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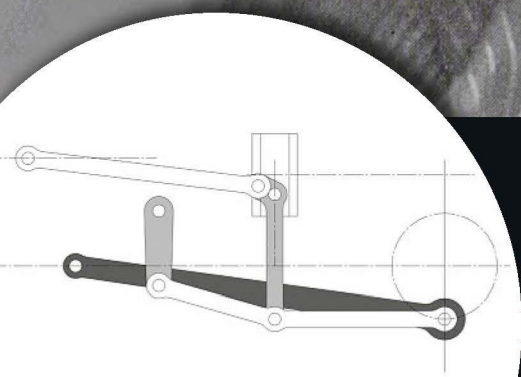
LittleLEC

We report
on the competition
in Swansea

Early Days

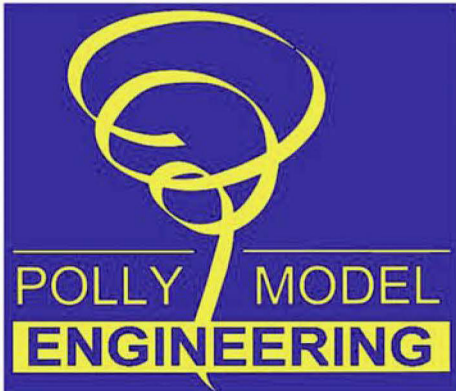
We follow the
birth and growth of
Model Engineer

The life of
**Percival
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Founder and
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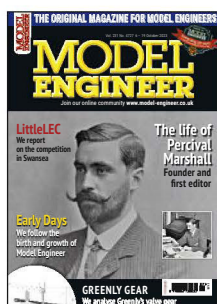
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Percival Marshall, founder and first editor of Model Engineer, at the age of 33.



This issue was published on October 6, 2023.
The next will be on sale on October 20, 2023.

www.model-engineer.co.uk



**MIDLANDS
MODEL
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EXHIBITION**

The advertisers on these pages will all be at this years Midlands Model Engineering Exhibition. The 2023 exhibition will see the return of the lectures which will be presented by Model Engineer and Model Engineers' Workshop. There is a full range of talks from leading magazine contributors as below.

Thursday 12th October

1.00 pm Roger Froud - A development in Steam Injector design

2.15pm Neil Wyatt - 3D Printing for Model Engineers

Friday 13th October

11.15am Stew Hart - Designing and building model stationary engines

1.00pm Roger Backhouse - The remarkable Jim Crebbin and his experimental locomotives

2.15pm Duncan Webster - A dummies guide to steam engine valve gear

Saturday 14th October

11.15am Bob Reeve - Why metals behave the way they do

1.00pm Chris Gabel - Powder coating in the home workshop

2.15pm Mark Noel - Hear the Earth: how to design and build a seismometer

Sunday 15th October

11.15am Roger Froud - Why a CNC milling machine is so useful

2.00pm Presentation of Awards

The Society of Model and Experimental Engineers will also be having a super-sized stand featuring models and tools from across its history. There will also be live demonstrations of 3D printing by MEW Editor Neil Wyatt daily. As always, nearly forty of the leading model engineering specialist trade suppliers will be present along with hundreds of fascinating models in competition and display classes and on nearly thirty club and society display stands and outside steamers.

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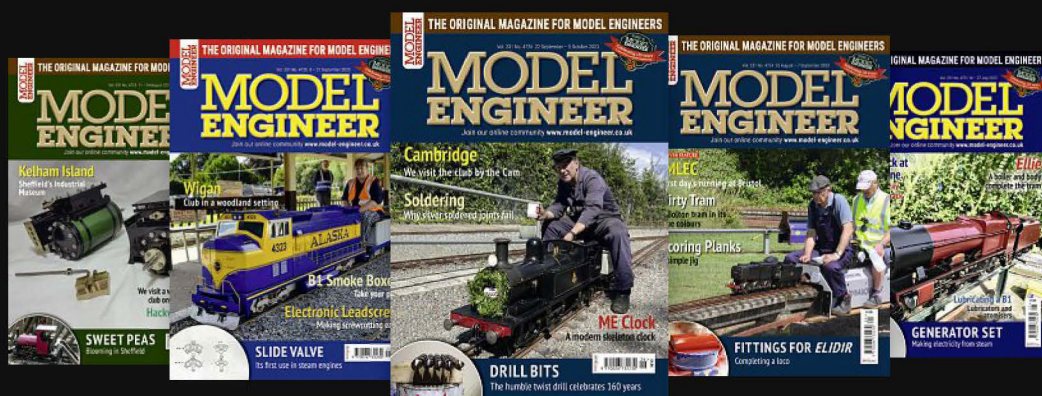


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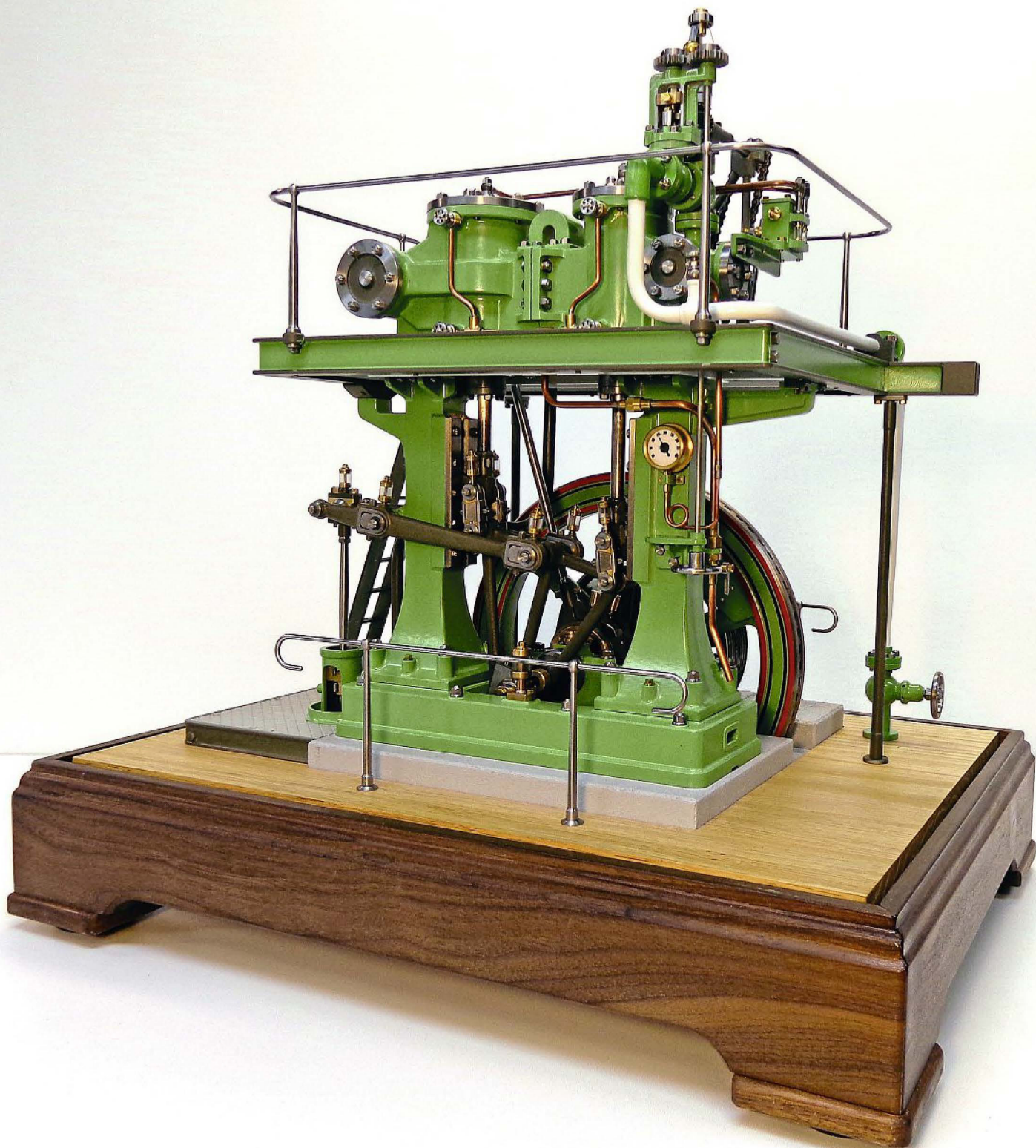
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125 Years

In this issue we include two special features to celebrate 125 years of *Model Engineer*.

Percival Marshall founded the magazine at the start of 1898 and, on page 498, Ron Fitzgerald begins his life story. On page 489 Roger Backhouse looks at the beginnings of the magazine and examines its broad scope in the early years.

Skills

Concern is often expressed that we, as a country, are losing the engineering skills vital for our economic success (see Postbag, page 504). It turns out that this is not a new concern. Ron Fitzgerald tells us that part of Percival Marshall's motivation in starting this magazine in 1898 was a *growing concern in Britain that a shameful neglect of adequate engineering training for engineers was destroying its competitive advantage*. Ron goes on to point out that the Germans were far ahead of the UK in the training of engineers. This was true also in France of course – Isambard Kingdom Brunel received an academic training in engineering at the École Polytechnique in Paris during the early years of the nineteenth century, at that time the world's only university of science and engineering. This distinguished him from the majority of his colleagues in the UK who had not received the same kind of training. Ron goes on to mention the founding of the Finsbury Technical College, set up to provide high quality – and comprehensive – technical education, combining academic learning with artisan engineering skills. It's worth mentioning that, at about the same time, the beginnings of an engineering department were developing at Cambridge University. This would result in the establishment of the mechanical sciences 'trapos' (i.e. course of study) in the 1880s. Oxford and Imperial College followed soon afterwards.



MARTIN EVANS
Editor



DIANE CARNEY
Assistant Editor



Exeter Garden Rail Show



LOWMEX



A fine view of the traction engine parade at the Haddenham Steam Rally.

I don't think we should be too gloomy. It seems to me that the image of engineering – and engineers – is 'on the up' and, with the rate at which exciting new technologies are being developed, it is these days perceived as a rather interesting career to pursue. Fears that engineering's demise in the UK is imminent may be allayed by the fact that the UK's manufacturing output has recently overtaken that of France. So, not all gloom and doom then.

Bradford Cup

This year's Bradford Cup was awarded to Steve Goodbody for his series on *The Eating of Elephants*. As for last year, it was felt that the National Railway Museum in York would be an appropriate venue for the award ceremony. Our photograph shows the cup being handed to Steve by Adrian Shuttleworth, president of the Bradford Society of Model Engineers.

Autumn Shows

As the summer draws to a close, and the mists roll in, the number of shows and rallies gets less and less. It is my duty, then, to highlight some of the shows still to come.

If you live in the West Country you may be interested



Steve Goodbody (left) receives the Bradford Cup from Adrian Shuttleworth (right), president of the Bradford Society of Model Engineers (photo: Jocelyn Fung).

in the South Devon Garden Railway Group's show on October 28th. This will take place at the Matford Centre in Exeter EX2 8FD and tickets cost £10, or free if you are under 15 years old. The show covers the garden rail gauges from 0 gauge up to gauge 3. A proportion of the show proceeds will go to the Devon Air Ambulance. Further details are available at www.exetergardenrailwayshow.com

For those clinging to the easternmost edge of the country there is of course LOWMEX, the Lowestoft Model Engineering Exhibition, held this year, as last year, at the East Coast College in Lowestoft NR32 2NB. This show, organised by the Halesworth MES, goes from strength to strength and takes place on October 28th and 29th. More details are available at www.lowmex.co.uk

Haddenham Steam Rally

Your editor enjoyed a fine day out at the Haddenham Steam Rally a couple of weeks ago. There was the usual collection of machinery lined up for inspection – traction engines (of varying sizes), tractors, motor bikes and classic cars. There were also some fine fairground organs and a funfair. This latter provided the perfect opportunity to get a good view of the traction engine parade, as you can see from the photograph.

Martin Evans can be contacted on the mobile number or email below and would be delighted to receive your contributions, in the form of items of correspondence, comment or articles.
07710-192953
MEeditor@mortons.co.uk

The First Year of *Model Engineer*

Roger Backhouse looks back at the beginnings of our magazine.



Model Engineer is a remarkable survivor. Surprisingly few magazines founded in the 19th century are still published in the 21st, surviving when such large circulation publications as *Punch*, *The Illustrated London News*, *Daily Sketch*, *John Bull* and *Titbits* have folded.

Founder Percival Marshall must have realised the right formula for success. Remarkably, it has continued as a niche publication, still including variations on the same type of articles published in the first issues. An emphasis on making engineering items in home workshops and advice to readers remains. Even today articles in the earliest issues could still be useful, though of course new methods and materials have come into use.

It began as a monthly costing just 2 pence (photo 1). *Model Engineer* and *Amateur Electrician* soon spawned large exhibitions and encouraged the formation of model engineering societies. Though the pioneering Edinburgh Society of Model Engineers was

founded in 1894, several other societies are almost as old as the magazine and flourish today. For example, the Society of Model and Experimental Engineers also celebrates 125 years in 2023.

Although many people made engineering models before *Model Engineer* emerged, the new magazine gave a focus for their previous lone activities. It can be said to have created a hobby. Probably the only comparison is with Ian Allan and his books of engine numbers that developed the train spotting craze of the early 1950s. Many of those spotters remained firm rail enthusiasts.

Percival Marshall

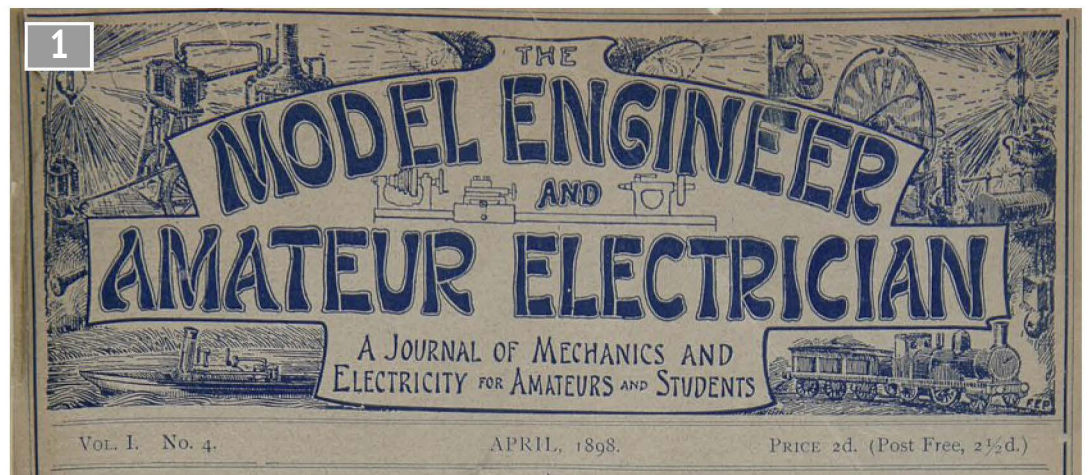
The idea came from Percival Marshall who was just 27 years old when he started the magazine. He had considerable engineering experience and was an Associate of the Institution of Mechanical Engineers. Strangely, he is not known to have ever made a model! However, his brother Alfred was an experienced model maker and later a judge

at *Model Engineer* exhibitions. Alfred also contributed articles about making a model dynamo to early issues and was one of the band who answered correspondents' queries.

Percival Marshall was born in London in 1870. After attending Finsbury Technical College where he studied science and engineering he went to classes at Birkbeck Institute, Manchester Technical School and Victoria University. He gained experience as an apprentice, improver, fitter and machinist and was reported to have spent time as a lathe hand in a French factory.

He took an early role in the Junior Institution of Engineers joining the committee at just sixteen years old. Whilst a career in engineering would have seemed appropriate he showed a liking for technical writing. This soon led to a role as editor of a photographic magazine where he conceived the idea of a publication aimed at model engineers.

Later he helped found the British Association of Trade and Technical Journals



Early masthead for the *Model Engineer* and *Amateur Electrician*.

2



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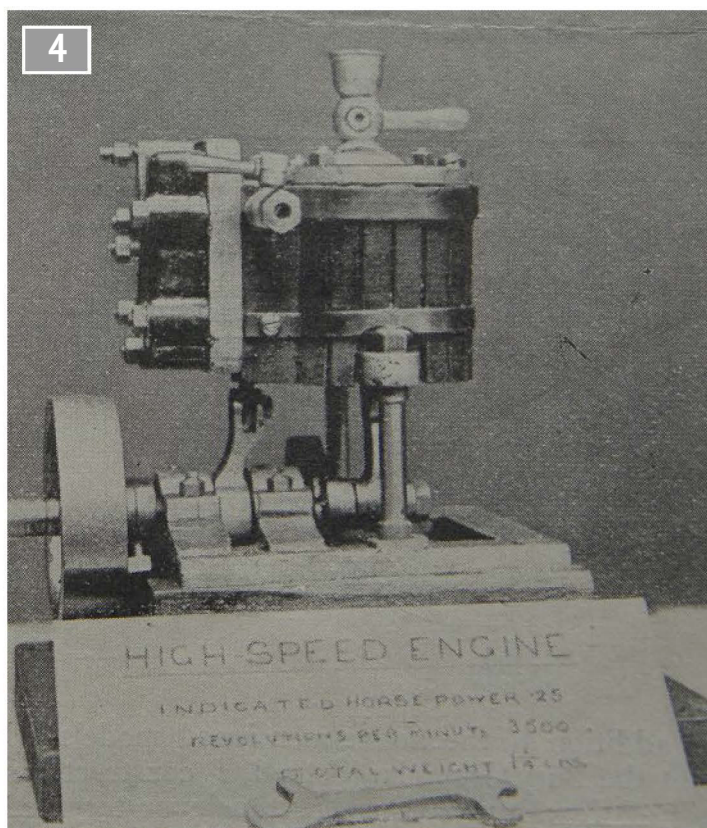
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Firms like W. Martin and Co. of West Ham were already supplying castings for a model engineer's market.



Frank Spicer's engine was intended to power a model boat. It weighed 1 1/4 lbs - about half a kilo.

and remained involved in representing magazine publishing, becoming a long-term member of the Press Club.

Outside publishing he was a keen golfer, fisherman and a good shot, once winning a silver cup at Bisley. He also enjoyed Bridge and crosswords and was a Freemason.

Percival and Alfred were from a family linked to the publishing house of Horace Marshall and Son and would have been aware of a growing number of people enjoying model engineering. Firms like Martin and Co. of West Ham, Stevens Model Dockyard and other companies already



Frank P. Spicer - first winner of a Model Engineer competition.

supplied castings and metals to model makers (photo 2). Despite warnings that model engineering was dying out (how often have we heard that?) and that a magazine would be lucky to sell five hundred copies, the first issues sold out and were reprinted later.

Percival Marshall was quite clear about his aims in starting *The Model Engineer and Amateur Electrician*. In issue 1 in January 1898 he said 'there is at present no journal in this country which is exclusively devoted to mechanics and electricity from the amateur's point of view, and the army of workers whose tastes lie in this direction has grown so large that there is a distinct want for a publication which shall make their interests its especial care'. He added that the magazine would be essentially practical in character and the contents would be so arranged that 'all amateur mechanics ... will find something of interest and assistance in every number'.

After close involvement with *Model Engineer* for many years he died in 1948, remembered for his quiet wit and commitment to the cause of model engineering over fifty years.

Developing the magazine

From the first issue *Model Engineer* was conceived as a journal of record with volumes, issues numbered and an index. Partly as a result many copies survived to be bound together preserving the content,

though usually losing the advertisements that now add further interest to old volumes. Unfortunately, the first issues used a very small font, probably only 8 points, making it difficult to read.

As was common practice at the time, contributors were often identified either by pseudonyms or initials. For example 'Zodiac' contributed an article about making an electric cycle lamp and 'A.W.M' articles about making model dynamos and motors. (This was Percival's brother Alfred who had considerable experience of electrical engineering.)

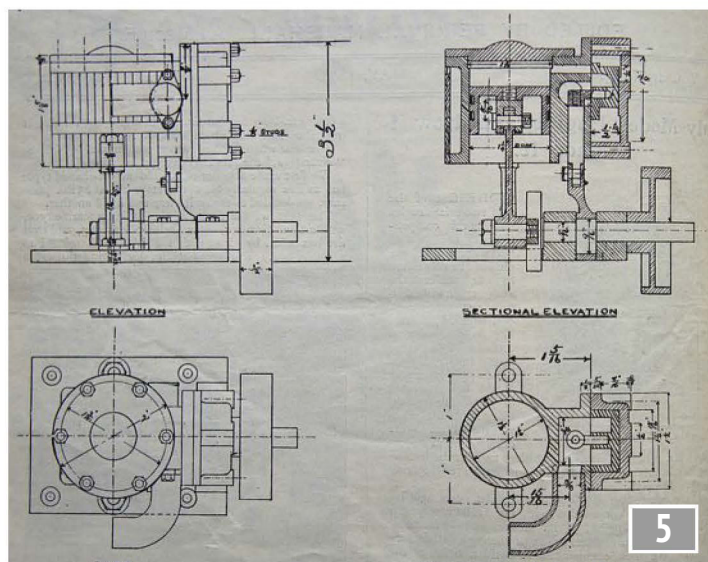
Gathering articles for a new magazine isn't always easy and it was probably Percival Marshall who hit on the idea of holding competitions. He invited readers to submit articles and offered generous prizes of £2-2s (two guineas - around £400-£500 now so worth having) for each winning entry on one of these topics:

- 1 My model engine and how I made it.
- 2 A Wimshurst machine, how to make and use it - to include a complete set of working drawings and describe experiments that may be carried out with the machine.
- 3 The lathe as a milling machine.

He also offered 10/6d as the prize for the best short article describing some useful workshop fitting or appliance to be of general interest to readers.

Entrants had to work for their reward. The maximum length for competitions was 2,500 words, all had to be written clearly and drawings made in Indian ink on white cardboard showing all necessary dimensions in plain figures. For the first competition entrants were expected to provide a photograph of the finished model. This initiative worked and entries came in with the winners published later in 1898.

The competition to build a model engine was won by nineteen-year old Frank P. Spicer of Prestwich, near



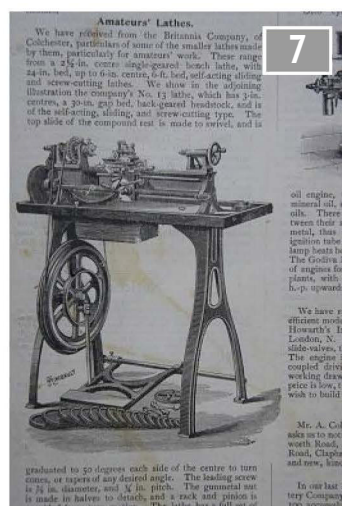
Frank Spicer clearly had good drawing skills - this is some of his design work for the engine.

Manchester (photo 3), and his article appeared in May 1898. He made a single cylinder single acting steam engine designed to power a model boat he'd built with his brother. The photograph (photo 4) shows a well-made model and the engineering drawings, presumably Frank's own, are excellent (photo 5). He stated that he made his own castings in brass and aluminium.

Frank had ambitions to become a mechanical engineer but information from the 1911 census found on Ancestry.com suggests that he became an electrical contractor and was then living in Harrow.

Percival Marshall intended that *Model Engineer* would help aspiring engineers by offering a queries and replies section from the second issue. He put together a panel of experts, including his brother Alfred, who would reply to correspondents on technical matters and this soon became an important part of the magazine, attracting a wide range of queries. He later added to the experts, noting in November that Messrs A. & S. Barker of Leyton would advise on oil and gas engines *gratis* to readers and Alfred P. Hill of Sheffield could advise on gas engines, machine and hand tools, models etc 'for out of pocket expenses'.

Not all the enquirers were well informed. One enquirer



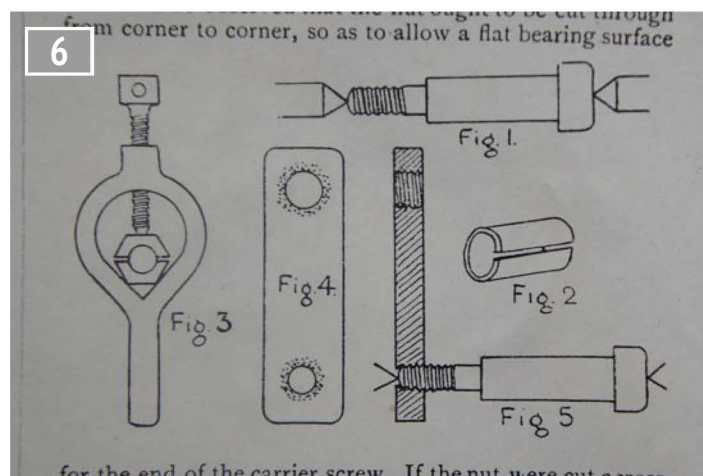
The Britannia lathe was made in Colchester and clearly had a market among home engineers. Treadle lathes were then near universal in home workshops.

mentioned in the October issue that had made the 'A.W.M' dynamo in brass and had 'polished up the magnets'. He wondered why it wouldn't work as a motor with six pint cells!

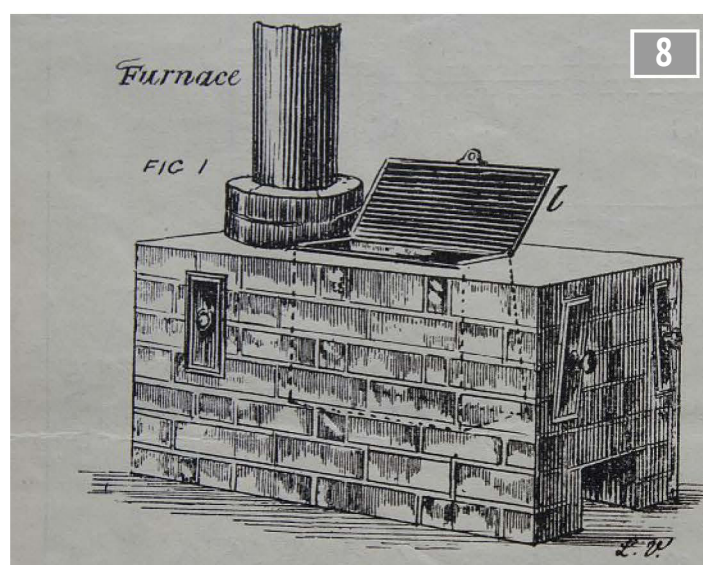
Workshop methods

Information about workshop methods appeared in all early issues. The first issue had an article about making screw carriers to avoid damaging a screw thread when carrying out operations on the non-threaded end. That article by 'Atlas' has suggestions that could still be useful today (photo 6).

