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Vol.199 No. 4308 14 - 27 September 2007.

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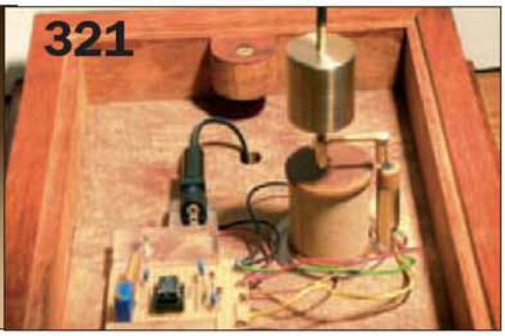

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ON THE COVER...

Some wonderful machinery was sent out from Britain to the sugar industry in the Caribbean in the 19th century, and deserves the attention of model engineers. Patrick Carnegy found one sugar plant, in a surprisingly good state of preservation, on the holiday island of Tobago. His fascinating report can be found on page 314.
(Photograph by Patrick Carnegy)

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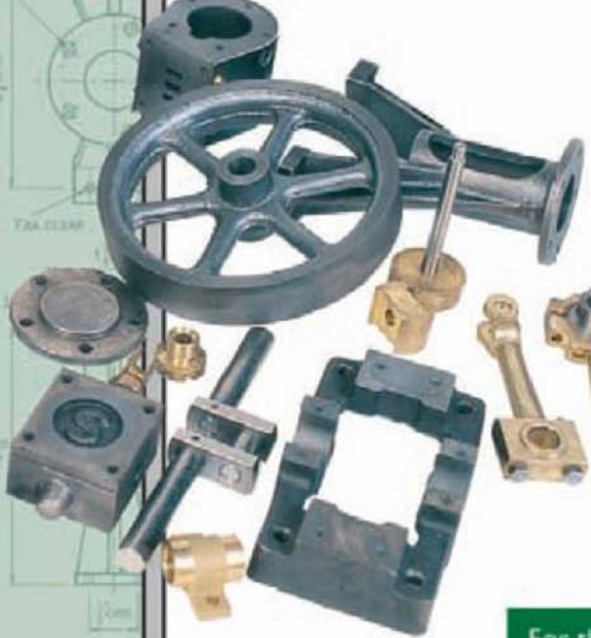

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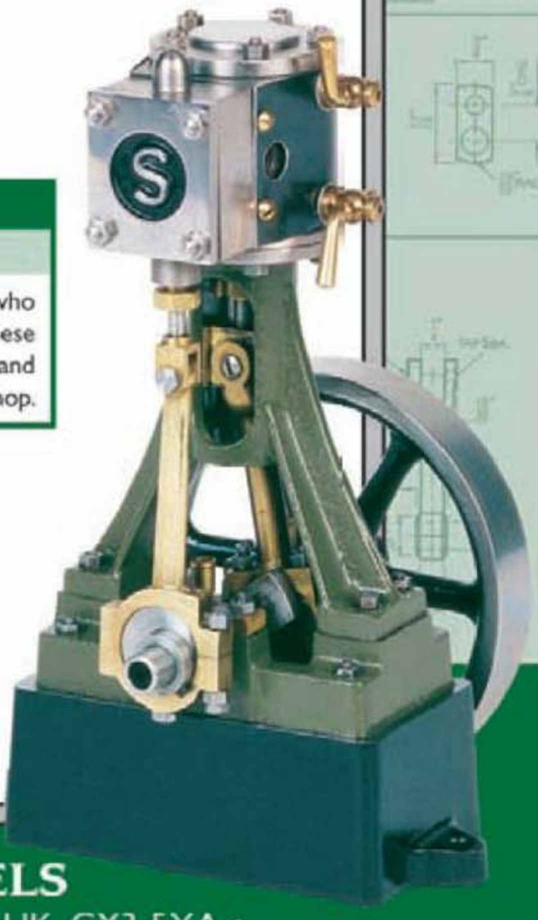

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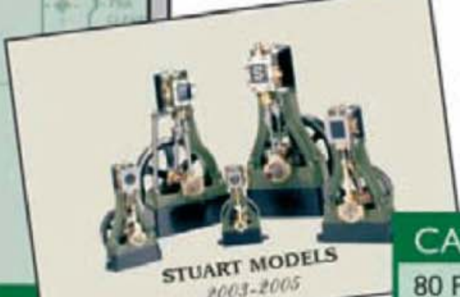

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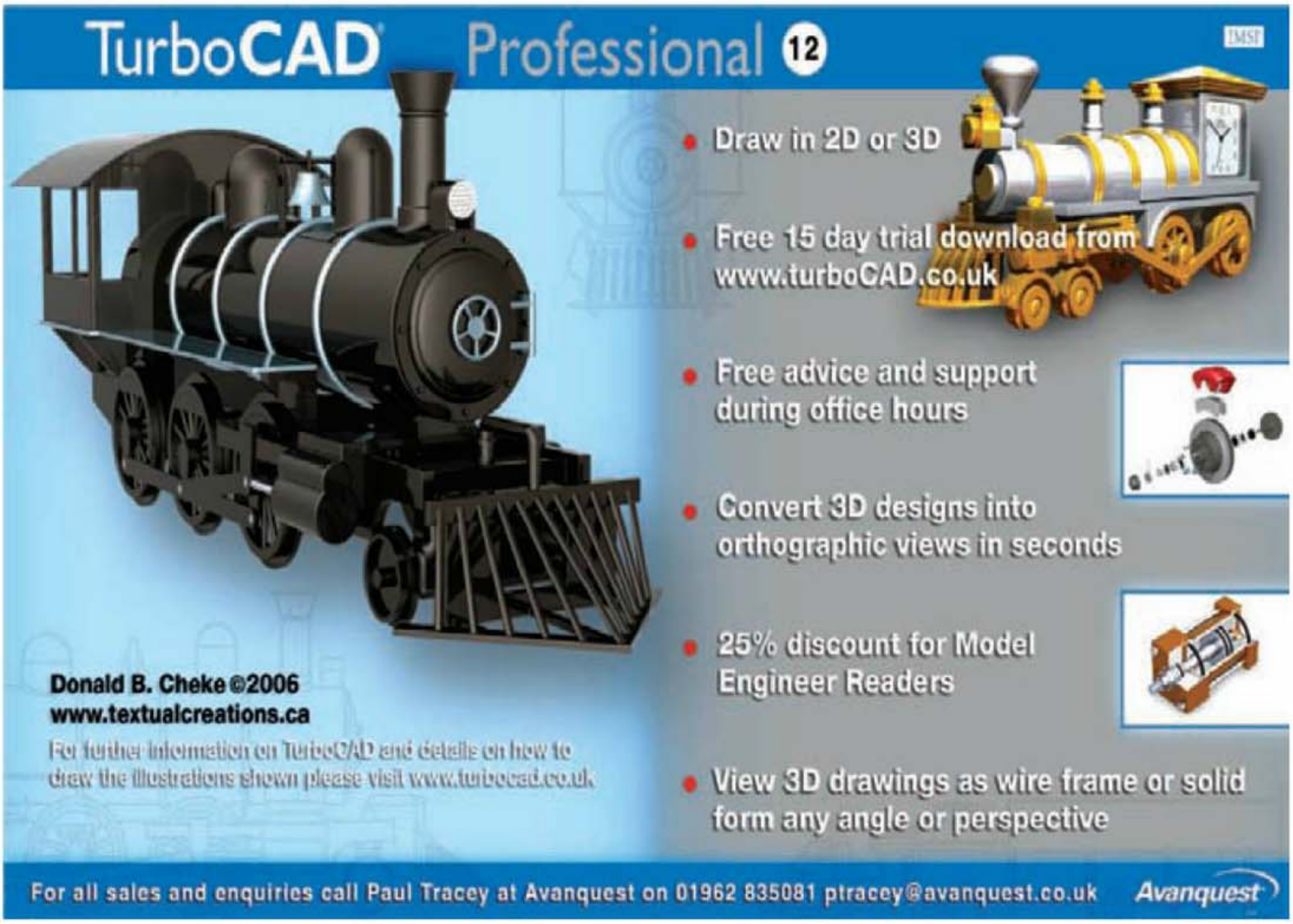
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SMOKE RINGS

Home sought for interesting boiler

Duncan Webster is trying to find a good home for the late Prof. Bill Hall's test boiler on behalf of his widow. It was used in his definitive series of tests on cylinder condensation, the reports on which can be seen at www.modeleng.org/articles/hall01.pdf. They are more interested in finding someone who would make good use of it than in getting the best price.

Having never been operated in public it does not have a boiler certificate, but it has been tested and Duncan has no doubt it would pass a second test. The boiler is horizontally mounted on a firebrick combustion chamber. It is all copper construction, professionally built, silver-soldered throughout

Shell is 8.375in. diameter, 16in. long, $^{3}/_{16}$in. thick. There are 54 firetubes 0.375in. dia., and longitudinal stays above water level. Heating surface is 7ft.^{2} (tubes) plus 1ft.^{2} (shell).

The gas burner is mounted in the combustion chamber, could possibly be converted to liquid, or even solid fuel firing. Prof Hall reckoned it would produce 30/40lb of steam per hour.

The boiler alone weighs over 70lb, so collection is preferred. Presently situated in Warrington, inspection is welcome by those with a genuine interest. Contact **duncan.webster2@ntlworld.com**

The late Prof. Hall's boiler.

Peter Rich drawings

We are fortunate in having another drawing in this issue by Peter Rich. His drawings are always a delight, and his general arrangement of the 4-4-0 County 'rough rider' is no exception.

This time he pays particular attention to the tender, sometimes given short shrift in locomotive descriptions, but budding Gold Medal winners need to give just as much attention to one as to the other.

The 4-4-0s of the Great Western have always been great favourites and make super models. For any budding high fidelity model builders out there, Peter's drawings and castings are available from Phil Williams:

www.churchwardlocos.com
T. 01495 750487.

Peter Rich has been designing and building model locomotives, specialising in the designs of the old Great Western Railway Company, for the past 45 years. To date he has built 15 very finely scaled 5in. gauge locomotives, and has been twice awarded the Henry Greenly Award, twice the J. N. Maskelyne trophy and also the Crebbin Memorial Cup at the International Model Engineering Exhibition. Together with these awards he has achieved Highly Commended, Bronze Medal, three times Silver Medal and twice Gold Medal standard. In addition one of his models, a coach, was chosen for display at the National Railway Museum at York.

He has also been deeply involved in the full-size railway preservation movement where, in recent years, he has been responsible for most of the new design work on the full size *Lady of Legend* and *County of Glamorgan* projects at the headquarters of the Great Western Society at Didcot.

Peter's aim is to design and build as authentically close to the full size design as it is possible to get and have a model which will be a very good worker. The idea about designing so close to scale is not so much that a modeller will actually build that close to scale but to provide a set of drawings whereby all information is within them so that if, for example, a constructor wants to make an exact scale lamp iron or an authentically shaped axlebox front, for his model then the information is in the drawings and the constructor is not left to try to find out these details for himself. It is all there if he wants it. The designs have all been prepared from the official Swindon Works drawings.

Ornamental turning

We have been asked to make clear that the gentlemen named in the article *Ornamental Turning Highlights M.E.* 4305, 3 August 2007, page 138, were responsible for the photos and not the actual work – well, not all of it. Also that some of the work should be described as decorative, rather than ornamental turning.

SEQLEC

A quick reminder that SEQLEC takes place on Sunday September 23 at Sutton Coldfield. Contact Neal Harrison 0121 378 3992

Robert Stephenson locomotives

We have received a request from the Robert Stephenson Trust, which occupies part of the remaining buildings of Robert Stephenson and Co. in Newcastle upon Tyne. The Trust aims to make today's generation aware of the achievements of the great engineer through its archives, and displays.

The Trust would like to hear from anyone who can loan or even donate models of Stephenson designed locomotives such as *Rocket, Northumbrian, Planet*, and *Paentee*, or indeed any other products of RS & Co.

More information is at robertstephensontrust.com
E. **rstrust@hotmail.com**
T. 0191 222 0905

POSTBAG

Making fitters

SIRS, - I found Neil Read's article on *Finding a Real Fitter* bringing back some memories. On leaving sixth form from the Grammar School in Morpeth, Northumberland, I was accepted into the apprenticeship programme at A. E. Reyrolles in Hebburn, Co. Durham as a third-year apprentice, this in the Dark Ages of 1957.

They had an excellent training scheme which could be copied by the few manufacturing concerns still extant in the UK. There was a school within the works run by gentlemen lately retired from the full-time workforce and who were literally full and running over with knowledge and skills.

Initially we spent, if I remember correctly, three weeks on hand skills. We were given a ½in. steel plate, 4 x 6in., and several cut-offs of steel bar and rod. Our task, should we choose to accept it (it sounds like Mission Impossible today!), was to flatten the plate and bring both flats, both ends and both sides, to parallel with their partners. Then, convert our off-cuts into: a cube, a triangle, a hexagon, and an octagon - exactly. That was the easy part - now we were allowed to use the drilling machine (geared head) to chain-drill inside our marked lines for square, triangular, hexagonal, and octagonal holes and, using files and hand scrapers, bring them to such a size that our initial efforts would fit and show no light when held up to the heavily (thank God!) begrimed windows of our classroom.

As if that was not sufficient to initiate us into the arcane skills of the fitter we had to cut out from one end of our plate, not a semi-circle, but an arc of 185 degrees! This was tested with a go/no-go gauge. When all was done we stamped our names on one edge of the completed plate (then re-flattened it!) and took the whole kit and kaboodle - with some trepidation I may say - to our instructors. I well remember two of my 'comrades-in-files' whose work was apparently not quite good enough; there was a roar of displeasure, some words inappropriate to today's genteel ears, and crashes as two half-inch plates, complete with all bits and pieces, flew across the room and rebounded from the wall.

As the two were first year apprentices they had to stay for another round of the same, before they could advance, as we did, to the machine shop, the 'Holy of Holies', where we learnt how to use horizontal millers, lathes, shapers and vertical mills. Not only that, but some of our work was actually used in production on the factory floor!

How today's young people would respond to the old gentlemen who taught us I have no idea. There was nothing that left permanent scars, physically or emotionally, and you did learn to keep your ears and eyes open and be aware. As Charles Sykes, author of *Dumbing Down our Kids...* remarked in the *San Diego Union-Tribune* –"Life isn't fair: get used to it." (See http://www.oz.org/school.html for the full text, an interesting read).

Mike Gray, British Columbia, Canada.

Small cross head screws

SIRS, - I recently discussed Philips and Pozidriv screwdrivers and queried the standard and type of mini-drivers required for the tiny cross-head screws found in cameras and watches etc. from Japan. My old set, although tiny do not fit properly.

Reader R. MacKenzie of Cheshire wrote to suggest that good cross-head screws may be stocked by Maplin Electronics. They list sets in a variety of sizes from small to large (with a dozen or more pieces). It is suggested that these tiny cross-head screws require a range of Philips from No. 1, and No. 0 right down to No. 0000 (No. 0-4).

Look for the brand names 'Maplin', 'Pro's Kit' or 'Rolson' at the Maplin store. In Australasia the name 'Jaycor Electronics' is apparently the one to look for.

The German make 'Wiha' is also thought to be of good quality. In Europe the website is www.wihat.de in America www.wihatools.com is the one to look at.

The web addresses for Maplin and Pro's Kits are www.maplin.co.uk and www.prokits.com respectively.

We thank Mr. MacKenzie for his detailed research. He tells us that he has removed camera and laptop screws using the above screwdrivers.

Peter Spenlove-Spenlove, Leicestershire.

Metric thread cutting

SIRS, - I found Dennis Randall's letter (*M.E.* 4301, 8 June 2007) rather interesting, having been initially a ship draughtsman, then a senior design engineer in various disciplines and at the end of my working life, a secondary school teacher.

Some time ago there was an article in *Model Engineer's Workshop* by a reader who had made what he called 'transporting gears' for his lathe with the object of cutting metric threads from the 8tpi leadscrew. He stated that he had made these gears out of aluminium alloy using a cutter with a pitch of approximately half that of the lathe's standard gears in order to bring the size of the required 127 tooth gear down to manageable proportions but did not realize that all other things being equal, the teeth would only have about half the strength of the originals.

Aluminium alloy is aluminium mixed with other metals in order to increase its strength or to increase its corrosion resistance.

As an alloy it is available in annealed, quarter hard and half hard (non heat treatable in both conditions) or single or double heat treatable. In the latter case the material is first heated to a specified level and quenched before being 'age-hardening' by immersion in a salt bath. A piece of aluminium alloy with the necessary properties will harden with

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Responses to published letters are forwarded as appropriate.

age and the salt bath simply accelerates this process.
In this condition aluminium alloy achieves an ultimate tensile stress roughly equal to mild steel with a weight of approximately one third. The bad news is that the application of heat invites distortion and this could become particularly acute in the manufacture of gears or other precision components.

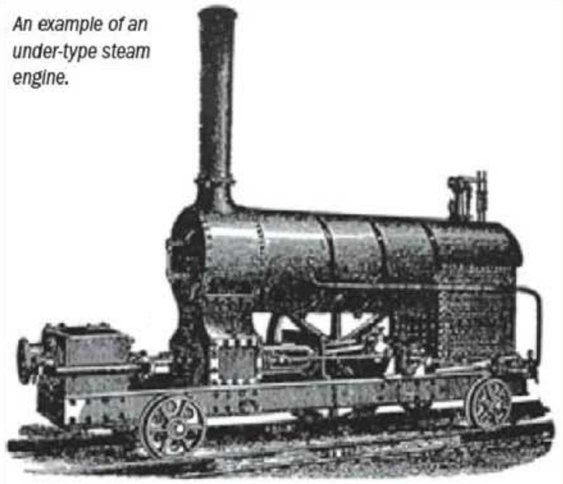
With regard to the topic mentioned in my second paragraph, viz. metric screw-cutting, I fail to understand why so much attention and subsequent trouble was generated by the cutting of metric threads on imperial leadscrew lathes. Many publications give change wheel combinations for the situation. Ian Bradley's book on the Myford ML7 being one.

A choice of change wheels on an imperial leadscrew lathe will serve to cut metric threads to a very close fit. Even the thread angle difference, (55deg. for Whitworth form versus 60deg. for Metric) requires very close grinding of the cutting tool. Rolls-Royce apparently utilised a system of worn versus new tool generation in selective assembly. Knowing Rolls-Royce's reputation, I do find this difficult to believe, but personally, I have found 0BA (47.5deg.) and M6 (60deg.) quite compatible and similarly 60deg. with 55deg. thread angle.

R. E. Ellwood, Sussex.

Choosing a lathe

SIRS, - I enjoyed the article by Mr. Harold Pearson (*M.E.* 4301, 8 June 2007) on choosing a lathe both informative and well balanced. As a retired technician, mainly in the field of laboratory instrument making I have used a number of lathes of different makes, and in a school workshop I became familiar with the Myford ML7. These were ideal small lathes for the model engineer at a modest price. Their slotted cross slide was a great asset with a number of uses. Probably one of my favourite small lathes was the now defunct Raglan.



An example of an under-type steam engine.

Just before retirement I started to build my own lathe. This was based on a part-machined bed similar to the also defunct Zyto, for which I used a number of Myford components. This self-produced lathe held me in good stead for a number of years, but for a certain job I had undertaken I needed a lathe capable of a higher speed than the one I had built with plain bearings. I therefore choose one of the Far Eastern lathes with a variable speed controller. It is good value for money and has done all the various machining jobs I have asked of it, but it does have some irritating aspects, e.g. the three nuts which attach the chuck to the mandrel are very difficult to start on their studs owing to their being so little room between the chuck backplate and the headstock. Changing chucks is a frustrating process! It is also difficult to operate the tailstock clamping nut when working close to the slide rest. I made a lever operated clamp but because there is quite a wide variation in bed thickness (was it ever machined on the underside?) it requires a considerable throw of the cam operated by the lever.

Should I ever purchase another lathe, an unlikely event at the age of 87, Mr. Pearson's suggestion of a second-hand lathe of well-known make is something I would seriously consider.

On an entirely different matter I wonder if any readers can give me information on the following; either through *Post Bag* or c/o our editor.

1. I am working on a freelance model undertype steam engine but illustrations of these engines are very sparse. I am drawn to the one shown in the enclosed photocopy, reproduced from an article by the late John Haining (*Model Engineer* 6 November 1982). Any news of other sources would be welcome.

2. Does anyone know of a source of Primus type nipples for paraffin fuel, or what the jet diameter should be if I have to make one.

3. I should like to obtain the name and address of any supplier from whom I could obtain small amounts of graphite bearing PTFE up to about ½in. diameter. I shall be pleased to reimburse any postage costs in connection with this enquiry.

Any information on the above will be much appreciated.

Louis Parke, Oxfordshire.

Inspiration

SIRS, - How refreshing to read the article *Headology* (*M.E.* 4302, 22 June 2007), which detailed all the human failings which we are all prone to. I admit I get model engineering magazines to boost my enthusiasm to get back in the workshop and crack on with my projects, most of which date from the late 1970s when my father used to help me.

It all seems so easy sitting in bed on a Sunday morning with a nice cup of tea, whilst reading the magazine and looking at photographs of immaculate workshops turning out dazzling components. Then we get back to the reality of an untidy workshop with nothing in it you need (well if it is there, you can't find it) which soon puts you off until the next issue of *Model Engineer* drops through the letter box to revitalise you again.

Also, it was nice to read an article where some of the esoteric terminology of steam engines was explained. I refer to the article in the same issue on the Savage's *Universal Carrier* where the simpling valve was detailed so that the layman who knows nothing about the functioning of a railway locomotive can understand it.

Please keep up this refreshing and inspiring approach to model engineering; I am sure it will get more of us back into our workshops.

What is a snifting valve anyway?

Allan Woodcroft, Northamptonshire.

Choosing a lathe (2)

SIRS, - I found Harold Pearson's article on choosing a lathe (*M.E.* 4301, 8 June 2007) most interesting. To me, his comments about accuracy and heavyweight build seemed to make sense.

Therefore, rightly or wrongly, I took the plunge and purchased a Colchester *Chipmaster*, similar to his own machine, from Home and Workshop Machinery of Sidcup, Kent.

My initial impressions lead me to believe that Mr. Pearson is quite correct in what he says about industrial lathes in general and the *Chipmaster* in particular.

These days, when we are quick to criticise bad service, I must praise the exemplary service shown by Home and Workshop Machinery. They are of the old school, and made us feel that our custom was >>

important to them. For anyone looking for machines, they come highly recommended.

I have no connection with the company, other than as a very satisfied customer.

Peter Snow, East Sussex.

Raglan and other lathes

SIRS, - In reply to your correspondent Ian Smith; some while ago I was fortunate in purchasing a Little John lathe, complete with all the listed accessories, including a parts list and handbook. The latter states the maker to be Messrs. Raglan Engineering Company (Nottingham) Ltd, Raglan Street, Nottingham, but I have not enquired if they are still in business.

It is a sturdy machine of 5in. centre height, with bolted on flat bed plates, which no doubt are hardened and ground. However, this lathe does not have any obvious relationship with the Boxford, which does have some affinity with the South Bend.

My other lathe is a Hercus, a really excellent machine. I believe Mr. Hercus was possibly a German who came to the UK after World War Two. I vaguely recall that he made one or two contributions to this magazine. After emigrating to Australia, he built his lathes under licence from South Bend. I corresponded with him about spare parts etc. but the rate of currency exchange made them rather expensive.

On the subject of lathes, I purchased a Wilfin Electrolathe when a local garage closed down. Any information as to the maker etc would be welcome. A number of these machines were employed in the machine shop of the S.E. Essex Technical College at Barking, where I spent a few weeks prior to call-up, but I was lucky to be allocated a $7^1/_2$in. Holbrook, truly the Rolls-Royce in this field.

Cyril Cannell, Isle of Man.

Construction of ellipses

SIRS, - Re: *Construction of Approximate Ellipse – M.E.* 4301, 8 June 2007, surely the order in which constructions are done cannot affect the shape of the resulting approximate ellipse. Its shape must be determined by the construction alone. I suspect that as the axial ratio of the ellipse to be approximated decreases, the point where the side and circular arcs meet becomes more apparent, giving the 'kink' to which Mr. Mount refers. Or, perhaps the actual construction is used but once and the 'parallel ellipses' are determined by the drawing of a series of concentric arcs.

Concerning the matter of parallel (true) ellipses, some seem to believe that if there is an ellipse with semi-axes a and b (a greater than b), then another ellipse with semi-axes $a+h$ and $b+h$ will be parallel to the first. This will only be true where the axes meet the ellipses.

The true parallel curve is one of higher order than an ellipse, but if the ratio b/a is greater than 0.5 for the thinnest ellipse, the error in the assumption is probably small enough to neglect. This is true in the Watts parallel motion linkage where the motion is not truly linear, but the error (for short distances) is less than the 'play' in the joints.

I have come across other constructions, including one using eight separate arcs with three different radii. Most just use four arcs, as in Mr. Mount's example. One such was published in *Practical Engineering*, 5 March 1942, which Mr. E. A. Newton of the Elliptical Turning Association sent me in 2005.

It is slightly simpler than Mr. Mount's example in that it does not require a tangential line to be drawn, the accuracy of which might be less than a line through points defined by the intersection of straight lines or circular arcs.

It is claimed that both for this and Mr. Mount's construction, that the junction of the arcs lies on the line of the true ellipse. My own attempts to prove this for the *Practical Engineering* construction were not successful.

