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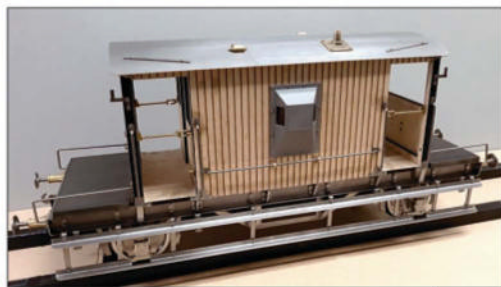
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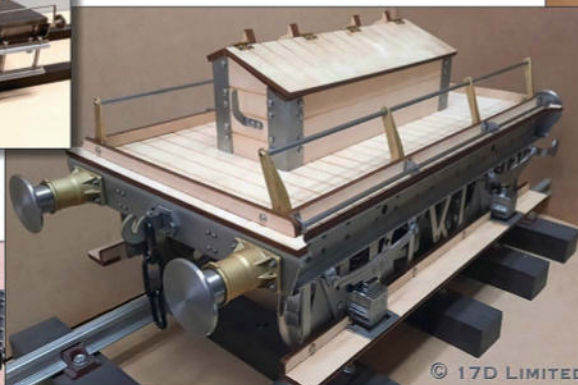
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MODEL ENGINEER

Published by Mortons Media Group Ltd,
Media Centre, Morton Way, Horncastle, Lincs LN9 6JR
Tel: 01507 529589 Fax: 01507 371066
© 2023 Mortons Media ISSN 0026-7325
www.model-engineer.co.uk

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www.classicmagazines.co.uk

ADVERTISING

Group advertising manager: Sue Keily
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Group, Media Centre, Morton Way,
Horncastle, Lincs LN9 6JR

PUBLISHING

Sales and distribution manager: Carl Smith
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SUBSCRIPTION

Full subscription rates (but see page 366 for offer):
(12 months, 26 issues, inc post and packing) –
UK £128.70. Export rates are also available,
UK subscriptions are zero-rated for the purposes
of Value Added Tax.
Enquiries: subscriptions@mortons.co.uk

PRINT AND DISTRIBUTIONS

Printed by: William Gibbons & Son, 26 Planetary
Road, Willenhall, West Midlands, WV13 3XB
Distribution by: Seymour Distribution Limited,
2 East Poultry Avenue, London EC1A 9PT

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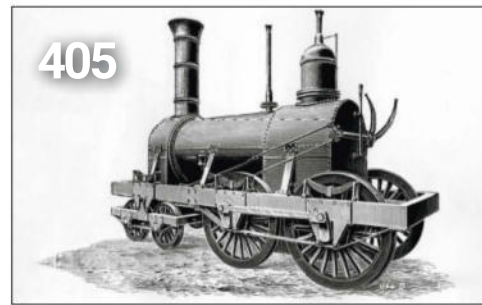
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This issue was published on March 8, 2024.
The next will be on sale on March 22, 2024.

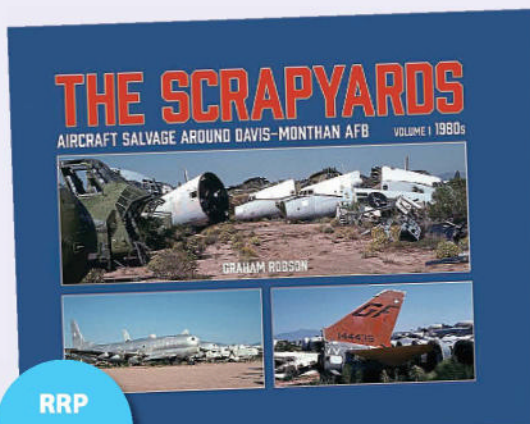


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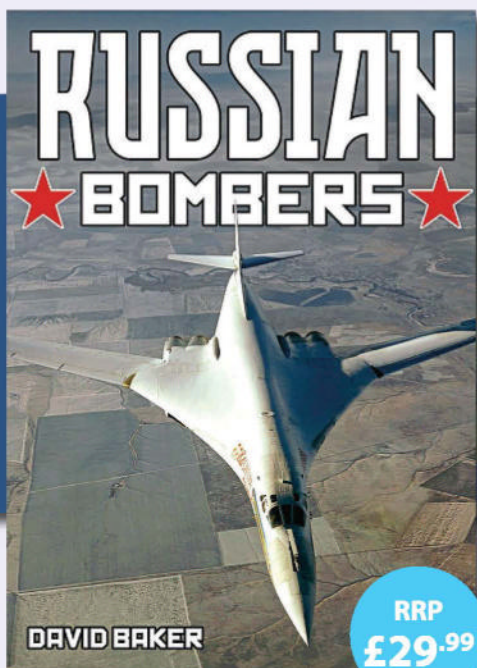
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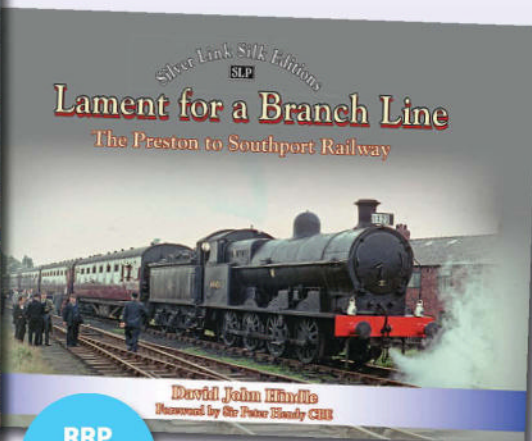
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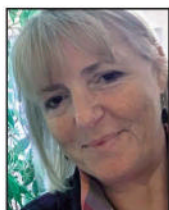
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Ellenroad Museum.

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Best of British

The UK's premier nostalgia and heritage magazine, *Best of British*, celebrates classic entertainment, transport, food and drink, and the great British countryside.

Regular features include *Treasures in the Attic* – a look at recently uncovered antiques and collectables, *Postcard from...* which casts a spotlight on a British town or city to visit or stay in, and *Window on the Past* – a compilation of archive images and memories from The Francis Frith Collection. As well as a lively six-page *Postbag*, readers are able share their stories in our *Yesterday Remembered* memoir section, while Doctor Who star Colin Baker writes about his personal connection to some of the issue's themes.

Features in the March issue will include a celebration 60 years of *Radio Caroline*, a visit to Beaumanor Hall – Bletchley Park's unknown other half, a chat with the Hovis boy, the history of the London Cigarette Card Company, a look at a British radio hoax that predates Orson Welles' *The War of the Worlds*, and an interview with John Lloyd, the man behind *Not the Nine O'clock News*, *Spitting Image*, *Blackadder* and *QI*.

Over the past 12 months we've looked at the origins of *Slade's Merry Xmas Everybody*, gone on the trail of the real-life *Dick Whittington*, looked back on 100 years of the *Shipping Forecast* and 180 years of *Nelson's Column*, uncovered the history of *Bentley Cars*, and celebrated 70 years of *Quatermass*, the golden age of motocross, and the record-breaking *InterCity 125*.

We've also featured interviews with the stars of

classic TV, film and music including *Randall & Hopkirk (Deceased)*'s Annette Andre, *Blue Peter*'s Sarah Greene, *Last of the Summer Wine*'s Sarah Thomas, *Doctor Who*'s Janet Fielding, *The Bill*'s Carry On's Larry Dann, *Carry On*'s Jacki Piper, *Grange Hill*'s EastEnders' Gary Hailes and *Return of the Saint*'s Ian Ogilvy.

You can find out more on www.classicmagazines.co.uk/bob002

Bradford Cup

The Bradford Cup is to be awarded to the author of the best article or series, by popular vote, published in *Model Engineer* during the previous year. Last year's winner was Steve Goodbody, for his series on *The Eating of Elephants*, who was presented with the cup at the National Railway Museum, York, by Adrian Shuttleworth, president of the Bradford Model Engineering Society.

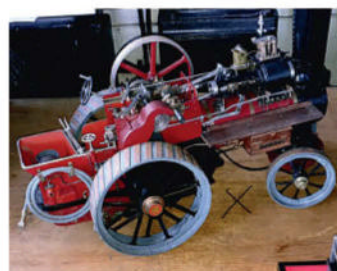
The organisers again invite nominations for the award of the trophy, to be submitted to the editor of *Model Engineer* by the end of March 2023, which should relate to articles published in *Model Engineer* during the year 2023. Readers will then be invited to vote for one of the top three nominations. Submissions should include the following:

- * The author's name;
- * The title of the article or series;
- * The issue number in which it starts;
- * Contact details for the person nominating the article.

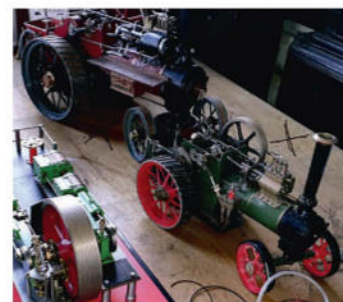
You may not, of course, nominate your own work!

Ellenroad Theft

I regret I have to report the theft of a couple of models. Bob



1 1/2 inch Allchin.



1 inch 'Minnie'.

Hayter writes to say:

'Our friends at Ellenroad Steam Museum, Milnrow near Rochdale, have unfortunately had a break in (late January). Stolen items were a collection of coins from the era when the mill was operating around 1900, a 1 1/2 inch Allchin traction engine and a 1 inch Minnie. Neither model has a boiler number. Photographs are attached. The museum can be contacted via their website www.ellenroad.org.uk'

Please let us know if you see either of these.

Scotsman Reverser

In *Postbag* last time (M.E.4738, February 23) Mike Joseph asked why the full sized *Flying Scotsman* and Peter Seymour-Howells's model had reverser stands of opposite handedness. Was this an error? As it happens, no, as some A3s were left-hand drive and some right-hand. The full-size stand pictured is for a left-hand drive locomotive but the model, as drawn by Don Young, is right-hand drive. Phew! Whoever said model engineering lacked excitement?

Correction

We have a case of mis-identification in Geoff Theasby's article on the Bodo Air Museum (M.E.4738, February 23). Photograph 2 shows what is claimed to be a Westland Lynx helicopter. Mr. Phil Mortimer has written to me to point out that it is, in fact, a Bell 204 helicopter. As a helicopter engineer who has worked on the Bell 204/205/212 series helicopters, he should know! To be fair, the outlines are fairly similar and I would be hard pushed to tell them apart.



Best of British.

BUILDING 3020 CORNWALL in 5 Inch Gauge

PART 1

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



The finished model of locomotive 3020 Cornwall.

The inspiration to build this locomotive

The idea of building this locomotive originated from discussions with a fellow member of the Northern Districts Model Engineering Society's (Perth, Western Australia) Bill Walker in early 2017. Bill is very interested in the early history of railways and he showed me some postcards from his collection and an article in a book called *Locomotives I have*

Known by J. N. Maskelyne, of a very attractive looking little locomotive, No. 3020 *Cornwall* (photos 1, 2 and 3). He suggested I might like to try building a model of it.

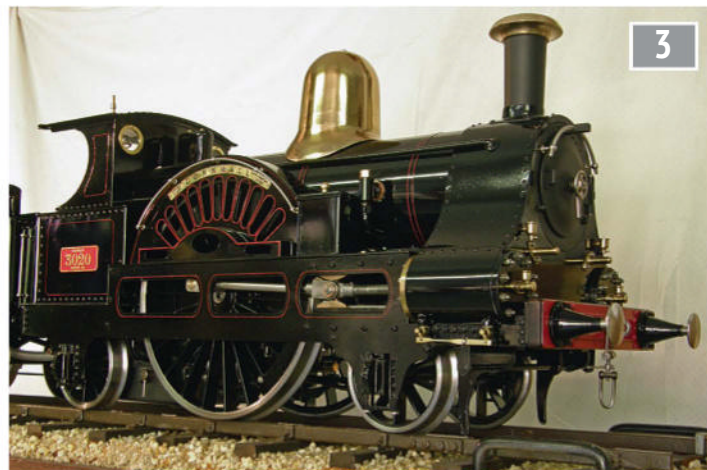
I gave this some serious thought over a period of time and started doing some research on *Cornwall*. A few things in its favour are that it still exists in preservation as part of the UK National Railway Museum collection and

there are some good photos of it available online; J. N. Maskelyne also provided some very detailed scale side and front elevation drawings of the locomotive and its tender in his book, based on his personal inspection.

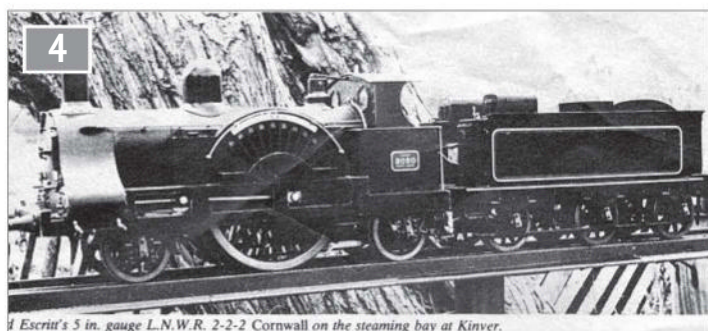
On the other hand, I could find no references to commercial model plans or castings being available, nor was there much information about any previous models of



A view of the Cornwall tender.



Lineside view of Cornwall.



Bernard Escritt's 5 inch gauge LNWR 2-2-2 Cornwall on the steaming bay at Kinver. Photo credit: Model Engineer magazine.

it that may have been made, apart from a picture of one in the UK in a 1982 *Model Engineer* magazine (photo 4).

If I was going to build *Cornwall* I would have to start from scratch and draw up my own plans for the model. Another challenge I thought I would like to take on was to fabricate everything, without using any castings. The wheels in particular have very thin spokes and would be difficult to cast to scale anyway. The biggest challenge with these was how to make the main driving wheels? My friend and co-conspirator in making difficult things happen, Ron Collins, came to the rescue here by suggesting that the spoke profiles could be wire cut out of a slice of steel billet.

So, with that encouragement, I set about drawing up the locomotive, scaling it for 5 inch gauge (the model to be approximately 1/11 of full size or 1 3/32 inch to the foot). I used J. N. Maskelyne's outlines as the basis and scaled the other features off various photographs of the full-size

engine. I decided it would not be an exact replica, but a coal-fired operating model with an exterior that closely resembles *Cornwall*.

To make it functional and hopefully reliable, I decided to use inside Stephenson's valve gear similar to that fitted to the rebuilt *Cornwall*. However, I followed the valve gear design for another model locomotive previously published in *Model Engineer* magazine (August, 1976) by Martin Evans, with some modifications for my own layout. I also made some further improvements after running the valve gear design through a software simulator for steam valve gear to check its performance in my application.

I decided that the two horizontal outside cylinders would be simple fabrications with slide valves, the frames would be laser cut from steel sheet and there would be a standard Australian Miniature Boiler Safety Committee Code-compliant copper boiler. The rest, as they say, is mere detail – but there is quite a lot of it!

Some history of the original locomotive

Cornwall has an interesting history which has allowed it to survive for over 175 years, although it had a major rebuild early in its life and has been overhauled several times since.

The locomotive was originally numbered No. 173 and was built at the Crewe Works of the London and North Western Railway (L&NWR) in 1847 as a 4-2-2 configuration (photo 5). The designer was Francis Trevithick, the son of the famous Cornish mining engineer, Richard Trevithick who was instrumental in the very early design and operation of high pressure steam locomotives for use in mines. Francis Trevithick was by this time the Locomotive Superintendent of the L&NWR. The locomotive was named *Cornwall* after the county of his birth.

Locomotive design during this era was highly competitive between the various railway companies and was largely focussed on the need for high speed for the emerging passenger services. Each company was competing to offer the quickest possible journey times. The only way this could be achieved with the technology of the day was to have locomotives with extremely large driving wheels, so that the rotational speed could be kept low while the velocity along the track was high.

Dynamic balancing of rotating and reciprocating

masses was poorly understood at the time and the strength of materials in use was variable. Locomotives whose wheels rotated too fast would quickly flog themselves, and the track on which they ran, to pieces.

The main problem with using such a large central driving wheel was that its axle was high above ground and conflicted with the boiler barrel, which needed to sit either above or below this axle. Placing the boiler above the axle raised the whole centre of gravity and made the locomotive more unstable, not a property compatible with high-speed running.

Thomas Crampton was another locomotive designer of the period who had come up with a solution to this problem, a few years earlier, by placing the large driving wheel at the rear, behind the firebox – a very distinctive and quite elegant arrangement. However, this necessitated a long, rigid wheelbase, which could damage the track. Crampton designs were popular in France and Germany but not so much in England, although the L&NWR did have a few of them which may have influenced the original design of *Cornwall*.

Francis Trevithick's answer to the speed and axle problem in the design of *Cornwall* was to use extremely large driving wheels (8 foot 6 inches or 2.6m diameter), placing the axle about 4 feet above the track, then slinging the boiler underneath it, with a transverse channel through the top of the boiler for the axle to pass through. In order to keep the wheelbase reasonably short, the trailing wheel axle then had to pass through a water-jacketed tube through the inside of the firebox. It worked, but all these complex compromises were difficult to manufacture, assemble and maintain.

In 1857 John Ramsbottom became Locomotive Superintendent of the Northern Division (lines north of Rugby) of the L&NWR, based at Crewe. Ramsbottom was another prolific and influential figure

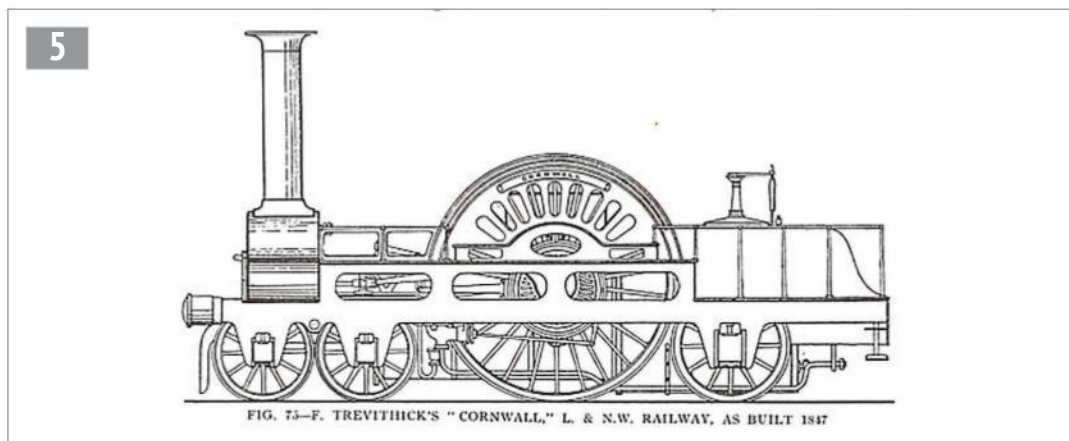
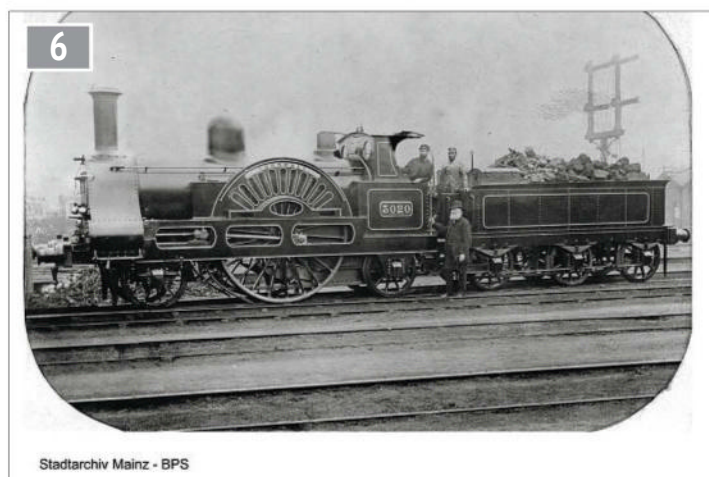


FIG. 73—F. TREVITHICK'S "CORNWALL," L. & N.W. RAILWAY, AS BUILT 1847

Cornwall as built in 1847. Photo credit: E. L. Ahrons (1927). British Steam Railway Locomotives. Source: https://commons.wikimedia.org/wiki/File:Locomotive_Cornwall_as_built_1847.png



Cornwall as rebuilt in 1858. Photo credit: Unknown, public domain. Source: https://commons.wikimedia.org/wiki/File:HLB_Lok_2.jpg

in steam engine development, his credits including the introduction of water troughs, the Ramsbottom safety valve and displacement lubricators, as well as other engineering inventions and improvements.

In 1858, Ramsbottom redesigned *Cornwall* almost completely. The young draughtsman who did the detail design drawings was to become yet another influential figure in railway history – Francis Webb.

Little of the original *Cornwall* survived the rebuild unchanged, other than the outside frames,

the connecting rods, the driving wheels with their distinctive 'paddle wheel' style splashers and, of course, the name. The wheel arrangement was now 2-2-2, shortening the wheelbase to just over 14 feet.

A new boiler was placed entirely above the centre driving axle in what would now be regarded as conventional practice, with the firebox dropping down between the centre axle and the trailing wheel axle. New cylinders were provided, fractionally smaller at $17\frac{1}{4} \times 24$ inches, with Stephenson's valve gear

inside the frames. Standard L&NWR fittings replaced the original Crampton-like features, including Ramsbottom's newly designed tamper-proof safety valves.

Another minor re-build in the 1870s provided a typical L&NWR style cab, with a short roof and semi-open sides. *Cornwall* was renumbered No. 3020 in 1886, as shown in **photo 6**.

Cornwall was a very successful, high-speed passenger express locomotive of its period. Records exist showing it running at an average speed of 50.7mph between Crewe and Chester in 1884, reaching top speeds over 70mph. It has been claimed that the locomotive achieved a speed of 85-90mph in 1919 and legends persist that it once topped the magical 100mph. This seems unlikely given the technology of the locomotive and the state of the track at that time, but it certainly had an exciting turn of speed!

The engine in its present condition dates from 1887 when it was given a new boiler and a circular smokebox door. *Cornwall* remained in regular passenger service

until December 1907 when it was withdrawn and put into Crewe Works Museum for a short time. In 1911 it returned to service until 1913, at which time it was fitted with a combined tender and saloon on a six-wheeled underframe and put into service as the Chief Mechanical Engineer Charles Bowen-Cooke's personal inspection train.

It appears the CME had a particular affection for *Cornwall*. The locomotive's normal black dome casing was rubbed back to polished brass, which was almost certainly unique on an L&NWR engine, and which it reputedly retained until 1927. It is last known to have operated in service in July 1920 when it conveyed Charles Bowen-Cooke in the CME saloon to Euston to visit his doctor. On its final retirement, *Cornwall* was deliberately put aside for long-term preservation, one of the first locomotives to be treated this way. By this time it had covered more than 1,000,000 miles in service.

