THE ORIGINAL MAGAZINE FOR MODEL ENGINEERS

Vol. 221 No. 4592 • 3 - 16 August 2018

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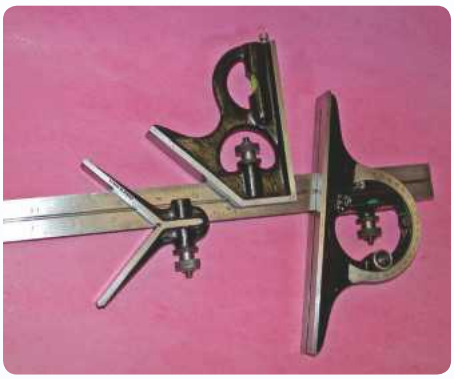

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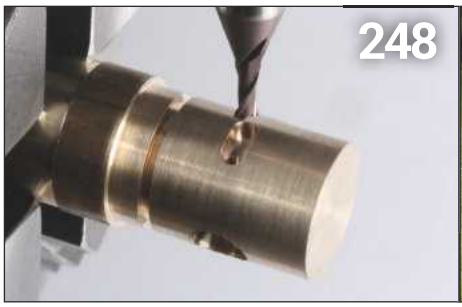

IN THIS ISSUE

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ON THE COVER...

Tom Armet from Fife, Scotland built this 4½ inch scale Foden SWB steam lorry, seen at the Bloxham Steam Rally, in just 18 months (photograph John Arrowsmith).

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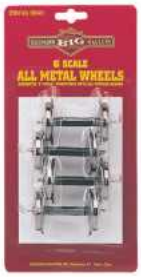

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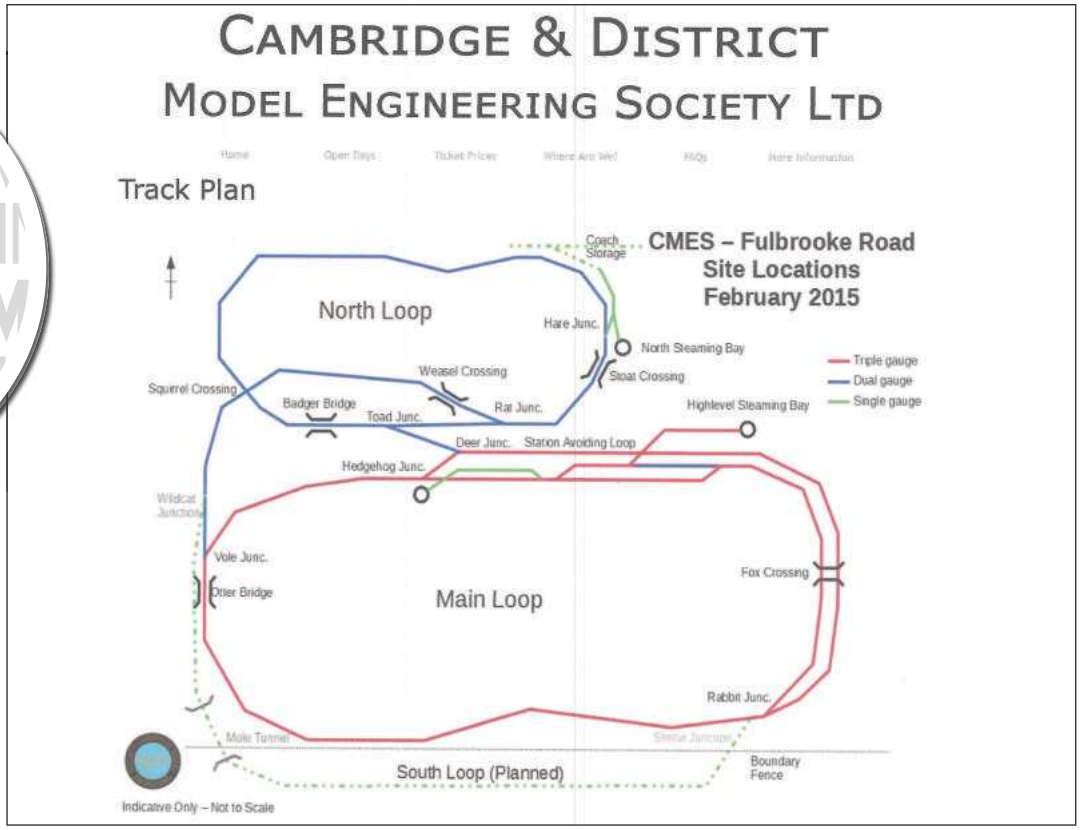

Southern Federation Rally

Tim Coles has contacted me and is keen that our readers should know all about the Southern Federation Rally for this year, so here goes.

This year the Southern Federation is holding its annual rally at the Cambridge and District Model Engineering Society Limited, on the 7th and 8th of September. CADMES has a pleasant part-wooded site extending to over two acres, on the Western edge of Cambridge city. It is easily accessible by road, only a mile or so from junction 12 of the M11. Cambridge is of course a significant tourist centre and there is a lot to see and do in the area.

The ground level main line circuit caters for 7¼ and 5 inch gauges and it extends to one kilometre in length. It is mainly laid with steel rail on recycled plastic sleepers. A large part of the layout also caters for 3½ inch gauge. There are two off-loading and steaming areas, both with hydraulic lifting tables and line-up systems, making it easy to unload from estate cars, trailers or vans. Each area has a number of steaming bays, with supplies of 12V DC and 24V DC power and soft rain water available at each. CADMES also caters for smaller gauge railways with an extensive table-top 32mm gauge layout.

A small boating pond will be set up for the rally and all types of model, railway locomotives, rolling stock, traction engines, boats, aeroplanes, stationary engines, or whatever, will be most welcome. Show models will be exhibited in a marquee and prizes will be awarded for various categories.

Visiting locomotives and traction engines are most welcome. Note that both 7¼ and 5 inch gauge riding trolleys will be available. As usual, current boiler certificates will be required for steam models and all running models will need evidence of public liability insurance. Static models of all types will also be very welcome. Space is allocated for those wishing to camp overnight or to bring caravans, although power and water facilities are limited on site.

I've included a diagram of the track and, as you can see, there is something for everyone there, especially if you like small furry creatures. You'll observe though that those who prefer clammy or spikey have not been forgotten.

You could even combine your visit with a look around the celebrated university town of Cambridge, with its dreaming spires or, perhaps rather more likely in this sultry weather, perspiring dreams (acknowledgements for these attempted witticisms must go to Matthew Arnold and Frederic Raphael).

Further information will be given in the information pack sent to those who register for the rally. Contact the CADMES Southern Federation Rally secretary Colin Bell on **colingb50@gmail.com** or call him on 01480 880665, for a registration form.

Last Time's Cover Photo

The cover picture last time showed Mark Atkins's quarter scale Burrell traction engine but I omitted to credit the photograph. I am pleased to say that it was taken by none other than Geoff Theasby Esq., our Club News reporter *extraordinaire*.

The Bloxham Steam Rally

John Arrowsmith attends the annual show put on by the Banbury Steam Society.

Brutus, *the 4 inch scale Burrell built in five months by Chris Mayall.*

All the way from Fife was this 4½ inch scale Foden SWB steam lorry owned by Tom Armet.

This well established steam rally held its 50th Anniversary Rally over the weekend of 23/24 June at their site near Banbury in Oxfordshire. A beautiful summer day greeted the large number of visitors who were treated to all the usual attractions that these events showcase so well. Lots of large traction engines and demonstrations combined with around 50 miniature engines and steam cars provided a real spectacle to be enjoyed by all. Added to all this was the usual gatherings of cars, vintage lorries, military vehicles, tractors, motorcycles and a very wide range of side stalls catering for every desire. In the evening a good programme of entertainment had also been provided which again covered a wide range of tastes and included Dr. Busker and friends. One of the highlights on Saturday was a fly past by a WWII Spitfire which really added to the happy atmosphere on the ground.

The large number of miniature steam vehicles were very well presented with some fine examples on show like the 4 inch scale Burrell Agricultural engine built by Chris Mayall from a Steam Traction World kit in just 5 months (**photo 1**). To build an engine to this standard in such a short time is, I think, remarkable. Another driver who was enjoying himself was Tom Armet all the way from Fife in Scotland with his 4½ inch Foden SWB steam lorry (**photo 2**). Tom told me that this lorry had taken 18 months to build and was

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From the Isle of Wight, Kevin Osbourn brought his 4 inch Burrell for a day out.

Not quite completed was this 4 inch Burrell Showmans engine built by Vernon Payne.

A very well made Fairmile D type MTB by Adrian Abbott.

Lots of atmosphere with this well worked Coaster.

Peter Jay's excellent model of a Shand Mason Fire Engine.

A fine example of a 1 inch scale Minnie traction engine built by Peter Jay.

Gordon Ockwell's model of a 1918 Titan tractor in 1:6 scale.

A Century of Steam Models, Toys and Meccano displayed by David Shirt.

road legal. A day visitor who had travelled a long way was Kevin Osbourn from the Isle of Wight who was driving his 4 inch scale Burrell Agricultural engine, *Lord Riley* and was really enjoying himself (**photo 3**). I was told an interesting build story by Vernon Payne from Margate who had with him his almost complete 4 inch scale Burrell Showman's engine which he had been building in his partner's lounge for the last eight months. She told me it made a beautiful coffee table! How many partners or wives would tolerate this machine (**photo 4**) in the lounge? It was also good to see the number of young people involved in all aspects of the show - very encouraging for the future.

In the Model Tent a good range of engineering models were presented for visitors to admire, in addition to some excellent models from the Daventry Boat Club. The Fairmile D-type MTB built by Adrian Abbot was a typical

example (**photo 5**) and a work-worn coaster was very well detailed (**photo 6**). A Shand Mason Fire Engine displayed by Peter Jay showed some excellent workmanship and detail (**photo 7**). Peter also had a very nice example of a 1 inch scale *Minnie* traction engine on show, complete with a set of tools (**photo 8**). It was good to see a model that featured in a 1981 issue of *Model Engineer* magazine. This was the 1/8th scale model of a 1918 built kerosene powered Titan Tractor built by Gordon Ockwell (**photo 9**) and still owned by him. I enjoyed my conversation with Gordon who gave me lots of background to the model and the original, which his son used to drive. A Century of Steam Models & Meccano was a large collection of different models and toys showing how the world of model making has changed over the years. It was presented by David Shirt and contained some interesting and well made examples (**photo 10**).

Back on the rally field, the various parades of exhibits were taking place and with a large entry of full size traction engines there were plenty of different types to admire. I am including a photo of a very well prepared Robey 5 NHP Agricultural Traction Engine as an example of the quality of engines on show (**photo 11**). The attractive Lykamobile Steam Car, a replica of the 1900's Locomobile Steam Car, was a forerunner of the Stanley Steam Car (**photo 12**). There was another very important steam lorry doing its duty during the very hot day and that was the half size Foden beer lorry. Painted in the livery of a local brewery (**photo 13**) it was a good example of what these vehicles used to do.

As always I cannot cover every exhibit or demonstration in this report but **photos 14**, **15**, **16** and **17** show a few more of the great exhibits. Suffice to say this was an excellent example of a traditional steam rally, well organised and providing a great day out. My thanks to everyone I spoke to for their good humour and information and to Margaret Powell, Secretary of the Banbury Steam Society for allowing me to attend. I thoroughly enjoyed my visit and would recommend it to anyone who wants a good day – or indeed a weekend - out.

ME

This 1908 Robey Traction Engine was a good example of all the quality engines on show.

The little Lykamobile Steam Car.

The Foden 'beer lorry' doing its rounds.

Luke Needham from North Devon with his 4 inch Burrell built in 18 months.

This young man was really enjoying himself with this 4 inch scale Burrell. James is six years old and has been attending rallies since he was three. They start them young in the TE world!

This 3 scale Fowler is owned by David Macdonald who was enjoying the lovely weather.

Another of Gordon Ockwell's beautifully made scratch built tractors in 1:6 scale.

Museum of English Rural Life, Reading

Roger Backhouse visits one of Britain's most important collections of rural industrial artefacts.

The Museum of English Rural Life collection was started in 1951 by Reading University to record and preserve objects from a rapidly disappearing countryside. Whilst there is much 'in store', there is plenty displayed in a museum building opened in 2016 (**photo 1**). The breadth of rural life includes country crafts like chair making and basket weaving and many everyday items, such as, for example, a collection of smocks. There is much farm equipment, many models (**photo 2**) and even land drains.

Improvements in tooling and engineering transformed the countryside and increased agricultural productivity, as did stock rearing improvements, selective breeding and more fodder crops. In 1800 some 90% of the English population lived in the countryside; by 1900 only 10% did so.

Many agricultural improvements came from more efficient hand and horse drawn tools rather than mechanisation (**photo 3**). Scythes and sickles made by firms like Tyzacks at Sheffield's Abbeydale Works were complex forgings of different steels, carefully worked and ground. They made hand reaping and haymaking more productive.

Similarly, horse drawn seed drills made precise sowing practical (**photo 4**). With row crops, a horse drawn hoe could now weed between rows, improving output on farms and market gardens. Horse gins (a word shortened from 'engines') enabled a horse to work barn machinery.

The descriptions here can only give a taste of this collection but for anyone from a farming area there will be many a comment along the lines of *'I remember one of*

The Museum of English Rural Life is now largely housed in a new building opened in 2016.

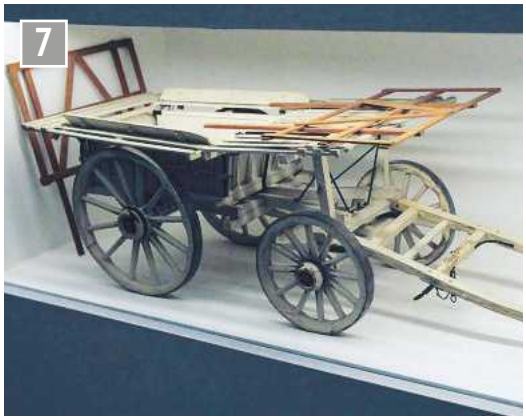
Model of a Romany caravan. The Museum aims to cover the breadth of rural life. (Item number 2007/21)

Part of the wide range of hand tools in the collection. Many items are stored in rolling stacks but can be viewed by appointment.

Jethro Tull's invention of the seed drill made seed sowing less wasteful and enabled use of horse drawn hoes to suppress weeds. Many different types were made. (Item number 65/326)

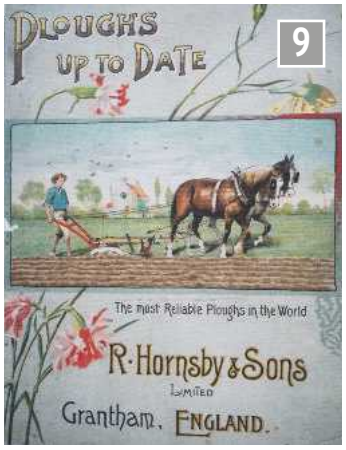
Land Rover Series 1 built 1949, classic and long lasting rural motoring. Highly successful with world-wide sales. (Item number 2013/11)

Lincolnshire farm box wagon from a large estate. (Item number 53/567)



Hermaphrodite wagons were two wheeled cars that could be converted into wagons for carrying harvest. This model is of one built in 1910/11 then costing £20. (Item number 59/463)

Ransome RHB plough introduced in 1873. Ransomes' invention of the chilled cast iron ploughshare and clever marketing made his firm a leading maker. (Item number 79/34)



Companies like Hornsby's of Lincolnshire followed Ransomes' lead with innovative products and their own advertising. (Item number TR RPD P2/A4)

those' … such as the early Land Rover (**photo 5**). Many of the exhibits on display are housed on rolling stacks but can be inspected by arrangement.

Carts and wagons

George Sturt's classic book, *The Wheelwright's Shop* remains a nostalgic account of disappearing craftsmanship. In the museum we can see just how good their work was. Each county had its own styles and designs were adopted for different purposes. For example, some Herefordshire carts had a high, robust body designed to carry heavy root crops. Others were more adaptable (**photo 6**).

Most carts here are classics of the wheelwright's art, combining strength with lightness. This is a collection model wheelwrights should visit but the diversity, plus models, makes an interesting display for all visitors (**photo 7**).

Speed the plough

Ploughing is often claimed to be the most important farm activity and better ploughs increased horse productivity. Different areas had their own types such as the Rotherham plough of 1730, popular in Yorkshire. In 1803 Robert Ransome of Ipswich patented the chilled cast iron plough share which worked far better than others (**photo 8**). The share and other parts could be replaced when worn or damaged. Other manufacturers followed with their own types and many are shown in a good display upstairs (**photo 9**).

Harvest home

In 1828 the Rev. Patrick Bell invented a reaping machine pushed by horses. It cut grain with pointed knives in a scissor-like action and pushed stalks onto a linen band to the side. However there was little demand at first.

Major developments came from the United States. Cyrus Hall McCormick demonstrated his reaper in 1831 soon producing 500 a year at his new works in Chicago. Use of it spread across the prairies. At the 1851 Great Exhibition his reaper aroused enormous interest with several UK firms soon producing their own designs. One variant had two men riding on the reaper tying corn into sheaves for later stacking but a sheaf tying machine was in use by the 1870s; the reaper binder (**photo 10**). They still

The Albion reaper was made in Leigh, Lancashire and proved highly popular. Similar reaper binders were still used on Herefordshire farms in the 1950's. (Item number 80/69)

featured on Herefordshire farms in the 1960s but were rapidly overtaken by combine harvesters developed in the USA and Australia. These reaped and threshed grain in one machine. At first these were tractor hauled but self-propelled machines are now universal.

Threshing machines

Andrew Meikle of East Lothian invented a threshing machine in 1786. Previously ears of grain were beaten from stalks with flails on a barn floor - heavy, slow work. Beaten grains were then winnowed by throwing them in the air as wind dispersed the chaff. Meikle's threshing machine was horse powered but later it was one of the first operations to which steam power was applied. There were both barn threshing machines and portable threshers hauled from farm to farm (**photo 11**).

Threshing machines were unpopular with farm workers. Though flailing was brutally hard it was often the only winter work available. When agricultural prices and wages fell after the Napoleonic Wars, rural poverty increased. Growing unrest made threshing machines targets for 'Captain Swing' protests in the 1830's. Nevertheless, threshing machines came to be a vital part of farming with local manufacturers offering their own types (**photo 12**).

Haymaking

Haymaking had its own machines including cutters, tedders and rakes. Turning hay to dry was originally done by hand but horse drawn machines speeded up the process. Balers came into use following the Second World War. Baler designs had to ensure that the bales were not over compressed to avoid risk of overheating or mould developing (**photo 13**).

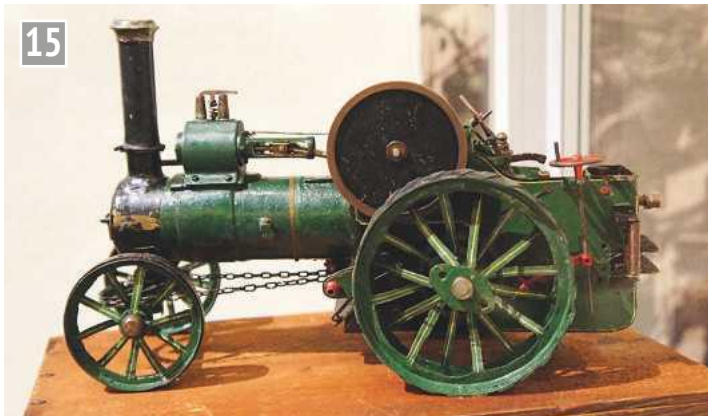
Silage for feeding cattle is now usual on British farms and has its own specialist machinery including green crop lifters.

Ransomes' threshing machine model. Almost certainly made by Bill Smith (A. F. W. Smith), who was for a long time the Records Officer of the Road Locomotive Society. (Item number 63/183)

Double blast threshing machine made by E. Humphries and Co. of Pershore, Worcestershire. (Item number 52/42)

Model of an elevator built by Messrs Reeves, (Item number 70/310) with an Agricultural Workers' Union banner behind, in a miscellaneous display.

Clayton and Shuttleworth portable steam engine. Hauled by horses between farms to work threshing machines or other equipment. (Item number 51/1284)



Working model of a single cylinder road locomotive made by George A. Froud in 1921 at the age of 16; the first model engine he made. Scale ½ inch : foot (1/24 scale) (Item number 63/183)

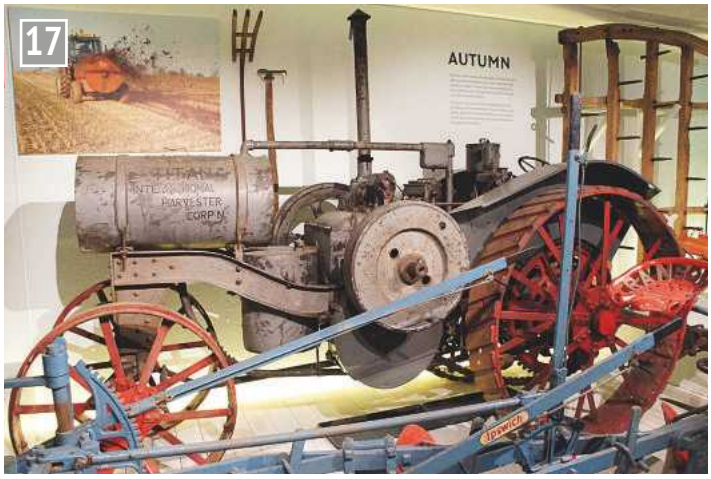
Magnificent steam lawn mower built by Ransomes. (Item number 55/338)

Steam power

In Victorian Britain several manufacturers like Clayton and Shuttleworth in Lincoln made portable steam engines which were horse drawn between farms to work threshers or other machines. They were usually hired from contractors when required (**photo 14**). Portables were still made - largely for forestry work - until the Second World War.

Many firms in Eastern England branched out from small foundries making farm equipment to making steam engines. Burrells of Thetford, Garratts of Leiston and Marshalls at Gainsborough became substantial makers in smaller towns near main grain growing areas of England. They later developed traction engines that could move themselves between farms (**photo 15**).

