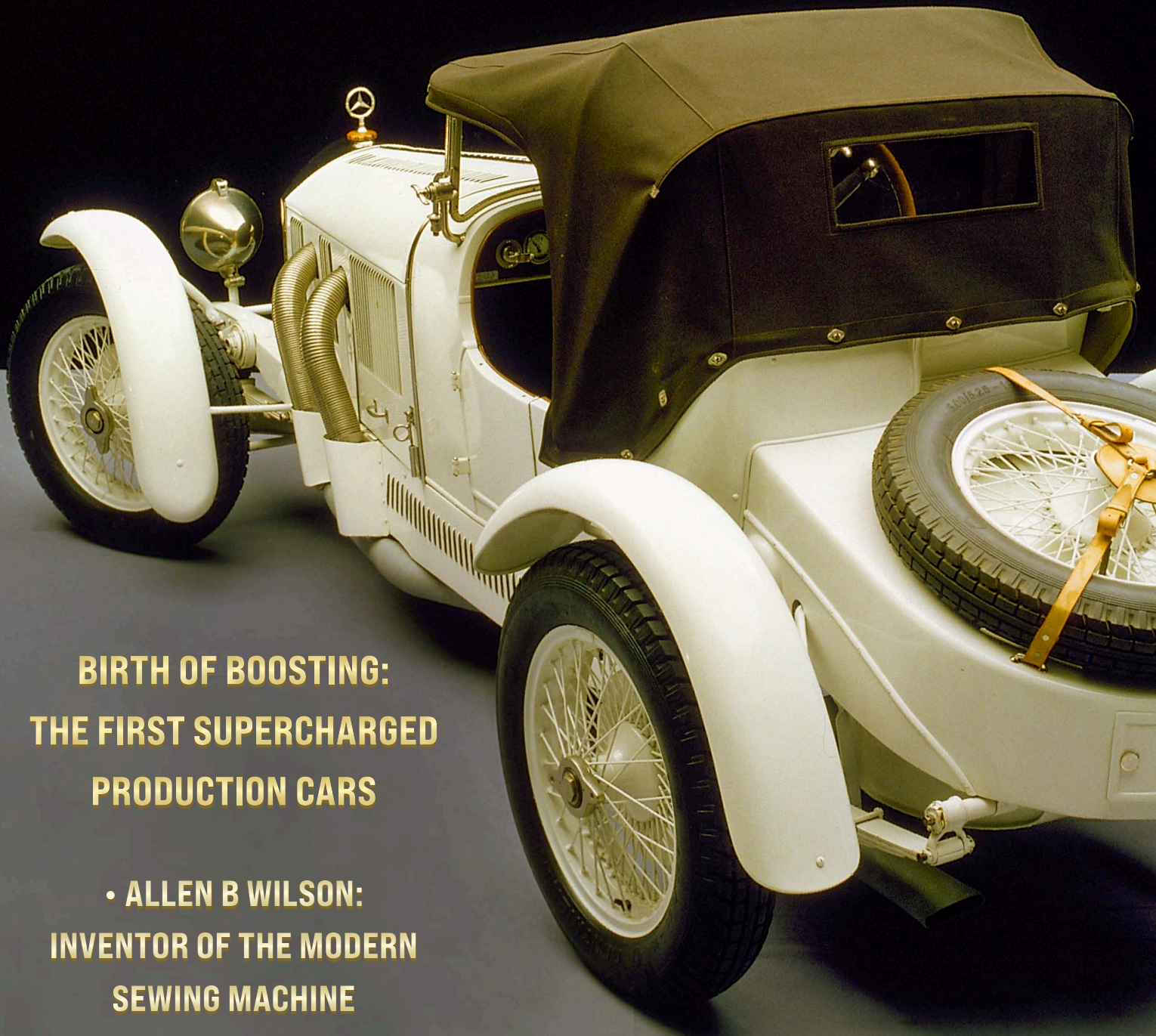


# NEWCOMEN **Links**

No. 260 | 09 2023



## **BIRTH OF BOOSTING: THE FIRST SUPERCHARGED PRODUCTION CARS**

- **ALLEN B WILSON:  
INVENTOR OF THE MODERN  
SEWING MACHINE**
- **IA MEETS AI**



**NEWCOMEN**  
The International Society for the History  
of Engineering and Technology

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The paper used for *Links* is responsibly sourced.

**FRONT COVER:** The Mercedes sports two-seater, type 10/40/65 hp, produced in 1923.



## Contributors

**ROBIN ADAMS** read classics and classical archaeology, and was employed in the Ministry of Works and its successors. The Viola da Gamba Society under his chairmanship began the publication of its *Thematic Index of Music for Viols*.

**DR ROBERT CARR** has been interested in industrial archaeology for a long time. He used to organise the London Visits for the Newcomen Society; reports of these visits were printed in the *Newcomen Bulletin*. Currently, he is organising the book reviews for the Newcomen Society's Journal.

**DR MARTIN GREGORY** read physics and did research for a DPhil at Oxford University. He spent most of his working life teaching physics at Winchester College, retiring in 1999. His engineering interests have centred on steam and Stirling engines, and on the sewing machine. He is the Honorary President of Twyford Waterworks Trust and has been a member of the Newcomen Society for over 60 years.

**DR JOHN KANEFSKY** studied and taught at the University of Exeter in the 1970s. He then joined the National Coal Board history project, afterwards moving into management. Following privatisation, Dr Kanefsky had a varied career at the Coal Authority; in the NHS; in educational research; and lecturing in economic history. He is an Honorary Fellow of Exeter University

**KARL LUDVIGSEN** Born in the USA in 1934, Karl Ludvigsen has resided in the UK since 1980. Dedicated to the

motorcar, he has headed a management consultancy and worked for GM, Ford and Fiat. His more than 1,000 articles and nearly 70 books have received 66 awards. Karl's three-volume history of supercharging and turbocharging, *Power Unleashed*, will be published by Evro Publishing in 2024.

**VAUGHAN POMEROY** worked for 10 years in the aircraft industry and with an international practice of consulting engineers before joining Lloyd's Register in 1980. After working in research and engineering design appraisal, he was appointed Deputy Chief Engineer Surveyor in 1992. He later managed research and development for the marine business, playing a key role in the development of naval ship classification and in the initiation of the Common Structural Rules for oil tankers and bulk carriers. Vaughan was subsequently appointed Technical Director, before retiring in 2010. He was appointed Visiting Professor at the University of Southampton in 2004.

**JONATHAN WILLIS MSc** spent his career developing strategies and major transport projects in London, working for the Greater London Council, London Transport and Transport for London. He was responsible for the planning and evaluation of the initial Docklands Light Railway and three of its subsequent extensions; also for the Croydon Tramlink and the Jubilee Line Underground Extension. He retired as Head of Planning of the Crossrail/Elizabeth line project. He is a past Chairman of Crofton Beam Engines.

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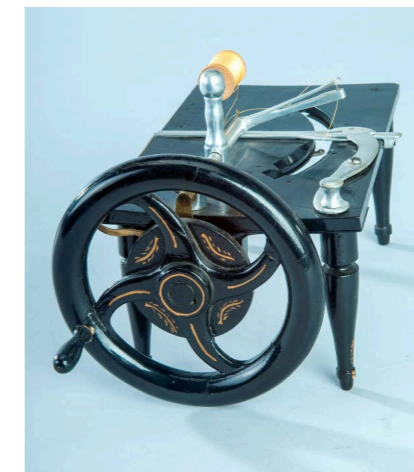
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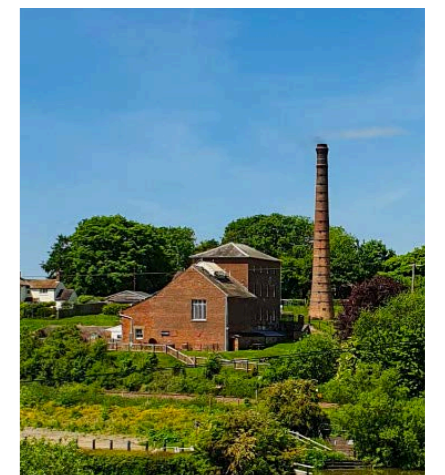
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## FROM THE PRESIDENT

WELL, THE LAST FEW MONTHS HAVE seemed pretty strange in terms of our notorious weather, in the UK at least. I hope that you have been able to get out and visit places of interest, many of which are struggling to recover from the impact of the pandemic on their income.

### NEWS FROM THE COUNCIL

In July, Council met in person for the first time since February 2020, when we visited the Museum of Making in Derby for a day of thinking about the future of the Newcomen Society. The museum, covering a wide range of manufacturing, is really worth a visit. Despite meeting on a day with rail travel affected by industrial action, we covered a lot of ground. This meeting was very timely, being at the start of our financial year when we looked at the impact of changes that have to be faced. We no longer have an office provided at no

cost; we now often have to pay charges for meeting rooms; and, as we all know, general costs are increasing. Still, we are determined that we must continue to provide our members with a good service and manage our finances to keep that affordable. I will just add a couple of specific matters of immediate interest.

### LINKS AND WEBSITE UPDATES

*Links* is an important benefit to all members. In *Links* 256, in spring 2021, the editor suggested that we could move to two larger issues each year. After careful consideration, Council has decided to publish *Links* three times each year, with each issue of 40 pages. On balance, that arrangement seemed preferable to four smaller issues whilst maintaining connection with members.

The programme of activities has become more fluid in recent years and the best way of informing members of meetings has become the website. Although for some years the maintenance and content management has

been carried out by a contractor, Council now intends to do more of the content management through a webmaster and some volunteers from the membership. This would be very beneficial in terms of containing the costs of our primary communication channel. If you have experience or skills, please contact me.

### CALL FOR JOURNAL PAPERS

Progress made with the Journal by the joint editors has given us plenty to read, and the 2022 volume is now complete. The inevitable consequence is that we are looking for more papers to maintain the publication drumbeat. If you have anything waiting, please do contact Julia or Felix. If it isn't really a paper for the Journal, please consider writing for *Links* and contact Belinda. We can now look forward to another season of lectures in the same convenient venues as before, and I hope to see some of you there.

VAUGHAN POMEROY, PRESIDENT

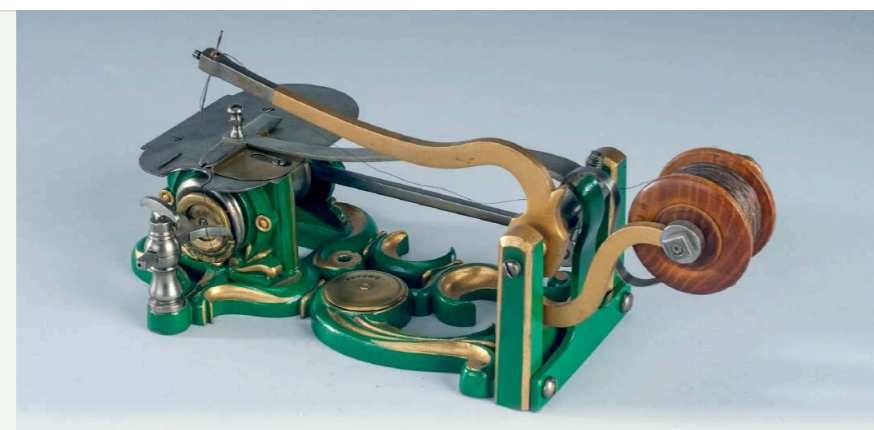
## EDITOR'S LETTER

THE EXACT PURPOSE OF THE BEAUTIFULLY crafted, swirling design shown here might not seem immediately clear, except perhaps to seasoned sewing 'bees', who'll spot the tell-tale reel and needle at once. The pretty patent model is the brainchild of the little-known American inventor Allen Wilson, who created a winning design for a sewing machine in 1852. To mark the bicentenary of Wilson's birth, Martin Gregory explores his inventive character, innovative patents and lasting legacy on pp.14-19.

### GLAM AND GROUND-BREAKING

The first supercharged, series cars blazed a trail on the highways of 1923, 100 years ago. To mark the milestone, Karl Ludvigsen tells their eventful tale in *Birth of boosting* on pp.20-29.

Both the boosted road car and the labour-saving sewing machine helped modernise everyday life, labour, travel and industry in myriad ways.



### AN INSIDIOUS SHIFT

Today, we're facing a more subtle and pervasive paradigm shift with AI, a theme taken up by Robin Adams in *IA meets AI*, where he relays his dialogue with AI chatbots, whom he challenged with some simple IA questions. As a topical talking point, *IA meets AI* is an amusing eye-opener that will, hopefully, stimulate further thoughts on AI in our lives and on the pages of *Links*.

Along parallel lines, mechatronics offers smart, new electronic ways of measuring and maintaining historic mechanical systems, such as the beam

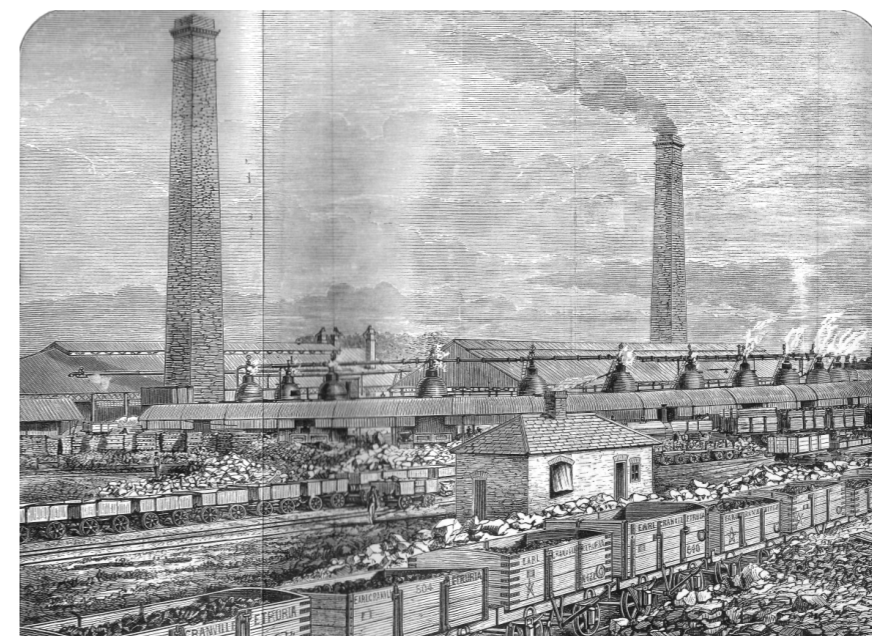
engines at Crofton Pumping Station in Wiltshire. To assess the value of mechatronics in studying 200-year-old machines, Jon Willis analyses the latest findings on pp.32-8. Tracking another smart idea, John Kanefsky spotlights an 'endless rope' transmission on pp.8-9.

Turning sadly to the untimely death of Elain Harwood, on pp.10-13, Robert Carr pays tribute to the architectural historian who championed the cause of Britain's post-war buildings and the 'beauty of Brutalism'.

BELINDA CURWEN, EDITOR

## SHELTON BAR IRON & STEEL WORKS

For visitors to the north, their initial impressions of Stoke-on-Trent could be both surprising and inspiring, as chronicled by some well-known writers, such as HG Wells, LTC Rolt and Arnold Bennett.



### VARIED RECOLLECTIONS

As might be expected, there is mention of Shelton Bar Iron & Steel Works in the novels of the local author Arnold Bennett (1867-1931). Equally, HG Wells (1866-1946) was considerably moved by the sight of the night-time ironworks, which provided inspiration when writing *The War of the Worlds* (1898). Wells also published an horrific short story, *The Cone* (1895), about a blast furnace in Stoke-on-Trent.

Another writer, the well-known engineering biographer and Newcomen Society member, LTC Rolt (1910-74), mentions these works in the first volume of



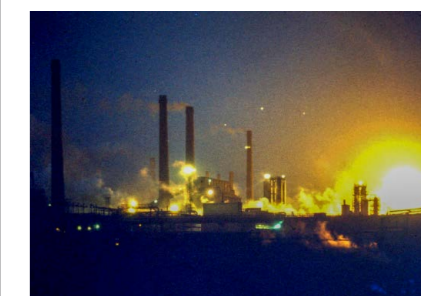
rapid development by the 1840s. Throughout the later 19th century and most of the 20th, these iron and steelworks and associated collieries and railways provided a major source of employment in the area.

The main works closed in 1978. Complete closure came in June 2000; and the last significant building was demolished in 2005.

DR ROBERT CARR

**01 | TOP** A view of Shelton Bar Iron & Steel Works, looking eastwards, March 1974. Most of these works were demolished four years later.

**02 | LEFT** An illustration of Shelton Bar Iron Works, c.1872. Based on a photograph, it was included as a fold-out sheet in *Griffiths' Guide to the Iron Trade...* (1873). HG Wells stayed in Stoke-on-Trent in 1888.



**03 | ABOVE** Corby steelworks at night, 25 December 1972, preview of a forthcoming article in *Links*.

# IA MEETS AI

ROBIN ADAMS puts some AI chatbots on their mettle, with some simple IA (industrial archaeology) questions.

In May 2023, I put some industrial archaeology (IA) questions to the artificial intelligence (AI) chatbot ChatGPT (<https://openAI.com>). Here are verbatim extracts from ChatGPT's replies. My commentary appears in aqua, in square brackets within the blue ChatGPT texts (see key at right). Omission of ChatGPT text is shown by an ellipsis.

## Q1 | TELL ME ABOUT THE TANFIELD ARCH IN COUNTY DURHAM

### A1 | CHATGPT:

The Tanfield Arch is an impressive stone arch bridge located in County Durham, England. It was built [RA: completed] in 1727 and is considered to be the oldest surviving railway bridge in the world. The bridge was designed by Ralph Wood and built to carry coal from the Tanfield Colliery to the River Tyne.

The Tanfield Arch spans over [No. ChatGPT does not understand the implications of its own phrase 'above the Causey Burn' in the next sentence] the [heritage] Tanfield Railway, which was once part of the Stanhope & Tyne Railway, one of the earliest public railways in the world [The Stanhope & Tyne (S&T) opened in 1841: this sentence is a chronological mess,

and irrelevant to the Tanfield wagonway]. The bridge [...] consists of a single arch [...] above the Causey Burn.

The construction of the Tanfield Arch was a significant achievement in engineering, as it was built using only hand tools and primitive equipment [ChatGPT doesn't – and cannot – ask itself how else bridges were being built in 1727, or what philosophy of history underlies 'primitive'.] [...].

Despite being over 290 years old, the Tanfield Arch is still in use today [Yes, but not to carry three-ton coal waggons] [...].

