

Impact & Engagement project: Electrifying Women: Understanding the Long History of Women in Engineering



Women's Engineering Society visit to a power station, c.1938 Source: NAEST 092/07/01
Caroline Haslett papers, Institution of Engineering & Technology Archives

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@ElectrifyingWmn

#electrifyingwomen

Women's Engineering Society Centenary

- WES founded in UK on June 23rd 1919
- The first women's engineering society in the world
- But why does Britain now have the lowest proportion in Europe (c.12%) of women in engineering?
- Can a more inclusive history of women in engineering enhance recruitment?

Women's Engineering Society conference, 1924

Courtesy WES/IET Archives





AHRC project: Electrifying Women: Understanding the Long History of Women in Engineering

Public engagement work in partnership with WES, IET, Wikimedia & Science Museum:

Aims:

- To share stories of women's collaborative participation in engineering from 19th century
- To show where more research is needed, how it can be done & how shared
- To enhance Wikipedia pages on women in engineering history through wikithons
- To develop inclusive forms of participation in women's engineering heritage e.g. creative writing and drama
- To support recruitment of women into engineering through heightened historical awareness

Outline of talk

- The Electrifying Women project
- The historiography of women in engineering
- Methodological issues
- Some early independent women in technical professions
- The significance of the First World War
- The launch of the Women's Engineering Society
- The broader implications of WES's persistence
- Comparisons with the Electrical Association for Women
- Conclusions

The absence of women in engineering historiography

- Thomas P. Hughes *Networks of Power: Electrification in Western Society, 1880-1930* (Johns Hopkins U Press, 1983)

Male engineers build power supply networks which apparently everyone wants – Edison in the USA sets the model for other countries.

- Ruth Schwartz Cowan, *More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave* (Basic books, 1983)

Domestic technology introduced to the U.S. home: from many options, this reduced the drudgery of housework but not women's overall labour.

- Judy Wajcman, *Feminism confronts Technology* (Polity Press, 1991)

Women involved in engineering during both World Wars, but excluded after.

Barbara Drake, *Women in the Engineering Trades* (1918)

Trades Unions project documenting thousands of women workers

No mention of any women working as engineers

Explicit claim that there are no feminist men in engineering.

Women active in spousal role within engineering partnerships

Rare for women to write about this – except Alice Gordon, *Decorative Electricity* (1891)

WOMEN IN THE ENGINEERING TRADES

A Problem, a Solution, and some Criticisms;
being a report based on an enquiry by a Joint
Committee of the Labour Research Department
and the Fabian Women's Group.

BY
BARBARA DRAKE.

TRADE UNION SERIES No. 3.

1918

LABOUR RESEARCH DEPARTMENT
(formerly the Fabian Research Department).
25, Tothill Street, Westminster, S.W. 1.
AND
GEORGE ALLEN & UNWIN, LTD.,
Ruskin House, 40, Museum St., W.C. 1.

1918.

Revisionist views

- Annie Canel, Ruth Oldenziel and Karin Zachmann, *Crossing Boundaries, Building Bridges: comparing the history of women engineers, 1870s-1990s* (Harwood Academic 2000) – introduction by Ruth Schwartz Cowan

At least some women practised as engineers in later 19th century, especially first quarter of twentieth century: France, Greece, Russia, Sweden, UK, USA.

Pathways through education, family business, facilitated by war & revolution

- Carol Pursell's history of the UK Women's Engineering Society (1993)
 - Henrietta Heald's *Magnificent Women and their Revolutionary Machines* (2019)
- How was it possible for UK to host the world's first Women's Engineering Society?
Aristocratic patronage, suffrage momentum & inclusivity in notions of 'engineering'.

Contrast: the WES offshoot Electrical Association for Women: successful in the 1930s-60s, but closed in 1986. Carol Pursell's (1999) 'Deficit' account of the EAW.