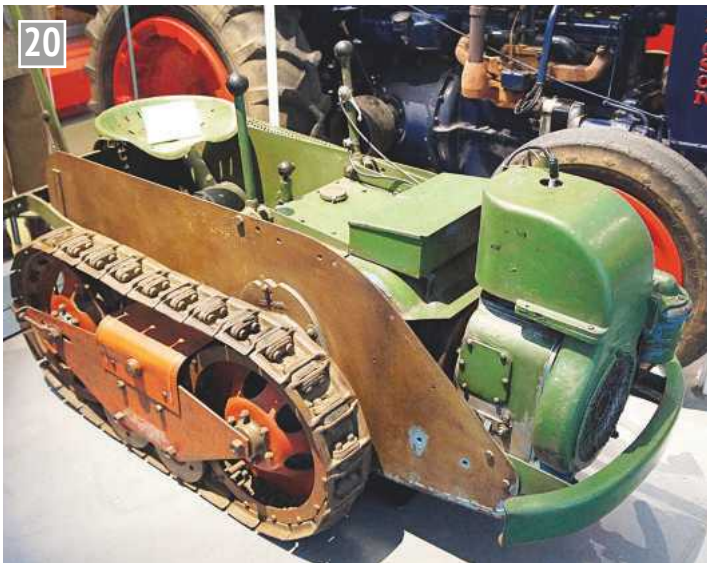
Largest of all were the steam ploughing engines. John Fowler invented the steam plough and the mole land drainer because he was concerned by the mass starvation of the Irish potato



This Titan tractor was made by International Harvester in the USA, probably the most successful tractor of the period. (Item number 56/280) Many were shipped to Britain during the First World War.

Engine detail; Fordson N tractor built 1937. (Item number 80/44/5) By 1938 some two-thirds of tractors on British farms were Fordsons. It had many variants.

The 'wee grey Fergie' designed by Harry Ferguson incorporated his three point linkage for pulling ploughs. It was especially popular in Ireland. This model was made in 1948 by Standard at Coventry. (Item number 80/68)



1953 Ransomes MG crawler tractor used in the grounds of a hospital. Larger versions were used in the Fens as they did not consolidate soil like other tractors. (Item number 81/146)

famine. A pair of engines drew a cable hauled plough between them across a field. This was quicker than horse ploughing and worked heavier soils improving farm productivity. Steam even found a role in large gardens and playing fields. Ransomes built the museum's magnificent steam lawn mower (**photo 16**).

Tractors

Internal combustion engines were lighter. Early moves to develop tractors (a word first used in 1907 by the United States firm, Hart Parr) were in the United States. In Britain Saunderson made a front wheel drive towing unit in 1904. The Ivel unit in 1907 is claimed as the first effective replacement for the shire horse but tractor use in Britain remained restricted. Horses consumed a quarter of all farm crops. International Harvester made the Titan 10-20 tractor in the USA. Suitable for smaller farms it was a great success at the time of the First World War (**photo 17**).

Many horses were commandeered during that conflict and the British ministry of munitions ordered 5000 US tractors in 1917 using a Fordson design. Saundersons were still produced. The Fordson Model F with its later variants set a prototype for UK tractor designs for the next 50 years (**photo 18**).

Threshing machines were unpopular with farm workers. Though flailing was brutally hard it was often the only winter work available.

Innovations included the power take off shaft, de-clutched from the transmission, which powered implements or machines when the tractor was stationary. That idea came from Hart Parr in the USA. Some steam engine makers developed internal combustion tractors, notably Marshalls.

The next major development came from Harry Ferguson whose revolutionary three point linkage meant safer ploughing. Thousands of 'wee grey Fergies' were made by David Brown near Huddersfield and then by Standard at Coventry (**photo 19**).

The Second World War brought in even more American tractors, mostly higher powered models. Caterpillar tractors were always a niche market but useful on fenland soils (**photo 20**).

Modern tractors are now even larger. Four wheel drive is now common and cabs are now standard, after many ≫

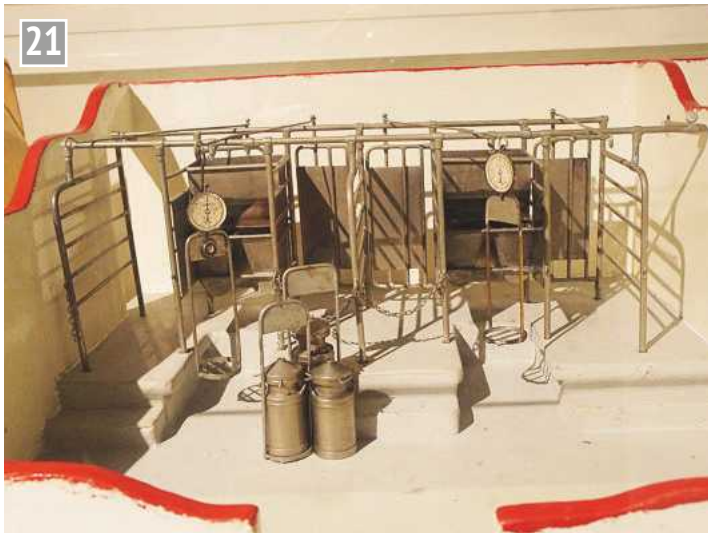
drivers were killed when tractors rolled over. Farming can still be a dangerous occupation.

Dairying

Dairying is a study in itself with the invention of milking machines, cream separators and other equipment. Some of the museum's models were used to help teaching (**photo 21**). Indeed the University still has an Agriculture Department. Butter and cheese making needed its own range of equipment such as the cheese press (**photo 22**).

Reading room

The Museum also offers a valuable resource to researchers through the reading room and this must be one of the best agriculture and traction engine related collections in Britain (**photo 23**). It has, for example, over 10,000 drawings from John Fowler & Co, part of a collection much used by members of the Road Locomotive Society. Advance notice to the library and archive staff helps visitors make the most of their time (**ref 1**).



A model of a 1920s milking parlour. The doors have long handles so that they can be reached by the operator. One of three milking parlour models made by staff at the National Institute for Research in Dairying. (Item number 96/15)

Cast iron cheese press made by Carson of Warminster. Many local foundries produced farm equipment, this was obviously aimed at the Wiltshire dairying market. (tem number 87/31)

Thanks to a changing programme of exhibitions and talks during the year there is always something new at this museum. One frustration is that most exhibits are not labelled, though the online catalogue is being developed to give full information about objects. Where there are labels, as with the wagon and plough displays, they are exemplars of clarity. This Museum takes its educational role seriously.

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The library is an important part of the Museum. It has a fine collection relating to traction engines including many works drawings.

Getting there and contact details:
University of Reading
Redlands Road, Reading RG1 5EX
Parking nearby is very limited and should be booked with the Museum.
The location is about 20 minutes walk from Reading Railway Station.
Some buses pass nearby.

W. www.merl.reading.ac.uk
Tel: 0118 378 8660

Museum opening
(Note: the Reading Room has different hours)
Monday – closed
Tuesday – Friday 9am to 5pm
Last Thursday of the month – 9am to 9pm
Saturday & Sunday – 10am to 5pm
Closed Bank Holidays. Check before visiting.

Admission free though donations welcome.

Facilities
Small shop and cafe in the museum.

Further reading
Shire Publications offer reasonably priced introductory booklets including:
Roy Brigden: *Ploughs and Ploughing.*
Roy Brigden: *Harvesting Machinery*
Nick Baldwin: *Tractors*
Jonathan Brown: *The Edwardian Farm*
David Viner: *Wagons and Carts*
Most are available in the museum shop.

Other attractions nearby
Didcot Railway Centre - home of the Great Western Society. This former Great Western Railway engine shed and locomotive stabling point has been converted into a railway museum. It includes recreated broad gauge and atmospheric railway track. Didcot Railway Centre is easily reached from Didcot Parkway Station. OX11 7NJ
Phone: 01235 817200.
W. www.didcotrailwaycentre.org.uk

Thanks to:
Dr Oliver Douglas (Curator of MERL Collections University of Reading) and Caroline Benson and colleagues for help with this article.

The Museum of English Rural Life for permission to use images of objects in the collection.

The Museum of English Rural Life, University of Reading.

REFERENCE

1. See also www.reading.ac.uk/merl/collections/Archives

PART 46

Garrett 4CD Tractor in 6 inch scale

Chris Gunn describes how he made a whistle for his six inch scale tractor.

Continued from p.92
M.E. 4590, 6 July 2018

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

Before I made and fitted the lever support to finish off the whistle base, I finished off the holes for the whistle valve. I had a square block tapped ⅜ inch BSP that was used for another job in the engine build, which I could use to hold the base while I drilled the holes. I screwed the base in the block as tightly as possible, as it needed to stay in position through the drilling.

The first operation was to drill the cross hole in which the valve ball sits. The block was held in the vice on the Bridgeport and I machined a flat on the upper face until it was about ⅝ inch diameter. Then I centred the spindle over the flat and centred the hole with a centre drill. Then I drilled the hole and tapped it ⅜ inch BSB, a fine thread for the plug, and drilled this past the centreline deep enough to make the seat for the valve ball. **Photograph 407** shows the hole being tapped. Then I followed this with a 3/16 inch drilled and reamed hole. I used a 5/16 inch diameter slot drill to make a flat bottomed face for the ball, as I did not want to seat the ball in the countersink made by the drill point.

The drawing shows a groove for an O-ring in the bore of the operating pin but I had no means of cutting such a groove, so I omitted this. I did find out that not every whistle has an O-ring on this part. I

Tapping the whistle hole.

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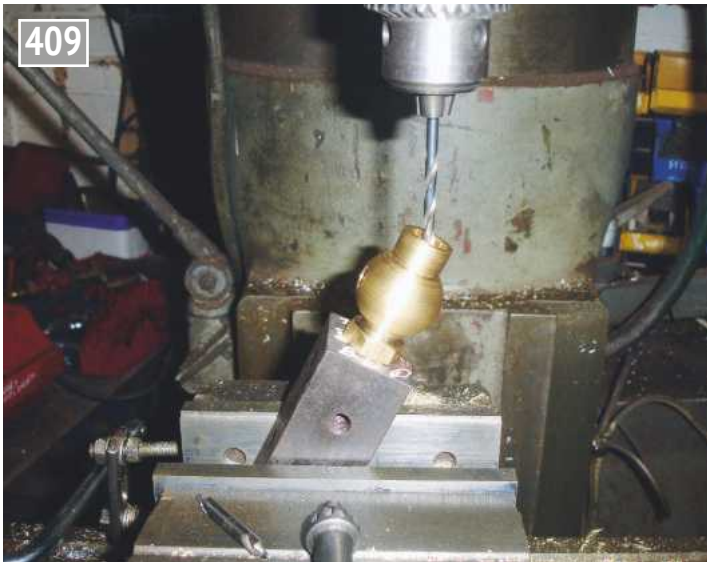
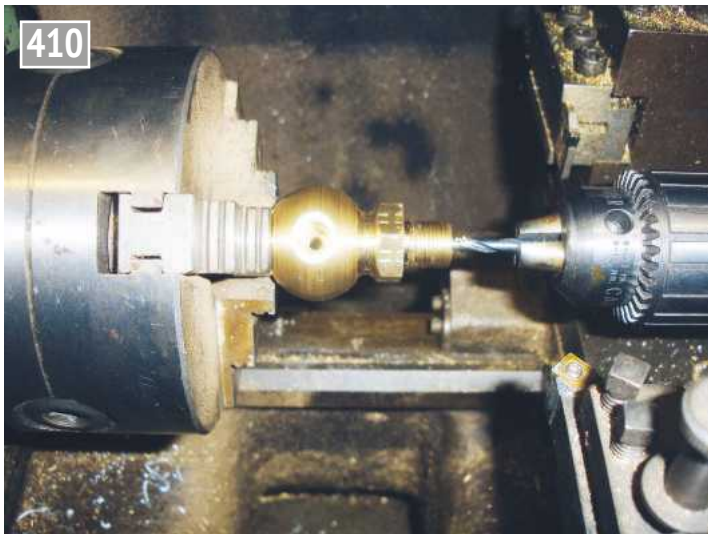
Drawings, castings and machining services are available from A. N. Engineering: Email: **a.nutting@hotmail.co.uk**

Centring the whistle hole.



Drilling the whistle hole.



Drilling the central whistle hole.

Lever supports ready for finishing.

would only have a potential leak of steam when the whistle was operated and I felt I could live with this.

The next operation was to drill the hole that links the valve to the whistle centre. I left the base in the block and I could use this to hold the base in the vice at the appropriate angle. I sketched the triangle that described the angle and this was calculated at 25 degrees. I set the block to 25 degrees using a protractor and then put a centre drill in the drill chuck and drilled into the corner of the hole as shown in **photo 408**.

The drill stayed true and I was able to drill a centre big enough to start the 3⁄16 inch drill that would follow. That was drilled next, raising the knee to put the cut on, as I did not want any drama when the drill broke through into the cross hole, as shown in **photo 409**.

That went well, with all holes finishing up where they should, which just goes to show that all that trigonometry I learned 55 years ago and can still remember was worthwhile. The final operation was to finish off the hole up the centre that was deliberately drilled short, so the base was removed from the block, re-chucked and the hole drilled carefully until it broke through into the cross hole (**photo 410**).

The next item to be tackled was the pivot collar for the lever, and this was made from a scrap of brass plate ⅜ inch thick. This was marked out for the various holes, one in the centre and those that defined the ends of the slots; the cross hole for the lever to pivot on was marked out in the ends of the blank. The holes were drilled and then the slots were milled to form the profile of the arms of the lever pivot. **Photograph 411** shows the plate after the slots were milled.

Whilst the blank was in one piece, I stood it up in the vice on the Bridgeport and drilled the cross hole (**photo 412**). This was much easier to do at this stage when everything was still square and rigid, than it would be had I brought it to the finished shape.

This completed the drilling of the lever support, and now I removed all the waste material by hand, using a hacksaw and my disc grinder to cut away the waste. I did leave the end of the slot closed at this stage, to avoid any distortion when the lever support was silver soldered to the base. The lever support was cleaned up all round and I tested the fit on the boss on the whistle base. It was tight so I polished up the base section in the lathe until the lever support went on easily, then the lever support was given a polish, as the next step required the blank to be mechanically clean.

The base was returned to the square block and screwed in a few threads and then the block was held in the bench vice. The two parts were brought together and the joints coated in some Easyflo flux, mixed to a paste. I stuck a 3⁄16 inch rod in the cross hole

Drilling lever support.

Whistle body after soldering.

Whistle parts.

Assembled whistle.

so I could use this to align the lever support, making doubly sure that the lever support was aligned in the right direction. Then I warmed up the base of the whistle using my propane torch and stood by with my silver solder rod and a tub of flux at the ready. It did not take too long to get the base to red heat and then it was a question of waiting for the flux to run and feeding in the silver solder. As the base of the whistle was pretty chunky, it held the heat and melted the rod so the joint filled nicely.

When I read some of the forums, one of the questions that keeps cropping up is how to silver solder and all the replies list the correct procedures but there is no substitute for practising, as it is hard to imagine that satisfying moment when the flux runs and the joint can be made - it needs to be experienced! **Photograph 413** shows the completed assembly cooling off.

I always like to let the job cool naturally; that way there should be no cracks in the joints. Once the base was cool, the flux was cleaned off and the end of the clevis was finished off by removing the surplus bridge across the end and radiusing the end using a file and emery.

With the whistle base finished, that left the small details to be completed. The whistle bolt, item 4 (see drawing in part 44; *M.E.* 4590), was made from a scrap of ¼ inch stainless steel, simply cut to length and each end threaded ¼ inch BSF. Item 6 was made from a piece of brass hexagon 0.520 inch across the flats. This was faced off and tapped ¼ inch BSF as well, then the nut was fitted to the whistle bolt and the dome turned on the bolt. In this instance the dome was formed by hand after chamfering the end.

The whistle plug, item 10, was another item made from the 0.520 inch hexagon and another simple turning job, as was the whistle pin, made from 3/16 inch diameter stainless. The ball is a 9/32 inch stainless ball bought from one of the model engineering suppliers. The whistle lever, item 11, was made from ⅛ inch stainless plate. The pivot pin at the moment is a 5BA bolt but it will be replaced by a stainless pin in due course. The parts to make up the whistle are shown in **photo 414** and the assembled whistle in **photo 415**.

At the time of writing, I still have to test the whistle and I may well have to reduce the diameter of the middle section, as this was deliberately left over size. I checked my time sheets and it took me less than 20 hours to make the two whistles and the form tool, or less than 10 hours per whistle, which I did not think was too bad.

●To be continued.

Next time I will continue with the guards and covers.

Young Engineers Training Day

John Arrowsmith visits the Hereford Club to observe the next generation of model engineers being 'shown the ropes'.

A superb little Oscillating engine built by 12 year old Matthew Kennington.

A new driver being shown the ropes by an 'old hand'.

Out in the country Oliver has the Sweet Pea *loco going well.*

'Fetch me some coal please' as Matthew does some firing.

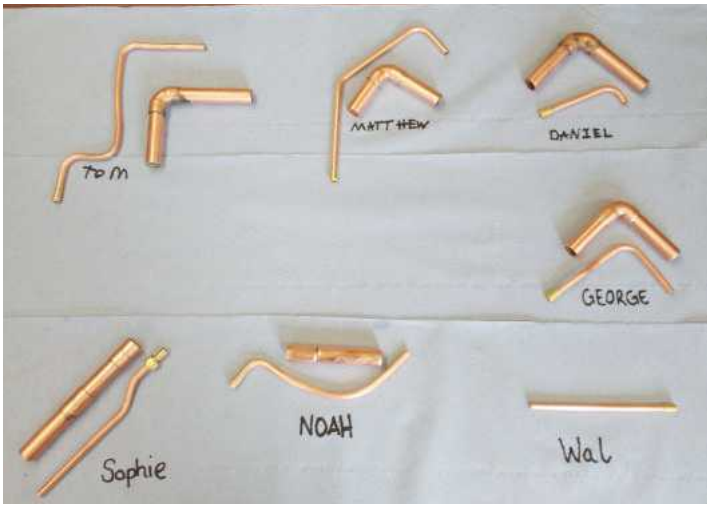
The Hereford Society of Model Engineers is well known for its progressive policy towards young engineers and one of the practices they are very keen on is to teach the young people how to drive and operate live steam locomotives. All of them take the 7¼ inch gauge proficiency test and once they have achieved the Silver standard they can use the club's steam locomotive. The club have found that the older – and, dare I say, more experienced youngsters - now take on the role of tutors to the new ones and complete novices; this works very well as the responsibility of teaching someone to drive a steam locomotive is taken seriously and ensures the safety rules are fully understood.

This method has two advantages because it gives the 'tutors' not only an opportunity to teach what they themselves have been taught by the senior members, but also to really appreciate all the small details and procedures that have to be undertaken even before steam is raised. In addition to this the youngsters quickly learn what problems can arise in preparation, for example, when a clack valve has stuck or the water supply to an injector is not what it should be. The senior members then help them perhaps to remove the offending valve and show them what has happened. The young driver can then carry out the necessary adjustment or repair before re-fitting the component to the engine. Carrying out tasks like this gives them valuable experience which they would not get by simply sitting behind a locomotive and operating the regulator. It is often found that the less experienced senior members join in with these jobs so that it is a 'win, win situation' all round. Two of the current ten young engineers at the club have now started building their first 5 inch gauge locomotive to a published design and in recent weeks, eight of them have been enjoying being taught the mysteries of TIG welding!

Sorting a problem while a senior member keeps a watchful eye.

First time ever George starts the Sweet Pea *away from the station.*

Another first as Tom is instructed by Matthew.



A selection of copper pipe bending undertaken by some of the juniors.

None of this, of course, could be done without the tremendous help given by the group of senior members and family members who attend the regular Saturday morning training sessions and the club are extremely grateful to the time and expertise these members provide for the young people. Does all this effort provide any sort of benefit to both the club and more importantly, the young people themselves? I can tell you that two of the older ones are now volunteers on a fairly local preserved railway and one of the fathers who has been attending the club's courses and is a senior teacher at a local school has started the process of using the school workshop to teach some basic engineering principles to interest pupils. Just a small step but it is a start; who knows what this might lead to? I hope the photos give you a flavour of these days and events. ME

A welding lesson in full swing.

Tom's mum is learning to weld as well.

A welcome tea break.

The large lathe being set up by Noah.

The Barclay Well Tanks of the Great War

PART 38

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

Continued from p.117
M.E. 4590, 6 July 2018

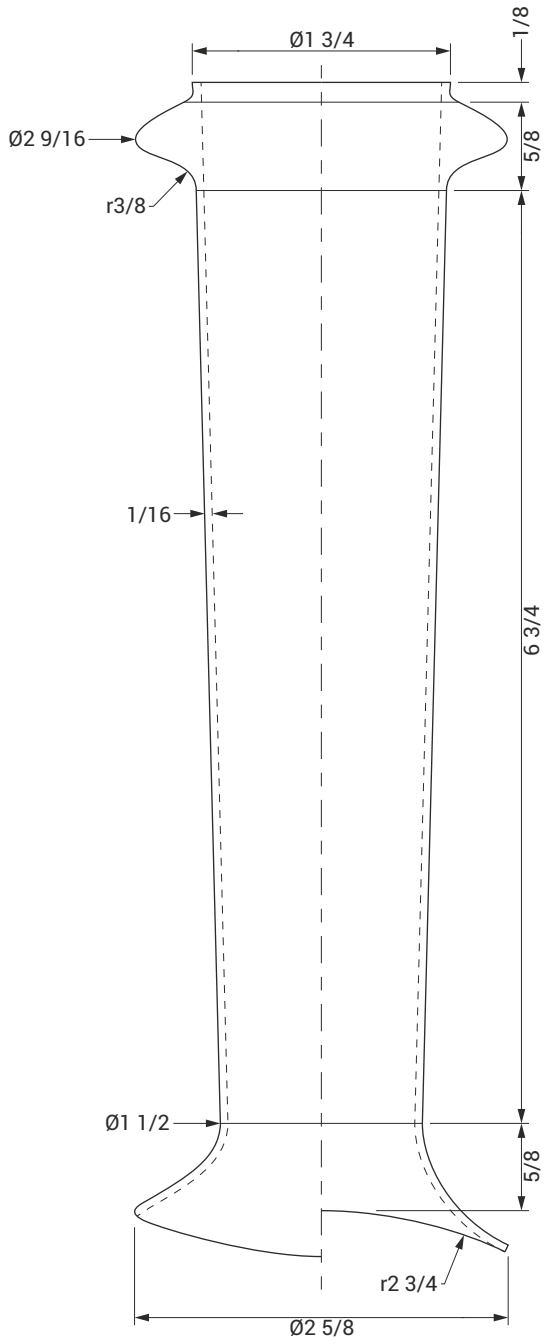
This constructional series addresses Andrew Barclay 0-4-0 and 0-6-0 narrow gauge locomotives supplied for use in the First World War. Built without the use of castings, the 0-4-0 design is described as two versions; as-built for the British Admiralty in 1918 and as rebuilt and currently running on the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

Chimney

My original chimney was made from one of the few castings used on the original model. The chimney and saddle were both cast using aluminium alloy – old car pistons if I remember correctly. The job was done during evening classes at the local school – but that was as far as it got, as the class was closed down not long afterwards due to not enough interest being shown. Fortunately, an old friend, who was also a model engineer, had a son who worked at a local foundry and he had a set of cast iron wheels made from my pattern. Everything else was fabricated.

