MODEL ENGINEER

Vol. 200 No. 4323

11 – 24 April 2008

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IN THIS ISSUE

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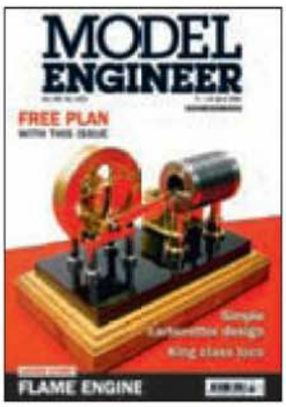
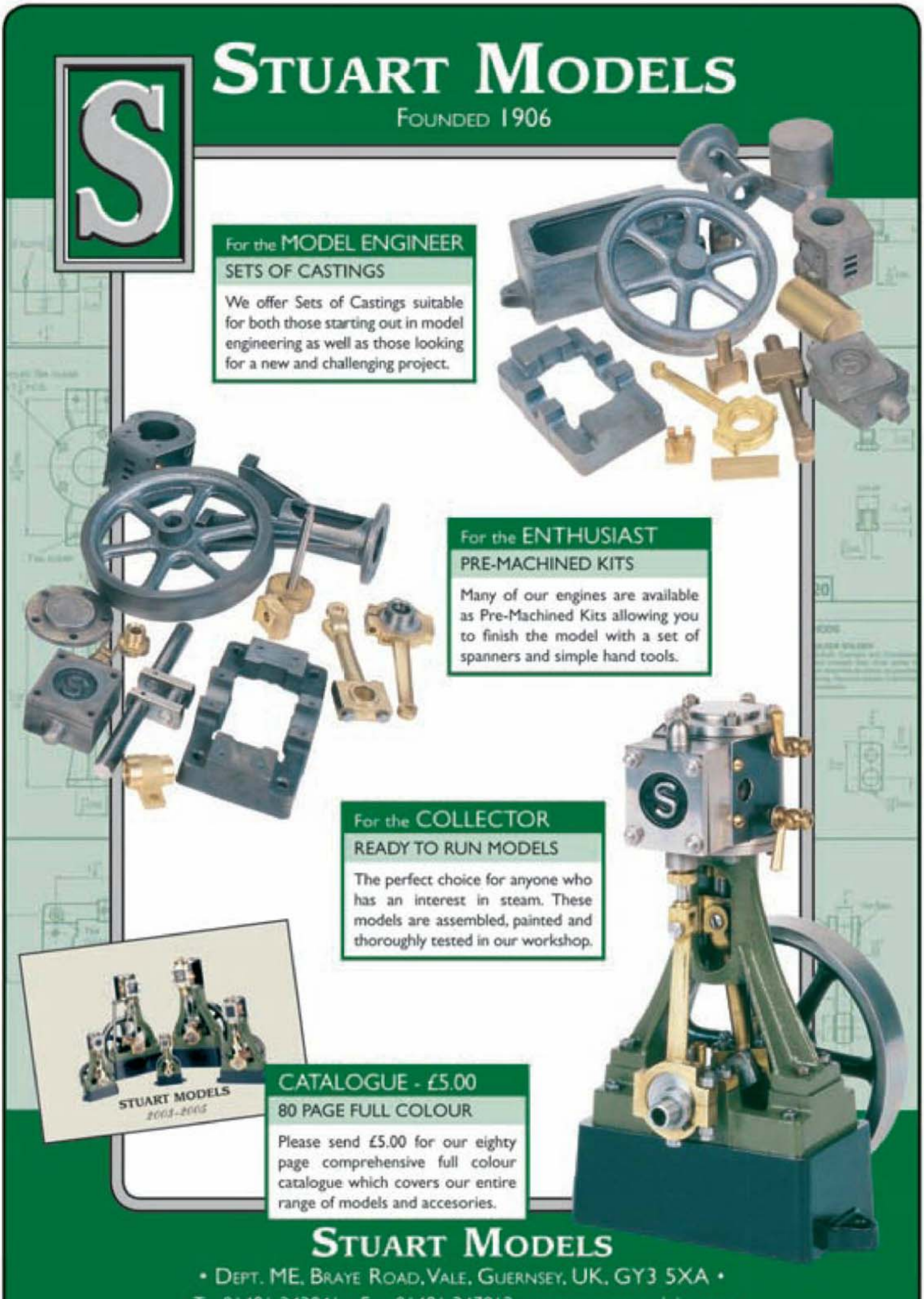


ON THE COVER...

Our cover feature for this issue is the flame eater, or more correctly vacuum engine, designed by Jan Ridders. It is a variation on the theme with its original valve arrangement. It makes a great project which can be completed quite quickly. Full drawings are included with this issue of *Model Engineer*.
(Photograph by Jan Ridders)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DVDs are very good teaching aids and these three will certainly help anyone wanting to start welding, in No's 1 & 2 using the readily available type of low power welding set. No.1 deals with making inert gas surrounded welds and No.2 covers conventional stick welding. No. 3 covers welding, brazing and cutting using oxy-acetylene and is perhaps the most useful to the model engineer. All are excellent in content and quality and come with a useful Wallchart of reminders.

Soldering, Brazing & Welding - a Manual of Techniques • Pritchard • £16.99

Very good book on all ways of joining bits of metal together. Covered are all ways of soldering and brazing, albeit slightly briefly and then, in much greater detail, Oxy-Acetylene, MMA, MIG and TIG welding. Most of the instructions refer to welding steel, but welding other materials and distortion control are covered in separate chapters, as is quality in welding. Recommended for those taking up welding, or as a reference book if you have some experience. 160 pages full of drawings, diagrams and photographs. Larger format paperback.

Farm and Workshop Welding • Pearce • £23.05

This really is exceptionally good although, as is implicit in its title, this book tends towards welding larger objects than the average model engineer will face. But the underlying principles are the same whatever the size of item and, as well as chapters on MMA welding, MIG/MAG welding, Gas Welding and Cutting, TIG Welding and Plasma Cutting, you get taught the special techniques for welding cast iron, pipe welding and hardfacing. Also covered are Soldering, Welding Plastics, Taps and dies, Drill sharpening and Basic Blacksmithing. The instruction is clear, and down to earth, and is greatly helped by numerous good illustrations, many in colour. 160 pages. Hardbound.

Artist Blacksmithing • App 154 mins • DVD • £29.99

Really tremendous two disk set, in which Peter Parkinson lets you into the secrets of blacksmithing; apart from a useful general Introduction, he covers Tapering, Upsetting & Spreading, Hot Cutting, Punching, Twisting, Bending, Joining, Toolmaking and Finishing. The whole thing was shot to a very high standard in Peter's workshop, and he is an excellent instructor. This really is very interesting - even my wife was fascinated by it. If you want to try your hand at blacksmithing of the artistic rather than the horseshoe variety, this is clearly very useful, but it is well worth considering if you are just intrigued by how a length of mild steel can be shaped using a fire and a hammer - plus a lot of skill.

The Artist Blacksmith Design and Techniques • Parkinson • £23.05

This really is a cracking good book! As its title implies this is about modern blacksmithing and making interesting shapes and designs, of which it shows plenty of examples. But it also has a heck of a lot more, on equipment, materials, safety and the various techniques required to produce all sorts of types of work. 160 pages crammed with colour photographs and B&W diagrams and drawings. Larger format hardback.

Smith's Work • 1899 • Hasluck • £ 8.05

Examples of Paul Hasluck's "Work" Handbook series pop up throughout our booklist. In many ways, most of the information in this book can be found in other books in this section, but what makes this different is, firstly, it is aimed at amateurs, so the explanations are perhaps that bit fuller and clearer as a result. Secondly, this book strays into the forging and making of cranks, which we cannot recall seeing elsewhere to any extent. So it is definitely worth adding to your blacksmithing library, even if you are not a Hasluck addict - many are! 160 pages. 211 illustrations. Paperback.

Build a Muller • Chastain • £13.50

Here Steve Chastain, author of a good number of the foundry books we sell, gives very detailed instructions for building a sand muller, or mixer - an indispensable piece of equipment for anyone seriously casting metal, as it makes light of mixing sand for molding boxes, or for cores. And the beauty of this is that the plans can be scaled up or down to make a small muller just for core sand, or a 42-inch one from a 500 gallon tank; everything you need to know is right here in this 96 page book, crammed with drawing, photos, tables and the like. Paperback.

Building A Gas Fired Crucible Furnace • Gingery • £ 12.15

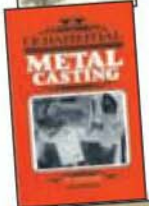
This is the first description of a furnace YOU can build and use, which will easily melt cast iron - up to 20lbs. As always with Dave Gingery, the design is well thought out and clearly described, with appropriate drawings or illustrations. 108 pages. Paperback. Satisfied customers confirm it melts well!

Iron Melting Cupola Furnaces for the small foundry • Chastain • £ 16.10

Dave Gingery's gas fired crucible furnace, above, whilst a superb design of which a fair few have been made, only melts small amounts of cast iron. NOW you can melt very much larger quantities, thanks to Steve Chastain who has written this brilliant book, highly recommended by Dave himself. The 10" diameter, 7' high cupola Steve describes in detail here will melt 330 pounds of iron per hour in its standard version, or 660 pounds per hour in the supercharged (or blown) version! This really is a very good book; the design is explained clearly - as is the maths behind it, so you can vary the size if you want. This is information you won't find anywhere else in such concise form, and if you build your own cupola, you can save a fortune on buying castings. We are not sure what your neighbours are going to say when you fire up this brute, but that is your problem. 124 page paperback, crammed with drawings, photos, tables and all you need to know.

Greensand Casting Techniques from David Gingery's Workshop • 45 mins • DVD £ 19.95
Advanced Green Sand Moulding with John Dilsaver • 45 mins • DVD £ 19.95

Two good semi-professional films for those of you interested in doing your own casting. In the first Dave Gingery goes through the basics of green sand moulding - the sand mix, tools required etc., and then gives a practical demonstration of the art, moulding and pouring a casting for a flywheel. You also see his famous gas fired crucible furnace, and some of the workshop equipment and models featured in his books. In the second film, John Dilsaver deals with how to do the moulds (and only the molds) for awkward items, and covers complex shapes, book moulds, green-sand cores, matchplate patterns etc. Both good watching!



Ornamental Metal Casting • Whitmoyer • £10.00

Super book on molding and casting unusual items such as plaques, sundials, figurines etc. Strong on lost wax casting and simple techniques of using Plaster of Paris to make incredibly detailed castings. Also details an enlarged version of Dave Gingery's Charcoal Foundry. An excellent book, really loaded with photos and drawings. 92 pages. Paperback.

Practical Wood Patternmaking • 1943 • Hall • £ 14.45

This is my type of book - lots of pictures and not many words. Seriously, this is a very good patternmaking book; it really does give you lessons in the art via practical examples, some of which may be useful in their own right. Early patternmaking books are great as they show how to make patterns not often seen today - IE for the items you and I want. This book also adds a more modern perspective to earlier books. *Want a good first book on patternmaking?* This is it! 188 page large format paperback groaning with illustrations and drawings.

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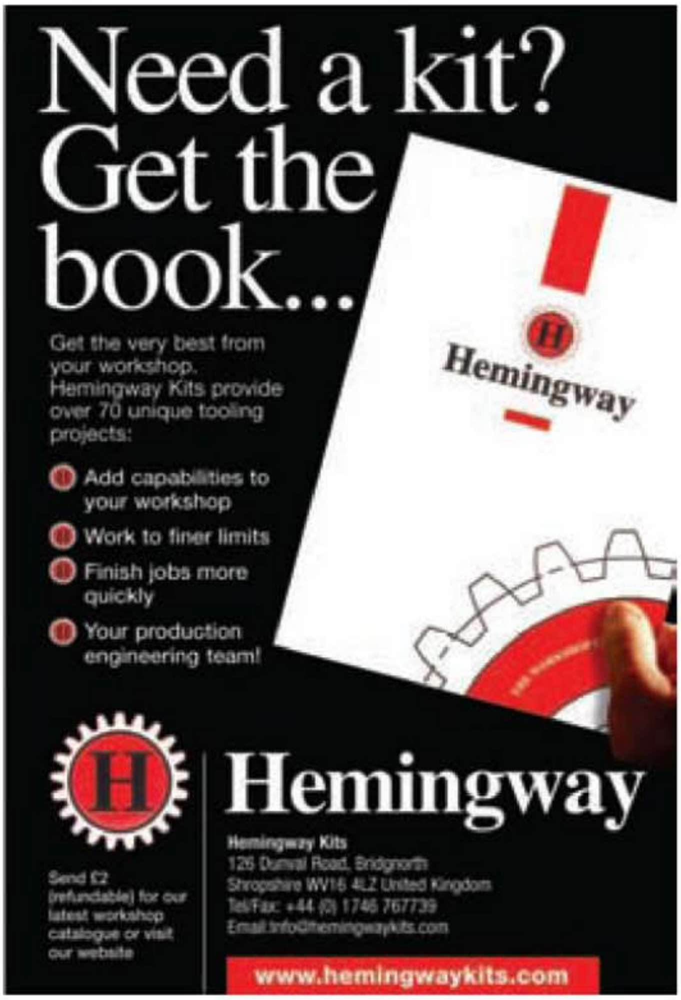

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SMOKE RINGS

M.E. index

We have received news that the online *M.E.* index available at http://www.itech.net.au/modelengineer/ was updated at the end of February to cover every issue up to the end of 2007.

This website has the great advantage of having a built in search engine, so that you can search for a title, author and, most usefully, indexed notes of the articles that have appeared since 1898. It will also search by volume, issue and page number. Results can be sorted into similar categories.

There was a recent problem for those of us with the latest Apple computers and the Firefox browser, which were not working with the site. If you experienced those problems you will be glad to know that problem has now been fixed.

This website is run from Australia by Alex Cameron and is a super resource for model engineers, especially those of us that have access to copies of 'ours' for years past.

Readers of *Model Engineers' Workshop* will be interested to know that magazine is now indexed at the same website although Alex says that the *MEW* index needs a little more work.

1. Ernie Mann on his centenarian run.

2. Philip Wickenden on song.

100 not out

Ten years ago Ernie Mann, a long time member of the Fylde Society of Model Engineers, celebrated his 90th birthday by driving his 2-4-6T locomotive around the club's track at Thornton Cleveleys, Lancashire. This event was recorded in *Model Engineer* (Vol. 180, issue 4066, p520). On that day Ernie had expressed a hope that he would be able to repeat the exercise when he reached the age of 100 years. That day arrived on Friday, 8 February 2008. Two days later, the following Sunday afternoon, he came down to the club "just to see what was going on."

He was unaware that steps had been taken to help him to celebrate his birthday in the manner expressed 10 years ago or at least as near as circumstances allowed. On arrival he was immediately invited to drive a train. This time it was Bob Duck's electric locomotive that was ready for him to drive, which he brought safely around the track to the station area where members were waiting.

Congratulations and much chat preceded Ernie cutting a specially decorated cake. The photograph on the cake was one of him on a previous occasion driving an 08 shunter.

Ernie's model engineering interests started in the mid 1940s when the *Model Engineer* cost 6d (2.5p) a copy. Since then he has built a Tich, the 2-6-4T mentioned above, an 0-6-0 petrol-engined shunter which was later converted to battery power plus several other locomotives.

Ernie has not been idle during the last ten years either. Pottering with model engineering until only very recently when he had to move into a rest home.

M.E. The musical

Robert Coles lives in Bath where "one becomes blasé about the many fine buskers that populate the streets. One stopped me in my tracks. A busker was playing old time American string band music on fiddle and guitar, at the same time. He achieved this by designing and building a frame into which a guitar was clamped and surrounded with a mechanism that allowed him to work a plucking mechanism via a treadle providing motion worked by his right foot. His left foot worked a series of pedals, which applied pressure to the strings against the appropriate fret on the neck of the guitar to make the chords.

"All the time his arms were fully employed in playing the fiddle. Each of his limbs was, therefore, carrying out their own individual task. Playing one instrument is beyond many of us but this chap was playing two and had designed and built the mechanism himself.

"The machine was fascinating to watch with eccentrics, rods, levers and wheels, a unique feature was the jerky nature of the many of the parts which of course directly related to the rhythm of the music. Even the frame on which it all sat was designed as a trolley with detachable wheels to allow it to be moved to the busking pitch. The music was incidentally very good.

"In a brief interlude in his playing I discovered that he was, as I had guessed, a model engineer, called Philip Wickenden. He told me that he took no newspaper and watched no television. The only magazine he takes, and reads avidly, is *Model Engineer*. His current project is a 2½in. gauge Stirling Single."

POSTBAG

Screw thread tolerances

SIRS, - D. A. G. Brown's article (*M.E.* 4311, 26 October 2007) was both welcome and helpful and was followed by Tony Weale's *Ayesha II* Part 10.

I began my *Ayesha II* when the series first appeared and, being a 'beginner' found the instructions excellent albeit probably unnecessary for your skilled readers, and the help I have received from the National 2½" Gauge Association very encouraging.

However, I have tried to make a regulator body and have a problem. I purchased a set of 40tpi. taps and dies from one of your regular advertisers and find that the ¼in. tap is 4 or 5 thou oversize. The supplier replaced it free of charge, but the replacement is no better. The split die cuts to the correct size but a sloppy fit results.

I wrote to the SMEE in London who wrote back that it is permissible and correct for the tap to be 4 or 5 thou. oversize and this baffles me.

My crude mathematics tells me that 40tpi. whether of 55 or 60deg. thread form produces a thread only some 16 thou deep with a theoretical thread engagement of say 75% and the chances of a steam tight joint on a 3⁄16in. length of thread is minimal.

Can your skilled readers please help me out?

A. H. Middleton, Gloucestershire.

Steam turbines

SIRS, - Reading Ron Isted's excellent history on Parsons and his steam turbine brings (*M.E.s* 4313, and 4315) to mind how widespread was the effect on generation of electricity.

Charles Brown Snr., an English engineer trained at Maudsleys, went to Switzerland where he had a notable influence on Swiss heavy engineering with the firms Escher Wyss, S. L. M. and Oerlikon. His son, also Charles was encouraged together with a Swiss, Water Boveri (they had been apprentices together at Oerlikon Engineering), to form a company, Brown Boveri, (BBC) to produce electrical machinery in 1890.

Brown Snr. saw the advantages of the steam turbine as a prime mover for generators and Brown Boveri negotiated a licence to manufacture and sell to Parson's design, although restricted to markets in France, Germany and Italy, and not for marine use (Parson's own speciality).

This was in 1900 and by 1901 they had delivered their first turbine generating set on the Continent, although of only 250kW. However, by 1912 they were designing their own turbine sets and the licence lapsed.

Their business flourished and by 1967 they produced the world's largest turbine generating set of 1300MW for Tennessee Valley Authority.

I can hear you saying "He's blowing the Swiss trumpet (or Alpenhorn!)." My answer is, "Of course, I worked for BBC for 39 years and came to admire their dedication and excellence in engineering." Incidentally, when I joined BBC in 1946, I was surprised to find the Swiss using Whitworth threads. During my tenure with them they gradually changed, first to metric below 5⁄16in. and eventually to all metric threads. Even so, our pipe threads persisted; not my influence I must add.

S. Wright, Shropshire.

Thermodynamics

SIRS, - I feel that the problem with the application of thermodynamics to miniature steam engines may be fundamental. Having spent my working life teaching chemistry, I always stressed that there were two great questions to be asked: (i) how fast does a process take place, and (ii) how far does the process proceed. The first question leads us to the study of kinetics and the second to thermodynamics.

There is no simple connection between these two, they are essentially independent of each other. We can only invoke thermodynamics if we can be certain that we are dealing with an equilibrium situation - what evidence is there that during its passage from the boiler through the super-heater the steam comes into thermal equilibrium?

In my view the approach should be direct experimental measurement not a theoretical study. Such experiments would not be difficult. I can do no better than recall the words of Professor Porter, one of the 20th century great exponents of thermodynamics: "The development of the steam engine owed little to the study of thermodynamics but the development of thermodynamics owes a great deal to the study of the steam engine."

Roy Froom, Berkshire.

Drummond spares sought

SIRS, - I am renovating a lathe which I rescued from being thrown in the skip. It is a Drummond 3½in. flatbed Model B, serial number 885. With the help of my very enthusiastic 7 year-old son, the renovation is coming on fine.

However, there are some items missing. The two main items are the tailstock and a securing nut (1in. x 16tpi.) for securing the main shaft in the headstock.

I wondered if any of our readers could help me locate replacements for these parts. I expect I could get the nut made locally, but the tailstock would be more complex and I would rather fit an original part if at all possible.

I would even consider another old Drummond lathe that is 'past its use by date' just to get the parts needed.

Am I expecting too much?

Peter Crowther, Hull.

Fusees

SIRS, - I would like to point out that the fusee in my clock (Stan Bray's Class A6 Clocks report, *M.E.* 4314, 7 December 2007) was indeed made by me and not purchased as stated.

It might be of interest to fellow clock makers to know how the arbours are retained in the fusees I make. There is a cross pin fitted in the arbour which locates in a keyway in the fusee and is trapped behind the ratchet wheel.

This makes pivot refinishing very simple if needed as the arbour is easily removable.

K. J. Allum, Oxfordshire.

Write to us

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Responses to published letters are forwarded as appropriate.

Carbon thanks

SIRS, - Can I convey many thanks for all your and readers efforts in assisting with my search for carbon-carbon material. I now have at least two current suppliers of this material. All I need now is the willpower to complete the necessary detailed calculation.
Bob Pridmore, Sheffield.

Ewins oil pumps (1)

SIRS, - On studying the operation of the Ewins oil pump (*M.E.* 4314, 7 December 2007) I am left puzzled. When the piston is in the raised position, I note that oil can fill the cavity between piston and oil valve by means of oil passages. When the piston descends, the oil passes the ball against the spring pressure. However, when the piston commences its upward stroke the ball valve closes and the oil passages are blocked by the piston body thus forming a hydraulic lock.

In this case how can the pumping action continue? What am I missing?
Jack Shillings, Notts.

Ewins oil pumps (2)

SIRS, - I hesitate to take issue with Neville Evans, especially in his recommendations of the Ewins mechanical lubricator. However, Neville seems to have the mistaken belief that the clack valve in the oil line is a back up to that in the pump itself (*M.E.* 4314, 7 December 2007). This is not the case. The clack in the oil pipe, which should be located as far downstream as possible, is there to prevent the oil pipe from emptying when the locomotive is at rest. Draining of this pipe would mean that the cylinders were starved of oil when the next run commenced until the pipe(s) had been primed by the pump. The fact that the Ewins pump can deliver such low flow rates makes the need for this clack greater - not less.
Barrie Purslow, Warrington.

Inspection micrometers and Bolney lathes

SIRS, - Re. the letter about micrometers from Mr. Arthur Bellamy (*M.E.* 4314, 7 December 2007). Yes they are intended for use in inspection departments and as far as I know they are still available. The Mitutoyo tool catalogue for April 1988, page 50, and the one for the year 2000, page 55, list them.

I have a Robert Pringle and Sons catalogue for 1920, illustrating a Boley Dreadnought watchmaker's lathe. I have one of these, which I acquired about 15 years ago. The parts are interchangeable with the BTM lathe.

I bought a BTM lathe as per your picture in 1948, from Southern Watch and Clock Supplies. The price was £20. This was when I was in the first year of my apprenticeship. I started off at £1 per week, rising by 10/- (50p) per year for 5 years, so £20 was a lot of money. We weren't allowed to use a lathe until we were proficient in the use of turns, vis like a dead centre lathe used, of course, with a bow.

Our lathes were always used with a hand wheel bolted to the bench, being belt-driven; in fact I still use mine the same way. I nearly caused a riot in the workshop, changing over from a catgut belt with a metal fastener to one made from Whiston's round PVC belting. The bearings and spindles on these lathes are made from hardened steel, with double tapers at both ends. These lathes were made so the head stock could be used on the left or the right. Try it the other way round, it is not easy. If you are looking for collets the Crawford number is 54. The smallest 0.3mm came with my BTM lathe.
John Sargeant, Reading Society of Model Engineers.

Lathe chuck security

SIRS, - I was recently called upon to produce an item with a left-hand internal thread for which I did not have the necessary die and consequently tried to do it in the lathe, a foolhardy exercise for the untrained! I made a tool with a ¼in. shank holding a ⅛in. HSS bit, secured by a 4BA grub-screw in the shank end. Of course it couldn't be mounted in the normal tool post, but why not in the rear post? Sadly it was virtually impossible to lower the tool to centre height as the tools usually mounted in the rear tool post are upside down. After much fiddling with packing I managed to get the cutting point to centre height - very satisfactory. With the table travelling toward the chuck and the chuck rotating in reverse I applied a series of very gentle cuts, but as the tool was not mounted in the topslide I could not spread the work a few thou either side of centre to reduce the load. So go gently! Then to my horror and amazement I could see the tool jumping in and out of engagement. Why? Because the 3-jaw was unwinding itself just a tiny bit - just enough to ruin the job.

I realise many readers will be amused, but as the experts seem to have a trick to overcome these little problems, will somebody tell me how to prevent the chuck from undoing. I keep the register well oiled and very clean, and I don't want a problem arising from it being forcefully done up too tight. But how do you cut a left-hand thread in the lathe? After a very frustrating Sunday, I managed to get the taps and dies from Tracy Tools by return of post and the job is done. As they say on the golf course, you can always get out by paying!
Dennis Randall, Oxfordshire.

LEDs and capacitors

SIRS, - Reference a simple dynamo *M.E.* 4317, 18 January 2008), I may have some helpful information when using LEDs and capacitors.

1. Light emitting diodes (LEDs) emit light only when the cathode lead is connected to the negative terminal and the anode lead to the positive terminal of a battery or bridge rectifier.

2. Identify the leads correctly. The cathode is normally the longest lead of a new LED and/or nearest to a flat on the mounting flange

3. Connection in the opposite direction will destroy the LED if more than 6 Volts are applied even for a short time.

4. The operating current for each LED must be limited by means of a 0.5 W series resistor. Start with currents of 20mA. This is also a safety issue to prevent internal short circuits, bad smells and failure.

5. Different colour LEDs will need a different series resistor to produce a similar light output.

6. A capacitor of 2000 μFD has a positive and negative terminal and a maximum working voltage which must be respected. The electrolyte of old capacitors you may find is not always in good order and are best avoided.
Jon Nixey, Suffolk.

Pop-pop boats

SIRS, - In *M.E.* 4306, 17 August 2007, there is a letter about pop-pop boats asking whether the vibrating diaphragm is a necessary feature. I conducted an experiment and found that the engine will work without it, but not nearly so well. I think the diaphragm acts like a displacer in a hot air engine.
J. M. Ryder, North Yorkshire.

Offset turning (1)

SIRS, - I have read with interest Stan Bray's series on the unusual engine *Rachel*. However, I have noticed an error in the latest issue which could mislead the inexperienced reader (*M.E.* 4318, 1 February 2008). For

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boring the valve eccentric he suggests putting it in the 3-jaw chuck with a spacer under one jaw equal in thickness to the offset required. If a self-centring chuck is used in this way, the offset will always be less then the thickness of the spacer. There is a formula for calculating the thickness required for a given offset; this can be found in the *Model Engineer's Handbook*.

Incidentally, I have always found it easier to machine eccentrics if the strap is made first. The halves can then be separated and the half strap used as a gauge for machining the sheave, thus ensuring a good fit without the need for precision measurement.

Derek Winks, London.

Offset turning (2)

SIRS, - I suspect that Stan Bray is mistaken (*M.E.* 4318, 1 February 2008) in suggesting that a 1.75mm throw eccentric can be produced by inserting a 1.75mm thick spacer under one jaw of a self centring 3-jaw chuck.

This procedure would produce the desired result only if the jaw concerned remained stationary as the packing is inserted. In fact it has to move outwards (along with the other jaws) to accommodate the increase in dimensions. This reduces the offset, meaning that a spacer greater than the 1.75mm is required.

The trigonometry of all this is quite complicated, so I am personally not able to state what packing should be used. Perhaps marking out is the best method, after all.

Neil G. Heppenstall, Cheshire.

Austin Seven wheel security

SIRS, - A very minor correction, by a relatively inexperienced model engineer, to an otherwise excellent article on screws (*M.E.* 4317, 18 January 2008).