Recovering the missing women in engineering history



- Lots of statues of Victorian engineers – all male
- Heroic histories of engineers – almost all about men
- Engineering Trade Unions – women only fully included by 1945
- Engineering institutional membership – difficult to secure work opportunities

BUT...

- Census data
- Patent records
- Biography/autobiography
- *The Woman Engineer* (1919-)
- Archival papers of WES/Caroline Haslett –
Archives of Institution of Engineering & Technology, Savoy Place, London.

Caroline Haslett, first Secretary of WES, first Director of WEA

The Women's Engineering Society

President—MISS R. M. PARSONS.

Secretary—MISS C. HASLETT.

The Women's Engineering Society is established in the Interests of Women engaged in Engineering and Allied Trades. The Aims and Objects of the Society are as follows :—

1. To promote the training and employment of women in Engineering and Allied Trades.
2. To work for the admission of women to all Schools of Engineering and Technical Colleges.
3. To give special attention to the future of women who have attained some degree of skill in the Engineering and Allied Trades and Professions, and who wish to continue their work.
4. To work for the admission of women :
To membership of all suitable Institutes of Engineers.
5. To enable technical women to meet and to correspond, and to facilitate the interchange of ideas respecting openings in the various branches of technical and mechanical science by the circulating of information on such subjects.

The Woman Engineer

Volume 1
1919-24

First issue
December
1919

3rd issue
June 1920

course she will need a great deal of determination and perseverance and must not mind how dirty she gets.

In spite of all this the work is most fascinating and absorbing and one becomes so interested in everything that one forgets to be tired and the time goes extraordinarily quickly and happily.

I see no reason at all why girls should not be as successful in Engineering as they have been in other trades which have hitherto been considered unsuitable for them.

After all, pioneers always meet with difficulties and discouragement and we cannot hope to be an exception to the rule, but I firmly believe that we shall succeed in the end.

The Direct Current Machine.

NOTES ON ITS CONSTRUCTION AND HABITS.

By MARGARET M. PARKINER, B.Sc.,
Graduate I.E.E.

THE standard Direct Current Machine consists of a rotating armature, described by some genius as "a bundle of wires tied up with tape," mounted in a stationary magnetic yoke, or field. Electric current runs through the wires of the armature, and through the coils of wire wound round the poles of the field.

It is easy to run a current through stationary coils, like the field coils; but how send a current through a wire which is racing round the main shaft at the rate of 500 or 1,000 times a minute?

At one end of the armature is the commutator, a ring of copper bars or strips—each insulated from the main shaft, and from its neighbour by mica. Every wire is soldered at each end to one of these bars. Pressing on to the commutator are two or more brushes which sweep over it as it revolves, and pick up or distribute the electric current. These brushes are usually composed of some preparation of carbon.

This is, very roughly, the construction of every Direct Current Machine, though its individual characteristics vary according to the different systems of winding the coils.

If we put an electric current through the armature and the field coils, we get mechanical energy from the reaction of the armature. The machine is then called a motor. Inversely, if we impart mechanical energy to the same machine

we get electrical energy generated. We then call the machine a dynamo.

The theory of the Direct Current Machine is very simple, and when it is properly and considerably treated, it is an honest and straightforward creature, but no machine reveals its treatment, either in construction or use, more quickly and vividly.

Suppose you take an inspection tour round our test bed.