Cornwall took part in steam during the Stockton & Darlington Railway and the Liverpool & Manchester Railway Centenary celebrations in 1925 and 1930 respectively. *Cornwall* retained its authentic L&NWR livery until early 1949, when it was repainted at Crewe. It was then exhibited at the Museum of British Transport at Clapham between 1963 and 1973. It returned to Crewe Works in 1975 prior to being acquired by the National Railway Museum and going on display at the NRM in York.

Cornwall was scheduled to take part in steam at the Rocket 150 celebrations at Rainhill in 1980 but the state of its boiler was found to be far beyond economic repair. It has since been cosmetically restored and has been out on loan for display at various venues (**photo 7**). Unfortunately, it appears that this graceful old survivor *Cornwall* is unlikely to ever run in steam again... but perhaps the model will!



Cornwall at Shildon in 2009. Photo credit: Gillett's Crossing from Bristol, United Kingdom.

● To be continued.

An Engineer's Day Out

A ride on the North Eastern Railway Autocar

Roger Backhouse spends the day at the Embsay and Bolton Abbey Railway.



In September last year I enjoyed a very pleasant day out with York Model Engineers - for a train ride (photo 1). Not your average preserved railway trip but to travel in the world's first internal combustion passenger train (photo 2). It is arguably just as significant in railway history as Stephenson's *Locomotion* or *Rocket* as it pioneered today's diesel electrics and multiple units. Over lunch members also enjoyed a presentation about the restoration by Stephen Middleton and Steve Hoather, both long term volunteers in the NER Electric Autocar project. Theirs was a remarkable story.

The railway

After years of dereliction, the autocar has been superbly restored and now runs regular services on the Embsay and Bolton Abbey Steam Railway, one of Yorkshire's shorter preserved lines at 4½ miles, but with plenty to see. The line is part of the former Midland Railway route from Skipton to Ilkley, where it linked to the North Eastern Railway. The preserved line keeps much of the Midland flavour with a Company signal box at Bolton Abbey, originally from Guiseley (photo 3). If the station seems large for the area, remember this line once handled significant excursion

traffic from Yorkshire's cities to this attractive area which is close to the present Yorkshire Dales National Park.

The autocar

At the start of the 20th Century, the North Eastern Railway was a highly enterprising company. Wilson Worsdell was Chief Mechanical Engineer and Vincent Raven Assistant CME. In the face of competition from electric tramways which were hitting urban passenger services, it electrified lines around Tyneside with great success. It had plans for mainline electrification from York to Newcastle but these were aborted by the First World War and later amalgamation into the London and North-Eastern Railway.

Engineers knew of the success of electric motors driving trains and were interested in possibilities on branch lines where the expense of third rail or overhead electrification could not be justified. Their solution was to create railcars which had a petrol engine that drove a dynamo to power the electric motor. Diesels were not then developed for transport use. These were the world's first internal combustion powered electric driven rail vehicles and anticipated later diesel multiple units. There was no need for a locomotive to run round a train and operation would be cleaner for passengers (photo 4).

Experimental railcars, numbered 3170 and 3171, were built at York Carriage Works in 1902-3, the first



The NER Autocar with trailer on the Bolton Abbey and Embsay Railway. Photo: Ian Cawthorne, 2023.



York model engineers await departure of the North Eastern Autocar. They thoroughly enjoyed their ride.



Signal box from Guiseley helps keep the Midland spirit of the line evident.



NER Autocar no 3170 with trailer photographed near Poppleton Junction probably around 1923. Photo: Ken Hoole Study Centre.

entering service in 1903. Although looking much like electric railway carriages of the period, with a clerestory, bow ends and large windows, they housed an engine room and had upholstered tramway type reversible seating (**photo 5**).

Like other carriages of their period they were made of wood and matchboard sides gave a decidedly American look. They had an open saloon, an engine room with the driver's position, a vestibule and then a rear driving compartment so the car could be driven from either end.

Inside they had electric lighting and had a certain 'Pullman' touch with the addition of curtains at the windows and so were popular with passengers. Both autocars had a whistle fitted, blown via an electrically driven compressor. Besides airbrakes there was an electric track brake as in tramway practice.

After first installing a vertical Napier engine, which was not

successful, the NER tried an 80 hp Wolseley petrol engine which was effective and lasted in service until 1923 when 3170's engine was replaced with one of 225 hp, reputed to have come from a First World War tank (**photo 6**).

This enhanced the torque and allowed it to haul an autococh trailer. Though maximum speed remained at around 36 mph the autocars were still considered underpowered.

It's worth remembering that this was a real pioneering venture; the world's first use of an internal combustion engine in a passenger carrying rail vehicle.

First used from Hartlepool to West Hartlepool, the autocars later operated routes including Scarborough to Filey before working the Selby to Cawood branch. From 1923 3170 worked services around Starbeck and it may have supplemented services on other LNER lines. Rapid starting



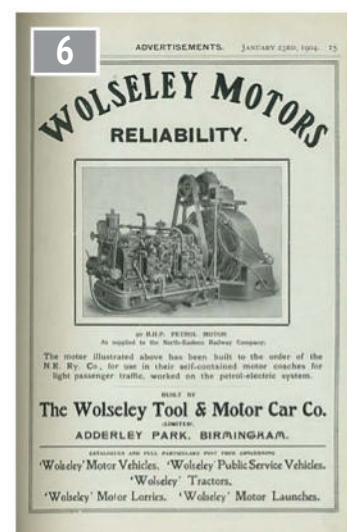
Frontal view as the Autocar arrives at Embsay watched by members of York Model Engineers.

would have made autocars ideal as a complementary service.

There is no evidence of a trailer except in one old photograph which may have been taken after the Autocar was re-engined in 1923. The NER Autocar Trust has added a trailer to increase carrying capacity.

Despite rapid acceleration the railcars had a limited top speed, though that could have been improved with a more powerful engine. Given the services operated, high speed was not a priority.

In retrospect it seems surprising that the railcar concept was not developed by the LNER. Perhaps internal combustion railcars did not fit with a steam dominated LNER mindset which used Sentinel



Advertisement for a Wolseley engine. These were the second engines to be installed and lasted until 1923.

steam railcars in the 1930s. It was a missed opportunity for the railway.



7
Derelict autocar in a field near Kirbymoorside. Inside the condition was surprisingly good. Photo: Stephen Middleton, 2003.



9
Underframe with Cummins engine under test on the Great Central Railway. Photo: Alan Chandler, 2016.

Dereliction and restoration

The autocars were withdrawn in 1930 and 1931. One was scrapped but the body of 3170 was sold and moved to a field near Kirbymoorside as a holiday home (**photo 7**). Stephen Middleton, a self-confessed Victorian carriage enthusiast, says 'it was disguised as a hedge' and arranged for its removal. He found original interior wood in surprisingly good condition but no underframe. Stephen then formed the NER Autocar Trust, a registered charity. They approached the Heritage Lottery Fund (HLF) for financial help who allowed two years for the Trust to prepare a business case before agreeing funding. After a commercial firm asked for £25,000 just to prepare an estimate of work needed, Steve Hoather, a retired British Rail engineer involved in the introduction of HSTs to service on the East Coast Main Line, wrote the performance specification. Details

were agreed with trustees and they approached five firms for quotes to do the work.

Key points included the need to operate as a two car unit, as carrying more passengers improved operational economics. It specified a maximum speed of 25 mph, as found on preserved railways, and an ability to start on a 1 in 49 gradient, the steepest on a British preserved line, as the Autocar might move to different railways. An underframe, engine and a motor bogie were required.

After using a temporary underframe, the Trust sourced a near correct frame, with Fox bogies and turnbuckle truss rods, from the North Norfolk Railway where it was used as a crane runner. They found former Southern Region motor bogies in Buckinghamshire, formerly fitted to a Sandite de-icing unit. The trailing bogie was restored at the Ffestiniog Railway's Boston Lodge works.

As the original engine had



8
The Cummins diesel engine was chosen and installed. Photo David Moore, 2012.



10
Body work restoration. Photo: Alan Chandler, 2015

long gone and petrol engines are no longer permitted, the engine (**photo 8**) was a new Cummins QSL six cylinder 8.8 litre diesel. It runs at 1800 rpm and powers main and auxiliary three phase alternators. The main alternator operates two standard Southern electric DC EE507 traction motors through a rectifier obtained from a Class 47 locomotive fitted for electric train heating (**photo 9**).

With these key elements available, the Heritage Lottery Fund recognised the importance of the project and agreed to fund the full amount requested of £468,000. The Trust had previously sought bids to carry out the work and Brush at Loughborough agreed to quote for restoration, but when Wabtec took over Brush they wouldn't do the work. However, it was carried out under the direct supervision of David Moore and coordinated by Steve Hoather. The HLF asked that the work be completed in five years

and eventually it took seven (**photo 10**).

Steve Hoather describes himself as a 'Steptoe' looking round for scrap parts, receiving 'excellent cooperation' from all around the rail industry. Even engineers he'd never met were amazingly helpful. Brakes are a British Rail type automatic air brake, in line with NER practice which used Westinghouse braking. There are separate brake cylinders for each bogie. Brake valves came from Northern Ireland Railways and West Coast Main Line stock. The original vehicle was air braked, then, around 1930, the LNER converted it to vacuum brake and it is now dual air/vacuum braked.

The controller and deadman's pedal were from a Class 58 diesel, cab gauges from an HST unit, the controller handles from a Class 08 shunter and a rectifier from a Class 47 diesel. It is quite a Heinz vehicle!

The whistle may bring



View of the driving position. Control arrangement is similar to British Rail era diesel locomotives.



Autocar interior superbly restored with reversible seats and electric lighting. Photo: Alan Chandler, 2017.



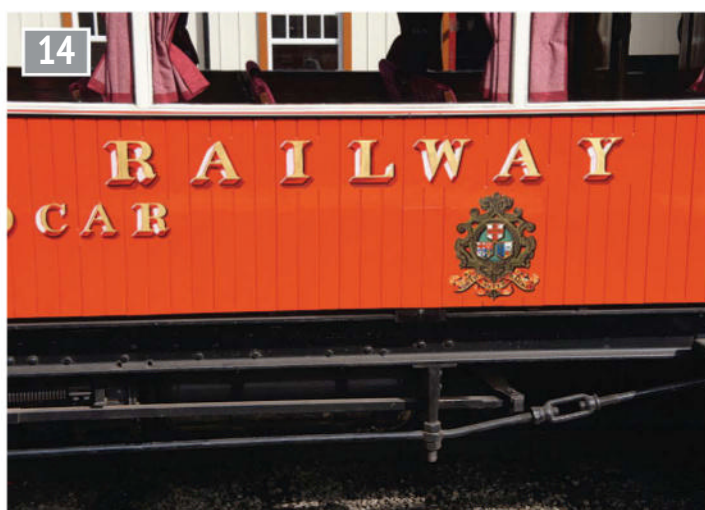
NER Autocar Trust volunteer, John Furness has done all the painting, varnishing and lettering and is seen here varnishing the trailer.

back memories for London commuters. Familiar to those who've used London's Metropolitan line, it came from LUL Amersham rolling stock.

Cab controls are similar to most British Rail locomotives with a standard controller

key. David Moore built the cab desks (**photo 11**).

Updating included fitting fire detectors and the engine is in a specially made housing offering a minimum of thirty minutes protection which allows time for evacuation



Autocar lettering is superb.

should that be necessary. HLF requires educational benefits to be apparent so an array of dials and gauges shows exactly what's happening with the engine.

Interior fittings include upholstered reversible seats copied from those on a Grimsby and Immingham tram at Crich (**photo 12**). Curtains have been fitted to the power car, which is electrically heated, and there are even straps fitted for standing passengers. The electric heating fitted has to cope with a variable voltage/variable frequency supply from the alternator. Drawings and a spares list have been prepared for future reference.

The trailer

The NER Autocar Trust has added a trailer to increase carrying capacity. This came from the NER Coach Association based on the North York

Moors Railway, who donated NER autocar No. 3453, built in 1904. They had restored it cosmetically in 1975 but since then it had deteriorated significantly.

The autocar was an historically appropriate matching vehicle to use as a trailer having the round porthole windows in the van end shown on the old photograph mentioned above. It was originally a steam push-pull driving coach. This vehicle too has been superbly restored.

During York Model Engineers' visit, Trust volunteer, John Furness was varnishing the woodwork (**photo 13**). He was responsible for all the painting, varnishing and lettering on the Autocar sides and what a beautiful sight it is (**photo 14**). Quite incredibly, the North Eastern Railway transfers are original, reportedly found in a drawer at York Carriage Works. ➤



The London and South Western Railway built this saloon coach for Queen Victoria.

After the ride

Following their ride on the Autocar, York's members enjoyed a conducted tour of the railway sheds where a number of interesting carriages, including several classic vehicles belonging to Stephen Middleton's *Stately Trains* were seen. Some are available for hire on special trains.

One special vehicle is Queen Victoria's saloon, built for her travel by the London and South Western Railway (photo 15). The realistic dummy of the Queen was found in a skip, thrown out by the National Railway Museum. Her Majesty was not amused.

Other vehicles seen were an LNER Thompson buffet car that probably featured in the film *Elizabethan Express*, a Bulleid carriage and a London and North Western Railway Director's saloon. Two LMS built coaches from Ireland had been sent there following an air raid on Belfast that destroyed much stock. Having been re-

gauged to 5 foot 3 inch, they are now back on UK standard gauge bogies.

Locomotives included a Fowler diesel shunter and a Lancashire and Yorkshire Railway 0-6-0 outside (photo 16).

Operation

The Autocar has operated on the Bolton Abbey to Embsay Railway since 2019. Beside summer service trains, usually on Mondays, the Trust also offers driver experience days.

Thanks to Ian Cawthorne, Alan Chandler, Steve Hoather and Stephen Middleton for help with this article and use of photographs. Particular thanks to Dianne Clunas who organised the visit (photo 17). A donation will be made to the NER Autocar Trust.

Thanks also to staff and volunteers at the Embsay and Bolton Abbey Railway for their help in making this a great day out.



Busman's holiday? Dianne Clunas was a driver with TransPennine Express and organised York Model Engineers' visit. Seen here trying out the Autocar controls.



Lancashire and Yorkshire Railway 0-6-0.

Further information:

The NER 1903 Autocar Trust

Membership Secretary
2 Lairs Crescent, Snainton, North Yorkshire YO13 9BQ
Website: www.electricautocar.co.uk

Embsay and Bolton Abbey Railway

Bolton Abbey Station
Bolton Abbey, Skipton, North Yorkshire BD23 6AF
Phone: 01756 710 614
Talking Timetables & Fax:
01756 795189
www.embsayboltonabbeyrailway.org.uk

Note that the Autocar may be hired out to other railways but details are not yet confirmed.

Group visits

York Model Engineers enjoyed their day out. Why not organise a visit from your model engineering society? You won't be disappointed.

Reaching the railway

There is a large car park at Embsay Station. The Dalesbus minibus service runs hourly on Mondays to Fridays from Skipton to Embsay and there is an infrequent Sunday service from Skipton railway station.

Note – the railcar is as at the GCR in Loughborough for the winter.

ME

Propane, an Ideal Model Locomotive Fuel

Charles Reiter explains the benefits of using propane to fire miniature locomotives.



Propane gas (fig 1) is not manufactured, it is a fossil fuel separated from crude oil by a process called 'cracking', discovered in 1857 by the French chemist Marcellin Berthelot and again in 1910 when it was discovered by American chemist Walter Snelling as a component of the then gasoline. He had the good sense to patent it. Gasoline was at that time sold in gallon sized containers and was very volatile. Buyers complained that they would get a container and by the time they tried to use it about half of it would have flashed off into the atmosphere. The higher vapour pressure of the propane component would boil off and cause the gasoline to be agitated and vapourize too.

Propane and butane are very alike and can be used in the same burner systems except that propane has a much higher vapour pressure. At 70 degrees Fahrenheit propane's

vapour pressure is 110 psi, versus 35 psi for butane. This is why your BBQ tank is steel and your pocket lighter is made of plastic. Oddly, butane has a slight edge in the amount of heat per volume. In the southern United States the propane you buy has more butane in it especially as a 'summer' mix and if you get your motorhome tanks filled while on summer vacation in Texas you won't be able to get a flame in Minnesota at Christmas. Propane and butane are both heavier than air and so they will 'pool' in containments like boats or closed bottom rail cars. This is compounded by the fact that compressed gasses leak unnoticed through very tiny openings. With pressures of 100 psi and above propane systems have to be durable. Pipes and hoses should be rated for pressure. Propane hose is rated for 300 psi and is physically durable.

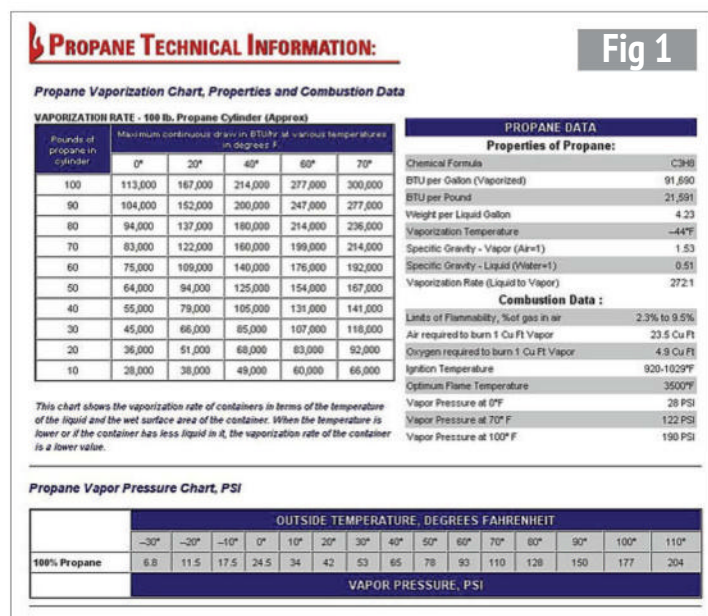
For our use the propane pressure needs to be reduced. This is accomplished by mounting a regulator at the tank. I recommend barbecue regulators that are adjustable and also recommend a gauge in the line so you know what your pressure is. Barbecues usually run at about 3 pounds pressure and most of the locomotive burners I have seen operate at 5 to 10 pounds of pressure.

A propane fire is basically just hot gas. Sure, there is some radiant energy released but nothing like our traditional solid fuels. The biggest problems for the use of propane in model locomotives are poor burner design and a lack of understanding of just what is happening in the firebox. So many burners

are mounted too high. The refitting of a gas burner to a coal burning locomotive is generally with the manifold mounted near the level of the original grate, with barber jets. These place the flames almost two inches higher than the grate so much of the water legs is heated by conduction, not directly. Add to that the cold air flowing into the firebox and cooling the firebox wall. I suppose you could make a case for 'it's preheating the air' but warmer air is less dense. I read a study of model locomotives that claimed that 80% of the heat of a coal fire was transferred in the firebox. You can imagine that it's going to be a lot more evenly distributed with a gas fire.

All of the 'science' of smokebox draughting and petticoats is pretty useless for propane. The ideal draughting now is to eliminate the pulsations of the exhaust up the stack and create a low but constant draught. The draught should draw secondary air into the firebox and evacuate the burnt fuel into the smokebox at a rate that just matches the gas burning rate. That's the ideal because with too little draught your fire becomes too rich and stinky as partially burnt gasses choke the fire. Too much draught and you're just wasting energy as the heat that is produced is very quickly evacuated to the smokebox and blown up the stack.

The secondary air is the air that is drawn into the burner area around the flames to provide an abundance of oxygen to further complete combustion. Air of course is a mixture of gasses and the one we need is oxygen which is typically 21% of the air. The



Some data showing the relative temperature pressure relationship and storage capacities.



1 A group of Barber jets, star and fan pattern. With a couple of jet burners and a propane torch head as well.



2 A home-made eight jet impinged burner with temporary gas connection for test.



3 Not quite, full burner.



4 A really extravagant and a simple bar burner. A ten-jet impinged burner with extra, smaller jets that create less heat. Also, a ceramic burner tile and mixing venturis both home-made and salvaged.

other gasses are along for the ride and are a medium to carry the heat. So the superheated gasses want to dump that heat and at 1500 degrees or so, a 300 degree locomotive boiler looks really cool. The challenge is to get enough gas to transfer its heat to the boiler walls, without pulling in too much cooling gas.

Primary air is that air that is initially mixed with propane gas in the burner to allow the gas to burn well, combining the hydrocarbons with oxygen. It is a reaction that starts with the addition of a little energy (a spark) and then the reaction releases so much heat it is easily self-sustaining. The burners job is to mix those gasses in the right ratios to release the maximum amount of heat. The volumes of propane to air are very different. Remember there is a lot of gas (78%) that is not part of the reaction that also needs to pass through the burner.

Hence the great size difference between the gas orifice and the ports supplying the air. Also, just to complicate this already complex system, we mix pressurized propane with air at atmospheric pressure. A jet of propane shoots out of the orifice at high speed expanding as it goes and the slight vacuum created behind it, drags the air into the burner. Ideally, there is enough but not so much air that you diminish the slight vacuum pressure in the mixing area.

Of course, we desire a system that has a wide control area and we control the output of the burner by turning up and down the gas flow. Let me point out that every valve is a pressure regulator, and as we close the control valve the gas pressure at the orifice (mixing jet) is lowered and the

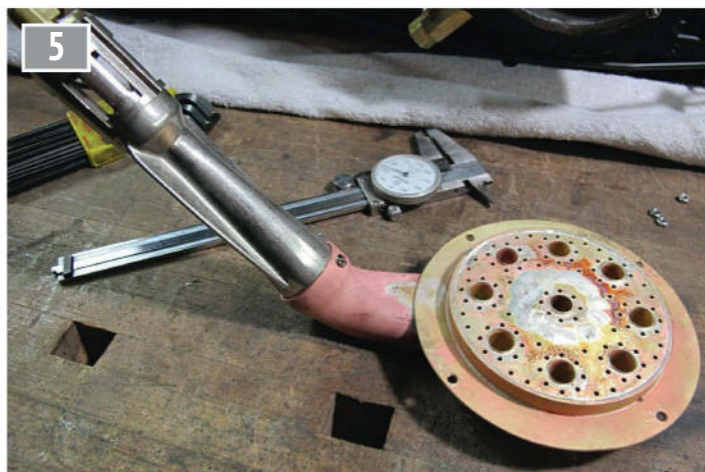
gas jet is not as energetic so the vacuum pressure drops and the amount of air dragged into the mix decreases. But it is not linear. The good news is that the system is fairly tolerant of these changes and our use

is fairly constant. I mean you use about the same amount of heat constantly unless you are just not using any steam. If your burner was too big then you could find yourself using less heat and operating in an inefficient area where the gas mix will go rich from not inducing enough air.

It seems like an ideal system would be one that turns on the required number of burners as needed. I built a burner array like that but although the theory was good, burners that are just sitting in the firebox with no cooling gasses flowing through them melt. Furthermore, in testing, throttling the gas supply worked as well as the staged burners.