I know a little bit about Austin Seven cars and agree that there can be problems with the rear axle half shafts, but not quite as Mr. Ellis suggests. I have heard of half shafts that have broken, but never of a wheel coming off, because the hub bearing is secured onto the hub stub with a separate inner retaining nut that is locked in place with a tang washer.

Perhaps the 'special' of Mr. Ellis had a nut or two removed by the previous owner.

Tim Glanvill, North Yorkshire.

Another mystery micrometer

SIRS, - I have in my possession a Moore & Wright 0-12mm micrometer, part no. 933M.

I have never been able to use this mike because the thimble is graduated in the wrong direction. That is to say, the numbers are engraved in ascending order to the right of the zero mark. The barrel graduations are quite normal, with the numbers increasing as the micrometer is wound open.

I would very much like to know the purpose of this tool and how it would be used. Can any reader help?

Bob Harper, Gloucestershire.

Good service praised

SIRS, - Let me praise a British company instead of knocking one. Recently my Myford Super 7 developed a problem with the electrics, about which I am completely clueless, so I contacted Myfords. From the outset they were very helpful, all the way from reception to Ian and Malcolm who sorted the problem out for me.

It was so nice to speak to real live people and not some totally annoying menu system. They also returned promised phone calls which seems unusual these days.

A. McLeish, Buckinghamshire.

Finding track sites

SIRS, - With reference to the letter from Mr. Michael Lee (*M.E.* 4313, 23 November 2007) regarding the availability of suitable sites for model engineering clubs to build tracks and other facilities, perhaps the experience of my own club, Erewash Valley MES, may be of help in this matter. As a first move we had joined the Northern Association of Model Engineers, whose help and advice was invaluable

Founded in 1974, with even at that time several clubs loosing their facilities in just the way as Mr. Lee describes, we decided that it should be our aim to acquire a suitable piece of land for ourselves to avoid the agony of loosing our base.

Initially we contacted one of the local councils, and with the help of a friendly councillor, were allowed to build on part of a piece of waste ground which was used as a play area for the local housing estate. As we were only to be charged £1 per year, and although not ideal, it did give us a start, and by purchasing some already made track in the shape of a simple oval, from another club, by 1976 we were up and running.

By the late 1980s we had been saving hard, and had raised sufficient money to make inquiries as to the availability of suitable land.

When such things as motorways are built and major road widening takes place, local authorities regularly finish up with small pieces of land, often agricultural and in a green belt.

Having kept our 'ears to the ground' and in close contact with all the local councils, it eventually paid off and we were offered a piece of land one acre in size, right next to the main Nottingham/Derby dual carriageway, which had been purchased when the road was built but was a corner of a field which was now cut off from the farm by the new road. This had taken place in the mid 1950s so the land was to say the least overgrown.

We stipulated that we could only go ahead providing the land came with the necessary planning permission to do and build what we wished for. Local councils have a statutory duty to provide leisure facilities and should not hold on to surplus land. We had saved the necessary money to buy the land and we had sufficient left to make a start on clearing the site. Because of the undergrowth it took us six months to find our boundaries!

One of the big advantages of being members of the Northern Association of Model Engineers is that they have funds to provide interest free loans to their member clubs, specifically to assist the member societies to advance the hobby. Since purchasing the site we have been pleased over the years to have taken advantage of this facility on three occasions to assist us in major projects.

The site has proved adequate to construct a raised track, for 2½, 3½ and 5in. gauge 550ft. long, and we are now in the last stages of completing a ground level one, which is over 1,500ft. long. We have a brick clubhouse, covered steaming bays, a covered station, car park, and every facility. It may have taken 30 years to get there, but it is all 'ours' and we have no fear of loosing it.

Nigel Thompson, Nottinghamshire.

Locomotive lubrication

SIRS, - This is to compliment Neville Evans on his "discussion on lubrication" in part 30 of his *Penrhos Grange* series (*M.E.* 4316, 4 January 2008). I have never designed a locomotive lubrication system from scratch as I have never built a locomotive. However, I have worked for a long time on a 'Make it work' project of a locomotive built by club members (separately and then put together) where nothing quite fitted mechanically or design-wise. There is nothing more frustrating than to find 'just one more' problem when one assumes that the beast is properly designed.

Neville Evans covers the lubrication system very adequately and all designers and makers of locomotives could do far worse than reading his article carefully ('read, mark, learn and inwardly digest' as the quote goes). As an illustration I refer to the end of his penultimate paragraph on page 32. "Think what would happen if you left the oil switched on and the boiler cooled down leaving a vacuum within, could be embarrassing."

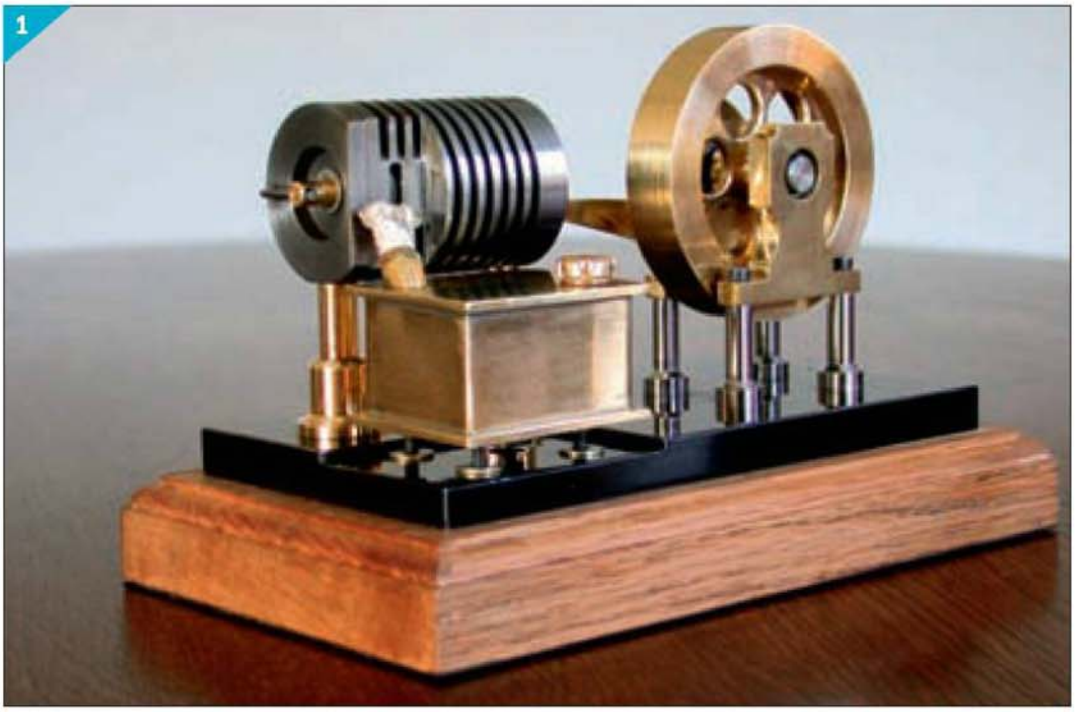
Read that carefully, see what it all really means, and it will take you back to re-reading the whole article and then knowing a lot more about the intricacies of cylinder lubrication.

Ted Wale, Canada.

SIMPLE VACUUM ENGINE WITH AN INTERNAL VALVE

Jan Ridders
of the Netherlands describes his unique and simple design for a vacuum engine ideal for inexperienced builders. Full drawings to build the engine are included in this issue.

1. Completed vacuum engine model showing the internal valve and wick positioning near the cylinder port.



The principle of vacuum engines, (variously called flame-lickers or flame-gulpers) is very simple. The cycle starts by drawing the hot gasses of a flame through an open port into a cylinder where it is cooled. The timing of this event is controlled by a valve. On the outward stroke of the piston (towards the flywheel), the valve opens, and the flame is drawn in to the cylinder. Near the top of the stroke, the valve closes and the gases in the cylinder cool. Atmospheric pressure combined with the reduced pressure in the cylinder (a partial vacuum) force the piston back on its power stroke. Finally, the inlet valve opens the cylinder port again.

Conventional valve design issues

However, the classic construction with an external slide valve that closes and opens the port in the cylinder or head every cycle, is functionally complex. Correct adjustment of this valve with all its driving mechanisms is critical.

Deviations from ideal conditions can easily result in a poorly running engine - or one that won't go at all. If the spring pressure on the valve is too high, this acts as a drag on the eccentric to slow the engine. On the other hand, if the tension is too low, the system starts floating and the timing of the head valve becomes erratic.

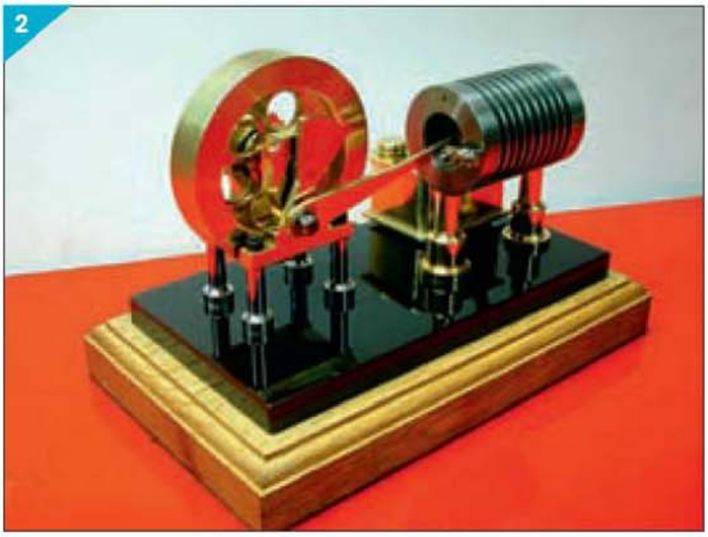
Additionally, spring pressure acting transversely on the movement of the head valve is critical, too. If excessively high this means extra friction. If too low, this causes a leakage between the surface of the valve and the cylinder. However, some looseness is needed to relieve back pressure.

As the piston moves towards the cylinder head (as a result of the vacuum created) the flame's gasses are excluded from the cylinder. Before the piston reaches the cylinder head, the partial vacuum pressure in the cylinder will have risen to equal atmospheric pressure. If the valve on the port is left closed too long, a restricting back pressure can develop.

On the other hand, opening this port too early also leads to a loss of engine power.

So, one has to determine, somewhat experimentally, how wide the valve port must be because this determines the timing of the valve. Additionally, the moment when the cylinder pressure (a partial vacuum) equals atmospheric pressure also depends on the cylinder temperature. While this temperature varies depending on a number of factors, the valve timing doesn't change.

These disadvantages of conventional vacuum engines >>



2. Engine seen from the connecting rod side.

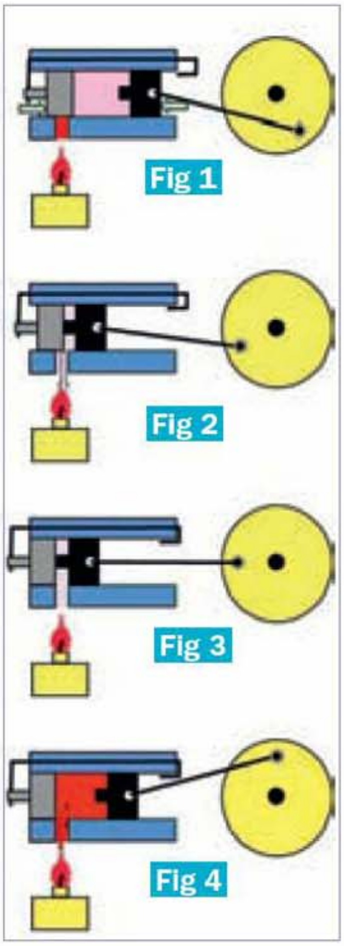
3. Top view of the engine.

Fig 1. Power stroke of engine. Internal valve covers the cylinder port.

Fig. 2. End of power stroke and the spigot on the cylinder begins to push to internal valve away from the port to prevent backpressure building up.

Fig. 3. Cylinder port completely open, ready for next intake cycle.

Fig. 4. Momentum of flywheel pulls the piston along sucking in hot gases from the flame. Cycle repeats when port is closed by internal valve (fig 1).



gave me the idea to create an internal head valve in place of an external one. In fact, this is a second piston that has a small stroke, which closes and opens the cylinder port from the inside, instead of on the outside, of the cylinder. This construction makes it also possible for the working piston to drive this valve directly in a very simple way.

Working principles

When the working (power) piston is at the right-most position (**fig 1**), the internal valve has closed the cylinder port by means of the valve rod that moves horizontally in holes along the outside cylinder wall. At that moment, the hot flame gasses are locked-up in the cylinder and start to cool causing a partial vacuum in the cylinder. Consequently, atmospheric pressure on the outside of the working piston pushes it back to the left on its power stroke (**fig 2**). The cylinder's vacuum also works on the internal head valve, keeping it in the right position, so the port in the cylinder stays closed.

As the piston moves to the left, the gasses (in partial vacuum) in the cylinder are compressed. When this compression equals atmospheric pressure, the internal valve is automatically forced open (**fig 3**). It works like a pressure relief valve so that high back pressure can never occur.

A small spigot on the power piston further pushes the head valve to its furthest open position. Momentum of the flywheel drives the connecting rod pulling the piston so that the flame's gasses are drawn into the cylinder again as the piston moves to the right (**fig 4**). This cycle repeats itself when the power piston has arrived again in the extreme right position.

The engine can be seen working on YouTube.

W. http://www.youtube.com/watch?v=XCp623s2WUU A two-cylinder boxer configuration is also shown there, too.

W. http://www.youtube.com/watch?v=lyrWRBoC-2c

Advantages of this design

This design has several advantages compared to the current construction with external head valve:

1. The rather precarious mechanism with a camshaft, pushrod and springs is eliminated completely and, with that, also the critical adjustments of the eccentric, the spring pressure on the head valve and the timing of this whole mechanism.

2. The airtight sealing of the internal head valve is simply a matter of making a good fitting valve in the cylinder just like the power piston

3. A restricting back pressure in the cylinder does not occur because the head valve opens the cylinder hole at the moment the pressure equals atmospheric pressure.

4. The friction of the internal valve in the cylinder is considerably lower than that of the complete mechanism for an external valve.

5. The temperature of the internal valve is lower. External valves operate directly in the burner and sometimes so do the springs that keep it tight to the surface of the cylinder.

6. The adjustment of the variables to run the engine are fixed in the design. In other words, after initial setup, there is nothing to adjust; therefore the timing can not drift.

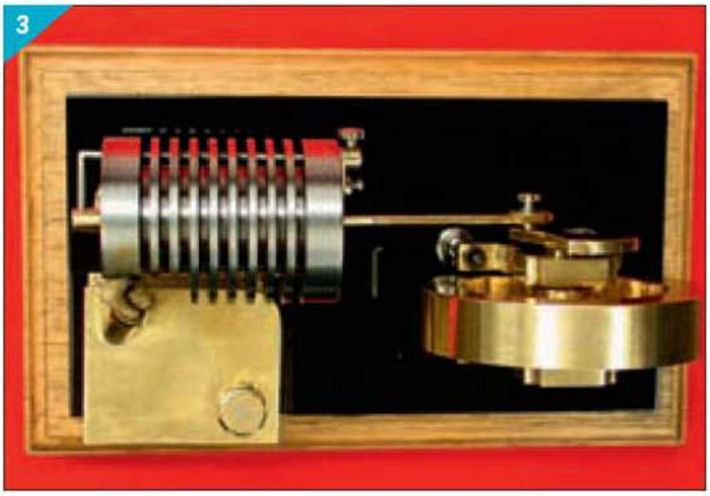
7. Because of its symmetry this engine runs in either direction. This may not be a huge advantage, but it is remarkable anyway.

8. This design is extremely simple and robust with a minimum of parts which are easy to make. Overall, it is a nice model for less experienced model builders.

Some specifications

The piston and the internal head valve are made out of cast iron. The most important reason is that this material has a low temperature expansion coefficient. This avoids jamming of the piston and/or the head valve in the cylinder. Furthermore, cast iron is more or less self-lubricating, even at high temperatures because of the high carbon content, it is wear resistant and the machining is rather easy.

I used cast iron for the cylinder, but one can use stainless steel as well. The bore in the cylinder must be cylindrical and smooth. The diameter of the piston as well as the head valve should be a little smaller (perhaps 0.03mm or less) than the diameter of



the bore, so that they can move with low friction, yet are able to seal well.

Push rod

The push rod for the head valve can be made either as one bent piece of wire, or out of two sections of steel wire with a diameter of about 2mm. If made of two pieces, they are silver-soldered together at the valve end in place of the bend. This rod must move easily in the bushes of the cylinder wall. The short part of the rod is fitted into a hole in the drive pin that is screwed in the head valve. Try to avoid slackness between these parts.

The opposite end of the push rod has a small adjuster attached, which the power piston strikes firmly, thus closing the cylinder port. This 'striker' can be adjusted and fixed with a 2mm screw and locknut. This screw can be fitted with a small knob on it so it can be easy undone by hand. This makes it easy to dismantle the rod, the piston and the valve, to clean these parts and the inner surface of the cylinder if necessary.

Adjusting the engine

There is hardly anything to adjust on this engine. An initial adjustment is made to the position of the striker on the pushrod. This has to be done at the two extreme positions of the piston.

Position one is top dead centre, where the piston has pushed the head valve away from the cylinder port (extreme left as shown in **fig 3**). The adjuster with its M2 adjuster must be set with the adjusting bracket grub screw so that a few tenths of a millimetre gap is left between the striker and the cylinder wall. In other words: the head valve has this small amount of backlash in this piston position.

Position 2 is at bottom dead centre (or when the piston is 180deg. opposite) where it has pushed the head valve over the cylinder hole. On the striker there is a long M2 screw that must be adjusted again to give a few tenths of a millimetre backlash between it and the piston rim. The lock nut is used to fix this adjustment.

If there is significantly more backlash in one or both piston positions, the engine may change its rotation direction arbitrarily! This may be amusing, but is not quite the intention. The most probable reason for this effect is the fact that at a certain speed the pushrod and the head valve start floating and the cylinder port is not opening or closing at the right moments in the engine cycle.

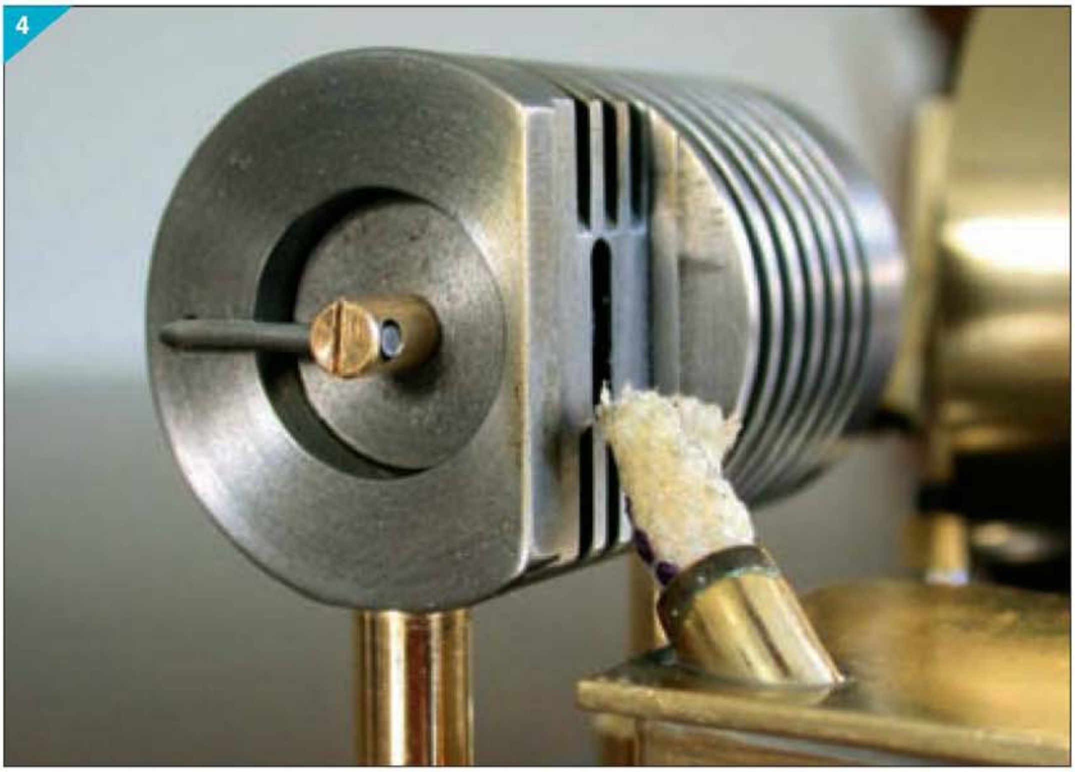
Adjustment of the spirit burner

All vacuum engines are very sensitive to the size of the flame and its position in front of the cylinder port. It is important to avoid sucking in cold air and flame gasses into the cylinder together. This can happen when the flame is deflected by draughts. Usually, the engine stops running almost immediately.

Also, too small a flame makes for erratic running. It is my experience that the width and the height of the flame must be about twice that of the cylinder port.

The position of the flame in front of the port is important, too. It seems it is necessary to position the flame a few millimetres away from the centre of the port in the direction of the cylinder head (away from the flywheel). Apparently the flame gasses are sucked-in at a certain angle.

Finally, the distance of the flame to the cylinder port is important. Find the optimal burner position by moving it in front of the cylinder hole and determine when the engine runs best. You can attach the burner to the base if you desire.



4. *Close-up detail of the internal valve, pivot stud and push rod. Also note the positioning of the wick relative to the cylinder port*

Industrial ethanol is preferable to spirits [meths] if one can obtain it. The flame temperature is higher and it causes fewer deposits on the piston, valve and inner surface of the cylinder.

In either case, it is advisable to clean these parts regularly and in the case of burning spirits, possibly even after every run. This because after cooling down the flame deposits (including soot) can attract water which will condense and stick to the surfaces of these parts, with a fair chance that the engine won't start next time. But the simple construction of the valve push rod makes cleaning an easy job.

Engine performance

The engine should start nearly every time one or two minutes after the spirit burner is lit. In those first minutes, water from the flame condenses in the cold cylinder, preventing the engine from starting. When this condensate disappears, the cylinder will heat up when you revolve the flywheel.

As mentioned, this vacuum engine has no preference for which direction it runs; a direct consequence of having no eccentric.

The maximum speed is about 400rpm.

This engine can be lubricated with a little, very thin oil, but wait until the cylinder is a bit warm before applying it.

Troubleshooting

To find and resolve possible problems, follow the troubleshooting list in the order given. The values shown relate to those of my engine, which runs very well.

1. The engine must run freely. Try a friction test with cold engine and without the flame. Push the flywheel briskly by hand. If disconnected from the piston rod, it must keep running for about 2 minutes; - With only the piston coupled the flywheel must

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freewheel for 20 to 25 seconds. With piston, internal valve and connecting rod connected, the engine should keep running for 5 to 8 seconds, about 25 revolutions.

If it seems there is unacceptable friction in the system. Possible causes and solutions are: combustion residues on the piston, internal valve and inside cylinder wall. This is almost always the case if the engine has cooled down after it being run for a while on a spirit burner. Usually, the engine fails to start-up again. The solution is to clean the piston, internal valve and cylinder wall with a lint-free cloth and some cleaning solvent. Wipe everything dry and repeat the friction test described above.

If the fit of the piston or the internal valve in the cylinder are too tight, lap them into the cylinder with some very fine grinding paste. Clean everything thoroughly and repeat the friction test.

The push rod may be binding. Make sure that there is a little bit of clearance on the hole where the valve push rod fits on the stud screwed into the internal valve. The valve must move as a result of a "pick-up" movement of the push rod.

The part of the push rod that slides in the bushes in the cylinder must be dead straight. The bores must be a little bit larger that the diameter of the rod to prevent sticking. You can lubricate the rod and bushes with a little drop of oil.

2. The air-tightness of piston and internal valve. Check the sealing of the piston and the internal valve with a cold engine and without a flame. Move the piston to its furthest right position (viewing the engine as in figs 1 - 4). Push the valve to close the cylinder port. Move the piston slowly to the left by rotating the flywheel. As a result of the compression that occurs immediately in the cylinder, the valve should be pushed to the left until it just uncovers the port. You should see a narrow slit between the port and the valve. If the piston were moved any further to the left the valve won't move because the compression is gone. If the valve doesn't move during this test there is a leakage in either the piston or the valve.

Poor piston or valve to cylinder sealing can be improved by putting a little, very thin oil at the piston and valve with a small paint-brush. This helps only when the engine is warm, because then the oil will be thinner. Thick oil causes more friction with a cold engine as a result of its viscosity. It may take somewhat longer to start a cold and over-oiled engine.

However, the only remedy may be to make a new piston and/or valve with good a good fit in the cylinder.

3. The adjustment of the valve push rod. In the furthest right (bottom dead centre or BDC) as well as in the utmost left position (top dead centre or TDC) of the piston the push rod must have a few tenths of a millimetre space to move. At TDC, backlash can be adjusted by moving the striker adjustment bracket along the valve push rod and fasten it with the M2 grub screw. At BDC (the furthest right position) of the piston, backlash must be adjusted with the long M2 screw that strikes the piston. Be sure to fix the position with the lock nut.

If the internal valve is pushed to TDC by the spigot on the piston, the cylinder port must be opened completely. If you follow the dimensions on the drawings, this should be the case. The distance of the cylinder to the centre line of the flywheel axis must also be adhered to.

At BDC, the internal valve should overlap the port, closing it, by 1 to 1.5mm.

4. Flame adjustment. A vacuum engine can only run if only the hot gases from the flame are sucked in. All 'flame-eaters' are very sensitive to this!

Therefore the following measurements may be helpful. The flame must significantly overlap the cylinder port. For this engine, the width of the flame must be at least 10mm and the height at least 15mm.

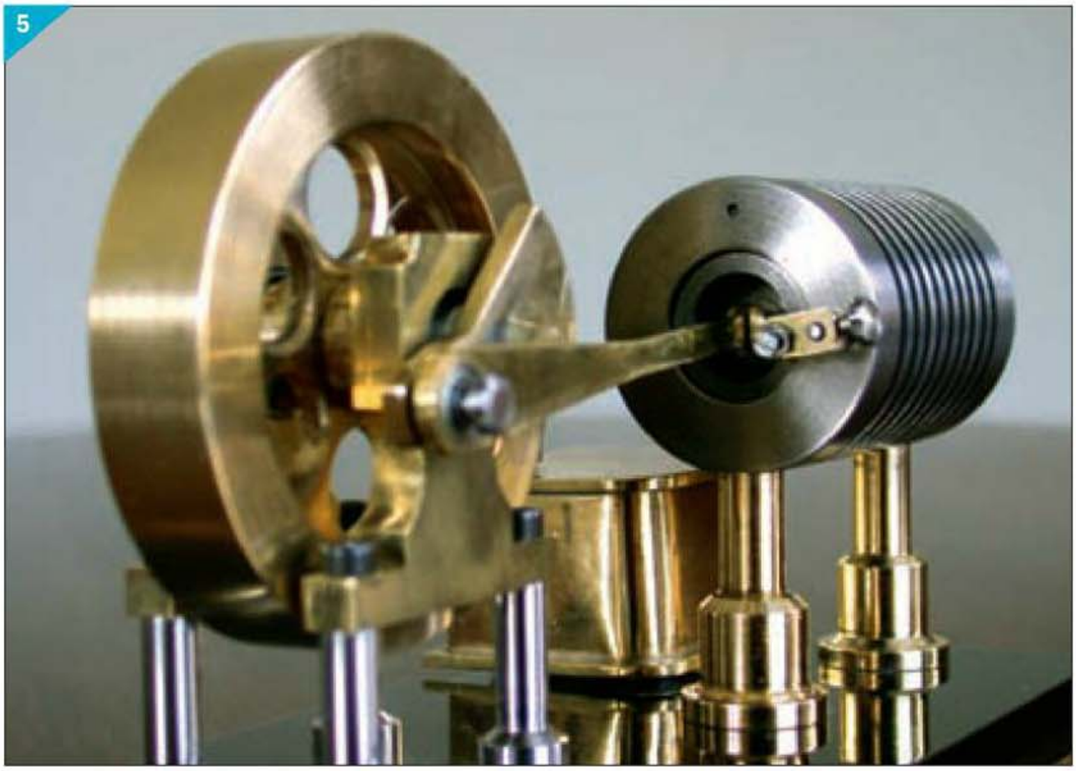
It is very important that the centre of the flame must be positioned 5 to 6mm to the left of the centre of the cylinder port. The reason is that the flame gasses are sucked in at an angle.