## Q2 | TELL ME ABOUT JOSEPH ATKINSON'S PICTURE OF THE TANFIELD ARCH

### A2 | CHATGPT:

Joseph Atkinson was an English artist and engraver who lived during the 18th and 19th centuries [b. c.1766; d.1802]. He was known for his paintings and engravings of landscapes and architectural structures [I think ChatGPT invented this generalisation. Joseph Atkinson was hardly known beyond Tyneside. There is a dubious record of a panorama of Manchester; his picture of the South Shields lifeboat was engraved by another hand],

## Q & A KEY

Q	=	IA question
A ChatGPT	=	AI answer
[comments]	=	Author's

and one of his most famous works [his only well-known work] is his depiction of the Tanfield Arch.

Atkinson's picture of the Tanfield Arch was created in 1818 [No: 1802 at the latest.] [...].

Atkinson's painting is a testament to the beauty and grandeur of the Tanfield Arch, as well as its importance as an engineering achievement.

[The picture (fig. 01) shows a major collapse of the western approach to the Arch.] [...].

## Q3 | HOW MUCH DID THE TANFIELD ARCH COST TO BUILD?

### A3 | CHATGPT:

The exact cost of building the Tanfield Arch is not known, as detailed records from that time are scarce. However, it is estimated that the bridge cost around £5,000 to build. [No. Dr Lewis, in *Early Wooden Railways* {1970}, at p.156, settled this from the detailed record: £2,252 16s. 1¾d.] [...].



[ChatGPT is fabricating from start to finish. No such article or book review exists. When interrogated, ChatGPT denies any knowledge of works by Colin Mountford.]

In this article, the author examines the history and significance of the Tanfield Arch within the context of the Tanfield Railway, one of the earliest public railways in the world. The article explores the construction of the bridge and its importance to the coal mining industry in County Durham, as well as its role in the development of railway engineering. The author also discusses the controversies

01 | ABOVE AND INSET A View of Tanfield Arch in the County of Durham, watercolour drawing, c.1800–02, after the oil by Joseph Atkinson. Inset: collapse of the causeway on the western side.

surrounding the claim that the Tanfield Railway is the oldest railway in the world and provides a detailed analysis of the evidence for and against this claim. Overall, the article provides a thorough and well-researched analysis of the Tanfield Arch and its place in the history of railway engineering.

[A quite remarkable indication of ChatGPT's untrustworthiness.]

# AN EARLY 'ENDLESS ROPE' TRANSMISSION

DR JOHN KANEFKY inspects an early report of an 'endless rope' transmission by the 18th-century engineer Simon Goodrich.

**A**mong the papers of the engineer Simon Goodrich (1773–1847) preserved at the Science Museum, London, are his notes of two trips he made to meet industrialists and see industrial processes in the Midlands and north of England in 1799 and 1803.<sup>1</sup>

These two documents contain many fascinating and detailed observations on a critical period of the Industrial Revolution, and deserve complete transcription and commentary; it is hoped this can be effected in due course. In

the meantime, one aspect that deserves a short note of its own is a report by Simon Goodrich of a transmission system at the Derby Silk Mill (fig.01), formerly Sir Thomas Lombe's silk mill (built by Lombe but operated by one Lamech Swift at this time).

### GOODRICH'S BACKGROUND

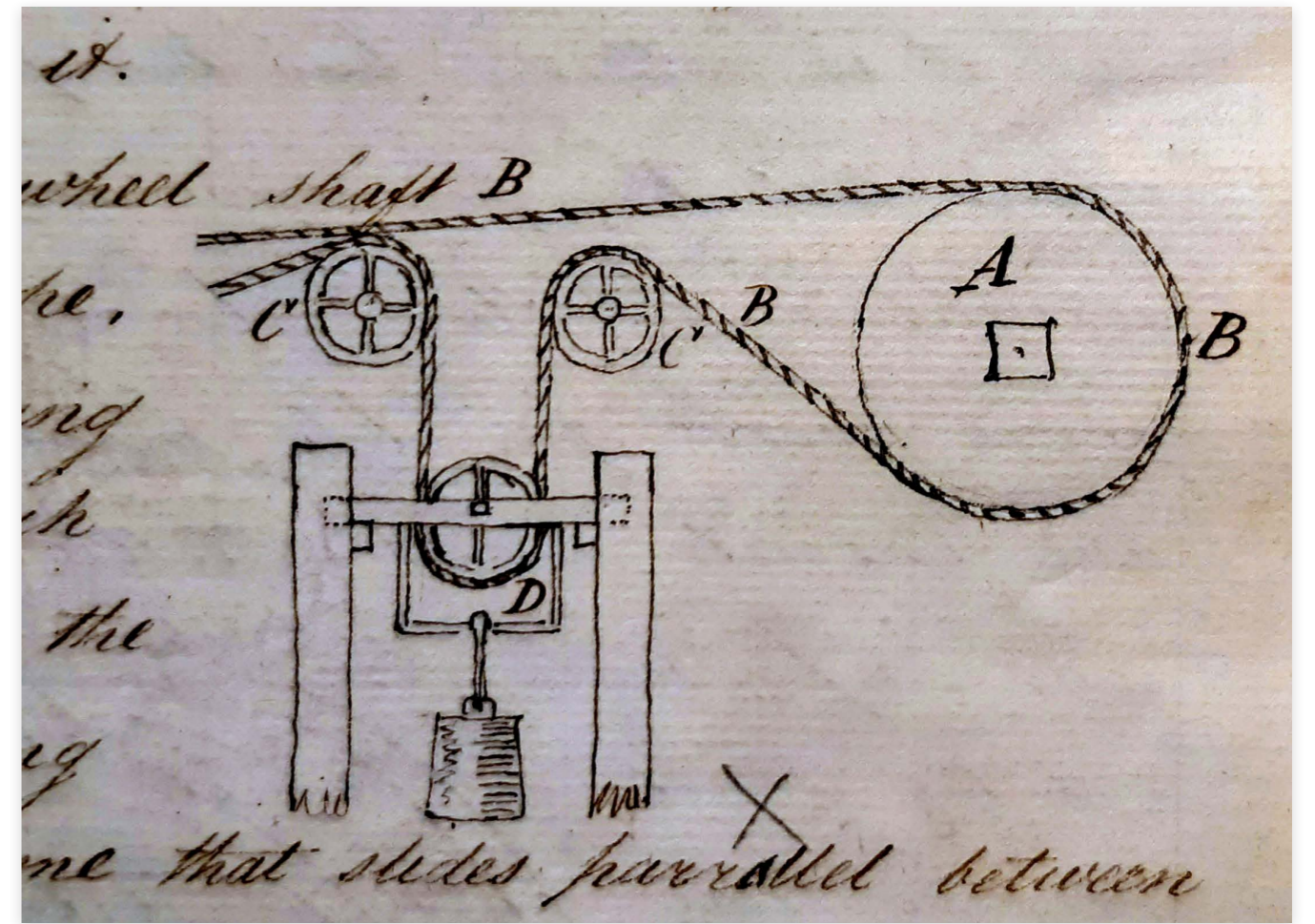
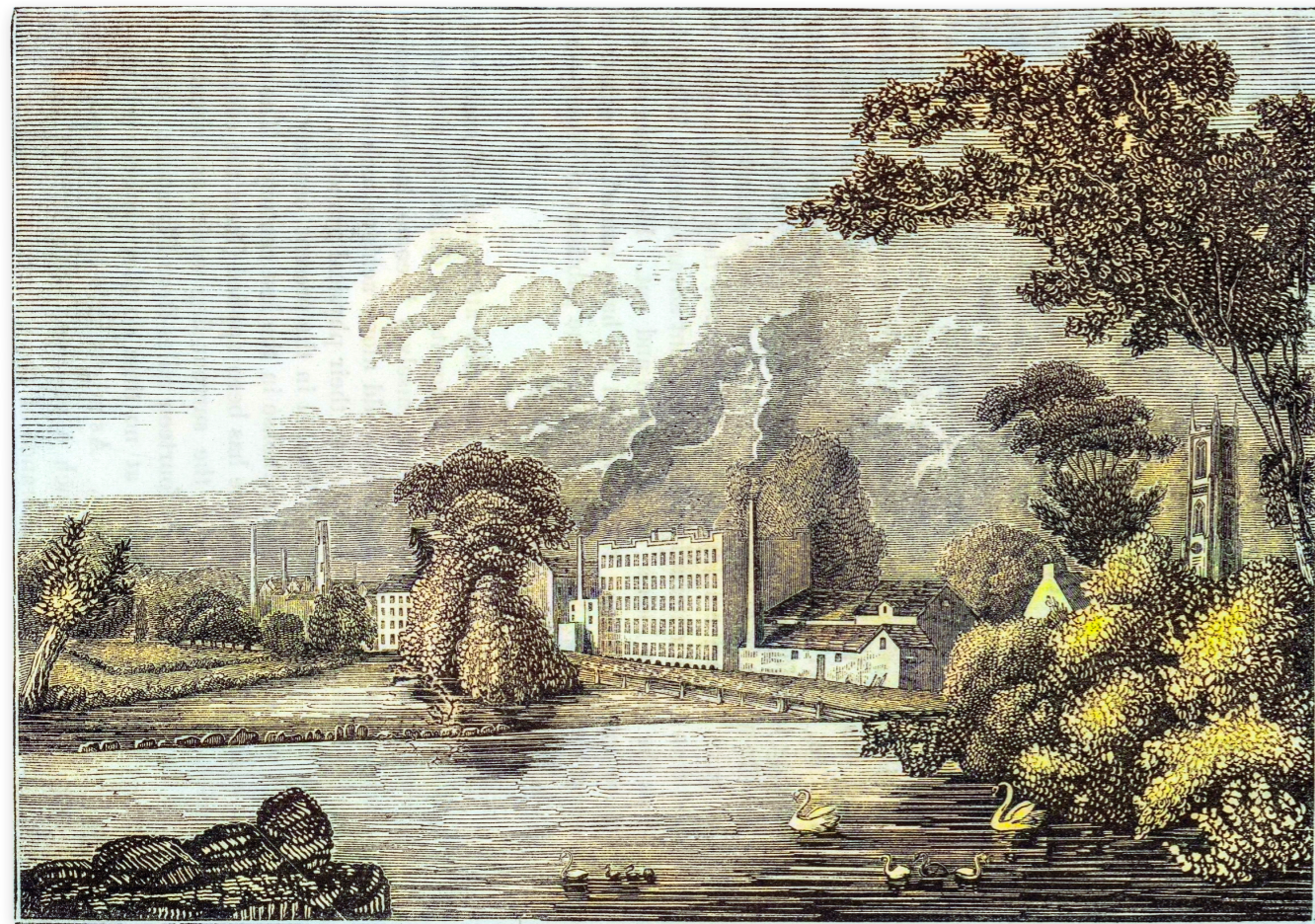
Little is known about Goodrich's early life and career but, at the age of 26, he was appointed 'Mechanist' (chief engineer) at Portsmouth Dockyard under Sir Samuel Bentham at the enviable salary of £400 per annum.

(For comparison, James Watt's effective deputy, John Southern, earned £222.10s, increased to £600 in 1800 when Watt retired; while William Murdoch's stipend was increased to £300 that year.)

### OBSERVATIONS AT THE STRUTTS' MILL

In late 1799, Goodrich set off by coach for Derby, where he had letters of introduction to the cotton mill owners, the Strutts, sons of Jedediah Strutt (1726–97).

**01 | BELOW** Sir Thomas Lombe's Silk-mill, Derby, engraving for Knight's Pictorial Gallery of Arts (c.1860).



After some preliminaries, Goodrich wrote as follows:

*'At 12 O'Clock called on Mr W<sup>m</sup>. Strutt, found him at Home and gave him the Gen<sup>l</sup> letter... Mr Strutt then took me round his Cotton Manufactory. First to an 8 Horse Steam engine of Messrs B&W which is the Premium Mobile of the whole Mill where it is fixed, and also spares the power of three Horses to work a Silk Mill in a Building at some distance from it. This distant Communication of three Horses Power first caught my attention it being effected merely by an endless rope of 1<sup>m</sup> Diam<sup>r</sup> which is supported both coming and going, and bent in several directions by cast Iron pullies of about 18<sup>m</sup> Diam<sup>r</sup> made as light as possible turning*

*on very fine pivots in brass bearings nicely adjusted, so that there are a great number of these supporting Pullies, and the rope has many considerable bendings yet the loss of power from the friction of the whole, was reckoned by Mr Strutt as to be very inconsiderable.*

*The endless rope was worked by (see the fig<sup>e</sup>) a wooden pulley on the fly wheel shaft about 3ft Diam. & in order to keep it in sufficient and regular tightness and at the same time admit of its great stretchings & contractions to which it was subject to from being exposed to all weathers. A stretching pulley fix'd in a sliding frame to which was hung a proper weight was suspended upon it.*

*A, the 3ft pulley on the Fly wheel B,B,B, part of the endless rope, C,C, two stationary or*

**02 | ABOVE** A close-up of Goodrich's annotated sketch of the 'endless rope' transmission that he observed at the Strutts' mill.<sup>2</sup>

*supporting pullies, of which there are a great many in the whole length. D the stretching pulley and weight fix'd upon a frame that slides between two weights, in order to prevent it vibrating. This pulley and weight keeps the endless rope of sufficient tightness.'*

### References

1. Goodrich, Simon, Science Museum, GOOD E1 and E2.
2. Ibid. GOOD E1, pp.3–5.

### Acknowledgements

My thanks to the Science Museum for permission to view the notes, and Tony Woolrich for drawing my attention to these documents.

# ELAIN HARWOOD (1958–2023)



© Courtesy Richard Walker

**01 | LEFT** Elain Harwood at London's Metro Central Heights, designed by the Modernist architect Ernö Goldfinger, and listed Grade II in July 2013.

**02 | OPPOSITE TOP** The glazed and chamfered tower at the Engineering Building, Leicester University.

**03 | OPPOSITE** Postage stamp depicting the Engineering Building in 1971, as part of the architectural series *Modern University Buildings*.

DR ROBERT CARR pays tribute to the architectural historian Elain Harwood, who championed the heritage of Britain's post-war architecture.

**It is with great sadness that we report the sudden, unexpected death of Elain Harwood on 19 April this year at the early age of 64. We have lost someone who brought recent architecture into focus and made some despised examples more popular.**

## HERITAGE CAREER

Initially an architectural *enfant terrible* in the eyes of a conservative general public, Elain became the heart and soul of the 20th Century Society. She worked for Historic England (formerly English Heritage) from 1984 and remained with them until her death. In the last

decade, her output of books has been truly prodigious.

Brought up with the values of the welfare state, Elain grew up believing they would last forever. In 1991, at English Heritage, with colleague Andrew Saint, Harwood co-authored a guide to the buildings of London in the *Exploring England's Heritage* series.

## FOCUS ON THE POST-WAR PERIOD

However, as time went on, she concentrated more and more on the post-1945 period.

In 1992, English Heritage set up a Post-War Listing Steering Group. Elain soon became an important member, visiting an enormous number of sites and buildings. Her obviously deep knowledge and forceful personality proved great assets.

The recommendations of the steering group were to some extent controversial, but Elain was instrumental in changing attitudes to modern architecture as she also embraced post-1945 buildings in traditional styles, which helped to soften the opposition.

## A METICULOUS SCHOLAR

Elain was a senior architectural investigator at Historic England, a post to which she brought immense scholarship and an amazing energy and determination. She had an extraordinary knowledge of interesting buildings in obscure or remote locations. For her books, she would include only the best photographs, many of which were her own.

At Historic England, her colleagues valued her as a hard-working executive and a meticulous scholar.

Elain was born in Beeston, Nottinghamshire, in June 1958, and read history at the University of Bristol. From 1984 to 1986, she studied building conservation at the Architectural Association (AA) in London. Back in Bristol, she researched the buildings of London's South



Bank for her PhD, which she completed in 2009, receiving her doctorate in 2010.

## THE ENGINEERING BUILDING

In Elain's opinion, England's most significant post-war building was the Engineering Building (figs 02–03 above/right) at Leicester University.





Now 60 years old, its architects were James Stirling and James Gowan, with Frank Newby as structural engineer.

In September 1971 the Leicester Engineering Building appeared on a Royal Mail 7½p postage stamp (fig.03). At that time, British postage stamps depicting new British achievements were a novelty and HM The Queen looks so young; this was the New Elizabethan Age. In 1993, the Engineering Building was listed Grade II\*.

To understand why the Engineering Building at Leicester University is so important, we need to introduce Frank Newby (1926–2011), the greatest British structural engineer of his generation.<sup>1</sup> Frank had the ability to work quickly and almost intuitively, as well as

being able to communicate his ideas simply in a readily understandable manner.

Working with an architect, he could suggest what structural forms were possible and also give some idea of the costs that would be involved. The Leicester Engineering Building was achieved via a working partnership between architects and a structural engineer.

#### THE RED TRILOGY

The Engineering Building was absolutely seminal in forming part of the Red Trilogy by the architect James Stirling. The Red Trilogy consists of the Engineering Building, University of Leicester (1959–63); the Faculty of History, University of Cambridge (1964–7), fig.04; and the Florey Building, The Queen's

**04 | ABOVE** Stirling Building, the Faculty of History at Cambridge University, part of the Red Trilogy.

College, Oxford (1966–71). Over time, an outcome of the Red Trilogy development was that British architects became sought-after abroad and many of our big-name architects did their best work in far-flung parts of the world, where there was sufficient money to finance ambitious projects.

#### ARLINGTON HOUSE, MARGATE

Another building that Elain Harwood showed an interest in was Arlington House, a high-rise apartment building in Margate near the railway station (fig.05). Nineteen storeys high, Arlington House dates from 1964. Before

1926, another railway station, Margate Sands, for the South Eastern Railway, occupied the site;<sup>2</sup> this railway station became the Casino Dance Hall but the dance hall burnt down in 1946 and the site was then just a car park. Arlington House was built to the designs of Russell Diplock. The ripple exterior gives every resident of the block a view of the sea. Close to Margate's seafront, this tall block has been the subject of local criticism. However, it is now quite a popular place to live; the flats are spacious with good views and, in 2022, flats in Arlington House had reached prices of about £150,000.

#### A PROLIFIC AUTHOR

Elain Harwood was a prolific author, but we have space to mention only some of her output. In 2003, Elain produced *England: A Guide to Post-war Listed Buildings*, a good introduction to the subject and a useful survey for readers interested in visiting buildings. Stirred by childhood memories, she published *Nottingham* in 2008. Otherwise, her works include *Chamberlin, Powell & Bon: The Barbican and Beyond*, which appeared in 2011; *Space, Hope and Brutalism: English Architecture 1945–1975* (below), published



in 2015; and *Art Deco Britain: Buildings of the Interwar Years* (2019). Two years later, Elain produced *Mid-Century Britain: Modern Architecture 1938–1963*. Her last title, *Brutalist Britain: Buildings of the 1960s and 1970s*, appeared in 2022.