The burners

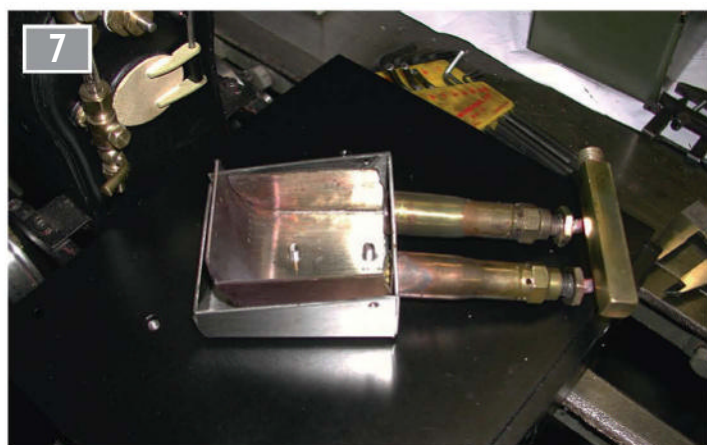
Live steamers basically use three types of burners - Barber jets, impinged burners and bar burners, and that seems to be



5 This burner was later replaced with one that was even thinner. The tube to the left is a venturi mixing the gas and air.



Here's a ceramic burner in a 4 inch diameter vertical boiler using a propane torch burner as a mixing system.



Here is a two-jet burner for a Tich firebox. It is made with repurposed propane torch burners.

in order of popularity (**photo 1**). Barber jets are a family of individually mixing units with various sizes and top caps to spread the air/gas mixing different patterns. The most commonly used is the star pattern. By making a manifold with mounting holes, arrays of burners can be created very easily and with some care the results are very successful. The burners need to have enough room around them for the flame pattern to do its job of mixing in the secondary air. For narrow fireboxes a fan pattern can be a better choice and with the fans spreading across

the width more burners can be utilized.

I recently built a burner with a single row of six fan burners. Now it's five burners because the air coming into the burner caused the furthest burner to starve and not mix gasses well. The burner assembly worked better with fewer burners operating at higher levels.

Larger fire boxes can benefit from an impinged burner design (**photo 2**). An impinged burner utilizes pairs of burner jets that have no spreader caps. The air/fuel mix is a stream and the pair of burners is mounted to cause the gas

streams to impinge on each other at 90 degrees. In use a ball of flame is formed at the point the streams impinge and this ball of flame uses all the air it needs. This type of burner is very efficient and clean burning and it also seems to throttle well - a time when 'crossing the streams' is a good thing. The mounting for the jets is more complicated but burner units made of cast iron are easily available through the internet. The obvious issue is that this type of burner needs a bit more height in the firebox.

I recently supplied a friend with a larger impinged burner for a gorgeous antique coal stove that heats his home and we ended up plugging four of the jets to lower the amount of heat. It was already using the smaller type of jet burner but this fine tuning made it just what he needed (**photo 3**).

Bar burners are often seen in stove ovens and barbeques (**photo 4**). The style is a piece of tubing with many narrow slits cut into the top surface or rows of perforations. In its simplest form the gas/fuel mix is accomplished at one end with a jet of gas firing through a simple venturi to drag the air

in and mix with the gas. This mixture then flows through the slots or perforations. The gas pressure in the tube is very low but the flames cannot propagate through the little holes.

Another burner I need to mention is one of my own devising. It was inspired by the need to have a good burner in the very shallow space under a tee boilered Shay, specifically a model of the MichCal #2. Based on the Bill Harris design, there is very little space under the boiler. To mount Barber jets in the firebox would place the burners very high and the air inlets to the burners would be in the area of the fire. Harris used a modified version of the Shattock pot burner for liquid fuel vapourization.

I built a burner plenum by making a box with circular arrays of burner holes, each around a center tube that passed down through the plenum to bring a source of secondary air into the circles of flames. The plenum is then fed by a venturi gas mixing system similar to the bar burner (**photo 5**). Essentially, I just changed the format of the bar burner to fit the space. It works quite well and gets the flames right to the bottom of the firebox. It can be built as a replacement for the ashpan structure. Beyond the Shay I have equipped a 'Speedy' (British design) with it, a vertical boiler unit, and another locomotive with a small firebox. All exhibited excellent results. When driven very hard the individual flames on the gas holes cease and the area becomes a mass of burning gas.

There are other types of propane gas burners, radiant types, ceramic and stainless and jet burners but they have not proven to be successful in our general size category. Ceramics are often used in G scale sizes and would be a possibility for 2 or 3½ inch gauge locomotives (**photo 6**).

Jets burners are fine but noisy (**photo 7**). I over burned a Falk 1 locomotive with four jets.



And I have to show this - Ken Brunskill was dissatisfied with the Marty burners he made and so he devised another top cap. I've named it the 'Brunsen Burner' and it works really well. It took a lot of experimentation but it gives a really good flame pattern.

Installation

The parameters of burner installation are driven by many factors. First off, we need to remember that everything will get hot. Sounds simple but it is often overlooked and I have seen rubber hose connected to a fitting on the burner pipe. A length of copper line does not isolate the heat much so be sure your controlling valve is up to the requirements. Another often forgotten item is the need to remove the burner for boiler inspection, so the burner assembly should be removable with a couple of screws or pins. That, and an easy gas line connection will reward

your forethought over and over. The burner needs good access to the air so if anything, open screening is about all you can put across the bottom. I have seen even 50% screens being too restricting and the burner running rich.

The sort of burner you use is affected by physical requirements. As always, the best approach is to see if there is a similar locomotive that is running successfully and evaluate how that would fit to your application. Here is where you have the opportunity to improve on what has been done.

Let's also address safety.

The output of burnt gas is carbon dioxide (CO₂) and carbon monoxide (CO) for the most part so only test and operate in a well-ventilated area. Also stay aware of the fact that it's an ignition source so be care with volatiles.

Making burners

Yes if you're handy in the shop and willing to take on a repetitive task, burners can be successfully built. And they can be modified as well. There are designs for Barber jets available and they have been around so long that there are no patent restrictions. I have built all sorts of burners but lately so



Barber jets.



Solarflo.

many are available that time is better spent on other areas, as long as these burners suit your needs (**photo 8**).

Here is an article written by GGLS member Dave August on his very successful method of making Barber jets (aka: Marty burners) note the six burners for his LE American: www.discoverlivesteam.com/magazineold/186/index.htm

I suppose the overall point of this article, beyond information, is that more is not always more and care in design and experimentation should be embraced. This coupled with educated operation will give you the reliable and easy steaming you desire.

So why did I say that propane is an ideal model locomotive fuel?

Simply, you can turn it off with the twist of a knob - heat with an off switch.

For further reading: solarflo.com/products/ This is probably the largest supplier of engineered burners. If you want to buy 500 Barber jets or heat full size railroad cars they are the people to talk to.

ME

Gas Turbine Electric Locomotive 18,100 Progress on a five-inch gauge working model

PART 2

Tim Coles
brings
us up to
date with his latest
gas turbine locomotive
project.



Continued from p.351
M.E.4737 February 23

The next stage involved a trip into darkest, deepest Somerset to visit electronics wizard and 18,100 team member Jon Freeman. Jon is well-known to readers of *Model Engineer* for his expertise on the electronic control of brushless and other motors and he had built up a custom control system for 18,100. We left the locomotive with him for a couple of days and went off touring the area. When we returned, Jon had fitted the system, together with two temporary power batteries to simulate the eventual supply of power by the turbogenerator set (**photo 21**). The system is radio-controlled using a relatively cheap model aeroplane transmitter. We took the model the short hop from Jon's house to the wonderful new Taunton club track, placed it on the rails and connected the batteries (**photo 22**).



Here the electronics have been fitted and seen under test on Jon Freeman's bench.

Hey presto! A gentle forward movement of the control stick and away the model went, quietly and gently. Pulling the stick back from the neutral position applied regenerative braking and brought the locomotive to a halt. To reverse the locomotive, a switch on the transmitter is thrown and then

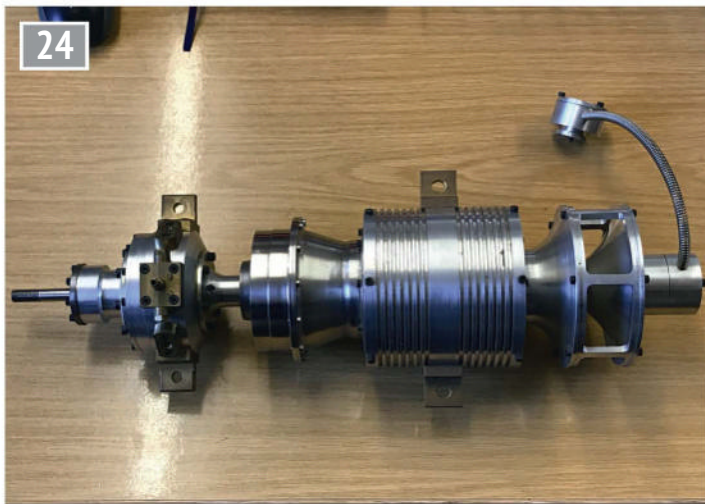
the power lever works in the same way, but the locomotive goes in the opposite direction. After a preliminary run with the engine light, we connected up a carriage, climbed aboard and proceeded to run up and down the partly completed Taunton track (**photo 23**). We were pleased by the quiet



John Freeman connecting up the temporary traction batteries prior to the first test run of the complete chassis, on the Taunton club track.



Helen gives the chassis a run at our local club track. The radio control system seems to work well, with good control of the locomotive, both forward and reverse.



The turboshaft engine looks complete in this shot but in fact it has no 'innards'.



The turboshaft engine dismantled on James Hill's work bench. It turned out that quite a lot of work was needed to get the engine into running condition.

and apparently effortless performance of the model but we did encounter one strange problem. The inner rings of the axlebox ball bearings tended to 'extrude' out of the bearing. I'm not clear how the lateral force needed to extrude the inner race developed but the problem has been cured by adding bolted discs on the end of each

axle.

A vital part of this electronic system is a circuit specifically included to control the prime mover, in this case the turboshaft engine (photo 24). The plan is that, as per prototype, when the driver moves the power lever forward, the traction motors demand power and these in



This shows some of the many parts of the turboshaft engine and reduction gear box.

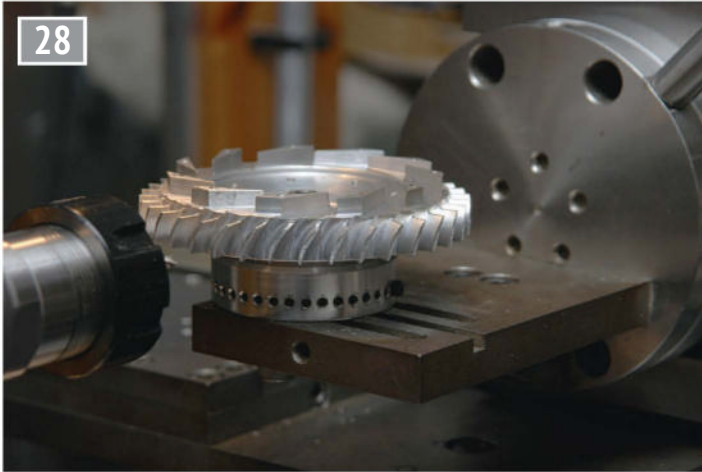


This is the heart of the turboshaft engine, the compressor, shaft tunnel and turbine wheel.

turn demand current from the turbogenerator set. Some careful experimentation is going to be needed to match the output curve from the control circuit to the performance curve of the turboshaft engine. The horsepower output from the turboshaft is very non-linear in relation to the rotor speed but

experience from the turbo-mechanical model of GT3 suggests that only modest power is required from the engine and at lower rpm levels the curve is more linear.

A further feature of Jon's sophisticated control system is a display panel showing the speed of the model in MPH, operating current and the



Here the diffuser section of the engine is being machined on the vertical slide of a Myford lathe.



The diffuser and shaft tunnel united.



The compressor and turbine now fitted to the diffuser section.

like. The plan is to make this panel visible through the cab windows.

At the time of writing, the Cambridge based team (Helen Hale and Tim Coles) is working on the layout of all the gubbins in the body of the locomotive, the turbogenerator set, main control electronics, rectifiers,

power-dump system, large condensers, small battery, cooling fans, display panel and so on. The chairman of the GTBA, James Hill, is working from his home in West Sussex to complete the turboshaft engine which Jerry had made a valiant start on building, using the drawings supplied by the



This is the 18 kW combustion chamber, as viewed from the back of the engine. The brass ring is the fuel supply to the 'sticks' which deliver vapourised fuel into the chamber.



Andrew Harding is making a superb job of the difficult cab structure.

sadly missed Wren Turbine company (photos 25 to 31). James is also planning to test the 'alternator' set by driving it initially with a large electric motor. Jon Freeman from Somerset is on standby to connect up all the remaining electrical circuits in due course. Andrew Harding of Bristol is close to finishing fine mouldings of the two

very characteristic cab ends (photo 32).

A lot has been achieved in the construction of this complex model, by some talented people, but a lot still remains to be designed, developed, built and tested. We'll let you know how we get on in the next year or so!

ME

We Visit the Coventry Model Engineering Society

John Arrowsmith visits Coventry's track at Ryton Pools.



My recent visit to the Midlands included a trip to the Coventry Model Engineering Society which is located at Ryton Pools just outside the city. Here, on reclaimed land, the members have established an interesting railway system which their members enjoy on a very regular basis. It was my first ever visit to Coventry and I was pleasantly surprised at the location of the club and was impressed by the work members have put in to establish a railway system to go with their club house (**photo 1**). I was met by chairman, Derek Morris who outlined the recent club history and how they arrived at the location. The club have quite a long history and they have been on this site since 1997 having previously been at Stoneleigh Park and in Coventry itself. When they had



A view of the substantial construction of the girder bridge.

to leave Stoneleigh because of redevelopment it took them about five years to find and then access this ground at Ryton Pools. It was being created by the local authority as a country park and the club asked if they would like a miniature railway, which met with a positive response,

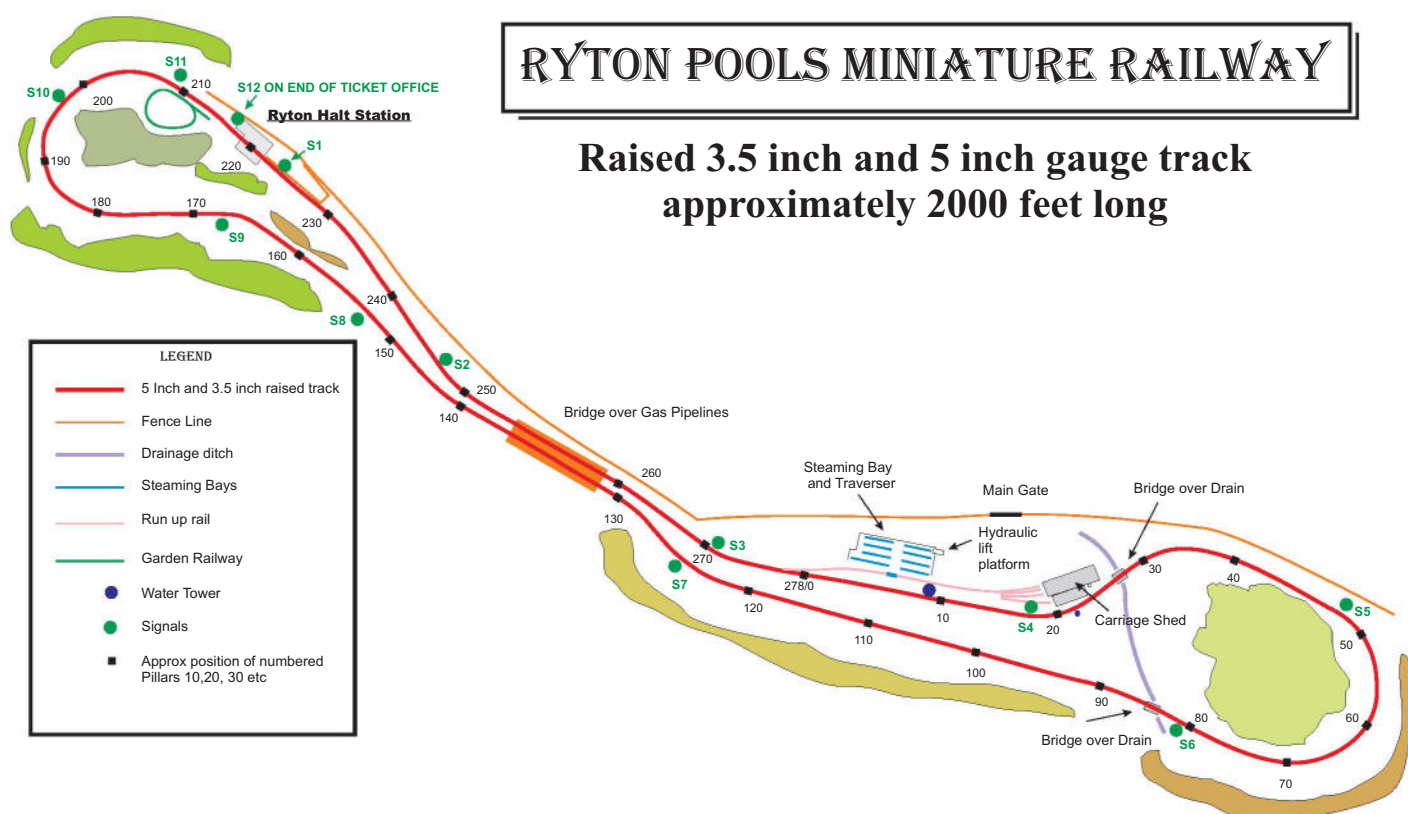
thereby starting the project moving.

As I said, it is on a reclaimed landfill site which has been attractively landscaped and because of this there is a methane gas removal system in place, operated by the local authority. Where the methane gas pipes leave the site there was quite a deep gully which the track would have to cross over. An embankment and ground support in this area was not permitted which resulted in the club building a fine string girder bridge (**photo 2**) to cross the gap. This certainly does make an attractive feature for the 3½ and 5 inch gauge track. The track is about 0.4 of a mile long. A good, well spaced out steaming bay area complete with hydraulic lift table for unloading (**photo 3**) and a sidings directly into the storage sheds, ensures that there should not be any necessity for heavy lifting during operating days. It also provides the ability to add additional stock to the main line, should it be needed, without any problems. A robust traverser gives access to all the steaming bays and main line and for the three road



The inside view of the club's clubroom.

Fig 1



The Ryton track plan.

engine shed, another traverser (**photo 4**) connected to Bendy Beam provides the access. They have a small but useful workshop with a decent sized lathe for any repair work.

Membership is now around 70 and they get a good response from this group in order to maintain and manage

their operations. They have a good working relationship with the local authority and Park Rangers based on the premise of 'we don't bother them and they don't bother the club', which works very well for all concerned. Having secured the lease from the authorities, the only commitment they

have is to operate the railway every Sunday from Easter until the end of September. The members are quite happy with that because it means they can operate for themselves whenever they want. When they first started they used steam locomotives as their primary motive power, but the

regular running stipulation has led to a gradual change to electric traction, which is more convenient, but that is not to say that steam is in any way excluded as many members come to the track with their engines and enjoy good track time.

That point was illustrated



A busy scene in the steaming bays with the hydraulic unloading lift in the foreground.



A smart roller keeps the traverser inline.



This fine example of a Stirling Single was just gliding round the track in a very impressive style.



A fine example of an LNER B1 built and owned by Stuart Ellis passes the steaming bays.



Roy Crick with his 3½ inch gauge 0-6-0 Molly.



A good example of a tender version of Sweet Pea was going well on the track with driver, Gareth Williams.



A class 47 comes off the reverser to collect its train.

quite clearly during my visit, with four engines in steam and all having extended runs. I enjoyed watching Jim Farr drive his Stirling Single around

the track; it was a superb working example of this type of locomotive (photo 5). Stuart Ellis had an excellent run with his 5 inch gauge B1 which he

had built (photo 6) and it really looked the part. It was also good to see a fine example, in 3½ inch gauge, of an 0-6-0 'Molly' built and driven by Roy Crick. It too was working very well (photo 7). A standard Sweet Pea was in the hands of Gareth Williams and, as usual, was steaming very well (photo 8). They were also running a well made Class 47 locomotive which is one of their mainstays on running days (photo 9) while in their main shed was another Class 37 and what looked like a Class 30. In another store were a couple of Sweet Peas and a freelance diesel outline engine along with a very old model which was built as the very first club locomotive about 70 years ago (photo 10). They have plenty of motive power available for both public and club operating days.

They have built an interesting water system for the club which, in these days of environmental awareness, is very green indeed. Water from all their buildings drains into a storage tank; it is then pumped to another larger tank which then supplies the watering points at the station (photo 11) and steaming bays. A smart, covered station building provides passengers with access to the track as well as ensuring the queues are managed simply (photo 12). It was stressed to me by a number of members that it is a very happy club and even more so when there are free bacon butties on offer!! They were available for my visit as well so I too can vouch for the quality! I was assured that the way the committee operates ensures all members are working with



The club's very first locomotive.



The smart little water column in the station

them rather than against them. Regular meetings take place twice a month, held in the cosy clubroom, and they are well supported, as are the regular working days on a Saturday.

To a round of laughter I was told that their Junior section are all aged under 80! Where have I heard that before?

They do have some younger members who are relatives of existing members but they have made a conscious decision not to have a specific junior section.

I enjoyed a drive round the circuit which is well laid and smooth. The girder bridge is interesting as it sounds very



Ryton Halt, the main passenger station on the track.



A well made Class 08 Shunter takes a small goods train round the Garden Railway.



Attention being given to one of the garden railway steamers.

realistic when crossing. As with many clubs, the garden railway is also very popular these days (**photos 13 and 14**) and the club is still developing an interesting layout. There was plenty of activity with an assortment of locomotives and trains in operation, all working very well.

I hope my notes paint a picture of this happy, progressive club which

welcomes everyone, whether prospective members or just an interested visitor, with the same enthusiasm. My thanks as usual to all the members who were on site and particularly chairman, Derek Morris for his hospitality, information and good humour. You have a great set up at Ryton and long may it continue.

ME

1934 McDonald Tractor

A working one-fourth scale model

PART 5



wooden dowels.

Making the core boxes for the inside of the engine posed a real head scratcher as I had to incorporate the cores for the water passage, the exhaust outlet and main cylinder/crankcase core. Designing cores entails engaging the brain in negative mode and to think of the shapes in the form of internal spaces (photos 45 to 48). This engine has a dry liner and is water cooled. Several ideas were tried but did not work out.

As can be seen in the photographs this engine has its cylinder and crankcase as one unit and trying accommodate both the dry liner and water passage into the completed flask was a delicate operation and took quite some time to make and assemble. I used the chemical sand mixture for both the cores and the main mould as this method

produces relatively strong blocks that can be glued together. Each flask took about a week to make and assemble ready for the casting process, with this being conducted at a friend's place as he had a larger crucible and furnace. The day arrived with the flask loaded into the car, great care was used to avoid the pot holes in the road and upsetting the carefully assembled cores. The aluminium was heated and poured and then allowed to cool down while we all had a well-earned cup of tea/coffee. An air of excitement pervaded the air as the flask was opened. Excitement soon turned to disappointment as I discovered that there were faults – oh well back to the shed to sort out what had gone wrong.

