



# *The Journal*

The Society of Model and  
Experimental Engineers



Book review  
Hearth Hound  
Digital Jottings  
The cathead and how to use it  
The Loughborough Bellfoundry

Cooling fin optimisation - part 1  
Breaking my 'Don't make a tool' rule  
Decorative heat bluing of steels - part 7  
"The New Year started badly for the G.E.R..."

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We look forward to receiving articles for inclusion in *The Journal* from you, the members of SMEE. Articles should be relevant to model or experimental engineering, and may be news items, technical articles, small ads, hints and tips, lessons learnt or any other topic likely to amuse, educate or enthuse your fellow members.

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or

Mike Tilby - Editor.

Norman Billingham and Mike Chrisp - article editing and final proof reading.

Mike Chrisp - Work on the Table; Graham Astbury - proof reading.

Alan Wragg - initial proof reading.

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# The Journal

The Society of Model & Experimental Engineers

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**Front cover image:** *The late Cherry Hill at the Midlands Model Engineering Exhibition - 2023. She is standing in front of three of her models and the Duke of Edinburgh Trophy which she won on nine occasions.*

**Photo:** Jonathan Tickner

## **Publisher’s statement**

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## View from the chair

As this is the first *Journal* of 2025, Happy New Year! Inevitably, at this time most of us look back on the year that has gone and forward to what the new year will bring. We make resolutions; some we manage to keep!

For SMEE, I look back with the combination of satisfaction, regret, some sorrow and a lot of gratitude. During 2024 we noted the inevitable passing of some well-known and well-liked members and we are thankful for the contribution every one made to the culture and well-being of our society. The deaths of Cherry Hill and Ed Turner were particularly felt. Ed's contributions to our training courses, particularly grinding, brought him wide contact and respect from within SMEE.

Cherry's contributions to SMEE and the hobby in general were widely noted in obituaries in the press and online. *The Daily Telegraph* devoted a half-page, *The Times* a marvellous full-page and the BBC Radio 4 'Last Word' programme included a lovely review of her life. SMEE has enjoyed the reflected glory of her more than 60 years membership. We shall include an appreciation in a future edition of *The Journal*.

Unfortunately, we have also learned that Harold Hall also passed away just before Christmas. His contributions to the hobby included a lengthy period as editor of *Model Engineers' Workshop*, taking over from Stan Bray, the editor who launched the magazine. His website (<http://www.homews.co.uk/>), many high-quality books and many videos have been so useful to newcomers to the hobby. Though slightly old-fashioned in today's YouTube world, they are superb primers for newcomers.

During 2024, visits to Amberley Museum in West Sussex and the Loughborough Bell Foundry were well-attended and our programme of talks and 'Tea Rooms' has been popular. Bill Carter's grandchildren Mary Crabb and David Hatherill gave two very contrasting talks in October and November. Bill Carter is remembered by older members for his excellent teaching and winning the Duke of Edinburgh Trophy twice. EBG online session by Joe Noci in Namibia on his work to help with wildlife conservation work for lions and by Quinn Dunki, the well-known online teacher of model engineering, from Canada, confirmed our footprint. Despite the rain Steve and Dilly Bil hosted a joint meeting with the Steam Boat Association at their boatyard and Peter and Elizabeth Wardropper were great hosts to a good turnout at their garden party. It was a very wet summer!

Final words on 2024 must include thanks to Martin Kyte for his contributions to *Model Engineer* on our behalf; to Mitch Barnes and others whose articles include mentions of their links to SMEE and to Dr Russell Walshaw who brought us the generous bequest from his aunt and uncle Stanley and Regina Wilkinson.

Unfortunately, at the year end, changes in banking arrangements and the process of transferring the role of membership secretary led to difficulties in membership renewal and sincere apologies are offered to those who have been messed about. Hopefully, things



Elliot Hirst

are now just about straightened out.

Looking forward, some tasks are clear. Thanks to Norman Billingham's help, our programme looks good, though we have experienced a number of last minute changes. Please update your diaries. We often receive comments that members would like to hear a bit more about models and model engineering topics. Please step forward if you can offer something. There will be a number of retirements from Council at the AGM as terms of office come to an end as required in our constitution. If you feel you could make a contribution as a council member or as part of the team, please come forward. We need some new faces and ideas to take the Society onwards. For me, I intend focusing on activities that make us better known and bring in more members. Getting our training programme restarted is a particular challenge and finding new ideas for the next Midlands Model Engineering Exhibition in October is another.

In closing, I think we should wish success to Neil Wyatt in his new task of editing the combined version of *Model Engineer* and *Model Engineers' Workshop*, *Model Engineer & Workshop* (See the announcement on page 34).

With best wishes

*Elliot*

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## Council Matters

1. Marshall House Electrical Testing – As required by our insurance, a periodic check of the electrical installations in Marshall House has been carried out by a registered contractor. No problems requiring immediate action were found but a number of important repairs and upgrades were noted. Council agreed that all of the recommended work should be carried out and approval was given for the required expenditure.
2. Finance – Banking Arrangements – The planned transfer of our main account from HSBC to Lloyds is continuing. (The Lloyds account is more suited to our needs as a 'not for profit' organisation.) Some of the recent membership renewal problems and delays were due to a combination of issues including this change.
3. Finance – Role of Treasurer – David Taylor has indicated that after more than 40 years in the role he feels it is time for a change. On behalf of the whole membership Council thanked David for his excellent management of our finances over this very long period and asked him to stay on Council as a co-opted member for a period to ensure the best possible transfer.
4. Finance – Budgets – to avoid members having to use their own money for minor purchases and consumables, small budgets for House and Workshop were approved.
5. Website – Brian Neale is working with others to update and improve the current user experience. This will be a gradual process. Efforts are to be made to increase the use of the site and it is planned to include a location for our monthly 'Work on the Table'. It was again noted that the WhatsApp groups that are being used by EBG and Workshop users are proving very useful for day to day updates but are not the place to store long-term or archived data.
6. Marshall House IT – Recent donations of a number of used PCs with good ▶

specifications will be used to provide PCs for the Electronics Lab, the Kemsley room remote camera, the Carter Room and the Library.

7. Membership Lists – To ensure compliance with latest recommendations Nick Lock will prepare a Privacy Policy as part of the process of publishing a new membership list.
8. Cherry Hill– The recognition of Cherry Hill in obituaries in many areas including national newspapers and BBC Radio 4 was noted. Mike Chrisp and Elliot Hirst represented SMEE at her funeral along with many other members. Her contributions to SMEE were noted in many anecdotes and it was agreed that an appreciation of Cherry would be included in a future issue of *The Journal*.
9. House – The lack of a House Chairman and Committee continues to be a problem and tasks fall to *ad hoc* volunteers who are currently looking at needs for internal decoration and some external repairs.
10. Workshop – revisions to the layout will accommodate the spare Myford Lathe and a bench is in construction for the CNC router that has been in store for some time. A small Sieg lathe that is surplus to requirements is to be sold.
11. New members – applications from the following were approved at Council meetings in December and January:

|                    |                      |
|--------------------|----------------------|
| Mike Ginn          | Danbury, Essex       |
| Staffan Qvarnström | Svartsjö, Sweden     |
| Brian Haseler      | Beaumaris, Anglesey  |
| Ian Armstrong      | Sandhurst, Berkshire |
| Charlie Allen      | Lewes, East Sussex   |
| Roger Nathan       | Oxford, Oxfordshire  |

SMEE

## Member to member

### For Sale: 6 ins scale 3 ton Burrell

A half size replica of the smallest engine built by Burrells – their 3 ton ‘Special Light Traction Engine’ of 1897 – as described in *The Journal* Vol. 27 (2), April 2019.

It is fully up and running and comes with driving trolley and everything necessary for operation – including several steaming-days worth of genuine Ffos-y-Fran coal.

Ideal for anyone wanting something a bit different to play with while they finish that long term project!

A new boiler was fitted in 2018. Since then it has had little use and been kept in a dehumidified workshop.

It was built from the general arrangement drawings published in Ronald Clark’s ‘Steam Engine Builders of Norfolk’.

Location – south Norfolk.      £12,000 o.n.o.

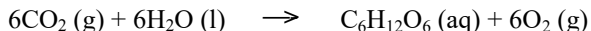
For more details of both the model and the prototype:-  
Bill Starling:      Tel.:



## Correspondence

### Photosynthesis

Dear Editor, Gareth's 'Hearth Hound' discussion of photosynthesis in the last *Journal* reminded me of my days of teaching basic thermodynamics to first-year chemistry undergraduates. As part of the course, students had to learn about measuring and using energy changes in chemical reactions. I tried to make it relevant by looking at reactions which have real importance. One such is photosynthesis, which is essentially the reverse of the combustion reaction of glucose:



|                                                                                                     |
|-----------------------------------------------------------------------------------------------------|
| $\text{g} = \text{gas},$<br>$\text{l} = \text{liquid},$<br>$\text{aq} = \text{in aqueous solution}$ |
|-----------------------------------------------------------------------------------------------------|

Using calorimetric data for the combustion, the students could calculate that the energy change for this reaction is  $2813 \text{ kJ mol}^{-1}$ . To add a bit of interest, I asked students the follow-up question "*Assuming that in photosynthesis the absorption of one photon leads to one molecule of  $\text{CO}_2$  being converted into glucose, calculate the longest wavelength (lowest energy) of light which could lead to photosynthesis, and comment on the answer.*" I found that looking at the answers very quickly showed which students thought about what they were doing and which simply wrote down an answer without thinking about it.

If anyone fancies a bit of calculation to bring in the New Year, have a go – I'll reveal my answer and the explanation next time. Just to save you looking it up, the relation between the energy  $E$  of a photon and its wavelength  $\lambda$ , is:

$$E = \frac{hc}{\lambda}$$

where  $h$  is Planck's constant ( $6.6 \times 10^{-34} \text{ Js}$ ) and  $c$  is the speed of light ( $3 \times 10^8 \text{ ms}^{-1}$ ). Avogadro's constant (the number of molecules in a mole of any substance) is  $6.02 \times 10^{23} \text{ mol}^{-1}$ .

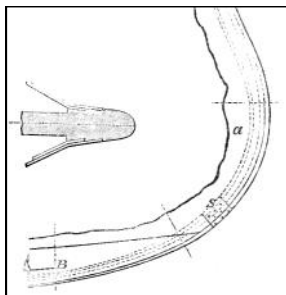
Norman Billingham, Sussex

### How did Victorian engineers plane around a curve?

The following is from the book *Shipbuilding in iron and steel* by E.J. Reed, published 1869.