Relatively few obituaries of Elain have appeared in the national press. Journalists were busy with the Coronation and, because her death was unexpected, there would have been no previously prepared drafts available for publication. Both the *Guardian* and *The Times*

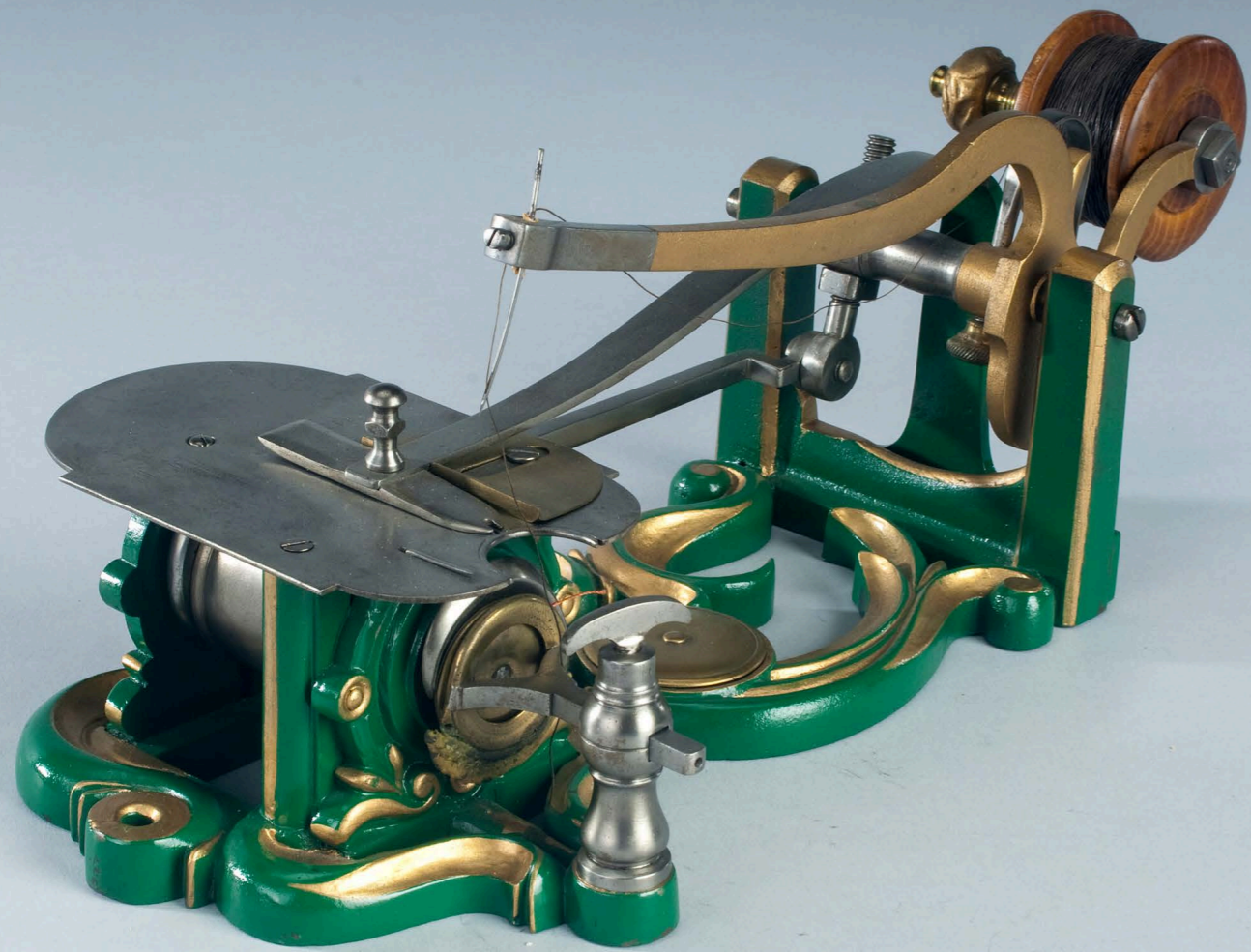
featured obituaries, but not until 8 May and 2 June, respectively. Had Elain Harwood lived longer, she would probably have become better known due to her numerous books, but there was hardly time for her later volumes to circulate. Sadly, she was someone we lost before this could happen.

#### Notes

1. Frank Newby was an active member of the Newcomen Society, a kindly and generous man.
2. Elain Harwood, *Brutalist Britain: Buildings of the 1960s and 1970s*, London, Batsford, 2022, p.38.



**05 | Arlington House,** a high-rise block of flats, viewed from the Tidal Pool on Margate's seafront, Kent. The rippled façade affords sea views from all flats.



# ALLEN B WILSON: inventor of the modern sewing machine

To mark the bicentenary of the birth of Allen Benjamin Wilson (1823–88), DR MARTIN GREGORY explores the story behind today’s sewing machine.

**01 | ABOVE**  
A front view of the curved needle in Allen Wilson’s patent model for his second rotary hook design (No. 9041) of 1852.

**T**he making of cloth was mechanised in the 18th century, but the making of cloth into clothes had to await the invention of successful sewing machines. These started to appear only when inventors ceased trying to make machines that imitated the processes of hand-sewing, and thought outside the box.

Two key inventions enabled the development of the sewing machine: (1) the lock stitch,

using two threads; and (2) the needle with an eye just behind the point. Both inventions originated in the 1830s in the USA with Walter Hunt, a New York mechanic. Sadly, Hunt, though convinced that his ideas were correct, did not patent his inventions, as he was unable to make a workable machine. Both ideas, however, were patented in 1846 by Elias Howe Jr, who incorporated them in a machine that made a lock stitch using a shuttle. Howe’s machine, however, could sew only a straight

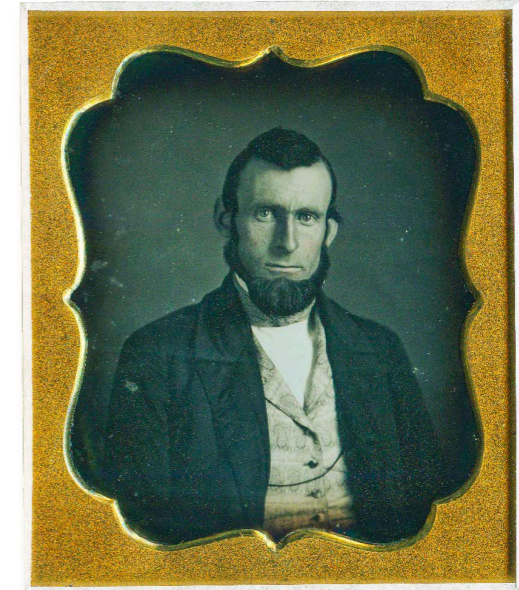
seam of very limited length and was therefore of very limited practicality. It would not be until after 1851 that the first useful sewing machines came on the market, not only with the innovations of Wilson (figs 01–10), but also with the founding of three giants of the early industry, Grover & Baker SM Co., Wheeler, Wilson & Co. and IM Singer & Co.

### ALLEN WILSON’S PART IN THE STORY

Enter Allen Benjamin Wilson (fig.02), the bicentenary of whose birth occurs in 2023. Wilson was born on 18 October 1823 in Willet, Cortland County, New York State. His grandfather had built a grist mill there, which he ran with Allen’s father. His father died in an accident at the mill when Allen was only two years old. From the age of 11, the boy worked for various relatives before being apprenticed to a cabinetmaker at 16 years of age.

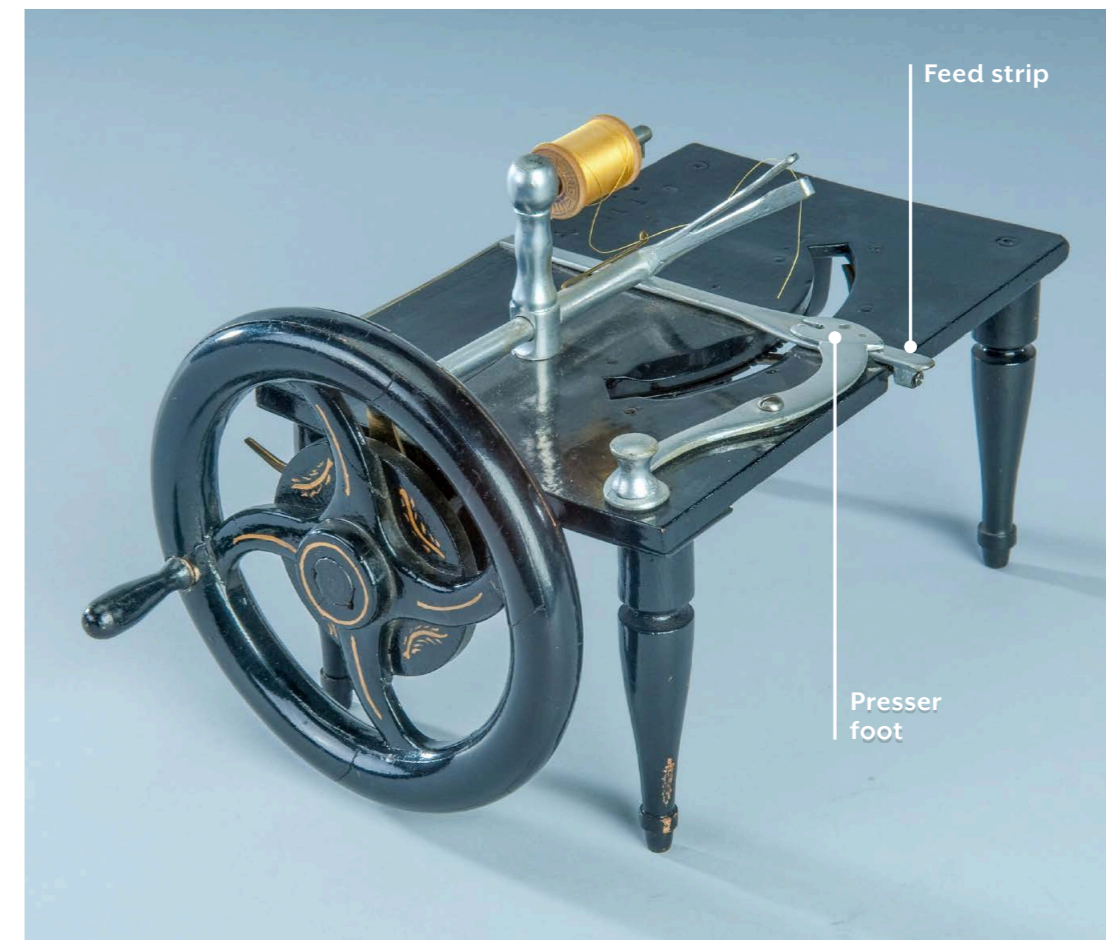
### THE SHUTTLE PROTOTYPE

In 1847, Wilson was working as a cabinetmaker in Adrian, Michigan. It was at this time that he conceived his initial ideas for a sewing machine. Wilson was probably unaware of the embryo machines of Howe et al in New England. As he suffered from a chronic ill-



**02 | LEFT**  
Daguerreotype photograph of Allen B Wilson, c.1856.

ness, Wilson was unable to work for many months at a time, delaying the progress of his prototype. Somewhat recovered, however, he moved to Pittsfield, Massachusetts (MA), still working as a cabinetmaker. The owner of the shop where he worked allowed Wilson to stay on in the evenings, making parts for his sewing machine. By the spring of 1849, Wilson had completed a prototype (fig.03). It made the lock stitch using an eye-pointed needle and a shuttle with a point at each end, so that it created a stitch on both the forward



**03 | LEFT**  
Wilson’s first patent model, No.7776, issued in 1850, based on his prototype for a vibrating-shuttle sewing machine. The labels indicate the presser foot and the serrated feed strip that moved the cloth forward.



**04 | ABOVE** Wilson's first rotary hook patent (No. 8296 of 1851), replaced his earlier shuttle mechanism (fig.03) with a rotary hook and reciprocating bobbin.

and return motions of the shuttle. Most importantly, the prototype had a serrated feed strip and presser foot that moved the cloth in a regular manner (fig.03).

Short of money, and living in North Adams, MA, Wilson sold a half-share in his machine to Joseph Chapin for \$200, using the money to process his Patent No.7776, issued on 12 November 1850 (fig.03). Wilson and Chapin assigned the patent to AP Kline and E Lee of New York City. Although Kline & Lee turned out to be fraudsters, Wilson's shuttle machine did get into production, with a handful of machines completed. One who saw his machine in New York was Nathaniel Wheeler, a manufacturer from Watertown, Connecticut (CT), in partnership with Allanson Warren and George Woodruff of the firm of Warren, Wheeler & Woodruff. It was Wheeler who realised the potential of Wilson's machine and of the 'improved' new machines on which Wilson was working. Wheeler extricated Wilson from the manufacturing business of Lee & Co. and made him a partner in his Watertown business, renamed Wheeler, Wilson & Co. in 1851. There, helped by Nathaniel Wheeler's brother, Joseph, Wilson would invent his rotary hook sewing machine.

#### THE ROTARY PATENTS

After abandoning his shuttle design in 1850, Wilson spent the next two years, from 1851

to 1852, perfecting and patenting his rotary hook machine, which made the lock stitch by a new, more elegant method: a rotating hook picks up a loop of thread from the needle and takes it around a stationary bobbin, before casting it off (fig.05). His partners meanwhile concentrated on building a large factory at Bridgeport, CT, where they adapted the 'American system of manufacture', as used by the small arms industry, to make and promote sewing machines in large numbers.

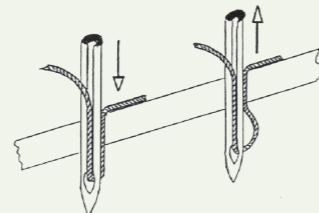
In Wilson's first rotary hook patent, No. 8296 of 12 August 1851 (fig. 04), the bobbin moved axially through the loop that was picked up by the hook. Only one machine fitting this patent is known to have survived, and the patented machine never went into production.

#### WILSON'S LOCK STITCH

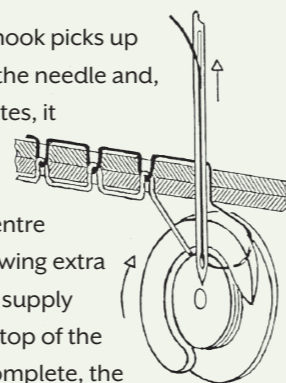
**[1]** The lock stitch, with two threads stitched on the cloth, one above and one below, interlocked at every stitch.



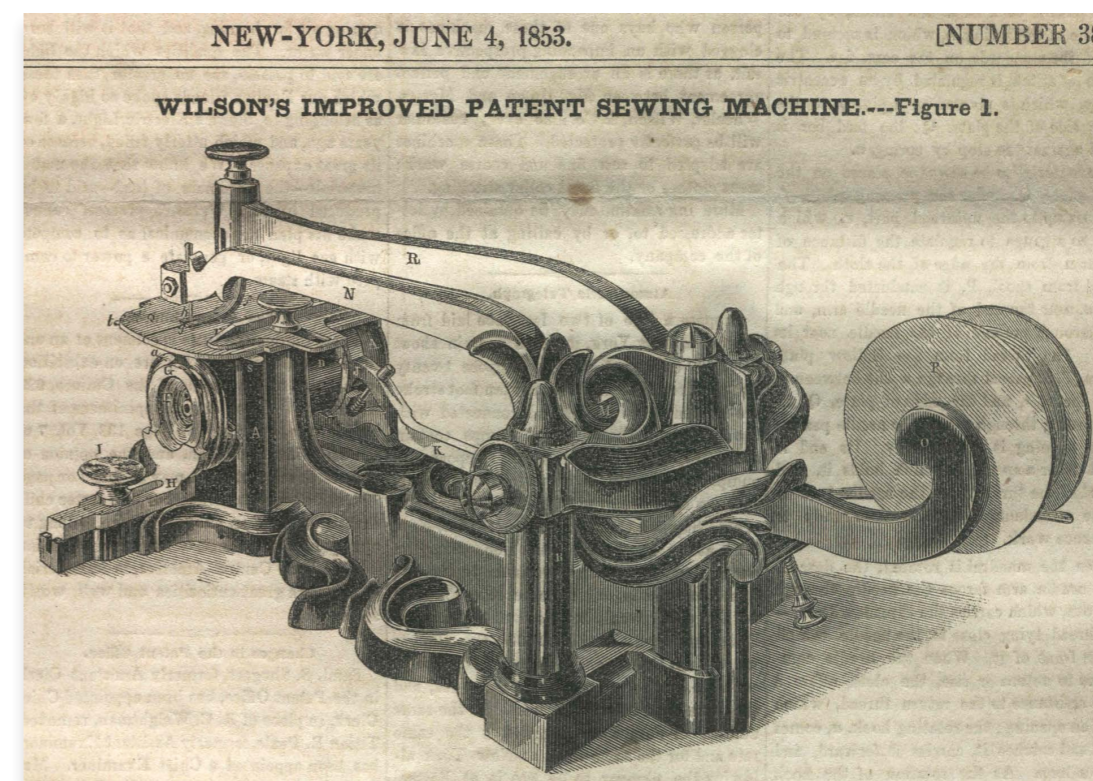
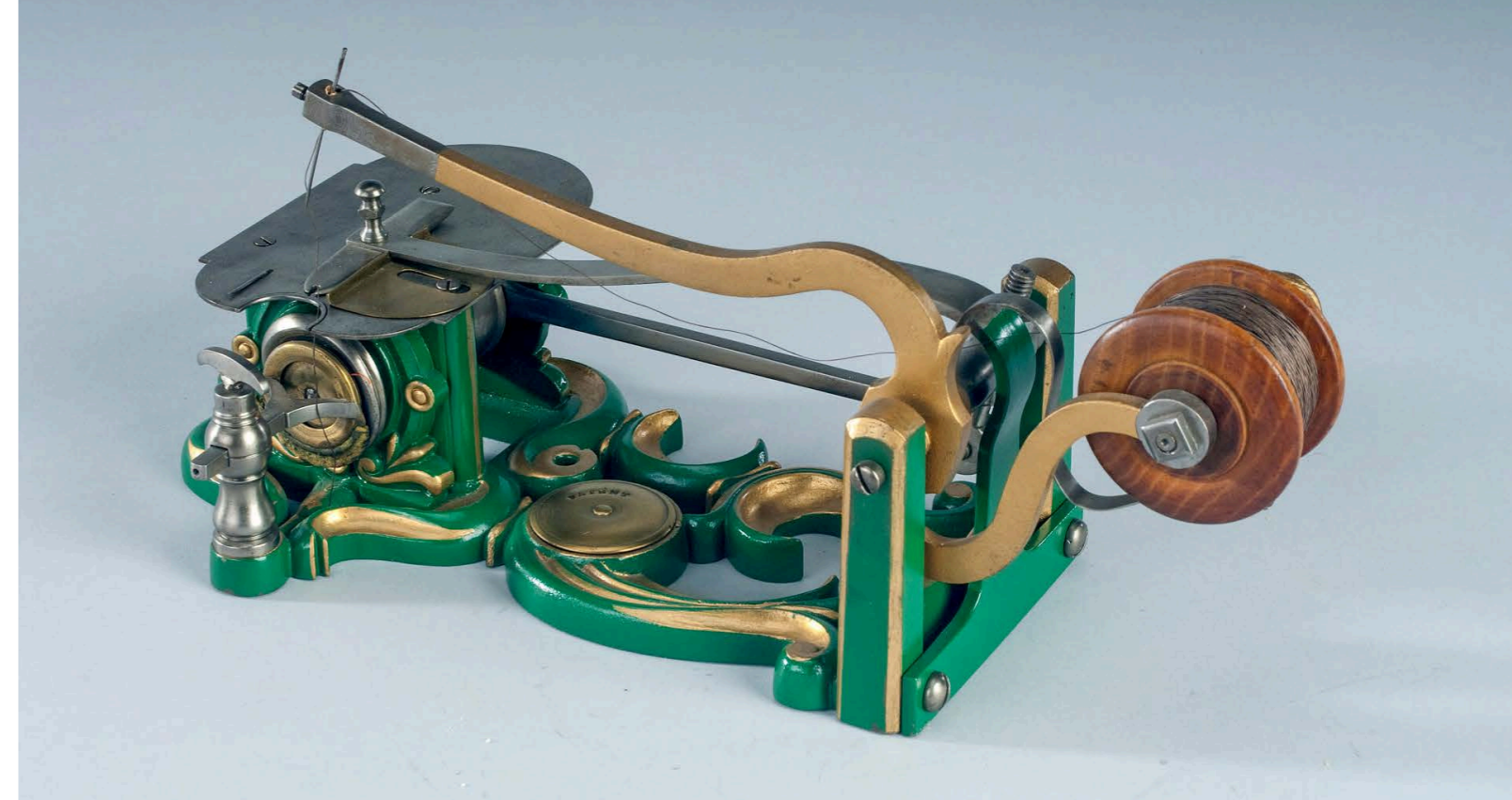
**[2]** To form the lock stitch, the eye-pointed needle takes a loop of thread through the cloth, leaving a small loop behind.