Sometime later a modified mark two was packed and a repeat performance followed but alas another problem



Engine pattern and core box.

George Punter is drawn to another tractor project.



In the past I have only made four stroke engines, but this engine was a two stroke with fewer parts to make and I thought that its construction would not be as complicated. How wrong was I! Had I started with the engine I feel that the rest of the tractor may not have materialised as there were times when the problems almost became overpowering.

I had already made a wooden mock-up of the engine but now it was time to convert the CAD drawings to 3D patterns that would be used in the casting process. The outside shape was relatively simple and was divided into units that I would be able to print on the 3D printer. These individual units were then held together with

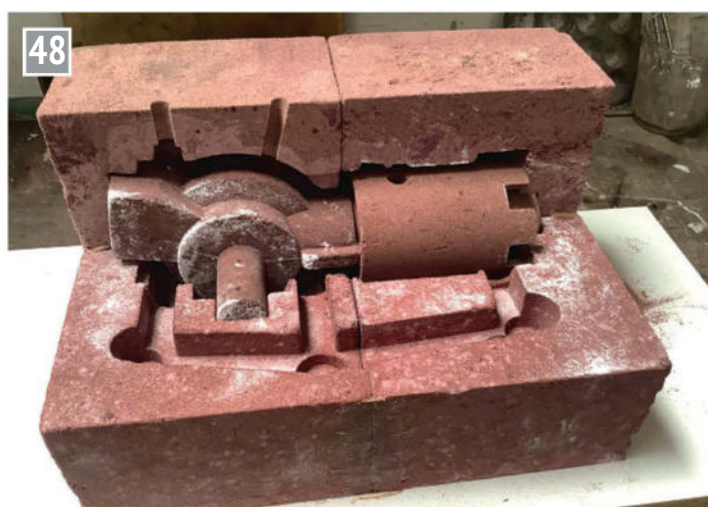
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Engine core and box.



Engine pattern in box.



Sand blocks and cores.



Engine casting.



Cylinder liner.



Piston and connecting rod assembly.



Air intake casting.

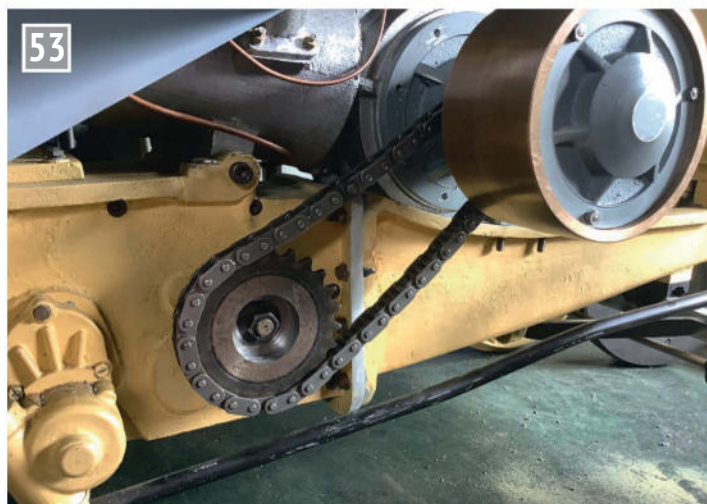
occurred – oh bother! Back to the shed for more modifications to patterns and core boxes and by this time I was beginning to pull out what hair I have left but I had come too far to give up now. A third attempt was made and this time at last success and now I had to make sure I didn't make any mistakes in the machining as this was a one off.

The casting (photo 49) was cleaned up and made ready for machining. As the crankcase cylinder unit is all one piece it did present problems of how to hold it for the machining processes. The completed tractor weighs 54 kg, and the engine has a bore of 45mm and a stroke 55mm giving a swept volume of 87cc and is the largest single cylinder engine

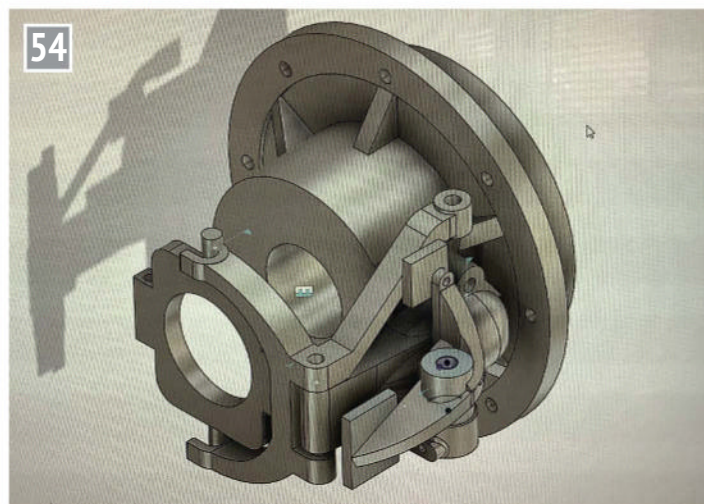
that I have attempted but it is all good experience. The cast iron liner (photo 50) was made and ported and then pressed in making sure that all the ports lined up.

The steel crankshaft is supported by ball races which were pressed into the machined recesses, both in the main casting and the clutch side bearing housing. Oil seals

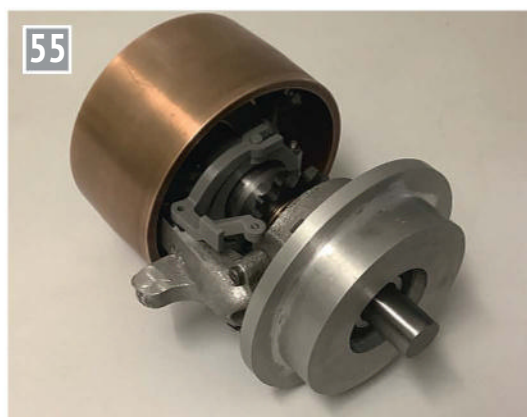
are also fitted in both sides. The crankshaft is pressed up with the big end receiving a hardened steel sleeve on which the needle roller bearing fits. The connecting rod is an aluminium casting and has a needle roller small end bearing. The cast aluminium piston carries three pegged piston rings (photo 51). Induction is via a reed valve at the back of the engine with the cast housing also holding the air cleaner in place (photo 52).



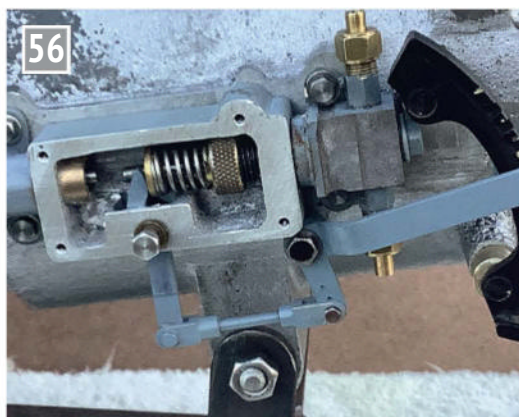
Chain drive.



Clutch 3D diagram.



Pulley/clutch assembly.



Injector pump.

The reeds are commercial (Boyesen) and were donated by the local Kawasaki motorcycle shop. The cast aluminium cylinder head is recessed into the barrel to keep the outer shape to scale.

I had to keep the bore of the engine to 45mm in order to fit in the water jacket and dry liner sleeve but this dictated that the connecting rod be reduced in length to prevent it coming into contact with the end of the cylinder liner near the crankshaft. Compression is not high as I wanted to have a slow revving flexible engine. The cylinder head does not have any water-cooling passages but does contain a pre-combustion chamber linked to the main chamber. A decompression valve is included in the head (as a safety feature) as is a 1/4 inch x 32tpi spark plug. The full-size tractor had this feature for ease of starting in cold weather and supplements the hot bulb ignition system. With this system the fuel is injected

into the hot tube which is preheated by the gas burner to start the combustion process. The engine was now beginning to take shape and in my mind I could already hear it making the sound of music!

The engine is linked to the gearbox by a chain and this makes for easier assembly and construction (photo 53). Drive from the engine is via a clutch housed within the pulley assembly. The clutch consists of a disc fixed to the crankshaft and two cork faced plates, one on each side, that are squeezed together by a compact and complicated system of levers and cams (photos 54 and 55). On the other side of the engine is the flywheel and injector pump and linkage to the lubrication oil pump. The flywheel weighs in at over 4kg and should help with low end power and slow running. As on the full-size tractor, a spring-loaded starting handle is incorporated into the flywheel. Behind the flywheel is the

eccentric that drives the pump and this unit also houses a bob weight system to give some form of governor control over the engine. The injector pump (photo 56) has a 3mm bore and variable stroke with this being controlled by the driver of the machine. Two check valves control the flow from the fuel tank and to the injector.

I did discover that the fuel system requires a good filtration system as any impurities block up the exceedingly small injector holes and prevent the check valves from seating. The first stage of filtration is a gauze filter in the fuel tank; in the second stage the fuel passes through a lawn mower type felt filter housed in the container bolted to the right-hand side of the engine cylinder and the last stage is a micro filter as used by aeromodellers.

With the engine now complete I had to finish off the details including a working gas burner for the hot bulb and all

the linkages to the steering, clutch and oil injector. Up until now I had been using cheese head fixtures as these were easier to take on and off but now it was time to replace them with the correct sized hex head and cut them to the correct length.

At this stage the rear wheels were devoid of any form of tread (as on the full-sized tractor) but I decided that rubber bar treads would be fitted to give grip and reduce noise. I used 3mm x 75mm rubber strip obtained from a local store. Using a circular saw with a small tungsten tipped blade 20mm strips were cut and then the strips cut to the correct angle and length. Fitting these is rather like cutting gears - you do not want to end up with a half space. The problem was solved by wrapping a strip of paper around the wheel and then working out the number of spaces and transferring these to the wheels. The treads are glued to the wheels with the rubber strips all pointing out at an angle. Well, that was the theory except I had both sets pointing in the same direction - just put it down to a senior moment! As the glue had not set they were quickly pulled off one side but unfortunately the paint came off as well. With the outside of the rim stripped and repainted the new treads were attached and a sigh of relief was to be heard from the workshop.

●To be continued.

A Centre Finder for Four Jaw Chucks

Dave Woolven makes a gadget for getting work precisely centred.

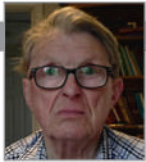
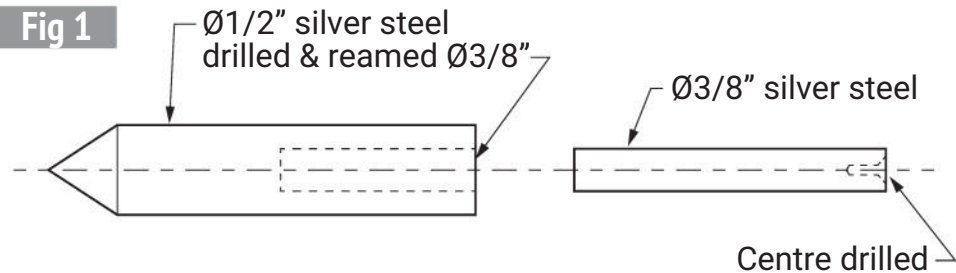


Fig 1



Component parts.

This little device is probably as old as the hills, one which everyone knows about – unless it happens that you don't or are new to modelling.

You have marked out and centre popped a piece of material that you are going to drill in a four-jaw chuck in the lathe. You line it up by eye, it looks okay, you bring the centre drill up to the pop mark – and either the end of the drill breaks off or it's pulled out of true because the pop wasn't as central as you thought. This device will put that centre pop exactly on centre.

As with most things I make, this was made out of what was lying about on or under my bench – sizes are not important.

To make

Take a piece of ½ inch diameter silver steel or BMS

about 8 inches long. Put it in the four-jaw chuck and centre it exactly with a DTI. Face off the end, centre drill, then drill and ream ⅜ inch to about 2½ inches deep – which was the maximum depth my reamer would go.

Reverse the ½ inch bar in the four-jaw chuck and centre again with the DTI.

Machine to a point (fig 1) – no particular angle, mine was done with the combination slide set over to give an angle of somewhere around 30 to 40 degrees.

Take a second piece of silver steel or BMS ⅜ inch diameter about 3½ inches long. Set in the four-jaw chuck with the DTI and face off the end. Centre drill this end. Reverse the bar and face the other end just to tidy it up (fig 2). You now need a small compression spring about 1 inch long that will drop into the reamed ⅜ inch hole.

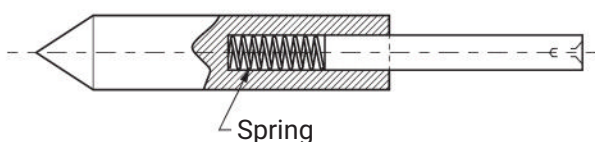
Put the piece of ⅜ inch bar into the reamed hole and that's it.

To use

You have centre popped the piece of metal that you want to drill and put in the four-jaw chuck, get it as near enough by eye. Put the pointed end of the centre finder into the pop then bring up the tail stock into the end which you have put a centre. Put this centre into the centre drilled end of the ⅜ inch bar and compress the spring a little. Put the DTI on the centre finder quite close to the four-jaw chuck, rotate the chuck by hand. Any movement caused by the centre pop being off centre will be picked up by the centre finder and transferred to the DTI and that in turn will allow you to set your work spot on (fig 3).

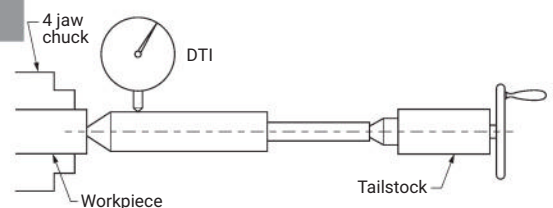
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Fig 2



Assembly.

Fig 3



Centre finder in use.

The View from Butterside Down

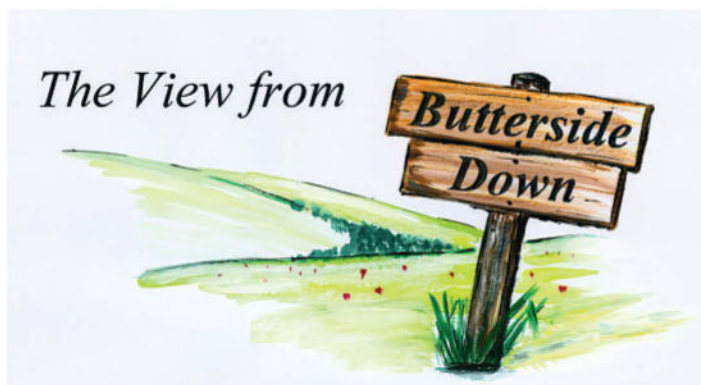
Part 6: Third hand transportation, part 2

Steve Goodbody takes a random walk through model engineering.



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The View from



In 2016, with a clank and a clatter and some worryingly splintered wood, Butterside Down welcomed a new resident, a beautifully built but undeniably third-hand Allchin traction engine, bearing the enigmatic name *Ruby Swann* and sporting a decidedly English air. And although this

splendid engine was now residing in her basement, the author's wife was blissfully unaware of the new family member because, let's face it, her husband is a barefaced coward.

The following week however, a few days after Jenny's Bangkok flight had touched wearily down onto Newark's bumpy runway and her jetlag had begun to subside, it was, without doubt, time for him to come clean.

Fair scrutiny

"I'm sorry, I must have misheard you. You did what?"

Jenny, it is fair to say, is not one for histrionics – calm and measured is her general demeanour – but after twenty years of marriage I could tell that she was rattled by my unexpected disclosure. I repeated the announcement, from a safe distance, and summarised the circumstances, adding that, while I knew it was an extravagance, a recent bonus had fortunately covered the cost.

"Okay, let's take a look at it"

she announced, quietly, fixing me with a disbelieving stare.

Now while you may find this hard to believe, because I am sure that, in every case, your Significant Other is in full lock-step with your hobby activities, it is an unfortunate fact that my lovely wife, while a fine and upstanding citizen in all other respects, has no real interest in model engineering and no interest at all in steam engines, and simply resigns herself to the fact that her spouse has an unusual and somewhat solitary hobby, likes to make things from metal and gets very dirty in the process. And this, despite being a degreed engineer herself. I ask you, what is the world coming to?

Anyway, despite my unfortunate failings as a responsible husband, and her long-established doubts of my sanity in general, upon seeing *Ruby Swann's* elegant copper chimney-top, all polished and gleaming, and her immaculately scalloped headlamps nestling jauntily beside her smokebox, I thought I could detect in Jenny's face the vaguest glimmer of a hint of a flicker of a look that suggested she was, grudgingly perhaps, not wholly unimpressed with our new expat resident. I mean - just look at her – how could anyone dislike *Ruby Swann*?

Of course, it is also possible that she was considering where best to hit me for maximum pain but I prefer my gentler interpretation.

However, to her immense credit, and perhaps realising that there was no obvious way



Eight-year-old Sam poses with *Ruby Swann*, her fire lit for the first time in America.

of returning this genie to its bottle, my exceptional spouse gallantly accepted the situation and, while I would never accuse her of such ulterior motives, probably realised that I would assuredly be on my best behaviour and extremely pliable for the foreseeable future; and that reason alone, she perhaps reasoned, would be worth the price of admission. And in fairness, in the years since, Jenny has never once uttered the words 'traction engine' to get me to finish a longstanding chore or to enforce household discipline; but the plain truth is she didn't need to, for I was my own judge, jury and jailer and was, without doubt, guilty as charged.

And so, with the dirty deed disclosed, and immense relief that I was still married, and having by that time thoroughly examined *Ruby Swann* in light of the damaged shipping pallet and run her on compressed air to check that she still turned over with no significant leaks, and with a to-do list begun and already sporting several items, the time came to prepare our traction engine for her first steaming under new stewardship.

Ignition

That weekend, with the assistance of eight-year-old son Sam, *Ruby Swann*'s boiler was filled with water, her grate layered with paraffin-soaked wood and charcoal, an almost-too-small electric blower attached to her chimney, and the contents of her firebox ignited using the remaining piece of paraffined wood dropped carefully through the firehole door (**photo 11**). And then, after Sam had popped several more pieces of charcoal onto the fire and everything was burning nicely, we added some lumps of Pennsylvania anthracite, granite-hard, impossible to break, and the only coal for sale in the only coal-yard in New Jersey. And, sure enough, unable to get to grips with the rock-solid material on which she was being forcibly fed, *Ruby Swann*'s fire did the only

thing it could realistically do and began to die.

Fortunately, Sam and I had foreseen this likelihood, so, temporarily abandoning the bag of near-diamonds, we returned to our box of charcoal, patiently coaxed *Ruby Swann*'s flames back into life, and continued to feed the more combustible fuel into the firebox until a decent but coal-free fire had been re-established.

Although it took a very long time with the little electric blower, and Sam got bored and went indoors for a snack along the way, eventually the water began to boil, the needle of the pressure gauge started to rise, the auxiliary fan was removed, and the engine's own steam blower valve opened. And, while it was clearly drawing the fire more effectively than the electric fan, allowing anthracite to finally be added to the firebox with a chance of catching alight, my goodness, what a deafening racket that blower made. Another item to be added to the to-do list.

Eventually, with the injector, water pump and safety valves all tested, and after making sure that everything was ship-shape and ready to go, and with the reluctant anthracite now burning nicely provided the jet-screaming blower was maintained continuously to prevent the fire from fading rapidly to black (**photo 12**), the time arrived when we felt safe in coupling the driving trailer to *Ruby Swann* and heading off for our first run around the garden. And, shutting the noisy blower and putting her into low gear, and of course after the obligatory three-step starting process beloved of all single cylinder traction engines and covered *ad nauseam* in *The Eating of Elephants*, off we went on our first lap.

Great expectations

Now at this point in the story, let's take a brief pause to consider some descriptions of *Ruby Swann*'s performance which have appeared in print and film over the years.

'You can trundle along without having to do much



The diamond-hard Pennsylvania anthracite, burning only under the continuous influence of the jet-screaming blower.

more than throw the occasional lump of coal onto the fire...' said *Old Glory* magazine in 2011.

'Makes steam like it's going out of fashion, will pull off with 40 pounds on the clock and be blowing off by the time you get to the end of our estate' enthused the Lincoln-based seller in both 2012 and 2015, with several videos to prove the point.

And finally, in 2016, our seller's video, backed by my kindly inspector's first-hand impressions, had convincingly demonstrated her steaming prowess just as the others had described.

And these assertions certainly matched my experience with mentor Bob Douglas's largely identical engine all those years ago in Crowborough, *vis-à-vis*, an Allchin is an excellent steamer, provided you remember to open the ashpan damper. Therefore, imagine my surprise when, with damper fully open and after only a few short laps of the garden, there we were, drawing to a halt through lack of puff, our once-bright fire now well on its way to blackness. Undeterred, we

checked the smokebox door for tightness, revitalised the flames with the screeching blower, rebuilt pressure, and tried a second time, and then a third, and finally a fourth, but, no matter whether the fire was made thick or thin or halfway between, the result in each case was the same, pressure falling as soon as we set off and showing no sign of recovering along the way. Sadly, it was clear that, for reasons yet unknown, *Ruby Swann*, despite evidently steaming well before departing England, was unable to draw her fire on the other side of the Atlantic. Disappointed, we let the fire go fully out, which did not take long, drained the boiler, and gave up for the day.

Later that evening, as I dried the boiler and polished both paint and brightwork after Sam had gone to bed, I began planning the investigation which, I reasoned, would begin with a good look at her smokebox. Hopefully, I mused, that might reveal what on earth was going on with our new engine.

●To be continued.

The Perpetual Demise of the Model Engineer

PART 1

Luker
campaigns
against self-
prophesized doom.

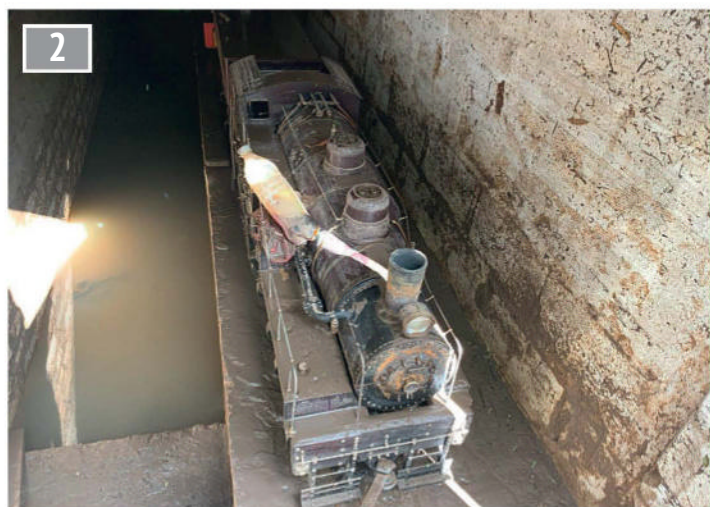


One of the retired members of our club took notice of my interest in model engineering when I first joined the club. He was kind enough to organise old model engineering magazines from as far back as LBSC's time. I have spent many a quiet evening (during load shedding) paging through these magazines. Even in those early days the contributors to the postbag columns were predicting the demise of the hobby. Sixty years later the same prophetic talk of demise or lack of young talent can be found on the model engineering forums and on other social media platforms. Well, guess what? People are still building incredible models and the interest in the hobby is increasing, and I have no doubt the hobby will continue for many years to come.