In the April issue C. R. Watkinson wrote about a simple and effective lathe



Lathe screw carriers illustrated in the first issue helped avoid damage to threads - potentially useful even today.



Casting brass at home was considered feasible for the home engineer. This furnace design appeared in May 1898.

chuck that could be fixed to a faceplate. Presumably he was from the firm of Messrs Watkinson and Co. of Carlton Hill, Leeds who offered the necessary forgings for just 2/9d post free.

Several firms advertised lathes clearly aimed at the home machinist market. The 'Pittler' lathe was one, which an article in the November issue claimed was better described as a universal milling machine. The Britannia lathe made in Colchester also featured (photo 7).

The same magazine reprinted information from an article in *American Machinist* of a suggestion for an amateur's bench lathe. In May readers offered details of simple and inexpensive lathes they'd built themselves, with the editor

noting that the subject 'is one of no little interest'.

Using a lathe as a milling machine was one of the first *Model Engineer* competitions and an article won R. Borlase Matthews a prize of two guineas. In a well thought through article he gave several examples of how the lathe could be used for milling.

Lionel Varicas gave a design for a model brass foundry 'as a sort of companion to the model workshop'. His plan made ingenious use of a kitchen range and gave details of mould boxes and making moulds with sand but he advised against using plaster of Paris as 'it is a most treacherous material' (photo 8).

Readers reported making their own patterns for castings making due allowance for

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shrinkage. If they couldn't follow the advice on creating a home foundry many towns then had local foundries who could cast items for model makers.

Telegraphy, electricity, radio and other new technologies

To set the early *Model Engineer* interest in electrical matters in context, nearly fifty years had passed since Cooke and Wheatstone applied for their telegraph patents and the Great Western Railway first installed the electric telegraph between Slough and Paddington. Using batteries was commonplace and there are several references to different types in Volume 1 with advice on making a 'useful' bichromate battery featured in the first issue and a Daniell cell featured in the November issue. Recharging a 'carporous' Leclanché cell featured in September. Alas, my Chambers dictionary gives no indication of what *carporous* means but these were wet cells with carbon and zinc terminals and an ammonium chloride electrolyte.

Domestic electricity was sometimes installed though still uncommon and used almost solely for lighting. Apart from Lord Armstrong's pioneering hydro-electric



Promotional picture for a new receiver for wireless telegraphy made by Miller and Woods of Gray's Inn Road, London.

power plant at his Cragside home no less than the Prime Minister, Lord Salisbury, had electric light installed at his home of Hatfield House. A man who liked to be well abreast of scientific developments, he was the guest speaker at the first annual dinner of the Institution of Electrical Engineers in 1889.

Colonel R. E. B. Crompton had established one of the first public electric light undertakings, the Kensington Court Electric Company, whilst Sebastian de Ferranti created Deptford power station to supply London north of the Thames during 1888-90. Few other places had such widespread provision.

very similar in outward appearance to those manufactured by Laurence, Scott & Co., of Norwich) and occurred in the month of June. After making all necessary drawings I proceeded with the various patterns for the bed-plate, field magnets, brush holders, rocker support, pulley, etc., and from these obtained the respective castings.

The three main castings, viz:—the two field magnets and bed-plate which were of the best cast-iron were the first to be manipulated. The surface on the bed-plate on which the field magnets rest was faced up by hand, the hard skin being first removed by an old file, and the surface then filed as flat as possible. I next turned the face of

the middle of this bar I keyed on a piece of cast-iron, the diameter being 1 17/32nds in., a little more than the diameter of the armature when finished. The steel blank was afterwards removed, and I filed twelve cutting edges on the face making a milling cutter of it. After being tempered, it was curved to the form of the bar, and was then ready to bore the magnets out.

In order to mount the boring bar in the place of the armature the caps which held the brasses were bed down with a piece of thin wood between the studs being previously screwed in the bed-plate. The centre of the armature was marked off each end and a 1/8 hole drilled through this being done

Mr. BURNHAM'S MODEL DYNAMO.

A Mr. Burnham made this model dynamo to his own design, although similar to those made by Messrs Laurence, Scott and Co. of Norwich, one of several writers interested in electrical engineering.

THIS NEW AMERICAN TALKING MACHINE 12

IT TALKS

Is the greatest invention of the age. As a private (drawing-room) or public entertainer it has no equal. Songs, Speech, and Music. Distinctly audible in the largest hall. Write for Price List.

Address:
The American Talking Machine Co.,
32, Glendarvon Street, Putney, S.W.

Advertisement for a American gramophone, all the rage in the late nineteenth century.

However, many factories and some homes had smaller installations. For example, a system using a Parsons turbine to generate electricity powered the Ormesby Iron Works in 1888.

So electric power was relatively new and, if readers will excuse the expression, generated great interest (photos 9 and 10). As the full title *The Model Engineer and Amateur Electrician* implied, several pages in each issue were devoted to electricity and electric appliances such as construction of model dynamos and motors. 'A.W. M' contributed a series on making a model dynamo.

Later articles featured a scheme for a new induction coil, improving on Ruhmkorff's coil, and a design for a battery powered electric light. Maybe

not revolutionary, but this was a time when gas lighting still dominated the domestic market. Advertisers in *Model Engineer* were already offering electrical equipment, for instance Acme offered a model dynamo for 15 shillings.

Radio also created interest. Guglielmo Marconi had attracted the support of the highly conservative William Preece, Engineer in Chief of the British Post Office, and was working to develop a receiving instrument (also known as a coherer or Branly tube), able to select radio transmissions from a potential range of radio signals. In 1897 Marconi made successful transmissions across the Bristol Channel, proving the potential of the new medium. So, in issue 1 of *Model Engineer* Leslie Miller AIEE offered advice on

13



THE "EVER-READY" DARK ROOM.

two inches above the ground to admit air. The fittings include two shelves, a lead-lined sink, with bench either side, and a sliding window, with either rubber

The 'Ever Ready' portable darkroom featured - perhaps inclusion resulted from Percival Marshall's earlier editorship of a photographic magazine.

how to make a coherer and a transmitter though warning that the Marconi patent might be infringed (photo 11).

The relatively new gramophone attracted interest with a feature on 'talking machines' in the August issue. This was of course mechanical sound reproduction and a horn gramophone featured in several advertisements for the American Talking Machine Company (photo 12).

In 1897 a Polish inventor, Jan Szecepanik, applied for a

British patent for apparatus to reproduce pictures at a distance by means of electricity. Images could be either still or moving and his 'telectroscope' attracted much interest. Naturally, *Model Engineer* readers were interested in such developments and the magazine reported on *Picture transmitting by electricity* in April but quoted the opinion of Dr. Silvanus Thompson that at the present time it was 'sheer nonsense'.

In the May issue Mr C.A. Lee suggested ways in which it might be achieved, though he admitted it would be very difficult and he had not built the apparatus proposed. Alas, neither the plans of Jan Szecepanik nor Mr. Lee were ever realised but both showed a typically Victorian confidence that such a device could be made as was later to be proved by John Logie Baird. (This was not the first time developments have failed to live up to the initial publicity think of Elon Musk's *Hyperloop* for a recent example.)

Another invention was a photo-theodolite introduced

by the instrument making firm Casella. That was reported to give true photographic perspectives and was equipped with a mechanism recording the information necessary for interpreting the picture. Perhaps this anticipated the recording of information in a digital camera by a hundred years.

Photography attracted some attention including a 'self assembly dark room' with adverts for photographic equipment. This may have reflected Percival Marshall's previous editorship of a photographic magazine (photo 13).

Submarines were then in their infancy. In July *Model Engineer* reported on the Holland submarine torpedo boat that had recently made a run of a mile and half under water with a five-man crew. It used a gasoline engine and batteries. That submarine was designed by John Philip Holland, an Irish Republican who wanted to use it against the hated English. Ironically the Royal Navy used the design and launched their first submarine, the Holland 1, in

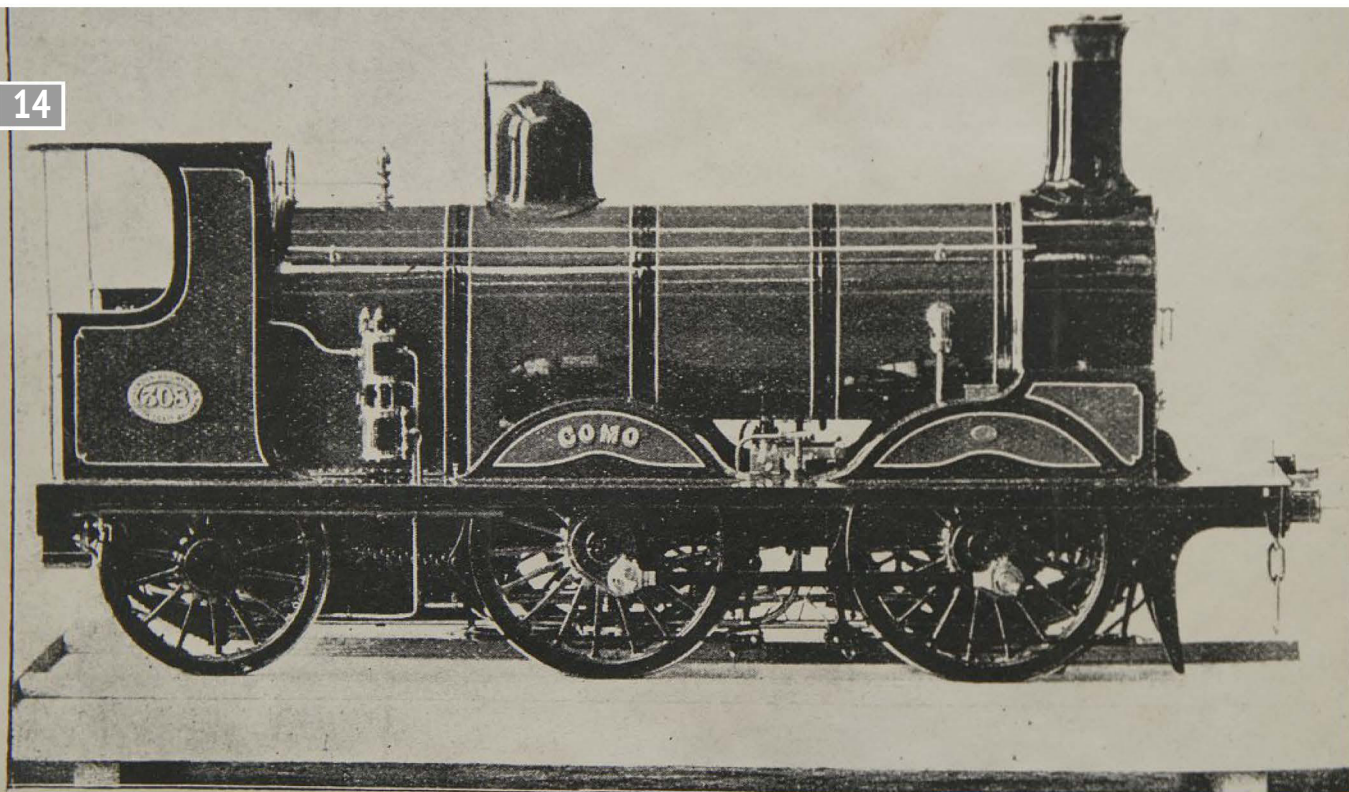
1901. It foundered on route to the scrapyard in 1913 but was raised in 1981 and is now on show at the Royal Navy Submarine Museum in Gosport.

Perhaps surprisingly aircraft and aviation are the subject of just one article and that in the May issue. The article is taken from Cassell's *Saturday Journal* and quotes Captain Baden-Powell, Secretary of the Aeronautical Society, saying that he saw no reason why aerial navigation should not shortly become an accomplished fact. He was correct. Alberto Santos-Dumont made the first proper dirigible flight later in 1899 and the Wright brothers made their first heavier than air flight in 1903.

Steam power

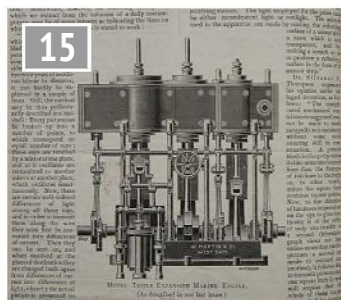
Among model engineers steam engines and their boilers remain as popular a topic as when *Model Engineer* started. The first two issues contained an interview with Dr. Bradbury - Winter about his locomotive *Como*, (photo 14) still a magnificent example of model engineering skill, and included a photograph of his workshop.

14



DR. BRADBURY WINTER'S MODEL LOCOMOTIVE.

Como - still one of the finest model locomotives. Built by Dr. Bradbury Winter of Brighton.



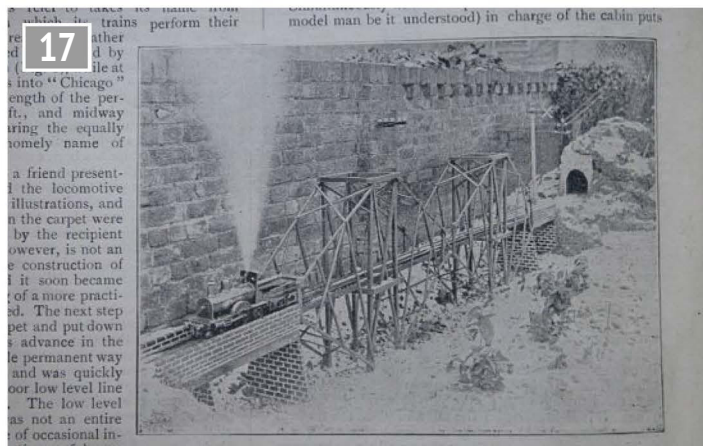
W. Martin and Co. sold castings for this fine triple expansion marine engine.



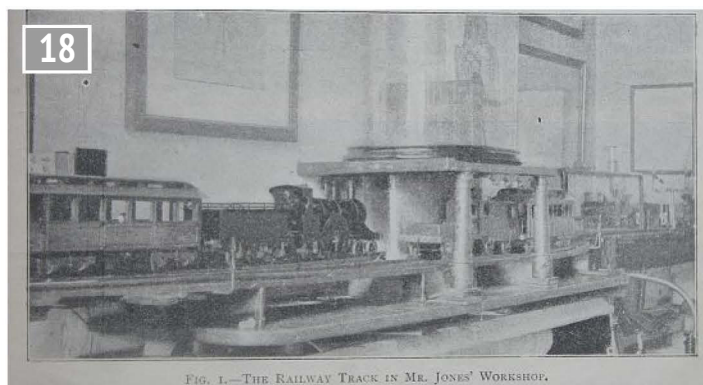
Engine made from Lipton's cans. Percival Marshal persuaded Lipton's to buy this engine. Such an engine presaged the vogue for tin can traction engines in the 1950s.

W. J. Tennant wrote several articles about steam locomotives and model construction but most of his discursive writings about construction assumed readers had some prior engineering knowledge and skills. Yet his articles about slide valves were very clear and remain informative today. Step by step instructions did not feature until LBSC started his long running series in the 1920s.

Suppliers like Bertrand Garside of Warrington made fittings for model steam locomotives and boilers including a pressure gauge for just 6 shillings so there was clearly a market. In March Martin and Co. of East Ham offered castings and drawings for a marine type triple expansion engine. It doesn't sound like a project for a newcomer but the magazine described the castings as clean and sound 'and will present little difficulty ... to any amateur of average skill and intelligence' (photo 15).



Built by a clergyman the Chicago to Jericho Railway boasted this fine cantilever bridge and even a working fog signal.



Rating surveyor Leonard Jones built this electric indoor railway of 2 1/2 inch gauge in his workshop. A church model he built is just visible.



The Duke of Westminster's Eaton Hall Railway was 15 inch gauge to serve the estate. Designed by Sir Arthur Heywood.

E. L. Pearce described making a brass six inch diameter model vertical boiler. It reads like a technically feasible project though brass would not now be permitted as a boiler material. Several readers sent in details and photographs of models they'd made. Thomas Bowker sent a photograph of an attractive horizontal engine model. The design derived from a Joseph Clayton engine

which the maker was able to measure. Another reader, who could not send a photograph, sent his tin can engine made using tins from Lipton products. This impressed the editor who persuaded Lipton's to buy the engine as a curio. An American magazine described it as 'one of the seven wonders of the world' - stretching a point perhaps but nevertheless the model was a good example

of what could be achieved with limited resources. It presaged the tin can traction engines which enjoyed a burst of popularity in the 1950's (photo 16).

Model railways

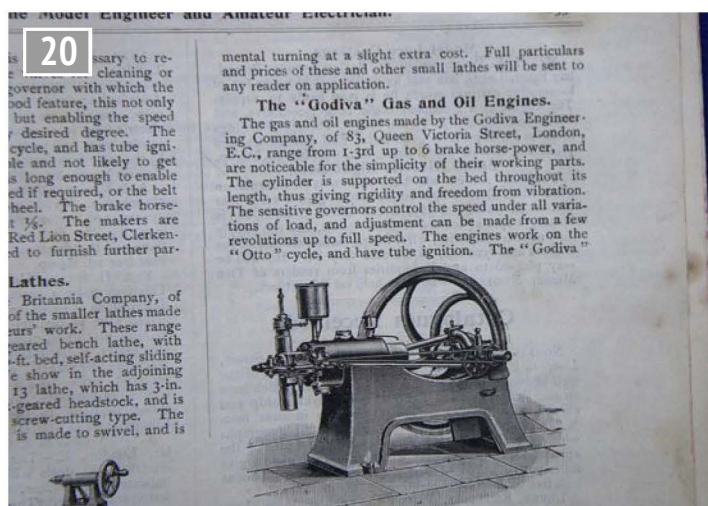
In the first year there were surprisingly few references to model railways although a design for a model wagon appeared in the first issue. One featured in September was the Reverend Harry Launcelet Warneford's 'Chicago to Jericho Railway' at his Windsor (England) home. The article is derived from information in an 1895 *Strand* magazine. With live steam locomotives, it featured 100 feet of track built to 2 1/2 inch gauge, several bridges of different types and a tunnel 'covered in nasturtiums' (photo 17). It was fully signalled, even having a fog signalman's hut where a small charge of powder could be ignited to warn of a red signal! The *Strand* magazine adds that 'his skill as an amateur engineer is only equalled by his success as a composer of music'. It would be interesting to know what he composed.

Rating surveyor Leonard Jones described his model locomotives and how they were built in the October and November issues. He had built a 2 1/2 inch track running round his workshop walls with electric locomotives and an ingenious electric brake (photo 18).

If not exactly a model railway, the Arthur Heywood 15 inch gauge railway for the Duke of Westminster at Eaton Hall featured in the October issue. That had opened in 1896 (photo 19).

Gas power

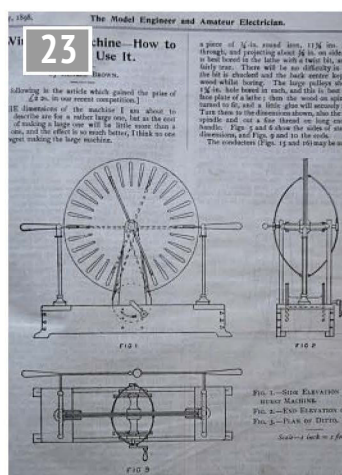
Though now largely forgotten, gas engines running on town gas were once common. Some in more remote areas could be fuelled from small producer gas units. *Model Engineer* offered a design by 'Atlas' for a small 1/2 bhp gas engine with a carefully drawn double page general arrangement drawing in the November issue.



The 'Godiva' engine could run on either coal gas or oil fuel.



Bateman's museum of models in High Holborn included locomotive and ship models. Some could be seen working.



Wimshurst machine drawings. This design and finished machine won Edgell Brown a prize of two guineas in an early competition.

The July issue noted a $\frac{1}{2}$ bhp gas engine produced by Butler Brothers of Derby with tube ignition and working on the Otto cycle. Castings and forgings could be obtained for just 15s and the complete engine bought for £3-10s.

Another firm making gas engines was Messrs A. & S. Barker of Leyton whose works

was visited by the editor. Their 'B' engines could be adapted to run on oil or gas and a number had been sent abroad to Russia with one about to go to the West Indies. The firm's catalogue would be sent post free to any enquirer mentioning *Model Engineer*.

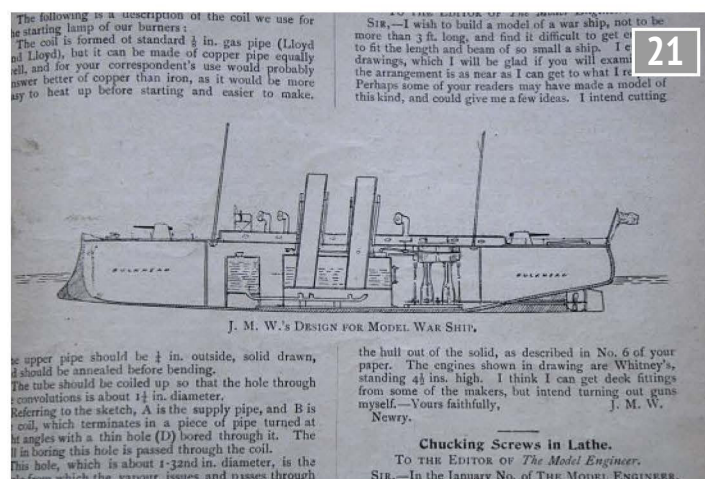
Others used acetylene gas. The August and September issues report on a home-made acetylene gas generator used for lighting. Many early cycle lamps were powered by acetylene gas and even in the early 1950s the former North Eastern locomotive shed at Kirkby Stephen was lit by acetylene.

These fractional horse power gas engines were largely superseded, first by oil engines and then by electric motors as power mains spread across towns and the countryside (photo 20).

Motor transport

In August *Model Engineer* reported on a new motor cycle powered by acetylene gas made by Ralph Lucas. He was almost certainly the engineer of Blackheath, south east London, who in 1901 made a valveless two stroke engine car which he drove with some success around Blackheath. That had a vertical twin engine with a common combustion chamber and transverse crank shafts.

Even when automotive experimentation was ubiquitous it was unusual, with the two stroke petrol engine housed beneath the



Proposed warship design. There was interest in building motor torpedo boat destroyers.

driver's seat. (By 1907 Lucas felt confident enough to form Valveless Cars Ltd. and displayed at the 1907 Olympia motor show on the stand of Crawshaw-Williams who made cars in 1904-06.)

The September issue reported that Self Propelled Traffic Association prizes had been awarded to the Lancashire Steam Motor Company of Leyland, presumably for a steam lorry.

Model boats

There are few references to model boats in the first year but many more articles soon followed. In August 'J.M.W.' of Newry asked for comments on his proposed design for a steam powered model warship (photo 21). Others asked for advice on making boat engines. In September 'H.R.' reported he'd just made a model torpedo boat destroyer 4 feet 4 inches long and powered by crosshead engines that could be run either at high pressure or expansively. He offered to show the model to 'J.M.W.' or write about it in *Model Engineer* giving more detail for readers. In November 'Stator' wrote about making deck fittings for such a model.

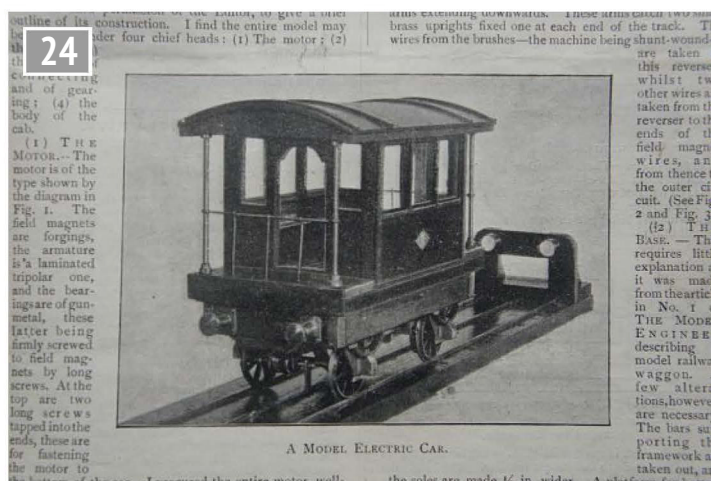
Charles Price of Croydon sent a photograph of a 10 inch high model marine engine. It was highly detailed and was reported to work well, even the reversing gear. Yet the whole engine was hand carved from wood using only a penknife and bradawl, a remarkable feat. Has it perhaps survived?

Several ship models featured at the 'Museum of Models' run by Messrs John Bateman and Company in High Holborn (photo 22). This business incorporated the Model Dockyard. The April issue commented on some of the models, including one of the American river steamer *Cape Charles*. That featured walking beam steam engines, feathering paddle wheels and a railway train on board. Again, what happened to these models?

Other devices

In August *Model Engineer* announced that an American firm had built the 'largest influence (i.e. Wimshurst) machine ever made' with eight plate glass discs each 60 inches in diameter and $\frac{3}{8}$ inch thick. Wimshurst queries took up part of the Queries and Replies section, suggesting that quite a few readers were interested in building such a device.