The chimney is shown in **fig 113**. Now that's what I call a chimney! Tall and elegant and

Fig 113



Chimney
Mat'l: Copper/brass

not a bit like the stovepipes fitted to the Class F 0-6-0s.

The only difficult bit to make is the base but *in lieu* of a casting this can be made by panel beating. Make it up from a piece of annealed 28mm diameter copper tube. Profile one end to fit on a diameter of 5½ inches then beat it over a stake held in the vice and form the base shape over a 5½ inch diameter former – cut this out from pieces of 5½ inch diameter hardwood glued together to make a semi-circular former at least 3 inches thick. Refer to the instructions for making the dome base above for detailed information.

Now that's what I call a chimney! Tall and elegant and not a bit like the stovepipes fitted to the Class F 0-6-0s.

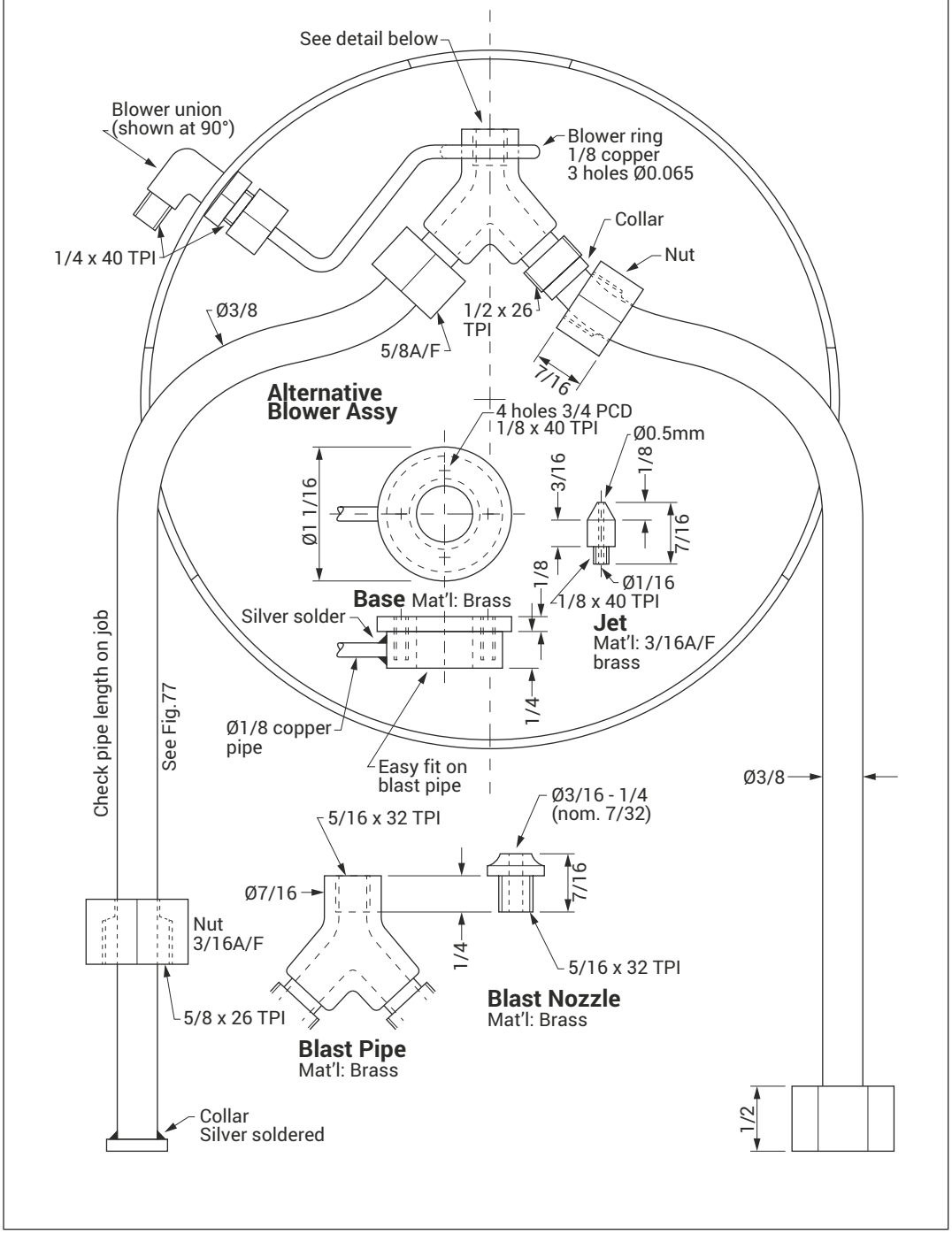
The top should be turned from a piece of large diameter brass stock. The tapered, centre section is rolled up from a suitable piece of 1/16 inch thick copper sheet or it can be cut down from a large diameter copper tube. To avoid having steps on the inside it will be necessary to butt joint the three parts with silver solder – not an easy job but not many are! The joints don't need to be perfectly smooth as the chimney will need painting with heat-resistant, smokebox paint – and this can hide a multitude of sins!

Blast pipe and blower arrangement

The blast pipe and blower assemblies are shown in **fig 114**.

Note that the fancy blower assembly shown above is based on the design of Laurie Lawrence (**ref 35**), erstwhile editor of this magazine in the 1970s. I have made many of these multi-jet blowers and they are well worth the effort.

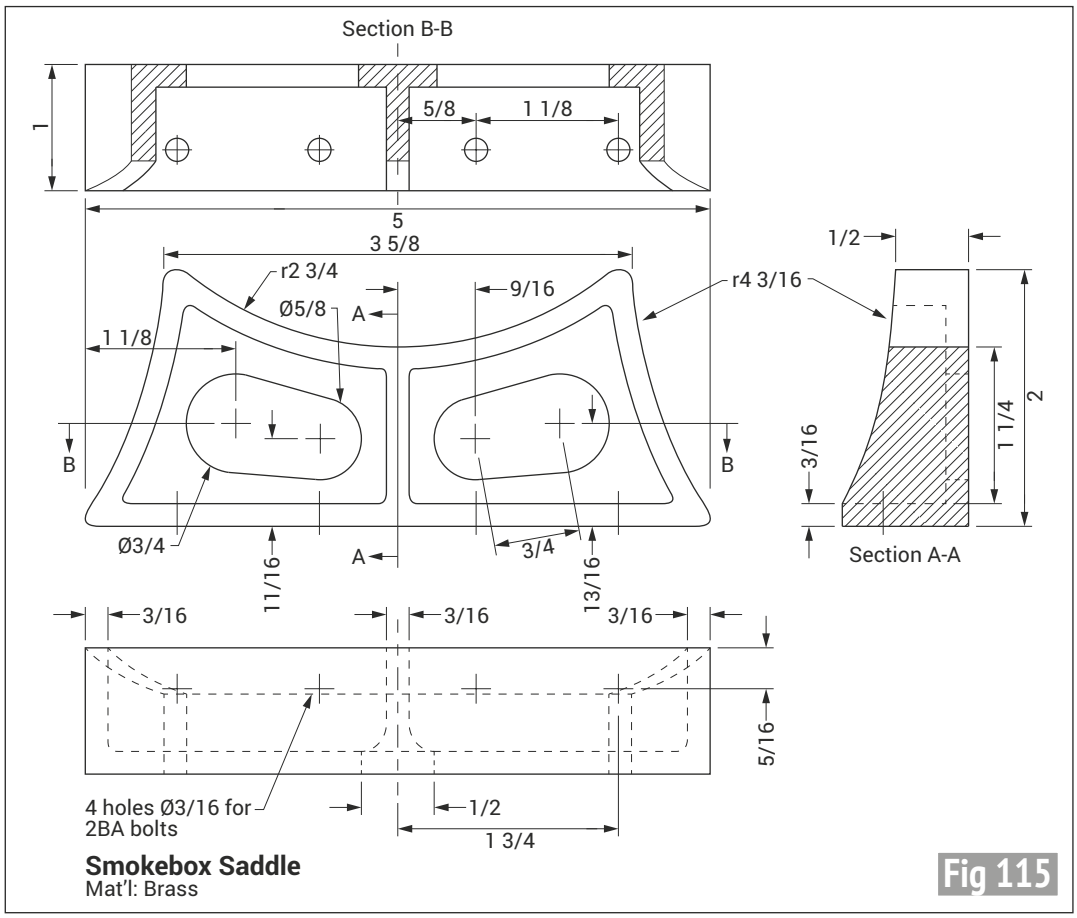
Fig 114



In every case, once steam pressure shows on the clock, it is possible to open the steam blower and remove the electric unit; making light work of lighting up – pun intended!

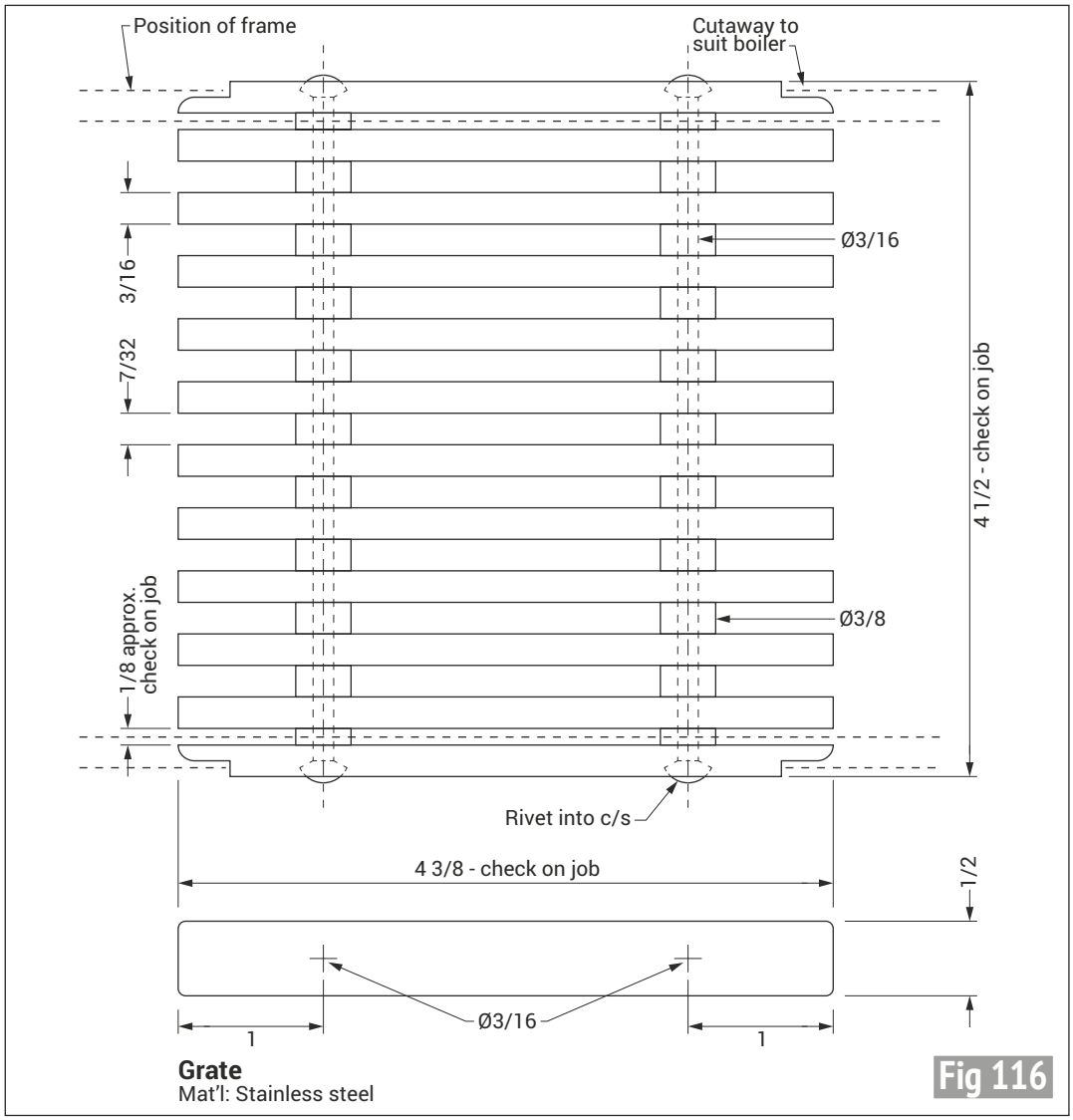
Photograph 183 is a view looking into the smokebox, which shows the blastpipe and multi-jet blower. The nominal size for the blast pipe is 7/32 inch diameter but the separate blast nozzle allows for relatively easy adjustment between 3/16 inch and ¼ inch diameter.

View inside the smokebox.



Smokebox Saddle
Mat'l: Brass

Fig 115



Grate
Mat'l: Stainless steel

Fig 116

Close-up of grate.

Smokebox saddle

Nice easy job this one – built up from 3⁄16 inch brass sheet and silver soldered (**fig 115**). The base is drilled 3⁄16 inch diameter to take four x 4BA holding down bolts. Turn these up from hexagon steel rod with slightly over length heads. Attach the smokebox to the saddle with four 4BA stainless bolts, tapped into the top of the bracket. Paint the finished item with smokebox paint along with the smokebox.

Grate

The grate is shown in **fig 116**. It could be made from mild steel but stainless steel, although a lot more difficult to fabricate, will last much longer. **Photograph 184** shows my grate, which has done almost 40 odd years of service without showing much in the way of wear or corrosion – I don't think mild steel would have lasted so long. If mild steel were chosen, the best procedure would be to simplify construction and weld it together without the 3⁄16 inch diameter riveted pins.

Note that my original grate has only 10 bars (wrongly stated in part 31 as eight – I had not counted the two, outer bars which are shorter). If you would prefer a 10 bar, rather than a 12 bar grate, (hey, what is this – a music lesson?) increase the main spacers from 7⁄32 inch to 5⁄16 inch wide with the outer pairs approximately 3⁄16 inch wide – see fig 116. These dimensions, of course, should be checked on the job.

Dropping grates

One item you may think is missing on the engine is the

familiar 'dropping grate', which is normally fitted to most working model locomotives. However, due to the high grate position relative to the frame, the square firebox and the large firehole, it is easy to remove the fire on the fireman's shovel – and in doing so quite a lot falls through into the ashpan. As mentioned earlier in the series (part 31 - *M.E.*4577, p.101, 5th January), the sliding bottom of the ashpan allows the contents to be dropped straight onto the track. All the 'dropping grates' I've ever made have suffered from the same problem; they're fine when new but soon seize up and are therefore not reliable. And where they are situated, the grit and dust see to it that maintenance is difficult. However, safety is paramount and I would not, for example, run a Simplex boiler without some means of dropping the fire - it all depends on the size of the grate/firedoor. This arrangement does allow for extended operation. Many times, I have been able to clean the fire, empty the ashes and make up the fire for another three or four hours of passenger carrying; especially with good quality coal and not too much clinker.

Ashpan with ash door partly open.

Ashpan

Note that the ashpan and grate were shown earlier in photos 142 and 143 (again, in part 31). **Photograph 185** is another view of the ashpan with the damper door shut and the ash door partly open as shown in the drawing, **fig 117**.

The location of the ashpan in the frame is shown in **fig 118**. This wasn't shown on the original frame drawing but it will not be difficult to drill and tap at this stage. Once done, spot through into the ashpan sides and drill 5/32 inch diameter to accept the 1/8 inch diameter spigots on the ends of the retaining bolts.

Fig 117

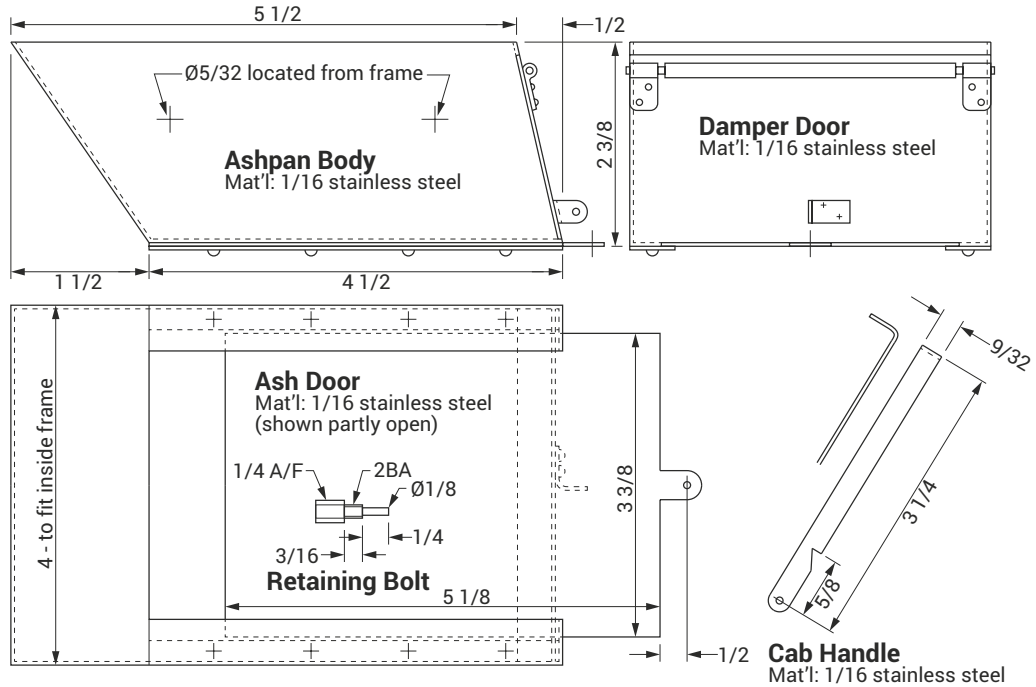
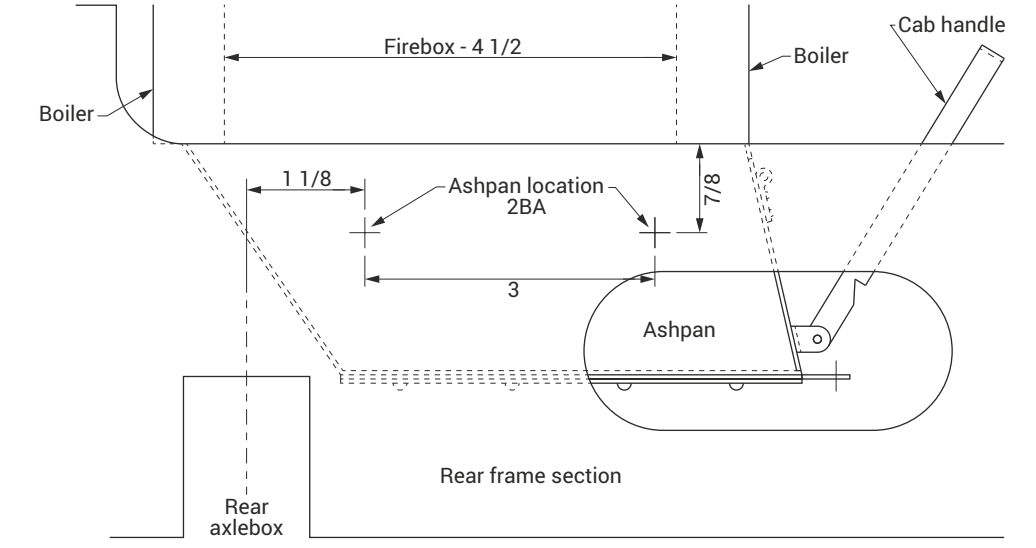


Fig 118



Next time we will subject the boiler to a steam test.

REFERENCE

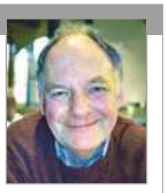
35. D.E. (Laurie) Lawrence, *Turrets and Things (Fittings for Small Steam Locomotives)*, Model Engineer Nos 3595, 3597, 3599, October to December 1978.

To be continued.

Steam Turbines Large and Miniature

PART 3

Transfer of energy to the rotor



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

Continued from p.121
M.E. 4590, 6 July 2018

Steam turbine types

The illustrations used in the previous articles showed the arrangement of blades used in the vast majority of turbines in which the overall flow of steam is parallel to the axis of the rotor – so-called axial flow turbines. But there are alternative configurations. In some Parsons reaction turbines the blades were mounted on the face of a rotating disc in a series of concentric circles which alternated with circles of blades mounted on the turbine case (**photo 7**). In Ljungström reaction turbines, alternating circles of blades were mounted on two facing discs which rotated in opposite directions. In another design, the rotor does not have typical blades but instead has rounded pockets cut into its periphery – as in the so-called Stumpf type rotor. This type of impulse turbine has been adopted in a number of models, such as that described by Mr. Westbury (**photo 8** and **ref 1**) and the turbine-powered locomotive *Turbo* by Mr. Southworth (**ref 2**). These rotors all change the momentum of the steam by changing its direction through causing it to flow around a curved surface, the same as in bladed turbines.