**[3]** The rotary hook picks up the loop left by the needle and, as the hook rotates, it carries the loop around the bobbin at the centre of the hook, drawing extra thread from the supply reel feeding the top of the needle. Once complete, the extra thread is recovered back up the needle groove, to tighten the stitch.



**05 | RIGHT** A step-by-step diagram of the lock stitch, as formed by Allen Wilson's second rotary patent of 1852, with a rotary hook and stationary bobbin.



In Wilson's second rotary patent, No.9041 of 15 June 1852 (fig.06), the mechanism was simplified so that the hook picked up a loop of thread and took it around a stationary bobbin. Wilson's subsequent patent for the four-motion feed to move cloth through the machine, in combination with a spring presser foot (No. 12116 of 19 December 1854), completed his contribution to the sewing machine story.

#### THE FINAL YEARS

In 1853, the partnership of Wheeler, Wilson & Co. was dissolved and changed into a joint stock company, the Wheeler & Wilson Mfg Co., at which point Allen Wilson retired, aged 30, due to his recurrent bouts of ill health. He purchased an estate in Waterbury, CT, where he lived quietly until his death in 1888. The company continued to pay him a salary

**06 | ABOVE** A view of the reel end of Wilson's second rotary patent model (No.9041 of 1852).

**07 | LEFT** An illustration from *Scientific American*, 4 June 1853, showing the production machine one year after the 1852 patent. A comparison reveals various small changes.



**ENDURING APPEAL**

By 1860, the Wheeler & Wilson curved needle machine had evolved into the most successful of the machines introduced in the 1850s (fig.08). The detailed design was due to Wilson, while the positive sales figures were down to Wheeler's marketing and the state-of-the-art factory at Bridgeport, CT. On a standard treadle table, with the belt pulley facing the operator and the hook assembly on the operator's right hand, machines sewed from right to left up to c.1855 (the Watertown machines); and from left to right thereafter, when production was transferred to the factory in Bridgeport. By 1862, over 100,000 machines had been produced. Once the patents expired, Wilson's design was widely cloned outside the USA, enabling it to become the first sewing machine to reach sales of 1 million. So popular was the curved needle machine with makers of shirts and other clothes using light fabrics, that Singer Mfg Co. kept it in production for another 20 years after their takeover in 1905.

**08 | ABOVE**

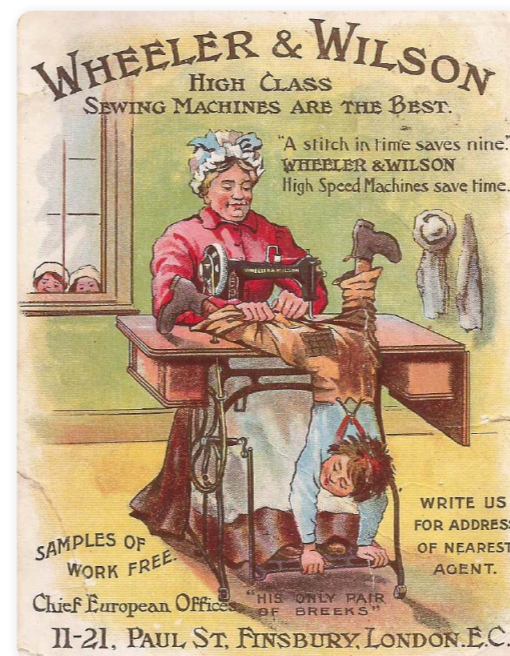
The standard curved needle machine was produced by Wheeler & Wilson from 1860 onwards. The 'No.1' here displays silver-plated arms and 'shiny bits'.

and a portion of the income from his patents until his death. Wheeler & Wilson Mfg Co. flourished and went on to become the largest manufacturer of sewing machines in the world in the 1860s and early 1870s. Eventually, at the turn of the century, in 1905, the Wheeler & Wilson Mfg Co. was taken over by the Singer Mfg Co.



**A LASTING LEGACY**

Looked at in 2023, almost all present-day sewing machines use Wilson's four-motion feed (fig.10) and the vast majority of lock stitch machines make the lock stitch using Wilson's rotary hook principle. Thus, Allen Benjamin Wilson has a strong claim to be the 'inventor of the modern sewing machine'. Wilson was a born inventor, with many diverse patents to his name. However, he was a poor businessman. After the experience with Kline & Lee, he was lucky to find an honest entrepreneur in Nathaniel Wheeler, with whom to develop his sewing machine. After he retired, his salary and patent revenue left him comfortably off, rather than a multi-millionaire like Howe and Singer. None of his other patents or projects made him any money and, after his death, his wife and daughters fell on hard times.



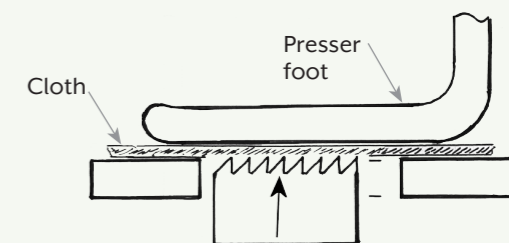
**09 | LEFT AND ABOVE** The popular 'No.9' was the last domestic sewing machine made by Wheeler & Wilson, and was continued by Singer after their takeover in 1905. Like all Wheeler & Wilson machines, it used a development of the rotary hook and four-motion feed invented by Wilson. The trade card above dates from the 1890s.

**10 | RIGHT** Diagram of the four-motion feed.

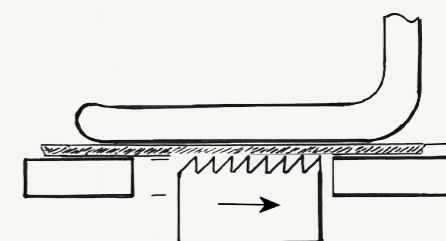
**THE FOUR-MOTION FEED**

**A step-by-step diagram of Wilson's four-motion feed moving the cloth from left to right:**

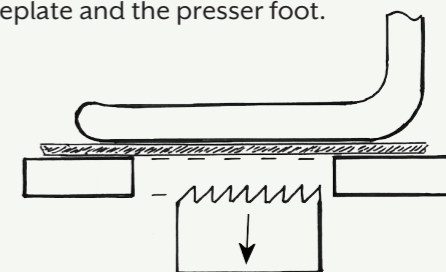
**(1)** The serrated feeder rises through the slot in the needleplate, gripping the cloth between the feeder and the presser foot.



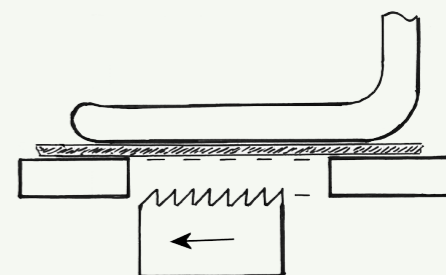
**(2)** The feeder pushes the cloth to the right.

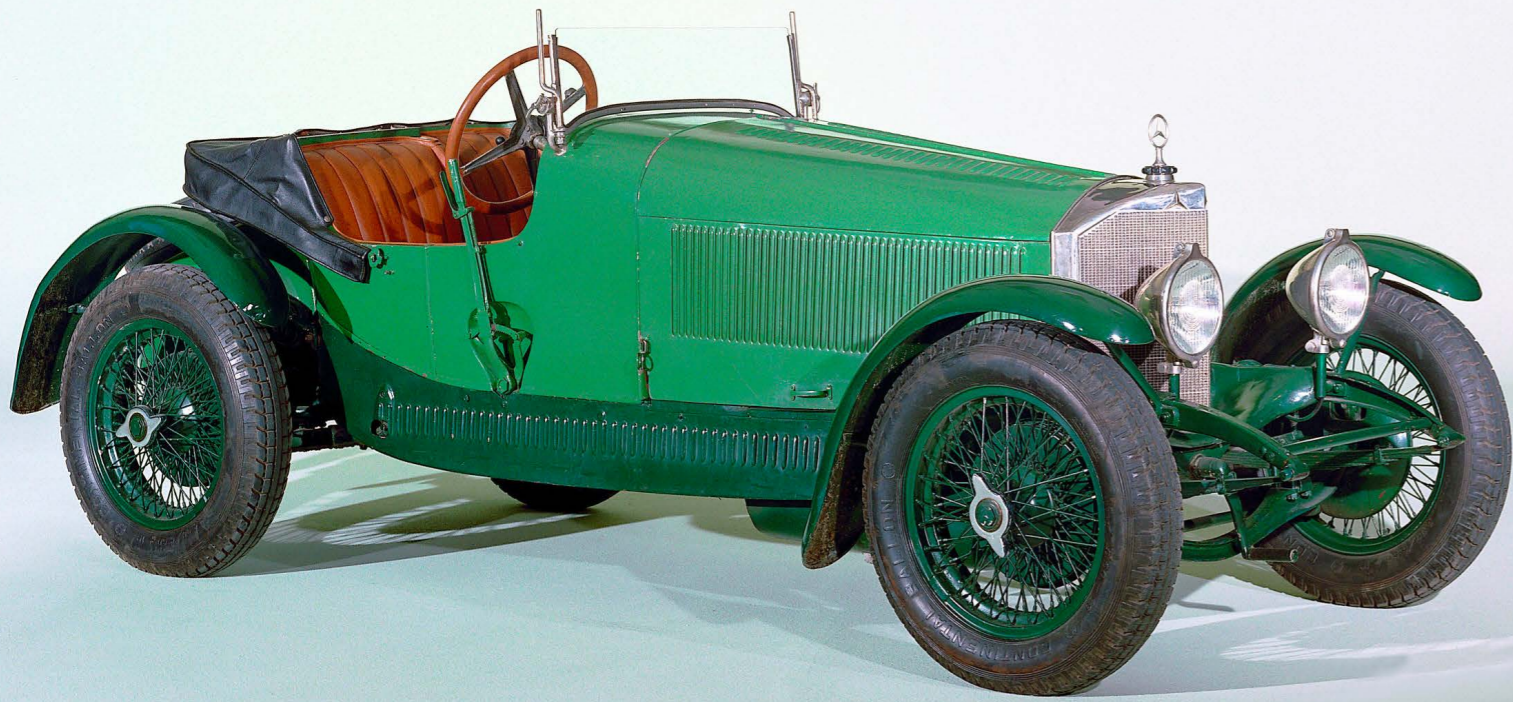


**(3)** The feeder drops below the needleplate so that the cloth is held stationary between the needleplate and the presser foot.



**(4)** The feeder completes its movement back to the left and is ready to rise again through the slot in step 1.





# BIRTH OF BOOSTING: the first supercharged production cars

Drawing inspiration from the supercharged aero engines of World War I (1914–18), Paul Daimler developed the first supercharged, series cars. To mark the centenary of Daimler’s innovations, KARL LUDVIGSEN traces their history.

**01 | ABOVE**

A star of the Mercedes-Benz collection is this 10/40/65 sports car, which begs to be restored and driven, as its rakish looks suggest.

**O**ne hundred years ago, the Mercedes-maker Daimler (Daimler Motoren Gesellschaft) introduced the first series-built cars to be supercharged. They took advantage of expertise gathered by their supercharging of aeroplane engines during World War I.

‘Although the special needs of the aviation engine directed attention to the supercharger,’ mused *The Autocar* in 1923, ‘and although the problems of engine power at high altitudes do not arise in motor-car engines, yet the conventional

limits set by the classification of automobiles by cubic capacity and the artificial limits enforced to a great extent by taxation make it necessary to consider how more power can be obtained from a given size of engine. Though supercharging in England has not been considered extensively, the German designer has been busy. For over ten years experiments have been carried out.’

**POST-WAR SUPERCHARGER DESIGNS**

How right the writer was. The German designer emerged from World War I with a bulging portfolio of supercharger designs,

tests and findings. Of those engine builders who were able to exploit their airborne supercharging know-how after the war, the Daimler Motoren Gesellschaft (DMG) stood out. Under the terms of the Versailles Treaty (1919), the DMG could no longer build big aero engines, but it could bring its boosting knowledge down to earth (figs 01–04).

Engineering director Paul Daimler (1869–1945) set up the program, continuing under the direction of Walter Schwerdtfeger, chief of the experimental department in Stuttgart.

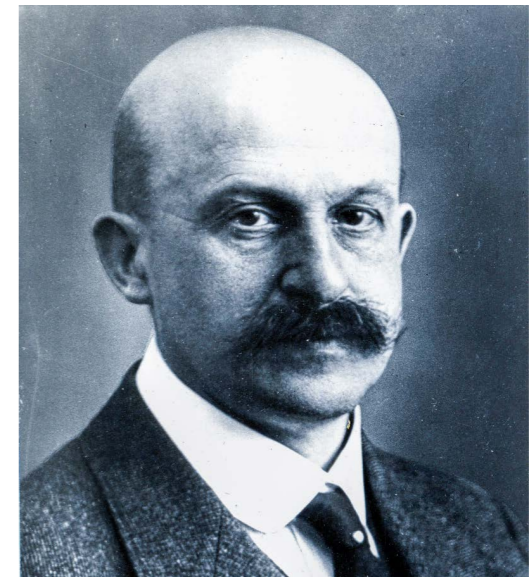
**KNIGHT’S SLEEVE-VALVE SYSTEMS**

One of Daimler’s key decisions before the war had been the acquisition of a licence to produce cars with the sleeve-valve system in-



vented by American Charles J. Knight (fig.05). Instead of poppet valves, Knight’s design used two concentric ported sleeves between the piston and the cylinder wall to control inlet and exhaust apertures (fig.06).

Paul Daimler’s first thought was to try supercharging a Knight engine. Problems with hot exhaust valves – a supercharging bugbear – would be avoided. If successful, boosting would make it easy to offer variations in the Knight models, whose sleeve-valve constraints made alterations in bores and cylinder capacity inconvenient. With poorer wartime lubricants, the Mercedes-Knight engines had dimmed the lustre of the Stuttgart star; Daimler hoped to implement supercharging



**02 | LEFT** Designer of the winning Mercedes in the 1914 Grand Prix, Paul Daimler instigated supercharging on Daimler’s wartime aero engines.

**03 | FAR LEFT** In a wartime supercharging test, a Daimler six-chain drive in a Halberstadt Ch II biplane (here) drove a Wittig vane-type blower.

as a means of enhancing the Knight engine’s power range and reputation.

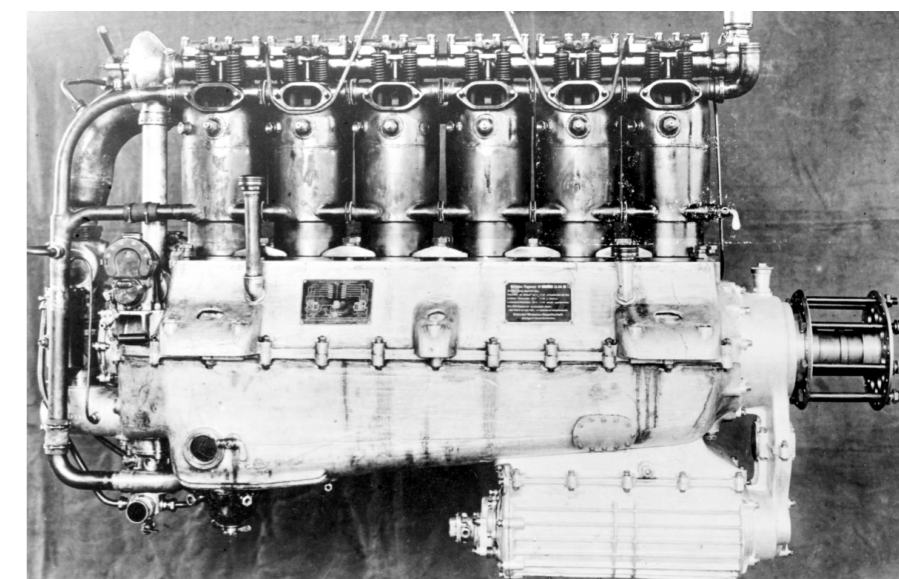
Chosen for boosting trials was the 2.6-litre four-cylinder engine of the 10/30 model, smallest of the series of three Knight-equipped engines, both larger and smaller than the original 16/40 models, which were in the Mercedes-Knight product range. The little 10/30 could also use added power.