The competition to design and build a Wimshurst machine was won by Edgell Brown who reported in the July issue (photo 23). He included drawings in his article and recommended making a larger machine with glass plates rather than ebonite. Even today his advice looks helpful to anyone thinking of making such a machine though it would be unwise to follow his suggestion of using it to light an X-Ray (or Röntgen) tube. However, interest in X-Rays was keen at the time. Percival Marshall later published a guide to X-Rays



G. H. Rooke built this model electric tramcar using third rail current supply. He added the superstructure to a wagon design in the first issue. This may be the first model to be built, at least in part, on plans published in *Model Engineer*.

and they were demonstrated at a 'Conversazione' held by the newly formed Society of Model Engineers in 1899.

Clocks

Although articles about clockmaking were common in later issues of the magazine there was just one in the first year and that on 'How to convert an old verge watch movement into a clock'. The article by 'C.M.R.' in the January issue clearly anticipates that readers attempting this will have considerable expertise in clocks and watches.

Models from *Model Engineer*

Probably the first model to be built, at least in part, from a *Model Engineer* article was a model electric car (i.e. tramcar) built by G.H. Rooke which appeared in the June issue (**photo 24**). He adapted a design for a model goods wagon that appeared in issue No. 1 and used the underframe design, adding an electric motor and superstructure. It ran on rails made from brass rod and had a 'third rail' type pickup underneath. How many models followed from *Model Engineer* designs? There must be many thousands.

Shaping the hobby - Society of Model Engineers

In June the idea of a model locomotive club was first suggested by a correspondent,

following the earlier pattern of model yacht clubs. By September this had matured into a plan for a model engineering club. A meeting to discuss was called at no. 6 Farringdon Avenue, the *Model Engineer* office.

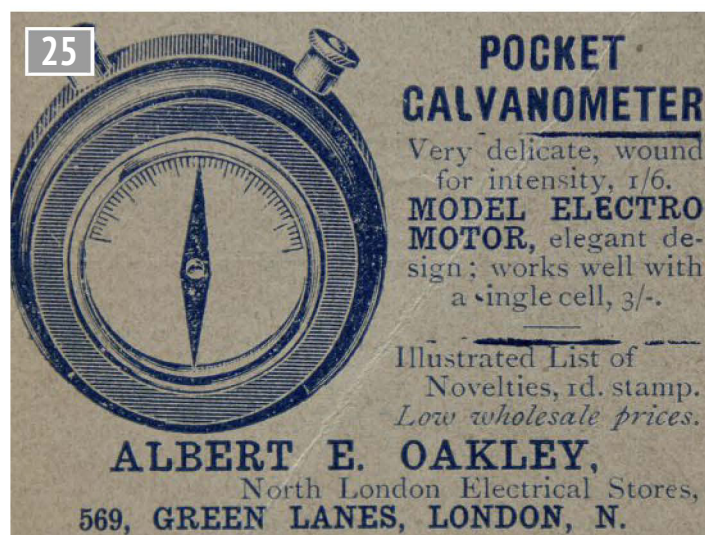
In November the magazine could announce that the meeting had been held and a society formed, to be called the *Society of Model Engineers*. Percival Marshall was the chairman and Jim Crebbin vice chairman. It was clear early on this was not to be restricted to locomotive matters and in 1910 it became the *Society of Model and Experimental Engineers* which flourished and is also celebrating 125 years in 2023.

When the society opened its own premises in south London in October 1950 it was fittingly named Marshall House, after the man who had facilitated its formation and was one of the first committee members.

In December Mr. Bryant of the Isle of Wight suggested a model engineering exhibition with prizes for the best exhibits. This was eventually carried through in 1907 and the *Model Engineer* Exhibition became an annual and popular event.

Circulation, overseas sales and spin-offs

In March Percival Marshall had already reported that subscriptions had come in from the continent and from America. In May he reported



Advert for a pocket galvanometer from the North London Electrical Stores.

subscriptions from Ontario, Schiedam (Holland), Port Elizabeth, Aden, Sydney and Kostromo (Russia) giving *Model Engineer* near world-wide sales. (In 1939 Jim Crebbin, an early *Model Engineer* subscriber and SMEE member, visited Argentina and was astonished to find *Model Engineer* on sale at a station bookstall!)

Although sales figures were never given the editor was pleased to announce in December that circulation had doubled in the last six months. What might have seemed a risky venture now looked stable.

From 1900 (Volume 3) *Model Engineer* became a fortnightly and in 1903 (Volume 8) a weekly, which it remained until the 1950s. It was impressive growth for a magazine which some expected to sell no more than 500 copies! Later Percival Marshall was to boast that it now sold in the tens of thousands.

Model Engineer's success meant Percival Marshall could branch out into book publishing. His later *Practical lessons in metal turning and screw cutting* is full of practical advice and still readable though largely superseded by later books. He also published a useful guide to X-Rays implying such machines might be constructed at home!

Themes today

Rust prevention remains an issue for model engineers today. Early proposals included

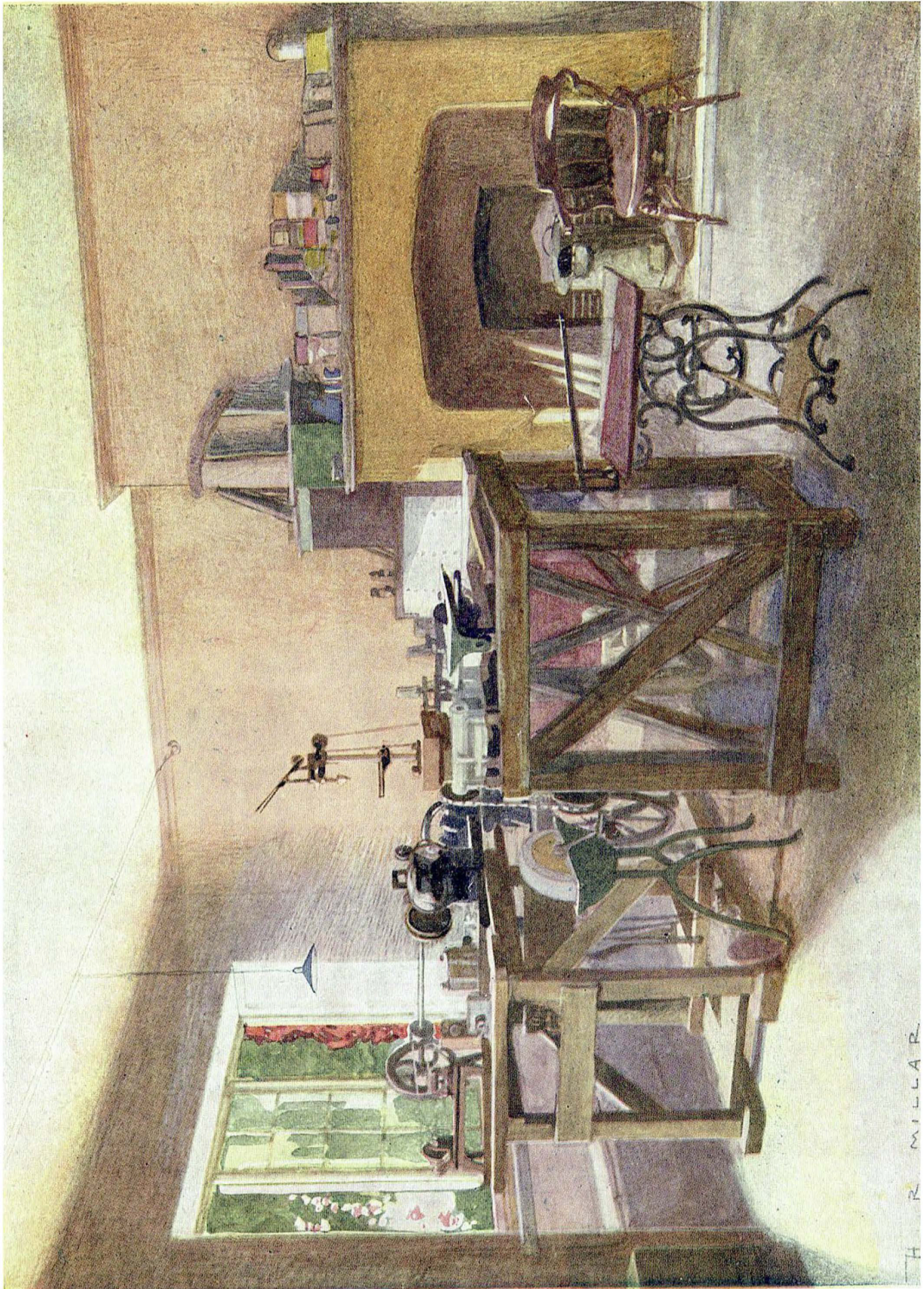
the use of copal varnish which sounds a possibility but Dr. Bradbury-Winter suggested in March using sulphuric acid 'which should be pure, not diluted' adding that he 'knew of no disadvantages to its use'. Nevertheless, it doesn't sound like one to try at home!

One notable omission is engineering nostalgia. There is a reference to a Newcomen engine near Birmingham but otherwise few mentions of historic machines. Many engines that would now be regarded as important relics were then in daily use. Steam and gas power were very much still contemporary technology even though electricity was making an impact.

Overall the impression from *Model Engineer's* first year is of enthusiastic readers, most with some knowledge of engineering, keen to use the engineering technology of the time. New technologies like X-Rays and radio attracted much attention with readers willing to try making them work (**photo 25**). Even more important, they were willing to join new societies and to help each other through correspondence, something that remains true even today. Percival Marshall and his team left a fine legacy.

Thanks to

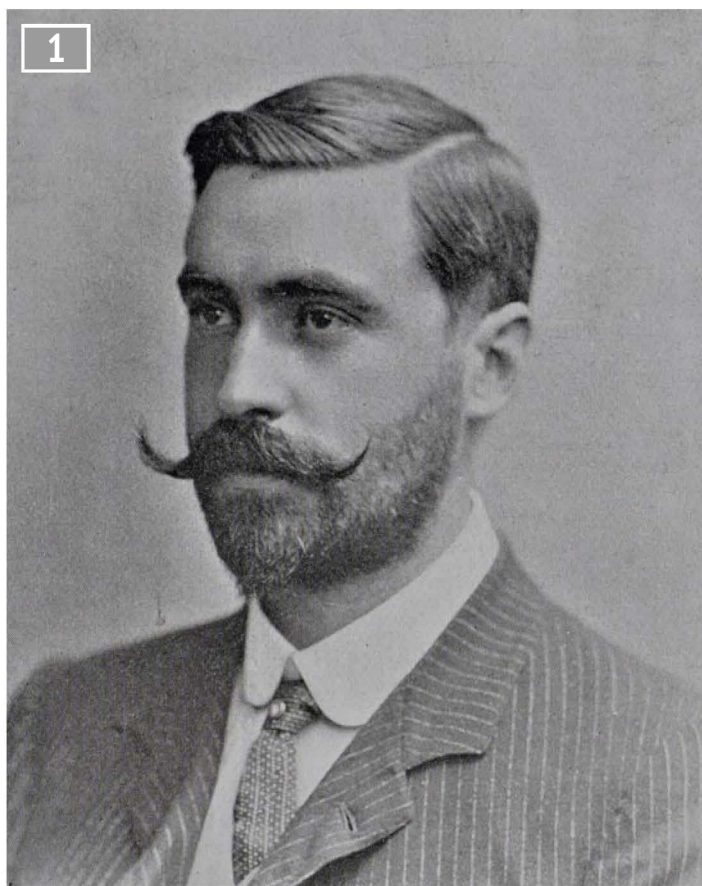
Mike Tilby (Editor SMEE Journal) for information from *Ancestry* about Frank Spicer.



'The Sun stole through the casement old, And touched each treasured tool with gold.'
A coloured illustration from Model Engineer January 4th 1923.

Percival Marshall

PART 1



Percival Marshall in 1904.

Ron Fitzgerald looks at the life of our founder and first editor.

For 125 years the *Model Engineer* has been the cement that has held the craft of model engineering together. With *The Autocar*, founded in 1895 and the *Railway Magazine*, started in July 1897, it shares the distinction of being amongst this country's longest surviving printed periodicals for enthusiasts. From January 1898, it was first published monthly, followed by fortnightly, then weekly from January 1903 up until 1962, when it reverted to a fortnightly circulation. The *Model Engineer* has never missed an appearance throughout this century-and-a-quarter, notwithstanding the twice destruction of its premises by bombs during the Second World War.

Percival Marshall (photo 1), the architect of this remarkable achievement, was born on the last day of 1870, the youngest son of Alfred John Marshall and his wife Mary Ann (née Jones). He had twin brothers, Alfred William and Malcolm and two sisters. The family lived at 5 Clifton Villas, Lambeth in South London. Alfred Marshall was a publisher whose younger brother, Horace Brook Marshall, had established the first distribution agency to specialise in supplying books and publications to railway stations. By the time that Percival was born, the business of Horace Brook Marshall and Son had become the largest of its kind in Britain. Percival Marshall can justifiably be said to have had

print in his veins and from his early teens he was drawn to journalism. Before he had left school he had learned shorthand and read avidly about the work of reporters, editors and authors (ref 1). His enthusiasm for writing was not exclusive for at the same time he developed a profound interest in engineering. This apparently first showed itself when a fellow schoolboy:

...took a piece of metal out of his pocket and showed it to me with great pride. "What is it?" I asked. "It's a casting for the cylinder of the model engine I am making." I examined it with much interest, for in those days I did not even know that a steam engine had such a part as a cylinder, nor had I the least notion how an engine worked. But I remember my feelings of admiration for this other boy who not only understood these mysteries but was actually engaged in the building of an engine in his home workshop... (ref 2)

The engineering aspect of Marshall's interests was initially to take precedence over journalism. At 14 he won a Mitchell Scholarship valued at £30 per annum which gave him entry into the Finsbury Technical College. The significance of this turn in his career is worth exploring more fully.

In the final quarter of the nineteenth-century there was a growing concern in Britain that a shameful neglect of adequate engineering training for engineers was destroying its competitive advantage. Germany, Britain's most formidable rival had, since 1820, developed a structured and universally accessible system of technological training which extended from first years through to the most advanced level in its technical

high schools, polytechnics and universities. As Britain attempted to confront the challenge of increasingly science-based technologies, it found itself relying heavily upon German trained chemists, electrical and mechanical engineers. As the Manchester chemist Henry Roscoe was told by a German chemist "While you in England have been perfecting your machines we in Germany have been perfecting our men". Moreover, these German technologists were no mere theoreticians; the educational system from which they emerged placed an equal value upon cultivating artisan engineering skills.

Finsbury Technical College was the first effective response to the growing panic over Britain's failure to provide high quality engineering education. The origins of the college date from 1877 when, through the combined action of the City Corporation and several of the leading Livery Companies, the considerable financial resources of the latter were directed into establishing the City and Guilds of London Institute which aimed to promote the improvement in technical education in London and the provinces. In 1876 the Institute undertook responsibility for the Society of Arts Examinations in technical subjects and three years later adopted the pioneering classes in technical education which had been developing in the basement of Cowper Street School, Finsbury. These began as a series of evening lectures for working men; the subjects included chemistry, physics, drawing, design, mechanics, mathematics, geology, metallurgy, steam and telegraphy. The teachers however were paid only from the fees and some acted gratuitously.

Under the City and Guilds Institute the basement of Cowper Street School became the first formal establishment in Britain to offer rigorous technological education for working men. The newly appointed Director, Sir Philip

Magnus, reorganised the curriculum into a formal departmental structure: physics including mechanics, work and thermodynamics taught by Professor Ayrton and chemistry under Professor Armstrong. The demand was overwhelming and, in March 1882, a separate department of mechanics was split off from the Physics Department. Professor John Perry was appointed head. At the same time it had also become clear that the Cowper Street premises were inadequate and, in 1880, ground was purchased in Tabernacle Street on the edge of the Cowper Street site with a view to building an extension. At the beginning of 1884 the City and Guilds of London Technical College at Finsbury, universally known as the Finsbury Technical College, was opened.

The college aimed to attract bright, enthusiastic, working men and from 1884, day classes were instituted in addition to the continuing evening lecture programme. These were more rigorous and extended over two years. Provision was made to admit apprentices and workmen who could give up a portion of their day but who were unable to take the whole day course. The entrance examination for the day course required that the successful candidate should have competence in algebra, geometry and trigonometry and about half of the candidates, it was later reported, could handle calculus.

All eminent in their fields, the senior staff produced a number of classic textbooks which formed the basis of teaching for the next thirty years. Silvanus P. Thompson, principal of the college from 1885, initiated the *Finsbury Technical Manuals*, published by Spon which sold widely and his *Elementary Lessons in Electricity and Magnetism* was essential reading for anyone interested in the new science of electricity. John Perry's book: *The Steam Engine and Gas and Oil Engines. A Book for the use of students who have*

time to make experiments and calculations became the first standard college text on the subject. Clearly, any student who completed a Finsbury Technical College course to a satisfactory level had a first class theoretical and practical training behind him.

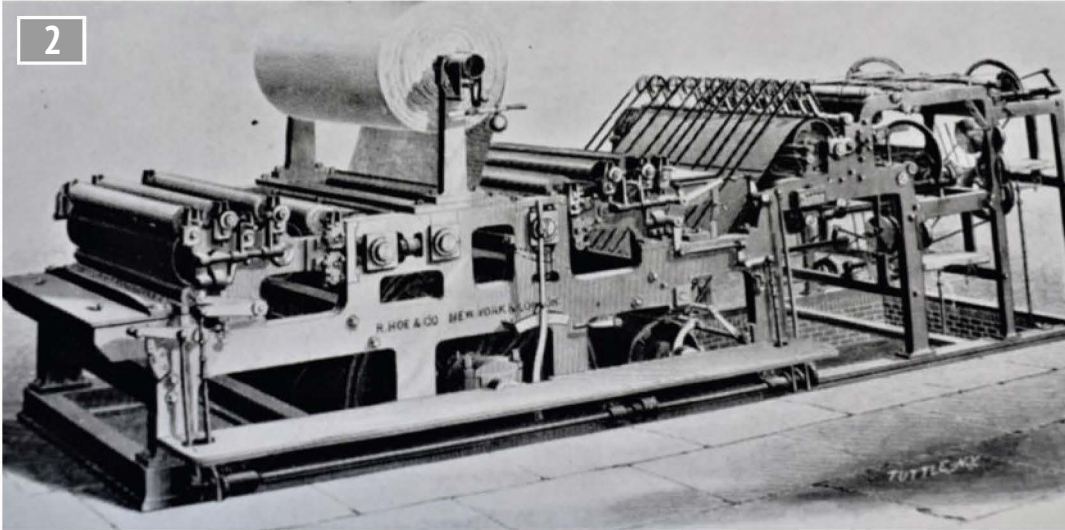
That Marshall should choose to enter the engineering profession by way of this academic path distinguished him from the vast majority of aspiring engineers. The alternative would have been a craft apprenticeship with an established engineering concern, which might cultivate trade skills but consigned the disciplined acquisition of theoretical knowledge to individual private study in the leisure time that remained after completing a fifty-five hour week. Two years of full-time study at Finsbury gave equal priority to theoretical knowledge and the acquisition of manual skills. Marshall entered the college at fifteen years of age and left at 16½ with a First Class Honours Diploma and as a City and Guilds of London Institute Medallist in Metal Working Tools. (Marshall retained a profound affection for the college in later life, bitterly condemning its closure in 1925. He also frequently expressed his deep respect for Professor John Perry.)

Marshall's transition from student to engineering journeyman followed. The journeyman was the recognised probationary stage after apprenticeship and entailed a succession of relatively short periods of employment intended to broaden experience by a variety of work. Labour Exchanges were not introduced until 1909; prior to that, the search for employment was a question of personal contacts or in default of such connections, tramping from factory to factory and enquiring at the door. He was to find the largely hidebound engineering industry indifferent to his qualifications regarding them and as no substitute for a formal apprenticeship:

...I started out very bravely calling on all of the engineering firms in the London area that I could find. At some places a gatekeeper would put his head out and point to a notice 'No Hands Wanted' and bang the door. At others I was told that I could not be interviewed without an appointment and when I wrote for an appointment I was told that there was no point in giving me an interview as there were no places ... Here and there some kindly principal or manager would ask me in and talk to me. It is true that they did not find me a place in the works but I was cheered that these busy men had taken the trouble to give me a few minutes of their time and some sympathetic and helpful advice. At one (firm) producing high speed engines, electrical and pumping plant, I succeeded in getting an interview with one of the directors. He listened to my story and after some depressing comments on apprentices generally he said that he would give me a start but that I would have to work for the first year for nothing. I replied that I was not prepared to do that. The director replied that I could take it or leave it.

He continues:

I got (a job) quite unexpectedly through an old schoolfellow whose father had put some money into a firm making sewing machines. This concern was at the stage of constructing automatic machine tools for the production of sewing machines in quantity. My schoolfellow wangled me a job. I got 8/- per weekthe works manager told me very soon after I started "While you are learning you cannot be earning". I learned quite a lot whilst I was in that small shop. I was everybody's mate helping a fitter here, a millwright there or a smith or a turner who wanted an extra hand. I acquired the painful experience of using a hammer and a cold chisel. I learned how to set a job up on a drilling machine so that the hole would come out at the right place at the bottom end, the



The Hoe Printing Press in its final form.

secrets of aligning shafting and countershafts. I became quite competent at hardening and tempering a chisel or a turning tool. I also acquired the skill of pushing a fourteen inch file for a couple of days on end without becoming too painfully blistered. (ref 3)

Having attained this modest competence, he received a surprise letter:

One of the firms that had noted my name and address wrote to me to say they had a vacancy. I went to see them and found they had just taken a large factory which they were equipping with new machinery throughout. They offered to take me as an unindentured apprentice and put me on a brand new Whitworth lathe just out of its packing case. I had read all about Joseph Whitworth, his surface plates, his millionth measuring machine his screw threads and his machine tools. Of course I accepted the job. I started a week later and not only did I get my new lathe but I met Jim Airey.

The firm that he moved to was Richard Hoe & Co. In 1833 the American, Richard Marsh Hoe, had taken over the printing press manufacturing firm started by his father. Nine years later he invented the rotary steam powered press that placed the type on a rotating cylinder rather than a flat bed. In 1870 Hoe greatly improved the performance of the press by adapting it to a feed from a

drum of paper, arranging the press to print both sides of the sheet, slitting the individual sheets and folding them. The Hoe 'Lightning Press' revolutionised the production of newsprint. Marshall maintains that when a leading newspaper ordered one of Hoe's machines they insisted that it be built in Britain and Whitworth undertook the work but by 1880 Hoe had decided to establish a manufacturing plant in London.

Marshall later expanded upon his reference to Hoe's workman Jim Airey:

He worked the next lathe to mine in my early apprenticeship days and taught me many things that make for good turning. He was one of the old school of mechanics who could turn his hand to almost any job in an engineering shop from the smith's forge to the fitter's bench or any kind of machine tool. I knew him as an artist at the lathe. He took an immense pride in his work; every job that came out of his lathe had to be right. I often used to see him discussing a particular job with the foreman. They would look it over, measure it up talk about it and finally Jim would do it. The foreman knew his man and beyond advancing suggestions, never imposed his own ideas. He used to watch me at work and give me a hint every now and again. If he was pleased with any job I did I felt I was really making progress; but if he wasn't pleased I was told about

it 'good and hard'. If I shyly asked him a few questions about his own job he would always tell me what I wanted to know. He seemed greatly concerned that I became a good craftsman perhaps not so much for his own sake as that he could not tolerate slovenly work or the clumsy or incompetent handling of a good lathe. My admiration of his work with a slight admixture of fear of his caustic criticism had much to do with my own shop progress and I have always been grateful to Jim Airey.

How long Marshall worked for Hoe is unknown but he subsequently moved to W. H. Allen's works, at that time located in Belvedere Road, south of the Thames, in Lambeth adjacent to Messrs., Peter Brotherhood. Both firms were shortly to migrate out of London but they shared a reputation for first class work through good management and top-quality shop floor engineers. The next move brought a break from the London engineering scene for he moved to the south coast to work in a small engineering shop. Here he participated in his first and only strike which arose from an intended change in the hours that made up his 55-hour working week. A diplomatic owner resolved the issue and after a morning of sun-bathing on the beach the workforce returned to its labours.

Again, Marshall's stay was

relatively brief and for the next couple of years he went north, firstly to the Coventry works of Herbert and Hubbard. The firm had been founded in 1888 to make steam engines but in 1889 Alfred Herbert took out a licence on a French patent to make tubes for the cycle industry. The substantial profit that accrued from this line of business generated the finance to enter into machine tool manufacturing, concentrating upon supplying specialised machine tools to the burgeoning cycle making industry. The company adopted the American model of streamlined production and their machines, particularly the firm's turret lathe (also known as a capstan lathe from the actuating wheel), were considered equal in quality to the American versions. Over the next half century Alfred Herbert and Company was to grow into the largest machine tool maker in Britain and amongst the biggest in the world. The company cannot have been more than two or three years old when Marshall joined it:

... as a fitter. My first job was to file the square ends for the handles on a batch of slide rest screws. A milling machine would have made short work of the job now-a-days but in my time it was a fitter's job. The shanks of the screws were in the round just as they came from the lathe and I had to square the ends to fit the handles. The handles were malleable castings with cored hole for the square shank to fit. The holes, roughly square in shape, had to be cleaned out with a drift and then finally touched up with file. It was a simple enough job but I mention it because it will show more modern readers how workshop methods have changed.

His observation of a particular incident at this time proved to be matter for subsequent reflection:

... I was working in the shops ... We were very busy and were working overtime. One evening the lathe opposite mine was vacant. Presently one of the partners in the firm came into

the shop in his shirtsleeves and went over to the lathe. He took a piece of round mild steel stock 12 inches long and 1½ in diameter, centred it and put it into the lathe. Then he took two front turning tools and bolted them both in the slide rest about an inch apart. The front tool was given a good deep cut with the following tool about a quarter of an inch deeper than the first. When the front tool had traversed about an inch the second tool started taking its quarter of an inch, a heavy cut. I watched this with interest; I saw trouble coming. The double cut was too heavy for the lathe. Suddenly the tool dug in, the work bent under the strain and it rode up over the top of the tools and fell out of the centres. One of the tools broke and the job was ruined. The partner stopped the lathe, picked up the job and walked away. I remember thinking 'what a fool to try a thing like that'. I thought 'that just shows how little he knows about lathe work. How silly he is to come into the shop and give himself away like that in front of the men.'

