

MODEL ENGINEER

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6-19 June 2008

COVER STORY

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EDITORIAL

Editor: David Carpenter Tel: 01689 899255

Production Editor: Kelvin Barber

Technical Editor: Roger Bunce

Assistant Editor: Michael Jones

Associate Editor: Malcolm Stride

PRODUCTION

Designer: Anne Hoppelthwaite

Commercial Designer: Ben Wright

Head of Production & Pre-Press: David Bond

Ad Production: Robin Gray Tel: 01689 899286

SALES AND MARKETING

Sales Director: James Burton

Tel: 01689 899237

Assistant Ad Manager: Duncan Armstrong

Tel: 01689 899212

Email: duncan.armstrong@magicalia.com

Subscriptions Director: Rebecca Blighton

Marketing & Subscriptions Executive:
 Chris Webb Email: chris.webb@magicalia.com

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 Owen Davies, Adam Laird, Jeremy Tapp



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ON THE COVER...

The amazing model De Havilland Goblin 35 gas turbine engine
 built to a 1:4 scale by John Heeley. John describes how he
 designed and developed the model in this Issue starting on page
 673. This engine has now run and it is hoped to be tuned and
 running by the time of the Model Engineer Exhibition in September.
 (Photograph by Michael Jones)

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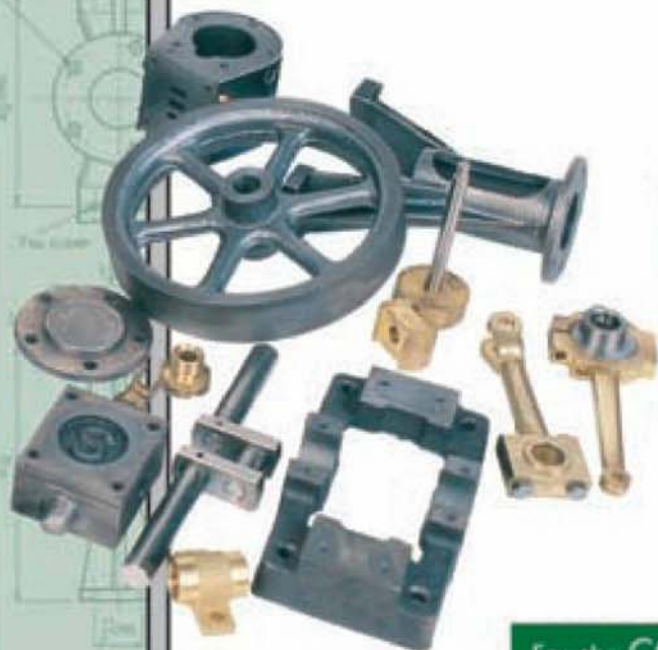
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Advanced Aspects of Machine Lathe Operation

120 mins • DVD £ 29.95

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Grinding Lathe Tools

125 mins • DVD £ 29.95

Here Rudy looks at all aspects of grinding lathe tools to perfection. Really very good, and also includes plans for building a simple, but effective, grinding table. In the main covers tools used in European type (IE horizontal) tool holders.

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N.B. These DVDs are not regionalised, so will play worldwide. However, readers in the U.S.A. should contact Bay-Com Enterprises, PO Box 351, Interlochen, MI 49643. Tel. (Toll Free) (888) 452-6947.

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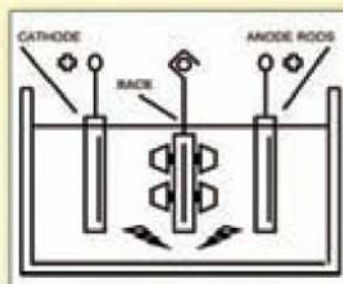
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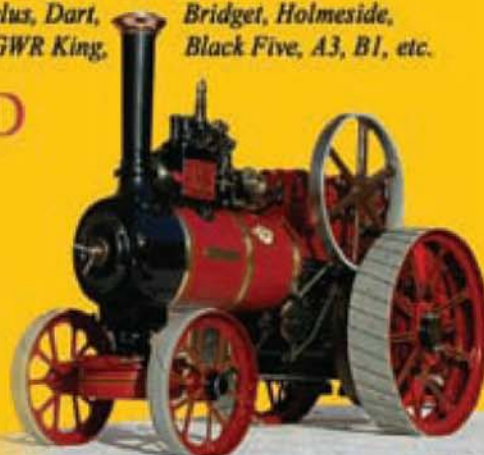
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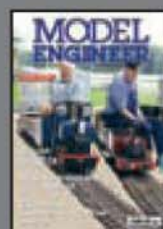


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Thrilled

We were thrilled to receive a call from Germany on the eve of the Harrogate show to say that we had an agreement to bring 2.5km of 5in. gauge track from Sinsheim to our event at Ascot in September. A flavour of what to expect can be found on pages 682/683.

We celebrated the good news at Wetherby races where, sad to say, our good fortune did not continue!

Napier celebrations

The Napier Power Heritage Trust is celebrating the 200th anniversary of the formation of the famous engineering company, D Napier & Son. Napier was among the most innovative engineering businesses during the 19th and 20th centuries, designing and building printing presses, stamp perforating machines, bullion scales, cars, commercial vehicles, aero engines, gas turbines, and rocket engines.

Napiers made a huge contribution to engineering, and at one time or another its engines powered a variety of world record-breaking cars, boats and aeroplanes. Famous engines included the Lion and Sabre, plus the Deltic in more recent times.

Displays of Napier's prowess including aero engines, a running Deltic locomotive, Napier cars including the Railton which will run, a Napier turbo charger exhibition, three-

wheeled mechanical horses, and models will be on display at the Buckinghamshire Railway Centre, Quainton Road Station near Aylesbury on June 21 and 22. All visitors are most welcome to attend this once in a lifetime display. For more information contact:

dpeacock@btconnect.com

See also:

www.napierheritage.org.uk

Speakers' corner

Finding new talks for a Model Engineering Society's yearly programme often causes club secretaries difficulty. Many of the talks given involve days or weeks, months even, of preparation, and it is a shame if some of this effort cannot be recycled for the benefit of others.

The website of Tony Finn <http://www.finnaj.karoo.net/tex.html> carries a list of talks which are available on topics of interest to model engineers, by speakers who are willing to travel to other clubs and societies to give their talk. Reasonable expenses are expected, and fees may be required by some speakers. The maximum distance a speaker is prepared to travel is given, but speakers may be prepared to exceed these distances by special arrangement.

If you have a talk that you would be prepared to share with other model engineering enthusiasts, please email Tony Finn, at finn.aj@tesco.net with the following details:

- Name of speaker
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- Town where speaker is based.
- Email address for contact by interested parties. However, if you haven't got Email, then a contact telephone number should be given for publication.
- Distance speaker is prepared to travel from base.
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Road steam rallying

The 23rd annual steam rally of the Model Steam Road Vehicle Society takes place on June 28 and 29 at Tewkesbury Rugby Club, Gander Lane.

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W. www.msrvs.org

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Lions meeting

The informal gathering of those interested in the *Lion* of the Liverpool and Manchester Railway is hosted this year by the Butterley Park Miniature Railway Society at the Midland Railway Centre. If you have a *Lion*, even unfinished, or any *Lion* memorabilia do take it along. No booking necessary.

There will be a competition for locomotives in 3½, 5, and 7½in. gauges to find the hardest working one in a ten minute test run. Track opens at 10.00 and competition starts at 13.00. Period dress is optional.

It can be reached by car on the B6179 a mile north of Ripley, and is signposted from the A38 and junction 28 of the M1. Buses operate from Derby, Alfreton and Mansfield stations.

For more information:

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Gremlins

The drawing of the basic carburettor of Nemett in issue 4325 was attacked by gremlins again. This time half a dozen things became changed after the pages had been read and corrected.

As a result we are putting extra checks in place after the normal editorial process has been completed.

Apologies all-round, especially to Nemett who was completely blameless, and we will print the correct version in full in the next issue.

Probable start area for the Sinsheim track in front of the Ascot grandstand.





Write to us

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Correspondents should note that production schedules normally involve a minimum lead time of six weeks for material submitted for publication. In the interests of security, correspondents' details are not published unless specific instructions to do so are given.

Responses to published letters are forwarded as appropriate.

3-phase supplies

SIRS, - I feel that I must write to you in order to correct a statement made by Adrian Parker in his letter on the subject (M.E. 4322 28, March 2008).

Adrian said that, "The disadvantage of a static inverter is that the lower voltage results in lower torque, which can lead to problems achieving top speed on some lathe conversions." This is obviously not correct if you take a few moments to think about it. A star connected motor has 400v phase-to-phase - which means that it has approximately 230v across each of its windings as Adrian correctly states. When connected in delta, it will also have 230v across each winding. Therefore, the torque at 50Hz - assuming it's a 50Hz motor - will remain the same.

The key shortfall of a modern, simple inverter - aka 'A Variable Frequency Drive' (VFD) - is as follows. As the frequency of the voltage to the motor is reduced (leading to reduced speed), the impedance of the motor winding is reduced - since this is a vector function of frequency x winding inductance + winding resistance. Consequently, if the voltage is not reduced as well as the frequency, the current may rise to a point where the windings 'burn out'. Therefore, at low speed settings of the inverter, the motor may not have enough torque. More sophisticated - sometimes called 'advanced' - inverters, incorporate features such as 'Torque Vector Modulation', which reduces the effects at reduced frequency settings.

Perhaps Adrian is getting confused between 'Static Converters' - i.e. those using only Capacitors and a Transformer to produce 400v pseudo 3-phase from 230V single phase - and (so called) 'Rotary Converters', which add a 'Pilot Motor' to the static converter to give a much better balance to the phase voltages.

Each 'size' of static converter has a minimum as well as a maximum power rating. Too small a motor will not result in

sufficiently balanced 3-phase voltages and the motor would, probably, be damaged. In some static converters, the starting current is usually limited to three times full-load current, which, in addition to the imperfectly balanced 3-phases, often means that the starting torque will be lower than the same motor connected to 3-phase mains supply or the equivalently rated single-phase motor.

To partially overcome this problem, static inverters usually have a manual 'Start Boost' button. Some can also be manually 'tuned' to the load motor for better phase balance. Additionally, it is usually recommended that a larger size static converter be used (e.g. 4kW converter to drive a 2.2kW motor). Sometimes, a higher power motor is required to accelerate the lathe up to its maximum speed.

Rotary Converters - assuming they are sufficiently larger than the total load to be driven - are, conversely, totally automatic and, if required, could be wired permanently into a workshop system. In effect, the workshop could be supplied with 3-phase from a rotary converter and the user could enjoy nearly all the benefits as if it were supplied with 3-phase mains.

**Andrew Houston C.Eng.,
F.I.E.T., by e-mail.**

Inaccurate *Post Bag* content

SIRS, - I refer to Mr. Parker's letter (M.E. 4322, 28 March 2008) in which he feels that a magazine of the standing of the *Model Engineer* needs to be a little bit more careful when publishing information upon electrical matters. Whilst I completely agree with his observations on the article by Mr. Eric Clark entitled *3-phase electrical supply and the home workshop* (M.E. 4315, 21 December 2007), I don't think it is fair to expect the editor, and his team, to flush out all errors and misconceptions over the huge gamut of expertise and subjects which is covered in *M.E.* And I have no quibble with Mr. Clark who, I am sure,

would not have written his letter unless he thought its contents were correct.

Although Mr. Parker was commendably polite in his observations, this is not always the case. I well remember a *Post Bag* letter of some years ago in which a contributor commented to the effect that "A. N. Other should have known better than to recommend grinding on the flat side of a wheel"; I asked myself "Why should he have known better?"

Then there are those articles whose contents may be very much a matter of personal opinion. I suggest that the last thing readers, or the editor, would want is to see is potential contributors being discouraged for fear of being impolitely criticised. So let the editor and his team do their best to flush out any obvious inaccuracies, particularly if safety is involved, whilst comments from readers are couched in terms which are both helpful and polite. After all, those who write include beginners, talented amateurs and professionals. I suspect that the editor, if he agrees to publish this letter, might well wish to add a footnote.

**Roger Castle-Smith C.Eng,
F.I.E.T., by email.**

Lathe chuck security

SIRS, - I fear that Mr. Randall (M.E. 4323, 11 April 2008) is paddling up the wrong creek. The chuck always goes round in the same direction. If you grip a length of studding in the chuck and switch on, the thread appears to move towards the chuck. You will not find left-handed studding but if a left-hand tap is chucked and started up the thread will appear to move AWAY from the chuck. This is the essence of left-hand screw-cutting.

To cut a left-hand external thread, start from a groove (of thread depth) at the left-hand end of the portion of the job to be threaded. The lead-screw drive is arranged to move the carriage to the RIGHT. The cross-slide handwheel dial is set to zero and the top slide set over to a little under half the thread

angle. Engage slowest speed and engage the lead-screw lever. (The dial may have to be in a particular place, depending on the tpi being cut). Stop when the tool reaches the end of the job. Disengage the lever. Back-off with the CROSS-SLIDE handwheel and return the carriage to the left. Re-set the cross-slide handwheel to zero and apply cut using the top-slide. Engage, watch the curl of metal and stop. Repeat the process, always returning the cross-slide handwheel to zero and applying cut on the top-slide.

Sorry for the detail, but it is important that the rhythm is established, because when screw-cutting the female thread, the tool is inside and, at the far end of the hole, cannot be seen. It is therefore important to follow the routine established when screw-cutting the male part: Zero the cross-slide and apply cut on the top-slide.

I hope that this helps Mr. Randall keep his chuck on the lathe spindle and I hope that it helps others who have puzzled over the same problem.

Tony Webster,
Northamptonshire.

Cutting left-hand threads

SIRS, - Dennis Randall asks: "How do you cut a left-hand thread in the lathe?" (M.E. 4323, 11 April 2008). Simple, you don't, as he did, reverse the spindle, for the reason he found out. You set up as for cutting a right-hand thread, but reverse the lead-screw drive and start at the inner end. If your lead-screw drive won't reverse, you need an idler gear in the change wheel train.

Tony Finn, East Riding of Yorks.

Odd micrometer query answered

SIRS, - I have looked at the M&W catalogue for 1965, and the No. 933M is illustrated and should be a perfectly normal micrometer. The most obvious explanation of Mr. Harper's oddball (M.E. 4323, 11 April 2008) is that it has been fitted with the wrong thimble.

The thimble on the M&W depth gauge micrometer (and presumably on all depth gauge

micrometers) is numbered in the way that he describes, and this is as would be expected for a depth gauge: it increases as you screw it in. I would expect the thimbles on all M&W normal style micrometers to be designed and manufactured in the same way, as there would be no sense having a different shape for, say, a depth gauge: the only requirement then would be that the graduation stage of manufacture would be different. A depth gauge thimble must have got mixed in with the micrometer ones and being the same shape and fit, no-one on the assembly bench noticed.

No doubt Mr. Harper would be able to get a new and correct thimble from M&W (now part of the Neill group) who may be interested to speculate as to how this mistake in manufacture has occurred!

Tony Finn, East Riding of Yorkshire.

Tap and die tolerances (1)

SIRS, - From my considerable experience in the model engineering trade, much of it as 'Technical Correspondent',

Mr. Middleton's letter (M.E. 4323, 11 April 2008) about taps and dies comes as no surprise whatsoever. In fact of the thousands of complaints I endeavoured to answer over 30 years, at least half must have been on this topic where cutting male and female threads caused a mismatch and loss of quality.

I am certain that this gentleman has purchased Carbon Steel Cut Thread (CSCT) tools for one reason only, cost! CSCT tools are a lot cheaper than the alternative High Speed Ground Thread (HSGT) tools. However, making male and female threads with the latter almost guarantees a quality assembly but the saying 'You pays your money and takes your choice' comes into play here.

CSCT dies can be made to produce a satisfactory thread to suit the tapped hole, but six extraordinary methods have to be adopted with the die. Firstly it MUST be a split die capable of adjustment. Secondly it must be secured into a dedicated die holder whose nominal diameter to accept it must be

increased by an amount up to 0.015in. (0.38mm). Thirdly the die holder must have FOUR adjustment screws, not three. Fourth, one of the screws should have a point on it to use as the 'enlarger'. A means of centring the die inside the holder must be sought and at the same time using the screws in similar fashion to those on a 4-jaw chuck. Lastly, one must machine exact diameter test pieces and, using the newly held die on them, adjust the die so that eventually it will cut a thread to suit either the correct full diameter, or the tap.

While you are doing this, I recommend you make up die holders for your entire collection - I did mine recently - all 43 of them and it was a lot of work amply rewarded.

David Piddington, by email.

Tap and die tolerances (2)

SIRS, - In response to Mr. A. H. Middleton's letter (M.E. 4323, 11 April 2008), requesting assistance with the problem of excessive thread clearances this problem is not confined to ME threads (i.e. 32 and 40tpi) it also occurs in coarser threads, particularly in the smaller diameters. To overcome the problem:-

1. Always tap the hole first and use some kind of tapping aid. I use an excellent device, described by W. S. Steer in M.E. Vol. 148, issue 3681, which consists of a ½in. dia. bush, which is held in the drilling machine or lathe tailstock chuck, in which a simple tap holder slides. This ensures that the thread cut is square and at least no larger in diameter than the tap used.

2. The split die is then used to cut the male part of the thread. Again, a tailstock die holder should always be used in order to ensure that the thread is cut squarely. Mr. Middleton states that his die cuts to the correct nominal diameter. The trick is to open the die as much as possible, using the centre pointed screw in the die holder, before cutting the thread. At the first pass it will be found that the thread will not enter the tapped hole. All that is



Mr. Field's picture of the turbine from King Edward.

Parsons turbines

SIRS, - Following Ron Isted's article on Parsons turbines and being a volunteer at the Scottish Maritime Museum where we have two of the King Edward's turbines, I enclose a photograph of one of them.

Although not in the best of condition, the precision that went into them can easily be seen. No digital and XY readouts but high engineering at its best.

As a motor chief engineer, or a man of many rotating parts I never sailed on a turbine, but am impressed at the longevity of these remarkable machines.

T. D. Field, Inverclyde.

now necessary is to gradually reduce the size of the die by incrementally easing the centre screw until a thread of suitable clearance is produced.

Incidentally, I would not expect to produce a steam tight thread using the above, or indeed any other, method. An O-ring, jointing paste or plumber's PTFE thread tape should be used.

As there appears to be no standard applied to tap shank diameters, and because larger taps have larger shanks, I have turned up a number of different sized holders, but all with a 1/4in. dia. shank to fit the bush. This is probably basic stuff to a lot of readers, but maybe it will help.

A. J. D. Wright, Middlesbrough.

Tap and die tolerances (3)

SIRS, - It sounds as if Mr. Middleton is over-tightening the die stock screws and making the die cut small. I suggest that he practices with the die adjustment as follows.

1. Pinch up the centre screw of the three on the stock, and then tighten the two outer screws. Do not over tighten. Small split dies can be broken if you are too generous when tightening the adjusting screws.

2. Make a test cut. If the thread is too loose, slacken the outer screws and tighten the central screw. This expands the die and cuts a larger diameter thread. Only make small adjustments with the screw.

3. If the thread is too tight, loosen the centre screw and tighten the two outer screws. Again do not over tighten.

Split dies are made that way to allow small adjustments on the thread diameter.

A good quality stock allows only a limited amount of adjustment, but many of the cheap stocks on the market have too much play between die and holder when the die is inserted, so again, be careful, do not try to open the die too far.

John Wilson, by email.

Help sought

SIRS, - I am writing to ask if any of our readers can help. I purchased a set of castings

and materials for the V-twin oscillating steam engine design by Blackgates.

I find myself at a complete loss as to how to machine the main casting and the cylinder castings which are cast in one piece.

Should I bore them in one and separate them afterwards or vice versa?

Although I have owned a lathe on and off for many years starting with a Drummond round bed lathe in the 1950s, I have little experience of making model engines.

I now have a Warco D4000E lathe and a Sieg U2 mill drill together with other smaller tools. As I am 75 years-old and do not drive, a club is out for me so I am hoping someone can advise me.

W. E. Smith, Cambridgeshire.

Ship stability

SIRS, - I may be able to throw a bit of light on the doubts that Ron Isted had about the piece of disastrous equipment that he studied (*M.E.* 4319, 15 February 2008) during the preparation of his interesting article.

Dennys pioneered the fast cross-channel turbine steamers but to gain the maximum speed and advantage they had fine lines, but the great disadvantage was that they rolled and had a bad reputation in this respect. From early days how to alleviate this attracted their attention.