**HIGH-SPEED ROOTS BLOWERS**

On 2 September 1919 Walter Schwerdtfeger wrote the work order for the construction of a Roots blower for the 10/30. His assistant Karl Schopper detailed its design (fig.04).

Research conducted towards the end of the war led to the design of a distinctively high-

**04 | BELOW** Finally, an expert integration of the Roots with an aero engine was achieved by the Daimler engineers.



**05 | ABOVE**

Charles Knight (right) shows Paul Daimler (centre left) and his colleagues his sleeve-valve system at a motor show in the early 1920s.

speed Roots charger. ‘Heretofore such blowers were driven at 500 rpm at the most,’ the DMG stated: ‘High power therefore involved large dimensions and great weight, so these blowers could not be employed in cases where light weight and small dimensions with relatively high efficiency were required.’

**DAIMLER’S INNOVATIVE PATENTS**

Daimler’s Roots chargers were designed to run at a minimum of 2,000 rpm and as high as 20,000 rpm, ‘at which speeds the specific power required by the blower is the least’. So ground-breaking was this that Daimler filed for a patent on the principle on 21 June 1918. Its research, the company said, showed that, with the Roots blower’s fixed gaps between rotors and walls, the efficiency of a unit running at moderate speed to deliver a specific gas volume fell precipitously below that speed. If, however, a smaller unit were made to run at higher speed, it reached and held a constant pressure for the same delivery.

Materials played a role. Karl Schopper’s design fabricated the compressor’s rotors and

housing from sheet steel to suit them to run at 10,000 rpm and beyond (figs 6–12). Schopper made an enclosure for the updraft carburettor, placing the blower just below it. A gear train along the right side of the engine, shared with the dynamo, stepped up the speed and included a cone clutch that could be used to shift the blower in or out of action. Bench tests of the engine started at the beginning of September 1919.

With senior mechanic Jakob Kraus, Schopper joined Schwerdtfeger for the first test run in the blown 10/30 Mercedes along the road between Degerloch and Echterdingen, south of Stuttgart, on 17 October 1919.

For Daimler, the Pallas firm produced a new updraft carburettor with a concentric float bowl especially designed to operate under pressure. Karl Schopper used one of these in a rework of the Mercedes-Knight installation that placed the blower horizontally at the front of the engine with its shafts in the vertical plane.

In December 1919, Paul Daimler filed for a patent on this layout, which incorporated a multiple-disc clutch for blower engagement.

**TRIALS AND REVISIONS**

Second thoughts soon surfaced about the suitability of the double-sleeve Knight design for supercharging. Instead of lubricating, the oil around the exhaust ports caught fire, causing seizures that often broke the sleeve drive. Heat dispersal from the piston through the double sleeves to the block was meagre. Nevertheless, the benefits of supercharging to the engine’s output were so great that Paul Daimler carried on, shifting the emphasis from his Knight designs to Daimler’s poppet-valve engines.

Daimler and Schwerdtfeger remained true to their concept of a blower that pumped air through the carburettor. This was the only modus operandi that allowed them to have a part-time blower, one that gave the engine the option of both atmospheric and forced induction. When properly designed, it reduced the problem of the blower’s lubricant being drawn into the mixture by negative pressure downstream of the carburettor. A bonus was that backfires affected only the mixture from the carburettor(s) to the engine, whereas the alternative, drawing mixture into the blower, meant that the latter contained an ample explosive charge.

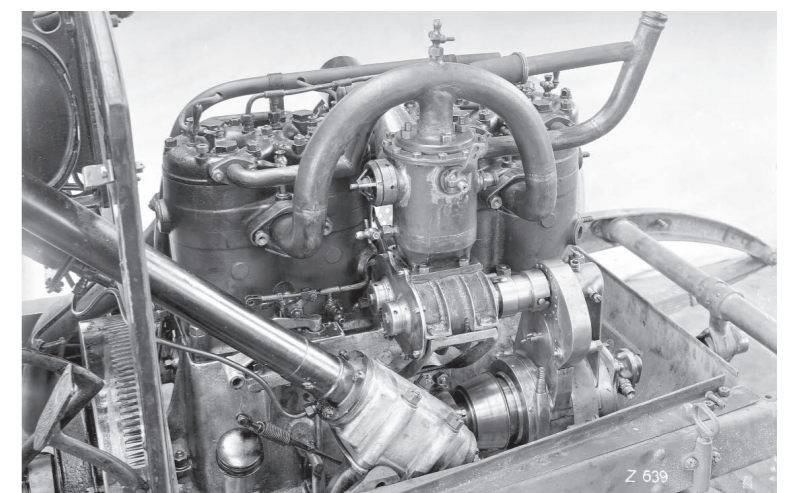
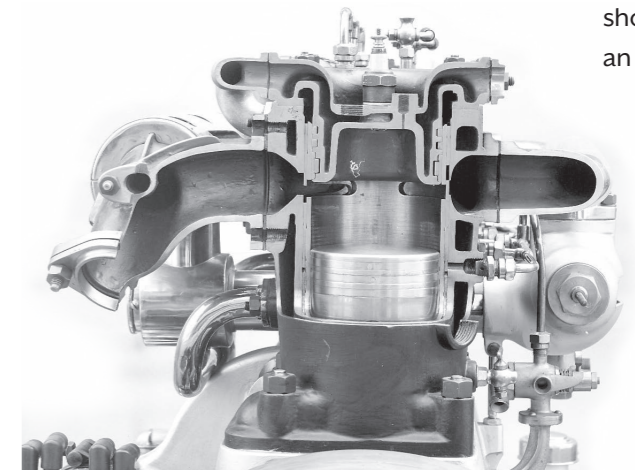
**PART-TIME BLOWERS AND VERTICAL CHARGERS**

The DMG researchers also signed up to the concept of part-time blower operation. On a touring car, this has the advantage of reducing to near-zero the amount of parasitic drag caused by the blower, with its attendant loss of performance and increased fuel consumption, when the full performance provided by the blower isn’t needed. It also meant that the engine could be lighter than would have been necessary if it had to stand up to full-time blower use. A subtle advantage was that the compression ratio could be fractionally higher, for better-off boost performance and fuel economy, than would otherwise have been the case.

The DMG engineers created ingenious linkages to operate the valves and clutch that implemented the part-time operation, working out through experiment the best way to

achieve a smooth transition into and out of blown operation. During 1920, the Daimler team adopted the engagement method of a linkage to the accelerator pedal, which assured robust engagement of the blower’s clutch. That year also witnessed the decision to mount the Roots charger vertically with its shafts in the longitudinal plane, driven by bevel gears.

Special care, demanding high precision, had to be taken to ensure a good fuel supply to the carburettor. Needing to avoid putting the fuel tank under surface pressure to deliver fuel to the float chamber against blower boost, Walter Schwerdtfeger invented and patented a rotary pump. It was expressly designed with loose clearances, which allowed the fuel to flow freely through the pump when boost was absent. As soon as the charger was engaged, an extension from the top of its input shaft set the pump spinning to ensure high-pressure delivery of fuel to the carburettor. Ingenious in its simplicity, this was adopted for production.

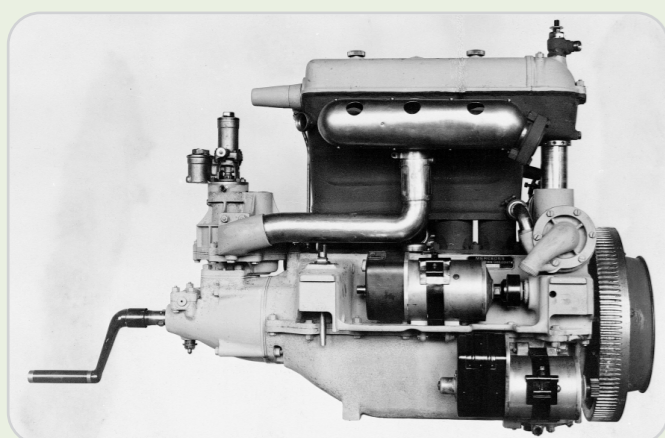
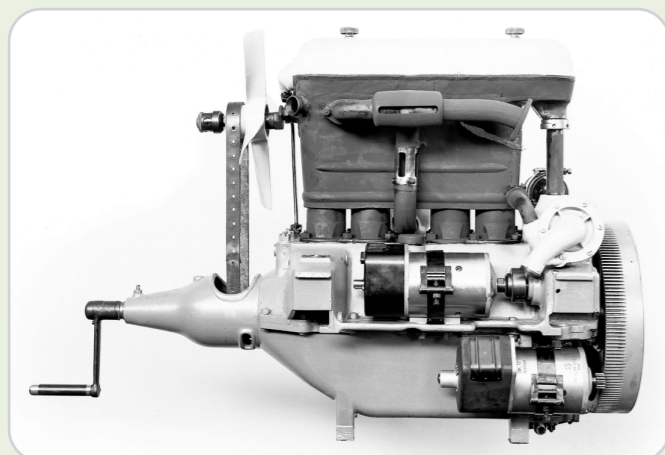
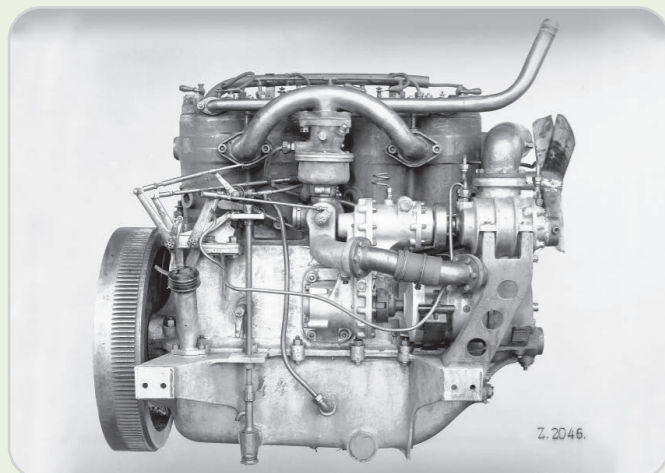
**06 | BELOW**

A cutaway reveals the way in which two concentric sleeves performed the valve function of an engine’s cylinder. It was Daimler’s choice for supercharging.

**07 | BOTTOM**

The first Roots blower installation on a Daimler 16/45 sleeve-valve engine in a test car. Its carburettor is shown here in an enclosure.

## EVOLVING ENGINES



**08 | TOP** A developed booster for a sleeve-valve engine was trialled, but failed its test.

**09 | CENTRE** The 1922 6/25 engine, with its shaft-driven overhead cam, formed part of Paul Daimler's new family

of four-cylinder engines with and without supercharging.

**10 | ABOVE** A 1.6-litre 6/25/40 supercharged engine, with its blower at the front; and the ducting of warm air via the exhaust manifold.

### SMALLER, SUPERCHARGED ROAD CARS

In 1920 Daimler laid down a new series of four-cylinder engines for a fresh range of smaller road cars that would replace the Knight-valved models. Forced induction was to be an integral part of their design. These were the first engines designed by Daimler expressly to be supercharged. In this decision, Paul Daimler had strong support from DMG's sales chief, Hermann Gross, also an engineer. With capacities of 1.6 and 2.6 litres, the fours were designated the 6/25 and 10/40, respectively, after their taxable and unblown brake-horsepower ratings (figs 08–12).

Vee-inclined overhead valves operated by rocker arms were a clear indication that the new fours were inspired by Daimler's World War I aero engines. Major design features were shared by both engines. Rocker arms operated the overhead valves from a single overhead camshaft, driven by a vertical shaft at the rear. Bevels from that shaft drove the water pump on the left and the magneto on the right. A take-off at the rear drove a generator along the left side of the crankcase with the starter motor below it.

Daringly, and perhaps even rashly, in terms of volume-production methods of the day, these engines used aircraft-type cylinder blocks with four steel cylinders surrounded by a welded sheet-steel water jacket (figs 11–12). This was ideal for supercharging, having an integral cylinder head with no potentially troublesome head gasket. Lower portions of the cylinders were left exposed. An aluminium crankcase carried their three main bearings, lubricated by a reciprocating oil pump with a smaller piston that topped up the sump's supply from a dash-mounted tank.

### BLOWN AND UNBLOWN OPTIONS

Although the engines were designed for supercharging, the DMG managers hedged their bets by offering them in unblown form as well. If the unsupercharged fours were not to be disproportionately heavy and bulky for their size, the argument went, they

could not be designed to cope with sustained use of the supercharger. By the same token, early adopters of forced induction might well prefer to have access to spirited, supercharged performance only when desired, instead of constantly with the associated penalties of noise and fuel consumption. Here were the rationales for the aforementioned decision to place charging at the driver's disposal by applying full pressure on the accelerator pedal.

Inside a housing finned for cooling, Daimler followed up its research findings by fitting a Roots blower whose steel rotors were of small dimensions running at high speed (figs 11 and 12). First of the two models to be finalised was the smaller 6/25. A pair of bevel gears gave it a 1:3.4 step-up ratio so its rotors would attain 9,500 rpm at the peak engine revs of 2,800 rpm when 40 bhp (brake horsepower) were produced. Unblown power of 25 bhp was reached at 2,400 rpm. Identical technology was fitted to the larger 10/40, whose Roots had longer rotors of the same diameter as those of the smaller engine to provide the needed air capacity. Its blown output rose to 65 bhp from the naturally aspirated 40 bhp.

In both engine types, the multiple-disc clutch that engaged the blower lay between the crankshaft nose and the driving bevel gear. Operated by the accelerator pedal, the blower-clutch linkage also controlled other transitions from unblown to supercharged when the pedal was pressed to the limit. Lubrication of the Roots was by a separate pressure-regulated oil supply from the engine.

Air entering the blower came through a large duct from a brass muff around the exhaust manifold (figs 10–12), on the left side, providing the warmth needed for better vaporisation of the fuels of the era. A control under the fascia adjusted the amount of warming by admitting unheated air, below the manifold, as needed. A smaller duct from the muff ran between the middle cylinders to the updraft carburettor on the right side, delivering the air that the engine breathed when it was not supercharged. The blower



**11 | TOP** Steel rotors of the 6/25/40's Roots blower were shrewdly configured to distribute stresses at their five-figure rotating speed.

**12 | ABOVE** The aluminium housing and attachments of the 6/25/40's Roots blower show its relative shortness within its casing. As installed, air entered the blower on the left-hand side.

linkage closed a butterfly valve in this duct when boost was demanded. Although the 6/25 was first shown with a conventional exhaust, production cars had twin exposed pipes on the left-hand side of the bonnet.

Normal fuel delivery was by air pressure in the fuel tank generated by a pump driven from the rear of the camshaft. In the supply to the carburettor was a four-bladed impeller in a bronze chamber driven from the top of the Roots blower's input shaft. Normally, fuel simply flowed through this chamber. When the compressor was engaged, however, as in Walter Schwerdtfeger's patented design, the rotor whirled to give a boost to the fuel pressure and volume delivered to the carburettor. Below the latter, was a spring-loaded pressure-relief valve to cope with backfires. Delivery from the carburettor was to the engine's two siamesed inlet ports (fig.13).

### 13 | BELOW

Under its bonnet, a 10/40/65 Mercedes reveals its longer Roots blower, designed to cope with the needs of its 2.6-litre engine. Delivery was upward through its special carburettor.

### A CUTTING-EDGE FAMILY CAR

Neither the 6/25 nor its larger sister was conceived as a sporting car. Rather, the concept was that of a light and lively family car of advanced technology that was available in a wide variety of body styles (figs 14–18). Its chassis, however, was not up to the times, with its rear-wheel braking, quarter-elliptic rear

springs and lack of dampers. Painfully evident was the DMG's effort to compensate for the high manufacturing cost of the new aero-tech engine by cutting back on the componentry of the rest of the vehicle.

In unblown form, the engines had a different sump casting and, in the 6/25, a nose extension to a crank handle. A belt from the crankshaft turned a four-bladed fan behind the radiator. When supercharged, however, the vertical Roots blower and its ancillaries blocked the space that a fan needed. In addition, the charging equipment intruded into the deeply veed radiator, a style that Daimler adopted with its Knight-engined cars.

Yet road tests of the supercharged engine gave no hint of overheating. The secret was that the DMG had retained a long-standing feature of its early engines, which had bladed fans as spokes in their flywheels. With tightly fitting bonnet panels, these sucked cooling air through the radiator and past the engine.

Between April and July of 1921, the Untertürkheim works delivered five pre-production 6/25 models to the experimental department for testing. One was equipped with the new Kompressor, as the device was named in German. Accompanied by Schwerdtfeger, Daimler took its wheel to demonstrate its performance to Ernst Berge, the DMG's general director. Here was a new kind of motoring that would demand the finest arts of sales chief Hermann Gross if its advantages were to be fully realised in the form of profitable deliveries.

### THE 'MERCEDES SECRET'

By the summer of 1921, Germany's motor trade was rife with rumours of the 'Mercedes secret' being engineered at Untertürkheim. 'Like wild-fire, this news ran through all the dailies,' said the in-house *Daimler-Zeitung*, 'and both experts and laymen scratched their heads about the nature of the innovation. It was clear to all circles that when the DMG presents an innovation it could not be of negligible technical significance.'

'You may have gathered from notes in the newspapers,' Gross advised his dealers on 21 July,

'that we have succeeded in raising the performance of automobile engines in a quite substantial manner. We can advise you that we have hitherto restricted our experiments in the increasing of performance to the [6/25] model and therewith have achieved outstanding results, so we have decided to bring the relevant improvement to this [6/25] type in general.'