A numerical method indicates that neither method satisfies that criterion, the error increasing as the ratio b/a increases. Indication is that if b/a is greater than or equal to $^2/_3$, the error would be small and that Mr. Mount's construction is the closer approach of the two. Whether or not the claim is true may be of little practical significance because of more significance is how well any approximate construction represents an ellipse at all points.

In these days of CAD, it may be that all such constructions are of little interest, but some may still have use for them.

I do not doubt that for the job described, either Mr. Mount's construction or that in *Practical Engineering* would be well fit for purpose.

Further details can be provided should anyone be interested.

G. S. Sayers, London.

Valve gear on 87xx class locomotives

SIRS, - I was very interested in the letter (*M.E.* 4301, 8 July 2007) by Don Ashton on valve gear accuracy, particularly his tables on the GWR 87xx class which take some believing, particularly when running at short cut-offs in back gear they show anything from 15% to 25% difference between the back and front ports!

Having fired these locomotives for many hundreds of miles, I can assure Don that these differences do not show up on the footplate, as one would expect, as uneven or jerky running when running bunker first.

In the 1950s, the 6.05am Wolverhampton Low Level to Birmingham Snow Hill was in our link and a 57xx was always rostered for this journey as on returning we had to go down the Wombourne branch and shunt Courtalds caustic soda and sulphuric acid tanks.

We were always late away from Low Level, waiting for our passengers who had a long walk from the buses.

One morning it was 6.15am when we set off, but my driver said "It'll be right time at Snow Hill".

Between stations he notched up to one notch off middle and the engine literally flew with our four coaches, about 120 tons on the long straight between Bilston and Wednesbury and on the level track the locomotive started a 'harmonic bounce' due to the coil springs on the back axle, which were in the cab. This occurred at about 55mph and was cured by shutting the regulator. These springs could give you a painful pinch on the bottom if the engine lurched when you were firing.

Yes, we got to Snow Hill on time with nearly empty water tanks. That was one of the other failings, only 1200 gallon capacity.

The 57xx and 87xx were the best 0-6-0 tank engines ever built, a joy to drive when shunting, starting briskly, stopping smartly and easy to reverse. They have never been bettered, their boilers would steam even with a dirty fire, the secret, a deep firebox between the middle and rear axles.

John Hurley, Wolverhampton.

3-phase electrical supplies

SIRS, - Could I offer my sincere gratitude to the readers who have generously contributed their thoughts and experience on this subject in answer to my original enquiry? I now think that further clarification of my experiences may perhaps cause a degree of amusement.

Having read the late T. D. Walshaw's articles on setting up a workshop I was certainly interested in having 3-phase supply for a lathe. By coincidence I happened to see the local electricity board workmen doing some maintenance on nearby electrical supply lines. I did enquire whether it was single phase or was 3-phase available. I was informed, "Nah! it's all 2-phase".

Although by now having at least twinges of doubt I did phone the local board. The reaction was a combination of "frosty" and "distant". None of my several phone calls was returned.

Although at one steam rally I did see a lathe being run from an 3-phase ex-MoD generator, there the matter rested until retirement had crept much closer.

I am a lecturer employed by a Middle East university and recently the university has spent a considerable sum on setting up a mechanical workshop complete with lathes, mills, drills, OA, MIG, MMA welding and the usual bench fitting facilities.

As the contractors were wiring in the various machines I happened to notice that although the main supply was clearly 3-phase the drilling machine power points were clearly labelled "3-phase, 220v".

I did question this and was assured that it was correct and that 3-phase was available at 220V although during my professional career I have only seen this at 415V. I did originally think that only two of 3-phase wires were being tapped for 220V but this seemed to baffle the contractor's electricians.

In the end, despite the extra expense a generator, whether single or 3-phase still seems to be the simple option but I shall give the whole matter much further thought.

James Wells, Essex.

Coffee pot locomotives

SIRS, - Reference the letter from Mr. Spenlove-Spenlove (*M.E.* 4293, 16 February 2007) regarding Coffee Pot locomotives.

As a young boy in the late 1940s I was encouraged by an old model engineer to start construction of such a locomotive from plans that had been published in *M.E.* Sadly although I completed the chassis the model was never completed, even though kept for over thirty years!

The coffee pot locomotive replica in New Zealand.

Reading Mr. Spenlove-Spenlove's letter reminded me of a replica of such an engine in the town of Foxton, here in New Zealand. The original was built in Dunedin in 1872 and was thought to be the first locomotive ever manufactured in NZ. It was named *Palmerston* and was designed for use on a wooden tramway between Foxton and Palmerston North; sadly it was not a success.

The engine in the photographs is in fact a replica of the original for display only, using a vertical boiler and a vertical twin cylinder engine. Sadly the engine has no drive to the axles so it is just a static display of how the original looked. Three foot six gauge of course. The makers name was Sparrow, drawings may exist in the Dunedin archives. The engine was originally mounted to the boiler in the same way as Merryweather fire pumps.

When the replica was made the boiler plate was cut away from the boiler and is still attached to the cylinder block, a patch has then been welded over the hole left in the riveted boiler shell.

Hoping these details may be of interest.

David Starling, Waikanae, New Zealand.

Ratchet Drills - a word of warning

SIRS, - A ratchet drill can be very useful to the model engineer. Most model engineer's workshops have drilling machines with a maximum capacity of $^1/_2$in. Above that one has to resort to the lathe; but if the item to be drilled cannot be swung in the lathe, the ratchet drill comes into its own. True it is slow, is nonetheless effective and time is not really of consequence to the model engineer.

In heavy engineering workshops it was the portable drilling machine of former years. Older readers will remember the latter day equivalent, the compressed air drill, fed by a flexible pipe from one of a number of compressed air outlets arranged down the side of the shop. This must have considerably increased production rates.

When building up say a bogie or pony truck in the Bogie Shop, the frame plates, centre casting, radial arm and horn blocks would be collected from the stores on Monday morning. They would be dressed with a file to meet the drawing requirement "all sharp edges to be removed", particular attention being paid to the inside horn-gap radii, so as not the leave any stress raisers.

If I recall correctly, it was the frames that were pre-drilled with the correct size holes; all of the other components were pre-drilled in the machine shop with undersize holes. The unit would then be built up using undersize slave bolts, with attention being paid to the setting of the horn-blocks.

Then on, say, Wednesday morning the pre-booked roving drilling gang would appear, set up the journeyman and air drill, and proceed to open out the undersize holes to match the correct size frame holes. They were then followed by the roving riveting gang, to complete the building up of the main unit.

Fitting of the side check gear and horn keeps followed and the horn block cheeks were checked and ground to tolerance. Finally, the unit was painted and ready to leave the shop by the weekend.

All this was achieved by one man and an apprentice, with the assistance of the drilling and riveting gangs. Had a ratchet drill have been used it would have taken much longer, even if two drills had been used.

However, to come to the real point of the letter, a friend of mine had his workshop in the cellar of the house. He had also acquired a ratchet drill. Visiting him one evening, his father said, "He's down the cellar, go down to him." This I did, to find him merrily drilling a hole in a plate with his ratchet drill. He was doing quite well, when the cellar door opened and his father's voice said, "What are you doing down there, I can't get in the front room?" The job was on the cellar floor, and purchase had been taken from the ceiling, jacking up the floor above in the process!

D. G. Monk, Derbyshire.

LBSC designed locomotives

SIRS, - Not being a locomotive fan I've only been taking a modest interest in the present series about *Ayesha* but the origins of the locomotive has aroused some personal memories.

My engineering career began in the early 1960s just as the great argument erupted between LBSC and K. N. Harris, with Martin Evans, the then Editor, trying to be completely impartial.

As an apprentice I didn't understand the real cause of the argument then and I still don't although there are occasional references in *Model Engineer* to this verbal contest.

Could one of your more experienced loco designers review the available evidence, submit an article and finally lay the whole matter to rest?

James Wells, Essex.

The Waterwheel at Arnos Vale

Patrick Carnegy visits a Tobagonian Temple to the Sweet Mechanical Muse.

1. Early morning sunshine lights up the Glasgow-made 32ft. overshot waterwheel (1857), sugar-cane mill and remains of the beam-engine in their lush tropical setting. When there was insufficient water for the wheel, the mill was powered by the beam engine.

2. The sugar cane was crushed by being passed to and fro between the hollow cast-iron ribbed rollers, now somewhat drunkenly fallen apart. The rollers were geared together at their top ends, the central roller being driven by the crown-wheel above it. The bevelled pinion at top right connects to the waterwheel; at the left, the gearing to the beam engine, seen from its valve-chest end, is incomplete. The rollers are 830mm long by 510mm diameter. The crown-wheel is about 1,700mm diameter.

The remarkably beautiful machinery sent out from Britain in the 19th century for processing sugar-cane in its colonies is too little known and is richly deserving of the model engineer's attention. Of the huge quantity manufactured very little remains, but on a recent holiday visit to the Caribbean island of Tobago I stumbled on what may well be the best preserved example of a mid-19th century sugar-cane factory.

Situated on the edge of the jungle at the Arnos Vale Estate (the Beatles liked to retreat to the nearby hotel there to work up their songs), the site's most impressive feature is an exceptionally well-preserved overshot waterwheel some 32ft. dia. by 32in. wide. It's set among towering clumps of bamboo which rise up like fountains from the creek which serves as a millstream. Alongside the waterwheel, and geared to it, is a cane-crushing mill with its three vertical rollers. On the other side of the mill stands the cast-iron framework of the galleried beam-engine that could be coupled to drive the mill when there was insufficient water to power the overshot wheel. Next to the engine stands the shell of the boiler which once steamed it.

A restaurant with pavilions and covered wooden walkways was very cleverly constructed around and about the machinery a few years ago. Where some owners like to decorate their eateries with old tools and farm implements, you could say that in this instance the proud remains of an industrial site have decorated themselves with a restaurant.

Although Tobago is a relatively small island (25 miles long by 7 miles across), sugar cane was once as intensively cultivated as the tobacco from which it takes its name. Traces have been found of 43 sugar factories, of which 25 were driven by waterwheels and 17 by windmills, with one of unknown power source. There were back-up steam engines at certainly three of the sites, but the only significant remnant of these is the one at Arnos Vale. All things considered, the engine, waterwheel and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crushing mill are miraculously preserved. Ben Russell of the Science Museum in London believes this may well be the most complete set of sugar machinery of its period in existence anywhere.

Provenance

Dating and provenance of the waterwheel could not be clearer. Its rim carries multiple copies of a cast name-plate inscribed "W. & A. McOnie & Co., Glasgow 1857". The maker's plate on the steam engine's valve chest is scarcely decipherable, apart from the word 'Glasgow' and the figures '18?7'. It therefore seems likely that the engine was also the work of McOnie, and also in all probability the crushing mill too. McOnie was one of many firms in the Glasgow area supplying a worldwide market for sugar machinery of which the British West Indies was only a small part. McOnie was in business until relatively recently and its archives are now at Glasgow University.

On the hillside just above the wheel, and at the point where the aqueduct (only its foundations remain) feeding it would have begun, stands a small pumping engine bearing the label 'W. H. Bailey & Co., Albion Works, Salford, Manchester – Lehmann's Patent no (illegible)', so it would seem that Glasgow did not have it all its own way. The function of this engine remains unclear. Some have suggested it may have been used to pump water into the aqueduct from a feed-reservoir, or possibly to keep that reservoir topped up.

All the machinery is exceptionally well made. Although crucial pieces are missing, most sadly the beam from the galleried engine and its gearing to the cane mill, it's not difficult to imagine what they would have looked like.

The mill itself is of great interest in that it has three vertical rollers, instead of the horizontal ones (permitting better control and distribution of pressure) that had become the norm by the middle of the century. Well-preserved examples of horizontal mills are on the island at Mt. St. George (maker, G. Fletcher & Co., London) and at Speyside (A. & W. Smith & Co., Glasgow). The rollers at Arnos Vale are of hollow, fabricated cast-iron construction, each about 830mm long and 510mm in diameter. The central roller is turned by the large crownwheel contrate gear above it (1,700mm dia.), and in its turn geared to the rollers on either side.

3. The gear train from the waterwheel to the crushing rollers.

4. The crown-wheel and gearing to the waterwheel photographed from the top of the beam-engine. The bevelled drive-pinion was disengaged by loosening the furthermost bearing of its drive shaft and wedging up the bearing immediately behind it.

Operation

The cane was first fed in through one pair of rollers for a coarse crush, and then back again through the other pair for a finer one. It's possible the cane may have been passed forwards and backwards through the rollers several times. The juice, or 'guarapo', was collected in a tray below from which it flowed through a sluice or pipe to a cistern in the sugar-boiling house, some of whose remains, including part of its chimney (British bricks, shipped out as ballast), are also visible at Arnos Vale. The lengthy process of crystallisation in successive large iron kettles yielded golden-brown 'muscovado' sugar which was shipped to England in hogsheads where it underwent further refining before its highly profitable sale.

McOnie's superb waterwheel is of the type invented by William Fairbairn around 1840. It's like a giant bicycle wheel in which the pairs of 28 wrought iron spokes 50mm dia. are alternatively parallel to each other or crossing and are held in tension by cotter wedges at the hub. The axle is 160mm dia., reducing to 114mm in its bearings. On the side of the wheel nearest the mill the axle rests in a half-bearing. I was puzzled by how the wheel would have been uncoupled from the mill when the latter was driven by the engine on

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5. The 28 spokes of the Fairbairn-type wheel are secured into the hubs with cotter wedges.

6. The 114mm diameter near end of the wheel's axle rests in a half-bearing, lined with gunmetal or something similar. On the far side, the axle runs in a full bearing bolted into the top of a huge rock.

7. At the near corner, the fluted Greek-style column supporting the gallery of the beam-engine is unfortunately missing, as is the beam itself. Overall the engine is about 3,375mm long by 790mm wide and 2,615mm high. The flywheel is probably not original. At the rear left can be seen one of the pavilions of the restaurant.

8. Close-up of the middle of the gallery, showing the beautifully detailed plummer blocks with central stubby column. The blocks are secured to the gallery with bolts and, at either end, with wedges.

its other side – and vice-versa. Close examination showed that it was somewhat crudely done by loosening the outermost bearing of the shaft driving the crown wheel, then wedging up the inner bearing so the pinion was lifted just clear of its engagement with the crown wheel.

Victorian elegance

In its pristine condition, the beam engine would have been a magnificent example of the art and science of the Victorian engineer. With its exquisitely panelled cast-iron base and six fluted Grecian columns supporting a finely moulded gallery, it would have been a veritable temple to the mechanical muse. It's approximately 3,375mm long, 790mm wide and 2,615mm from ground level to the top of the gallery. Even in its present corroded and lichen covered state, the wealth of mechanical-architectural design is astonishing. The pierced plummer blocks for the beam pivot, the chests for the unusual piston valves and the sadly rusted remnants of their linkages are particularly finely detailed.

The cylinder pot (480mm external diameter) is larger than one might expect. Concealed inside the bath-like base with its sculpted semi-circular end, are a further cylinder which was probably the water-pump for the boiler, and the incoming steam pipe. This would have been connected via a (missing) governor to the valve chests, but it remains unclear exactly how. The eccentric sheave for driving the valve gear is present on the crankshaft, though there's no sign of its strap and linkage to the valve chests. It seems possible that a rod from the strap activated a linkage hung from two swan-neck brackets (one of which is still in situ) attached to the top of the gallery.

The two pivots for the arms of a Watt parallel motion are plainly visible inside the gallery. Only a short section of the connecting rod remains in place on the crank-web, though another piece of it can be found leaning up against the outside of the base. It would have taken a mighty sledgehammer to have broken it. A fabricated flywheel is in place, but its incongruent utilitarian design suggests it was probably not the original one. A fragment of what may have been the original axle and hub are lying on the ground nearby. A single pinion on the crankshaft is all that remains of the gearing that would once have connected the engine to the crown-wheel driving the mill.

Rampant vegetation

The saddest loss is of course that of the beam itself. Could it have been plundered as a spare for a similar engine at one of the neighbouring estates? Around 1884 a financial depression and fall in the price of sugar (perhaps because of the cultivation of sugar-beet in temperate climates?) precipitated the demise of the sugar industry in Tobago. The Arnos Vale mill would most probably have crushed its last cane around that time. Who knows but that some souvenir hunter may have claimed an elegant neo-classical beam as his trophy? Somewhere or other it may still be adorning the wall of a private house or, who knows, even a restaurant.

All the machinery was evidently made and shipped in manageable sections. Some of the pieces are very substantial, especially the 40mm thick stanchions supporting the wheel and the rollers. It would have been a major task to have transported them on primitive donkey carts from the coast to the Arnos Vale site. Highly skilled fitters would have

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been needed to assemble the machines and get them safely up and running.

One reason why the machinery has survived so well is because its foundations are so soundly built. But they're under ever-present threat from the rampant vegetation of the tropical bush which even the proprietors of the cohabiting Waterwheel Restaurant cannot entirely control. Trees can spring up almost overnight and there's much danger from their roots. Just before one of my recent visits, a huge tree close to the boiler had to be felled because dead branches had suddenly crashed down onto the roof and balustrades of the restaurant. Vegetation is continually seeding itself in the nooks and crannies of the machinery. It's not every day you have to weed a steam engine before you can photograph it.

Further research?

Many questions remain about the Arnos Vale machinery and the functioning of its sugar factory. No drawings have yet come to light in the Glasgow archives. There is a not dissimilar galleried beam engine in the London Science Museum. Readers may well know of other engines of this kind. Further work in museums and in the Patent Office may yet uncover the original, or at least similar, designs.

My hope is that the publication of this brief account will inspire further research into these magnificent machines

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9. The engine's gallery photographed from above, with the top end of the cylinder plainly visible. In the foreground, nestling far below in the base, can be seen what was probably the top of the water-pump. At the back is part of the green roof of the restaurant.

10. The engine has what appears to be a most unusual valve chest, presumably housing piston valves, seemingly separate pairs for each end of the cylinder. Activation of the valves was by rocker arms which may have been moved by a linkage suspended from the swan-neck brackets on the top of the gallery, and ultimately connected to the pierced eccentric sheave on the main crankshaft. The maker's plate is just visible framed by the decorative moulding on the right-hand bottom section of the valve chest.

11. Close-up of the rocker arms for the valves with, on the top of the gallery, one of the pair of swan-neck brackets from which an activating linkage would probably have been suspended.

and that it may encourage someone to construct a working model of the installation. Maybe two models, for only the barest information about this important historical site is currently available there. It could well be that the proprietor might be interested in commissioning a functioning model for permanent display at the restaurant, thereby greatly increasing its attractiveness to visitors.

I will gladly make available my own investigations and extensive photo-documentation of the machinery. Best of all would be for anyone interested to begin by planning their own Tobago holiday around a visit to this hauntingly beautiful site and its testimony to the genius of British engineering in the Victorian age. Return flights by Excel Airways are to be had for as little as £312.

I warmly acknowledge my indebtedness to Edward Hernandez, curator of the Tobago Museum, to a conservation proposal for the site prepared by the University of Florida (1988), to a dissertation on the industrial archaeology of Tobago by Thomas Hales Eubanks (1992), and to the Archives of Glasgow University. **ME**

NEW SERIES

3-CYLINDER RADIAL ENGINE

PART 1

Les Kerr from Australia gives details of a delightful radial engine well suited to the less experienced and experienced alike.

The first time I saw the concept of using the crankshaft and its housing to provide valve action was in a single-cylinder engine designed by the Rev. Canon Ron Dyson. In this engine, a flat was ground into the crankshaft. As the crankshaft rotated, the flat aligned with two holes drilled along the axis of its housing effectively connecting the two holes together. If steam was connected to one hole and the other to the top of a cylinder containing a piston, then the piston would move down. As the crankshaft rotated, the holes would no longer align with the slot cutting off the steam flow. A similar slot and holes provided the valve action for the exhaust cycle.

John Symons developed the concept further making a twin and a 3-cylinder version. In his 3-cylinder version, the crankshaft was stationary with the cylinders rotating about it.

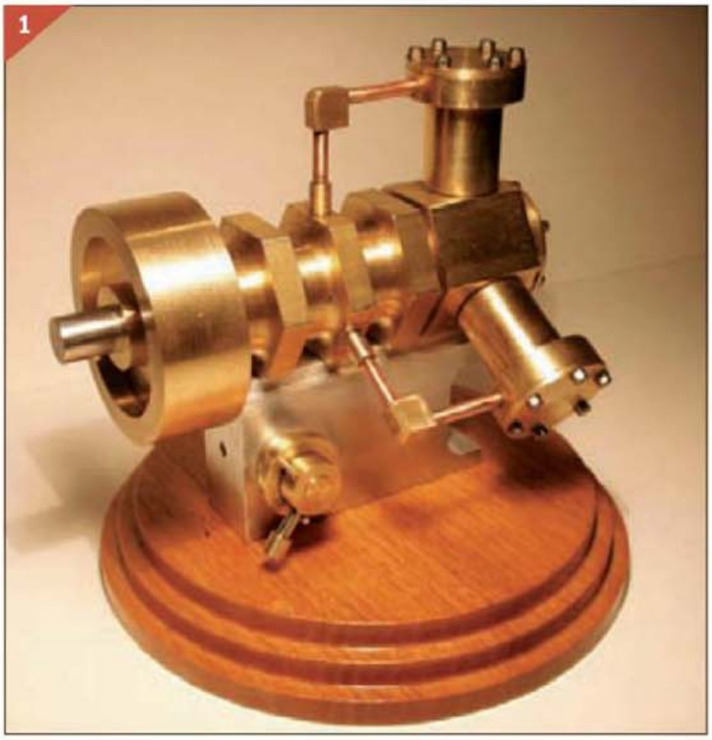
I decided to design a new 3-cylinder radial engine in which the cylinders remained stationary and the crankshaft rotated. **Photos 1** to **3** show various views of the engine.

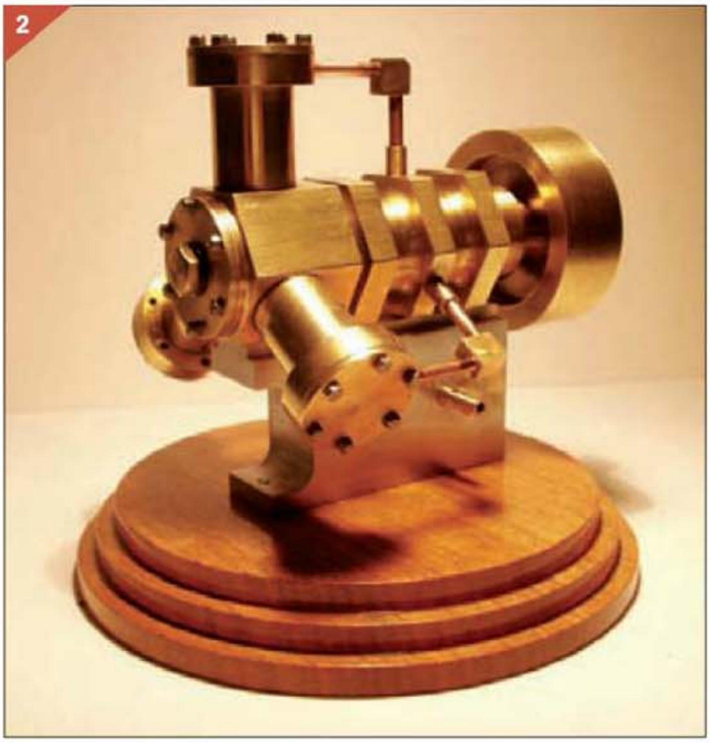
The advantages of this design are that it is self-starting, balanced, made from standard bar stock and can be reversed by the operation of a lever.

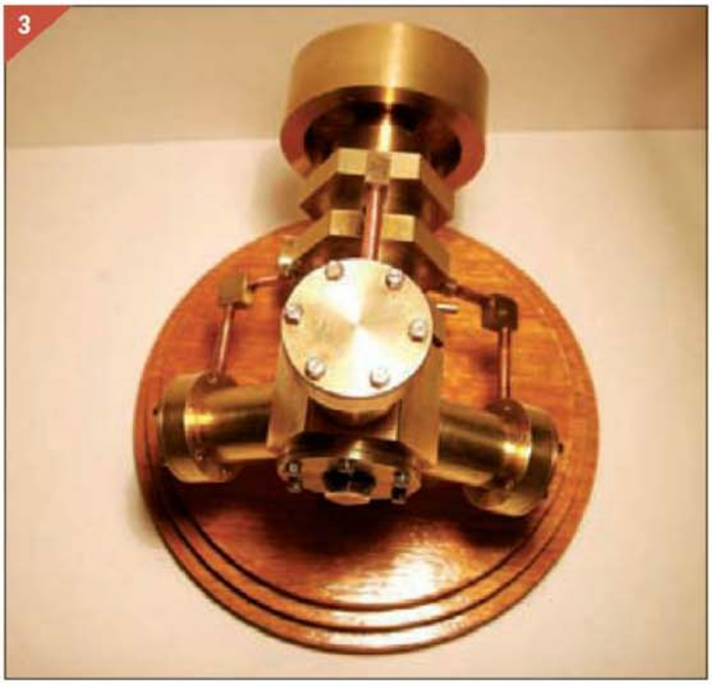
Probably the best place to start is with the crankshaft. If you look at **fig 1** you will notice that there is a groove on the left that has a connecting passageway to a flat ground into the top of the shaft. A similar groove on the right connects to a flat, this time on the bottom of the shaft. These flats are offset from each other by 180 degrees. If the shaft is now placed in the engine (see **fig 2**) we find that we have an inlet port aligning with the groove on the left and an outlet port with the groove on the right. Around the circumference of the centre line of the flats three holes offset by 120deg. are each connected to the top of its adjacent cylinder by pipe. As the crankshaft rotates, the inlet and outlet ports in turn connect to each cylinder.