I served an engineering apprenticeship with J. S. White & Co at Cowes, IOW, and we were part of a group building destroyers. This group consisted of Dennys, Scotts, Yarrow, Thornycrofts, and Whites. We had already delivered three Fleet destroyers - *Jersey*, *Kingston*, and *Olna* (for the Polish Navy). The *Quorn* and *Southdown*, Hunt class destroyers, were already launched and fitting out in June 1940, but after stability tests to calculate meta-centric height (proof of Naval Architecture theory) it was realised something was wrong, and as this was June/July 1940 there was a modicum of panic.

It was found that this class of ships was 2ft. 9in. narrower in the beam than what had been specified, and somehow the Admiralty at Bath had not noticed when the drawings were submitted. The result was that they would never be a stable gun platform.

Dennys then came to the rescue. Each ship was fitted with Denny/Brown stabilisers. These were an active type and controlled by a Gyroscope, and were put out on either side of the hull by hydraulic cylinders. They were aerofoil in section and the trailing edge angle could be varied as the ship rolled, similar to what is now fitted to trim an aircraft. They were tested on trials and I well remember the violent motion in a calm sea without warning. They proved very successful, but were very susceptible to accidental damage. I do not recall how many of this large class of ships were thus fitted.

One of the reasons for my interest was that I had constructed a 40in. steam-driven model destroyer (Yarrow R class) in 1938/39. It suffered from the same problem but for a different reason, the boiler was too heavy!

More recently the 'Flume' system has been developed and many cross-channel ferries and passenger ships are now fitted with this. Basically it consists of two tanks, one on each side, connected with a pipe. The water passes back and forth out of phase, and I suspect the system Ron Isted describes is the forerunner of this. The ships I notice start to roll but after a few degrees return to the upright position with a jerk, and the roll is controlled.

After this we built the HMS *Abdiel*, a fast minelayer, one of the fastest ships the Royal Navy ever had (40 knots). She was one of four that were built in the war. A fifth was built just pre-war (*Apollo*), but was not exactly the same. I worked on the Parsons turbines, she had twin screws, an HP and LP on each shaft, and although we went up to Gourock to join her for trials, she never had

any. The rumour was that she laid mines off Brest where the *Sharnhorst* and *Gneisenau* were sheltering. The mine-layers were very useful ships, rarely used for their design purpose, and carried Gold, Commandos, etc. Unfortunately the *Abdiel* sat on a mine while berthed at Taranto putting Commandos ashore, and sank.

For Merchant ships the astern power is usually 68-70% of the ahead power. Although I worked on, and sailed with many ships with Parsons turbines the two of an another design stick high my memory. These were for installation in SG 9 (HMS *Grey Goose*) the lead steam gunboat of a class of nine and also the flotilla leader, designed by Metropolitan Vickers, of Manchester. Lieutenant Peter Scott was the commanding officer, an Artificer was the Engineer and they seemed small to the normal ships we built. They had gashed rotors and a single Yarrow boiler; and were very advanced for that time. The fitter and I worked with duly assembled turbines for full-speed/no-load tests ashore. With some dismay we found that the critical speed (causing whirling) was very close to the maximum speed. A foreman from Metropolitan Vickers duly arrived and to our astonishment went up to higher and higher speeds, quite frightening at the time, the turbines 'danced' on the blocks, but he raised the critical speeds. Something must have changed!

SG 9 had many delays at first but it was fast. As originally built I remember racing through the water at 42 knots. Then the Admiralty in their wisdom mounted a bigger gun on her main deck, but retained the two Rolls power-operated turrets. This gave her less freeboard and from memory the highest speed she attained was 39 Knots. Even so they were fast and silent and could surprise German E-boats whereas their petrol-driven sisters could be heard miles away, and were highly flammable if hit.

Michael Duggan, County Kerry.

De Havilland Goblin 35: A 1:4 SCALE MARVEL

John Heeley describes the research, construction and testing so far on this amazing jet engine model.

My interest in gas turbines goes back more than 40 years and at various times I have dabbled with experimental models, some more successful than others. After completing a Bentley BR2 to L. K. Blackmore's drawings, I decided it was time to realise a long-held ambition by building a 1:4 scale model of an early jet engine. My choice was that classic of the 1950s, the De Havilland *Goblin*. Originally known as the H1, this centrifugal gas turbine was designed by Frank Halford, who already had the *Gipsy* series of piston engines and the Napier *Sabre* to his credit.

Design work on the *Goblin*, as it became known, took barely a year. The prototype ran in 1942 and in March 1943, two H1 *Goblins* powered Gloucester's F9/40 Meteor. Then, in September of that year, the aircraft for which the *Goblin* was designed, De Havilland's twin-boom Vampire, took to the skies.

Vampires in various marks served in British and overseas air forces for more than 30 years, proof that Frank Halford

got it right from the start.

The *Goblin* is a straightforward design: a single-sided compressor, 16 combustion chambers and a turbine. However, it has often been said that gas turbines are simple machines entirely surrounded by complex equations.

Prototype to model: research

My intention was to produce a working model as close to scale as possible, but I realised from the beginning the internal parts would have to be designed from first principles, so I set about studying the gas flow and thermodynamics that make these engines function.

I am not a complete beginner when it comes to gas turbine theory and, at least on paper, it seemed possible to run an engine at speeds and temperatures that 'normal' materials could withstand, provided I wasn't aiming at much power. So, I started to think about the actual construction.

There was, however, one small problem: while a great

deal of technical information is available, I have never found even the most basic general arrangement drawing in any publication. Fortunately, there are *Goblin* engines in most aviation museums and, armed with a tape-measure, notebook and camera, I visited the Yorkshire Aircraft Museum collection at Newark, where the enthusiastic staff permitted an eccentric chap claiming he was 'making a jet engine' to examine in detail their historic exhibits.

Modelling methods

I based my model on the *Goblin 35* from a Vampire T11 trainer. Now, at this point, most engineers would produce sheets of drawings, possibly with the help of a computer, but that isn't how I work. Trained professionals will throw up their hands in horror at this but, given photographs and basic measurements, I go straight to the metal.

Questions about whether I use metric or imperial don't really apply when most components are a proportion of a known dimension on the prototype, scaled down, each

1. The complete *Goblin 35* (right-hand side) in miniature - 1:4 scale.

2. Left-hand side of the engine.



3. Turning the compressor form in the lathe. The profile is being checked with a template.

4. The compressor was slotted in the milling machine to receive its vanes (one is shown being tried for fit).

5. The vanes for the completed compressor shown are screwed from the back.

6. Turbine blade machining on the milling machine using a boring head.

7. The completed power turbine with 45 blades; each is pinned in place.

8. The main shaft with turbine installed.

9. Parts of the combustion chamber, flame tube and burner.



made to fit the previous part. I make gauges, jigs and fixtures for machining batches of identical parts, but there is little actual measurement. All I can say is this method works for me. Everything was machined from the solid or fabricated. There are no castings and no welding and, in two years of mainly weekend work, the project steadily grew on the bench until I had an almost complete *Goblin 35* in miniature.

How close to scale is it? Well, my calculations required the compressor inlets to be slightly enlarged and the connections between combustion chambers are oversized. There is also an extra bearing behind the impellor to support the shaft when the front housing is removed.

Accessory drives

I have tried to simplify maintenance without compromising the appearance too much. All the accessories are genuine working items, driven by bevel gears cut in my workshop: the generator and Heywood air-compressor at the top, next to the Marshall cabin blower, and on the lower gearbox, a starter motor with a clutch, the fuel pump and control levers for fuel. Inside the sump an oil pump and baffles to permit 10 seconds of inverted flight. Yes, I know this is taking things a bit far but, as they say, "if a job's worth doing..."

Model dimensions and speeds

The model is a substantial machine, 12in. diameter and just over 24in. long, including the jet pipe, bigger than some full-size engines (photos 1 and 2). The compressor has 18 radial vanes and is 7 $\frac{3}{4}$ in. diameter (photos 3, 4 and 5). The turbine is 6 $\frac{7}{8}$ in. across with 45 blades $\frac{3}{4}$ in. high (photos 6, 7 and 8). The casings round rotating parts are deliberately over-engineered to contain the shrapnel if it over-speeds or my stress calculations prove to be incorrect. I may be a mad eccentric, but I'm not a fool, and something this size has to be treated with respect.

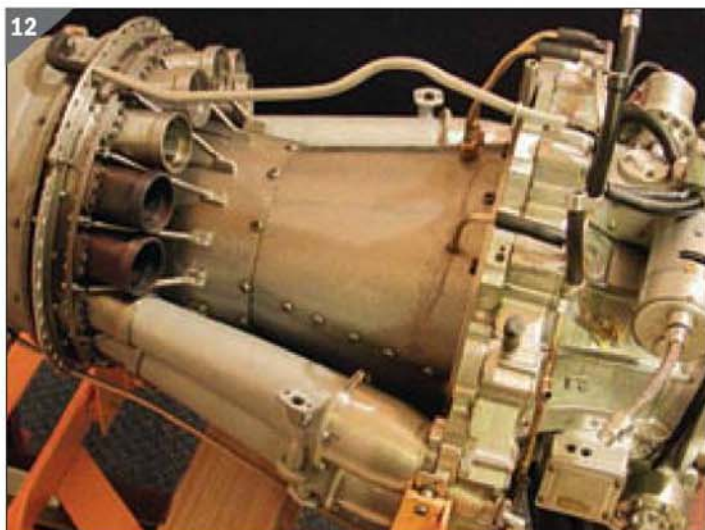
By gas turbine standards, it is designed to just idle. Both mass flow and pressure ratio are very low, but at about 8,000rpm, with a turbine inlet temperature around 500deg. C, all those complicated

mathematical calculations say it should run.

Combustion testing

Now we come to the interesting part: this isn't the kind of model where you just press a button and it goes. First, a suitable design of combustion chamber flame tube had to be worked out by experimental testing (photo 9). An extra combustion chamber was made up and fitted to a test rig off the engine, using air from a modified vacuum cleaner and bottled gas, with several U-tubes to measure pressure, and a digital thermocouple for temperature readings (photo 10). The position, size and angle of every hole is critical: primary air has to be right, or the flame will be blown out; secondary air must complete combustion in the chamber; and finally, there has to be cooling air not passing through the flame, to



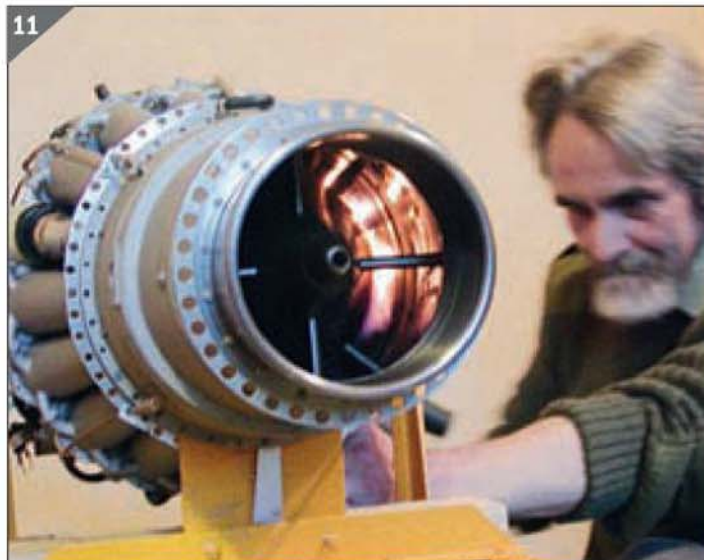


keep the hot end of the engine within design limits.

These tests are fascinating to watch, but the real breakthrough came when my son, an ex-RAF propulsion technician, suggested short pipes to pick up a known percentage of primary air in the duct leading to the diffuser, away from any turbulence. Suddenly, combustion performance was transformed. These are now referred to as 'Craig tubes'. The best design to date is actually very similar to full size, with miniature simplex burners and swirl vanes. Two of these quite sophisticated flame tubes have been experimentally fitted to the engine. The remaining chambers are still empty shells (**photo 11**).

The engine will turn with its own starter, but the little motor soon gets hot, so for these early tests, I disconnected the gearing and used a hand-held starter directly on the front of

the main shaft. This spins the engine to just under 3,000rpm. As a precaution, I arranged an auxiliary air supply to the turbine housing, not enough to turn the engine but to guard against torching the blades, a very real danger at low speeds. What can be made can always be mended, but I don't want to wreck things unnecessarily. In this condition, the engine lights easily, the flame spreading to the second chamber with no problems. Once the starter has been removed at 2,800rpm, it will continue to run for several minutes but, of course, with only one-eighth of the thermal energy, it does slowly wind down. This is exactly as predicted by the test rig, so it's very encouraging. By comparison, if the engine is run up cold with the auxiliary air but no ignition, it slows down in about 30 seconds.



Conclusion

At the time of writing (December 2007), I am working on the internal components to complete all the combustion chambers, a task that will take several months. This is very much an on-going development programme and I'm learning all the time.

Some fellow engineers from my local club, Barnsley Society of Model Engineers, are surprised that I am prepared to risk all the painstaking work involved in building a scale model on test-bed research, but my *Goblin 35* isn't destined for a glass case just yet. When that day comes, it will look more authentic with a few oil stains and signs of heat around the turbine inlet manifold.

10. A close-up view of the firing of a combustion chamber mounted on a test rig.

11. A low-speed test of the complete engine. "We have ignition."

12. A view of how the combustion chambers fit into the engine.

13. Front view with the housing removed, the compressor is visible.

I would like to thank my son for his sometimes critical support and for documenting the project with excellent photographs. I will keep you informed of future developments.

ME

ED: We hope to see John's engine at Ascot - running!



Nemett shares some information on carburation and reminds readers about the Nemett Cup in advance of this year's Model Engineer Exhibition.

I have received a very comprehensive letter from Ron Wright of Surrey who comments on my recent reference to the operation of S.U. carburettors. Ron's letter provides a very full explanation of carburettor operation so I have included it more or less as received. I am indebted to Ron for providing the following information:

SIRS, - I refer to the article *I/C Topics* (M.E. 4319, 15 February 2008) in which on page 203 a slight technical error seems to have crept in. There is a reference to the suction piston of an S.U. carburettor being driven by the inlet manifold depression. This is not strictly true, the piston is in fact 'driven' by the mass airflow through the carburettor which is created by the pumping action of the pistons and regulated by the position of the throttle butterfly.

The manifold depression exists between the throttle and the pistons and when at its strongest (lowest pressure) is isolated from the carburettor by the (almost) closed throttle. Consequently the mass air flow through the carburettor is at its minimum and the piston at its lowest position.

Conversely at full throttle there is virtually no manifold depression and the air flow is at maximum with the piston at its highest position.

The manner in which the piston movement is controlled is shown in the diagram (fig 1) which shows an atmospheric inlet hole (A) beneath the piston and a

vacuum discharge hole (B) on the down stream side of the piston which causes air to be exhausted from the chamber above the piston by the ingoing air stream passing the hole at speed.

Hence the piston rises against its return spring thereby varying the venturi gap between its base and the jet bridge (C). Consequently:

- Large air mass flow, large venturi
- Small air mass flow, small venturi

This maintains the venturi depression at a constant value (constant depression or CD) with the fuel flow being governed by the profile of the tapered needle, thereby supplying correct mixture strengths at all speeds and loads.

The article goes on to mention the difficulties encountered in providing effective carburetion for miniature engines, so maybe the following notes concerning the basic principles of carburetion may be of interest to readers.

Carburettor operation

If we consider a basic fixed jet carburettor as shown in fig

2. The various parts are numbered and identified below:

- 1 Fuel entry
- 2 Needle valve
- 3 Float
- 4 Float chamber

- 5 Main jet
- 6 Fuel passage
- 7 Spraying beak
- 8 Fuel level
- 9 Venturi
- 10 Throttle butterfly
- 11 Inlet manifold to engine

As air flows through the carburettor a depression is created within the narrow venturi (9) which is dependent upon the air speed; i.e. fast airspeed strong depression (low pressure) slow airspeed weak depression (pressure near to atmospheric).

This is due to the air molecules (principally oxygen and nitrogen) accelerating as they enter the venturi waist which causes them to separate and hence to lose density and therefore pressure.

The fuel spraying outlet (7) is situated in the venturi and atmospheric pressure exists within the float chamber. Consequently a pressure difference is created across the main jet which causes fuel to flow up to and out of the spraying beak, to join the air

1. An example of the Walbro carburettor.

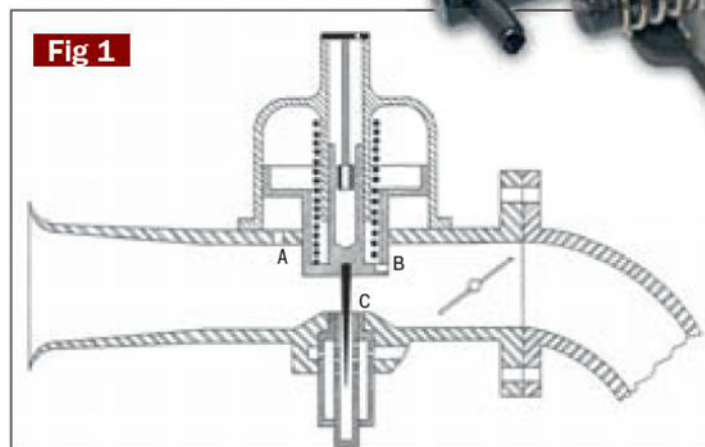
Fig 1. Cross section of the S.U. carburettor.

Fig 2. Section of a simple fixed-jet carburettor.

Fig 3. The variation in mixture from lean to rich due to increasing engine speed.

Fig 4. A capacity well carburettor.

Fig 5. The mixture variation with the well carburettor.



stream and form a combustible mixture.

However, as the venturi pressure reduces due to increasing air speed (i.e. rising engine speed) the pressure difference across the main jet increases; which raises the fuel flow and this extra fuel flows into air which is progressively

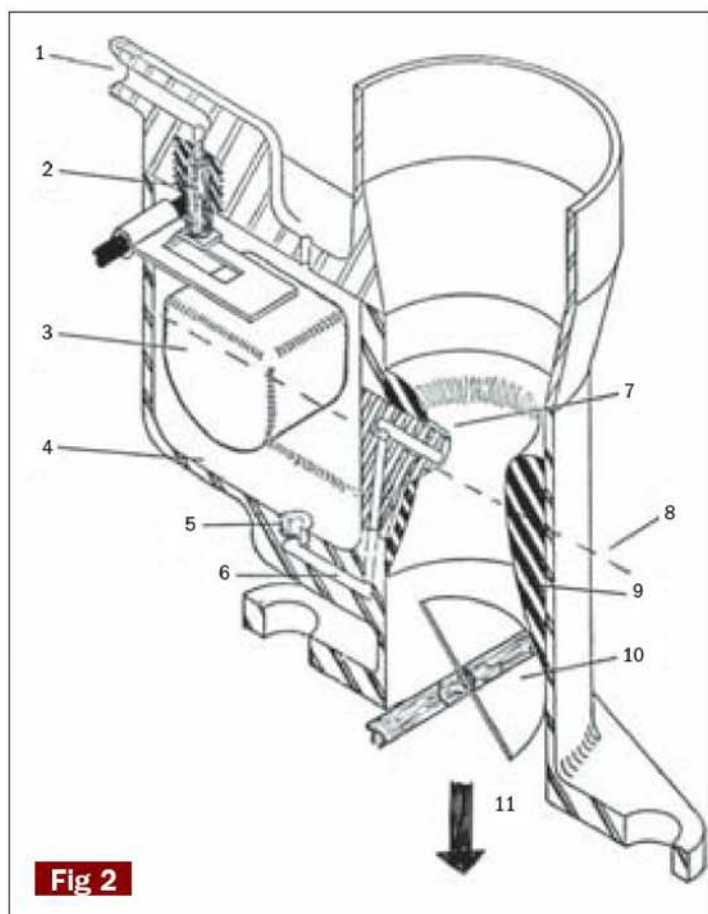


Fig 2

reducing in density.

The result is that as the engine speed increases the mixture strength steadily enriches (fig 3) until a point is reached at which it will no longer ignite and the engine stops.

Hence this type of carburettor can only be used on a single speed engine driving say a compressor or generator etc.

In order to compensate for this mixture variation, a capacity well, open to the atmosphere, is introduced between the jet and the spraying beak (fig 4). When the engine is stationary this is full of fuel.

When the engine is running this fuel is drawn off to leave the well empty and to provide an air bleed downstream of the jet. This destroys the pressure difference across the jet which means that fuel can only flow through it because of the head of fuel behind it in the float chamber, and this is at a constant rate.

Consequently as the engine speed rises the constant rate fuel delivery into the increasing airflow rate will result in the

mixture becoming progressively weaker until again the engine stops (fig 5). By combining the two systems (fig 6) the enriching mixture from the main jet will be compensated by the weakening mixture from the capacity well and its compensating jet (fig 7).

