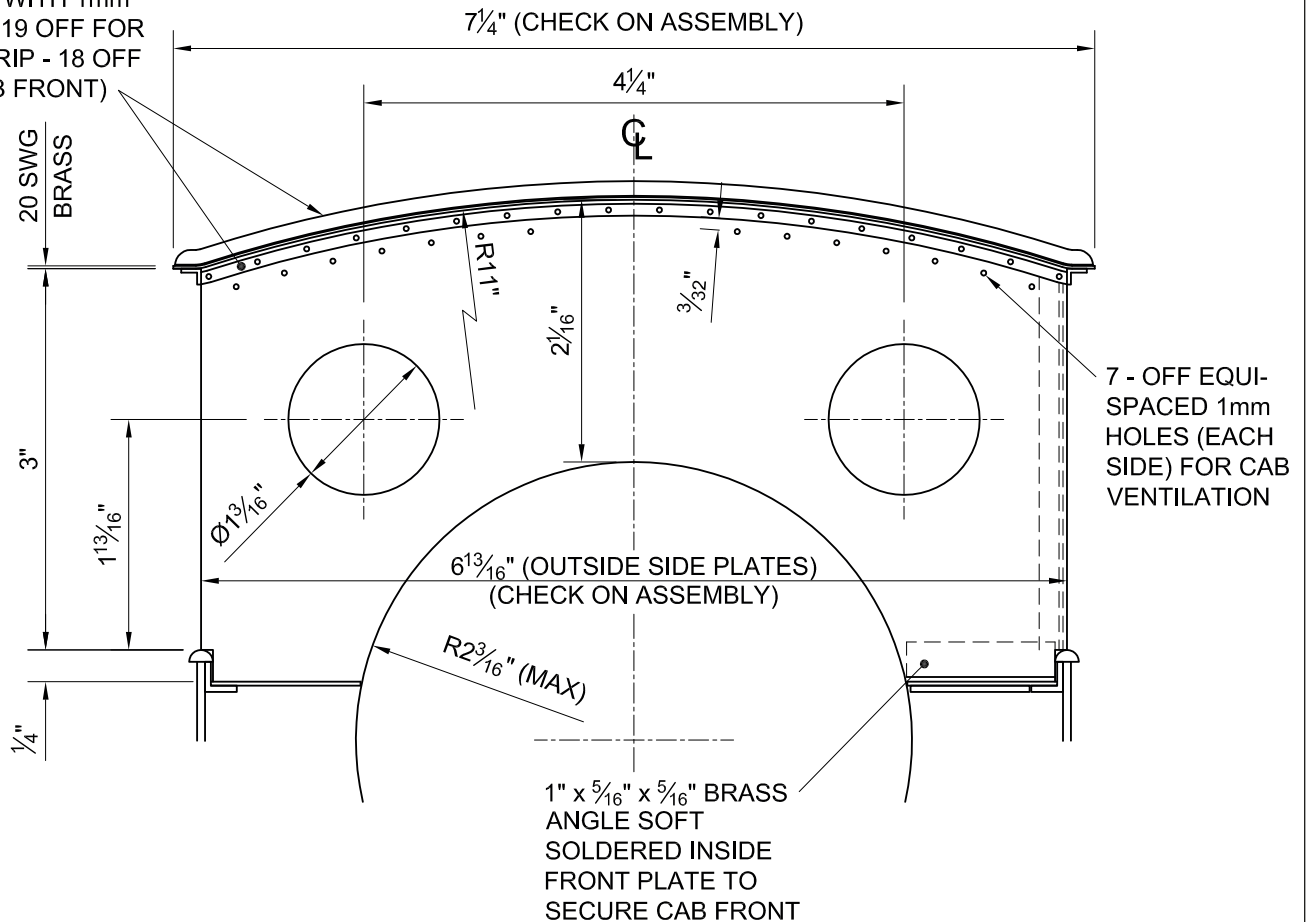
The next task was to cut out the spectacle window openings and here I marked out the centres and drilled a pilot hole about $\frac{3}{16}$ " diameter through each. To drill the material I used my lathe with the cab front tightly clamped with some wooden packing onto an angle plate on the cross-slide. The small drill is put in the 3-jaw chuck to act as a centre location and then a series of larger drills are used at slow speed to remove most of the material. To complete the holes I used my boring head; removing $\frac{1}{2}$ mm

at a time until the correct diameter was achieved. Cutting out the opening for the boiler was done by hand by hacksawing in from the two ends to a row of chain drilled holes in the centre of the curve. It will be seen from the drawing that I have left this radius smaller than the diameter required for the final boiler cladding. This is because the fit of this opening around the boiler cannot be definite at this stage and some adjustment may be required for width and height when that time comes.

We can now move on to the addition of the various angles and, starting with the cab front, a piece of $\frac{5}{32}$ " brass angle has to be hot formed to suit the curve just generated for the roof joint. Here again I used my thick plate and arranged for the material to be formed to overlap the cut-out so the angle did not 'sag' when heated. Rather more heat is needed than for the beading we did previously but the principle is the same. Do not cut the material to length; just clamp the angle to the plate and, starting at one end, make the reverse

HOT FORM $\frac{5}{32}$ "
BRASS ANGLE.

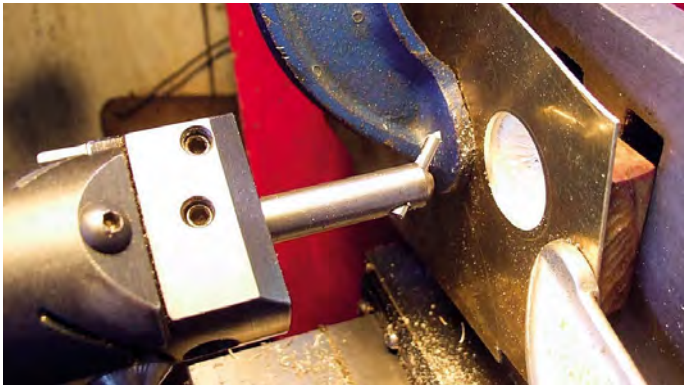
ATTACH WITH 1mm
RIVETS (19 OFF FOR
RAIN STRIP - 18 OFF
FOR CAB FRONT)



FRONT VIEW OF CAB (18 SWG BRASS)
(CAB FRONT TO OVERLAP SIDE PLATES)

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Photograph 5 – Using a boring head in the lathe to machine out the window opening to the final size.

curve first and check it matches the cab front. Here it is wise to ensure that the end being formed is the right end for the cab front as it will be soft soldered to the outside at the top. My pictures show what I mean and, once the main curve has been formed, the material can be moved along so the part being heated is over the cut out. Frequent checking is required to ensure the bend is smooth and the flanged edge is kept upright.

When the angle has been formed tin the joint edge with soft solder and do the same along the top edge of the cab front. Position one end with a small clamp about 1" in from the end and use a packing block to allow the clamp to hold the joint flange not the edge. Heat the end and make the joint then allow it to cool and check what has been done. If it is not right unsolder the joint and have another go. Once this first joint has been made use the clamp to hold the soldered end and work on around the strip. Here I use quite a few clamps to ensure the angle stays in line with the cab top; the task is surprisingly quick to do if you start out with nicely formed parts.

The next task is to add the 1mm rivets and I was fortunate to obtain these as they are a very good size for our purpose. In this application rivets with $\frac{1}{32}$ " or $\frac{3}{64}$ " diameters are completely wrong.



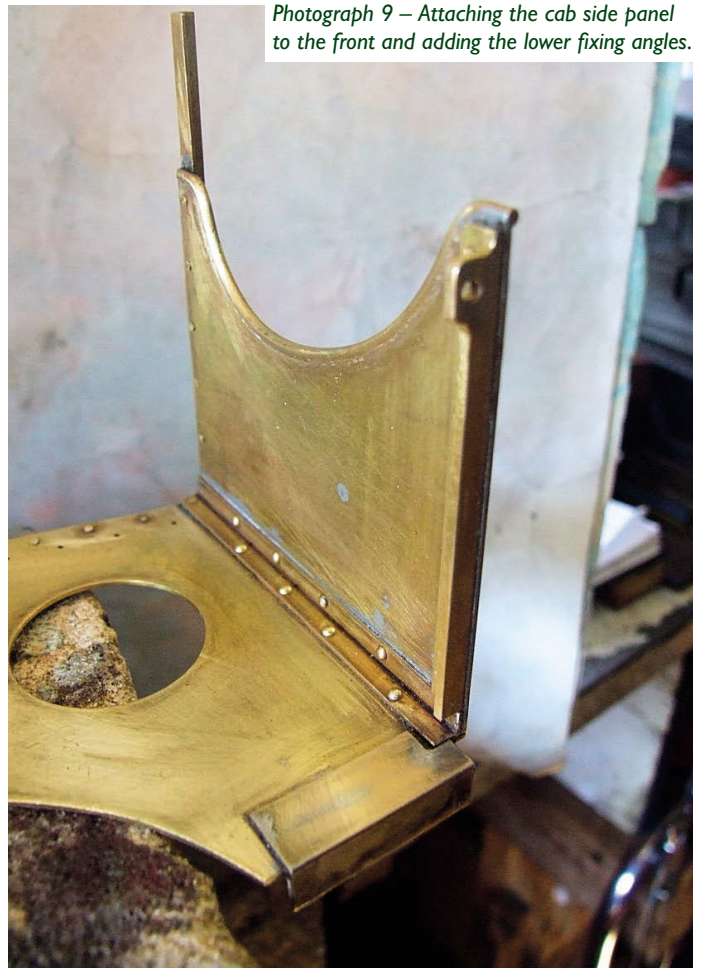
Photograph 6 – Checking the size of the cab front against the assembled side panels.

Start by checking where the two end rivets will go to pass through the $\frac{3}{16}$ " angle that is already on the cab side panels. These two holes are the end points for the 18 equi-spaced rivets required. As builders may have a different overall width to their cab fronts than mine my drawing does not specify the pitch needed for these rivets, but my layout required them to be just less than 10mm apart. It is best to do a trial run with a ruler and pencil to check



Photograph 7 – Hot forming the end of the cab front outside fixing angle.

Photograph 8 – Checking the curvature of the angle against the top of the cab front plate.



Photograph 9 – Attaching the cab side panel to the front and adding the lower fixing angles.

what dimension suits the overall width and, when the decision has been made, mark out the holes for the rivets on the back of the cab front, not on the angle itself as any marking out errors will be difficult to hide. Drill all the holes and de-burr them. Now the fun starts as the rivets need to be about $\frac{1}{8}$ " long and, like mine, I am sure a few will disappear during cutting, trimming or when being held with tweezers to insert them in the holes. Make sure the snap to hold the rivet head has a flat on one side to allow it to sit close to the angle without damaging it. Do not make the mistake of adding the rivets at the very ends as these must be drilled through the corner angles after the side panels have been soldered on.

To continue the assembly tin the surfaces of the corner joints for the cab front to the side panels. Use a small clamp to position the panel and make the first soldered joint in stages. At the top the remaining 1mm rivet can be added and when the panel has been correctly positioned and fully soldered, fit a few more $\frac{3}{4}$ " rivets down the edge fitted from the inside and finished flush into small countersinks on the outside. Take great



Photograph 10 – The two infill plates fitted in front of the cab structure, notched to fit inside the side sheet fixing angle rivets and with the addition of the thickening plates for the fastenings.

care trimming any excess material off the rivets with a fine file as the cab front face could easily be scratched.

Before we go on to the roof there are two small pieces of brass sheet that act as a platform for the cab front to sit on. I made mine from 18SWG brass 2" long and $1\frac{1}{8}$ " wide and they require a radius to fit inside the angle of the cab sides under the handrail and carefully positioned notches to fit around the inside ends of the rivets. Before fitting add a small block of 2mm

brass about $\frac{3}{4}$ " by $\frac{3}{8}$ " with silver solder to the underside where the cab front will be, making sure that these are positioned to avoid contact with the side angle. Do a trial fit and then soft solder the plates in position. The cab front also has a short length of $\frac{5}{16}$ " brass angle soft soldered to the inside of its bottom edge. Prepare two short angles and each will need to be notched to sit snugly against the internal corner.

At this stage I reduced the overall height of the cab front at the ends to allow for the thickness of the infill plate and the angle to be added. I made mine from a larger section stock and left the upright leg full width as will be judged from my photograph. For now small clamps can be used to hold the front of the cab in place. Adding the fixing holes and tapping the strengthened plate will be carried out later once the assembly is complete but I see my drawing does not specify the 10BA bolts to be used.

The cab roof can now be fitted with the two curved angle sections that need to be added to the rear edge. Take care to form them the right way round. The one underneath has the flange facing outwards and is positioned a flange width away from the edge. The second one is immediately above it with the flat edge of the angle in line with the rear of the roof. This means the two flanges are in line with each other and the line of rivets will be on the centre line of both of them. I have looked at many pictures of the prototype locomotives and it appeared in some of them that there were also side gutters fitted but I have not been certain of this and so I am offering no details.

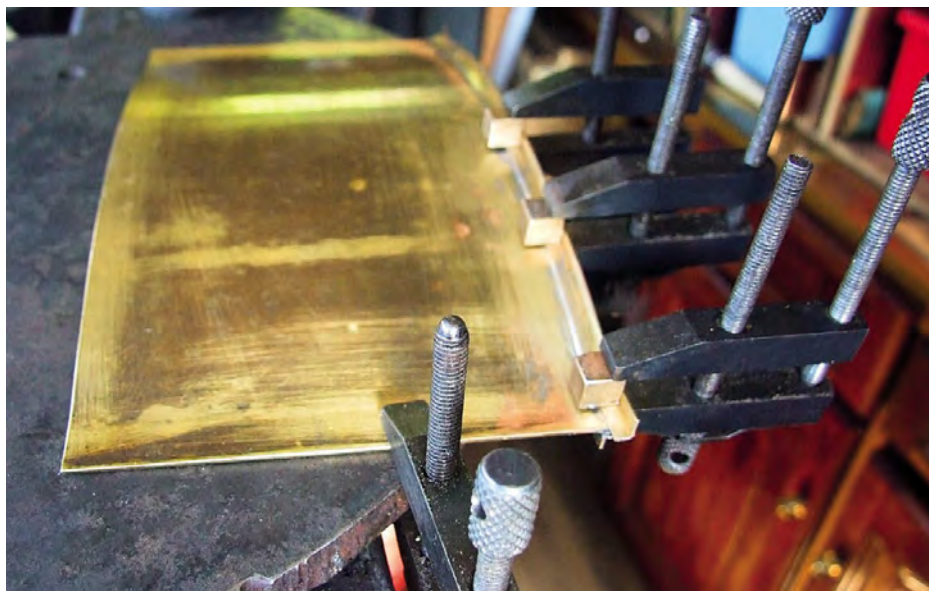
Start by adding the lower angle; my photograph shows how I used many small clamps to hold it in place to do the soft soldering and moved the clamps to complete the joint along the angle. The same is required for the upper angle but here you need a selection of small blocks to reach over the flange when holding the two parts. When the angles are in place the final task is to add the 19 small rivets marking out carefully and this time inserting them from the top.

Next time I will complete the roof assembly and describe the two spectacle plate windows, then go on to the front beam and the rear steps.

Photograph 11 – Adding the first rear angle to the underside of the cab roof using many clamps.



Photograph 12 – Carrying out a similar operation to attach the upper angle with small blocks to ensure the pressure goes on the contact flange and not the edge.



To be continued

Cardiff Steam Rally 2016

by John Arrowsmith

The annual Welsh Rally at the Cardiff MES was held over the weekend of the 11/12th June at the Heath Park tracksite. A damp morning ensured there was plenty of atmospherics for photographers recording the wide variety of visiting locomotives and traction engines. The excellent hospitality the Cardiff club members have a reputation for was very much in evidence when I arrived and a hot coffee and bacon butty were soon to hand – most welcome. This very active society has built a new access ramp and bridge to enable disabled visitors to gain access to the centre of the tracksite. A superb construction job both by members and contractors, it provides a tremendous facility for the less fortunate, allowing them to be able to visit all areas of the site.

The steaming bays were a bustle of activity with both large 7¼" gauge and the smaller 5" gauge locomotives being prepared for the day's duties. The first train of the day on the ground level circuit was a good looking 7¼" gauge Romulus

brought to the rally by Richard Cable and Ted Burge from the York City SME. It ran very well all through the day. On the elevated track a little 5" gauge 2-6-0 freelance Mogul started the proceedings and was quickly followed by a GWR 1500 Pannier driven by Jonathon Williams from the Llanelli club. Both performed very well and had a good long running time. Large standard gauge locomotives were next to take their turn on the track and the first of these was the LMS Black 5 of Mick Tandy. Immaculately turned out, it created quite a spectacle as it pulled out of the steaming bays. Following on from Mick was Chris Wilson with his 7¼" gauge Bagnall 0-4-0 and the next locomotive onto the track was the impressive 7¼" gauge Bullied "Q" class built by Len Steele, driven at this rally by Pete Lawson.

There was a small selection of traction engines in attendance and John Styles of the host club soon had his 4" Garrett steamed up. From the Llanelli club John Davies had brought his 4" scale Savage

tractor which was ticking over quite nicely. Another popular engine on the rally scene was the 4" scale McLaren owned by Rob Hoskins.

Meanwhile the track operations were in full swing and I noted a very nice 7¼" gauge Stirling 4-2-2 being put through its paces. Mike Fox's LMS Black 5 was also putting in a good turn and creating lots of atmospherics in the damp air. A rarely modelled example of a Sentinel 0-4-0 shunter was attracting a lot of attention in the steaming bays. Another impressive locomotive was the 5" gauge 2-6-0 LNER K5 built by Geoff Elliott to a design by Michael Breeze. Geoff told me that as far as he knew this was the only example of this particular LNER locomotive in the country. It was performing exceedingly well on the elevated track.

As with everything all good things have to end and so did my time at Cardiff. My thanks as usual to all at the club for the hospitality and for another good day out. ■



Richard Cable turns his 7¼" gauge Romulus to leave the shed.



This little 2-6-0 freelance Mogul was first on the elevated track.

Jonathon Williams has a good head of steam as he nears the station.



Mick Tandy and his Black 5 set off on his first run.





Under the new access bridge with the Bullied Q class Pete Lawson has lots of steam.



John Syles with his 4" Garrett proceeds slowly out onto the roadway.



The 4" scale Savage of John Davies from Llanelli.



A great sight was this 7 1/4" Stirling 4-2-2 as it progressed through the ground level station.

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Electric Traction Engines and Steam Wagons

Ian Jones describes why he started to build electric powered steam engines and highlights some of the advantages of these engines compared to his 4" scale live steam traction engine



Ian's electric engines alongside his 4 inch live steam Burrell.

As many model engineers are now running electric powered locomotives on their club tracks I wonder if there is also a place for electric powered miniature traction engines, rollers and wagons in the world of model engineering and on the rally field. After all, electric vehicles are much cleaner, safer and easier to operate than their live steam counterparts, they are much easier to maintain and usually cost a lot less to build and run. Also, as they don't get hot, don't smell and are environmentally friendly, they can even be used safely indoors! I would therefore like to share my experiences of building and running electric engines and hopefully encourage other people to 'go electric'.

So, what prompted me to start building electric engines? Well, I developed the steam bug at an early age and attended many steam rallies with my family when

I was growing up. By the age of ten I desperately wanted a Mamod traction engine but my parents couldn't really afford one so I came up with the idea of building a small showman's engine out of cardboard with an electric motor mounted in the tender to drive the back wheels. The finished model actually looked quite good and worked surprisingly well. Forty years later it still looks pretty much the same as when it was built and the motor is still in working order.

I did eventually get a Mamod and I have since owned several much bigger engines including a 4" scale Ruston Proctor which I refurbished and then rallied for several years. However, when I became a Dad, I grew increasingly worried that a hot engine with lots of moving parts may not be very compatible with young children so I decided to build something that would be a bit safer.

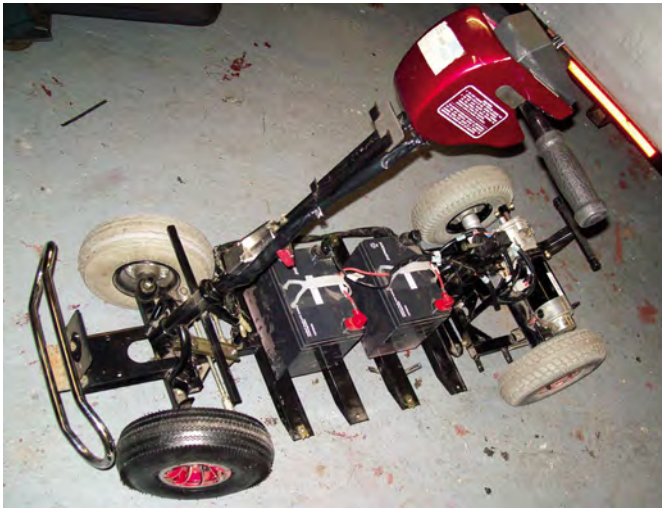
The cardboard electric showman's engine that Ian built when he was only 10 years old.



One cold windy morning, while I was trying to get my engine into steam at a rally, I spotted a man on a mobility scooter. This gave me an idea and, following a conversation with him, I purchased a second-hand scooter from eBay with the aim of building a 3" scale Foden steam wagon using its chassis.