To fully understand the complete cycle, **fig 3** shows the position of the cylinders and the inlet and outlet flats on the crankshaft at -45deg. intervals of rotation. If the ports are connected as shown the direction of rotation will be anti-clockwise. If we follow cylinder 1 we see that it is at the top at 0deg. and is connected to the inlet port, the result is that the piston is driven to bottom dead centre just after -45 degrees. It remains near bottom dead centre until just after -135deg. at which time it is connected to the outlet port. It remains

1 to 3. Three views of the 3-cylinder radial engine built by the author.







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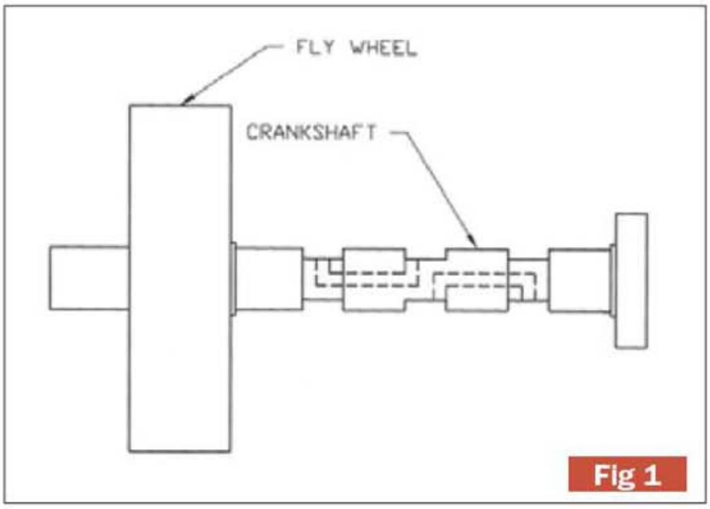


Fig 1

connected to the outlet port until just after -225deg. at which time it has reached top dead centre. It remains near top dead centre until just before -315deg. at which time it is again connected to the inlet port starting its downward movement once again.

Construction

The best place to start is by obtaining a 6in. length of 3/8in. dia. 304 stainless steel with an excellent surface finish. This will be used for the crankshaft but as its fit in the engine housing determines how efficiently the engine runs we will make the engine housing first. Its diameter should be as close to 3/8in. as possible.

Engine Housing (Item 1)

Take a 4in. length of 1.25in. across the flats hexagonal brass bar and, using the 3-jaw chuck on the lathe, set it to run as true as possible. Centre drill the end and, using tailstock support, turn the outside profile as shown on the drawing. I used a 6mm wheel profile tool to obtain the curved shape.

Next, using a drill chuck fitted in the tailstock, drill a 6mm dia. hole into the end for a distance of 3.5 inches. Note, to prevent drills from catching in brass the cutting edges should be blunted by grinding a chamfer onto them.

Enlarge the hole to 23/64in. dia. then ream out to 3/8 inch. Now try the 3/8in. dia. crankshaft rod for fit. If you are lucky then it should fit tightly in the 3/8in. hole. If it is a sloppy fit then the only solution is to try and find a piece of rod that is slightly larger in diameter. Later on we will lap the hole for a nice running fit with the crankshaft.

Now bore out the hole to 0.875in. dia. to a depth of 0.844 inch.

Transfer the work, still in the chuck, onto the dividing head set up on the milling machine and, using the dial gauge, set one surface of the hexagonal bar to be exactly horizontal. Drill the 5/8in. dia. hole for the cylinder then rotate the head 120deg. for the second cylinder hole and again 120deg. for the third. Repeat the procedure for the three valve port holes. Rotate the head 60deg. then drill the inlet ports and drill and >>

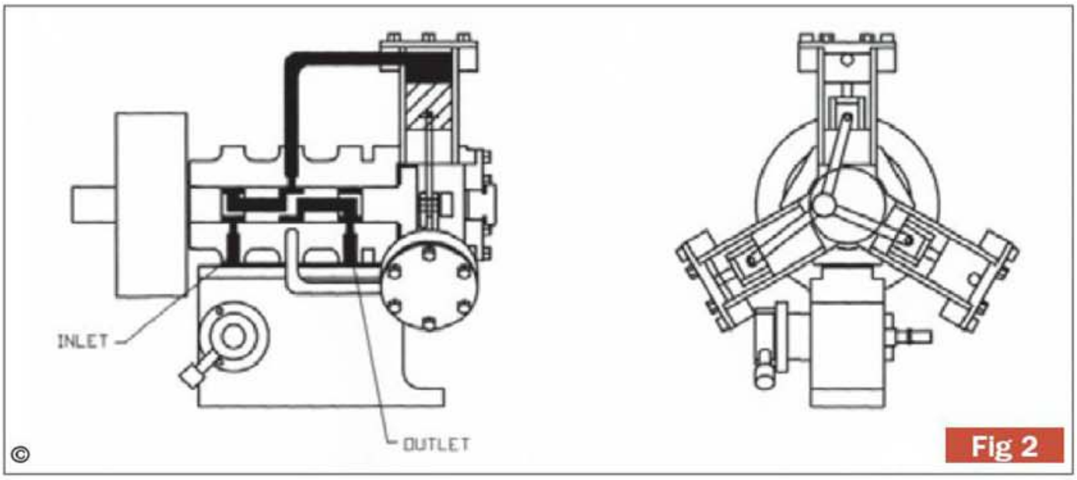


Fig 2

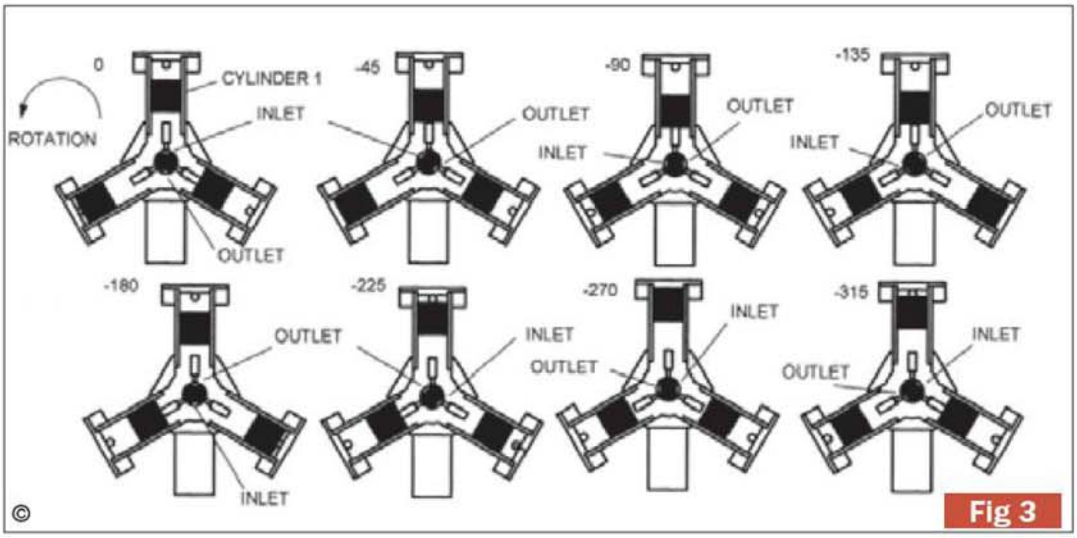
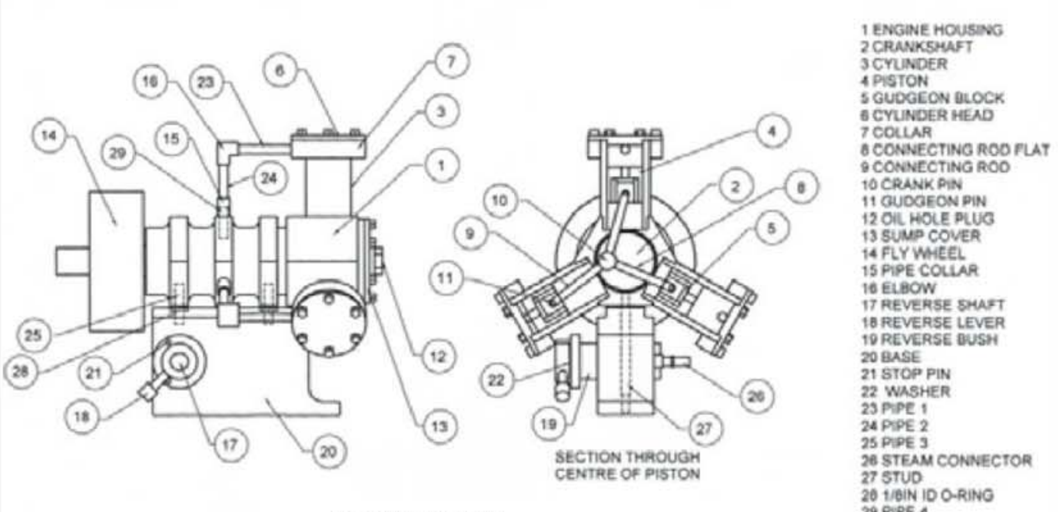
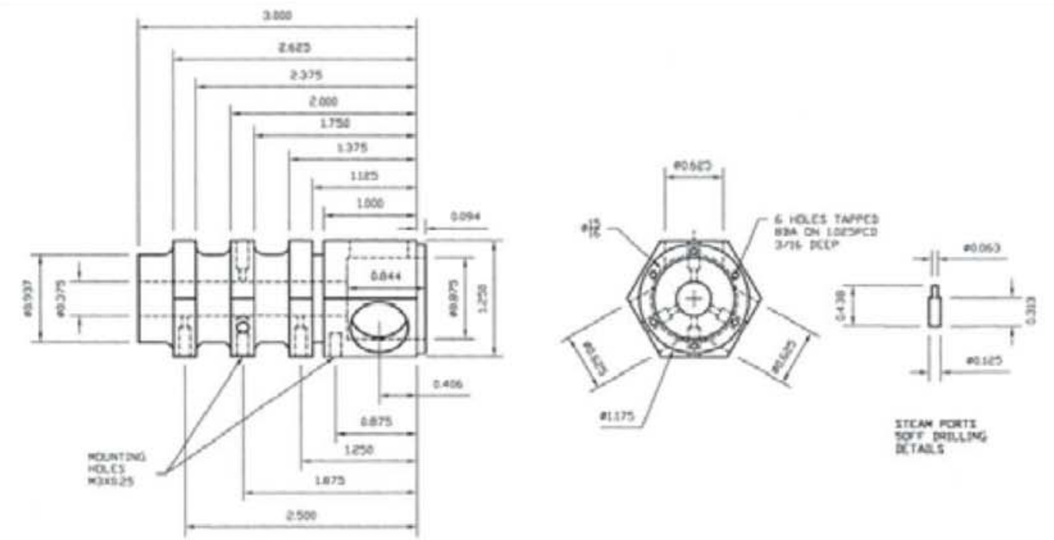


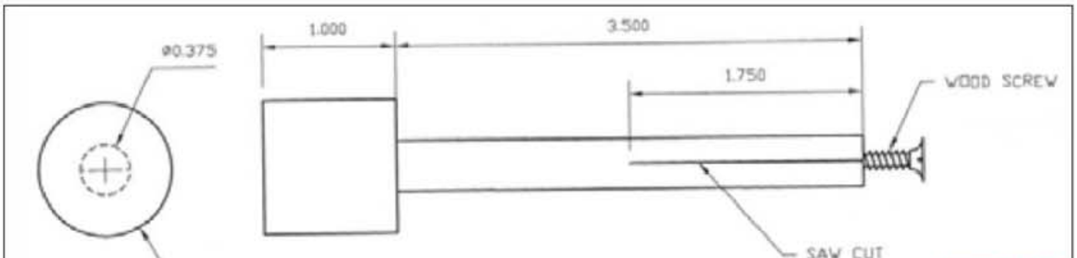
Fig 3



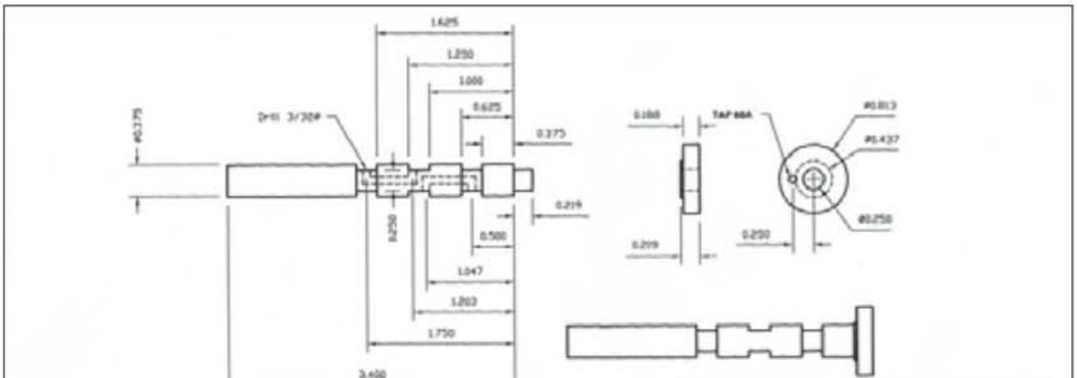
© **ASSEMBLY DRAWING**



© **ITEM 1 ENGINE HOUSING**



© **Fig 4**



© **ITEM 2 CRANKSHAFT**

tap the mounting holes. All that is left are the six 8BA tapped holes for the sump cover. These were made by placing the dividing head horizontal on the milling machines table.

To lap the crankshaft hole I made a lap from hardwood (see **fig 4**). I loaded the lap with very fine valve grinding paste and oil, mounted it on the lathe, slid on the engine housing and adjusted the screw so I could just turn the housing by hand. Running the lathe at low speed and preventing the housing from rotating I slid it back and forth along the axis of the hole, at all times taking care to ensure the lap remained in the housing.

After about a minute, I reversed the housing and repeated the procedure for a further minute. I then cleaned all the grinding paste from the hole and tried the crankshaft fit. I kept repeating the process until the crankshaft rotated smoothly in the housing with minimal play.

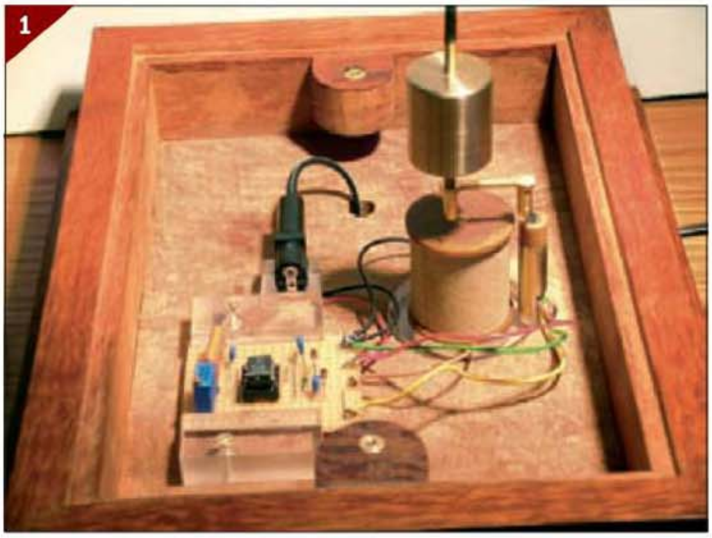
Crankshaft (Item 2)

Take the 6in. length of $^3/_8$in. dia. rod and mount it in the 4-jaw chuck so that approximately 1in. protrudes. Using the dial gauge adjust the chuck so that the rod runs true. Be careful not to over-tighten the jaws as the last thing you want is to score the surface of the rod. Using a $^1/_8$in. dia. centre drill, centre the end. Turn down the end to $^1/_4$in. dia. for $^7/_{32}$in. and cut the $^1/_4$in. wide groove. Undo two jaws of the chuck and adjust the rod so that approximately $2^1/_4$in. now protrudes. Again using the dial gauge set the rod to run true. Using tailstock support machine the second $^1/_4$in. wide groove.

Transfer the job still in the chuck onto the dividing head. Set up the work so it is horizontal on the milling machine. Using a new slot drill and supporting the end, mill the $^1/_4$in. wide flat on the crankshaft. Be very precise with the depth as this dimension affects the timing of the engine.

To be continued.

New Pendulum drive system



Richard Stephen describes an improved pendulum drive system for the magnetic drive clock recently described in these pages.

1. Drive set-up.

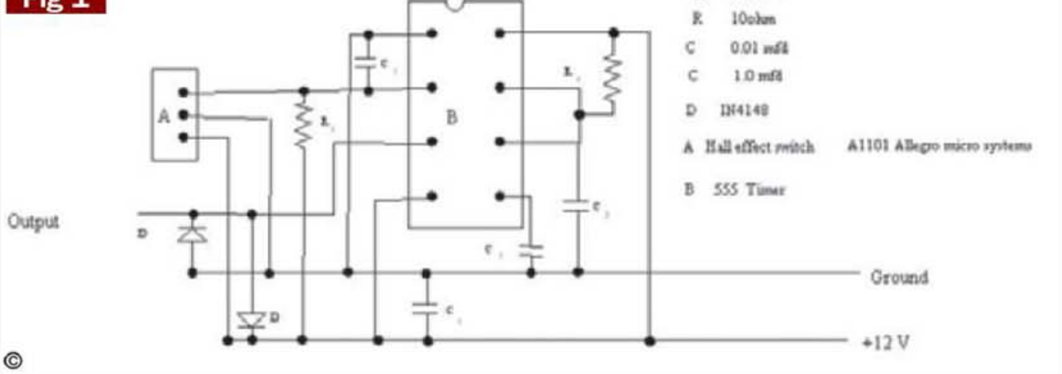
Fig 1. New drive circuit.

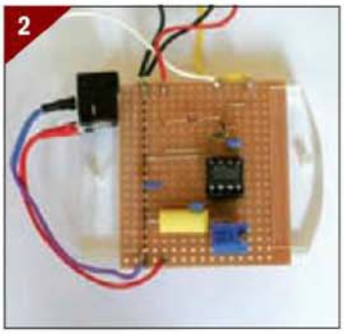
Since completing the writing up of the clock described in the recent series I have been developing a new drive system for the pendulum. This has required quite a lot of experimentation to sort out all the minor problems associated with the new drive circuit. The circuit originally described works very reliably, however it does have the drawback of being rather difficult to regulate the clock. With the original circuit the period of the pendulum is determined by the duration of the first delay in the circuit. For a half second pendulum this must be set at exactly 500 ms. The pendulum is then simply a slave as it is forced to follow the circuit delay. It was this aspect that prompted me to see if it was possible to modify the drive system so that the pendulum controlled the circuit and the generation of the impulse delivered to the pendulum to keep it swinging. The new drive system is illustrated in **photo 1** and the details of the drive circuit shown in **fig 1**. In photo 1 there is now only a drive coil, the sensing coil used in the previous circuit has been replaced by a device called a Hall effect switch. The Hall effect switch has be set in the top of the 8mm dia. brass post positioned directly behind the drive coil in photo 1. The Hall effect sensor used in the switch is sensitive to a south (S) magnetic pole. In the position shown for the Hall effect switch the magnetic field generated by the drive coil has no effect on the switch. The pendulum has now been fitted with two magnets, the one attached at the end of the pendulum rod is the drive magnet that impulses the pendulum. A second switching magnet is attached to an arm fixed to the pendulum rod. As the pendulum swings the rear magnet passes over to centre of the brass post containing the Hall effect switch. The Hall effect switch used in the drive circuit will only switch when a S magnetic pole passes over the surface of the device. The output of the Hall switch, in the absence of a S magnetic pole, is held at +12V, the circuit line voltage. When the switching magnet passes over the Hall device the output is momentarily grounded (i.e. fall to 0 volts). The negative voltage change triggers the 555 timer in the drive circuit. The output pulse of the 555 timer, turned on for a time set by the values of R1 and C1, energises the drive coil and impulses the pendulum.

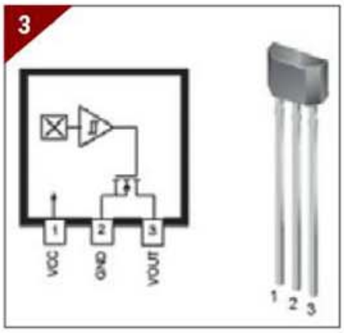
When I was experimenting with the above circuit I experienced the following unexpected problem. As the pendulum swings across the brass base plate of the clock as illustrated in the series, the drive and switching magnets induce in the surface of the plate circulating electric currents, referred to as eddy currents. In exactly the same way as the drive current that flows through the windings of the drive coil induce a magnetic field the circulating eddy currents also induce a magnetic field. These eddy current magnetic fields oppose the motion of the pendulum or in effect reduce the effective impulse delivered to the pendulum. These eddy currents will also affect the switching of the Hall effect sensor. I was aware of the effect the eddy currents could have on the switching of the Hall effect sensor when I started to experiment with the drive system. To overcome this problem the sensor was exposed, flush with the surface of the base plate. Fortunately the drive coil I had made was large enough and had sufficient number of turns of wire to generate a pendulum impulse of sufficient magnitude to swamp the opposing eddy current fields.

I have since been experimenting with the overall design of the clock and have made a slightly smaller version >>

Fig 1







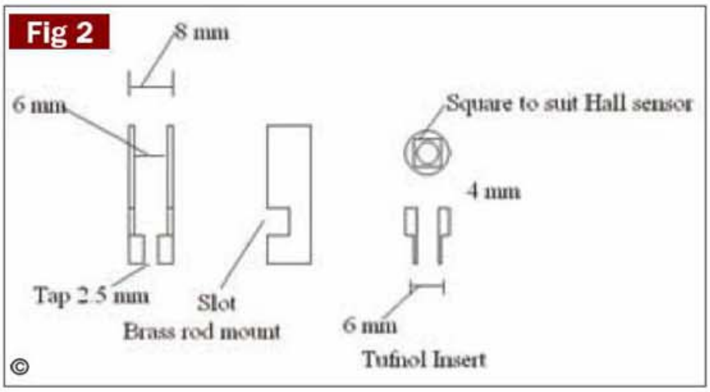


Fig 2

2.Circuit component layout.
3. Hall effect switch connections.
4. Hall effect mounting.
Fig 2. Hall effect mount.
Fig 3. Coil support.
Fig 3a. Base cut-out.

of the clock. I reduced the size of the drive coil in order to fit it in the smaller wooden base I made. The coil was more than adequate to drive the pendulum when I tested the circuit in the absence of the brass base. With the base plate fitted the pendulum simply stopped. There were two possible solutions to the problem of the eddy current braking of the pendulum. Increase the size of the drive coil or replace the brass base plate with a one made from a non-conducting material. In fact I have done both. The base plate has been made of the same wood as the wooden base. This has enabled me to secrete both the coil and the Hall effect sensor in the base. The wooden base plate solved the problem of eddy current braking but created another problem. I found that it was very difficult to regulate the pendulum amplitude. Over time the amplitude would slowly increase until it was so large that the pin (or ratchet) wheel rotated past two pins (or teeth) instead of only a single one. I spent some time trying to adjust the drive but was not able to get the pendulum amplitude to remain constant. It eventually occurred to me (in the middle of the night!) that the eddy currents induced in the brass base which I had considered a problem could actually be the solution for regulating the amplitude. I placed a small piece of 1.5mm brass sheet on the surface of the wooden base on both sides of the pendulum. By adjusting the positions of the pieces of brass I was able to regulate the amplitude by inducing the appropriate amount of eddy current braking and so prevent the problem of double pulsing. I still need to fit the two pieces of brass in the wooden base plate.

Moving house to the Channel Islands has halted all work in the workshop. I should be up and running again quite soon. I have also tested the clock with the brass base plate, the impulse is now sufficient to overcome the eddy current braking of the pendulum.

Adjusting the pendulum amplitude

The amplitude of swing of the pendulum depends on the size of the impulse delivered to the pendulum. As the switching magnet swings over the Hall effect device the 555 timer is turned on. The voltage pulse generated is applied to the drive coil and a magnetic field is generated by the electric current flowing through the coil. Suppose that the direction of the current flow in the coil produces a S magnetic pole at the top of the coil. A S magnetic pole at the end of the pendulum placed in the coil field will be repelled away from the centre of the coil and will impulse the pendulum. If the coil connections were reversed and a north (N) pole generated at the top of the coil the drive magnet at the end of the pendulum would also have to be reversed in order to have a N pole at the end of the pendulum rod.

The magnitude of the pendulum impulse depends on four basic factors, the size and strength of the drive magnet, the size, number of turns in the drive coil and the circuit line voltage, the 555 timer pulse duration and lastly the distance between the drive magnet and the surface of the coil. The last factor occurs because the strength of a magnetic field decreases as the distance away from the pole increases.

Constructing the Hall effect drive system

The circuit diagram for the drive system is illustrated in fig 1. It is a relatively simple circuit to construct. If you have not used a 555 timer before it would be worth consulting the wealth of information on 555 timers available on the Internet. I made up my circuit on a piece of strip board (Vero board). To do a neat soldering job on strip board a needlepoint soldering iron is, I have found, essential. The layout of the components on the board is illustrated in **photo 2**.