*"The stem having been forged ...., is sometimes bent to form and planed afterwards, and at other times planed first and then bent. The best method is to bend it first and plane it afterwards ; but the planing in that case occupies a long time, and is very costly, owing to the planing-tool having to be made to travel round the varying curvature of the stem."*

The stem was a large forging that formed the leading edge of the bow. It generally had a T-section as shown in the drawing, The plating would be attached in the rebates on either side. I assume the planing operation was to form the rebates that had to be well formed so as to be suitable for riveting on the plates.



Can anyone explain how Victorian engineers planed around a curve?

Mike Tilby, Newcastle upon Tyne

# The Loughborough Bellfoundry

## John Spokes

describes the SMEE visit on 6 November 2024

**P**ossibly a case of self-deception, but I've developed a view that engineering today is more machine code than, what was commonly described as, manual skills. This notion was somewhat moderated by the SMEE visit to the Loughborough-based Bell Foundry of John Taylor and Co on 6 November. This was a trip splendidly organised by our Chairman, Elliot Hirst, and the day was rounded off by a very sociable late lunch at a town hostelry.

The origins of the company can be traced back to nearby Leicester, where, in the 14th century, the then mayor of Leicester, Johannes de Stafford, established a small bell foundry. In 1784 the Taylor family became involved. First, Robert Taylor (1759-1830) and then his son John Taylor (1797-1858). The foundations of the Loughborough works were laid in 1839. John Taylor had bid successfully for the recasting of the bells in Loughborough's Parish Church, but a condition of the contract was that the work had to be executed in Loughborough.



**Photo:** Ashley Dace, CC BY-SA 2.0, <https://commons.wikimedia.org/w/index.php?urid=17753308>

Commonwealth. The subject of bell founding may immediately lead one to recall Whitechapel, but this company ceased trading in 2017, the premises since receiving some rather exotic schemes for redevelopment.

Since 1839 the Loughborough foundry has cast 25,000 bells, the most notable of which is Great Paul, cast in 1881 and which rings out from St Paul's Cathedral and weighs 16 tonnes. During the bell's eleven-day journey to London many roads were damaged or destroyed with consequent complaints and claims against the company. For the pop aficionados among our members, one of Taylor's bells was taken by the Australian Rock band AC/DC on their Back to Black tour in 1980. There is a video of the relevant track, *Hells Bells*, on YouTube and small memorabilia of the occasion are exhibited in the



*John Spokes*

museum, together with mementoes for sale in the museum shop. The Taylor-cast bells in St Thomas's Church on New York's Fifth Avenue can be heard in The Pogues and Kirsty McColl's *Fairy Tale of New York*.

The casting process begins with making the bells inner mould, the core, using foundry loam and this is given the required shaped inner profile of the bell using a 'strickle' or 'sweep', as it is called. The core is then kiln dried after which a special coating is applied and set alight. This coating protects and reinforces the core during casting. The outer mould, the cope,

is constructed in a cast iron case, any inscriptions are added, and the outer mould lowered over the inner mould to create the complete casting assembly.



**Photo:** Jonathan Tickner

In most instances the cast iron cope for bells of a particular size and tone are already available from earlier projects. Bells are cast (logically) from bell metal, which is a bronze containing 78% copper and 22% tin, by mass. The metal is heated to 1100 °C (2010 °F) and, before pouring, any slag is ladled off and the metal stirred with a willow pole, evidence of the black arts still employed. The salicylic acid in the willow removes any final impurities. For reasons of safety, the mould assembly is buried in a pit of sand and once the metal has been poured it is left for a few days to slowly cool before the mould is lifted and the core and cope separated to reveal the new bell. Now begins the challenge, that of tuning the bell.

In the 16th century bells were cast in different sizes to sound a particular note, an initiative driven by the desire for change-ringing. This process was refined by chipping pieces off the bell edge or from the inside surface and, even at this time, some bell makers were using a type of lathe. In 17th century Holland, the renowned bell founding brothers, ▷



iron cope for bells of a particular size and tone are already available from earlier projects. Bells are cast (logically) from bell metal, which is a bronze containing 78% copper and 22% tin, by mass. The metal is heated to 1100 °C (2010 °F) and, before pouring, any slag is ladled off and the metal stirred with a willow pole, evidence of the black arts still employed. The salicylic acid in the willow removes any final

Pieter and Francois Hemony, together with the brilliant, but blind musician Jacob van Eyck, gained an understanding of and developed a tuning system for the five separate and distinct tones contained in each bell's ring – the nominal tone and four overtones, which sounded in a similar way to a chord on a guitar or piano. This enabled bells to be made that rang in harmony and gave rise to carillons. By the 19th century, tuning had attracted the attention of science and became highly developed. It was realised that over the length of a bell the frequency of the note varied with the square of its thickness and inversely with its diameter. The Hemony's approach was rediscovered by Taylors in the late 19th century and was the catalyst for the now familiar harmonically-tuned English church bells. In 1876, Taylors manufactured a ring of twelve bells to fit inside Sir Christopher Wren's, then vacant, Northwest Tower in St Paul's Cathedral. Four of these bells were donated by The Turners Company, one of the oldest Livery Companies in the City of London, and which was already a guild in the 12th Century. Some 200 years later, Edward III decreed that 'wooden measures, as well for wine as for ale' should be made only by 'turnours' with marks of their own – and the medieval turners established the English 'pint' as an official measure. In 1604 the Company received its Royal Charter from James I. To this day, the Company continues to celebrate and support the 'art or mysterie' of turning. Although for most of its existence the Turners were working in wood, the next opportunity you have to create swarf on your Myford, Colchester, etc, think on; someone had been at this craft long, long before it came to your attention!



Today, all of Taylors bells are tuned by turning, primarily using a Webster and Bennett 48 in. vertical turning and boring machine, although the tuning workshop was equipped with two other similar machines dating back over 100 years. The nameplate on the W and B machine indicates a Coventry origin, however, the company is now located in Oldbury and still sells similar vertical turning and boring machines up to 72 in. chuck diameter and a range of CNC machines and machining centres of various configurations. So, we are back to computers and to reinforce this message I have to sadly relate that Taylors bell tuning has a similar ring (groan!) in that a computer is used to determine where and how much metal



has to be turned from the inside surface to obtain that perfect nominal tone and harmonics.

All is not lost! The Taylors' works employs many skilled craftsman and apprentices from what appeared to be a relatively young work force. Taylors is able to provide a complete service of bell manufacture and renovation including items such as the bell headstock, the wheel, the clapper and the complete bell frame. The clapper is cast iron, as is typically the headstock, although some are of welded fabrication. The wheel, constructed from eleven pieces of specially shaped wood, is assembled on an adjustable

*Photo: Jonathan Tickner*



jig. Traditionally, bell wheels are constructed from three different types of wood. The spokes are made from oak, the sole (the part of the rim on which sits the bell rope) from ash and the shrouds (the sides of the rim which contain the rope) from elm. The bell frames can be constructed or repaired using timber, usually oak, however, Taylors' usual way of creating a new frame is as a welded steel fabricated structure. During our guided tour the sordid subject of Bitcoin did not arise, as



**Photo:** Jonathan Tickner

I recollect, but as the production of bells and their accoutrements are heavily skilled labour-intensive activities, then I can imagine the cost of renovating or replacing a peal of bells probably relies largely on some rich benefactor.

Twenty-six members of SMEE, including partners and friends, participated in our visit. Some had travelled a considerable distance and, in addition to the guided tours, there was the opportunity to investigate the museum, which very proficiently outlined the history and art of bell making, together with some fine examples of the art and craftsmanship of Taylors' skilled work people throughout the years. Bell casting normally takes place on a Thursday, the day after our visit, but unfortunately the visitor's gallery for this event is relatively small and is reserved for those who have some attachment to the bell or bells being cast, probably a sponsor.

For those who missed this excellent day out, I would recommend a visit if you are in

the vicinity of Loogabarooa, (as our Stateside cousins call it) and I point out other nearby attractions, such as the Great Central Railway, operating at a scale of twelve inches to the foot, and Leicester, where was recently buried the remains of Shakespeare's malevolent villain, King Richard III.

**Photographs** are by the author unless otherwise noted.

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## Breaking my ‘Don’t make a tool’ rule

**David Hatherill**

describes a very useful yet simple innovation.



David Hatherill

Anyone who knows me will know that I am not interested in making tools, although that doesn’t mean for a minute that I don’t have plenty of tools. As Lee Mack (comedian) said on *Celebrity Bake Off* “*Why would I make a Swiss roll, when I can buy one for 99p?*” I have much the same philosophy: If I need a tool I will buy it, and if I can’t buy it, it suggests that there’s already an established better way of doing something that hasn’t occurred to me yet: a prompt to work out what it is. Yes, special tools are required for certain operations specific to a part, but a need to make generic tools? No.

Very occasionally though you come up against one of those, why hasn’t anybody thought of this, type moments.

Some time ago I had a need to cross drill a small shaft. A not uncommon need and one that can be accomplished by a variety of methods, some less accurate than others.

A great way of doing this is to use the V grooved drill pad that goes in the tailstock. This ensures that the drilled hole is properly on the centre line of the shaft.

I have a Myford one of these and it works well...ish. I say ish because according to Myford “*This is used in the tailstock. The work is to be clamped to the pad, allowing you to drill using the headstock.*” All well and good except the back of the pad is in fact machined at an angle making clamping an impossibility. That’s not a criticism of ‘new’ Myford by the way as they have always been like that, and those produced by other lathe manufacturers are mostly the same.

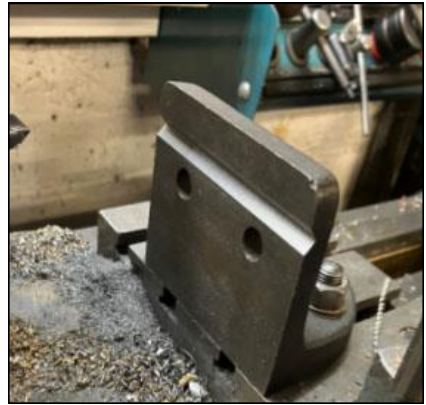
You can hold the work in the Vee, but it risks machining the back of your knuckles away on the drill chuck, and the work is likely to move as you change from initial centre drill to twist drill, added to which Myford tailstock barrels are prone to jiggle a bit as the locating key becomes worn (which mine is).

So, a sound principle, but rather lacking in practicality.

Surely there is a better way.



The answer is in fact a very simple adaption of the same principle. I purchased (why make it after all: remember that Swiss roll) a relatively small used angle plate for a bargain price, bolted this to the cross slide and machined a V groove across it with a 90 deg carbide cutter, which must, due to the method used, be at centre height.



And that's it: job done.