On testing my new acquisition I was very impressed; it was very powerful as it used a 24 volt motor to drive the back wheels via a built-in gearbox and differential. It was also very manoeuvrable and simple to drive as the direction and speed were operated by a thumb lever on the handlebars, which also incorporated an electronic braking mechanism. I was also impressed to learn that these scooters had a range of about 20 miles on a full battery charge so, although the addition of smoke and sound units would use additional power when it was converted into a steam engine, it looked likely that the chassis would have more than enough power for a full day at a steam rally.

I had to design everything as I went along and the first job was to relocate the steering column further back from its original position, as the Foden cab extends some way back from the front axle, so I used the front end of an old bicycle frame to create a new steering column. I then constructed a new upper chassis frame to support the body of the Foden using steel box section from an old metal framed table. The bodywork was then constructed from bits of plywood and some aluminium sheet, and many of the other components were made from scrap or household items e.g. a cake tin was used for the smokebox, an old tapered breakfast bar leg was used for the chimney and an industrial nylon caster wheel was used for the flywheel, so the basic build cost of this engine was minimal.



The stripped down scooter chassis.

I then added a separate motor for the flywheel and motion, which shared the power supply for the main drive motor so that it would start, stop and rotate automatically when the engine moved. I also added an electronic sound unit to make a realistic chuffing noise, which was synchronised with the flywheel, and an electronic whistle.

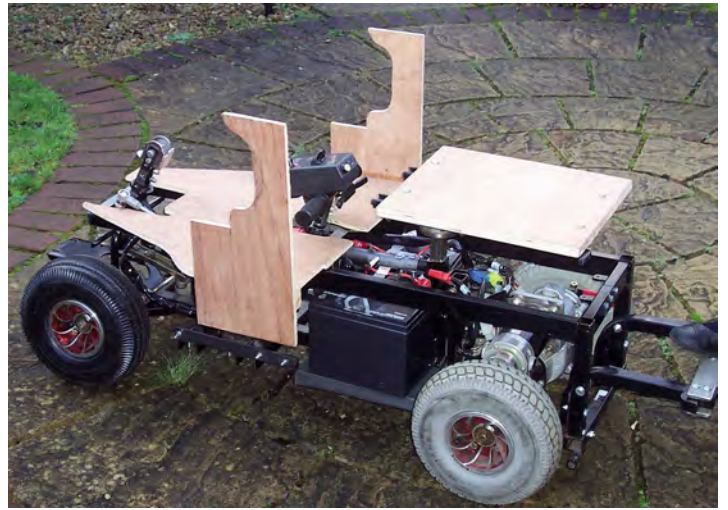
Everything was going well until I spotted a large, but strange looking, freelance wooden traction engine on eBay. Although, in its original state, it wasn't very strong, couldn't pull any passengers and needed a lot of work to make it look presentable, it did appear to have some well-made components that would provide a good basis for a new project so my focus turned to building an electric powered passenger hauling showman's engine. This resulted in the half-built Foden being sheeted up and pushed to the back of the garage.

The showman's engine was far more complex to build than the Foden and only really utilised the basic motor and electrics from the mobility scooter with everything else either being

The Traction engine's gear covers made out of cake tins.



The new dummy water tanks for the traction engine.



The Foden taking shape.

adapted from the old wooden traction engine or purpose built from wood, aluminium, various pieces of scrap metal or household items e.g. cake tins were used for the gear covers and a plastic drainpipe was used for the chimney extension. I had to build quite a few new components, including a set of dummy water tanks and a new cylinder block and I also had to carry out major alterations to the motion, hornplates, tender and the front end of the old wooden traction engine.

To make the engine strong enough to pull adult passengers I had to build a new welded steel chassis so that the motor, wheels, steering and tow hook were all structurally connected to each other. I was then able to just drop the wooden body onto the new rolling chassis. I added electronic smoke and sound units and a motor to the crankshaft so that everything looked, moved and sounded right.

Although the showman's engine had to be of a freelance design, due to the nature of the parts used to build it, I loosely based it on a Foster and it looked pretty good when it had been painted, lined and detailed with a proper brass plate on the smokebox, transfers on the water tanks, real brasswork, nameplates and working lamps.

It also proved to be very powerful, easily pulling me with my wife and our two children around the rally field all day long on a small passenger truck so, with the sound and smoke units completing the illusion, the electric engine fitted in quite nicely among all the other miniature traction engines at steam rallies.

Happy with my achievements, I ended up just taking the new electric showman's engine to most rallies so I eventually sold the Ruston Proctor. However, a few years later, when my children had grown up a bit, I was bitten by the steam bug again and I bought a 4" scale live steam Burrell. It was great to be driving a 'real' steam engine again and my son was now big enough to sit on the tender, so it looked likely that the electric showman's engine would end up at the back of the garage alongside the part-built Foden.

Ian and his children with the electric showman's traction engine.





Playing with our 4" live steam Burrell.



The completed Foden.

However, I quickly started to miss some of the features of the electric engine and I realised that my family had become used to the convenience and immediacy of electricity, particularly when everyone was getting impatient as we waited for the engine to raise steam and get up to pressure before we could actually go anywhere.

I was also reminded that running a steam engine was an 'all-or-nothing' job i.e. once it was in steam you couldn't leave it unattended; whereas with the electric engine we could just jump on, drive off and then park, take the key out and leave it as a static display if we wanted to look around the trade stalls, watch an arena event or go for lunch. In fact it felt like a bit of a hassle that we had to keep stoking the fire, keep an eye on the water level and make sure that we had enough water and coal on board each time we went for a drive.

It was also a bit frustrating at the end of the day, when everyone just wanted to go home for tea, that we had to wait for the fire to die down, the grate to be emptied and the tubes cleaned out before putting it back on the trailer; whereas, with the electric engine, we would have just loaded it straight onto the trailer and gone home.

I then also had the ongoing tasks of general maintenance, boiler tests, draining it down for the winter and recommissioning it again in the spring, whereas the electric engine didn't need anything doing to it once it was connected back up to its automatic charger. So the big advantage here was that, if we felt like an impromptu drive, the electric engine could be ready for action at any time by simply unplugging it from the charger, switching on and driving off around the estate, whereas the Burrell wasn't going to go anywhere in a hurry!

I was consequently starting to think that maybe I should complete the electric Foden steam wagon. There wasn't actually much work left to do so it didn't take long to get it up and running. I was delighted with the end result as it was quick, very manoeuvrable, didn't need a passenger truck and could be transported in the back of the car.

However, as good as the electric engines were, I couldn't quite bring myself to part with the Burrell so, to keep everyone happy, we started to take the electric engines to some shows and the live steam Burrell to others but, if we were taking the steamer, we often put the electric Foden in the back of the car as well. This meant that while I was firing up the Burrell, my wife and kids could head off to the trade stands and other attractions with the electric Foden, as it was ready to go straight off the trailer and could be taken safely into the more crowded areas of a rally field.

The electric engines at the Midlands Model Engineering Exhibition.



Running the two engines together did, however, again highlight quite a few of the advantages of the electric engine over the live steamer i.e. you can stop for lunch or watch arena events without worrying about the water level or keeping the fire going, you can put the engine away quickly or throw a plastic sheet over it if it starts to rain, there are no ashes to dispose of when you've finished for the day, you don't have to carry any water or coal, you don't need to take an extensive tool kit and several different types of oil with you, you have clean hands when you come to eat your lunch, you don't get sparks in your eyes and you don't end up looking like a coal miner with your hair full of soot when you go home!

So I concluded that electric engines had quite a lot going for them and, gauging by the interest that they attracted wherever we took them, other people seemed to think so too and some people even asked if I would build them one or sell them some drawings. So, with that thought in mind, I set about designing my next electric engine so that it could potentially be replicated or produced as a kit at some point in the future.

I decided that a standard Sentinel steam wagon would be an ideal subject as it was an undertype without complex motion-work to produce. The forward-mounted cab would also mean that the existing steering column on the mobility scooter chassis could be used in its existing location and that there would be plenty of room for passengers on the back of the engine without the need for a passenger truck.

I scaled the drawings for the cab from full-size Sentinel plans and I then designed everything else to fit around the mobility scooter chassis. However,

Ian's children – Thomas and Abbie – take a ride on the Sentinel.



Ian with his family and the two electric engines.

instead of building this engine as a one-off from scrap, in the same way as my previous engines, I enlisted the help of an engineering company, who created CAD drawings and laser cut steel components from my original hand-drawn plans, which were then assembled, powder coated and fitted onto a rolling chassis from another mobility scooter. I also commissioned some bespoke sound and smoke units from specialist suppliers to run directly off the 24 volt power supply from the chassis.

As I had experienced some issues with the driving position on my Foden, which was very wide and a bit uncomfortable, I decided to put comfort and practicality before looks on the Sentinel and made cut outs at the front of the rear lorry deck with footboards mounted on the scooter chassis below. This made the driving position much more comfortable. As the engine is quite long and also very powerful it can easily carry one or two adults in relative comfort and my son was recently seen driving it with three other children on board! It could also potentially tow a small truck if a tow hook was added and the engine could be modified with additional detailing and drop-down sides to the lorry deck at a later date.

Like the Foden, the Sentinel is only about 5 feet long so it will fit into the back of our car with the seats down but, on this engine, I have taken advantage of the two part chassis and quick release mechanism from the mobility scooter chassis. This allows the rear section (which houses the rear axle and motor) to be removed and this reduces the overall length of the largest section to about one metre. It also greatly reduces the weight so that the engine can be lifted, stored and transported in smaller sections.

The engine was just about completed in time to make an appearance at the 2015 Midlands Model Engineering Exhibition alongside my two other electric engines where lots of people, including Martin Evans and John Arrowsmith from the Engineering in Miniature team, had a go on it and most people seemed to be impressed.

Of course, electric engines will never quite have the smell or character of a live steam engine but they are certainly a good alternative which can offer many advantages over a live steam engine.

They could provide an ideal and affordable route into the world of steam for young people and beginners who don't necessarily have the time, skill, funds or patience to build or run a live steam engine. They may also appeal to existing members of the steam community as a supplementary vehicle to their normal steamer or as a support vehicle for miniature road runs. They would also be an ideal run-around for owners of full-size engines, who could use the electric engine to pop over to the beer tent or the bacon butty van while their big engine remains confined to the static line-up between arena appearances!

Also (and uniquely), as the steam wagons utilise the chassis from a mobility scooter, an original seat and steering tiller could easily be re-fitted to create a very special customised mobility scooter for those steam enthusiasts who have restricted mobility; however driving it down the high street or in a shopping centre may cause a bit of a stir!

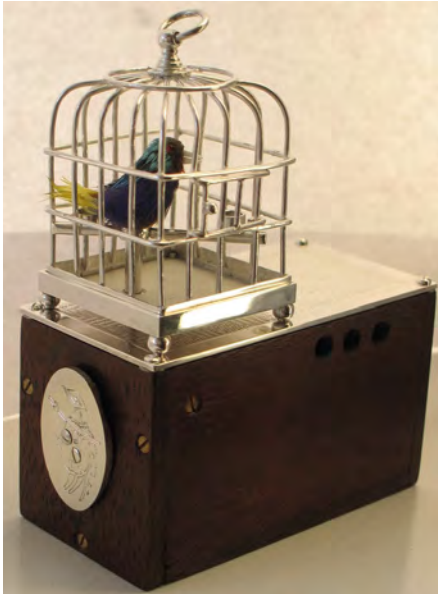
I consequently hope that this article will inspire other people to build an electric engine and if you would like any information or advice please contact me on ians.electric.engines@gmail.com or look out for me at Midlands-based steam rallies or at the Midlands Model Engineering Exhibition next month. ■

A Simple Singing Bird Automaton

A manually operated singing bird in a silver cage

by John Moorhouse

This small project was driven by two objectives; as a test bed to try out some new techniques for the construction of a singing bird, and as a short simple project to provide relief after spending considerable time on a long-running project. Subject to their success the plan is to incorporate these techniques into other projects.



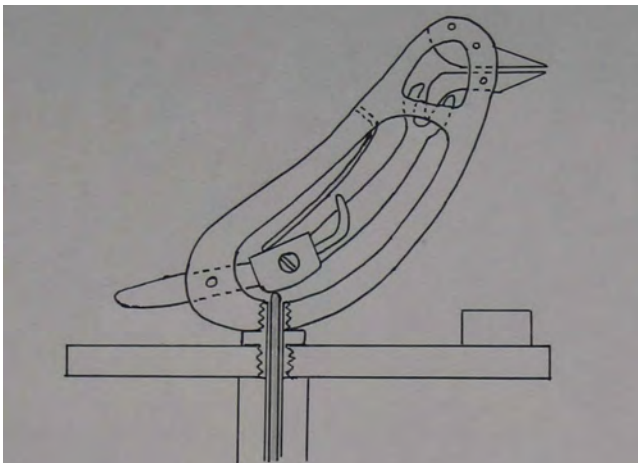
Left-hand and right-hand bird shells were domed in a hydraulic press from 0.5mm thick copper sheet using a flexible rubber (urethane) pressed into a shaped profile in a 7mm thick plate. Body shell depth was then enhanced with a round punch before cutting out. The body height is 17mm.



The brass body frame was sawn from plate and two saw cuts provided channels for the internal moving parts. The conventional way of attaching the body shells to this frame is to insert fine pins, which makes them hard to remove. As an alternative two turned bosses were hard soldered on near the base which were then drilled through and tapped so that each body shell is secured with a single screw (1.2mm outside diameter x 0.25mm pitch). This makes it very easy to remove one or both shells for making the internal adjustments necessary for correct wing operation.



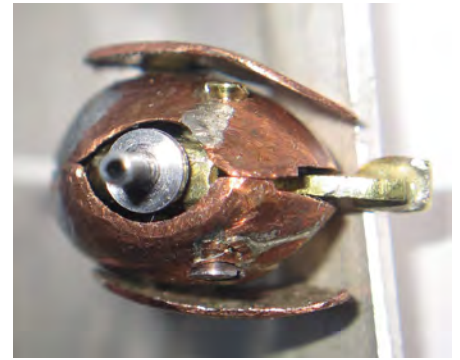
A central brass armature fits within the saw cut channels and rocks to provide tail, beak and wing action. Beaks were filed up from opaque white perspex. The upper beak is rigidly fixed with two pins and the lower beak swivels on a secure pin. Holes for pivot pins for beak, wing hinges and armature were 0.4 mm (No. 78).



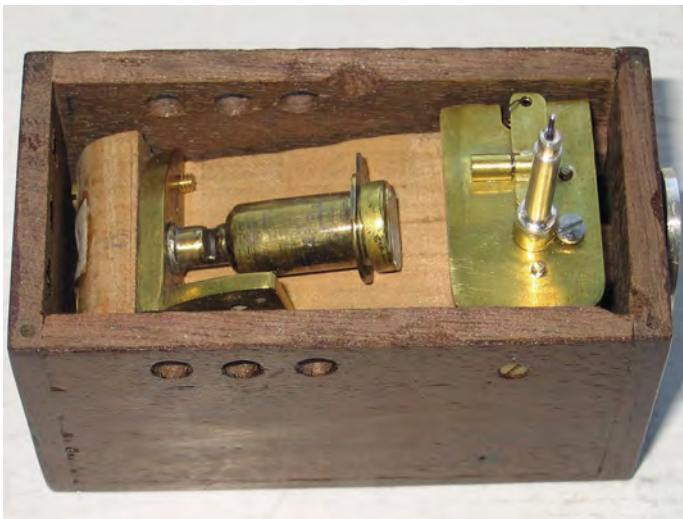


A hollow male/female (1.2mm outside diameter x 0.25mm pitch) steel connector screws into the base of the bird frame. This is a new fixing technique ensuring a strong attachment of the bird to its stand at a vulnerable point.

Each wing is soldered to a hinge block and it swings on a 0.4mm diameter steel pin, across the shell and soldered in at each end. Fine wire springs act on the armature and on the top part of each wing hinge. A small block is screwed onto the armature and two wires were soldered into it so that lifting the armature lifts the wing hinges. The three springs ensure that the armature and wings fall back smartly.



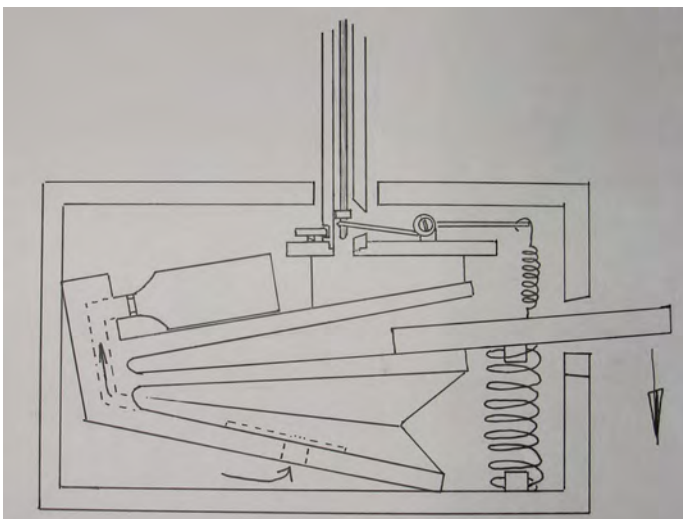
Very thin skin (zephyr) was glued onto the shell and coloured to hide the copper colour. The smallest feathers were plucked from two stuffed birds, both originally from a Victorian display. Feathers were glued on individually, starting at the tail end, with dilute fish (hot) glue, each overlapping the previous. Care was taken not to restrict the moving parts.



The single chamber bellows were cut from fine grained fruitwood. They have a base part and a moving part, with a leather hinge. The bellows are covered with folded zephyr and have a single non-return valve allowing air to be drawn in and then rapidly closed during exhaust, supplying air directly to the whistle.



Conventionally a flat paper non-return valve attached with a paper hinge is used to cover the air inlet hole but the valve can be prone to distortion leading to leaks. For this reason, in this project, the non-return valve is a very thin flat rectangular brass plate. A paper strip glued across the flap ensures that it stays in position.



Each press down on the external bird plaque, acting against a return spring, pumps the bellows and the air flows directly to the whistle. At the same time a small coiled spring on the pumping plate pulls on a brass lever to lift the vertical steel actuation pin. This pin lifts the armature to operate simultaneously the three bird functions. A fine single coil spring returns the brass lever allowing the actuation pin to fall.

The bellows were screwed securely to the box with countersunk 10BA screws. The whistle has an 8mm internal bore and has a closed end. Sound outlet holes were provided in the box to ensure that the sound of the whistle is not muffled.



The vertical actuation pin moves freely in a silver tube and the steel bird stem is screwed into the top of this tube. The stem also acts as the support for the silver bird feeder arm which was secured with a IOBA silver grub screw. All active components were made to ensure a free action without risk of jamming.

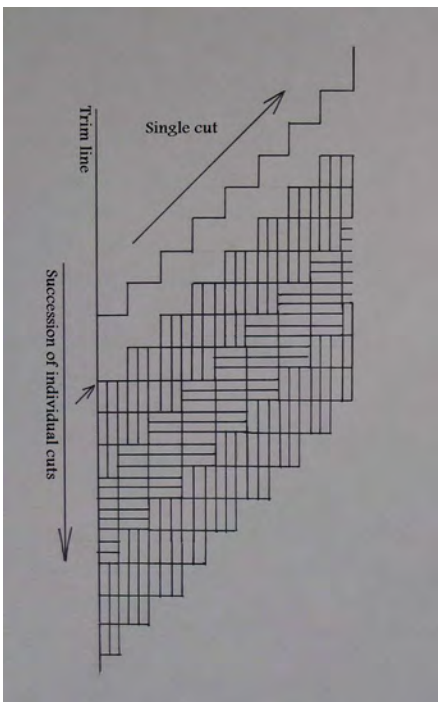


The cage was assembled from 1mm diameter silver wire, shaped on a wooden former and soldered at most of the points of intersection. There is a small hinged access door. A silver finial on the top of the cage has a loose but captive silver ring.

The cage framework was soldered to a square lower rim which is a light press fit into the recess in the cage base, allowing easy removal. This base has 4 turned silver bun feet which are soldered on. These feet locate in 4 holes in the box top plate and are attached by steel screws from underneath. The box top plate is attached to the wooden box with 4 domed silver screws.

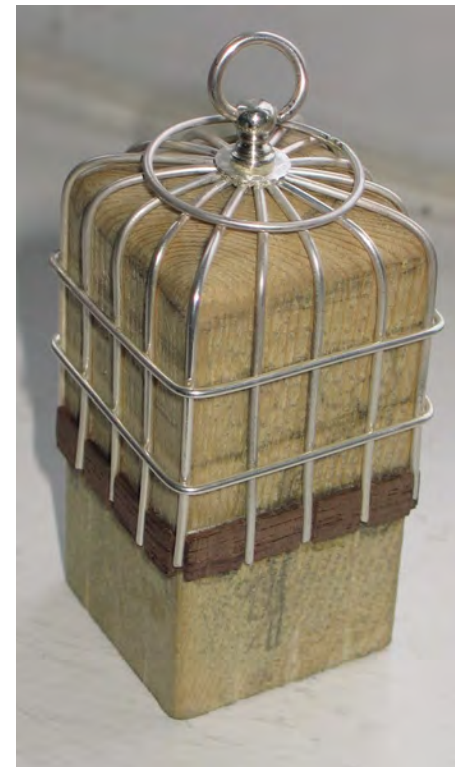
The silver top plate of the box was decorated with an engine turned pattern. The pattern is made up of a series of 2mm pitch "saw cut" type lines, cut on the 45 degree diagonal of the plate, and is a type of elongated square basket weave type pattern.