I have often wondered since whether he was the fool or me. I don't think he was a fool for he has built up one of the biggest machine tool businesses in the country and is an acknowledged leader in that branch of the engineering industry. I think the probable explanation is that he was planning some new lathe design and wanted to put to practical test some point in the arrangement of the cutting tools or permissible depth of cut with certain tools on certain types of material (ref 4).

From Marshall's own account of his life during this period it is clear that he spent time at a number of smaller and larger engineering works of which now no record remains. At one point he worked for a Manchester machine tool maker where he recalled being sacked under dubious circumstances:

I had been taken on as a turner and set to work in one section of the machine shop devoted to the production of smaller details. For the first

week all went merrily as a marriage bell. The foreman was satisfied with my work, I had good shop mates and having previously tramped around Manchester looking for a job I thought I had struck lucky. At the end of the week a chargehand from another section of the machine shop asked me if I would come and work for him on a bigish lathe which was then vacant. ... I agreed and with the consent of my foreman on the following Monday I took over the lathe and found that my job was to turn and cut some long square threaded screws for the vertical slides of a batch of big planing machines. Writing from memory the screws were about 10ft long and about 2½ inches in diameter ... I proceeded carefully with the work. My boss was friendly at the outset but later in the week he came over and asked me how many screws I had cut, how long I would be finishing that one and other similar questions which indicated that he was not pleased with my rate of output. On Saturday morning he walked over to me from his own lathe and said 'tha'll 'ave to finish oop today lad, tha's too slow, the chap that worked thy lathe afore thee could fairly weave they screws.' I informed him as politely as I could that I was a turner not a weaver and at 12 o'clock I wrapped up my tools and we parted.

I learned a day or two later that my place had been filled by a pal of the chargehand who had come along during the week and asked him to find him a job. From what I gathered his screw weaving abilities were little better than mine. My previous lathe had been occupied by another man ... I had to go on the tramp again ... as I wandered from shop door to shop door I found myself in the company of a group of mechanics engaged in a similar quest. Some were turners. Some were fitters, some smiths, some millwrights and here or there one or two of the group would find a vacancy for his particular trade. Sometimes a bit of news that so-and-so had

just got a contract for building some big engines or a textile plant would start us off in a fresh direction. I was not out for many days. I happened to pop my head in at a door of a big general engineering firm at the right moment and after a few sharp questions from the foreman - a big bearded Scot - I was told to come right in and take my coat off. I stayed there some months during part of which I worked on an exceedingly ancient lathe which caused me some amusement but also considerable anxiety when a really accurate job had to be done...

Marshall has a further account of his time in this Manchester works:

My regular work on the particular lathe was the machining of sets of governor parts for small steam engines. A dozen sets of castings used to be dumped beside my lathe and I had to do all the turning, boring and screw cutting required. One day the foreman came along and said "here's a job that will suit you." He handed me a chunk of mild steel bar 4 inches long and 1¾ square; "I want that boring up and screw cutting as a nut for this screw." He handed me a steel screw about 18 inches long and 1 inch in diameter cut with a double-threaded left-hand screw of ½ inch pitch with a square thread. There was a twinkle in his eye as it was one of those jobs which are not quite as simple as they seem (!!!!). In the first place you have to make a special tool to suit the width and rake of the thread, in the second place the starting of a cut at the far end of a 1 inch hole 4 inches long with a comparatively delicate tool has its anxious moments. Then again the finishing of the two threads to equal depth and thickness so that the nut may be a snug working fit on the screw is another part of the job which requires more than a little care. I went to the fitter's forge kept for odd jobs and knocked up a boring tool into the rough shape for a threading tool. Then I set out to correct the rake of the left handed thread and filed

up the tool to suit. It needed to be very carefully hardened and tempered to get maximum strength but it did the job without any of the chipping or breaking which is so annoying in a specially made screw cutting tool. I mounted the square bar on an angle plate, bolted this onto a faceplate, put an out-of-balance weight on the opposite side of the faceplate and drilled and bored out the hole. I then worked out the correct change wheels, put them in place, chalked them at the right places for dropping into gear and went ahead with the screw cutting. Everything went smoothly and the job came out right but I do remember some frightfully anxious moments when starting up the fresh cuts and when taking those fine finishing cuts ... the springing of the tool and a trifle of backlash in the slide rest did not make my life any easier but it is wonderful what you can do with a lathe when you know its little tricks and failings ... when you are starting the cut at the far end of a 1 inch hole you have got to work backwards and your tool must be in exactly the right spot every time you start your lathe or 'bang!' it goes and there's a hour's job to make another one. In those days if you were turner you were expected to tackle any job that came along and I have no doubt that any other lathe hand in the shop would have done equally well. I remember that I thought an awfully long time over the job ...making the tool, constant starting and stopping of the lathe and 'feeling' for the cut took time that seemed out of all proportion to the finished job ... I have often wondered how much the customer was charged for the job ... (ref 5)

In spite of his now full-time employment, Marshall did not consider his education in theory complete when he left Finsbury College. Whilst in London he studied at the Birkbeck Institute, founded in 1823 by George Birkbeck as the London Mechanic's Institute. Like Finsbury College it was primarily intended to promote working class education,

mainly through evening study. Marshall attended the evening classes in plain and solid geometry which he considered were exceptionally well taught by Henry Angel. He also sat for the Science and Art Department Examinations in machine drawing, geometry, steam and applied mechanics, duly collecting the green cardboard certificates. His attempt at the Honours Stage of Machine drawing brought a less happy result. The subject was a shearing and punching machine with which he was unfamiliar. As he wryly remarked, the result was more appropriate to Heath Robinson and he was accordingly failed. He nevertheless entered for the Technical Examinations of the City and Guilds of London Institute resulting in his being placed second in the all England lists with a medal in the Metal Working Tools Examination and a 1st Class Honours Diploma in Mechanical Engineering.

During his time in Manchester he attended evening classes at the Manchester Technical School, reconstituted from the declining Mechanic's Institute by J. H. Reynolds in 1883. Like Perry at Finsbury, Reynolds had introduced instructional workshops and laboratories, teaching working students

to take the City and Guilds syllabus. In the examinations of 1890 the Manchester Technical School led the country outside London in its results. In 1902 it moved to new buildings in Sackville Street and later became The University of Manchester Institute of Science and Technology (U.M.I.S.T.). He also attended Owen's College, precursor of Manchester University which took a more elevated view of its scientific teaching duties.

In Manchester, Marshall discovered the existence of the Union of Lancashire and Cheshire Institutes and entered for the paper on Machine Calculations which gained him a First Class Certificate. Marshall considered that, unlike most of his other academic experiences which were mainly of a textbook character, the Lancashire and Cheshire examinations were more practical. Whilst in Lancashire he also undertook teaching evening classes in the principles of machinery and steam engines to mechanics and miners. At this time he first began to publish in technical papers but unfortunately none of these articles have so far been discovered.

Drifting south again, when he was nineteen, he spent time in the employment of the printing press and general engineers

R. Furnival & Co., of Redditch (Furnival's also ventured into building gas engines, one of which is preserved at the Anson Museum but this was probably made after Marshall's time). Here he worked in the drawing office and it would appear that there were further episodes as a draughtsman but details are lacking. This sojourn in provincial England was brought to a close when he returned to London to join his brother, Alfred, who had begun to manufacture dynamos, motors and arc lamps in 1892. His time with his brother lasted for about four months before the urge to wander again overtook him.

Up to this point in time Marshall's experiences in the engineering world would have been largely familiar to his more adventurous fellow journeymen but his next move was much more exceptional. Endowed with the usual minimal French language skills of school days he decided to improve his linguistic abilities by continuing his journeyman career in France. He subsequently described his experiences:

Tramping between jobs is a weary enough business when you are in your own country but imagine the difficulties when you are a stranger in the land, barely able to make yourself

understood and still less to understand the voluble refusal which is hurled at your head in a foreign language. It needs a good deal of courage to seek a job under those conditions, especially when you know quite well that the fact of your being a foreigner makes it long odds against your being taken on even if there should happen to be a vacancy. However, I was young when I tried my luck across the Channel and when you are young and fit and able to do your job the skies are blue. Looking for a job in Paris whilst struggling with the language was something of an adventure. I tried shop after shop and office after office. On two occasions I thought I had touched lucky but both fell through; funds were very low and it looked as though I would be stranded. I often lunched off a small roll and an orange and lots of fresh air. Then one morning in the little café where I took my breakfast I picked up a cycling newspaper and saw an advert for mechanics for a cycle factory in the north of France. I put in an application and received a postcard asking me to attend an interview in the Paris head office of Messrs., Hermet and Miquet of St. Aubin-sur-Scie (photos 3 and 4). I did so and after a few preliminary questions as to my nationality and shop



Percival Marshall's place of work in Paris. Image from Google.



Hermet and Miquet bicycle from the period of Marshall's employment by the firm. Preserved in France. Image from Google. Preserved in France. Image from Google.

experience I was asked could I work a 'tour à décolleter.' That stumped me for a moment but I realise that it was some sort of lathe and I quickly replied "oui m'sieu parfaitement." I was told I was engaged and was to report to the factory at on the following Monday morning. I in due course presented myself at the factory. I was taken into the machine shop and introduced to my mysterious 'tour de décolleter'. It proved to be nothing more terrifying than a capstan lathe built by Alfred Herbert Ltd., of Coventry in whose shops I had already worked. (Alfred Herbert had a highly successful agency selling turret lathes to the French cycle building trade) ... They were just coming into use and this was the only tool of its kind in the factory. My French shopmates sympathised with me when they saw me given this tool. They told me that several men had been given the job previously but no-one had been able to make a success of it. I looked the lathe over and soon understood the reason. The slides were slack and the lathe generally was out of adjustment. The cutting tools were badly made and set. I think the firm when buying the tool had assumed that because it

was one of these new-fangled turret tools it could be worked by any unskilled operator. I knew that cutting principles in a turret lathe were exactly the same as in an ordinary lathe and that it was only a matter of having the right tools and applying them directly to the work. I soon had the lathe properly adjusted. I asked for samples of the jobs the lathe had to produce and looked over the tool equipment of the turret. Where necessary I made new tools or reground and reset the existing ones. In a couple of days that lathe was merrily turning out its quota of finished pieces. (ref 6)

Marshall's shop mates were worthy of a French opera. Anarchy was fashionable in much of continental Europe at this time and to a lesser extent in Britain. The operator of the lathe adjoining his own was of this persuasion but this did not deter Marshall from forming a strong friendship with him. A talented mechanic, Jacques also rejoiced in the skill of knife throwing although whether his talents extended to bomb making is not stated. At one point Marshall almost decided to go on the tramp with him with the ultimate intention of joining a ship as the Frenchman

has previous experience as an engine room greaser. Discretion prevailed and Marshall remained at St. Aubin (ref 7). That anarchism was not confined to his lathe mate was apparent when President Carnot was assassinated and work stopped whilst jubilation took over.

So typical of the man, Marshall's final assessment of this experience was tolerant, humorous and philosophical:

They were not bad fellows those anarchists except for that one terrible mental kink... in other ways they were just big children and song, jest and laughter marked their daily round.....Bebe, the idol of the polishing shop, a dirty unkempt half sized little wisp of a fellow but full of jokes and cheery philosophy with a passion for

fishing. ... with my journalistic passion I produced a comic paper for the amusement of the people in the works. It was a one-man job...I searched the village for some decent white paper and with pen and ink and a box of colours I produced one copy only of St. Aubin Pour Rire (St Aubin Laughing). It was quite a success. There were quips and jests about all of the notabilities of the works but the star feature was the whole page cartoon of Bebe at the river side with his nose glued to the butt end of a fishing pole and fish popping their heads up out of the water laughing at him. "Bebe au moment solonel" was chuckled over for many days.

Percival Marshall returned to England in 1895 at the age of 25. Following his two years of full-time education at Finsbury College he had spent five years in the shops as a fitter, turner and all-round hand with a further three years as a draughtsman and general technical assistant. He had worked on engines, pumps, machine tools, textile machinery, cranes and printing machinery. At the same time, he had continued his academic studies wherever a local technical school or university was available. Although his enthusiasm for engineering was undimmed the urge towards journalism was now taking over but probably an equally persuasive factor in this change of direction was his impending marriage to Zoe Beatrice Bridgen which took place on the 1st February 1896 at St. Giles Church, Reading.

●To be continued.

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- Ref 7** M.E.2070 January 9th 1941, Smoke Rings.



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Skills

Dear Martin,

Having read the article by Roger Backhouse about his visit to the Kelham Island Museum in Sheffield (M.E.4723 August 11 et seq.), it was nice to read about our heritage but also sad to read about it as we don't seem to be able to make anything in this country anymore and that our young people only see our engineering heritage as so-called stuffed museum pieces. I suppose that the majority of our readers are of a certain age and can remember the things that were made in Sheffield and elsewhere but no longer, it seems, are being made. I know that when I left school in 1962 without any exams to my name I was able to go into a small general engineering firm in Clerkenwell to learn a trade and eventually to go to evening classes to study for my City and Guilds Mechanical Engineering Craft Practice certificates which I passed. This has stood me in good stead even during my 6 years' service in the British army in REME - we always made a pun on our initials, saying it stood for 'Rough Engineering Made Easy' but - far from it - the army and other services have had a lot of highly skilled engineers, both men and women.

Hopefully there will be a good uptake in craft apprenticeships which we badly need to replace those of us as we get older and retire. I took early retirement 16 years ago at the age of 60 but I still keep my hand in by doing simple repairs to items that come into the charity shop where I do a couple of afternoons a week as a volunteer. It seems to me that most engineering done nowadays is more in the 'model engineering' line rather than factories making things. Yes, I know companies like Rolls Royce Aerospace still make aero engines etc. but we do still badly need to be able to make things here rather than rely on getting them from overseas.

How would we fare for instance if we were in the same situation as in the Ukraine today? Hopefully this would not happen to us.

It was also very interesting to read about the part our women played in both WW1 and WW2 to keep the factories running to keep the supplies going, which were vital to keep the troops at the front supplied with the weapons etc. to help us to victory. It's a great pity that our engineering has gone down the tubes, so to speak. We do need to pass our skills on to the up and coming generations so that we don't lose them. I notice that our model engineering clubs do try to encourage both boys and girls to enrol with them in junior sections where they can learn skills which unfortunately seem to be not taught in schools anymore as the technology workshops seem to be closing and the machinery and tools etc. sold off. Having worked as a technician in my local school's technology department I know it is an expensive part of schooling, both in resources and in recruiting and retaining the staff to run the department.

I hope that when we have the next general election whoever gets into government will realise that we do need to reverse the decline in manufacturing industry and ensure that both training and employment in engineering

are encouraged for our young men and women as they leave school so that they can have a good career with good pay and prospects. This is something I could not help but notice in the then Federal republic of West Germany - yes, they had university graduates but they also encouraged people to go into manufacturing industry and kept training them in up to date things.

Yours sincerely,

J.E. Kirby
(London)

Directors' Saloon

Dear Martin,

I live in Adelaide, South Australia having migrated from England in 1969, coming originally from Blackburn, Lancashire. I am a member of the Adelaide Miniature Steam Railway which I joined 38 years ago. I run either a 5 inch gauge 'Torquay Manor' or a British Rail Class 22 electric locomotive.

I also have several items of English style rolling stock but the main reason for contacting you is to mention that a few years ago I built a 5 inch gauge version of the Old Gentleman's Saloon as featured in the 1970's version of the Railway Children.

I originally managed to contact Mr. Chris Lawson, the owner of the coach, who very kindly supplied me with a line





drawing of the saloon. It took me quite a while to build it but I found it a very enjoyable project.

I've attached two photographs to show you the end result. One is a side view with the coach on a stand and the second shows my granddaughter holding the roof open.

The interior is complete in detail with chairs, table, etc., fitted out toilet and washroom, attendant's compartment and a fitted kitchen with a kettle and saucepan. A roast chicken has been prepared for the evening meal.

I notice a Mr. Mike Glegg has also built a 5 inch gauge version, as featured in *Model*

Engineer (M.E.4715 April 21) which is remarkably similar.

I trust you find this email of interest to let you know that the *Railway Children* film is enjoyed both in England and Australia.

Kind Regards,

Peter Cooper
(Australia)

Electrical Safety

Dear Martin,

Seeing Mike Joseph's account of his electrical clanger (M.E.4709 January 27) reminded me that some years ago I managed to commit the same electrical clanger twice. I was asked to make a bespoke cord for a toaster oven that sat on a counter in the kitchen because the cord provided was too long and a nuisance. To get the new cord I plugged it in, determined the needed length and cut it. I was rewarded with a flash and a loud bang; I had neglected to unplug it. Luckily,

with my liking to have the tools for the job, the AMP Champ tool has insulated handles. Score one for doziness.

Not six months after, fitting a light over the sink at the cottage, I managed the same stunt when working out the length of the required cord! Now score two for doziness!!

Out of curiosity, I looked up a cutting, crimping etc. tool on the web. I was astounded to note that this useful tool now costs over US\$80 new and I had thought it expensive when I paid just under \$8 for mine in 1971 here in Canada.

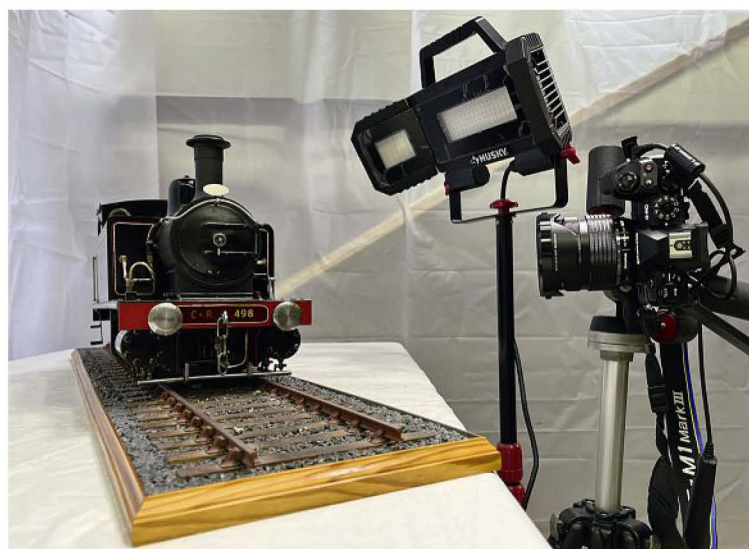
Tempus fugit.

Best regards,

John Bauer
(Canada)

It's good to know that, despite your best efforts, you are still with us! – Ed.

NEXT ISSUE



Curtains

Steve Goodbody is back with his exposition of the art of photographing models, with particular reference to *Jennifer Ann*, recently featured in this magazine.

Percival Marshall

Ron Fitzgerald continues the life story of Percival Marshall and follows the rapid growth of the magazine after its foundation.

LNER B1 Boiler

Doug Hewson presents a design for the boiler of his true to scale 5-inch gauge LNER B1 locomotive.

Manx Motor Museum

Geoff Theasby shares with us the contents of his photo album, recently augmented during his visit to the Isle of Man.

Clupet Rings

Martin Gearing explains how you can make your own Clupet rings.

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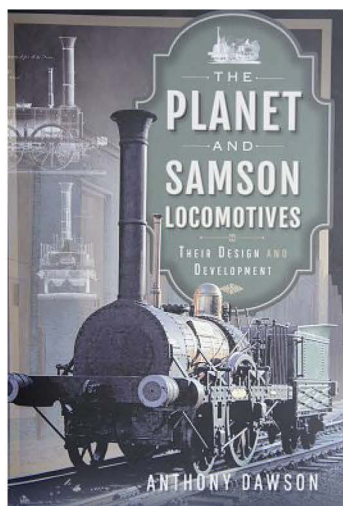
ON SALE OCTOBER 20 2023

Book Review

The Planet and Samson Locomotives: their design and development.

Anthony Dawson

Published by Pen and
Sword Transport 2023
(www.pen-and-sword.co.uk)
ISBN 978-1-39909-264-7
£25, 182pp, hardback



Besides the intrinsic interest of steam locomotive history this book is fascinating because it demonstrates early rail technology evolution. The period from 1825 to 1835 featured rapid technological progress. Though Stephenson's *Rocket* is best known for its part in the Rainhill Trials and early work on the Liverpool and Manchester it was soon out of date. As with computers in our own time progress was fast.

Anthony Dawson has already written about steam locomotives before *Rocket* and the locomotives of the Liverpool and Manchester Railway, establishing his place as a knowledgeable chronicler of early railways. This book enhances his reputation by adding accounts of how steam locomotive technology spread to Europe and North America.

Planet was the first modern locomotive incorporating design elements that were standard on steam locomotives until large scale construction ceased. They included boilers with inner fireboxes in the boiler shell, smokeboxes with

a blast pipe, domes, steam risers and internal steam pipes. The cylinders were set low on a proper frame fitted with leaf springs, horn blocks and horn guides for the axles. *Planet* has been rebuilt as a replica, helping understanding of construction techniques and materials employed. Numerous photographs from that reconstruction help this book.

Robert Stephenson seems to have thought of the design as early as December 1827 when he returned from his South American adventures. He was influenced by Sir Goldsworthy Gurney's steam carriages which in various manifestations had outside cylinders driving a crank at the rear or cylinders between wooden frames driving a cranked rear axle. Whilst he used fixed eccentrics and a gab valve gear this was designed to be reversed easily by a lever. Gurney was an overlooked genius and it is curious that he devoted little attention to steam locomotives.

Planet's building began in 1830 and it ran on the Liverpool and Manchester that year. It managed to travel the whole line in one hour, a wonder of the age, and the design was soon copied by others. Similar locomotives were used on the Bolton and Leigh, Glasgow and Garnkirk and the London and Greenwich railways among others. Alec Butler Rowley even tried putting a rotary steam engine (not a turbine) on the Liverpool's *Mars*, a poor choice as that locomotive was worn out. The engine performed well in the circumstances and avoided problems with hammer blow on the track.

Engines of the *Samson* class started work on the Liverpool

and Manchester in 1831. They had four coupled wheels and cylinders between frames. Again, similar examples were built for other railways. The *Tyne* for the Newcastle and Carlisle line also boasted a steam organ with eight pipes instead of a whistle. Perhaps the original steam calliope? Sadly, we cannot know what it sounded like.

Examples of both *Planet* and *Samson* types were soon exported to France. For some lines the choice was influenced by Marc Séguin, who visited Robert Stephenson's Newcastle works and tested a Leeds built *Planet* in France. Following a serious accident at Meudon involving two British built locomotives and where the *Matthieu Murray* broke an axle a scale model was built to try to find the cause. Was this the first use of a model in an accident investigation?

British imports to early United States railroads included the *John Bull* for the Camden and Amboy in 1831 which was soon modified with a pilot to suit US tracks. The inventor Robert A. Young devised a spark arrester as engines now burned wood fuel. Other railroads followed but there were many American made copies. Matthias Baldwin was one copyist but the builder of most *Planet* type engines worldwide was the now forgotten Locks and Canal Company.

Anthony Dawson rounds off with a detailed assessment of the *Planet* design, containing much information helpful to anyone making a model. Overall an excellent book on highly influential locomotives that is a credit to author and publishers.

Roger Backhouse

A Model Engineer's Clock

PART 2

Jim Clark makes a skeleton clock making good use of modern manufacturing methods.



Continued from p.453
M.E.4726 September 22

The main spring, barrel and stop work

A further use for the test rig - which I thought of later - was to provide an estimate of how much spring torque we might need to run the clock reliably, without over- or under-powering the escapement. The small metal weight I was using to power the test rig weighed 57 grams and was suspended from a string wound round a 16mm spool on the arbor, therefore the torque applied was 57g at a radial distance of 8mm, or a torque of 45.6g-cm, or 0.00447 newton metre. This amount of torque produced a very definite pendulum action and would pick up the pendulum to a steady ticking from the point of being almost stalled.

In fact, it continued to work quite well down to half of that weight and it still just worked at 20g, so a good range to aim for torque at the third pinion seemed to be between say 25g x 0.8cm = 20g-cm and about 60g x 0.8 = 48g-cm.

To get power from the spring to the third wheel arbor we go through the great wheel and centre wheel, the overall ratio being:

$$\frac{200 \times 300}{9 \times 10} = 666.6:1$$

So, the torque required on the great wheel arbor (provided by the main spring) would be between 20g-cm x 666 = 13,320g-cm and 48g-cm x 666 = 31,968g-cm (between 1.31 and 3.14 newton metre), ignoring friction losses in the gear train.

This works out at somewhere between 1.3kg and 3.2kg of force applied at a 100mm radius on the spring arbor - definitely requiring a strong spring that will need some winding up!

As mentioned earlier, I designed the clock to have



The rough castings for two spring barrels.



The finished barrels.

a large spring barrel to accommodate a range of main springs, as the selection of a suitable spring still remained undecided.

Most large clock spring barrels are relatively flimsy affairs, but I decided to make castings that would provide a very robust barrel, which would be supported on small ball bearing races (**photos 6 and 7**).

The issue of how to work out what size a suitable spring should be was still not resolved, though. I decided to buy the largest spring I could get, which

was 0.7mm thick and 35mm wide. When this one arrived, it was immediately clear that it would be far too strong! I then tried to obtain a smaller one - the next size down that I could find that was available was 0.45mm thick and 25mm wide. When that spring arrived it appeared more reasonable, but how to measure the actual spring force?

I decided to build a mainspring winder, a simple mechanism that hooks both ends of the spring and allows you to wind it up in order to



Mainspring winder with improvised measuring weight.

insert the spring into a spring barrel. By attaching an arm with a weight to the winding handle, I was able to measure the spring torque at different numbers of winding turns (**photo 8**).

This allowed me to record the torque of the spring at each full turn, starting from the fully wound position, unwinding it one turn at a time, as shown in **fig 1**.