This now allows much more convenient clamping and can still be used as a standard angle plate at any other time. It's quick to set up, easy to use, more accurate than before and cost a smidgeon over £10 to make which was just the cost of buying an old angle plate.

In addition it is possible to accurately space multiple holes where more than one is needed: see below.



Having broken my 'Don't make a tool rule' I am off for a lie down.

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## Decorative heat bluing of steels

**Guy Gibbons, OBE, MIMechE**

Part 7 (of 7) - Bluing machine tool components and overall summary.

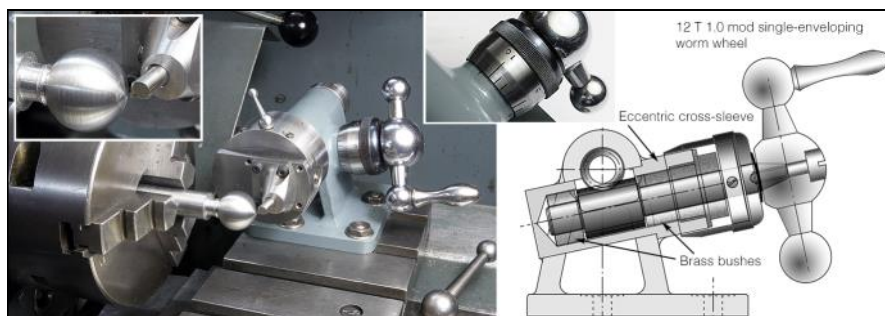


*Guy Gibbons*

### Machine tool handles

Which brings me back full-circle to Figure 1 at the start of Part 1 and the PID-controlled bluing box's performance on ball handles.

Having a few extra second-grade ball handles made for my Quorn tool and cutter grinder some years ago using my own design ball turning attachment – **Figure 28** – I experimented with bluing them in the PID-controlled bluing box on a sheet of 0.25 mm Nomex, the smaller one at a SV of 290 °C for 100 minutes and the larger one at a SV of 295 °C for 160 minutes. Machined from EN1A steel and finished with 150 grit paper before heat bluing, the results were successful – **Figure 29**, the blue colour taking on a darker hue when wiped with oil as is appropriate for a machine tool handle. Indeed, the larger handle with its longer soak time at a slightly higher temperature (SV) took on a slightly blacker hue as perhaps can be seen from **Figure 29**, left.



**Figure 28:** Making a ball handle using my spherical turning attachment. Using a modified Geo. H Thomas dividing head tailstock casting offering a far more robust accessory than one mounted in a lathe top slide, this attachment is based on the Alfred Herbert Ltd design illustrated in W.A.J. Chapman's Workshop Technology, Part III, Figure 248.

### Feed screw thimbles

Another example of machine tool components made by the author can be seen at the top centre of Figure 28. Made in the style of those fitted to Myford Super 7 lathes, the fine straight-knurl to this friction-adjustable feed screw thimble was the first machining job while there was plenty of bar stock to hold in the lathe 3-jaw. After finish machining, the fiducial marks were then engraved using a Vee-point screwcutting tool set on its side in the set-over topslide before stamping the numerals with a punch. The punch burrs were dressed off with a smooth flat needle file.

Being too large to fit in my PID-controlled bluing box and perhaps being less critical on ►

uniformity of colour, the whole thimble was then heat-blued over a tray of brass swarf using a flame and quenched in oil. The bright steel areas were then polished with 1200 grit paper to leave the fiducial marks and numerals clearly readable\*.



**Figure 29:** Machine tool ball handle bluing trials. No lidded chamber was used, but the Nomex sheet coupled with the handles' large thermal mass and long soak time did contribute significantly to the even colouration

## Overall summary – Parts 1 to 7

Flame-bluing undoubtedly has a place in the skill-set needed by engineers as can be seen not only from Figure 28 but also for bluing the occasional screw on a bluing plate held in a flame (Figure 3). So too does bluing in bluing salts, but it is hugely messy.

But as a mess-free alternative, the PID-controlled bluing box definitely does have advantages in many applications. As in all 'ovens', one crucial factor is the avoidance of thermal gradients above the hotplate, and no matter how well-fitted the lid, the temperature does decrease with distance above the hotplate. It is why domestic ovens are fitted with circulating fans and top-mounted heaters. The effect of these thermal gradients can be minimised by placing the component to be blued parallel to the hotplate surface and keeping the gap between hotplate and lid as small as possible (ie. immersing the component in a thermal layer with as uniform a temperature gradient as possible).

Whatever bluing method is used, the time taken to achieve the correct blue colour will vary depending on the soaking time as well as the temperature. This is dependent upon the method and rate of heat transfer (conduction from touching the hotplate or convection from the fluid (air)), the number of touching points, and the rate of heat absorption at other non-touching points. In this respect, 0.25 mm Nomex sheet does help considerably in improving the uniformity of the achieved shade of blue, even if it does increase the soaking time.

The thermal mass varying along the length of the component will also affect the local heating (and hence soaking) time, and the consequential uniformity of the blued colour. This lack of uniformity can be minimised by using a lower temperature for longer soaking times (e.g. 10 minutes or more – see Figure 5).

Bluing larger components such as machine tool ball handles was successful using Nomex insulating sheet and long soak times (> 60 minutes). Cooling in oil also tends to

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\* A method described, I think, in one of Geo. H Thomas's writings many years ago.

improve the uniformity and darkness of the finished handle.

The achieved shade of blue will vary depending upon the alloy content of the steel and the surface roughness (surface finish), but these factors I have not investigated in any depth\*. Nor have I investigated heat colouring to temper colours other than blue (eg. straw, browns or purples), but in all cases the changes in colour take place over a very narrow temperature/time band. It is on this point that, theoretically, the PID-controlled bluing box should score heavily, especially if the exact shade of colour needs to be the same on a number of identical components.

An observation window in a bluing box is a real asset in determining the temperature/time settings for a repeatable colour.

## The future of PID-controlled bluing

Overall, I think I can say that the PID-controlled bluing box does result in successful bluing, though, perhaps like all workshop equipment, it did not entirely remove the human element (both in set-up for the specific type of component coupled with operator gaining experience in its use from bluing components). As mentioned before, using long soak times at a lower temperature does improve the uniformity of the colouration<sup>1</sup>. However, one huge benefit of the PID-controlled bluing box is to remove the messy elements of flame bluing or bluing in salts.

I have a number of thoughts about how the primary issue of avoiding thermal gradients within a bluing box might be addressed, but to do so would require a fundamental reconfiguration of my design. My wilder thoughts suggest induction heating under the control of some type of thermal imaging device, but this really is blue sky thinking and well beyond my ability.

Coming back closer to ground, perhaps the most fundamental need is to learn from domestic cooking oven manufacturers and provide fan-circulation<sup>2</sup> of the heating fluid while supporting the component preferably on an insulated shelf in a lidded casserole dish? But having already taken thousands of hours work (and thousands of pounds Sterling) on my research, it would be a new design project for which I have no immediate plans.

## Acknowledgments

My grateful thanks to SMEE members Adrian Garner, Mike Tilby, Jake Sutton and Brian Neale for their most useful thoughts both during my trials and in their subsequent comments on the format and content of this paper. My thanks also to Justin Koullapis of WatchClub (Royal Exchange, London) for his experiments that led to the development of my borosilicate test tube chambers for bluing small components.

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\* In general terms, the higher the polish and harder the steel, the more iridescent the blue.

<sup>1</sup> Staying with an analogy to domestic kitchen equipment, it is perhaps like a dishwasher: you get good results, but whereas hand-washing the dishes perhaps takes a few tens of minutes, a dishwasher takes a few hours.

<sup>2</sup> Maybe a Peltier effect motor driver ('stove fan') could be used to avoid the need for an additional power supply?

## Digital Jottings - 17

**Brian Neale**

CNC Coordinate Systems – just where in the world are we?

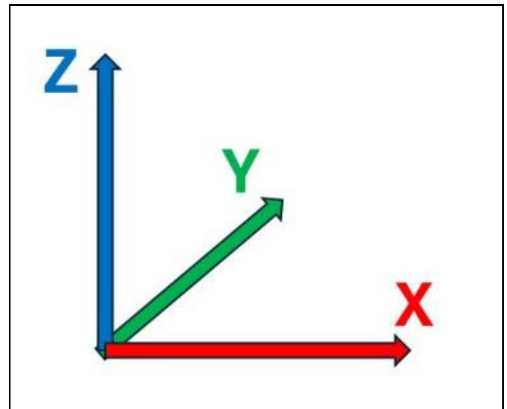


*Brian Neale*

In my last column, I mentioned the need to understand coordinate systems and how they applied to a CNC machine. This is an area that does confuse newcomers to the subject, and even though I come from a fairly mathematical background I was a bit baffled about what all these fancy words that I had read about meant in practice and how to apply them. Still, as with so many things, it all became clear with practice and I don't even think that much about it today. But it would have been so much easier to have had it explained in terms that suited a beginner! So, here goes...

Let's start with something that most of us will have encountered in school – a simple graph. Imagine a piece of blank paper in front of you, with the usual axes marked on it, going left-to-right and up-and-down. Can you remember which is X and which is Y? My mnemonic for this is “X is a-cross” – left-to-right, in other words. Not as instantly

memorable as some of the mnemonics used by medical students where “*the ruder the better*” is the guiding rule but this one works for me! Let's also assume that the axes meet in the bottom left-hand corner, at the point where  $X=0$  and  $Y=0$ . However, our machine needs a third axis, the Z axis, which we can't draw on our piece of paper as it stands. We can imagine, though, that it passes through the origin (the point where the axes cross) – but does it come up out of the paper or down into the table? In fact, while both are potential answers, the convention that is universally adopted in the CAD and CNC world is to assume a ‘right-hand coordinate’ system.



*A right-hand coordinate system.*

If you were looking at the head of a (right-hand thread – the usual kind) screw inserted at the origin and started to unscrew it, then it would move along the Z axis. In other words, the Z axis comes up out of the paper. Although I have never seen it explicitly stated in so many words, all CNC machines and all the software that creates toolpaths to use with them use this right-hand system. Not an issue if you are using a ready-built machine but if you have built your own from scratch, this is the way you should set up the three axes.

Now, take a walk with me out to our imaginary workshop where we shall find a typical model engineer's milling machine. To be precise, a bench-top machine where the table

moves left-right, forwards-backwards, and the spindle moves up and down. Not every machine is like this, but it probably represents the kind of machine most of us have. Convention says that the X axis means left-right movement; Y axis is forwards-backwards, and Z axis is spindle up-down. Remember the imaginary piece of paper we created above? Place it on the machine table so the X and Y axes are aligned with the machine axes, and the origin ( $X=0$ ,  $Y=0$ ) is at the front left-hand corner of the table. Now move the table so that the spindle is over the origin – front left-hand corner, of course. Take a good mouthful of your hot beverage of choice because we are getting to the bit that confuses people.