After patterning, four perfectly rectangular trim lines were cut to remove any swarf and give a neat result.



The hand engraved plaque was attached to the bellows pumping plate with 2 silver screws. The design of the bird was based upon jewellery by French jeweller Alexis Falize from c1869. Pressing down smartly on the plaque operates the bird and its song.

The new aspects of bird assembly have proved to offer many advantages and the new type of flap valve is reliable to date in any orientation. My plan therefore is to incorporate these improvements into my other singing bird projects.

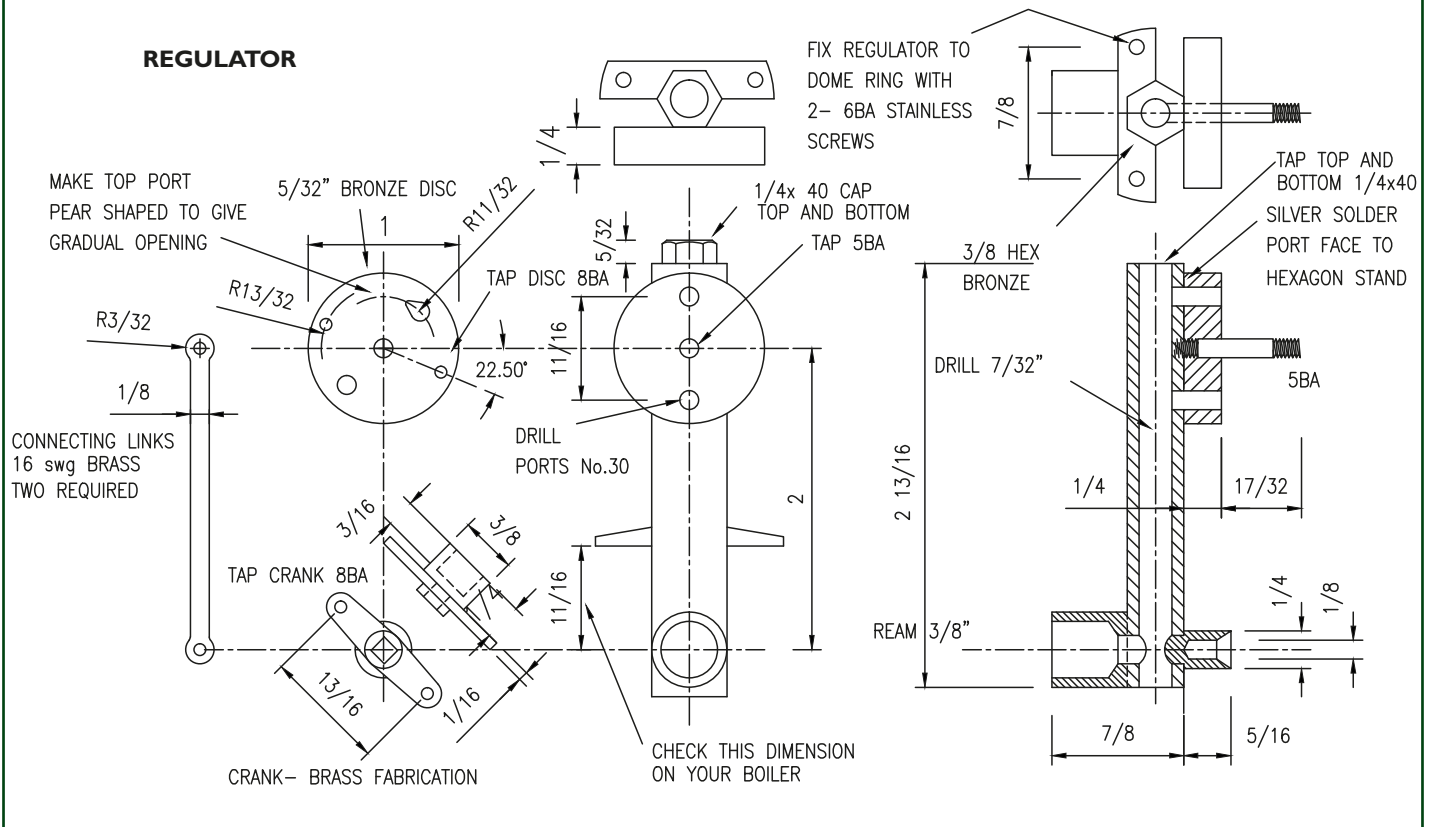


Further reading: 'Mechanical Singing Bird Tabatiers' Geoffrey Mason, published by Robert Hale, London ISBN 070906303 2. ■

Automata at the Midlands Model Engineering Exhibition

To encourage a wider interest in model making in general and automata such as singing birds it was decided to expand the scope of Class 9 from Horological and Scientific to Horological, Scientific and Automata. John is hoping that the interest shown at his lecture results in Automata items being entered in the exhibition and to this end the Music Box Society has put forward a number of awards for the winning entry. The builder of the winning Automaton will get a full year's membership of the Music Box Society, a miniature musical Racca piano and a cheque for £25. There is a growing interest in the USA in automata and a recent conference in March of this year at the Morris Museum near New York was devoted entirely to this topic.

REGULATOR



Making the front boss for the regulator. You can just see here that I have put a generous countersink in the end to assist when fitting the main steam pipe as you will have to do this more by feel than sight.



Parting off the regulator disc valve from a 1" brass bar.

said is that you should also cut the top hole into a pear shape using a fine three cornered needle file so that it gives the regulator a gradual opening. It is amazing how useful this is, especially when shunting to buff up to a loan wagon on a siding where it may run away if you hit it. With my existing Y4 I can creep up to hook on very slowly if I need to. In any event it looks far better and far more prototypical than charging about.

All there is to do now is to make the two links to connect the crank to the regulator disc and I made mine from some nice 1/4" x 1/16" brass bar. You will also need to make up some screws for

the regulator from 3/16" brass rod. I turned a length of about 1/8" to 0.089" diameter first and threaded that 8BA and then turned the next 70 thou to a good fit the holes in the links. I turned the bar down to 5/32" diameter and these were then parted off 3/32" long. Once you have made four the same then you can slot them with a junior hacksaw and they should tighten up in the crank without trapping the links. If you drop the regulator in place and push a piece of 3/16" rod through the bush in the backhead it will hopefully line up with the crank. I have made a start on the shaft but we will tackle that next time.

I just thought you might like to know that I finally got my Y4 put back together this week so I tried it on air. There was a bit of a cough and I had an air leak where the right hand steam pipe enters the steam chest but after a bit of coaxing it ran in both forward and reverse fairly well. I just need to check the valve setting again now and put a bit more PTFE tape on the pipe thread so hopefully we will be away then. I am full of optimism!

To be continued

More pictures on page 93.

The Atkinson Steam Wagon

by **Graham Sadler**

Continued from page 53, August 2016

Crosshead

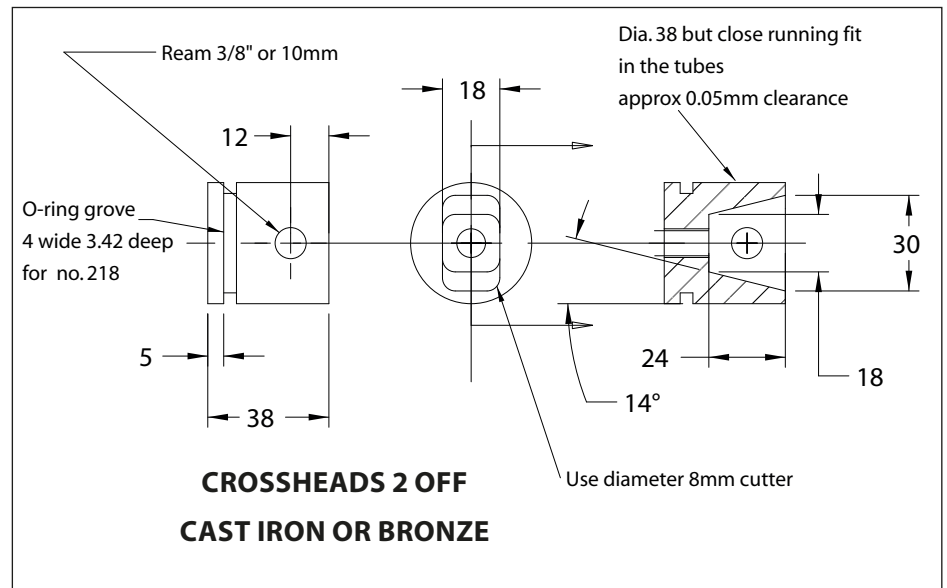
Before starting this component check the overall distance from the crank pin when on front dead centre to the rear face of the stuffing box enlarged counter bore. This should be a tad less than 144mm (actually 143.75mm). If yours differs from this adjust the centres of the con rod.

The crosshead in Ray Prime's design was a plain piston-like cylinder. In use, I am told, a lot of oil escapes into the stuffing box and there is some ingress of water into the crankcase which ruins the oil. In view of this it has been slightly enlarged and an O-ring seal has been incorporated. It may be an idea to leave the crosshead a little over length at both ends until after assembly when it can be faced to the finished size. Although it will make setting the length difficult I will cover it as if it will be made exact to the drawing. What we are aiming for is that both ends of the crosshead should reach their extremes of travel beyond the respective ends of the bore in order to prevent the formation of a wear ridge. As designed, the crosshead will be exposed by 2.25mm at the front and 1.75mm at the back. If you have a cylinder hone it would be a good idea to give the bores of the tubes a bit of a light treatment with it but go gently and not for long.

A Short Discussion about Clearances

We will aim to get a clearance of between 0.045mm and 0.055mm between the tube bore and the crosshead, as needed for a close running fit. In the early days of my engineering I had real difficulties wanting exact fits, so an exact 10mm reamed hole had an exact 10mm shaft turned to fit it. The constant frustration despite a dead accurate on-size shaft was that it was really an over-tight fit and wouldn't really work. Learning the different ranges of clearances after much frustration really changed things – this was a 'wheel keying' fit. Tubal Cain's excellent Model Engineers' Handbook is one of many sources of information and much easier to understand than the industrial production versions.

Even a reamed hole is set to a specification, the better ones classed as 'H7' – a check of my reamers reveals five of them etched with this. However care needs to be exercised. I picked up a new Dormer $\frac{5}{8}$ " machine reamer at a rally. The H7 specification for this size is + zero at the lower limit and + 0.7 thou at the higher limit (n.b. the H7 tolerance varies with the size of the hole) but I didn't notice the fine engraving saying $\frac{5}{8}$ " -0.0007" to -0.0011". For a precision running fit a clearance of PLUS on size for



the hole or MINUS for the shaft is needed. This reamer produces a superb finish but clearances are complicated and the shaft needs to be $\frac{5}{8}$ " - 0.002" in order to get the correct 0.0009" and a piece of ground or silver steel is a drive fit! It was probably produced as a special for this purpose. I suspect many of the cheaper reamers available from our usual suppliers are made to H8 or even H9 specifications (H9 in this size has a range of + zero to + 1.6 thou – rather large).

Often people complain in magazine mailboxes about the lack of tolerances in drawings. Well, for one thing many people would be confused by them (too much detail on small drawings), many could not achieve them because of machinery and measuring limitations, and we generally make very small batches of components in one location (our home workshop, not the other side of the globe) and finally we, hopefully, have an understanding of the function of the piece being made and the class of fit needed for it (achieving it is another matter!).

As you can see from the above the problem is further complicated as model engineers (including me) just won't pay the full price for the correct tool! So on the whole tolerances are best left out. It takes long enough to prepare these articles as it is without worrying about such things. So, with reference to Tom Walshaw, I use "close running" or "large clearance" etc. to describe the fits. Make up a spreadsheet for these clearances using his data, laminate it and stick it up on the wall, so much easier than trying to work it out each time. Mine is in constant use.

Full industrial tolerance specification, where interchangeability is an absolute necessity, is unrealistic for us. In Model

Engineering, as we tend to make one piece fit another, our machines are generally not as accurate as industrial equivalents which now work not in thousandths of an inch but to less than a micron - one thousandth of a mm. That's why these days a car engine doesn't need a rebuild after 20,000 miles and the service interval on my campervan is 50,000km, not every 1000 miles as in my first 'banger'. It's all down to good design, design analysis and CNC production. I once took my 6th form for a visit to a plant producing decking planks; they had a 2 micron tolerance on grinding the cutters which produced those little beaded grooves on the planks. Phew, its only wood and it will move!

Back to Work....

Using the reference above we have a nominal bore and shaft of 1.5" (38.1mm) with a constant clearance figure of 0.0006" plus the hole size figure of 0.0012" (0.8 thou per inch) which comes to 0.0018" i.e. as good as 2 thou or in modern money 0.04572mm (so 0.04mm - 0.05mm). Begin by chucking a piece of 40mm diameter cast iron at least 90mm long in the 4-jaw chuck, which will provide a more secure grip. Skim the outside just enough to clean it up, face and centre. Bring up tailstock support and turn the outside diameter to size with a fine finish for just under half the length of the bar. Produce the O-ring groove 5mm from the faced end, with a square parting tool, finishing 4mm wide and 3.43mm deep for a 1½" outside diameter ring with 0.139" section (listed as no.218). Partly part off a little over length at 39mm in order to make things easier later. Drill in stages 20mm deep before tapping the $\frac{3}{8}$ " x 26 piston rod thread. The thread must be produced at the same machine setting as

the outside diameter and should be tight, perhaps using a slightly smaller tapping drill than normal.

Now mark which bore this is to be fitted to, N (nearside) or O (offside) as they are unlikely to be exactly the same! Reverse in the chuck but use protective shim on the now finished embryo and this time be more careful with centering as there is little material left to remove. Face, support and turn the outside diameter as far as the central groove and repeat as before. With tailstock support in the threaded hole it is possible to almost part this off fully or, if your nerves are not up to it, go in as far as you dare then finish with a saw, not forgetting a piece of wood on the lathe bed to protect it on breakthrough. Face the bit left in the chuck 38mm overall length and also the one just parted off.

Now grip high in the miller vice by the ends and use an edge finder to centre the spindle on the centre line of the embryo and then find the front end, then move the spindle 17mm further in. Don't forget backlash while doing this task – or the edge finder radius. Centre, drill in stages and ream either $\frac{3}{8}$ " or 10mm preferably with a machine reamer so we can clear the vice. Without one of these go as far as you can until you touch the vice, then remove and finish by hand. If you do use a hand reamer it is not advised to put it in the drill chuck. Instead, fit a centre in the spindle, hang a weight on the quill feed to maintain a small downward force (leave it close to the ground in case of slippage [H&S devil warning!]) then with a tap wrench on the reamer it will follow the hole precisely without wobbling. The easier exception to this method is to remove the

chuck and work from the lathe immediately after tapping the hole, and fit in the dividing head to produce this hole – a lot easier, but it depends on your kit. If you can adjust the angle of the dividing head spindle, producing the tapered clearance hole for the con rod will be a doddle, but when yours truly undertook this task such a device was well beyond the dreams of avarice!

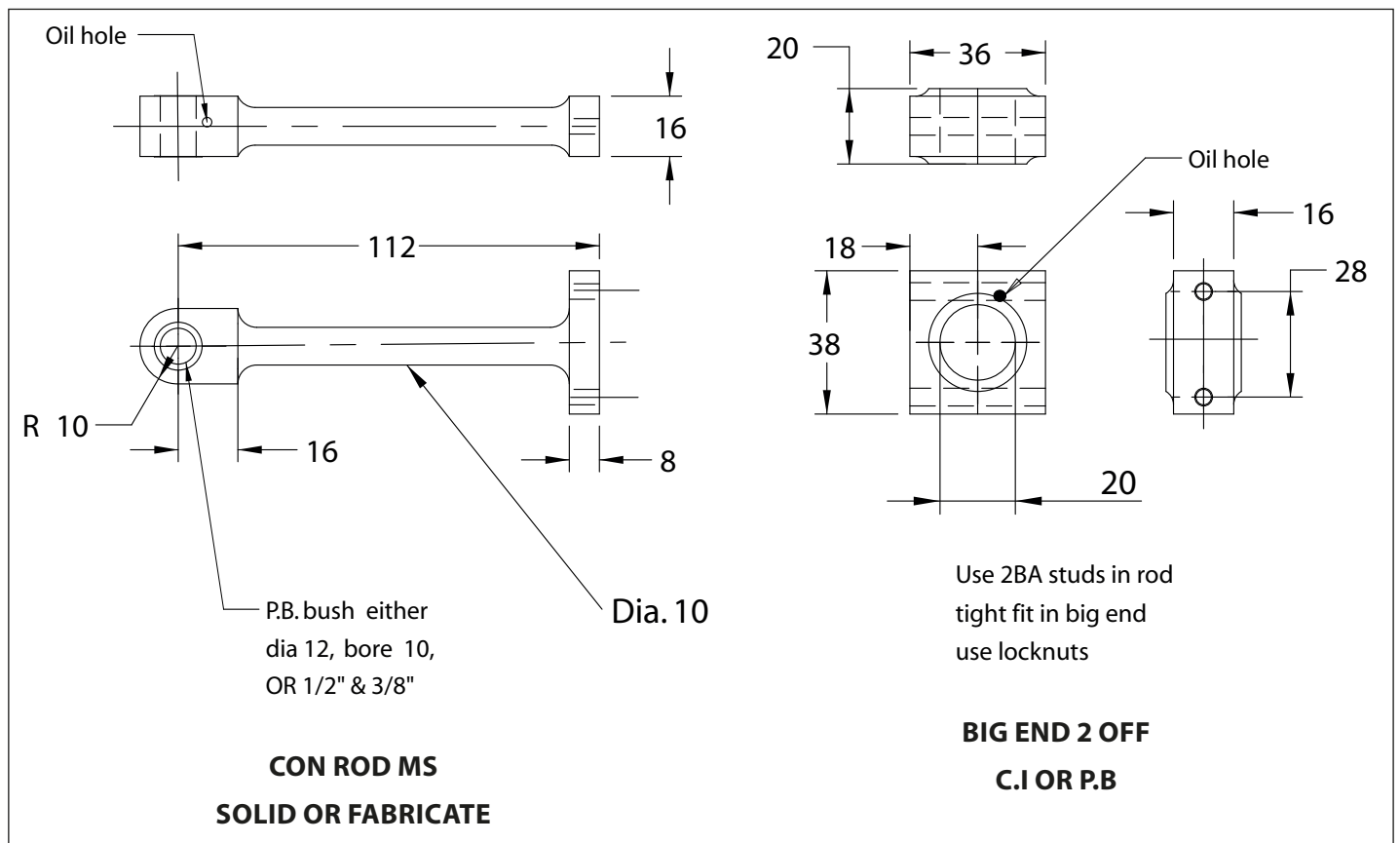
Producing the Tapered Pocket

This is a tricky bit of machining, made worse by the difficulty of seeing what is going on, there being a lot of recording of figures from the x and z feed dials using my old workshop note book – always keep these! It has good clearance all round so we don't need to be exact. Mount it in the vice thread down to do the pocket but it has to be set square to the pin hole just finished so put a piece of silver steel in the hole to get it parallel to the vice jaws. Centre the miller spindle on the crosshead, centre drill and drill as big as you can up to 16mm, to a depth at the point of the drill of 11mm. This will break into the tapped hole in the front of the blank (hmmmm... just realised this pocket core could be bored in the lathe resulting in a flat bottomed hole – wish I had thought of this before!). Drilling with the big drill will make short work of milling the pocket stage 1, the central square, with an 8mm slot drill, which will be 18mm wide (at right angles to the cross hole) and 17.5mm long to 24mm deep from the end. **DO NOT REMOVE FROM THE VICE.** Next use a piece of flat tight against the machine vice fixed jaw and drills or slips to measure the gap to the bar replaced into the cross hole

which will be round about 9mm. Now we can slacken the vice and tilt the work to 14° (a simple card template can be used to set this) and use the gap measurement found above to get the radial position correct. This way the 18mm wide slot will still be centred on the spindle. An angle vice (could be difficult to set up) or the tilting dividing head mounted vertically will also achieve this task or again a vice mounted on a variable angle table... just depends on what you have! However you set it up (I did it as described above) the taper now needs careful milling to get the edge of the slot drill lip just to skim the bottom edge of the pocket, so the outer edge is 4mm at its widest point. To get things more even at the bottom a ball-end cutter could be used but I doubt if this would be long enough. The pocket will have 1mm clearance each side of the rod, 2mm at the front end and on the pocket edge with the crank at its highest point (not top dead centre but 14° in front of it, recognise the figure?) of 1.5mm according to my CAD - says he with tongue in cheek with the rod having 1.5mm clearance on the end of the crosshead tube.