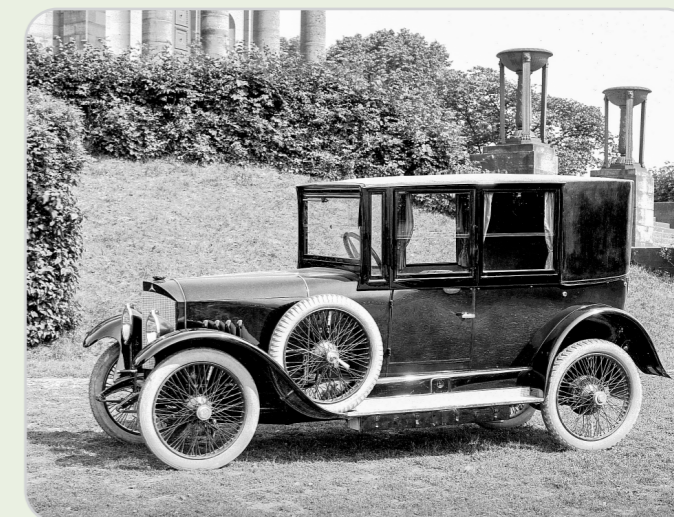
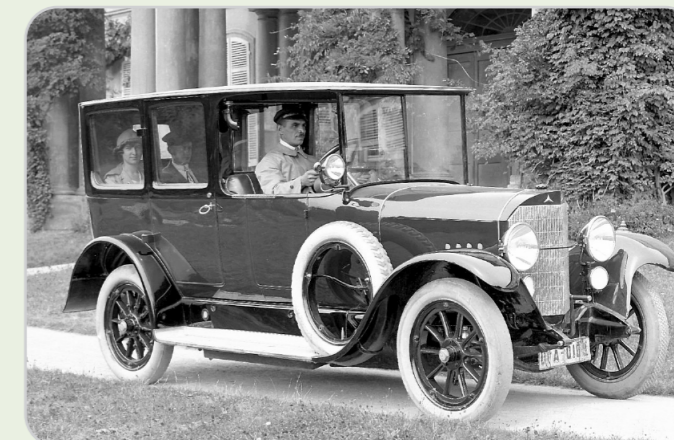
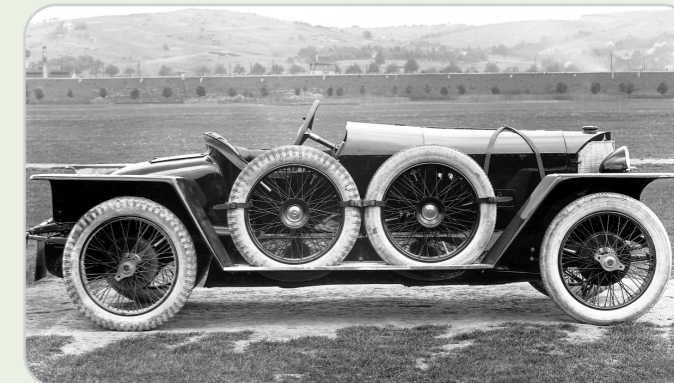
### UPBEAT REVIEWS AT THE BERLIN MOTOR SHOW

All eyes were now on the Berlin Motor Show, set to run from 23 September until 2 October 1921 – the first such exhibition in 10 years. One example of each of the new 6/25 and 10/40 models was on show, a sports phaeton of the smaller model and a sports six-seater of the larger. Also exhibited was a 10/40 engine, but none was equipped with the much-rumoured performance-increasing device. That no such engine was shown on the Mercedes stand prompted a catty comment by *The Autocar*'s William Bradley: 'Rivals claim that the special engine only exists in the mind of the Mercedes advertising manager.'

'These new creations,' wrote the *Allgemeine Automobil-Zeitung* (AAZ), 'are equipped with a device for occasional overloading, which required the creation of a special carburettor. The constructive delineation of the overloading device is not externally recognisable. It is evidently still secret, but its effects will be shown to the press in demonstration vehicles.' The cars in question were open tourers, one of each model completed eight days earlier, then driven from Stuttgart to Berlin by racing drivers Otto Salzer and Christian Lautenschlager, the latter being the feted winner for Mercedes of the 1908 and 1914 French Grands Prix.

Fully laden with motoring correspondents and accompanied by two other Mercedes, both cars were driven on a test route from the Kaiserdamm Palace and returned on Saturday 1 October. Although the cars' bonnets were not lifted to permit inspection, their principle was disclosed, said the *Berliner Zeitung*: 'Our earlier suppositions are confirmed: it is a blower motor. Applied at the front of the

## MERCEDES FOR TOWN AND TOURING



**14 | TOP** A well-equipped Mercedes 10/40/65 sporting tourer with front brakes.

**15 | CENTRE** Prestigious bodywork of the 10/40/65 tourer made it an ideal choice for the chauffeur-driven.

**16 | ABOVE** This charming 6/25/40 town car demonstrated the versatility of the new range of supercharged Mercedes automobiles.



engine is an air pump that delivers compressed air to the cylinders. The air pump substantially increases the degree of filling and raises the motor's effectiveness by up to 50 percent.'

'In the Tiergarten,' the *Berliner Zeitung* continued, 'where our group was split apart by the traffic, Salzer had an opportunity to put the air pump in action. It is connected to the accelerator, which has a hindrance half-way down its travel which, when it is pressed through, brings the pump into action. The effect made itself immediately evident: the car pulled powerfully forward and was quickly attached again to the group ahead.'

#### 17 | BELOW

Looking lithe and lovable, this Mercedes 6/25/40 roadster had great appeal. Its owner could fully exploit the excitement of supercharging.

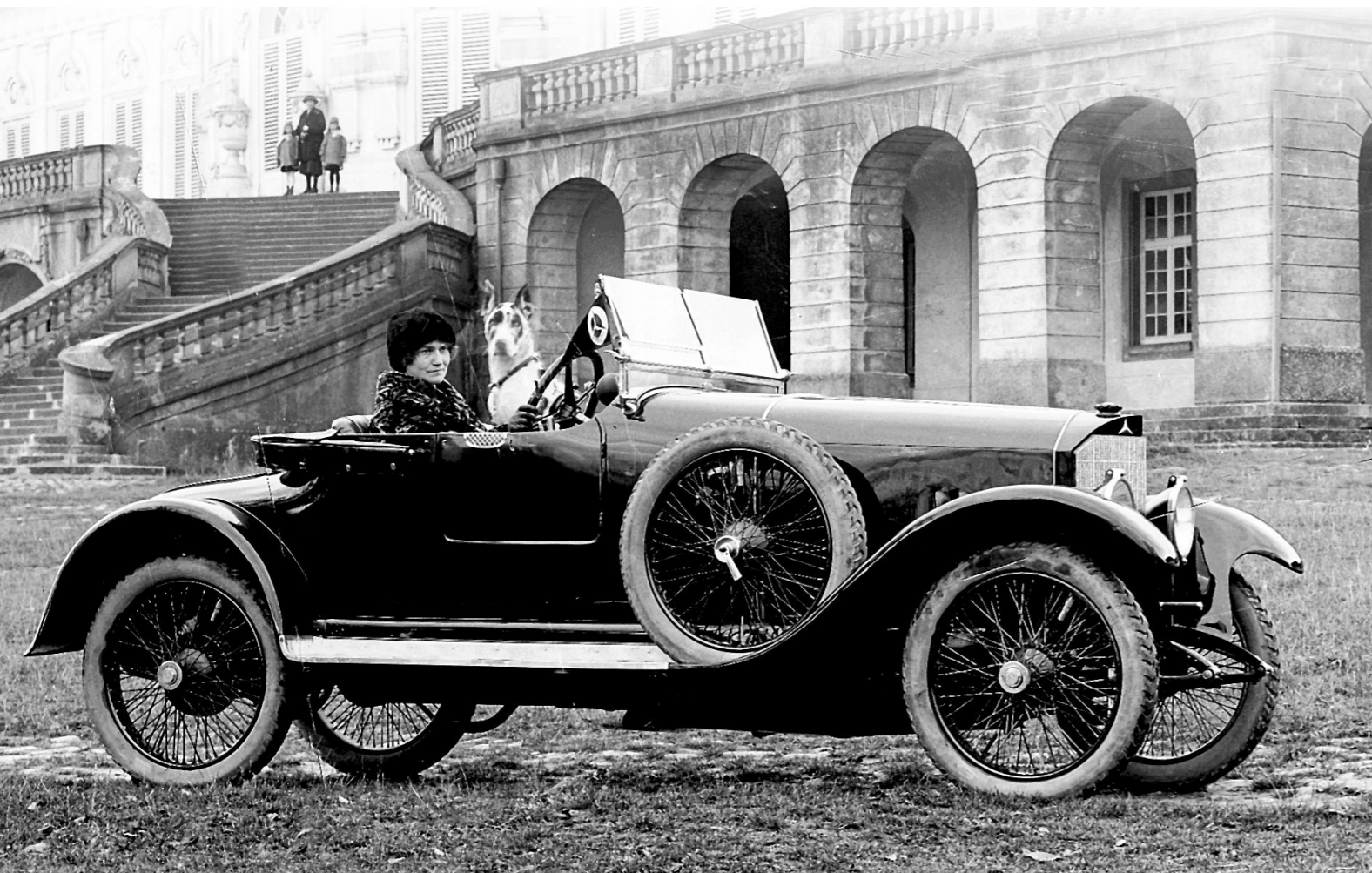
Chasing the others in the group, said the man from the *Berliner Tageblatt*, the smaller of the two cars 'reached 90 [km/h] with insouciant ease, then a step down on the accelerator, a remarkable singing noise and the kilometre needle passed 100 and climbed up to 110, 115 and swung toward 120.' This, equivalent to 75 mph, was performance right out of the ordinary for a 1.6-litre automobile in 1921. Daimler had indeed engineered a stunning advance.

The design of the 'Mercedes secret' remained just that for many months while

pundits speculated about its details. The comment by the *AAZ* that 'the first production cars cannot be delivered for eight months' was close to the truth. In fact an accounting from the experimental department in December 1921 said that they had 35 '6/20' models under test, of which five had superchargers. Only one had the final vertical mounting that would be produced. Similar totals applied to the '10/35'.

#### THE FIRST ON THE ROAD

Although it started life later than its smaller 6/25 sister, the 2.6-litre 10/40 caught up with and passed its sibling. Customer deliveries began with one car each in August and September 1922, followed by a dozen cars in November and December. Thus the 10/40 PS (*PferdStarke*) Mercedes captured the laurels as the first series-production car to be supercharged. In April 1923, half a year later, deliveries of the 6/25 PS began, gathering pace to number some 30 units by the end of July. From 1924, the cars officially had designations of 6/25/38 and 10/40/65, the new third digit giving their boosted horsepower.



#### PRODUCTION FIGURES

Continuing through 1924, annual production of these entry-level Mercedes models remained at three-figure levels, thanks in no small part to their prices. The company's policy of constraints in chassis equipment to compensate for the high cost of the engines still left its blown cars dangerously exposed. Of the two, the larger model proved the more marketable.

After 1924, the phasing out of both supercharged models was a consequence of an agreement that year between Daimler and Benz to co-ordinate their production and sales activities, a precursor to their amalgamation in 1926. The smaller car proved to be the less attractive proposition. After its high point of 190 units in 1923, sales tapered off, ending with a total of some 360 produced, not including 25 sports specials. Offering a higher performance/price ratio, the 10/40/65 attained 504 deliveries in 1924. Total production of this 2.6-litre model is estimated at 1,050 units.

Uniquely among auto makers, the newly formed Mercedes-Benz would continue to



offer supercharged models from these years until their production was terminated in 1943 – a 20-year span. Fifty years later, in 1993, it commenced the supercharging of some of its production models with its charming SLK roadster. Boost was back and very welcome.

BY KARL LUDVIGSEN based on research for his forthcoming *Power Unleashed: Trailblazers Who Energised Engines with Supercharging and Turbocharging*, to be published in three volumes by Evro Publishing.

#### 18 | ABOVE

Wire wheels add to the sportiness of this 6/25/40 tourer, a Mercedes-Benz Museum car with heavier tyres than used in its period.

#### 19 | LEFT

A glance under the bonnet of the Mercedes 6/25/40 reveals the absence of the blower of its earlier sister, the 10/40/65.

# RETURN OF TWO PORTFOLIOS TO THE KARLSRUHE ETI

On discovery of two early portfolios of electrical drawings in the Newcomen Society's archives, VAUGHAN POMEROY has returned them to their rightful home.

**D**uring the clearance of the Newcomen office in Blythe House, London, I discovered two portfolios of large drawings of electrical machines. There was no interest in retention, but they looked unusual and spiked my curiosity.

Each portfolio, entitled *Konstruktionstafeln für den Dynamobau...*, contained a complete set of 60 large (c.A2) drawings describing electrical generators (figs 01–03). One set covered DC machines (*Gleichstrom Maschinen*), the other AC (*Wechselstrom Maschinen*); and the drawings are based on machines for contemporary installations.

## A GIFT OF SYDNEY GLENDENNING

The portfolios seem to have been gifted to the Newcomen Society by Sydney Glendenning, whose name was ink-stamped on each sheet. Sydney Glendenning was born in 1880, started to work with Laurence & Scott in 1897 and, with a few interruptions for study, training and military service in World War I, worked with this company until 1939. He died in 1956.

## THE PORTFOLIOS' CREATOR

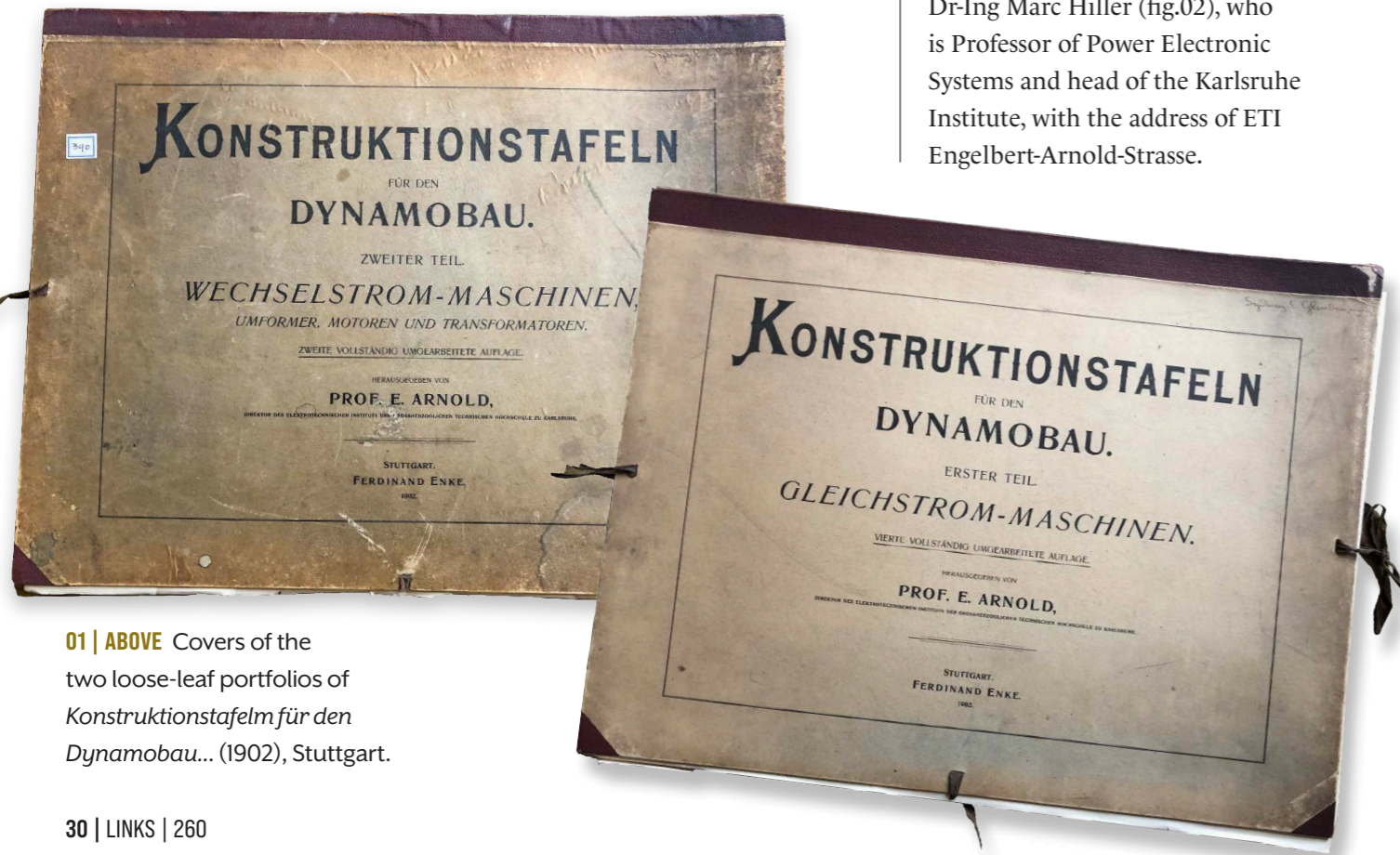
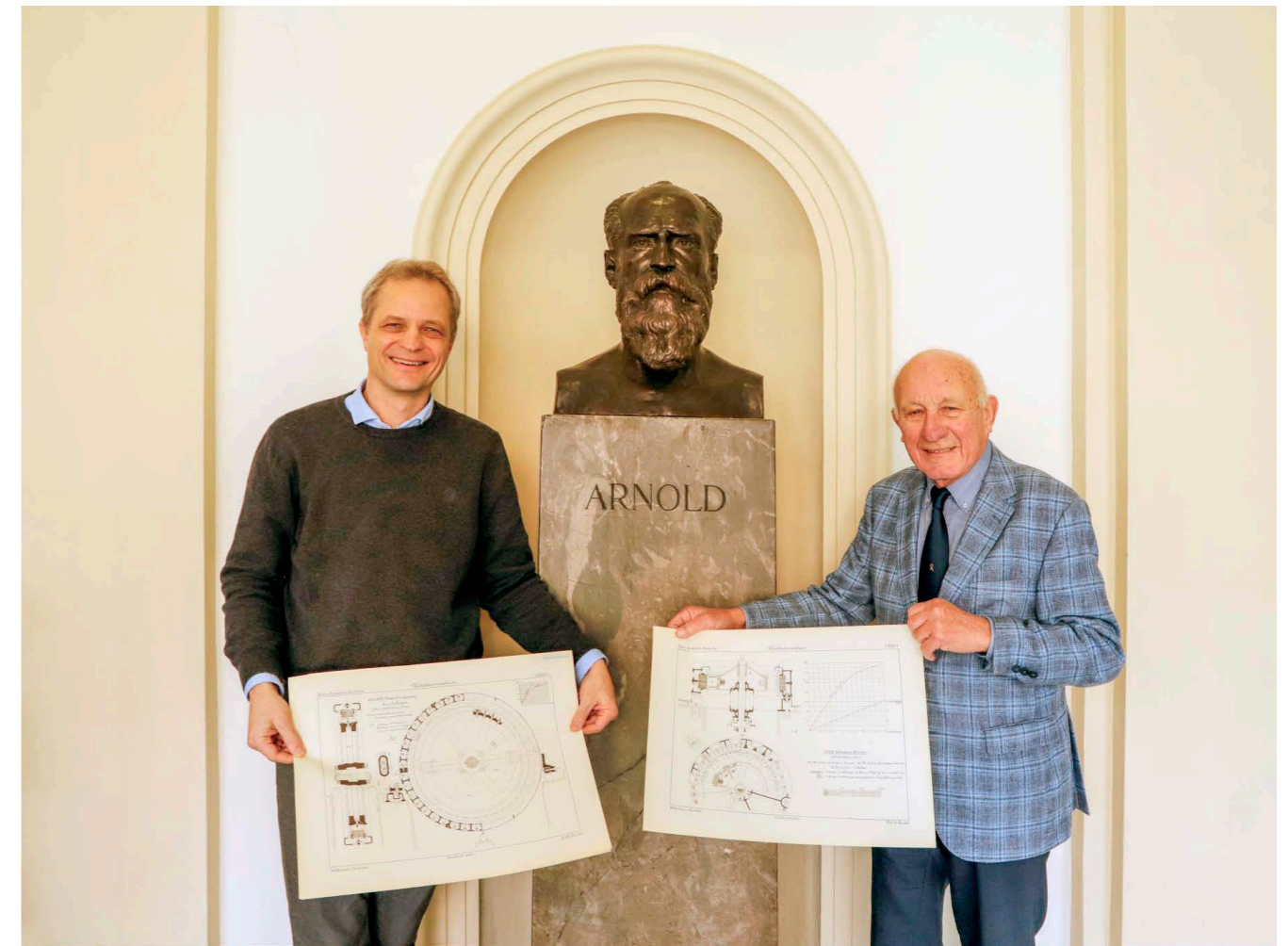
The portfolios, dated 1902, were prepared by the Swiss engineer Professor Engelbert Arnold (1856–1911), who founded the Elektrotechnischen Institut (ETI) des Karlsruher Instituts für

Technologie (KIT) in Germany. The drawings are similar to various plates in Arnold's textbooks.