A fluttering flame due to air drafts is fatal. 'Flame-eaters' generally stop running if they suck in cold air.

The performance and the reliability of the engine can be significantly improved by using 98% pure ethanol instead of methylated spirits. The heat value of ethanol is considerably higher and its flame is less polluting compared to spirits. Spirits also contains about 10% water, 2% methanol and a colouring agent.

A possible disadvantage of (industrial) ethanol is its availability that could be somewhat more difficult.

Never use 100% methanol because it is very poisonous!



5. A flywheel view showing the valve push rod adjusting mechanism and the power piston at its extreme stroke.

Finally

Because of its extreme simplicity this engine will, I hope, prove popular with beginners. I also hope that this unique design will be valued by the many connoisseurs in the world of vacuum engine builders.

Many more of my engines can be seen at my website. W. http://heetgasmodelbouw.ridders.nu/index.htm

Drawings

The complete drawings to build this engine are included in the special supplement A2 sized sheet included with this issue. **ME**

I/C TOPICS

Nemett provides two possible identities for a mystery engine and introduces a basic carburettor design.

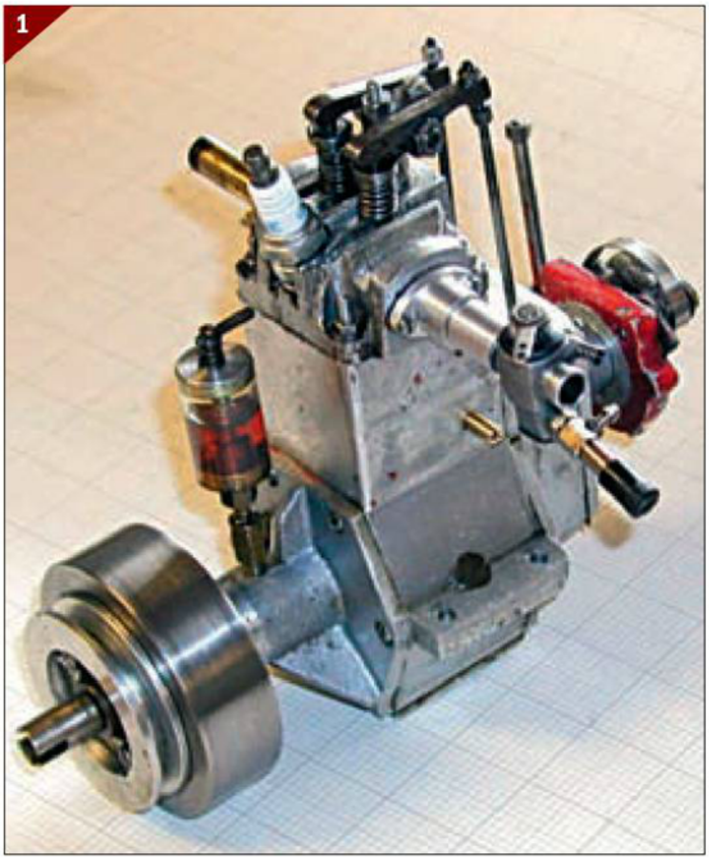
In the last *I/C Topics* (*M.E.* 4319, 15 February 2008), I sought readers' knowledge to identify a single-cylinder 4-stroke engine owned by Dave Loveridge from Sussex. I have had two responses; one from a reader who did not leave contact details, who identified it as an *Otter* 15cc, designed by L. V. R. Haydock and published in *Model Maker* about 1957.

The other response was from Malcolm Beak who provided the following information and photographs:

"SIRS, - Reference the mystery engine; it looks very similar to one I have (**photo 1**). There a number of differences; the crankcase in particular, mine has vertical sides to the cylinder portion and an angled face below that. But the hexagon-shaped front cover held on with small round head screws; the cylinder head and the timing case look identical. Obviously it would have been an easy task to produce either shape crankcase.

My engine is about 17cc. It was built in the early 1950s by Len Gates who was a member of the Victoria Model Steamboat Club. I understand that he made a small number, and it was an attempt to provide an engine of similar size (and I suppose performance) to the *Gannet*, but at a much lower price. When I got this engine, I took it apart when it became obvious that some replacement parts were needed. In particular I had to make new timing gears and cam followers – luckily the cam was in excellent condition. As you may observe, it is fitted with a relatively modern commercial carburettor (I've no idea what make). This is because the one originally fitted when I got it was very sensitive to the needle valve setting, and only a small speed range could be obtained without having to adjust it."

I thank both gentlemen for their responses and hope that we can clarify this situation further.



1. Malcolm Beak's single-cylinder 4-stroke engine.

Response to a query

In response to the query from Mike Burton (*I/C Topics, M.E.* 4317, 18 January 2008) regarding fuel/gas injection systems for miniature engines, I have had a response from Jim Service:

"SIRS, - Regarding the item in Nemett's column referring to a 2-stroke engine, Mike Burton might try the dual fuel carburettor designed by Edgar Westbury for his *Wyvern* and *Centaur* engines.

I have twelve 4-stroke model I/C engines and one 6-stroke which run on butane. Eight of them use the Westbury carburettor; some of the others have an American design carburettor which is roughly similar to the Westbury. Westbury's original design used castings but it can easily be constructed from bar stock. I find that all of these engines require surprisingly little gas - a mere whiff in some cases. Indeed they will not run at all if the gas is excessive. A fine control valve is therefore an essential in the gas line.

It so happens that I am currently (on and off) constructing an open crank 2-stroke - probably the same engine that Mike has. I have to say that as construction progresses (slowly) I have become increasingly doubtful that the thing would work at all - so it is encouraging to know that someone else has got it to run - however briefly.

If it does happen to be the same engine, the Westbury *Centaur* has roughly the same cylinder capacity.

Jim Service, Scotland.

I thank Jim for his response and hope that it is helpful to Mike Burton. I have to say that I have not had much success with the dual fuel carburettor on my own *Wyvern*, but that is probably down to a lack of experimentation on my part and I have not tried it on gas at all.

A basic carburettor design

Following all this talk of carburettors and some requests following my comments on Len Mason's carburettor experiments (*M.E.* 4319, 15 February 2008), I have produced a design for a simple barrel carburettor (**figs 1** and **2**) for miniature engines. It will be the carburettor used on the new NE15-IT, but since the drawings for the carburettor are complete, I introduce it here.

I will stress at the start, that this is not a full compensating carburettor, but is of the type found on a large number of miniature engines these days. It is a barrel type with an adjustable jet and an adjustable auxiliary air-bleed for slow running. It is of similar type to that specified for the NE15-S but is designed for smaller cylinders and has a slightly different air-bleed arrangement. All the throttle stops and adjustments are built into the body, so the carburettor is completely self-contained.

It should be suitable for normally proportioned (i.e. bore and stroke roughly equal) engines with a bore between 20 and 40mm depending on the type. In general terms, a high revving engine will need a carburettor choke (air passage) diameter anything up to ⅓rd of the bore whilst a slow revving engine will be happy with a choke of ⅙th of the bore. The

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average engine will be happy with around ⅕th of the bore. Don't forget that the bigger the carburettor choke in relation to the bore, the touchier the engine will be and it will not throttle down as well. In general for an easy handling engine keep to a choke size no larger than ⅙th of the bore.

The carburettor has an adjustable air-bleed which comes into operation as the throttle is closed and allows the mixture strength to be adjusted to obtain the best slow running and also a 'clean' pick-up when the throttle is opened. One important point to mention is that engines with non-compensating carburettors of this type will not pick-up cleanly from slow speed if the throttle is 'snapped' open. The throttle should be opened gently to allow the engine speed to keep up.

A glance at the cross-section (**fig 3**) shows how the air bleed comes into operation. At the point shown, the throttle has been partly closed (the barrel has been rotated anti-clockwise from the straight through position) and as can be seen the top right-hand edge of the barrel passage has cleared the vertical air-bleed passage, allowing extra air into the fuel/air mixture flowing (from left to right) into the engine. This extra air makes the mixture leaner (more air for a given amount of fuel) and the amount of extra air admitted is controlled by the slow running adjustment screw which can be screwed in to partly close off the air bleed.

The throttle stop screw acts on the flat cut into the end of the barrel. In the wide-open position, the flat rests along the edge of the adjustment screw (**fig 4**) providing a positive 'open' position. As the throttle is closed (rotated clockwise in this case), the flat tilts away from the screw edge and eventually rotation is stopped by the flat coming into contact with the end of the screw (**fig 5**).

Screwing this in or out controls how far the throttle can close. It helps the adjustment action if the end of the screw is rounded. I have used Alibre Design to produce the drawings, so am confident that everything fits together correctly (famous last words!).

The machining is not difficult, although the locations of the various holes have to be precise. I have left the barrel and engine side inlet tracts parallel making machining easier. The carburettor inlet just needs flaring into a smooth curve to improve air-flow.

The air passage is drilled in the barrel and body with the parts assembled and the throttle set in the open position as described above.

For materials, the body and

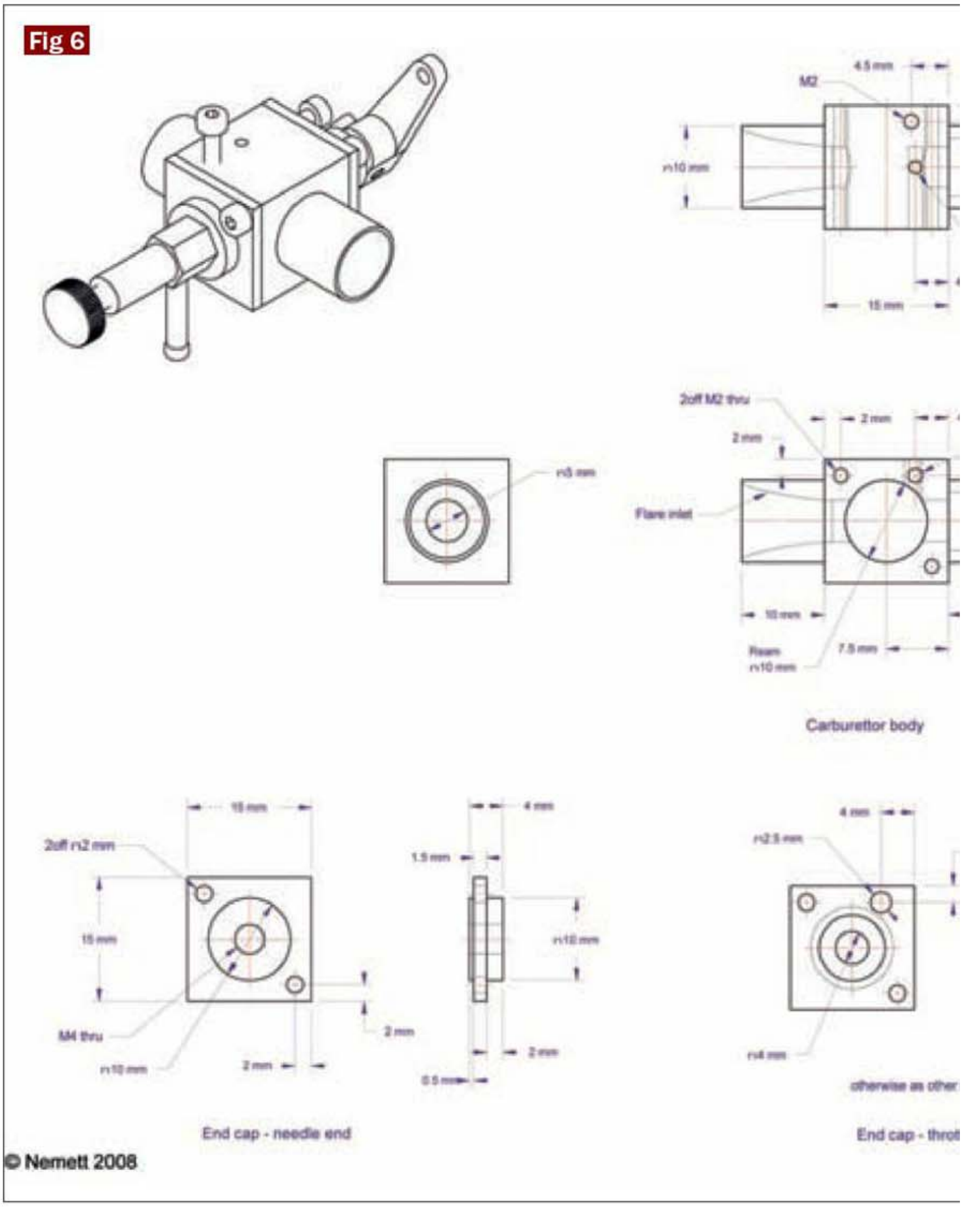

Fig 1. The external view of the basic carburettor.

Fig 2. An exploded view, showing the part relationships for the carburettor.

Fig 3. Cross-section showing the slow running air-bleed operation.

Fig 4. The throttle open, showing the position of the barrel and throttle stop screw.

Fig 5. The throttle closed, with the barrel flat stopped by the end of the screw.

Fig 6. Detail drawing, sheet 1 (of 2).

end caps can be free cutting aluminium alloy, the barrel, spray bar, fuel pipe and lever can be brass and the needle valve can be stainless steel. The fuel pipe is silver-soldered into the spray bar.

The end cap and lever screws (five in total) are M2 x 6mm socket screws with M6 x 12mm for the two adjusting screws.

I should also stress that I have not made one of these carburettors yet, so will be interested in any feedback from readers who do build one.

I will describe the basic machining for this carburettor when I do the full construction notes for the new engine. In the meantime, those wishing to make one will find that most of the machining set-ups are similar to the NE15-S carburettor (*M.E.* 4287, 24 November 2006). I have included the first drawing sheet here (**fig 6**) and will put the other sheet in my next column. Next time I will describe how to set up this type of carburettor.

ME

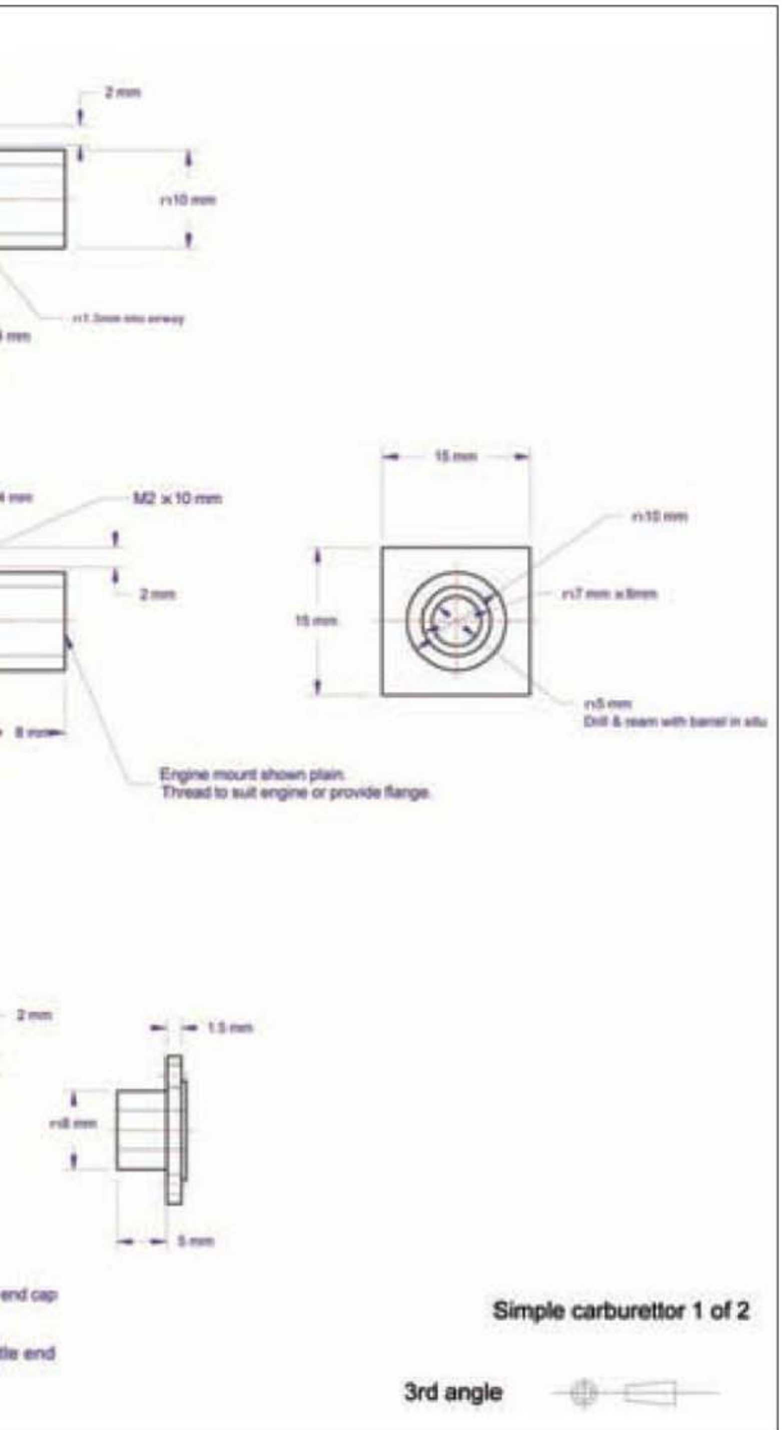

Fig 1

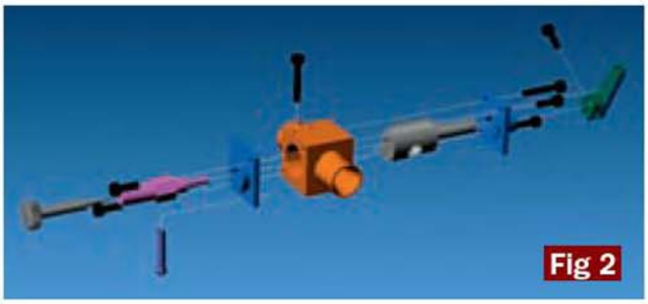

Fig 2

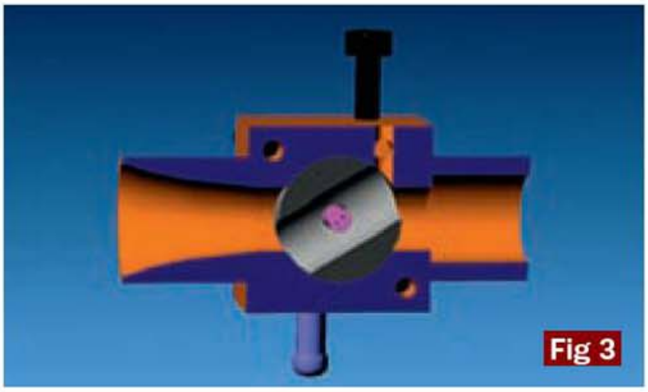

Fig 3

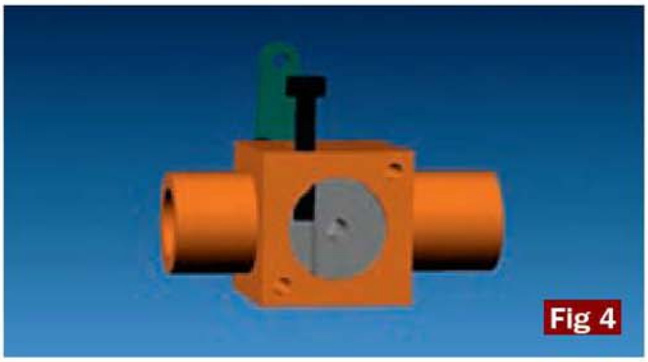

Fig 4

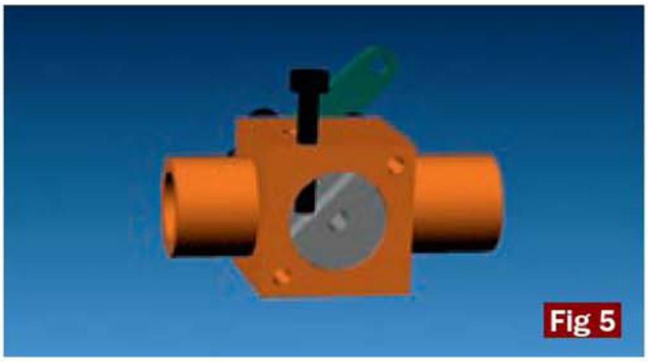

Fig 5

Self-starting single-cylinder double-acting steam engine

Les Kerr
provides detailed electronics diagrams for the stepper motor driven valves and begins detailed construction notes for the valves.

Continued from page 318 (M.E. 4321, 14 March 2008)

Complete circuit diagrams for the electronics are shown in **figs 19** to **23**. The stop/start and reverse circuits (figs 19 and 21) were built on one board. The 'Channel 1' stepper driver was assembled on a second; the 'Channel 2' stepper driver was made (fig 22) on a third board and the 40V power supply (fig 23) was built on a fourth.

All boards were installed into an old CD player case as shown in **photo 5** (see *M.E.* 4321, 14 March 2008). The controlling push buttons, standby switch and LEDs were mounted on the rear panel. Three small heatsinks are needed, two for the BD682 transistors (one on each stepper driver) and one for the LM2577T IC on the 40V supply. These are made from ¾ by ¾ by ⅛in. blackened aluminium.

Mechanical parts

Let's start with the rotary valves. **Figure 24** is the assembly drawing for the valves and the parts will be referenced by the numbers shown.

Stepper motors

Item one is a unipolar 48 step, 24 Volts, 0.5Amp DC stepper motor, part number PM35S-048 made by Minebea Electronics (NMB). I purchased mine from Oatley Electronics (usual disclaimer) for $12 Australian each (£4.80). They can also be obtained from Ocean Controls. Both suppliers are on the internet and UK suppliers also offer these.

Stepper motor bushes

The stepper motors (item two) are supplied with a 3mm dia. by 4.5mm long shaft. As the gears have a bore of 6mm we need to make a bush 3mm I/D by 6mm O/D by 12mm long. This bush **(fig 25)** needs to be perfectly concentric. To make it turn down a piece of brass to about 6.4mm dia. for a 12mm length. Centre drill the end and then enlarge the hole to 2.6mm dia by 16mm deep. Ream out the hole to 3 millimetres. Part off and dress the end so that the length is exactly 12 millimetres. Next, using a piece of mild steel, turn up a mandrel 3mm dia. so that the bush is a press fit on it. Reduce the outside of the bush so that the gear is a slide fit on it.

Next attach the bush to the stepper motor shaft using Loctite, So that you don't get any Loctite in the motor, only coat the inside of the bush with it, then wipe clean the end that is to be closest to the motor. Slide the bush on leaving a small gap between it and the motor.

Gears

Item three is a 0.8 module 30 tooth plastic gear with a 6mm bore. It is attached to the motor using a 3mm grub screw.

I purchased mine from Small Parts and Bearings (usual disclaimer) under the part number GS0.80-30-0300B0600-

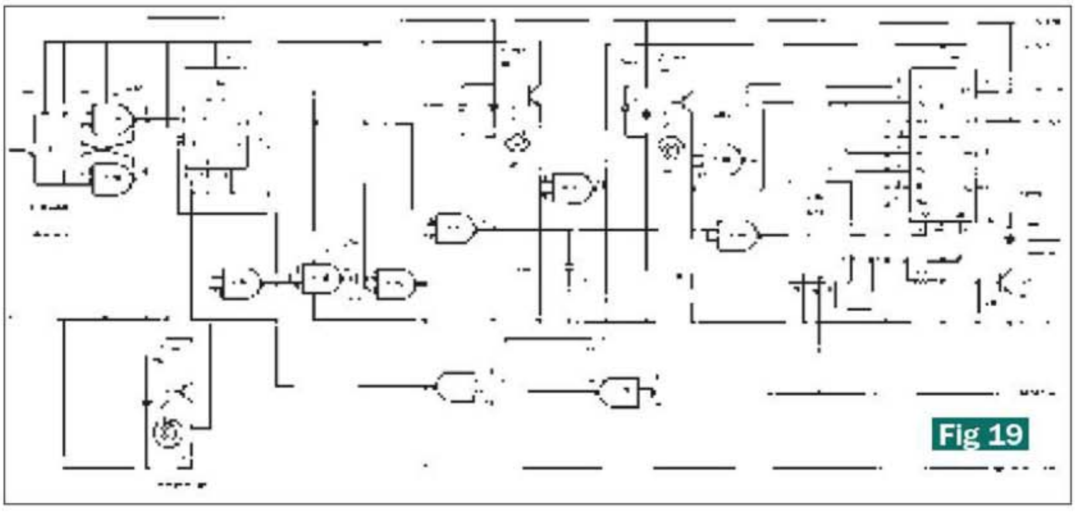
Fig 19

Fig 19. Reversing circuit (can share board with start/stop circuit (fig 21)
Fig 20. Channel one stepper driver circuit.
Fig 21. Start/Stop circuit which controls overall operation (can share board with reversing circuit (fig 19).
Fig 22. Channel two stepper driver circuit.