Wind the table all the way to the left. Forgetting the fact that we moved the table, look at the position of the spindle over the axis drawn on the paper. Can you agree that the spindle has ended up at a positive X value? That is, as we moved the table, the value of the X coordinate increased. This is at the heart of most confusion – even though the table moved to the left, the X coordinate increased. The machine moved in the positive X direction. You must forget about the table movement, whether it was left, right, or whatever, and just look at the position of the spindle with respect to the table. If the table starts over the LH end of the table and ends up over the RH end, X is increasing.

Now wind the table back to the starting point – over the origin on our piece of paper – and wind the table towards you. This is movement along the Y axis, and we can see that because the spindle is now over a positive Y value, then the machine movement was in the positive Y direction.

If you can get to grips with X and Y, then let's think about Z. Actually, this is not too bad on a bench-top mill as the table stays put and it is the spindle that goes up and down. Doesn't matter if we are looking at the quill movement with the head staying still or the whole head goes up and down – it's the relative movement of the spindle and the table that matters. However, it seems a bit more intuitive that as the spindle goes up, Z increases – and that agrees with the imaginary Z axis coming out of our piece of paper that had the axes on. It gets less intuitive for a floor-standing machine where the spindle stays still and the table goes up and down. In that case, as the table goes up, the spindle gets closer to it – and that means that the machine is moving in the negative Z direction! Not so intuitive, but if you think about it, it does make sense.

Setting up the machine so that the X, Y, and Z axes move as per the above is vital for a CNC machine, but the same things apply if you are doing something like installing a DRO on a manual machine. You should really set it up so that the figures on the display change in the way I have described above. It is possible that this might not agree with the dial calibrations on one or other axis, and this can lead to even more confusion. I would strongly suggest that you ignore the dials from this point on, and especially if there is any conflict between the dial and the DRO calibration. After all, if you have a decent DRO installed, why do you need to look at the dials anyway? Maybe this sounds a bit heretical to some, but I have barely ever looked at the handwheel dials on my manual vertical mill given that there is a nice big easily-read



DRO at eye level that I can read wherever I stand at the machine – and it never loses count of how many full turns I have put on, as I used to do with my Dore-Westbury back in the day. In fact, although I used (several different) Myford lathes and was well-used to reading handwheel dials, once I bought a second-hand lathe with DRO fitted I was completely converted to the electronic displays.

Which reminds me that there are a couple of other situations to consider. As an example, some years ago I built a CNC router and like many similar machines, it uses a moving gantry. The Y axis means movement of the spindle along the gantry (towards and away from me) while the X axis moves the gantry left and right along the bed of the machine. In order to stick with convention, the ‘origin’ is again at the bottom LH corner of the bed. However, the machine is configured to take into account the fact that in this machine, it is the spindle that moves above a fixed table – the exact opposite of the milling machine that I used in my example above. Just think about where the spindle moves in relation to the table/workpiece and ignore which bit of the machine provides the actual movement.

The other situation is the lathe. Naming the axes and getting the positive and negative movements correct generates an awful lot of hot air and confusion on Internet discussion forums from time to time! In fact, it is quite easy. As far as the coordinate system is concerned, the lathe is just a vertical milling machine lying on its back. So, cross-slide movement across the bed is X, saddle movement along the bed is Z, and if you should happen to have a vertical slide fitted, this would give you Y. It all makes perfect sense – but you might need a few minutes to think about it!

One last snippet while we are talking about movement axes. X, Y, and Z are all linear movements. What about rotary movement? For example, you might have a dividing head on the milling machine table. Well, corresponding to the X, Y, and Z linear axes, we have A, B, and C rotary axes respectively. So, with the usual way a dividing head is set up with its rotary axis along the table – along the X axis, in other words – this provides us with the A rotary axis. Spindle rotation would be around the C axis. But don’t ask me about naming of axes on the modern 5-axis machining centres – that can wait until they are regularly seen in amateur workshops, and I’m not expecting that to happen any time soon!

Well, rather than a few minutes you have a couple of months to think about it, and I’ll see you in the next edition of *The Journal*. I would like to take our discussion of coordinates to the next level by discussing machine coordinates, work coordinates, the relationship between them, and when and how to use them. Another area of potential confusion for the starting CNC-er that we can try to clarify.

*To be continued*

## Correct answers to the Christmas Quiz

- 1: A. Locomotion No. 1 (formerly *Active*)
- 2: B. 1825
- 3: C. 1959
- 4: C. Aston Martin
- 5: A. Corgi
- 6: B. Forging
- 7: A. Ohm
- 8: C. Triumph
- 9: C. Harley Davidson
- 10: B. Relay
- 11: A.  $\frac{1}{4}$  -20 UNC
- 12: B. 0.2%

The winner will be announced at the Society's meeting in February.

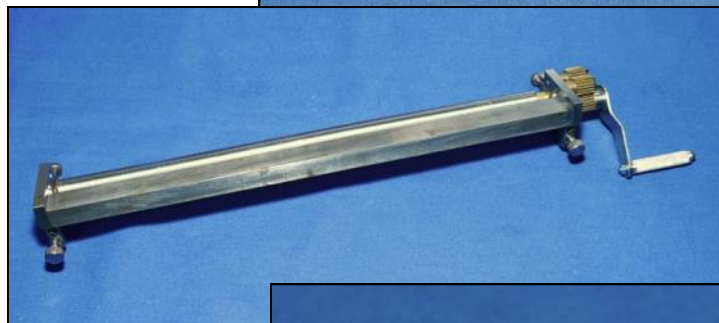
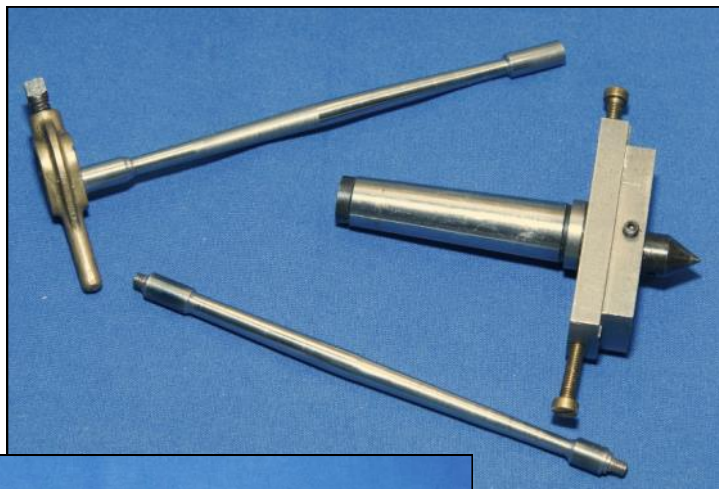
## Work on the virtual table

*Joseph Sissons says that he has been building a work bench to fit his extremely small shed so he can fit in his Myford lathe. He says this is still work in progress since he plans to install under-bench drawers and increase storage arrangements on the walls.*



## Work on the real table: 20 December 2024

*Currently building a James Coombes table engine with castings from Stuart Models, Allen Berman showed his early experiments in producing fish bellied rods using a tailstock taper turning attachment from a Hemingway kit.*



*Graham Nickson is making good progress with his small bending rolls which are nearing completion.*

*One of a pair of tender toolboxes made for the Webb 1800 gallon tender of his L&NWR locomotive, Charles Warr showed progress so far and notes the requirement of individual hinge pins to be fitted after painting.*





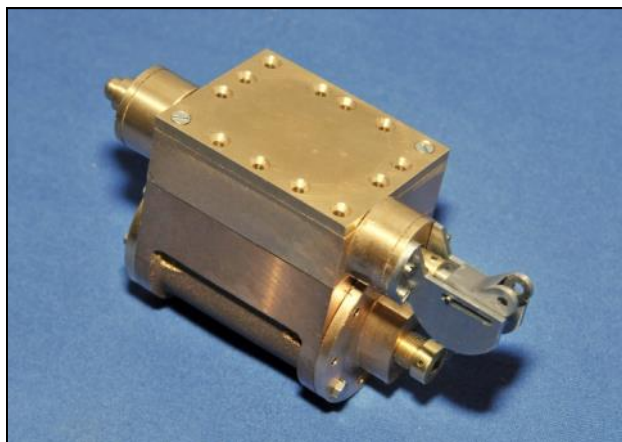
*Jonathan Tickner's solid toolpost for his Boxford lathe with its custom box.*



*Joe Sissons showed three items including a slot drill re-sharpened on a Worden tool and cutter grinder, a bearing and screw assembly for a standing press for bookbinding and a copy of The Amateur's Lathe by L.H. Sparey re-bound using the press.*

**Photographs  
by  
Jonathan  
Tickner**

## Work on the real table: 11 January 2025



*Stephen Milward showed a nicely machined cylinder assembly for the LMS Stanier 2-6-4T he's building to Martin Evans' 3½ in. gauge Jubilee design, a locomotive commemorating the Diamond Jubilee of Model Engineer magazine in 1953.*

## Looking back to 2024



*20 December: Elliot Hirst cuts a slice from the pork pie, hand-made for us by his local butcher, to celebrate our pre-Christmas meeting.*

*Photos: Jonathan Tickner*



### **Some of the speakers who gave talks at the Society's general meetings**

*(These are all the speakers for whom I could find photos)*

**Photos: Jonathan Tickner**

*Video recordings of these talks and many more are available on the SMEE website*



*Allen Berman: Conservation of the Harry Roughton Mill Engine (3 February).*



*Roger Backhouse: Why make models? ( 2 March).*



*Alasdair Milne: Making battleships (6 April ).*



*Marilyn Greene: Trains, drains and remains (4 May).*



*Mary Crabb: Forces in transition (5 October).*



*David Hatherill: Why accuracy is important and sometimes it isn't. (2 November).*

## **Details of Cherry Hill's award-winning model of the 1863 Blackburn Agricultural Engine**

*(A photograph of the entire model and a brief description are shown on the back cover)*



For full details of this amazing model see: David Carpenter's description at:

[https://  
www.modelengineeringwebsite.com/  
Cherry\\_Hills\\_latest.html](https://www.modelengineeringwebsite.com/Cherry_Hills_latest.html)

Photos: Mike Chrisp



# Cooling fin optimisation - part 1

**Graham Astbury**

investigates the best arrangement of fins for cooling a small hot-air engine and is surprised at the answer.