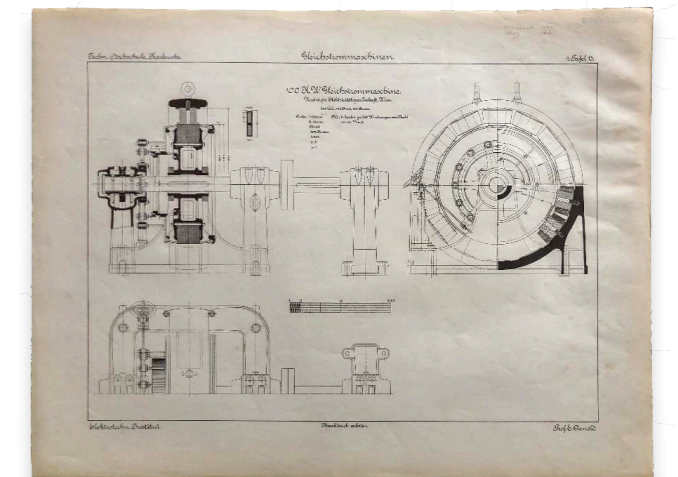
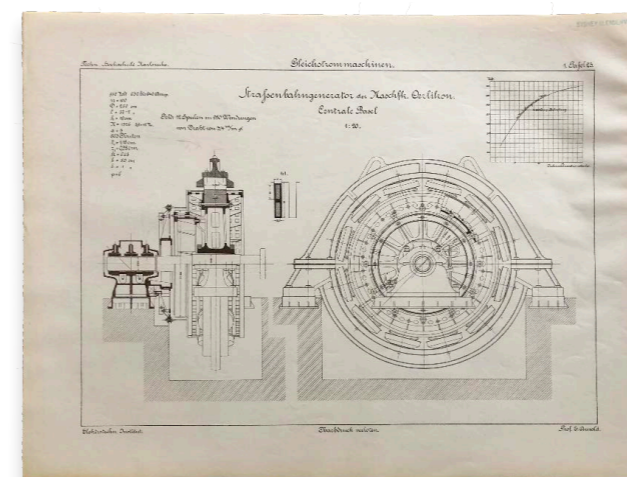
## RETURN TO KARLSRUHE

Through the contacts of my former colleague, Ir Willem de Jong, we arranged for these two folios to be returned to the ETI in Karlsruhe, where they have very few original documents relating to Professor Arnold and the early days of the institute. The institute will place some of the drawings on display with an acknowledgement to the Newcomen Society as donors.

Willem de Jong visited the ETI in Karlsruhe in December 2022 and met with Professor Dr-Ing Marc Hiller (fig.02), who is Professor of Power Electronic Systems and head of the Karlsruhe Institute, with the address of ETI Engelbert-Arnold-Strasse.



**01 | ABOVE** Covers of the two loose-leaf portfolios of *Konstruktionstafeln für den Dynamobau...* (1902), Stuttgart.



It seems very appropriate to place these volumes with the ETI, where the originator is still celebrated, for the benefit of the academic community. It is evident that the work of Professor Arnold is well known among the electrical machines community through his textbooks; at least the people who

I know all recognise the name and the reference works!

Through a rather unlikely route, the Society has ensured that the historic documents now reside where they are most likely to be discovered and used in future research into the history of the engineering of electrical machines.

**02 | TOP** Professor Dr-Ing Marc Hiller (left) beside Willem de Jong (former Deputy Chairman of Lloyd's Register) display folios from the *Konstruktionstafeln...* beneath a statue of Professor Arnold.

**03 | ABOVE** Folios 13 and 23 from the *Konstruktionstafeln* portfolios.

# Mechatronics at Crofton: marrying 200 years of technology

Following a pilot report in *Links 252*, JON WILLIS assesses the role of cutting-edge mechatronics at Crofton Pumping Station, a Grade I heritage site in Wiltshire.

**S**et deep in the Wiltshire countryside, our historic Boulton & Watt and Harvey beam engines are still working today, and able to keep the summit of the Kennet & Avon Canal full of water when we steam, just as they have done since 1809, making them the world's oldest working examples (fig.01).

Since 1968, Crofton Pumping Station, with its two engines, has been owned by the Kennet & Avon Canal Trust, and now for over 50 years, it has been maintained by volunteers (fig.02).

Unlike many similar machines, which are often just turned over by electric or hydraulic motors, our steam-powered engines can run at full load on 'steaming days', when the Canal & River Trust's electric pump is switched off,

letting our steam-powered engines pump over 10 cubic metres of water a minute. As a Grade I listed site, comprising both buildings and engines, we have an important duty of care to ensure our engines continue to run, and run safely, for as long as possible, not least to enable future generations to appreciate their extraordinary industrial technology.

## THE ROLE OF MECHATRONICS AT CROFTON

Mechatronics, the term invented by the Japanese engineer Tetsuro Mori in 1969, is the application of electronics to mechanical machines. So why did we think about applying electronic sensors to our engines? Essentially, to help answer some crucial questions: first, are we doing any damage by continuing to run the engines at full load?

Second, is there any way in which we can possibly reduce stresses and strains on the engines? Third, can we improve their efficiency? The last item, however, presents a real challenge. We know such engines have an efficiency of around 2% at best, but if there is any way in which we can reduce the amount of coal, or ecofuel, which we now need to explore, by even a small percentage, this would be financially worthwhile.

While such historic machines have been the subject of much research, modern technology can help us delve further into their performance, extending our knowledge. We believe that the scope and accuracy of our mechatronics system is already enabling us to examine engine characteristics that were previously unclear or unknown.

Fourth, and not least, can we use our system to help attract more visitors? Crofton is highly dependent on visitor admissions and, since Covid, our numbers have fallen and our costs risen. With marketing to the right audiences, however, we could show off our use of 21st-century technology, alongside Crofton's unique fusion of old and new technology, which could potentially develop a significant new audience.

## CREATIVE COLLABORATION WITH AWE

Following initial exploration with undergraduates from Bath University, we presented our ideas for Crofton to an International Systems Engineering conference, after which we were approached by the Atomic Weapons Establishment (AWE), who proposed a collaborative programme. The resultant partnership between AWE plc and Crofton Beam Engines has been in place since 2019.

Each year, AWE recruits a number of graduates who, as part of their training, are assigned to an external project. The scheme seems mutually beneficial. For Crofton, it provides a team of keen graduates, eager to put their training to the test; while for AWE it affords a real-world setting in which to train a select few of their graduates in a short timeframe. For the graduates, the scheme offers experience in working with off-site customers, managing stakeholders and their expectations, interfacing

new and old technology, working in a listed building, navigating AWE processes and being responsible for delivering a technical project.

In the first year of cooperation, AWE graduates helped specify the system and initial sensors to measure the beam position and the upper cylinder pressure. This provided us with a very accurate part of the classic indicator diagram, as devised by James Watt (1736–1819) and developed by John Southern (c.1758–1815). Unfortunately, the second year was ruled out by the Covid pandemic, but in the third year the team was tasked with confirming the accuracy of initial results, and explored the measurement of the opening and closing of the valves. In the current year, the latest team has been exploring the means for accurately measuring the quantity of water pumped. As a separate project, Crofton volunteers have constructed a simple balance scale to weigh the quantity of fuel being used, thus enabling the overall efficiency of the plant to be monitored.

## HERITAGE FUNDING

Around the same time in 2019, Crofton was in the process of working through a grant from the National Lottery Heritage Fund (NLHF) to tackle a number of serious problems caused

## 02 | BELOW

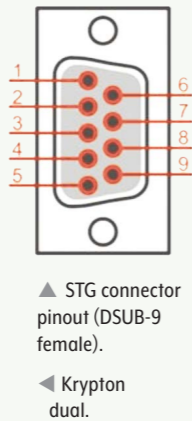
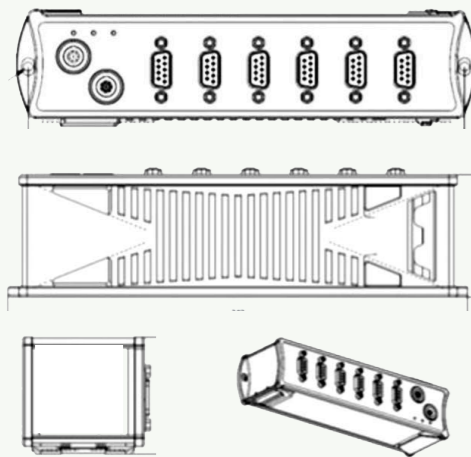
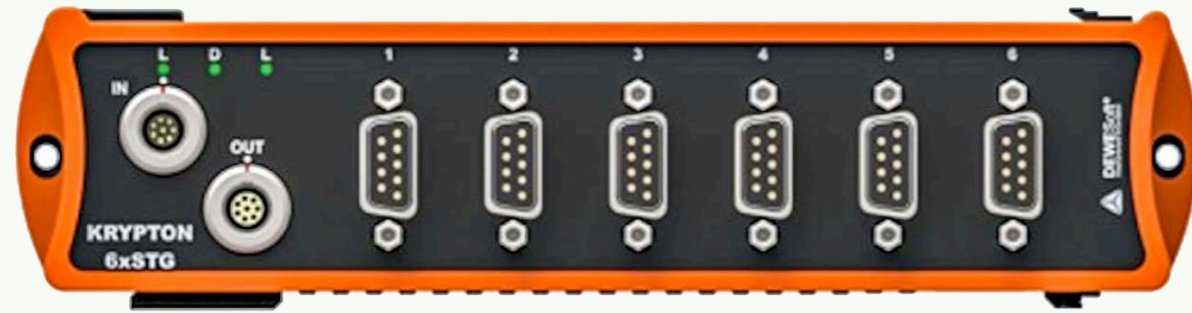
A volunteer stokes a Lancashire coal boiler on a 'steaming day' at Crofton Pumping Station.



## 01 | ABOVE

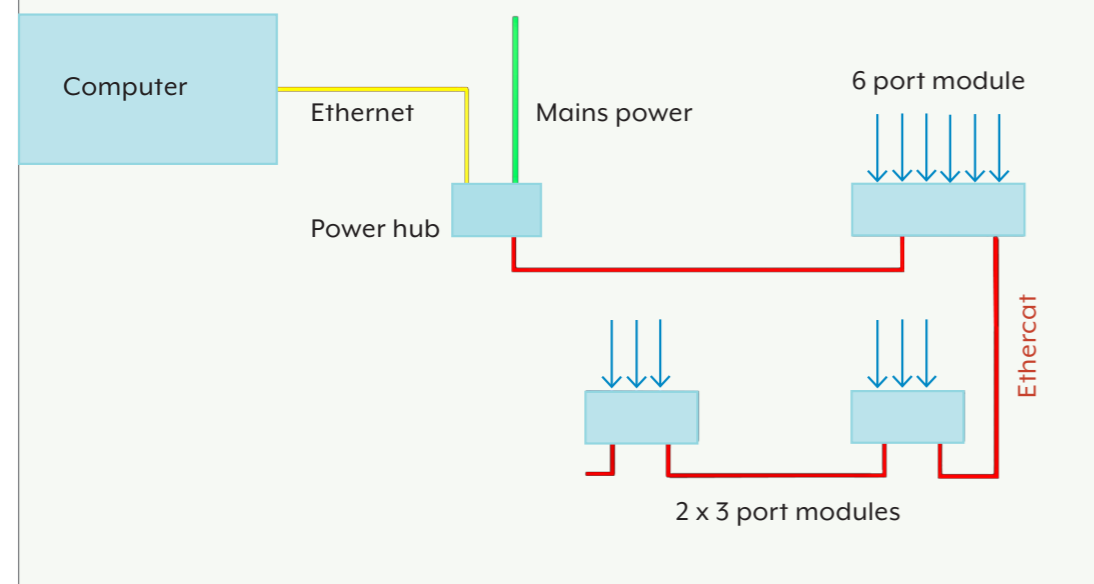
The pumping station at Crofton supplies water to the summit of the Kennet & Avon Canal in Wiltshire.

### DEWESOFT DAQ KRYPTON MODULE SYSTEM



PIN	NAME	DESCRIPTION
1	Exc+	Excitation+
2	In+	Input+
3	Sns-	Sense-
4	GND	Ground
5	R+	¼ Bridge/Shunt
6	Sns+	Sense+
7	In-	Input-
8	Exc-	Excitation-
9	TEDS-	TEDS

### DEWESOFT SYSTEM CABLING AT CROFTON



**03 | ABOVE** Diagrams of Dewesoft DAQ Krypton module system, with associated table.

**04 | LEFT** Diagram of Dewesoft system cabling and daisy-chaining at Crofton.

by water ingress to the building. In particular, structural timbers supporting the heavy iron engines needed additional supports and steel splints to ensure their integrity. At the same time, a significant quantity of asbestos lagging from steam pipes was removed. Helped by savings in other areas of the project, there was an opportunity to include in the bid an initial mechatronics system. The cost of this was around £8,000, funded by the NLHF, Kennet & Avon Canal Trust and a number of generous donations.

We needed a system that could cope with the arduous demands at Crofton, robust enough to handle the hot and often wet conditions, as well as:

- ▶ being flexible and extendable;
- ▶ offering a wide range of sensor interface choices;
- ▶ collecting data at a good precision and rate;
- ▶ providing a graphical display for the general public;
- ▶ exporting data for post-collection analysis, both on- and off-site;
- ▶ being readily programmable by volunteers;
- ▶ and affordable.

#### BENEFITS OF THE KRYPTON MODULE

The Krypton module developed by the Slovenian company Dewesoft – and recommended to us after research by the AWE graduates – is a robust compact data acquisition device (DAQ) incorporating a range of inputs (fig.03). Separate units can be ‘daisy-chained’ from a single power supply and linked via an ethernet cable to a computer (fig.04). A key advantage of the system is that, once a unit has been purchased, the software to drive the analysis and displays is freely available. In effect, we can share the data and invite others to help with its analysis at no additional cost.

So far, we have installed a range of sensors to monitor and record pressures, temperatures, movement of the engine and the timing of valves. (For examples of the displacement and pressure sensors installed, see fig.05.) Armed with this data, which is freely available to accredited academic establishments, we can look for early signs of where maintenance might be required and immediately understand any changes in performance.

Measuring the performance of such engines is not a new idea. Since the early days of steam power, there has been a need to maximise the work done against the amount of coal

### DISPLACEMENT AND PRESSURE SENSORS



**05 | TOP TO BOTTOM** Commercial wire-drawn displacement sensor; Crofton engineer's wire-drawn sensor; commercial pressure sensor.

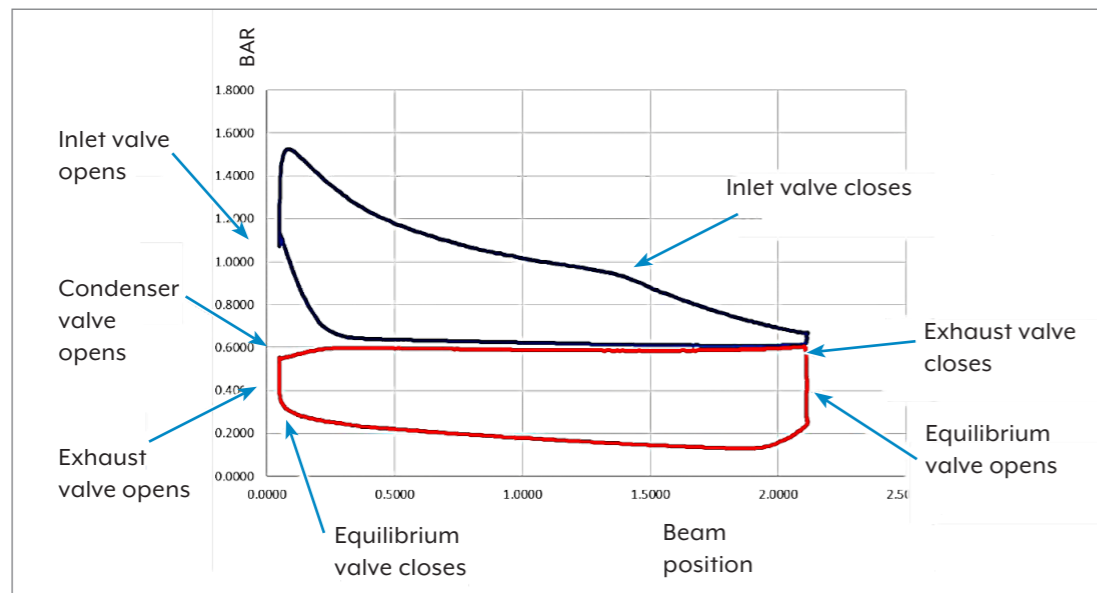


**06 | ABOVE**

Typical real-time display for the benefit of visitors and post-steaming analysis.