However, another widely mentioned design is the Tesla turbine in which the rotor lacks any blades at all but consists of a number of closely spaced thin discs with a large central bore through which the exhaust steam escapes (**fig 9**). For me, Tesla turbines are a frustrating topic because, despite the large amount that has been written about them and how to build them, I have found little clearly expressed description of the underlying theory. Often, various technical-sounding statements are made that do not really explain anything. Furthermore, despite claims that these turbines are capable of very high efficiencies, such claims do not seem to be backed up by any relevant measurement of their performance.

Radial flow turbine built by C.A. Parsons part of a turbogenerator installed at Cambridge in 1892. Now in the London Science Museum. (Image from Science and Society Picture Library.)

Stumpf type rotor by E.T. Westbury (ref 1).

Some information on the internet seems to come from enthusiasts who have the misguided belief that conventional turbines were very inefficient and Nikola Tesla's 'brilliant invention' gave a great increase in efficiency. Also, it has even been claimed that conspiracy by vested interests in the engineering establishment acted to suppress the development of Tesla's invention.

In fact, detailed analyses of Tesla turbines have been published but these are in technical journals that are not readily available. I have obtained copies of several of these articles but the best time to discuss the pros and cons of this turbine will be after describing the nature of fluid flow and the effects, on this, of friction. The key point to make here is that Tesla turbines resemble impulse turbines in the sense that steam is accelerated in a nozzle and then its kinetic energy is transferred to the rotor. However, this transfer of energy from steam to rotor is a result of drag or friction between steam and the faces of the discs instead of from the change of momentum that results from flowing round a curved surface. Indeed, in an ideal conventional turbine, flow

around the curved blade would be totally without friction.

Steam does work on the rotor

The last article described the principle by which the force exerted on a rotor by steam flowing around a blade can be calculated. However, in the mechanical world, exerting a force is not the same as doing work (i.e. transferring energy) and in a turbine the key thing is to transfer as much energy as possible from steam to rotor. Therefore, we need to calculate the work done by steam on a rotor. The previous article explained that the magnitude of the force which acts on a rotor in a particular direction is equal to the mass of steam that flows round the blades every second multiplied by the change in velocity, measured in that direction, that the steam undergoes as it flows through the rotor:

$force = m \times (V_1 - V_2)$

where m = mass flow rate (kg/s) and V_1 and V_2 are the velocities of steam (m/s) in the specified direction measured relative to the blade at entry and exit respectively.

This is a simplification with the aim of showing how force can be calculated from the steam flow characteristics. Also, it was described in relation to an impulse turbine where V_1 is always greater than V_2. The same principles would apply to a 100% reaction turbine but since, in that case, the steam accelerates as it leaves the rotor, V_2 is greater than V_1 so the resulting force is negative. This reflects the fact that the reaction force acts in the opposite direction to the impulse force, as was described in the last article.

To calculate how much work is done by the steam on the rotor we need to know more than just the strength of force exerted by steam on the blades. Work is done when a force acts on a body *and moves it over a distance*. In the example used in the previous article where steam flowed round a curved blade, the blade was fixed and since it did not move no work was done on it by the steam.

Measurement of work

James Watt seems to have realised the principle of measuring the work output by steam engines in the 1790's but more serious attempts at such measurements apparently originated in France about 1820. People started to make careful measurements by causing engines to lift known weights through measured distances. Weight is the force acting on an object due to gravity so this is an example of the principle that mechanical work done (or energy transferred) equals the magnitude of a force multiplied by the distance over which that force acts i.e.

work = *force* x *distance*

Units of work are Joules and one Joule is the work done when a force of one Newton acts over a distance of one metre. To make this more tangible, one Joule is very roughly the amount of work involved in lifting vertically by 3 feet an object weighing about ¼lb (or by 1 m and an object weighing 100g).

Work done on a blade

To help understand how to calculate the amount of work done in a turbine we'll use another example of steam flowing around a curved rotor blade (**fig 10**) but this time things are made to resemble a Stumpf-type rotor because the blade turns the steam through 180 degrees so it leaves the blade flowing in the reverse direction, i.e. steam leaves the blade with a velocity which is the negative of the inlet velocity. We can calculate the force as in the previous article by letting the mass flow rate of the steam be m kg/s and its velocity be V_1 m/s relative to the turbine case. Firstly, let's assume the blade is stationary, so the velocity of the steam relative to the blade is also V_1 m/s. As before, for the sake of simplicity, we'll assume there is no friction so that the steam leaves the blade at the same speed that it arrived, but in the opposite direction. Therefore $V_2 = -V_1$.

$force = m \times (V_1 - V_2)$
$= m \times (V_1 - (-V_1))$
$= m \times (V_1 + V_1)$
$= m \times 2V_1$

Now, since the blade has zero velocity relative to the turbine case and, since *work* = *force* x *distance*, work done is zero.

Let's put some values into these equations by assuming the mass flow rate m is 5kg of steam per second at a velocity, V_1 of 20m/s so that V_2 = -20m/s. Therefore:

$force = 5 \times (20 - (-20)) = 5 \times 40$
= 200Newtons

In this case the steam velocity of 20m/s is the same

Fig 9

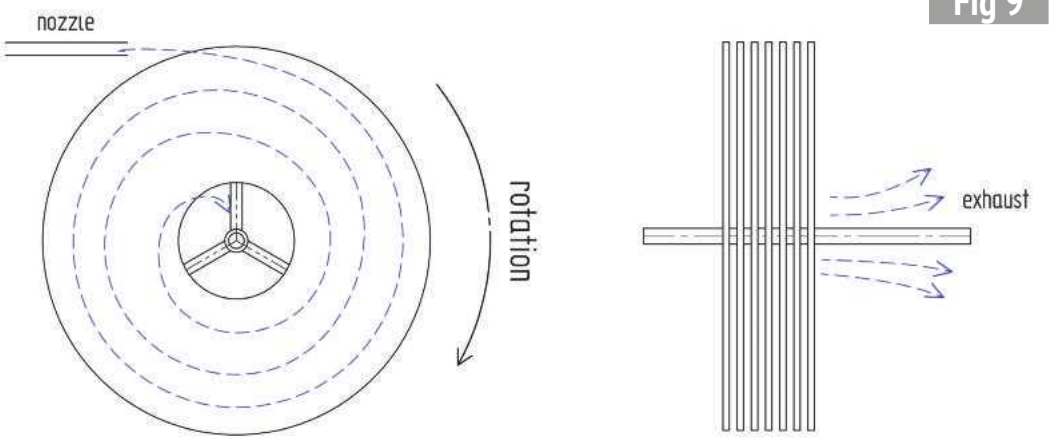
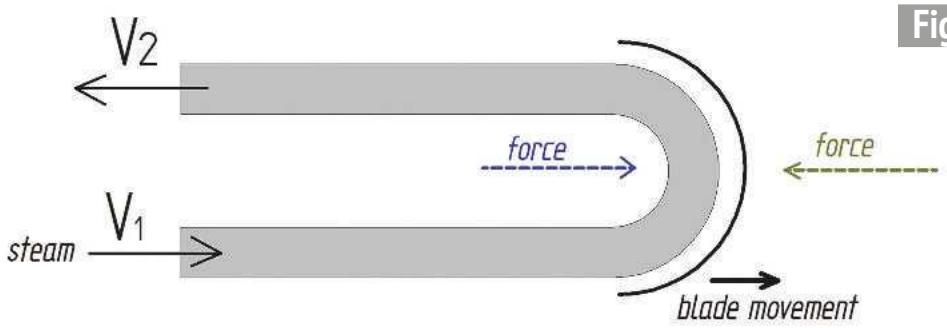


Diagram of a Tesla turbine rotor. Blue dashed lines represent the steam path.

Fig 10



Steam flow round a semi-circular blade.
Dashed arrows denote the average forces acting between steam and blade.

whether it is measured relative to the work bench or to the turbine blade but it is the velocity relative to the blade that determines the force exerted on the blade. So, with a moving blade it is necessary to first calculate this velocity. Let us now suppose that the blade moves in the same direction as the steam and at a speed of 5m/s so that the speed of inflowing steam relative to the blade is: 20 – 5 = 15m/s. The steam flows round the curve of the blade and exits at the same speed *relative to the blade* but in the opposite direction. So calculating the force exerted on the blade as before we get:

force = 5 x (15 – (-15)) = 5 x 30 = 150Newtons

But this time, although the force is less, the blade moved and so work was done by the steam. Work done per second equals force times the distance moved per second. i.e. force times the blade velocity of 5m/s. So the work is:

150 Newtons force x 5 m distance = 750 Joules per second.

This result tells us the *rate* at which work is done, otherwise known as the power of the turbine. This is measured in Watts and 1 Watt = 1 Joule per second. So, at that blade speed, our imaginary turbine produced about 1hp since 1hp = 746Watts.

An alternative way of looking at this process is to calculate the kinetic energy carried by the steam before and after it passes through the rotor blade. Kinetic energy and momentum are both important for understanding how turbines work. As described previously, momentum is a measure of the tendency of a moving object to continue in its state of rest or movement along a straight line (or spinning about an axis in the case of angular momentum).

momentum = M x V

where M is mass and V is velocity.

So, doubling velocity gives a doubling of momentum. In other words, momentum is directly proportional to velocity (**fig 11**). In contrast, the amount of kinetic energy in any moving object or body of fluid is:

kinetic energy = ½ M x V^2

where M is mass and V is velocity.

This indicates that, if you increase the speed of an object, its kinetic energy grows at an ever increasing rate (fig 11). The equation for momentum seems reasonable but the equation for kinetic energy may seem less intuitive. If you are not already familiar with this equation and don't like to accept it at face value, the text in the box might give a more intuitive grasp of why it takes the form it does.

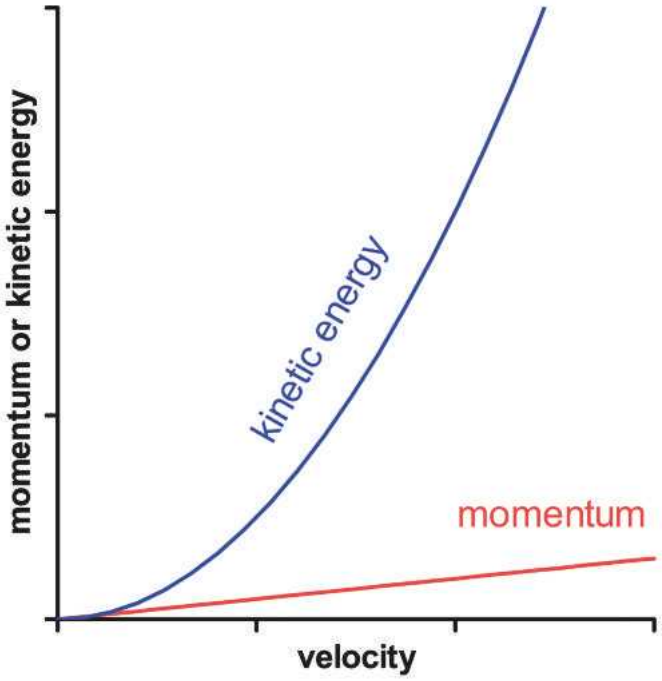
To compare kinetic energy of the steam before and after it passes through the rotor blade we should relate steam velocity to the casing of the turbine rather than to the rotor. Now steam leaves the rotor at 15m/s relative to the rotor but in the opposite direction to the rotor's own movement. Therefore, to obtain the speed of the steam relative to the casing we must subtract the blade speed to give 15 – 5 = 10m/s.

Using the equation for kinetic energy ($E = ½MV^2$) we can calculate the kinetic energy of the 5kg of steam that passes each second. At 20m/s, this is 1,000Joules/s and at 10m/sec it is 250Joules/s. So, the kinetic energy lost from the steam is 1000 – 250 = 750 Joules per second, in agreement with the above calculation of the rate of work done by the steam on the rotor.

Blade speed

From the above it is clear that the amount of energy derived from the steam varies with blade speed so to design an efficient turbine we need to find the blade speed that gives maximum transfer of energy. The efficiency of energy transfer to the rotor at various ratios of blade velocity to steam velocity for our simplified example is shown in **fig 12**. This shows that maximum efficiency is attained when blade velocity equals half the steam velocity.

Fig 11



Comparison of how momentum and kinetic energy vary with velocity.

KINETIC ENERGY

Let's consider an object (but the same applies to a body of steam) moving at velocity V. The kinetic energy of this object is the amount of energy or work needed to accelerate it from stationary up to velocity V. In this we ignore effects of friction so the same amount of energy would be released when the object's velocity was reduced from V to zero – e.g. the energy released in a car crash. To bring about the acceleration (or deceleration) it is necessary to apply a force to the object. The amount of work done when applying a force is equal to the strength of the force multiplied by the distance over which it acts. For simplicity, let's assume that the force acting on our object is constant and this means the acceleration is constant. So, the kinetic energy of our moving object is equal to the force used to accelerate it multiplied by the distance moved during the acceleration. Suppose that, after accelerating the object from zero to velocity V, we continue to accelerate it using the same force, so as to achieve double that velocity and double the momentum. Now, at the start of this second phase, the object is already travelling at velocity V and so, even though the force and rate of acceleration remain the same as before, in this second phase the object will cover a much greater distance than in the first, so the amount of energy or work necessary to achieve the same increase in velocity is greater. This pattern is accurately defined by kinetic energy increasing with the square of speed. The kinetic energy equation also includes a division by two. This reflects the need to take the average velocity over the period of acceleration.

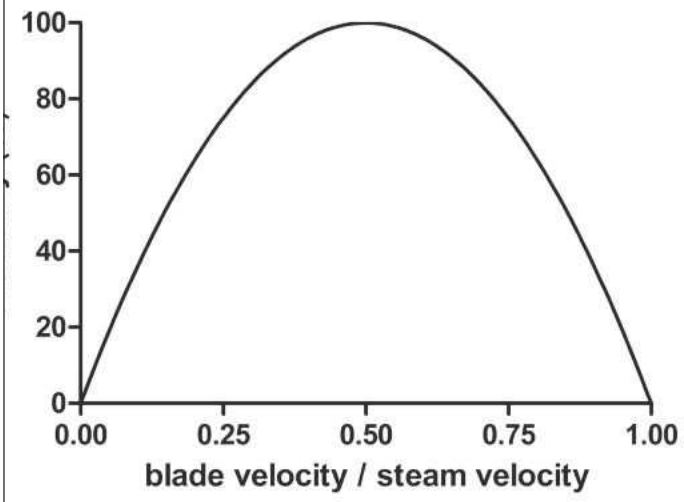
A moment's thought reveals the reason this is so. At this ratio, the steam leaves the blade at the same speed as the blade is moving but in the opposite direction. This means that, relative to the case of the turbine the exiting steam is stationary and so all its kinetic energy has been transferred to the rotor.

The above analysis is greatly simplified compared to an actual machine and it merely aims to demonstrate some basic principles relevant to turbine design. In an actual machine it is usually necessary for the steam to enter and leave a rotor blade at an inclination to the direction of rotation. Also, the final steam velocity cannot be zero because the exhaust steam has to move away from the rotor. Nevertheless, we can see that, for maximum efficiency in an impulse turbine, blade velocity should be roughly half of the steam velocity, where both velocities are measured relative to the turbine casing. Also, we see that the curve in fig 12 is rather broad so that if rotor speed is slightly less than the optimum speed, the efficiency will only be decreased slightly. In a 50% reaction turbine things are different since the ideal blade velocity there is approximately equal to the steam velocity.

Origin of the word 'turbine'

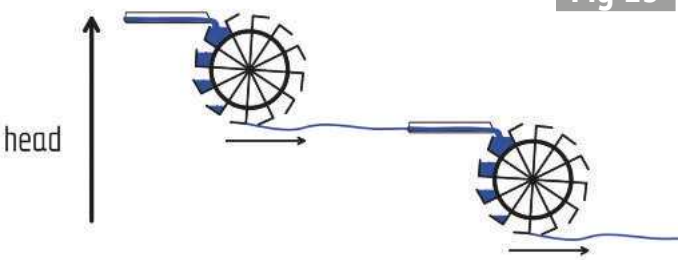
The word 'turbine' was not used until early in the nineteenth century when it was proposed by a Professor Claude Burdin (1788 – 1873) who taught in The School of Mines at St. Étienne in Loire, France. He was interested in the idea of a machine to extract energy from swirling water as an alternative to the traditional water wheel and he based the word on the Latin *turbo* which means whirlwind or spinning top. The most efficient water wheels of his day generally worked by using the weight of water in their buckets to drive rotation (**fig 13**), unlike the primitive and inefficient paddle-type wheels mentioned in part 2 of this series. When weight of water is the driving force, in order to exploit the greater amount of energy that is available in a higher head of water, it is necessary either to make the wheel larger in diameter or to use two or more smaller wheels in sequence (fig 13). However, in a water turbine, the potential energy due to ***any*** pressure or head of water is converted into rapid movement of the water, i.e. into kinetic energy. That energy is then converted into the mechanical output in a relatively small machine. If a turbine had been used instead of the giant 72 ft 6 in diameter Laxey wheel on the Isle of Man, the same power would have been generated by a machine just a few feet in diameter. Professor Burdin did design a turbine but it was not very efficient and it was one of his ex-students, Benoît Fourneyron, who developed his ideas further and built the first practical and efficient hydraulic turbine. He first demonstrated it in 1827, i.e. about the same time that the Stephensons were building *Rocket* in Newcastle upon Tyne. In Fourneyron's design, water entered the top of the machine centrally and then passed outwards through a circle of specially shaped vanes which directed the water into the encircling rotor. In the rotor the water was accelerated and exited through specially angled blades (**fig 14**). The reaction from the accelerating water caused the rotor to spin. Many Fourneyron turbines were made and sold around the world. They were efficient since their power output could exceed 80% of the power theoretically available in the water supplied to the machine. In the following decades several other types of water

Fig 12



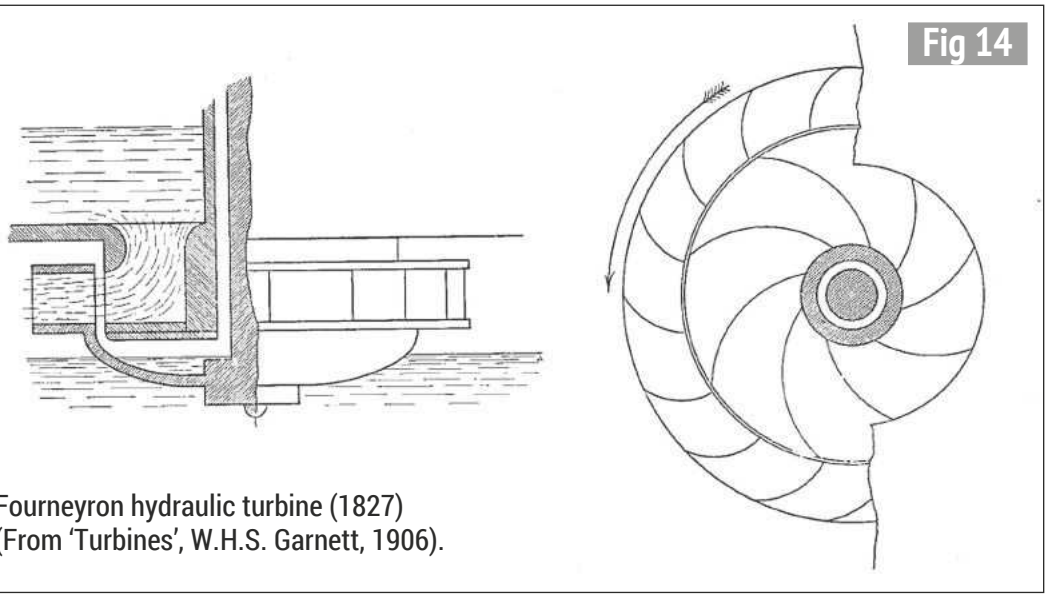
Relationship between efficiency of energy transfer and the ratio of blade velocity to steam velocity.

Fig 13



Breast or pitch-back type water wheels.

Fig 14



Fourneyron hydraulic turbine (1827)
(From 'Turbines', W.H.S. Garnett, 1906).

turbine were invented and are known by the names of their inventors, e.g. Kaplan, Francis, Jonval and Pelton.

Hydraulic versus steam turbines

Now it may seem strange that engineers had been designing efficient hydraulic turbines for nearly 60 years before a successful steam turbine was built. This was not due to lack of interest since, during the 19th century, well over 100 patents had been filed for steam turbine designs but none were practical. The chief reason for the delay in development of steam turbines lies in the differences between steam and water regarding density and compressibility. As a consequence of these difference steam turbines need to be very different in design to their hydraulic equivalents. Although these differences between steam and water are obvious, it is worth dwelling on them a little since they serve to illustrate some important aspects of turbine design.

Density is important because turbines work by utilising the kinetic energy in the moving fluid and kinetic energy depends upon mass and velocity. For a body of flowing steam to have the same kinetic energy as a body of flowing water, the steam should have the same mass as the water and move at the same speed. Alternatively, if the mass of steam were smaller, then it would have to flow faster. Some values for density are shown in **table 1**. To have the ***same mass*** as a volume of water, the volume of dry saturated steam at 60 and 1 psig would need to be 365-fold and 1560-fold larger respectively and this would determine the size of a turbine. On the other hand, to keep volumes comparable would mean using a smaller mass of steam which would therefore have to move at a higher velocity. For example, compared to a volume of water travelling at 100 ft/s, for the ***same volume*** of saturated steam at 60 or 1 psig to have the same kinetic energy, it would need to travel at 1,900 and nearly 4,000 ft/s respectively. This subject of steam velocity is crucial for turbine design because, as we've seen, to extract as much energy as possible from the moving fluid, the periphery of an impulse turbine rotor must move at a velocity roughly equal to half the fluid velocity.