Connecting Rods

These can be made from the solid or fabricated. For the latter, start with 20mm square steel well over length (blessed be the 4-jaw self centring chuck) and turn a spigot on the end to 8mm diameter with a small centre in the end to locate the bolting flange. Reduce the rest to 10mm diameter with tailstock support and using a round-nosed tool to provide the fillet at each end. Prepare the end flange from 20mm wide steel and braze up ensuring



Use 2BA studs in rod
tight fit in big end
use locknuts

BIG END 2 OFF
C.I OR P.B

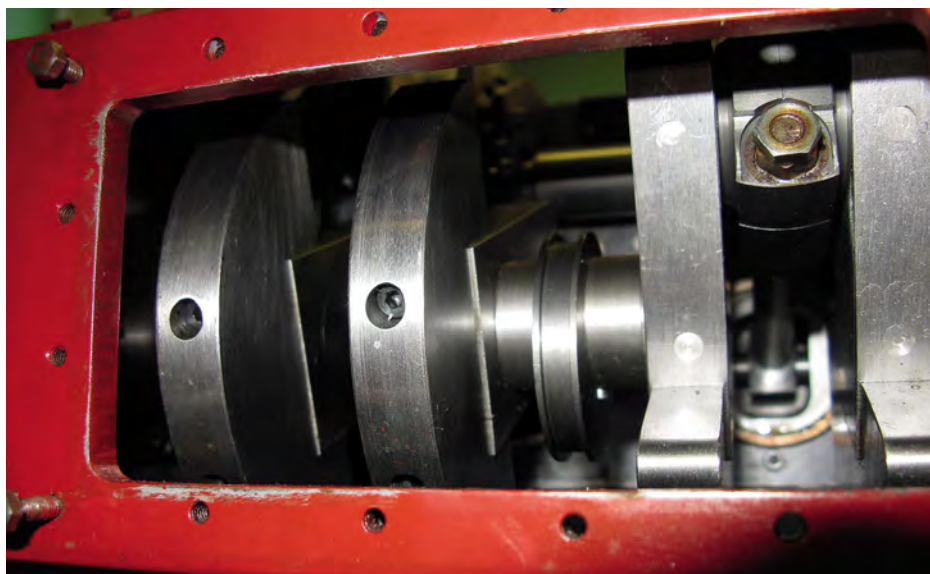
the pieces are in the same plane. Back in the lathe, support with the tailstock half centre and face the flange true. For the solid version, use 20mm x 40mm flat and saw or mill the long bit to 20mm square then repeat as above. Don't thin the small end boss yet.

The big ends are simple blocks of cast iron or bronze finished to 20mm x 36mm x 18mm, drilled (a tight fit on the screws) by co-ordinates then clamped in place to spot through onto the rod flange. Use a long piece of flat clamped to the bar to get it all aligned. Now tap the flange 2BA or M5 and fit cap screws. These will be permanently loctited in place when finally assembled. Fit the big ends and mark out the centre holes with a scribing block on the surface plate with packing under the little end to bring it level. Carefully punch the centre of the big end on the joint line and use dividers set to 130mm to scribe the centre at the little end.

As it is not vital to get the centres on each rod the same length to precise limits a holding spigot-type jig will not be required, so bolt a piece of aluminium to the faceplate, then fix the rod to it with clamps at the ends and centre the little end with a dial test indicator and telescopic wobbler. Drill then bore and ream the bush hole to 1/2" diameter or 12mm depending on the hole in the crosshead. Do the other rod, then repeat the setup for the big end using a bit of the 20mm diameter material left over from the crank pins to size the bore. This needs a precision running fit and could be finished with a hone or, as an alternative, bore to a tight fit, oil well and "wear it in" with a slow spindle speed and the 20mm diameter bar but watch your hands on the clamps! This was done with my Myford size dividing head tailstock barrel. When the spindle was put in the bore it took about 20-30 seconds for it to slide through the casting! To say the least I was a bit pleased!

The bush can now be fitted to the little end, which is now reduced to 16mm thick and the 20mm radius end finished. Remove the big end, bolt it together then reduce the width by facing with a round nosed tool to ensure clearance in the crank web space with only the thin inner boss at full width. Finally, drill at an angle an oil hole in the big end, enlarged with a small slot drill to help catch the oil to feed it through to the crank pin, and do the same for the little end. This one is angled forwards.

The clearance to the back of the engine is quite tight as the big end is quite close to the back of the engine case and 6 mm to the inside face, but here we have the pocket created by the access hole in the back so assemble the components with locknuts in place and check with a straight edge that the bolts clear. If there is any fouling do as I did as seen in photograph 1 (I didn't paint this too well and decided to use this colour on the chassis). A small groove is first cut in the end of the cap with the depth to give the clearance and a step just deep enough to allow the entry of



Photograph 1 – Big ends and crankshaft.

spanners etc. Yes, the crank case could be made longer, but as already mentioned this causes troubles with the rear spring hanger fouling the rear engine cover bolts and moving the engine forward on the chassis brings the steam entry to the manifold under the footplate. In the photograph the discolouration around the bolts is the loctite nut lock.

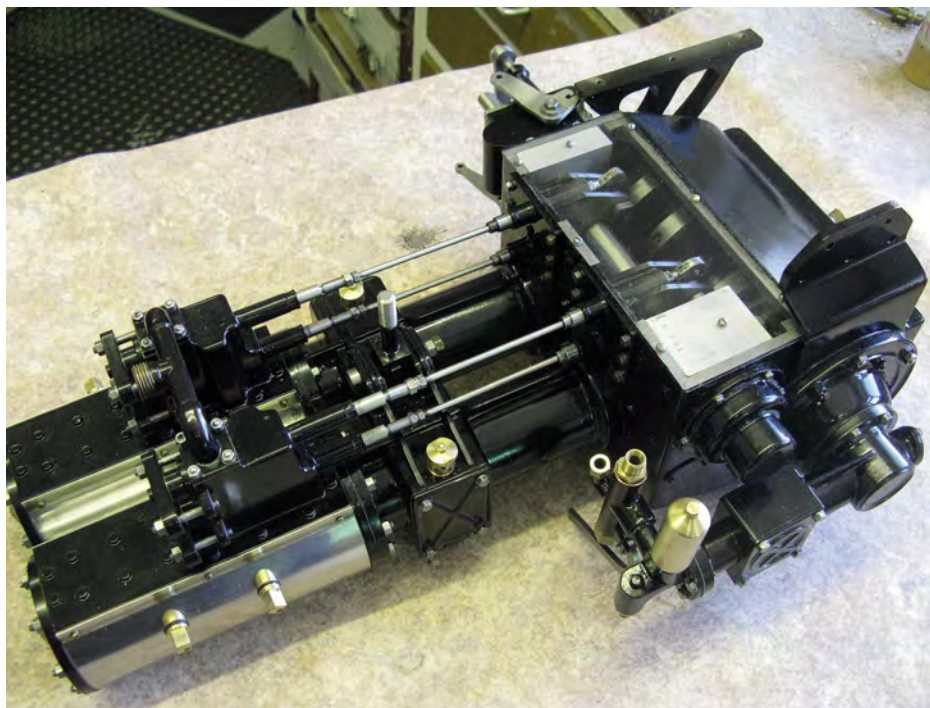
Now at long last it's the best time to finish the crankcase. Completely strip it down to individual components. Clean all joints with abrasive and flux it (to match your solder) all well during assembly. Re-fit the camshaft bearing blocks and check all is correctly aligned then remove them again. Warm up the whole case and apply a high melting point soft solder, being very generous over the screw heads to fully fill them. Be careful not to overheat the

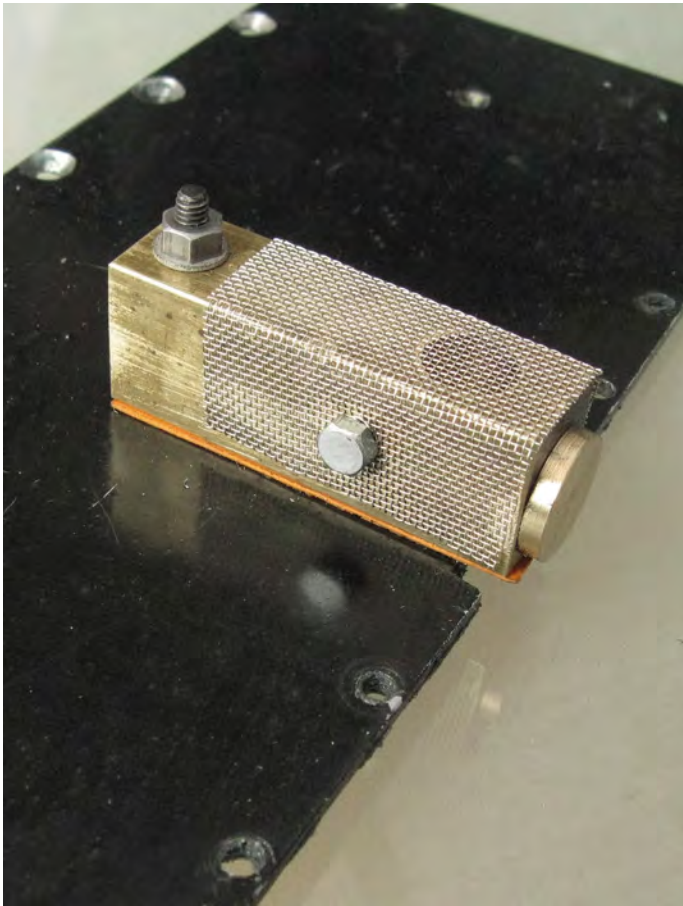
assembly – use a small soft flame working on one section at a time, then let it cool for a minute so that the finished solder does not melt and run. Check all is well and thoroughly scrub the assembly with kitchen cleaner etc. to remove the last traces of flux which tend to be highly corrosive. Now file a decent radius on all outside edges except where the as yet unmade front cover will be fitted and file the solder flush on all the screw heads.

Top Cover

Originally this was a acrylic cover, fitted to enable a view the workings through a hole in the load platform, but it was so dark in there nothing could be seen. Furthermore, the amount of oil which is splashed around soon obscured the view and leaked from under the cover. In

Photograph 2 – Finished engine showing the first top cover.





Photograph 3 – Crankcase breather and top cover.

addition, when the decision was made to make a tractor rather than a flat load lorry it became a little academic as the engine is well hidden under the tank. So assemble the cam bearing blocks and fit the tappet guides and rough cut out a piece of 1.2mm steel. Clamp this in place and scribe round all the outline, cut to size then mark out for 8BA round or cheese-head screws. Don't put any in the back nearside corner as it will be very difficult to access them when the nearside engine mount is bent to shape. This is clearly shown in the picture (photograph 2) of the finished engine with the clear cover. You will need a lot more fixings than shown here! Make a gasket to seal this cover.

Crankcase Breather

I made a breather on the front cover from 12mm square brass 50mm long with an 'L' shaped hole (3 drillings one plugged) overhanging the front between the tappet guides. It was done like this so that oil is not thrown out if made the same as the stuffing box vents and any oil entering the tube will drain back into the case.

Plug in the front, glue or solder in place and bend a piece of gauze to a U shape to fit over the top, secured with a single bolt through the assembly in order to stop the ingress of muck (photograph 3). I'm not even certain if this will be needed but under test there was a bit of air movement. A simpler alternative would be to for a vertical tube of at least 8mm bore bent over at the top into a tapped hole high in the top offside rear of the engine. I didn't do this though as it would mean a complete strip down of the engine to remove any swarf. Don't bend the top until after the engine is fitted into the chassis, making it as high as possible but, again, it will be vulnerable when removing the engine.

Well that completes the entire crankcase assembly except for the camshaft so be ready soon for an epic swarf making exercise – the cylinders!

To be continued

The regulator body propped up on a block of steel to keep it level for silver soldering. This is before adding the supporting bracket.

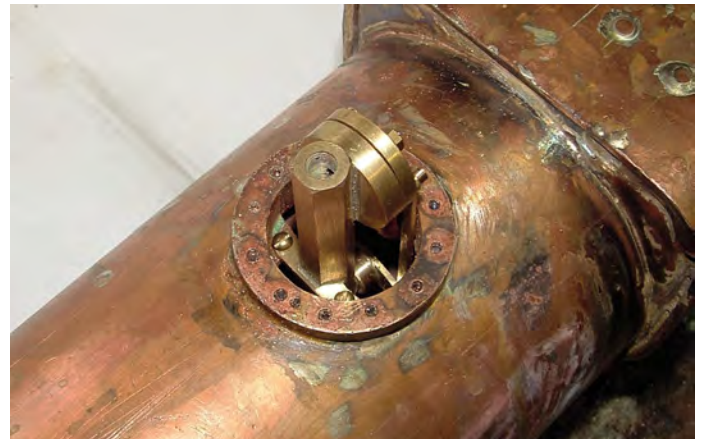


(Right) - Finally, I managed to drop the regulator in place to make sure everything lined up where it should. It is then fixed with 6BA screws. I did not have any stainless steel ones in stock but there is no reason why brass is not perfectly alright.

(Below) - This shows the fabrication of the crank from two pieces of brass. The crank is tapped 8BA.



Filing a notch out of 1/4" x 1/8" brass bar to make the bracket. I used a 10BA brass screw to locate it for silver soldering.



'Quickie'

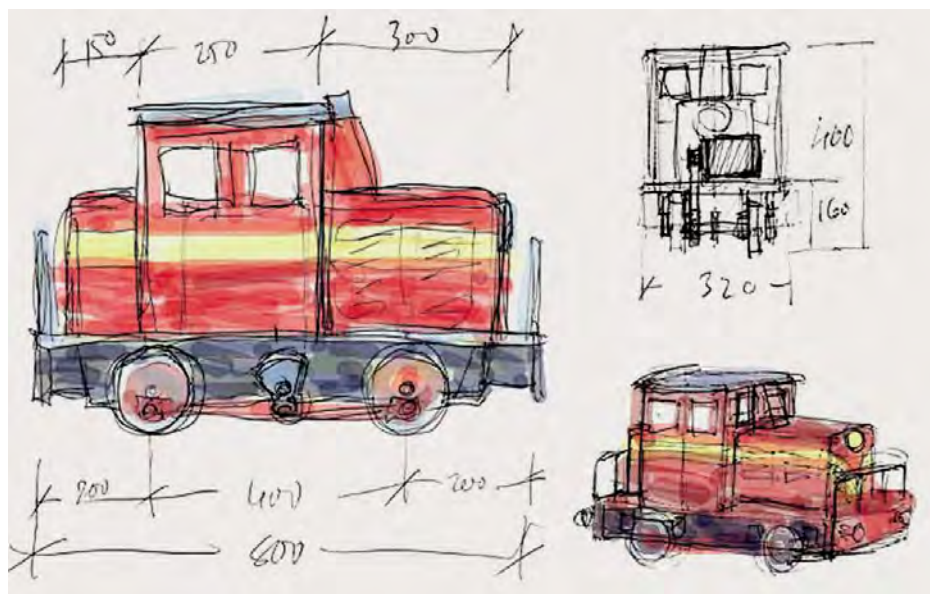
Building a battery-powered locomotive in a few weekends

by Jan-Eric Nyström

After a few summers of running my first live steam locomotives, noting how interested all the children of relatives, neighbours and friends were in my new backyard railroad, I decided to make something 'just for the kids'!

This, of course, meant a battery-powered locomotive. Since I didn't intend to spend much time or money on this project the design had to be extremely simple. In fact, one of the incentives for this undertaking was that I wanted to find out how quickly and cheaply a functional locomotive actually could be built! An 0-4-0 wheel arrangement is ideal but from experience with the rather light 4-4-0 live steam locomotive on the grades of my track (over 4%, easily causing wheel slip) I knew that the heavier I could make the locomotive, the better.

Car batteries are heavy! Planning the locomotive around two standard car batteries I would get all the weight I needed and enough stored power to run for many hours. Car parts shops sell batteries, often with a multi-year warranty, for as low as £40 apiece. Even though they are not intended for "deep-cycle" use they are so cheap that they can easily be replaced when worn out after a few years – or maybe even exchanged free of charge if they happen to conk out during the warranty period! This is very unlikely, provided they are not discharged too deeply before being recharged. I had no environmental scruples either since almost all our shops accept old batteries to be recycled free of charge – some may even



This first, quick sketch helped me visualize the locomotive before I started detailed planning and building. The main dimensions are shown in millimeters. The length of the locomotive is only 32".

charge a fee if there are no old batteries available for trade-in.

The outline of the locomotive was determined by the size of the batteries. Taking inspiration from a Finnish 'yard switcher' diesel engine, I made a quick sketch (figure 1) from which to work. I wanted the locomotive to be as small as possible but still look somewhat 'real'. My gauge is 7 1/4" so I designed the locomotive with a wheelbase of 16 inches. The total length of the locomotive would only be twice that.

The Motive Power – a Stroke of Luck

Finding a suitable motor, powerful enough, is no problem. A windshield wiper motor from a lorry or bus has the stamina to run continuously for many hours despite the friction of the wiper blades against the large windscreen. They usually run on 24 volts so connecting two 12 volt car batteries in series will provide the right voltage.

So I set out to get hold of such a motor. Not wanting to pay the full price for a new unit, I called a municipal bus service depot in my neighbourhood and asked if they had an old, but still serviceable wiper motor I could buy. No, they did not – but they had a brand new one of a model that didn't fit any of their buses, and I was welcome to pick it up. Wasn't that a lucky break!

Thanking the depot foreman with a few photographs of my live steam train (he was a model railroader, in HO scale), I happily carried home the 8" long motor, which had a worm reduction gear attached to the output shaft. (The gearbox did cause some design problems, as described later.)

Windscreen wiper motors may differ in design and size, but the important thing is to get a motor small enough, and powerful enough to pull a few wagons loaded with kids. My motor had no specifications on the manufacturer's label, but it draws a maximum of 10 amps at 24 volts, i.e. 240 watts, or about 1/3hp. There are other suitable motors, intended for other uses, which would do just as well as a wiper motor, and I'll return to that later. Please note that automobile starter motors are not suitable. They do have a large torque,

Photograph 1 – 'Quickie' waits for passengers while the author demonstrates his 4-4-0 live steamer at a museum in Ekenäs, Finland. Five hundred feet of portable track was laid on the gravel walks.





Photograph 2 – Wheels turned from slices of bar stock. The crankpins are already fitted to the wheels. PTFE-coated sleeve bearings are also shown.

but they are not intended for continuous operation, and they would quickly drain the batteries.

Wheels and Bearings

Having a few 1" thick slices of hot-rolled round steel bar left over from making the car wheels for my first train, I had the ideal material for the wheels of this locomotive. Turning the four slices to the IBLs profile took just a couple of hours. In photograph 2 you can also see the bearings I used: steel bushings, coated on the inside with bronze and PTFE (i.e. Teflon). Such bearings cost very little compared to ball or needle bearings and are very easy to use – they're simply press fitted into drilled (and preferably reamed) holes. To boot, they don't even need to be regularly lubricated, thanks to the PTFE coating!

If you do not have a lathe you can still build a locomotive like the one described here if you buy the wheels ready-made. Some hobby rail manufacturers offer solid steel wheels intended for 7 1/4" gauge passenger cars. These would do admirably and the cost is not very high.

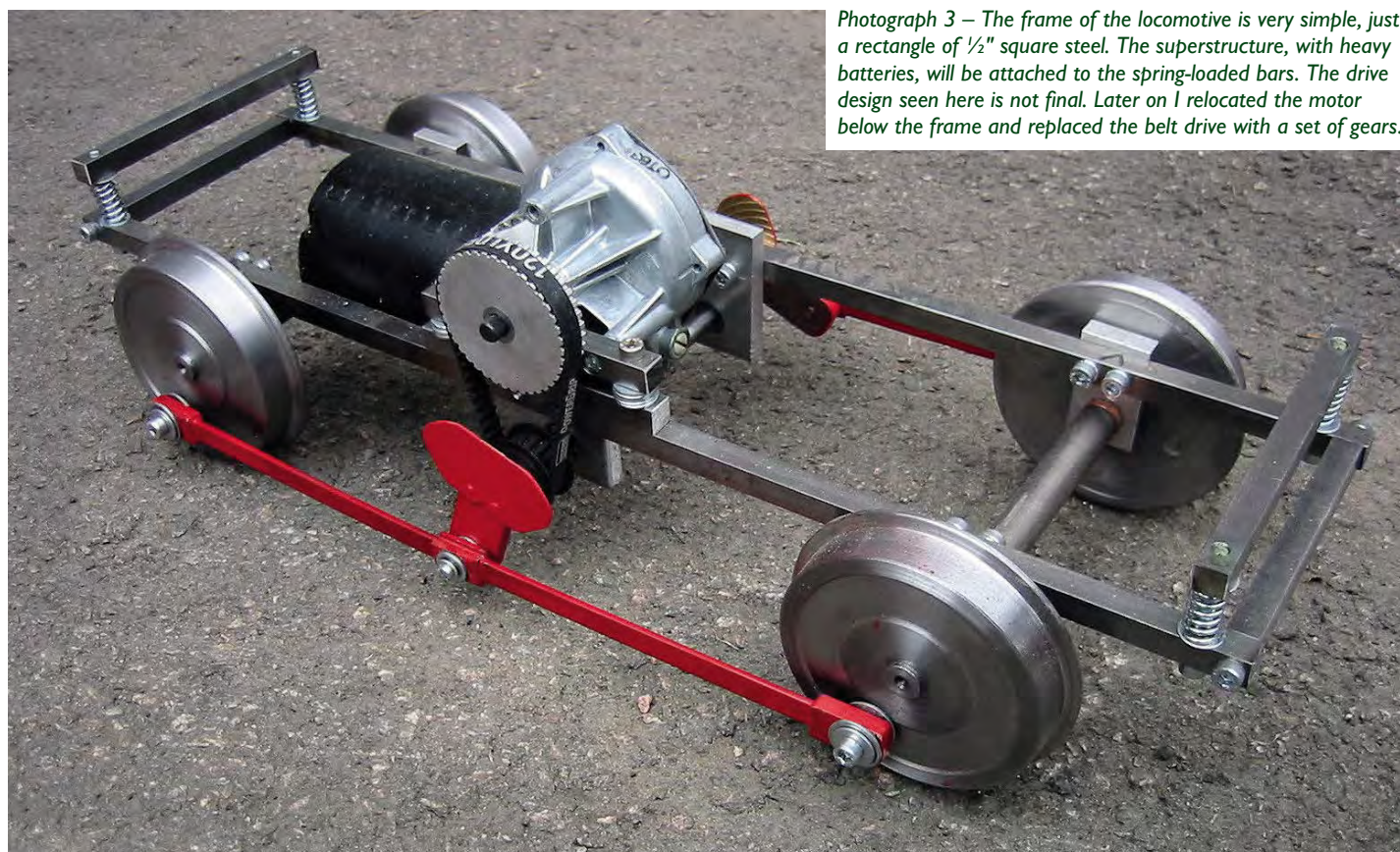
The drive system for a little 0-4-0 locomotive can be designed in many ways, depending on the available material. I had no suitable bevel gears or any chain drive parts in my scrap box so I decided to use connecting rods between the axles. This of course also necessitates crankpins on the wheels and, in my case, due to the large size of the motor, a third axle with cranks for driving the rods, seen below the motor in photograph 3. The red 'counterweight' on the crank is purely cosmetic and made of thin brass plate – it looks nice bobbing up and down when the locomotive is running. With another type of motor you might well be able to design an even simpler drive mechanism without this third driving axle.