The Hall effect sensor connections are illustrated in **photo 3**. The flat surface of the sensor is the switching surface and this surface must be placed uppermost across which the switching magnet passes. In photo 1 the sensor is shown placed at the top of an 8mm mounting tube. To fit the sensor in this position the three leads of the sensor need to be bent at 90deg. to the active surface of the sensor. As the sensor is placed some distance from the circuit board the leads of the sensor have to be extended by soldering to each lead a length of light PVC-covered stranded wire. Use red green and yellow wire for VCC (12V), ground (0V) and the output. Solder on the wires before you bend the leads. The solder joints and the exposed leads of the sensor must be insulated to prevent the leads shorting. You will need to find some fine wall sheathing for this. I used some fine PVC tube which I stretched to reduce its diameter to achieve the required diameter.

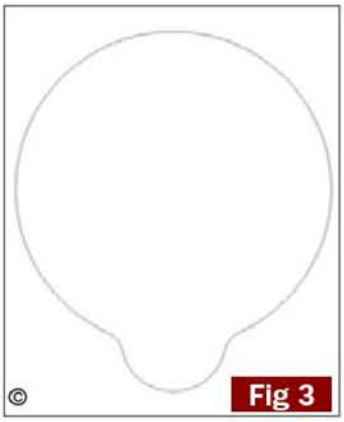


Fig 3

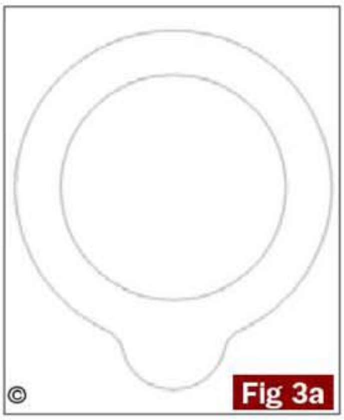
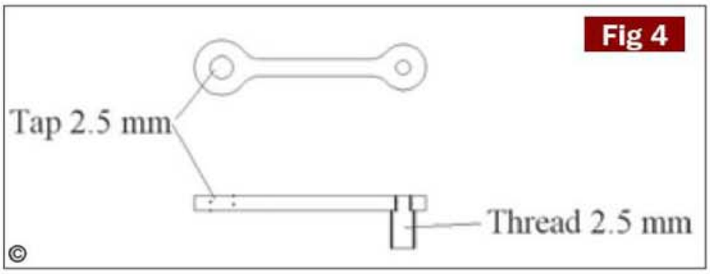
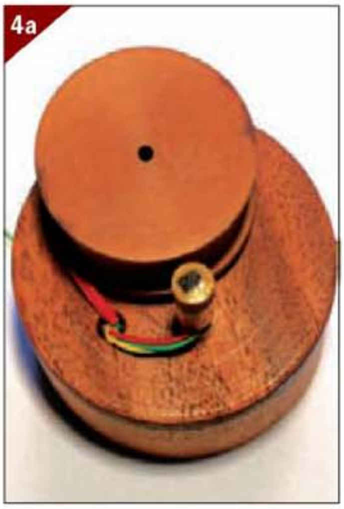
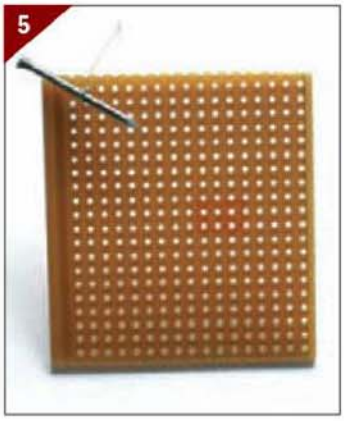


Fig 3a







5. Forming the connections.
6. Testing the pendulum drive.
Fig 4. Magnet arm.

The Hall effect sensor is fitted into a short length of 8mm dia. Tufnol rod (see **photo 4**). If you don't have any rod you can turn up a piece out of an off cut of 12mm thick sheet. You could use grey PVC rod if you can't find any Tufnol. The details of the mounting tube are illustrated in **fig 2**. The square at the end of the piece of Tufnol can be formed either with a square punch or using a suitable file. The other end of the Tufnol rod is turned down to 7mm dia. to fit into the end of the brass section. Bend the leads at 90deg. and fit the Hall effect sensor in place. Glue the sensor in position with slow set epoxy resin. The brass section of the mount is made from a length of 8mm brass rod. The overall length of the mount has not been shown as this will depend on the dimensions of the wooden base of the clock. It is essential that the Hall effect sensor be flush with the surface of the brass base plate or at the same height as the drive coil if a wooden base is used. Drill a 7mm dia. hole leaving about 6mm at the one end. This is then drilled and tapped for a 2.5mm mounting screw. A 6mm slot is cut in the side as shown for the wires for the sensor leads to exit.

The Hall effect sensor is placed adjacent to the drive coil (see **photo 4a**). Fortunately in this position the sensor is unaffected by the magnetic field generated by the drive coil. Photograph 1 illustrates the mounting of the drive coil and the Hall effect sensor. The details of the support are shown in **fig 3**. I made my support out of a scrap of 10mm thick Perspex. The support fits into a recess, of the same shape as the support, in the bottom of the wooden base of the clock. I used CNC to cut out the support and to mill the recess in the base for the clock. I have not given any dimensions for the support as these will depend on the dimensions of the drive coil and the wooden base. If you are using a brass base plate for the clock a recess will have to be milled on the base plate. For a 3mm base plate the recess for the coil will need to be approximately 2.5mm deep. The Hall effect sensor will have to be just over 0.5mm higher than the top of the drive coil so that it can just project through the brass base plate (**fig 3a**).

Assembling the circuit

The circuit board is not difficult to assemble. The component layout is illustrated in photo 2. You will need a needle point soldering iron and some resin cored solder. Apart from the components listed on the circuit diagram you will need about 1m of 24swg tinned copper wire, an 8-pin dil socket for the 555 timer and a piece of strip board 50 x 50 millimetres.

Begin by stretching the length of copper wire to straighten it and then cut it into three 30mm lengths. The 8-pin dil socket is soldered in place first. Position the socket in the centre of the board and hold it in place with a piece of masking tape. The tracks between the pins of the socket must first be cut through. This is best done with a sharp 4mm dia. twist drill. Make sure after cutting the tracks that there are no tiny pieces of copper track that could cause a short. Solder the socket in place using the minimum amount of solder to ensure a good connection. Orientate the board so that pin 1 and pin 8 are on the right-hand side and pin 1 uppermost. Count three tracks in from the left of the board and draw a line using a black, indelible, felt tip pen from top to bottom on the upper surface of the board. This track will be the ground or 0V line. Count a further three tracks in and draw a red line. This track will be the 12 V line. These lines I find very useful when assembling a board. Connections to the 0V and 12 V lines at both ends of the tracks are added next. **Photograph 5** illustrates how to form the most satisfactory type of connection to track board. Using a tapered broach enlarge the holes at both ends of the two tracks. Double over a 50mm length of copper wire in the middle and push the two ends into the enlarged holes. Push a piece of 1.5mm rod through the loop formed in the wire. Grip the ends of the copper wire and pull hard to form a neat round wire loop and solder the wire to the track. Trim off the excess wire. Further similar connection will need to be added later to connect the coil and the Hall effect switch.

Using suitable lengths of copper wire connect pin 4 and pin 8 of the socket to the 12 V line. Leave one hole vacant when making the connection for pin 8. Connect pin 1 to the 0 V line. Next connect pins 6 and 7 together with a loop of wire. Use masking tape to hold the wires in place when soldering them. Next connect a 10nf capacitor between pin 5 and 0 Volt. Connect the 1nf capacitor between pin 6 and 0 Volts. The variable trim potentiometer is added next. The resistance value required depends on the pendulum period. For a seconds pendulum use a 500ohm trim pot and for a ½ second pendulum use a 250ohm trim pot. Solder the trim pot connections to pins 8, 7 and 6. Note pins 6 and 7 are already connected which means that the variable resistance is only between pin 8 and pins 6 and 7. This completes the connections to this end of the board.

The Hall effect switch requires a 10ohm pull-up resistor connected between the output of the device (lead 3) and the 12V input voltage (lead 1). The output of the Hall switch is connected to the input of the 555 timer (pin 2). The pull-up resistor is connected between pin 2 and pin 4 (previously connected to 12V). Use a 0.125 Watt rated resistor for the pull-up. The Hall effect switch also requires two 10nf by-pass capacitors. These capacitors are connected between the output and ground (0V) (leads 2 and 3) and between the input voltage and ground (leads 1 and 2) of the Hall device. The appropriate connections on the board are between pin 2 and pin 1 for the first by-pass capacitor and between the 12V and 0V lines.

Finally, the two protection diodes have to be fitted. If the diodes are examined you will observe that there is a black band on one end of the diode. This band corresponds with the line on the drawing of the diode in the circuit diagram and is the » positive end of the diode. The diodes are connected between ground and pin 3 the output of the 555 timer and the second diode between pin 3 and the 12V line. When soldering in the diodes keep the leads at least 6mm long.

Attach connection loops to the board to pin 3 the timer output. As the input to the timer is on pin 2 the connector loop is move to one side a few holes and connected to pin 2 by a length of copper wire (see photo 2). This completes the board.

Before testing the board carefully check all the connections against the circuit diagram. Then check all the solder joints making sure that there are no 'dry' joints and there are no shorts between any of the copper tracks.

Mounting the board

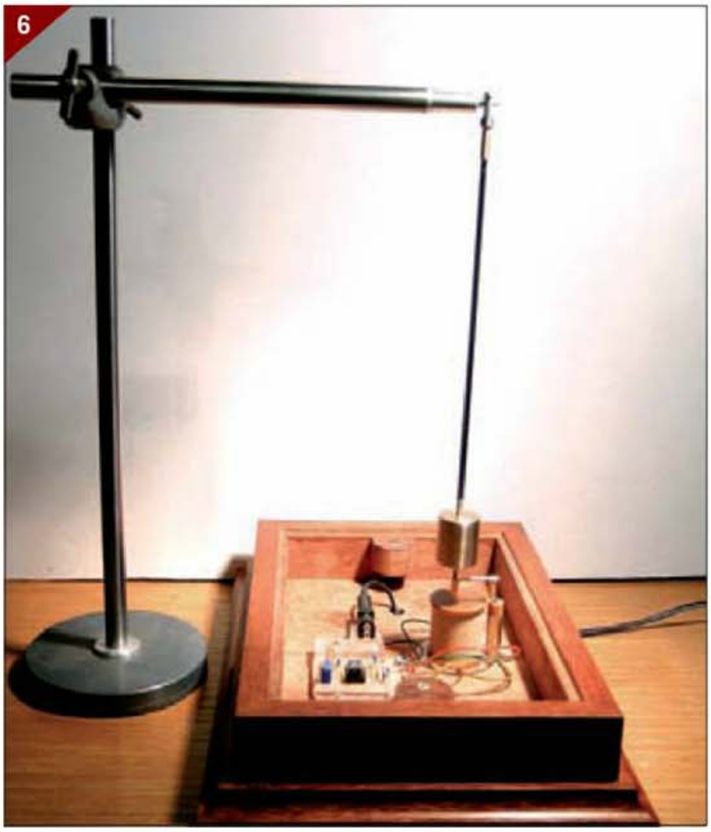
The board is mounted between two pieces of 12mm Perspex. Cut and mill two pieces of 12mm Perspex 50mm long and 12mm wide. Mill a 3mm deep slot in the middle of the long side of each piece 1.5mm wide using a slot drill. The board will be a nice tight fit in these slots (see photo 2). Drill a 2.5mm hole in each piece for the 2.5mm screws to attach the board to the base. The power supply for the board is a 12 V regulated DC mains adaptor. To connect the power supply to the board you will need a socket that fits the plug on the end of the power supply lead. This socket is glued to one of the Perspex pieces (see photo 2) with super glue. Connect the socket to the lower board connectors (see photo 2). Connect the Hall effect switch to the board, the output to pin 2, VCC to 12V and ground to ground. The ground line of the coil has also to be connected. Bare the ends of the two ground lines and twist together and solder to the loop connector. The remaining coil connection is attached to pin 3. The board is now ready for testing.

Testing the board

To test the board you will need to use an oscilloscope. Do not insert the 555 timer into the socket to begin with. Connect the 'scope ground to the ground on the board and the live lead to pin 2, the output of the Hall switch. Turn on the power. The 'scope should read 12 V. Pass a S pole of a magnet over the Hall switch. The 'scope beam should drop to 0 V and return to 12 V after the magnet is removed. This indicates that the switch is functioning correctly. Turn off the power and insert the 555 timer. Connect the live 'scope lead to the output of the 555, pin 3. Using a small screwdriver set the trim pot to the middle of its range. Turn on the power again. The beam of the 'scope will be at zero. Pass the S pole of the magnet over the Hall switch. A 12V pulse of duration set by the trim pot resistance should be seen. For a 500ohm pot the width will vary between 0 and 500ms. This indicates that the circuit is functioning correctly. You now need to check that the drive coil is generating a magnetic field of the correct polarity to repel a S magnetic pole. Suspend a magnet on piece of thread at the side of the coil, level with the top of the coil. If the coil connections are correct the magnet will be repelled. If it is attracted the connections to the coil will need to interchanged.

The drive, switching magnets and magnet arm

Neodymium magnets are the best to use for the drive and switching magnets. These are available on ebay at a very reasonable price. A 5 x 5mm cylindrical magnet is ideal for the switching magnet as this will operate the Hall switch up to 6mm from the device. For the drive magnet you will need to experiment with the size to find one that will give the appropriate pendulum amplitude. A 4 x 3mm cylindrical magnet is a reasonable start. The design of the magnet arm is shown in **fig 4**. The dimensions will depend on the distance between the centre of the coil and the centre of the Hall device. I used 1.6mm engraving brass for my arm. A 5mm length of 2.5mm screw rod is attached to one end of the arm to attach the switching magnet. The design of the magnet holders has been given in the clock series.



6

6. Testing the pendulum drive.

Getting the clock running

The pendulum amplitude needs to be approximately + - 4 degrees. This allows the pendulum to rotate the pin wheel just enough for the catch to lift over one pin in the wheel. If the pendulum amplitude is much larger than 4deg. the catch may well lift over 2 pins. To avoid this problem the pendulum impulse need to be set at just the right value. Begin with the pendulum swinging on its own suspended as illustrated in photo 6. The pendulum swings on a 1.5mm pivot at the end of the horizontal bar in Fig (10). To attach the pendulum to the 1.5mm pivot a modified arbor clamp (see the series) bored 4mm to hold a 1.5mm I/D. ball race. The Hall effect sensor will trigger reliably with a 5mm dia. x 5mm cylindrical neodymium magnet at a distance of up to 6 millimetres. I usually set the distance at about 3 millimetres.

The size of the drive magnet required depends on the circuit line voltage. For a 12V supply a 4mm dia. by 3mm neodymium is a good starting size. Begin with the magnet about 1mm above the coil. Turn on the power and swing the pendulum. The pendulum will not start of its own accord. Increase the drive pulse width until the pendulum starts to impulse. It is likely that the amplitude will increase beyond 4 degrees.

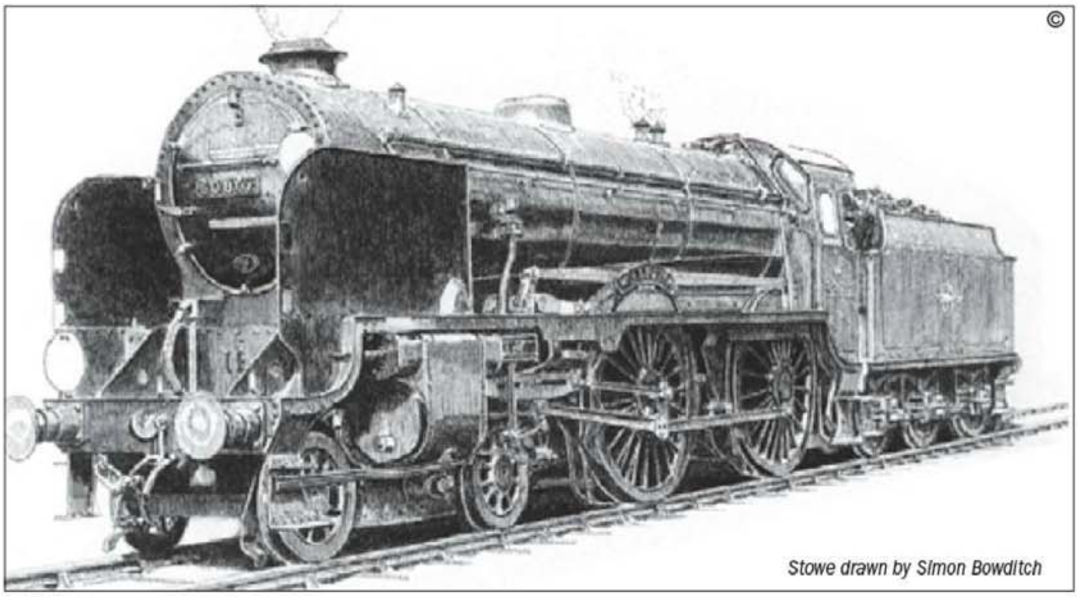
To decrease the amplitude the size of the drive magnet can be reduced as well as increasing the distance of the drive magnet above the coil. The switching magnet must remain at about 3mm above the Hall effect switch. Neodymium magnets are sintered and are quite hard. The can be easily machined in the lathe using a sharp carbide tool. By carefully adjusting the size of the magnet, the height above the coil and the drive pulse width the amplitude can be set to the required value. This can take some time and adjustment. **ME**

STOWE SOUTHERN RAILWAY Schools class locomotive

PART 14

Continued from page 208 (M.E. 4306, 17 August 2007)

Neville Evans describes the smokebox and smokebox door for *Stowe* before re-evaluating his predictions on 'the shape of things to come'.



Stowe drawn by Simon Bowditch

The Schools class smokebox is a slightly larger version of the smokeboxes fitted to the two Highland locomotives that were described a few years ago. A successful feature of these artifacts was that they were provided with separate flat floors, which dramatically simplified the fitting and sealing of such things as the exhaust pipes and the steam pipes. The new locomotive follows these principles and should present no problems in manufacture.

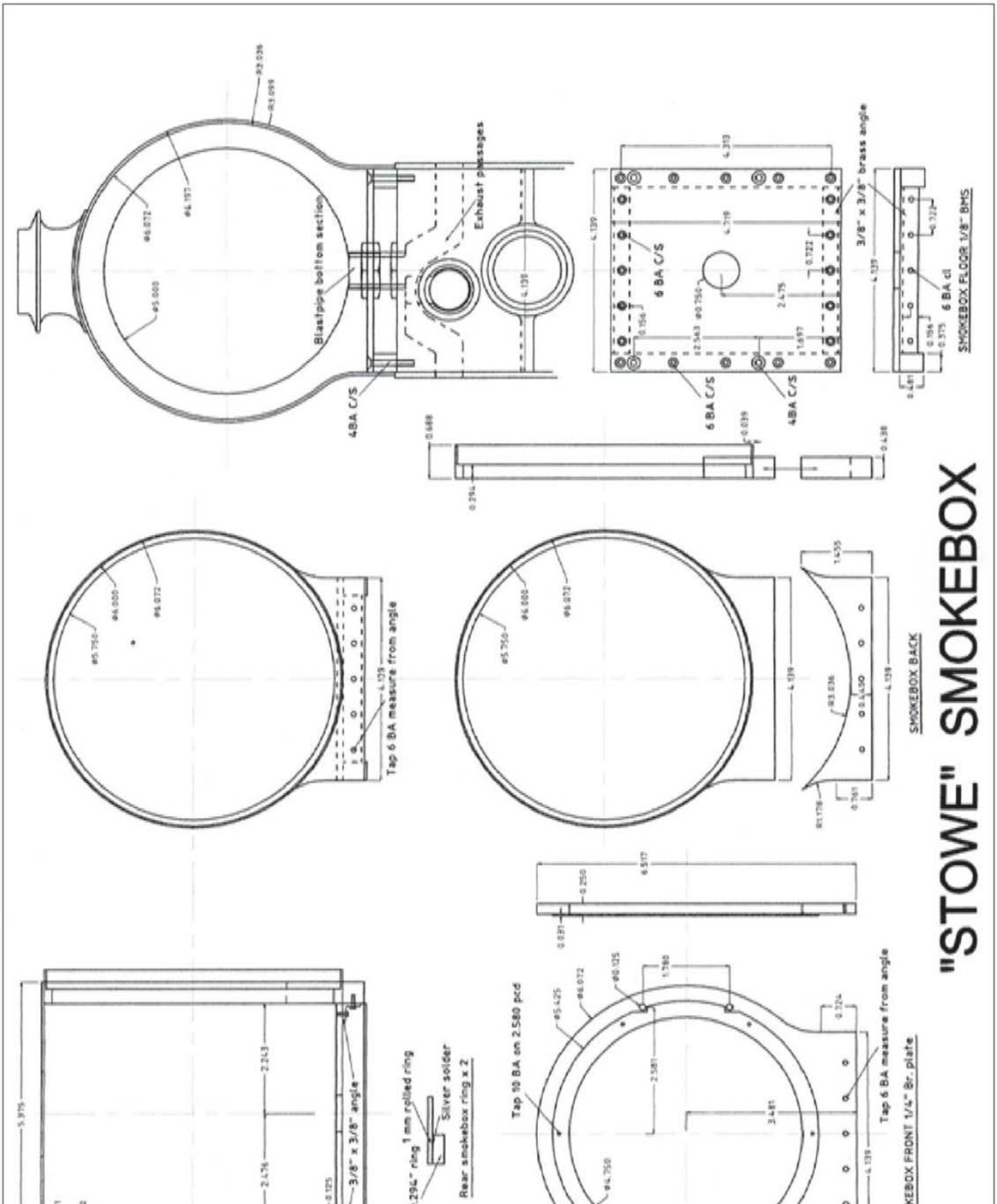
The outer shell is formed from a piece of $^1/_{16}$in. brass sheet, cut and rolled to the dimensions shown. I must say that I found no difficulty in forming my 'Loch' smokebox by hand. I first annealed the sheet by heating it uniformly to a dull red. I did this job on a dull evening so that it was easier to spot the slight colour change. Don't overdo it or you will run the risk of damaging the brass. I always allow brass to cool naturally so that there is less risk of distortion. You will need a plate 5.375 x 20in. which will allow some trimming of the bottom edges after bending.

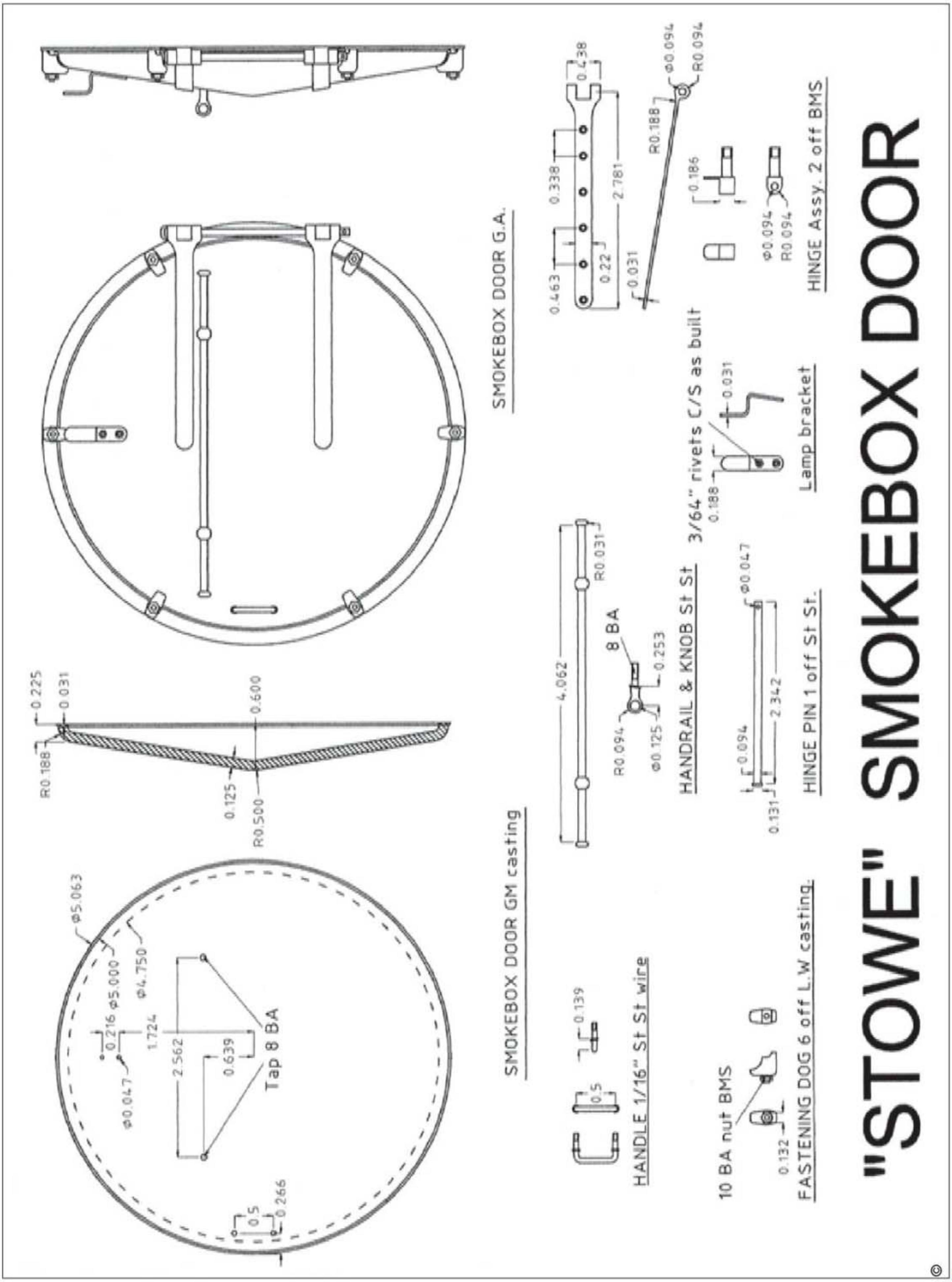
Before grappling with the metal however, it will be necessary to make the smokebox front and rear pieces. The front may be available as a laser cut item, which will save a lot of work, in hacking it from a $^1/_4$in. thick brass plate. The rear ring is due to Derek Tulley. We were in conference over the Edison-Bell apparatus the other day regarding the fragility of the $^1/_{32}$in. thickness of this part, how to make it, etc. when he pointed out that it would be quite easy to simply bend a couple of rings up and silver solder them together. Quite right mate, just bend the thin ring around the barrel, butt joint it and bend up the $^1/_8$in. bit to suit, as per the art-work.