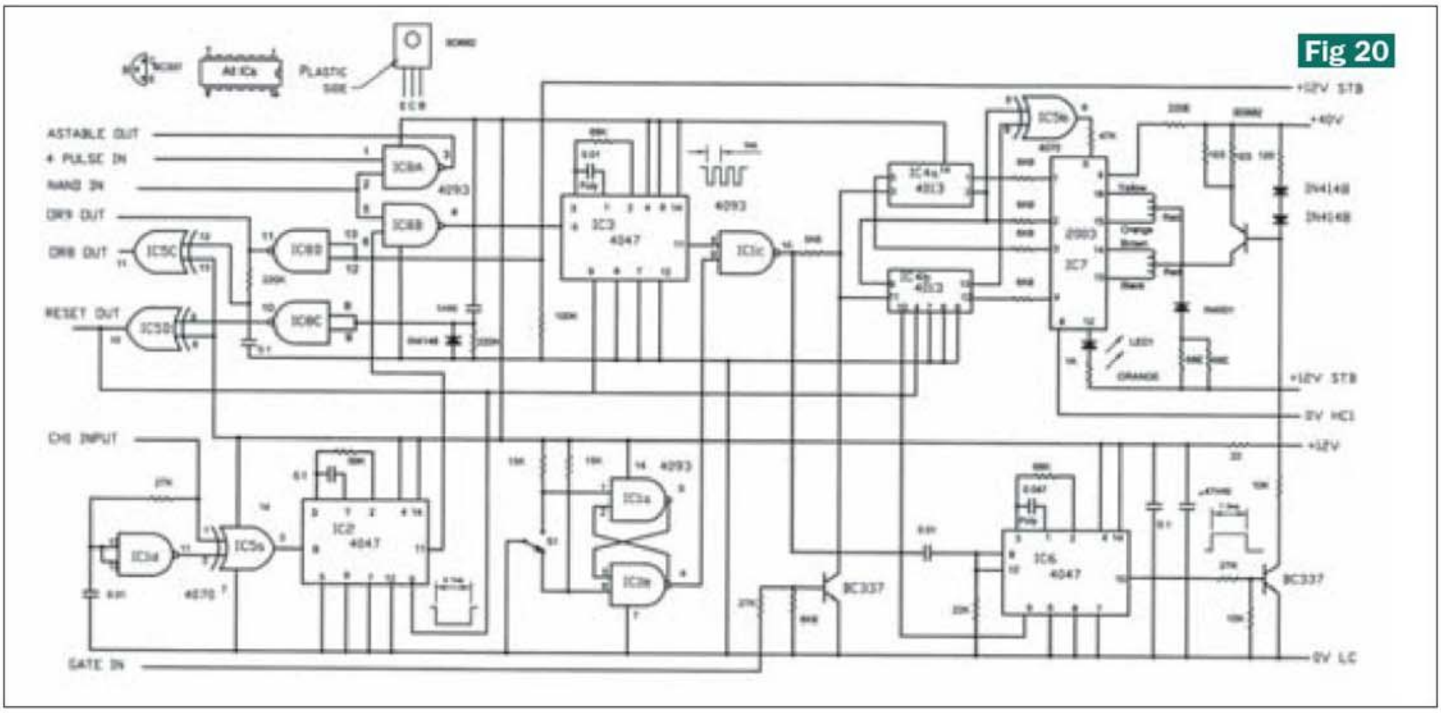

Fig 20

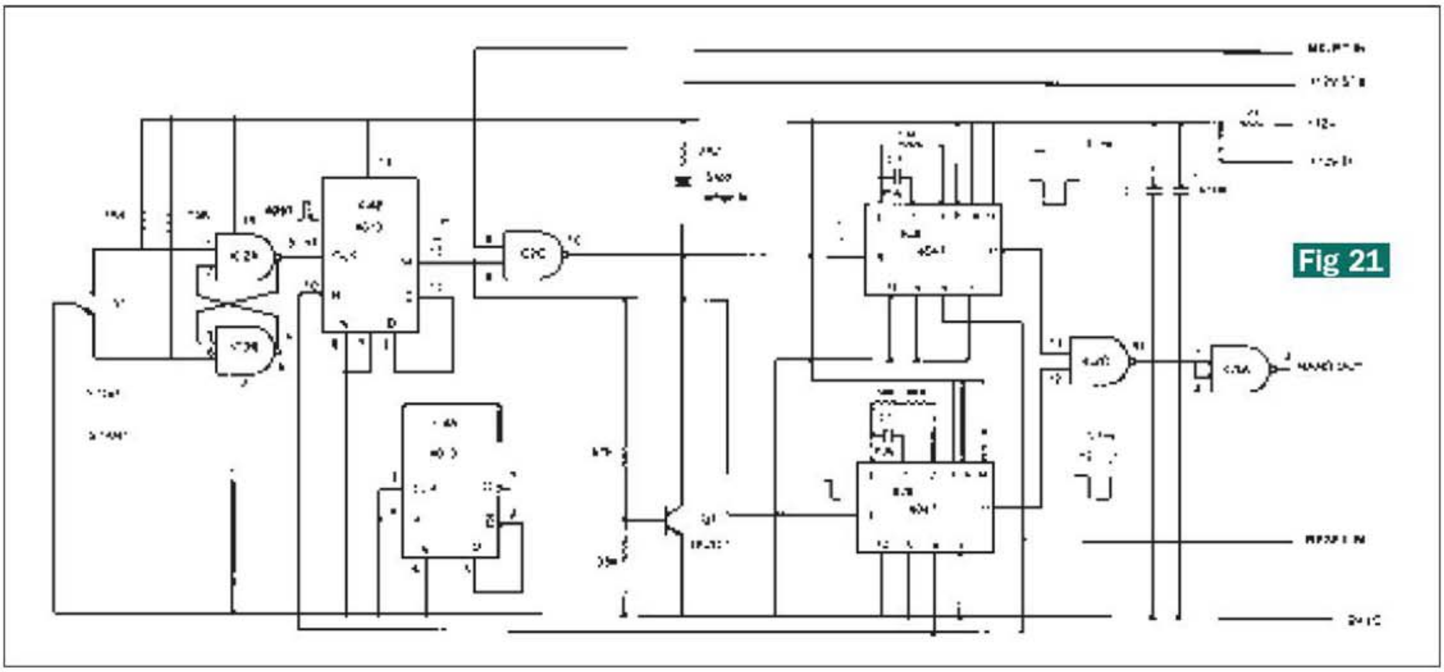
Fig 21

ACB-HS. Many suppliers in the UK and elsewhere can supply gears for this project.

The pinion is a 0.8 module 20 tooth plastic gear with a 6mm bore. It is attached to the valve centre using a millimetre grub screw.

I purchased gears from Small Parts and Bearings via the internet (usual disclaimer) under the part number GS0.80-30-0300B0600-ACB-HS (for item three) and GS0.80-20-0300B0600-ACB-HS (for item four). Many UK suppliers can provide these, too.

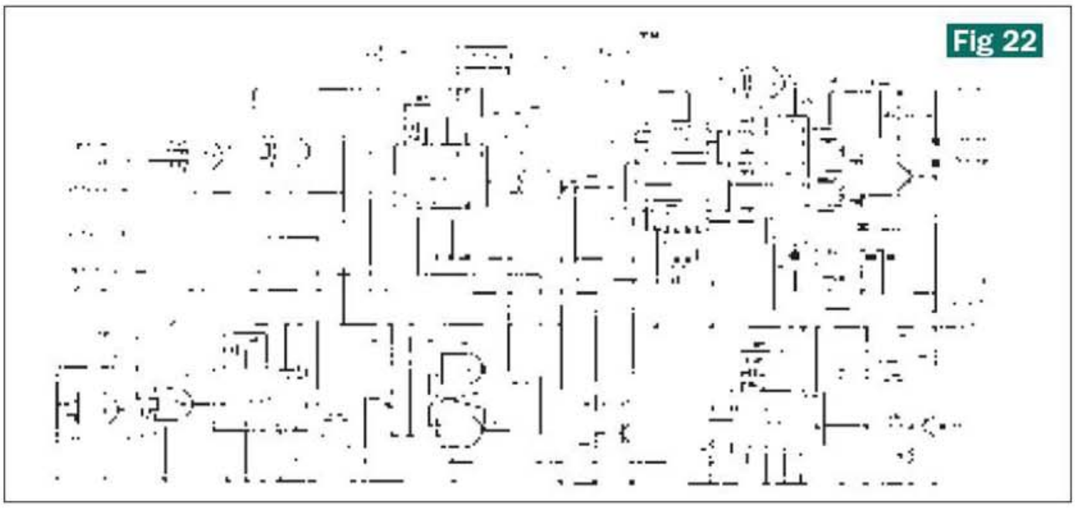
Fig 22

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Fig 23

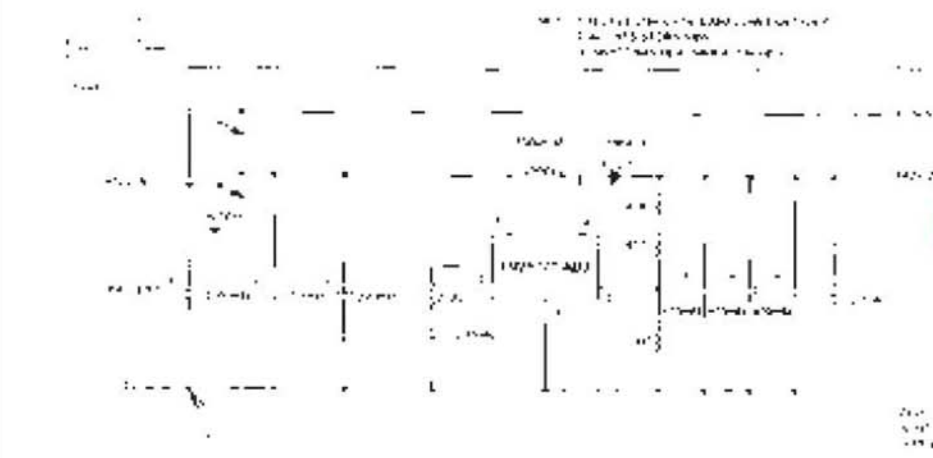
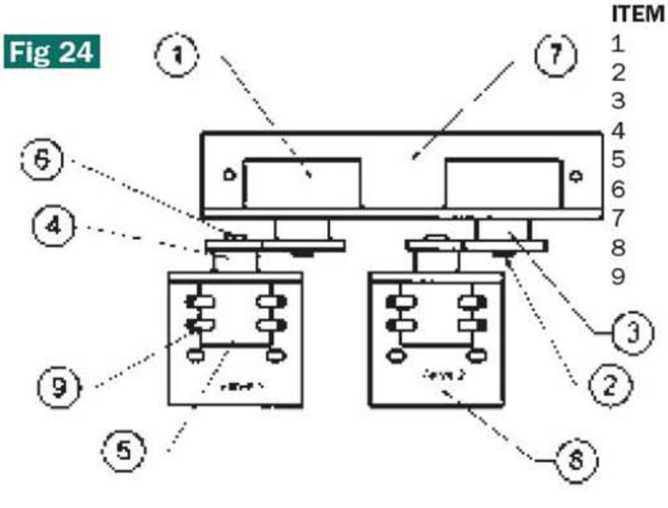


Fig 24



ITEM	DESCRIPTION	QTY
1	STEPPER MOTOR	2
2	STEPPER MOTOR BUSH	2
3	30T 0.8M GEAR	2
4	20T 0.8M GEAR	2
5	ROTARY VALVE HOUSING	2
6	ROTARY VALVE CENTRE	2
7	MOTOR BRACKET	1
8	ROTARY VALVE BRACKET	2
9	TUBE CONNECTOR	12

Fig 25

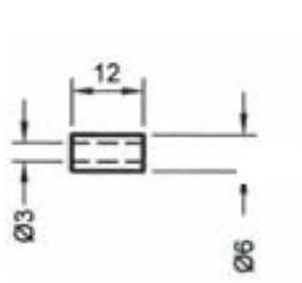


Fig 26

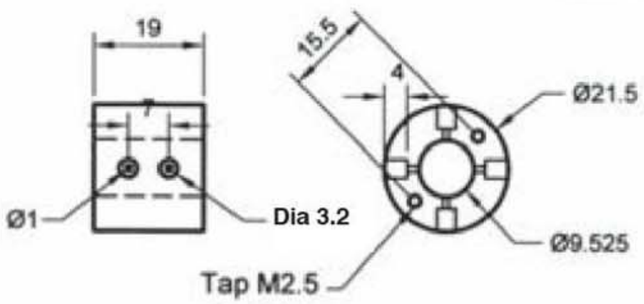


Fig 23. Power supply circuit.

Fig 24. Layout of the rotary valve assembly. Note: the remaining four tube connectors are fitted in holes that are below the valve housings closest to the gears.

Fig. 25. Motor bush (item 2 in fig 24).

Fig. 26. Rotary valve housing (item 5 in fig 24).

6. Drilling ports using a indexer and the milling machine to make ports in the rotary valve housings.

Rotary valve housing

In a 3-jaw chuck, place a piece of 1in. dia. brass rod to make the housing (**fig 26**). Face the end and for 19mm turn the outside diameter down to 21.5 millimetres. Centre drill the end, then enlarge this to $\frac{11}{32}$in. dia. for a depth of 1 inch.

Transfer the chuck with job to the dividing head which was previously mounted vertically on the mill (see **photo 6**). Align the drill chuck with the centre of the $\frac{11}{32}$in. hole and to a point

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6mm from the turned end. Start a hole using a centre drill then enlarge it to 3.2mm for 4mm deep. Finally, finish drilling all the way to the central $\frac{11}{32}$in. dia. hole by using a 1mm drill. Rotate the dividing head 90deg. and repeat the procedure. Then rotate a further 90deg., etc., until you have four holes around the diameter.

Move the table 7mm and drill the remaining four holes as before. Leave the mill set up with the rotary table for making the valve centre next.

Return the 3-jaw chuck with its job to the lathe and using a $\frac{3}{8}$in. dia. reamer enlarge the $\frac{11}{32}$in. hole to size.

Finally, part the valve housing off to a length of 19 millimetres. Using the 1mm drill and the $\frac{3}{8}$ reamer clean out any debris remaining in the 1mm holes.

To polish the inside of the valve, take a piece of hard wood and turn its diameter for a tight fit in the valve for a length of 2 inches. Add metal polish with light oil to the wood and, using a small piece of kitchen paper towelling to hold the valve, slide it back and forth with the lathe running at mid speed. Reverse and repeat the operation until you see a smooth finish on the inside of the valve.

If the cylinder binds on the timber, let go of the paper and switch off the lathe. Also remove any tools from the tool post that may get in the way.

Rinse the valve in hot soapy water to remove any excess metal polish. Don't forget to make two of these rotary valve housings.

● *To be continued.*

Superheaters: PRACTICAL EXPERIENCES

Dennis Postlethwaite continues his look at the merits of superheating based on more than 30 years experience with several locomotives.

Continued from page 315 (M.E. 4321, 14 March 2008)

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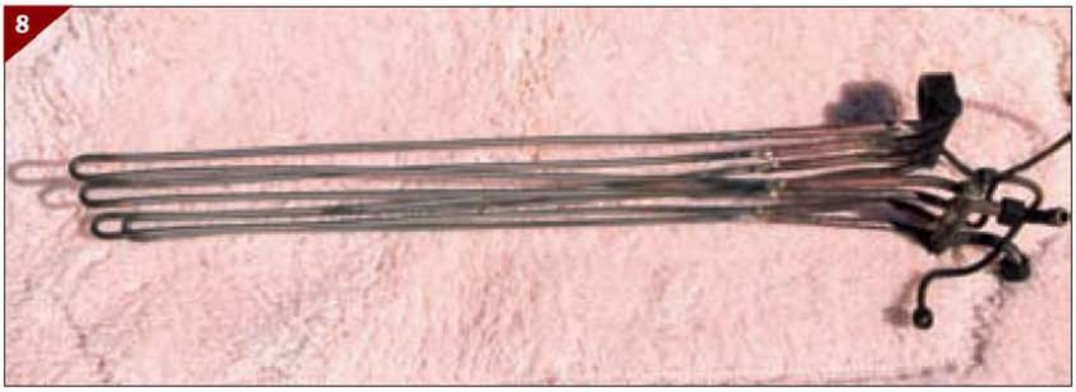
After running for some time, I was forced to retire off the track earlier than usual. The ashpan was full, but I put that down to 'bad coal'. The following week it was worse. I was having difficulty maintaining water level in the boiler. The axle pump was worn but the injector worked well – until steam pressure dropped. Then the blower didn't work well. 'Down the nick' and resorting to the hand-pump, even on the run! In the following weeks the light dawned. Superheaters may not markedly improve performance (in terms of pulling power or speed) but they do affect water and coal consumption. No wonder the grate had become choked - I was using much more water than normal and with it much more coal, generating more and more ash (and clinker). This led urgently to the construction of a new set of superheaters for the Hall, an undertaking that took some time, but the results were worth it. The little engine went with new blood! The magic sinecure! I had no further problems in that respect and had many enjoyable Sunday runs thereafter. Since then, I have been convinced of the benefits of superheaters and a firm advocate of them. I still have the little manifold I made, but regarded it for 'emergencies only'.

I mentioned earlier that there were some caveats about superheaters. The main one is the design or type. The importance of this became apparent after I acquired the 3½in. *Black Five* (No. 5420). This was based on LBSC's Doris, constructed by my good friend and fellow WMES member, Mr. F. Wallbank.

Black Five 5420 was a lovely locomotive (and still is), but it was always something of an enigma. When I first used to drive it, I invariably 'took over' from Mr. Wallbank (always at his request of course) after it had been running for about an hour or so. Although getting away quite well as a fresh driver, I almost inevitably found that not long afterwards the sparkling performance, displayed by Mr. Wallbank, deteriorated to a point where it was 'struggling for steam'. Neither Mr. Wallbank nor I could get to the bottom of this. This being his engine, he was always somewhat disappointed. He attributed the problem to badly fitting piston valves and spent much effort tuning them up or making new ones – but without much success. He was never satisfied and, in the end, »



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converted the locomotive to slide valve (on the old maxim that 'piston valves wear out, slide valves wear in'). This did result in an improvement. The revised valve system definitely made the engine livelier denoted by a heavier and, more importantly, crisper beat. However, it didn't cure the problem of performance fade after running for an hour or so.

My dear friend Mr. Wallbank died in September 1986. Some time later, I was astounded to learn that he had very generously bequeathed 5420 to me! When it was appropriate, I went to collect it from his garage-cum-workshop. I knew it was in pieces because, on my weekly visits to Mr. Wallbank and his wife, I had helped him with some of the work aimed at correcting a few faults that had emerged. Yes! 5420 was there – but in several large pieces and many small ones. The latter consisting of a myriad of nuts, bolts, screws, unions, pipes, fittings etc, all mixed up and contained in a washing-up bowl (**photo 7**).

Reassembly proved a mammoth undertaking, which severely tested my knowledge, patience and ingenuity. In rebuilding the locomotive, I decided to fit radiant superheaters extending into the firebox. These comprised stainless steel tubes with a smooth reverse bend - no block and no welding (**photo 8**). Making such tight bends in $\frac{1}{8}$in. and later $\frac{3}{16}$in. dia. stainless steel tube was no mean feat. In fact, I was shown how to do it by an expert. The new superheaters were fitted into 5420 which, by then, was nearing the end of its refurbishment.

Then began the tedious job of cleaning and de-greasing in preparation for painting. It had all taken much longer than I anticipated but eventually 5420 was complete and ready for the paintshop. The model was spray-painted glossy black and, for the first time, fully lined-out in true LMS style. It had taken some effort and a lot of patience – but I was extremely happy with the end result (**photo 9**). My only regret was that my old friend Mr. Wallbank, its builder, had not been able to witness his lovely engine in such fine fettle.

It was now time to see if 5420 performed as well as she looked. To my pleasant surprise, the first runs exhibited an amazing improvement. **Photograph 10** shows 5420 going well on the Royden Park track of the Wirral Society in 1989. Most importantly, there was little or no fading of performance even after a couple of hours of hard running.

I eventually attributed this to superheater design. The original design had the traditional (at that time) block-ends made from solid copper at the end of the copper superheater tubes. When inside the superheater flues, these ends obstructed the flow not only of hot gases but, more importantly, of particulate matter. Thus, fire debris inevitably accumulated around the block ends. The build-up of deposits/ash against the blocks slowly but surely blocked the superheater flues in succession (a phenomenon known colloquially as 'bird-nesting'). Hence the fall-off in performance. All became clear - *Fiat Lux*! (my old University motto – 'Let there be light').

To be continued.

10

King Edward VIII

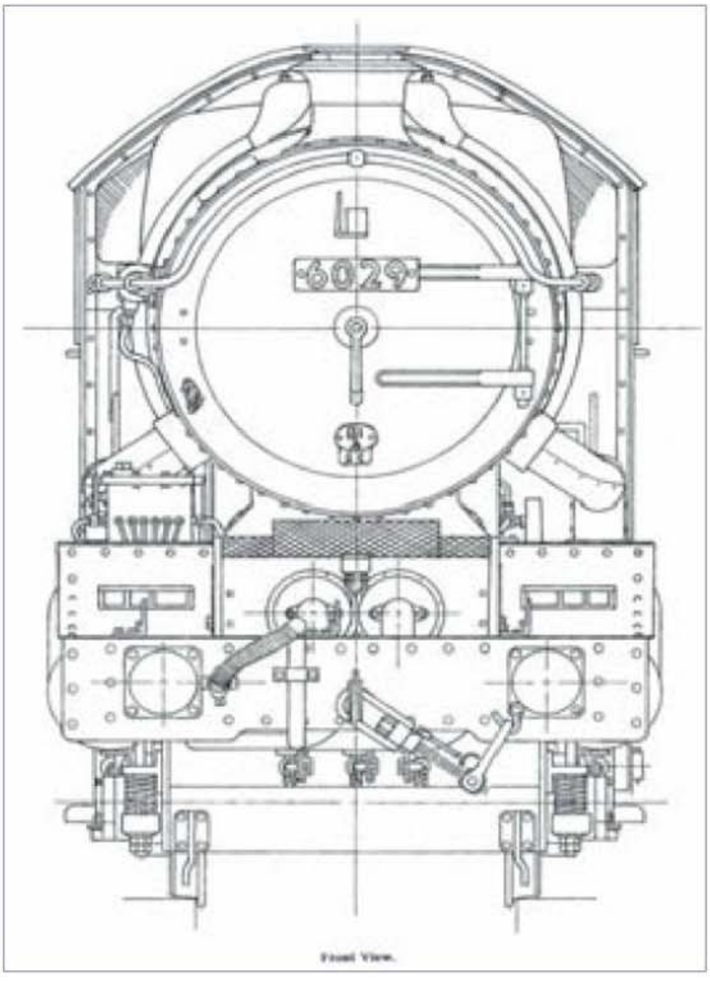
Peter Rich
describes the one that slipped through the net.

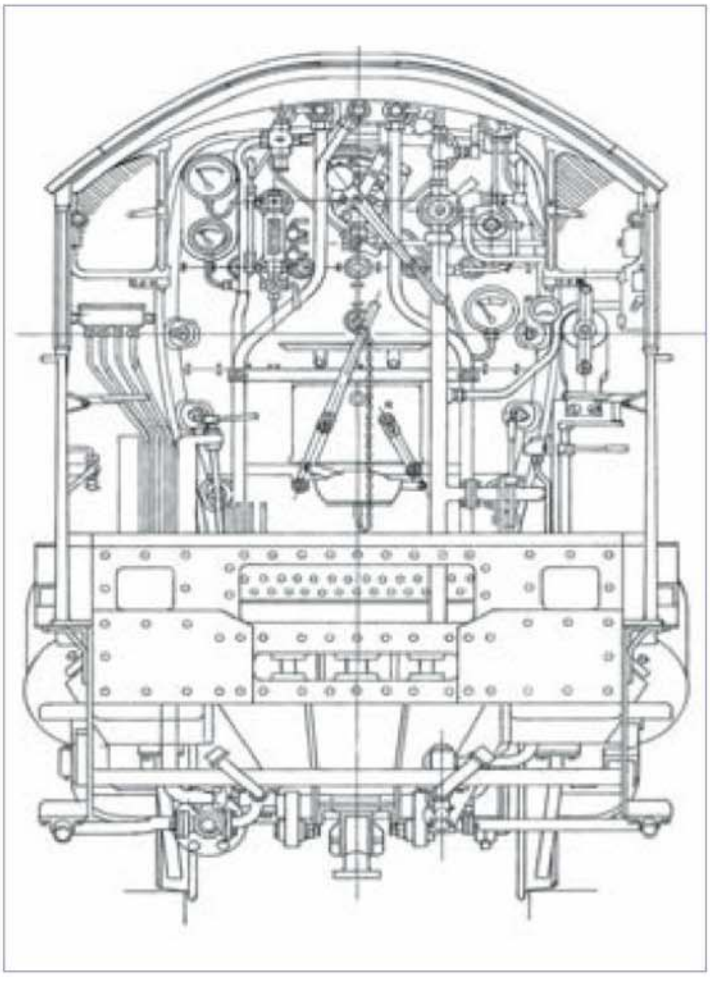
I was out on *Twm Barlwm* mountain a few days ago, having a serious blast on the pipes playing *King George V's Army,* when it occurred to me that, while much has been written about the Great Western King class over the years, there was one engine in the class about which very little has been written. In fact, I have never seen what follows mentioned anywhere other than between my old pal Eric Youldon (Exeter) and myself. I have never seen it mentioned that No. 6029 *King Edward VIII* was unusual among the King class, as indeed was its human namesake among our monarchy. But it was.

Before going into the details a few words about the Kings in their later life may not be amiss to those of you who never knew these engines. Most of the older generation will know that these engines were the premier passenger locomotives of the Great Western from the time of their introduction in 1927 until their final demise in 1962.

Little changed

Until their last decade of life, there was very little visible alteration to their appearance other than the changes of livery in the 1930s and again in the 1940s. After that small changes took place which were noticeable such as the alteration of the curvature of the outside steam pipes at the smokebox and the large steel pressing on the right-hand side of the smokebox. The top plating at the front of the inside cylinders was also altered and squared off to provide a better foot hold at this point. Another small alteration, which took place in the very last few years of their lives, was that they were fitted with the large Collett pattern parallel buffer stocks. Until this time they all carried the Churchward tapered type. During these years mechanical lubricators also appeared on them on the right-hand footplate, first to the rear of the steam pipe but latterly ahead of the pipe. In the early to mid-1950s Swindon, under the guidance of Sam Ell, was carrying out investigations to the draughting arrangements. Such was his success that he improved the steaming of most classes, notably the modified Halls, Counties, and





Manor classes of 4-6-0s. The improvements were also applied to the smaller engines.

During the same period, further investigations were made on the single chimney Kings. The chimney bore was made smaller and the height of the blast pipe was reduced. This arrangement was fitted to two Kings in 1952, namely No. 6001 *King Edward VII* and No. 6017 *King Edward IV*. As fitted, No. 6001 was put through some very heavy duty tests involving hauling 800-ton trains, on the main line, at speeds in excess of 60mph, between Reading and Stoke Gifford.

Big improvement

Whereas before World War II the Kings had been required to produce steaming rates of between 25,000 to 26,000lbs per hour, No. 6001, with a small alteration to its blast pipe and chimney, produced a front end steaming rate of 33,600lbs per hour. Examination of photographs of the time would appear to show that most, if not all, of the single chimneys engines were similarly converted. The above was obviously a big improvement over the original draughting arrangements on the Kings. These alterations could readily be identified because, although they retained their original copper capped single chimneys, the internal exhaust tube was much smaller in diameter than the original and this could be seen protruding above the top of the chimney. I believe these became known as 'sleeved' chimneys .

About this time, another type of single chimney was tried out which did not have the normal capuchin, but only three Kings were so fitted including No. 6000. This always looked rather disconcerting to those of us who were used to seeing copper capped chimneys with capuchins.

Sam Ell was obviously not satisfied with the improvement brought about by the above. At that time there was plenty of available data at Swindon regarding double chimneys, No. 71000 *Duke of Gloucester* and an LMS Pacific having recently been fully tested on the 'home trainer' in the Test House. The outcome of the testing of the Duke was that it was fitted with a pair of blast pipes. These were of similar to the blast pipe on the old Dean Goods engines which had already proved to be superior when tested against the LMS designed 2-6-0 No. 46413 also tested at around that time. With this information at hand, Sam Ell decided to try to bring about improvements to the Kings so, in September 1955, No. 6015 *King Richard III* was experimentally fitted with a double chimney, an alteration which had the most profound effect on the appearance of the engine. It was a flat-sided steel fabrication and sat centrally between the front and rear of the smokebox.

Quite a lot has been written about the exploits of the double chimney Kings but that is not what I am about here. This article is more in the way of a model engineers guide to these engines during the double chimney period of their lifetime.

Not a lot has been written about the double chimneys themselves. In point of fact, I cannot recall anything in *Model Engineer* about them so perhaps I can put something on record here.

No works drawings

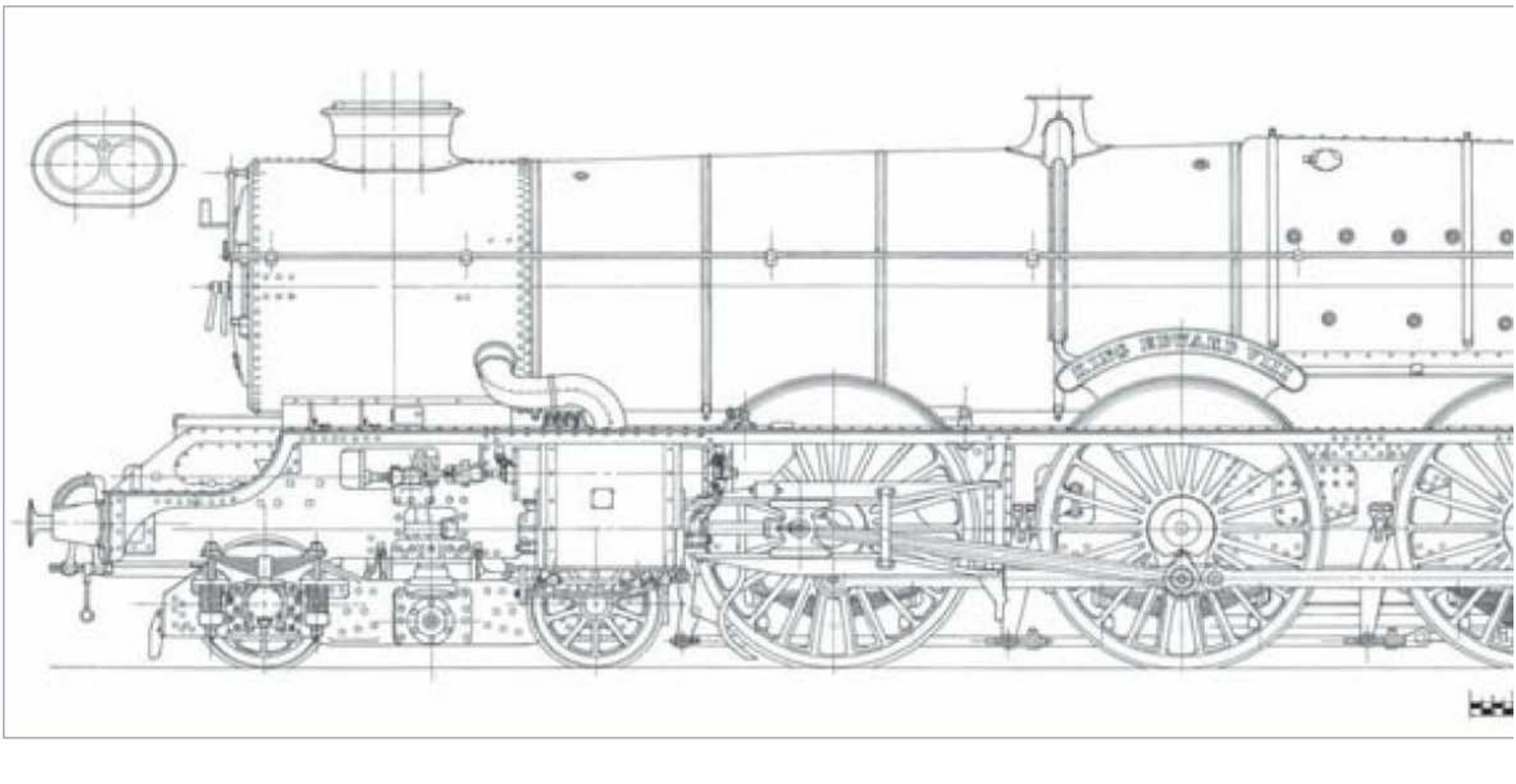
As far as I am aware there are no Swindon drawings in existence of the double chimneys, only G/A drawings of smoke boxes. So, for my article, I have had to rely on the dimensions I took from the locomotives when they were being cut up and also on the G/A drawings mentioned with an added touch of designers licence.