Table 1

Fluid	Density (lb/cu.ft)
Water	62.5
Dry saturated steam at 60psig	0.17
Dry saturated steam at 1psig	0.04

Heat engine

Another fundamental difference between the two types of turbine is that steam turbines are heat engines. Since water is essentially incompressible, the energy that drives a hydraulic turbine comes solely from the pressure or head that is forcing the water along the pipe. In contrast, the compressibility of steam means that it has internal thermal energy available for conversion to kinetic energy. Consequently, for similar pressure drops, steam can attain much higher velocities than water. Also, compressibility of steam makes it much more difficult to predict its behaviour as it flows through nozzles and blades.

Now that we have seen how it is important to ensure the velocity of blades on a turbine rotor match the steam velocity, it is appropriate to move on to describe how to calculate the steam velocities actually attained in nozzles. In the next article, a start will be made on tackling this topic.

●To be continued.

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Wandong Live Steamers

PART 1

Les Phillips tells the story of the Wandong Live Steamers, based in Victoria, Australia.

Late last year I presented an article on the New South Wales Illawarra Live Steamers 'Hot Pot' Invitation Run (M.E. 4573, 10th November 2017). I then had the thought you may also like to read of the Invitation Run of another Australian club, this time in Victoria, Wandong Live Steamers, of which I am a member. With further thought I decided we had a fascinating history so why not combine the two? I hope you agree.

Location and site

Wandong is a small town (but growing!) approximately 90km north of Melbourne, adjacent to the Hume Freeway to Sydney and on the Sydney-Melbourne railway. I believe the history of this somewhat extraordinary club makes for interesting reading. Why extraordinary? Maybe that word is a bit 'over the top' but I use it because of its location, infrastructure and the amazing few people who created it.

Our club is located on an old railway quarry site that was established in the 1870's to quarry and crush stone for ballast for the Melbourne-Sydney main line which is adjacent to one side of our property. Luckily for us they quarried into the side of the hill (**photo 1**) and not down, creating a magnificent cliff face on which peregrine falcons nest and above which, on occasions, wedge tail eagles soar. An awesome sight! Also, it is not unusual, if you are the first to drive along the dirt road to the entry to our site, to be faced with several kangaroos on the road as they take off to head across our property to higher ground - much higher ground!

The old quarry site.

The quarry closed in 1929 but the foundations for the crushing plant remain (**photo 2**), as does a shallow cutting behind the club house (an old guards van) for the spur line going to the mining area and crusher.

Being adjacent to the main line certainly makes for some interesting trains going by and many drivers of these know we are there, generally making their presence known from a considerable distance away. This is also accentuated by the fact that four of our members are drivers!

The site, in which we take great pride by trying to encourage local flora and eliminate anything else, is leased from the Victorian Government's Dept. of Sustainability and Environment with whom we have a good working relationship. Occupying about 20 acres, there is a creek running through the property which dries up in the summer but can become a torrent in winter. **Photgraphs 3** and **4** show the conditions at the extremes. Fortunately, neither occur very often. The bushfire was part of a major Victorian fire event in 2009, which became known in Victoria as 'BLACK FRIDAY'!

The foundations of the old crushing plant.

The extreme conditions at the creek.

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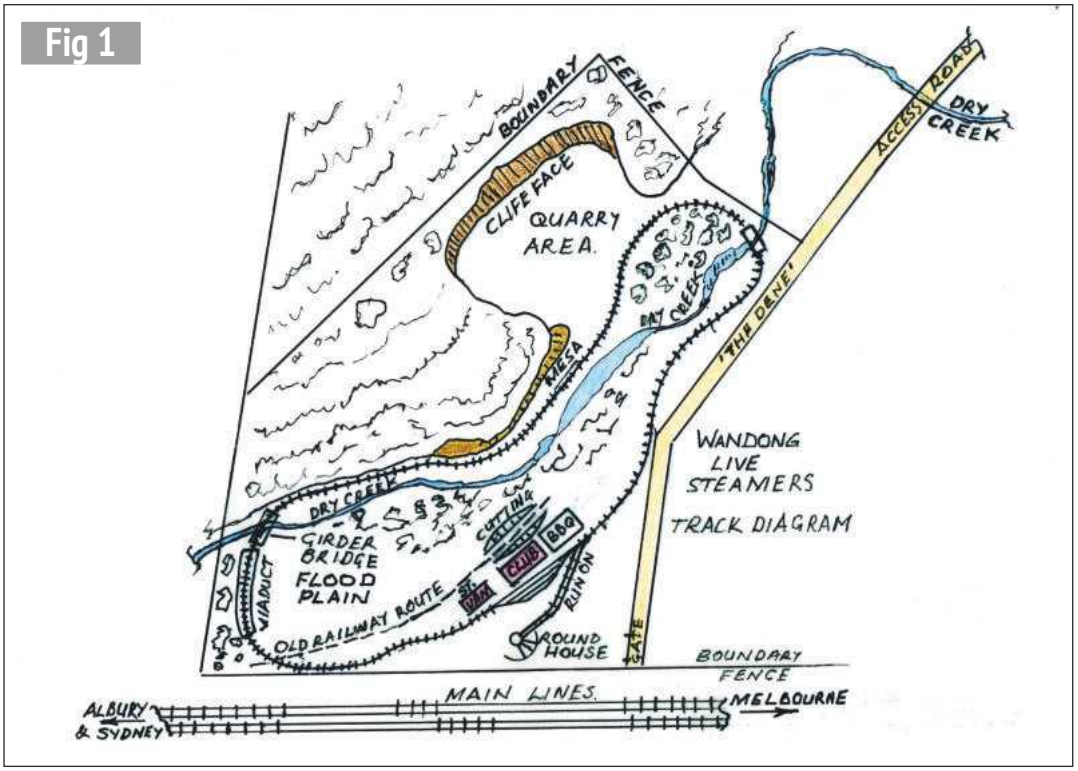
Our story

Wandong Live Steamers was established in 1987 by four founding members with three of them from the Steam Locomotive Society of Victoria, seeking a more extensive ground level layout. After a fruitless search our present site was suggested by another S.L.S.V member who had a passion for peregrine falcons. They fell in love with the bush site as soon as they set eyes on it. Their vision, enthusiasm, will to succeed and skill to overcome the major obstacles ahead of them carried them through. "What obstacles?" you ask. Well - if they were to build a railway they had two substantial creek crossings and a flood plain to traverse! At that early stage they had absolutely nothing in the way of facilities; just brain, brawn and ingenuity. Funds were limited and they were literally out in the 'back blocks' but this also did not deter those few who soon joined them.

A track layout was arrived at (**fig 1**) which would provide a run of approximately one kilometre but would involve some major infrastructure to cross the creek twice plus the huge challenge of the flood plain, requiring an elevated long 'viaduct' (my word - the original plan calls it a 'west end trestle') on a curve. It was decided that the east and west creek crossings would be based on independent designs but before the crossings were tackled the first task was to install a turn table, steaming bays and access run on to where it would eventually join the main line. For the bank leading to the turn table spoil was utilised from across the creek and cliff area, utilising a loader and trucks.

Fig 1



One of the early projects was to build a club house/shelter/storage structure and it was decided in 1989 to bring in an old guard's van to serve in this capacity, whilst a builders' toilet provided that essential facility! Readers will be pleased to know (as were the members!) that eventually a toilet block was built and, moving ahead a bit, an enclosed and lockable goods van was put in place in 2008 for storage of tools, equipment etc. The original van could then become just a club house.

After a detailed examination of the situation at the east end creek crossing area it was decided that a truss bridge would be installed. Designed by structural engineers, it was built in three pieces 'off site' at a member's factory in Melbourne and each piece was 'trailered' to the property. Reassembled on site, it was craned into position on concrete abutments (**photo 5**). Each piece of the truss is approximately five metres long, giving an overall length of fifteen metres. At each end of the truss section R.S.J. beams provide the leads onto and off the bridge, each approximately 12 metres long. This project was completed in July 1990.

Meanwhile, track was being installed in some of the less daunting areas of the site either side of the truss bridge and a big celebration occurred when the first section of main line was finally joined to the steaming bays, giving a point to point run. Limited runs were then organised but involved running forward and then in reverse. These runs made it seem all the hard work was worthwhile and engendered enthusiasm for the remaining tasks ahead.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The east end creek truss bridge.


6

The west end girder bridge.

Finally, the main line was complete to either side of the flood plain and west creek crossing. This gave a longer run of approximately 0.75km but still involved running forward and then in reverse! With the thought that it is going to be some time before the track is joined, it was decided as an interim measure to install passing loops and turntables at each end to eliminate this. They had to have SOME fun! Meanwhile planning for the west end creek crossing and flood plain was progressing.

Obstacles overcome

For the west end creek crossing a longer span was involved to cross the creek, because of the slope of the bank. Members decided on a girder bridge (and a very substantial one I might add) comprising two deep R.S.J's spaced approximately 1.5m apart with cross beams of heavy angles (**photo 6**). As the span was too long for one R.S.J., two were joined end to end lengthwise by welding and gusseting, giving a span of twelve metres. This then had to be hauled across the creek with rollers, tackle, an improvised TRIPOD and 'hard yakka'.

The flood plain was another matter altogether. The final decision resulted in a plan to install what I call a 'viaduct' with a total length of SEVENTY FOUR metres on a long shallow curve! Large concrete foundations were to support sixteen vertical columns, which in turn support a longitudinal box section of two steel channels welded together to which cross beams were welded (**photo 7**). The whole was designed by professional people, bearing in mind this WAS a flood plain, so it had to be of a height and construction considering rainfall records of what had occurred in past years, as you saw in photo 1. The foundations were dug, partly by hand and partly by mechanical means. With the columns concreted in, the sub-structure went up and the main line was joined in September 1993. The completed bridge across the creek and viaduct gives a total elevated run of ninety four metres and I consider this section of the run as quite an experience.

Celebrations

The joining of the track was celebrated by breaking out the champagne. Then President Peter Gray and Secretary Neville Levin, two of the four original foundation members, are shown getting right into the spirit of the thing (**photo 8**). Unfortunately, both are no longer with us. As you can see it was a 'top hat ' occasion, although please note the attire included gumboots! A special run was held soon after. After seven years of what to me was an extraordinary endeavour, they had a fantastic track to run on and they were 'over the moon' or, more correctly, 'over the creek' (and perhaps more importantly not 'up the creek'!).

I would point out that that I did not join until the late 1990's and to this day I am simply staggered by what this small group of guys had achieved with the limited resources available to them. Every time I run there I have two thoughts - what an amazing site for a miniature railway and if I cannot drive the real thing this is as close as I will ever get!

Geography

The track is 5 inch gauge only and has two 'higher' flat areas; the main yards/club house area and the 'Mesa' as mentioned, over by the quarry face. Consequently there are some 'steepish' grades, the worst - or best, depending on your point of view - being a couple of one in forties for about fifty metres, the others roughly around the 1:100 mark. The main yards adjacent to the club house have five roads and work has commenced to provide another three. The flat area of the Mesa adjacent to the cliff initially had only the main line passing by, then a passing loop was added and, a few years later, a new yards area.

As to the name 'The Mesa' someone suggested calling it that and it has been that

Crossing the flood plain.

ever since. Personally, I like to pull in there, park and simply admire the view, listen to the silence and the bird life until disturbed by the 11.15 goods battling its way up the 1:40 grade to the summit and, having reached the level section, coasting away on the down grade to the girder bridge.

The layout provides three longish straights for a fair turn of speed and I have to say there is not much level track, the only other section being a short run in front of the cliff face. Thus, from the main yards you descend to a creek crossing then climb to the Mesa, descend to the short section of level, cross the creek and climb again to the main yards where you started. Or in reverse as we do run both ways.

Somewhere around 2000 two fairly substantial works were undertaken. Firstly, the existing 'swivelling' unloader was replaced by a hydraulic lifter (hand pump as we have no electricity) in conjunction with a traverser which allows several unloading/loading operations to be taking place at the same time and provides for a safer, easier and more convenient operation. The second was the erection of a roundhouse to provide protection from inclement weather.

Last but far from least I have to mention – WATER - the elixir of life both for us humans but also for our steam locomotives. As there was no water available on site for some years we took our own water up in containers - looking back, I can only think, crikey, we were a hardy lot! Then also around 2000 our then President Peter Gray came up with a solution. On the hill adjacent to the quarry we located a reasonably level area and we installed three tanks. Higher up we built a 'ground level roof' with gutters from which we ran a pipe to the tanks. This was piped to the water points in the yards and we were in clover! Then the bush fire destroyed the tanks and roof, so we had to start again, taking the opportunity to implement some improvements. When the roundhouse was erected we put in a tank and collected water from that. Then more pipe work so that we can pump it up to the tank on the hill. Almost a never-ending story!

I have been a bit long winded with all that and I suppose the foregoing shows my enthusiasm for this club. I also hope readers do not mind that, in a way, it is also my tribute to those who went before me.

●To be continued.

Celebrating the completion of the route.

No 4 Edward Thomas At Nant Gweronl Station on the Talyllyn Railway.

A Few Puffs of Steam

Ralph Oliver takes a gentle stroll down memory lane and recalls the early days of the Heritage Railway.

Railways play a large part in everyday life. Main line and commuter trains are packed, high speed systems are gradually being built and heritage lines continue to flourish.

My own youthful interest goes back to the nineteen thirties when visits to Scarborough meant a ride on the North Bay Railway (for more detail see *Model Engineer* Vol. 220 No 4579 p.220). Open carriages were pulled by lovely green 'steam' engines – which were actually diesel powered – and at the Scalby Mills terminus, the line looped round through a tunnel in the cliffs so that a decoupled engine could run round the other end of the train and again face forwards. A visit sixty years later showed that the tunnel no longer existed! Sadly, soon after the line had been opened, a head-on collision occurred on a blind bend which resulted in the death of one of the drivers. Belatedly, a baton system was introduced to prevent such easily avoidable accidents.

The Severn Valley Railway in the Midlands is a successful, standard gauge line. A walk down the road from Arley station leads to a pub, picnic sites or a fine riverside path to Bewdley. From the train, in its early days, you could spot rhinos and giraffes at the nearby Safari Park. At Christmas, multiple Santa Clauses dispense goodwill and presents to the children, who clearly think their Santa is the only one! In December 2017, heavy Sunday snowfall resulted in the cancellation of one of these days and returned bookings were said to total £35,000. The Gloucester and Warwickshire line, which now runs from Cheltenham to Broadway, lost a smaller sum which it could ill afford. Line extensions, bridge works and earlier landslips have made every penny count.

Just after the war I became aware of a disused narrow-gauge line between Welshpool and Llanfair Caereinion. Years later, grandchildren in tow, we used the reopened line as a gateway to Wales. The car would be driven along the road to various vantage points

where the children would wave as the train trundled past.

Single track mountain roads run from Lake Vyrnwy to both ends of Bala Lake. Here, an attractive little line runs the full length of the lake with pleasant views everywhere. Whilst visiting Aberdovey, we were in an hotel discussing our next move when we noticed a poster on the wall advertising the Ffestiniog Railway. Standing by the poster, I heard a resonant voice behind saying "can I be of any assistance?". The helpful man was Sir Timothy West, the well-known actor who was staying in the hotel with his wife, Prunella Scales (of *Fawlty Towers* fame). He went off to get some brochures whilst Prunella was very friendly and showed interest in our common Yorkshire heritage. More recently, the couple appeared on a televised programme on canal journeys.

The Ffestiniog railway was redesigned some years ago to incorporate a 'climbing loop' in order to raise the line's height. For some reason, I had imagined the loop to be inside a mountain and was pleasantly surprised to find it neatly circling a low hill. The line had originally been built in order to bring slate down from quarries to the coast; it is now one of the most popular narrow-gauge lines, famous for its conjoined engine 'facing in both directions'.

The Tal-y-llyn is another 'must visit' line in this part of Wales. Parking the car at Towyn, we caught what turned out to be the last train of the day. The station at Abergynolwyn is not quite the terminus, as the line continues along the side of a hill and finally turns into a halt up a lovely wooded valley. We failed to check on the train's movements and after a stroll alongside a crystal, chattering brook returned to see the train puffing out of the station. My wife suggested a short hike along the line, despite having children with us, but for once I played it safe and walked a long dog-leg down to the village and back up to the main station. Hot and perspiring, we were lucky this time in that the train had a long-scheduled stop at Abergynolwyn.

Some old lines now fulfil a different purpose; the route from Bodmin to Padstow is now a cycle track called the Camel Trail. The loss to railway buffs is a gain to those fitness frauds who like a nice easy, flat ride!

The North Yorkshire Moors line has recently featured on television. Our experience goes back to the time of the Fylingdales (Missile) Early Warning System, nicknamed 'the balloons' by the children when walking on the Moors at Eller Beck. The train line ran nearby at one of its highest points; distant trainspotting allowed the children to run close to the line as it passed. We loved the views when traveling in a diesel railcar, but the hang-gliding at the impressive Hole of Horcum was best viewed from the main Pickering - Whitby road.

More recent visits include the Isle of Wright Steam Railway and the line which runs up the Wensleydale valley in Yorkshire. Here, the booking office and coffee shop were in a railway carriage and I was impressed by one of their engines. This 0-6-0 tank engine was exactly the same as a Hornby Dublo engine of 1939, which was black, and another of 1998, which was green. The only change was that die-cast metal had been replaced by a plastic moulding, but the quality remained excellent.

It is clear that the Heritage lines, in particular, represent more than 'a few puffs of steam'. They are dependent on public support and on generous patrons but when engines like *Flying Scotsman* are involved, become even more dominated by financial requirements. Personally, I'll always have a soft spot for the little railways of Wales. A final thought: would Dr. Beeching have been surprised by the modern success of many of the lines he closed?

ME

Hunslet Austerity 0-6-0 ST, Army No.WD192 - Waggoner *on the Isle of Wight Steam Railway.*

PART 18

Lathes and more for Beginners

Graham Sadler machines the tool holder step, which accurately and repeatably locates the removable tool holders.

Continued from p.171
M.E. 4591, 20 July 2018

Angling the top slide for milling the step.

Step milling in progress - note packing strips to set the step height of 6mm.

Machining the tool holder step

This is the most important part of the post. The step should be 6mm high. Without a vertical slide, there will need to be some repositioning after each milling cut, which may well leave some small steps on the back edge, but these won't matter as the tool holder fits against the pins, not the back wall. The machining method depends on what kit you have.

How to face the packing to size, mounted on what will be a tool holder.

Method 1 - top slide only

With an S7 lathe, the top slide method (**photos 81** and **82**) will mean using different thickness of packing and machining *in situ* with the slide set almost parallel to the chuck. This is not so easy with the ML7. The slide should be angled as much as possible and moved to the end of travel. This will still probably be insufficient for the cutter to clear the end of the slot, so we need to temporally extend the inward movement of the cross slide. We can do this by making a couple of spacers to distance the feed screw bracket from the cross slide itself. The length of the spacers will depend upon how much extra travel you need. The feed screw bracket is removed and reattached with the spacers in place, using 2BA studding or long screws. Use washers to protect the counter-bored pockets.

For the ML7 the top slide will not swing as far as the S7 but here is another unorthodox dodge. Screw in the top slide as far as it will go, then remove the handle which is screwed on - a spanner on the flats of the dial flange will hold the feed screw stationary. Then remove the dial which catches on the edge of the cross slide, normally limiting the angle of swing. The gib screws will need to be fully tightened as the thrust face has been removed and the slide will move on its own as soon as you start milling. Of course, the whole lot will need

re adjusting on completion of the task. Take care with this 'bad practice' - don't be cruel to your Myford!

Set the block true to the lathe chuck with the ruler trick, mount the 12mm end mill and cut a slot across the end making it 13.5mm deep. This ensures that when we finally assemble the post the setting pins will be 1.5mm clear of the back of the tool holder step under the embryo post.

Next, set the post on packing - two strips of 5mm thick strip - which will bring the bottom of the platform step 12mm above the top slide if using a 12mm cutter and your centre height to slide is 17mm --- the same as mine. The base of this step is a critical surface.

If you need to machine packing to the correct thickness, screw a strip onto one of the bars which will form the tool holder with deeply countersunk screws then either face off in the four-jaw chuck (**photo 83**) or fly cut with the bar clamped on the top slide.

After milling the step, which at this time will be a slot, you will be left with a piece about 2mm thick at the top of the step. To remove this, you can saw and file, or invert the block on the top slide and arrange suitable packing to lift the block to mill it off. Perhaps you will decide to pre-drill some holes to mean there is less milling, okay, but I am not keen on this because I think it leaves a lot of edges which are not kind on the end mill as it can grab them. However, it's up to you and the milling would certainly be quicker. I cut at 450 rpm and had the feed set by my imperial gearbox at 0.002 inch or 0.5mm per revolution.

Method 2 - using an angle plate (the worst choice)

Here the small angle plate I recommended is bolted vertically on the cross slide. It needed eight mounting stud clamps (**photos 84** and **85**) and the block at the top is just a spacer. Sit the chuck face of the block on parallel packing to ensure it is in the correct orientation. It will need to be repositioned after the first cutting to finish the back of the step. Cut from the lathe centre towards the front.

View from the chuck side.

Tail stock view of the use of an angle plate to hold the block for milling the step. Ugly!

Milling the step the easy way on the vertical slide.

Milling the pin extension pockets - these could be drilled holes if no vertical slide is available.

Setting the hole position for the detent pin.

Method 3 - using the vertical slide

This is easier than the first two methods but, unfortunately, the photograph was lost so I had to do a simulated one later. **Photograph 86** makes the set up clear, machining from front to back to avoid climb milling. This is the method I used, although I did take a cut on the block using both of the other methods to prove they work.

The final task is to mill the two pockets which will provide clearance for the tool holder pin whenever the tool has to be extended for light difficult cuts especially when using the tailstock to support longer shafts. These can be simple drilled holes rather than as drawn in fig 2 (**photo 87**).