## Background

Many years ago I built a hot-air engine to the design of T.E. Haynes (**Ref. 1**) but only recently made a propane gas burner to be able to run it properly (**Ref. 2**). Previously I had used a Bunsen burner which had to be hand-held as the burner was too long to place under the hot end of the cylinder and this proved rather inconvenient other than for short periods. Haynes suggested in his book that some form of cooling such as fins or a water jacket might be beneficial, so I did try a cooling coil made from  $\frac{1}{4}$  inch diameter copper tube and some 28 mm copper tube as I had some to hand. This too proved inconvenient as it necessitated filling and then draining the reservoir for every run and had to be filled almost to the top, making spillage of hot water likely (**Photo. 1**). I had never run the engine for a long period as holding the Bunsen burner by hand was not particularly comfortable. So, having fitted a new burner, I decided to investigate the use of direct air cooling using fins for the cold end, instead of water cooling. The 'cool end' of the engine is just about 25 mm long and 32 mm in diameter so the problem was to design the fins to get the maximum cooling in the limited available space.

## The problem

The major problem with setting out to design some suitable fins was the almost total lack of basic data of how much heat needed to be dissipated. In cases such as these, it can be useful to carry out a Fermi Approximation, which is a methodology to estimate a value for an unknown quantity by making considered estimates from sparse known data (**Ref. 3**). From the previous results obtained for the new burner for propane (**Ref. 2**), the gross heat output of the burner is a nominal 340 Watts by calculation using gas flow data supplied by the jet manufacturer and a literature value for the calorific value of the propane. Since hot-air engines are known to be inefficient, it is likely that the heat losses would far exceed the work output. A previous test resulted in an estimated power output of the engine to be



*Graham Astbury*



**Photo. 1.** *The engine with the new propane burner and the original copper cooling coil.*

about 1 Watt but this has not been reported separately. Assuming that the entire engine was perfectly adiabatic, i.e. there is no loss of heat except from the cooling fins, then the heat to be dissipated would have to be  $340 - 1 = 339$  Watts. This is clearly unreasonable as the flame is open and does not heat the hot end of the cylinder up to a temperature where it is visibly red hot. The efficiency of a modern condensing domestic central heating boiler is typically at best 90% efficient and some older non-condensing boilers will have efficiencies much lower, typically around 60% as there can be gaps which admit cold air into the combustion chamber between the flames, reducing efficiency (**Photo. 2**). Consequently, as the output of the new burner

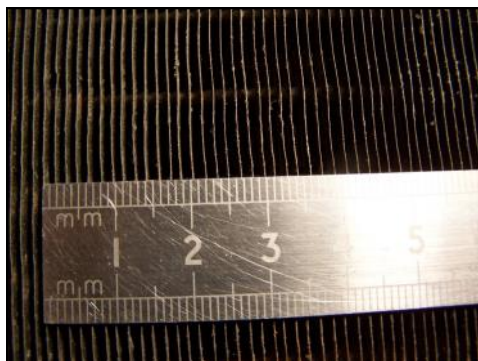


**Photo. 2.** A typical burner for a non-condensing central heating boiler showing the gaps between the flames. (Photo courtesy of Paul Huzar, Boiler Services Ltd, Hawkchurch, Exeter).

on the engine is much less than that of a boiler, and it is not enclosed to conserve heat, the maximum efficiency is likely to be much less, so a figure of around 10% might be more realistic. This would suggest that the heat actually used by the engine is more like  $340 \times 0.1 = 34$  Watts. Taking the mechanical power output as 1 Watt, the heat not doing useful work and being rejected by the engine (i.e. lost to the surroundings) would be something around  $34 - 1 = 33$  Watts, which is not excessive and could probably be achieved using fins. Consequently, the best way forward would be to try to establish the most efficient fin arrangement - that way, it would dissipate the maximum amount of heat with the lowest temperature difference between the 'cold' end of the engine and the surrounding air, yet would fit into the available space. Therefore it seemed appropriate to have a look at the readily available information on heat transfer to air.

Looking at an automotive finned tube heater matrix, the fin spacings are 1.6 mm (**Photo. 3**), whereas domestic central heating panel radiators have fins spaced at typically at 20 to 25 mm centres, protruding about 25 mm between the two panels (**Photo. 4**). Consequently, it appeared that the fins were designed for their specific duties as there is a wide discrepancy between these two types. The closely spaced fins are used for forced convection where air is blown over the fins by a fan in the car ventilation system and the heat transfer is not reliant on just natural convection as is a domestic central heating radiator. Therefore it seemed sensible to see what design information, if any, was available for natural convection from domestic central heating radiators.





**Photo. 3.** Closely spaced (1.6 mm) fins on an automotive heater matrix.



**Photo. 4.** A 'Type 11' domestic single panel domestic heating radiator.

## Domestic radiators

As central heating radiators are specifically designed to dissipate their heat by natural convection, a manufacturer of such radiators was used as a starting point (**Ref. 4**). Looking at the available designs, there were radiators which had one panel which was plain on one side and finned on the other - a 'Type 11' radiator as in Photo. 4 - and a double radiator with two panels, one panel plain on both sides and the other panel finned on one side and plain on the other as in **Photo. 5** - a 'Type 21' radiator. For a Type 11 radiator 300 mm high and 1200 mm long, the output was 674 Watts at a temperature difference of 50 K. For a similar sized Type 21 radiator the output was 938 W at the same temperature difference. Note that the usual unit for temperature difference is the Kelvin (not degree Kelvin!) and uses an upper case 'K' to distinguish it from the lower case 'k' which is the abbreviation for kilo. The difference between the two outputs can be seen to be that of a single panel which is plain on both sides, by effectively subtracting a Type 11 radiator from a Type 21 radiator. As the radiator size for these data is 1200 mm × 300 mm, the surface area of both sides of a single panel without fins is  $1.2 \times 0.3 \times 2 = 0.72 \text{ m}^2$ , so the heat transfer rate is  $(938 - 674) / 0.72 = 367 \text{ W/m}^2$ . As the temperature differential for the specified output is 50 K, the overall heat transfer coefficient is  $367 / 50 = 7.34 \text{ W/m}^2\text{K}$ . The term 'overall heat transfer coefficient' is a way of specifying the heat lost from a surface per unit area and unit temperature difference between a heating surface and the surrounding air. Where there is a 'film' of heated air, it



**Photo. 5.** A 'Type 21' domestic double panel domestic heating radiator.

is often called the film coefficient as the heat transfer from the water to the air through the steel of the radiator consists of three coefficients: the inside film coefficient for the water in the radiator; the coefficient for conduction through the steel of the radiator; and the film coefficient of the air on the outside. As water has a high specific heat and high density compared to air, the water-side film coefficient is very much higher than that of the air side and the steel also conducts heat very well, so it is the air-side film coefficient which is the ruling case.

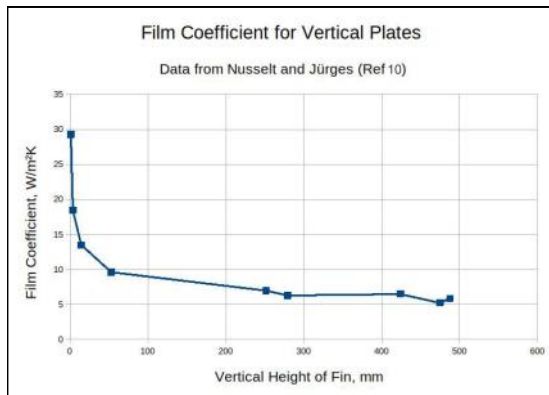
## Literature search

Taking a more scholarly approach, some chemical engineering and heat transfer text books were consulted, particularly **Refs. 5 - 8**. They were all more descriptive of industrial scale units, with only little attention being paid to natural convection from fins. Of the four, Coulson and Richardson did provide a calculation method for circular fins on a horizontal pipe, which is much the same as would be required for the hot-air engine cooling. However, their method did not take into account the fin spacing and was mainly centred on small fins of 8 mm height. There is a nomogram published in Perry (**Ref. 9**) to estimate the heat transfer coefficient of a flat, vertical surface exposed to free convection of air. Unfortunately, due to copyright restrictions, it cannot be reproduced in this article. This is rather old data and is presented in imperial units, so the nomogram result has been converted into metric units. In compiling this nomograph, several assumptions were made. The first assumption is that the average film temperature of the air is 50 °C. The air-flow pattern is very complicated and assuming an average temperature is a great simplification, as the air film at the bottom of the vertical surface will be almost at ambient temperature, whereas the air film against the top of the surface will be much hotter. The other assumptions are that the temperature difference between the surface and the surrounding air is 50 K; and the pressure is 1 atmosphere absolute, i.e. atmospheric pressure. Assuming that the film temperature of the air against the surface is an average of 50 °C; then the heat transfer film coefficient is about 6.0 W/m<sup>2</sup>K. Note that the average temperature has been estimated because of the variation in air film temperature mentioned above.

Shack (**Ref. 7**) also presents some data from Nusselt and Jürges (**Ref. 10**) on the film coefficient of air heated by a vertical isothermal plate, which shows that the film coefficient is high for a short vertical distance, and rapidly falls to a broadly constant value when the height exceeds about 300 mm. The data is presented in graphical form in **Fig. 1**. From **Fig. 1**, it can be seen that at the size that would be anticipated for the cooling fins of about 100 mm in height, the film coefficient is around 9 W/m<sup>2</sup>K, giving a good estimate of the film coefficient that could be expected from the fins. Whilst this did give some guidance, it was not specifically for multiple vertical fins.

As the semiconductor industry often relies on natural convection from finned heat sinks for cooling power devices, there is a plethora of extruded aluminium heat sinks of sizes from the very small to those of considerable size and this seemed an appropriate area for searching for a design method, rather than a largely historical treatise on industrial cooling systems. The most useful item found was a diagram giving the temperature rise versus ►

heat dissipated for various sizes of single square vertical flat aluminium plates. This was available for download from **Ref. 11**. Choosing one of the curves applying to an aluminium plate 10 cm square, i.e. 100 cm<sup>2</sup>, of 5 mm thickness, in a vertical position would dissipate 25 Watts with both sides free and a temperature difference of 81 K. From this data, the film coefficient can be estimated by ignoring the thermal resistance of the vertical flat plate itself, with the relevant calculation being:



**Fig. 1.** Data of Nusselt and Jürges for natural convection (from Ref. 10).

$$Q = U \times A \times \Delta T \quad (i)$$

Where:  $Q$  is the overall heat transmission rate in Watts,  
 $U$  is the overall heat transfer coefficient in W/m<sup>2</sup>K,  
 $A$  is the surface area in m<sup>2</sup> and  
 $\Delta T$  is the temperature difference in Kelvins.