Hence by selecting optimum sizes for the main and compensating jets a correct mixture can be supplied over a wide range of speeds and loads.

An alternative system is to use an air bleed jet positioned in the top of the capacity well (fig 8) so as to restrict air entry into it, such that the pressure difference across the main jet is only partially destroyed; i.e. it is reduced. This also causes the fuel level in the well to reduce progressively as engine speed rises.

Consequently fuel flow through the jet will be partially by pressure difference and partially by fuel head, which will increase and decrease as engine speed rises and falls.

Again by correct selection of jet sizes, the correct mixture strength will be supplied over a

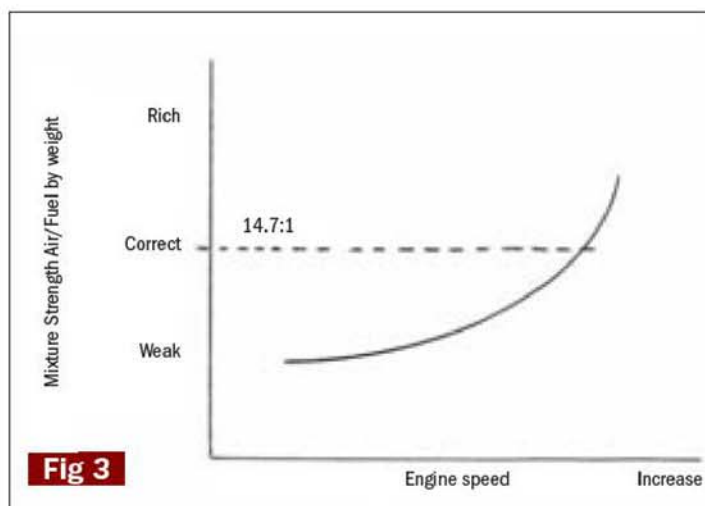


Fig 3

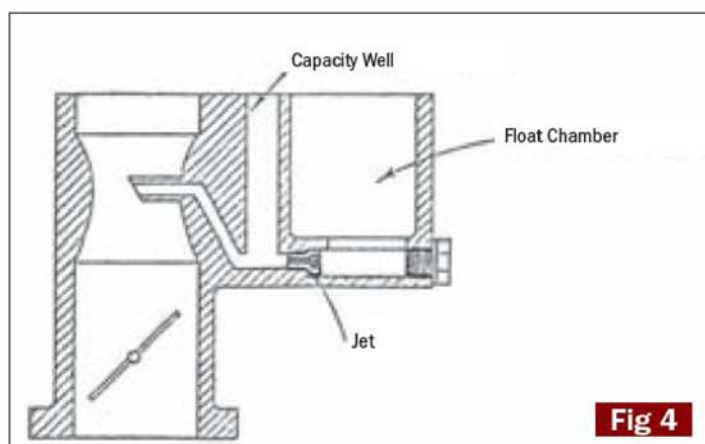


Fig 4

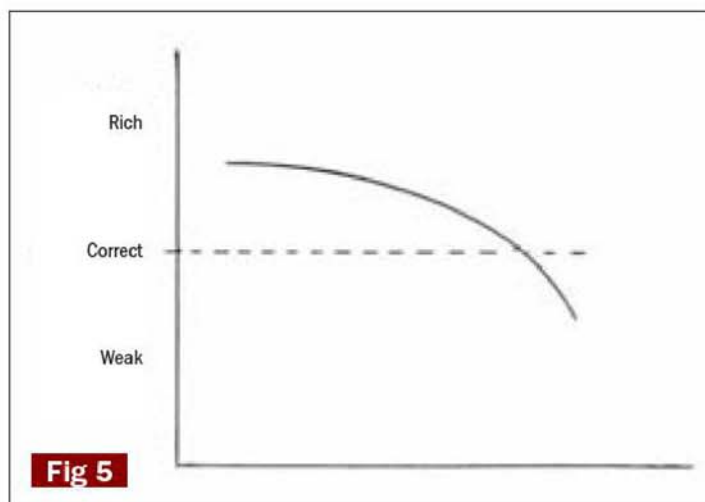


Fig 5

wide range of speeds and loads.

To refine the situation even further, the air jet is provided with a perforated diffuser tube (fig 9) which protrudes down into the well, the jet area being equal to the sum total of the side hole areas.

Consequently as the fuel level in the well falls the holes are progressively uncovered causing the air correction flow to increase as the engine speed rises.

By correct sizing and positioning of the holes (to suit any given engine) a generally enhanced mixture supply can be obtained.

I thank Ron for his comments and I am sure they will be helpful to many. I am not entirely convinced of his arguments on the S.U. carburettor because I am sure that the inlet vacuum must play a part in the operation of the piston. In particular, if

we consider the extreme case with the throttle shut and the piston at the bottom. At the point the throttle is opened, no air can flow through past the piston and therefore the resulting manifold depression is the only thing that can act on the piston to lift it. Once it

starts to lift, then the airflow will start to have an effect which I think will increase as the throttle is opened. I suppose it all illustrates what a clever piece of kit the S.U. carburettor is. The other problem with variable jet carburettors in small sizes is that if machining the correct

needle profile. I remember many years ago trying different (commercial) needles in the twin S.U. carburettors on a Riley 1.5 and the difference in behaviour for a very small change in the needle profile was considerable. This would be much more so with miniature versions.

The other general point to make about miniature carburettors relates to the scale factors which cause many of the difficulties encountered. As an example with a full-size carburettor of the type shown in fig 9, surface tension and friction will have a disproportionate effect on the flow of the fuel through the various passages because the fuel head is very small. Obviously these factors have less effect as the engine size increases and there are several engines around with very close to scale carburettors so there is certainly still much to experiment with.

At a recent club meeting I attended, the subject of the Walbro carburettor (photo 1), as fitted to many chainsaw engines and other similar engines, was raised. I have a 35cc Zenoah 2-stroke engine fitted with one of these carburettors, but the choke size at around 15mm. would be too large for anything less than this cylinder capacity. This carburettor is quite sophisticated with a built

in diaphragm fuel pump and a diaphragm controlled valve for the fuel flow. In addition to the normal throttle position stop, there are separate mixture adjustments for fast and slow running (all on the left side in the picture). The photograph is from the engine side and the brass disc seen in the air passage is the throttle butterfly. The carburettor also features a built in choke for starting.

The Nemett Cup

Can I take this opportunity to remind those who have built the NE15-S single-cylinder engine that the Nemett Cup will again be awarded at this year's Model Engineer Exhibition at Ascot. There are several engines I know to be completed and running, and 75 sets of drawings have been sold, so let's have those engines on show this year. Last year one of the engines, by a first-time builder, was also awarded a Silver Medal, so there is no excuse.

ME

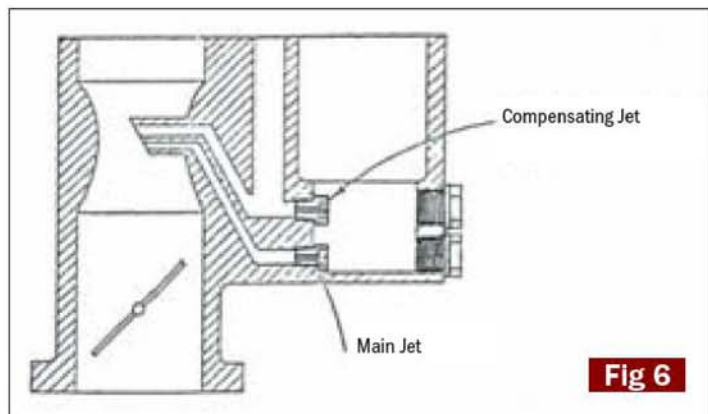


Fig 6

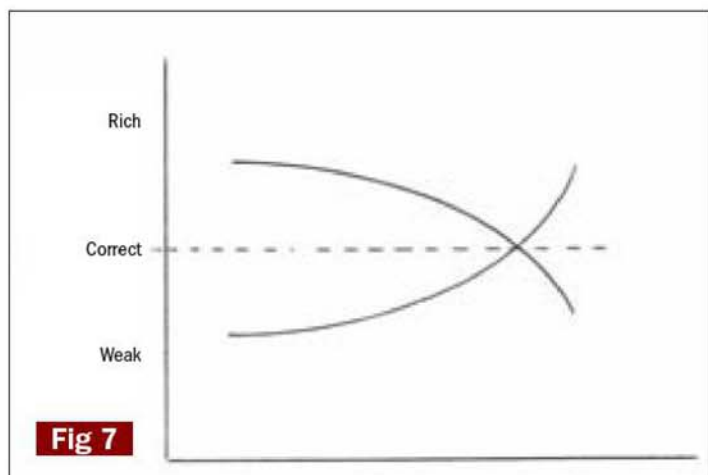


Fig 7

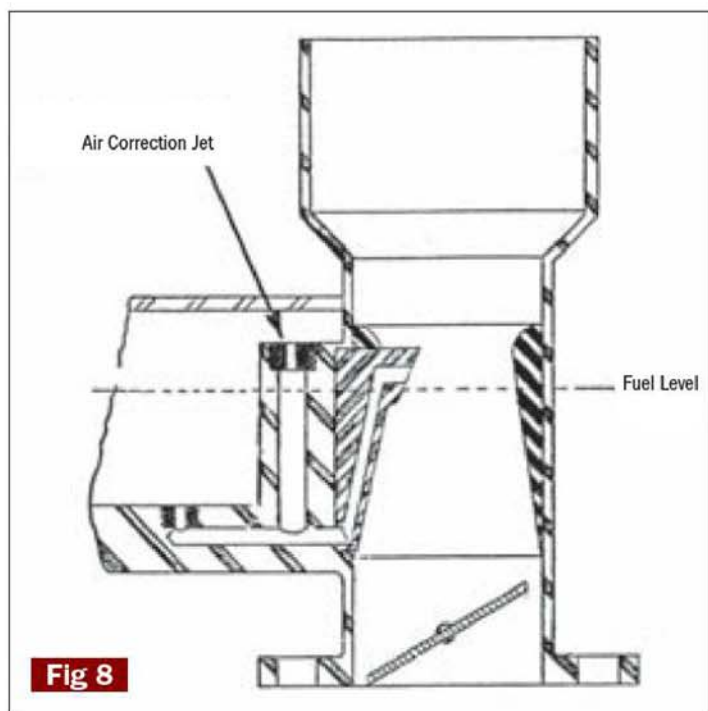


Fig 8

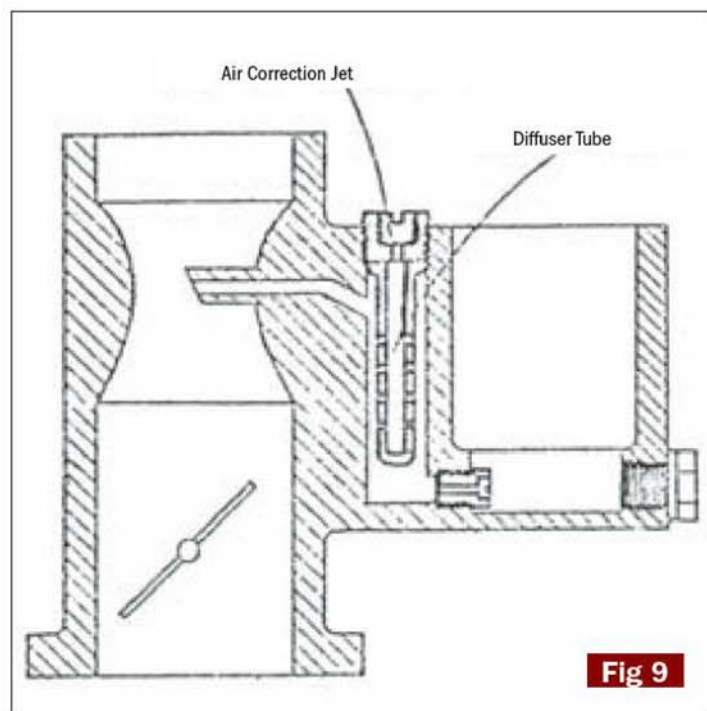


Fig 9

Fig 6. A compensating carburettor.
Fig 7. The mixture variation from one jet is cancelled out by the other jet.
Fig 8. A capacity well carburettor with a compensating air jet.
Fig 9. The same carburettor fitted with a diffuser tube.

My first boiler

Julia Old
recovers from near
disaster and goes on to
solder the crown stays.

*Continued from page 555
(M.E. 4325, 9 May 2008)*

Disaster! As I was soldering the final side of the firebox wrapper, with insufficient locating rivets to prevent twisting, the clamp fell off and a wide gap appeared! My mentor quickly grabbed a pair of tongs and closed the gap, while I applied heat and solder to complete the joint. In the end, a sound joint was produced (**photo 7**), but the tubeplate was not square to the wrapper (**photo 8**). The tubeplate at the top left-hand end of the firebox had slipped back from the front edge of the wrapper. At the bottom, where there was a locating rivet, the tubeplate was square to the wrapper. At this point I had thoughts of scrapping the inner parts and remaking them, but I was advised that, with care, I might be able to rescue the situation.

The basic idea was to bend the tubes to align with the wrapper and accept that the top of the tubeplate was twisted. As a result of the heat applied during soldering, the copper is very soft and care was needed to get the tubes to bend in the right place. I was given, what turned out to be, excellent advice, namely: to tackle the superheater tubes first using a steel bar

inserted the full length of the tube. The wrapper was clamped in the vice on its former, to ensure that there was no movement where it was not wanted (**photo 9**). It did not take much force to bring the superheater tubes into alignment and, to my surprise, some of the smaller fire tubes came with it. Somehow I think my adviser had done this sort of thing before! Using the front tubeplate as a reference, I then brought the smaller tubes into near alignment.

I now had the tubes sufficiently aligned to allow the firebox to be fitted into the outer wrapper. Instead of a foundation ring, I used a $\frac{5}{16}$ in. wide rectangular bar to space the rear tubeplate from the throat plate, and held the two securely together with toolmaker's clamps (**photo 10**). Again using the tubeplate as I guide, I tweaked the tubes into close alignment. I was very relieved when I finally got the front tubeplate to slide over the tubes (**photo 11**). This would have been next to impossible without using alignment plugs to slip into the tubes. The plugs have the same outside diameter as the tube with a short section reduced to the internal diameter. With the

tubeplate resting on the ends of the tubes, these plugs are fitted one by one. When the last plug has been fitted, the tube plate was pushed down over the tubes. Well, that was the theory. Sometimes I have to jiggle some of the plugs and other times I fitted the tubeplate without the aid of the plugs at all.

This session taught me a lot, namely: that copper is capable of being reformed, but above all, to take more care in the future. It strikes me that boiler making has similarities with dressmaking. I started out intending to work accurately, but when I got into a hole, I had to rely on the flexibility of the copper to alter shapes.

Crown stays

The next job was to fit the crown stays. I was able to solder the two halves together at home without any difficulty using just a propane torch. This enabled me to 'save a week', as I was able to attach the crown stays to the firebox on my next visit to the club.

After my less than successful results with the firebox tubeplate, I decided to use bronze screws to locate the larger girder stays for soldering (**photo 12**). I turned some 6BA cheesehead screws from $\frac{3}{16}$ in. ➤

7. A sound joint between firebox wrapper and tubeplate.

8. Tubeplate not square to the wrapper!





9. Carefully pulling the tubes back in-line.

10. Rear tubeplate and throatplate clamped together.

11. Alignment plugs used to help fit the tubeplate.

12. Bronze screws to hold the larger girder stays ready for soldering.

13. All major soldering was done using an oxy-propane lance and a propane torch.

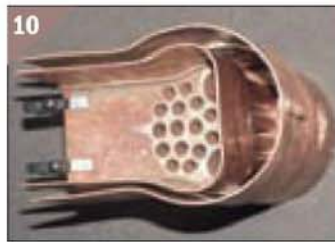
bronze bar (PB102), as they are not available from the usual suppliers. The smaller central stay seemed quite happy with a couple of rivet pegs for location.

The first task when I got to the club was to return the firebox to the acid pickle as it was not sufficiently clean. The mating surfaces were coated with flux and the screws tightened and then slightly undone to provide a gap through which the solder could penetrate. More flux was then applied around the joint.

All major soldering was performed using an oxy-propane lance together with a propane torch (photo 13). The propane torch was used to provide background heat and to keep the area being worked near, but below, the melting point of the silver solder. The oxy-propane provided intense heat that quickly brought the area immediately under it to above melting point. Care was needed to avoid overheating or burning the copper. The difference in using propane alone is that the intense heat enables a

small area to be brought above melting point with surrounding joints remaining solid. Another significant advantage is that the life of the flux is greatly extended since, away from the working area, the flux is not subjected to a fierce heat that might otherwise burn it out before it was time to apply the silver solder. The hot area must not be too small because this will result in poor penetration. From my observations, this is most likely to occur when insufficient or no background heat is applied.

During soldering I was forced to change the set up. I found that, with the top of the firebox sloping, most of the flux ran



10



11



12

to the front. This was the first soldering where access was restricted and this, together with the increased size of the 'lump of copper', made life more difficult. Fortunately, an experienced hand was available to guide the torch or even take over (photos 14 and 15).

Before I could permanently fit the firebox, I needed to

finalise how I was going to fit the regulator. As drawn, it has a shoe that goes under the dome bush and is secured by two countersunk screws directly through the boiler barrel. I did not like this because the screws would need to be sealed with soft solder. It took me a long time to come up with what was perhaps the obvious solution,



13



which was to fix a mounting lug on the dome bush (**photo 16**).

Before fitting the firebox, I soldered the front section of the foundation ring to the

outer shell's throat plate. As insurance, the foundation ring was held in place with countersunk bronze screws through its ends into the

outer wrapper.

I gave some thought on how to locate the tops of the crown stays against the outer wrapper during soldering. The use of bronze screws through the outer wrapper was suggested but the idea did not appeal. I opted for toolmaker's clamps around the foundation ring but I used a G-clamp to pull the crown-stays up against the outer wrapper before these were tightened (**photo 17**).

The restricted access above

the firebox makes this one of the more difficult joints to make successfully. With just a propane torch, the only option would be to apply heat from the outside. However, the oxy-propane lance has its own oxygen supply, and is slim enough to pass between the girders.

The boiler was supported between firebricks so that background heat could be applied to the outer wrapper from below (**photos 18 and 19**). With the right equipment, it did not take long to solder the tops of both crown stays. Attention then turned to the front section of the foundation ring, which was soldered at the same heating.

● *To be continued.*



14. A helping hand.

15. The expert takes over.

16. Regulator mounting lug.

17. Crown stays held against the outer wrapper before clamping the firebox.

18. Boiler supported on firebricks to allow background heat to be applied to the outer wrapper from below.

19. Using the oxy-propane lance in the confined space above the firebox.



Sinsheim comes to Ascot

David Carpenter gives preliminary details of a major addition to this year's Model Engineer Exhibition.

1. Famous Sinsheim track at closing time.
2. A Sinsheim turntable with plenty of customers.
3. One of the traversers, note the ash dump tray in the foreground.
4. Busy sidings packed with carriages and wagons waiting their turn.
5. Track runs between cafes.
6. Assistant editor, Michael Jones, surveys the line of the track at Ascot.

When we organised the Centenary Model Engineer Exhibition at Ascot last year, people challenged us: "How are you going to follow that?" Not an unreasonable question, really. After all it was by common consent the greatest collection of models ever seen. As I said at the award ceremony: "many of these models will never be on public display again."

No, we couldn't possibly match that array of models. But we were already thinking about how we could make the event another landmark one in the 101st year.

In January Mike Jones, Jez Walters and I, packed our bags and took the tour to Sinsheim in Germany, home to the exhibition, which attracts more than 20,000 visitors each year. This year no less than 22,000 came. That's two or three times as many as attend the major UK model engineering exhibitions.

Walking around the exhibition halls in Sinsheim, it is not difficult to see why it is so popular, with visitors from all over Europe, as well as Germany. As you walk in you are embraced by the aroma of coal and oil from locomotives.

There are a lot of locomotives running. And when I say a lot I mean it. There is constantly something to please the eye – a great locomotive, tram, a strake of fine wagons, some prodigious passenger hauling, and exquisite coaches. Elderly drivers, child drivers, sitting up or lying prone, steam locomotives, electric power, models from all over Europe, pristine or well-used, built over many years or assembled from kits.

We also took some time to find out about the organisation of the Sinsheim

event. We spoke first to Eberhard Zimmermann and his colleagues from the firm he founded, E. Zimmermann GmbH. That is primarily a car component business, but the passion is for building model locomotives, which are also available as deservedly popular kits.