To this end, I have included a plan view of the double chimney to give some idea of what it was like. Readers will note that I have shown a small hole between the chimneys on the right-hand side. This is the exit for the steam exhausted from the vacuum ejector. This was arranged in this way to avoid the complication and expense of a combined casting to allow exhaust to discharge up the chimney as in the case of the single chimney engines.

The effect of the modification was an immediate reduction in the back-pressure on the cylinders allowing a much freer running engine and a much more even draught over the whole surface of the fire. It also allowed the engine to burn lower grade coal more efficiently.

Marked improvement

Trials with this engine showed that there was a very marked improvement in its performance. When the results were examined it was found that, at points where normal single chimney Kings would run up to speeds in the mid-80mph's, No. 6015 easily ran at up to 100mph. Indeed, Inspector Andress clocked one quarter mile section at 108.5mph. The stopwatch was not reset and was taken into



Swindon on the following day and shown to Sam Ell.

The double chimney was such a success that No. 6017 was so fitted in December 1955 and, over the next few years, all of the Kings received the double chimney. Those fitted in 1956 (about half of the class) had the flat-sided type as for No. 6015.

The only King with this type of chimney that I had the opportunity to look at and appreciate was No. 6010 *King Charles I* which was steaming very slowly out of Bristol Temple Meads Station for Paddington on 8 April 1956. My old mate, Gary Davies, and I were travelling down to Eastleigh to visit the Railway Works there. Number 6010 was obviously brand new out of Swindon Works having just been fitted with its new chimney and it looked a picture. From late 1956, the design of the double chimney was altered to a casting, which was elliptical in plan with tapered sides to the upper copper part, so much so that it now looked like a flower pot compared to the previous chimneys.

This type was first fitted to No. 6004 *King George III* in November 1956. Personally I always thought that this was a horrible looking design and completely changed the whole appearance of the engines. I felt that someone had robbed them of their masculinity. As far as their appearance was concerned, I always preferred the original single chimney.

I have to say that, to me, the steel flat-sided type added a further masculine dimension to the engines, which was completely spoiled when the flowerpots were fitted. What is it about locomotive chimneys - if they don't look right, the whole engine doesn't either?

Front-end changes

From 1954 the whole class was withdrawn and fitted with new front-end half frames with new cylinders etc., due to serious faults having been found. In order to make up for the disappearance, the Western borrowed some LMS Pacifics and Southern 4-6-0s to cover the gaps, which were returned to their regions as the Kings came back into traffic. The famous railway author, O. S. Nock, always regretted that the new cylinders, fitted at that time, did not have streamlined ports, being of the opinion that they would have been 'Super Kings' if this had taken place.

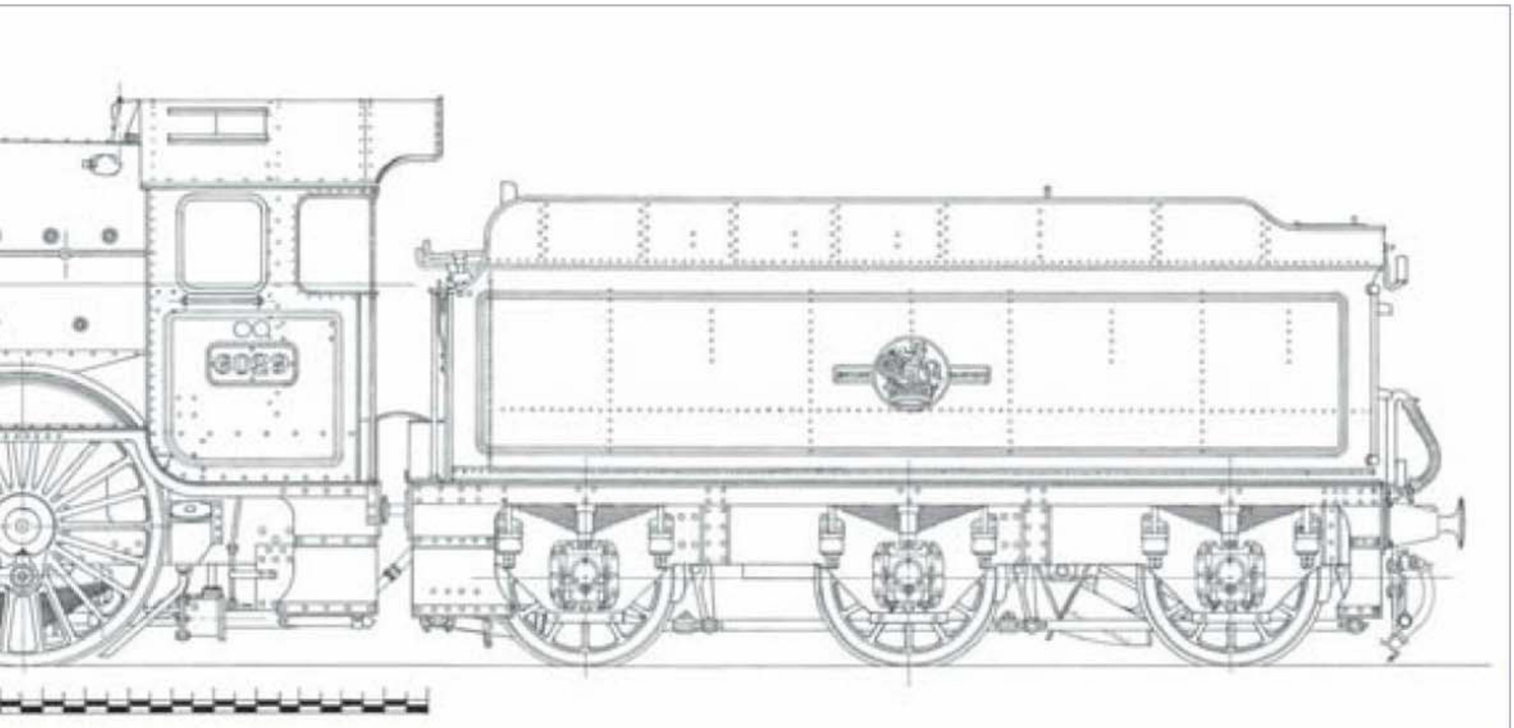
Newcomers to steam locomotives will note that the axleboxes and springs of the leading axle of the bogie were carried outside its frame. The reason for this was that these engines were 4-cylinder jobs and had their inside pair of cylinders fitted above the leading axle. These were larger than hitherto and the axleboxes, etc., were fitted outside the bogie frame to provide greater clearance for the larger design of inside cylinders.

Late in 1955 Gary Davies and I paid a Sunday visit to Swindon Works. In those days, works passes were normally available on application. After our visit we made our way back to Swindon Station to eat our pasties and drink Pespi Cola (Mam always made corned beef pasties for those occasions). We positioned ourselves near the Bristol end of the 'up' platform. I cannot now recall precisely what the time was but, sometime between 4.30 and 5.00pm, we heard the sound of a train approaching from far away in the Bristol direction.

As we sat there, the sound of the train grew louder and louder and was obviously travelling very fast. I would say that it took at least three minutes before it came into sight. When it did, we saw that it was a King and was being thrashed along. It came down past the works, its exhaust merging into a crescendo of increasingly deafening sound. As it veritably thundered past us we saw that it was No. 6015 *King Richard II* newly fitted with its double chimney.

Fastest ever

I don't think I have ever seen a steam train going so fast, either before or since, and I have certainly never seen a steam locomotive being worked so hard as on that day 50 odd years ago. I don't think Gary or I realised at that precise moment that No. 6015 had been fitted with the new double chimney, it was going too fast for us to notice. Ever since that time I, have always wondered whether Gary and I were witnesses to the trials with this locomotive. The introduction to this article refers to *King Edward VIII* as the 'one that slipped through the net'. I am sure you will realise that I am not referring to our uncrowned Edward VIII who also slipped through the net, as it were, and became the Duke of Windsor in the 1930s. No, I am referring to the Great Western's King class locomotive No. 6029 which was originally named *King Stephen* until our King George V passed away and was succeeded by



Edward VIII in 1936. On this, eventuality, the Great Western, loyal as it was, renamed its last King Class locomotive in honour of the future King. As we all know Edward VIII was never crowned as our King, having abdicated in favour of his brother. Whereupon, the Western's locomotive No. 6028 was renamed to *King George VI*, having previously been *King Henry II*.

As a small aside from my main purpose, the GW King Class engines were named backwards into history: No. 6000 was *King George V*, No. 6001 was *Edward VII*, 6002 was *William IV*, 6003 *George IV*, etc. If you were a student of history, all you had to do was to remember the number and name of each King class locomotive in order to get the various successions to the throne. Just goes to show what we model engineers can learn from our hobby.

Unusual

Having got that little bit of a history lesson out of the way I now turn to the real reason why No. 6029 *King Edward VIII* was unusual among the Kings. It is all to do with its double chimney. No. 6029 was one of the engines that should originally have received the elliptical flowerpot chimney in December 1957, together with the last style of British Railways monogram.

All of the engines that carried the flat-sided chimneys, were adorned with the old 'cycling lion' emblem. Their flat-sided chimneys were replaced by flowerpots at some time in 1957 after the later monogram was introduced. At this point they were also adorned with the new emblem. From this you would deduce that no flat-sided chimney locomotive carried the new monogram - but you would be wrong! The new monograms had been introduced about six months before No. 6029 received a flat-sided type so it also carried the new monogram.

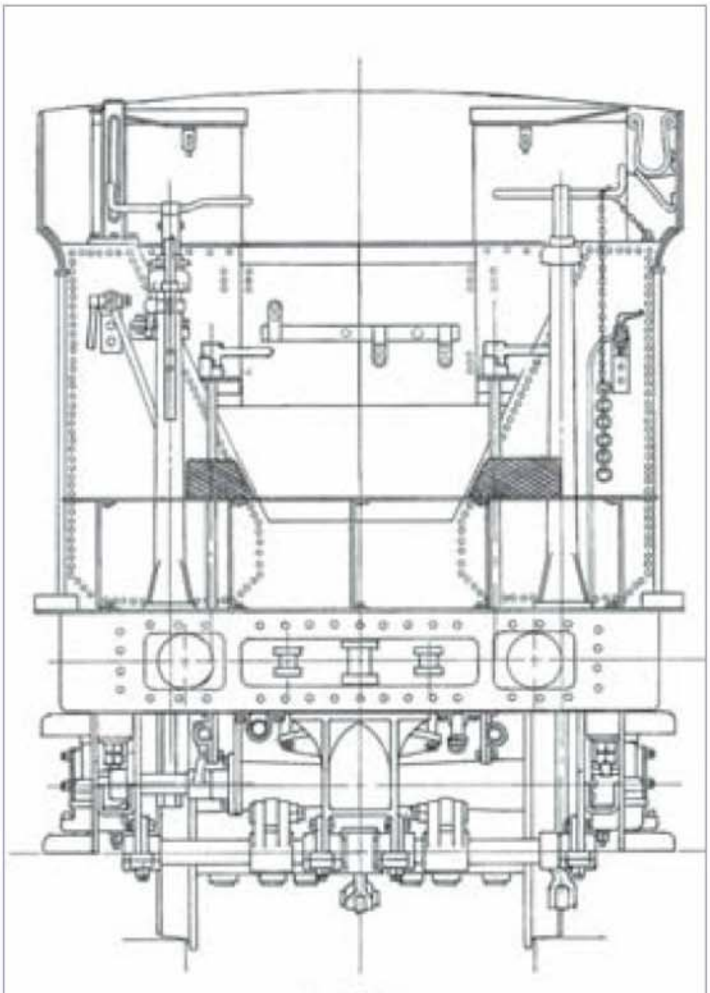
At this time No. 6029 was also fitted with the parallel buffer stocks mentioned earlier and, therefore, became the only King to have the built up flat sided chimney and these buffers. These are two bits of authenticity, which would have disappeared into the mist of time if I hadn't mentioned it here.

This situation seems to have occured on its first boiler change after the elliptical double chimneys were introduced. I can only assume that its new (overhauled) boiler was one from an earlier flat sided engine and its chimney was overlooked. Thus 6029 became the only King to receive the flat sided type chimney together with the post 1957 British Railways monogram. *King Edward VIII* received its flowerpot type chimney in about 1959 and remained as such until withdrawn. Therefore, it was the one that slipped through the net for those few years.

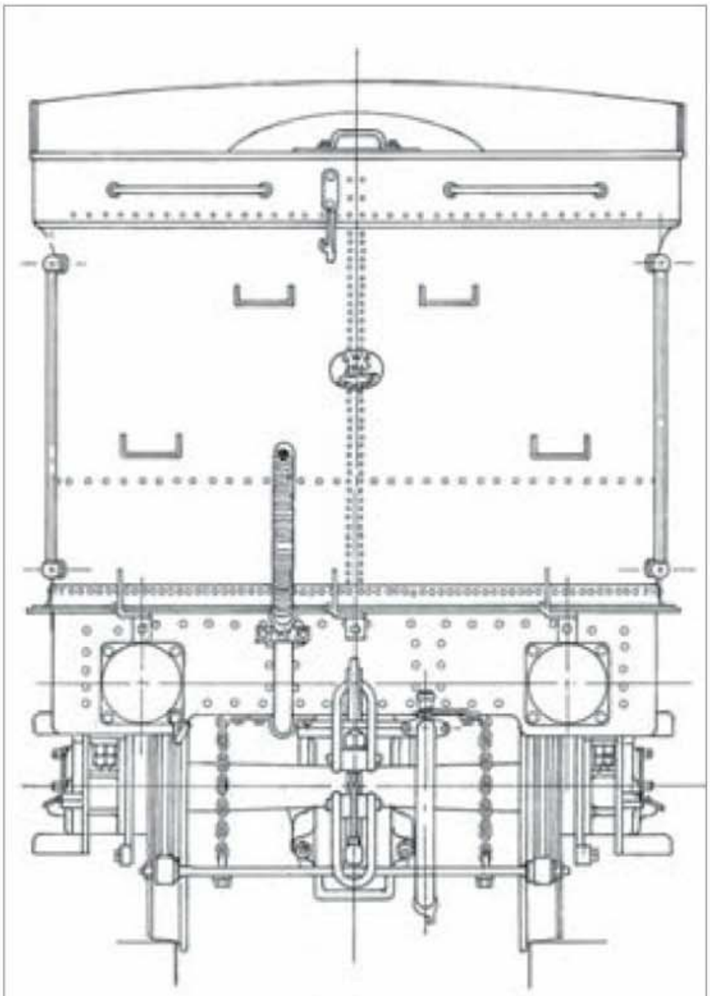
Few photos

There are not many photographs around which show No. 6029 with the flat-sided chimney. Kenneth Leech, in his book *Portrait of Kings,* shows one. Richard Blenkinsop, in his book *Reflections of the Great Western,* shows another complete with the later monogram dated 21 May 1958 and working an ocean liner express. I haven't done a great deal of study on the Kings over the years but, for the benefit of those of you who may be contemplating building one of these locomotives, the following are some points of authenticity which are not readily available and may not even be shown on works drawings:

When originally built, the first few Kings had long spring hangers on the leading axle of their bogies but these were altered to have supplementary



Front View.



Rear View.

springs as shown in my drawing. This alteration came about as a result of a derailment of No. 6003 while working an express near Midgham in 1927.

As originally built, the front top lamp iron was located on top of the smokebox. To facilitate access to this, a small footstep was welded to the lower front right-hand side of the smokebox door (for shorter firemen!).

Not all locomotives had this fitting. At least one, No. 6009, carried this feature until the early 1950s. The upper lamp irons began to be removed and be fitted to the upper part of the smokebox door by 1932.

The engines in the series 6020 to 6029 were fitted with pipes to the top feed that curved backwards behind the nameplates, while in the earlier engines these pipes were vertical and disappeared down inside the frame.

Until about 1953, the outside steam pipes alongside the smoke box, turned through small curves to lead down to the cylinders. After some trials on No. 6016, pipes with larger radii were fitted. This was done to counter cracking, to which these pipes were prone. This alteration was also applied to the Castle class.

Whistle shields appeared on locomotives Nos. 6006 onwards and earlier engines were fitted retrospectively. Cab roof ventilators were fitted from about 1954.

One last point of authenticity about these locomotives, and which is not immediately noticeable: The trailing driving wheel springs contained no less that 34 leaves, whereas those of the leading and driving axles contained only 18 each.

The above is just about all I know about the King class, except for that shown on the various works drawings in my possession.

Last days

Until the last few years of their life they were virtually absent from South Wales. Having said that, I recall that in the early 1950s there was a King which came through the outskirts of Newport as part of a triangular working between Bristol, Shrewsbury, London and Bristol. This train used to pass around the Maindee triangle in Newport at about 5.00pm on Mondays to Fridays and, although I tried many times to see it, when I arrived at the triangle I had always just missed it by a few minutes.

This was in the early days of British Railways and the Kings were painted blue but I never saw a blue one. Apart from this, and for a few days before 1939 when two Kings were allocated to Ebbw Junction for trials on the iron ore workings to Ebbw Vale, it is probable that no Kings came to South Wales. Hence, the opportunity to observe and study them did not avail itself to us Welsh.

From about 1960 Cardiff Canton Depot had an allocation of seven Kings which took over most of the workings from the Castles and Brittania Pacifics. These had been quite adequate for years. This was to be the King's swan song. It was obvious that they were only making up their mileage prior to withdrawal. They all went for scrap in 1962 except for the three now preserved.

Trainspotting memory

Another memory of my trainspotting days is that I only saw locomotives with hot boxes on two occasions (apart from those at the Ebbw Junction Workshops). Believe it or not, both occasions involved the same locomotive No. 6015 King Richard III.

The first occasion was in 1954 when this engine was working the down Bristolian and had stopped at Swindon with a hot box on its tender. The second occasion was on the trip already mentioned, when Gary Davies and I were on route to Eastleigh in 1956. When we got to Westbury, No. 6015 was stopped there with a hot box while working an up Cornish Express.

The tender

A few words about the tender shown on my drawing: This is a standard Collet 4,000 gallon tender, but I should point out that the word standard should be regarded fairly loosely. At a glance these tenders looked all the same, but when you look at them closely it is surprising how many differences there were between the various batches. Once again I roll out my standard advice: You must look at good quality photos of what you are intending to model if you want to maintain authenticity.

For example, I have found that there were at least four different shaped mainframes.

The arrangement of the vertical handrail at the front of the tender was different on one of the early batches.

Some of their tanks were fitted with one central water filler point at the rear top while others had two, one either side of the tank.

Another little point that is very easy to overlook concerns the horizontal row of rivets at the lower edge of the coal space fender. At a glance it is easy to assume that this row of rivets continues right around the rear of the tender and returns back to the front on the other side, but this is not the case. The rivets finish at the point where the fender starts to turn around the end of the flare and re-starts at the point it starts to become straight again.

Looking at my front view of the tender it is easy to assume that both the water scoop column and brake handle column are equal distance either side of the centre line but look again because the brake column was two inches further from the centre line than the scoop column.

Likewise with the water control valve handles. Here the position was reversed in that it was the left hand handle, which was further from the centre line. Not only that but both handles pointed to the left of the tender when the valves were closed.

Authenticity

Final words regarding authenticity: You will note that there is no lining out on the rear face of the tender's tank. This is quite right for most of the British Railway's liveries. However, I have recently found evidence that some locomotive works, not on the Western Region, applied lining on the rear of bunkers on tank engines and also on the rear of tender tanks. The only time lining was applied on the rear of tender tanks of ex-GW engines was in the very early days when British Railways words were applied to tender sides in Great Western style lettering.

When I started to write this article I subtitled it 'The Unique King' but as I was finishing off the last paragraph, I realised that 6029 was only unique in respect of what I have outlined.

Unique

There are other members of the class to which the title could equally apply. For example, number 6001 *King Edward VII* was fitted with a speedometer in the 1930s, which was attached to the outside of the right-hand cab side between the cut out and the cab side window. This was removed at a later date. However, in order to be fitted, the cab side window had to be reduced in width to accommodate it and the window was never altered back to its original size.

Number 6014 *King Henry VIII* was fitted with a streamlined casing in the 1930s and had a wedge shape to the front of its cab. The streamlining was removed piecemeal in the 1940s but it retained the wedge-shaped cab until it was cut up in 1962.

One of the King's bogies carried a front cross stay, which had a large slot or cutout. This was fitted to No. 6004 *King George III* when first built but was later carried by Nos. 6023 and No. 6028.

Well, I'm away over to the foreshore now for a bit of a practice on the pipes. I think it is now time (November, 2007) for me to leave the kilt at home because its getting a bit cold and snow has even been a feature of the weather forecasts. **ME**

EDWARDIAN ELEGANCE: CHARLES PARSONS AND THE FIRST OF THE TURBINE DRIVEN PASSENGER STEAMERS

Ron Isted
concludes his description of the Dieppe before rounding-off the series with the possibilities for turbine-drive in scale model ships.

Continued from page 332 (M.E. 4321, 14 March 2008)

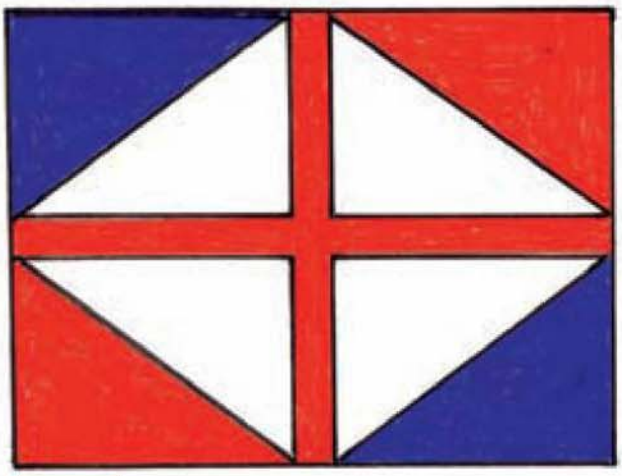


Fig 21

The *Dieppe* returned to the Newhaven-Dieppe service in July 1919 and then became the property of the Southern Railway in 1923. She served her new owners for a further 10 years, before being sold to - guess who? Well, I would have thought it would have been obvious! Having written off the *Roussalka*, aka *Brighton*, off the Galway coast, Sir Walter Guinness, now Lord Moyne, was naturally in desperate need of a new luxury yacht. So, in September 1933, history repeated itself, and another elegant 22-knot cross-channel steamer was stripped of her Parsons turbines (and her fore funnel) to be turned into a diesel-engined 15½-knot travesty of her former self. The aft funnel was also removed and replaced by a shorter, oval shaped job, though at least it was better proportioned than the one on her unfortunate sister ship. Once again, the name was changed, this time to *Rosaura*, but not being a tabloid journalist, I have failed to discover a salacious connection between any Spanish lady so named and the Irish millionaire. In her new guise, *Rosaura* survived rather longer than *Roussalka*, and was requisitioned by the Admiralty at the outbreak of World War Two. She was sent to the Mediterranean, but in 1941 became a total loss after striking a mine off the Libyan coast. She was not the last ex-LB&SCR direct drive turbine-steamer to survive, as two French built ships, the *Newhaven* and *Rouen*, just about survived the war.

I am not certain of the full details of the colour scheme of the LB&SCR turbine-steamers, but the hull above the waterline was black, with white upperworks, funnels white with black tops and lifeboats white with black gunwales. Below the waterline I believe was red, separated from the black by a white line. The house flag comprised a red St. George's cross on a white background, with alternate corners of red and blue (**fig 21**).

Design conundrums

A total of three-dozen direct drive turbine-steamers were built in Britain between 1901 and 1912 for commercial service around the coast of Britain and Ireland. Of these, exactly half came from the Dumbarton shipyard of William Denny and Brothers, who, incidentally, were responsible for both the first and last vessels of this type: the *King Edward* and the second *Queen Alexandra*. My personal opinion is that most of the later ones were generally much less elegant - apart from the second *Queen Alexandra*, of course, which was a virtual copy of the first ship of that name. From about 1905 onwards, the funnels in particular became so large that they were out of all proportion to the rest of the vessel. The Isle of Man Steam Packet Company *Viking* of that year is a classic example, although it is only fair to add that this popular and long-lived ship was another flyer, whose 2 hour 22 minute record for the crossing from Douglas to Fleetwood remained unbeaten for nearly 90 years until the advent of the *Seacat* in the last decade of the 20th century. But purely from the point of view of appearance, I feel very strongly that many of the later direct drive turbine ships lacked the beautiful proportions of the earlier vessels.

As discussed earlier, the major difficulty with the direct drive Parsons steam turbine for maritime use was that in order to operate efficiently, it needed to revolve at a much higher speed than any propeller could cope with. The smaller the vessel and the slower its intended operating speed, the more acute became the problem. The obvious answer lay in the use of gearing, but in the early days the technology of producing gears capable of standing up over an extended period of time to the ultra high rotational speeds of the turbine simply did not exist. However, in 1909, after various experiments going back many years, Charles Parsons successfully re-engined an existing 4,350 ton cargo ship, the *Vespasian*, with a set of geared turbines and once again his ability to get it right first time was quite remarkable. With the same set of boilers, the fuel consumption was reduced by 15% through the substitution of single reduction geared turbines in place of the original triple expansion reciprocating engines. What is perhaps even more extraordinary is that after many more years of commercial service, the ship herself was worn out and consigned to the scrap heap, but Charles's experimental geared turbine assembly remained in such good condition that it was transferred to another vessel for further use. The consequences of the introduction of geared turbines were in some ways more radical than the changes brought about by his original invention: fuel consumption fell in many cases by nearly 50%, partly because full use could now be made of superheated steam and higher boiler pressures. However, although the later turbine ships equipped with single or double reduction gearing are a fascinating story in themselves, they really are beyond the scope of this article. On the other hand, when it comes to building a miniature turbine driven vessel, a geared drive is probably unavoidable, as we shall see.

Scaled-down drive?