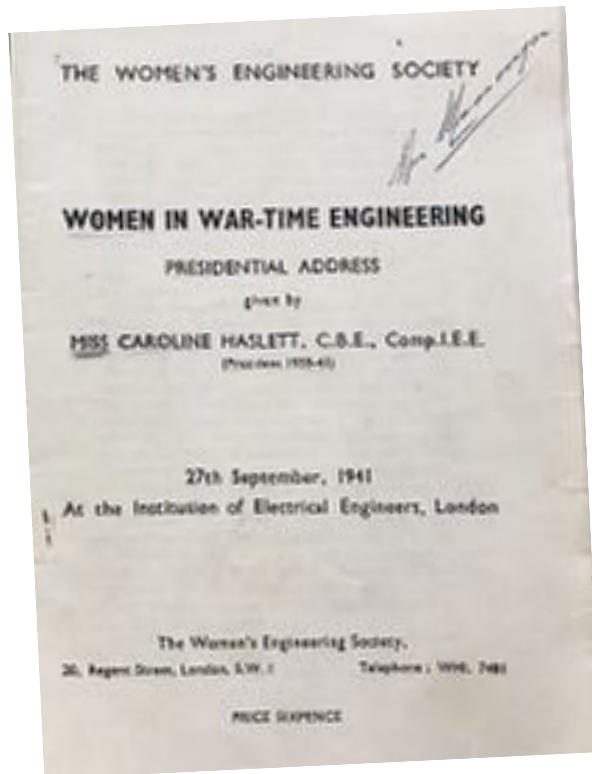
The first apparatus we come to, a girl, wears a worried look, and a pair of alternatives for us are perfect ladies we do not call them, women! She is running two machines coupled together, and is providing current for the motor from the main supply, and is using up the current produced by the dynamo to heat a radiator—at least that is what she wants to do—but as soon as she starts the motor the commutator becomes a ring of sparks. This will not do. First she tests the field circuit. Yes. Current there all right.—Then she tests the separate coils with a compass needle to see if the polarity of the magnetic poles is correct. Nothing wrong there.—She examines the commutator. Blackened, but otherwise O.K.—The winding of the armature appears all right and all the connections to the brushes.—What about the spacing of the brushes round the commutator? No trouble there.—Oh! now we are hotter—the spring, which should hold the brush firmly on the commutator, has moved out of place. She adjusts that and all is well.

It is no fallacy that the slightest fault takes the longest to find.

Next we come to two boys who are giving a break lead to a series motor. They have made the break themselves. It is a long wooden lever covered with ferro break compound, which one person draws on to the pulley of the machine, while the other takes readings of the speed and electric pressure and current (volts and amperes). One boy thinks he is being as strong as two horses because the motor shows that it is doing 2 h.p. Yes, but he forgets that his break lever is a long one, though he would remember quickly enough if you were to suggest that he should shorten it.

Here is another girl, very busy. Her machine appears to be running perfectly—pleasant hum—not too hot—everything in the garden is beautiful. "Please, my machine is running ever so much faster than it ought to." Whose fault is that? It may be that you have some extra unwanted resistance in the field circuit, or the voltage of

Recalling the 1841 Census in 1941



Caroline Haslett's WES
Presidential Address
in September 1941

Haslett quoting
appendix on 1841
census data in:
Ivy Pinchbeck,
*Women Workers
and the Industrial
Revolution* (1930)

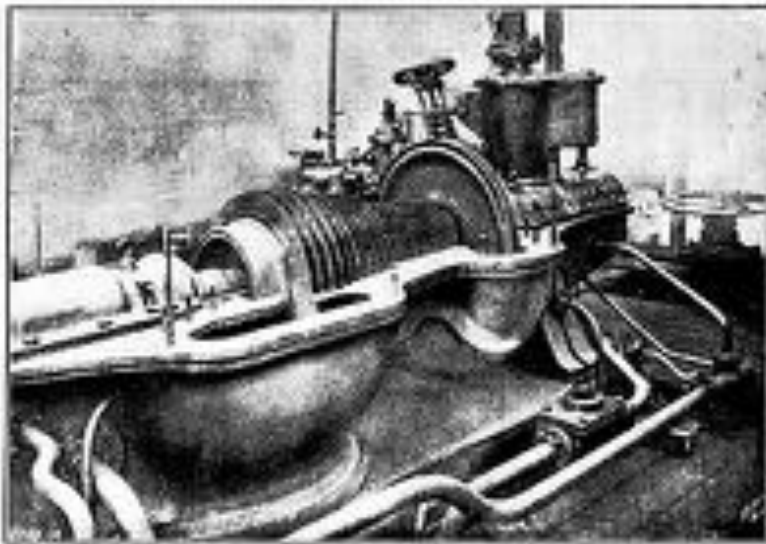
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employment long before the years of so-called emancipation. The following are for England alone :