The green shaded area represents the optimum working area to provide the estimated torque range that will be required at the third wheel arbor. The grey torque line shows the actual measured torque of this particular spring at each turn. The horizontal axis with two vertical blue lines allows for starting one turn back from fully wound, then six further full turns of the spring to its least wound state, corresponding to eight days of operation.

For this spring, the torque varies from 17,800g-cm down to 6,000g-cm over the six turns of operating range, almost 3:1 variation. This demonstrates the benefits of using either a weight-driven movement (where the torque applied by the weight remains constant over the whole operating period), or the fusee design, where the varying diameter of the fusee barrel compensates to a large degree for the variation in spring tension as the spring unwinds.

However, my design for the Model Engineer's Clock will be direct spring driven and does not incorporate a fusee, so we shall have to see how well it performs!

Based on this (fig 1), it appeared that the 0.45 x 25mm spring would not be strong enough to power the clock

properly, as only the first two turns fall within the optimum working area. I needed to look for a stronger one (either thicker or wider or both), which would lift the whole torque curve higher, and preferably a spring with a longer length, which would help to flatten out the curve and reduce the variation in torque over the six turns that are required between the clock being fully wound and unwound.

More to do about springs ...

After considerable Internet searching for suitable springs, I finally tracked down what perhaps looked like a suitable mainspring of 0.55mm thickness and 30mm width, available from H.S. Walsh in the UK. Before ordering it, I did some estimations of how that spring might perform, based on the measurements taken from the one I already had. I was unsure of the actual physics of coiled springs, as overall spring force is dependent not only on the elastic properties of the spring steel (Young's modulus) but also the radial distance of each coil, which keeps changing as the spring is wound up. I thought perhaps the increase in overall force relative to the first spring would be roughly proportional to the increase in material thickness plus the increase in width, so that is what I calculated and plotted as the light blue dotted line 'Estimate 2nd spring' in **fig 2**.

The estimate seemed to fall mostly within the desirable green area, so based on this and the fact that there were only three available, I ordered the second springs.

When the new springs arrived a few weeks later, I repeated the original load test on one of the new springs, shown as the green dotted line (fig 2). Pleasingly, it was fairly close to the estimated line, although somewhat flatter. After measuring the new spring and finding it was 2.4m long as opposed to the original one of 1.8m, this seemed sensible and, in fact, desirable as there

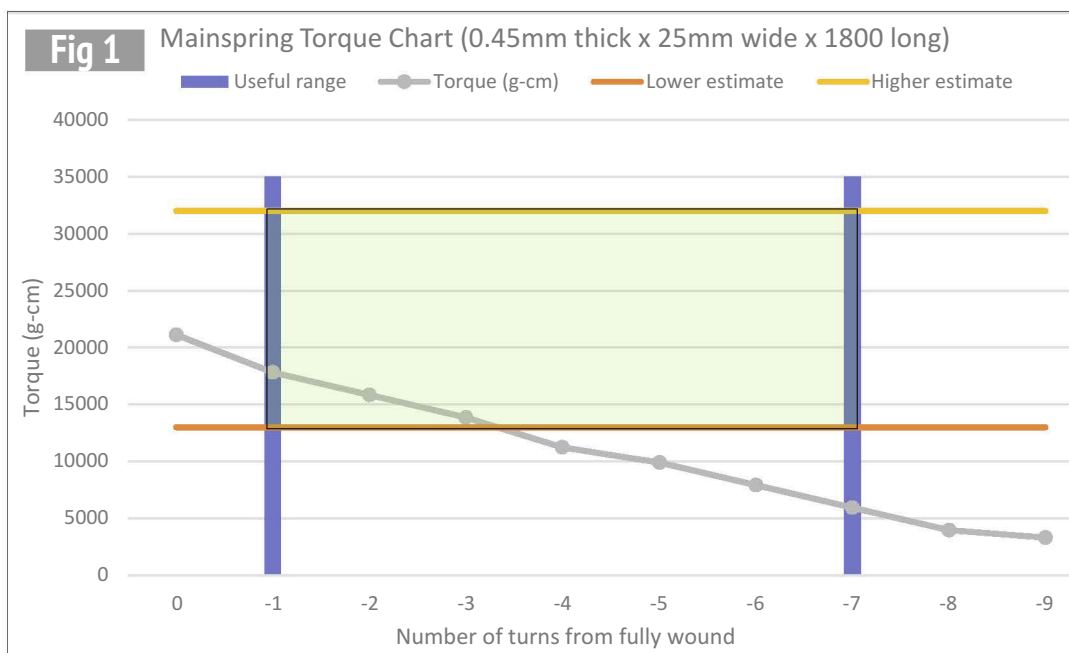


Chart of mainspring torque vs. turns.

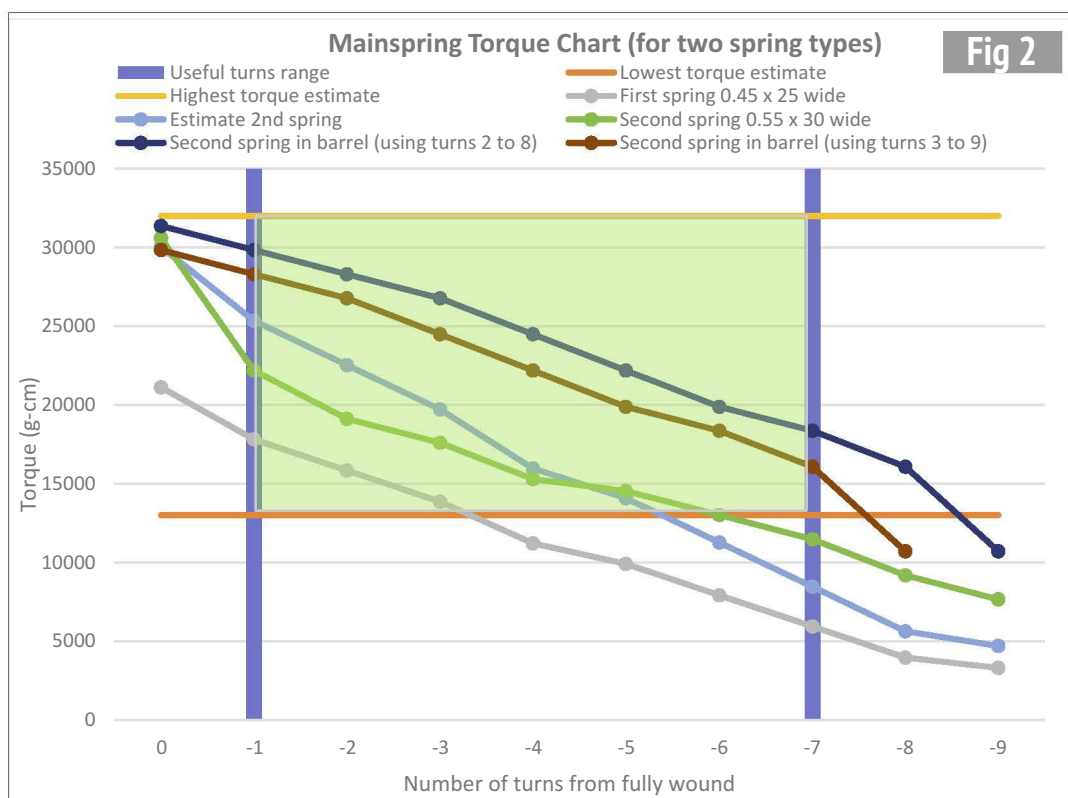


Fig 2

This chart is developed from Chart 1 and shows the accumulated results of further investigations and trials.

is less variation over the operating range. Looking like a good choice of spring!

Another thought that occurred to me was that the spring force would probably be different when the spring was

constrained inside the barrel, rather than free to take up whatever shape it liked during my tests.

I was also somewhat concerned as to whether I would have enough useful

turns available when it was inside the barrel. To check this, I drew the spring up in CAD using a number of concentric circles to represent its fully wound and fully unwound states, calculating the number

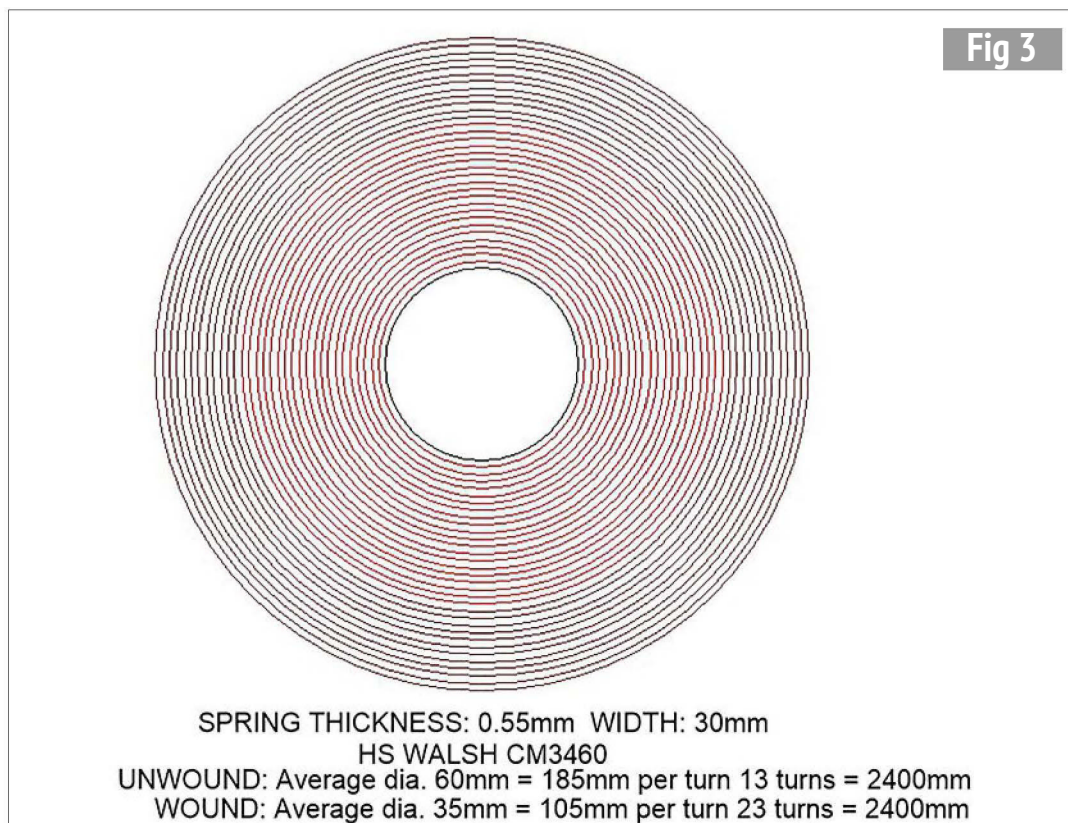


Fig 3

Using CAD to check how many turns to expect in the barrel.

of turns that would be accommodated in each state for a spring 2.4m long (fig 3).

This indicated I should expect to get about 10 turns of the barrel from fully wound to unwound, enough to cover my desired operating range of six full turns.

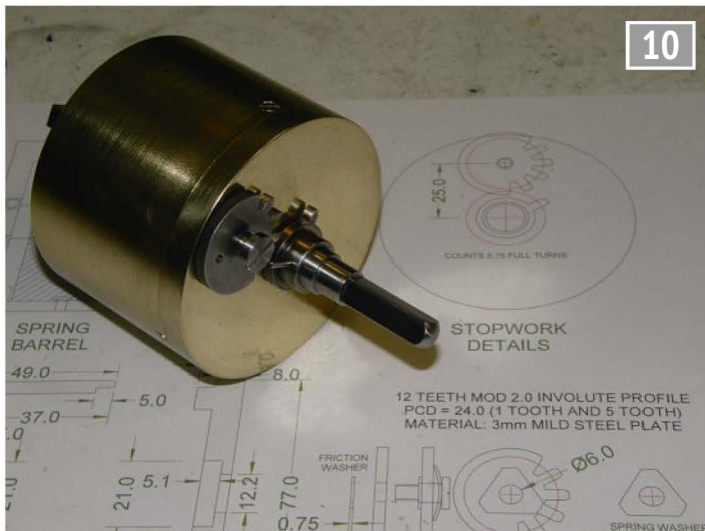
This was an important check, as these springs are seriously big and scary and very difficult to handle when fully wound. I knew I could use my mainspring winder to pre-wind the spring and get it into the barrel, but once it is in there, I don't have any safe or easy way of getting the spring out again without damaging the barrel and possibly myself. Clockmaking books contain many dire warnings about the danger of injury from improperly handled mainsprings, so I took the precaution of wearing welding gloves, a thick jumper and a full face shield when working with the springs – just as well, because I did cop a whack on the wrist from the handle of the mainspring winder which raised a pretty good bruise.

Having decided that the spring would fit inside the barrel, I committed to installing it, which in fact was fairly straightforward. I pre-wound the spring on my mainspring winder and tied it with wire, then slipped it into the barrel and carefully undid the wire tie. It took a bit of juggling to get the outer end hooked onto the barrel hook, then the arbor was installed (photo 9).

I then set up another simple test rig to measure the torque of the completed spring barrel, which appears on the chart in fig 2 as the dark blue dotted line 'Second spring in barrel (turns 2 to 8)'. As suspected,



Yes! - we have a fully loaded spring barrel.



Barrel with stop work fitted.

this is a bit different from the free air test because the spring is constrained within the barrel and is already well tensioned against the barrel wall even in its 'unwound' state.

A further very neat horological trick is the so-called 'stop work', which is a pair of modified gears that fits between the spring arbor and spring barrel (**photo 10**).

It is a simple turns counter: each time the arbor goes round as the spring is wound up, its single tooth engages with the count wheel, moving it one tooth space at a time, until the solid part of the count wheel is reached, when the arbor can rotate no further. When the spring unwinds, the reverse happens until the count wheel reaches the other end

of the teeth in the count wheel and the clock is stopped in a controlled manner at that point, rather than just running right down, erratically and unreliably.

The stop work primarily prevents the clock from being over-wound and also prevents the spring from unwinding completely. But it does serve a very useful secondary function – it allows the spring operating range to be selected simply by setting the start position of the count wheel. In this way, the power available to run the clock throughout its eight day running period can be controlled very precisely.

There are in fact $12\frac{1}{2}$ full turns available with this spring in the barrel, which gives us the flexibility to pick the $5\frac{3}{4}$ operating turns we need from somewhere in this range, in order to either raise or lower the overall spring force available to the clock, as shown in the dark red dotted line 'Second spring in barrel (turns 3 to 9)' in fig 2. We can therefore adjust the power

available to the clock, should we need to either increase or decrease it when the clock is finally assembled and running.

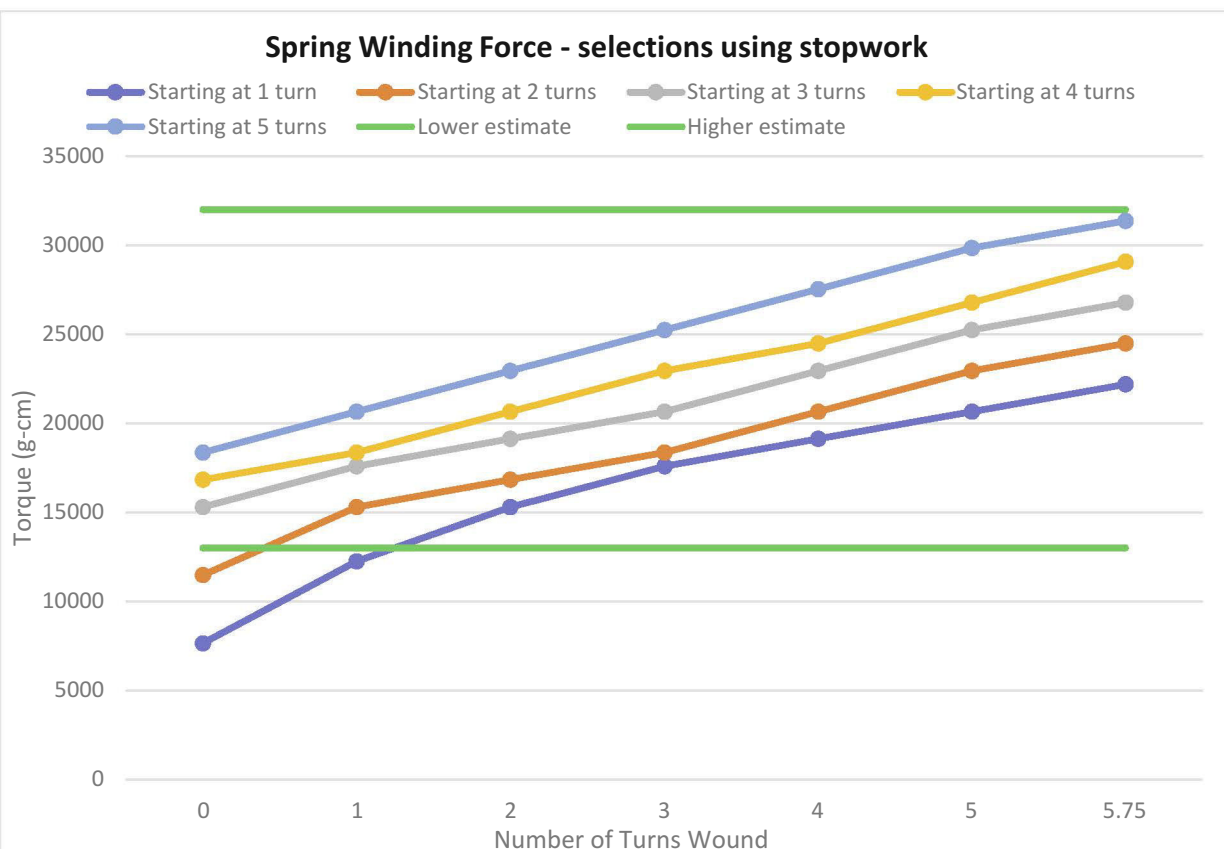
To further check this, I did several more tests with the loaded spring barrel, using the stop work to set the start position. This gives a set of several torque curves that are available from this spring barrel, any one of which can be selected to power the clock. The selected torque curve can easily be changed by adjusting the count wheel if the clock is found to be over- or under-powered in operation.

Looking at these test results (**fig 3**), the desirable torque range lies between the two green lines marked 'Lower estimate' and 'Higher estimate'. Three of the curves sit comfortably within this range: starting at three turns, four turns and five turns.

Any one of these selections should power the clock adequately.

● To be continued.

Fig 3



Torque curves that can be selected using the stop work.

RECYCLING PART 6

A SOUTHERN SCHOOLS 3½ INCH LOCOMOTIVE

Robert Hobbs takes a box of bits and turns out a Schools Class 4-4-0



Continued from p.444
M.E.4726, 22 September



The tender chassis with brake gear fitted.

With all the components manufactured and the painting having been completed we enter the final stages of the project and one of the most demanding; a scratch from a misplaced spanner, screwdriver or a poorly positioned section will destroy months of work and really stress the builder, so carefully... carefully was the order of the day.

The tender frames were fitted with the axleboxes, keeps,

wheels, buffers, steps, brake shoes, links, cross beams and pull rods as shown in **photo 112** which shows the frames from the underside. **Photograph 113** shows the top of the water tank and the filler cover ready for assembly with the tender body. The three-quarter rear view of the tender is shown in **photo 114** and clearly shows the hand rail and rear steps for access to the water filler. The front end of the tender, displaying the



The tender rear platform and filler cover.

toolboxes, raised apron and hand brake operating stanchion is shown in **photo 115**.

Moving on to the locomotive, **photo 116** shows the boiler in position with the brass boiler bands, safety valves, steam dome and snifting valves, whilst **photo 117** shows a close-up of the smoke deflectors, which are quite a prominent feature of the Schools class. When approaching the end of a project there is always something missing and this project was no different;



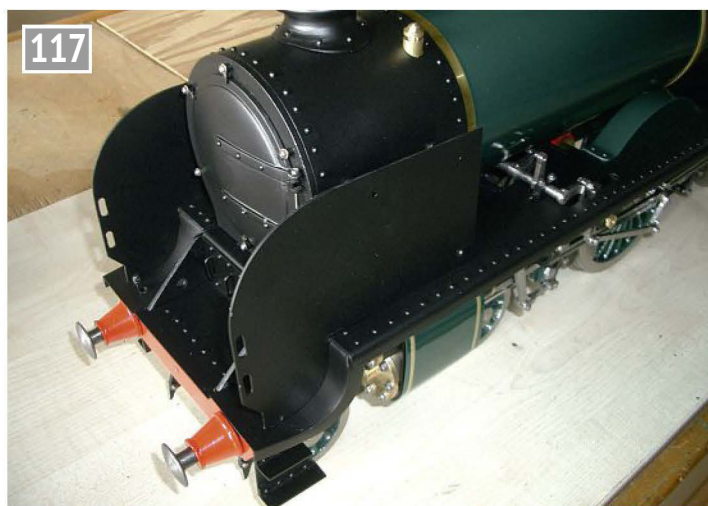
Rear view of the completed tender.



Front view of the completed tender.



The boiler, installed complete with boiler bands.



Smoke deflectors.

photo 118 shows the locomotive and tender together for the first time with the recently rolled and painted cab roof *in situ*. Phew! That was close. There was, however, yet another hoop to jump through. I had failed to mark out the positions of - let alone drill and tap the boiler for - the handrail stanchions. So much for planning ahead! Firstly the locomotive had to be set up level with blocks under the buffer stocks and then low tack masking tape applied to the boiler casing. A level line was drawn along the boiler on both sides, with a pencil held in a scribing block. This line

was then divided up to suit the spacing of the stanchions. A No. 1 centre drill was used to spot the holes, hoping that the drill would not slip or wander. The spots were then drilled and *extremely* carefully tapped 8BA. Well ... **photo 119** shows the handrails in place and that I had got away with it, avoiding a further potential disaster.

Adding the finishing touches is real pleasure and when the beautiful nameplates had arrived from Peter Wood at Model Engineers Name Plates, the mounting brackets were made to secure the plates on the front splashers (**photo 120**). The locomotive was named



The locomotive and tender, paired up for the first time.



The handrails are added.



The nameplates are fitted.



The tender receives the locomotive's number.



The completed Schools Class locomotive.

Winchester because I live in Chandlers Ford, which is near the Eastleigh Railway Works where many of the Schools were built and Winchester, which is just up the road, is one of my favourite cities. The transfers for the tender sides were supplied by Simon Thomas from the Old Time Workshop (**photo 121**) and add a splash of colour to the rather stark tender. These just finish off this Schools project.

The completed *Winchester* is shown in **photos 122** and **123** and shows what can be achieved by recycling projects that have been left unfinished and in whatever state. A little research and careful sourcing of information and components can produce a beautiful model at a fraction of the cost of new castings or a full kit.

My next project is a 3½ inch Stirling Single and gets me back on the track of building locomotives of different wheel arrangements, having already completed an 0-6-0, 2-6-0, 2-6-2, 2-6-4, 4-4-0 and several 4-6-2 Pacifics. A final thanks to my wife, Eva, who proof reads these ramblings and once again thanks to Diane and Martin for including this project in the *Model Engineer* magazine. I hope it will encourage many more readers to have a go at this super hobby of ours, which keeps our minds active as well as our bodies and provides endless hours of fun - and keeps us from under foot, as Eva is prone to say.

LittleLEC 2023 Report

Arthur Green reports from the Swansea Society of Model Engineers.



The busy steaming bays.

After plenty of site and track maintenance we were ready for the 2023 LittleLEC. The weather was excellent and tee shirts and shorts were the order of the day. Due to the low entry numbers it was decided to make it a one day event on Sunday the 11th June. We had three visitors who had ventured over the Severn Bridge and

two Swansea SME members competing.

The steaming bays were soon a hive of activity and the first engine was ready (**photo 1**).

Run No. 1

The first competitor was Sean Pritchard driving a well turned out 3½ inch Juliet (**photo 2**). Sean set off at a steady pace and lap 2 was going well but

at the lowest point of the track steam pressure was a bit low and he came to a standstill. Once pressure was raised Sean set off to complete lap 2 and continue into lap 3 but unfortunately pressure was lost again and Sean ran out of time.

Run No. 2

This was William Powell driving 'The Purple One' (**photo 3**). This engine has been made up from a 2½ inch gauge LBSC Southern Maid chassis found in a skip that he has widened to 3½ inch gauge and fitted with a boiler from a Canterbury Lamb. The regulator and blower controls are globe valves fitted on either side of the steam dome. The locomotive looks like an 0-6-0 but is a 2-4-0 as there is not enough room for coupling rods to the front axle.

William set off and managed the gradients very well. There was a minor stoppage on the start/finish straight and the same thing happened on lap 2. Lap 3 went with no problems and four laps were squeezed into the 25 minute time allowance. He achieved an efficiency of 0.256%.

Run No. 3

Next was Tom Henderson (SSME member) driving a 3½ inch Rob Roy (**photo 4**). Tom set off opting to go for four laps and he finished in 22.34 minutes with an efficiency of 0.169%. One of the experimental features on the locomotive is that the feed water is taken into the space in the superheater tube and then into the boiler.

Run No. 4

This was William Musselwhite (SSME member) driving a 3½ inch Rob Roy (ex the late Bill Roebuck – **photo 5**). William had a problematic injector on the start line but copious amounts of cold water made



Sean Pritchard making steady progress on his first run.



William Powell and the 'Purple One'.



Tom Henderson preparing his Rob Roy.



William Musselwhite at the controls of the late Bill Roebuck's Rob Roy.



The winners line-up, from right to left: William Powell – first place with 0.256% efficiency, William Musselwhite – second place with 0.201% efficiency, Tom Henderson – third place with 0.177% efficiency, Sean Pritchard – the Bill Roebuck Trophy.

it behave. William set off with the minimum of wheel slip and reeled off five laps at a steady pace, achieving an efficiency of 0.173%.