I am going to stick my neck out here and now and say that I believe the construction of a practical miniature version of a multi-stage Parsons turbine, suitable for powering a five or 6ft. model ship for example, is an impossibility. However, I am fully aware that the word simply does not exist for many model engineers and I would be delighted if somebody could prove me wrong. Various proposals have appeared at intervals in *Model Engineer*, especially in the magazine's early days and I got quite excited about a design published way back in 1903 - until I discovered it weighed just over a hundredweight (51kg)! It was actually intended for use as a private electricity generator for somebody's house, but the designer omitted this rather important piece of information until the end of the article. One of the earliest of the excellent little Percival Marshall handbooks originally published in the early 1900s was entitled *Model Steam Turbines*, the 1929 edition was reprinted about a dozen years ago and is still a mine of useful information (see references). A few years further on into the 20th century, this magazine became much less enthusiastic towards turbines, and when somebody asked in the *Queries & Replies* section about boiler sizes suitable for a small marine turbine, he was given the brusque answer: "just put in the biggest boiler you can get into the available space", while another querist was simply informed that small turbines were "notoriously inefficient", not the most encouraging reply. The main problems with the Parsons system, as described earlier, are the enormous steam consumption in small sizes, partly due to unavoidable leakage past each individual row of fixed and moving blades, and also between successive stages of expansion, but also the complexities of the many rows of blades required and the difficulty of achieving the high rotational speeds necessary for efficient operation. There is also the essential requirement of really accurate balancing of the rotor, which of course, necessitates the production to very close limits indeed of the large numbers of identical blades for the multiple rows of each stage of expansion, and capable of standing up to prolonged operation at ultra high rpm, although that is no longer the problem that it was a few years ago.

So, if you wish to build a working miniature version of one of these elegant ships, I would suggest you have three options. The first one is to forget any form of steam propulsion altogether and use an electric drive, in which case you could, if you so wished, probably achieve an engine room that at least superficially is a very passable representation of the full-sized article, including scale size 'turbines', provided, of course, that you have enough space in the hull after the installation of motor, batteries and radio control. However, I don't envy you the watchmaking involved - and is it worth it for what is after all a deception, when all the fine detail work is hidden by the casing, which in turn is hidden below the deck? But it is a clean and relatively uncomplicated method of propulsion and of course lends itself to radio control. An electrically-driven model of *Turbinia* was described by Charles Sells in the September 2006 issue of *Marine Modelling International*. However, with the pencil slim hull of that particular vessel, there is little enough room for the motor and batteries, let alone a 'glass case' type engine room. The second option is to use a steam plant, but to stick with the faithful old reciprocating engine, either a scratch built job, or one of the many commercially available units such as those from the Stuart Turner (sorry, Stuart Models) or Cheddar range. Again, this seems to me somehow a bit of a con trick and in a funny sort of way defeats the whole object of the exercise, but perhaps I'm being pedantic.

Westbury design

The third option is to take the bull at least partly by the horns and go for a miniature steam turbine, but not the Parsons type. Many have been the variations on the turbine theme through the years, including (in alphabetical order) the Curtis, de Laval, Ljungstrom, Rateau, Riedler-Stumpf and Zoelly. Of these, the Laval would appear to offer the most promising option for 'our' sizes and a design by the late Edgar Westbury published in *Model Engineer* more than 50 years ago is discussed below. The Laval turbine was invented by a Swedish engineer, Gustaf de Laval, in the 1880s at around the time Charles Parsons was slaving away in Ireland and Newcastle at his machine, but the Laval is a much less complicated piece of apparatus and in its primeval form was intended for use in an ice cream maker! Potentially at least, it is subject to far fewer problems with steam leakage in small sizes compared to the Parsons design. The single wheel of a Laval turbine carries a series of 'buckets' round its periphery, into which steam is squirted from a number of angled nozzles, usually three or four in full size machines, disposed equally round the circumference. The conically shaped, convergent/divergent interior passage of each nozzle (not unlike the steam cone of an injector), is designed to increase the velocity of the steam in one stage by expansion from its initial pressure down to that inside the casing surrounding the turbine wheel, and the range of a full size example using a condenser, might be, for instance, from 215lbs absolute pressure (200psi) down to 0.93lbs absolute. With such a range of expansion, it will be obvious that the column of steam emerging from each nozzle will not exactly hang about to admire the scenery. It would, in fact, emerge (if you want the theoretical figure for the above example) at 4,127ft. (1258m) per second, or about 2,814mph, a speed that makes most modern jet aircraft look as though they are flying backwards! As the turbine is at its most efficient when its peripheral speed (alright - the speed of the buckets) is just under 50% of the steam velocity, a 4in. diameter wheel would need to revolve at not far off 120,000rpm in order to achieve

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the optimum results.

Contemplation of the accuracy required to produce such a device does not sound too joyful a prospect for the would be constructor armed with little more than bags of enthusiasm and an elderly ML7, but don't despair, it is not impossible! The late Dennis Chaddock managed to achieve 118,000rpm with his experimental Laval type machine, producing just under ¼hp, and his series of articles on his trials and tribulations (and occasional triumphs) is well worth reading (*M.E.* Vol. 104, Jan-Jun 1951). A rather more modest geared single wheel impulse turbine based on the Laval principle, but using Riedler-Stumpf type blades, was described in detail by E. T. Westbury in this magazine as part of a series entitled *Utility Steam Engines* (*M.E.* Vol. 111, July-Dec 1954) and would seem to be well worth investigation. The 1½in. (38.1mm) diameter rotor is intended to run at a surprisingly modest 20,000rpm, with a simple 5 to 1 reduction gear, giving a propeller speed of 4,000rpm. Although he does not specifically say so, I suspect that Mr. Westbury intended his engine to be installed in a high-speed model powerboat, so a higher gear ratio is probably advisable for the more sedate progress of a miniature passenger steamer. This would obviously decrease the rpm of the propeller and at the same time provide the increase in torque required to drive a larger and heavier boat at a reasonable speed. No condenser was specified in the design and the steam pressure at the nozzle outlet was around 30psi, hence the relatively low rpm. I would have thought that providing you have the space, a condenser in a model turbine steamer would be well worth the extra complication, but, of course, increasing the range of expansion in a single stage will push up the number of revs again. Apart from any considerations of a potential enhancement of efficiency, desperately needed in small size turbines, all full-size vessels were fitted with condensers, so it seems sensible to incorporate one, if possible, into a model turbine steamer.

Further examples

Possible designs for both jet and surface condensers suitable for such vessels can be found in K. N. Harris' *Model Stationary and Marine Steam Engines* (see references), an excellent little book in many ways, although in view of the title, the word turbine is strangely conspicuous by a total absence from its pages. To return to the Westbury design, the overall size of the turbine, including gear case, is about 4in. (101.6mm) high by 2in. (50.8mm) wide, so if you wished to install such a turbine in a miniature *King Edward*, for example, you would need to build to a scale of at least 1:50, producing a model just over 5ft. (1.52m) long. This would give a depth of hull to the underside of the promenade deck of about 4¼in. (108mm), which is cutting things a bit fine, so perhaps 1:48 would make life easier, giving a depth of 4½in. (114.3mm), a length between perpendiculars of 5ft. 2½in. (1.59m) and an overall length of about 5ft. 6in. (1.68m). Unfortunately, Mr. Westbury gives no indication of the size of boiler required to feed his turbine, which he christened the *Spinette*, but at least he had built one himself and could therefore guarantee that it worked.

Another successful miniature single wheel steam turbine, originally intended to drive a 4ft. 6in. (1.37m) model destroyer, was described by T. B. Rose in *M.E.* Vol. 130, No. 3259 15 October 1964. Having served on the full-size vessels, it is not surprising that Mr. Rose was determined that his miniature version should accurately reproduce the overall proportions of the original, including the shallow draft and high length to beam ratio of about 10:1, in other words a narrow hull by comparison to its length, nearly as pencil-shaped as *Turbinia*. This naturally restricted the overall size of the power plant, particularly the overall width, and his turbine incorporated a single brass wheel just 1in. (25.4mm) diameter by 3/16in. (4.8mm) thick, equipped with 55 blades, cut with a home-made silver steel cutter and enclosed in a duralumin shrouding. After several experimental versions, his 1964 design was fitted with three steam jets made from No. 3 size Serum Hypodermic needles(!), but unfortunately, Mr. Rose did not reveal his source of supply for these potentially lethal items. These days, I can imagine all sorts of complications in trying to obtain such items, however innocent their intended use. Their measurements were 0.035m. (0.89mm) O/D by 0.020in. (0.51mm) I/D, parallel bore. The rotor, running at 54,000rpm, was mounted on a ¼in. (6.35mm) diameter steel spindle running in ⅝in. (15.9mm) O/D ball bearings, one of which was free to 'float' longitudinally in its housing in order to allow for the different expansion coefficient of the various metals. The reason for the relatively large spindle dimension was to enable a 15-tooth pinion to be cut directly into the shaft, simplifying the assembly. The turbine was geared down at 19:1, although the builder suggested that 25:1 might have been a better figure, and drove twin output shafts, as in the full-size ship. Mr. Rose gave few details of the boiler apart from telling us it was a flash steam job consisting of 16ft. (4.9m) of 3/16in. (4.8mm) copper tube and that it had successfully, if unintentionally, run a Westbury *Cygnet* at twice its designed speed! The working pressure was 60psi (4 bar), although the three-jet turbine described above drained the boiler to the extent that this figure was reduced by some 75% - but, according to Mr. Rose, without any noticeable effect on performance. Full-size drawings of turbine, gearbox and blade-cutter were included in the article.

Exactly four years later, in *M.E.* Vol. 134, Nos. 3355, 18 October and 3356, 1 November 1968, Mr. Rose described an improved, slightly larger version of his small turbine, together with a new flash steam boiler, again using 16ft. of tubing, but now stainless steel, 5/16in. (7.9mm) O/D, gas-fired, using Camping Gaz cartridges. The rotor on the new turbine had been increased to 1½in. diameter, but running at the same rpm as the original, thereby increasing efficiency since the peripheral speed had gone up by 50%. Mr. Rose had substituted friction drive for his original reduction gearing, but at the time of writing the article and after discussion with Dennis Chaddock, was also experimenting with epicyclic reduction gearing. Finally, he had superseded his potentially lethal trio of hypordermic syringe jets by a single home-made jet with a throat diameter of 0.31in. (0.79mm). Unfortunately, the more recent articles include no working drawings of the new turbine, but do have photographs of the various components and the complete power unit. The model Hunt class destroyer in which it was installed was 5ft. 9in. (1.5m) long, about a third longer than that originally planned, but had achieved an actual maximum speed of 4.84mph, equal to just under 30 knots in full size. This would be ideal for a model of *Turbinia*, but is a bit fast for any of the passenger steamers described earlier. All three of Mr. Rose's articles would seem to be well worth investigation, partly because of the basic simplicity of the entire concept. I'm sure the construction of such a machine would be well within the capabilities of the hypothetical elderly ML7 owner mentioned above.

Laval or Riedler-Stumpf

At this point, I'm going to put my head on the executioner's block again by putting forward the suggestion that perhaps a series of Laval or Riedler-Stumpf type turbine wheels might be worth trying, so that the velocity and/or pressure of the steam is reduced by stages, thereby decreasing the rpm. As we have seen, the full-size ships described above have all been equipped with multi-stage turbines driving three shafts, and it would be very satisfying and more true to the prototype to have a two or three stage turbine in a miniature version, even though it is not based on the Parsons design. As a mere locomotive man, I am probably talking through my proverbial hat and can imagine all sorts of reasons why the idea may be totally impracticable - steam leakage, surface friction in such narrow bore tubes, heat dissipation, etc., but if the suggestion only starts a useful discussion, it will have been worthwhile. A steam turbine-driven model of *Turbinia*, complete with three shafts and nine propellers and built in Sweden, was described by Chris Chambers in *Marine Modelling International* in September 1996, but the article is rather light on hard facts and figures, not even giving basic dimensions such as the scale or length of the vessel. There are, however, several excellent photographs, including one of the professionally made single turbine wheel and gearbox, together with a view of the whole assembly installed in the hull, showing the three prop shafts. It is perhaps significant that, despite generally satisfactory trials, the gas-fired Saito boiler was found unable to cope with the demands of the rotary engine, and at the time of writing the article, further work had been suspended until an alternative could be found. This model has a wooden hull, but of course, all the full-size ships described in these articles, including *Turbinia*, were steel hulled and if I were building one, I would certainly go for metal. Once again, as in my article on the River Dart steamer (*M.E.* 4244, 1 April 2005), I would strongly recommend the study of a wonderful constructional series by Oliver Smith that began in *M.E.* Vol. 126, No. 3180, 21 June 1962 and continued for about two years. It deals with the construction of a model of a 1959 built coaster, the *Cranborne*, and the hull construction follows full-size practice very closely, that is to say laying a metal keel, fitting metal ribs and stem frame, followed by plating, except that the recommended metal is brass rather than mild steel. The series is superbly illustrated by photographs of every stage of construction and is a classic of its kind. Obviously, the earlier articles deal with the hull construction, and if you can borrow *M.E.* Vol. 127 (July-December 1962), I'm sure you will not be disappointed.

There is no doubt in my mind that the whole subject of miniature steam turbines is a fascinating field for those willing to spend time in patiently experimenting, as Charles Parsons did with the full-size machine well over a century ago. He, and indeed his father, the Earl of Rosse, both possessed brilliant investigative minds, and both men made very important contributions to progress in several other completely unrelated fields, optics being the best known example. However, some of Charles Parsons' lesser-known efforts are reminiscent of that extraordinary genius of the 15th century, Leonardo da Vinci: for instance, Parsons Junior has been credited with building and flying a successful working model steam driven helicopter as far back as 1893, just a year before the debut of *Turbinia*, and a full 10 years before the Wright brothers became airborne. Perhaps the most way out of all his inventions is one rejoicing in the exotic title of the Auxetophone, a device for sound amplification by means of a controlled flow of compressed air through a valve. The results were remarkably pure, particularly in the field of music, and it was successfully employed at a concert in London's Queens Hall exactly 100-years ago by the famous conductor and founder of the Promenade Concerts, Sir Henry Wood. Unfortunately, the equivalent of the Musician's Union of the day objected strongly to the reduction in the number of orchestral players required (particularly in the string section) as a result of Charles' brilliant invention and it was quietly dropped - basic human nature changes little over the ages. He also spent many years and much money experimenting with the manufacture of diamonds from crystallised carbon, but in spite of achieving pressures of 5,000 tons per square in. and temperatures exceeding 15,000deg. C as part of the process, he was no more successful at affecting an entry into this Utopia of potentially unlimited wealth than the old-time alchemists of the days of yore. My apologies - I digress, as is so easy when dealing with such a fascinating character! To return to the subject of these articles, a working miniature turbine steamer would make a fine memorial to a brilliant man who died three quarters of a century ago and who seems to have been largely forgotten these days. Perhaps someone can do for the miniature marine steam turbine what Tim Coles and others have achieved with the miniature gas turbine?

Acknowledgements

In conclusion, I would like to recognise the help so willingly given by Andrew Choong, Curator of Historic Photographs and Ships Plans at the National Maritime Museum, Greenwich, Peter Bailey, Curator of the Museum of the Newhaven Local Historical Society and the Information and Library staff at the Institution of Mechanical Engineers, London.

References

1. National Maritime Museum, Greenwich, London SE10 9NF. Various builder's drawings from the Denny collection covering *King Edward*, *Brighton* and *The Queen*, all as originally constructed, and LBSCR rigging plan of *Brighton* dated 1913. The NRM has kindly sent me a full list of drawings available for the above vessels, (over two dozen!) and I would be happy to pass on any details to anyone interested. Note these drawings can only be photocopied at the same size as the originals, which in some cases are several feet long, but they are of excellent quality.
2. Tyne and Weir Archive Services, Blandford Square, Newcastle NE1 4JA. Three drawings of *Turbinia*: one side elevation as originally constructed, one side elevation and plan as modified in 1896. Note these are available for purchase as photocopies or as JPEG images on CD.
3. Scottish Maritime Museum, Harbourside, Irvine, Ayrshire KA12 8QE. The museum contains two of *King Edward's* turbines, while Denny's ship model Experimental Tank, Castle Street, Dumbarton G82 1QS is also open to the public.
4. *The Marine Engineer*, 1 August 1903: *The Steam Turbine and its Application to the Propulsion of Vessels*. Transcript of a paper by Charles Parsons read in Dublin on 26 June 1903. The article contains various drawings of *Turbinia* as modified in 1896, and a complete transcript of the report by Professor Ewing.
5. The Denny List. Compiled D. Lyon, pub. National Maritime Museum 1975. Extremely useful volume in four parts, giving small outline side elevations plus excellent brief biographies of ships built by William Denny. Unfortunately out of print for several years, but NMM will photocopy individual pages for a small charge.
6. *Engineering*, 5 July 1901: Good descriptive article and superb photograph of *King Edward*, the first commercial turbine-driven vessel on her initial trials.
7. *The Engineer*, 19 June 1903: Good descriptive article and superb photograph of *The Queen*.
8. *The Engineer*, 3 July 1903: Further descriptive article on *The Queen* with cross-section of engine layout.
9. *The Engineer*, 1 September 1903: Good descriptive article and superb photograph of *Brighton* on her original trials.
10. *Engineering*, 4 September 1903: brief article on *Brighton* with additional details, not illustrated.
11. *Engineering*, 18 August 1905: Excellent article on *Dieppe*, including small side elevations, deck plans and drawings of engine layout.
12. *Turbine Steamers of the British Isles*: Nick Robins, pub. Colourpoint Books, 1999. Good outline history, well-illustrated, but contains some factual errors.
13. *Golden Years of the Clyde Steamers 1889-1914*: Alan Paterson, pub. David & Charles, 1972. Well-researched general history, republished 2001 by John Donald, Edinburgh.
14. *Merchant Fleets: Britain's Railway Steamers*: Duncan Haws, pub. TCL Publications, 1994. Lists of steamers including very small side elevations and brief biographies.
15. *Newhaven - Dieppe Service*: Peter Bailey & Claude Feron, pub. Editions Bertout, 2001. Good picture history, including several photographs of *Brighton*.
16. Laurie Marshall Collection: Excellent photograph of *Brighton* on the 'grid iron' at Newhaven, c. 1910 showing details of bits usually underwater.
17. *The Marine Steam Turbine*: J. W. Sothern, pub. Crosby Lockwood 1909 (3rd edition). "A practical description of the Parsons Marine Steam Turbine", but also includes Curtis and other types.
18. *Model Marine Steam Turbines*: H. H. Harrison, pub. Percival Marshall, 1906-1929, reprinted 1994 by TEE Publishing. Although dated, much useful general information, including various methods of blade manufacture.
19. *Model Stationary & Marine Steam Engines*: K. N. Harris, pub. Percival Marshall/MAP/Argus Books, 1958-1980. Useful drawings for model jet and surface condensers, but not a mention of a marine steam turbine!

ME

ANNA

A MANNING WARDLE LOCOMOTIVE FOR 7¼in. GAUGE

D. A. G. Brown and Mark Smithers provide guidance on boiler assembly and testing.

Continued from page 328 (M.E. 4321, 14 March 2008)

In the last instalment we left the copper parts of the boiler completely formed and ready for assembly. As noted, the rolling and bending operations were done carefully, so that both sides of the firebox were similar, to avoid a drunken appearance. It is relatively easy to coax soft copper into such conformation, especially at the beginning and end of a curved section. Say, for instance, that a 180deg. bend starts ⅛in. too low on its left flank and the same amount too high on its right flank. Try inserting it back in the bending rolls with the right straight flank pointing out of the nip roll pair (**fig 1**). With the rolls in their original 'action' position, rock the material back and forth at the end of the semicircle and encourage the bend to go that final tiny amount to correct the error. That is fine for the longer of the two tails, but for the shorter end, insert in the bending rolls the wrong way up and attack the extreme end of the curved portion with the pressure roller inched right back just to touch the inside of the copper surface; by so doing, you will be applying maximum bending moment at the end of the curve and it will deform back to a straight line.

Assembly of the boiler

I am now going to deal with the method which I used successfully to assemble the boiler; bear with me if I labour some of the points about conditions and protection of the copper to conserve the heat during the process. First, let me describe the equipment used. For pickling I had diluted some battery strength sulphuric acid by about 20 to 1, to give a weak but effective solution. Having stored it from the previous job in some 10 litre plastic containers, my original 'acid bath' was too small for the latest effort, so a visit to the local plumbers' merchant produced a medium sized black polythene water tank for a few pounds. This enabled me to dunk to a depth of about 15in., or nearly half way up the finished vessel. Verdict: just okay, but quite economical on the acid!

Heat conservation scheme

For many years I have had a 3ft. long bench lying around with a thick 'Sindanyo' top, which I believe to be a very tough, well bonded asbestos material, which originally came out of a pilot plant for which I was responsible some 40-odd years ago. Although probably not still available, the material is hard, strong and does not flake when attacked with a flame, so it does the job. Come to think of it, an old ceramic hob would do just as well, courtesy the council dump, although it might crack if jumped on!

At one period of my working life I had responsibility for a dozen or so lime kilns, which were partially re-bricked every year. This process yielded many different shapes and compositions of insulation and firebricks, just ripe for legitimate pickings.

A word about the principles involved seems relevant at this stage. At the heart of the kiln, the operating temperature is about 1,300deg. C and in this zone a heavy refractory brick is required. Such a material is heavy and expensive, but withstands the temperature well, slowly losing heat through its thickness. Outside of this material, a more conventional firebrick, say silica, will withstand a slightly lower temperature, and is not only cheaper but has a rather better insulation performance than its heavier neighbour. Outside the ring of firebricks, the objective is to conserve the heat and this

Fig 1. The longer tail being 'coaxed' in the bending rolls.

1. Selvert torch with main No. 2943 nozzle; the cyclone burner is on the floor, ready to be piped to the spare outlet of the regulator.

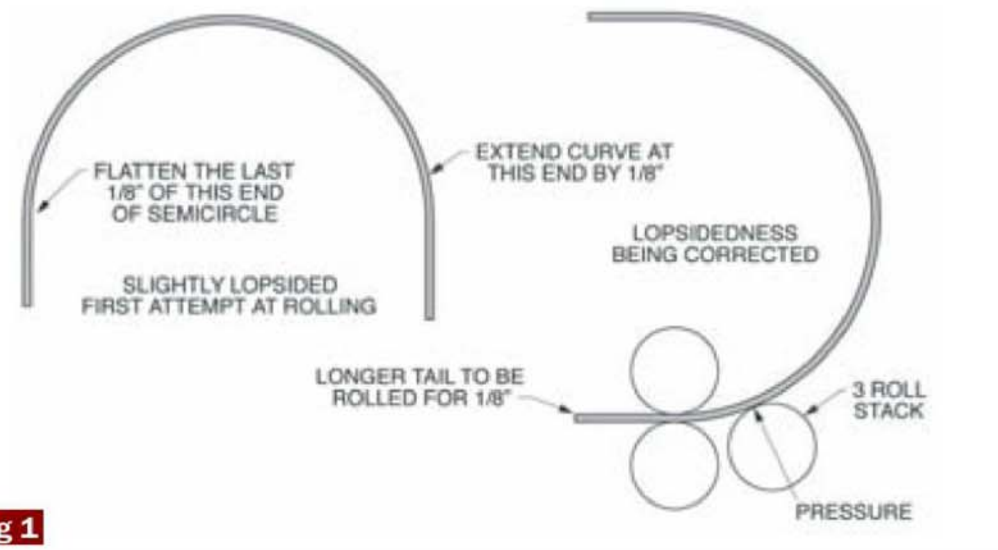

Fig 1

is achieved by using insulation bricks, which are porous and light, but have limited ability to resist high temperatures. If we use such bricks in circumstances where a flame is played right onto them, they are likely to crumble and fail to do the job. One word of warning: in no circumstances be tempted to press building bricks into service: they explode violently if heated with a gas flame. Furthermore, all refractory and insulation bricks must be kept bone dry, again to avoid violent cracking or decrepitating.

Other sources of suitable refractory material include old fire-backs (sometimes with loose bricks) and storage heaters (again courtesy the council dump or Steptoe's yard). I have also kept over the years an old asbestos blanket, but don't tell the HSE. Handled carefully, this makes an excellent cover for the boiler barrel and can be held in a vertical position by a few strands of thin wire. A modern equivalent is a fire blanket as supplied to kitchens, made probably of spun silica.

During the heating process the objective is to cover with insulation all surfaces which are not in the firing line; so, for instance, if working on the firebox end of the nearly finished boiler, much of the firebox itself is bricked, while the barrel is wrapped in its blanket, snug as a bug in a rug.

Heating equipment

I have an old Sievert gas torch; its supply tube can be connected to one of two outlet branches on the regulator, which means that I can run a borrowed torch as well as my own on the same supply. I find that a 13kg propane bottle just lasts the complete boiler job and is fairly manoeuvrable. Gas pressure should be regulated to three bar, which gives a noticeable improvement in power output compared with running at the more normal two bar pressure. Some regulators are not adjustable, so you could have problems getting enough heat to do the job my way. In **photo 1**, my Sievert torch is fitted with a No. 2943 nozzle, which is the largest in its range. Still larger nozzles, which are specials for coping with such mundane matters as tar boiling, are not really suitable for the present use, since their flame characteristics are not right. Note that there is a blind nut on my regulator diametrically opposite the outlet to the supply tube. If this nut is removed (clockwise), the borrowed second torch is screwed in its place and that second device is fitted with the cyclone burner No. 3526, which is on the floor beside the propane bottle. Now the output of this second burner is about ⅔rds that of the main burner, but its significance is that it takes its air supply from the pipe end of the burner tube and can be inserted into the inside of the firebox, to provide extra heat just where it is most needed as the boiler takes shape and gets heavier. I have had to make an adaptor in order to fit the cyclone burner to my torch, but that is a simple detail for the workshop; I would guess that on modern equipment there will be no trouble, or Sievert will supply an adaptor.

When two torches are in use with two operators, you must be careful and vigilant; not only may there be a risk of setting fire to each other, but if two flames impinge on one another from an angle very far removed from parallel, one or other will suffer oxygen starvation and immediately blow out. The rule must be: operate both torches from the same side of the job and agree in advance how to move around it to tackle the various elements of jointing.

I must confess to owning one other luxury, namely an oxy-acetylene set. I realise that these are not common in home workshops, but on a boiler of this size I have found it to be invaluable for some of the final correction work, especially stays in awkward positions. I used a No. 18 nozzle and that proved to be ideal; if you need this luxury, you should be able to prevail upon a local tradesman to help – more than likely he will be interested in the project!

1

Solder and fluxes

I have made a personal resolution to use only genuine Johnson-Matthey materials, having once been caught out using dodgy supplies which happened to be available at the time. As the leading supplier in the metallurgical world, you can trust their alloys to flow and penetrate in a predictable fashion, wetting the base material perfectly if the correct procedures are applied. You can do everything with Easyflo No. 2, which starts to melt at 617deg. C; there need be no fear of the last joint melting when the succeeding one is run, since the remelting temperature is much higher within an established joint. For the main joints I used 2.5mm solder sticks, whose rigidity at the end of a pair of tongs makes them easily controllable. For application to the stays, the more normal 1.5mm sticks were wound up like springs around some $\frac{3}{16}$in. silver steel, chopped into circles and flattened, ready for placing over their targets prior to the heat being applied. As a guide, one standard stick yields about 35 stay circles, so if you reckon on 250 stays, each with two ends, you can estimate how many sticks you will need – then add a bit for luck. You must also provide for 40 double-ended $\frac{5}{16}$in. stays connected to the top of the firebox and these can be similarly provided with pre-formed solder rings of larger diameter.

The best flux to use is Tenacity No. 4, which has a rather longer active life at temperature than the usual Easyflo. This becomes more and more important as the assembly proceeds. Mix the flux to a stiff paste, adding a couple of drops of washing-up liquid to the mix, not only to make it smell fresh, but also to improve wetting of the joints. Experience teaches how much paste to mix for each session. Suffice it to say I used virtually a whole 250g container for the entire boiler.