This can be rearranged to calculate  $U$  from: 
$$U = \frac{Q}{A \times \Delta T} \quad (ii)$$

and substituting the values from the example above, remembering that there are two sides to the plate, would give:

$$U = \frac{25}{2 \times 0.1^2 \times 81} = 15.4 \text{ W/m}^2\text{K}$$

This is rather higher than the estimated values from the domestic radiator manufacturers (Ref. 4); the nomograph given by Perry (Ref. 9) and the work of Nusselt and Jürges (Ref. 10). As the information presented with this graph is not authoritative, it may be unreliable since there are two different formulae suggested for calculating the thermal performance and both cannot be correct. As the performance is considerably higher than the values from other sources, it can be taken to be optimistic and will not be used unless further data suggests otherwise. Clearly, a realistic value of film coefficient is required in order to allow the fins to be designed so as to give the required heat dissipation without the fins becoming excessively hot, which is what is required when cooling an engine. From Equation (i), it can be seen that the heat lost,  $Q$ , is directly proportional to the temperature difference,  $\Delta T$ . This linear relationship is known as Newton's Law of Cooling where the rate of cooling is proportional to the difference between the hot body and its surroundings. This is not strictly true for all cases as radiation begins to play its part as the temperature of the hot body rises. For semiconductors, the junction temperature inside the

device must be held below about 125 °C so the maximum differential temperature between the plate and air must be kept below about 50 K, assuming an ambient temperature of 40 °C. At a temperature difference of up to about 50 K, Newton's Law is almost perfectly true. Assuming that the fins of the heat sink have a very much higher thermal conductivity than the air, it can be taken that the fins are isothermal - in other words, the fins are at the same uniform temperature all over. The validity of this assumption will be examined later.

In the next part, the variables and their effects on the cooling will be discussed.

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*To be continued*

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## Editorial

There is no room for much of an editorial this time, I am pleased to say. However, if future issues of *The Journal* are to be similarly full, then we need more people to submit articles (or ideas for articles), whether long or short to:

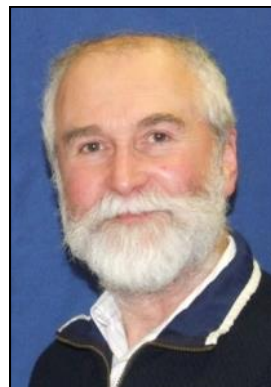
*Mike Tilby*

## The cathead and how to use it

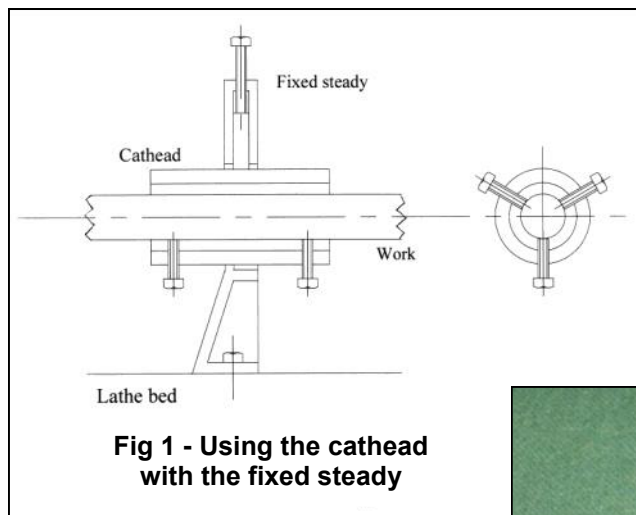
Neil Read

introduces a little known tool of particular value to the lathe operator.

Picture, if you will, the following circumstances. You have a piece of nominally round bar which needs turning for some project you have in mind. The material has been hot rolled, is heavily coated in scale and anything but round. Its outer diameter is too large to pass through the bore of your lathe mandrel yet it is too long to be faced and centred without additional support. Under these circumstances a suitable cathead may come to your aid.



Neil Read.



**Fig 1 - Using the cathead with the fixed steady**

support the overhanging end of the work in your fixed steady. **Fig 1** should make this clear. Of course the gadget is useful for material other than nominally round, hot rolled bar. It could, for example, be utilised when machining large section hexagon stock. A cathead made with eight clamping screws (four at each end) is useful if machining square or rectangular material (**photo 1**).

The cathead is a tubular device having an accurately machined outer diameter. This can be slipped over the workpiece and locked in position so that its outer diameter runs true to the lathe spindle. This can be verified with a dial test indicator during setting up. The outer surface of the cathead can now be used to



*1. A simple cathead made from steel tube and fitted with eight screws.*

## Variations

Several variations of cathead are possible. Some will favour keeping their cathead as simple as possible and basing it on a piece of steel tubing. This is the arrangement represented in both fig 1 and photo 1. The disadvantage of this is that you can end up with exposed screws or bolt heads whizzing round not too far away from your anatomy. Others may elect to go for an arrangement a bit like a dumbbell, either solid or fabricated, and using grub screws that can be recessed out of harm's way. There may well be a case for a good, old fashioned compromise. Use a simple tubular design but fit it with detachable covers to keep the exposed screw heads safely shielded.

Whatever your choice, it is as well to bear in mind that the outer running surface is likely to suffer wear during use and need cleaning up from time to time. For this reason I suspect that many catheads are made to carry out a specific machining task and discarded after use. The likelihood of the same circumstances appearing again is perhaps too remote to justify their retention. However, if your luck is anything like mine, it is probable a similar piece of work will appear the day after a suitable cathead was discarded!

## Retain

If the intention is to retain a cathead for further use then steps should be taken to preserve the outer diameter from wear. In his book *The Amateur's Workshop* Ian Bradley suggests using a strip of well oiled card between the tips of the fingers of the steady and work of a critical nature that could become scored. This is advice I have followed on many occasions and can add my support to Ian Bradley's recommendations. Strips of breakfast cereal boxes seem to be a good choice of card. Prevention of damage is infinitely preferable to trying to clean up the cathead after it has happened through wear and tear. **Photograph 2** shows the cathead shown in photo 1 supporting a length of  $\frac{5}{8}$ in. square mild steel on my Myford Super 7B. The work is being driven by a 4-jaw self centring chuck. Note how the card strip is secured by trapping it under the hinged, top portion of the fixed steady.



2. Well oiled card can help prevent work being damaged by the jaws of the fixed steady.

## Amiss

It would be amiss to suggest that setting up a cathead is easy. Like most things it needs practice to do the job quickly and efficiently. I find it helps to start the procedure with the ▷

screws positioned such that their ends are flush with the inner surface of the tube. Then advance each screw the same number of turns until all are in contact with the work. The task of getting the cathead to run true can now be completed by using your dial test indicator. It can help to mark up the screws fitted to the device to facilitate counting the number of turns applied. Numbering them can also help.

I trust that readers will find these notes useful and commit the idea of the cathead to memory. Despite owning a wide range of publications on workshop technology I have only found a couple of mentions of this potentially useful device. It seems that the vast majority of workers go through life blissfully unaware of its existence. At least readers of *The Journal* now know what a cathead is and how to use it!

SMEE

## Model Engineer & Workshop

As many (most) of you will know already, *Model Engineer* and *Model Engineers' Workshop* are to be merged into one magazine titled *Model Engineer and Workshop*. This will appear monthly and the first merged issue will be dated March 2025. It will be volume 234, issue 4762 and so will continue the numbering sequence of *Model Engineer*.

The first issue will go on sale on 21 February and copies can be ordered from [www.classicmagazines.co.uk](http://www.classicmagazines.co.uk)

Neil Wyatt is taking over as editor of the merged publication and the following are his comments about its future content:

*"If your hobby includes any aspects of engineering, the ME&W will have much to interest you in its pages. Bigger than either of its predecessors it has the space to cover all aspects of model engineering from traditional live steam models to gas turbines, from clocks to toolmaking. We look in depth at the skills you need to get the most out of your hobby: using maintaining and improving lathes, mills and other workshop machines such as 3D printers and CNC. We also cover the widest range of workshop activities – traditional ones like casting, brazing and welding to modern skills like using embedded electronics. Finally, we keep you up to date with what's happening in the world of hobby engineering with our event reports, news features and reviews".*



## Hearth Hound

### Gareth Hughes

contributes to the maintenance of food quality.



Gareth Hughes

At my local Repair Cafe I was seated across from a well-dressed young woman, and on the table between us was what looked to me like a rather battered digital caliper case. It was, rather ironically, held together with tape marked "Fragile" and had certainly seen better days. Curiosity and caution led me to gingerly open the case, revealing to my surprise that it was indeed a very nice set of Moore & Wright digital calipers. This surprise was partly due to her smart business attire not being typical of digital caliper users, but also due to the sorry state of the tool itself. It was dirty, but not with oil, grease and grime. It was more of a sticky substance forming lumps and bumps on the surfaces.

I happen to own the exact same model, and despite being just a rebadged Chinese make they have proven to be the best I have owned, so I was curious about the fault presented. She explained that the little knurled screw, to lock the slide, had gone missing. Her fear of incurring the wrath of her manager over this minor fault prompted her to seek repair. Seizing the opportunity to ask about her line of work, I discovered she was a food inspector for a supermarket chain, and used the calipers to measure the diameters of fruits and vegetables for her reports.

Now, here I began to puzzle over why food items need to be measured to a precision of ten micrometers? It seemed a tad excessive. I couldn't help but wonder how she managed to measure larger items like apples, swedes, and potatoes with the short jaws of digital calipers, which seemed ill-equipped for anything beyond the diameter of a large strawberry. Surely, manual external calipers with a suitable scale would serve her better?

Her explanation was that her bosses insisted on seeing the numbers displayed on the LCD of the digital calipers in the photos she sent for records. The missing screw, it seemed, was only a worry because her bosses might see its loss in the images. Further, she explained that as she manipulated calipers, berries and her smartphone camera, the sticky residue on the tool was a testament to many blueberries that had met their untimely demise in the name of compliance.

After rummaging through my toolbox, I was pleased to be able to fit a standard pan-head M3 screw. My concern that it didn't look like the original knurled one was brushed aside as she considered them too ignorant of the tool to notice. Her only unease now was the battered case, and I think I have a spare one of those at home for her. Again I confirm what I learned long ago - don't judge a book (or a person or tool) by whatever covers it. And don't judge a blueberry by its diameter.

*"Not everything that matters can be measured"*

- attrib. Albert Einstein

**SMEE**

## “The New Year started badly for the GER ...”

### Roger Backhouse

describes the new year's day railway accident at Ilford, Essex in 1915.

In understated language, the *Great Eastern Railway Magazine* (Ref. 1) began a report of the Ilford railway accident on 1 January 1915. It was the worst accident on East London's suburban lines in many years, devastating local families and marring the railway company's good safety record.

This article looks at how the accident happened and local responses, with information from the Board of Trade accident report, railway magazines and the *Ilford Recorder* which produced a special edition the day the accident happened.