Crankpins can be made of any suitable piece of round, smooth-surfaced steel. I had a length of silver steel that was well suited for this – by cutting four pieces to length, and drilling and tapping a hole in one end of each piece, I had my crankpins! The threaded hole takes a bolt and a washer, thus securing the rod from coming off the pin.

The most important thing is to get all the pins at the same distance from the wheel centres on all four wheels. Careful marking using dial or vernier calipers, checking once more after punching the mark, and then drilling with consecutively larger drills, starting with 1/8" or even smaller, will ensure correct positioning. After drilling, I fixed the pins in the wheels with Loctite 603.

I work in metric sizes, so my crankpins are 10mm diameter, and the axles of the locomotive are 15mm (around 3/8" and 5/8", respectively). PTFE-coated bearings for these sizes cost less than a pound each and they have stood up to many summers of use with no problems. They are available in several widths but, if necessary, they can be cut to dimension with a grinding disk – one must only remember to chamfer the cut edge. Before deciding on axle and pin dimensions, check with a local or mail order bearing supplier and plan your work according to the sizes they offer from stock. Buy a few extra so you have spares!

To be continued



Photograph 3 – The frame of the locomotive is very simple, just a rectangle of 1/2" square steel. The superstructure, with heavy batteries, will be attached to the spring-loaded bars. The drive design seen here is not final. Later on I relocated the motor below the frame and replaced the belt drive with a set of gears.

Building a 3D Printer

by Roger Thornber

Continued from page 63, August 2016

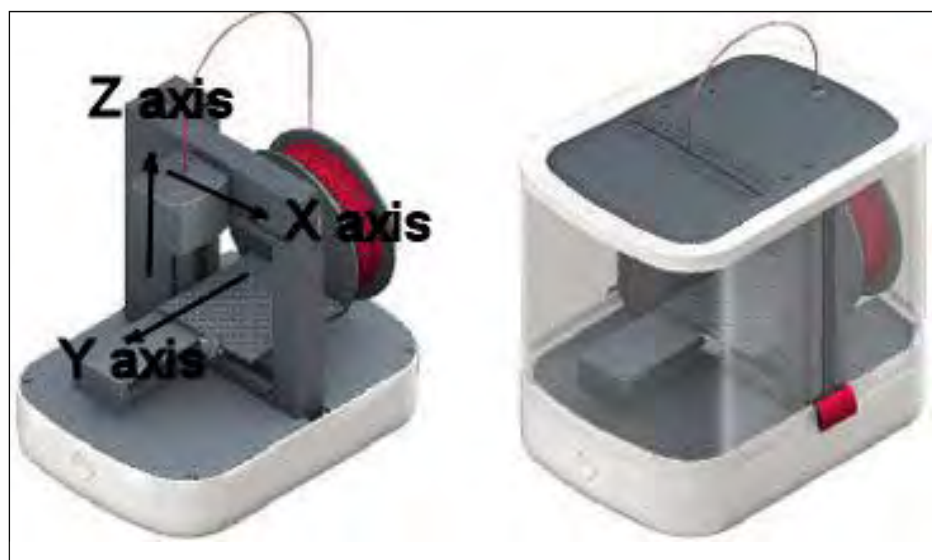
Another 3D Printer!

In the spring of 2015 I entered a design competition run by Eaglemoss who produce a weekly magazine called '3D Create and Print'.

Surprisingly, I won and the prize was a fully assembled printer that they were producing in weekly parts. The printer is called the 'Vector 3' and is designed by Sebastian Conran Associates. Clearly a lot of thought went into producing a printer that is user friendly and I think they have succeeded. This printer is yet another configuration with the Y axis moving backwards and forwards. The Z axis moves the build plate up and down and the X axis moves horizontally. All axes have microswitch end stops which give a configuration close to mine.

Commissioning

If the power unit and the electronics are added at an early stage in the build they may be used to test the various axes as they are built up. The build instructions for the Ormerod 2 on the Reprappro website, for example, give very detailed instructions for commissioning the units – they describe what should happen and what to do if it doesn't! Firstly several pieces of software need to be downloaded to your laptop –



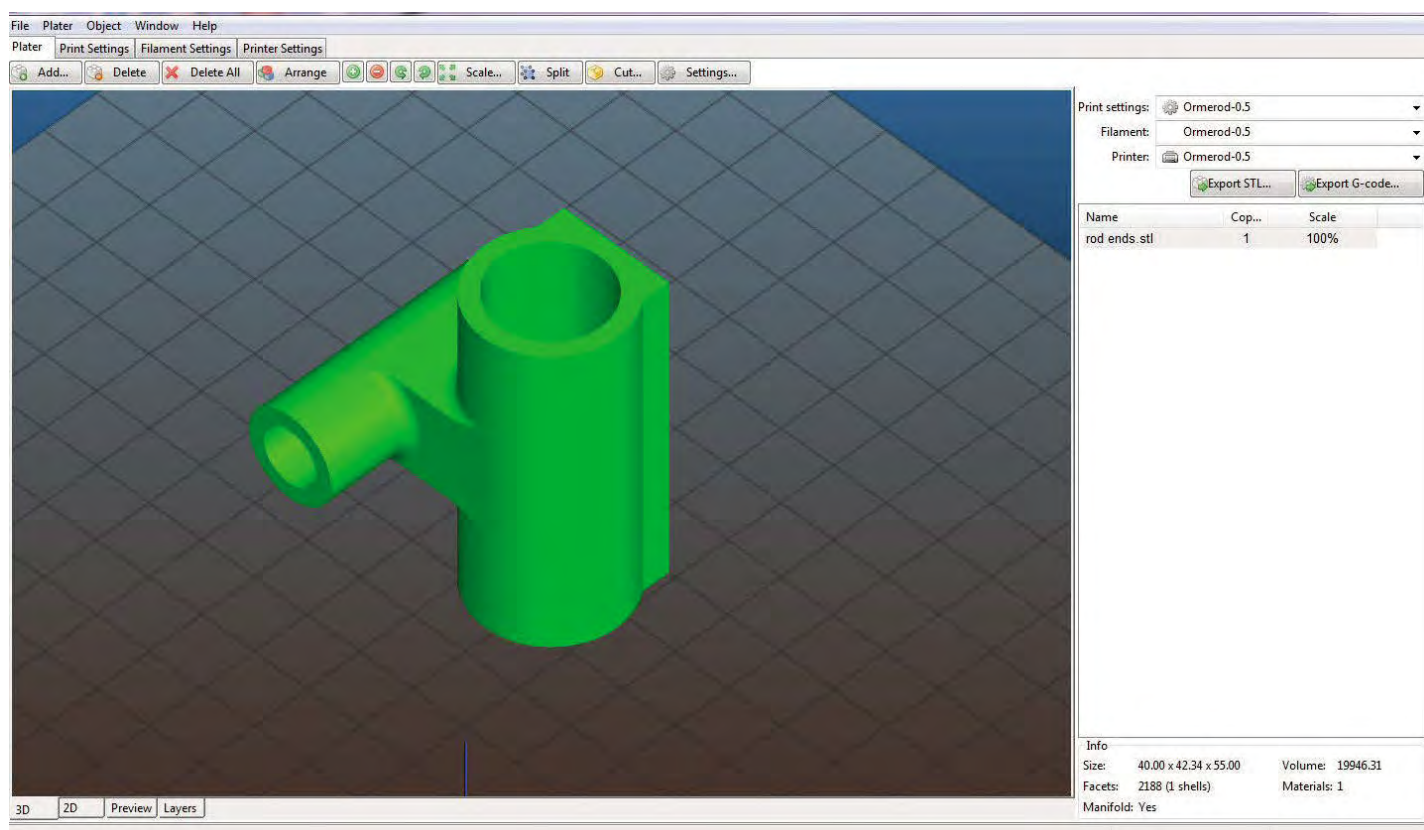
The "Vector 3" printer designed by Sebastian Conran Associates

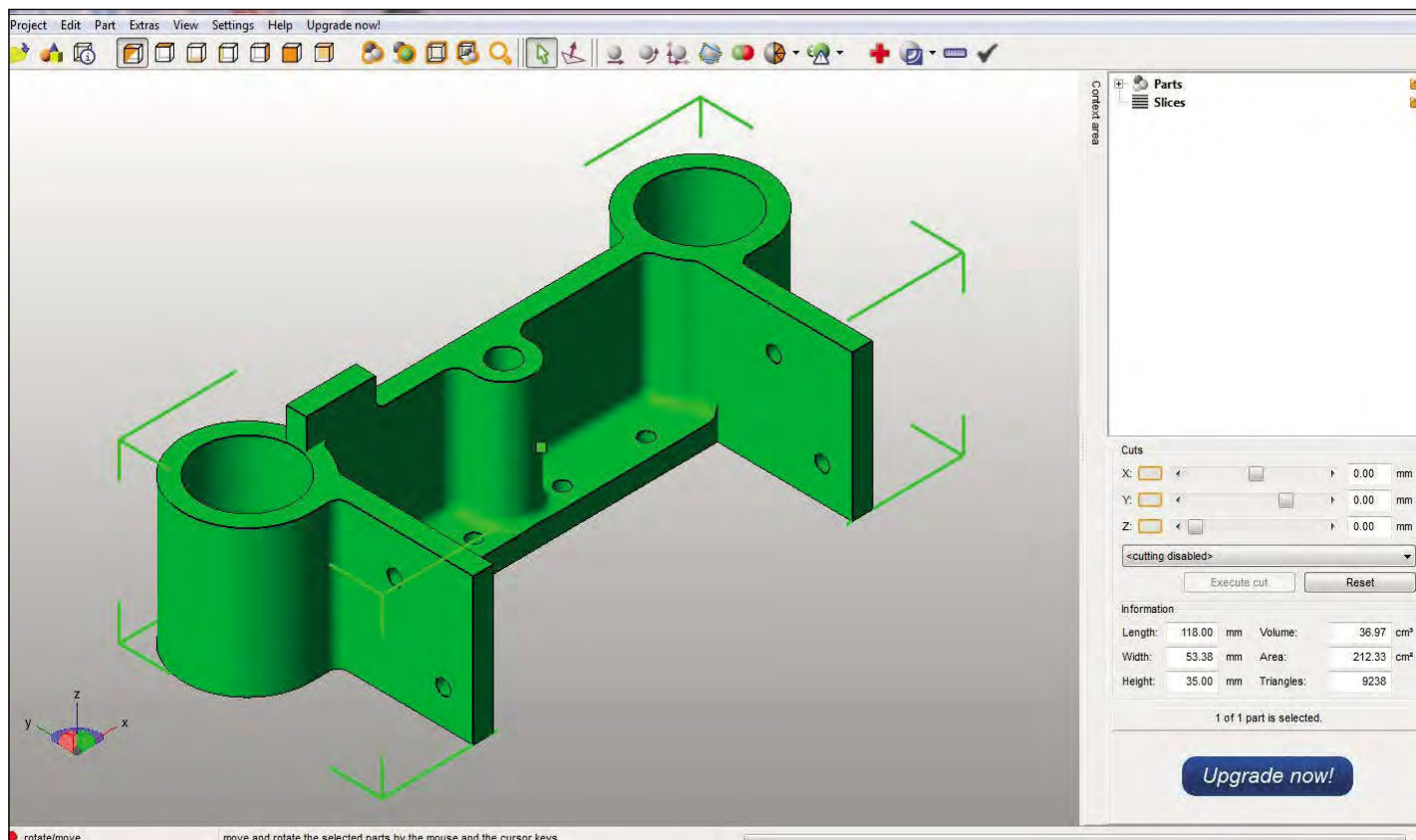
full details of where they come from are given. Initially the laptop is connected by USB cable to the electronics unit – without mains power – and a red LED should illuminate near the USB connector. The Duet (electronics) unit comes with firmware pre-programmed but may need updating. Again full instructions are given. The SD card supplied with the unit needs to be programmed to match the firmware.

Software

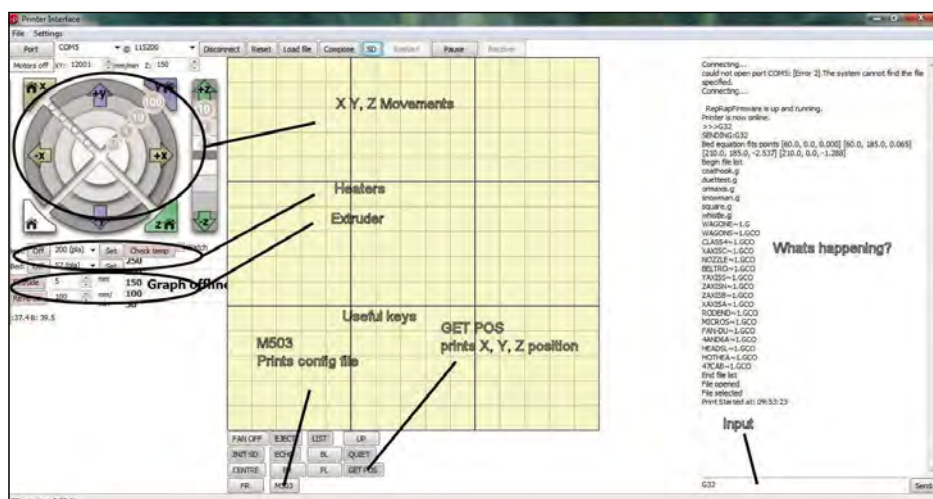
One of the axes can now be wired to the electronics board together with the microswitch. Connect to the laptop via Pronterface – one of the programs downloaded earlier. Assuming that the mains switch has been connected to the power unit, and the power unit to the electronics, power can now be switched on. If there is no

The slic3r screen



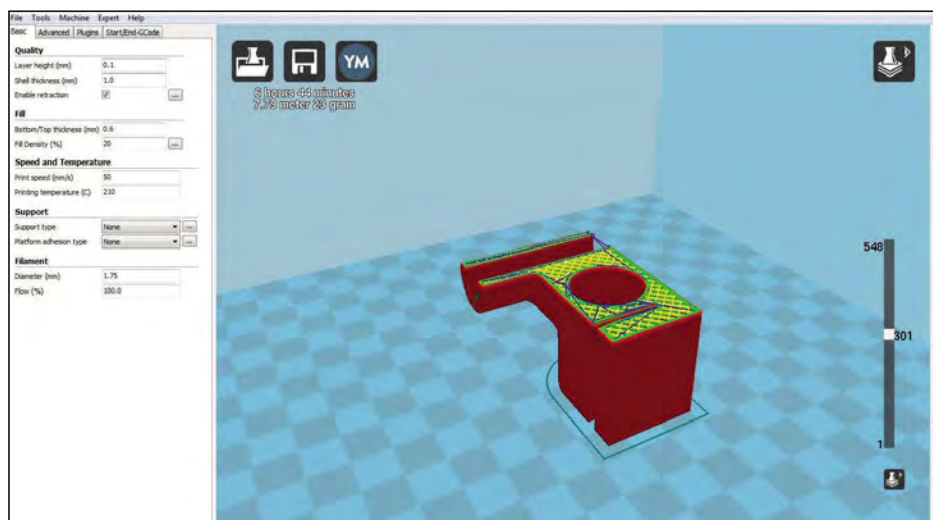


The netfabb screen



The Pronterface screen

The Cura screen



blue smoke and a green light comes on in the power unit there should be another red LED illuminated alongside the axis microswitch connector on the electronics board. The head slider can now be moved backwards and forwards using the appropriate axis on the Pronterface screen. Operating the microswitches manually should put the LEDs out.

The rod end slider is shown on the slic3r screen. In the right upper corner it shows that the program is configured to be suitable for the Ormerod printer. The item would print as shown but support material would be needed. It would be better if rotated 90 degrees so the flat surface is against the bed.

Netfabb is a useful program as it allows rotation in all axes but also shows a big red exclamation mark if there is an error in the part. It will then correct the part. Shown in the picture is the lower bearing holder for the Z axis (note no exclamation mark!).

The last screen is from Cura which is used on the Ultimaker but can be used here if configured to suit the machine parameters. The item shown is an XY slider. Cura will tell you how long the print will take. As with the other programs it is possible to look at individual slices. Here the slice is roughly half way down with the outer layer shown red and the infill yellow. These are just a few examples of the programs that are available.

To be continued

“Yorkie” – a Yorkshire Engine Company

0-6-0 Locomotive in 16mm

By **Malcolm High** and **Derek Crookes**

Continued from page 56, August 2016

Gas Burner

The gas burner is a piece of $\frac{3}{8}$ " thin walled brass tube available from your local model shop. Carefully mark out and drill the holes as shown in the drawing. Turn the blank end from brass bar and silver solder in place. The other end of the burner tube fits into a piece of brass turned as shown in the drawings. This needs to be a tight fit in the firetube. The other end is turned and tapped to hold the gas jet. None of these turning jobs should present builders with any problems.

The gas jet is a number 5 and is available from a number of suppliers. Turn the holder from brass bar.

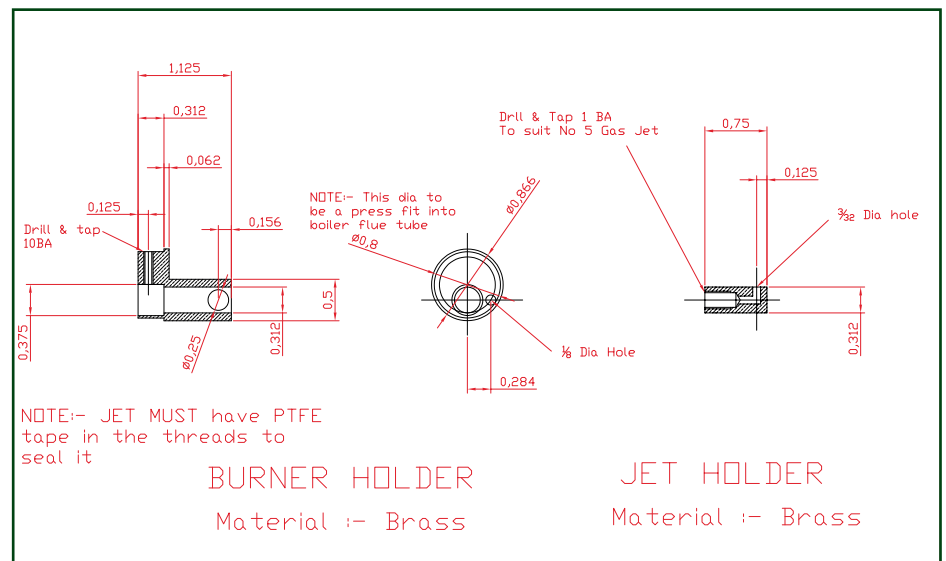
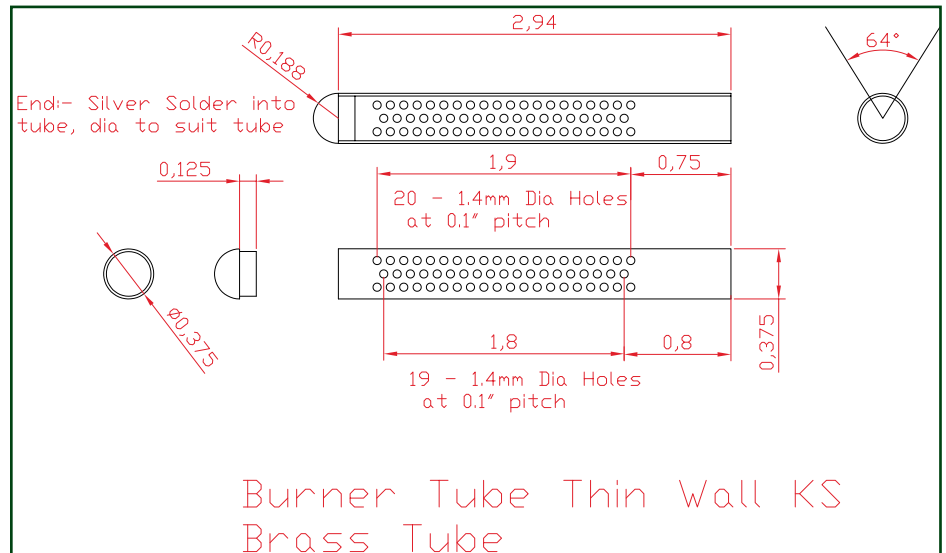
Gas Tank

The gas cylinder sits on the left side of the footplate. It is made from a piece of 22mm diameter tube. The ends are pieces of brass bar turned as shown in the drawings; note how the base has a tapped spigot to fasten it to the footplate. The filler is a Ronson type which has a very unusual thread: M4.5 x 0.5. Taps can be obtained from a number of suppliers. Note that on the filler there is a small hole on the threaded section; this is the vent and it must not be covered up. The tube and the end plates are silver soldered. The cylinder must be tested to 300psi and needs an identification number stamping on it. On top of the cylinder is a gas valve. This is turned from brass bar and the individual parts are silver soldered. The handle is from 3mm diameter stainless steel.