Run No. 5

This was Les Pritchard driving a 3½ inch Mona. Les took his grandson Sean as a passenger and he set off in fine style. Laps 1 and 2 were brisk though steady. Lap 3 started the same but unfortunately a mechanical problem caused an enforced retirement from the contest.

Run No. 6

In the afternoon, running restarted with the 'Purple One'.

Once again William made a steady start but came to a stop on the start/finish straight but after a blow up running resumed. Laps 2 and 3 reeled off in a steady uneventful manner. He achieved an efficiency of 0.244%. This locomotive has a lovely exhaust note on starting and not only is William a really good locomotive builder he is no slouch as a driver.

Run No. 7

Tom Henderson was next at the start line and ready for his second run. He reeled off five laps in a very steady and efficient way with an efficiency

of 0.177%. There is talk of a top-secret Rob Roy boiler project in progress at the Henderson workshop - perhaps all will be revealed at next year's LittleLEC.

Run No. 8

William Musselwhite's second run was carried out in a steady manner that belies his age of 18, four consistent laps being recorded inside the time allowed. This was his first attempt at a LittleLEC and he achieved 0.201% efficiency.

Run No. 9

The last run of the day was Sean Pritchard. There was some priming at the start but Sean soon got on top of things and recorded two steady laps, watched by his grandfather Les. Lap 3 required a short stop, lap 4 was steady, lap 5 required a short stop and Sean continued to complete a sixth lap in the time allowed and showed an efficiency of 0.158%.

The results were William Powell first with 0.256%, William Musselwhite second with 0.201% and Tom Henderson third with 0.177%. A presentation was held (photo 6) with the prizes being presented by the Swansea SME chairman, Colin Morgan. In addition, there was a special trophy presented in memory of the late Bill Roebuck who was a Swansea SME member and a

regular LittleLEC competitor in recent years. This trophy was awarded to Sean Pritchard who participated in the spirit of the LittleLEC and it was presented by Bill's widow, Hilary.

The day was enjoyed by all. Thanks go to Gill Holmes and Hilary Roebuck for the refreshments, also to all the members who have maintained the grounds and the track. Also, thanks go to local company **Planeweighs Ltd.** who loaned us a digital platform scales to weigh the locomotives, rolling stock, drivers and passengers.

The leader board table gives all the results.

Postscript from Bryan Finch, LittleLEC co-ordinator

The coordinators of the LittleLEC (now under the stewardship of Guildford MES) wish to express their thanks to Arthur Green and the team at Swansea SME for hosting this year's LittleLEC and also to all the competitors without whom there would be no competition.

Next year, LittleLEC will be hosted by the North London SME over the weekend of 8th and 9th June 2024. Details will be published early in the new year.

For more details about the LittleLEC competitions, its concept, guidelines, efficiency calculations, and past runners and results, please take a look at the LittleLEC website www.littlelec.co.uk

Driver	Loco	Gauge	Run No.	Laps Run	Work Done	Coal Used	Energy Released	Average Speed	Eff	Status	Comments
					ft lbs	lbs	ft lbs	mph	%		
Sean Pritchard	Juliet	3½"	1	2	3628	0.331	3728630	0	0.097	Ran out of time	
William Powell	Southern Maid	3½"	1	4	9531	0.331	3728630	0	0.256	Finished	1st
Tom Henderson	Rob Roy	3½"	1	5	10675	0.560	6313813	0	0.169	Finished	
William Musselwhite	Rob Roy	3½"	1	5	9013	0.461	5195224	0	0.173	Finished	
Les Pritchard	Mona	3½"	1	3						Retired - mechanical problem	
William Powell	Southern Maid	3½"	2	3	7148	0.260	2933189	0	0.244	Finished	
Tom Henderson	Rob Roy	3½"	2	5	10675	0.534	6015523	0	0.177	Finished	3rd
William Musselwhite	Rob Roy	3½"	2	4	7210	0.318	3579485	0	0.201	Finished	2nd
Sean Pritchard	Juliet	3½"	2	6	8357	0.470	5294654	0	0.158	Finished	



Photographs by various Swansea SME members.

ME

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The Twist Drill Bit

PART 2

Neil Raine remembers the 160th anniversary of the invention by Stephen A. Morse.

The cutting action of a drill bit

Material offers resistance to being cut that is related to its hardness and this must be overcome in order to shape it. The resistance with which a material withstands cutting is broadly equivalent to the size of the cutting force required to initially penetrate it. The term 'material strength' is typically favoured over the term 'material resistance' (ref 10). Nevertheless, the intention of any machining operation is to successfully unsettle the equilibrium between opposing forces.

During drilling, the material is placed under two categories of loading: torsional loading and transverse loading. Torsional loading is the rotational force and transverse loading is the pressure that is applied perpendicular to the material. In engineering, these forces are commonly manipulated by adjusting the rate of speed and feed of the machine. The drill bit itself also experiences similar forces although these operate in exactly the opposite direction to those applied to the material. When drilling is clockwise, the drill bit is exposed to a torque force in the anticlockwise direction. Thrust

is the force that acts against the drill bit as it is placed under transverse loading when fed into the work. For ease, the combination of the forces required to shape the material shall be called the cutting force. As a consequence of the cutting force, the material experiences shear stress that causes it to fail in a predictable direction (ref 11).

With any type of machining operation, including drilling, there is competition between the material strength, the size of the cutting force required to shape it and maintaining the integrity of the tool. Mostly, it is the size of the cutting force that is manipulated by the engineer as the hardness and strength of the material is fixed. Two factors that determine the size of the cutting force are: the shape and the sharpness of the tool's cutting edge and the energy applied to it or the moving workpiece in the case of the lathe. Ideally there will be an optimal balance between these two factors and the tool shall withstand the forces applied to it. Occasionally, though, the drill bit will lose this fight and it will fail, usually by breaking into two parts and often becoming stuck in the workpiece.

The cutting action of a drill bit is similar to most other metal cutting tools and is best described as a planing action. When drilling, the action of cutting can only be seen at the surface where the drill bit first enters the work (photos 8 and 9). The unique demands of drilling a hole are such that the drill bit must cut the entire circular cross-sectional area of the material as it advances through the work. To accomplish this, the drill bit has two cutting edges that span the diameter of the hole. What is typically considered to be the depth of cut taken by a lathe tool is equivalent to the width of cut taken by a drill bit; this is simply the consequence of the different orientation of the machining operations. For larger drill bits, the cutting edge to work surface area of contact and the size of the cut taken are quite high. Consequently, there is a lot of stress placed upon the drill bit. The swarf that is produced during drilling seems to have a unique appearance, at least when it remains in long sections (see photo 9). The swarf is spiral-shaped and arranged as a concertina. The explanation for this is unclear and might depend on the combination of



Progressing from a centre drill to a standard twist drill bit. Only the point of the drill bit is embedded in the work as the corner of the flank's cutting edge is still visible at the top of the drill bit. (The lathe was stopped).



The drill bit was backed out of the work to show the cone impression cut by the point of the drill bit. The centre drilled hole is still visible in the work. (The lathe was stopped).

10



A factory ground drill bit. Photographed to show how the helix is ground to produce two facets on each flank – four facets in total. The flank is convex directly behind the cutting edge and flattened to the rear. Described by the manufacturer as web thinning and a facet point grind.

the rotational cutting action of the drill bit and the orientation between the cutting edge and the work.

The effectiveness by which a drill bit cuts material is determined by: the shape of the cutting edge, the sharpness of the cutting edge and the energy applied to it. When the angle of the cutting edge is lowered by grinding, the drill bit will overcome the strength of the material more easily. This principle has been shown for lathe tools. By progressively increasing the rake angle of the cutting edge of a lathe tool, the power consumed by the electric motor driving the lathe also becomes progressively less. But, as alluded to earlier, a compromise must be reached between the ease of cutting the material and maintaining the integrity of the tool. As the cutting edge is thinned it becomes weaker and is more susceptible to failing. Conversely, when the cutting edge of the drill bit is blunt this adds to the resistance to cutting that is already inherent in the strength of the material. If sharpening the tool is forsaken, only the rotational and compression forces can be changed in effort to penetrate the material and this is when potential problems can arise.

The wedge shaped cutting edge of a drill bit is determined by convergence of the point angle, the helix angle (rake angle) and the clearance angle. These are chosen so the drill bit can both cut the material

and withstand the forces applied to it. The assumption is the cutting edges are kept sharp. As the helix angle of the cutting edge is located inside the flute, it is not accessible for shaping by the engineer (photo 10). To maintain the serviceability of a drill bit, only the point angle and the clearance angle are ground in combination to keep the cutting edge sharp. When sharpening the cutting edges of a drill bit, particular care must be taken to maintain the correct point angle, the correct clearance angle, the convex shape of the flank of each helix and the symmetry between both cutting edges. This rigorous and quite unique set of demands is the explanation why drill bits tend to be ground using a dedicated sharpening jig (refs 12 and 13).

Owing to the complex shape of the point of a drill bit, it must be ground correctly in order to work properly (ref 14). A blunt drill bit is at risk of wandering off-centre in the work-piece and it will require additional force to cut the material and therefore risks breaking. But, dulling of the cutting edge is not the only problem to influence proper drilling. A sharp drill bit that is the incorrect shape poses additional problems. When the point of the drill bit is central but the cutting edge and lip height of one flank is greater, the drill bit will cut only on the flank with the shortest cutting edge and it will experience all of the cutting

11



Damage to the cutting edge and flank of a twist drill bit that has reasonable shape - chips of metal have split from the outer aspect of the flank where the stresses of drilling are the greatest.

forces. Alternatively, when the lip height of the two flanks is equal but the cutting edge of one flank is greater, the point of the drill bit dislocates toward the shortest flank and becomes off-centre. The outcome is the shortest flank shall again perform all of the cutting work and the resulting hole shall be oversize.

It has been mentioned that only certain factors can be controlled by the engineer to manipulate how effectively material can be cut. In addition to the shape of the cutting edge, the rate of rotation (revolutions per minute, rpm) of the drill bit and the rate at which it is fed into the work (mm per minute) can be adjusted. These two factors are commonly referred to as the rates of speed and feed. The rate of rotation of a drill bit shall directly increase the rotational force applied to the workpiece. An increase to the force of compression shall increase the rate at which the drill bit is introduced into the work. A compression force acts along the length of the drill bit although the axis of the force will depend upon the orientation of the drill bit and the work; e.g. Z-axis when drilling using a lathe and Y-axis when drilling using a pillar drill. Additional forces applied to the work will, of course, mean the stress placed on the drill bit is correspondingly increased and this increases the risk of the tool failing. Once it is known the drill bit is suited to cut

the material and is sharp, it is useful to consult charts for the recommended rates of speed and feed for drilling different materials.

Functional properties of some design elements of the twist drill bit.

When the flattened end of the drill rod is ground into a cone-like shape, the distance between the centre of the tip and the outer perimeter of the drill bit increases. The consequence of this is the length of the cutting edges increases. A conventionally pointed drill bit enables it to work more economically as the work of removing material is divided across a greater operational surface area. This division of work also lowers the torque force experienced at each position of the cutting edge.

Despite this benefit to drilling economy, the work of removing material is not distributed equally along the length of the cutting edges. Moving from the centre of the drill bit towards the periphery, the circular path followed by each portion of the cutting edge increases and there is a corresponding increase in the demand to remove material and perform work. The demand to cut material is matched by the speed of rotation that also increases along the length of cutting edge, moving from the centre to the periphery. As more work is demanded of it, more stress

is placed on the periphery of the drill bit (**photo 11**). Morse understood this demand perfectly when he designed the twist-drill bit – ‘...and the edge is strongest at the periphery, where the strain is greatest’ (**ref 15**). The rising thickness of the helix that is seen when moving from the aris in the centre of the drill bit towards the periphery, is more exponential than linear. In summary, Morse’s design ensures that at every location on the cutting edge there is a matching of the physical demand of cutting and the structural integrity of the tool.

There is yet another feature of the helix that adds strength to the cutting edge. The profile of each flank behind the cutting edge is typically convex rather than being ground flat (**photo 12**). More material in the flank of the helix adds strength and support to the cutting edge. While the convex profile of the flank allows sufficient relief of the cutting edge, taking a very heavy cut is prohibited. The cutting edge is not able to embed sufficiently into the material even with the addition of excessive compression force. In effect, the convex profile of the flank protects the cutting edge from becoming easily damaged, makes it more resilient and ensures the hole is deepened by progressively advancing the drill bit in manageable increments. This situation is a stark contrast to when the flank of the helix is ground flat. Flattening of the flank lowers both the clearance angle and the thickness of

the cutting edge, weakening it. Under less resistance, the cutting edge is then able to dive into the material enabling very heavy cuts that cannot be sustained. Shortly, the cutting edge will fail. Compared to a drill bit with a convex profile, a drill bit with the flanks ground flat feels aggressive as the cutting edges grab the material and are pulled into it.

Although not mentioned in the patent gained by Morse, the helix design is predicted to add to the overall strength of the drill bit compared to other options. Theoretically, the drill bit could be manufactured with the opposing sector shaped flanks orientated parallel along the length of the drill bit. The actual design of a clockwise helix is predicted to better oppose the torque force that operates in the opposite anti-clockwise direction when drilling.

In the production of a drill bit, a narrow ribbon of metal called the land is left behind when both helixes are ground down the entire length. The land is positioned on top of the leading-edge of each helix and can be seen clearly as it follows the spiral of the helixes down the length of the drill bit (**photo 8**). Being raised or in relief, the land is the only point of contact between the drill bit and the bore of the hole. The purpose of the land is to minimise resistance, friction and the accumulation of heat during drilling. The ‘V’-shaped cutting edge formed between the land and the inner face of the helix also performs a secondary cutting action to leave the

wall of the hole smooth.

Considering the rotation speed of the drill bit and the length of each helix, each section of the bore receives a considerable honing when drilling. This is also the explanation why the land usually appears shiny or polished compared to the remainder of the outer helix. As the function of the land is honing the bore rather than primary cutting, it does not typically require sharpening.

In the original patent for the twist drill bit, Morse does not mention the term flute, as is commonly used nowadays, and describes the spaces between the helixes as the grooves: ‘I make the spiral grooves with an increasing twist that is to say, the distance from one spiral to another in the direction of the axis is greater at the upper part of the drill than it is near the point. This increasing twist enlarges the space in which the borings are received, and they traverse the groove more nearly in a line with the axis, and consequently with less friction’.

In a modern twist-drill bit, the inclusion of flutes as a route for swarf to pass out of the bore has clearly persisted. However, it does not seem as though Morse’ design element of reducing the pitch of the helix when moving away from the cutting edge was broadly adopted. Perhaps there was insufficient benefit to be gained by complicating further the design of the twist-drill bit and the process of manufacture.

The perfect cone that is cut into the work shows how the drill bit advances through the material. The cone, however, is not an accurate impression of the point of the drill bit. The reason for this is the cone is cut by the two cutting edges that are the only point of contact between the work and the point of the drill bit. As explained earlier, the shape of the point of a drill bit is not truly conical. Of interest is the role of the point in stabilising the drill bit during cutting. As the cutting edges are longer in a pointed compared to a flat-bottomed drill bit, this creates a greater cutting edge to work surface area of contact. This in turn is predicted to benefit stability of the drill bit during cutting. Stability of the drill bit is expected to grow as the hole deepens owing to the rising tool to work surface area of contact along the length of the drill bit.

Conclusion.

The apparently simple task of drilling a hole into metal is in reality far from this. The materials from which twist drill bits are made and the scale of modern-day production has likely advanced more than the fundamental design of the tool invented by Stephen Morse in 1836. It is impossible to predict whether the twist drill bit has a future as long as its past but it has already been a remarkable success because of its intelligent design.

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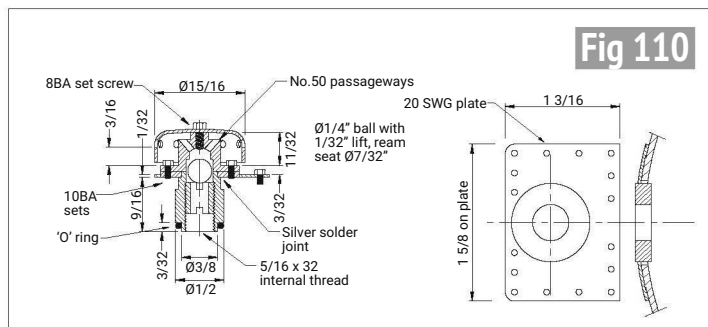


A standard example of a factory ground drill bit with convex flanks.

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Fig 110



Anti-vacuum valve.



Chimney and anti-vacuum ('snifting') valve.

them. On one of the drawings you will see both of these items positioned to the works drawings.

There is one other small item that you could add to your collection of bits and that is the blast pipe and blower nozzles. These are all small fabrication jobs from brass. The blower nozzles all want to slope inwards at the same angle. To do this I just cut a small sloping step in a piece of wood so that they aimed towards the centre of the chimney choke, but I didn't do any calculations for the slope, it was all done by eye. It just drops over the blast pipe with a slight push fit and the pipe will hold it in place. I was going to go into details about the superheaters but they would not be much use to you without a boiler to put them



So-called Mayflower with visible rivets. (photo: John Thompson).

in so next time we will get on with some boiler making.

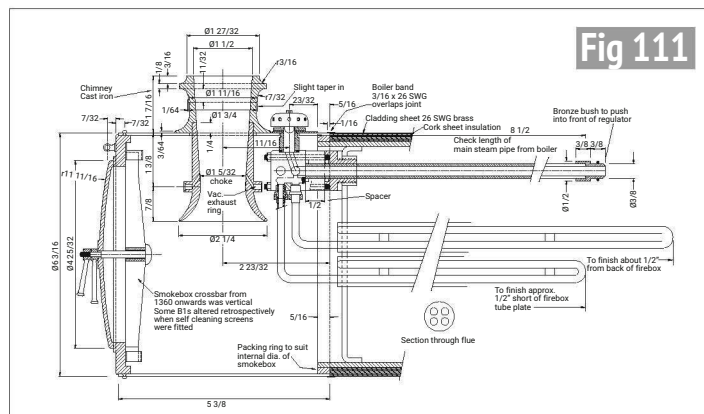
Now we have three photos to look at and the first one is **photo 202** which shows the chimney and anti-vacuum valve, both of which are on 61264. The next one is **photo 203** which is the smoke box door on 61264 which has no visible rivets on the door hinges either on the door or the hinges and neither has it got a step on the door as they were dispensed with a lot of years ago. **Photograph 204** does have its step left on the door and it does have rivets on its door hinges. However, they look like shallow headed ones to me. Note that some of the rivets are not equally spaced so I will leave this in your capable

203



Rivet-free hinges on B1 61264.

Fig 111



Petticoat pipe and superheaters.



B1 61319 with a full complement of rivets (photo: Rail Online).



B1 61351 with no visible rivets (photo: Rail Online).

hands. It is 61306 although it says *Mayflower* on the smokebox which of course is wrong so that was just done for cosmetic reasons (sorry, one of my pet hates!).

Now for a couple more. **Photograph 205** is a very nice photo of a black B1 61319 and it does have its full complement of rivets around the smokebox. It is also another B1 with narrowly spaced door hinges on the door. The last photo (**photo 206**) is of 61351 has not been fitted with any AWS gear yet. Also, it has the two-piece tender sides but no rivets

around the smoke box or on the buffer beam. Now, I think I have shown this photograph before but that must have been ages ago. I have shown it aging as it was the first B1 built with the new frame plates for both engine and tender so one more thing to be aware of and it is just another B1 with the narrow door hinges.

● To be continued.

NEXT TIME

We get to work on the boiler.

Joint Failure in Silver Soldered Stainless Steel

PART 2

Graham Astbury researches an unexpected metallurgical problem.



Continued from p.449
M.E.4726 September 22

Galvanic corrosion

This primarily occurs where there are two dissimilar metals connected together in the presence of an electrolyte such as water. Initially it would appear that, since the two parent metals being silver-soldered together are the same, there should not be any galvanic corrosion. This would be the case had the parts of the weather-vane been held together with stainless steel fasteners or rivets, or by welding. However, as there is a filler metal present in the form of the silver solder, galvanic cells can easily be formed between the surfaces being joined. This is discussed by Takemoto and Okamoto (ref 7, part 1, M.E.4726, September 22), where they conclude that corrosion of joints in silver-soldered 300-series (austenitic) stainless steel components is bimetallic corrosion caused by a galvanic cell between the silver solder silver-rich phase and 'active' stainless steel at the silver solder interface. The stainless steel is 'active' since the flux removes the protective passive film on the stainless steel. They believe that this is one of the causes of *inter-facial corrosion*. From the foregoing,

it is necessary for an electrolyte to be present for this type of corrosion to occur. In the case of the weather vane, water was not present all the time - just when it rained. Consequently, it took many years for the joints to fail. Had the joints been in permanent contact with water, the failure would have occurred much more quickly.

Reducing the corrosion

According to Kulikov and Lekhtsiyer (ref 9), the addition of nickel to the silver soldering alloy reduces the corrosion, particularly in combination with a reduction in zinc content. They suggested that a silver solder with the composition of 63% silver, 6% tin, 2.5% nickel and 28.5% copper resulted in almost no corrosion at all but the fluidity of the silver solder was poor. This composition corresponds to the ISO standard Ag 463 (ref 10). They also suggest that a silver solder with the composition of 40% silver, 2% nickel, 28% zinc and 30% copper has much better fluidity and still has adequate corrosion resistance. This corresponds to the ISO standard silver solder grade of Ag 440. These grades are given below in **table 1**.

The mechanism behind the reduction in corrosion by addition of nickel is also suggested by Takemoto and Okamoto (ref 7) who noted that where a silver solder which did not contain nickel was used on austenitic (300-series) stainless steels, then nickel migrated from the parent metal into the interface, forming a nickel depleted ferritic phase in the parent metal at the interface. The silver solders that they used contained at least two phases - a silver-rich phase and a copper-rich phase. The production of the nickel-depleted layer allowed the formation of galvanic cells between the ferritic area of the parent metal and the copper-rich phase in the silver solder as well as between the silver-rich phase in the silver solder and the 'active' stainless steel at the interface. These galvanic cells allow corrosion to occur in aqueous environments and can be virtually prevented by addition of nickel at up to 2% in the silver solder. Reducing the zinc content of the silver solder also will reduce the effect of corrosion but the fluidity of the molten silver solder also reduces and the melting range rises. In the case of the weather vane, use of a high-zinc silver solder is the most likely explanation for the corrosion as the weather vane had been exposed to the weather in excess of thirty years.

However, whilst the use of an inappropriate silver solder appears to be the cause of the problem that occurred, there is also the types and actions of fluxes to consider. The question of fluxes is discussed later.

Table 1

ISO 17672 Specification	EN 1044 Specification	Melting range degrees centigrade	Ag ¹	Zn	Cu	Cd	Ni	Other
N/A	AG 303 ²	608-617	42	16	17	25		
Ag 456a	AG 403	600-711	56		27		2.5	14.5 Indium
Ag 449	AG 502	680-705	49	23	16		4.5	7.5 Manganese
Ag 440	N/A	670-780	40	28	30		2	
Ag 463	N/A	690-800	63		28.5		2.5	6.0 Tin

¹ Ag = silver, Zn = zinc, Cu = copper, Cd = cadmium, Ni = nickel

² Easy-flo No.2

Compositions of selected silver solders

The solution

Having found out that the original silver solder was inappropriate for the exposure to the weather, it became apparent that the silver solder to be used for the repair would have to be a grade specifically formulated to avoid the corrosion of the zinc. Therefore, it would need to have the least amount of zinc present and a small proportion of nickel added, to minimise the susceptibility to corrosion. According to Johnson Matthey (**ref 11**) their alloy Argo-braze™ 56 silver solder, with the ISO reference Ag 456a, was specially developed for the purpose of avoiding corrosion of the joints in austenitic stainless steels. It contains 14.5% indium to lower the melting range and increase fluidity. Because of the indium, it has a wide melting range of 600-711 degrees centigrade so can suffer from 'liquation' which occurs when the alloy is heated too slowly - the lower melting point indium tends to melt first and flows into the capillary joint, leaving behind the remaining alloy which now has a higher melting point, so making it difficult to make a neat joint. The same problem can happen with capillary soft soldering using a non-eutectic alloy and there is a good description of the phenomenon with accompanying photographs in Tubal Cain's book (**ref 12**). The Ag 456a alloy requires rapid heating and it tends to form large fillets. As the zinc in silver solders promotes wetting and high fluidity, so a reduction in zinc content may result in inadequate penetration into capillary gaps and require a redesign of the joint geometry to promote the formation of fillets to retain joint strength. Silver solder to the Ag456a specification is not particularly easy to purchase in small quantities and is very expensive due to the indium content - indium is around twenty times more expensive than silver. However, I did manage to obtain a small amount of Ag 456a silver



The smooth fillets at the joint using Ag 456a silver solder.

solder and used it successfully by heating the job up to around 750 degrees centigrade prior to applying the silver solder which then melted rapidly and formed a reasonably smooth fillet (**photo 5**). Hopefully, the repaired weather vane will last at least another thirty years. The compositions of Ag 456a solder and other grades are given in Table 1 below. Note that, in the table, there is a column showing the now-superseded European Standard Specification for silver solders which did specify the Easy-flo No.2 silver solder (**ref 13**). This obsolete standard has been replaced by the ISO Standard (**ref 10**). For American readers, there is also an American Standard, listing similar specifications but with different identification names, so the composition of the various solders will have to be compared (**ref 14**). Unfortunately, some of the solders specified in one standard may not be available in the other standard, so a compromise may have to be made. Note that the ISO Specification solders should be available world-wide.