I personally feel the hobby of model engineering has the potential to grow exponentially,



Driving my Stirling 2-2-2 single on one of our open days. This specific locomotive outperformed the larger and more famous 4-2-0. Sadly, all locomotives in the class were scrapped in the early 1900's so there are no large-scale examples. All we have are these models but isn't it amazing to be able to see them in steam, albeit in miniature? (Photo: my beautiful wife.)



A series of terrible floods damaged the club's station, workshops, clubhouse and members' locomotives that were stored in the club bunker. The cost of the flood damage wasn't only financial; imagine seeing your 6000-hour plus project covered in abrasive flood mud and gunk. (Photo: Leon Kamferr.)

and in so doing can be used to inspire the youth to make the world a better place through engineering and innovation (not by rolling around on the streets complaining about oil while wearing synthetic clothing). The 'right to fix' movement is gaining momentum; I can think of no better set of skills as offered by the model engineering hobby to contribute and guide that movement. The hobby is likely to morph into something else due to the natural evolution of the social economic landscape. That, in itself, is an interesting prospect.

It's a sad truth that museums are losing the much-needed government support. It's going to become more difficult to keep large scale engineering history intact for future

generations. Again, model engineering is the answer. Scale models take up a fraction of the space of the 'real deal' and most of the time are built to be functional (**photo 1**). Videos of these models or even donated displays will be invaluable as our population grows and museums are forced to scale back.

Doom and gloom for the hobby?

I think not! But there is always room for improvement. The following is a look at how we managed to attract the youth to our club, a parable of how a brilliant club chairman changed the fortunes of his club and some thought on how the hobby can be promoted and made more accessible to the average person.



Passenger haulers are given the express lanes and right of way but still smaller locomotives are welcome to improve variety on any open day. The passenger haulers aren't necessarily driven by the builders but other members that have a love for trains and driving. For them the hobby is more about honing driver skills and less about building.

A hypothetical chairman that saved his hypothetical club

There was a hypothetical club that was in a dire financial state. The grounds were devastated by a number of freak floods (**photo 2**), which looked to become a regular occurrence. Incidentally, this had nothing to do with climate change but more to do with the lack of governmental planning and poor waterway design. In essence, the club was in debt, the committee was in analysis-paralysis mode, with personalities clashing regularly, and not contributing to any turnaround strategy. The previous chairman and old committee realised they had run the club into the ground and jumped ship.

The new chairman would never be able to fix a mess like this by himself but he had the traits of a good, no-nonsense leader. He took the reins of the club and turned things around in a very short time. This was incredibly impressive as most of the turnaround happened over Covid when clubs were buckling under the strain of the pandemic.

The well-published 80/20 rule applies to many things in life.



Other attractions were invited to share the grounds and in so doing increase foot traffic and ultimately passenger ride income.

80% of accidents are caused by 20% of drivers, 80% of the work in non-profit organisations is normally done by 20% of the members, etc. It's amazing how true this is. Unfortunately, this is unavoidable but what can do further damage is when the 80% that do nothing try to manage and point fingers, hindering the people who actually want to help. In addition, his club was known for its politics and egos. The chairman realised this was a major hurdle to turn things around, so he came up with a simple yet effective approach. Any member that complained was asked how they were going to fix the problem, they were given a budget and asked for a deadline, and that was the end of it! Members that didn't contribute, personally, to fixing problems had basically no say on any of the club's activities. The club's membership fees were increased to buy decent coffee and eats for the 20%'s, including the passenger haulers and anyone contributing to the club positively.

The chairman realised that the club's financial model of paid for parties and public rides was precarious at best, and the revenue brought in was not sustainable. Various public days were organised and social media were actively used to promote the open days. The idea was simple; get the public to the grounds and the funds will come in naturally with the increase in public participation. Coffee and pancake vendors were encouraged to come

every open day and for a ridiculously small 'parking fee' were allowed to sell their produce. The idea was that this would contribute to the foot traffic and will naturally improve the ride sales. The entrance fee was increased slightly but one free train ride was included. This made sure to hook the kiddies and the parents by forcing them to take at least one turn around the amazing track. The chairman made an effort to encourage all the builders to bring their finished trains as well as any other unfinished projects to show and engage with the public on the open days. With so many varied trains on the track the public is never bored and will always see something new. It was a simple matter of separating the passenger haulers at the station and always giving them right of way to keep the crowds moving (**photo 3**).

The chairman took it one step further and invited a number of other hobby clubs to use the grounds; he even made sure the space given was developed. This further promoted the grounds and increased the foot traffic (**photo 4**). Previously the club membership was fiercely guarded by restricting applications to active builders, or known model engineers. The definition of model engineer was broadened to anyone with an interest in the hobby, essentially opening up the membership pool. This approach brought all manner

of people into the fold, as long as they contributed to the club. It seems ludicrous to deny club access, for example, to accountants or media experts just because they are not actively building. Some of the members will never build a locomotive, or any complex model for that matter, but they'll spend the open days driving the passenger haulers with incredible skill, constantly trying to improve their boiler management and driving technique. One member has a keen interest in media production; his contribution was filming the open days and promoting the club on social media. Imagine if the club refused to turn around their snooty membership criteria; these fine contributors would have never had the opportunity to apply their unique skill to the improvement of the hobby.

The grounds have been developed with the additional income and it is not uncommon to have tens of thousands of visitors at the club on an open day. These simple steps turned around a club that was in dire straits and are so easy to implement in other clubs. The chairman's steps can be summarised as follows:

1 Anybody with a complaint needs to come up with a plan and budget to fix the problem. They themselves need to manage and complete the project. If you don't contribute you don't complain, end of story!

2 The grounds were opened to other attractions (coffee stands, other hobby groups; etc.), specifically to increase the foot traffic and hence the open day income.

3 A fee was charged on entrance that included one free ride. This free ride encouraged participation by getting the kids young and old 'hooked' on a fantastic train ride.

4 Members were encouraged to bring trains or even unfinished projects to show the public. This improved the variety of each open day, drastically improving the attraction for regular visitors.

5 You don't need to be an





Our youngest builder's 5-inch gauge 0-4-0 starting to take shape. This is in spite of limited tooling, schoolwork and other hobbies. (Photo: The builders WhatsApp group.)



One of the videos showing our resident stationary expert starting up one of our museum's engines. The video focused on a recent theft in the museum but then changed tack and showed how the amazing members of the RSME were unfaltering in getting the engine up and running again.

engineer or model engineer to join; you just need to find a way to contribute positively.

6 A concerted effort was made to use social media and videos to promote the grounds and hobby.

This story is somewhat fictional but actual events have been used in the narrative. It illustrates how a club can be turned around by implementing strategies that have proven to be successful. Any resemblance to persons or clubs should be considered as coincidental.

All clubs need to consider member attrition rates

During one of my 'closed eye design sessions' while attending our club's AGM, I was rudely awoken to a debate on the future of our club's membership and the lack of youth to take the hobby forward in our region. The joke that tore me away from my virtual design space was that I single-

handedly halved the average membership age, and was the best person to entice the youth to take up model engineering. Not one to shy away from the challenge, I accepted. That was a few years ago, at a time when the only youth members attending were dragged along by their fathers or grandfathers. Today it is not uncommon to have the youth outnumber the retired members in the steaming bays during a steam meet. Most of them are active builders (photo 5), and nearly all of them have their driver's licence, and in most cases are far better drivers than the retired members. Our youngest driver had to wait a few years before he could officially get his driver's licence but he can manage the smallest and largest club locomotive without blowing off the safety valves while keeping the boiler balanced. This is in the backdrop of the retired member's safety valves



The next generation of model engineer looking at my little loco. I said the following: 'Careful - it's hot like a real steam train' and 'I built everything in my back yard, and so can you if you want to'. Planting the seed of 'anything's possible'. (photo: Jaydan Clarke)



A screen grab of one of the videos with two of the younger club members. These videos were fun to make and challenged the perception that this hobby is only for the retired artisans. The youngsters in our club are very active in multiple spheres of the hobby.

popping constantly in the station and on the track.

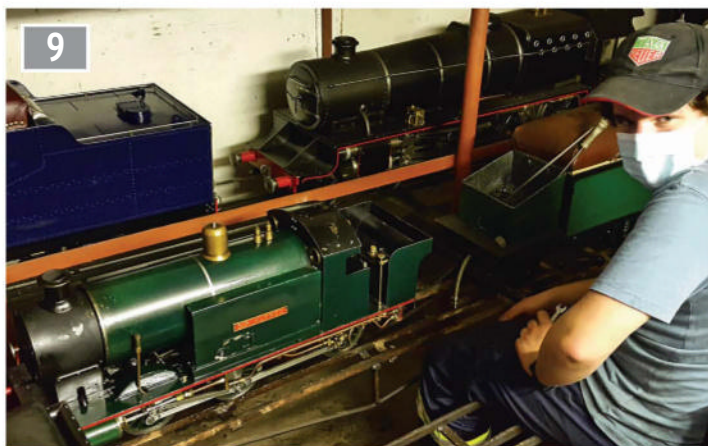
If any model engineer thinks using techniques applied by the foreman on apprentices at the turn of the century will work for today's youth, they are sorely mistaken. I also don't believe for a second that the attention span of the youth is so short that our hobby will never attract them. The notion that they are constantly on their phones or behind a computer is an excuse for us not to bother to attract them to the hobby. The youth don't have the necessary tools; they don't have proper technical training or schools, blah blah blah. I realised very quickly that asking the members for help to fulfil my new mandate was a mistake. So how on earth did I manage to attract a number of younger members in such a short space of time, without them having any affiliation to the club or the members? Simple - I used a completely different approach

to attracting the youth, something that has never been tried at our club and possibly the rest of our country.

Enticing the youth

The misconception that the youth of today have a short attention span comes from the fact that today's media are actively forcing this type of content on them by every means possible. This makes business sense because the ads (which bring in the bulk of the revenue) to content (which is an expense) ratio is very favourable. A famous kiddies program (Sesame Street) was one of the first TV programs to keep the content segments short and they were very successful. Blues Clue's, a later kiddies TV program, showed that a kid's attention span can be held for long periods provided they understand the content and they don't become confused with the narrative. With that in mind, it seems absurd to explain complex engineering principles, or even explain 5000 hours of labour to a 6-year old on the side of the track taking an interest in a fine looking locomotive. Saying something simple like "I made this little loco in my backyard, just like your mom makes cakes in the kitchen. I just use different tools. You can also make one if you want to" is enough to plant that seed of engineering (photo 6). In 40 years, give or take, that young one might become one of the best model engineers of their time. The younger the kids, the longer the game plan, and the less likely you'll see the benefits of that encouragement. Regardless, you need to look at the long and short game equally.

Most of my efforts were focused towards the high school and varsity teens. I thought that this age range would be the most likely to spread the word and also the club would see some immediate benefit to having youngsters around helping where they could. I took control of the Facebook page and rearranged the



One of the youth members doing some guided maintenance on the oldest club locomotive. This youngster has taken a keen interest in this locomotive and spends much of his time at the club doing maintenance and driving the old girl around our track with incredible skill.

home page, bringing all the visually appealing photos and information to the forefront and moving the boring club related information to a dedicated group's page where the members could still access it. Interactive videos were made that were about as professional as a local politician soliciting votes but I tried to make the content interesting and fun (photo 7). The general theme was 'look what amazing things are possible'. Not once was any mention made of the time and commitment required to build a model.

Within a relatively short time the number of people following the page grew and we were seeing a positive influx of youngsters interested in the hobby. All the members of our club knew to send any youngsters to me, as I had a youth plan that was beginning to take shape. A WhatsApp group was established that was designed to bring the youngsters together, sharing videos and ideas on the hobby. It was also a perfect planning group for attending club days. I asked a few of the retired club members to join the group to help with technical advice and encouragement. This responsibility came with a stern mandate to be positive and encourage the youngsters. Any technical advice needed to have the ethos of 'try it like this', rather than 'do it my way, or else'. This group has been incredibly successful and

has probably been one of the main contributors to keeping the youngsters motivated to complete their various builds.

I realised that I could start changing the face of the hobby with these youngsters, so they started to feature in some of my videos. The idea was that other youngsters would be more comfortable to visit the club if the face of the club wasn't a bunch of elderly gentlemen. I must be honest, I had more fun than I thought possible making these short videos and I wish I could have used half of the content we made but alas, some rules can't be broken (photo 8).

One of the largest hurdles when attracting youngsters to our hobby is the sheer time and commitment required to build something of reasonable complexity and scale (photo 9). Everyone is enticed by the romantic notion of scratch building a steam engine but spending 5000 hours plus is a tough sell. Trinkets like wobblers or put-put boats are easy and quick to build and can be finished over a weekend but normally these get tossed out soon after the novelty has worn off or the builder's sense of achievement begins to become overshadowed by other members' achievements. I noticed this dynamic in my early days of attending club meets where members would display finished assemblies on the display tables. A few pointed questions can shift



All too often model engineers are introduced to the hobby through other interests like motorcycle restoration or customizing etc. I like to use the example of my bike's badges to attract interest in our hobby, with the simple phrase "those three badges were made from scrap using a cell phone charger". Typically I get disbelief, then interest...

the focus of the completed item to the manufacturing process and very quickly all items on the table become equal and everyone learns from their peers, especially the youngsters. On the other side of the coin I make a point of asking all retired members to encourage the youngsters whenever they bring something to add to the display table.

All of this is very good to attract the youth but the single most successful strategy I've used to encourage the youth is to shift the romantic notion of 'scratch building a complex model' to 'anything can be easily built, with everyday items lying around, provided you have the knowledge'. Immediately the focus shifts from not having the correct tooling to the more achievable goal of acquiring the knowledge to build it yourself; while just keeping an eye open for usable items. My favourite example is the name badges of my Harley. These were made from scrap pieces of aluminium garden edging, using a toner printer, a little paint and a cell phone charger (photo 10).

Model engineering, as advertised

We as model engineers need to understand that the average

person has probably never heard of the hobby; in fact, most engineers have never heard of model engineering, nor will they be interested in it. The average person will, however, know a few people that might be interested in giving the hobby a bash. Sometimes we forget that these people are very useful in spreading the word. All too often I hear some of our members explaining to some poor housewife how a specific component was machined or made. They will never remember the manufacturing details and in all likelihood would have been put off by the technical jargon. If that same housewife was told how everything was made in the members' back yard with minimal tooling from scratch, and anyone could do it, she is far more likely to spread the word of this interesting place to her friends with kids that like to tinker.

When I was looking at attracting the youth to our club I made a conscious decision to avoid going to schools etc. I never had the time but I also doubt it would pay dividends. The only thing I remember from our morning school assemblies is the tomfoolery, definitely not the keynote speakers. Word of mouth is by far the best method to get the model engineering message across and the best part is its free! Looking at our club's Facebook page, the number of shared and re-shared posts is impressive. Even if a small percentage of the people reached comes and visits the club it adds to a substantial number of visitors. In today's times where people are kept together by technology, word of mouth includes the various social media platforms. These unfortunately take time but, if skilfully managed, can pay off.

The fact is we should promote what model engineers can do and not what we do, this makes it easier for the average Joe to draw parallels with their interests and see value in the specific skills of the hobby.

●To be continued.

LNER B1 Locomotive

PART 40 – ASH PAN – PART 2

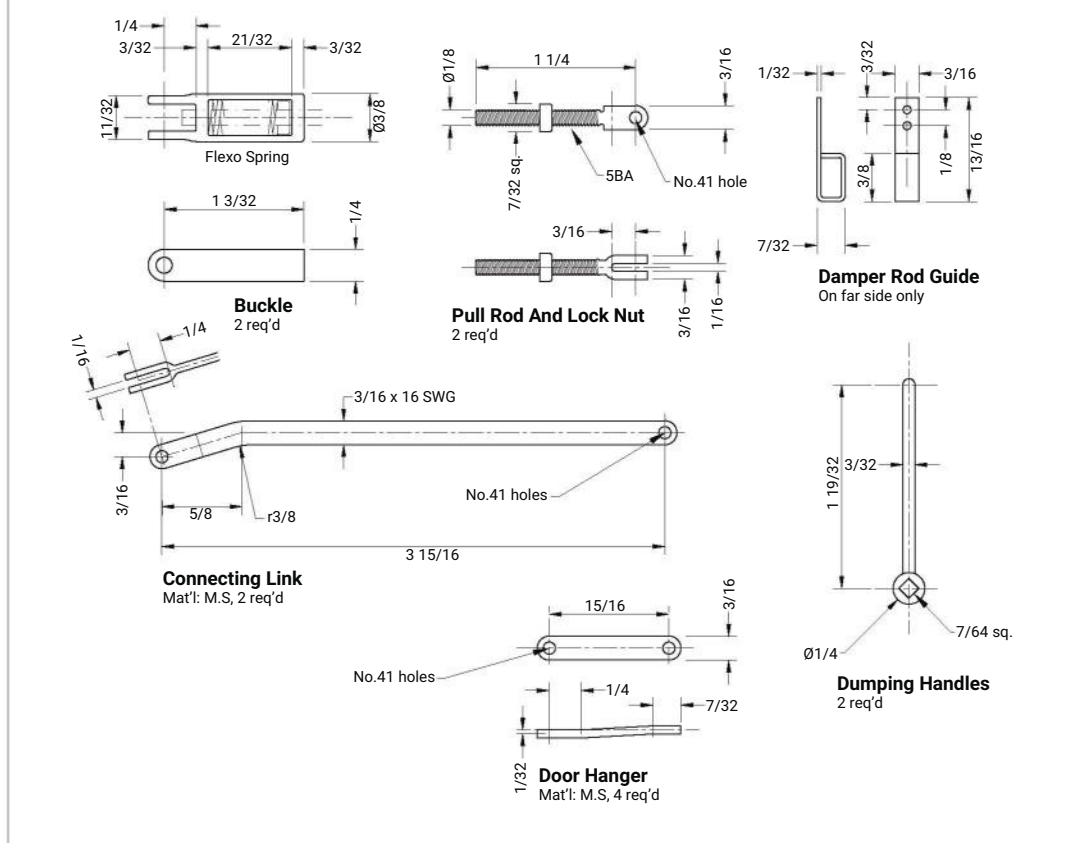
Doug Hewson

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



Continued from p.317,
M.E.4737, February 23

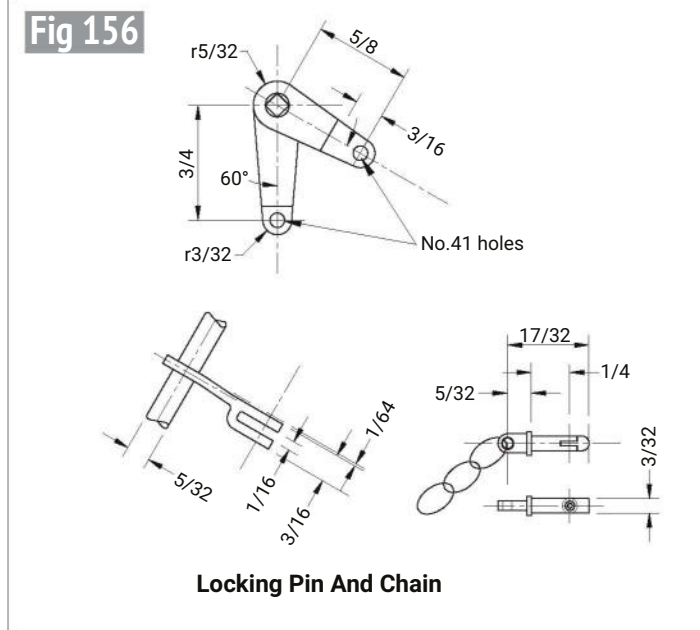
Fig 155



Various fittings.

We will carry on now from where we left off. There are all sorts of linkage and springs associated with the ash pan doors as they both open together and, all being well, they should return once the ash has been deposited into the pit. The first drawing (**fig 155**) is for the linkage and for this you will need a couple of medium strength compression springs $\frac{1}{4} \times \frac{5}{8}$ inch. There are a couple of kinked links which connect the two doors together. There are also four door hangers which have a slight set in them and one of those can be seen in a photograph shown in the previous article (photo 282, M.E.4737 February 23). Also, in the first photograph in the

Fig 156



Locking pin and bell crank.

The Williamson Engine Revisited

PART 3



It meant that countersinks had to be made in the lower holes to accommodate the heads of the screws but, once done, assembly was trouble-free. Interestingly, two 7BA countersink setscrews are provided in the kit, though the countersink is not shown on the plans. A slight nuisance, as it is easier to cut a countersink at the same setting as the original hole. Accurately picking up the centre of a hole to add a countersink at a later stage can be time consuming.

Piston and rod

The piston 7/32 inch long x 5/8 inch diameter was made from a length of brass rod. A piece of brass rod 3/4 inch long x 3/4 inch diameter was supplied in the kit to make the piston. I chose to make my piston from a longer piece of brass rod, taken from my store of metal. To my mind it is safer to have more metal gripped by the jaws than protruding out, although I am sure that the metal supplied would be adequate. The diameter of the piston was turned to be just too big to fit into the bore of the cylinder. It would be finished to size once attached to its rod. I used a square ended parting tool 3/32 inch wide to cut the groove for the packing material. The hole for the rod was drilled and tapped 5BA. A small countersink was formed so that the end of the rod could be peened over to stop the piston unscrewing from the rod. The piston was then parted from the parent metal. I used my favourite quick cut parting tool but any sharp parting tool set at centre height should suffice.

The piston rod supplied in stainless steel 2 1/2 inches long x 1/8 inch diameter rod needed to be cut to length 2 5/16 inch and threaded 7BA at one end and 5BA at the other end. The method for holding piston rods in the lathe needs careful thought. It is essential that the rod is held so that it is concentric with the spindle and gripped securely without marking the surface. An average three-jaw self-centring chuck may or may not hold the part concentrically to a high standard and there could be runout. I have a self-centring four-jaw chuck that holds rod in a perfectly concentric manner. However, there is a risk of marking the surface if the jaws are too tight or too loose. I favour my ER collet holder as it never slips, does not mark and runs in a perfectly concentric manner. For the Williamson engine, I threaded each end of the rod then screwed on the piston until it was tight. The diameter of the piston was then turned until it was a close fit in the cylinder. A sharp tool and high speed are required for this. To peen the threads of rod projected into the countersink, I removed the rod and piston from the lathe. I avoid hammering objects held in the chuck or collets as I am not sure how it will affect the bearings. I rummaged around and found a steel block with a hole that would take the rod. With the piston resting on the block, I lightly flattened the end of the threads using a small hammer and a pin punch. I decided that there was no need to go all around the end and just gave four taps around the

Ray Griffin
builds the
Williamson
column engine according
to Tubal Cain.