Lubricator

In this scale lubricators are of the displacement variety. This is another tube with end plates so is probably best made with the gas cylinder. On the bottom plate is a drain; this pipe is also used to fasten the lubricator to the footplate. Steam is fed through the $\frac{1}{8}$ " diameter copper tube in the top of the lubricator. Any steam that condenses displaces some of the oil which is taken through into the cylinders via the 0.2mm diameter hole in the pipe. The lubricator is filled via the screwed cap in the top plate. Since the lubricator is at steam pressure it requires testing to twice boiler pressure.

Before the chassis can be run on steam the reverser stand needs to be fitted. This also holds the miniature servo which controls the regulator. It is



A view of the backhead with the gas jet removed.

made from 1.5mm steel and a laser cut kit is available to make it easier to manufacture. The reach rod is made from 1.5mm steel and is attached to the reversing lever by a small pivot pin.

With the lubricator and gas tank bolted to the footplate the pipework can now be coupled up. A pressure gauge is fitted off the regulator and needs to be in a visible position when the locomotive is in steam. The level indicator will eventually sit in the left hand bunker but for the time being it will have to sit on the bench.

To be continued

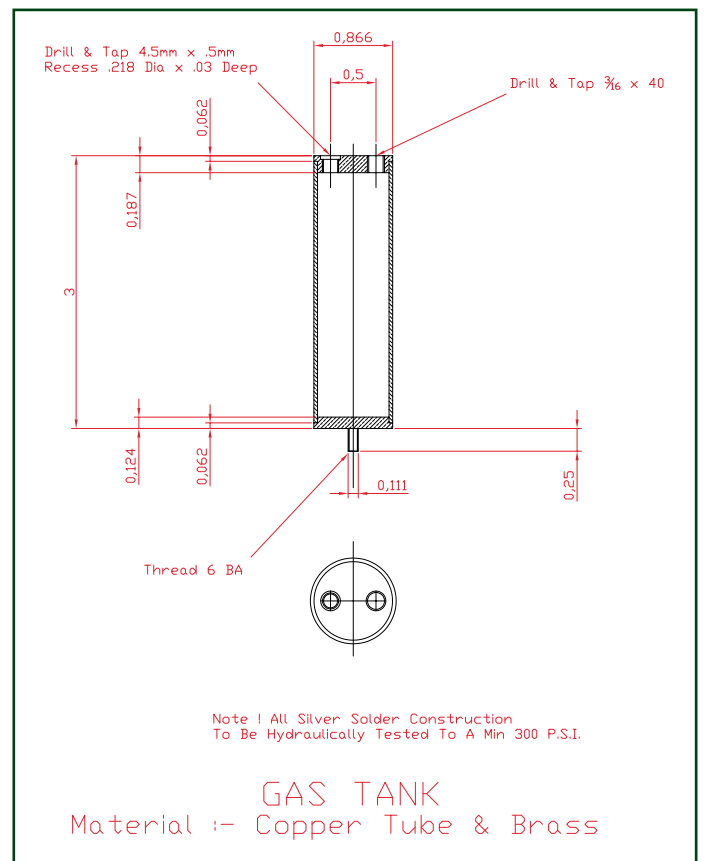
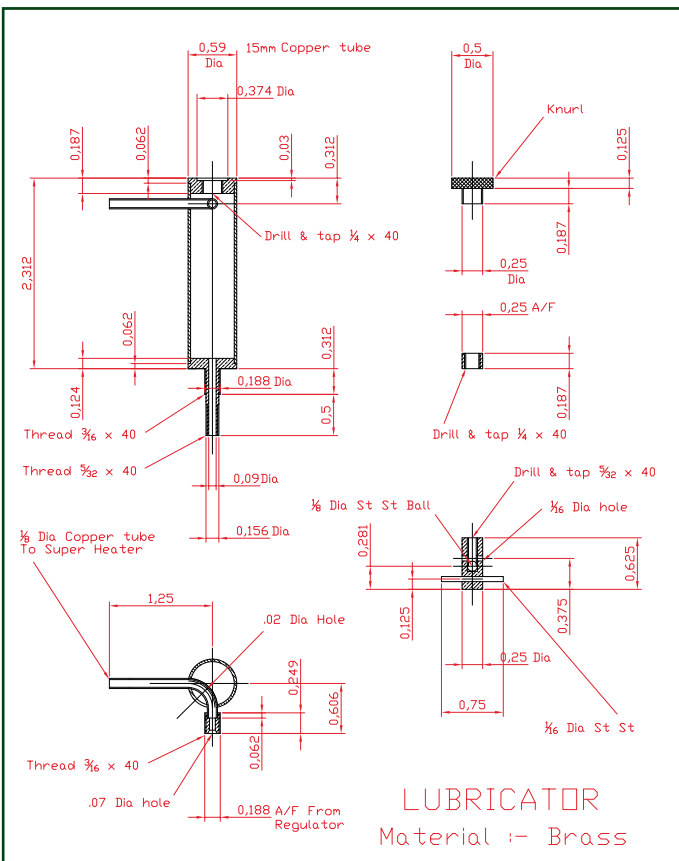
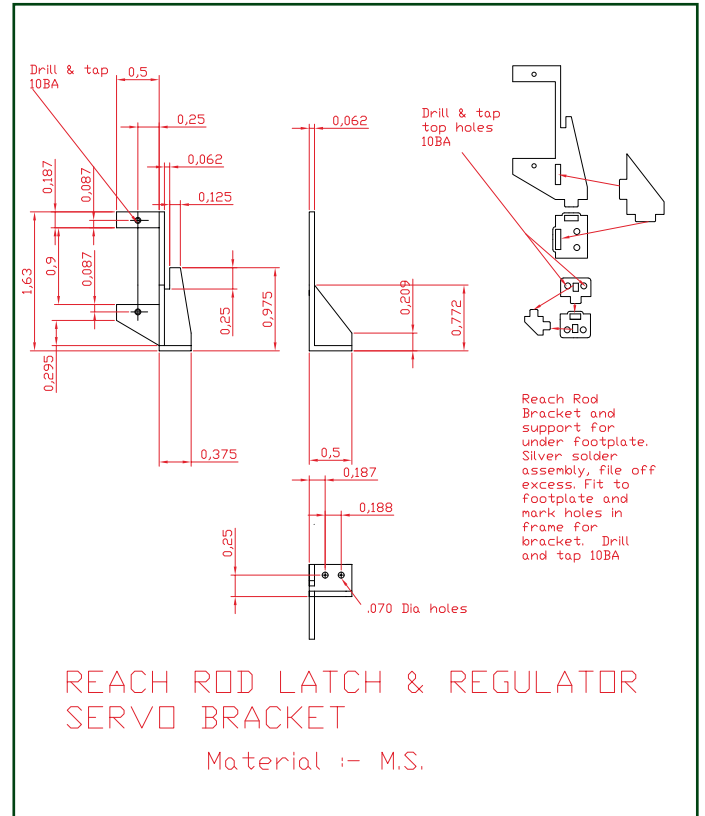
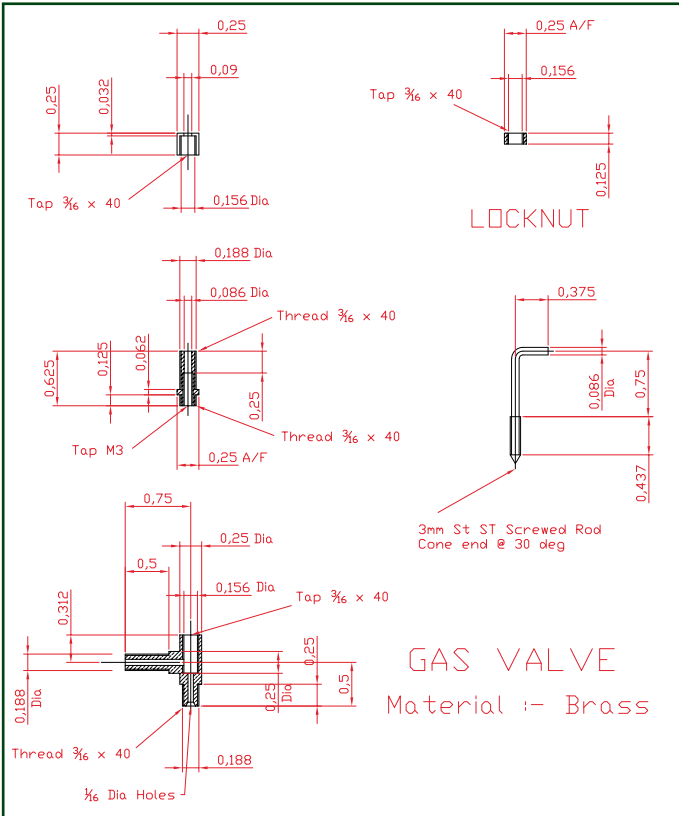




(Left)
Gas burner and jet.



(Right)
Gas jet and associated pipework.



Making a Regulator Clock to a New Design

Part 13 – Making the case

by John Reynolds FBHI

Continued from page 61, August 2016

In the last two parts of this series I describe the construction of a simple yet elegant wall-hung case for the regulator. The text, photographs and drawings ensure that the construction is as easy as it gets using a few basic woodworking tools. The case described here is not exactly the same as the one I made for the prototype clock as I have developed it to be easier to construct and, in retrospect, I think it is better than the prototype.

The case consists of a backboard around which the rest of the case is constructed, two glazed sides with top, middle and bottom glazing rails, a fully glazed door and top, bottom and base panels. It is finished with decorative mouldings applied to the top and bottom. The backboard is inset into rebates in the sides, but the door overlaps the sides and is overlapped by the top and bottom panels.

The first step is to measure very carefully the three main dimensions of the finished regulator movement. The width is determined by the outside diameter of the bezel. The height is from the top of the mounting plate to the bottom of the complete pendulum. The depth (D), from the front face of the backboard to the front edge of the bezel, is the most critical measurement. If the case is too shallow it would be difficult to reduce the depth of the movement. At the same time the bezel needs to be very close to the rear of the door glass. In the case described here, the gap is only 2mm. The case measurements given in the drawings are based in the dimensions of the prototype clock. However, they may need adjusting slightly to fit a different clock.

In the case section shown in figure 58, X is the distance from the front face of the backboard to the rear face of the door. Y is the distance from the rear face of the door to the rear face of the glass. Then $X + Y - 2\text{mm} = D$, so $X = D - Y + 2\text{mm}$. Don't forget that the position of the rear face of the glass (and hence dimension Y) will be affected by the glass thickness chosen. 3mm glass is ideal but difficult to source. 4mm glass is too heavy so 2mm glass may have to be used. Having established dimension X the overall outside width of the side frames can be calculated. It is $X + 15\text{mm} + 2\text{mm}$. The 15mm is the thickness of the backboard and the 2mm is for a 1mm inset of the backboard (see below) and a 1mm allowance for finishing the front of the side frame.

The timber required for this case is ten 52in (1.32m) lengths of 50mm by 23mm American Cherry and two 4ft (1.22m) by 12in (305mm) boards of 15mm Cherry (or similar) veneered MDF for the back, top and base of the case. I obtained this from a local furniture maker. The timber was supplied with a planed and sanded finish and the MDF boards were edged, although the edging was not really necessary.

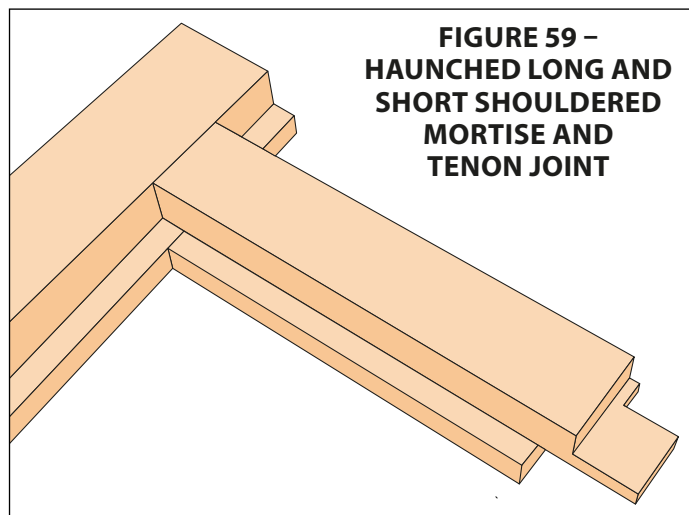
American Cherry was chosen because it has a fine texture and works well with both hand and machine tools. It is widely used in furniture making and should therefore be readily available. Good alternatives are Honduras Mahogany and Utile.

The first step is to take seven lengths of the Cherry and make a full length 10mm wide by 16mm deep glazing rebate in each one. The objective is to leave a 7mm lip. If a different thickness of timber is being used then the depth of the rebate should be adjusted. These are for the stiles (vertical

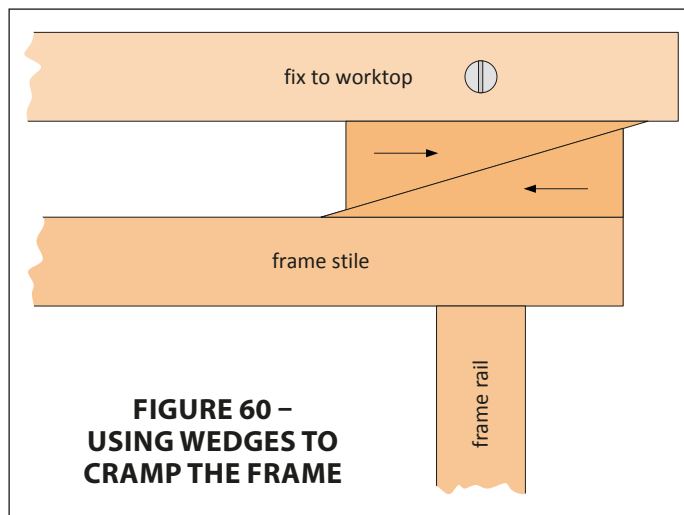
members) and rails (cross members) of the door and the side frames. Do not make the rear rebates in the side frames for the backboard at this stage. They are of different dimensions and are made after the side frames have been assembled. Also, leave all the timbers at their full width for now.

There are several ways of making the rebates. I cut mine out using a table circular-saw. By this method the rebates are roughed out in two cuts, one for depth and one for width, with the saw set a little shy of the full dimension. They are then run through again at full dimension keeping each piece tight up to the saw fence. An alternative is to use a table router, again taking a roughing-cut first followed by a fine cut to full dimensions. Another alternative is to use a hand-held router to cut the rebates after the frames have been assembled. In this case it would be necessary to cut the corners square with a chisel. Also in this case, the mortice and tenon joints would be simpler to make. Of course, a traditional rebate plane is yet another alternative, but the rebates would need cleaning up to perfection with a shoulder-plane.

The first part to make is the door. It is essential that this is perfectly square and flat and to achieve this it is necessary to take great care when marking out and making the joints. Don't forget to mark each joint pair with a unique letter or number to ensure that the frame is always assembled in the same way. The corner joints of the door frame are haunched long and short shouldered mortise and tenon joints as shown in figures 58 and 59. The mortices were made first using a 7mm slot cutter in my milling machine. This ensured accurate mortices, but it was



**FIGURE 59 –
HAUCHED LONG AND
SHORT SHOULDERED
MORTISE AND
TENON JOINT**



**FIGURE 60 –
USING WEDGES TO
CRAMP THE FRAME**

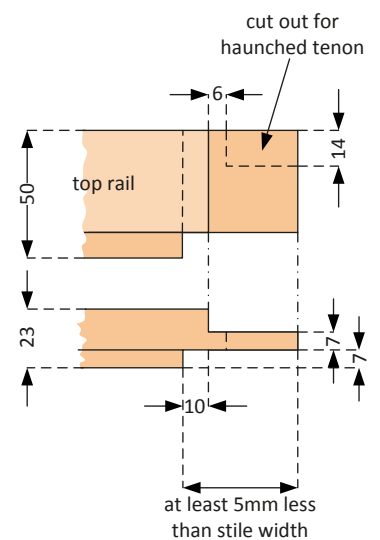
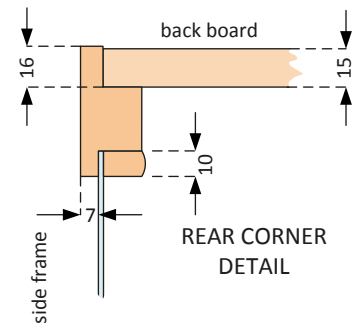
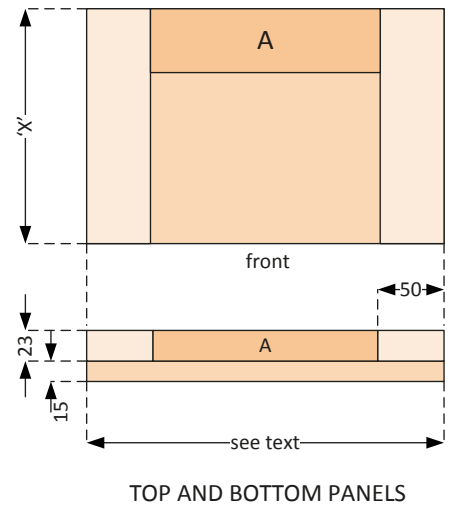
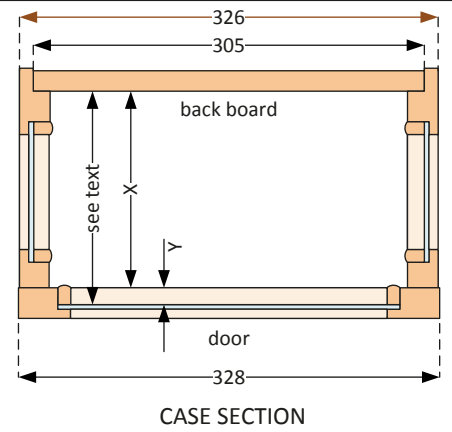
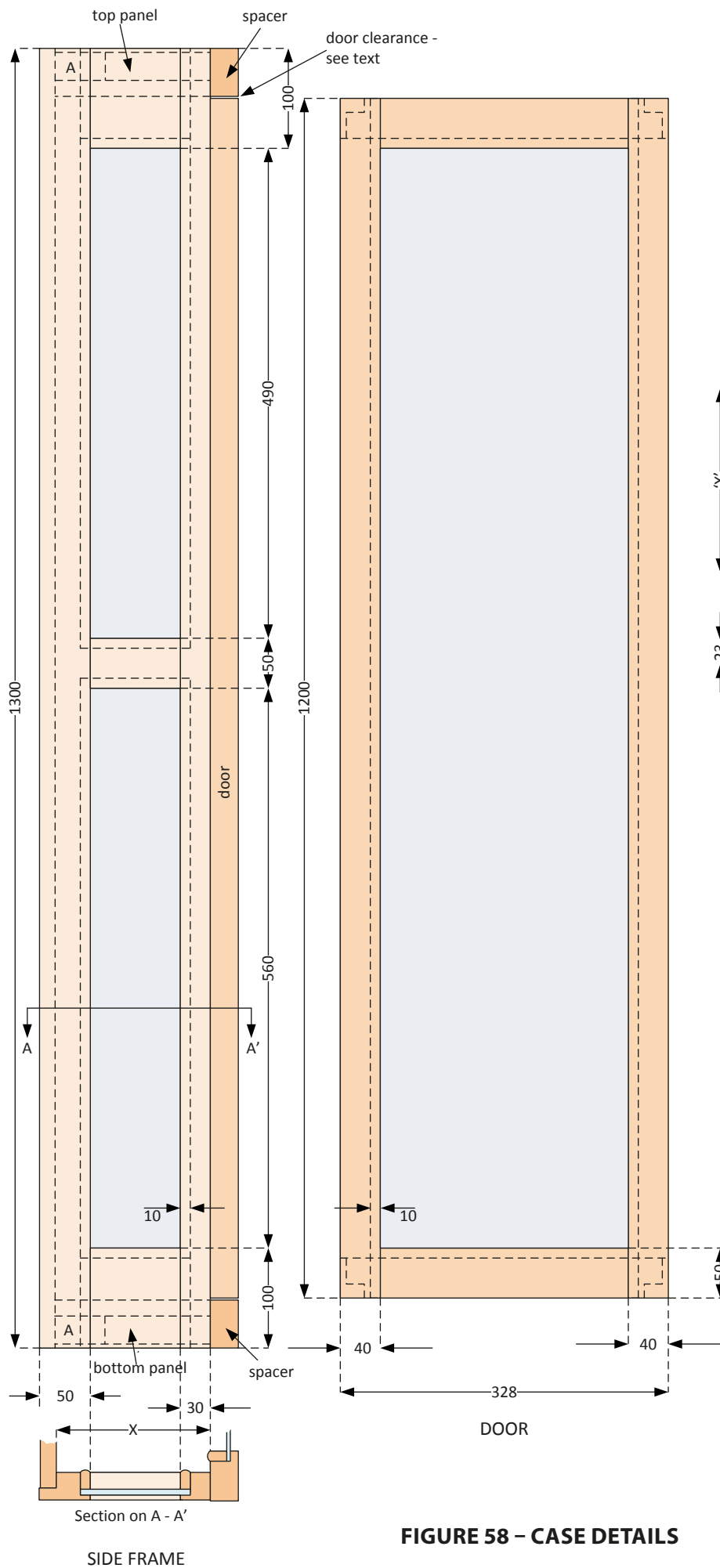