They introduced us to the people who run Messe Sinsheim GmbH who not only own the place, they also organise a wide range of events there and elsewhere including the January Echtdampf-Hallentreffen which is the proper name for the event colloquially known as Sinsheim among model engineers.

To our great pleasure the Sinsheim organisers were prepared to collaborate with the International Model Engineer Exhibition at Ascot. We left happy in the knowledge that we had an agreement in principle that the famous Sinsheim track could come to Ascot.

All very well, but where to put it? We weren't keen on moving the event from Ascot, especially as we had been through the traumas of getting a new venue to understand what a major model engineering exhibition is all about.

There certainly were some teething troubles last year as they did not quite appreciate the scale of the venture, and there were some difficulties on the set up days. Following lots of discussion, all those problems should now be in the past, and exhibitors can look forward to an easier time from now on.





The mighty grandstand was not right for the track location. It is just not big enough!

We looked at a number of options outside the grandstand that were less than ideal. And then we had what we hope will prove a great idea.

Immediately inside the famous racetrack is a service road that is used for emergency vehicles during racing. That would give a great surface for the Sinsheim track with its steel sleepers.

At the time of writing, we hope that will provide us with a unique track in 5in. gauge. It will run the length of the straight in front of the grandstand giving the scale equivalent of main line running. At each end there will be loops to join the two straights.

To complete the line, we will have at least one turntable and a large traverser, plus passing loops, sidings, and so on. All together we will have 2.5km of track.

We shall be working out details of the track with experts from Sinsheim.

Visitors will be able to watch the action from the comfort of the seats in the grandstand, where the entire line will be in view, and you can relax with a drink and a bite to eat. For those that want to get up close, there is a foot tunnel under the racetrack, which comes out at about the middle of the railway.

If you don't fancy the walk, there will be a shuttle bus service that will also take in Ascot railway station, the exhibition entrance, the camping area, Ascot Locomotive Society (whose multi-gauge line is well on the way to completion), and the start of the 5in. gauge track.

The track is officially on Ascot Heath, which is normally open to the public but will be closed for the duration of the exhibition. There will be access via a security gate for



people bringing locomotives and wagons to run. All other entrances to the centre of the racetrack will remain closed.

So, that's how we plan to follow up last year's centenary event.

If you would like to run a steam or electric locomotive, some carriages, wagons or passenger trucks, do please let us know. We need to know

before September 3. There is a short form below, which you can use (photocopy is okay) or just a note giving the information requested. It is a good idea to get your entry or entries off as early as possible as there is likely to be strong demand for what must be a limited number of places. Entries can be made either by individuals or organisations.

ME

INTERNATIONAL MODEL ENGINEER EXHIBITION 2008 STEAM AT ASCOT

ENTRY FORM

To enjoy the 2.5km of 5in. gauge ground level railway track from the Sinsheim organisation please complete the form below (photocopies are fine) and send it to:

Model Engineer. MEX steam entry, Berwick House,
8-10 Knoll Rise, Orpington, Kent BR6 0EL
Or email details to: mex.steam@magicalia.com

NAME:

ADDRESS:

.....

T.

E.

WHICH DAY(S) WOULD YOU LIKE TO ATTEND

- ☐ FRIDAY 19 September
☐ SATURDAY 20 September
☐ SUNDAY 21 September

Brief details of entry(ies)

.....
.....
.....

NOTE

It will be possible to bring vehicles direct to a steaming bay to unload/load. Naturally, current boiler certificates and insurance will be required. It would be helpful if you could send a photo of your entry(ies) for inclusion in our programme.



LETTERS TO A GRANDSON

M. J. H. Ellis continues his description of alternative ways of machining.

I had hoped to give you an insight into all the various ways of removing material (not necessarily, metal) by more gentle means, rather than 'tearing it off' with a sharp tool. There was lots of published information on the electro-chemical process, but I have experienced great difficulty in finding details of other methods which I intended to describe including: electron-beam, ion-beam, electrical discharge, plasma arc, ultra-sound, and water-jet machining. I will tell you as much as I was able to discover; after which, I shall change to a completely different, and more amenable, subject.

Electron beam machining

This process has to be carried out in a vacuum otherwise the electrons would be scattered as they collide with the air molecules. Its principal use is in drilling very fine holes and forming very narrow slots. There is no need for the material to be an electrical conductor.

I think the equipment used is similar to that found in a television tube. A beam of electrons, moving at high

speed, is focused onto the work. The electrons are emitted from an electrically heated cathode, and accelerated towards a highly charged anode. The electron beam may be focused using a series of cylindrical anodes, each at a higher positive potential than the preceding one (fig 1). Alternatively, a magnetic field can be used (fig 2). When an electron strikes the work, as in any form of impact, heat is generated and this is intense enough to vaporise a minute amount of material.

It is possible to drill a hole only 0.001in. dia., through a work-piece ½in. thick! Obviously, very precise focusing of the beam is important.

Ion beam machining

This process resembles electron-beam machining except the work is bombarded by a beam of much heavier, positively charged, ions of an inert gas. Inert gases include: helium, argon, neon, krypton and xenon. By far the most abundant is argon, which constitutes 0.937% of the earth's atmosphere; I assume that this is the reason why it is used.

Inert gases are unique among the chemical elements because they do not form compounds with other elements. Their atoms will not even unite with one another in pairs to form molecules, such as those of elements including hydrogen, nitrogen, and oxygen. At high temperatures, the argon atoms dissociate into free electrons and positively charged ions. One way of achieving this would be to pass the gas through an electric arc, but I do not know whether this is the method used.

However, I can definitely state that these ions are accelerated in a vacuum, in a similar way to the electrons in electron-beam machining, and focused on the work-piece. Each ion dislodges between 0.1 and 10 atoms from its target. I presume the spent ions pick up electrons and revert to the normal atomic state, but my sources are not specific on this point.

Since this process takes place in a vacuum, continuous

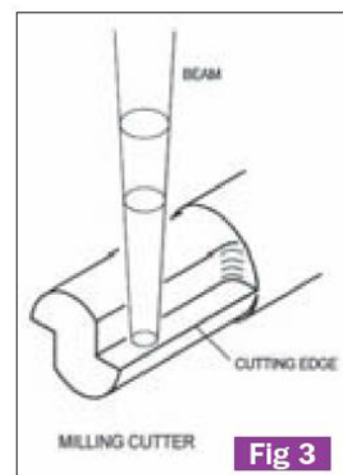
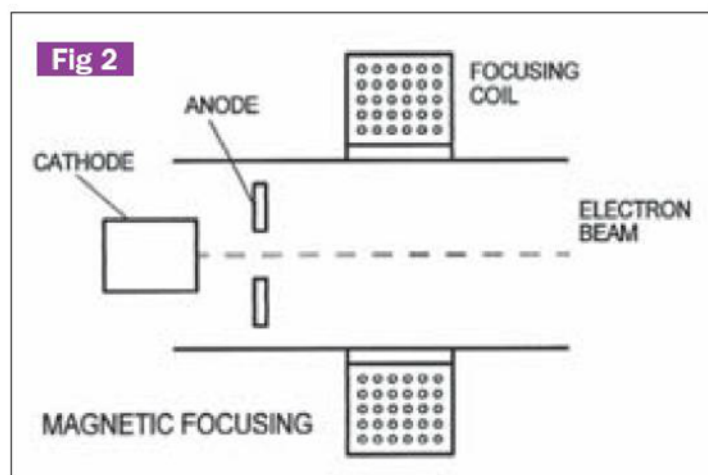
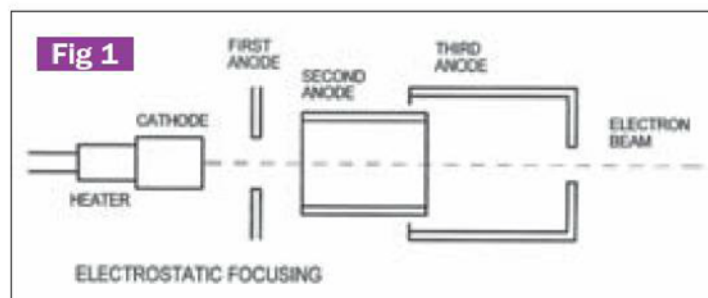
pumping must occur to remove the used argon gas. My sketch (fig 3) illustrates machining a tiny milling cutter from HSS or tungsten carbide using this technique. Assuming that the ion beam can be focused as sharply as an electron beam, the diameter of the circle, where the 'cutting' occurs, would be of the order of 0.001in., and the overall diameter of the work-piece would be about 0.005 inches. The radius of the cutting edge of the tool is stated as 10 to 50 nanometres (about 0.000,000,4 to 0.000,002in.).

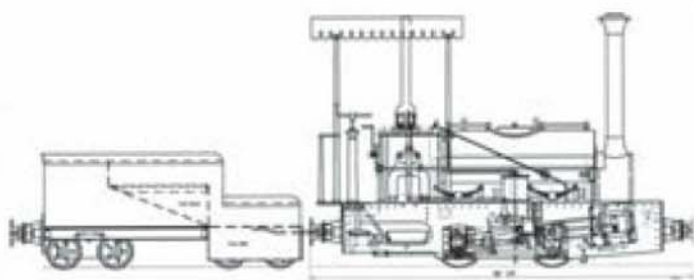
Electrical discharge machining (spark erosion)

In this process, a high frequency spark discharge takes place between a graphite or soft metal tool and a work-piece made of a conducting material. Materials which can be machined using this method include hardened steel and tungsten carbide. The action takes place in a bath of insulating fluid. A spark gap of between 0.0005 and 0.020in. is automatically maintained between the end of the tool and the work-piece.

The concentrated heat of the arc slowly vaporises or melts the work-piece, and the fluid carries away particulate matter. The process is slow, but it is capable of producing accurate work. A well-known application is the removal of a tap, which has broken off beneath the surface of the work. Likewise, this is a convenient point for me to 'break off'.

Your affectionate Grandpa.





ANNA

A MANNING WARDLE LOCOMOTIVE FOR 7 1/4 in. GAUGE

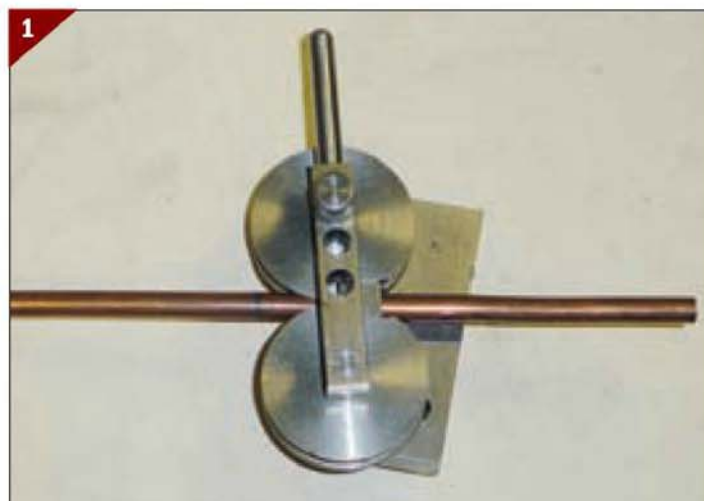
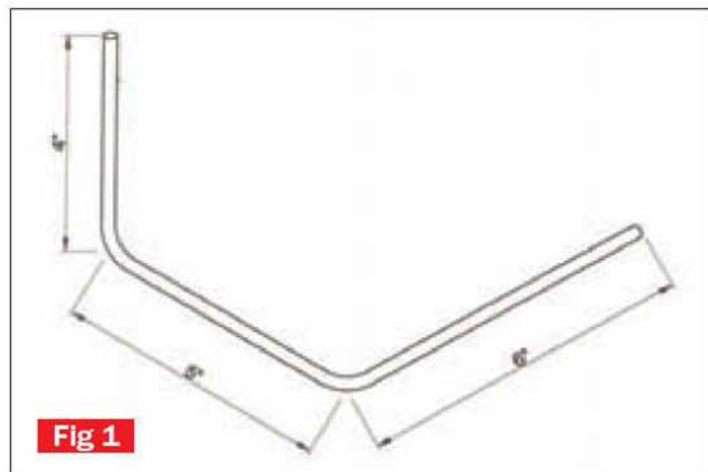
D.A.G. Brown and Mark Smithers discuss pipe fitting and offer advice on bending methods.

*Continued from page 572
(M.E. 4325, 9 May 2008)*

We left the steam fittings ready to mount and I mentioned that this time we would consider the niceties of pipe strangling. In a model of this nature, well executed pipework makes a significant difference to the final impression. Some years ago I published a design for a pipe bender in *MEW*. This produces uniform bends of radius three times the pipe diameter and can get adjacent curves within quite a short distance of one another. The difficult bit to understand is just how to position the bends and to get them to lie in the right direction. As an illustration, **fig 1** is an isometric view of an hypothetical job, which will be discussed lower down the page; it is quite easy to get the finished result pointing in precisely the wrong direction; much bad language might then follow!

Here is a way of getting a high chance of success. **Photograph 1** illustrates the pipe bender, rigged for bending 1/4 in. pipe, which accounts for most of the pipe runs on the locomotive.

1. Pipe bender set up for 1/4 in. pipe.
Fig. 1. The hypothetical pipe bending job which is described in the text.



I have dreamed up a slight simplification to enable the bender to work even better than it does in the original design; perhaps I might publish it in this learned journal in the future if there is the demand for it.

It soon becomes impossible to unthread the pipework through the assembled bender, so it is necessary to withdraw the pins and take things to pieces, a very simple operation.

Pipe bending tips

In **fig 1**, the isometric drawing, a 4in. vertical leg is followed by a 5in. section pointing towards the operator and finally a 6in. length mutually at right angles as drawn. Don't try to guess the finished pipe length, merely start with an adequate piece. Make a pencil mark 4in. from the end of the pipe; this is the nominal location of the centre of the second leg of the pipe after bending. With the pipe held in the bender ready to take the strain, adjust the 4in. mark so that it is level with an imaginary line touching the far edges of the two rollers

(this is clearly visible to the left side of the assembly in photo 1). Always think of bends as having dimensions to their centre lines, rather than their extremities. When now you bend the pipe, its straight length will be gripped firmly within the pipe anchor (middle of picture) and the bend will take up material well past the pencil mark. You can stop whenever a set square indicates that you have turned through a right angle. Note that the precise length of material used is difficult to calculate, since the bending process tends to stretch the outside of the bend more than it shrinks the inside of it. This method avoids calculation and estimation.

We now come to the second bend, which is required mutually at right angles to the first, but pointing to the right rather than the left in the diagram. Make a pencil mark 5in. from the centre line of the first bend, and draw another pencil line running along the length of the pipe, but in such a position that ➤



2. Right side pipework from low down, with cab side and sander removed.

3. Right side of finished locomotive.

4. Rear cab view with cab structure and floor removed.

5. Rear cab view of complete locomotive.

it will finish up on the *inside of the bend*. Now reassemble the bender around the pipe, with the 5in. mark level with the far side of the rolls. Just taking up the slack, turn the pipe so that the first leg is vertical, and with the longitudinal pencil mark facing towards the groove of the fixed roller (the lower one in the picture). The bend will now appear in the correct orientation.

You may wonder what all this rigmarole is for in such a simple example; as the pipe run becomes more contorted, it is sometimes difficult to

imagine in which direction the next bend is going to lead, so the above is merely a simple way of achieving the right orientation before bending the metal; it is particularly useful if the bends are at odd angles to each other.

To cut to finished length I use a pipe cutter bought from our local builders' merchants, which advertises itself capable of cutting anything from 15mm down to 3mm pipe; this range is governed by the diameter of the cutting rollers, which I notice are in contact with each other at the small end of the range. It remains only to trim the inside of the pipe after cutting, before fitting the nipple in place.

Fitting the connections

For each of the pipe runs, the nipples should be silver soldered into place, making sure that the seal is perfect,



and not forgetting to thread the union nut into place before making off the joint! You will surely find that some of the pipe runs require a joint somewhere along their length, merely to enable the pipe to be fitted and stripped down again.

It does not pay to construct a Chinese puzzle, which requires the whole engine to be taken apart before a particular pipe can be serviced. In such circumstances my own preference is not to make a complete union, with a nut each end and a loose fitting in the middle. Rather I favour a single ended union, one end of which is silver-soldered direct to the pipe. This takes up less space and has one joint fewer to make, see **fig 2**. Obviously, this variation of design takes up less space than the full union, which is pictured alongside, together with their common nuts and nipples.

The pipe runs

Let us now examine the pipe runs, making use of photographic evidence.

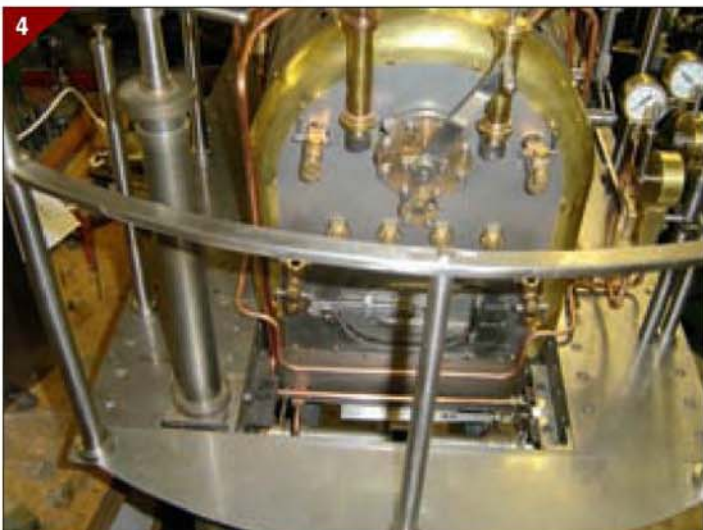
Photograph 2 portrays the right side of the locomotive from low down, with the sand boxes and cab sides removed. Unless otherwise stated the pipes are all $\frac{1}{4}$ in. dia., which makes life easy.

Starting with the blower line; this starts from the front steam valve on the firebox top, which is clearly visible in the view of the right-hand side of the finished locomotive (**photo 3**). I elected to use a length of

$\frac{1}{4}$ in. pipe for this run, although it is not really necessary. It heads vertically downwards to the bottom of the tank, which it follows all the way to the smokebox union, which requires a slight set ($\frac{1}{8}$ in. of offset) to keep things looking neat. The bold smokebox elbow was detailed on drawing No. 32 and in part 20 of the series. If you look carefully at the beginning of the long pipe run along the lower edge of the tank, you can just see in photo 2 that I have silver-soldered in a branch which drops down to just above footplate level and then heads backwards to finish a couple of inches short of the backhead face with a slim piece of brass. This is a Schrader valve from a motor car tyre that enables the locomotive to be steamed by applying compressed air to the (closed) blower line, rather than by using an ugly steam-raising blower on top of the chimney.

Water pump supply

Photograph 3 clearly shows the pump water line straight from its valve near the front of the saddle tank. A 65deg. bend leads it vertically downwards to footplate level, where it does a Z-bend to get it under the boiler and level with the pump; it does a U-bend right under the axle and into the pump inlet connection. The pump delivery is short and direct with just a Z-bend to deliver the water into the clack valve at the front of the boiler; in the middle of the horizontal section of the Z, a $\frac{1}{4}$ in. pipe has been let into the



top of the copper, by drilling and silver-soldering. It snakes its way roughly along the top of the main frame, before turning vertically up the side of the cab sheet and into the water pump relief valve; this, with its stubby half handle is visible in the finished view. The outlet, to be directed at passers-by, is a single bending job to bring it to just above footplate level; a couple of simple clamps like handrail stanchions ensure stability of this vulnerable item.

Sand pipes

While looking at the right side, I should point out the $\frac{3}{8}$ in. sand delivery line which screws into the bottom of the sander, performs a shallow Z-bend, and finishes in a clamp level with the bottom of the main frame and just outside the $7\frac{1}{4}$ in. gauge position, so that it deposits its grinding paste on the middle of the rail. I have enlarged the hole in the footplate through which the sand pipe passes; making it say 1in. dia. greatly helps in threading the assembly through the footplate without disturbing the paintwork; the hole does not show.

Drain cock pipes

You will notice the end of a $\frac{3}{4}$ in. dia. pipe sticking through the buffer beam just inboard of the buffer; I drilled two pairs of $\frac{7}{32}$ in. holes $\frac{1}{4}$ in. above each other near the bottom of the buffer beam and bent up the two pairs of cylinder drain cock pipes to an angle of $83\frac{1}{2}$ deg., anchoring them to the bottom of the cocks in the usual way, but using $\frac{3}{4}$ in. x 32 union nuts and olives to mate with the drain cock tails drawn in M.E. 4229, 3 September 2004, page 260. This detail appears on drawing 5 of the full set of plans.

This positioning keeps the drain cock pipes well out of harm's way.