Invert the block with the cap fitted and located using the piece of bar we turned at the start and spot drill to mark the pin position in the cap. This is where a drill is used to mark the exact 'as made' position on its mating component. The process is not needed in industry where the holes are generally highly accurately positioned on both pieces, which never meet each other until they are assembled! For multiple holes of this nature, which are generally for bolt fixing, I tend to clamp, spot drill one or two holes just deep enough for the drill to cut to full diameter, then change to the tapping drill, tap the hole(s) then bolt up to drill the rest, Alternatively, I drill to depth through both pieces at tapping size, then open up the top to clearance, but this needs a lot of drill changes.

Drill with a 6mm drill into the cap to a maximum depth of 5mm to the point or the holes will break through when the cap has its angles cut. The setting pins will extend up into these pockets and will keep the cap in its correct orientation.

While you are at it, find a pair of compression springs and drill holes in the top of the block. Mine were 4.5mm diameter. On assembly open the last coil to stop the spring

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The main block assembly with the Loctite, springs and pins.

Reaming the hole - pump centre in action again!

Profiling the block and cap at the same setting - cross slide method.

Profiling - vertical slide method.

Cutting the cap angles. This makes the unit seem a lot lighter.

from falling out (**photo 88**). These springs will lift the cap whenever it is loosened enabling rapid tool changing. The pins will have a small flat filed just less than half way through - mark the position *in situ*.

They are held in place with medium strength Loctite (trade name). This is an industrial adhesive in differing strengths, e.g. for nut lock, stud lock, bearing fit and permanent retainer. There always needs to be a small amount of clearance between the parts and surfaces must be completely free of oil. I clean both components with cellulose thinners and cotton buds, leave the components to fully dry in air then glue away. The adhesives set when they have no access to air and the grab time can be quite short, so it's a question of having everything ready. Assemble with a twisting action and wipe away any surplus straight away. These adhesives can be removed with heat, so sometimes they can be used to hold components for machining. Whatever type of adhesive you get, Google it to find the recommended clearances.

Detent pin flat

Mount on the vertical slide using a strap clamp again or use the angle plate (**photo 89**). Set the block at the correct angle to bring the detent hole radial to the mounting post. Use the pump centre in the chuck to get the position onto the corner. Mill the flat with the 12mm end mill or fly cut it. The flat should finish at 12mm wide. Then use the pump centre to get the hole position, which should be in the centre of the flat and 6mm above the bottom face of the block. Centre drill, drill to 9.7mm and ream to 10mm diameter into the centre pocket (**photo 90**).

The remaining two edges can be profiled either by using the vertical slide or packing up on the cross slide (**photos 91** and **92**). both methods use the fly cutter set at about 200 rpm with an infeed of 0.5 to 0.75mm. The top cap is machined at the same time and is located by the plug we made at the start. The angle at the back is for clearance of the tailstock when the block is angled, so drill and saw most of the material off then fly cut smooth. I angled each edge of the top cap by fly cutting to give it an angle as it looks better this way. This is an easy job with the vertical slide but could also be achieved by clamping to the angle plate on the cross slide with packing on one edge to set it at an angle (**photo 93**). That finishes the main body.

●To be continued.

Next time we will make some tool holders for the tool post.

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Two Pistons and Three Con Rods PART 6

Wolfgang Tepper describes a water-cooled four-stroke opposed-piston engine.

Continued from p.95
M.E. 4590, 6 July 2018

Carburetto

Carburettors are often, in my view at least, a bit fiddly - they sometimes won't do what they should do. Consequently, I fit any new engine initially with an evaporation carburettor, as used at the ancient Benz-Motorwagen in 1885. The induction air passes into a fuel reservoir over the liquid's surface and absorbs vaporized petrol (**photo 74**). This is a foolproof carburettor and best suited for first running tests, as it always does its job. One disadvantage of these devices though is that they do not easily allow for fine power control. Jan Ridders applied this principle many times to model engines and he reports in detail about it here: http://ridders.nu/Webpaginas/pagina_benzinedamp_carburateur/dampcarburateur_frameset.htm

Eventually my engine will finally acquire a 'real' carburettor (**photos 75** and **76**) with an idle-, full throttle- and idle-air-nozzle.

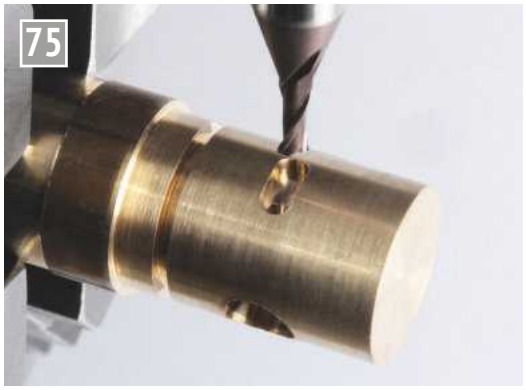
Previous experience with wiggly needle valves led me to an alternative design (**fig 19**). The fuel- and air-flow rates are controlled by rotating cross-holes. A tiny cross-hole and its counterpart overlap just a little bit at their outer diameters. In full open position a fuel-flow cross-section of just 0.2mm² is created. The flow-rates may be adjusted sensitively and no arresting spring is needed. A small 'O'-ring seals the nozzle and also serves to locate it (**photos 77** and 78).

Here is my evaporation carburettor variant; on the left the incoming air may be regulated, on the right side additional air may be mixed in by means of a bypass inlet. Then the fuel vapour/air mixture will leave through the silicone pipe.

Operation

The completed engine started after just a few tries – with the evaporation carburettor. Ordinary motor-car petrol does the job but it is not an optimal choice and does not work for very long. This kind of fuel consists of various constituents of differing volatility. Certain components evaporate early and others remain, such that the composition of the petrol changes during operation. Camping petrol (white gas), available in one litre bottles, runs fine, is highly recommended here and it is free of toxic benzene (see also Jan Ridders' article referred to above). As the engine has no oil distribution system, some drops of oil should be added to the fuel, at least for extended running. The ball bearings, as well as the cast iron piston that runs in the lead-alloyed liner, are tolerant of the lack of lubrication but we have to keep track of the aluminium piston, which may run dry.

An evaporation carburettor cannot be used with an oil mixture as the oil evaporates



The carburettor throttle just got its fuel-inlet channel.

The throttle valve is adjusted to the carburettor case's inner diameter. In front the high/low stop dogs are visible.

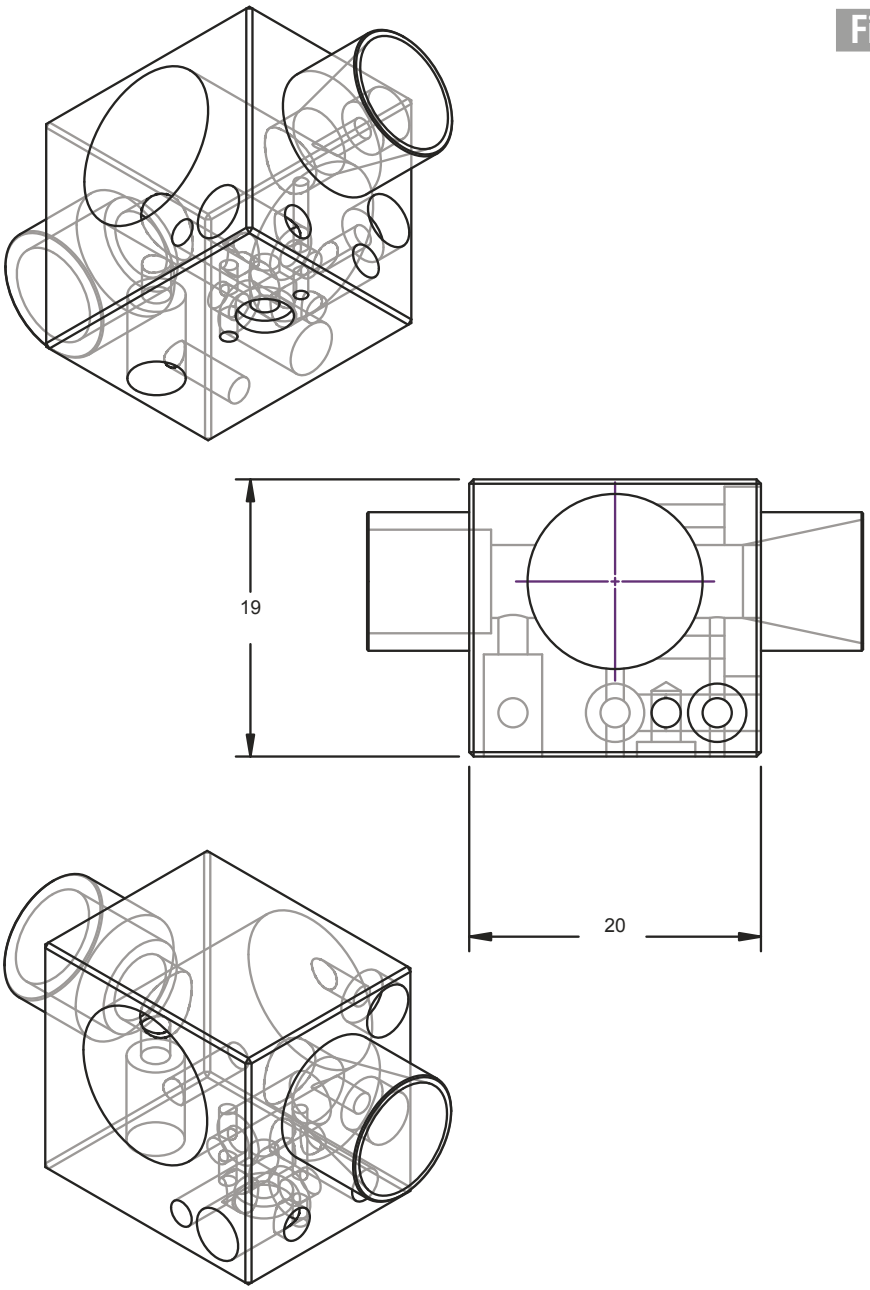
late and remains in the reservoir.

Oil mixtures can be used with the three-nozzle-carburettor presented here. To start with a little trial and error and a few nozzle-turns and adjustments are required but then the engine runs steadily and the nozzles don't move out of adjustment. However, I have not found an optimal configuration yet. With the evaporation carburettor the motor accelerates easily up to high rpm, whereas with the nozzle-carburettor only quite a low stable engine speed can be reached. With this latter carburettor the motor does not appear to like running at high speed. Possibly it is a little bit too large (diameter 5mm) for this engine.

Originally my objective was to run the motor in self-ignition mode with an ether mixture. I was hoping I could obtain a litre of this particular kind of fuel, which is not so easy – at least here in Germany. However, I did not find the courage to give it a try. Maybe it will run right away or perhaps it will suck up a mouthful of liquid and everything will be warped as a result of the consequent water hammer! Perhaps I will try it – later. But, before that, an adjustable compression piston will be installed in the fourth slanted bore to facilitate the start procedure.

ME

Fig 19



These are all the components of the carburettor. The bronze bushes will be glued in before being bored crossways. The long bolts will adjust the stop dogs and the four tiny cylinders will seal the open bores in the carburettor case.

The carburettor is flexibly attached by a piece of silicone tube in the inlet pipe.

Write to us

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Responses to published letters are forwarded as appropriate.

Engineering Projections

Dear Martin,

I was interested to read Graham Sadler's 'Lathes and more for Beginners' in *M.E.* 4586 where he discusses the types of engineering drawings.

I live in Tasmania, Australia and have been a subscriber of *Model Engineer* since 1973.

Over the years the standard of drawings published in *Model Engineer* have varied between the absolute shocker to almost industry standard, which is my standard. Graham in his article alluded to this also. In Australia engineering drawings are to conform to Australian Standard (AS) 1100 and the method of orthographic projection is third angle.

I did an apprenticeship in fitting and machining during the 1960's and the jobbing shop I worked in relied on tradesmen being able to read drawings. Going through my trade training and later as a tradesman I had no idea of the difference between first or third angle projection. I do remember once having an argument with the foreman - which he won, he was the boss! - about how to machine a Volvo truck front wheel spider that our foundry had cast. I had to proof machine the spider on a centre lathe (CNC wasn't about then, this was the early 1970's). I machined it wrong - to the foreman's instructions - if I had done it my way it would have been correct. I assume the drawing being European was in first angle, the foreman hadn't picked it and I then just didn't have a clue.

Fast forward to the mid 1970's, I got retrained to become a design mechanical draughtsman (HNC equivalent) and have been producing engineering drawings ever since, first on the board, then with AutoCAD and now I use Inventor and do everything in 3D.

My first job as a draughtsman - notice the spelling as opposed to draftsman (for which you need a law degree and you produce legislation for parliament) - was at a paper mill here in Tasmania that produced newsprint from eucalyptus (the first in the world to do so) and they had a drawing office with about 12 staff (they have none now) and we had to conform rigidly to AS1100 in line weight and text height relevant to the size of sheet being used and of course the views used, all third angle.

I also taught engineering drawing at the local Technical College (second job and up to three nights a week) for 13 years and I tried to instil in the students that an engineering drawing is an aid for production and not to be a hindrance. Scales had to be correct, linework and lettering to meet the standard and all views to be correct. I did get them to do one drawing in first angle and then repeat the very same exercise in third angle. For the most part, they could not understand why anyone would want to draw in first angle - it wasn't logical to their minds, mine neither. Graham and I are one on this.

Just to bore you a bit more, I recall an incident from the early 1980's. Someone (it could have been me but I don't think so) had to draw up what is called a doctor back for Paper Machine 3 (PM3). This machine was built in the UK by Walmsley's and installed about 1966. It produced a paper width of about 7 metres. A doctor back is a specially shaped beam with trunnion journals each end that locate in bearings (usually rolling element types) and carries a thin blade (from memory 1.6mm thick by approximately 50mm wide) that bears against a roll (press roll, dryer cylinder or calendar stack roll) in the machine and in this case 7 metres long. The blade is mounted in a holder of 914mm (36 inches) long with bolt holes 9.50mm diameter (0.375 inches) at a pitch of 76.2mm (3 inches). You bolt enough of the holders onto the back to make up the length holder for the blade to be used. The blade holders and blades were of UK supply and for the draughtsman there was an installation drawing containing (from memory) an end view and plan of the holder setting out relevant details, especially of the holes. Drawings were produced, checked by another draughtsman and signed off by the Design Engineer. The mill's workshops fabricated and machined the doctor back, drilling over 90 holes 9.50mm diameter. The fitters fitted the first holder segment and the next wouldn't line up with the drilled holes. In the ensuring witch hunt the drawing was wrong (the drawing office received a right kicking from the tradies) and eventually it was realised why the drawing was wrong. The suppliers' installation drawing was in first angle and with only two views could be interpreted in this case as either first or third angle. The manufacturing drawing was revised, all the holes in the back welded up, the mounting surface re-machined and the holes re-drilled. This time there were no hitches with

Electrical Connections

Dear Martin,

Although the writer extols the virtues of modern crimped connections, there is one situation in which they can prove faulty!

As the connectors are made from tin plated steel, their manufacture involves them being cut from plated sheet metal, leaving the cut surfaces unprotected.

In the event of any moisture being present, the unprotected steel will rust, the rust creeping underneath the narrow contact areas, resulting in poor-to-failing continuity. This cannot be detected by inspection, and only proved on dismantling the connector, this made difficult on account of the increased friction due to rust occupying a larger volume than the original intimate tin-to-tin interface.

David E. Hockin, B.A.(Hons), LBIPP (Portishead, Somerset)

the holder installation.

There has been - as Graham mentioned in his article - over the years an improvement in the standard of drawing in *Model Engineer* - CAD I believe has had a lot to do with this - but generally they still don't quite match the standard I'm used to. I used to say to my students, I mark your work out of 10 marks and not one of you will ever have the perfect drawing because I will find something wrong. I think the highest mark would have been 8/10 and that was very rare.

Graham's article on drawing in his series was timely and I hope we get to see more of an improvement on drawings in *Model Engineer*. As I mentioned above a drawing is an aid for manufacture and should not be confusing or ambiguous.

Many Regards, Tony Reeve

Van de Graaf Generators

Dear Martin,

At the Doncaster Exhibition on the York City and District Society of Model Engineers stand, there was a Van der Graaf generator built by Roger Backhouse. Having had a brief discussion with Roger about this, I mentioned a book which I had read more than 50 years ago in my local Library. I could not remember the author, the title or even the publisher. Roger remembered the book too but also could not recall the author or title, so I am hoping that 'out there' there will be someone who has a copy or knows the title and author. The book was published around 1950s to 1960s and was hard backed and probably about quarto sized (8 by 10 inches). I am sure that it was published in England and was aimed at schoolchildren as it was in the Junior section of my local library. It was definitely not an American book due to the spelling of 'aluminium' - I would have remembered if had it been the American spelling!

It gave detailed instructions on how to build a Van der Graaf generator using two aluminium pudding basins for the spherical top; a Wilson cloud chamber made using a rubber sink plunger; and a Tesla coil made using a washing up liquid bottle as the main insulator and transformer secondary former. It is possible that it also contained details of building a Wimshurst machine using two old 78 records.

Perhaps anyone who knows the details could forward details to me via you?

Many thanks more in hope than expectation.

Yours sincerely, Graham Astbury (Skipton)

Balancing

Dear Martin,

I was pleased to see that you published, in *M.E.* 4588, my e-mail of 14 May 2018. However, on reading the text in the magazine I realised that my comment that the out of balance force due to the reciprocating mass is out of phase with the rotating mass is incorrect. It is correct that the maximum total (both cylinders) out of balance force due to reciprocating mass occurs when both cranks are forward (or aft) by 45 degrees relative to the vertical plane through the driving wheels. However, this force acts in the horizontal plane only; there is no vertical component and hence no associated load on the axle. The vertical component of loading on the axle arises if the reciprocating masses, or a proportion thereof, are balanced with rotating masses in the wheels. As for the balancing of rotating mass the balance weight is positioned on the opposite side of the wheel to the crank pin. The out of balance forces due to the reciprocating and rotating masses are therefore in phase. The maximum hammer blow applied by the axle to both rail occurs when both balance weights are at 45 degrees below the horizontal plane and is a function of the out of balance rotating mass on that axle, not of the reciprocating mass itself. The maximum hammer blow applied by a wheel to one rail occurs when the balance weight on that wheel is directly below the axle i.e. closest to the rail.

Like Geoff Moore's *Minx*, my Y4 has gunmetal cylinders but it cannot claim his locomotive's competition pedigree.

Best regards, Jeremy Buck (Alton, Hants)

Shipbuilding

Dear Martin,

In the article by James Wells on shipbuilding (*M.E.* 4587, May 25th) he notes that compound armour was always rolled with the steel on top and wrought iron beneath but it is not known why. Through my father, I was fortunate to be able to see the River Don engine rolling armour plate on the last Sunday before it was de-commissioned (later to become a major exhibit at the Kelham Island museum in Sheffield). An important feature of this engine was the ability to reverse very rapidly and I was told that this was necessary to minimise the standing time as it was used in conjunction with a single stand and the steel was passed back and forth repeatedly through the rolls with the rolls being adjusted between passes. The reason for the rapid reversal was that if the steel was left stationary the cold rollers on the roller tables either side would locally chill the steel and cause hard-spots, so it was essential to reverse very quickly. I wonder if the same issue was known about in the days of compound armour and, by ensuring that the wrought iron was always below, the steel was protected from this chilling effect during rolling?

Regards, Julian Sturdy

Photographing Locos

Dear Martin,

An interesting article, as always, from Doug Hewson and not before time!

Something he doesn't mention, or 'appear' to make use of, is 'editing out' extraneous items...

Photoshop, even the inexpensive 'Elements' version, and the free, Open-source Gimp, can make a big difference to the original pictures.

For instance, the car tailgate - and the roof of another car, in one shot - can be easily cloned out with a touch more tree foliage. The line-up of four engines at the turntable could have had the rail ends that he mentions obscured and, with the removal of the big, out-of-scale white wall in the background, would have made the scene indistinguishable from a full size scene.

He mentions a 'brazing hearth' but in fact it appears as though it's another high-level water tank, quite a natural item to be found at a railway! We aren't aware it's a brazing hearth until he tells us! The white football goal is an unnecessary distraction from the railway scene and a few moments easily cloning some grass could have made a difference, concentrating one's attention on the railway.

I look forward to his continuation of this useful article.

I wonder if he could be persuaded to extend his discussion later to photography in the workshop?

David E. Hockin, B.A. (Hons), LBIPP (Portishead, Somerset)

Rusty Rails

Dear Martin,

The article in the 16th March issue (*M.E.* 4582) 'Renewal of the Guildford MES Ground Level Track' provided some fascinating details of track construction, including their use of steel rails and track circuits for the signalling system. I wonder how they keep the railheads clear of rust, which is not a very good conductor of electricity!

Mike Hanscomb, Volunteer Signal Engineer, Beer Heights Light Railway, Pecorama, Beer, Devon

The Restorer

In the first of an occasional series, **Mitch Barnes** brings a forgotten and neglected model back to life for future generations to enjoy. Restored six years ago and now a century old, this is its story.

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GUN-METAL.—1 each Piston and Valve Glands; 1 Crosshead; 1 Connecting Rod; 1 Eccentric Strap with Rod; 4 Main Bearing Brasses; 1 Slide Valve; 1 each Steam and Exhaust Flanges; 1 Valve Rod Guide.

CAST STEEL.—1 Crank Shaft.

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The Sale of this Set of Castings has been enormous—over 2000 lbs. weight being delivered per Parcel Post during December, 1904.

Foreign Orders sent Carriage Forward unless cost of postage is included in payment, weight packed is under 7 lbs.

W. B. writes "I received your castings, and I think they are the best I ever clapped my eyes on."

G. W. writes "Received castings safely this morning, I am very much pleased with them, thanking you for your promptness and attention."

6

The No. 7 as illustrated in the Stuart Turner 1906 catalogue detailing materials used.

The man himself: Thomas Kenneth 'Ken' Tilston, as an apprentice at Chester Hydraulics in 1918, while building the engine. This photograph now appears at the back of the model's case.