**07 | RIGHT**

Indicator diagram for Crofton's beam engine No.1, produced after the engine has warmed up and is running smoothly.



consumed. In the early days, this was described as the 'Duty' of a pumping engine, measuring how many pounds of water could be lifted so many feet (lb x ft) per bushel (around 90lb) of coal. For very early engines, the Duty number was around 10 million. Over the years, James Watt, Richard Trevithick and others improved the performance of engines, raising the Duty to over 40 million. We think the number for our engines is around 20 million, which is not bad for a 200-year-old machine.

**PROGRESSIVE INDICATOR DISPLAYS**

Another important measurement, also devised by James Watt, is the production of an indicator diagram for the engine. This is a plot of pressures inside the engine against the displaced volume of the piston. From this diagram, a number of observations can be made, including the effect of adjusting the valve timing and the calculation of the horse power (hp) of the engine. Ours have been measured at around 40hp.

Over the years, there have been many designs for instruments to produce indicator diagrams. At Crofton, we have on display a 19th-century Richards indicator, used in the 1970s, when it was mounted in place of the lubricator on our No.2 engine. The pressure is measured directly from above the piston and the displacement of the piston, and hence volume, by a string attached to the beam. A drum holding the paper rotates as it is pulled by the string (returning under spring tension) and the pen is moved vertically by cylinder pressure, so plotting the graph.

**MECHATRONICS DISPLAYS AT CROFTON**

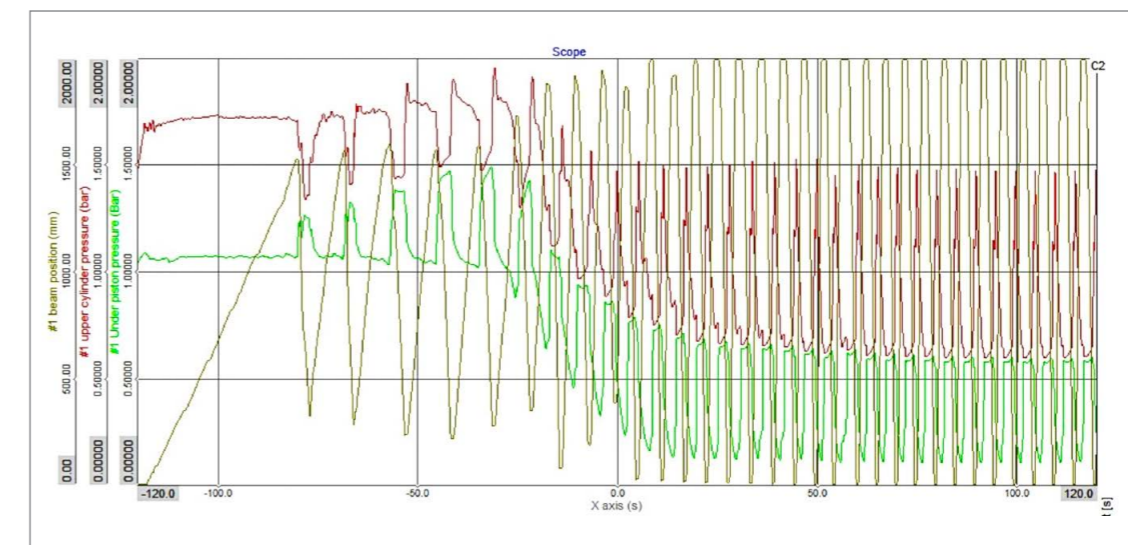
Today, we are also able to accurately examine the timing of the opening and closure of the valves, which we think has not been done before. Overall, we believe we are now producing the most accurate measurements ever for such an historic machine.

To date, we have installed 13 different sensors. These analogue signals are fed into the Dewesoft Data Acquisition System and each is synchronously sampled at 100Hz. This produces real-time displays for the benefit of visitors and post-steaming analysis. Fig.06 shows a typical public display. Over 2 million sets of readings are recorded after a normal steaming day, making up 100Mb of data. We have identified a number of extra items to measure in the future, such as the volume of water pumped and the temperature and composition of the flue gases. Fig.07 shows a typical indicator diagram

produced after the engine has warmed up and is running smoothly. It displays both above and below piston pressures and indicates that, for the major part of the cycle, pressures are below atmospheric. The approximate position of the valve timings is also shown.

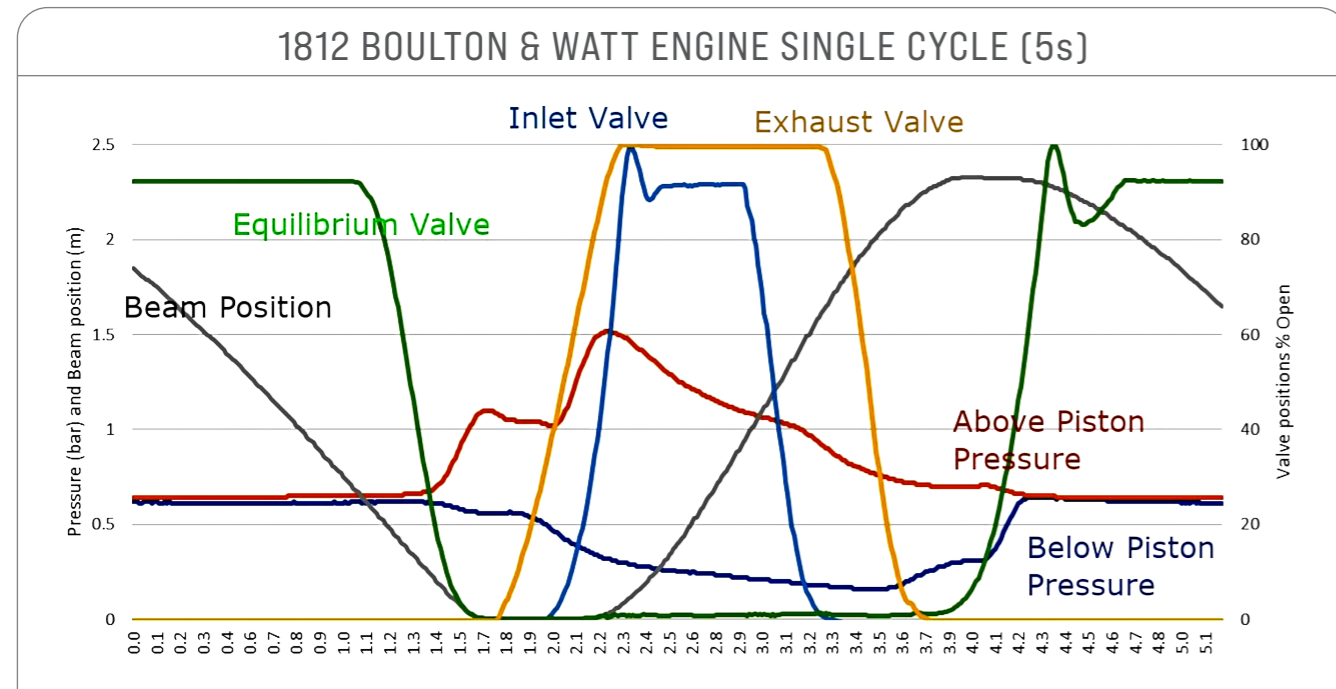
Fig.08 displays the start-up of the engine, with the movement of the beam in ochre, the above-piston pressure in red and the below-piston pressure in green. It clearly shows the below-piston vacuum requiring around 10 strokes before it fully builds up.

Fig.09 shows the plot of a single cycle of the engine against time. The precise timing of the opening and closing of the valves can be observed. Variations in the pressures over the cycle can be seen, with fluctuations, most likely resulting from leaking valves or the piston. On this diagram, we can see that both the inlet and exhaust valves 'bounce' on opening. Valves on these engines are opened by gravity and closed by movement of the engine. Simple weighted rods open the valves. At some point in the unknown past, 'friction boards' have been installed on these rods in an attempt to dampen the bounce. Their poor design has been a constant irritation to the duty engineer and driver, as they often caused the valves to stick, requiring a quick response from the driver and a somewhat hazardous visit, under the working engine with a spanner, from the engineer. As an experiment, the friction boards have been largely disabled. This has now produced a consistent timing for

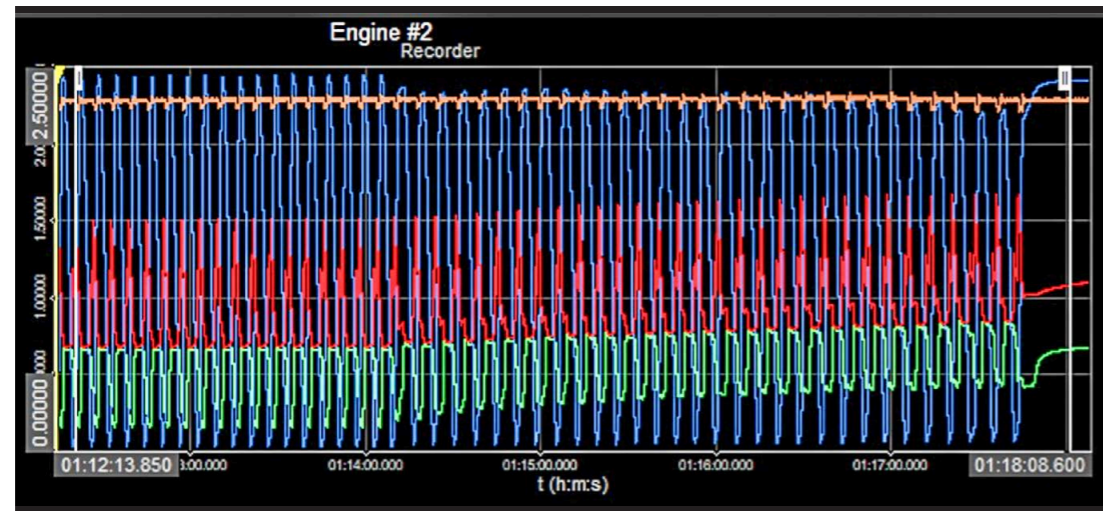


**08 | LEFT**

Engine start-up cycles, with beam movement shown in ochre, the above-piston pressure in red and the below-piston pressure in green.



**09 | ABOVE**  
Display of a single engine cycle for Crofton's Boulton & Watt beam engine.



**10 | RIGHT**  
Display of engine No.2's cycle showing loss of vacuum with failing condenser valve.

the engines; the bounce is a side product of this, but analysis has shown that this does not impact the steam flow in the engine.

Earlier this year, we experienced a problem with our No.2 engine in that normal operation could not be sustained without driver intervention. Analysis of the data as presented in fig.10 shows a progressive loss of vacuum. The plot indicates that the driver, not immediately being aware of the loss of vacuum, opened the throttle valve further to keep the engine running. Subsequent examination of the condenser injection valve revealed that it had significantly corroded and displaced, rendering it likely to jam in different positions and requiring replacement.

**MODERN TOOLS FOR HISTORIC MACHINES**

We believe our Mechatronics system provides Crofton with a significant tool to assist in enabling our historic machines to continue in operation. Unlike the paper indicator diagram, we are able to produce continuously monitored data for display and analysis. We do not think such accurate and detailed information has been obtained from such ancient engines before. By analysing unusual occurrences and comparing results over time, we are in a unique position to identify any problems, ensuring early intervention if required. Analysis of the data can also significantly increase our knowledge of how these amazing machines work.

**REVIEWS**

**EARLY STEAM ENGINES IN CENTRAL EUROPEAN MINING CONFERENCE, IEEC3, 7-8 October 2022, Slovakia**



THE IEEC3's October 2022 conference took place in the former mining town of Banská Štiavnica, Slovakia (above). The event was supported by the Newcomen Society, with several members attending, including some who also presented papers. The conference was hosted by the Slovak National Archives, the Special Division Slovak Mining Archives and the Slovak Mining Museum. Participants took part from many countries, including Slovakia, Belgium, Hungary, Austria and the Netherlands, as well as the UK.

As several requests for a conference report have been received, it is hoped to provide one in the forthcoming edition of *Links*, alongside an update on the aftermath and effect of the fire in the town that so nearly resulted in the loss of important documents from this internationally significant archive.

BY DAVID HARDWICK

**NEWCOMEN NEWS**

**NEW MEMBERS**

A welcome to new members:  
Eddie Birch, James Brandon, Tim Bryan, Andrew Godfrey, Edward Hart, Phil Healey, Adrian Holley, Philip Lawlor, Alexander May, Peter RK Prescott, Kevin Urquhart, Ronald Yee

**RESOURCES**



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**The Third International Early Engines Conference (IEEC3) Summerlee Museum of Scottish Industrial Life . 22-24 March 2024 Conference Details and Call for Papers**

Building on the success of our previous conferences, we are delighted to confirm our third event, (IEEC3) will be hosted by the Summerlee Museum of Scottish Industrial Life from 22-24 March 2024

**DATES, TIMES AND VISITS?**

The event will run from noon Friday 22nd until noon on Sunday 24th March 2024 and it is our intention to arrange group visits to three surviving Newcomen Engine Houses on Thursday 21st and to a number of significant Scottish stationary engine sites on Monday 25th. Please note both visits are not covered by the conference ticket as detailed logistics have still to be confirmed

**FORMAT, CULTURE AND WHAT ABOUT PAPERS?**

We are again determined that the culture of the event will be inclusive, co-operative and non-elitist. If you haven't attended previously ,we will ensure you feel welcomed and included. The format will be similar to IEEC1 and 2 including publication (at no extra charge) of the Conference Transactions.

As you would expect, there will be a focus on early engines and engine builders in Scotland and we have received proposals for papers on the Caprington and Farne Colliery engines and early Scottish Engines . Outside Scotland we have proposals for papers on Heslop engines, Early engines around Ironbridge, Humphrey Potters European Engines and others. We seek additional proposals for papers as early as possible and no later than the end of October 2023.

**WHAT IS DIFFERENT FROM IEEC1 AND 2?**

Because we do not have an external "soiree" on the Friday evening ( our event will be inside the Museum around their Grant Ritchie Steam Winder) our ticket prices will be lower than previous events. We hope this encourages those residing south of the border to make the journey to Scotland

**COSTS**

Full Ticket £95, Day Tickets £35, £50 and £20 (see separate booking form)

**CONTACTS AND QUESTIONS**

Web Site – [www.earlyengines.org](http://www.earlyengines.org)  
E Mail - [admin@earlyengines.org](mailto:admin@earlyengines.org)  
Facebook – International Early Engines Conference

IEEC is sponsored by The Association for Industrial Archaeology, The Northern Mine Research Society, The International Stationary Steam Engine Society and The South Gloucestershire Mines Research Group





# Newcomen events

**11 10 2023** @ 18:00–20:00

*The Craftsman Engineer  
& the Industrial Revolution*  
by Mike Clarke  
An online presentation only

**19 10 2023** @ 18:30–20:00

*Drilling technology in 19th-century  
metal mines* by Roger Burt  
BRISTOL & online: Rm 1, BAWA,  
589 Southmead Rd, BS34 7RG

**24 10 2023** @ 18:30–20:00

*The challenge of bringing  
Quarry Bank's history to life*  
by Hannah Barker  
MANCHESTER: IABF,  
Engine House, Chorlton Mill,  
3 Cambridge St, M1 5BY



**08 11 2023** @ 18:00–20:00

*Rochester Bridge in the 19th  
century: from medieval stone to  
modern steel* by Sue Threader  
LONDON & online: Alan Baxter  
Gallery, 75 Cowcross St, EC1M 6EL

**23 11 2023** @ 18:30–20:00

*Simon Goodrich's fact-finding  
industrial tour in 1799*  
by Dr John Kanefsky  
BRISTOL & online, Rm 1, BAWA,  
589 Southmead Rd, BS34 7RG

**28 11 2023** @ 18:30–20:00

*Computing diagrams*  
by Dr Guy Marshall  
MANCHESTER: IABF,  
Engine House, Chorlton Mill,  
3 Cambridge St, M1 5BY

**13 12 2024** @ 18:00–20:00

*RAF planes that won the Battle  
of Britain were built on German  
machinery* by Dr Jonathan Aylen  
LONDON & online: Alan Baxter  
Gallery, 75 Cowcross St, EC1M 6EL



**10 01 2024** @ 18:00–20:00

*Images of steam engines: 1712  
to c.1870 and possibly later*  
by Prof. David Perrett  
LONDON & online: Alan Baxter  
Gallery, 75 Cowcross St, EC1M 6EL

**18 01 2024** @ 18:30–20:00

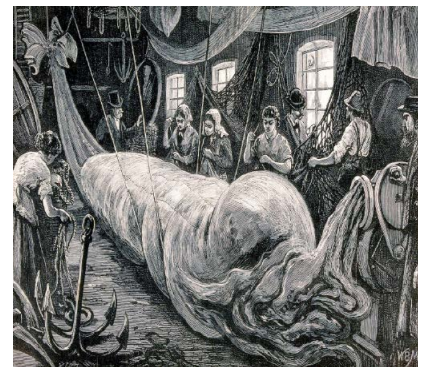
*Great Western and Albion Dock*  
by Tim Bryan  
BRISTOL & online: Rm 1, BAWA,  
589 Southmead Rd, BS34 7RG

**23 01 2024** @ 18:30–20:00

*Building connections: the  
architecture of telephone  
exchange buildings* by Lisa Kinch  
MANCHESTER: IABF,  
Engine House, Chorlton Mill,  
3 Cambridge St, M1 5BY

**14 02 2024** @ 18:00–20:00

*The Dickinson Lecture: animal,  
vegetable and mineral*  
by Dr Nina Baker, OBE  
LONDON & online: Alan Baxter  
Gallery, 75 Cowcross St, EC1M 6EL



**15 02 2024** @ 18:00–20:00

*Drifting into digital dependence:  
control systems in merchant  
shipping* by Vaughan Pomeroy  
BRISTOL & online: Rm 1, BAWA,  
589 Southmead Rd, BS34 7RG

**27 02 2024** @ 18:30–20:00

*Going underground: tunnelling  
on the Liverpool & Manchester  
Railway* by Anthony Dawson and  
Eric Shenton; jointly with SLS  
MANCHESTER: IABF,  
Engine House, Chorlton Mill,  
3 Cambridge St, M1 5BY

**19 03 2024** @ 18:30–20:30

*The side-lever steam engine:  
an engineering story* by Ian Hoose  
MANCHESTER: IABF,  
Engine House, Chorlton Mill,  
3 Cambridge St, M1 5BY

**FOR REAL-TIME UPDATES:**

[https://www.newcomen.com/  
events-calendar/](https://www.newcomen.com/events-calendar/)