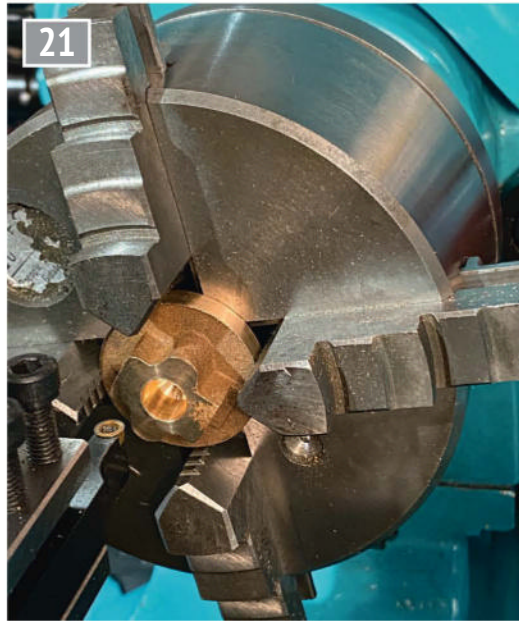
Steam chest and valve gear

The steam chest and slide valve gear follow the lines often found on steam engines and I followed conventional methods to make this model. It is worth noting that the plans give the impression that the cover for the steam chest is held in place with four 7BA studs with nuts. I did this and found that the completed cylinder assembly would not fit into the column. The two lower nuts were the obstruction. I decided to replace these with countersink 7BA set screws.

Continued from p.333
M.E.4737 February 23



Cylinder top cover from the kit.



Machining the top surface of the top cover.



Setting the flats using the height gauge.



Scribing the centre of the flat to receive the slide bar assembly.

circumference. This seemed to me to be sufficient to stop the rod unscrewing from the piston.

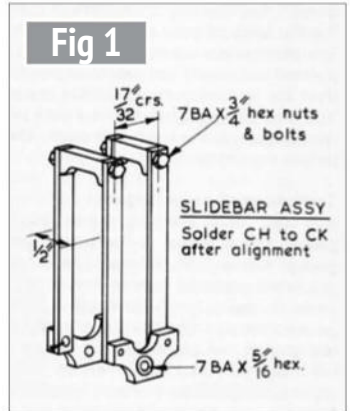
Cylinder upper cover

Accurate workmanship on this piece of the engine is critical to successful running. It not only guides the piston in the cylinder but also provides the base for the slide bar assembly, crosshead and slippers. Any misalignment here will result in resistance to proper functioning. The upper cover for the cylinder is supplied as a casting in gun metal with a small spigot

(photo 20) which I gripped in my three-jaw chuck and machined the diameter and end face and oversized boss. At this point, the diameter and face were turned to just remove the rough casting marks. Turning to dimensions would be done later. The casting was reversed in the chuck held by the boss, with the new face nestling firmly on the face of the chuck. I used my accurate self-centring four-jaw chuck. The hole for the piston rod was drilled and reamed to size and the larger hole for the gland drilled.

To face the end, the only

tool in my collection that did not foul the jaws was a button tool (photo 21). A two-step mandrel was then made with the smaller diameter fitting the bore of the piston rod and the other a tight fit in the bore of the gland. The mandrel served two purposes; one was to true the cylinder flange and the other to machine the flats that are the attachment for the slide bars. It is essential that these flats are at exactly 180 degrees to one another and also equidistant from the centre of the piston rod. Tubal Cain achieved this using a vertical slide on his lathe. It was easier



The slide bar assembly. Copied from the drawing in Building the Williamson Engine, Tubal Cain, 1981. Model and Allied Publications, Argus books Ltd. ISBN 0 85242 7190.

for me to use the milling machine and dividing head. I used the arm of a height gauge (photo 22) to make the flat on the casting parallel to the bed of the mill, then milled one side flat, rotated the casting through 180 degrees and milled the second flat at the same setting.

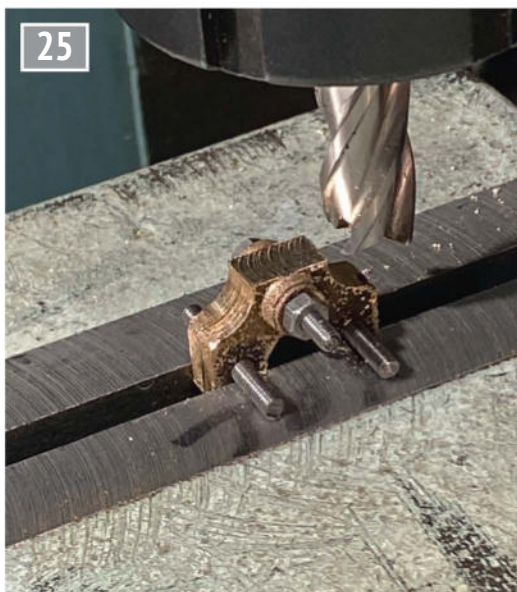
Back to the lathe, on the mandrel, to scribe the centre line of the slide bar flats, in line with the piston rod. I used a chisel edged centre height finder set at centre height (photo 23). It was then useful to drill the holes for attaching the cover to the cylinder. If you make this engine, do not be tempted to position the four holes without checking that the flat valve chest face on the cylinder is parallel with the flat for the slide bar assembly. Failure to do this would result in an ugly misalignment of the cylinder and slide bars. More crucially, the crosshead would not be parallel with the crankshaft leading to tight running. To make mine parallel I attached the cover to the cylinder with a long bolt, then put the valve face flat on a surface plate and rotated the cover until the slide bar flat was also parallel, checking with the flat under surface of a height gauge arm. The long bolt was tightened ready for the holes to be drilled and tapped.

Slide bar assembly

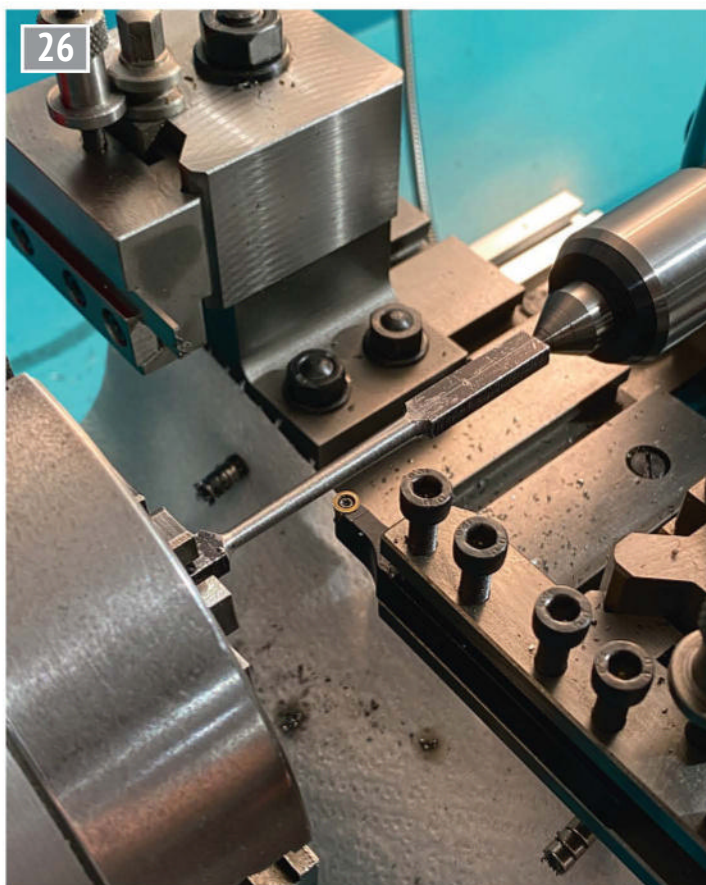
The slide bar assembly is made up from two pairs of bars held at the top by brass brackets



Facing an anchor block.



Milling the anchor blocks to size.



Turning the taper on the connecting rod.

and at the bottom by anchor blocks that fix to the flats on the cylinder cover (**fig 1**). The anchor blocks are supplied as gun metal castings. They require a flat surface to be machined on the surface that mates with the flat on the upper cover and flat surfaces to attach the slide bars. Also required are two holes tapped 7BA, to fix the lower ends of

the slide bars. A third hole of 7BA clearance fixes each block to the cylinder cover. The dimensions of the anchor blocks and position of the fixing holes locate the slide bar assembly. Smooth running of the engine requires them to be the same on both blocks. They were easily machined as they have a good chucking spigot. Each piece was held

by the spigot in the lathe and faced to size (**photo 24**), then the 7BA clearance hole drilled. Both pieces were faced and drilled. I bolted them together with a 7 BA bolt to ensure that they would match, then the two holes tapped 7BA were made. I then put 7BA bolts in the new holes so that the whole assembly could be held for machining to size on the mill (**photo 25**).

Once all the pieces were made, I fastened them together and screwed the assembly to the cylinder cover. At this stage I checked that the distance between the slide bars was the same at the top and bottom and that the whole assembly was in line with the piston rod. Now it is the time to adjust, to get it correct. I was lucky, and mine fitted well first time. Tubal Cain suggests soldering the assembly together once good alignment is achieved. I took mine apart, thoroughly degreased and reassembled with slow setting Araldite on the surfaces that made contact. It was screwed up tightly and left in a warm place for 24 hours to allow the epoxy to set. Solid resin squeezed out of joints was cut off using a scalpel blade. Once I joined together the cylinder and cylinder cover with slide bar assembly I could see the engine taking shape. Then on to the connecting rod and crosshead.

Connecting rod

Material for the connecting rod was supplied as a length of steel $3/16 \times \frac{3}{8} \times 3\frac{3}{4}$ inches long. I marked the centreline on the wide side then positioned and spotted the centres for the big and small ends. The length of the round section was also established and marked out. I also scribed the centre on the flat at the big end. The steel strip was held, big end out, in my small independent four-jaw chuck with a short length projecting. My marked centre was brought into line with the spot of a laser held in the drill chuck of the tailstock. I then used a centre drill to make a centre. Two of the jaws were loosened sufficiently to allow the parent metal to be pulled out far enough to machine the rounded section. The loosened jaws were tightened and the outer end supported with a centre in the tailstock.

My button turning tool gave rounded ends to the shoulders (**photo 26**) and I used the top slide to cut the taper, set over to just under 1 degree, as suggested by Tubal Cain. The two holes drilled for the small and big ends must be at 90 degrees to the body of the connecting rod and parallel with each other. My drilling machine is accurate but the mill is easier. I put the steel strip in the vice of the milling machine resting on an accurately ground piece of steel. The vice was tightened and the piece of ground steel removed. The two holes were then centred and drilled. The small end is $5/32$ inch drilled and reamed. The big end is more complex. It consists of a split brass bush sitting in a rounded fork end of the rod and held in place by a 'U'-shaped strap of mild steel secured with cotters. Tubal Cain gives comprehensive instructions on making the parts; they were not difficult to make. The little cotters were fiddly but so satisfying when finally in place.

● To be continued.



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Gasses

Dear Martin,

I've just been reading Steve Goodbody's third part of 'The View from Butterside Down' (M.E.4735, January 26). As soon as I got to the part where he explained how measuring the amount of methane and other hydrocarbons were done by freezing the sample and seeing the amount of gas which came off at each temperature, I was reminded of a problem with using mixed gases for fueling small scale locomotives. Last week was very cold (freezing literally) but clear sky. The entire track was covered by a layer of frost. This did not deter our biweekly morning running of Gauge 1 locomotives. One member turned up with a gas fired loco and, in consideration of the temperature, he filled the tank with a mix of propane and butane gas. Initially the run was good but soon you could see signs of frost on the tank and performance tailed off. By filling the tender with warm water (the tender did not hold water pumped into the boiler) some life returned. Despite there being some gas left in the tank, performance was not as good as before – probably because the propane had evaporated in preference. I look forward to Steve revealing what the different boiling points of the hydrocarbons has to do with model engineering – but the above effect is certainly one which those working in garden scales experience.

I ran my meths fired NER T2. The cold weather resulted in some great steam effects as can be seen on this short video I made: drive.google.com/file/d/14ffgo1nyQX1J2DyyQYUjbi99kUjyCUB9/view?usp=sharing. Yes, I know that a Mk1 BCK is unorthodox at the end of a loose coupled train but I do not have a freight brake van. At least there is a brake vehicle at the end of the train.

Regards,

Dave Robinson



Securing Fixings

Dear Martin,

On reading Martin Gearing's method of ensuring that screws could not work out by splitting their protruding ends (M.E.4732 December 15 2023) I thought that readers might be interested to know that this approach has been used industrially in the past. The photograph shows the front pulley assembly of a 1938 Ford truck being restored at the Canadian War Museum. The assembly consists of a central piece which fits on the end of the crankshaft and has a crank handle adaptor on its nose (reverse side) and of the pulley. The two are held together by plain shouldered pieces of round steel which are fixed in place by the deformations shown in the picture. The item came into my hands for some cosmetic restoration on the other side.

Best regards,

John Bauer
(Ontario, Canada)

Innovation

Dear Martin,

Is there nowadays room to experiment in an economy that is largely run on efficiency? No, the result of today counts. This is often due to short term thinking and as a result there is no time to do so - creativity and inventiveness are discouraged. Let me give an example. We in The Netherlands had a world-famous aircraft manufacturer, Fokker Aircraft Company. They needed some funding for future investment - only a couple of hundred million guilders. The government decided not to agree and as a result the

company vanished in 1996. As a result, 1000's of employees lost their jobs and, furthermore, their specific knowledge was lost for society. Now there is a shortage of technicians etc. How many people/companies exist in the world having the knowledge to build airplanes from scratch?

The existence of an organisation like the SMEE shows that your British society recognizes and also values trial and error, not as mistakes but as experiments. And in consequence society will benefit maybe not in the short term but in the long run. This is because society is not standing still, but on the move, giving interaction between several disciplines and - as I quote you now - 'They can influence the development not only of an individual but also of a nation'.

With best regards,

Henk-Jan de Ruiter
(Netherlands)

Chatter

Dear Martin,

The article by Neil Raine on parting tool chatter (M.E.4736, February 9) was of great interest to me as I am not an engineer by trade but one who has taken up the hobby out of interest. May I ask that there are more such articles for those of us who are in the learning stage of renovating a 5 inch Black 5 and building a 5 inch gauge Terrier. It's a huge learning curve but enjoyable, made easier by such informative articles.

Kindest regards,

Roger L. Jones

We shall do our best! – Ed.

The American Locomotive

PART 1

David Rollinson explores the development of the classic American 4-4-0 locomotive.



While featured in countless American Western movies, locomotives of the 4-4-0 wheel configuration were not unique to North America. However, for a variety of reasons, they were ideal for use on the burgeoning railway, or railroad, system of that continent. Originally known as 'eight-wheelers' or 'standard' locomotives, the term 'American' became common after 1872 as the result of an article in the *American Railroad Gazette*. Over 25,000 of these locomotives were reportedly built before the design became redundant in the early 1900s. Why was the American-type 4-4-0 so successful and last so long? To answer that question it is necessary to understand the America of the mid-1800s.

The United States of America is a vast country that stretches west and south from the north east Atlantic seaboard where the first European settlement began. The Lewis & Clarke Expedition, which reached the Pacific Ocean in 1805, publicized the extent and agricultural potential of the central plains, initiating a slow westward settlement over the following decades. After the passing of the Homestead

Acts of 1862, which allowed settlers to claim and cultivate plains land, it was the railroad companies that sold the land to eager buyers, provided the means to ship the grain and livestock produced to eastern markets and ship west the domestic and farm supplies that would support settlement on the Great Plains. It fell to the iconic American type 4-4-0 to haul the trains that opened up, and then supported, these new farms and communities.

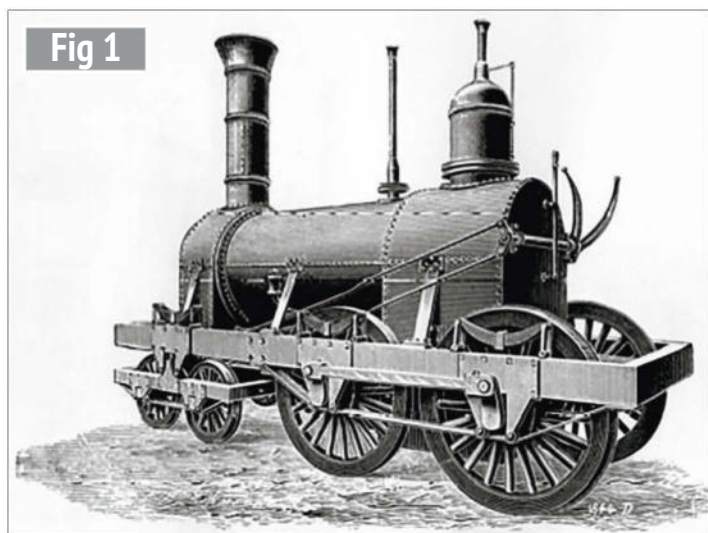
The north eastern seaboard of the United States was well settled by 1861. Large cities such as New York and Philadelphia were bustling commercial and industrial centres. Philadelphia and its population of over half a million people were at the heart of a growing rail network that supported manufacturing and iron working. As one travelled west the population centres became sparser and manufacturing was replaced by agriculture. Beyond Chicago, the settlements and communities became scarcer the further west one travelled. Connecting these isolated communities to larger centres back east entailed the laying of thousands of miles of track, over often indifferent terrain, and the economic viability of these connector lines in the early days of settlement could be fragile.

The speed of expansion of the American rail network, and its extent, was staggering. Referring to the Federal Government report *Transportation in the United States*, published in 1890, the growth of railroads in the country and their expansion westward becomes evident. According to the report, in the whole of the country in 1830 there were 40 miles of track, with 30 of these being in New England and 10 in the south.

Thirty years later the total mileage had risen to almost 29,000 with 239 in the west, an indication of new settlement. By 1880, the heyday of the American 4-4-0, there was a staggering 87,800 miles of common carrier track, with 15,500 in the western states where agricultural expansion and settlement had taken place. It is these statistics that help explain the mass production of the 4-4-0. The first transcontinental line to join the eastern states with the Pacific opened in 1869. By 1900 it had been joined by four others, each connected to a spider's web of secondary lines that covered nearly every corner of the country.

The first practical steam locomotive to operate in America was the *Stourbridge Lion*, an English-built 0-4-0 supplied by Foster, Rastrick & Co., which first ran in Pennsylvania in 1828. Fitted with the vertical cylinders in common use at the time, the engine was too heavy for the track being used so was not put in to commercial service. However, the appearance of *Lion* spurred local interest in the potential of railways and a version of England's railway mania. Railway promoters and investors began to build commercial lines around the developing urban and industrial centres of Philadelphia and Baltimore and a local locomotive building industry was born. Locally inspired innovations in design and manufacturing saw rapid changes in engine construction, with these new locomotives reflecting the operating needs and financial capabilities of the railroads.

In 1836 an experienced railway engineer named Henry R. Campbell was issued a US patent for a 4-4-0 locomotive (**fig 1**). A prototype began



Henry R. Campbell's patented 4-4-0 locomotive.



William Crooks locomotive (photo: Lake Superior Railroad Museum).

trials a year later and proved to be a good hauler, certainly when compared to the 4-2-0s being produced at the time. Unfortunately, Campbell's inside-cylinders engine turned out to be prone to derailment, probably due to its rigid four-wheel leading bogie. Others tried to build 4-4-0s but again with limited success until an eight-wheeler was built in 1837 that incorporated a more flexible wheel arrangement. By 1840 the eight-wheeler concept incorporating a non-rigid four-wheel leading truck had proven itself to be a practical design. The Rogers Locomotive and

Machine Works of New Jersey built a 4-4-0 in 1843 (**fig 2**) that clearly shows its antecedence to later locomotives.

By the early 1850s the eight-wheeler had become a modern locomotive. The round-topped Bury firebox and hook-motion style valve gear of the Rogers design were replaced by a locomotive type boiler and Stephenson's inside link motion. A single pivot four-wheel bogie had replaced Campbell's fixed design and equalizer beam suspension provided excellent adhesion. By 1855 the eight-wheeler locomotive had become the

standard type, in use over most of America's standard gauge lines. Contemporary with the railroad expansion of the mid-1850s a growing economy funded an industrial-scale iron industry able to provide the necessary materials, tools and workforce to build these new locomotives in numbers (**fig 3**).

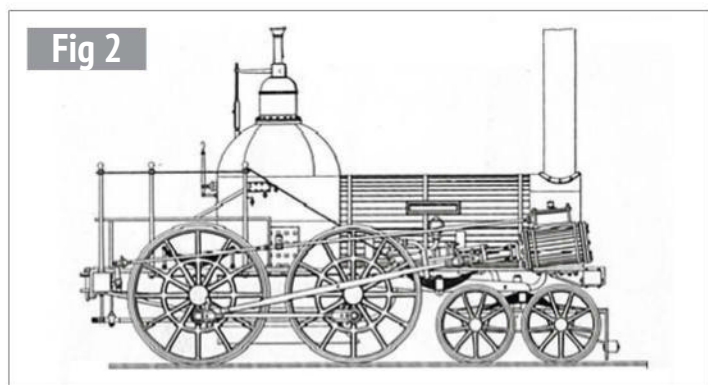
In 1861 the New Jersey Locomotive & Machine Co of Paterson, New Jersey, turned out the *William Crooks* (**photo 1**) incorporating the features that were to remain the standard for the American 4-4-0 until the early 1900s, when it became an obsolete design. Originally a wood burner, the *Crooks* was fitted with two 12 inch by 22 inch outside horizontal cylinders with inside Stephenson valve gear. With driving wheels of 5 foot 3 inch diameter and a boiler pressure of 110 lb per square inch the 50 ton locomotive had a 4,700 lb tractive effort. By the time the *William Crooks* entered service North American locomotives had evolved their own distinctive style.

The rapid expansion of a railroad network over a vast distance required an enormous investment for a still developing country. To help reduce costs, much of the new mileage was laid as single track, using 56 or 66 lb iron flat bottomed rail spiked to wooden sleepers that were laid on a road bed often not much more than a scraped surface. The all-time record for a day's single track laying was 10 miles! Any locomotives employed on these lines had to be able to survive operating conditions that at the time would have been considered untenable in England. It is difficult today to imagine the logistics necessary to maintain locomotives over such an enormous geographic range. In his 1937 biography *Life of an American Workman* Walter P. Chrysler, of car building fame, described his early start in life as a roundhouse mechanic in Kansas.

Beginning his apprenticeship in 1893, in the era when the American locomotive was still common, Chrysler recounts his experiences working to maintain and repair locomotives from small remote shops that were equipped with the minimum of tools and equipment. He also relates how issues related to poor feed-water quality and extremes in operating conditions made the mechanic's job a continual challenge. It was under these circumstances that a simple and ruggedly-built locomotive was essential.