Over the last few issues I have given some of my own insight into the phenomenon we are all aware of; the incomplete and unfinished project. It's a shame that having got that far, unfinished projects have not yet fulfilled their potential and given the intended satisfaction to their original builders. Furthermore, once-completed models that have been fiddled with and are now incomplete projects also suffer the same fate. In a small attempt to remedy this, I have decided to go ahead and complete several from my own collection and others I have been asked to finish. This occasional series details my humble efforts to turn unloved and unfinished models into objects of desire. I hope you'll enjoy reading it at least as much as I have enjoyed scribbling it down and that it may even encourage you to finish a model or two…

More often than not, when a model steam engine turns up there is no trace of its history, let alone the name of its builder. This model was a pleasant surprise in this respect at least, but in others it was fairly typical. It had been completed 94 years previously and, since then, had been allowed to deteriorate over the decades. It had remained in the ownership of one family until I came across it, intent on halting its decline and, if possible, returning it to its original condition and glory.

History of the No. 7

Having opened for business in 1898, Stuart Turner by 1904 had expanded his range and introduced the little 1 inch bore and 1 inch stroke 'No.7' vertical engine as a smaller version of the Nos. 1, 2, 4 and 5. In common with full size engine builders, the plan here was to follow the same design as the earlier engines in the range. While maintaining similar proportions, he simply changed its size, thus making one of their range of models available to model engineers with access only to smaller lathes. Like its larger siblings, the new No. 7 followed a configuration commonly used in full-size practice, with a cast 'standard' attached at the rear of the bedplate, supporting the cylinder on its top. This was braced by an elegant, turned front column, a rigid arrangement which allows easy access to the crankshaft, connecting rod, main bearings, piston rod and its gland.

The 1906 catalogue (**photo 1**) refers to over 2000lb of castings (around 300 sets) being dispatched in December 1904 alone, so it must have

been popular! The No. 7 had disappeared from the Stuart Turner catalogue by 1915 due to pressures of war work and numbers of their staff joining up but returned in the years after the Armistice.

The model underwent some changes later on including for a short while, as the 7A, with two rear standards facing each other and by 1926, with a new boxbed to accommodate it. In 1935 it became the tunnel crosshead version we know today.

Over the years I have endeavoured to collect examples of the Stuart range, in as many configurations as I could – there are still some holes in the collection but I was really pleased to fill one of them with this little example of the No. 7.

It wasn't quite complete, had sustained damage in its life and the vendor's photographs showed it painted in a bright, bilious green but a deal was done and payment was made.

Every model has a story to tell: while most models arrive from sources unknown, this one was happily different. The seller was the builder's grandson; having an inevitable clear-out he had come across this model, for which he could find no interest among his family. He had played with it as a child but had no desire to hang onto it which is fair enough; hence it came my way. When he told me his grandfather had built it, he was astounded that I was interested to hear this at all. To me this is wonderful as it puts the model in context, in much the same way that an artist signs his or her work.

Perhaps Thomas K Tilston (**photo 2**) thought the same. He made a tiny plate still affixed to the front of the boxbed, with his name and date stamped into it. This of course, could have been part of his apprenticeship exercise – he built it while training at Chester Hydraulics in 1918 – and would have helped examiners to keep track of whose model was whose on his course. He had made a charming attempt at the plate with its sculpted screw lugs.

As far as his family knows, this was the only model that Thomas K. Tilston made, though in the 1950s he built a caravan and the Tilston family toured the country with it - quite an achievement!

The model was packed really carefully and it duly arrived, safe and sound (**photos 3** and **4**). I emailed my thanks and said that if he had any more info. on his grandfather, I'd be really interested. He emailed me to say all he had was a photograph of the great man himself, taken at the time he built the engine! I decided there and then that I would clean the photograph up (it was scanned from a damaged print) and print it out to fit onto the back wall of the model's display case.

'Iffy' paintwork never fazes me. I always assume that if it is in poor shape I'd be repainting anyway and it would definitely be required on this one. Generally, I would do this in the colours that the model first appeared in, if I could find out what they were; if not, a repaint would be in some suitable colour that would enhance rather than detract from the model. Lurid colours do not enhance an engineering model! I have seen many models 'destructively restored' with paint applied by numerous means including some that seem to involve neither a paintbrush nor a spray-gun! My way of looking at this positively is that dreadful paint usually conserves the metalwork, in the hope that it will at least arrest any ongoing corrosion where present.

Looking closely at my new purchase, I noticed that it had been painted more than once - the last time in that particular shade of bright green but thankfully not overall. That meant there'd be less to remove! Large parts of the box bed were free of any paint and this was the biggest surprise of all. Stuart castings are generally iron, apart from the bearings and glands which are gunmetal. On their models this size and smaller, the connecting rod and eccentric rod are also usually gunmetal. The photographs I'd been sent hadn't been clear enough colour-wise to show that this model was an unusual example indeed – it was *entirely* cast in gunmetal. I have heard unsubstantiated rumours of Stuart Turner making some sets of No. 7 Castings in bronze or gunmetal for use in salt water environments but it was not clear in this case whether this was one of those. I remain open to further input on this if any reader can enlighten us. An anecdote repeated does not become a fact.

One could speculate that use of gunmetal may have been because this model had been withdrawn from the range by the second half of 1915, so the only way young Tilston could build it was if he made his own castings...

Regardless of the materials used this is a unique example of this once popular design and an exercise in building a small model steam engine in the early days of model engineering.

I have since obtained another (iron) Stuart No. 7 of this pattern and found a few detail differences that would seem to imply that this engine may be from Stuart castings but quite possibly not from the same patterns. It may even have originated as an apprentice piece in the form of drawings only; possibly in 1918 young Tilston had made his own patterns and cast his own parts, as well as machining and assembling them, as one of his apprenticeship exercises! This was quite an achievement for an 18-year-old in those days, even with all the facilities to hand, though it may have been required in order to qualify at the end of his apprenticeship.

●To be continued.

The model as received; only lacking a few fixings and in need of a clean up and a repaint - easy!

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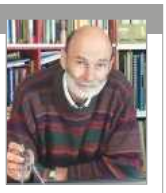
ME Vertical Boiler - Constructing the Boiler PART 10



A project aimed at beginners wishing to develop their skills or those requiring a robust vertical boiler for the running or testing of small steam engines. **Martin Gearing** flares his firetubes.

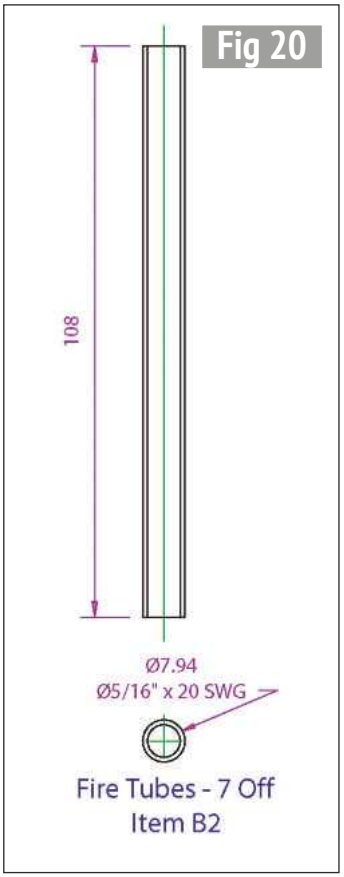
Continued from p156
M.E. 4591, 20 July 2018

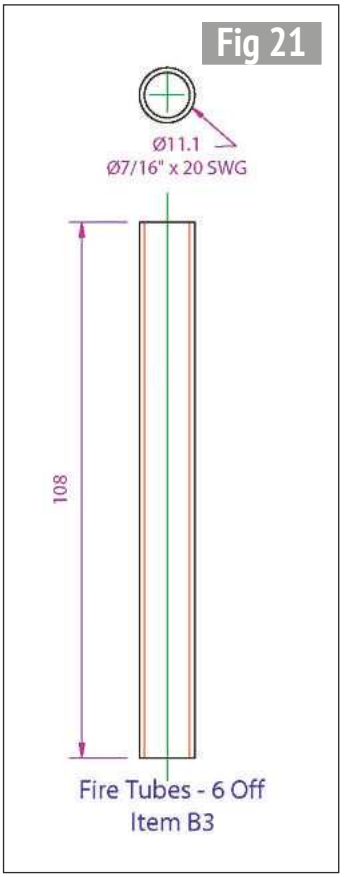
Having prepared the boiler barrel last time, we will now move on to the preparation of the tubes.

Inner firetubes – Item B2

5/16 inch diameter x 20swg copper tube **(fig 20)**

I would like to describe a technique that does not seem to be in common usage but that is applicable to making multiple items all to the same dimension. The affordable digital calliper has to be considered as one of the greatest conveniences to arrive in the home workshop in recent years. Quite apart from the fact that you can use the same tool for measuring in metric, imperial, inside, outside and depth very quickly, it has the ability, because of being able to be zeroed at any point, to tell you directly how much material needs to be removed from a blank to become correct to size.





First, the oversize blank requires both ends to be skimmed to **JUST** remove any trace of saw marks. The digital calliper is first zeroed with the jaws shut. The head is then carefully moved along the beam until the required **FINISHED** dimension is displayed. The calliper is then zeroed again.

If the blank is now measured the calliper will show how much **MORE** than the set (FINISHED) dimension it actually measures. This is the actual amount that has to be **REMOVED** to bring the blank to the required size.

A word of warning must be mentioned – if you either cut the blank too short before facing off both ends OR were overly heavy with the amount skimmed to '**JUST** remove any trace of saw marks' instruction you will still see a reading - but one preceded with a minus sign (-).

That is telling you how much you are UNDERSIZE of the required dimension. ≫

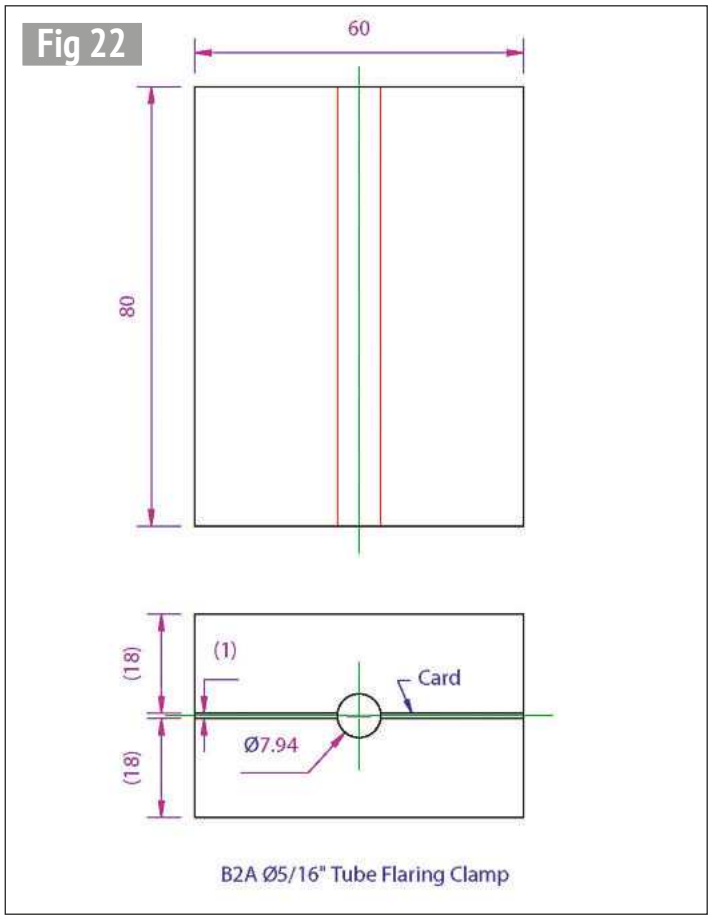
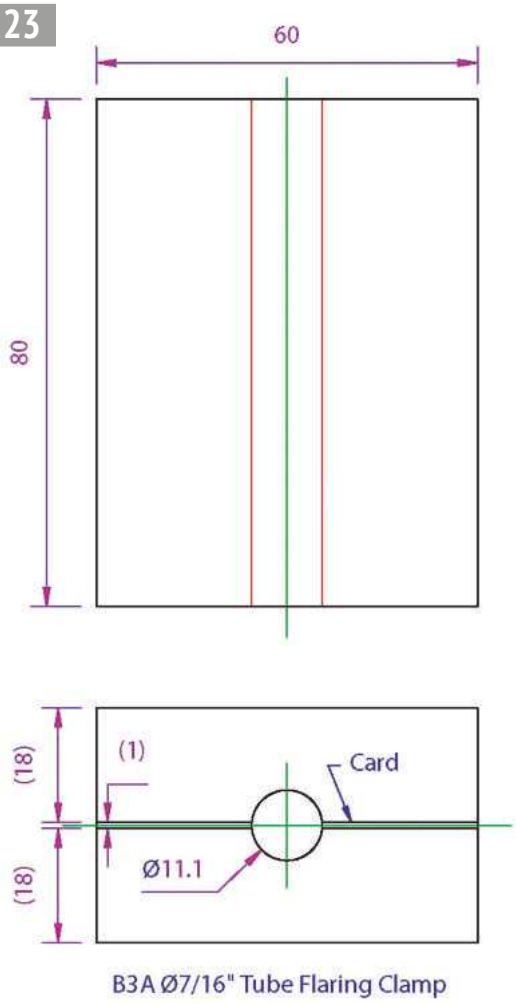
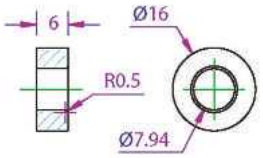


Fig 23



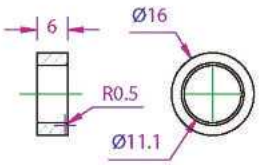
B3A Ø7/16" Tube Flaring Clamp

Fig 24



B2B Ø5/16" Tube Forming Ring

Fig 25



B3B Ø7/16" Tube Forming Ring

If you're **very** lucky, it could still be in tolerance given that most dimensions have a plus as well as a minus figure. If not, cut another blank and take more care!

Using a fine (32 TPI) toothed hacksaw, cut seven lengths of tube at least 110mm long. Hold in a self-centring chuck with 5mm protruding and skim the end – taking light cuts with a sharp right-hand knife tool until all traces of the saw marks are **just** removed. Carefully deburr the end face bearing in mind all said previously. Turn around and face off the second end in the same manner. Remove and measure and deduct 108mm, the result giving the amount that is required to be machined off carefully, taking light cuts. Remove from the chuck and deburr. Repeat this process for the remaining six tubes. Put the seven tubes to one side.

Outer firetubes – Item B3

7/16 inch diameter x 20swg copper tube **(fig 21)**

Repeat the process as described for the inner fire tubes for the six outer firetubes. Put to one side.

Flaring the firetubes

I came across this method for locating the tubes in the tubeplates when reading the excellent book *Building Small Boilers for Gas Firing* by Alex Weiss assisted by Kevin Walton, published by Camden, and was struck by the simplicity of the process which absolutely guaranteed the tubes remained exactly in the position required with **no chance** of failure through unseen movement whilst silver soldering.

Flaring tube clamps

The 'Tube Clamps' (**figs 22** and **23**) are quickly made from four 60 x 80mm rectangular pieces of the same sheet material as used previously for the supporting discs and 'nests'. Cut two pieces of cereal packet or similar thickness card to the same dimensions, putting one thickness of card between two rectangles of wood, before clamping together. Stand these long-ways vertically 10mm **clear** of the base in a drilling or machine vice and fit an additional clamp in the centre near to the top to prevent the rectangles separating during drilling. Mark the two rectangles to retain correct orientation. Set the spindle to the middle of the 60mm width and on the centre of the card's thickness before drilling 5/16 inch diameter through the length of the 'sandwich' (**photo 39**). Take apart and dispose of the two pieces of card and put to one side. Repeat using the second set of wood and card rectangles, but this time drill 7/16 inch diameter (**photo 40**).

Forming rings

See **figs 24** and **25**. Hold a length of 16mm diameter brass or steel in a self-centring chuck with 20mm protruding and face off. Centre drill, drill 6mm diameter x 16mm deep. Because the purpose of this ring is to prevent an increase in the outside diameter whilst flaring the tube, I strongly recommend boring the 5/16 inch (7.94 ±0.02mm) diameter x 8mm deep hole required, as drilling generally produces an oversize hole with a debateable surface finish. Having achieved the bore dimensions, machine the 0.5mm radius detail as shown in fig 24. Part off the ring 6mm wide. Carefully remove any burr formed on the ring by the parting off. Put to one side.

Re-face the end surface, before opening out the 6mm diameter by drilling 10mm diameter x 8mm deep. Bore out to 7/16 inch (11.11 ±0.02mm) diameter, machine the 0.5mm radius detail as shown in fig 25 and part off the ring 6mm wide and deburr as before (**photo 41**).

Drilling the tube flaring clamp.

Two pairs of tube clamps.

Tube flaring drift

See **fig 26**. Hold a 70mm length of 12mm diameter mild steel or free cutting stainless in a self-centring chuck with 25mm protruding. Face off and machine 8mm diameter x 16mm long. Swing the top slide anticlockwise 5 degrees. Take light cuts, adjusting the depth of cut with the cross slide and feeding along slowly by hand using the top slide. Stop at the shoulder 16mm from the end, formed by the increase in diameter. Continue until the full-length of 16 mm has been machined to 5 degrees taper. Take care not to reduce below 8mm diameter. Machine the 1mm radius on the end face as drawn (**photo 42**).

Turn the rod around and hold with 25mm protruding. Face off. Take light cuts, adjusting the depth of cut with the cross slide and feeding along slowly by hand using the top slide. Stop when the length of 5 degrees taper section has reached 20mm. Machine the 1mm radius on the end face as shown (**photo 43**).

The result will be a double ended tapered drift that should just enter the deburred end of the relevant tube (**photo 44**).

Flaring rings.

Machining small end of flaring drift.

Machining large end of flaring drift.

Completed flaring drift.

Flaring the tubes

Slip the 7/16 inch diameter forming ring over the end of a firetube with the radiused face facing outwards, before locating the firetube between the pair of 7/16 inch flaring clamps. Adjust the assembly so that when the forming ring is butted firmly against the ends of both flaring clamps, the copper tube protrudes 3mm beyond the forming ring, with the tube horizontal midway between the top and bottom edges of the vice jaws and flush to the right hand side of the jaws (**photo 45**). Tighten the vice. Take the large end of the flaring drift and with a soft faced hammer gently tap the drift into the open end of the copper firetube, stopping when you feel the drift meet resistance (**photo 46**). Dismantle the flaring clamps, slide the forming ring down the length of the tube until it is free, and then repeat the process for the remaining five tubes. Put to one side.

Setting tube protrusion prior to flaring.

Flaring tube.

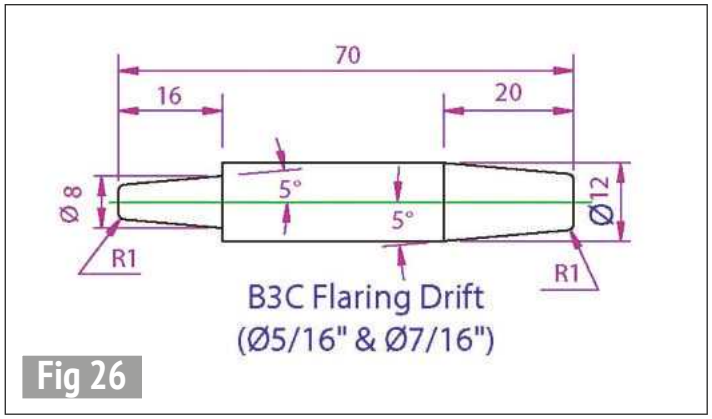
Using the 5/16 inch end of the drift, flaring clamps and ring, repeat the process on the seven 5/16 inch tubes, bearing in mind **less force** is required on the smaller diameter tube. Put to one side.

The ends of the tubes will now have a definite 'flare' consistently positioned 3mm in from one end of all the fire tubes (**photo 47**), the purpose of which will become clear a little later when the boiler assembly is undertaken.

Tubes after flaring.

●To be continued.

Next time we will flange the tube plates.



CLUB NEWS

Geoff Theasby reports on the latest news from the Clubs.

Andy Giffen's 15F at GCMES.

My worm precessor has developed a flute but I have a columbine to right, so bare with me...

GDPR permission is now required for data protection. The regulation has been differently interpreted by different people. Only one club has written to me asking my permission to keep my details on file. This was readily given. Others do not share such details and say my express permission is not needed. So, for the avoidance of any doubt, any club may take my permission to retain my details, as granted.

My model engineering career lurches along, like a train on a neglected railway. I'm building a clock. (Horologists turn away now! I have provided a bucket.) I downloaded a clock face which Deborah liked, from t'internet, stuck it to some Plastikard and fitted a quartz movement behind it, using suitably ornate hands. A second quartz movement, possibly a watch motor, will power the seconds hand in a separate dial. (So, it is not in synch with the main dial, how many will notice?) I'm still thinking how to drive the moon phase dial. One revolution in 28 days means a step down ratio of 672 to 1 from 1 rev per hour, before we start thinking about the precise length of a lunar month. Tamiya gearboxes might fit the bill, some can accommodate such a reduction or two in series. Fine adjustment could be made by feeding the motor through a simple voltage adjuster or an electronic timer switching the motor on and off every half minute or so.

In this issue; a lock-up, a matador, divination, a rustbucket, turbine blades, a last ride (for Cutie?) and a manual.

Carried over from *M.E.* 4591 are more photos from my visit to **Grimsby & Cleethorpes Model Engineering Society.** This SAR was built in South Africa and belongs to Andy Giffen (**photo 1**). **Photograph 2** is a close-up of the piping over the firebox. Geoff Hoad's Q1 is powered by electricity and ran all the time I was present. It was running for the first time at Grimsby (**photo 3**). The society's *The Blower,* June, opens with an interesting exhibit from the Doncaster Show; a Stirling engine, running off a tea light,

15F piping at GCMES.