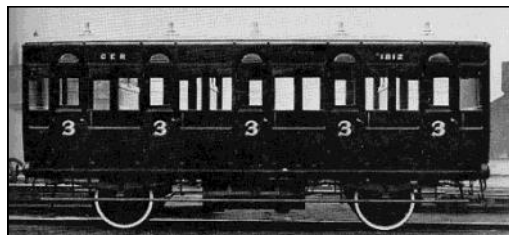


Roger Backhouse

### What happened

The accident happened at 8.40 am on Friday 1 January. New Years Day was then a working day and the railway ran its usual suburban service. A local train, the 8.20 am from Gidea Park to London Liverpool Street, picked up passengers at Seven Kings station and travelled through Ilford's platform three without stopping. Some morning rush hour local services missed the Ilford stop, a pattern that persisted until the 1970s.

GER suburban trains comprised four wheel wooden coaches each with four compartments (Ref. 2). There were 18 coaches in all, old fashioned and not crashworthy.



A GER tank engine and a typical varnished teak four-wheel GER coach from the early 1900s.

However, it was a light weight train and the tank engines used could accelerate quickly away from stations.

The local train was switched from the slow lines on the north side of Ilford station to the fast line to the south. This was common practice to speed up suburban services into Liverpool Street especially when a fast lines train was delayed.

Unfortunately the 7.06 am express from Clacton with eight bogie carriages including dining cars was running a few minutes late on the fast line 'up' to Liverpool Street. For unknown reasons the driver missed signals at danger and crashed into the local train as it crossed from the slow line to the fast. Both trains were well filled but the local service was not as crowded as a normal weekday.

Though the express driver braked late he could not stop the collision. Witnesses in the local train saw the express coming alongside them and slicing sides off local train carriages. Coaches in the middle of the local train overturned. The express engine then fell into coal drops (**Ref. 3**) south of the fast line.

Express coaches remained upright though the front three were derailed. Most suffered some damage but casualties were lighter. Passengers in the local train were less fortunate. The eighth coach - first class - was described as “*completely broken up*” and five other coaches near the middle of the train were badly damaged. Here the worst casualties occurred. Yet coaches at the front and rear were less damaged and most passengers were able to get out unaided.

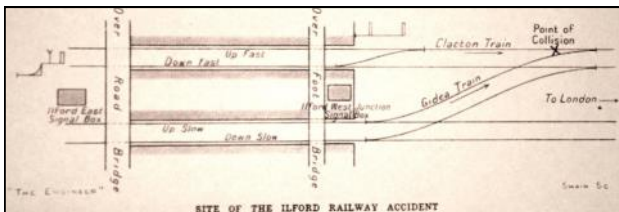
## Casualties

Ten passengers died in the collision or soon after, all were travellers in the local train. A further 500 were reported to have been injured or suffered shock.

Some lost limbs. The *Ilford Recorder* published a list of some of those injured (**Ref. 4**).

John Buttress, driver of the local train, was an Ilford man from St Mary's Road. Like his fireman, E.M. Hicks, he was unharmed, though both suffered shock. On the express, driver Fred Bloomfield of Colchester and fireman George Adams were scalded by steam when the engine fell into the coal drops.

Walter Walls, conductor of the choir at Ilford Congregational Church was returning on the express from a few days in Clacton. He travelled next to the restaurant car kitchen and was reported to have “*escaped from the car severely shaken but covered in the contents of certain cooking utensils.*” (**Ref. 5**)



*Ilford Station plan - this diagram is as published in The Engineer (8 January 1915) with south at the top and east on the left..*



*GER locomotive similar to the one involved in the crash. This is No. 1900 (Claud Hamilton) as newly built in 1900.*



*The express locomotive (from the Railway Gazette)*

## Lucky escapes?

George Savill of Grove Steps Ilford Lane, described as a haulier, was with a horse and cart in the coal drops collecting coal for Ilford Paper Mill. The express locomotive crashed above trapping him. He was badly scalded by escaping steam but survived. His horse was put down. Surviving photographs show the locomotive in the coal drop upright but damaged.

Owen Waters, a Councillor for Seven Kings on the Urban District, gave his account to the *Ilford Recorder*. Reading his paper whilst sitting in a compartment near the rear of the suburban train he heard a whistle. *“As I looked up sharply from my paper I saw the Clacton train running parallel with us and rapidly we seemed to be getting nearer to it. ... Then there was a cracking and splintering of timber, then a smash with severe jolting all this while - and then a stop”*. Seated with his back to the engine he was first out of the carriage and helped a fellow passenger who'd been thrown across the compartment.

Once out of the train he asked the signalman if he'd put signals to danger which he had. He called on passers by to ask Dr Houghton in York Road to come, and to telephone other doctors. Seven local doctors turned up to help.

## Helping the injured

Morrison Matthews, Secretary of the local branch of St John Ambulance Brigade, later wrote to the *Recorder* to say that two of his officers were on the station when the accident happened (**Ref. 6**). His members took a leading part in helping the injured.

There was then no London wide fire or ambulance service though Ilford's fire brigade run by Ilford Urban District Council arrived quickly. Their training in first aid was praised as an example of the foresight of the Council. Reports praised local Boy Scouts who commandeered doors to carry the injured.

Territorial soldiers from the 6th Battalion Essex Regiment on duty at Ilford station gave help early. Ilford station staff were helped by Mr Unwin, the stationmaster, who came in on his day off to help. Workers from Stratford, main works of the Great Eastern, were on the scene by 10am to help clear coaches.

Local doctors came to the scene to give first aid to the many injured. Nearby residents in York Road were praised for providing brandy, whisky and hot milk for victims, and gave cloths to make bandages. Some victims were taken to Ilford Emergency Hospital and to the London Hospital. Others, less seriously injured, were helped home on tramcars or went to local doctors for treatment.

Local clergy, including the Catholic priest Father Patrick Palmer, were soon on the scene to help victims.

## Inquest

The coroner's inquest with a jury took place over several days in the Town Hall. The GER was represented by senior officials including Henry Thornton, GER General Manager, who accepted the Company's responsibility. An ASLEF representative was there to represent the express fireman, E.M. Hicks. Presumably the express driver was not an ASLEF member. The NUR London area Organising Secretary represented his members including the Ilford East signalman.

The inquest heard statements from all the signalmen involved, train guards, passengers, local residents who'd heard detonators and then the drivers of both trains. The GER locomotive superintendent gave evidence about likely stopping distances. Jurors asked about the possibility of criminal damage to signalling but this was ruled out.

Another juror, clearly well briefed on railway matters, asked about the installation of automatic train stops. These would have prevented this accident and many others in the years ahead but railway companies were slow to install. Almost all evidence suggested the express driver had failed to see signals.

One juror asked why the brother of one of those fatally injured, Frederick George Allen of Charlbury Gardens, was refused permission to see him at the London Hospital. In what appears to be medical callousness Dr Davey argued that the shock would have been fatal. Frederick Allen died soon after of injuries with his brother unable to visit.

## Inquiry

Railway accidents involving death or injury were subject to an official inquiry. These were carried out by the Railways Inspectorate, made up of Royal Engineer officers who were independent of railway companies but had technical expertise to analyse accident causes.

Lieutenant Colonel von Donop carried out the Ilford inquiry starting in a crowded waiting room at Ilford Station. He gathered statements from 5 January and submitted his report to the Board of Trade on 16 February 1915, just six weeks after the accident. He interviewed witnesses and railway staff involved, giving a careful picture of operations and exploring possible causes including signaller's errors, faulty brakes and flaws in signalling arrangements.

In his report the Inspector showed little doubt of the cause (**Ref. 8**). The express driver had failed to brake at the Ilford east distant (warning) and home (stop) signals and only applied brakes at the Ilford west home signal, a classic 'SPAD' (Signal passed at danger) pattern. Only detonators on the track alerted the driver to danger. He braked but far too late.

Though the driver claimed the distant signal wasn't at danger checks showed this was unlikely. The possibility of malicious tampering with the signal was ruled out early. It is difficult to explain his failure as he was an experienced driver who knew the route well. Weather conditions were good and the Westinghouse brake (one of the best then available) was working properly. The driver claimed steam from the engine obscured his view of signals - a common problem with steam locomotives - but this argument was ignored in the Inspector's verdict.

Colonel von Donop pointed to the importance of having *"some arrangement for giving the driver an unmistakeable warning as to the position of his distant signal when he passes it"* and noting that other companies had already made trials of such devices. Unfortunately the company failed to act and automatic warning systems did not become universal until the 1960s.



## Other accidents

Ilford's railway accident was soon overshadowed by the horrific disaster at Quintinshill in May 1915 which remains Britain's worst railway accident (**Ref. 9**).

Nothing so severe happened on Great Eastern suburban lines until 1944 when another accident happened at Ilford Station. Again a driver missed signals, this time in fog, and crashed his express into a stationary train. Ironically, this would have been prevented had Colonel von Donop's recommendation of additional warnings of danger signals been carried through.

## Ilford now

Ilford station approaches have long since been remodelled. A viaduct takes local trains over the fast lines reducing the possibility of a collision. All signal boxes have gone and signalling is now centrally controlled. Also automatic stop systems should prevent drivers over-running signals, finally achieving Lt-Colonel von Donop's 1915 recommendation.

## Technical notes

Under the so-called lock and block arrangements signals at the East signal box could not be lowered until the train was accepted by the West signal box. There were also complex interlocking systems which ensured signals could not allow conflicting movements at junctions and crossovers like that at the west end of Ilford Station.

As a further safeguard the east home signal on the main line had a detonator placer fitted. If the signal was at danger it placed two detonators on the rail as an audible warning to the driver that he'd passed a red signal. It was probably the sound of these detonators that alerted the express driver that he had overshot signals.

To see a traditional main line signalling system in operation visit the Gainsborough Model Railway in Lincolnshire (<http://gainsboroughmodelrailway.co.uk/>) where original signal box instruments control 0 gauge model trains. Also, the model railway from the Lancashire and Yorkshire Railway signalling school is operated monthly at the National Railway Museum, York.

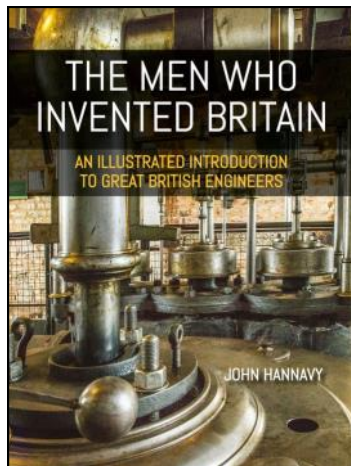
## References

1. *Great Eastern Railway Magazine* February 1915.
2. John Watling, *GER carriage building in 1914*. *Great Eastern Journal*. January.2014.
3. Coal drop - a siding where trucks were offloaded into road carts below. Photos taken in 1911 show this operated by Rickett Smith and Co.
4. *Ilford Recorder*, 8 January 1915.
5. *Ibid.*, 8 January 1915.
6. *Ibid.*, 22 January 1915.
7. *Ibid.*, 29 January 1915.
8. *Board of Trade report into the Ilford Railway accident*. 16 February 1915.
9. L.T.C. Rolt. *Red for danger*. Pan Books 1960 ed.