Emergency hand pump

In part 19 of the series I detailed the functions of the four clack valves. Since then I have exchanged two of them, so that the right rear valve

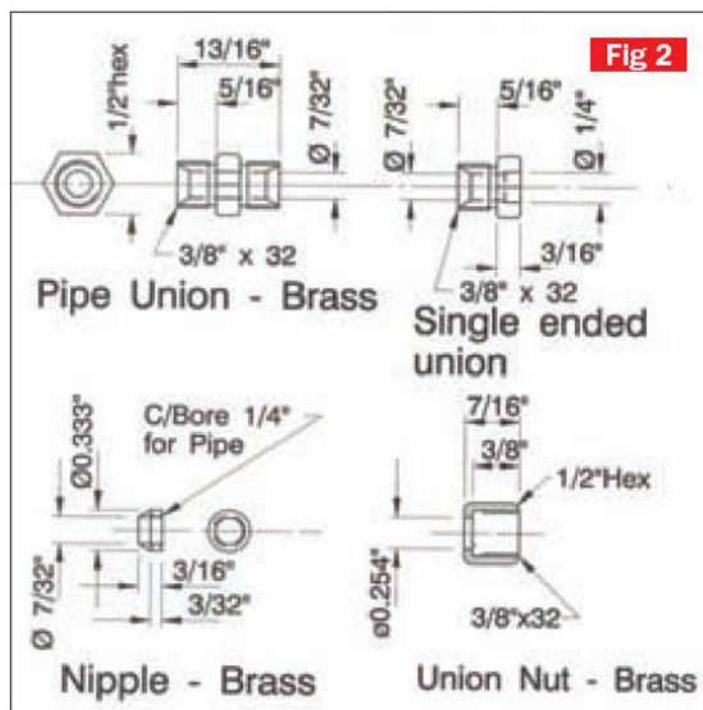
takes the delivery from the hand pump, whereas the front left valve is connected to the traditional injector, which keeps all the plumbing on one side.

I detailed the splicing of two pipes into one for both the inlet and delivery of the pump, but did not stipulate where they should run. In photo 2 you can see both of the runs close together just under the right footplate and invisible from the normal viewing position. We need to install a balancing line between the two legs of the saddle tank and this is done by fitting a line which runs round the belly of the boiler cladding, some 14in. behind the smokebox rear flange; here it is behind the sanders and out of view, although visible in the picture with the sanders removed. A distance of 1in. below the tank, the balance pipe is breached by a tee joint, which leads through the footplate, turns back towards the cab and heads for the pump inlet branches between the frames. I found it essential to break the pipe run some three inches behind the weighshaft, making use of one of the single ended unions detailed at the beginning of this article. The other short union just above the footplate enables the balance pipe to be fitted before coupling up, and it is let through the footplate by cutting a short slot at the front end of the hole which is already there for the reversing gear vertical crank. To install this pipe run, I started from the cab end, with some fairly tortuous bends to miss the ashpan and damper gear. Having led the pipe through the footplate, the best lengths and position for the final connection into the balance pipe could be determined.

The pump delivery line is a similar job, but does a U-bend through the lightening hole in the frame, in order to reach the clack valve. There is no intermediate joint in this line.

Brake pipes

Returning above the right footplate, the two **photos 4 and 5** illustrate the brake pipework. The steam services are fed from the two valves alongside



the dome bush, inclined at 35deg. to clear the safety valve chimney. The two brake controls are fixed side by side with their respective gauges neatly clearing the reversing gear and drain cock lever. The two pictures and photo 2 reveal how the pipework is run and how it is dipped between the frames under the cab floor. Most lines are in one piece and further mention will be made shortly of the vacuum line from the left side of the engine. The vacuum train pipe is run to the rear buffer beam, where it is fixed in a plain hose fitting pointing towards the tender. Beneath the footplate, a vacuum limiter valve is just visible in photo 2 as a

stubby brass cylinder; its short $\frac{1}{4}$ in. line is merely teed into the vacuum line below the footplate.

The steam supplies for the brake systems are taken from the valves screwed into the dome cover; I have altered the detail of these two positions, so that they incline the valves at 35deg. from vertical, thereby clearing the safety valve chimney and allowing the valve handles to be easily turned. This angle makes these two valves' axes parallel to the others on the firebox barrel. So the steam brake is fed from the right side of the dome and the vacuum ejector from the left side. That brings us to the left side of the locomotive, ➤





6. Broadside view of left pipework.
7. Left view of complete locomotive.
8. Nested valve gear components in four different thicknesses from the laser cutter.

which shows in **photo 6** that this short run enters the little ejector body above the footplate, aligned nicely at the same level as the vacuum exhaust line through to the smokebox; you may remember that this line exactly mirrors the blower line on the right side. This view also demonstrates the gentle S-bend which the front of this pipe makes before it enters the smokebox union. Two further details on this picture are important; the first is the enlarged hole for the sander pipe through the footplate to which I referred earlier, and the second is the dummy $\frac{1}{4}$ in. black bolt in the frame extension in front of the rear hanger of the front spring assembly. In full size this would have anchored the foreshortened spring hanger to clear the valve gear.

The dominant feature of the left side pipework is the plumbing to the Giffard injector; this was drawn in detail in part 19 of the series and appears on sheet 31 of the drawing set. To me it was sheer pleasure to drill and fit the four 4BA screws on their correct p.c.d. in the tank water connection and to find how they mated perfectly with the holes in

the tank which the laser had produced. I have made use of stainless steel screws for these purposes, fitted with fibre washers inside the tank and a hand-cut gasket outside; the stainless nuts are backed up by washers, which gives a neat finish. The injector overflow is let through a ($\frac{5}{16}$ in.) hole in the footplate and its horizontal tail can just be made out beneath the footplate angle.

What the layout diagram in the original drawing did not show was the way the pipes are threaded in front of and behind the frames; the delivery into the bottom of the rear clack valve is by means of a swan neck behind the frame, which turns neatly towards the camera above the frame, having executed another couple of right angle bends from the bottom flange on the injector body. You can see how the



water line executes a 'snake's honeymoon' operation with the delivery line; you may need to do some gentle persuasion here! By comparison the steam supply from the front valve on top of the firebox is simple, with a single joggle lining it up with the injector steam inlet. The three rigid anchorages allow the whole device to ride freely alongside the tank, avoiding any visible means of support. This important historical detail from the early days of injectors should in no way be compromised in making this model.

The other 'model engineering' injector is fed from the rear valve on the firebox, which was originally used to heat the water in the tank, not really a good thing in our circumstances. I have routed the steam pipe vertically down the back corner of the firebox wrapper; it has to be sharply bent to finish

up pointing towards the front, having passed through the large opening at the rear of the frame. The water line merely travels from the rear buffer beam in a short reverse bend, neatly in one plane behind the footstep. The delivery line has to travel all the way to the front clack valve, crossing through the hole in the frame alongside the sander pipe; the finished view. **Photograph 7** shows the delivery as it passes between the area behind the sander and the clack valve; it must pass through the frame just behind the sand pipe.

Improving component supplies

As part of our commitment to provide many pre-cut components, it has become advantageous to change a few things; helpful dialogue with Malcolm High has improved some of the laser cut components, producing them in sets, which both keeps down the cost and avoids the risk of losing some of the small bits. As an example, the 25 pieces in the set of valve gear components now come nested in just four pieces of different plate thicknesses. **Photograph 8** illustrates the result, from which it can be seen that corners have been radiused to ease the passage of the laser. As a general rule, holes are finished if they are of diameter greater than the plate thickness; otherwise they are spotted.

● To be continued.



Self-starting single-cylinder double-acting steam engine

Les Kerr concludes his description of construction of the steam engine and instructs on how to set up the electronics.

*Continued from page 561
(M.E. 4325, 9 May 2008)*

8. A close-up view showing the cams, matrix board and photo interrupters.

9. Top view of the engine to show how the tubing connectors are used to connect the various parts.

Fig 38. Cylinder cover.

Fig 39. Crosshead trunk guide.

Fig 40. O-ring cover and tool (see text).

After you have made the cylinder, proceed with the cylinder cover (fig 38). This way you can ensure it is a tight fit in the cylinder. I made mine from aluminium only because I didn't have any brass of that diameter. The holes are drilled when it is fitted on the cylinder.

Crosshead guide

The crosshead guide was made from a 2.5in. length of 1.25in. dia. brass (fig 39). Mount this in the 3-jaw chuck with approximately 2in. protruding. Face the end and drill the $\frac{1}{16}$ in. hole all the way through. Using a larger drill and boring tool open out the hole for a length of 1.5in. to a $\frac{19}{32}$ in. diameter. Take several passes of the boring tool to ensure the bore is uniform in size. Turn the outside diameter for 1.625in. to size. Part off to just slightly longer than finished size.

Reverse the job and mount it in the 4-jaw chuck. Using a

dial gauge set it to run true along the axis. Face the end to size and using a small boring tool cut the hole for the O-ring and O-ring cover. Next turn the outside flange to size. Finally turn the lip so that it is a tight fit in the cylinder end. Leave the job in the chuck and transfer the assembly to the milling machine fitted with a dividing head. Fit the O-ring cover with the small extraction tool. Drill and tap the 10BA holes that hold the cover in place. Next, drill the 8BA clearance holes. Using the tool remove the cover. Next drill the $\frac{1}{32}$ in. dia. adjustment hole noting its location in relationship to the mounting holes. Finally using a lap similar to that used on the cylinder, polish the bore.

O-ring cover

If you make this item after you have made the crosshead guide, then you can ensure it is a tight fit in its end (fig 40). I made up a little tool from brass which is shown on the drawing next to the

cover to remove the cover once it was in place during this operation.

Cams 1 and 2

Cams one and two were turned up in the lathe from aluminium rod (fig 41). I used a slitting saw in the mill with a dividing head to cut the two grooves for the slot. The rest of the material being removed using a $\frac{1}{16}$ in. dia. end mill. Finally, drill and tap the M3 hole and fit a 3 x 3mm grub screw in place.

Mid point cam

Construction is similar to the other cams (fig 42), the only difference being that in the mill, a $\frac{1}{16}$ in. thick slitting saw was used to cut the slot.

Cylinder and flywheel support

Both of these were made from aluminium (fig 43). The cylinder support was made from 20 by 50mm bar and the flywheel support form 20 x 40mm material. Adjust the diameter of the bearing holes in the flywheel support so that the bearings are a push fit.

Smaller parts

The crankshaft is a 3in. length of $\frac{3}{16}$ in. dia stainless steel. A gudgeon pin is made from a $\frac{3}{16}$ in. length of $\frac{1}{8}$ in. dia stainless steel rod. From a length of $\frac{3}{16}$ in. dia. rod a crankpin should be made with its end reduced and threaded M4. Loctite it in place in the flywheel. ➤

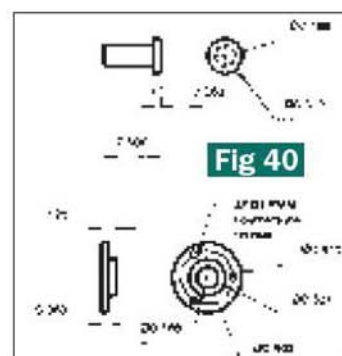
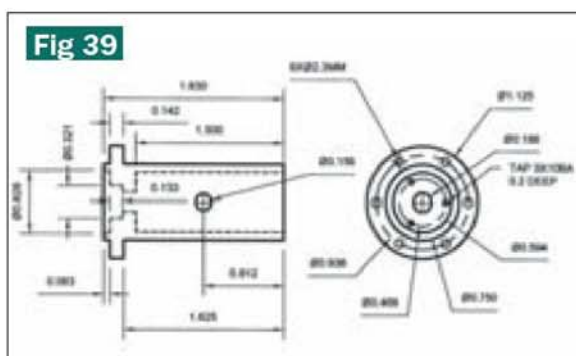
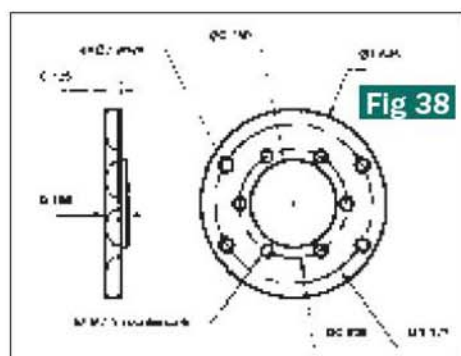
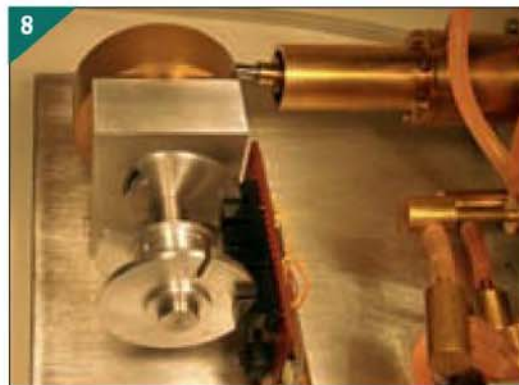
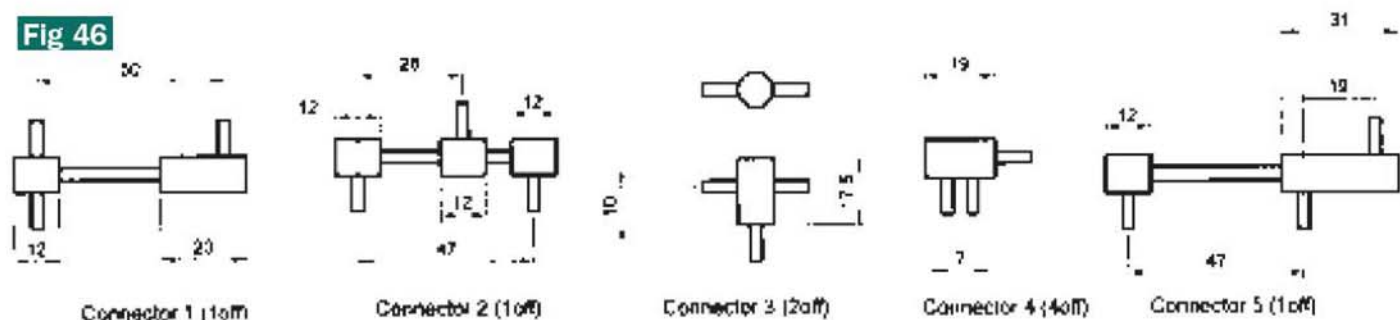


Fig 46

Tubing connectors

Figure 46 and **photo 9** shows the ones I made. For the bodies I used $\frac{3}{8}$ in. dia. brass and for the connectors I used $\frac{1}{2}$ in. lengths of $\frac{3}{8}$ in. dia. pipe. All the holes were 3.2mm which gives just the right clearance for the $\frac{3}{8}$ in. tube. They are held together with Loctite.

There are two additional ones for the cylinder ports which were made from $\frac{3}{8}$ in. lengths of $\frac{3}{8}$ in. O/D copper tube. Loctite them into the cylinder ports.

Final mechanical assembly

Attach the engine and flywheel assemblies to the mounting base using M3 by 8mm screws so that the flywheel turns freely. The mounting base drawing is **fig 47**.

There is a small amount of play in the $\frac{1}{8}$ in. dia. holes which is there to take out any small

variations in size.

Next attach the motor and valve sub-assembly using M3 by 10mm screws and nuts and washers. Adjust the position of each valve sub-assembly so that the gears rotate freely with minimum backlash.

Connect the valves, tubing connectors and engine together with $\frac{3}{8}$ in. tubing as shown in **photo 9**.

Putting it all together

We first have to adjust the valves so that they line up with the stepper motors when activated. To do this connect up the 12v DC battery and switch the power switch M1 on and you should see the anti-clockwise rotation yellow LED illuminate. Next rotate the engine until cam one (closest to the flywheel) is blocking its associated photo cell. Press the advance button

S1 on CH1 stepper driver until the two marks on its valve are close together. Undo the 20 tooth gears M3 attachment grub screw and move the valve centre so that the two inscribed marks on the valve precisely line up. Tighten the grub screw. Do the same thing for CH2. Finally switch off the power switch M1.

Running the engine

Now to running the engine. Switch on the power switch M1 and the yellow anti-clockwise LED should illuminate. If you adjusted the valves correctly in the previous procedure then the two marks on valve one should line up and the same for valve two.

Connect about 25psi to the inlet tube and the engine should rotate anti-clockwise. Press the reverse push button and it should change direction. Pressing it again the rotation direction should revert back to what it was when you started.

Press the stop/start button and the engine should stop just past the piston's midpoint of travel. Press it again and the engine will start again in the same direction.

If you reverse the engine then press the stop button it will stop on the other side of the mid point of rotation of the piston. If you now hit the reverse button followed by the stop/start button the engine will run in the same direction as before then quickly reverse.

Note: Power is always supplied to the CMOS integrated circuits. This way the circuit remembers where the motor is. The current drawn is small; about eight milliamps so it will take a long time to flatten the battery. If you do remove this circuit from the

battery then the memory will be lost and you will have to reinstate it by going through the following procedure.

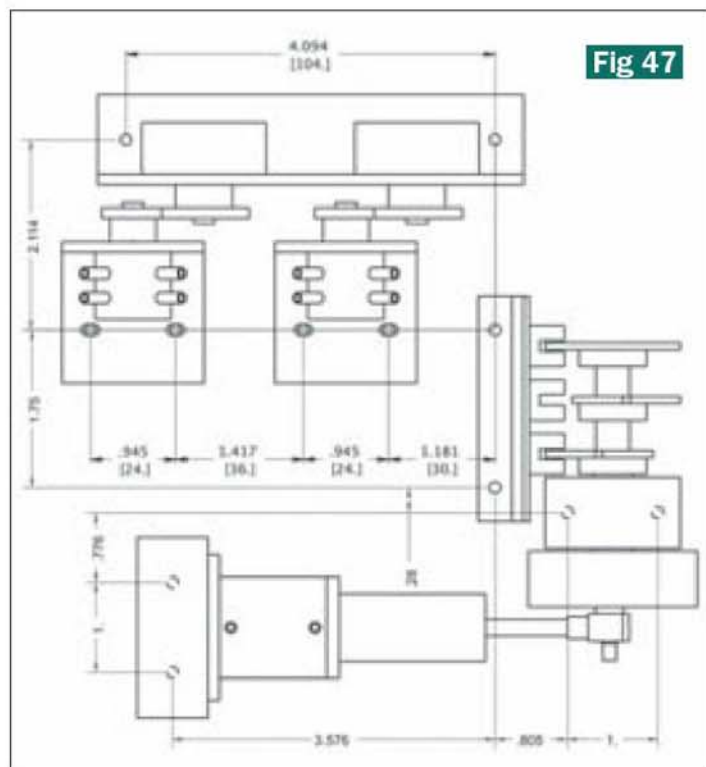
Connect up the 12 Volt battery and switch the power switch M1 on and you should see the anti clockwise rotation yellow LED illuminate. Next rotate the engine until cam one (closest to the flywheel) is blocking its associated photo cell. Press the advance button S1 on CH1 stepper driver until the two marks on its valve line up. Do the same thing for CH2. The engine is now ready to run.

Discussion

The engine I've described is not meant to be of any use; it was simply made to test the author's theories. It has been shown that the principle works but what can it be used for.

1. You can make a simple, powerful, double-acting steam engine that is self starting.
2. You can make a two cylinder engine whose pistons are 180deg. out of phase that is also self-starting. The huge advantage is that the engine would be balanced with the result it could rev higher and if used in a locomotive would not waste energy by pounding the rails.
3. By adding a shaft encoder it would be possible to tell at any time the position of the engine shaft thus making the cams redundant. You then would be able to programme when the valves would open and close, thus leading to a higher efficiency of engine than that obtained under current technology.

The author may be contacted at E. lvkerr@northnet.com.au ME

Fig 47

Which digital micrometer?

David Stokes

takes a look at what's on the market for the digital version of this workshop measuring mainstay.

There are enormous advantages to using a digital micrometer. Firstly, they are a lot easier to read and, secondly, they can be changed from imperial to metric at the press of a button. They are of course a lot more expensive than traditional types, but then you never get 'owt for nowt'.

As with all things electronic they need batteries and I can hear the old guard muttering in their beer, "What happens when the battery is flat?" If you are well equipped you will have spare batteries. When the battery fails, some can be used as a mechanical type but, in the samples I had, this could only be metric.

As usual we looked at price,

ease of operation and, for those like me who are close to, or already have a bus pass, whether you need strong specs to read the readout.

Under normal workshop conditions, all those tested were accurate, when checked against slip gauges. All but one of the micrometers were 0-1in. and metric equivalent.