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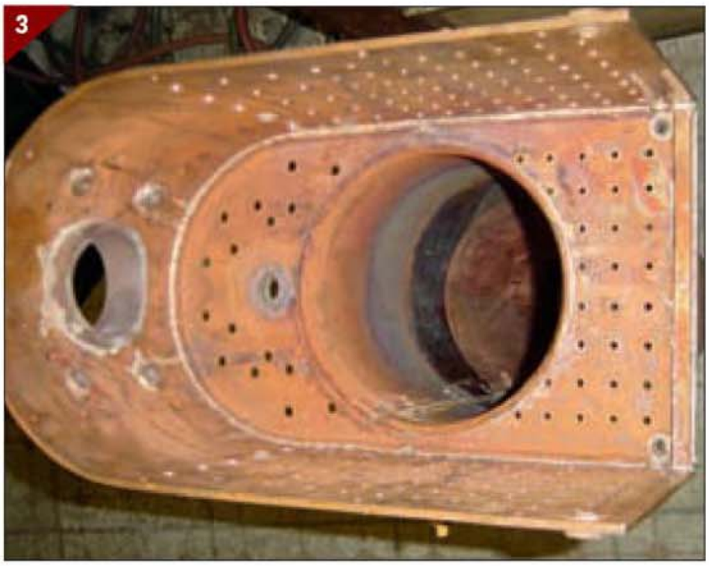

2. Boiler plates flanged, with inner firebox partly built up. Note the rolled ring.

3. This shot demonstrates the good penetration around the major joints. Solder has flowed through from the outside. Bushes have been run from inside.

Beginning the assembly

May I be forgiven for repeating **photo 2** of the boiler plates first shown in *M.E.* 4321, 14 March 2008; I would recommend starting off by silver-soldering the stays and firehole ring into the inner firebox back. As already specified, the stay rivets should be knurled just under their heads and this enables them to be fitted tightly in their holes; however, to aid the ultimate insertion into the backhead panel, these 40 rivets should be tapered for ¼in. at their tips. Starting the assembly with this component gives you the opportunity to check the penetration of the solder and to verify your geometry around the firehole ring; penetration here is also important.

Coming now to the first of the big jobs, the boiler barrel is fitted with its butt strip above the centre-line. It also accommodates the rolled ring which will be fixed into the throatplate. Hold the bits in their correct positions by means of 3⁄32in. rivets at say 4in. centres; before closing the rivets, coat the hidden surfaces with flux paste and coax the joints closed by means of a soft hammer.

The long boiler seam is a good example of where benefit can be gained by insulating the naked surface away from the flame; throwing the blanket over the top of the barrel stops heat escaping upwards while the joints (at the bottom of the assembly) are run with solder. Be prepared to melt the thick end of a couple of 1.5mm rods (or their equivalent) on just the long joints. While the barrel is hot, you can turn it round and tackle the rolled ring say ⅓rd of its circumference at a time. Do not forget the four water-entry bushes in the barrel. After thorough pickling (which takes longer with this sort of flux), inspect to make sure that you have got good penetration. A successful result deserves a good stiff glass of whisky to celebrate.

Having sobered up from this last extravagance, now is the time to build the boiler barrel into the firebox outer. The rolled sheet of the firebox wrapper can be riveted onto the throatplate and all the various bushes placed for a single jointing operation, which includes the large dome bush, ready drilled and pilot tapped for four threads in each of the stud holes. I advocate building in the front member of the foundation ring at this early stage, when it is easy to verify that it fits the contour of the throatplate (**photo 3**).

Standing the boiler with the barrel pointing upwards, the latter can be blanketed to conserve heat, and bricks placed around the firebox for the same reason. The large joint between the wrapper and the throatplate should be the first to run, this taking a lot of solder to make sure of the penetration. It can be followed by the ring joint into the barrel and the various bushes as drawn. Before heating, I had peened the inside of the ring itself, which closes the joint with the barrel, keeping it securely in place. If there is flux in the joint and the gaps are kept small, the solder has a good chance of flowing where it is needed.

Having run the main joints from the outside, it is unlikely that the flux around the dome bush and its associated small bushes will have reached its activation temperature, so the barrel can be carefully rotated horizontal and supported on bricks, with the dome bush pointing downwards. Soldering these bushes can now be done from inside the firebox. **Photograph 3** illustrates not only how good was the penetration of the main seams, but there are also give-away splodges of solder resulting from application within the firebox. The dome bush was one of the few areas of my construction where the penetration was not quite perfect and it gave rise to problems when it came to pressure testing, requiring some rectification work from the outside of the completed job, as described at the end of this article.

All the above work was carried out using the single Sievert nozzle No. 2943 as already described. After pickling (the boiler that is to say), your club boiler inspector should be given the opportunity to inspect the major seams while they are still visible. Ours was more than happy!

Inner firebox assembly

I have already described the flanging and bending of the two plate components to be joined at their front ends. As before, riveting is in order to keep them true to each other. The next task requires the tube nest to be positioned true to the tubeplate. Here I made use of four of the sixteen 5⁄16in. stay holes in the crown. As **photo 4** shows, a length of 2 x 5⁄16in. steel bar was coordinate drilled to match; the four holes were furnished with spacers and long bolts to keep the bar offset but parallel to the firebox crown. At the front end of this bar, an angle iron was contrived to hold the front tube plate in its correct position relative to the firebox, but forgetting about reaching out to its full extent at the front of the boiler.

All the tubes could then be threaded into place, with the little bulges near their bottom ends stopping them from falling through, but the tiny nicks mentioned earlier allowing solder paths to the inside of the box. The one heating fixes the long front joint, all the tubes, the foundation ring side sections and the fusible plug bush inside the firebox crown. Since there are five rows of tubes, I did not trust my ability to get the innermost tube ends to penetrate properly, so I split the job into two, the first run being done with about six strategic tubes removed to allow sight access to the rest of the joints. After pickling it is wise to examine all the joints very critically, using a magnifying glass; it is amazing what you can miss by a casual look. Looking at **photos 4** and **5**, it is possible to observe that the solder has penetrated through to the inside of the firebox around all of the tubes.

The major assembly

We now have two quite heavy lumps of copper, albeit each one being quite easily manageable on it own. Things are about to change with the incorporation of the two assemblies into one! By now the total weight is over 100lbs and this demands handling into and out of acid by two people. Be careful, too, how you support the boiler, since its own weight carelessly supported can even cause distortion.

In all the following operations, the second torch comes into play, so make sure that your helper is conversant with the method of assembly.

If the two sections are offered up to each other, the tubeplate is pushed into the smokebox end and supports the tubes easily and firmly without fixing. Indeed fixing at this stage would be disastrous, since the tubes must float during work within the firebox. Clamping the foundation ring into shape, I made a set of small crude G-cramps, which proved to be invaluable. It is possible to make small movements of the inner assembly relative to the outer, constantly observing the size of the water space at each side. Row by row, the knurled and fluxed stays can be driven in. For ⅝in. water space and ³⁄₁₆in. plate, the rivets should be 1½in. long, to be cropped after assembly. The ½in. tail is invaluable, providing a 'hot finger' to get hold of the heat just where it is needed.

It is most important for this assembly stage, to have the two rear plates fitted to the firebox in their correct attitude; thus both the inner firebox rear panel and the backhead need to be loosely in place. I machined up some 6BA bronze screws and tapped the flange surfaces of the copper so that they could be pulled up slightly; integrity of these threads is not important, but a fitted screw is better than fiddling around with a nut. Thus we have a dry assembly of the whole caboodle, knocked about until square and tight at all the seams. When the screws are taken out to release the soft backhead, it should all stay put, ready for soldering the other joints (photo 5).

Before taking out the backhead, fit the long transverse stays and the (almost) vertical ones between inner and outer boxes. For the vertical ones it is necessary to drift the holes in the outer wrapper to an elliptical shape. For this operation I silver-soldered an 18in. extension to the butt of a ⁵⁄₁₆in. drill; operating this in a power drill soon did the trick. Again, the long stays were all knurled to hold them in place during the heating operation; only one moved and had to be re-fixed.

The solder application is done in two stages: pictured in photo 5 is the set-up for the second stage. In the first operation, the inner right stay heads and the outer left stay tails had been run, together with the long verticals and the left ends of the horizontal stays above water level. Heat had been applied by the conventional torch to the outside of the wrapper, while the cyclone burner applied heat inside the water space. For the inside joints the principal heat source was the cyclone burner within the firebox, the main burner backing up obliquely at the bottom of the stack. You can see how the solder has run through all the joints, very reassuring. In the event, some of the vertical stays were less than perfect at the top and rectification of these gobbled up quite a lot of solder. Photograph 5 also illustrates how flux has been applied ready for the next run; after this operation, and while still hot, the boiler was erected onto its barrel end and more solder was run into the back firebox joint, just to make sure of its integrity. You can see some of the eight small screws holding the flanged joint together; these were individually treated with solder.

In the final operation on the firebox, the backhead is inserted and the longitudinal

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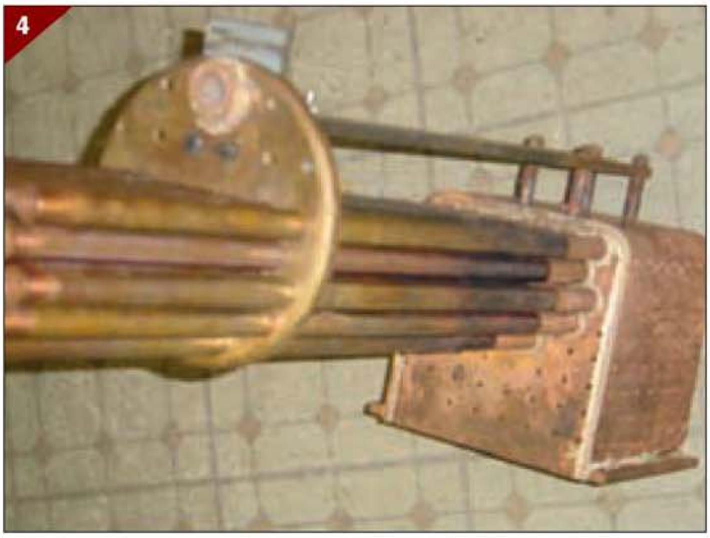

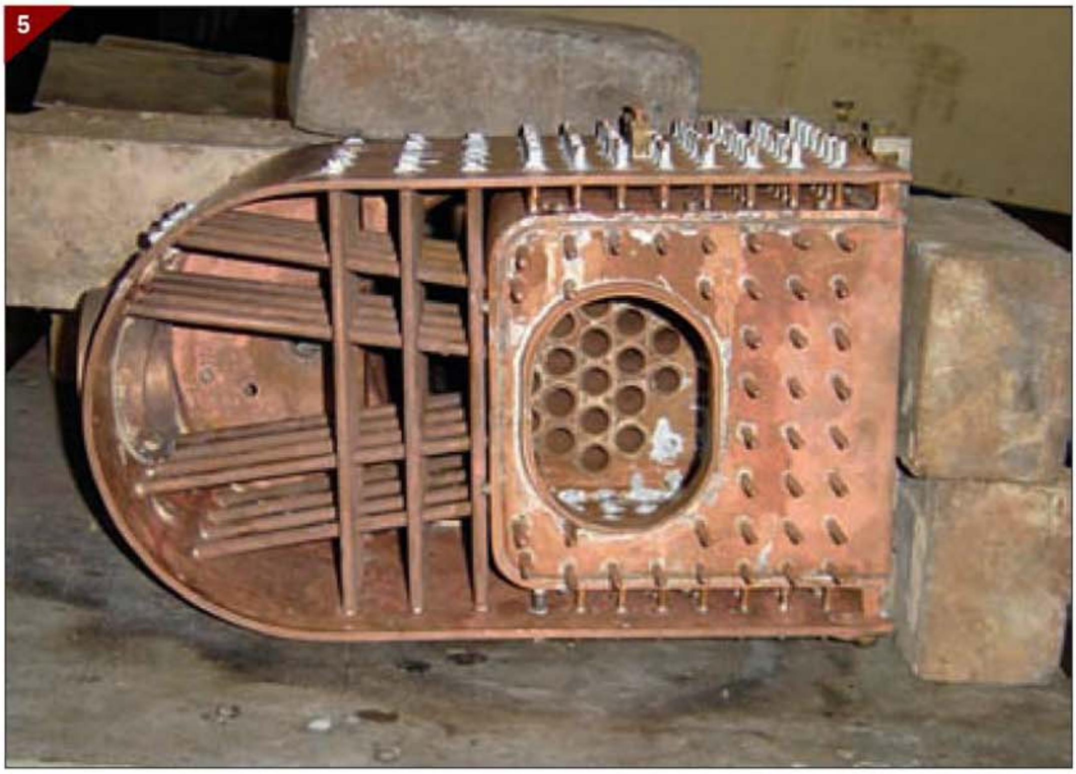

4. Inner firebox assembly and precise support for tube nest given by four bolt assemblies and steel outrigger to front tubeplate.

5. The set-up for the second stage of soldering the firebox (see text).

stays fixed at the rear end. You will see from **photo 6** that the backhead has already been fitted out with all its bushes and the brass anchor points for the firehole door gear. Careful positioning of these pads, making use of the stay holes as a guide is vital to allow for successful location of the door gear after installation. Because the stays which pass through the door pads have to cope with an extra layer of material, penetration in these positions is a problem worthy of attention; in retrospect, I should have enlarged the outermost ends of the holes in the brass pads, to maintain location for only a short distance. The inner firebox stays have probably endured some rough handling, so they may require aligning to mate with the backhead. As already noted, their ends should have been tapered to aid location, but I would still advise enlarging the backhead holes by a good 0.015 to 0.020in. over nominal size to allow the rivets free passage. With the backhead in place and held with the little bronze screws, the door ring can be 'encouraged' to fit, with similar treatment being given to the remaining joint of the foundation ring, its bespoke clamps being used as necessary. Any last chinks in the foundation area will require filling with slivers of copper. Now is the time for a final check for gaps, to be closed before soldering.

To prepare for the big heating job on the backhead, it is best to position it on its barrel, with the dome facing you. Inside the firebox may be filled with insulation, as well as extensive lagging of as many of the outside surfaces as possible. While the main burner is played on the backhead, the cyclone burner gives back-up through the dome bush, which enables the solder to be run easily, starting with the main seam, and following up with all the stays and the firehole ring. While still hot after filling the backhead joints, the boiler should be turned on its back, with the firebox bottom pointing to the ceiling; this enables the finishing of the closing joint at the rear of the foundation ring, making sure that there is not a gap or hole in either of the two corners. Again the two torches come into their own and success is indicated by a neat bead of solder shimmering along the joint; for this operation, it is essential to lag all the outside surfaces to conserve the heat.

In this heavy work at the firebox end, the employment of the higher rated flux is demonstrably sound; so long as it has not been overheated during the main job on the stays, it should endure some cooling while repositioning the boiler as just described, so that around the foundation ring is still active when the temperature is raised again. It pays to have some flux ready mixed so that it can be picked up on the tip of the solder stick to encourage any small doubtful area at the last gasp!

Smokebox tubeplate

Throughout the firebox operations, the tubeplate has been loosely in place and its location should be assured by resting on the butt strap and the front clack valve bushes. Having thoroughly pickled the boiler barrel, the final push involves heating it in the vertical position, with the whole of the firebox etc. lagged. Bear in mind that if you play a flame on the tubes, that flame needs somewhere to exhaust, so make sure that there is ample ventilation at the firebox tubeplate position. With the whole joint area well fluxed, the two torches should make short measure of bringing the front of the boiler to correct temperature for the final joints to be run. I used circles of 1.5mm solder for each of the tubes, which meant that by the time the long joint around the barrel had been finished, most of the tubes had fused. I did feed even more solder into the area, just to make sure; better to sacrifice the odd stick of solder in this final operation, than having to reheat subsequently.

Having completed the job and well pickled it, inspection with a magnifying glass revealed a few suspect stays. These were tackled locally, by preheating with the large (2943) torch, the final fusion using the oxy-acetylene set, which avoided overheating any of the surrounding areas.

Testing

After pickling, I sealed up the boiler, which meant making the final flanges, and regulator complete, as well as some blanking plugs. I then raised pressure pneumatically to about 60psi, which showed up a few further stay weeps; in the quietness of the workshop and with the compressor cut out at full charge, the weeps could be discerned using a length of rubber tube with one end extended by a short piece of ¼in. tube and the other end stuck in my ear like a stethoscope. Use of a squeezy bottle of washing-up liquid also pinpointed the locations of the trouble spots.

Then came the day of the final hydraulic test to 180psi. Our club boiler inspector discovered a weep around the dome bush, which only appeared at near the full test pressure. Quite rightly he insisted on the fillet being revisited, which meant a complete strip-down and treatment with oxy-acetylene. Apart from the odd trivial leak, which succumbed to peening, the final test went well and for this occasion all the correct valves were fitted, thus proving their tightness to hydraulic pressure.

● *To be continued.*

Drawings, castings and laser cut components for this locomotive are available from the designers. Contact D. A. G. Brown, T. 01780 753162, E. dag@brownmallards.org.uk or Mark Smithers T. 01609 773734, E. marks_northall.yorks@tiscali.co.uk

6. The completed boiler after emerging from a pickling bath.

KEITH'S COLUMN

KNOTTY
A UNIQUE LOCOMOTIVE
Designed for 5in. and 7¼in. gauge

Keith Wilson explains how to make axleboxes and hornblocks.

Continued from page 341 (M.E. 4321, 14 March 2008)

These are parts that need some precision (many do not) so herewith some ways to assist.

Axlebox machining

The axleboxes should come as double castings (**figs 1** and **2**), i.e. one casting with two boxes top-to-top. This alone means matched pairs of boxes, important. The easiest way to machine these to size is to grip them in a 4-jaw chuck and face off one side, taking care not to go to finished size at this stage. When all three blocks are done on one side, do the other side. If the casting is in the chuck pressed against the chuck jaws, then they should finish up parallel. On the milling machine, clean-up one side of each casting, finished to size as far as flange is concerned, remembering that there is some to come off from the other side, of course. It is important that both sides are dead parallel, so set up a bar on the milling table and take a light cut along it to ensure accuracy. If the block is now pressed against this (machined side inwards) before clamping, both sides should end up exactly parallel.

Now it looks odd at first, but although the bore position sideways is important (i.e. relative to the side) the vertical position (relative to top or bottom) is nowhere near so important. It follows that mounting the block on the lathe faceplate for boring, using a piece of steel as a guide, will make for ease in locating the bores. As long as the block is in contact with this guide, the two boxes must end up as a matched pair when parted - don't part yet though! If you have a ½in. internal micrometer there should be no problem in getting the bores dead to size for the bearings. If not, then I suggest making a go – no-go plug gauge. The lugs in the bottom for the links to the spring buckles should be done before parting, 'cos 'tis easier to hold a large block than a small one. Parting should be no problem; the tops may be cleaned up using the 4-jaw chuck.

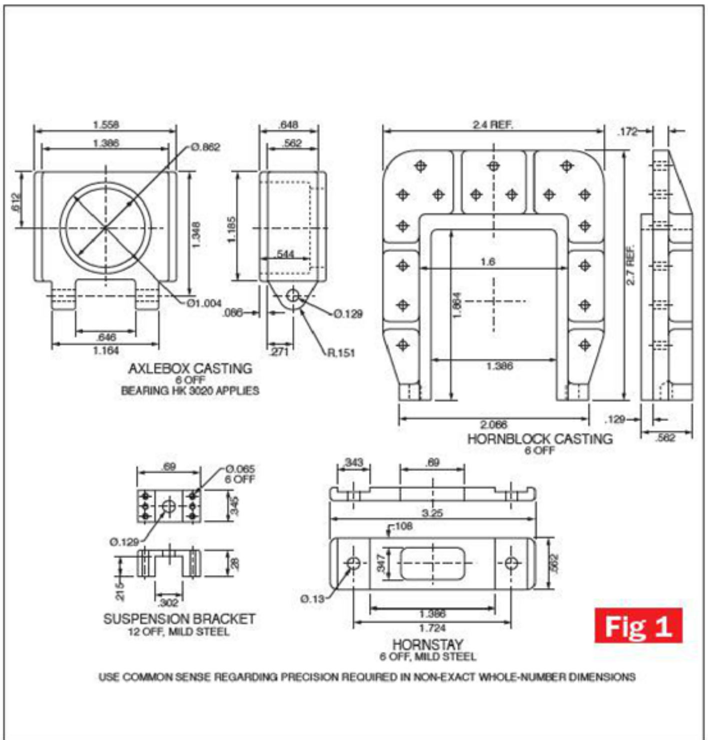

Fig 1

Fig 1. 5in. gauge Knotty axlebox and hornblock drawing.

Machining hornblocks

Just as a matter of interest, to the best of my knowledge full-size puffers do not use hornblocks the same shape as ours (see figs 1 and 2); at least I have never seen such used. Horns were two separate castings (probably manganese steel) bolted to the frames and to some degree adjustable; I believe that some wedging may have been employed in some circumstances.

The Swindon way was the use a grinding machine to finish horns to size. The rear horns of the drive centre were ground up to be at right angles to the centre-line of the locomotive with low tolerance by optical measurements as distinct from the older method of a tightly stretched wire. No matter how tight the wire it was bound to sag slightly and obviously to use a giant try-square from the wire was tricky.

I think it was K. J. Cook who brought this optical method to Swindon, it came as far as I know complete with some subsidiary parts, such as dead-to-length gauge-bars for wheel-centre spacings, horn gaps and cylinder positions. There was a self-centring mount to get the telescope lined up in the cylinder bore, and a collimator (I think that's the correct term, but I still haven't got my library here as yet) with a right angle set up to get the line-of-sight truly aligned across the frame. If you've got access to the book Swindon Steam 1921-1951 by K. J. Cook then it is well described.

I believe it was he who gave the lecture to the Mechanic's Institute entitled The Steam Locomotive – a Machine of Precision.

I think it can be best justified by the fact that after a locomotive was wheeled it always gave him satisfaction to see the wheels barred round to suit the first coupling rods, then the assembly crew would go to the other side and some of them would pick up the other set of coupling rods and put them on; they would fit perfectly without further ado. I believe that the tolerance in rod manufacture was about the 6 thou. range, bush

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Fig 2. 7¼in. gauge Knotty axlebox and hornblock drawing.

Fig 3. Left-hand profile of Knotty, note the different drawing styles and detail between this and fig 4.

Fig 4. Right-hand profile of Knotty.

Fig 5. Revised crankaxle drawing for 7¼in. gauge Knotty.

diameter tolerance three thou. Be that as it may, when you recall that horns, axleboxes, crankpins, wheels etc. all had to be pretty accurate, please doff hats or tug forelocks in honour of the process.

I cannot see us getting as accurate as this; you can't have a 'scale' oil-film!

I have made a few hornblock patterns in my time, always making a double pattern bottom to bottom, like two horseshoes foot-to-foot. This make for a little more trouble, a stronger pattern, and a much easier machining with greater accuracy. For this is a case for accuracy, each pair of blocks must match 'spot-on' and match its slot in the frames, and match axleboxes. I seem to remember learning that at Swindon if an axlebox was put into its blocks, it would stay put even under its own weight. When we consider old square-cube law, this gives food for thought.

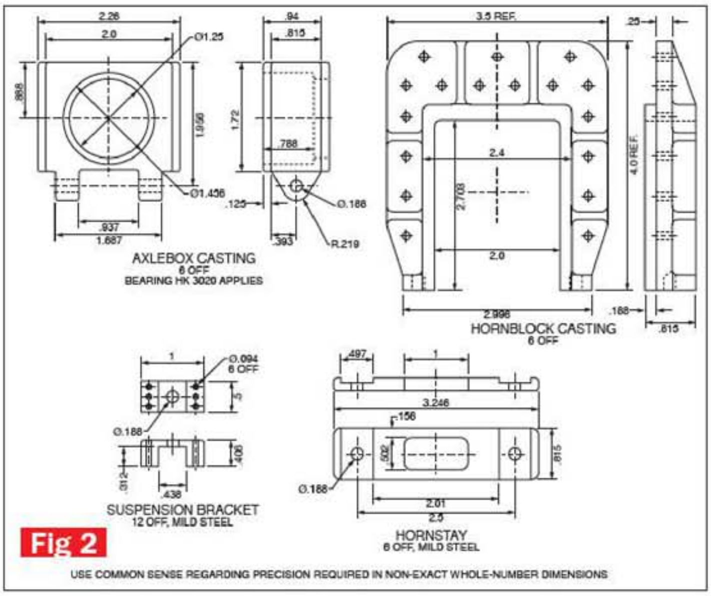


Fig 2

So if you remove any protuberances with a file, or easier still on that very useful tool the linisher, the casting can be mounted face-up on the milling machine table and set parallel to an axis, and machined to match the frame slots, remembering to keep the matching sides of the flange about equal. By flange here I mean that part that goes into the frame slots; to be a good fit therein. The mounting face should be machined at this stage. At the risk of stating the obvious, the fewer times the job has to be re-set on machines the better, and the more operations that can be done at one setting the better, for it is not very easy to re-locate a job accurately once it has shifted.

By crafty arrangement of clamping, the hornblock double does not need to be unclamped for the important machining operations; it only needs turning over once to clean up the inside face a bit.

The block should be mounted on a couple of parallels about ⅛in. clear of the milling table, taking care that the clamps are immediately above these bits. Two pieces of ½ by ⅛in. will do nicely. You can either start with clamps in the middle so that the outside (mounting face, fitting horn flange into frame bits) following up by clamping on the outside and then removing the inside clamping to permit access for the 'axlebox' faces.

"Taking care that the clamps are immediately above these bits?" A little hint for beginners here. A casting should never be clamped in such a way that it would be distorted, aided by machining stresses. In other words, if you have a job that has to rest on two parallels, any clamping must be so placed that the clamping force is not a bending force but directly 'pinches' the casting over all or part of the parallels. Also, recollect that removing metal from whatever job you're doing weakens it. I had personal experience of this, with bolting some large driving wheels onto the smaller Myford faceplate about 50-plus years ago.

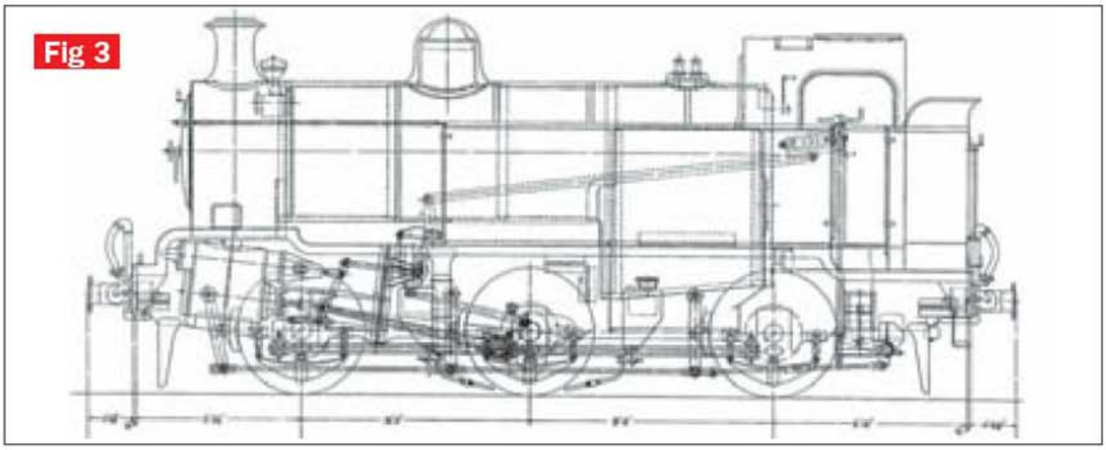
Knotty progress

The further I get into this design, the slower it seems to get. The drawings are both small, about 10½in. long. It is difficult to decide which is best, for alas they are not quite the same in some details. The right-hand one has many details clearer than the left (**fig 3**), whereas the left has details clearer than the right (**fig 4**)! So much has to be semi-informed guesswork. Much photographing and enlarging various parts helps, but of course lines get thicker in this process.

I am near the completion of the general arrangement, so things should be a bit better. Alas however, one or two details already published have been found wrong, amongst these is the crank axle and complete crank. I got the angular set of the eccentrics a bit out; it should have been 12.5, not as shown. New drawings for this item herewith (**fig 5**).

I tried for a long while to get the cylinder inclination right by use of trigonometry, but more recently a short written description of big Knotty stated

Fig 3



that this angle was 9deg. – so I have taken this figure as true. Swindon drawings of inside-cylinder slopes are often given as x by y, as distinct from degrees.

Fortunately, my CAD program allows for drawing rotation as well as swinging the cursor lines as required, but this has to be used with care for whilst enlargement applies to all layers on, off, or frozen, rotations do ignore frozen layers, so if you rotate the whole drawing so that cylinder centres are horizontal without making sure that all layers are 'on' things get confused to say the least, especially if much work has been done meanwhile.