## Book Review

### Roger Backhouse

John Hannavy: *The men who invented Britain: an illustrated introduction to great British engineers.*  
Whittles. 2024. Paperback. 187pages. £18.99.  
ISBN 978-1-84995-568-3



**B**ack in the nineteenth century Samuel Smiles promoted the doctrine of ‘self help’. His book of that title was a best seller and he followed with several more books including industrial biography about men who’d risen from humble origins to achieve success. In doing so he made engineers like George Stephenson into heroes, something an author had never done before.

Now John Hannavy has taken some of Smiles heroes and added others like Brunel to provide readable and informative short biographies of key engineering figures in the 18<sup>th</sup> and 19<sup>th</sup> centuries. He goes from canal engineers like William Jessop and James Brindley to mechanical engineers such as Henry Maudslay and James Nasmyth, also including the polymathic I.K. Brunel. Obviously this is a biographical study, rather than a historical study like L.T.C. Rolt’s *Victorian Engineering*, but it succeeds in giving something of the spirit of the age and the men who made it.

There are particularly good chapters about William Fairbairn and William Arrol, responsible for steel erection on the Forth Bridge and prolific inventors. Another who receives attention is John Scott Russell, shipbuilder, who was traduced by L.T.C. Rolt in his biography of Brunel but here receives deserved credit. (Though I don’t accept the author’s view that *HMS Warrior* was a result of Russell’s design. Russell would have produced a much more manoeuvrable ship!)

This book follows the author’s excellent works on transporter bridges, the governor and the gas tramcar. Like those works this is attractively illustrated and the author’s own photographs are models of clarity.

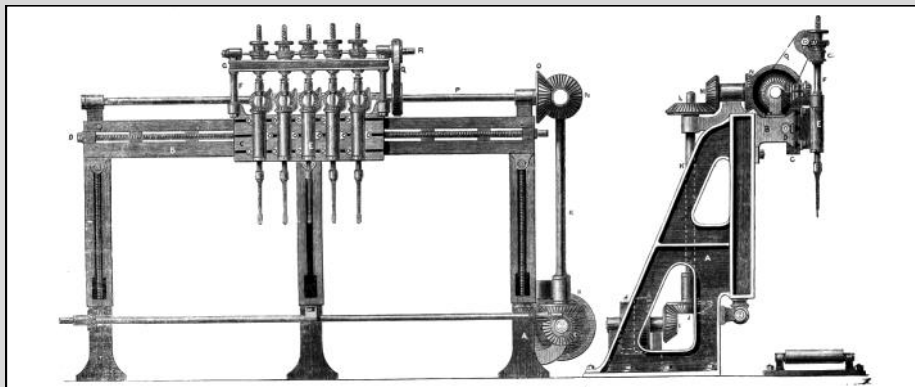
My one regret is that some engineers and inventors weren’t included. Perhaps Henry Cort, David Joy and Benjamin Outram could have featured among many others, but that would have made for a very long book. We can hope for a follow up volume perhaps?

In summary, a visually attractive, well researched book making a useful introduction to some of the greatest engineers in British history. And even better, it sells at what is these days a sensible price.

**SMEE**

## PICTURE FROM THE PAST

### CLAPPERTON'S PATENT MULTIPLE DRILLING MACHINE



“This ingenious machine has been invented and constructed for the purpose of facilitating the boring of holes in girders or other structures at different pitches. .... There is no room to doubt that this machine will supply a want very much felt in the construction of girder work. If the drill is ever to displace the punch it must take the form resembling more or less the tool described”.

**From:** *The Engineer* Jan. 4th 1867

## Engine Builders Group news

**U**nfortunately, we must make some changes to the programme:

- 22 February 2025** - The talk planned for this date has been cancelled and the meeting on this date will be a tea room.
- 22 March 2025** – The visit to Marshall House by the veteran James and Browne car has been postponed to 17 May 2025. The meeting on 22 March will now be an EBG tea room.

*Charles, John, and Elliot*  
(EBG Steering Group)

## Digital Group News

**N**ot a lot of news this time round as we are just coming out of the Christmas and New Year break. However, I do hope that Santa brought both lots of new (digital?) goodies for the workshop (I certainly have a couple of things to keep me busy for a little while) and the time to play with them. Sometimes, it is finding the time that is the most difficult part!

Please let me know if you have any digital-related topics that you would like us to cover in our online sessions, if you have been working on something that might interest other members (and whatever your level of knowledge and experience in a particular area, there will be others who are fresh to it among the attendees), or if you know of potential speakers. You can contact me via my details given at the back of the Journal.

*Brian Neale*  
Digital Group Coordinator

## Forthcoming events at Marshall House

### General meetings

### Competition Day 1 February 2025

**T**his year, Competition Day will be held in February, to link more easily with our AGM for Prize Giving. It's a great occasion not only to put your best work into competition but also to display work on the table which you don't want to enter for competition judging.

We are very much hoping for a good collection both of Competition entries and of general Work on the Table, so please bring along both finished and part-built work for fellow members to look at and appreciate. It doesn't have to be perfect – everyone's work is of interest.

Models may be set up from 11:00

The Rules for the Society's Annual Competition were published in the last issue of *The Journal* (December 2024, page 36) and can also be found on the SMEE website.



## Rummage Sale

15 February 2025

**T**his is the opportunity to buy those fine engineering items that you always wanted but were too shy to ask for! You are welcome to bring along your pre-loved, engineering related items for sale.

## How a non-programmer can build software-powered gadgets

1 March 2025

by Dr Stewart Bryant

**S**tewart has been a member of SMEE for over 10 years. His interests in model engineering include 3D printing CNC machining and flying model aircraft. He is also a very active radio amateur.

Microprocessors and software have transformed engineering. Modern AI technology allows people who are non-specialists to generate software that works. Driven by his recent experience using AI tools (ChatGPT) to generate software Stewart will demonstrate examples of converting conversational English into working code to drive software driven gadgets.

This meeting replaces the previously advertised meeting

*Turbine Building* by Andy Gray

as, unfortunately, business commitments have caused Andy to postpone.

## Visits and events

**We have provisionally booked the following two visits for this year:**

### **de Havilland Aircraft Museum, Salisbury Hall, London Colney, St Albans, AL2 1BU Wednesday, 30 April 2025**

**I**n September 1939, the de Havilland Aircraft Company established the Mosquito design team in the Hall; the prototype Mosquito E0234/W4050 subsequently being built in the adjacent buildings, to the side of Salisbury Hall. These have since been demolished. The collection was originally built around the definitive prototype and restoration shops for the de Havilland Mosquito and now also includes several examples of the de Havilland Vampire – the third operational jet aircraft in the world. The museum is the largest such museum devoted to one manufacturer in the country and the exhibits include many engines and aircraft from the company's history.

**Our provisional booking includes a group guided tour for a minimum of ten people. Please contact Elliot ( to register interest so that we can decide whether to confirm our booking.**

**Fawley Hill Railway & Museum**  
**Fawley Hill, Fawley, Henley-on-Thames, RG9 6JA**  
**Sunday, 29 June 2025**

**F**awley Museum is a private museum established in the 1960s by the late Sir William McAlpine at his estate near Henley on Thames. It hosts a fine collection of memorabilia and models relating to railways and other forms of transport together with a working standard gauge railway operating on the steepest gradient in the country. Ed Turner, who many members will remember, was an enthusiastic volunteer at the museum.

**Our provisional booking is for a group of 30 people. Please contact Elliot to register interest so that we can decide whether to confirm our booking.**

## General notices

### Books still available

**W**e still have copies of Jörg Hugel's book on drill sharpening (see October 2018 *Journal* for full details) and of Roger Backhouse's fascinating book about Jim Crebbin (See December 2019 *Journal* for full details)

Jörg's book is available only from SMEE. To order, please contact Norman Billingham. Roger's book is available direct from SMEE at the special price for members of £10 plus postage and packing.

To order, send an email to

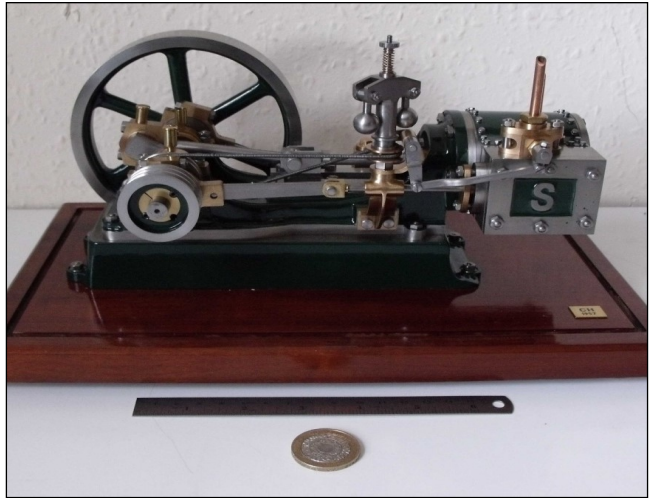
**Books can now also be ordered via the website.**

### Next issue

The next issue will be April 2025, due out on 1 April

- Hearth Hound - Gareth Hughes
- Digital jottings 18 - Brian Neale
- Some history - Neil Read
- An economist's day out - Jim Cahill
- A day on the footplate - Darius Coombs
- Cooling fins part 2 - Graham Astbury
- Torque converters and fluid couplings - part 6 - Mike Tilby

Contents subject to alteration



**Right:** This Stuart Turner No. 9 was the first model to be made by Cherry Hill. Constructed during 1956 and 1957 it is now in the SMEE Collection. It was entered for competition in the 1964 Model Engineer Exhibition where Cherry was awarded a Bronze Medal.

**Below:** Cherry Hill's model of the 1863 Blackburn Agricultural Engine (Patent No. 1482) at the 2011 Model Engineer Exhibition where it was awarded the Bradbury - Winter Memorial Challenge Cup and a Gold Medal. It was also awarded the 2012 Duke of Edinburgh's Award. The model is in 1:16 scale, contains about 7,400 parts and took about 7,900 hours of work to research and build.

(See page 25 for additional photographs of this model.)

Photo: Mike Chrisp