ME

TESA MICOMASTER EASY 0-30mm/0-1.2in.



Guide Price	£134
Reads to	0.001mm
Need of adjustment from new?	No
Case?	Yes
Contact	01952 681349 www.tesabs.ch

Beautifully put together, very high quality but, unlike most of the other digital micrometers, it can't be used as a mechanical if the battery fails, there just isn't a mechanical scale.

TOOLSTATION 33962

Guide Price	£49.46
Reads to	0.001mm
Need of adjustment from new?	No
Case?	Yes
Contact	0808 100 7211 www.toolstation.com

Looks very much the same product as Sealey's, has the same enamelled finish etc. Nicely put together piece of kit, comes in a case with the adjusting spanner and a spare battery. Same good smooth action but a lot less in the way of cost.



DRAPER 52426

Guide Price	£79.34
Reads to	0.001mm
Need of adjustment from new?	Yes
Case?	Yes
Contact	0845 299 0149 www.toolsnstuff.co.uk

Very angular appearance, very clear readout, much simpler control buttons than other micrometers. Comes with the adjusting spanner. Well presented in a plastic case.



SCREWFIX 35092 HILKA

Guide Price	£49.99
Reads to	0.001mm
Need of adjustment from new?	No
Case?	Yes
Contact	0500 414141 www.screwfix.com

Again, a similar item to Toolstation's and Sealey's offerings, so you should, with these micrometers, probably buy by price. Comes in a case, can measure items in metric and imperial. High value.



CHRONOS SMT230

Guide Price	£49.70
Reads to	0.001mm
Need of adjustment from new?	No
Case?	Yes
Contact	01582 471900 www.chronos.ltd.uk

The thing that stands out with this electronic micrometer is that, unlike most of the others on test, it cannot be used as a mechanical micrometer. There are no graduations on the thimble. The price is not high given the competition and it comes with a spare battery, a tool to undo the battery cover and a plastic case.



ALLENDALE ELECTRONICS ME-DI-MIC-0-25



Guide Price	£34.95
Reads to	0.001mm
Need of adjustment from new?	No
Case?	Yes
Contact	01992 450780 www.machine-dro.co.uk

Well put-together digital micrometer, nice size screen, easy to read, traditional ratchet at the end of the thimble. Comes in a wooden case along with a spare battery and an adjusting spanner.

SEALEY AK9635D

Guide Price	£65.95
Reads to	0.001mm
Need of adjustment from new?	No
Case?	Yes
Contact	01283 510645 www.toolcrew.co.uk

Good clear readout, well presented in a tough, click-shut, plastic case, good clear instructions. Comes with an adjusting spanner and a spare battery. Smooth easy action.



MITUTOYO 293-832

Guide Price	£70.57
Reads to	0.001mm
Need of adjustment from new?	No
Case?	Yes
Contact	08709 907033 www.lawson-hls.co.uk

As one expects Mitutoyo's digital micrometer 293-832 is beautifully presented, has an excellent smooth action, is easy to read both as an electronic and a mechanical micrometer. Supplied in a plastic case with the traditional adjusting spanner.



EARLY MYFORD LATHES

When, in September 1934, Cecil Moore

founded the Myford Engineering Company by occupying a spare room in a five-storey lace mill in Beeston, Nottinghamshire (the address in the early sales sheets was given as Neville Works) few could have foreseen the day when, 10 years later, he was to occupy all but a fraction of the same building. The foundation of this success was a range of just four lathes: the ML1, ML2, ML3 and ML4, all designed and priced to appeal to the model engineer.

Each was of identical construction, lightly built, on a flat-top, 'cantilever' bed of box-form section (and with the same width of 60deg. edge ways), had a 6:1 ratio backgear and did not differ greatly in quality or accuracy from any number of other pre-WW2 competitors.

However, despite their limitations of size and strength, the machines proved immensely popular and the Myford Company, based on its reputation of offering value-for-money accuracy, went from strength to strength to emerge as the pre-eminent maker of small lathes in the UK.

Earliest known

The first known catalogue (photo 1) makes no mention of a model type, just the Myford 3-inch. This single model was to develop first into the ML1 and ML2 (Myford Lathe 1 and 2) both with a 3 $\frac{1}{2}$ in. centre height and admitting 15in. between centres, and then, a little later, into the 3 $\frac{1}{2}$ in. x 24in. models – the ML3 and ML4. Both ranges were made until 1941 when, with instructions received from the (wartime) Government's Machine Tool

Control Rationalisation Board, Myford was obliged to take over from the Drummond Company (busy with the important Maximatic production lathes) manufacture of the Armed Services' standard small lathe the M-Type. However, what the official directions relating to production of Myford's own lathes were is not clear and manufacture must have continued with sales literature issued during 1940 (but dated 1939) having stamps over the ML1 and ML2 entries stating: "This type withdrawn for duration of war". Subsequent brochures for ML2 and ML4 appeared in both November 1941 and March 1943. The 1941 edition contained an official Machine Tool Control Price List and repeated that for the duration the ML1 and ML3 would be withdrawn from sale. According to a letter written by the company's sales department in September 1946, it was intended that production of the ML2 would resume in the summer of 1947 – and the ML4 a little later.

Indeed, in October 1945 the company had 1,000 copies printed of a redesigned ML2 and ML4 catalogue together with a further 1,000 in January 1946. However, very shortly afterwards, the new ML7 was announced, with the first catalogue stamped 'Provisional'. The cover of the ML7 brochure was dark-blue with the single word 'Myford', in the company's traditional script, picked out in gold.

Although catalogues listed the ML3 and ML4 as Superior – and the ML1 and ML2 as Standard – the precise specification of the latter was not stated. However, one important difference was that early versions of the ML1 and

ML2 were generally cast with headstock and bed cast 'as one' while the ML3 and ML4 both had a bolt-on headstock.

Significant mods

Other significant modifications were that the ML3 and ML4 had a shrouded ball thrust race to the spindle – which ran in bronze bearings and not direct in the headstock casting as on the ML1 and ML2 – a longer cross slide with 4.5 instead of 3.25in. of travel and a quick-action lever instead of a bolt to release the tailstock.

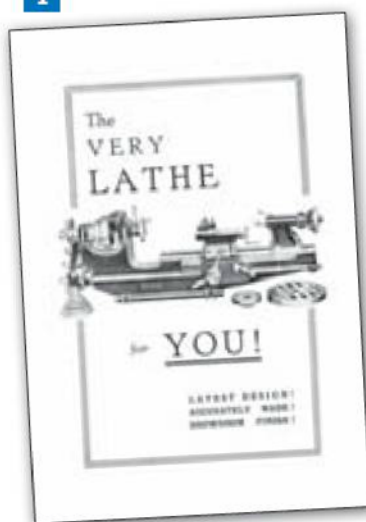
A tumble reverse mechanism was available for all types – at 10s (shillings) extra in 1939, or, if combined with the optional $\frac{1}{2}$ in. bore spindle with a No. 2 Morse taper, £1 5s 0d. By 1943, in a rationalisation of production, the tumble reverse and larger spindle appear to have become part of the ordinary specification. Lathes with the smaller 1in. diameter spindle carried a $\frac{7}{8}$ in. dia. 8tpi thread while the larger were equipped with a 1 $\frac{1}{2}$ in. 12tpi nose identical to that used on the post-war ML7.

A 3-step flat-belt cone pulley (with diameters of 2.375in., 3.125in. and 3.875in.) to take a $\frac{3}{4}$ in. wide belt was fitted as standard – at least until 1943 and the arrival of a much-improved stand with integral countershaft – though during the late 1930s, for a mere 2s 6d extra, a V-pulley could be ordered instead.

Another option, though it can seldom have been taken up, was for a 2-speed cone pulley to take a 1in. wide flat belt. Like many contemporary small lathes the covering of belts and gears was either rudimentary, or non-existent. However, by the late 1930s several designs of changewheel cover appeared,

Tony Griffiths outlines the pre-ML7 lathes.

1



1. Cover of earliest known Myford catalogue.

2. A 1930s Myford still in use.

obviously in search of a simple but economical solution. The first cost an extra 7s 6d and bought a rather crude hinge-up affair that lacked an inner cover. The next development – and a type fitted to many of the later models – was an assembly that used a cast-iron plate bolted to the end of the bed with the cover located by a dowel at the back and a knurled thumb screw at the front (just like the ML7). Finally, but very rare indeed, a guard was provided that hinged open in the manner of that fitted to the Super 7.

Although the later division into Standard and Superior models brought with it a choice of a spindle running directly in the cast iron of the headstock (an excellent situation if the spindle is hard and carefully finished) or bronze bearings. In the 1930s, when money was tight, many lathes were sold without countershafts, the owners preferring to construct their own from handy scrap.

Every ML1, ML2, ML3 and ML4 had a carriage of similar construction with a simple, lightweight apron in cast-iron secured to the saddle by two slotted-head screws and a direct rack-and-pinion drive from a balanced handwheel – a small movement of the handle producing a disproportionately long travel of the cutting tool. To solve this problem the makers offered a handwheel for the end of the $\frac{1}{2}$ in. diameter, 8tpi leadscrew end by which meant the carriage could be advanced more slowly and a steadier cut

taken – the leadscrew being clasped by cast-iron split nuts running in short V-edged guides fitted with adjustable gib strips.

All versions were given a T-slotted cross slide and a swivelling top slide with, on early lathes, a simple etched micrometer dial (with 80 divisions giving 0.96 thou. per division) fitted to just the cross-slide feed screw. However, just occasionally an original lathe is found where the owner must have pushed out the boat and ordered one for the top slide as well.

Later lathes

From an indeterminate date, these appear to have been fitted with both dials as standard. The slides (which were hand scraped and fitted only by experienced slide fitters carried square-thread feed screws of 12tpi. Unfortunately the screws, instead of being fitted with replaceable nuts, ran directly in threads tapped in the castings making replacement awkward.

Retained by just a single stud that passed through its pivot point, the first lathes had a top slide that was obviously inadequate and the more familiar type, with a curved slot on the front to provide an extra clamping point, must have been introduced very quickly judging by the very few examples of the earlier kind encountered.

Although dating a pre-war Myford precisely can be difficult other pointers to early machines include a shorter guard over the spindle bullwheel and a lack of knurling

on the tailstock handwheel.

Screwcutting was by changewheels that ran directly on their mounting studs – the gears being joined by pins when assembled as a compound drive. Although the ML7 and Super 7 changewheels are the same D.P. as the ML1 to ML4 type, they are mounted in a much-improved way with the centre of each gear accepting a keyed bush that turns on a hardened stud. This system can easily be adapted.

Arranged at the rear of the headstock, as a cluster near the chuck end, the backgear was carried on an eccentric shaft. As a point of interest the writer has seen many examples of early Myford lathes where an owner has attempted to engage backgear by disengaging the bullwheel from the spindle. Unfortunately this quickly wrecks both gear and spindle and the correct method is to release the pulley from the spindle (look for a grub screw through either the bottom of a V-groove or through the pulley's end boss).

Unfortunately the only ML1, ML2, ML3 and ML4 parts that can be replaced by those from the later ML7 lathes are the screwcutting changewheels, the complete tumble reverse assembly and (if thinned down) the backgear cluster. If the lathe is a late-model ML4 the 1.125in. bore bullwheel, can also be made to fit.

Because the (stronger) ML7 tumble-reverse assembly is a direct replacement for the (flimsier) unit used on the ML4, there seems to be no good reason why a lathe without this facility could not be retro-fitted with it – though care would be needed in positioning the mounting stud and to marking out the indent positions for the location plunger.

By far the weakest part of the lathes was the No. 1 Morse taper tailstock with its 3in. of barrel travel. The problem lay with the alignment being entrusted to a flimsy side plate that used an awkward system of adjustment by two screws; operating the lever to clamp the tailstock to the bed caused the plate to flex and the in-line

setting to be lost. In fact, so poor was the original design that Myford issued a sales leaflet extolling the virtues of a much-improved (and expensive) replacement. However, all Myfords have a proper split-cylinder clamp that acts directly on the barrel – and with its mounting stud screwed deep into the casting.

Two stands

Two design of stands were produced, early and late, both of cast-iron construction. The older type was very lightly built and is easily recognised by the large decorative letter 'M' cast into the lower section of each leg. The stand was sized slightly differently for 3.125in. and 3.5in. lathes and could be had as either a plain assembly or complete with either a treadle and flywheel drive or a motor-driven countershaft. The latter was a clumsy arrangement that bolted to the underside of the chip tray with the drive section cantilevered backwards behind the headstock. The motor was hung from a bar, bolted between the rears of the legs near floor level, with the flat drive belt tensioned by its weight.

The later stand, from 1943, was of very much heavier construction and, with its deep chip tray and three sheet steel shelves resting on cast-in plates was, in effect, a miniature version of that used on the Myford/Drummond M-Type. The long countershaft, also a smaller replica of the type used on the M-Type, was heavily constructed and pivoted from a plate bolted to the back of the headstock end leg; fitted with double-step motor pulleys (and in conjunction with backgear) 12 all V-belt driven speeds were available. Adjusted by an over-centre lever the tension of the headstock belt could be adjusted by a left-hand/right-hand turnbuckle – a system still used years later on the ML10.

A very rare fitting for early lathes was a 'foot-motor' – a self-contained treadle-driven device with a 56lb flywheel for bolting under the owner's own bench. Most ML1 to ML4 lathes ➤



were supplied as standard with a 6.5in. dia. faceplate, 10 changewheels, a chuck backplate and two Morse taper centres in tool steel. Myford lathes of the early 1930s were painted black but at some point towards the end of the decade the makers switched to what they described as "grey/blue" - but which, in fact, resembled a dreadful shade of 'vomit green'.

Accessories

A wide range of useful accessories was listed for all types including, in addition

to those already mentioned, countershafts for bench, stand and ceiling mounting, plain and swivelling vertical milling slides (but much lighter in construction than those for the Series 7 models), fixed and travelling steadies, machine vices, V-blocks, thread-dial indicators, a wood-turning hand rest, 4-way toolpost, saw table (very rare), plain and V drilling pads for the tailstock and extra changewheels.

The lathes could also be adapted for light production work with the makers offering

a cut-off slide and a choice of four or six-hole bed-mounted capstan units.

A number of ML2 and ML4 models were sold ready-converted with capstan equipment while a surprising number of other types, probably listed as variants on the ML6, were more seriously modified for repetition work with different beds, headstocks and drive systems.

It is interesting to note that a version of the ML4 continued in production until as late as the early 1980s

in the guise of the Perfecto in the UK. These machines sold into a niche market offering enthusiastic amateurs the chance of a new, good-capacity small lathe at a price considerable below that of the (admittedly far-superior) ML7.

Myford have no spares for any pre-war models and, unfortunately, cannot supply any written or illustrated material about them.

However, www.lathes.co.uk offer an interesting data pack that contains copies of all known literature.

ME

Miniature Internal Combustion Engines

BY: MALCOLM STRIDE

This new book is a welcome addition to the somewhat sparse

information that is available on the subject. When I first became interested in the subject, I was rather surprised at how little information there was available and, over the years, it has become obvious that this is a definite minority interest among model engineers with very little support at the club level.

However, there are a growing number of enthusiasts, although they do appear to be largely of the hermit temperament. It is to be hoped that this book and Malcolm's column in *Model Engineer* will cause a surge in interest, and we shall start to see a greater number of engines appearing.

The book should help in this as it treats the subject very clearly and makes the point that there is nothing more difficult about producing an I/C engine than any other form of model and that the tools and equipment required are, if anything, less than that required for a steam locomotive or traction engine.

In fact it was the lack of requirements for brazing and riveting that attracted me to this aspect of the hobby in the first place! I enjoy machining

and that is the main activity on an I/C engine and, even with the more complex multi-cylinder engines, I always tell people that it is all basic turning, milling and drilling, although sometimes rather a lot!

The book is well-produced and split up into sensible sections, the first being a general review of the subject where types of engine and operating cycles and some notes on design principles are discussed.

Careful study of these first two chapters should give even the newest beginner enough information to be able to make an informed decision as to the likely path to be followed in the choice of a first project.

The points about CAD systems and workshop equipment are well made and neatly lead onto the final chapter of this first section where the type of equipment needed is discussed. As can be seen, there is nothing here that is out of the ordinary in any workshop, but I would strongly endorse the fitting of digital read out to the milling machine, I do not think that I could have built my engines without it.

The second section deals with manufacturing methods and detail design of the various components, starting with crankshafts, and going through the necessary components for a complete engine.

This section is well-illustrated with suggested machining

set-ups and also discusses suitable materials for the various components. As with any suggestions of machining methods, there are some with which I would take issue but they certainly give a good framework for someone starting in I/C engines, and there are some points which could even be of interest to the more experienced builder.

The final section takes a look at the 2-stroke engine and the varying methods of porting, valve timing and control for these engines. There are suggestions for production of components where they differ from the 4-stroke engine.

The next chapter takes a broad look at different engine types including the two types of sleeve valve engines and actually made me understand, at last, how the Wankel engine works.

The final chapter deals with engine operation and trouble-shooting, usually a very necessary activity when I remember the problems I had starting my first attempt.

Altogether a well produced and illustrated book on the subject which I wish had been available when I first started in this branch of our hobby.

Obtainable from:

The Crowood Press, Crowood Lane, Ramsbury, Wiltshire SN8 2HR, Price: £19.95.

ISBN: 978 1 86126 921 8

W. www.crowood.com

B.P.



Variety at Taunton Model Engineers 2008 exhibition

Robert Coles reports on an interesting collection of models seen at an exhibition hosted by the Taunton Model Engineers in Somerset.

Taunton Model Engineers held their annual exhibition on 5/6 April at Heathfield Community School, Monkton Heathfield. As with previous shows, the host club was well supported by other societies in the area. As a departure from the norm, and on one of the first stands in the main hall, there was a display of mechanical models made by year five and six pupils at Wellsprings Primary School. It's good to encourage them. They also considerably reduced the average age in attendance!

The 150th anniversary of the British Horological Institute was celebrated with a display of clocks including a limited edition National Geographic Society World Time Clock displayed by David Spicer, secretary of the Bristol Branch of the Institute (**photo 1**).

On the stand for the West Huntspill Club, Reg Robinson's diagonal paddle engine was particularly attractive. The adoption of round eccentric rods gave the engine a more elegant look than the original Edgar Westbury design (**photo 2**). The feathering gear for the paddles and other details have yet to be completed.

Although the exhibition was held in deepest Somerset, the L&NWR was well represented. Andy Webb's 7½in. Benbow class locomotive was nicely displayed over a mirror so the inside motion could be seen from all angles (**photos 3**). The first job was making wooden patterns for the

wheels that were then locally cast in iron. These are the only castings used on the locomotive. Steel tyres are fitted to the wheels.

Next to the Benbow was an L&NWR 2-2-2 Problem class locomotive in 5in. gauge by Chris Rayward (Hotspur Designs) of Monmouth (**photo 4**).

An interesting comparison of the size differences between 3½in. and 7½in. gauge was provided by the two Adams Radial Tanks built by David Cox of the South Somerset MES (**photo 5**). David knew the originals well from his school days when living in Uplyme.

Outside, between the two halls, the 'yard' was busy with traction engines (**photo 6**) and a Foden 'C' Type lorry owned and driven by Jeff Horrell of Tiverton and District MES (**photo 7**).

The Bristol SMEE stand included *Lion* built by Harry Frewen of Cardiff to the

drawings by John Hawley (**photo 8**). These are the first major departure from the original LBSC design of 1953 and follow the prototype more faithfully.

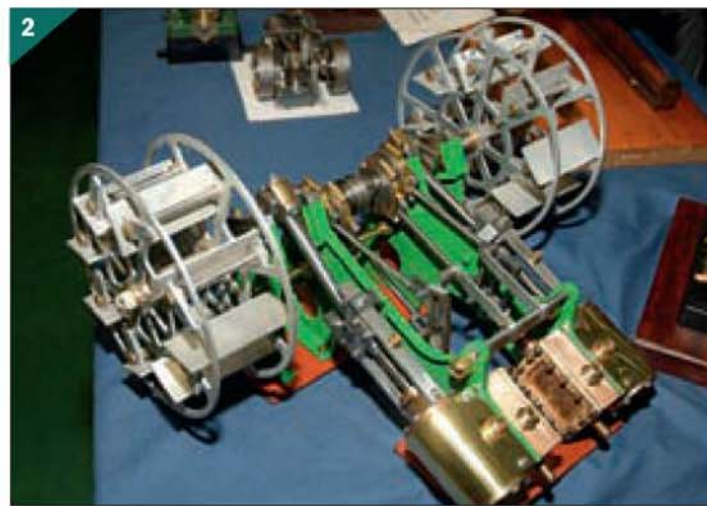
At the other end of the scale was a venerable 2½in. gauge GWR King with a patina that can only be acquired with age (**photo 9**).