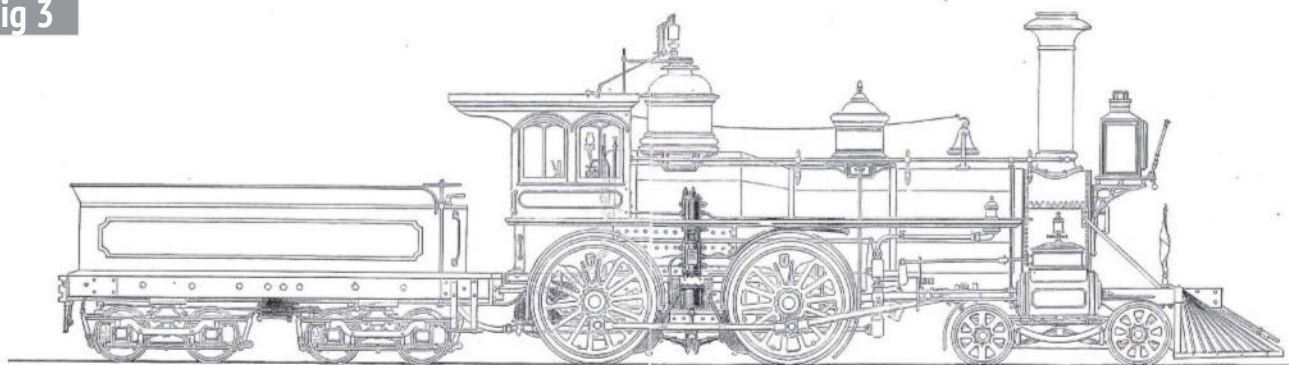
In 1871 Gustavus Weissenborn, an American engineer and technical writer, wrote 'The first and most prominent quality of the American locomotive is its flexibility: in rounding curves, in moving over rough and uneven track, yielding in all directions, it maintains both its position on the rails and its adhesion to them in a surprising manner'. Speed was not a requirement on the railroads of the West but staying on the rails, hauling capacity, ease of maintenance and repair were.

In 1878 Robert H. Thurston,



4-4-0 locomotive produced by the Rogers Locomotive and Machine Works in 1843.

Fig 3



Classic American 4-4-0 locomotive produced in large numbers.

a highly regarded and experienced professor of mechanical engineering in America wrote his *A History of the Growth of The Steam Engine*. The cross section of a contemporary Baldwin American locomotive is included in the book, accompanied by his comments on the type:

'The standard passenger-engine on the Pennsylvania Railroad has four driving-wheels, 5½ feet diameter; steam cylinders, 17 inches diameter and 2 feet stroke; grate-surface 15½ square feet and heating surface 1,058 square feet. It weighs 63,100 pounds, of which 39,000 pounds are on the drivers and 24,100 on the truck. The (locomotive) takes a train of five cars up an average grade of 90 feet to the mile.

'The American locomotive-engine has a maximum life which may be stated at about

30 years. The annual cost of repairs is from 10 to 15 per cent of its first cost (which was about \$12,000).... And a ton of coal to each 40 or 50 miles run.'

The 'cars' in question, if they were regular passenger-type, would be about 46 feet long and 10 feet wide and high. The body would be of heavy wooden construction, supported on an iron frame and riding on two four-wheeled passenger car trucks. Providing seating for 54 passengers, the car weighed in at 39,000 pounds.

Close study of the design and construction of the American-type 4-4-0, a wheel arrangement which was also used in Great Britain and Europe, not only reveals the similarities between the two but also the areas of divergence. At the heart of any locomotives are their frames, with bar frames being used exclusively in the American-type locomotive.

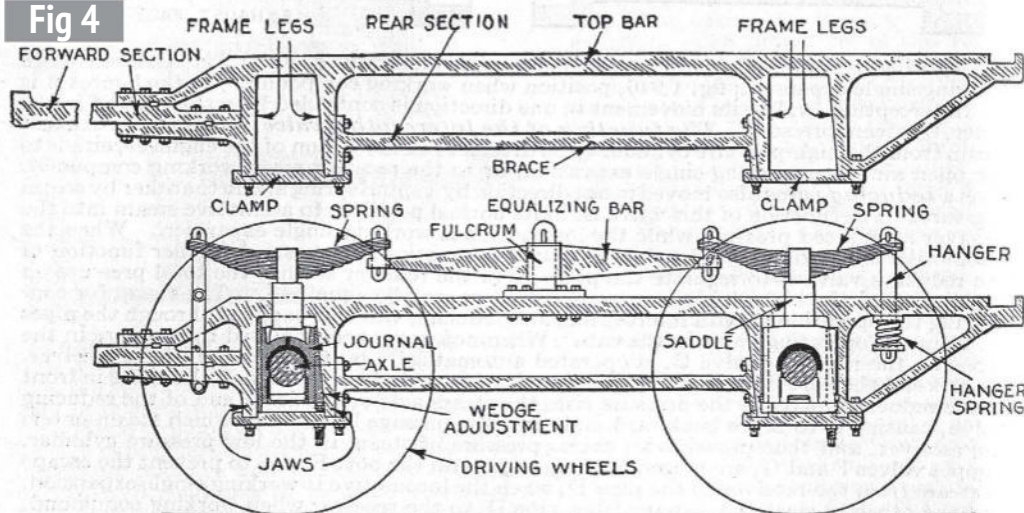
Wrought iron bar frames were used by Edward Bury for his 1830 locomotive *Liverpool*, replacing the plate iron and wood combination common at the time. First used in America in the early 1840s, bar frames proved to be ideal for the large locomotives allowed by the more generous North American loading gauge.

Bar frames offered American locomotive builders several advantages. Most importantly, iron plate was in short supply due to a lack of plate rolling mills, but bar stock was available in quantity. Bar frames are not only strong but also easy to produce with limited machinery, an important advantage as, even as late as the 1870s, the Altoona shops of the Pennsylvania Railroad were relying on considerable hand work for locomotive building. Bar stock frames could be drilled and bolted

together with the almost complete absence of rivets. Short lengths of stock could be used, allowing for easy replacement if needed, and few cross stays were required to reinforce the frames. Bar frames made the mounting of cylinders, suspension and brake gear simple, and axle boxes easy to install and maintain. However, there are some disadvantages related to the use of bar frames. When compared to plate frames they are heavy, lack vertical rigidity but are excessively rigid laterally, not good traits when running on poorly-laid track. They could also result in some structural weakness at the front end related to the use of leading bogies, a situation only resolved with the adoption of cast smokebox saddles.

The layout of a set of bar frames (fig 4) shows the arrangement of the major components for an American-type 4-4-0 locomotive. The illustration shows clearly how the frame consists of two separate horizontal sections bolted together using short vertical bars. The forward section consists of a single bar and it is to this that the cylinders and cross stay for the front truck is bolted. The simplicity of the layout is evident, as is the ease of access to all the moving parts. As machine tools became available the frames were machined using large planers, reducing the amount of hand labour required and increasing the accuracy of the assembly.

Fig 4

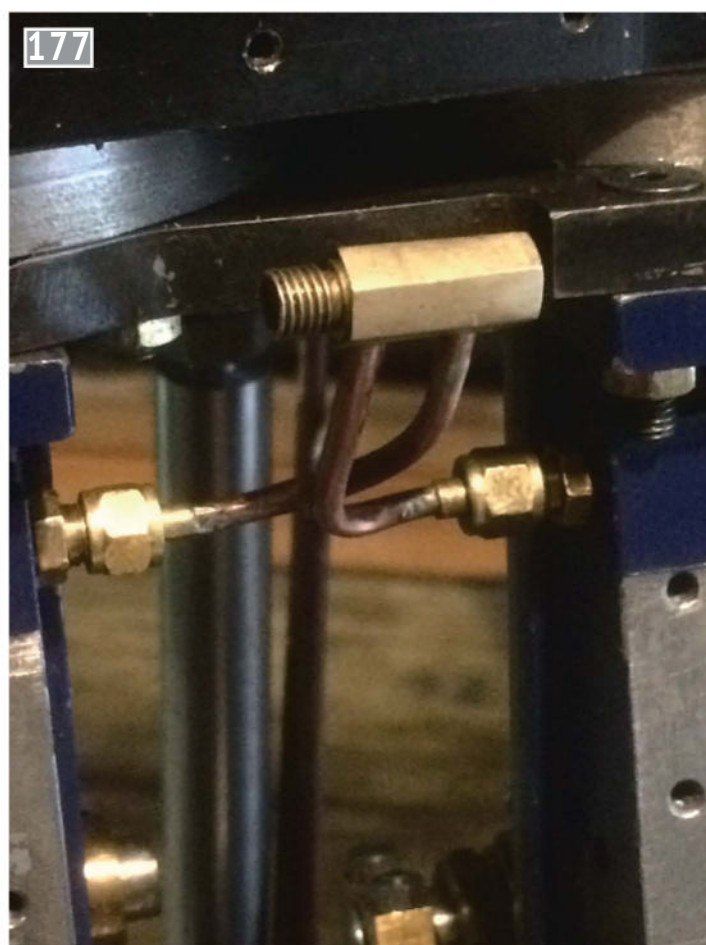
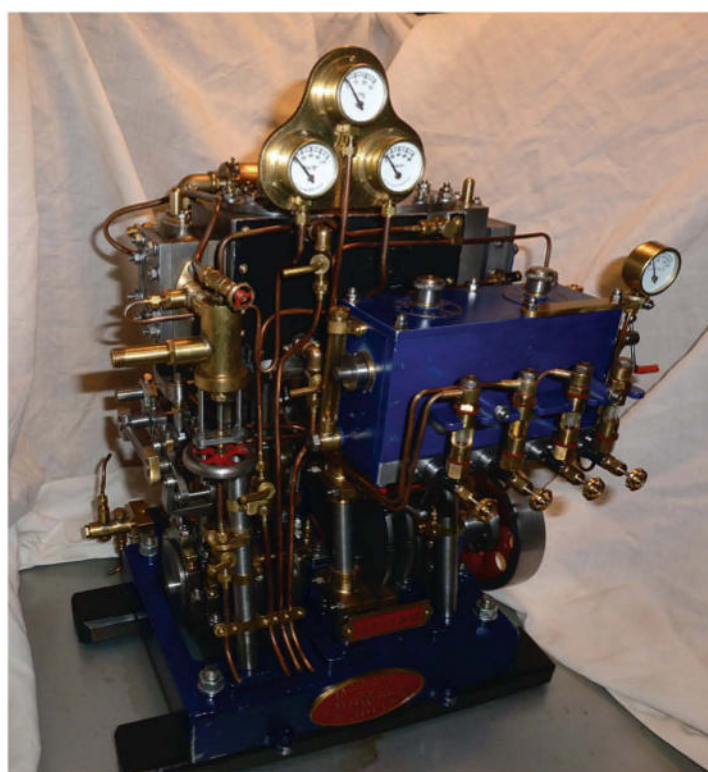


Bar frame layout.

●To be continued.

HERCULES

A twin cylinder compound condensing marine steam engine. PART 9



Oil feed to the two crosshead slides and wrist pins.

Chris Walter

builds an engine described in *Model Engineer* 100 years ago.



Oil manifolds and pipes

Try as I might, I have difficulty with piping. Any size piping, that is, from very small for models up the domestic plumbing size. I try not to touch house plumbing unless I have to, as there always seem to be problems, however careful I am. One never knows what part will be needed until the problem item has been disassembled and the water mains turned off and then, when you find that you need a particular washer, O-ring or whatever, you know that this will be the one thing you haven't got in stock.

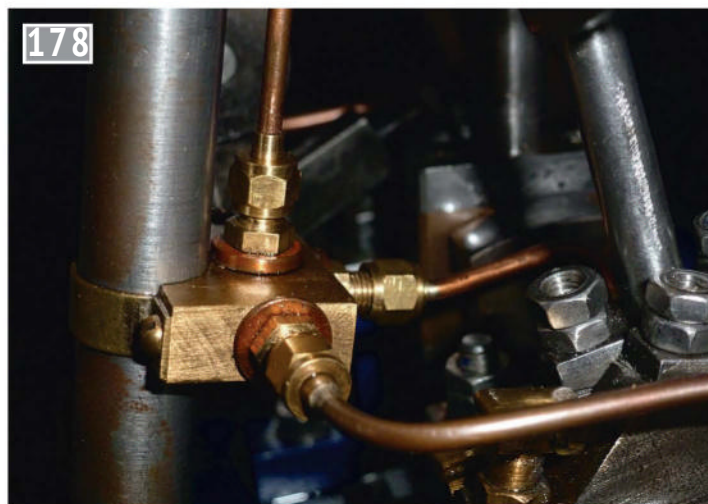
One of the oil feeds needed was a feed to the two unions at

the top of the two rear support columns, which were to supply lubricant to the crossheads and wrist pins. To join these to the one supply pipe, a single 3/16 inch x 40 pipe union was made with two pipe feeds to connect to the columns. To achieve this in the small gap available, the pipes had to face in opposite directions (**photo 177**).

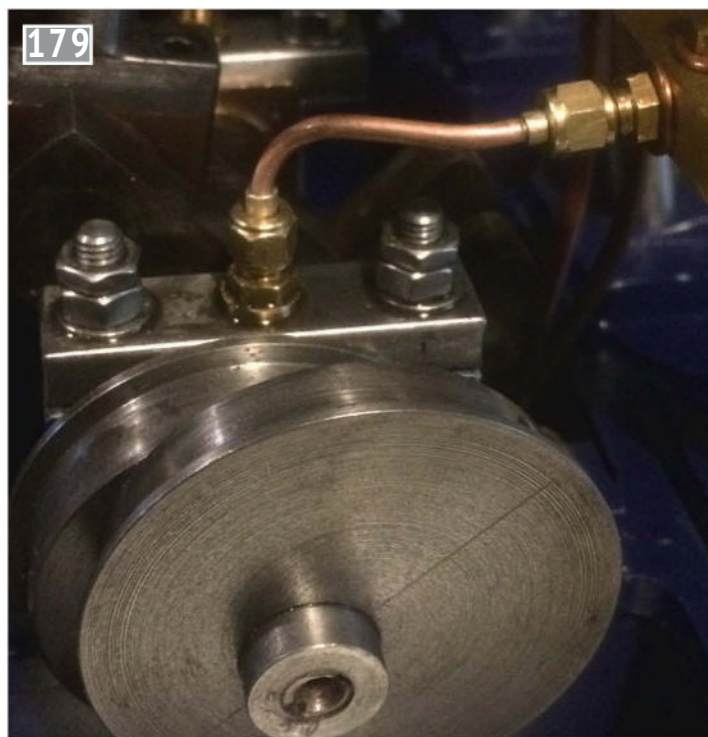
I also needed to provide an oil feed to all four of the main

crankshaft bearings. This would necessitate lots of small pipe bends and runs and, in order to try and make them at least presentable, I decided to make two fittings which would secure to the outer front support columns and act as multiple unions for the various pipes (oil manifolds, for want of a better name). These were simply small sections of brass flat, drilled 1/2 inch diameter

Continued from p.313
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Manifold for oil feed to main bearings 3 and 4.



The pipe connection to main bearing.

to fit the column then split into two parts which could be clamped onto the column. Each unit was drilled and fitted with three connected 3/16 inch x 40 pipe unions, one facing up to receive the in feed and the others to be connected to two of the main bearing caps (photos 178 and 179).

Lubricator

Some few years ago when I first thought about making this engine, very high on my mental wish list was a decent mechanical lubricator with all the bells and whistles. At the very least I wanted to ensure an adequate oil supply to both

cylinders and the crankshaft main bearings, as well as the crossheads and wrist pins. Having just the odd oil cup was not going to be acceptable.

For a considerable time, whilst I was making the major engine components, I could gradually think through a few of the lubricator details and how I wanted to achieve them. Not being in possession of a large enough steam boiler I knew that I would, at least initially, be running the engine on compressed air.

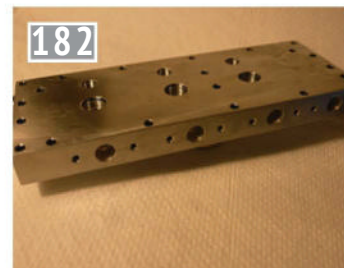
I needed to have two oil tanks, one to supply steam oil to the cylinders and the other to provide SAE grade lubricating



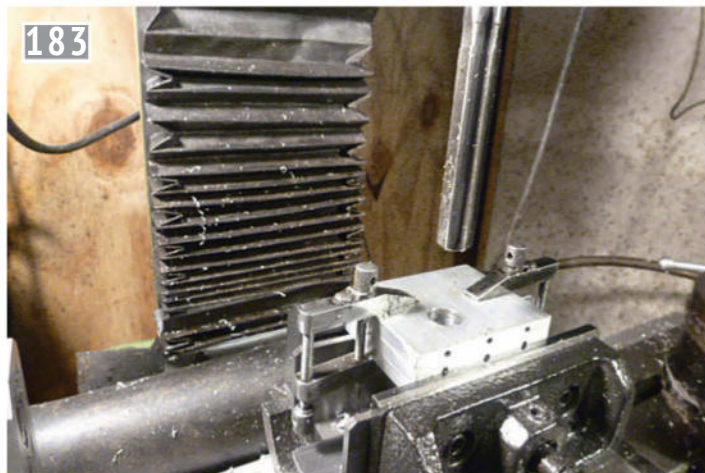
Lubricator unit.



Tapping the bottom oil gallery plate.



Finished gallery plate.



Reaming the main shaft hole through the tank sides.

oil to all the different bearings. To achieve this would require at least three pumps, as a separate pump would be required for each of the two cylinders. Initially when running on compressed air the steam oil would be replaced by ordinary lubricating oil.

When the time came to actually concentrate on the lubricator, I had completed quite a lot of experimentation and had built and discarded several mock-ups. This process had allowed me to finalise the design and I knew where I was going - well, nearly, anyway (photo 180)!

The casing is divided into two tanks and is made from 1/4 inch aluminium plate, except for the base which is 1/2 inch thick. This thickness is necessary as the base contains all the oil channels from the three pumps and three pressure relief valves, and also the feeds to the four demand valves and sight feeds.

The tank and base are held together by JB Weld adhesive assisted by numerous 6BA countersunk machine screws. If they can make supercars with adhesive, it is good enough for my lubricator (photos 181, 182 and 183)!



184
Main shaft, eccentrics and followers.



185
Trial assembly of components in the tanks.



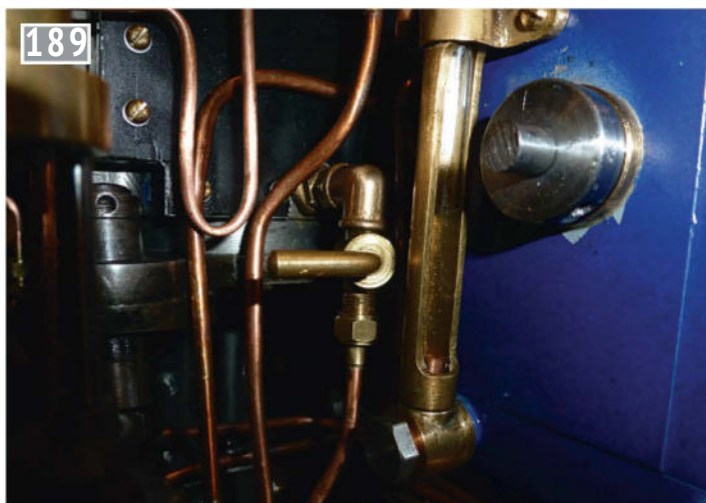
186
Pump components and ram.



187
Banjos and seals.



188
Completed sight feed unit.



189
One of the two oil level indicators.

The three pumps were based on a conventional design which uses two O-rings to seal the ram and ball. However, for my design the base part had to be altered slightly so it could be screwed downwards, feeding into the oilways in the base of the lubricator (**photos 184 and 185**).

I also used a modified form of three-sided yoke (if that is the correct terminology) which

encloses the eccentric and can have a thick retaining washer with grub screw so that, in effect the eccentric is enclosed in a box (**photo 186**).

From the pumps the oil passes into a gallery, part of which leads forward to go through a hand-wheel controlled valve, where it passes up through a glass sight feed and on to its destination via a banjo union

(**photos 187 and 188**).

The other part of the gallery extends backwards and ends in an adjustable pressure relief valve, which, when the pressure exceeds its setting, allows the oil back into the main tank. As the pumps run all the time this ensures that the pump components are not overstressed if the feed valve is shut.

The left-hand tank has two pumps, one to supply each of the cylinders, each with its own relief valve. Oil is fed to clack valves via unions on the valve chests. The right-hand tank has one pump and relief valve, but feeds two adjustable sight feeds.

This is not ideal, but as the main bearings and crossheads generate no back pressure, and are below the level of the lubricator, only a slight pressure of oil seems to be more than sufficient. At the very least the sight feeds will indicate that oil is being fed, if not the amount! Each tank has a glass oil level indicator in a

brass casing (**photo 189**).

Photograph 190 shows testing taking place to find a form of relief valve that consistently worked.

There was only one sensible place I could find to mount the lubricator so that it was within reasonable reach of the virtual engineer who had control of the throttle valve and reversing gear. This was across the upper front right of the engine and supported by brackets fixed to the centre and right-hand front columns. I had, after much head scratching, already reduced the size of the lubricator as much as possible but it was still over large and, in this position, completely hid the two LP cylinder drain cocks so these would have to be moved.

The mounting brackets were very similar to those of the reverse gear quadrant and were made the same way. They did, however, require to be extended slightly, to give the lubricator something flat to sit on. Various clearance holes had to be cut in these brackets to accommodate the hex heads of screws used to join the bottom and sides of the lubricator tanks (**photo 191**).

To operate, the lubricator main shaft needed two one-way needle bearing clutches. One of these is in the left-hand end shaft bushing and the other is fitted within the drive lever at the right-hand end, just behind the priming handle (**photo 192**).