FIGURE 58 – CASE DETAILS

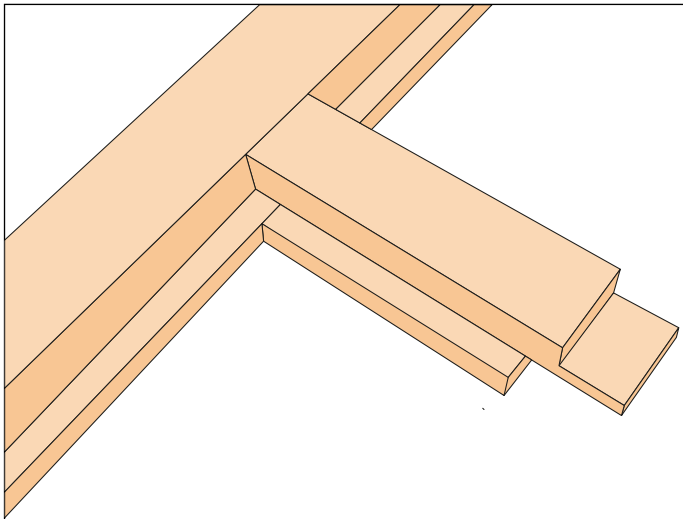


FIGURE 61 – LONG AND SHORT SHOULDERED MORTISE AND TENON JOINT

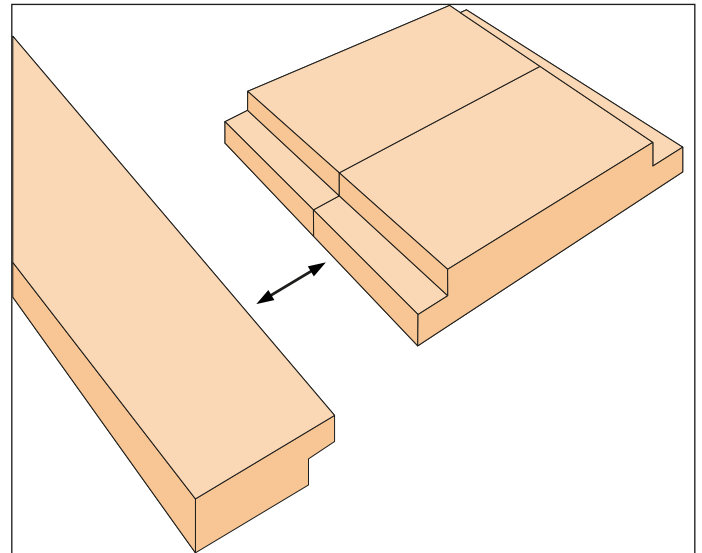


FIGURE 62 – TOP AND BOTTOM SIDE RAIL JOINT

necessary to square the corners using a sharp chisel. Alternatively, the mortices can be cut out using a sharp mortise chisel. The tenons are marked out with a mortise-gauge and cut with a tenon saw. Normally all the marking out for both the mortices and the tenons should be done first but when working with a combination of hand and machine tools I tend to mark one part from another for a simple non-repetitive job like this. The long and short shoulders need careful marking out and the haunch can be tricky to get right so care is required. Note that the lengths of the tenons should be at least 5mm less than the finished width of the stiles.

For both the door and the side frames attention should be paid to good alignment of the rebates for the glass rather than the faces. Both inside and outside faces can be finished with a smoothing-plane later to correct any misalignment.

When all the joints have been cut any trimming required needs to be carried out carefully. Tenons need to be the right length (see above and figure 58) and must not be too tight. If the joints are very tight it is difficult to achieve a flat frame. They should push together by hand fairly easily.

The door frame should be assembled and glued on a flat surface; a piece of kitchen worktop is ideal for this. If a pair of sash cramps is not to hand to cramp up the frame whilst the glue sets a pair of “folding” wedges can be used at the joints in the following way. Screw two parallel strips of 2in x 1in down on to the worktop. The strips need to be a little longer than the frame and the gap between them should be the door width plus about 50mm. Make up two pairs of wedges from an off-cut of 2in x 1in and tap each pair against each other to cramp the frame as shown in figure 60. Before actually gluing the frame up assemble it dry to see if all the joints fit well and the frame lies down without the slightest twist. If all is well apply PVA wood glue to every surface of each joint, getting it into all the corners with a small spill of wood. Assemble the frame and cramp it up using sash cramps or wedges. Wipe off as much excess glue as possible with a wet rag and leave it overnight to set. The cramping system can then be removed and the frame examined for any sign of twist by sighting down the frame. If just a slight twist remains, the glass may accommodate it but if much twist

is evident the only answer is to start again. Trim the top and bottom stiles of the door at this stage but leave them at their full width for now.

The side frames are considerably easier to make as they only have long and short shouldered mortise and tenon joints (as shown in figure 61) for the middle rails. The top and bottom rails do not have joints as such (see figure 62 and photograph 56). Again lay them on a flat work-top for gluing and cramp them with sash cramps or folding wedges.

Although the case described here has glazed sides a simplification would be to have solid sides. If this option is chosen it is best to use veneered MDF to match the backboard because cross-grained mouldings are to be applied to the top and bottom of the finished case. However an edging to the front of the sides at least 15mm thick will be required to fix the hinges.

Lay the glued-up side and door frames in turn on a flat surface with a temporary bench stop and with a very sharp smoothing plane with fine setting, flat off their inner and outer faces. A panel plane that will easily span the frames is best for this job (photograph 57).

Photograph 56 – Bottom of side frame.



Photograph 57 – Cleaning up a side frame.





Photograph 58 – Back board and sides.



Photograph 59 – Fitting the top panel.

The rebate for the backboard in the two side frames should now be made as shown in the case section of figure 58. Put the two frames together inside to inside and mark clearly with a pencil where the wood is to be removed to create the rebates. It is so easy to make the rebates and then realise that they are on the outside!

The rear corner detail shown in figure 58 shows that the width of the rebate should be 1mm more than the thickness of the backboard as noted above. This is to ensure that the backboard is well hidden when looking from the side. The width of the rebate is half the difference between the width of the backboard and the finished width of the clock. This was 11mm for the case being described here but this dimension needs to be checked very carefully.

Remember that at this stage the front stiles of the side frames are still at their full width. These should now be cut down and cleaned up to give the exact internal depth of the case. This is shown as X in figure 58, and determined as described above.

The next task is to make up the top and bottom panels. The details are shown in figure 58. They must be made flat and “square” as any inaccuracies will result in the whole case being out of true.

Lay the backboard on a couple of thin strips of wood on a flat surface (the piece of kitchen worktop used above is ideal for this purpose). Place the frames either side such that the backboard is fully in the rebates on both sides. The thin strips of wood under the backboard and sash cramps across the ends at backboard level will help to ensure this (see photograph 58). Make up the two panels using dimension $X + 1\text{mm}$ for the width. The length should be slightly more than the distance between the two side frames, measured next to the backboard. Leave out cross-piece A for now. Now offer in the panels to determine their exact length and trim them to size. Place the door centrally on top of the sides with an equal gap top and bottom. Place the panels between the sides and move them up and down to establish their exact final position, using the ends of

the backboard to check that they are perfectly square (photograph 59). Their internal faces should be just slightly above and below the top and bottom of the door.

Either cramp across the case top and bottom to hold everything in place or mark out for and insert two screws through the side frame into the panel at each of the four corners. These screws will be covered by mouldings later on. If everything comes together favourably the panels can be glued in place but be sure that they touch the backboard. Protect the backboard from spreading glue with pieces of paper tucked into the rebates as shown in photograph 60. The front edges will be just a little proud and these can be planed off to size when the glue has set. To be safe, glue one end one day and the other end the next day. Cross member A (figure 58) can now be cut to size for each panel and glued into place but make sure that it is not glued to the backboard.

The two spacers which fit above and below the top and bottom of the door (photograph 60) can now be cut to length from the 23mm x 50mm Cherry. Lay the door on the case and place a strip of thin card across the top and bottom of the door to give clearance and then glue on the two spacers. They can either be cramped in position or held on with two screws into the side pieces of the panels. Again, they will be covered by the upper and lower mouldings. The door can be cut to width now, making sure that it is wider than the case by 1mm on each side. Nothing looks as bad as the case overlapping the door!

The backboard can now be fixed to the case using two screws top and bottom into the panel frames, and two thinner screws in each side going into the frame. These should be slightly angled towards the centre of the side frame stile. Insert two extra screws through the backboard into the top cross member as this takes the weight of the clock via the hanger.

To be continued

Photograph 60 – Protecting the rebates and fitting the top spacer piece.



September already – where is the year going? There are plenty of model engineering events looking forward with both club and steam rallies to attend so no excuses, please, for saying there is no model engineering taking place. The relocated Model Engineer Exhibition at Brooklands is scheduled for the 16/18 September and this of course is followed in October by the Midlands Model Engineering Exhibition at The Warwickshire Exhibition Centre at The Fosse which is going to be another first class event. It was good to see so many people I knew at the relocated exhibition in Doncaster in May. I thought it was a good venue and had plenty of space both inside and out which I think was appreciated by both exhibitors and visitors alike.



On the club scene lots of activities are taking place with clubs preparing their Winter working programmes as well as social events like Santa Specials. Tickets are on sale already at a number of clubs. The 7¼" Gauge Society will be holding their AGM this year at the Beer Heights Railway at Beer in Devon and the Sutton Coldfield Society are holding a Narrow Gauge Day on 4th September. An LNWR gathering is taking place at the Leyland Society on the 24th. As always for more information on any of these events contact the clubs direct.

During the Birmingham SME's AGM the Society presented Peter Pullen with the Rose Bowl trophy which is awarded each year to the member who has contributed the most time and effort to the club during the previous year. The club have had a couple of their locomotives overhauled and returned to service in recent weeks with John Walker completing one 0-6-0 and Barry Pallett doing likewise on another. The Gauge 1 track fittings have had a re-vamp with the breaking plastic point motor and circuitry boxes being replaced with new metal boxes built by members.

The Chairman of the Bristol SME reflects in the latest issue of their club magazine about the need to record the models, tools and equipment you may have for when the time comes to go to that big workshop in the sky. Many families struggle with trying to find out what everything is and although it is a sad subject to consider it is probably the only future event we can all anticipate with certainty. So give it some thought as it will help those left behind. The club's 'On the Table Night' was well attended with a wide range of components and fittings on display ranging from parts for a small hot air balloon to parts for a half-scale Burrell traction engine. It must have been an interesting night.

Progress is being made at the Lynsport ground of the Kings Lynn Society where a new track is under construction together with new club buildings. All this has come about because of a new road being built by the local authority. The construction work means that for 2016 the club will not be able to offer any public running at their site but they will be attending various shows with their portable track so at least they will be getting in some revenue.

The latest newsletter from the Lancaster & Morecombe Society has some interesting articles which cover a variety of subjects. Lancashire CC are looking to hand over responsibility for the parks and woodlands they own to others. This could impact on the club so members are waiting to hear what this change will mean to them. Ron Strachan is making good progress with his latest locomotive which, he says, will be his last. It is a 5" gauge LNER B16 4-6-0 and looks to be a fine locomotive and will no doubt be up to Ron's usual excellent standard. They have had a donation of a large amount of new ballast which will be used to refurbish the outer track to the standard of the inner track. Another encouraging sign that engineering, or just simply making things, is staging a come-back is that the local Kendal College is opening their workshops on a Monday evening for 2½ hours for anyone to use. It will provide an opportunity to use machines that are larger than those usually found in the home workshop, including 3D printers, CNC mills and lathes. So far ten people are making use of this facility with a capacity of up to twenty. Sounds good to me.

The Lincoln & District MES will be holding their 15th Annual Open Weekend and Steam Rally at their North Scarle site over the weekend of 24th/25th September. The Society will also be celebrating their 82nd year as a model engineering club. The dual 7¼"/5" gauge railway runs for approximately ⅓rd of a mile and the site also provides a good surface for both model and full size traction engines of which there will be a number attending. A short road run has also been organised. A Bring & Burn BBQ will be available on Saturday night as part of the social gathering for all exhibitors. The adjacent local pub and village bakery will also be providing good food and other refreshments. The usual certifications will be required (boiler certificates and third party insurances) as well as road traffic insurance for traction engines. This all sounds like a good weekend so contact Dave Pierce at the club for more information or to book in. I am sure they will be pleased to see you.

At the Nottingham SMEE the committee are looking into the possibility of extending their 7¼" gauge track, with preliminary survey work being undertaken. The extension would leave the existing track just before the bridge and cross the site entrance road. It would then enter into the copse to return into the far end of Park Gate Station making it a through station, which would mean it is used more frequently than at present. Completing this work would also extend the scope for further work. So far there has been a favourable response from both the council and park wardens. A new camera system is to be employed around the site

Colin Brooks steam tests his new A4 on the track at Gilling.



to improve security, on the recommendation of their insurance company, and this coincides with additional storage capacity which is available to members. A new 3½" gauge event was scheduled to be held at the club in July and it will be good to hear how this day progressed. A number of clubs are finding that the smaller gauges are making something of a comeback so a new event like this can only encourage this development.

The weekend mainline rally was well attended at the Ryedale SME earlier in the year and involved plenty of scale working to interest both participants and spectators. With good weather and lots of stock and locomotives it was a very busy event. A visit from a couple of motorcycle clubs also added to the atmosphere. Colin Brooks had his new A4 locomotive steam tested on the track and, after some adjustments to safety valves and injectors, the locomotive passed its test so it was a very successful day for him. Re-sleepering is also continuing and fine adjustments were made to track alignment before the mainline event to ensure the usual good running conditions prevailed.

A recent meeting at the SME was notable because, for the first time, members not attending Marshall House were able to enjoy the proceedings 'on line'. It was all organised by the Digital Group as an experiment and entailed a considerable amount of work to ensure it was successful. It is hoped that this feature can be expanded in the future but it really depends on the membership taking up the idea. The Society is looking for a new Secretary as Allan Bermann wishes to step down from this post. A new Editor for the magazine is also required as the temporary incumbent Alan Wragg does not wish to continue after the December issue. Both these posts are an essential part of any organisation so I hope they can be filled by other members. Participation in the Dartford Steam Fair was an enjoyable day for the Society which provided an opportunity for "new blood" to be attracted to model engineering. It was noted that SME life member Roy Darlington has also been made the first Life Member of the Stirling Society. This coincides with the 200th anniversary of the patent for the 'Heat Economiser' by the Revd. Dr Robert Stirling. ■

This month's Young Engineers column is written by Nick Kane, from the Sydney Live Steamers, who tells us of his acquisition of a part-built Blowfly locomotive and its subsequent completion. This is the story of Blowfly 'Hart' No. 12.

'Hart' No. 12

by Nick Kane

On the 11th of September 2015 Blowfly No. 12 'Hart' moved under its own power for the first time. This was the result of much work by Simon Collier, and a number of other members of the Sydney Live Steam Locomotive Society, who have made the steaming of this terrific little engine possible. Since then it has been run a number of times at the club grounds bringing an immense amount of joy to me and proving to be an excellent performer on the track. Perhaps a few details on the completion of this locomotive may be of interest.

In early 2012 SLSLS member Simon Collier started constructing a 5" gauge 0-4-0 Blowfly locomotive for me, to Barry Potter's excellent design. This was the result of my desire to experience the construction of a live steam locomotive. The previous year, at the tender age of 13, I had purchased my 3½" gauge Atlantic 'Maise' from Graham Tindale, something which proved to be very exciting and somewhat daunting at first. However, I really had no idea as to how a live steam locomotive such as this was constructed. Experiencing the construction of a Blowfly in Simon's workshop gave me an undeniable appreciation for the skill and effort that is required to build such a locomotive. After suitable driving wheels were very kindly donated by Ross Bishop construction began in earnest with visits being made to Simon's workshop most Thursday afternoons after school and many days during the school holidays. Gradually axles, axleboxes and eccentrics were completed.

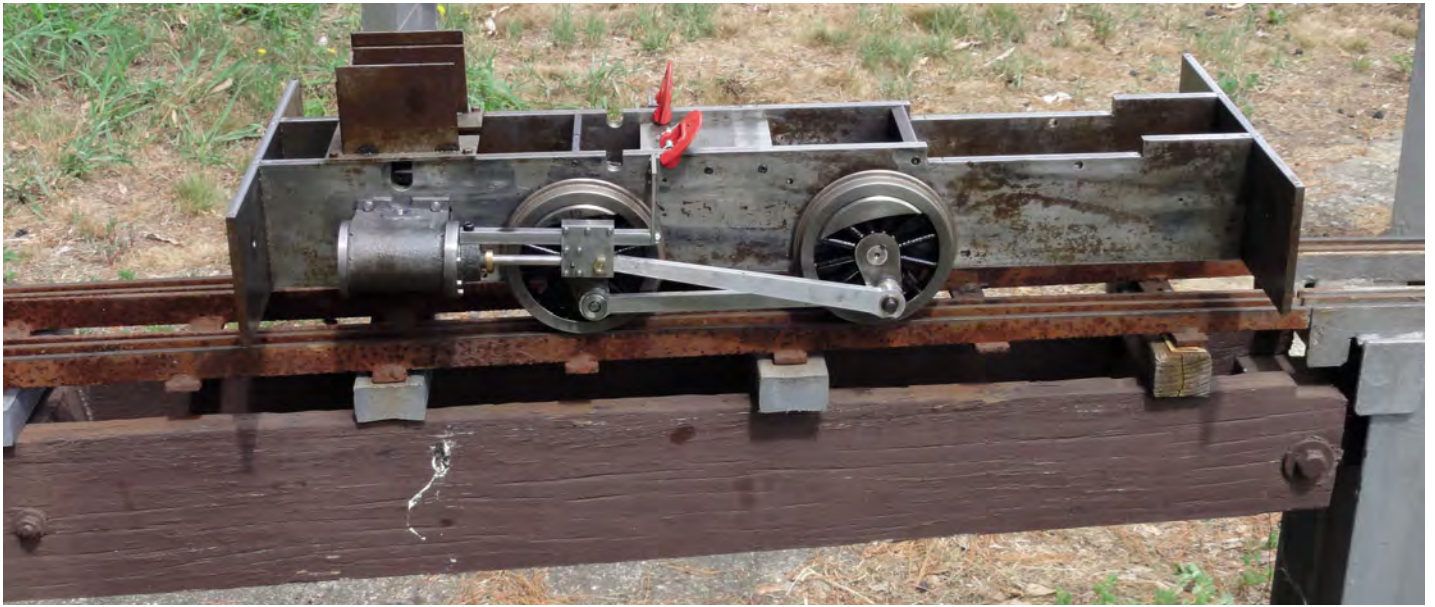
On Friday the 7th September 2012 I received a telephone call from Simon saying that a surprise was in store for me the next day at the club. Upon arriving at the club grounds early Saturday morning I discovered that Hart Brammer, an SLSLS member whom I had never had the pleasure of meeting, had decided to give his part-built Blowfly to me. Hart could only be described as a gentleman and I regret that I did not have the opportunity to see him again after this day. He had started a Blowfly many years before but was unable to find the time to complete it. The parts he had completed were all to the general Blowfly design specifications and were made to a very high standard. These consisted of frames, axles and axleboxes, eccentrics and eccentric straps, driving wheels

(unfinished), coupling and connecting rods, crossheads (unfinished), cylinders and steam chests (unfinished), riveted side tanks, exhaust passages and many other smaller parts such as the displacement lubricator. Although I am unsure as to the exact year that Hart started the locomotive, the design of certain parts would suggest that construction began very soon after the Blowfly series was published in the Australian Model Engineering magazine.

I will always be extremely appreciative of Hart's kindness and generosity in giving the part built engine to me. Unfortunately he passed away before the Blowfly was completed so was never able to see the engine run. Shortly before his death permission was gained from Hart to name the engine after him, something which he was quite touched by. I feel this is a fitting tribute to both his skill and kindness.

Nick Kane with 'Hart' No. 12.





The locomotive is quickly completed to the rolling chassis stage for testing on the raised track.

Because construction of a Blowfly had already been started before Hart gave his part built engine to me we now had several duplicate components. A decision was made to use as much of Hart's parts as possible so the duplicate parts were set aside for a possible future engine. Work was soon started on getting the engine to a rolling chassis stage and this was achieved by the October club running day in 2012, with the opportunity being taken to push the chassis around the elevated track. Following this, gradual steps were taken to get the engine running on air, with the cylinder ports and passages machined and pistons and valves made to suit. Work on the chassis and running gear was sporadic as much attention was turned to the construction of the boiler. The chassis was run on air for the first time on the 10th February 2014; a wonderfully exciting moment. It was marvellous seeing the valve gear burst into life when compressed air was admitted to the cylinders. Around the time the chassis was being worked on, a very enjoyable day was also spent at Ross Bishop's workshop making the cab, which was cut out from the zinc annealed sheet and the sides folded to form the general cab structure.