	No. of women engaged
Agricultural Implement Maker ..	58
Anchor Smith and Chain Maker ..	103
Blacksmith	469
Boat and Barge Builder ..	19
Brass Founder and Moulder ..	43
Brazier, Brass Finisher and Tinker ..	110
Buckle Maker	43
Burnisher	216
Button Maker	1,638
Carpenter and Joiner	389
Chair Maker	280
Clock and Watch Maker ..	185
Coach Maker	116
Cooper	119
Cutler	159
Die Engraver and Sinker ..	8
Engine and Machine Maker ..	53
Engineer and Engine Worker ..	102
File Maker	123
Fork Maker	42
Gas Fitter	2
Gun Maker and Gun Smith ..	79
Hook and Eye Maker ..	67
Jeweller, Goldsmith and Silversmith ..	365
Lamp and Lantern Maker ..	10
Locksmith and Bell-Hanger ..	42
Mason, Paviour and Statuary ..	150
Mathematical Instrument Maker ..	2
Metal Manufacturer	163
Millwright	28
Moulder	17
Musical Instrument Maker ..	23
Nail Manufacturer	4,039
Needle Manufacturer	748

Hon. Charles Parsons & Katharine Parsons

The steam turbine engine
and 'Turbinia' c.1894



Lady Parsons documented in the *Transactions of the North East Coast Institution of Engineers and Shipbuilders*

Lecture: 'Women's Work in Engineering and Shipbuilding during the War'
July 1919

'It has been a strange perversion of women's sphere – to make them work at producing the implements of war and destruction and to deny them the privilege of fashioning the munitions of peace'

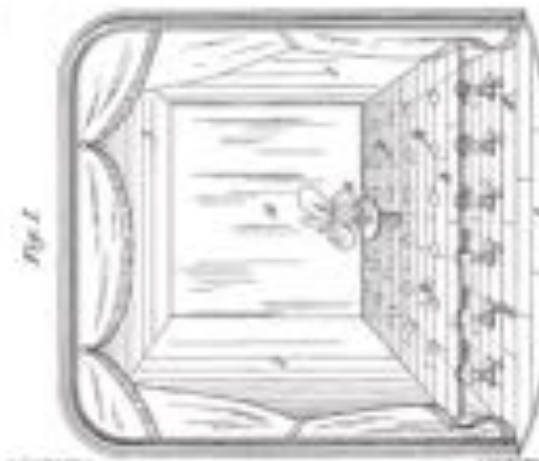
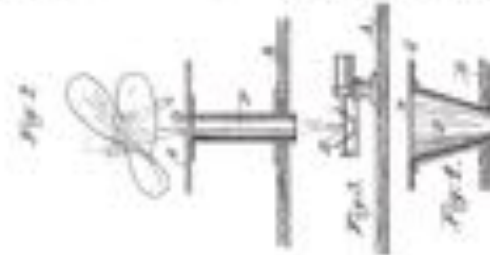
Obituary 'The Hon. Lady Parsons (Hon.Fellow)' published in 1933

'She was always at [Sir Charles Parson's] side, always there to help him when he needed her, always supporting him with her really powerful mind and ready tact, and perfect understanding.

'Lady Parsons was the possessor of a remarkable character, she was almost fiercely independent... She had in many ways a very masculine brain - and a love of business organization and leadership.'