According to Shaun Meakin of CuP Alloys Ltd. (**ref 15**), silver solder conforming to the

ISO Specification Ag 449 also would be suitable as it has a reduced zinc content and has nickel in it which helps avoid the leaching out of the zinc. However, due to the nickel and manganese content, it has a higher solidus (the temperature below which the alloy is fully solid) but a narrower melting range so does not suffer from the same potential for liquation to occur as in the ISO Ag 456a. The ISO Ag 449 solder does have a bonus in that, according to the Thessco Group literature (**ref 16**), their alloy M19MN™ (which complies with the specification ISO Ag 449) is also suitable for silver soldering grey cast iron, so can be useful for other fabrication jobs in the workshop. The specifications of these silver solders are given in table 1. An alternative is the alloy Ag 440 which contains less silver so is marginally cheaper but has a greater melting range.

The problem with zinc

The presence of molten zinc in contact with stainless steels has another effect of causing cracking of the stainless steel. Bruscati (**ref 17**), describes two types on interaction of molten zinc on austenitic (300 series) stainless steels. The

first type of cracking, or liquid metal embrittlement, occurs at relatively low temperatures, between 420 and 570 degrees centigrade, and progresses slowly. The rate is low as the zinc has to diffuse along the grain boundaries but eventually the parent metal fails where the molten zinc has been in contact with the stainless steel. In a silver-soldered joint where the liquidus (the temperature above which the alloy is fully liquid) of the silver solder is less than about 700 degrees centigrade, this type of cracking is unlikely to be a problem if the parent metal is not overheated during the soldering operation. I could not find any authoritative literature on whether this type of cracking would occur with a zinc-containing silver solder where the zinc might diffuse in the solid state over an extended period if the joint is held within the temperature range of 420 and 570 degrees centigrade.

The second type of liquid metal embrittlement occurs at higher temperatures, in excess of 750 degrees centigrade, where the parent stainless steel is under stress. The resultant cracking propagates rapidly perpendicular to the stress. The ➤

classic case of this occurring was the Flixborough accident where zinc embrittlement of stainless steel piping resulted in the release of several tonnes of cyclohexane which subsequently exploded (ref 18).

In relation to model engineering practice, it might be thought that a brass brazing-alloy joint would be ideal to withstand the high service temperature of a stainless steel radiant super-heater, as the brass (60/40 Cu/Zn) has a melting point of around 900 degrees centigrade. However, this will almost certainly crack the stainless steel during the brazing process just because of the zinc content and the high temperature. Therefore a zinc-free silver solder alloy would be the best choice to avoid cracking in these circumstances if a silver soldered joint were chosen.

Fluxes

A majority of standard silver soldering fluxes are based mainly on potassium borate, with additional components added to assist the removal of the oxides on the surface of the parent metals. Boron compounds are toxic when ingested or injected intravenously but on the surface of intact skin they are relatively slow to be absorbed (ref 19) - so much so that boric acid has been used in the past as a preventative treatment for athlete's foot and highly-diluted solutions have been used in eye wash preparations (ref 20). These standard fluxes are only suitable for the lower temperature range of silver solders as the flux quickly becomes exhausted.

The stainless steel grades tend to have higher operating temperature ranges and contain more fluorides than standard grades to enable removal of the chromium oxides which form the passive film on the surface of the stainless steel. These fluorides make the fluxes more corrosive and toxic. The fumes that emanate from the flux if overheated are extremely irritating and also toxic. The

glassy residues contain acidic fluorides so are very corrosive and they are more difficult to remove as they are insoluble in water. Generally, soaking for 30 minutes in a warm (> 40 degrees centigrade) 10% solution of caustic soda (sodium hydroxide) will dissolve the residues and allow them to be scrubbed off afterwards in running water (ref 21). As a safer alternative to caustic soda, sodium carbonate ('washing soda') can be used as this is less corrosive to the skin than caustic soda. Note that aluminium containers should not be used for caustic soda or sodium carbonate solutions as the aluminium will dissolve rapidly in such solutions.

Higher temperature rated fluxes for special purposes can be used also but some contain free elemental boron, which has a tendency to migrate from the flux into the stainless steel surface forming intermetallic borides, which weaken the adhesion of the silver solder to the parent metal (ref 22). Therefore, the higher melting fluxes containing elemental boron should not be used on austenitic stainless steels. Before using any flux, it is best to find the Material Safety Data Sheet (MSDS) for the flux, which should list all the ingredients including elemental boron if present. These Material Safety Data Sheets can usually be found on the supplier's website. Note that specifically for the Johnson Matthey fluxes, the suffix of 'A' usually means that it contains elemental boron and therefore should not be used on austenitic stainless steels. For other manufacturers of fluxes, their Material Safety Data Sheets should be consulted.

Conclusions

- The failure of the silver-soldered joints on the weather vane was caused by inter-facial corrosion due to using a high zinc nickel-free silver solder where water can be present.
- Austenitic stainless steels to be used in corrosive environments should be

soldered with a low-zinc content silver solder which contains nickel. Typical specifications that should fulfil these requirements are ISO 17672 Brazing Filler Metals Ag 449, Ag 456a or Ag 463 grades.

- Zincfree silver solders may not have adequate fluidity for capillary filling and so tend to form a fillet which must be allowed for in the joint design.
- The incorporation of nickel in the silver solder reduces the tendency for de-zincification and inter-facial corrosion to occur.
- The correct grade of flux must be used to remove the chromium oxides and avoid exhaustion of the flux during the silver soldering operation.
- Fluxes which contain free elemental boron should be

avoided when silver soldering 300-series stainless steels.

- Residues from grades of flux suitable for stainless steel are corrosive and insoluble in water.
- Flux residues can be dissolved using a warm (> 40 degrees centigrade) solution of 10% sodium carbonate in water, followed by scrubbing under running water.

Acknowledgment

I would like to thank Mike Tilby, of the Society of Model and Experimental Engineers, and Professor Norman Billingham of the University of Sussex for their constructive suggestions and help with the figures and photographs during the preparation of this article.

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News From Cardiff

Mike Denman brings us the latest.

Model engineers in societies with their own grounds will know that there seems to be as much time civil engineering as mechanical engineering. Cardiff Model Engineering Society is no exception. They are currently future-proofing maintenance tasks as much as possible. New powder coated metal fencing is replacing wooden that needs repair and painting and an impressive stone wall is an eye-catching feature. A steel front door and frame has been constructed by a member and that is also going off for powder coating. Another member has created a stylish laser cut logo for this smart new entrance. The new steel signal gantries, also powder coated, have been completed with rebuilt semaphores for use on running days (**photo 1**). Two extra storage sheds have been built, one each for the raised and ground level locomotives.

It's not all work and no play of course. The Society is back with its 31st annual Welsh Rally held over a weekend in June. As usual the raised level 3½ and 5 inch track and 7¼ inch ground level running lines were reserved for visitors with

twenty-eight caravans and motor homes, and a handful of stalwarts preferring tents, taking advantage of the on site facilities and the Saturday night hog roast. About 160 attended - making for a friendly, family atmosphere - bringing 26 plus locomotives to run on the raised level, ground level and garden railway.

The Society's members from Japan made their annual visit and the donor of some 50 antique 0-gauge models was presented with a newly printed catalogue of the collection which had been thoroughly researched and which included some details going back over a hundred years.

Next year's Welsh Rally will be on 7/8/9 June 2024 and as usual pre-booking for caravan spaces is essential via the secretary's email address - secretary@cardiffmes.co.uk.

Work on rebuilding the Society's Hunslett 0-4-0ST 7¼ inch gauge steam locomotive was disrupted by lockdowns. It now shares duties on public running days (**photo 2**). On the raised level a smart new battery powered unit has been constructed, based on a modern continental tram profile.



www.cardiffmes.co.uk

The Society's ground is set in an attractive public park. Unfortunately, the garden railway suffered a set back during a storm when a tree branch demolished the recently completed raised level extension. The Park authorities, who are responsible for the trees, took it down; sadly it was the second mature tree lost from the site.

The Cardiff Model Railway Show returned last year, and this year the 00-Group has taken over the organisation. The show will be at the Glamorgan Cricket Ground in Cardiff over the weekend of 21/22 October.

As always, there's lots of activity on many fronts including visits and Thursday night talks. The Society has been pleased to welcome new members and there's always room for more. Information about the Society can be found on their web pages www.cardiffmes.co.uk and www.facebook.com/Cardiffmes.

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Between running days the signals are safely stored away on a bespoke running car, which facilitates delivery to each gantry as required.



The cab of the reworked 7¼ inch gauge Hunslett showing signs that it is now a working engine in steam.

WHAT IS AVAXHOME?

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brand new books, trending movies,
fresh magazines, hot games,
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Unlimited satisfaction one low price

Cheap constant access to piping hot media

Protect your downloadings from Big brother

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18 years of seamless operation and our users' satisfaction

All languages

Brand new content

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AvaxHome - Your End Place

We have everything for all of your needs. Just open <https://avxlive.icu>

Radial Valve Gears Again

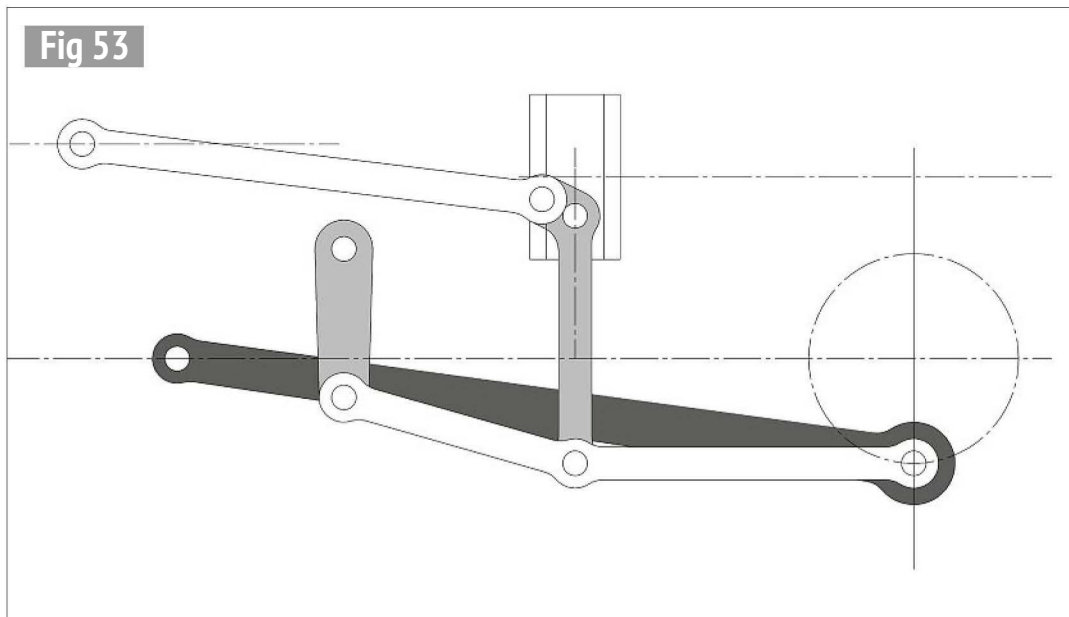
PART 10 – GREENLY'S CORRECTED GEAR

Duncan Webster sheds light on what is often seen as a complex subject.



Continued from p.431
M.E.4726 September 22

Fig 53



Greenly's gear – outside the frames (source: Greenly's Model Steam Locomotive Designs and Specifications, 1952).

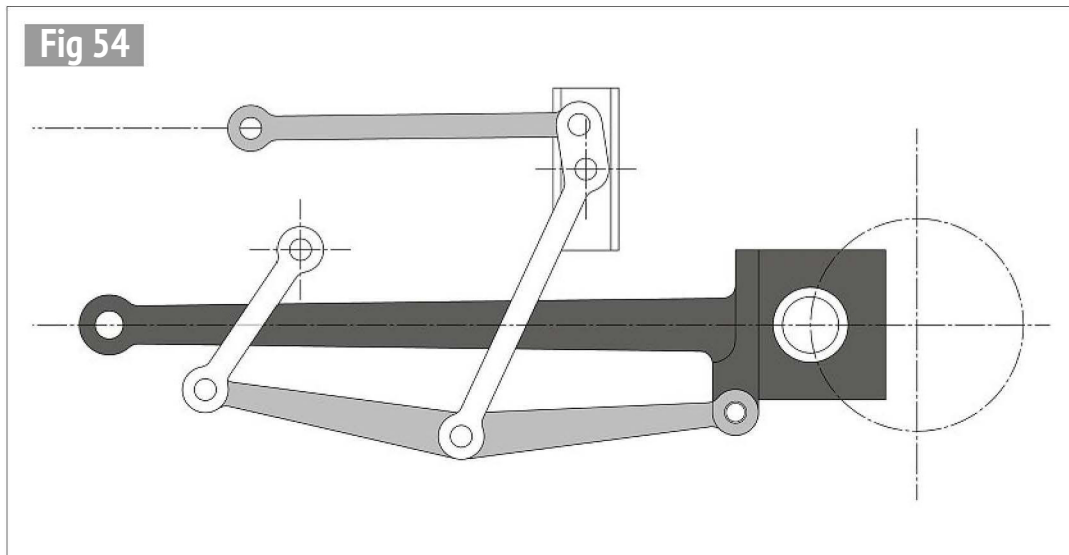
This is yet another type of radial gear, invented by Henry Greenly, a respected model engineer from the early days of the 20th century (born 1876, died 1947). It comes in two varieties for

mounting outside the frames (**fig 53**) or inside (**fig 54**), although one could fit the inside gear outside if one were so inclined. These drawings are copied from sources shown in the captions, with a bit of

artistic licence. **Figure 55** is a generalised schematic so that the various pins/points can be identified.

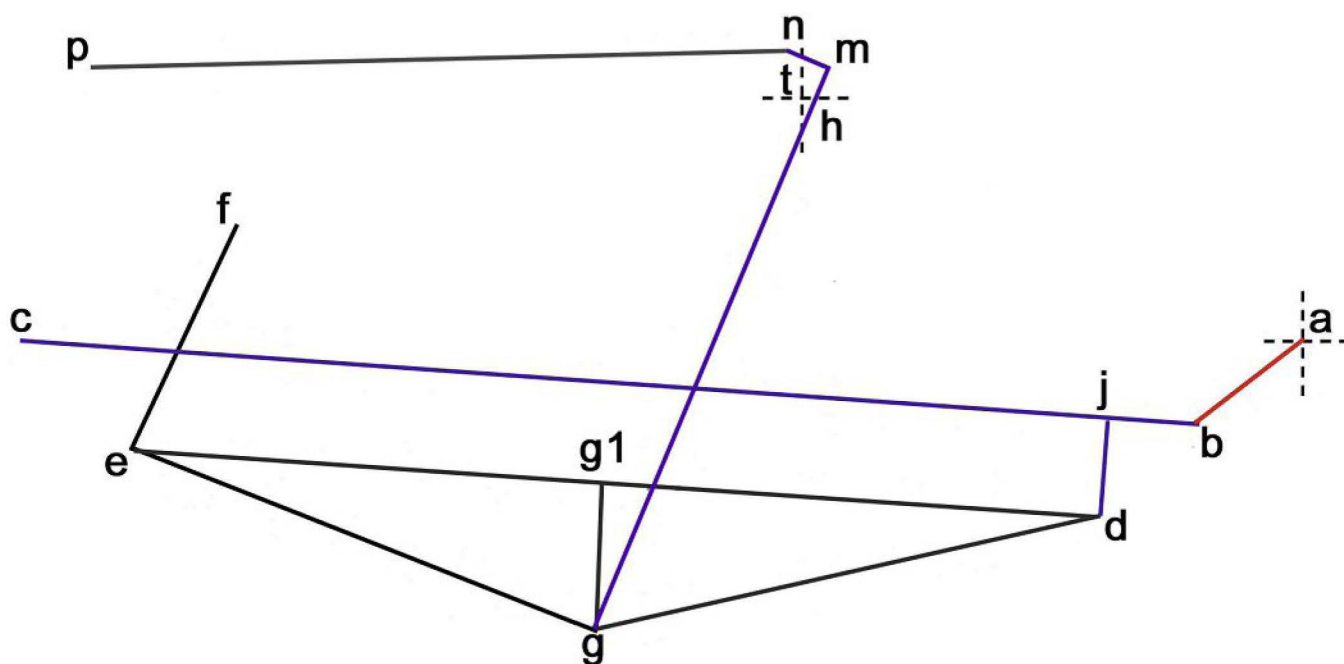
Starting with the outside version, the reader will notice that it bears a marked

Fig 54



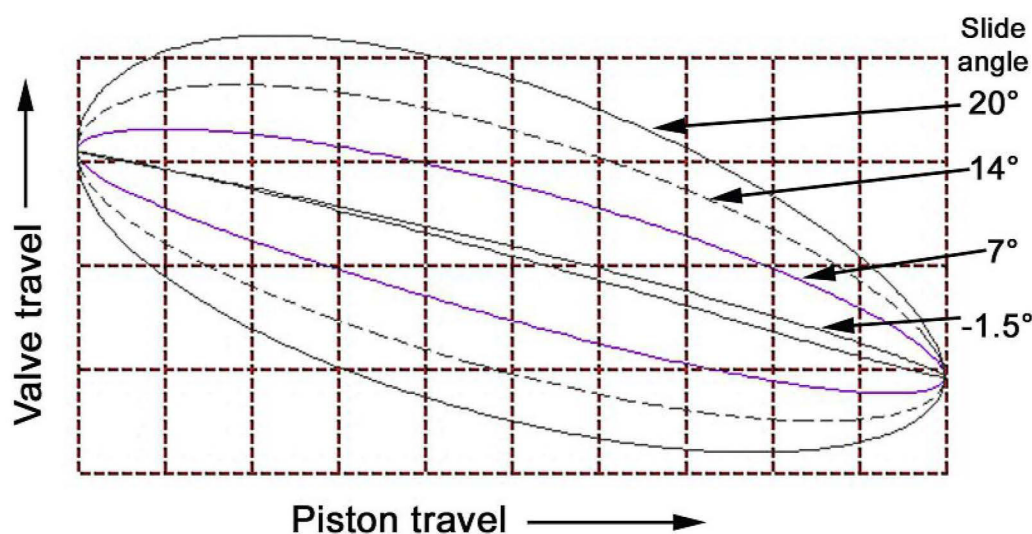
Greenly's gear – inside the frames (source: Greenly's Model Steam Locomotives, 1954).

Fig 55



Greenly's gear – generalised schematic.

Fig 56



Greenly's gear – simulation results.

resemblance to Brown/Heywood gear as described in part 8 of this interminable series (M.E.4725, September 8), the difference being that the slide, drive beam and anchor link are in front of the axle rather than behind, so no need for a detailed description here. The drive beam is bent and the top joint of the vibrating lever is offset, but those were features of Heywood's gear. His locomotive *Muriel* was built

in 1894, when Greenly was only 18 years old. Heywood in his book acknowledges that his gear is a development of Brown's, so perhaps this should be Greenly/Brown.

The inside version is driven from a lug offset below the connecting rod, with the drive beam in the same plane as the connecting rod. The bent drive beam is not always required but can be employed if desired.

The design of both versions is straightforward using a CAD program as described for Heywood/Brown in part 8.

Yet again there is a computer model, so the performance can be assessed without recourse to cardboard and drawing pins. See **fig 56** for typical results. If the up travel of the die is markedly different from the down travel, then adjust the length of f_e and the position of point f and try again. It will be

seen from fig 56 that results are quite good. If you get full gear with much less than 20 degrees slide angle, you can move t , g and $g1$ towards the cylinder and start again.

Would I use this gear? Well, it is mechanically quite sound. Link *gm* shaped like a tuning fork to straddle the drive beam (and connecting rod for the inside version) gives a good mechanical arrangement and it doesn't require eccentrics on the axle, leaving plenty of room for cranks/big ends etc on an inside cylinder locomotive. You might struggle to get pin *d* between any fly-crankes. If making a model of a prototype I'd stick with whatever the prototype had but I've no intention of ever making an inside cylinder locomotive anyway - too fiddly.

Unlike the other valve gears, the model for this is written in C, so it should run on almost any 64 bit PC without having to download anything else (famous last words).

Next time an even more obscure gear, Morton's.

●To be continued.

A Five-Inch Gauge

0-4-0 Padarn Railway Tender Locomotive

PART 13

Luker builds a five inch gauge model of a Welsh slate quarry locomotive.



Continued from p.464
M.E.4726 September 22

The crosshead pump

The crosshead pump and clacks are one of the few places where I deviated from the large scale a little. Originally these components had flange connectors with the pump gland the normal (flanged) compression type. This would not fit on the model (literally). In fact, it didn't fit on the large scale either and the builders had to cut off large sections of both flanges to clear the connecting rods and reversing rod. With the power of hindsight, I took the morally questionable route of changing the flanges to standard ME compression nuts, which gave me all the space I needed to clear the components that would have otherwise clashed. I don't think the original builders would have minded!

The sizing of the pump was of considerable interest to me. I designed the pump to match the model steam rate requirements, with a reasonable safety factor. This ended up almost identical to the scale model which had two of these

pumps where I'll only be fitting one (**photo 130**). I'm guessing they ran both pumps at a lower feed rate to balance the forces on the crosshead but this would have sucked air into the boiler which, of course, is to be avoided to prevent corrosion. In the model this is not as big a problem because the pump will be run with the air bleed valve set to normally fully closed with the water flow rate regulated by the tender valve. Even though the boiler is stainless I would prefer limiting the amount of air ingress into the boiler. The left-hand side of the model will have an injector to fill the boiler and quell the safety valves from blowing off in a packed and crowded station.

Back to the build - the body of the crosshead pump could have been cast but making it a soldered assembly is far easier. All the individual components are simple machining and filing operations with small screws

smothered in Tippex holding the lot together for soldering. To get the mounting holes as close as possible to drawing the assembly was screwed to a backing plate with the holes correctly marked out (**photo 131**). The ram hole is pilot drilled prior to soldering and is reamed right at the end to make sure that the ram has a nice straight passage to slide along.

The pump and clack caps were an interesting component to machine and hold, especially the hex section at the top (**photo 132**). Most of the machining is simple turning and threading operations in the lathe. The blank is then screwed onto a scrap piece of hex-bar with a locking screw through the bottom. The hex bar is machined, two faces at a time, using a suitable sized guide to get the across-flats dimension correct. These caps are fitted to the clacks and



Completed crosshead pump with by-pass air valve.



The crosshead pump assembled using screws for silver soldering and hold-down screws to a backing plate to keep the mounting holes closer to drawing.



Machining the caps for the crosshead pump and clacks.

pump and the correct ball lift is found by screwing the M2 to just touch the ball and backing it off to the required lift based on the thread pitch.

Crosshead pump air bleed valve

The pump air bleed valve is incredibly small but not difficult to machine (**photo 133**). The idea of the valve is only to dampen large shocks to the crosshead and prevent cavitation on the pump ram; the metering of the flow rate should be done on the tender water valve. The valve would need some minor adjustment in the first couple of runs with the lever extending to the back of the engine so that even a large-scale driver can change the setting.

Fitting the crosshead pump assembly to the boiler is tricky! The pump ram cannot be tight for any part of the stroke or the glands will never seal properly and there will be water shooting forward towards the cylinders. Not very graceful for the majestic *Fire Queen*! By lightly clamping the pump to the boiler, with the cylinders and crosshead fitted, the best running position can be determined with the three



The completed sight glass.

fixing holes used as drilling guides for fixing to the boiler. Any further stiffness can be further alleviated by skimming the end of the ram for a little clearance to the sides of the crosshead pin.

The sight glass

The sight glass follows the prototype with the glass offset to the side and the dummy tri-cocks to the right (**photo 134**). A standard sight glass actually



The tiny little air-bleed valve.



Sight glass bottom assembly prior to soldering, consisting of multiple turned components held together by Tippet covered screws.

won't work for the model due to the limited space on the backhead and the clearance required for the drain cock and drain line. The biggest problem with making a sight glass like this is the inevitable damage to the machined components when soldering. This can be avoided to some degree by holding the lot together by Tippet covered screws (**photo 135**). If clamps were used, the perfectly machined sections would deform under the heat and clamping loads.

The sight glass has a top and bottom section for ease of assembly; the bottom spigot that fits into the tri-cock

cylinder needs to be a good fit and as long as possible. This is to prevent unnecessary stresses on the glass when the bottom cock is opened to clear the glass during steaming. On final assembly these two components are held together with a little high temperature retaining compound. Incidentally, breaking the assembly into discrete components sorts out any tolerance stack-up issues by shifting all the misalignment to the one joint.

Most builders battle to make taper cocks, with sealing the biggest issue. There are a few tricks to making them. The first



One of the little sight glass taps.

item that needs to be made is the taper spindle. This is a taper cutting operation using the taper slide and a collet in the lathe. Make sure to cut at the correct speed to get a good quality finish, which is easy with stainless if your tools are ground properly.

Without changing the setting, the reamer for the brass body needs to be machined (from

silver steel), leaving a 1mm flat at the end. The reamer is then milled halfway, quenched and tempered the normal way. An oil stone is used to dress the cutting surface leaving a keen cutting edge. I actually made a video of this for the young chaps at our club and it can be found on YouTube (search terms: *Luker*, model engineering, making taper reamers).



Clack seats showing the coned surface to help sealing by increasing elasticity on the contact surface.



Completed boiler clacks and blow down valves.

The body of the sight glass is made from square bar, machined and threaded in a three-jaw holding collet, but not parted off. The bar is then moved to the milling machine and a pilot hole drilled centre. The reamer is incrementally plunged into the hole until the taper spindle fits correctly. The square bar is flipped 90 degrees for the assembly hole used to keep everything together when soldering.

The spindle is fitted in the hole and tightened with the handle in the opened position, returned to the lathe and the through hole drilled. Finally, the spindle is removed and, using 600 grit sandpaper, any burr is dressed and reassembled with a little copper slip. Don't turn the spindle before removing the burr; it will leak if you do.