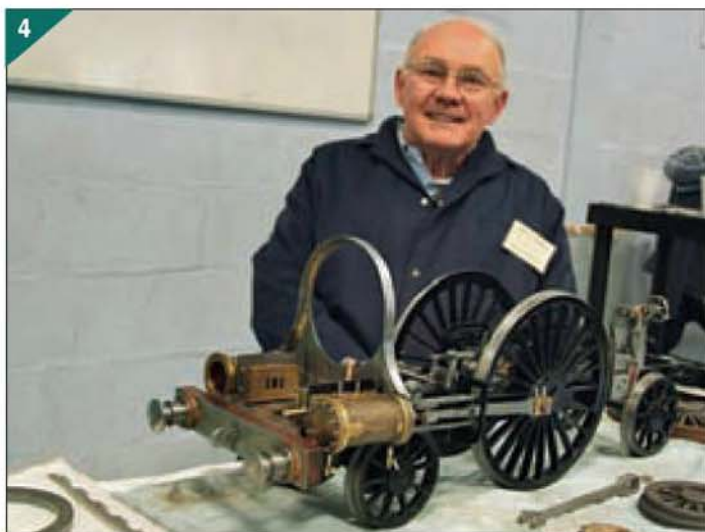
The work of model engineering was demonstrated by John Selby of Taunton who was employed filing a pair of frames. A completed tender chassis was in the foreground as an example of 'one I made earlier' (**photo 10**).

Great Western Railway broad gauge was represented with a Rover class 4-2-2 *Alma* built from official GWR drawings by Vic Doswell of the Taunton ME (**photo 11**). It is built roughly to 1:16 scale for running on 5in. gauge track. Vic likes to model the unusual and also displayed his model of an 1848 Stringfellow's steam

1. David Spicer, secretary of the Bristol Branch of the British Horological Institute with the display celebrating the 150 years of the Institute. The globe is the limited edition National Geographic World Time Clock.

2. Diagonal Paddle Engine to design of Edgar Westbury but with round eccentric rods. Built by Reg Robinson of West Huntspill MES, paddle blade feathering and steam valves have still to be constructed.





aircraft engine.

The 7 1/4 in. Gauge Society displayed several models including an A4 Pacific without its streamline casing and a Warship diesel hydraulic. There was also a large display of photographs showing the world-wide interest in the gauge.

The Taunton exhibition also included perhaps a unique opportunity to compare the valve

gears of the original and rebuilt West Country Class locomotive, with the chassis of Dave Cox's West Country Class with the Oliver Bulleid chain valve gear (how is he going to make the oil bath?), and *Padstow*, the rebuilt version by Bernard North, Bristol SMEE, to original works drawing. It is complete but had been dismantled for painting (**photo 12**).



3. L&NWR 4-4-0 Compound, Benbow class, in 7 1/4 in. gauge, by Andy Webb, one time chairman of the host society.

4. A 5in. gauge LNWR 2-2-2 simple expansion Problem class locomotive designed and marketed by Chris Rayward.

5. Two Adams radial tanks by David Cox, South Somerset MES gave the opportunity to directly compare 7 1/4 in. with 3 1/2 in. gauge. David knew these engines well with footplate trips back home to Uplyme when a schoolboy.

6. A couple of the traction engines working in the yard between the two halls of the exhibition.

7. Foden C Type Lorry owned and driven by Jeff Horrell.

8. The 7 1/4 in. gauge Lion featured on the Bristol SMEE stand was built by Harrye Frewen of Cardiff.

9. A 2 1/2 in. gauge King (LBSC's Kingette) on the Bristol SMEE stand had the patina that only age can bring.

10. John Selby of Taunton Model Engineers showing the hard work involved in producing frames, in front is 'one he made earlier'.

11. GWR 4-2-2 Rover class broad gauge locomotive built to a scale of approximate 3/4 in. to run on 5 in. track by Vic Doswell.

12. Two West Country class light Pacific locomotives, each with different valve gear, allowed examination of both types. The top model by Bernard North is 34008 *Padstow* with rebuilt gear, the lower chassis, by David Cox, and has the original chain-driven Bulleid gear.

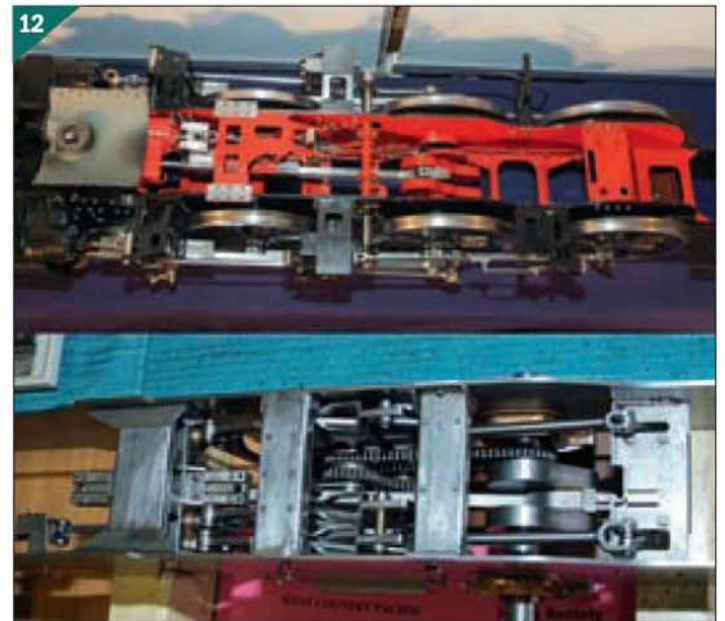


Trade stands included Tracy Tools, Axminster Tools, JB Cutting Tools, HJH Tooling, Noggin End Metals and the boilermakers Western Steam and Cheddar Valley Steam (is there something about Somerset that

attracts boilermakers?)

Saturday attendance was well up on the previous year and Mike Johns, chairman of Taunton Model Engineers, expressing his thanks to the committee, the clubs, trade and caterers who had helped to

make it another success. Plans are already being made for next year's exhibition. **ME**



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- Report from a super Harrogate show
- Steam turbine-powered launch
- BR Ivatt Class 2 locomotive
- Which vernier caliper?
- Club's lottery funding success
- Turning short tapers
- Simple skeleton timepiece
- Oscillating engine
- Stowe locomotive
- Pete's Page

Plus all your regular favourites

Contents subject to change

ON SALE 20 JUNE 2008

LILLIAN

A narrow gauge locomotive for 7 $\frac{1}{4}$ in. gauge

Keith Wilson describes building Lillian's boiler and some general aspects of 'urn' construction.

Continued from page 590 (M.E. 4299, 11 May 2007)

1. Firebox tubeplate (water side) with one tube which just missed getting sufficient silver solder.

2. Firebox side of the tubeplate showing full flow of solder around the tubes.

Fig 1. Side elevation of Lillian's boiler.



A useful habit that I have always encouraged – infuriating to some – is to look both ways before crossing road or railway track, any size, irrespective of pedestrian crossing, state of signals. For it is obvious that deaths of pedestrians only occur when the pedestrian steps carelessly off the pavement; the exceptions to this are very rare indeed. Crossing a track is just as potentially dangerous, and I look both ways on every track, even in a shunting yard where there are many parallel tracks. I know of one fool living in Wolverhampton who likes to think that it is invariably the pedestrian who should have the right of way. I wish he would set the example. Roads would be much safer!

Before I boiler over!

In view of Derek Brown's recent articles on the boiler for Anna (I have heard the words 'Ice Cream Parlour' from the grape vine), there does not seem to be any great need for a complete description of the process for Lillian. However, one

or two things come to mind. In a simple round-topped boiler, to pre-drill all the required stay holes whilst the plates are still 'in the flat' has some merit; some care being required in calculating and measuring hole positions. But I don't think the process would usefully apply to a Belpaire! For those not familiar with the name, the Belpaire firebox on the big GWR types tapers not only on top but on the sides as well. I do not say it would be impossible, but hardly worth the effort.

A similar problem applies to boilers with taper barrels, of which there mainly two types. I am not here dealing with boilers like the 'standard No. 4' for Swindon (Cities, giant Prairies, 72xx, 42xx, Moguls, and one or two others, which have a parallel section immediately behind the smokebox followed by a taper portion up to the firebox. The taper is neither particularly easy to calculate nor simple to mark out. It is possible, but tricky.

Having made quite a few taper barrels myself over the years, (about 200) the easiest course is to make the barrel about 1in. longer than required, roll it into the taper section required (calculations simple), fit the butt strip if not using a coppersmith's joint, silver-braze the joint, and prop the barrel upright on a flat surface and jack it up with bits of metal so that for GWR 'kettles' the bottom of the barrel is dead vertical, when a height gauge can mark out the cutting lines for the final barrel.

Non-GWR 'urns' did not necessarily have the bottom of the barrel horizontal; some

had the centre-line of the barrel horizontal.

Sawing off can take place, by hand, bandsaw, jig-saw – take your pick – and a finisher or hand-held power file will give you a nice clean finish. To line-up such a taper barrel with its firebox looks tricky, but putting the barrel and the outer firebox upside down on the flat surface long enough to suit the boiler. It is then easy to take care of the vertical alignment by means of a spacer at each end, the front edge of the firebox resting on the flat surface. Side-to-side alignment is then a matter of one or two long straight edges. Clamped to the lower edge of the wrapper they make life easier.

I imagine most first-time builders would be building boilers to published designs, but if there are no published designs that suit you, then you pretty certainly will need to do your own. There are very few things to worry about. For the first stage, plate thickness is required. The highest stress is on the diameter of the barrel, this force is exactly twice the longitudinal force. Fortunately, the calculations here are linear – that is squares and cubes, etc., do not apply.

The factors applying are diameter, working pressure, safety factor, strength of material. On these factors depends plate thickness. Generally speaking, boiler materials are either steel or copper for our sizes. Stainless iron can be used, but here it seems we have to tread carefully, there being many varieties. I am unaware of any details here so cannot advise. For that matter, I have

no experience of steel boilers either, but I believe it to be relevant that steel boilers are designed for corrosion, copper boilers for strength, in our sizes of course.

The formula for this plate thickness is absurdly simple. $T = P \times D / 7$. Thickness = Pressure times Diameter divided by 7. This gives plate thickness in thousandths of an inch. This is for copper boiler barrels with a safety factor of 10. This is more than enough, but (as mentioned above) it is linear; that is, half the diameter means half the thickness. So go to the nearest commercially available size above and that is that; no harm will be done by going next size smaller but it will not affect the steaming and the extra weight is useful. All other platework in the samovar should be the same size, apart of course for the tubes.

Obviously, the outline of the kettle will be taken from the prototype – if any. I always leave a gap of $\frac{1}{4}$ in. for cladding; $\frac{3}{8}$ in. for 5in. locomotives. Length of firebox is settled from the prototype. But if such does not exist, then firebox length could be about half the length of the barrel for a narrow box (Belpaire), or the equivalent square for a wide or Wooten

box. Tube length should work out at $1\frac{1}{2}$ to two times firebox length. If longer than two, then a combustion chamber should be considered. Tube diameter is given by tube length. If L/D squared works out between 50 and 70 'tis about right.

For tube spacing, allow $\frac{3}{16}$ in. between neighbouring tubes in 7.25in. size, $\frac{1}{8}$ in. in 5in., not less than $\frac{3}{32}$ in. for smaller sizes.

Reasons for differing from dear old Curly; the matter of scale and drilling tubeplates. He advocated as many tubes as you can get in, and I am sorry to state this, but draw out the tube layout carefully of his Doris boiler (3.5in. gauge Black Five – a very successful puffer) I have made several boilers for this design, and is a merry dickens of a job drilling out the tubeplates even if you start (as you should) from the tubes nearest the centre and work outwards; drilling small holes (about $\frac{1}{8}$ to $\frac{3}{16}$ in. diameter) opening out later.

Holes in tubeplates should be a bit oversize, NOT reamed dead to tube size. Reason: a much better joint is made with the silver-braze material flowing right round the joint and therefore protected and in shear therefore a much



stronger joint results. It is not only easier than dead-size holes with three or four filed nicks round the hole, but better. Incidentally, the idea of a pilot hole first avoids the hole turning out pentagonal (Oh yes it can!).

Many people set tubes into the completely silver-brazed firebox from the outside; exactly just how one can be assured of proper penetration round the inner tubes of the nest, unless you do them one row at a time. Also, it can be a problem to prevent them falling through. Friend Larry Barker made a little gadget for putting an outside dimple in his tubes with this in mind.

Personally, I put the tubes into the firebox tubeplate first, setting this into the firebox later. This means silver-brazing from the inside so to speak; one big advantage being that you can see all around each tube. This is rather difficult from the system mentioned in my last paragraph.

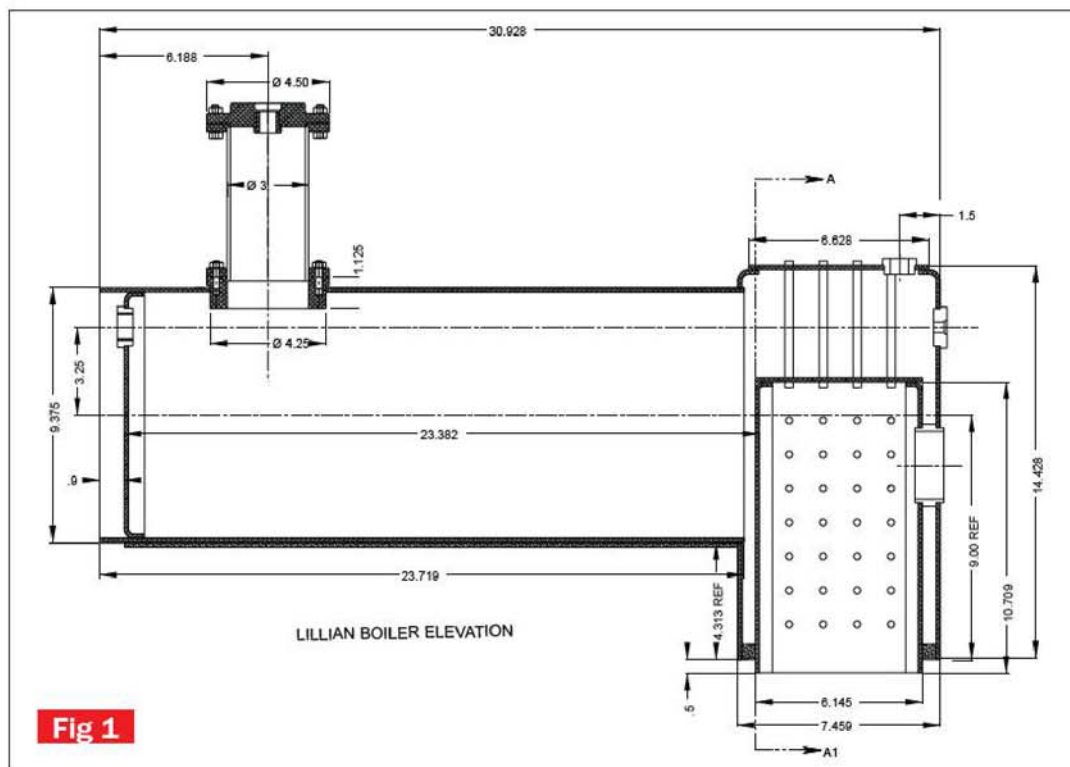
At time of writing we have just set in 35 flues plus six superheater tubes, for some reason we missed marginally one the flue tubes, but this did not show up until after pickling. A brief re-heat plus a bit more flux cured the matter. From the photographs, note that this is quite clear (photos 1 - 4).

On the subject of pickling, several solutions are solutions to the pickling fluid. Copper oxide is quite easily dissolved in acid, whereas copper itself only soluble in concentrated Nitric acid. (I write of fairly common acids, avoiding stuff like Hydrofluoric acid and aqua regia, both stuffs to be very carefully handled and even better avoided).

But there are several mild acids that will do the job at about zero risk. I use sulphuric acid myself at a concentration of about 1 in 30 to 40.

At this concentration, it is relatively safe although it will only sting a little if it gets into an open wound. Take care to rinse immediately afterwards any acid on the skin.

Soap is a good alkaline substance and washing hands with soap will cure any possible problem.



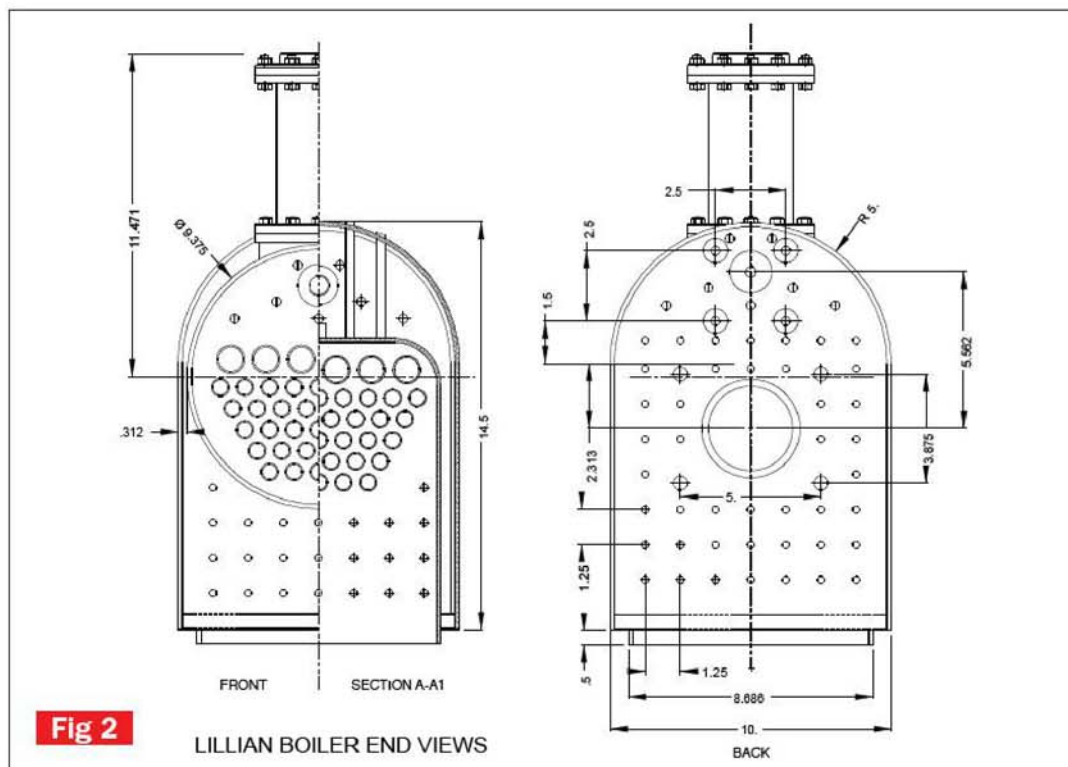


Fig 2

LILLIAN BOILER END VIEWS

3. The firebox parts are assembled to check for fit as construction of the 'urn' continues.

4. Front of the firebox (barrel end) showing the partially completed inner firebox (less tubeplate and tubes) being checked for fit.

Fig 2. End views of the boiler.

Acids for pickling

The only real problem with sulphuric acid is its affinity – when concentrated – for water.

The only worry is that when diluting it, under no circumstances pour water into the acid. Oddly enough, pouring acid into the water is quite reasonably safe. The reason is that when water into acid occurs, no immediate

dilution of any great importance occurs and the immediate reaction can spit the concentrated acid about a bit. With acid added to water, immediate dilution occurs. So the reaction is very much milder. Once a dilution of about 50 percent is reached, it matters very much less and it doesn't matter which is added to which. Although, 'tis best to always do acid-to-water as this encourages the habit. A good deal of heat is produced either way.

Another suitable pickle can be citric acid. Obtainable from reasonable chemists it is a bit easier to dispose of after use. I have not used it myself, but it is well recommended. I would think that formic acid is good too, but I have only

used it in descaling boilers when required. It is sold as Kilrock descaler (other similar products are available), but I suspect could be more painful than the dilute sulphuric acid; for it is (like citric) organic and in the case of formic, evolution has developed its use over a few million years in insects (ants) and nettles (stinging types) as a weapon.

Back to boilers

I suggest that when a crane or overhead hoist has to be used to get the firebox/tube assembly into the outer shell, you are beginning to learn something about boilers!

Useful tips: Have a couple of fairly hefty clamps handy. They make lovely cool handles!

Two or three pieces of preferably stainless steel about ¼in. dia. with a hole in one end the same diameter as your silver-brazing sticks. Reason for stainless? Poor conductor of heat. Alternatively, two or three surgeon's forceps. A friend handy can be a friend indeed, don't I know it!