Before starting on the shell, find a cylinder, pipe or what-have-you, 6in. in diameter, and bend it around that. Offer the job up to the drawing until you are sure that you've formed enough to go round and then put in one of the bottom bends around a 2in. bar, holding the job the while in a smooth jawed vice. Do likewise for the other side and trim off to size. Place the front plate on a flat surface (don't forget the $^1/_{32}$in. ring) drop the shell over it, clamp across and put a small countersunk screw in the top. Squeeze the sides up to the front clamping and screwing at about 2in. intervals, as before. Don't put the countersink in more than is required to hold the screw and not as deep as the screw slots. File the screw heads off flush with the wrapper and finish off by fluxing inside the joint and running in soft solder. *Ditto repeato* for the back end which, although different in detail, follows the same principles. I always drill large holes for blast pipes and similar after bending to ensure a uniform bend and to form a hole that is truly circular.

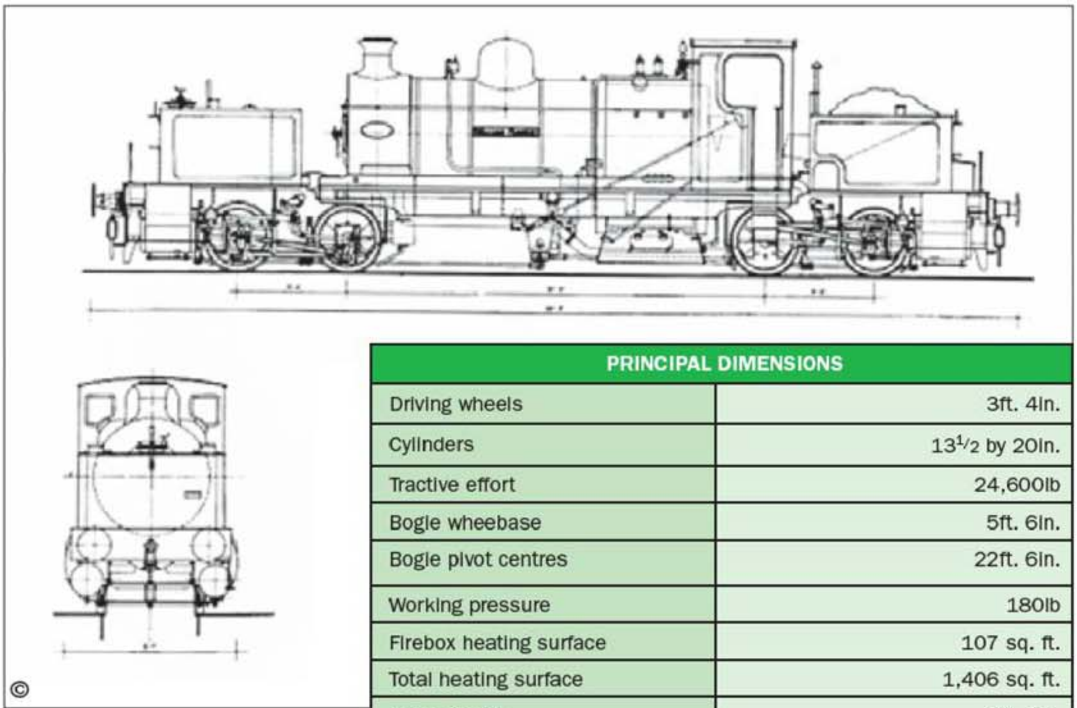
Smokebox floor

Quite straightforward but I should point out there is one missing hole, that for the inside cylinder steam pipe. Fear not as it will appear in the near future, when the inside cylinder castings turn up and have received the Tulley seal of approval. The same applies to the outside cylinder pipes which will be detailed in the next »


"STOWE" SMOKEBOX
Blastpipe bottom section
Exhaust passages
4BA C/S
6 BA C/S
4BA C/S
3/8" x 3/8" brass angle
6 BA cl
SMOKEBOX FLOOR 1/8" BMS
Tap 6 BA measure from angle
SMOKEBOX BACK
Tap 10 BA on 2.580 pcd
Tap 6 BA measure from angle
SMOKEBOX FRONT 1/4" Br. plate
1 mm rolled ring
Silver solder
1/8" x 0.294" ring
Rear smokebox ring x 2
3/8" x 3/8" angle
©


"STOWE" SMOKEBOX DOOR
SMOKEBOX DOOR G.A.
SMOKEBOX DOOR GM casting
HANDLE 1/16" St St wire
FASTENING DOG 6 off L.W casting.
10 BA nut BMS
HANDRAIL & KNOB St St
HINGE PIN 1 off St St.
Lamp bracket
3/64" rivets C/S as built
HINGE Assy. 2 off BMS
Tap 8 BA
8 BA
Ø5.063
Ø5.000
Ø4.750
Ø0.047
R0.188
R0.500
4.062
2.342
2.781
©

Beyer-Peacock 0-4-4-0



gripping instalment when the internals of the front end are to be revealed.

Smokebox door

A complex little item, the functional beauty of which I have always greatly admired, much to the annoyance of my father (not as the GWR would have it). All the blobs and gadgets are quite straightforward with the possible exception of the dogs, which will be available as tiny lost wax castings.

The shape of things to come, part 2

In part 11 of this series (*M.E.* 4298, 27 April 2007), I discussed the possibility of building an Atlantic tank following the design of the locomotive that I started and never finished many years ago. One of the design parameters of this engine was to be ability to handle it and particularly to be able to put it in the boot of an average car, such as my Astra. A few days ago I had occasion to actually handle the locomotive again, and for an experiment, screwed in the cylinders and put on the boiler. I then realised that to all intents and purposes the darn thing was going to turn out to be nearly as heavy as my 'Jeannie Deans' which is of course a compound version of a 'Royal Scot'. Time for a drastic rethink. All that I needed was a 5in. gauge engine that was capable of being handled by one man - after all it has to be lifted around the workshop while under construction - was easily transportable – easy, quick and cheap to build – fun to take on one of those rallies where you pull a few friends around on a stop and start basis – could be expected to shift 20 or 30 adults with ease when required – and look charming. So obviously an eight coupled locomotive with all the weight on the drivers for maximum adhesion – remember the lightness requirement, an ideally proportioned boiler and possibly four smallish cylinders, outside Walschaerts valve gear driving slide valves, and everything accessible to a ham fisted sort of chap like myself. Piece of cake.

A year or two ago I was discussing, with Mike Williams, the possibility of building a local engine (local that is for ourselves) and settled provisionally on the delightful standard gauge 0-4-4-0T that the Vivian copper works in the Hafod, Swansea, ran for many years in and around the steelworks. This little masterpiece filled the bill perfectly. It could be made to be transportable in three largish pieces and used a lovely little wide firebox boiler, complete with short fat barrel. The 'mitey hauler' part, as Curly Lawrence would have called it, could be facilitated by carrying separate lead rectangles of about 5lb each so that the adhesive weight could be balanced for any required duty. A most versatile and capable little locomotive.

The little industrial 0-4-4-0 which Beyer-Peacock turned out in 1924 for Vivians, solved the problem of obtaining a powerful locomotive capable of surmounting a 1 in 20 gradient and curves of 97ft. radius with loads of up to 170 tons. The success of this little engine made it the forerunner of further industrial Garratts. The original locomotive changed owners when Vivians was taken over by British Copper Manufacturers Ltd., and again when they in turn were absorbed by ICI, who finally transferred the locomotive to their Billingham works, where it was scrapped.

PRINCIPAL DIMENSIONS	
Driving wheels	3ft. 4in.
Cylinders	$13^{1}/_{2}$ by 20in.
Tractive effort	24,600lb
Bogie wheebase	5ft. 6in.
Bogie pivot centres	22ft. 6in.
Working pressure	180lb
Firebox heating surface	107 sq. ft.
Total heating surface	1,406 sq. ft.
Boiler length	9ft. 6in.
Front ring dia.	5ft 0in.
Tube dia.	$1^{3}/_{4}$in.
Number of tubes	288
Water capacity (front)	950 gallons
Water capacity (rear)	550 gallons
Coal capacity	12 tons
Weight in working order	$61^{1}/_{2}$ tons

Further industrial Beyer-Garratts to the same design were supplied in 1931 to the Sneyd Collieries, Burslem, Stoke-on-Trent, to Guest, Keene and Baldwins Cardiff works in 1934, and to the Baddesley Collieries near Atherstone, Warwickshire in 1937, this being the last in service, finally ceasing work in 1965. These locomotives were built, as were most industrial engines, with slide valve cylinders, driven by Walschaerts valve gear, and were unsuperheated. The full size engines used 3ft. 4in. wheels and tiny 14 x 20in. cylinders, and 180psi. for a tractive effort of about 24,000 pounds. This would equate to 3.5in. drivers with 1.25 x 1.75in. cylinders in our sizes. One of the problems that has to be overcome, is that of ensuring the 'dismantleability' and presumably 'mantleability' at the other end to facilitate transport. The other day my pal John, who owns the local firm of Talbot Hydraulics, showed me a flexible armoured hose that will take 400 or so psi and 300 plus degrees Celsius. I'm hoping that after testing these components will make excellent steam pipes, with high pressure connections at both ends. The exhaust is envisaged to be an O-ring or lip seal joint. To prove all these points, I'm just starting in on a pair of 0-4-0 Polly chassis and a boiler to match to act as a test bed to try the whole thing out. Watch this space.

To be continued.

NEW SERIES

SENTINEL DG8 WAGGON

PART 1

Alan Beasley introduces us to his superb Sentinel waggon and tells us something of the extensive rebuild he carried out on it.

This article was initiated by the rebuilding of my 2in. scale Sentinel DG8 steam waggon, see **photo 1** of the waggon in its rebuilt state. As it was going to be a comprehensive dismantle, repair and repaint job, it seemed an excellent opportunity to take a complete set of photographs of the model and thus do an illustrated article. I will not be providing the companion set of drawings, as the amount of work involved in sorting out and transcribing the hundreds of mostly A4 sheets of pencil drawings is something I have not the time to do.

Before I get on to the description of the various model parts and rebuilding work involved, I will outline a little of the history of the Sentinel DG6 and DG8 waggons, and the development of my model. The Sentinel term 'DG' stands for double geared, i.e. the waggons had two geared road speeds, to cope with different driving conditions.

Sentinel DG6 - DG8 waggons

Sentinel introduced the 'DG' series of waggons in 1927, with a small batch of the 6-wheel version. The more common 4-wheel model, the DG4, was introduced in 1928. The main difference from the preceding 'Super Sentinel' model was the provision of the two road speed gear ratios arrangement within the crankcase. The boiler was also up rated to 275psi and up to 700deg. F, (370deg. C), by an improved super heater. It also reverted to the more conventional cross water tube design compared to the rather complicated curved tube arrangement of the 'Super' waggon boiler.

The notable feature about the DG6 waggons was the arrangement of the rear suspension. Rather than just having two conventional axles, a pair of balance beams were used each side, carrying the wheels at their extremities, and pivoted at their centres on a substantial hollow axle upon which the suspension leaf springs were fixed. This arrangement allowed a significant independent vertical movement of each wheel, each having double solid tyres and having an inner brake drum for both steam power operated and handbrake shoes. These brake drums also carried the chain sprockets for the drive from the engine and for a coupling chain to the trailing set of wheels. Radius arms to the front ends of the beams were used to maintain the correct sprocket centres. **Photograph 2** shows the general arrangement; this is a photo of the model in its DG6 form, as I haven't actually got any good photos of the whole, full-size waggon.

The DG8 model was introduced in 1930; this was the world's first rigid 8-wheeler. Only eight were produced, all being tipper bodied models, although a few DG6 waggons were converted to the eight wheel layout by Sentinels. The original models were still on solid rubber tyres. The front suspension arrangement was along the same lines as the rear, using a single axle on leaf springs with, in this case, a single balance beam pivoted on each end, the forked end of each carrying pivots for the king pin for the wheel stub axle. All four wheels steered, using Ackerman steering geometry. Unfortunately no DG8 waggons have survived into preservation.

Altogether, some 800 DG models were produced over the period 1927 to 1935, and were generally considered to be a very successful model. A comprehensive description of the Sentinel 'DG' waggons, and much else, is given in ref. 1.

Sentinel DG6 waggon No. 8213, GF 8655.

This is the full size waggon that my DG6 model was based on and is shown in **photo 3** as I first saw it. The original waggon was built in 1930 as a ready mixed concrete lorry for the British Steel Piling Co and was the first in Britain. It had a five cubic yard demountable mixing drum unit that was manufactured in America. The drum was mounted horizontally and driven from the waggon engine via a chain drive to the drum gearing. The drum was

1

2

pivoted at the rear end and tipped using an engine driven oil pump to deliver the load.

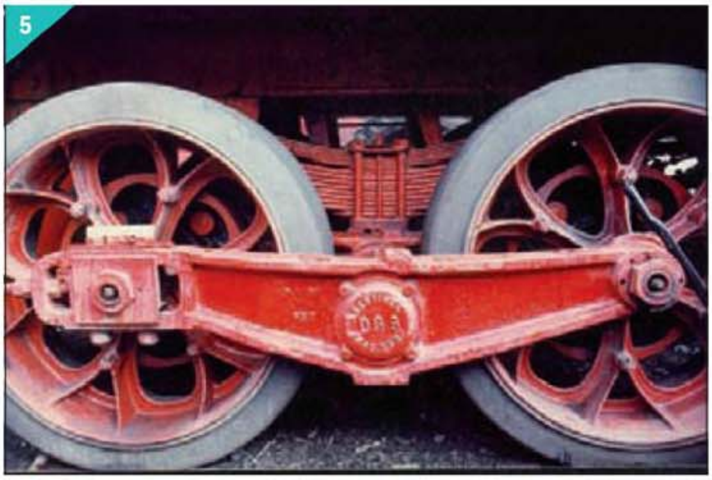
At some later date it was converted to the drop side platform waggon and was in E. N. Shone's 'Crown Steam Haulage' fleet, when I first saw it. More recently it went to Mr. J. Hatfield in Sussex, where it also changed colour to maroon.

Model history

It all started with the model shown in **photo 4**. This is my version of the popular 'Minnie' traction engine in 1in. to the foot scale by L. C. Mason, and was my entry into the world of model engineering. This was started back in 1979, exactly why I started it is lost in the mists of time but it was an excellent little model, though of course it was not heavy enough to haul a passenger trolley on anything but very smooth surfaces, so I started to think of something a bit bigger and more effective.

At a traction engine rally at Saling, near Braintree in Essex about 1981, I saw the Sentinel DG6 waggon, GF 8655 (see photo 3). It is not a very good photo, but it shows the essential feature of the four-wheel bogie at the back. It struck me that if one had a model so the driver was sitting over this bogie, it would provide the best arrangement of traction and load carrying capacity that one could desire and hopefully be reasonably comfortable to drive.

I already had the book *The Undertype Steam Road Waggon* by Maurice A. Kelly, (ref. 1.) an excellent book, and this gave me a lot of basic dimensional data on the DG waggons. In order to sort out the scale to build the model, I set up some bits of plank and blocks to represent the wheels and sat on these to get the desired weight distribution and to see if the controls would be reasonably accessible. The scale came out roughly to 2in. to the foot, so that's what I used.



I then managed to get in contact with the driver of GF 8655 and arranged to go and see it at the yard in Cricklewood, London, where it was stored. This was in early 1982 and there I took lots of photographs and detail measurements and this enabled me to start the design process. Later I had to take more photos when it came to sorting out internal cab details, rear braking system, etc. and of course one has always missed some detail anyway, in spite of trying to prepare a checklist of items to photograph. **Photograph 5** shows an example of the rear balance beam and springs, note that the heavy drive chain linking the two rear wheels has been removed, it is not really needed for road use. The little white bar on the left of the beam is a 6-inch reference used to scale the photograph.

Once I saw how complicated some of the parts were, I did wonder if I had bitten off more than I could chew, but I decided to press on. **Photograph 6** shows an example of the Sentinel pattern inner boiler shell standing on top of the outer shell, note the seven banks of cross water tubes in the squared section.

I wanted to build a model of the DG6 that used the same design principles as the full-size waggon, i.e., same type of engine, boiler etc, and that looked like a miniature version as well. The design might well have to be modified a bit, for example the boiler in copper, not steel, and some fittings and controls made larger or more robust to make a driveable model capable of fairly hard use.

3. The full-size Sentinel DG6 waggon registration number GF 8655. This was built in 1930.

4. The Minnie traction engine that was the author's first attempt at the hobby of model engineering.

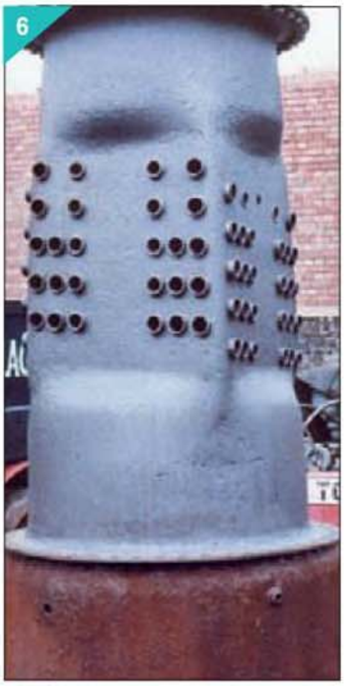
5. The distinctive rear balance beam that is a feature of this model of Sentinel steam waggon.

6. The Sentinel boiler inner shell. It is standing on the outer shell.

References

1. *The Undertype Steam Waggon* by Maurice A. Kelly, published by Goose & Sons Ltd., 1975.

●*To be continued.*



3F to 3F
An ambitious conversion

PART 9

Continued from Page 217 (M.E. 4306, 17 August 2007)

Geoff Dowden completes the boiler and starts on the cab.

A suitably sized hole had to be drilled and filed out of the top of the wrapper in order to accommodate the safety valve bushes in the top of the firebox and, anticipating the future attachment of the two halves of the circular safety valve base cover plate, I took the opportunity to attach a 2¼in. dia. disc of 1/16in. thick brass to the wrapper, secured with four 10BA round head brass screws, that will serve as an anchorage for the safety valve base cover fixing screws. This disc of course, also required clearance for the hexagon bases of the safety valves so it was provided with two 2 1/32in. dia. holes in matching positions before screwing to the wrapper as shown in **fig 28B**.

The top half of the front plate was now finally screwed into position and all the heads of the countersunk screws soft-soldered over together with a fillet applied to its joint line with the wrapper sheet. The soldered areas were then filed flush and given a light dressing with a piece of worn emery cloth. The small radius around the front corner was then produced with the judicious use of a fine file, the operation being fairly minimal as the photographic evidence suggested that the radius was much less severe than that given to the later Stanier dynasty of firebox upper front corners.

The next task was to fit the 1/8 x 1/8in. brass angle to the bottom edge of the firebox wrapper where it adjoins the running plate and matches the radius of the curved sections of the splashers. I had long considered that this requirement was likely to be a difficult exercise, but nevertheless the nettle had to be grasped. Having set about the job I was grateful for a demonstration that previously had been given by a club colleague for my benefit.

In practice, the six straight lengths, three either side of the firebox, and comprising one each side of the space chopped out of the wrapper for sandbox filler access, (somewhat disrespectively referred to as the 'keyhole' by non LMS followers!), and one piece along the short return at the bottom edge of the lower front plate, proved to be reasonably straightforward. However, the four curved sections were a bit of a tease and, at times, taxed my patience almost to its limit. However, by persevering with the demonstrated technique of annealing, bending, tapping round a suitably sized former and repeating as necessary, I was able to produce results with which I was completely satisfied. As the final curved section to be produced took a fraction of the time it took me to complete the first one, I realised that the essence of an additional skill had just been spawned and that practice does indeed make perfect.

As mentioned earlier, I had been putting off the fitting of the firebox angles for some time, until the demonstration referred to, which was actually in connection with the fitting of the cab roof rainstrip. This gave me the confidence to make a start and in chronological terms therefore, the fitting of the firebox angles followed completion and erection of the cab assembly as described later.

At the outset it had been my intention that the horizontal flange of the angle would be utilised to hold down the wrapper to the running plate. Fortunately, a trial fitting of the curved sections revealed that a 12BA clearance hole drilled in the corner of the angle, where it meets the running plate, coincided with the corresponding fixing point of the splashers as shown in **fig 28C**.

After this stroke of good fortune and satisfied with this arrangement, the vertical flanges of the angles were marked out, lightly centre popped, started with a No. 70 drill twirled in a small hand held pin chuck and transferred >>

10. Cab assembly.

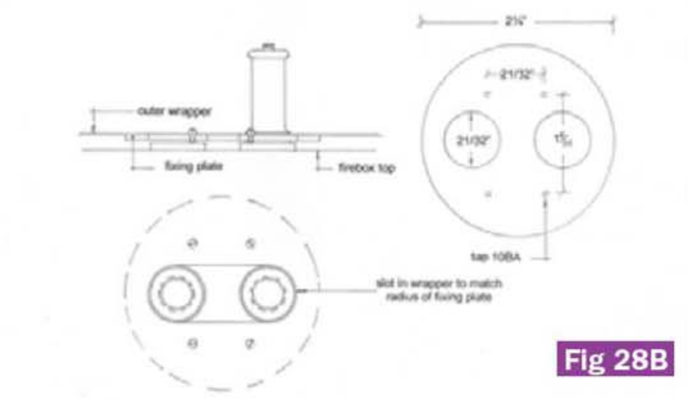


Fig 28B

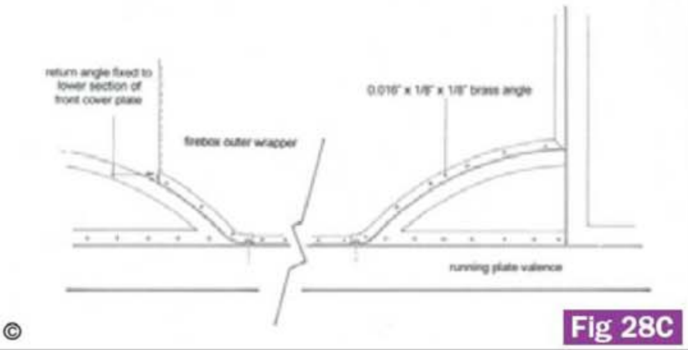


Fig 28C

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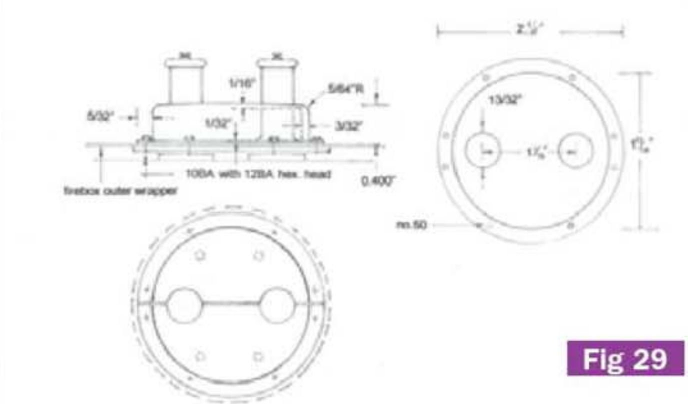

Fig 29

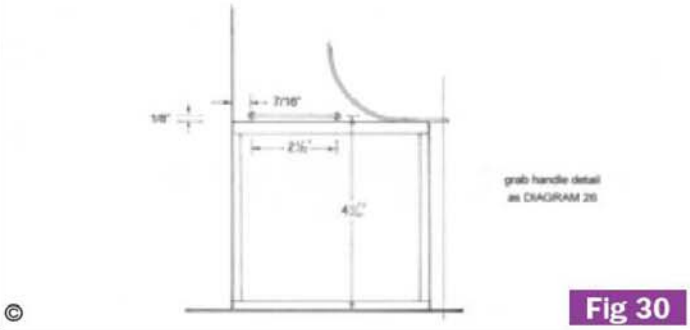

Fig 30

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Fig 28b. Safety valve base cover - fixing plate detail.
Fig 28c. Firebox wrapper fixing details.
Fig 29. Safety valve base cover detail.
Fig 30. Cab side sheet grab handle.

to the bench drill for drilling $^1/_{32}$in. After clearing the burrs from the back, the angles were then secured, firstly with Loctite Retainer and after setting, the holes were run through the wrapper.