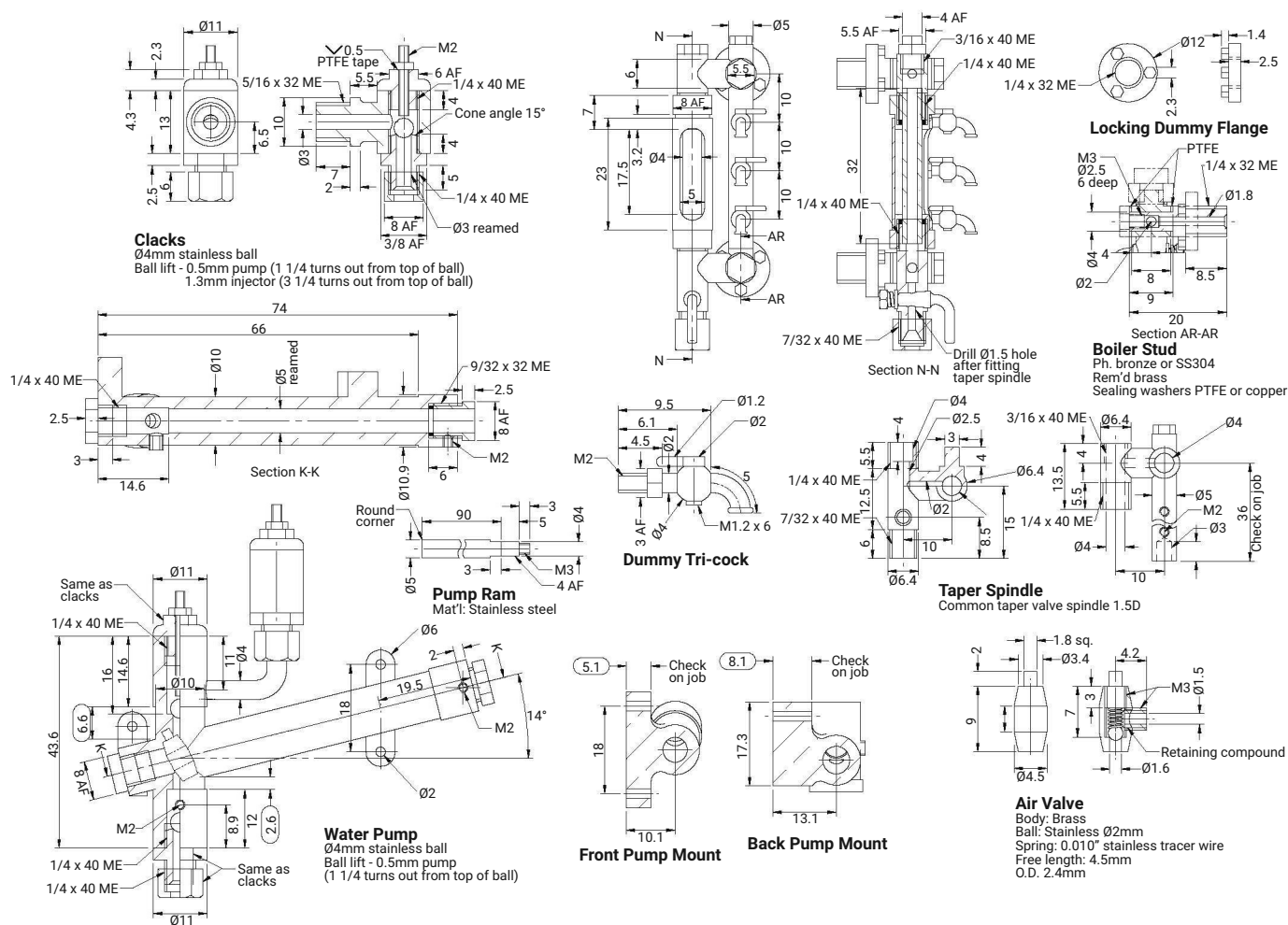
The small washer at the end of the spindle is to prevent the spring from rubbing against the body by locating on flats at the end of the taper. These are drilled and parted from brass bar stock and the oval hole in the centre made using a home-made press tool with a lead-in the same size as the pilot hole.

The sight glass tap

The little sight glass tap deserves a special mention (**photo 136**). It pushed the limits of my manufacturing capabilities (until I try making something smaller of course). Most of the machining is done using ground HSS tools with the end spout drilled using a centre drill to create the illusion of a working tap. The bend was made by holding the machined body in a drilled piece of mild steel rod, the end heated and bent with another piece of rod sporting a suitably sized hole.

Just before I did this component, my neighbour told me I should do a video of building a locomotive for YouTube. Condensing over 5000 hours of build time into a short video is just not possible, so instead I did a ten minute video of the manufacturing process of this little component. It's a horrifically boring and long video if you're not interested in machining but it was my first try at such a video. If you're a sucker for punishment, have a look (search terms: *Luker*, model engineering, dummy tri-cock).

Fig 26



Crosshead pump, clack and sight glass.

The clacks

The clacks (**photo 137**) are another item that builders often battle with to get a proper seal. Some builders use soft seats and 'O'-ring spindles to get around sealing issues but most of the problems can be traced back to a poorly seated ball on a non-round hole. The same issues are found on the steam valves. A standard two-flute drill will most certainly produce a clover hole. Even commercial reamers don't produce perfect holes, because of the multiple cutting edges. A single tip tool in a lathe, on the other hand, will produce a 'perfectly' round hole, assuming of course the lathe and chuck are in good

nick. This method of machining is not practical for a tiny little clack hole, so another approach is needed. The trick to get this right is to use the machining process to force the hole round.

For all my clacks I machine the ball (sealing) side of the clack first, centre drill and drill with a pilot drill through to the other side. For these smaller clacks the ball needs a little help seating so the seating surface is slightly coned (**photo 138**). I then flip the component around and machine the other side with the threaded part held in a tapped mandrel. Concentricity on this side has now been lost

but this isn't an issue on the pipe coupling side. I then run a toolmaker's reamer from the back end through to the seating surface. Most of my toolmaker's reamers are just the back end of a drill that has been ground at 60 degrees to the midpoint of the drill and polished with a little 600 grit sandpaper. Because the shank will be completely in the hole before it gets to the seating surface the shank will make sure the hole stays perfectly round and any concentricity issues will be taken up by the flexibility of the reamer and the tailstock.

The part is then removed from the threaded mandrel

and the seated surface is very lightly de-burred, in a radial fashion, with steel wool (outside the workshop away from my machines!). Nine out of ten times the ball seats perfectly and this is tested by the normal, very scientific, method of suck and seal using your tongue and see if it sticks. If it doesn't, then a light tap with a piece of brass on a scrap ball normally fixes the problem.

●To be continued.

CLUB NEWS

Geoff Theasby reports on the latest news from the clubs.



To continue from the end of last issue's column, ho hum, nothing to see here, move along please. The writing of that column took ages because newsletters only trickle in. Very much the same state of affairs prevailed again with this one. So much so that the later publications were fallen upon with glee and spirited off to a quiet place where I could wring the last ounce of copy from them, cutting through the missives like a hot knife through concrete.

Regarding my electric locomotive *Deborah*, it has a motor reversing switch, which jammed in use. Inspection revealed that the mechanism had become deranged and was preventing movement. So, I took it apart, cleaned it and reassembled it. This repair lasted about 10 minutes, so back to the workshop. Clamping the parts together with nylon ties and in a vice, I epoxied the switch to hold it permanently. I hope. So far it has remained operational. Yes, I could buy a new one, costing £12 or more, but it was all present and correct internally. So why not? I've also built the



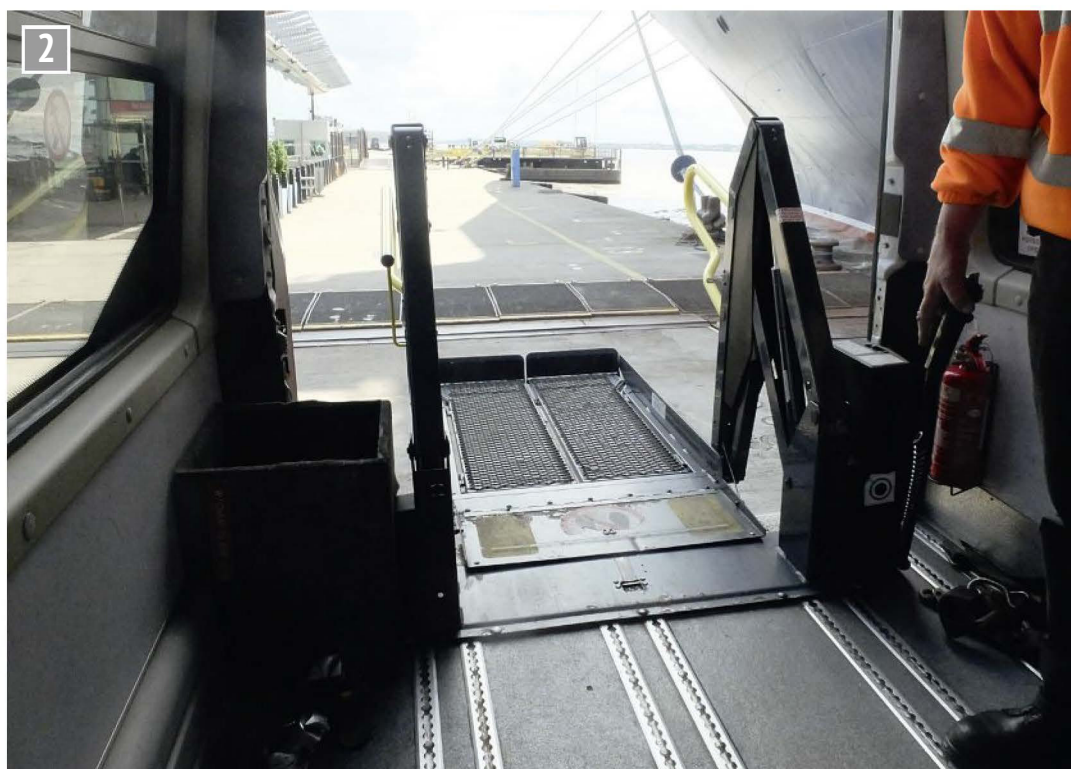
Max's Moveable Machinery... (photo courtesy of Jim Clark).

motor control circuit. It is very simple, but needs vastly over-specified Hexfets to stand a chance of surviving in use. I've also acquired two radio control transmitters in an auction lot. I know nothing about radio control, so I have much to learn.

I was thinking about our recent cruise to the Barents Sea, Spitzbergen, Bear Island, Kerguelen, Svalbard, Novaya Zemla, all places we didn't visit. I also picked up a quirky, often funny, *Social Guidebook to Norway*, by Julienne S. Bourelle. It agrees with my experiences too. One day at

work in the Satcoms company, I was introduced to our Norwegian agent, one Kjell. I was rather startled when he clicked his heels at me. I didn't think they did that. One of the towns we visited was Olden, often omitted from cruise ship itineraries. There, we visited the Briksdal glacier, got cold and wet and thoroughly enjoyed it. Forget Skegness, go to Olden! One thing is, that people dress quite conservatively because, Heaven knows, in Olden Days, a glimpse of...

In this issue, ramblings about the Vikings, wheelbarrows,



Mobile chairlift, embarkation, Liverpool.



Wreck in the Irish Main.



Statsraad Lemkuhl Kristianasund.



Bollinder engine as was used in many fishing boats.



The Midnight Sun in Glorious Monochrome, at 1.34 am, 19-7-23.

a carillon, Max's Mobile Machinery, a teepee? clocks and an early motorcycle.

Steam Whistle, August, from **Sheffield & District Society of Model & Experimental Engineers**, begins with a picture of more activity to provide enhancement to the club track. John is manoeuvring a battered wheelbarrow - where do they get them from (chip shop? - Ed.)? All I see in the shops are new and shiny ones... The Open Day was

commemorated in photographs taken by Don Butterell, including a Sheffield bus from 1965, and the cab interior. Mike Peart writes on the Tamar Bridge in Cornwall and Alan Thorpe found a carillon in a Hope Valley church. This is a sort of mechanised bell ringing, so arranged as to play simple tunes. The only one I have heard in reality is at Bradford Town Hall - a video is on YouTube. The Hope Valley carrillon was restored

recently and was written up in the *Bradwell News*. Murray's Thoughts extend to Robert Oppenheimer, father of the atomic bomb, and the Manhattan Project. I saw this film about a fortnight ago. Too long by about half an hour but good to watch. Thinking of the parlour game *Degrees of Separation*, there is a member of SSME who has a connection with the atom bomb project. Now, who could that be? Their Open Day in support of Sheffield CH Hospital raised £3,300.

W. www.sheffieldmodelengineers.com

A series of images follow which readers may find diverting to distribute amongst my text for idle amusement. A workshop on a 'ute', by Max Leggett, NDMES (**photo 1**). This is how I boarded ship

in Liverpool (**photo 2**). A wreck, somewhere south of IoM (**photo 3**). Steel hulled, sail Training Ship *Staatsraad Lemkuhl* in Kristianasund, built 1914 in Germany (**photo 4**). Bollinder engine at Alta Museum (**photo 5**). The Midnight Sun in Glorious Monochrome (**photo 6**). My camera notes in Kristianasund: '...fine on the starboard bow' (no, not Klingons on the starboard bow, starboard bow... - Geoff) 1.34 AM, 19th July.

Murray Lane sends the **Model & Experimental Engineers Association** Newsletter for August. Bryan bought a dog tag machine so, no more anonymous dogs in Auckland! Graham Quayle has finished his horizontal engine and all that remains is to paint it. Graham explains that some of the work is very fine and

must be carefully done, for instance threading at 40 tpi. Away from work, he built a boat and, one night, a storm blew up and one of the crew was swept overboard with the anchor in his arms. When he surfaced, to find himself being asked, "Where's the anchor?", he was not amused.

Steam Lines, Sept-Oct, from **Northern Districts Model Engineering Society (Perth)** says that they were invited to visit the old Midland Workshops of WA, HQ of the Machinery Preservation Group. They have a large number of exhibits, including a Clayton & Shuttleworth Traction Engine of 1904, *Bert*. The portable track running was powered by Bill Wall's 'Speedy' and other members ran their own models. Bill also restored a Marshall traction engine, which was present on the day. Hardy's steam whim was there and a wooden one (no jokes, it's too obvious - Geoff). The newsletter article was by Jim Clark. Max Leggett had a workshop, driven by steam and with overhead shafting, all mounted on his Bedford 1950 ML truck (see photo 1 – again).

W. www.machinerypreservation.wa.com
Phil Gibbons is worried about people posting to Facebook etc. with details of their prized etc. possessions, as their house may be targetted by burglars, thieves and vagabonds. Please think for a mo, he says. (I must admit I have perpetrated similar transgressions, albeit unintentional, and fortunately without revealing too much – Geoff.) Dave Barlow has joined the staff of the Bargain Basement, at the usual pay grade (nothing!). He has published a list of identifiable items, including lots of metal bars, rods, roods and perches, in divers materials, as many as one could desire, and invites those who wander within range to inspect their wares AND BUY THEM! Jim Clark recommends *Blondihacks* videos, on YouTube, who has made several, and his particular favourite 'de jour'

is about 'tapping in'. Not 'tapping' but 'tapping in', the art of positioning a workpiece so as to be precisely located for the most accurate results. www.youtube.com/watch?v=VHYDqA7Lxrk - a candidate for rubber hammers etc.

W. www.ndmes.org.au
Sheffield Society of Model & Experimental Engineers has a Royal Scot kit, 5 inch gauge, for sale. A significant kit, started, but not assembled beyond the front bogie, frames and wheels.

Gauge 1 North, Yorkshire Group, offers a preliminary assessment of Gauge 1 North, Bakewell, in that they attracted 380 visitors and made enough to keep them going for another year. Another meeting had no sound because the venue could not supply electricity to their requirements. Malcolm High has created a 3D printed model of *Rocket* using free *Thingiverse* files from the internet.

W. www.gauge1north.org.uk
Stamford Model Engineering Society's August Newsletter has editor Joe Dobson drawing our attention to a site called Heritage Crafts. When Googled, it provides a thoughtful insight into our hobby. Members also visited Flag Fen Archaeological Centre, a recreated medieval dwelling exhibiting some of the archaeological finds around the site, buried in the peat. The Visitor Centre has an interesting construction. Wooden beams have a metal socket at each end and these are matched with suitable points in the roof. Splayed out in a circular style, and at different angles, they created a wide open space showing off the clever idea. A similar technique has been used in Sheffield's Winter Gardens. (The Sheffield project was overseen by a friend of ours.)

My fellow author, Steve Goodbody, has a fine sense of humour, so even if you are not building the model, his work is well worth a read. Finishing his locomotive, he wanders off in the echoing canyons of his mind to think of words used in connecting pipes together,

like 'piped'. This could be expanded so we might have *pipulated*, or *tubulated* and, by extension, *cubulated*, etc. Another range of suffixes to be considered in like vein are -oid, so that items might be cuboid, ovoid, humanoid yet, for further amusement (Theasboid? – Ed.).

Halesworth & District Model Engineering Society autumn Newsletter opens with a pic of Andy Belcher in a scratchbuilt stepside pickup, just big enough to sit in. I'm sure I spot a drawer handle in the front bumper... It is modelled on a character in the film *Cars* and Andy hankered after a drive. Eventually the time cameth in their Club Picnic, and Lo! Quite a change for one who used to drive trucks thousands of miles to Krasnodar in Russia. Secretary Brian Sinfield, in his Jottings column, advises that the Science Museum has taken over the collection of the Clockmakers Guild, founded by the Worshipful Company of.... etc. It is a large collection and may be worth a special visit to the Metropolis.

The LOWMEX Exhibition is girding its 'lines' [!] for the excellent event, which promises to be as good as last year. 28/29 October, www.lowmex.co.uk John Child is building a Cornish Waterworks beam engine and is currently involved with the entablature. Making the decorations, gargoyles, warning notices of 'Here be dragons', plus curliques and twiddly bits was quite a challenge. Tom Rackham converted a trolley which was not substantial enough to stand up to a 4-day steam rally. The same was likely to happen at the next show so he converted it to a driving trailer, in the style of a traction engine waggon. He thought it may take a few days to do. Boy was he wrong! This period became several months and the only item from the original vehicle is the handle... Richard Walton always fancied a steam engine since being about 14. He has just bought a Ruston Proctor of 1918 (1st registered 1921) named *Lincoln Imp*, after the odd gargoyle high in the roof

of Lincoln Cathedral. It isn't hard to find, as there is often a spotlight aimed at it - also look for the clock winder in the cloisters. The cathedral, which is not spotlit, is at the top of a steep hill, called Steep Hill. In a courtroom in adjacent Lincoln Castle, I once sentenced a man to death. When we saw him later on that day, he asked about his fate. I told him he could go free, as we couldn't get the staff.

W. www.hdms.co.uk
On that note, I caught a glimpse of an Audi on YouTube, which converts from hatchback style to a pickup, with a good load area. Very interesting. On researching, I find that it is a concept car, not a production model. Look for Audi Activesphere.

I strongly recommend that readers watch this video on YouTube - 'Bentley v. Dennis' and, if available, the advertisement which spawned it. I'll not comment further...

Bradford Model Engineering Society's September *Monthly Bulletin* gets off to a fine start with chairman Adrian Shuttleworth describing the civil engineering of the river Douro, seen during a recent holiday. This was followed by Ryedale Model Engineering Society Open Day at Gilling, and the Steam Toys and Meccano Show at Armley Mills, Leeds. Nicholas Wright recently ran his five inch gauge Plymouth electric locomotive, in the rain, at the Social Evening. This impelled editor Graham Astbury to think of his own locomotive just started... well, he has the 4QD controller! The first practical motorcycle was built by Hildebrand & Wolfmüller. Member Herbert Stumm made a model of this 1469 cc machine, which had no clutch, or gears. The piston rods drove the rear wheel directly, so running with it then jumping on was the starting procedure.

W. www.bradfordmes.co.uk
And finally, looking for a boyfriend in engineering? The odds are good, but the goods are odd.

ME

Club Diary 4 October – 19 November 2023

October

4 Bradford MES

Talk – Graham Astbury, 'Twist Drills', Saltaire Methodist Church, 19:30. Contact: Russ Coppin, 07815 048999

4 Bristol SMEE

'On the Table' evening, Begbrook Social Club BS16 1HY, 19:30.

Contact : secretary@bristolmodelengineers.co.uk

5 Sutton MEC

Bits and Pieces evening 20:00.

Contact: Paul Harding, 0208 254 9749

5 Warrington & District MES

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

6 Rochdale SMEE

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

6 Warrington & District MES

Night running at the club track. See www.wdmes.org.uk/events

7 Tiverton & District MES

Running day at Rackenford track. Contact: Chris Catley, 01884 798370

8 Bradford MES

Public running day, Northcliffe, 13:30. Contact: Russ Coppin, 07815 048999

8 Bristol SMEE

Public running at the Ashton Court Railway BS8 3PX, noon-17:00. Contact : secretary@bristolmodelengineers.co.uk

8 Canterbury MES

Public running. Contact: ginapearson@btopenworld.com

8 North Wilts MES

Public running at the Coate Water Railway, 11:00-17:00. See www.nwmes.info

8 Sutton MEC

Track Day from noon – 16:00. Contact: Paul Harding, 0208 254 9749

8 Warrington & District MES

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

15 Canterbury MES

Public running. Contact: ginapearson@btopenworld.com

15 Guildford MES

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

15 North Wilts MES

Public running at the Coate Water Railway, 11:00-17:00. See www.nwmes.info

15 Taunton Model Engineers

Public running, Vivary Park, 14:00-17:00. See www.tauntonme.org.uk

15 Warrington & District MES

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

17 Taunton Model Engineers

Meeting, West Buckland, auction, 19:30-21:30. See www.tauntonme.org.uk

18 Bristol SMEE

Talk: 'Steam Launches and Engines', Begbrook Social Club BS16 1HY, 19:30.

Contact : secretary@bristolmodelengineers.co.uk

19 Warrington & District MES

Talk: Jeremy Nichols on 'British Railways in WW1', St Mary Magdalene Church, WA4 3AG, 20:00. See www.wdmes.org.uk/events

20 Rochdale SMEE

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

22 Bristol SMEE

Public running at the Ashton Court Railway BS8 3PX, noon-17:00. Contact : secretary@bristolmodelengineers.co.uk

22 Canterbury MES

Public running. Contact: ginapearson@btopenworld.com

22 North Wilts MES

Public running at the Coate Water Railway, 11:00-17:00. See www.nwmes.info

22 Tiverton & District MES

Running day at Rackenford track. Contact: Chris Catley, 01884 798370

22 Warrington & District MES

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

26 Guildford MES

Open day, 10:00-13:00. See www.gmes.org.uk

26 Newton Abbot & District MES

Club night at Rydon Community

Hall, Kingsteignton. See nadmes.org.uk

26 Sutton MEC

Afternoon run from 12 noon. Contact: Paul Harding, 0208 254 9749

28 Brandon & District SME

Hallowe'en run, Weeting track, 14:30 until dark. See www.brandonanddistrictsme.com

28 North Wilts MES

Hallowe'en run at the Coate Water Railway, 15:30-20:30 (booked slots). See www.nwmes.info

29 Bristol SMEE

Public running at the Ashton Court Railway BS8 3PX, noon-17:00. Contact : secretary@bristolmodelengineers.co.uk

29 Canterbury MES

Public running. Contact: ginapearson@btopenworld.com

29 North Wilts MES

Public running at the Coate Water Railway, 11:00-dusk. See www.nwmes.info

29 Warrington & District MES

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

November

1 Bradford MES

Autumn auction, Saltaire Methodist Church, 19:30. Contact: Russ Coppin, 07815 048999

1 Bristol SMEE

Talk: 'Use of Machatronics at the Crofton Pumping Engines', Begbrook Social Club BS16 1HY, 19:30.

Contact : secretary@bristolmodelengineers.co.uk

2 Sutton MEC

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

2 Warrington & District MES

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

3 Rochdale SMEE

Talk: 'Garden Railways', Castleton Community Centre, 19:00. See www.facebook.com/RochdaleModelEngineers

4 Tiverton & District MES

Running day at Rackenford

track. Contact: Chris Catley, 01884 798370

5 Canterbury MES

Public running. Contact: ginapearson@btopenworld.com

5 North Wilts MES

Public running at the Coate Water Railway, 11:00-dusk. See www.nwmes.info

5 Warrington & District MES

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

12 Canterbury MES

Public running. Contact: ginapearson@btopenworld.com

12 North Wilts MES

Public running at the Coate Water Railway, 11:00-dusk. See www.nwmes.info

12 Sutton MEC

Track Day from noon – 16:00. Contact: Paul Harding, 0208 254 9749

12 Warrington & District MES

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

15 Bristol SMEE

Talk: 'Meccano – a History', Begbrook Social Club BS16 1HY, 19:30.

Contact: secretary@bristolmodelengineers.co.uk

16 Warrington & District MES

Talk: Clive Jones on 'Aerospace Materials', St Mary Magdalene Church, WA4 3AG, 20:00. See www.wdmes.org.uk/events

17 Rochdale SMEE

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

18 Sleaford & District MRC

Charity model makers' show, 10:00 to 16:00 at St George's Academy, NG34 9BY. Contact: Eddie King, 07821 618718

19 Canterbury MES

Public running. Contact: ginapearson@btopenworld.com

19 North Wilts MES

Public running at the Coate Water Railway, 11:00-dusk. See www.nwmes.info

19 Tiverton & District MES

Running day at Rackenford track. Contact: Chris Catley, 01884 798370

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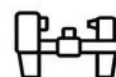
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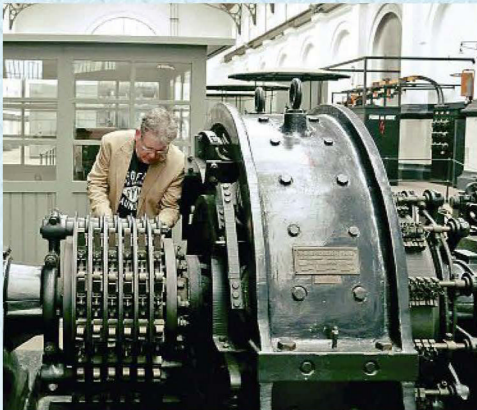
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