Construction of the boiler was a part of the build which I must say I found to be particularly enjoyable and interesting. Fortunately a copper barrel and tubes were part of the gift from Hart and other boiler material was obtained from Barry Potter. After the boiler plates were formed the big soldering operations began. Initially I found these rather terrifying but gradually became used to them and came to find them quite exciting. The heat-ups were done on Simon's front porch and I noticed some very bewildered looks on the faces of people passing by on the outside footpath, gazing at the roaring torches and glowing green boiler. Although not all soldering operations were 100% successful, and at times morale dropped a little, it all came good in the end. Simon did a wonderful

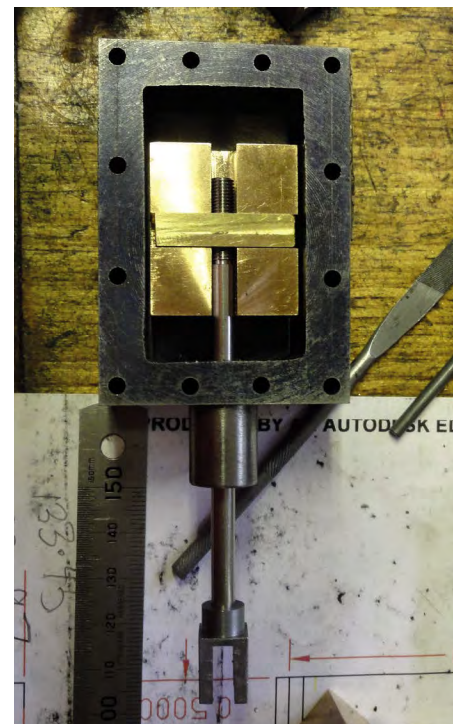
job on the boiler and his dedication meant that it eventually passed its hydrostatic test with flying colours.

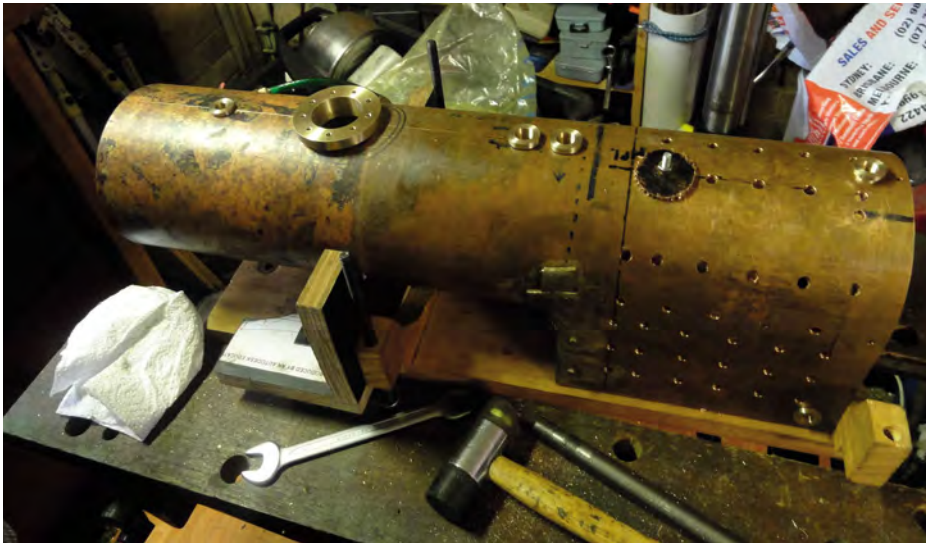
Before boiler construction began a decision had been made not to fit superheaters initially but still to have provision for superheating, should it be desired to fit elements in the future. However, after a discussion with Warwick Allison, it was decided that superheaters should be fitted before the engine was completed. Stainless steel elements were supplied by Warwick and the ends welded by Martin Yule but these elements turned out to be troublesome. The walls of the stainless steel elements were quite thick and much difficulty was found in trying to fit the superheaters into the superheater flues in the boiler. Unfortunately, for this reason, they could not be used. Simon

The boiler begins to take shape.



A cylinder and valve chest for the Blowfly locomotive.





Only the stays, bushes and backhead remain to be fitted, before the boiler faces its first test.

instead decided to manufacture thinner walled copper elements of $\frac{1}{4}$ " diameter and these were duly fitted to the boiler.

A very nice ball valve regulator was also made by Warwick to his design, as seen in Australian Model Engineering magazine.

John Lyons constructed the smokebox, using a recycled bollard from Plumpton High School, and did a beautiful job. This included the smokebox door, hinges and of course, the chimney. A real lot of work went into this particular component of the locomotive and it certainly looks terrific. A lovely brass chimney cap was supplied by Hart, which I believe he purchased from Hucar Engineering.

A lot of thought was put into No. 12's livery. Simon and I both agree that a Blowfly is the type of locomotive that needs a good paint job, with the big side tanks and cab lending themselves well to lining in addition to the base colour. Various colour options were considered, with maroon being the favourite idea for a while. However after looking at the book 'Steam Trains in Your Garden' by Brian Wilson, and seeing his two tone green 16mm scale Peckett, I fell in love with

this stunning paint job. Simon also agreed it would suit the Blowfly splendidly so Humbrol paint samples were selected and used to have automotive spraying enamel made up to match, and the engine was eventually fully decked out in gorgeous two tone green with white lining. Simon put a lot of work into the paint job and the end result really looks terrific!

Name and number plates were purchased commercially and these are held onto the side tanks and cab with strong adhesive. The cab valves, water gauge, pressure gauge, whistle and safety valves are all commercial items, purchased from the various live steam suppliers. The safety valves are of the pop type and work reasonably well, although they do have a tendency to lift water. The Blowfly design displacement lubricator that Hart made was fitted and has proved to be extremely efficient. The engine's water feed consists of two injectors supplemented by a very good axle pump. The pump is to the design specified in the Blowfly series but was modified to minimise dead space. One injector feeds from the side tanks while the other injector feeds from an external water tank in the riding truck. The axle

pump, as would be expected, feeds from the side tanks.

To go with the locomotive, Brian Muston very kindly constructed a 5" gauge bogie riding truck for me. It is in the form of an open top wagon and looks great behind the Blowfly. It's large size means that it holds more than enough room for tools, oil cans, coal and a water tank, while also being very comfortable to sit on. Brian also made two beautiful working lamps to sit above the front buffer beam, which really add a lot to the appearance of the engine.

As already mentioned No. 12 'Hart' was run for the first time on the 11th September, exactly three years to the week that Hart presented the part-built engine to me. It was a wonderful feeling to see the engine in steam after watching it grow for so long. No. 12 passed its steam test without any trouble and was given some good lengthy runs, during which an issue was noted. While the engine steamed beautifully, for some reason it seemed to be fairly gutless and at full regulator only just potted along. On the first run this was put down to the engine still 'running in' but by the second steaming things hadn't improved so this theory was dismissed. The general consensus of opinion was that the superheaters were restricting the flow of steam to the cylinders due to being too small a diameter, so these were removed and Simon made the ordinary saturated steam pipe that is specified in the Blowfly design. Unfortunately this made no significant improvement to the engine's performance, so again opinions were sought and the problem was eventually tracked down. It was found that the regulator steam pipe was pretty much hard up under the top of the dome, something that was quickly amended and transformed the engines performance! The superheaters have since been refitted.

With steam flow no longer restricted, the Blowfly has been found to be very powerful, having a large haulage capacity for its size. The engine has been put to work on several SLSLS public running days, during which it has performed faultlessly.

As you can no doubt tell from the general tone of this article, the Blowfly has turned out to be a wonderful engine and has brought me a huge amount of joy. I will be forever grateful to Simon Collier, John Lyons, Warwick Allison, Ross Bishop, Brian Muston and all the other members of the Sydney Live Steam Locomotive Society who made its completion possible. In addition to this, I would also like to thank Mark Gibbons who assisted a great deal with photographs and information throughout No. 12's construction. It was also very useful to photograph Bernie Courtney's and Brian Kilgour's Blowflies for reference during the build. I am overjoyed with the locomotive and look forward to not only driving it myself but also seeing other people take a turn at the regulator.

I think Hart Brammer would be very pleased. ■

'Hart', driven by Simon Collier, double heads with another Blowfly at a track public running day.



SEPTEMBER DIARY

- 3 Friends of Nottingham SMEE Visitors Rally.
- 3 Bridgend MR. Public running Parc Slip 12:00–16:00.
- 3 City of Newport SME. Public running at Glebelands Park 11:00–16:30.
- 3 Ickenham & District MR. Public running 12:00–17:00.
- 3 South Lakeland MES. Public running Lightburn Park 13.30pm–16:30 every Saturday.
- 3/4 Chesterfield MES. Miniature Railway Weekend at Hady 10:00–17:00 each day.
- 3/4 Hollycombe Model Weekend, Liphook Hampshire.
- 3/4 Langford & Beeleigh Railway. Museum of Power, Langford, Maldon, Essex. American Custom Car Show and public running from 10:00.
- 3/4 Saffron Walden SME. Public running Audley End from 12:00.
- 3/4 Steam Fair, Harewood House, Harewood, Leeds.
- 3/4 Sussex MLS. Public running at Beechurst MR 14:00–17:00.
- 4 Ashmanhaugh Light Railway. Public running at Wroxham 14:00–17:00.
- 4 Andover MES. Open Day 09:30–16:30.
- 4 Basingstoke MES. Public running at Viables Craft Centre 11:00–16:00.
- 4 Bedford MES. Public running Summerfields MR 10:30–16:00.
- 4 Belfast & County Down Railway. Public running Upper Gransha Road 13:00–17:00.
- 4 Bournemouth SME. Public running Littledown Park 11:00–15:00.
- 4 Bradford MES. Public running Northcliffe Woods, Shipley 13:30–16:00.
- 4 City of Oxford SME. Public running Cutteslowe Park 13:30–17:00.
- 4 Chelmsford MR. Public running Meteor Way 14:00–16:30 every Sunday.
- 4 Cheltenham MES. Public running Hatherley Lane 14:00–17:00.
- 4 Chingford MEC. Public running Ridgeway Park 14:00–17:30 every Sunday.
- 4 Coventry MES. Public running Ryton Pools MR 13:00–16:00.
- 4 Crawley MES. Public running Goffs Park LR 14:00–17:00 every Sunday.
- 4 Doncaster MES. Public running Thorne Memorial Park 11:00–15:00.
- 4 Eskvalley MES. Public running Vogrie Park MR 14:00–17:00 every Sunday.
- 4 Frimley Lodge MR. Public running Sturt Road 11:00–17:00.
- 4 Gravesend MMES. Public running Cascades Leisure Centre 14:00–17:00 every Sunday.
- 4 Grimsby & Cleethorpes MES. Public running Waltham Windmill 10:00–16:00.
- 4 Harrow & Wembley SME. Public running Roxbourne Park, Ruislip 14:30–17:00 every Sunday.
- 4 Kinver SME. Public running 14:00–16:30.
- 4 Maidstone MES. Public running Mote Park 14:30–17:00 every Sunday.
- 4 Malden MES. Public running at Thames Ditton Railway 14:00–17:00.
- 4 North London SME. Public running at Colney Heath 14:00–17:00.
- 4 North Wilts MES. Public running at Coate Water Park 11:00–17:00 every Sunday.
- 4 Portsmouth MES. Public running Bransbury Park 14:00–17:00 every Sunday.
- 4 Reading SME. Public running Prospect Park 13:30–17:00.
- 4 Rochdale SME. Public running Springfield Park from 13:00 every Sunday.
- 4 Rotherham MES. Public running Rosehill Victoria Park 12:30–16:30 every Sunday.
- 4 Ryedale SME. Public running at Gilling 12:30–16:30.
- 4 Scottish MET. Public running Wester Pickston 11:30–16:00.
- 4 Scunthorpe SME. Public running Normanby Hall Country Park from 12:00.
- 4 Southampton SME. Public running Riverside Park 13:00–16:00 every Sunday.
- 4 Southport MEC. Public running Victoria Park 11:30–16:30 every Sunday.
- 4 Spenborough SME. Public running Royds Park Railway 13:00–16:00 every Sunday.
- 4 Sutton Coldfield MES. Narrow Gauge Day Bellany Green from 10:00. Contact Club direct for more information.
- 4 Taunton SME. Public running Vivary Park 14:00–17:00.
- 4 Tyneside SME. Public running Exhibition Park 11:00–15:00.
- 4 Urmston MES. Public running Abbotsfield Park 10:00–16:00 every Sunday.
- 10 Brighton & Hove MR. Public running Hove Park 14:00–17:00.
- 10 South Cheshire MES. Open Day and public running The Peacock Crewe Road 12:00–16:00.
- 10/11 Bure Valley Railway. Steaming in Miniature. Aylesham, Norfolk.
- 10/11 Malpas Yesteryear Rally. Malpas, Cheshire.
- 10/11 Sale Area MES. Open Weekend, Walton Park, Raglan Road, Sale from 10:00.
- 10/11 South Downs Light Railway. Steam Gala at Pulborough 11:00–15:30.
- 11 Bracknell Railway Society. Public running at Jocks Lane 14:00–16:00.
- 11 Brighouse & Halifax MES. Open Day and public running Ravenssprings Park 13:30–17:00.
- 11 Bristol SME. Public running Ashton Court 12:00–17:00.
- 11 Cambridge MES. Open Day and public running, Fulbrook Road 12:30–17:30.
- 11 Canterbury MES. Public running at Bretts of Fordwich 14:00–16:00.
- 11 Cardiff SME. Public running Heath Park 13:00–17:00.
- 11 City of Sunderland Open Day Roker Park from 13:30.
- 11 Harlington Locomotive Society. Exhibition Day from 11:00.
- 11 Leeds SMEE. Public running at Eggborough 10:00–16:30.
- 11 Northampton SME. Public running Delapre Park 14:00–17:00.
- 11 Norwich SME. Public running Eaton Park 13:00–17:00.
- 11 South Durham SME. Stephenson Locomotive Trials 10:30–15:00 at Hurworth Community Centre, Darlington.
- 11 Sheffield SME. Public running Abbeydale Park MR 13:00–17:00.
- 11 Surrey SME. Public running Mill Lane Leatherhead 11:00–16:00.
- 11 Welling MES. Public running at Falconwood 14:00–17:00.
- 16/18 Model Engineer Exhibition from 10:00. Brooklands Museum, Weybridge, Surrey.
- 17 Echells Wood Narrow Gauge Weekend, Kingsbury Water Park.
- 17/18 Eastleigh Lakeside Railway. Small Engines Gala weekend from 10:00.
- 18 Chichester MES. Public running Blackberry Lane 14:00–17:00.
- 18 Keighley & District MES. Public running at Morley 13:30–17:00.
- 18 National 2½" Gauge Association Rally hosted by the Stockport Society. South Park Cheadle Hulme 11:00–16:00.
- 18 Nottingham SMEE. Public running at Ruddington 11:00–16:00.
- 18 Northolt MRC. Public running The Manor House, Northolt 14:00–17:00.
- 18 Pinewood (Wokingham) MR. Public running at Pinewood Leisure Centre 13:30–16:00.
- 18 Polegate MES. Public running William Daly Recreation Ground 14:00–17:00.
- 18 Plymouth MS. Public running and Exhibition Day, Goodwin Park from 11:00.
- 18 Ramsgate MEC. Public running Ellington Park 13:00–16:00.
- 18 Rugby MES. Public running Rainsbrook Valley Railway, Onley Lane 14:00–17:00.
- 23/25 Llanelli MES. Autumn Rally at Pembrey Country Park.
- 24 Evergreens MR. Public running Stickney 10:30–16:00.
- 24 Leyland SME. LNWR 2016 Gathering, Worden Park.
- 24 Model Engineers Society of Northern Ireland. Public running 13:00–17:00 at the Ulster Folk Museum, Cultra.
- 24/25 Miniature Traction Weekend at Claymills Pumping Station 10:00–17:00.
- 24/25 St Albans MES. Annual Exhibition Townsend School, High Oaks St Albans.
- 25 Guildford MES. Open Afternoon Charity Day, Stoke Park 14:00–17:00.
- 25 Hereford SME. Public running Broomy Hill 12:00–16:30.
- 25 Huddersfield MES. Public running Green head Park 11:00–16:00.
- 25 Staines SME. Public running Commercial Road 13:00–17:00.
- 25 Stroud SME. Public running Stratford Park 14:00–16:30.
- 25 Tiverton MES. Autumn Open Day, Worthy Moor from 11:00.
- 29/3 7¼" Gauge Society AGM and Get Together. Pecorama Beer Heights Railway, Devon.

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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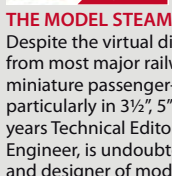
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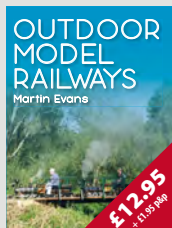
STIRLING ENGINE PROJECTS - Volume 1 by James G. Rizzo
In this book, the first in a projected series, the author covers 'Bell-Crank' engines, where a Bell-Crank is the key component of the drive mechanism. The first two chapters of this book deal specifically with this mechanism, with chapter three covering Heating and Cooling and chapter four providing a very useful guide to fault finding and trouble shooting. The six 'Projects' which follow describe in detail how to build increasingly sophisticated Stirling engines. Full drawings, for metric and imperial are included, as well as numerous photographs of parts, machine set ups and the like. This is a book which is likely to appeal to anyone with an interest in the Stirling engine.



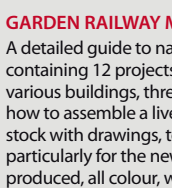
BUILDING A SMALL STEAM LOCOMOTIVE by Peter Jones
If you have an ambition to build a small live steam locomotive then this is the book for you. The author is highly regarded for his knowledge of small scale locomotives and garden railways and writes regularly on the subject. The book covers all areas of construction of a model locomotive including boilerwork and guides the reader with step by step project guides.



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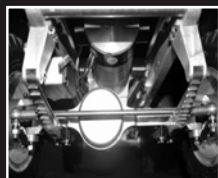
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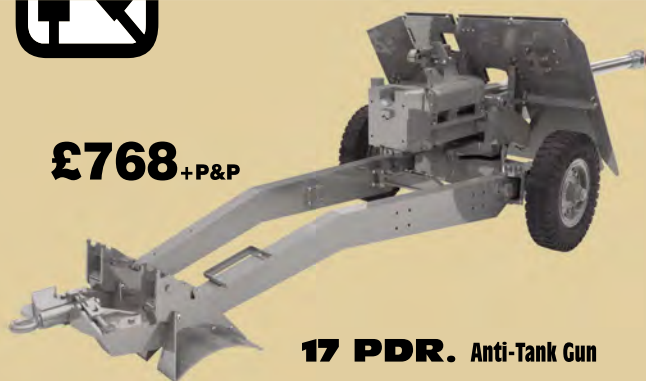
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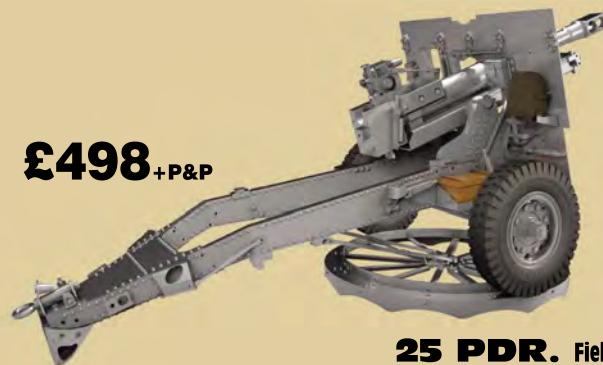
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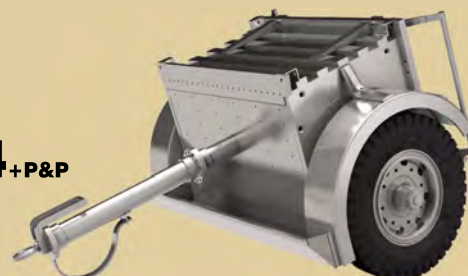
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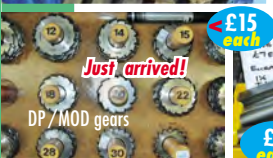
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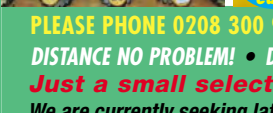
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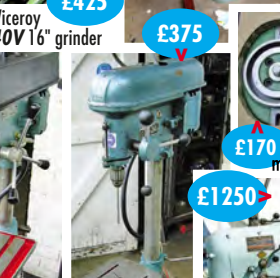
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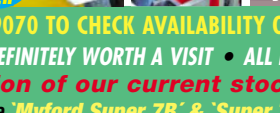
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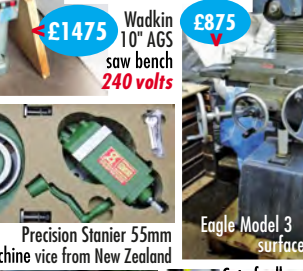


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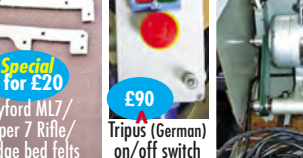
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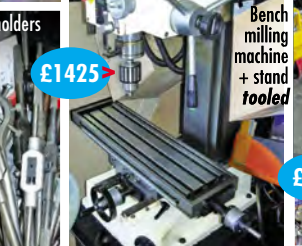
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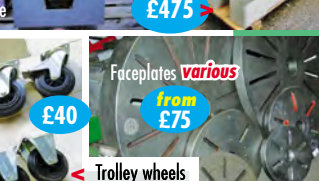
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