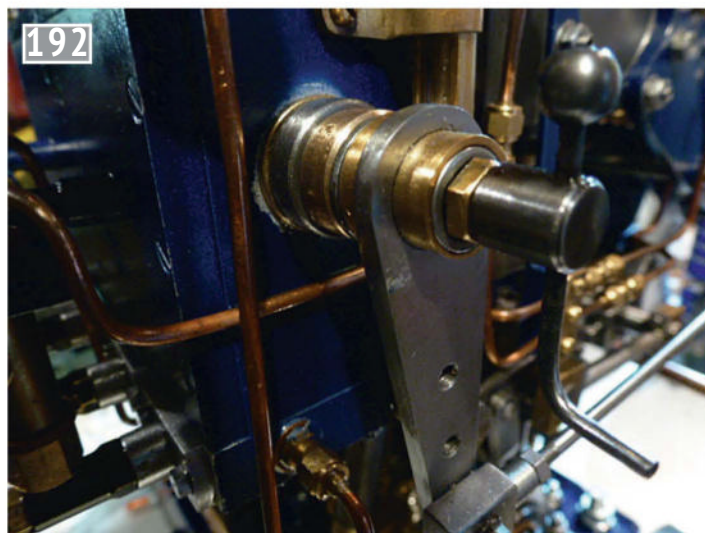
There is a permanent lid fitted to the two tanks and a filler with a screw cap is



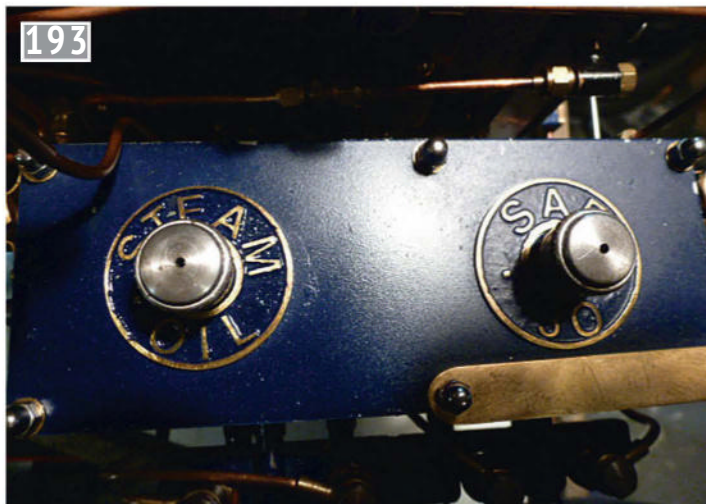
Testing the oil pressure release valves.



The two support brackets on the columns.



The drive lever clutch unit with the priming handle.



The two filler cap labels. One of the tanks contains steam oil for the cylinders and the other SAE30 oil for the bearings etc.



Lubricator drive shaft.

provided for each. A circular brass engraved notice surrounds each filler, listing the type of oil required (**photo 193**).

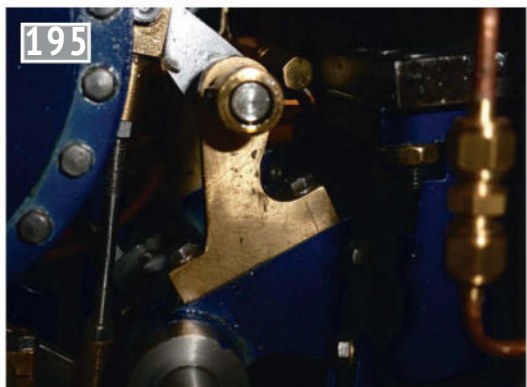
Lubricator drive linkage

The lubricator drive is taken from the air pump drive levers as these provide motion in time with engine speed, and by positioning the connection near to the pivot point, a very short stroke.

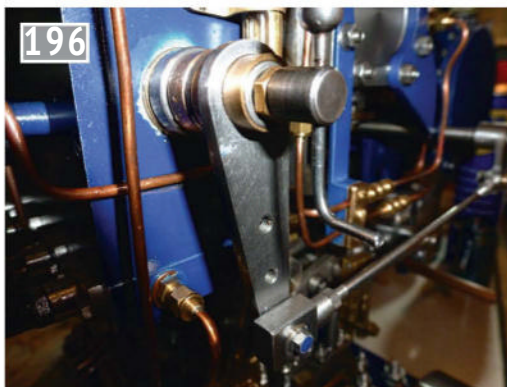
From the air pump levers a vertical link connects with another lever attached to a $\frac{1}{4}$ inch diameter shaft that runs across the rear of the engine, above and parallel to the weigh shaft (**photo 194**).

This shaft runs in bearings in two brass brackets affixed to the tops of the weigh shaft bearing brackets; so it's a bracket on a bracket on a column. I seem to remember my grandmother quoting something about... 'These fleas have more fleas who have other fleas upon their backs to bite them!' (**photo 195**).

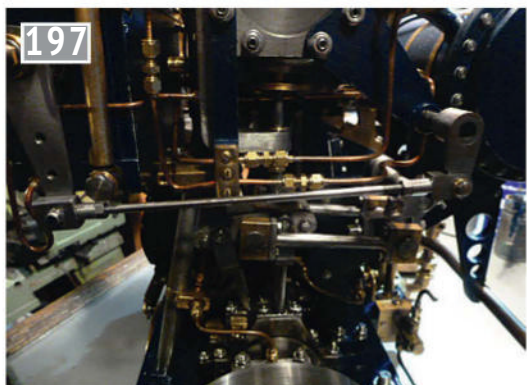
The very end of this shaft runs through yet another bearing on a support bracket fixed to the LP valve chest and then, by means of another lever and cross rod, transmits movement to the clutch drive lever on the lubricator. Possibly a bit Roland Emmett but it seems to work and it was the simplest, if not the only way to do it (**photos 196, 197 and 198**).



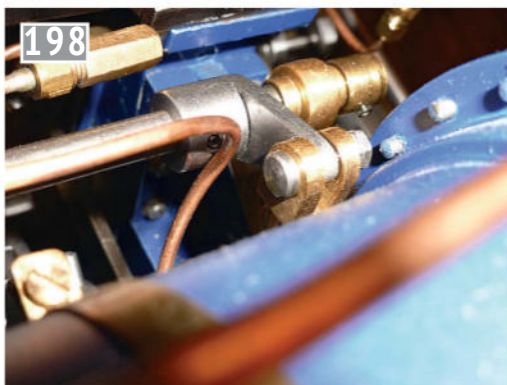
Shaft bracket.



Lubricator clutch drive lever.



Cross linkage.



Second shaft lever.

●To be continued.

CLUB NEWS

Geoff Theasby reports on the latest news from the clubs.



In this issue, "I'm sorry Sir you can't start there. It's the rules you see. Section Q of the *Beginning of Literary Products* Act 1932 says 'that no scribe or other penman shall begin his written submission with insufficient introductory remarks'. (Defined as 'Text', Sir, in the colloquial speech of those intended as subscribers.) For a list of permitted languages, creoles or pidgins, see Room 2794 of Great Universal Government Towers, Miss Hill, Thursdays, AM only."

"Will this do, then?"

"Not for me to say, Sir."

Well I'm going to start. Blow your whistle, constabule.

For the purposes of beginning this column, the following shall be regarded as so authorised - Geoff.

In this issue, rogue clock winders, climbing tree stumps, the Black Hand Gang, conifers away!, some acid remarks apathy, paint colours, (shaken, not stirred) and books on obscure interests.

York Model Engineers' January Newsletter, was

first in the 'slush' pile (not a derogatory term) wherein we find the news that editor, Roger Backhouse is to retire from the office. I hope the next incumbent can match his lively, often humorous, expressions. He begins his dolorous epic with a note about the father of flying, Sir George Cayley of Brompton nr. Scarborough. Born in 1773, he conceived the requirements for heavier-than-air flight, lift, drag, etc. and built a glider which actually flew, in the vale behind his residence (I've been there). He had other ideas too, like theatre safety curtains and outward opening exit doors. The caterpillar track was his idea but, as with flying machines, he lacked a lightweight engine. For railways, he proposed block signalling, cowcatchers and improved buffers. A model of his glider is in the Yorkshire Air Museum, Elvington. Opinions vary as to who made the first flight across Brompton Vale but it did happen. Mike Pindar wrote about Corpet locomotives, helped by a family history by Anne C, but hindered by almost all the

menfolk being called Lucien. Next in line is Richard Gibbon's 'Corpet' locomotive, *Saucy Jo Nut* (anag.), a 5-inch gauge model of an 0-6-0 coal mine locomotive, which he describes as Paris built, Swiss designed and used in Spain, with Brown valve gear, a favourite in Switzerland and the Duffield Bank Railway but nowhere else. Paul Tanner designs locomotive safety chains, after being inadvertently treated to a ride in a 'slip coach'. York Clock Group roams York streets wide and narrow winding up public clocks. This seems a harmless occupation and who am I to judge? Neil Rowley uses a Sherzer rolling lift bridge for the garden railway. This type of bridge has no pivot but a grooved working surface on the moving part engages with a line of steel studs set in the kerbside. This maintains alignment and needs no lubrication. There are several in the UK - I saw one in Grimsby on the dockside some years ago (www.newcivilengineer.com/latest/reopening-of-grimsby-rare-bascule-bridge-delayed).



Rolling bridge with builders, York model engineers (photo courtesy of Roger Backhouse).



The essence of the bridge (photo courtesy of Roger Backhouse).

as-condition-more-severe-than-thought-09-10-2023). **Photographs 1 to 4** explain who and how: photo 1, the bridge and its builders; photo 2, the basic idea; photo 3, a real bridge on the River Hull; photo 4, how it works, in close-up. Mike Pindar writes a book review of Caroline Roope's *The history of the London Underground map*. He is not impressed with the book, pointing out several inadequacies, despite the fact that it is obviously well researched and detailed. 'But it could have been much more...'. Finally, a bracket fungus has been found in the woods on the club site. It MAY be edible but don't try it unless you know **exactly** what you are doing. As has been said, everything is edible – ONCE!

W. www.yorkmodelengineers.co.uk

News from the **Society of Model and Experimental Engineers**: Martin Kyte advises that the recent talk by Alan Welbourne was well received by those present at Marshall House and also on Zoom. Alan worked in gear design for production, beginning with Blaw Knox, makers of quarrying and roadmaking equipment. As well as the usual production of engineering equipment, he also had to take into account the endurance and wear characteristics of the product in a specific environment, using a forestry logging application, one of which was puzzling the customers' engineers. Whilst the rest of the power

transmission was without problems, the gearboxes still broke. The problem lay in the vehicles having to climb over the three foot stumps of trees already cut down. This exceeded the requirements for a normally articulated axle but this could be redesigned accordingly. Forthcoming is a virtual talk by *Blondihacks*, (mentioned in these pages at intervals) on building battleships. (Will this be a 'practical'? - Geoff)

W. www.sm-ee.co.uk

Goodwin Park News, from **Plymouth Miniature Steam**, winter, begins with the chairman, Ian's summary of the past year, and the well-attended Hallowe'en event, with even some visitors dressed up for the occasion, including the Grim Reaper, a Space Shuttle and a gorilla (?). The club 'track gang', here known as the 'Vandals', reminded me of the Welsh Highland platelayers which featured your scribe for a while prior to reopening. (Well they couldn't have done so afterwards... I bet he looks neat on the driving seat of a vehicle made for one.) Anyway, be that as it may, they are (or were) known as the Black Hand Gang. (That Molyslip grease is very black and gets everywhere! - Geoff)* Ursula Brown visited the Royal Saloon 798 at the Severn Valley Railway and described its internal fittings and other facilities. Ian Jefferson described the A1 Trust Convention, including the new cylinder block for new-build *Prince of Wales* - and what



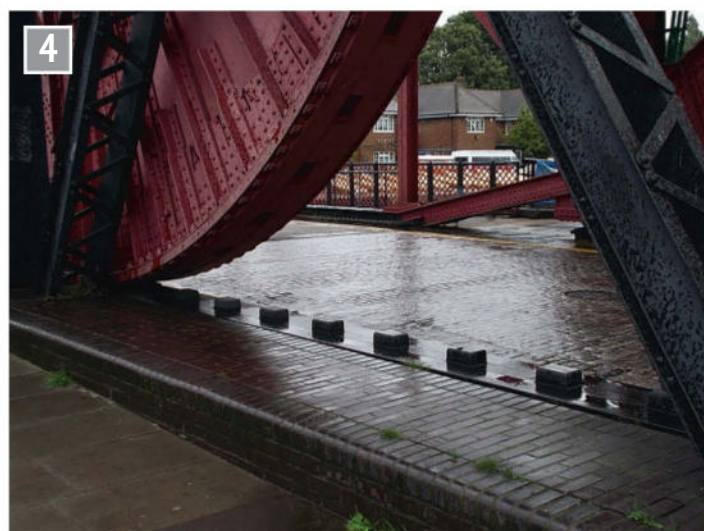
A real bridge in Hull (photo courtesy of Roger Backhouse).

a casting, it weighs 5½ tons! and also the very early Skerne Bridge, by Ignatius Bonomi.

W. www.plymouthminiaturesteam.co.uk

Steam Whistle, from **Sheffield Society of Model & Experimental Engineers**, January, contains the forthcoming programme of talks. In March Stephen Gay will give part two of his talk about the closed Woodhead line. Later that month, Dr Phil Judkins will speak on electronic warfare. I find this subject most interesting, ever since I first read Alfred Price's excellent book *Instruments of Darkness*. Phil is a very good speaker, who delivers his lectures very smoothly and professionally. I have attended several of them. The small conifers outside the clubhouse, around and through which children and dogs have played 'chase', have

been decimated (in its proper sense) since the marquee was damaged in the high winds of January, so one of them had to go and the conifers 'lost the vote...'. Treasurer Mike Gibbs says our increasing income means the Society is now 'eligible' to pay VAT. This causes him more work but has some advantages. Speaking of hard work, Zee Kavetzis has acquired a kit for a wagon, which will form the basis of a driving truck. Oddly enough, Mike Peart this month covers railways and bicycles. At the turn of the 19th Century, cycling was very popular and railway companies often had specialist coaches for to carry them. Station staff had to establish whether a vehicle was one of several types, with appropriate fees to pay. The small 'Blue Pullman' belongs to (and was built by) Mick Vere. A



How the alignment system works. This is in Wapping, London (photo courtesy of Roger Backhouse).



Caption competition! Taken at South Yorkshire Transport Museum.

period carriage seen at the Fun Run on January 1st contains a passenger with an underarm pig, although not wearing a green suit. (The passenger... Oh, please yourselves!) Before leaving this publication, I draw your attention to Tom Ingall's video on progress made in building 72010, *Hengist* in Sheffield (www.72010-Hengist.co.uk). Another club visit to the works is planned in April.

W. www.sheffieldmodelengineers.com

Model & Experimental Engineers, Auckland, tells us Peter Phelan is moving to a retirement village and wishes to exchange a set of 'number' drills and a set of 'letter' drills for a metric set. (Oh, the rot's setting in, thin end of the wedge etc... - Geoff) As a change from mending delicate clocks, Michael Cryns has repaired a hammer drill. The chuck takes drills with a stepped end but those sourced from China do not fit. A cure was to nickel-silver solder a prepared end to them. This will stand up to

the vibration, well, so far at least! Roger van Ryn has some concentrated sulphuric acid for disposal (very carefully!). (This reminds me of how a suspect item was found in a previous employer's premises, and spirited away under cover of darkness, wrapped in black bin bag.) Completing his Monosoupape engine, Murray Lane says, 'So there you have it. The end of a project started in mid October 1993 which included 58 large drawings and around 50 smaller ones of setups and machining details for the complicated jobs. It is a 1/3rd scale of a standard Mono and includes every part of the full-size engine. It is 430mm long and 326mm in diameter but has never been built to run as it would be an extremely difficult job to get all the internal parts to be lined up in the correct position'.

We haven't held a caption competition before, so try this for size – (photo 5).

A correspondent writes 'Are there any clubs which

don't send you newsletters?" Err, how would I know? Think about it. (Name withheld to save embarrassment.) Well, there are Rochdale, Leyland and North Wales, to name but three. Then there are the British Interplanetary Society (Flat Earth Division), The Over-80's Nude Formation Hopscotch team, The International Apathy Group... Some claim they have nothing to say but this is almost invariably wrong. Very rarely do I find nothing worth noting in details of club activities, and I don't drink that Dutch lager.

Gauge 1 Model Railway Association, Yorkshire Group, Newsletter contains a list, thought lost, in secretary Malcolm High's archives, regarding the near-correct shades of car paint compared with railway colours. (And, see my opening remarks in M.E. 4737 - note that this list is more comprehensive.) Gauge 1 North is shaping up well, at Bakewell as before. Also, the group has been asked to supply the Moordale layout to the Wensleydale Railway event on May Bank Holiday at Leeming Bar. A previous attendance there was very successful, so try to do your bit.

W. www.gauge1north.org.uk

A nicely restored 1937 Bedford WTL at South Yorkshire Transport Museum (photo 6).

I acquired a small collection of railway-themed books from a lady who wanted her father's

library to go to a good home. They have joined the ranks of my reference collection and include publications such as *Big Four Cameraman* and *Western Cameraman*, R J Blenkinsop, *Main Line Lament*, Colin Walker, and J H Russell's *Great Western Coaches Appendix, Volume 2*. Others of note may be reviewed in further issues. I am amazed by the amount of detail recorded in the GW coaches book. Despite being into railways from the mid-1960s, I am still astounded by the comprehensive information therein, beginning with slip coaches and ending thirteen chapters later with sundry brown vehicles, like fish vans, fruit vans etc., some converted from broad gauge stock and capable of being attached to passenger trains. Also in this collection was, incongruously, a map of all airfields in the UK and Ireland, which will look good on my wall alongside the Great Circle map of the world centred on Moose Jaw, Saskatchewan.

And finally, If Marcel Marceau was arrested, would he have the right to remain silent?

*This reminds me of visiting the water mill near Chatsworth. Much of the machinery was open and we were warned not to get too close 'or you will get grease on your clothes, and grease is expensive.'

And, if you have been, get thee behind me...

ME



A more prosaic photograph from SYTM.

Club Diary

6 March 2024 – 3 April 2024

March

6 Bradford MES

Annual General Meeting, 19:45, St James' Church, Baildon, BD17 6HH. Contact: Russ Coppin, 07815 048999.

7 Sutton MEC

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

7 Warrington & District MES

Projects/natter night, St Mary Magdalene Church, WA4 3AG, 20:00. See www.wdmes.org.uk/events

10 Sutton MEC

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

10 Warrington & District MES

Running day at the club track. See www.wdmes.org.uk/events

15 Rochdale SMEE

An informal exhibition night.

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

17 Guildford MES

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

17 Warrington & District MES

Running day at the club track. See www.wdmes.org.uk/events

17 Westland and Yeovil MES

Running the track at Yeovil Junction – Steam Train Day.

Contact : Michael Callaghan, 01935 473003

20 Bristol SMEE

Talk: 'Goliath, a model of a 1903 French tug boat', Begbrook Social Club BS16 1HY, 19:30.

Contact: secretary@bristolmodelengineers.co.uk

21 Warrington & District MES

AGM. See www.wdmes.org.uk/events

22 Warrington & District MES

Running day at the club track. See www.wdmes.org.uk/events

23 Bradford MES

Spring Social Meeting, 19:30, Northcliff. Contact: Russ Coppin, 07815 048999.

23 Westland and Yeovil MES

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

25 Sutton MEC

Afternoon run from 13:00.

Contact: Paul Harding, 0208 254 9749

29 Warrington & District MES

Running day at the club track. See www.wdmes.org.uk/events

30 Bradford MES

Easter Bunny Event, 12:00 - 15:00, Northcliff. Contact:

Russ Coppin, 07815 048999.

31 Plymouth Miniature Steam

Public running and easter egg

hunt, 14:00-16:30, Pendeen Crescent, Plymouth, PL6 6RE, Contact: Rob Hitchcock, 01822 852479

31 Westland and Yeovil MES

Running the track at Yeovil Junction – Easter Event. Contact: Michael Callaghan, 01935 473003

April

1 Westland and Yeovil MES

Running the track at Yeovil Junction – Easter Event. Contact : Michael Callaghan, 01935 473003

3 Bradford MES

Meeting: 'Low Moor, Ring of Iron' by Mary and Geoff Twentyman, 19:30, St James' Church, Baildon, BD17 6HH. Contact: Russ Coppin, 07815 048999.

NEXT ISSUE

Camshaft Grinder

Gerard Dean explains how he ground the crankshafts for his 1450cc V12 motorcycle engine.

Bradford Challenge

Bradford Model Engineering Society invites entries for a fun competition to design a racing engine that goes fast and manages to stay on the track for two laps.

Steam Engine

Ron Fitzgerald explores the history of hydraulic engines – engines powered by gravity by means of a head of water.

American Locomotives

David Rollinson traces the development of the classic 4-4-0 American locomotive.

Williamson Engine

Ray Griffin completes his Williamson engine by making the crosshead and crankshaft, paints it and runs it for the first time.



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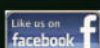
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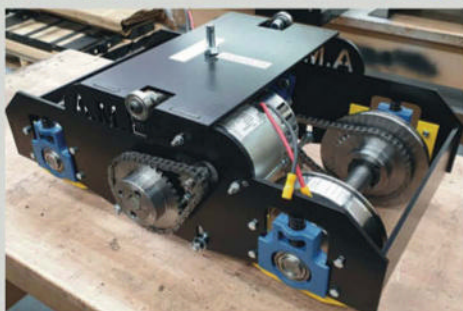
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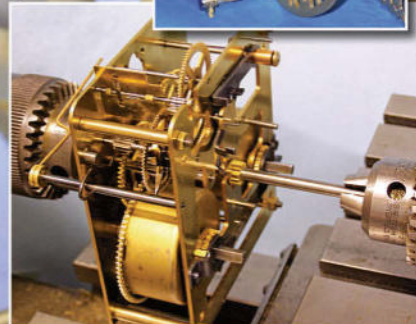
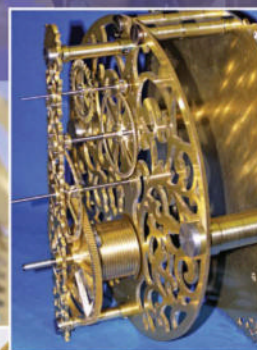
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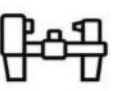
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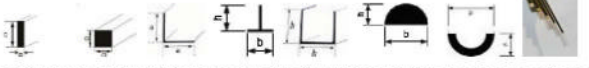
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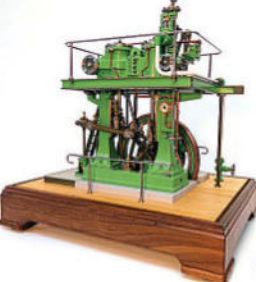
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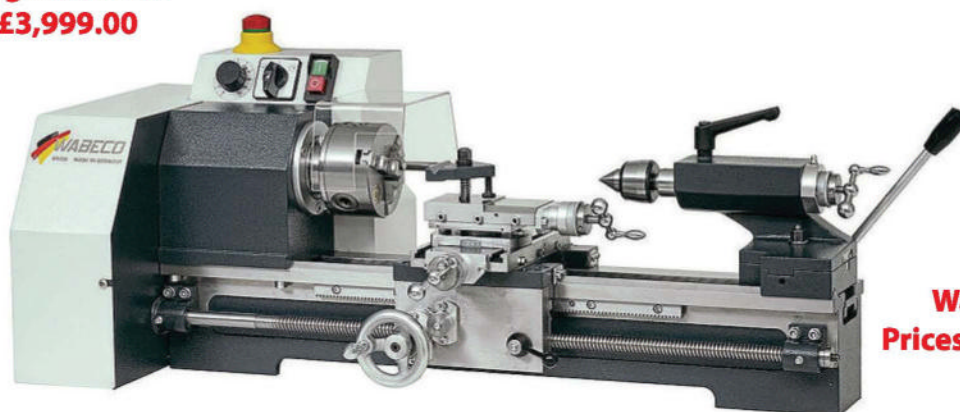
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