The inside of the holes in the wrapper were then lightly countersunk, $^1/_{32}$in. brass rivets pushed in and the backs tacked in with a drop of soft solder. The excess rivet was then snipped off and the rivet stumps filed flush with a fine file.

By the mid 1930s photographs showed that many of the class 3s had acquired a set of boiler washout plugs towards the top of the firebox and that in some cases, the original mud hole doors had been plated over. I decided that my locomotive would be turned out to represent an example of this modification so firstly, four plates were fitted over the mudhole door positions. These were simply discs of 24SWG brass, curved to firebox wrapper radius and secured with four $^1/_{32}$in. brass rivets fixed with Loctite and the protrusions bent over on the inside of the wrapper.

A set of lost wax brass washout plug castings was purchased so that four plugs could be duly inserted on each side where depicted on the official works drawing and fixed with a drop of Loctite, not forgetting to make allowances for the more forward location of the four on the right-hand side of the firebox. I decided to omit the lower single plate, which is evident on some photographs, as my research led me to believe that this plate was only occasionally fitted.

The pair of firebox bands could now be prepared, the works drawings indicating that they were 2in. wide and were attached to the wrapper in two halves with the joint at the centre line on top of the firebox. Consequently, appropriate lengths of $^3/_{16}$in. wide brass banding strip were straightened and marked out for the six fixing positions, four up the side and two across the top, and drilled No. 60. In order to keep things nice and square, a strip of masking tape was then applied to the firebox assembly, one of its edges representing the line of holes for spotting with a sharply pointed scriber through the brass banding. After starting the holes carefully by hand with a No. 58 drill, they were opened out under the bench drill with a No. 55 and then a 12BA brass nut tacked into position on the back of the wrapper with soft solder to be followed by a run through with a 12BA tap. The holes in the banding were then opened up to No. 55 for fixing in position with 12BA shortened brass roundhead screws.

A $^1/_4$in. right angle was then created a fraction short of the firebox top centre line, the band removed and a No. 55 hole drilled fairly close to the outward side of the bend. I allowed the width of a 12BA nut plus a bit so that my 12BA nut spinner would fit. The operation was repeated for the other side of the firebox and then another twice for the second band.

Finally, the flat sections of the wrapper were lined with strips of $^3/_{32}$in. thick balsa sheet secured in position with UHU cement, the nuts and other appendages creating their own little pockets when the balsa was pressed into position. As previously with the boiler, the firebox wrapper now had a solid backing, which hopefully will be a little more tolerant to the accidental knock than otherwise would be the case with softer insulation material. However, because of the curvature, the radiused corner areas at the top were lined lengthways with strips of the Kaowool blanket glued to the wrapper as before.

Safety valve base cover

A decade or so into LMS ownership, the Midland style safety valves and elongated base covers had been replaced by the Ross pop type and upturned dish-like circular covers. A suitable drawing was therefore prepared by scaling up the 4mm version and is shown as **fig 29**. The component is a simple turning job and I utilised a chunk of non-ferrous material from the stock box, one of several largish diameter bar off-cuts given to me by the workshop manager of a local engineering company involved in the manufacture, among other

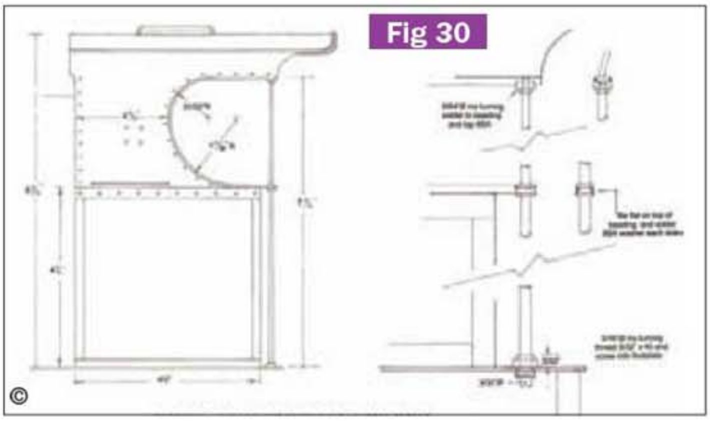


Fig 31. Cab lookout beading and handrail details.
Fig 31a. Cab roof ventilator.

things, of bits and pieces for torpedoes. Following the turning operation, the dish was drilled twice by $^{5}/_{8}$in. to match the two holes in the fixing plate and then drilled around the flange on the rotary table as shown.

It was then sawn in half with a fine saw blade and given a minimal clean up with a very fine file. With the safety valves screwed in, each half-cover plate in turn was placed on top of the firebox, taking care to maintain the perimeter alignment, so that the 10BA tapping positions can be spotted through onto the wrapper with a sharply pointed scriber. As before, I started the holes with a No. 56 drill and then, under the bench drill, went through the wrapper and fixing plate with a No. 54 drill. The fixing plate was then undone and the holes tapped 10BA when the firebox wrapper and the cover plate flange holes were opened out with a No. 50 drill. The two halves of the cover plate were then refitted with 10BA bolts with 12BA hexagon heads.

The final task on the firebox assembly was to drill a No. 30 hole for fixing the whistle, which, while being a 'dummy', will nevertheless emit steam when the real one sounds. The fixing hole is positioned $^{13}/_{16}$in. to the left of the firebox centre line and $^{3}/_{4}$in. in front on the cab spectacle plate.

The whistle itself was machined from a length of brass bar to roughly the dimensions shown in the Jinty notes. However, the steam line is a short loop of $^{1}/_{16}$in. copper tube connecting the left-hand side of the whistle to the valve in the cab. The driver's control is represented by a straight 2in. length of brass rod, inserted through an appropriately positioned hole in the spectacle plate and fixed to the back of the whistle with a few threads of 10BA. The necessary joint in the steam line at the front of the cab was produced by threading the cab end of the copper tube 10BA, which was then inserted into the end of a $^{3}/_{16}$in. length of $^{1}/_{8}$in. AF brass hexagon. The opposite end was tapped 8BA for connection at the front of the spectacle plate to a 'special' union fitting with a locknut from $^{3}/_{16}$in. AF brass hexagon.

Cab assembly

My full attention could now be focused on the erection of this rather daunting section of the locomotive superstructure (**photo 10**). No drawings, so once again I resorted to the cardboard game plan and wrapped a suitable sized piece of stiffish card up, over and down the opposite side of the spectacle plate in order to determine the length of the $^{1}/_{16}$in. thick brass sheet required.

There is no obvious joint where the top of the side sheet meets the roof panel on these locomotives, just an 'up and over curve' with a smaller radius above the top of the cab lookout. Having since had the opportunity to view the works drawings, I know now that the prototype sidesheet was jointed at the lower edge of the cab lookout, but I do not think that this information would have been much help even if I had been aware of it at the time.

Hoping that I had calculated the dimension correctly, the sheet was cut to size, marked out accordingly and all the various bits and pieces cut out to create the forward projection of the roof area over the spectacle plate, the cab lookout opening and the rear roof extension. Once this task was accomplished, a colleague with a metal folder assisted me to produce the inverted U-section with a $10^{1}/_{4}$in. radius for the arc of the roof.

At the trial fitting I discovered that I had got it wrong and the top of the lookouts were marginally too low. Unfortunately, this meant that I had to file away further metal from the top of the lookouts and therefore unavoidably lost a little of the rather distinctive shape of the class 3 sidesheets. Not for the first time I was somewhat disappointed, but on this occasion, not to the extent that this example of my misjudgement should be consigned to the scrap bin in favour of a second attempt!

Lengths of $^{1}/_{4}$ x $^{1}/_{4}$in. brass angle were then attached to the side edges of the spectacle plate with four 10BA countersunk brass screws tapped into the former, the spare thread then being filed off flush with the front of the spectacle plate. Likewise, a length of $^{3}/_{16}$ in. square brass bar was curved to the arc of the roof and fixed with seven equally spaced 10BA countersunk screws. However, before attaching the cab section to the spectacle plate, I thought it prudent to add the various appendages such as the lookout beading, handrails, roof rainstrip and the lines of rivet detail visible on photographs of this style of cab.

I began with the horizontal handrail when a 3in. length of $^{3}/_{32}$in. diameter mild steel rod was given approximately $^{5}/_{16}$in. of 7BA thread at one end with the tailstock die in the lathe. It was then annealed and bent around a former to produce a right angle and then repeated to produce a second 90deg. angle at $2^{1}/_{8}$in. centres as shown in **fig 30**. The $2^{1}/_{8}$in. length is then clamped horizontally in the bench vice and the opposite end threaded with an equivalent length of 7BA thread. I recall that I was unable to use a conventional die holder as the upstand of the previously threaded return fouls the handles of the holder as the die is rotated. I therefore made use of the body of the tailstock dieholder taking great care to ensure that it had a vertical start to produce a correct thread. There is little resistance and the die was easily rotated by normal hand pressure.

A short length of $^{5}/_{32}$in. diameter mild steel rod was then drilled and tapped 7BA, the outer end being lightly chamfered each time before parting off four $^{1}/_{16}$in. slices for the spacing washers. The hand held tap was then run through the off-cuts again to remove any burrs. The spacers are then screwed up the right angle returns to the full extent of the thread, which, if necessary, can be adjusted at this stage to ensure that the rail is parallel to the cab sidesheet. When satisfactory, the fixing positions can be marked and the holes drilled out so that the rail can be attached with a washer and nut behind the sidesheet, the spare thread being filed off to a semi-round.

To be continued.

CENTRE DRILLS

Peter Spenlove-Spenlove offers suggestions on how to get the best from these tools and introduces some of the rarer types.

A range of normal Imperial centre drills are shown in **photo 1**. A similar metric range is also available. Variants are a long-shanked series (**photo 2**) and those of the single-ended variety. Those marked with the letters A, D, E and G in photo 1 are unused. Note the full length of the pilot tip. Centre drills C, F and I have worn, reground pilots and it may be necessary to deepen the hole left by the pilot with an ordinary drill to avoid the lathe centre tip bottoming. Provided this is done they can, however, still be used to prepare work for turning between centres.

On the centre drills marked H and J the tip has worn away or broken. Such tools can be used for de-burring work or countersinking to the 60deg. included angle of the cutting edges. Being made of good quality high speed steel they also make very good cutting tools for boring bars and the like.

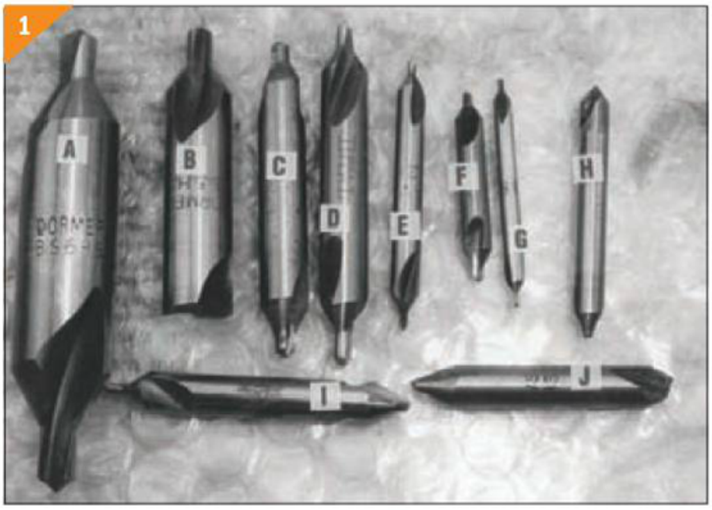
Centre drill B has been shortened deliberately as the borrowed drill chuck jaws would not grip the middle of the shank without one jaw 'gripping' in a flute. Since then I have modified my own drill chucks by drilling them out deeper to accept the pilot. Most of my drill chucks are of the standard key geared Jacobs type and their bodies are still soft. It was therefore relatively easy to fully open the jaws and drill through the blind cavity thus exposed. Putting their shanks in the tailstock of the lathe and driving the drill with the headstock was used for this.

Easy removal

If you think you may have to remove the drill chuck from its shank at some point, the hole produced can be through drilled into the tapered cavity housing the end of the shank. Drill to the tapping size of a suitable thread and tap it so that a screw can be used to jack the chuck off. You may have to use just a second and plug tap for this, as the taper tap probably won't have enough clearance. This modification works well on the types of chuck mentioned but may not be applicable to every type so check the construction and hardness of your chucks before you act.

Photograph 3 shows a centre drill for producing protected centres. Note that the part that cuts the centre seat is formed in two, connected tapers. These are rare now and not available from all suppliers. Protected centres are of a type sunk into a shallow counter bore so that any accidental damage from a knock or a fall is less likely to form a burr in the tapered centre itself. A typical example of a protected centre can be seen on the end of the lathe mandrel in **photo 4**.

Of course a suitable counter bore can be turned using a lathe tool so the special drill is by no means essential but it is convenient if a number of components have to be drilled in this way. **ME**



1. Assorted centre drills - some new, some old.

2. Short and long series centre drills.

3. A centre drill for producing a protected centre.

4. A typical protected centre on a lathe mandrel.

Churchward's rough riders

Peter Rich looks at the County class locomotives and give plenty of guidance to produce an accurate model.

I was out with the pipes by the mud flats on the banks of the Severn the other day contemplating a few laments when it occurred to me that another class of locomotive which has not been written about very much is the GW Churchward County class of 4-4-0 tender engines, which, during their day, became known as "Churchward's Rough Riders" due to the fact that they could roll quite alarmingly when starting a heavy train and when they were running at speed. It also occurred to me that tenders do not get a great deal of coverage compared to locomotives so this article is intended to redress the balance a little.

The 4-4-0 Counties were long gone by the time I became involved with the railway but I did have some experience with the 2-6-0 locomotives of the 4301 class which were a similar size and design as far as their cylinders and boiler were concerned. I can tell you that when the 43s were starting off a heavy load they would rock and heave back and forth across the track as if trying to get their shoulders to heave behind the load. This rolling could be very pronounced and I imagine it was even more so with the Counties because of their larger driving wheels.

One thing which has always puzzled me about the Counties is that in 1904, when they were first built, Churchward usually produced a one-off prototype and thoroughly tried it out before going ahead with the production series. But not with this class.

The first, No. 3473 *County of Middlesex*, appeared from Swindon in May 1904 and by October there were ten of them in operation, Nos. 3474 to 3482 all named after English or Welsh Counties. Another puzzling thing about these engines is that at that time Swindon was still well into building 4-4-0s with double frames, e.g., the Bulldogs and Flower classes and carried on with this until 1910 when the last Bulldog was built. So right in the middle of this double-framed building programme, this class of inside framed engines was produced. I have read that they were built specifically for the North to West route from Shrewsbury through to Bristol, via the Severn Tunnel, because the LNWR would not allow the larger Saint class 4-6-0s to work over its lines.

Differences

Would be modellers of this class should take note of the differences between the batches especially if you are aiming at authenticity or award standard at exhibitions. The first batch consisting of locomotives 3472 to 3482 were built under Lot No. 149 with the Standard No. 4 boiler, had straight footplating, and were reversed via a lever as shown. They were steam braked and carried their brake levers ahead of the driving wheels with the pull rods suspended outside the wheels. These remained steam braked and consequently their tenders also were steam braked at first. the Dean 3,000 gallon type were fitted first.

When they first appeared they had the small copper capped chimneys as fitted to the early Saints and Stars and, as was standard with Churchward engines at that time, the cylinder centre line was horizontal and set two and a half inches above the driving wheel centre line with half of the smokebox saddle cast in, a practice which I believe was brought in from America. These engines carried the pre-October 1906 livery with Indian Red frames and cylinder cladding together with the double lined out boiler and tender tank liveries.

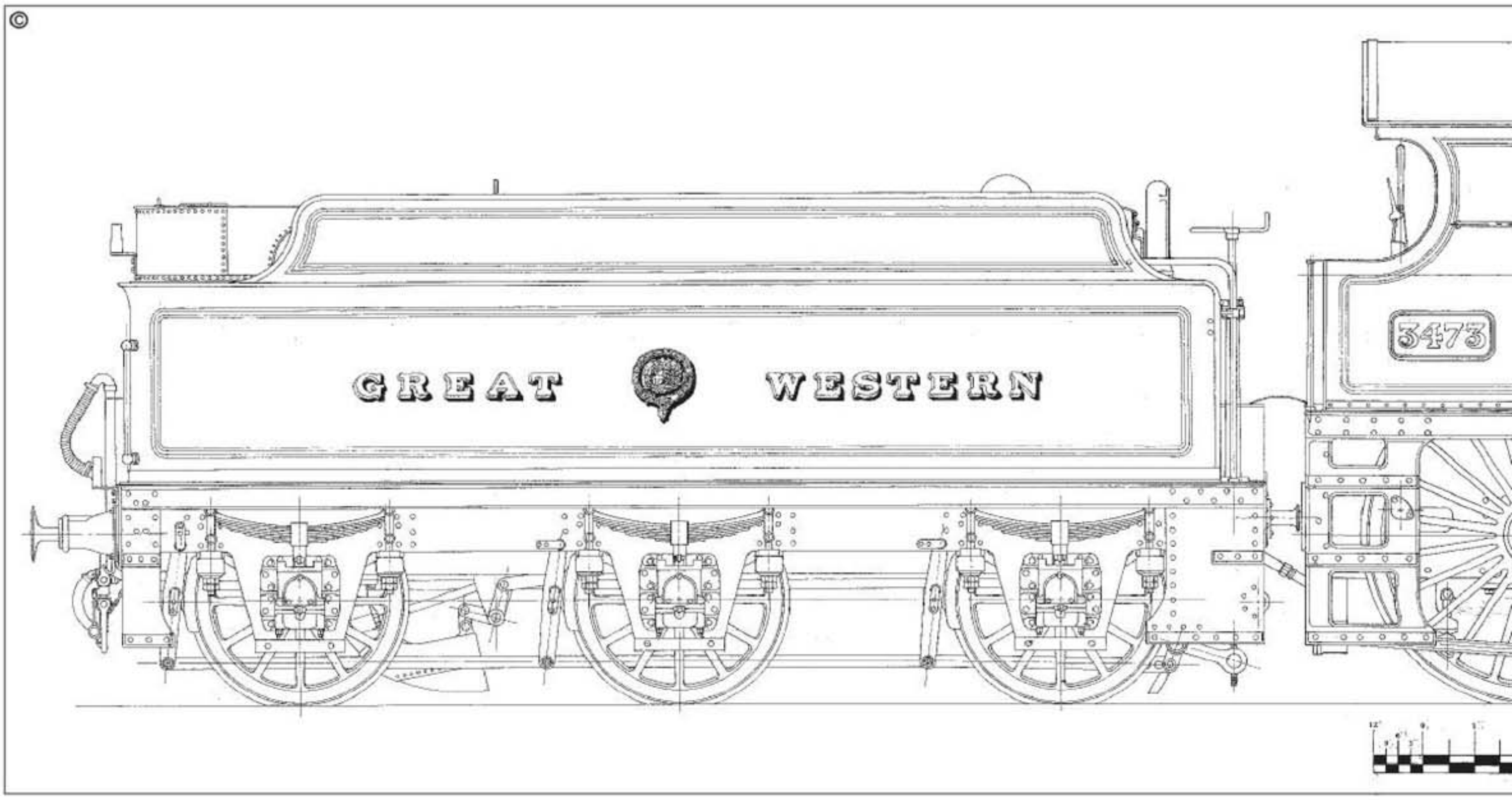
The tender tank sides were finished with three separate lining panels the centre one of which carried the old entwined GWR lettering. Having said that, there was some experimentation going on at this time and at least two of these Counties carried plain GWR letters all of which were confined to the centre panel on No. 3478 *County of Devon*, and one in each panel on No. 3479 *County of Warwick*.

While on the subject of liveries and for the sake of historical authenticity, I should refer you to the numerals of the painted buffer beam numbers for locomotives of the pre-1914 period. The numerals of those days were a different shape to those applied later and that their main body was gold, not yellow as later. As far as I am aware most commercial suppliers sell the latter type.

Examination of photographs of this batch in its first 'as built' days appears to show that cylinder relief valves were apparently not fitted. This is wrong, they were fitted but were not placed on the cylinder end covers as in later days, they were in fact located on the front and rear walls of the cylinder block almost out of sight behind the valve chests.

High lever

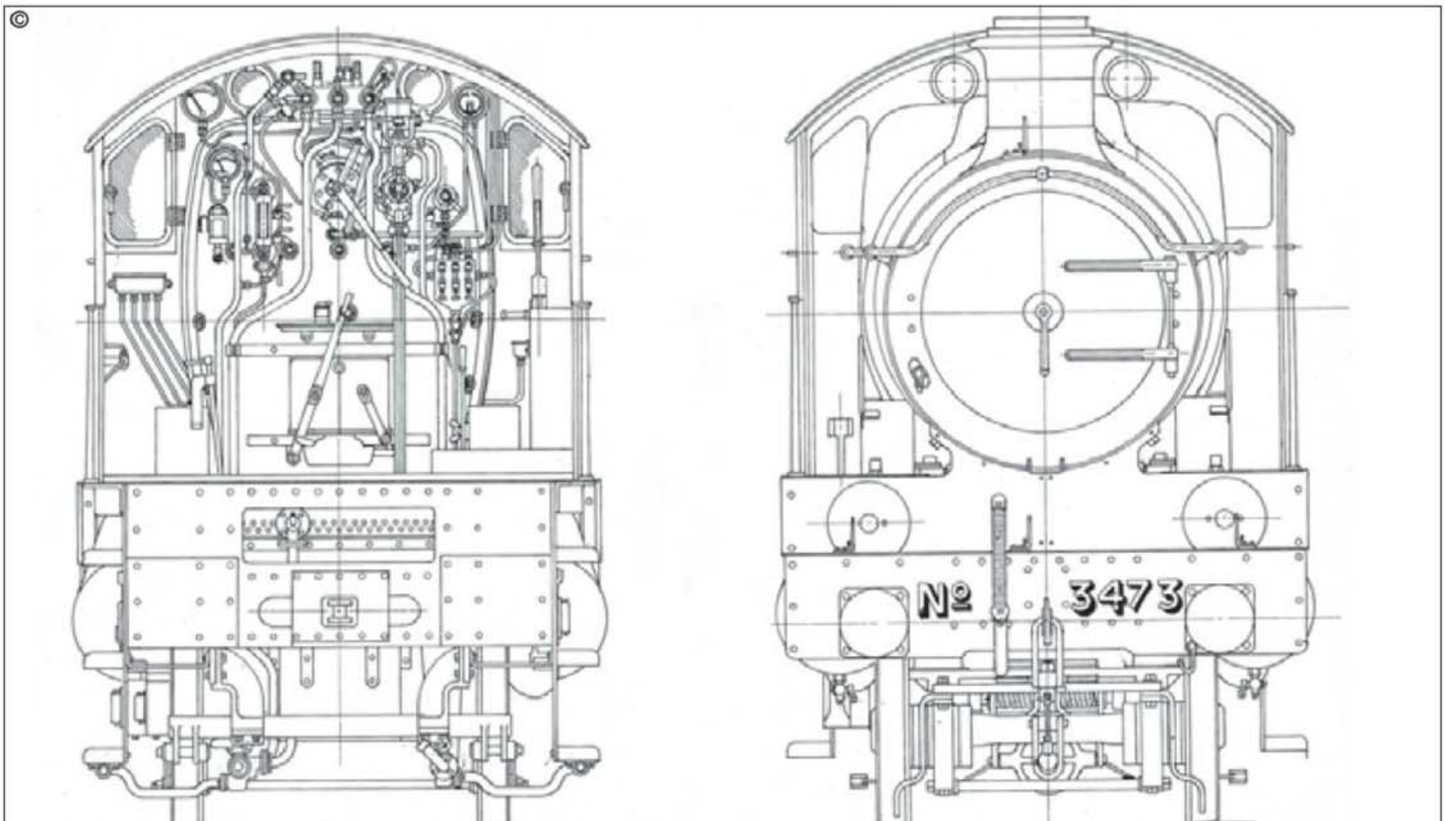
Knowledgeable modellers may be surprised at the very high position in which I have depicted the reversing lever, but I assure you that all dimensions for this lever and its position are taken from the official Swindon Works drawings of the lever itself, and I have confirmed this by photographs and measurements on lever reverse fitted >>

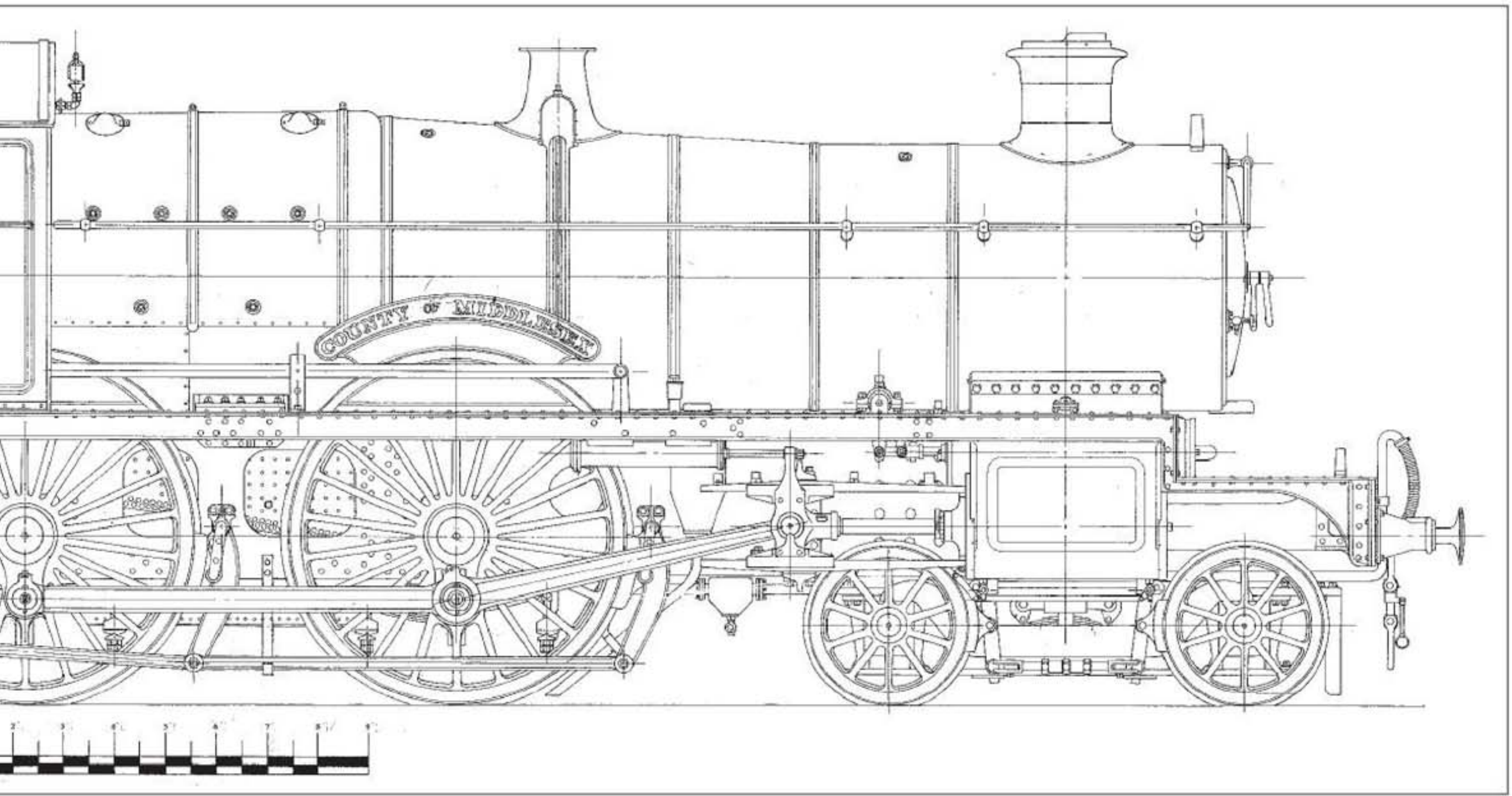


locomotives in preservation.