Bucket of cold water handy. Reason: flesh is a very poor conductor of heat, thus when – not if! – you get a burn put offended portion of body in cold water as soon as you can. It

works very well – I should know!

On a big kettle, a piece of chain is useful. For if you have to work on a hot samovar and it is not too stable, the chain can be a useful connection to an overhead hoist or beam. Kept just barely tight, should the kettle be nudged a gnats too far, then 'tis not likely to fall far or badly. Also it can help you to remember NOT to try and catch the cauldron.

A scam warning

Although 'tis not model engineering, this is a very important message. There are people about who will deliberately cause a road accident (under certain conditions) in order to make an exaggerated and fraudulent claim on your insurance. I have been done in this way, a freshly started car followed me to the opposite side of the road from theirs and carefully rammed into my driver's door, without any warning such as skid, horn honk or flash of light. There were two of them both bigger than me.

This occurred several months before I learned that deliberate accident causers existed, so I let the matter rest – couldn't do much else.

About a year later via a fraudulent solicitor they tried to claim over £5,000 for hiring a car whilst theirs was 'under repair'; for this sum they could have purchased several cars of the type they used.

If such 'accidents' occur to you, then there are people looking into the matter and correlating matters, so please T. 0800 328 2550. or visit W. <http://www.insurancefraudbureau.org/>

●To be continued.



WILSON'S WORDS OF WISDOM

A great tragedy of science - the slaying of a beautiful hypothesis by an ugly fact.

T. H. Huxley.



Malcolm Stride reports

Notices

Northern Association Narrow Gauge MLEC 2008
Rochdale SMEE - 14/15 June.

The **Rochdale SMEE** Narrow Gauge MLEC Steering Committee has now released the information with regard to the rules of the competition and entry application forms.

Further information with regard to the competition, which is open to all and not restricted to society members of the Northern Association, can be seen on the society website at www.RSMEE.com or by contacting Richard Guthrie, T. 01706 369430.

Napier Heritage Trust

The Trust celebrates the 200th anniversary of the company (D. Napier & Son) this year, and among other events is holding **Napier Powerex 200**, a weekend event at the Buckinghamshire Railway Centre, Quainton, Buckinghamshire, on 21/22 June 2008. There will be numerous exhibits of the company's products including the following on display: aero engines, **Deltic** locomotive (running), Napier cars, Napier turbo charger exhibition, the Napier **Railton**, (which will be run), three-wheeled mechanical horses, extensive model display, a working Napier slot car track, and displays by other organisations. An RAF fly-past has been requested. Further details of this and other events can be obtained from E.

secretary@napierheritage.org.

uk or from the website at www.napierheritage.org.uk

Nuneaton SME Exhibition

We have received notification from Secretary Andy Crow, of the **Nuneaton SME Exhibition** which will be held at the Heritage Centre, Avenue Road, Nuneaton, Warwickshire over the weekend of 2/3 August from 10.00am until 4.00pm on each day. The entrance fee is £1.50.

Whissendene 2008 – a last minute reminder

The **Melton Mowbray DMES** Miniature Steam Rally will be held on Saturday/Sunday 7/8 June 2008 at Whissendene Sports Club, Melton Road, Whissendene near Oakham in Rutland.

This rally is run by model engineers for model engineers and enthusiasts, and it is probably the largest rally of its kind in the country. Over 90 miniature steam road vehicles (traction engines, rollers and wagons) will be in attendance ranging in size from 2in. scale up to half size together with two full-size steam wagons and a steamroller. The emphasis will be on engines working and giving demonstrations including giving rides around the extensive grounds.

One of the highlights will be the road runs into the village - two on Saturday and one on Sunday. These are great occasions to see the engines working - particularly on the one mile long up-hill return journey. They are well supported by the villagers.

Over 20 railway locomotives have been booked in and all will have the opportunity to run on the society's ground level 3½, 5 and 7½in. gauge track, again, giving rides. In addition there will be an exhibition of model engineering and also model aircraft with some trade stands.

Refreshments will be available throughout the weekend (and the bar will be open at certain times).

Admission is free, everyone is welcome. The event will be signposted from the A606, Melton Mowbray to Oakham Rd.

North Cornwall MES

Geoff Wright, secretary of **North Cornwall MES** has sent details of forthcoming events at the society. There are two Sunday Steam-up events at which visitors are welcome. The dates are 22 June and 27 July. The elevated 3½ and 5in. gauge private track is located at 'Appleton', Week St. Mary, Cornwall, approximately 6 miles from Bude, and further details can be obtained from Geoff Wright on 01566 86032.

UK club news

The centenary year at **Bradford MES** has got off to a good start with two excellent winter meetings produced entirely by members. The centenary clock has finally been completed and members will have at least four versions to choose from. The design of clock face used has been accepted for the commemorative floral clock to be provided in Lister Park during the year by the council. In spite of all this excitement, maintenance tasks still continue with around 200 sleepers on the ground level track replaced with recycled plastic ones. The siding into the left-hand carriage shed has been levelled and work on the gardens continues. By the time you are reading this, the boating section will have held the 100 Boats Event at the boating lake to celebrate the anniversary.

One of the items mentioned in the March newsletter of the **Stamford MES** is the book **Trustee from the Toolroom** by Nevil Shute. The main character in the book is possibly based on Edgar T. Westbury and it is required reading for all model engineers. Many readers may not be aware that the book is still in print and is available with the paperback version (ISBN 9781842323014) published by House of Stratus. The February meeting was a talk by Steven Perry entitled **The History of Perkins** and was the story of Perkins diesel engines where Steven had worked for 31 years.

It has been a productive year for the **Westland & Yeovil**



1. A busy scene in the steaming bays of Westland & Yeovil DMES.



DMES. The Thursday gang have put the club track into good shape, a new container has been purchased to ease the storage problem, and the club engine has its new boiler. Chairman 'Spike' Humphries is described as "a wizard with the weather gods" so all the outdoor steaming events were blessed with fine conditions. The highlight of Thursday evening events this winter was Bob Alderman's talk on the **Tornado** project, which was reportedly attended by the entire membership. This April, the society display at the Taunton model show was well populated with models, all different to last year, and under almost constant siege by visitors. At the AGM in April, Secretary Colin Walford retired after 25 years of service and was replaced by Malcolm Sadler. For more information and the events list see the club website at www.communicate.co.uk/twc/yeovilmodelengineers.

Winter maintenance work at **York City DMES** has included fitting the final vertical palings, cappings for the posts, and long cappings to bridge the top edge of the palings on the new fence. The one remaining job is to cut some blocks to fit at the centres between each post position to secure the long capping to help prevent distortion.

The material stack behind the clubhouse has been sorted and items either consigned to the skip or restacked behind the fence for future use.

Brian Wardman has continued his efforts to level all areas where he can and will continue to excavate the space allocated for the ground level track shunting area which is to be extended.

Some tree pruning and felling has been carried out to encourage the Hawthorn to bush producing more blossom at a lower level and helping to screen the running shed etc. The advice received from the council regarding the Elm was to cut down to ground level any that were at or close to six inches in diameter as these are at risk of Dutch Elm disease. This would also encourage a particular type of butterfly habitat.

John Sutcliffe continued work on the ground level track station and the signal steelwork has been delivered by Pat Martindale.

The lengthy job of fitting the retainers for the anti tilt rails on the raised track has continued with the help of many members over the last few weeks and there is still much to do.

World club news

Canada

The **British Columbia SME** is starting its 16th year of operations at the Confederation Park track site. This prompted Lindsay McDonnell to comment in the newsletter about the changes that have happened to our hobby over the years. Particularly the trend towards bigger locomotives, the increase in numbers building in 7½in. gauge and more passenger carrying running. Is this trend signs of a decline in our hobby or is it beneficial?

There was an interesting attachment for milling (or drilling) machines shown at the April meeting of **Toronto SME**. Member Ken Strauss brought in a lighting fixture he has made using LEDs housed in a piece of scrap plastic pipe screwed to an aluminium back plate. He bought the LEDs from Hong Kong and built a regulator into

the fixture. It draws only 5 watts and is very bright. The fixture mounts around the spindle of his milling machine and is held in place by magnets.

New Zealand

There was a good collection of items at the **Auckland SME Bits & Pieces** meeting in February including a very nice chemical works tank wagon in 5in. gauge by Chris Ratcliff from a Doug Hewson kit. Next were a couple of drill sharpening jigs by Brian Cotton, one made in Japan was reasonably accurate and one from China not quite so, Bruce Lawson produced an old but well made remote controlled car mostly made from Meccano. It all worked well judging by the demonstration run around the floor of the clubhouse.

Murray Lane showed a portable lathe he made to machine some of the parts of a full-size beam engine.

Murray Granger had some parts of a 3-cylinder petrol engine he is building.

Hugh Martin displayed the manifold for his **Prairie** locomotive. The base was a casting but the valves were all Hugh's work. Hugh also showed a lovely little oscillating engine and boiler set he made for his Grandson for Christmas.

Mike Jack had some of his CNC made connecting rods plus some CAD drawings to make some more.

Bill Parker brought along the chimney for his traction engine. He is trying various paint systems to see which handles the heat best.

Graeme Quaille has obtained rail and sleepers to make garden gauge track. The sample section looked good and is available in 3.6 metre lengths, saving a lot of joints.

Graeme Murray had another couple of his ingenious gadgets. The first was a cutter to cut plastic tube cleanly from the inside. The other was a system to put a small amount of soluble oil where it is needed. This avoids breathing in any of the fluid that could have bugs in it that cause lung problems.

Locomotives at the Waitangi

Day run at **Hutt Valley MES** included the three club engines; No. 2970, Ec8 and *Speedy* along with Mike Hartle's Dg760, Brian Wheeler's *Bridget* and Henry Hillind's *Harry*. The variety of motive power ensured that plenty of visitors took rides behind several different locomotives and the six-trip tickets proved popular. There was a slight hiatus when one of the larger locomotives derailed at the points causing a slight backlog while it was re-railled. It was reported that the public appreciated the excitement.

Members of **Maidstone MES** have done quite well at the track. The society had fine weather, (almost drought conditions), on both running days in February and managed good takings. Because of the drought conditions the club has used only the petrol-engined club locomotive in the last few months. The fire risk to surrounding vegetation is seen as extreme, and members are not prepared, for the meantime, to risk the use of solid fuelled steam locomotives on the track. The petrol-engined locomotive has performed well; it has certainly earned its keep. There is still some work to complete to bring the second petrol driven engine, the NZR TR, to the stage where it can be used for regular passenger duty.

Humour time

So I rang up British Telecom, I said "I want to report a nuisance caller", he said "Not you again."

I saw this bloke chatting up a cheetah; I thought "he's trying to pull a fast one."

"Doctor, I keep thinking I'm Mickey Mouse or Donald Duck."

"How long have you been having these Disney spells?"

Good King Wenceslas phoned Pizza Hut with his order. "Is that the usual?" the man asked.

"Yes, deep pan, crisp and even."

All from **Auckland SME**.

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.

George Blair	Toronto SME
Tom Lund	Rochdale SMEE
Brian Shadwick	North Cornwall MES

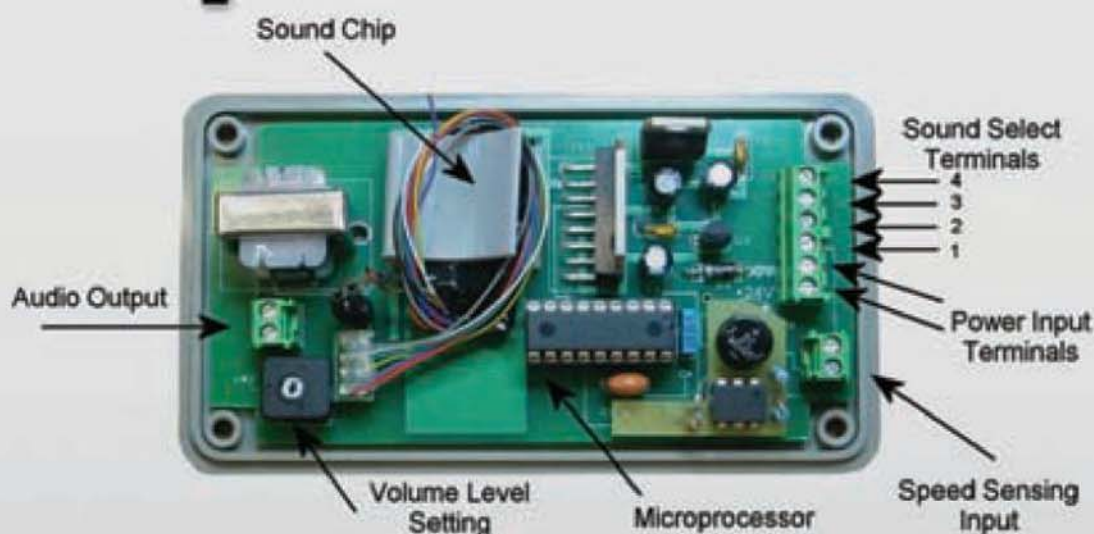
JUNE

- 6 Aylesbury (Vale of) MES.** Track Night. Contact Andy Rapley: 01296 420750.
- 6 Maidstone MES (UK).** Evening Run & Pizza. Contact Martin Parham: 01622 630298.
- 6-8 New Jersey Live Steamers, Inc.** Spring Meet. Contact Karl Pickles: 718 494 7263.
- 6 Rochdale SMEE.** Alf Molyneux Remembers. Contact Bob Denyer: 0161 959 1818.
- 6 Romford MEC.** Competition Night. Contact Colin Hunt: 01708 709302.
- 6 North London SME.** Tim Coles: A Gas Turbine for Sin. Gauge. Contact Rachael Chapman: 01442 275968.
- 7/8 Cardiff MES.** 18th Welsh Locomotive Rally. Contact Don Norman: 01656 784530.
- 7/8 Dockland & E. London MES.** Public Running. Contact John Slocombe: 01708 222658.
- 7 Hereford SME.** Public Running. Contact Nigel Linwood: 01432 880649.
- 7 Ickenham DSME.** Public Running. Contact Ian Mortimer: 01895 635596.
- 7-9 MELSA.** Queen's Birthday Run. Contact Graham Chadbone: 07 4121 4341.
- 7/8 Melton Mowbray DMES.** Whissendine 2008. Contact Phil Tansley: 0116 2673646.
- 7/8 Oxford (City of) SME.** Sweet Pea Rally. Contact Chris Kelland: 01235 770836.
- 7 Romford MEC.** Trackside Afternoon. Contact Colin Hunt: 01708 709302.
- 7 SM&EE.** Stationary Engine & Gauge 1 Day. Contact Maurice Fagg: 020 8669 1480.
- 8 Bradford MES.** Rae Gala. Contact John Mills: 01943 467844.
- 8 Bristol SMEE.** Public Running. Contact Trevor Chambers: 0145 441 5085.
- 8 Canterbury DMES (UK).** Public Running. Contact Mrs P. Barker: 01227 273357.
- 8 Carlisle DMES.** Open Day. Contact Geoff Routledge: 01228 530767.
- 8 Edinburgh SME.** Track Running Day. Contact Robert McLucke: 01506 655270.
- 8 Harlington LS.** Public Running. Contact Peter Tarrant: 01895 851168.
- 8 Leeds SMEE.** Running Day. Contact Geoff Shackleton: 01977 798138.
- 8 Leicester SME.** Public Running. Contact John Lowe: 01455 272047.
- 8 Lincoln DMES.** Running Day. Contact Terry Peacock: 01522 681424.
- 8 Maidstone MES (UK).** Public Running. Contact Martin Parham: 01622 630298.
- 8 Norwich DSME.** Running Day. Contact Shirley Berry: 01379 740578.
- 8 Nottingham SMEE.** Public Running. Contact Pete Towle: 0115 987 9865.
- 8 Saffron Walden DSME.** Public Running. Contact Jack Setterfield: 01843 596822.
- 8 Sutton MEC.** Track Day. Contact Bob Wood: 020 8641 6258.
- 8 Taunton ME.** Public Running. Contact Nick Nicholls: 01404 891238.
- 8 York City & DSME.** Running Day. Contact Pat Martindale: 01262 676291.
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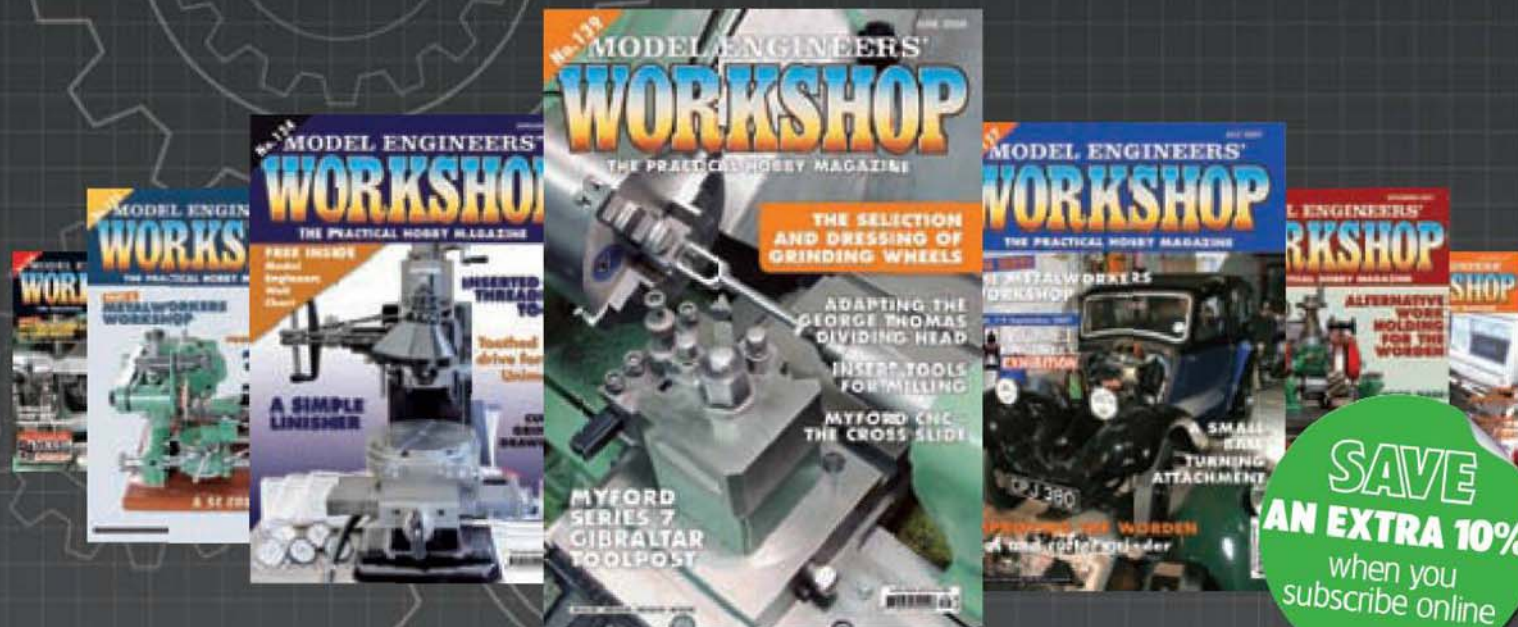
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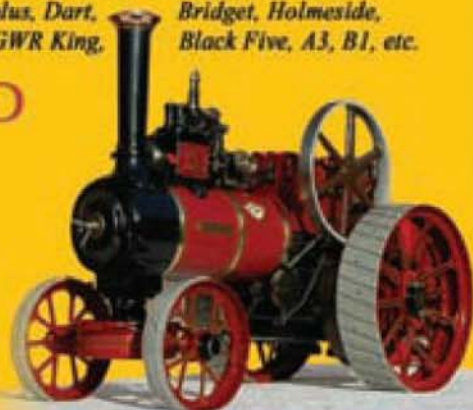
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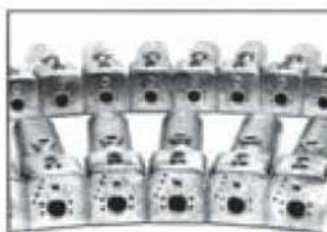
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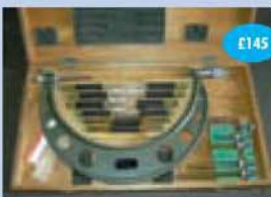
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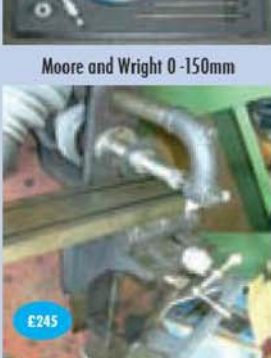
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