This reminds me of a particularly obnoxious chief draughtsman who was quite convinced that he was better qualified than anyone else to do anything. He was in his office talking to one of the firm's bigwigs some of whom knew a little about the job. He needed to show his boss a drawing that was under way on a junior draughtsman's board, so instead of stepping out of his office with the bigwig, he stalked out, took the drawing off the board and took it back into his office. As any drawing office person will (or should) know, this just isn't done in good offices, for it can take quite a while to re-set that drawing accurately on the board. This stupidity was by no means unique.

On one occasion he decided that he did not like a drawing of mine which needed a hydraulic two-way ram with a stroke impossible to contain within the machine it had to fit. Now I know there are double and even triple stroke rams, but a) they were not two-way and b) they still could not double the stroke required. I had designed a mechanism that would just double the stroke. It was a small trolley that was pushed forward by the ram (or retract as required) said trolley having four wheels of the bicycle chain-wheel type, one part of the chain (a continuous one) being fixed to the machine framework and the other part connected to the moveable part – I think it was part of a lifting platform. This device obviously doubled the effective stroke and eventually worked perfectly. But he decided that there was a better way, and came up with the stupid idea that it could be solved by putting in two rams nose-to-nose! I could not think of anything polite to say about his idea, and doubtless to your surprise too I said nothing! I still remember his crow, "then we've got it!"

There are those amongst us who have never realised that "against stupidity, the gods themselves contend in vain."

Branching aside for a moment, many fans may recall the Hammer horror-films, and some may know that one of the chief problems was to stop the audience laughing! I remember going to a cinema to see the full-colour film *Dracula*. The cinema frankly was asking for trouble with this phenomenon, for in the vestibule was a smartly uniformed St. Johns Ambulance chap with at least one stretcher to hand plus numerous medical bottles and bandages etc. The film itself asked for trouble, for in a scene near the end the usual chase between Dracula (Christopher Lee) and von Helsing (Peter Cushing) in horse-drawn hearses, the first one crashed through a toll gate. Perhaps needless to state, the toll-keeper had just finished repairing it when along came the second to wreck the gate again.

After that there was no holding the audience, for the film kept treating everything so seriously that the laughter was hysterically infectious and tears of laughing were running down cheeks from just about everybody. Reminds me of our youngest son Phillip pointedly wringing out his handkerchief at the end of *Jaws*.

To be continued.

Fig 5

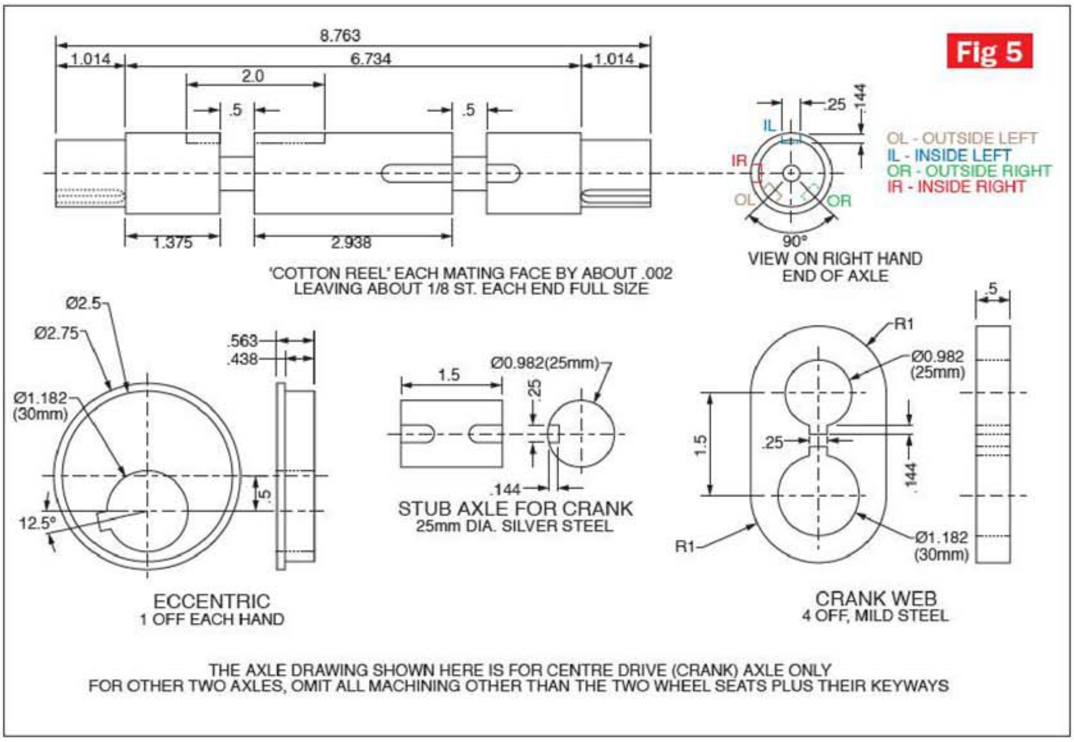
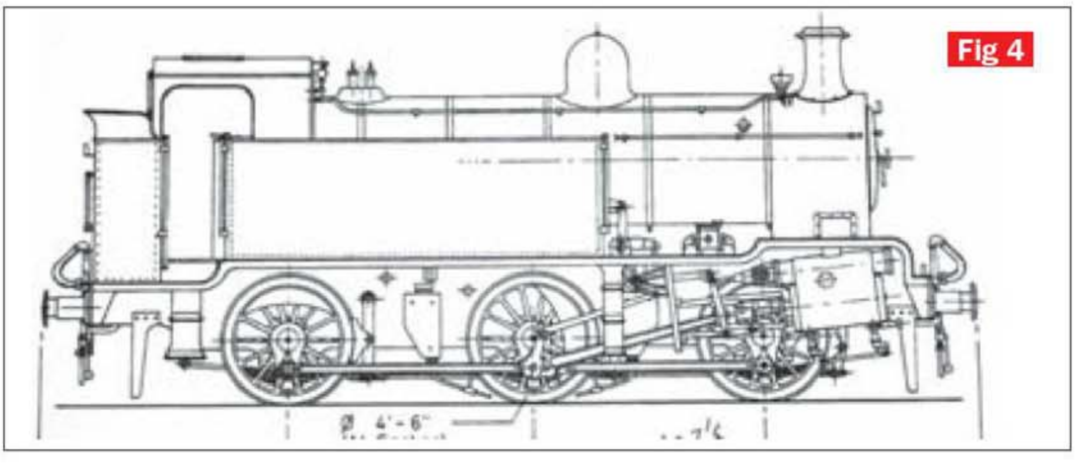


Fig 4



WILSON'S WORDS OF WISDOM

Mistakes are the rungs of the ladders by which we reach the skies.

H.S. Lewis.

M. J. H. Ellis poses two conundrums and looks at energy efficiency.

Dear Adrian, before I embark on my principal subject, I have two conundrums for you:

There was a time when I used to share an office with an engineering graduate who taught electrical engineering at night school. If students had hopes of catching him out, they were disappointed. He always had a rational explanation, which was not immediately obvious.

Such a case was that of a student who saw that an electromagnet is energised only as long as current flows in its winding. This consumes power, but a permanent magnet remains energised without consuming power. Why the difference?

In both cases the magnetic field was/is created when current flows in a coil. Suppose that this current is drawn from a battery. When battery is connected to the coil the current rapidly increases to a steady value determined by its ohmic resistance. However, while the current is increasing the strength of the magnetic field induced in the magnet increases with it. This change in turn induces an emf in the coil, which, in accordance with Lenz's Law, opposes the change which produces it. Part of the energy supplied by the battery is thus transformed into the 'potential' energy of the magnetic field, while the remainder is dissipated as heat by the ohmic resistance of the winding.

If the magnet is soft iron, when the current ceases the magnetic field collapses. The rapid reduction in its strength now induces an emf in the coil which tries to keep the current flowing, and the energy of the magnetic field may thus give rise to arcing across the switch contacts. If, however, the magnet is made of hard steel, or a special alloy such as Alnico (composed of aluminium, nickel and cobalt) it remains in the magnetised state indefinitely, and the magnetic field retains its 'potential' energy.

It is often helpful to think in terms of a hydraulic analogy. In my diagram (**fig 1**) P is a centrifugal pump, which creates sufficient pressure to raise water to a certain level in the tank T. If the pump stops, the water runs back out. In **fig 2** a valve V has been added, and once in the tank, the water remains there.

My second conundrum relates to a simple mechanical system (**fig 3**). P is the bob of a pendulum pivoted at A. The weight W hangs by a cord from the drum D, and causes the crank C to rotate. The crank is articulated to the pendulum by the rod R. Given that the cord is weightless and perfectly elastic, and that all the parts move without friction, what will happen if the system is set in motion? Maybe you will be able to get your Dad to help you!

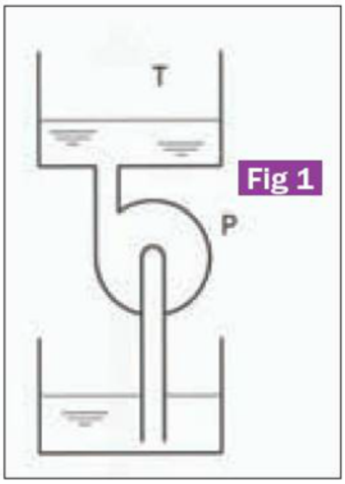
Now to my principle subject: I have been amusing myself by making a comparison between dispersing the molecules of metal by ECM and by liquefying it. Armed with my trusty friend the Mechanics' and Machinists' Pocket Book and the services of the public library I set to work:

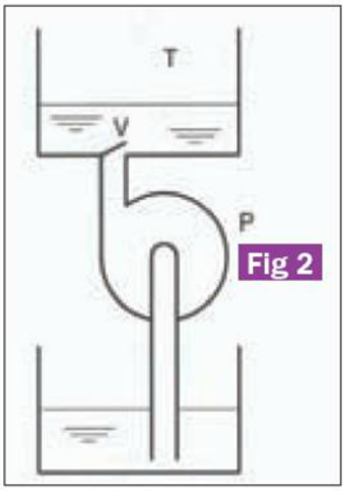
Firstly, I considered the energy to melt 1lb of wrought iron: The melting temperature is 2,768deg. Fahrenheit. Using the specific heat of wrought iron, which is 0.114 BTU/lb., and converting from heat to mechanical units, the heat required is equivalent to 240,200 ft lbf of work. To change the state of the iron from solid to liquid one needs to use the latent heat of fusion of iron, which is 69.1 calories/ gram. After converting from metric to British, and then from heat to mechanical units we arrive at the equivalent of 96,000 ft lbf of work needed to change state from solid to liquid. So, the total equivalent mechanical energy to melt 1lb of wrought iron is 336,450ft lbf.

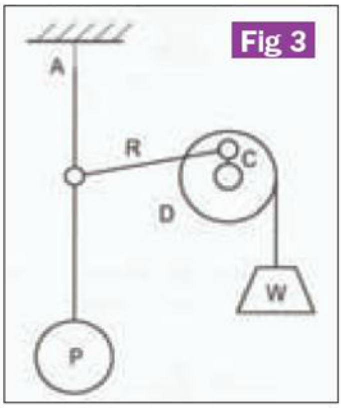
Secondly, I considered matters from the ECM point of view: We know that a current of 10,000 amperes, at say 20 volts, is needed to remove one cubic inch of metal per minute. Hence, with a bit of arithmetical manipulation, and converting from electrical to mechanical units, we can calculate the mechanical work needed to dissolve away 1lb of metal. This works out to be 31,362,000ft lbf.

If Grandpa's assumption and arithmetic are correct this leads to the astonishing result that ECM is only 1.07% as efficient as conventional casting! No doubt ECM has very substantial merits, but energy conservation is not one of them.

Your affectionate Grandpa.







NEWS

Malcolm Stride reports

Notices

Colchester SMEE has a change of secretary. Jon Mottershaw has taken on the role and can be contacted at Colchester SMEE, The Club House, 13A President Road, Colchester, Essex CO3 9ED, T. 01206 769192.

We have received notification of the 2008 calendar from **Birmingham SME**: 20 April - Official opening of the new footbridge; 27 April - BSME locomotive efficiency trials; 1 June - Public Gala Day; 29 June - Vintage Car Club Visit; 19 July - Acorns Hospice Fun Day; 2 August - Public Gala Evening and Pig Roast; 13/14 September - National Locomotive Rally; 4 October - Non-steam Running Day open event.

The contact for further details is John Walker (T. 01789 266065).

Midland Railway Society's Annual General Meeting will be held at the Midland Hotel, Derby on Saturday, 23 April 2008 from 11.00am followed by the Presidential Address given by Peter Wilts on 'The Great War and the Midland Railway'. Contact: T. 01462 451090 or www.midlandrailwaysociety.org.uk

The **Model Steam Road Vehicle Society** has also notified us of two meetings: 19 May - Model Night, - Bring your latest project; 16 June - PC K. Ireland, from the Crime Prevention Panel Gloucestershire Constabulary.

Both events are to be held at the Gloucestershire Club GL2 9RG. Contact John Bagwell (T. 01452 304876) for further information.

Peterborough SME will be holding the Peterborough Model Locomotive Rally (PMLR) on Saturday 30 May and Sunday 1 June 2008. The raised track has 3½, 5 and 7¼in. gauges. A free ploughman's lunch will be available for anyone bringing a locomotive and running on the track. Current boiler and insurance certificates will need to be produced. Saturday is more formal and Sunday afternoon is public running. Anyone interested should contact the secretary (E. secretary@peterboroughsme.co.uk, T. 01780 470369) so that the society can plan numbers for catering. Visit the society website (www.peterboroughsme.co.uk) for details of the club, track and pictures of previous events.

We have been informed that this year's Kew Bridge Festival of Models will combine the Medway Queen Model Show and the Kew Steam Models Show in one event on the 4/5 October 2008. If you would like to exhibit, contact Richard Halton (for boats and military models) or John Child (stationary and traction engines) both c/o the Kew Bridge Steam Museum T. 020 8568 4757 or www.kbsm.org

UK club news

The old level crossing at **Cambridge MES** has now finally been removed thanks to the efforts of Graham Clarke's new hydraulic digger. The foundations are being dug for the new crossing. These are to be one metre deep to ensure that the new crossing remains stable.

The society has been given an overgrown piece of land to the right of the present site. This will be used to extend the parking area and the track. A group of members are busy clearing the undergrowth. A refurbishment of the club 0-6-0 locomotive *Jack Moore* is currently in progress. The intention is to carry out a comprehensive strip down, a repaint and to rebuild with new or reconditioned parts as required.

We have received a summary of the last year's activities at **Harlington Locomotive Society** which included, in April, a rally of Maunsell locomotives with 10 locomotives running and eight on display; in June, an exhibition and main line evening running; in August, the 60th anniversary celebrations attended by the Mayor of Hillingdon; in September, the gauge one members cabin was completed and two gauge one rallies staged. **Photograph 1** shows a good group enjoying the new Gauge 1 facilities.

At long last permission has been granted to **Hereford SME** for construction of new toilets and a club canteen. Progress will now depend on availability of grants from the council. The committee have agreed to the construction of a canopy over the loading area of the raised track. It looks like being a busy year for the members. The Tuesday workers were rewarded for their efforts with a 'splendid three course lunch' (Soup, roast beef and apple pie) in the clubhouse last December. Some 30 members enjoyed the event. The meal was prepared by Derek Foster and Gordon Wood. A telephone system has been installed on the site. The night running session last autumn was so successful that it is to be repeated and some LED lighting has been purchased to illuminate the signals and lighting will be provided in the station. The society is hosting the **GL5 Association** AGM on Sunday 3 August this year.

Winter work at the **North Norfolk MEC** was slowed due to the weather but the hut now has power, lights and a water connection so the consumption of tea has increased! Four tons of soil has been delivered to the site for levelling and had to be moved. At the time of the report, another load is expected and a call has gone out for 'more willing hands'.

The New Year steam-up at **Plymouth Miniature Steam Locomotive Society** saw two new traction engines in steam. One

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1. The new Gauge 1 cabin and spectator stand at Harlington Locomotive Society.

2. The impressive covered bridge at Waushakum Live Steamers in Massachusetts.

3. The control tower at Waushakum live steamers.

is described as 'quite a monster' being an American Case engine in 3in. scale. The society is another that has recently featured on television. This time the local BBC station was filming an item on a possible change of use of the park which is the base for the society. Members responded to a call for locomotives and in the end the railway gained about 1½ minutes of free publicity. It appears that the possibility of a change of use has now receded somewhat.

At the February club night at **Saffron Walden DSME** there was a good selection of bits and pieces to be discussed. Among others, Jeff Dickinson showed an axle pump from his *Sweet William*, Fred Finch brought along a 7¼in. gauge carriage bogie, John Parmenter brought a hardness comparator, described some year's ago in the *Model Engineer*. He also had an elegant tap wrench, where a single adjusting screw moved the four collet elements together, and a 2½in. gauge Sentinel shunting locomotive with flash steam boiler built many year's ago by his father. Ian Couchman brought along the cylinder assembly from his 4in. scale Ruston Proctor tractor. Jim Green showed a Gauge 1 copper boiler made some years ago. It had been successfully pressure tested and was left on the bench full of water. After sometime in the bright sunshine it suffered significant distortion although it was still pressure-tight. Dave Harper showed us a rail-bending jig he is making for rolling 7¼in. gauge steel rail. Of substantial construction it uses a 1hp motor to drive the rolls and a 5-ton jack to get the curvature. Dave also showed an axle box he is making for his Lister locomotive, the inscription on the cover being changed from 'Lister' to 'Harper'. John Whitehead produced an interesting air gun that he started making as an apprentice some 60 years ago. The charging cylinder looked very substantial but the barrel was missing - it was removed by his father who said it was going to be a far too dangerous weapon. Tim Hopkins presented his finely detailed 5in. gauge Sentinel complete with its Stuart D10 engine and Cheddar boiler. Paul Bailey brought along one of the chassis from a pair of Simplex locomotives under construction. After some difficulty getting a smooth running chassis he has made some adjustable coupling rods. After the length is finalised a pair of dowels are fitted to the crankpin holes and measurements transferred to the finished part.

Stafford DMES is having a talk by Malcolm garner on 'Indian Railways' on 29 April. The society has received an award from the Awards for All scheme which will be used to construct an easy access passenger carriage for the less able and also an internal combustion-engined locomotive. This will be a reliable simple to operate locomotive to enable the railway to be operated on more occasions and to encourage more members to become trained drivers.

World club news

United States

I have received a note from Jed Weare, an ex-pat Brit who has lived in Massachusetts USA for the last 25 years. I will let Jed tell his story:

"I find *Model Engineer* a great link back to the old country and my life-long hobby. I was a member of Derby SMEE in the mid-1960s, when Dennis Monk was the President, and Roy Amsbury was building his first engine, a beautiful *Britannia*. I helped them and others build the ground-level track in Darley Abbey, but sadly went away to college in 1967 and never returned.

I am now an active member of the **Waushakum Live Steamers** based in Holliston, MA, USA. This club has quite a history, and has around 150 members. At present, the club owns a 23 acre wooded lot. We have an elevated track (**photos 2** and **3**) for 3½ and 4¾in. gauge that is 2,100ft. long, and a 7¼in. gauge ground level track of over 3,500 feet. The tracks wind though the woods and there are substantial gradients. Most of the major building work is done, after seven or so years of hard work, though we still are working on a station building, workshops and a signalling system (that's my baby).

I am enclosing a few photographs I took on New Year's Eve 2007, the day before our annual New Year's Day Meet, after the track was cleared. You will see we had a lot of snow this year, though the weather for the meet was perfect (in a Polar Bear type of way): just below freezing, so no mud; bright sun in the morning, no wind, and then a light snow storm during the afternoon to set the atmosphere. You have to like winter here in New England! Despite the low temperatures, we successfully ran several steam engines, on both tracks."

I was delighted to receive Jed's note and look forward to more from him in the future. The society has a website at **www.steamingpriest.com/wls/wls/Welcome.html**

Humour time

This time some male/female differences from **Maidstone MES**:

Nicknames: If Laura, Kate and Sarah go out for lunch, they will call each other Laura, Kate and Sarah. If Mike, Dave and John go out, they will affectionately refer to each other as Fat Boy, Godzilla and Four-eyes.

Eating out: When the bill arrives Mike, Dave and John will each throw in £20, even though the bill is only for £32.50. None of them will have anything smaller and none will actually admit they want change back. When the girls get their bill; out

come the pocket calculators.

Money: A man will pay £2 for a £1 item he needs. A woman will pay £1 for a £2 item that she doesn't need but it's on sale.

Bathrooms: A man has six items in his bathroom: toothbrush and toothpaste, shaving cream, razor, a bar of soap, and a towel from M&S. The average number of items in the typical woman's bathroom is 337. A man would not be able to identify more than 20 of these items.

Arguments: A woman has the last word in any argument. Anything a man says after that is the beginning of a new argument.

Cats: Women love cats. Men say they love cats, but when women aren't looking, men put them out.

Future: A woman worries about the future until she gets a husband. A man never worries about the future until he gets a wife.

Success: A successful man is one who makes more money than his wife can spend. A successful woman is one who can find such a man.

Marriage: A woman marries a man expecting he will change, but he doesn't. A man marries a woman expecting that she won't change, but she does.

Dressing up: A woman will dress up to go shopping, water the plants, empty the bins, answer the phone, read a book, and get the post. A man will dress up for weddings and funerals.

Natural: Men wake up as good-looking as they went to bed. Women somehow deteriorate during the night.

Offspring: Ah, children. A woman knows all about her children. She knows about dentist appointments and romances, best friends, favourite foods, secret fears and hopes and dreams. A man is vaguely aware of some short people living in the house.

Thought for the day: Any married man should forget his mistakes. There's no use in two people remembering the same thing.

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.

Stan Calland	*Wigan DMES*
Gordon Diplock	*Romney Marsh MES*
David Foord	*Romney Marsh MES*
Roy Moody	*Moonee Raceway, Chicago*
Brian Shadwick	*Plymouth Miniature Steam*
Doug Wood	*Auckland SME*

DIARY

APRIL

11 **Ascot Locomotive Society.** *Racing at Ascot.* Contact Lee Porteus: 01344 884385.

11 **Brighton & Hove SMLE.** *Derek Green: Slides of the Society.* Contact Mick Funnell: 01323 892042.

11 **Hereford SME.** *Richard Donovan: More from Down Under.* Contact Nigel Linwood: 01432 880649.

11 **Polegate & District MEC.** *David Jones: The Bluebell Railway.* Contact D. F. Pratt: 01323 645872.

12 **SM&EE.** *Mel Martin: Fault monitoring on Gatwick Express.* Contact Maurice Fagg: 020 8669 1480.

12 **York City & DSME.** *Stephen Greener: CNC Machines – A Primer.* Contact Pat Martindale: 01262 676291.

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

13 **Canterbury DMES (UK).** *Public Running.* Contact Mrs P. Barker: 01227 273357.

13 **Edinburgh SME.** *Track Running Day.* Contact Robert McLucke: 01506 655270.

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

13 **Leeds SMEE.** *Running Day.* Contact Geoff Shackleton: 01977 798138.

13 **Leicester SME.** *Public Running.* Contact John Lowe: 01455 272047.

13 **Norwich DSME.** *Running Day.* Contact Shirley Berry: 01379 740578.

13 **Sutton MEC.** *Track Day.* Contact Bob Wood: 020 8641 6258.

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

14 **Bedford MES.** *Peter Titterton: Digital Photography for the Modeller.* Contact Ted Jolliffe: 01234 327791.

14 **Melton Mowbray DMES.** *Ladies Night – Air Ambulance Service.* Contact Phil Tansley: 0116 2673646.

15 **Chesterfield MES.** *M. Melbourne: Railways in Colorado.* Contact Mike Rhodes: 01623 648676.

15 **Northampton SME.** *Bits & Pieces.* Contact Pete Jarman: 01234 708501 (eve).

15 **Nottingham SMEE.** *Malcolm High: Laser Cutting.* Contact Graham Davenport: 0115 8496703.

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

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

15 **Taunton ME.** *Roger Goodchild: Working in the Dark.* Contact Nick Nicholls: 01404 891238.

16 **Bournemouth DSME.** *David Howell: RNLI.* Contact Dave Finn: 01202 474599.

16 **Bristol SMEE.** *Mike Horlick: Gears.* Contact Trevor Chambers: 0145 441 5085.

16 **Chingford DMEC.** *An evening with Ralph Lance.* Contact Ron Manning: 020 8360 6144.

16 **Leeds SMEE.** *Video Evening.* Contact Geoff Shackleton: 01977 798138.

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

16 **MELSA.** *Meeting.* Contact Graham Chadbone: 0741 21 4341.

16 **Saffron Walden DSME.** *Club Night.* Contact Jack Setterfield: 01843 596822.

17 **Isle of Wight MES.** *Meeting.* Contact Malcolm Hollyman: 01983 564568.

17 **Sutton MEC.** *AGM.* Contact Bob Wood: 020 8641 6258.

18 **Rochdale SMEE.** Brian Howarth: Parkside Electronics. Contact Bob Denyer: 0161 959 1818.

18 **Romford MEC.** David Callaghan: VC. Contact Colin Hunt: 01708 709302.

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

19 **SM&EE.** Gauge 1 Track Day. Contact Maurice Fagg: 020 8669 1480.

20 **Birmingham SME.** Official Opening of New Footbridge. Contact John Walker: 01789 266065.

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

20 **Frimley & Ascot LC.** Club Run. Contact Bob Dowman: 01252 835042.

20 **Isle of Wight MES.** Annual Rally at Broadfields. Contact Malcolm Hollyman: 01983 564568.

20 **Leicester SME.** Public Running. Contact John Lowe: 01455 272047.

20 **Northampton SME.** Boiler Testing Day. Contact Pete Jarman: 01234 708501 (eve).

20 **Norwich DSME.** Running Day. Contact Shirley Berry: 01379 740578.

20 **Oxford (City of) SME.** Running Day. Contact Chris Kelland: 01235 770836.

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

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

21 **Model Steam Road Vehicle Soc.** Tony Webster: 3in. Foden Lorry. Contact John Bagwell: 01452 304876.

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

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

23 **Chingford DMEC. Quiz Night.** Contact Ron Manning: 020 8360 6144.

23 **Midland Railway Society.** AGM. Contact Andrew Surry: 01462 451090.

24 **Cambridge MES.** Noel Shelly: Foundry Work. Contact Tim Coles: 01954 267359.

24 **Leyland SME.** Mistakes Night. Contact A. P. Bibby: 01254 812049.

24 **Romney Marsh MES.** RMMES Dinner. Contact John Wimble: 01797 362295.

25 **Brighton & Hove SMLE.** Mike Wheelwright: Development of the Modern Steam Locomotive. Contact Mick Funnell: 01323 892042.

25 **Chichester DSME. AGM.** Contact Brian Bird: 01243 536468.

26 **Brighton & Hove SMLE.** Public Running. Contact Mick Funnell: 01323 892042.

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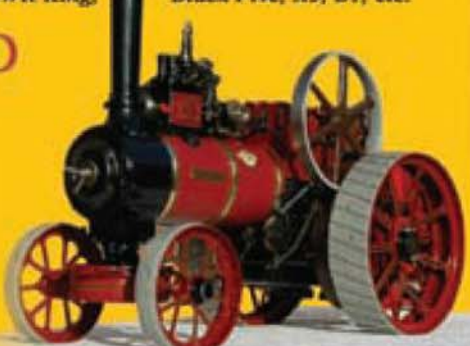

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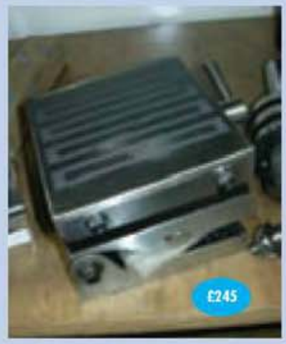

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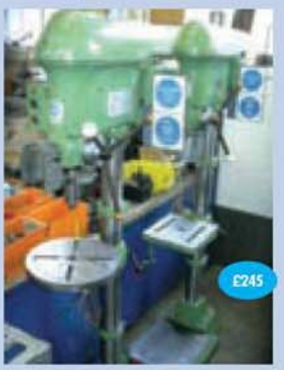

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