Note also that the upper two apertures in the right-hand cab footstep hanging plate are narrower than the bottom aperture and I point out that this was so only on the right-hand side of the engines. It was also the same on the lever reversed Saints, 28xx 2-8-0s and 47xx 2-8-0s, (but not the 4301 class) and the reason for it was that the pivot of the reversing lever was bolted to the hanging plate and is shown by the triangular shaped plate on the step. Some of the early Counties had the lower apperture plated over in later years, and you should refer to photographs for your chosen subject. Before leaving this first lot I point out that their sandboxes were mounted below the footplate level and only to the leading driving wheels.

The second batch, built in 1906 under Lot No. 165 consisted of locomotives Nos. 3801 to 3820, the first ten of which were named after Irish counties while the rest after





those on the mainland. These were the same as the first batch except that they were fitted with vacuum brakes and carried their brake levers to the rear of the driving wheels with their brake pull rods inside the wheels, the vacuum brake cylinder being located inside the frames to the rear of the smoke box. With these engines, and the following batch, the sandboxes were fitted half above and half below footplate level both ahead of the wheels.

They further differed slightly from the first batch in that they carried the small cast iron chimney as fitted to the original Cities, and are reputed to be the first locomotives to be adorned with the post-October 1906 livery, with the last style of lining out on the green parts and everything below footplate which had previously been Indian Red was now changed to gloss black, also fully lined out. The tender tank side was now adorned with the words "Great Western" in gold lettering with the garter coat of arms between the words. As on the first batch works building plates were fitted centrally on the front of the smokebox saddle.

The third batch, Nos. 3821 to 3830, were built under Lot No. 184 in late 1911/12, but these were very visually different from the previous batches. They were vacuum braked engines and now carried the large copper capped chimneys of the day and their footplating was curved downwards at each end in the style we are familiar with these days. A point here which can catch you out if you are not aware of it is that the curved plating at the rear was at 1ft. 3in. radius while that at the front was at 1ft. 1in. radius, the same as the later Saints. Examination of photographs and the works outline sketches appears to show that their cab roofs were slightly higher and longer than hitherto, indeed they appear to be the same design as on the 4301 class 2-6-0s which had also first appeared from Swindon in 1911.

They were screw reversed engines and the reversing reach rod could be seen on the right-hand side sloping forwards and down and passing behind the nameplate. Decorative brass beading was fitted to the wheel splasher edges whereas the earlier batches had simply plate steel strengthening strips riveted on. Another point to be borne in mind is that the right-hand nameplate was set inwards a few inches from the edge of the splasher, as was so on some of the Court series of Saints at that time.

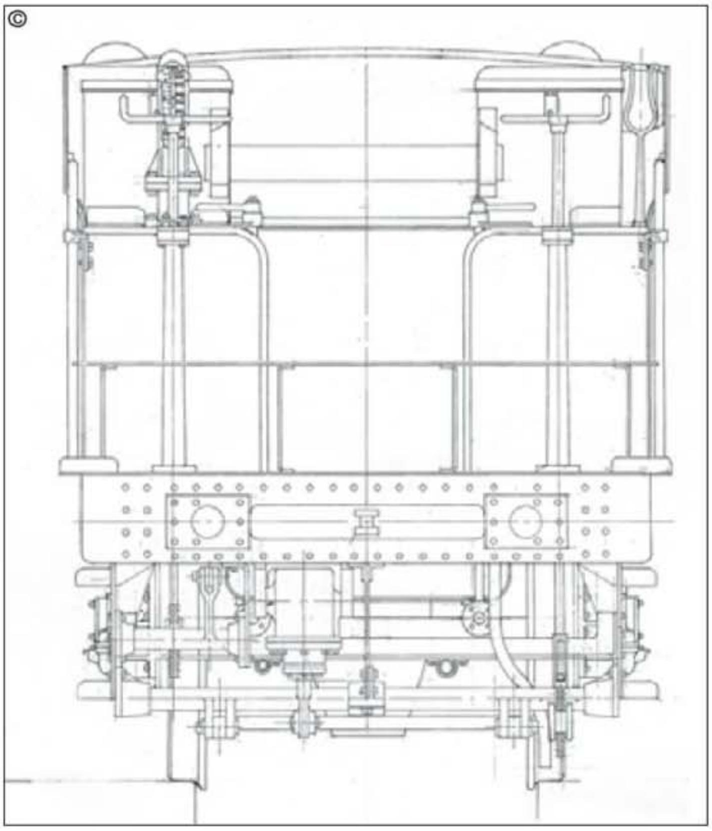
Nameplates

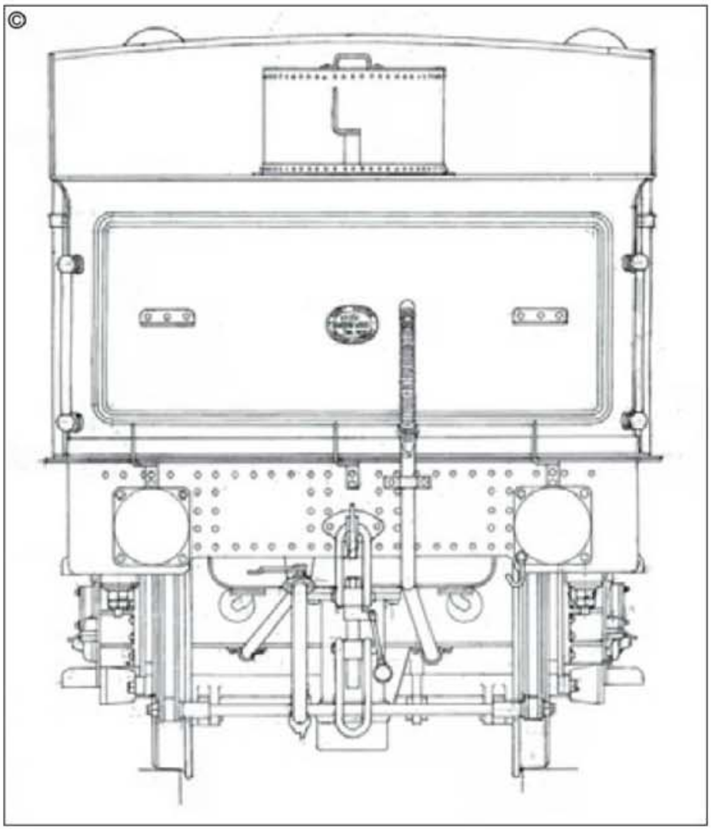
On this point photographs show that the early nameplates fitted appear to be of the early wooden backplate type as carried by a number of engines of the time. These engines carried superheated boilers right from the start while the earlier locomotives were brought into line by 1912. The Churchward 3,500 gallon tender, with the larger coal fenders, was standard for this batch and they were fitted with Court series cylinders which had their centre lines coincident with those of the driving wheels.

They further differed from the earlier two batches in a way which cannot be detected but I feel I should mention it for completeness sake and to ensure that it doesn't disappear in the mists of time. I am referring here to the weight transfer of the front end onto the bogie. The earlier engines were fitted with a swing link suspension connecting to the bogie but this last batch was constructed with the more modern De Glenn type suspension via two bearer pads which are situated up behind the cylinders and cannot be seen on the 2-cylinder locomotives, whereas it is very easily seen on the Castles and Kings. Works plates were not fitted to this batch and were eventually removed from the earlier batches from 1911.

A further item I should draw to your attention is that the cab roofs of all Great Western Locomotives were constructed from wood until about 1920. They were laid in jointed planks from front to rear whereupon canvas was laid over the top and bedded in with white lead. Wooden slats were laid across the roof at the front and rear to secure the canvas and the whole lot painted black. As far as I can see steel cab roofs appeared in 1921 possibly with No. 6370. Details of the beaded wooden slats and their fitting can be found in my drawings for the cab roofs of my Dean and GWR 2-cylinder classes.

Bogie brakes were standard on all engines and were vacuum operated, but were removed from November, 1924. I have never seen a description of this mechanism in *M.E.* However, I won't go into its operation at this point, but it is worthy >>





of a future article and I have prepared drawings of the bogie brake gear within my Castle and Saint series from which these drawings are taken.

Driving wheels

Just a note or two about the driving wheels on these engines. The driving wheels were the same as fitted to the Saint class 4-6-0s and when making my 5in. gauge drawings for these GW designs I found that there are at least seven visually different shapes of wheel boss carried by these engines over their lifetime. Usually model designers show and describe a simple straight sided pear shape for the wheel crank but Churchward's wheels were much more decorative and interesting than that.

I have shown the original design as fitted to these engines, and the Saints, when first built and photographs appear to show that the boss and crank are of quite slender proportions. However, this is very much an illusion in that the main bulk of the boss is positioned into the spokes and it is only the outside protruding part which is small. Some of these early designs were also of the straight sided pear shape type but they also had the 'small' crank boss.

Over the years the design was modified until about 1919 a very heavy straight sided pear shape boss was adopted. From that point on driving wheels of all types could be fitted and often there were two different patterns on the same engine. (*Caerphilly Castle*, preserved at Swindon, being such a case) Quite a few GW preserved locomotives have original type Churchward wheels fitted, so there is plenty of information out there to satisfy authenticity.

Unusually for Churchward locomotives at this time this class was not fitted with compensated springing and therefore compensating levers and brackets are not shown. The first crossheads used were a very neat cast steel affair and painted Indian red at first but these were soon replaced with a forged body type left bright steel, with bronze slipper blocks as shown.

My drawing shows the engine substantially in original condition but with the lengthened smokebox, large rolled steel type chimney and top feed type safety valve of about 1912. Just a word about G.W. safety valve covers, it seems to be accepted that the tapered part of the cover is straight and is usually shown as such by designers in our scales and indeed the official Swindon Works drawings show this probably because it was intended to be so and its was easier to draw them like that. However, in my experience of examining thousands of photographs and actually working on the full size I can say that this was very rarely the case. The 'straight' part of the taper was normally slightly curved in a convex way a shown on my drawing. Indeed it would be difficult to make straight sided covers for these items in view of the varying radii required to suite the shape of the round and tapered boilers.

It should be noted that the first batch of engines were re-numbered in 1912, No. 3473 changing to 3800 while Nos. 3474 to 3482 became Nos. 3831 to 3839 in order. All the rest retained their original numbers.

Tender details

Now for some words about the tender shown. As I said at the start not a lot gets said about tenders but in this case I feel that a few words are appropriate for those among you who want to be authentic and learn more about your interest. If you think you know about G.W. engines then have a good look at this tender because it is not what your eyes may tell you it is at first glance.

It is very easy to think that this is a standard Churchward 3,500 gallon tender which were built at Swindon from June, 1905, through to April 1925. But this is not so. It is in fact a drawing of a Dean 4,000 gallon tender, which has been rebuilt by Churchward, only 20 of which were built between April 1900 and February 1904, under Lot Nos. A46/51/53/55/56 and A60. Their works numbers were 1456-1461, 1509-1518, No. 1539, 1560, 1561 and 1582 which could be found on the oval brass plate located centrally on the rear of the tender tank as shown. When first built the first seventeen were fitted with coal rail fenders which curved downwards at the front and were attached to the side flare. The last three had the small plate side fenders, which were also fitted to the earlier tenders in their first decade which I will describe in a future article. The last four of them were built specifically for Churchward locomotives the first tender of which was attached to his first 4-6-0 No. 100, and I believe remained with it for most of its life. The other three were attached to Nos. 97/98 and 171. As far as I am aware at the time of writing, none of these tenders ever carried snap head rivets showing on their tank sides.

My drawing of the tender depicts its condition post 1912 but in the early days of their life these tenders, unusually, had water scoops operated by a vacuum cylinder which was set up into the well tank. Also at that time their coal bunkers were of the squared off pattern now seen on locomotive No. 2516 at 'Steam' in Swindon. In 1912 they were rebuilt with sloping bunkers which effectively reduced the water capacity which was counteracted by raising the height of the roof of the tender to the top of the side flare to the rear of the crosswise coal fender at the rear of the coal bunker. So here we come to the point at which we can identify these tenders when examining photographs and believe me, in view of the small number built, it is surprising how many photos depict them. Look at the drawing and at the rear you will see that the tank filler is set very high, in fact its lower edge is level with the side flare. Now look at the water gauge on the front of the tender and you will see that it has been raised by 6in. because the extra height of the tank roof at the rear of the tender would have caused water to come out through the gauge. A further point of identification is that when attached to engines the horizontal part of the front handrail is usually in line with the lower edge of the cabside cut out, whereas with the 3,500 gallon tenders this is set about 4in. below the cut out.

There are other points that help to identify these tenders concerning the vertical handrails at the rear of the tanks in that they remained at the standard 3,000 gallon length leaving a longer gap between the upper stanchion and the top of the flare but it does need a trained eye to distinguish this. In their pre-1912 days the front vertical handrail was simply that and finished just above the tankside flare where it was attached by a bracket to the top of the flare. It was further supported by the additional bracket at the bottom of the flare which was also in place. The 1912 rebuild also involved the fitting of the larger coal side fenders as shown and the front handrail was then turned back horizontally and became attached to the coal fender as shown and in a similar manner to those of the 3500 gallon tenders.

In the 1930s the tank from at least one of these tenders, No. 1560, was fitted to a chassis with a modern Collett main frame and the coal fenders were altered to the continuous type as on Collett's 3,500 gallon tender design of 1929.

Table 1

Cylinders	18in. dia. x 30in. stroke
Boiler barrel	11ft. long. Diameter = 4ft 10$^{3}/_{4}$in. + 5ft. 6in. Pitch at 8ft. 6in.
Firebox	7ft. 0in. long. Pressure = 200lbs. Grate area = 20.56sq ft.
Wheels	Bogie 3ft. 2in. dia. Coupled 6ft. 8$^{1}/_{2}$in. dia.
Wheel base	7ft. 0in. + 8ft. 6in. + 8ft. 6in. = total 24ft.
Leading overhang	2ft. 6in.
Trailing overhang	4ft. 6in.
Boiler	Standard No. 4. dia. 4ft. 10in. + 5ft. 6in. Firebox 7ft. 0in. long.
Working pressure	200lbs.

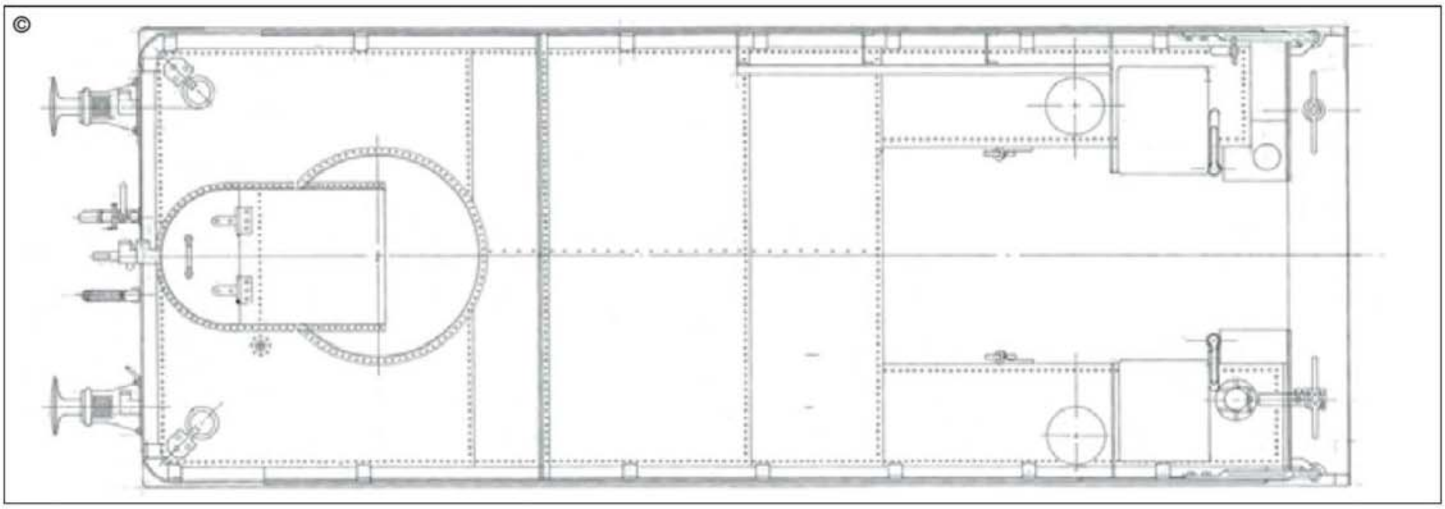
For the sake of authenticity and for completeness I should point out that at least two of these tenders carried different liveries to the normal of the time, and were painted black and fully lined out. I refer to tender, works number 1561, which was built for locomotive No. 97, lined out in red, and to the tender attached to the engine *La France* No. 102, lined out in white. As far as other liveries are concerned they are probably unique in that over their lifetime they carried every change of livery through from the Indian red frames and entwined monogram of the Dean era to the very last British Railways livery of 1957.

Should anybody be further interested in the drawings they are available via my old friend Phil Williams on website www.churchwardlocos.com.

For those of you who want to work out your own statistics for this class I add the following dimensions of the full-size locomotives which are also applicable to my drawings and I have included a scale from which you can measure from. Most of my dimensions (**Table 1**) have been taken from the full-size works drawings, from known standard dimensions and from official photographs so they should be fairly accurate.

Tenders of the Dean 3,000 gallon, Churchward 3,500 gallon and Dean 4,000 gallon tenders were fitted at various periods of their lifetime.

So now I'm off for a quiet blast on the pipes to practice the fingering of various crunlueths before I sink into bed with one or two of those famous malts which the Scots are not embarrassed about. If only I knew how to build a still! **ME**



MACHINE TOOLS

Emco milling machines

Tony Griffiths examines the range of compact milling machines from Emco.

Surprisingly, for a company so devoted to its range of amateur and semi-professional machine tools, Emco produced only one small conventional vertical miller, a 'Mill/Drill' unit that evolved through three versions. The original model, introduced during the 1960s, had a 4-speed geared head and was often catalogued in the UK as the Mentor - though this was a designation more usually applied to educational versions fitted with armoured electrical cables and safer electrical switchgear.

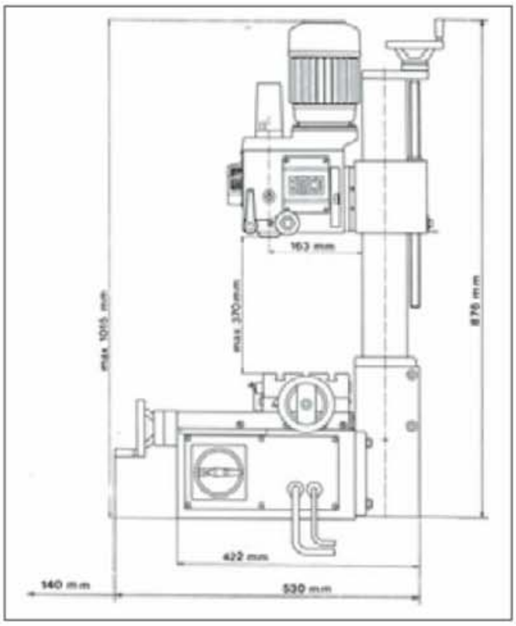
By the 1970s the machine had evolved into the 6-speed geared-head FB-2 and, by the 1980s, was in its final form as the simplified and cheaper-to-manufacture F1 and FP models each with belt-driven heads - the former with a miniature V-belt and the latter with a better-gripping Poly-V drive. The F1 was also available as a CNC machine, intended for industrial training as well as hobby use and today is a highly sought-after machine and capable of remarkable work.

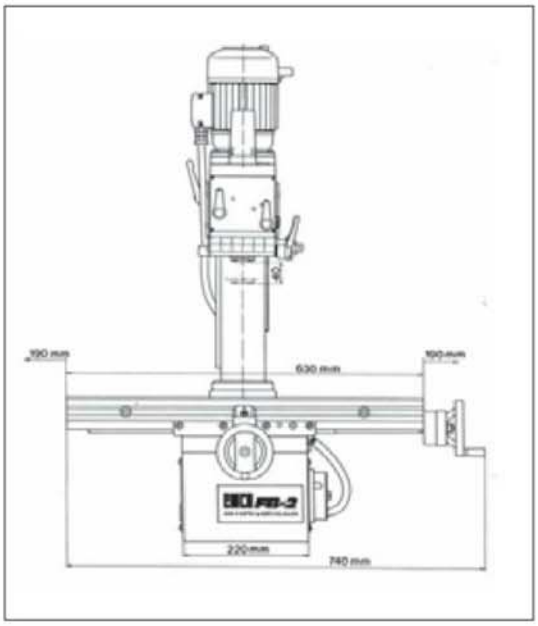
Besides being sold as a complete milling machine the 4 and 6-speed heads, together with their vertical column and base socket, were offered as an optional-extra on most of the larger Emco lathes including the 7, 8.4, 8.6 and all versions of the 10 and 11. The FB-2 has also been found badged as an Ajax, a name used by a UK-based import company, originally based near Stockport in Cheshire.

All varieties of the miller, from first to last, had tables 150 mm wide (with three full-length T-slots) but that on the 4-speed model was, at 520mm long, some 110mm shorter than the other versions and its longitudinal travel of 350mm 30mm less. However, at 150mm, the 4-speed model enjoyed 10mm more cross travel than the other types.

While 'newer' can often mean 'better', in the case of the table's longitudinal stops the reverse was true. The original fitment was a pair of decently-sized, chrome-plated handles that allowed settings to be made without recourse to a spanner, but these were replaced first by square blocks held by socket-headed screws and then, on the 6-speed model, by even simpler and cheaper-to-make buttons.

Although these change saved the company a few pence per unit Emco also (at some point) exchanged the table's original and cheap-looking plastic handwheels for what must have been very much more costly and attractive aluminium items with chrome handles, identical in design to the type originally used on the head's fine-feed control. When the F1 was introduced the aluminium wheels were





retained, but the handles reverted to plastic.

The feed-screws, which ran through slotted nuts and adjustable by twin clamping screws (to reduce backlash) were fitted with clearly engraved and zeroing-micrometer dials of a good size.

Although not listed for either the 4-speed geared-head or FP models the FB-2 was offered with the option of an expensive (and so now very rare) 3-speed table-feed motor unit that worked through a safety-overload clutch and gave travel rates of 1.3, 2.5 and 6.7 inches (33/65/170mm) per minute.