Geoff Hoad's electric Q1 at GCMES.

driving an alternator to provide power to a transistor radio. A caption competition shows Paul Gilby driving his traction engine, with Dave Smith sitting on a trailer and bearing some form of horse whip, in case Paul runs amok. My enjoyable visit was photographed and documented. The photo shows your scribe slumped on a grassy bank recovering from the exertions of pressing his camera shutter and not suffering from a surfeit of lamps, it being broad daylight, even on the GWR. (Obscure joke.)
W. www.gcmes.com

Port Bay Express, June, from **Portarlington Bayside Miniature Railway** begins with an item by Norman Houghton on the river steamers plying twixt Brisbane and Ipswich, 40 km away upriver. Later, Queensland Railways took some traffic and by 1918 was the majority carrier. The river traffic continued until 1974, when floods destroyed the Ipswich wharf facilities.
W. www.miniature railway.com.au

City of Sunderland Model Engineering Society draws my attention to their latest newsletter, *The Oily Rag,* for June. Member, Bill Clouder has died, having reached the very respectable age of 98. President, Noel Maw once encountered real life water divining. Northumbrian Water couldn't find a pipe under his drive after hours looking with the aid of much electronic equipment. One of the water men produced two L-shaped bits of wire and found it immediately. Astounded, Noel asked for a try but nothing happened. His wife, Mary, had a go and it worked for her! Science does not yet have all the answers. A little humour is mentioned, from Paddy Roberts (whom God preserve) of the 1950s. A gently-spoken, witty performer of old folk songs with 'interesting' subjects. He can prove they are old folk songs because as a member of the old folk, he wrote them. I say no more.
https://www.youtube.com/watch?v=Fk62xSRXWK0
W. www.csmes.co.uk

The Whistle, June, **from British Columbia Society of Model Engineers** opens with a fine picture of young Jayden on the garden railway with his live steam 0-4-0 switcher. By the time you read this, the new garden railway will have had its public opening. Editor, Paul Ohannasian has written a ten-page article on this vast edifice, not built in the Albert Speer tradition but very well done all. There are lots of photographs including a fine collection of concrete blocks arranged around the site in an aesthetically pleasing manner. Paul also announces a 'shed sale' (he's selling a shed).
W. www.bcsme.org

Branch Lines, Summer, from **West Riding Small Locomotive Society** has Editor, Stuart Merton confessing to sailing the briny deep, in the Norwegian Fjords. Some are very deep, going 1 mile straight down from the surface, whilst the ship sails past only meters from the sheer rock. Debs and I went on such a cruise a year or two back and it was the best holiday I ever had. Stuart also heaps praise on his Alfa Romeo pin-ups (Cars, not er... other subjects) However, I will now rain on his parade by mentioning that utter rustbucket, the unlamented Alfasud...

On Track, June, from **Richmond Hill Live Steamers** sees them preparing for their big Open Day. Track fettled, station decorated, site swept and mowed; it's going to be a biggie!
W. www.richmond-hill-live-steamers.tripod.com

The Journal, June, arrives from the **Society of Model & Experimental Engineers**. It begins with Charles Marks describing his lathe attachments, including a chip tray, which he was told was essential. Although it looks good, he says it gets little use as it is much easier to lay a paper towel over the lathe slideways and just as effective! A mandrel crank handle (for use in manually rotating the lathe when cutting threads) is one of the most useful, however. Most of these items were made from Hemingway kits. In his 18th and final contribution on steam turbines, Mike Tilby explains how turbine blades were made in the early days, including forging root and blade in one piece and having to hold by the blade when cutting the root profile. Hollow blades were made by forming a steel outer around an iron core, then dissolving out the iron in an acid bath, leaving a hollow steel blade. Norman Billingham informs us that SMEE occasionally receives letters asking for help in building a perpetual motion, or zero-energy machine. He sets out exactly why these machines are not possible, despite what the conspiracy theorists claim. Finally, there is a photograph of Roger Backhouse receiving his award of the Tommy Bartlett Cup for the many and varied articles he has contributed to *The Journal*.
W. www.sm-ee.co.uk

The Waushakum Journal, May, from **Waushakum Live Steamers**, reveals that Roland Gosseln has sold the track from his Squannacook Junction railway, so Editor, J B Mentzer, asked for a last ride, accompanied by Hank Walther, before it was removed. This is documented in several photos.
W. www.waushakumlive steamers.org

The Cam, June, from **Cambridge & District Model Engineering Society** contains an informative item by President, Ian Morris on avoiding legal liability claims by taking any such incidents seriously, being seen to follow safety procedures and having a helpful, friendly attitude. Tim Coles reviews favourably the Doncaster Exhibition, paying particular attention to the Gas Turbine Builders' stand, often drawing crowds four deep when his GT3 locomotive was started up on its rolling road. Tim also reported on the Riverside Railway in St Neots, newly opened in May. 900 passengers were carried on the first day, with 1100 on the second, so great things are expected of this railway. Founder Ivan Hewlett had the idea for such an amenity only two years ago but it is not supported by a model engineering society as such.
W. www.cambridgemes.org.uk

The Prospectus, June, from **Reading Society of Model Engineers** opens with a good picture of tanks on the club lawn, under the command of Gill Whittaker. Though models, they are quite large. Note the guard dog (**photo 4**). Mike Manners relates a calamity from the recent running day, in that the Baldwin's valve gear became deranged and everything jammed. Sliding the locomotive into the steaming bay revealed that

Tanks on the lawn! Reading SME. (Photo courtesy of Mike Manners.)

the only way to treat this was to drop the front driving wheelset. The problem was that a wheel, 'keyed' on its axle with a machine screw, had rotated, rolling the axial locating screw around the axle-wheel joint. Locked solid! President, Les Dawson, noticed an AEC Matador remembered from his service in the 1950s RAF. '61249' continues his thoughts on the privatisation of his railway, giving the 'other side' of the often expressed desire to Nationalise them. The UK may have (some of) the highest fares in Europe but less well known is that we also have the lowest. John Spokes writes on the impermanence of the not-so-permanent way. The area of contact between rail and wheel is the size of a fingernail. If not properly set up, short wheelbase vehicles like 4-wheeled goods trucks will begin to 'hunt' or roll regularly from side to side. This is exacerbated by high speed and asymmetric dips in the level, as at rail joints and can lead to derailments. (I learned about this when tracklaying on the Welsh Highland – Geoff) 'Creep' next time (nothing to do with a teacher I knew...). 'Wolverton Pug' lists a number of departmental locomotives, including some exotic survivors.

W. www.prospectpark railway.co.uk

Welling & District Model Engineering Society's *Magazine*, June-July, contains Fred Holdsworth's description of the Furness Railway, which was much more extensive than I thought. Its second Chief Engineer was William Pettigrew, who wrote in 1899 what was to become a standard work on the subject, *A Manual of Locomotive Engineering*. Engineman Bert Hooker wrote in 1974 (for *Model Railway* magazine) an item on Bulleid locomotives. 'An engineers' locomotive,' he said. Mr Hooker was at one time a member of Welling & DMES. Activity in WWI German East Africa, a lesser -known conflict than it deserves, was led by one General von Lettow-Vorbeck, an equivalent of Laurence of Arabia and the British official history claims that the campaign against his terrorism was a notable military failure. C. S. Forester's *African Queen* is set amid this dispute.

W. www.wdmes.co.uk

I visited a radio rally and bought a millivolt meter and some small stuff. The original meter battery types are no longer available but someone has produced a 'fudge', using modern AAA cells, so I have ordered the bits. It appears untouched on the inside, therefore I am quite hopeful. The outside is quite attractive too; gone are the days when meters and switches were placed seemingly at random. It's an Advance VM78 if you are interested and it cost me £5. If it is junk, well the case is worth that... My test equipment has been without such a meter for years, so it isn't mere acquisition of 'stuff', although Deborah is not convinced. Ordinary test meters do not measure so low, and, furthermore, I can build a simple circuit which will help me use it more fully and which will also work with digital voltmeters and oscilloscopes. Jane Austen was correct when she wrote, 'It is a truth universally acknowledged that an experienced constructor in possession of a quality millivolt meter must be in need of an RF probe...' or something similar (**photo 5**). I also spotted a gentleman wearing a T-shirt publicising Welsh slate caverns so I greeted him with 'Iechyd da pob Cymru' and got a blank look.

VM78 millivoltmeter, rescued from a fate worse than death.

B&DSME News, June, from **Bournemouth & District Society of Model Engineers** reports that the Ellie Project continues apace, with many making lubricators as part of a lathe course and some boilers awaiting steam tests. An article in EiM caused a surge of interest. A 'well done', too, for Pippa and Sheila, who look after the colourful flower beds.

W. www.littledown railway.co.uk

Ryedale Society of Model Engineers' May *Newsheet* found Editor, Bill Putman, happily mowing the football field, innocent of any doubt as the mower was behaving well, when, Crunch! You guessed it...

W. www.rsme.org.uk

Well, I've run out of writing fodder again. I'll take the rest of the day off and see what tomorrow brings.

And finally; the item on Men in Sheds in *M.E.* 4588 reminds me of other uses for sheds, such as housing illicit stills, accommodating illegal immigrants, a trysting place, carnivorous plant breeding, eddies in the space-time continuum, tunnelling a secret way to the pub... . So remember, What Occurs in the Shed, Stays in the Shed, or 'Watch the wall my darling, as the men in sheds go by.'

Contact:
geofftheasby@gmail.com

AUGUST

1 **Bradford MES.** Summer steam-up, 7.30pm start, Northcliff track. Contact: Russ Coppin, 07815 048999.

1 **Brandon DSME.** Meeting at The Ram Hotel, Brandon, 7.45pm. Contact: Mick Wickens, 01842 813707.

1 **Bristol SMEE.** Talk: 'Sandford Station Railway Heritage Centre' – Lois Brenchley. Contact Dave Gray: 01275 857746.

1 **Grimsby & Cleethorpes MES.** Schools summer holiday public running, Waltham Windmill, noon-4pm. Contact Dave Smith: 01507 605901.

1 **Oxford (City of) SME.** Running day. Contact: secretary@cosme.org.uk.

2 **Sutton MEC.** Bits and pieces. Contact Paul Harding 0208 2544749.

2 **West Huntspill MES.** 'Summer Holiday' special, 2-4.30pm. Contact Geoff Stait: 01278 794176 (eve).

3 **North London SME.** Edward the Compressor rides again – bring an engine! Contact Ian Johnston: 0208 4490693.

3 **Portsmouth MES.** Members present their completed large projects, 6.30pm. Contact Roger Doyle: doyle.roger@sky.com.

3 **Rochdale SMEE.** '1965 Part 2' - Noel Coates, at Castleton Community Centre, 7.30pm. Contact Rod Hartley 07801 705193.

4 **Southampton SME.** 'Singles Day' – for 'single wheeler' locomotives. Contact David Goyder. 02380 421201.

4 **Tiverton & District MES.** Running day at Rackenford track. Contact Bob Evenett: 01884 252691.

4/5 **North Wiltshire MES.** Public running, Coate Water Country Park, Swindon, 11am-5pm. Contact Ken Parker: 07710 515507.

5 **Chingford DMEC.** Public running at Ridgeway Park. Contact secretarycdmec@gmail.com.

5 **Grimsby & Cleethorpes MES.** Public running and car boot sale, Waltham Windmill, noon-4pm. Contact Dave Smith: 01507 605901.

5 **Lancaster & Morecambe MES.** Public running at Cinderbarrow. Contact David Wilson: 07721 020489

5 **Northampton SME.** Open to the public 2 - 5pm. Contact: secretary@nsme.co.uk.

5 **Oxford (City of) SME.** Running day. Contact: secretary@cosme.org.uk.

5 **Portsmouth MES.** Public running, Bransbury Park, weather/participant dependant, 2-5pm. Contact Roger Doyle: doyle.roger@sky.com.

5 **Plymouth Miniature Steam.** Public running, Goodwin Park (PL6 6RE), 2 – 4.30pm. Contact Malcolm Preen: 01752 778083.

6 **Peterborough SME.** Bits and pieces, 7.30pm. Contact Terry Midgley: 01733 348385.

7 **Romney Marsh MES.** Track meeting, 1pm visitors/spectators. Contact Adrian Parker: 01303 894187.

8 **Grimsby & Cleethorpes MES.** Schools summer holiday public running, Waltham Windmill, noon-4pm. Contact Dave Smith: 01507 605901.

8 **Oxford (City of) SME.** Running day. Contact: secretary@cosme.org.uk.

9 **West Huntspill MES.** 'Summer Holiday' special, 2-4.30pm then loco running and fish'n'chip supper, 6-9pm. Contact Geoff Stait: 01278 794176 (eve).

10 **Tiverton & District MES.** Club meeting at Old Heathcoat Community Centre, Tiverton, 7.30pm. Contact Chris Catley: 01884 798370.

11 **Westland & Yeovil DMES.** Track running day 11am – 4.30pm. Contact Bob Perkins: 07984 931 993.

11/12 **Leeds SMEE.** August Rally and public running. Contact Geoff Shackleton: 01977 798138.

12 **Bracknell Railway Society.** Public running 2-4.30pm. Contact Paul Archer: 07543 679256.

12 **Cardiff MES.** Steam up and family day. Contact Rob Matthews: 02920 255000.

12 **Chingford DMEC.** Public running at Ridgeway Park. Contact secretarycdmec@gmail.com.

12 **Grimsby & Cleethorpes MES.** Public running, Waltham Windmill, noon-4pm. Contact Dave Smith: 01507 605901.

12 **Lancaster & Morecambe MES.** Public running at Cinderbarrow. Contact David Wilson: 07721 020489.

12 **North Wiltshire MES.** Public running, Coate Water Country Park, Swindon, 11am-5pm. Contact Ken Parker: 07710 515507.

12 **Portsmouth MES.** Public running, Bransbury Park, weather/participant dependant, 2-5pm. Contact Roger Doyle: doyle.roger@sky.com.

12 **Sutton MEC.** Sunday track day from noon. Contact Paul Harding 0208 2544749.

12 **Welling DMES.** Public running at Falconwood 2-5pm. Contact Martin Thompson: 01689 851413.

12 **West Huntspill MES.** 3½ inch gauge loco running day, 2-4.30pm. Contact Geoff Stait: 01278 794176 (eve).

14 **Romney Marsh MES.** Track meeting, 1pm visitors/spectators. Contact Adrian Parker: 01303 894187.

15 **Chingford DMEC.** H 2 O transportation. Contact secretarycdmec@gmail.com.

15 **Grimsby & Cleethorpes MES.** Schools summer holiday public running, Waltham Windmill, noon-4pm. Contact Dave Smith: 01507 605901.

15 **Oxford (City of) SME.** Running day. Contact: secretary@cosme.org.uk.

15 **Salisbury DMES.** Natter night. Contact Jonathan Maxwell: 01722 320848.

16 **Sutton MEC.** Club Night: fold and fly paper aeroplanes – materials supplied. Contact Paul Harding 0208 2544749.

16 **West Huntspill MES.** 'Summer Holiday' special, 2-4.30pm. Contact Geoff Stait: 01278 794176 (eve).

19 **Chingford DMEC.** Public running at Ridgeway Park. Contact secretarycdmec@gmail.com.

19 **Grimsby & Cleethorpes MES.** Public running, Waltham Windmill, noon-4pm. Contact Dave Smith: 01507 605901.

19 **Guildford MES.** Teddy Bear's Picnic 2-5pm. Contact Mike Sleigh: pr@gmes.org.uk

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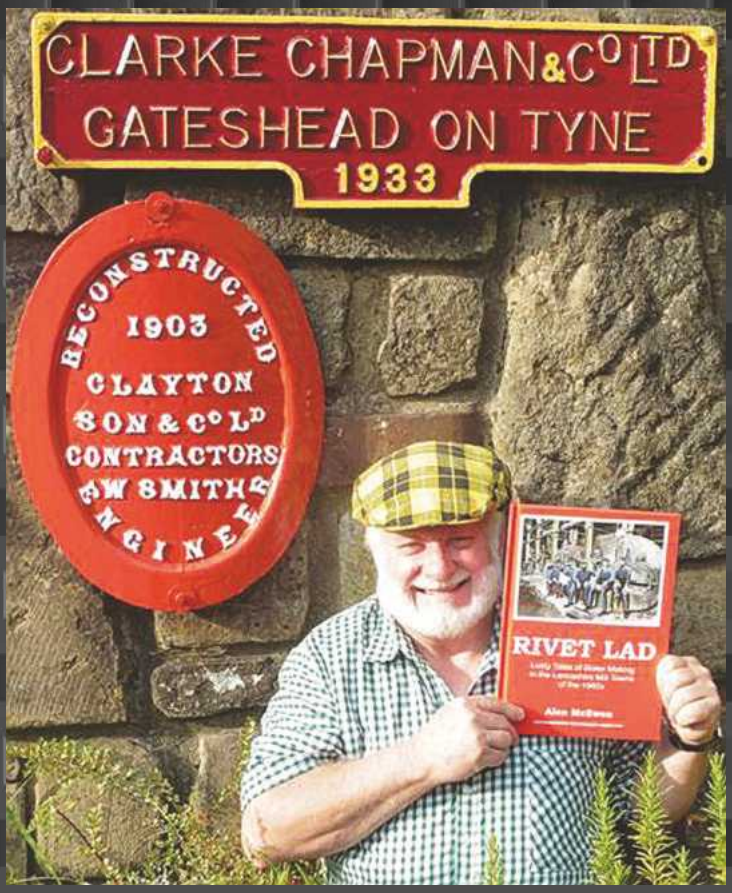

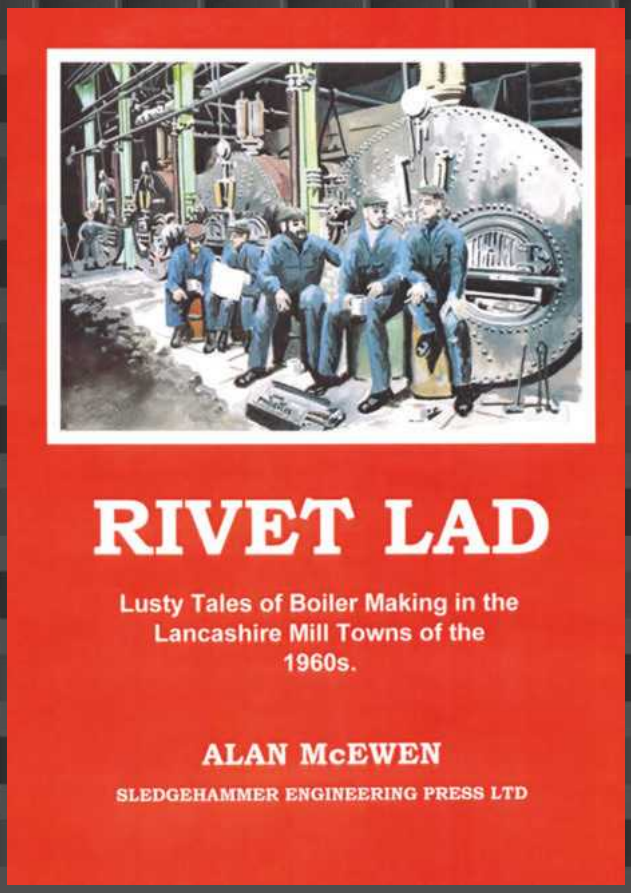

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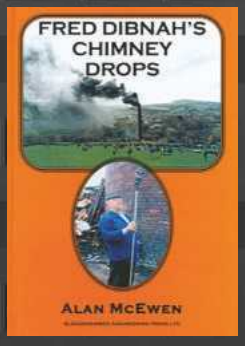

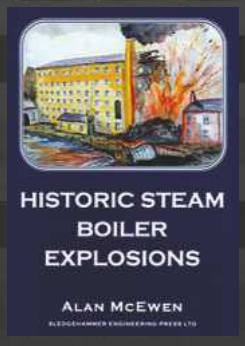

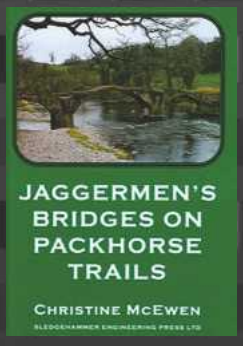

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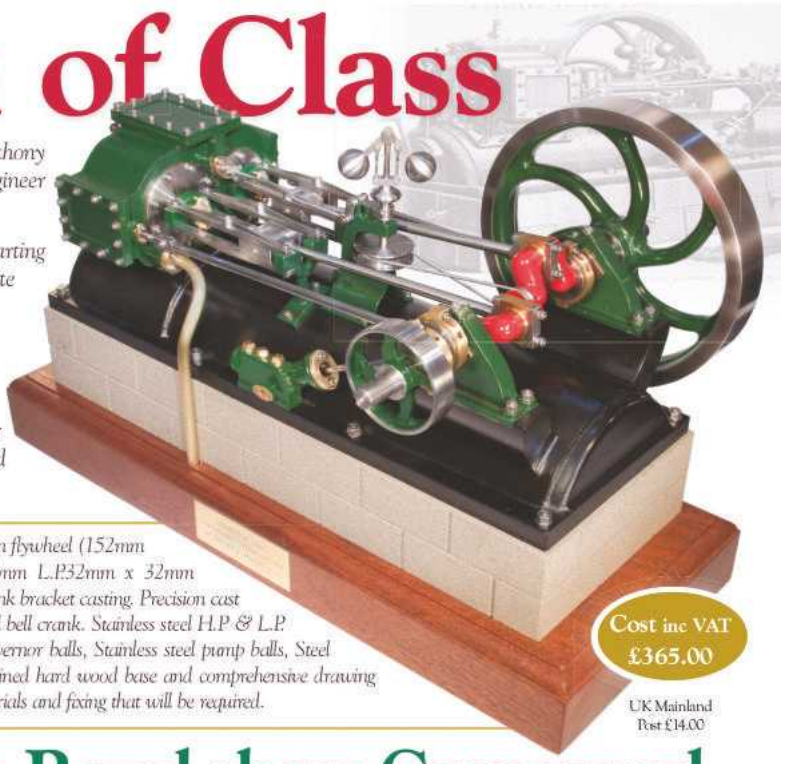

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