All years of production were fitted with a useful metal-ruler scale, engraved with inch or metric markings, on both X and Y table movements.

Of particularly neat and compact construction, early versions of the head were produced in two models: one carried a side plate labelled Emcomat and was fitted with a 0.14hp 1-phase motor while the other, badged Maximat, was equipped with a slightly taller and more powerful 0.20hp 1-phase (or 0.35hp 3-phase) motor. All 4-speed heads were lubricated by grease (Emco order 602-005, but which today can be replaced by any good quality, high-temperature lithium-based product), and ran at 350, 640, 780 and 1,450 rpm. However, the 6-speed unit was lubricated by an oil-bath and enjoyed a very much more useful range of speeds: 120, 280, 370, 1,100 and 2,000 rpm. The final production model, the belt-drive FP1, attempted to compromise with 350, 600, 1,100 and 2,300rpm.

Most versatile of all was the F1P fitted with the (optional) variable-speed motor; as the machine also retained its 4-step belt drive this gave speed ranges on each pulley setting of: 100 to 500rpm, 200 to 1,000rpm, 400 to 2,000rpm and 800 to 4,000rpm. When fitted with a 60 rather than 50-cycle motor spindle speeds were generally some 25% faster.

To users of older machine tools the small-diameter, finned-body motors all appear to run very hot - but this was merely a result of their volume-to-power ratio and reflected the use of efficient modern insulation materials. Even so, these units do not enjoy a reputation for long-term reliability and replacements are both difficult and expensive to obtain.

While the 4-speed head used paddle-type speed-change levers located by tiny, fiddly-to-engage pins (as also found on Emco lathes of the time) the 6-speed version had much larger, more easily gripped plastic handles fitted with spring-loaded indexing. The belt-drive models were, of course, a lot slower to change speed: first the belt-guard plate on the side of the head had to be removed, the motor unclamped and swivelled to slacken the belt, the belt shifted to its new position and tensioned, the motor clamp retightened and finally the guard-plate replaced.

All models had a head that swivelled through 360deg. (with a vernier scale for precise setting), a No. 2 Morse taper socket and a quill under the control of a quick-action, spring-return lever working through rack-and-pinion gearing. The quill (together with the bolt head for the draw bar) protruded though the top surface of the head and, while protected by a rather flimsy plastic cover on the 6-speed models, was left exposed on the 4-speed version.

The head had a fine-feed drive, but only at 90deg. to the table and by winding the head up and down the column; hence, with feeds along the axis of the quill limited to rapid-action the machine's capacity to handle very sensitive angled jobs was restricted to setting them up in an angled vice, or similar.

Although resetting the head's vertical position on the column took much twirling of the control handle it was (unlike the competing Taiwanese mill/drills) guided by a gib block and so stayed in perfect aligned throughout its travel. If the head needed to be rotated around the vertical axis of the column the latter could be unclamped from its housing by two socket-headed screws and, guided by a ring of degree markings, swung to whatever position was desired.

While quill travel on the geared-head models was 40mm, on the belt-drive types this was increased to 50 millimetres. The 4-speed head had a throat of 145mm, the necessarily deeper 6-speed version had 163mm of clearance and the belt-drive units – which required an even greater spacing between their pulleys – 195 millimetres. Although the latter figure gave the belt heads a capacity advantage over the geared type (and was a useful feature in so compact a machine) the extra leverage it imposed between cutter and column meant that rates of metal removal could not be as heavy.

Both the spindle and 'head-to-column' were locked by simple clamp bolts fitted, on the 4-speed model, with ordinary nuts but on other versions by a type of propriety lever that could be indexed round to the most convenient operating position.

The Emco miller was always an expensive proposition with a basic FB-2 costing, in 1992, over £2,500. By the time a stand and chip tray, table-motor unit, vice and collet-chuck were added this rose to more than £4,200, a figure then well beyond the pocket of all but the wealthiest amateur and one that explains the attractions of the cruder, less versatile but tough mill/ drill machines from the far-east that commonly sold for between £650 and £1,200.

An exact copy of the FB-2 was also made in Taiwan and marketed, during the 1970s and 1980s under various brand names for between £900 and £1,250; it appears to have been a soundly engineered proposition and the few examples encountered by the writer all worked with commendable precision and quietness.

For further details of Emco machine tools visit www.lathes.co.uk **ME**

Notices

A Correction

Following my report on the model engineering weekend (*M.E.* 4305, 3 August 2007) at the **Milestones Museum** in Basingstoke, Graham Blisset from **Basingstoke DMES** has sent the following correction:

"The Metropolitan locomotive in photo 4, on page 135 and a further comment on the miniature railway operating at Milestones, were both attributed to Larkswood Railway. These references are inaccurate.

The 5in. gauge Metropolitan locomotive is owned by Guy Harding a member of the Basingstoke & District Model Engineering Society (B&DMES).

Larkswood Railway was operating the ground level $7^1/_4$in. gauge miniature railway with, so far as I am aware, their own locomotive. However, both the raised and ground level 5in. gauge miniature railways were owned and run by members of the Basingstoke & District Model Engineering Society, who had put significant effort into arranging and supplying the miniature railways. In fact, one of the passenger coaches and the set of points for the ground level track were only finished two days before the event."

I apologise for this and am pleased to let Graham set the matter straight.

Driver Training for Beginners

The Ryedale SME, at their railway in Gilling East, North Yorkshire, and the **Lindsey Model Society** are running a driver training day for absolute beginners on 13 October 2007.

The track is worked on mainline practice and consists of an extensive, fully signalled, double track mainline. Additional facilities include a locomotive shed to house about 50 engines, marshalling yards to accommodate 600 wagons and carriage sidings for 30 or more coaches.

Following a classroom introduction, there will be a walk round the line to explain the functions of all the signals followed by a practical lesson on preparing engines and raising steam.

Once the engine is in steam, the new drivers will be able to run up and down one of the long sidings in the Up Yard until they get a feel for working the engine and are completely at home with their new situation. Some shunting will then be required to marshal a pick up goods train to work on the mainline. The drivers will then be shown how to prepare the engine for working on the mainline and will be accompanied by one of our Pilot men to learn the road and working to the semaphore signals.

The fee for the day is £70 and includes a buffet lunch and tea or coffee all day. Space is limited to 10 candidates and applications will be treated on a first come, first served basis.

Application forms are available from Doug Hewson, 73 Victoria Road, Barnetby le Wold, North Lincolnshire DN38 6HY (E. **doug@the hewsons.co.uk**).

In Memoriam

It is with the deepest regret that we record the passing of the following members of model engineering societies. The sympathy of staff at Model Engineer is extended to the family and friends they leave behind.

Mike Holt	*Wigan DMES*
Wilson Selowa	*Centurion SME (South Africa)*

Engineering Courses in Swansea

We have received the following details of engineering courses at Gorseinon College in Swansea from Michael Wildin, the course tutor. The classes start in September, so don't delay if you are interested.

Welding for Beginners meets on Wednesday evenings, 7.00 - 9.00pm. The course teaches the beginner how to weld safely, using various types of welding equipment (gas and arc). Welds will be produced under supervised and controlled conditions in the workshop. This is a useful course for those who may wish to learn welding for work or for interest and hobby purposes. Assessment is via a portfolio of evidence of skills acquired - a BTEC Award at Level 1 will be achieved on successful completion of the course.

The **Model Engineers Club** meets Thursday evenings at Gorseinon College, under the auspices of the City & County of Swansea. It offers a friendly environment for a creative and enthusiastic group of people to make a wide range of projects. Full use of all the Engineering Workshop facilities is provided, with assistance given to those who are unfamiliar with the operation of any of the equipment. For further information on either course, or to reserve a place, please call (01792) 893054 or 890754.
www.gorseinon.ac.uk

Llanelli Autumn Miniature Rail & Road Rally

The Llanelli Autumn Miniature Rail & Road Rally will take place on 29/30 September. The society is trying to expand on last year's attendance of eight traction engines and 25 locomotives. As well as the exhibits, there will be a variety of traders and children's fair rides.

On Saturday, a three-mile road run is planned to a nearby Pembrey village with a refreshment stop for thirsty engine drivers. All of this will take place in the beautiful Pembrey Country Park, familiar to those who attended IMLEC this year. Further details can be obtained from Rob Rayner (T. 01554 835286).

Boiler identification

The **Southern Federation** Newsletter comments that many boilers are being submitted for testing without having a visible serial number or other means of identifying the boiler that the certificate relates to. The note points out that failure to have a serial number on the boiler could result in the insurance company declining to settle a claim in the event of an accident because the boiler does not have a proven valid boiler certificate. As the federation says "You have been warned".

Boilers do fail, albeit rarely, and the newsletter relates the tale of a 5in. gauge Mayflower boiler which failed while steam was being raised. The boiler had operated for the previous season with no problems. Those who examined the boiler concluded that silver solder had failed to penetrate the firebox stays, which eventually pulled out. Remember that stays should be pickled before use and that the fit should allow room for the solder to penetrate.

UK Club News

The petrol-hydraulic locomotive at **Basingstoke DMES** has moved on to a new home and is being replaced by a Maxitrak Class 66 locomotive which will be the new electric club locomotive. The society has secured a 10 year lease for the Viables site and is now looking at longer term plans for the railway and other facilities.

At **Cardiff MES**, the 27 May public opening was seriously affected by the weather and described as a "relentlessly wet, cold and miserable day". It set the record as the worst ever with fewer than 40 visitors. As I sit writing this column in early August, the description still seems appropriate!

In contrast, the following day was bright and sunny with attendance almost setting a new record for the highest number of visitors.

Brian Hawker gave an illustrated talk in March on The Severn Crossings in which he described the history of the various bridges across the River Severn. He discussed the politics and design challenges of the Second Severn Bridge with which he was involved in his work as a civil engineer.

Mathew Carroll, who is very involved with bus preservation, arranged to drive a group of members to the Gloucestershire and Warwickshire Railway in his classic, restored bus. The trip home included a stop at a pub for a lovely drink and meal.

The steam outline petrol/hydraulic locomotive Pengwyn, built by Graham Penn, is now fully track proven (**see photo**).

The **Ground Level 5" Gauge Main Line Association (GL5)** held a rally meeting and AGM over the weekend of 11/12 August at the **Colchester MES** track site. Eight fully detailed model trains were run on the track on Saturday, with a similar number running throughout Sunday. This was the first time that the Colchester ground level track had been used for this type of event.

GL5 members travelled from many different parts of the country, bringing their locomotives and rolling stock to run on the Colchester track and marshalling yards. For details of further events and a programme see the Colchester society website at www.csmee.co.uk or telephone 01206 822735 for details. New members are always welcomed.

Lincoln DMES is extending its existing 2000ft. track by another 500ft. towards the village of North Scarle.

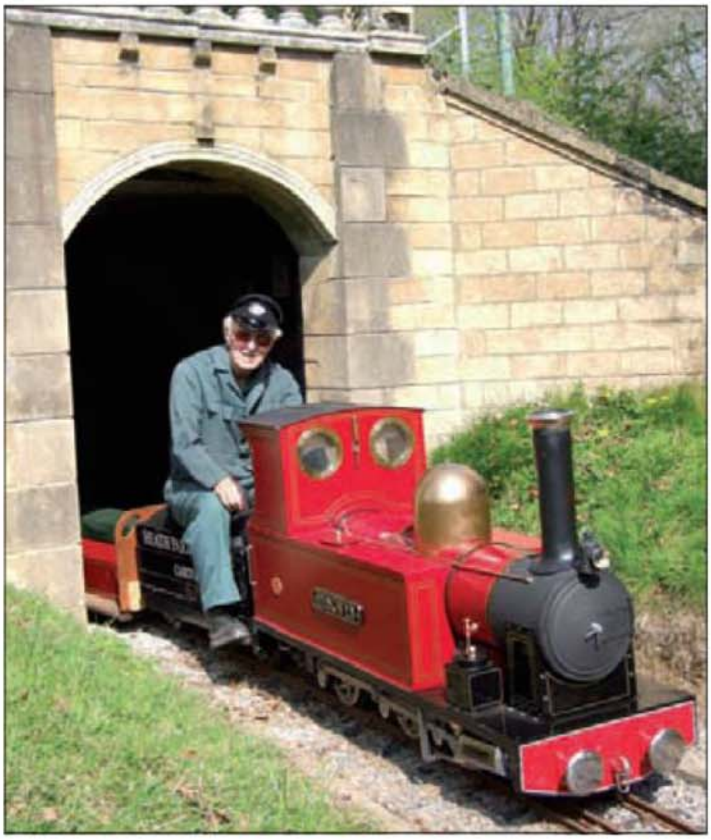
Northampton SME reports that three important milestones have been passed along the route to achieving the long term development plan for the Society. These are Planning Approval, Landlords Consent and Land Drainage Act consent. The last one came as a surprise requirement; it is required because the ditch forming the southern boundary is classed as a 'main river'. The next stage is to apply for external funding from the National Lottery "Awards for All" scheme.

At the **St. Albans DMES**, Roy Verden, secretary, has carried out exhaustive tests on the new club badge to check its resistance to high temperature, water immersion and shock. He reports it passed perfectly. His testing method: leave it on the tee shirt and give it a trip through the washing machine!

The sale of boats donated by member Eric Grant has resulted in winners all round. Those who bought the boats have got most of them back up and running (sailing?) again and the money raised by the sale has funded a laptop computer which will run the club's existing digital projector.

Unfortunately the club barbecue in June was declared a wash-out at the first attempt, but another date was set in July.

Stafford DMES is making good progress on its new ground level track layout with some new points installed. A new bridge spanning the raised and ground level tracks is almost complete and will provide safer access to the centre area.



Graham Penn with Pengwyn at Cardiff MES (photo by Trevor Bailey)

Sutton MEC operated the extension to its Gauge 1 track for the first time over Easter this year. The extension includes a fine new bridge and at the time of the opening this still needed to be painted.

At **Wigan DMES**, Roy Holt gave a presentation on his voluntary work with the East Lancashire Railway. He has been a volunteer for the last 16 years and described everything to do with full-size preservation as big, heavy or dirty and frequently all three. Roy had a large compilation of colour slides for the evening, many taken from viewpoints not accessible to the public.

World Club News

Australia

The Model Engineers and Live Steamers Association (Maryborough) held two working bees recently. In the first, six metres of top dressing was spread in and around the track using a mini-digger. The second working bee was held to lay and connect power to the station building.

The following week, all the concrete work was carried out with material donated by Byrne Brothers Concrete who have supported the club over the last 31 years.

The society received recognition at the 2007 Australia Day Awards. A plaque was presented by Maryborough City Council for the club's Sunday in the Park event.

Humour Time

The following was found in the **Nottingham SMEE** newsletter:

"Two men are fishing quietly and drinking beer at their favourite fishing spot.

Almost silently, so as not to scare the fish, Melvin says, "I think I'm going to divorce my wife - she hasn't spoken to me in over two months."

Keith continues slowly sipping his beer, and then thoughtfully says, "You'd better think it over - women like that are hard to find."

>>

DIARY

SEPTEMBER

14 **Canvey R&MEC.** *Visitors Running Day.* Contact Brian Baker: 01702 512752.

14 **Chichester DSME.** *Auction at Club.* Contact Brian Bird: 01243 536468.

15 **Canvey R&MEC.** *Southern Federation Rally.* Contact Brian Baker: 01702 512752.

15-16 **Lincoln DMES.** *Miniature Steam Weekend.* Contact Paul Thompson: 01522 888228.

15 **Maxitrak Owners Club.** *Factory Open Day and MOC AGM.* Contact Eric Penn 0208 979 4335.

15-16 **Nottingham SMEE.** *Thomas The Tank Engine.* Contact Pete Towle: 0115 987 9865.

15 **Wigan DMES.** *Visit to the Butterley Miniature Railway Society.* Contact John Chamberlain: 01744 882255.

16 **Basingstoke DMES.** *Lions Event.* Contact Guy Harding: 01256 844861.

16 **Bristol SMEE.** *Public Running.* Contact Trevor Chambers: 0145 441 5085.

16 **Canvey R&MEC.** *Public Running.* Contact Brian Baker: 01702 512752.

16 **Frimley & Ascot LC.** *Club Running.* Contact Bob Dowman: 01252 835042.

16 **Guildford MES.** *Charity Day & Public Running.* Contact Dave Longhurst: 01428 605424.

16 **Maidstone MES (UK).** *Public Running.* Contact Martin Parham: 01622 630298.

16 **Norwich DSME.** *Public Running.* Contact Shirley Berry: 01379 740578.

16 **Oxford (City of) SME.** *Public Running.* Contact Chris Kelland: 01235 770836.

16 **Pinewood MRS.** *Public Running.* Contact Paul Archer: 0118 989 4516.

16 **Plymouth MSLS.** *Public Running.* Contact Malcom Preen: 01752 778083.

16 **Reading SME.** *Efficiency Competition.* Contact Brian Joslyn: 01491 873393.

16 **Saffron Walden DSME.** *Open Day Rally & Hog Roast.* Contact Jack Setterfield: 01843 596822.

16 **St. Albans DMES.** *Puffing Field Morning.* Contact Roy Verden: 01923 220590.

17 **Cardiff MES.** *Visit by Brean Sands Modellers.* Contact Don Norman: 01656 784530.

18 **Brandon DSME.** *Family & Invitation Day.* Contact John Martin: 01842 75 2493.

18 **Chesterfield MES.** *Meeting/ Slide Show.* Contact Mike Rhodes: 01623 648676.

18 **North Cornwall MES.** *Meeting & Maintenance Evening.* Contact Geoff Wright: 01566 86032.

18 **Nottingham SMEE.** *Steve Tough: Nottingham Express Transit (NET) Phase 2.* Contact Graham Davenport: 0115 8496703.

18 **Romney Marsh MES.** *Track Meeting.* Contact John Wimble: 01797 362295.

18 **South Durham SME.** *Afternoon Steam-Up.* Contact B. Owens: 01325 721503.

18 **Taunton ME.** *David Hartland: From Setback to Success.* Contact Don Martin: 01460 63162.

19 **Bristol SMEE.** *Bring & Buy.* Contact Trevor Chambers: 0145 441 5085.

19 **Chingford DMEC.** *Geoff Moore: Progress on the Mikado.* Contact Ron Manning: 020 8360 6144.

19 **Guildford MES.** *Bits & Pieces.* Contact Dave Longhurst: 01428 605424.

19 **Hull DSME.** *Members' Current Projects.* Contact Tony Finn: 01482 898434.

19 **Leeds SMEE.** Meeting. Contact Colin Abrey: 01132 649630.

19 **Maidstone MES (UK).** *Members' Run.* Contact Martin Parham: 01622 630298.

19 **MELSA.** *Meeting.* Contact Graham Chadbone: 07 4121 4341.

19 **West Wiltshire SME.** *Steaming at club track.* Contact R. Nev. Boulton: 01380 828101.

20 **Adelaide Miniature SRS.** *Meeting.* Contact Peter Cooper: 8264 3471.

20 **Isle of Wight MES.** *Talk: Turbocadd in model engineering.* Contact Malcolm Hollyman: 01983 564568.

20 **Sutton MEC.** *Last Evening Steam-Up of Year.* Contact Bob Wood: 0208 641 6258.

21 **Canvey R&MEC.** *Meeting.* Contact Brian Baker: 01702 512752.

21 **North London SME.** Narrow Gauge Railways of WW1. Contact Rachael Chapman: 01442 275968.

21 **Rochdale SMEE.** *Video Night.* Contact Bob Denyer: 0161 959 1818.

21 **Romford MEC.** *Marylyn Bullivant: Military Museum.* Contact Colin Hunt: 01708 709302.

22 **Brandon DSME.** *Running Day.* Contact John Martin: 01842 75 2493.

22 **Chesterfield MES.** *Public Running.* Contact Mike Rhodes: 01623 648676.

22-23 **Guildford MES.** *Polly Rally.* Contact Dave Longhurst: 01428 605424.

22-23 **Kempton Steam Museum.** *Steaming Weekend.* Information: 01932 765328.

22 **Malden DSME.** *Families Day & Night Run.* Contact John Mottram: 01483 473786.

22-23 **Nottingham SMEE.** *Thomas The Tank Engine.* Contact Pete Towle: 0115 987 9865.

23 **Sutton Coldfield MES.** *SEQLEC competition. Contact Neil Harrison 0121 378 3992.*

23 **Adelaide Miniature SRS.** *Public Running.* Contact Peter Cooper: 8264 3471.

23 **Basingstoke DMES.** *Members' Running Day.* Contact Guy Harding: 01256 844861.

23 **Bedford MES.** *Public Running (Teddy Bears Day) 11am - 4-30pm.* Contact Ted Jolliffe: 01234 327791.

23 **Bristol SMEE.** *Public Running.* Contact Trevor Chambers: 0145 441 5085.

23 **Cambridge MES.** *Members' Steam-Up.* Contact Tim Coles: 01954 267359.

23 **Cardiff MES.** *Open Day.* Contact Don Norman: 01656 784530.

23 **Harlington LS.** *Public Running.* Contact Peter Tarrant: 01895 851168.

23 **Lincoln DMES.** *Public Running.* Contact Paul Thompson: 01522 888228.

23 **Maidstone MES (UK).** Public Running. Contact Martin Parham: 01622 630298.

23 **MELSA.** *Bracken Ridge.* Contact Graham Chadbone: 07 4121 4341.

23 **North Cornwall MES.** *Sunday Steam-Up.* Contact Geoff Wright: 01566 86032.

23 **Norwich DSME.** *Public Running.* Contact Shirley Berry: 01379 740578.

23 **Romney Marsh MES.** *Autumn Track Meeting.* Contact John Wimble: 01797 362295.

23 **Saffron Walden DSME.** *Public Running.* Contact Jack Setterfield: 01843 596822.

23 **Staines SME.** *Public Running.* Contact Stan Bishop: 01784 241891.

23 **Taunton ME.** *Public Running.* Contact Don Martin: 01460 63162.

23 **Worthing DSME.** *Public Running.* Contact Bob Phillips: 01903 243018.

24 **Bedford MES.** *It's cooler up front Pt.1.* Contact Ted Jolliffe: 01234 327791.

24 **Northampton SME.** *Club Efficiency Competition.* Contact Pete Jarman: 01234 708501 (eve).

24 **York City & DSME.** *Running Day.* Contact Pat Martindale: 01262 676291.

25 **Basingstoke DMES.** *Meeting.* Contact Guy Harding: 01256 844861.

25 **Birmingham SME.** *Great Western Day.* Contact John Walker: 01789 266 065.

25 **Chelmsford SME.** *John Smith: Distilleries.* Contact Tom Sharich: 01277 222611.

25 **Romney Marsh MES.** *Track Meeting.* Contact John Wimble: 01797 362295.

26 **Chingford DMEC.** *Trade Visit by Romford Supplies.* Contact Ron Manning: 020 8360 6144.

26 **Stockholes Farm MR.** *Members' Running Evening.* Contact Ivan Smith: 01427 872723.

27 **Cardiff MES.** *Bits & Pieces.* Contact Don Norman: 01656 784530.

27 **Leyland SME.** *Project Night.* Contact A. P. Bibby: 01254 812049.

27 **Sutton MEC.** *Chat Night.* Contact Bob Wood: 0208 641 6258.

27 **Worthing DSME.** *Marine Evening.* Contact Bob Phillips: 01903 243018.

28 **Colchester SMEE.** *Presentation by Mr Stapleton of Phoenix Paints.* Contact K. Wraight: 01255 434091.

28-30 **Ascot Locomotive Society.** *Racing at Ascot.* Contact Lee Porteus: 01344 884385.

28 **Ickenham DSME.** AGM. Contact David Sexton: 01895 630125.

28 **Kinver & West Midlands SME.** *Beer & Skittles Night.* Contact John Campbell: 01384 891244.

29 **Canvey R&MEC.** *Members' Only Running Day.* Contact Brian Baker: 01702 512752.

29 **Guildford MES.** *SMEE Day.* Contact Dave Longhurst: 01428 605424.

29 **National 2½in. Gauge Ass'n.** *South Eastern Area Rally.* Contact Clive Young: 01233 626455.

29 **Romney Marsh MES.** *Boiler Testing.* Contact John Wimble: 01797 362295.

29-30 **St. Albans DMES.** *Annual Club Exhibition at Francis Bacon School.* Contact Roy Verden: 01923 220590.

29 **SM&EE.** *Visit to Guildford MES Track.* Contact Maurice Fagg: 020 8669 1480.

30 **Basingstoke DMES.** *Public Running.* Contact Guy Harding: 01256 844861.

30 **Bristol SMEE.** *3½in. Locomotive Rally.* Contact Trevor Chambers: 0145 441 5085.

30 **Chichester DSME.** *Steam on Sunday.* Contact Brian Bird: 01243 536468.

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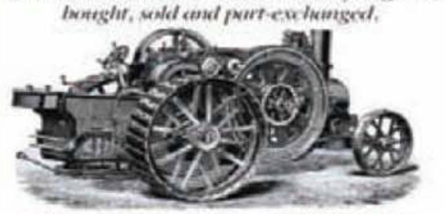

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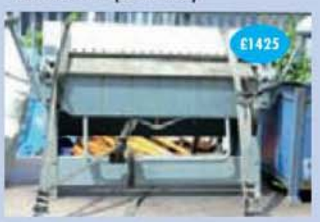

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