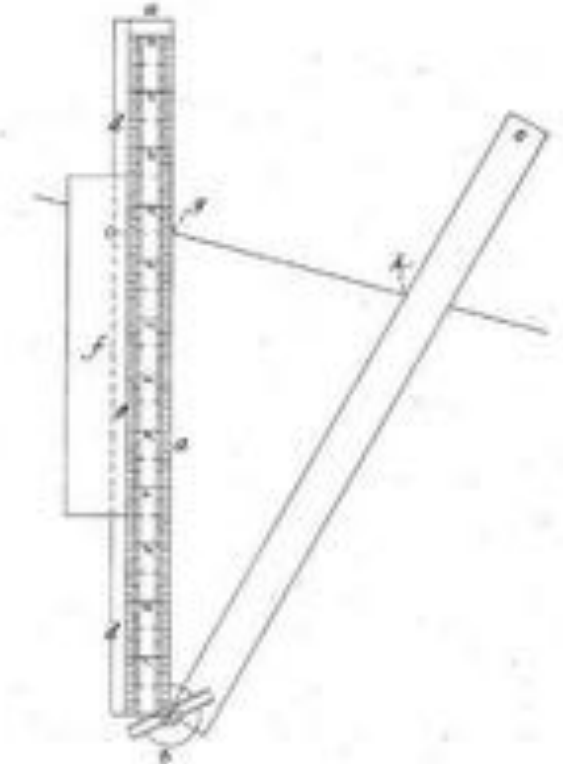
Women as
inventors/patentees

(No Model.)
M. L. FULLER.
EXTRACTOR FOR THE PRODUCTION OF STARCH EFFLORES.
No. 513,102. Patented Jan. 23, 1894.



WITNESSES:
H. A. Brunsell
H. M. Johnson
Inventor
Maria Louisa Fuller
H. M. Johnson
attorney

(No Model.)
P. S. MARKS.
DRAFTSMAN'S DIVIDING INSTRUMENT.
No. 510,450. Patented Jan. 6, 1895.



Witnesses:
George W. Allen
Robert Smith
Inventor
Phoebe S. Marks
By *James L. Strong*
attorney

Hertha Ayrton (1854-1923)

- **1899:** Hertha Ayrton elected first female member of the Institution of Electrical Engineers (now IET)
- Feminist, mathematician, inventor, patent holder physicist, electrical engineer, and suffragist.
- **1854:** Born Phoebe Sarah Marks to impoverished Jewish-Polish migrant family
- **1876-1881:** Studied Mathematic at University of Cambridge and London (BSc)
- **1884:** Granted first patent for line divider

Right: Portrait of Hertha Ayrton, painted by H  lena Ars  ne Darmest  ter, supplied by The Public Catalogue Foundation.



Hertha Ayrton: Physicist & Electrical Engineer

1884: Studies Physics at Finsbury Technical College, meets Professor William Ayrton

Early 1890s: Begins researching electrical arcs – powerful outdoor and indoor lighting

1899: Elected first female member of Institution of Electrical Engineers for her arc light research

1902: *The Electric Arc* wins wide praise and secures her the Royal Society Hughes Medal

1916: Ayrton anti-gas fan used in WW1 trenches – over 100,000 issued to British Army in France



IWM FEQ 492 Ayrton Anti-Gas Fan. Courtesy of Imperial War Museums (IWM)

Mrs Hertha Ayrton was I think the first member of the fair, but no longer frail sex, to distinguish herself in the engineering world,

...though perhaps the woman engineer would not have arrived yet, had not the war, which upset so many masculine traditions, proved that woman was capable of doing many things which had hitherto been considered strictly within the provenance of the more assertive male...

Andrew Stewart, 'On Making the Best of It'
***The Woman Engineer* 1 (1923) pp 284–286**

Broader cases of women in STEM before WW1

- Well known cases of individual women
- Caroline Herschel in astronomy – family connections (father/brother)
- Ada Lovelace – collaboration with Charles Babbage
- More known about collaborative spouses (contrast Ayrtons) e.g.:
 - Maunder and Huggins in astronomy
 - Pierre and Marie Curie in physics/chemistry
- Cases of women in STEM local to Oxford

Sarah Angelina Acland (1849 – 1930): photography pioneer

26 June 1849: Born on Broad Street, Oxford

1856: Photographed by Lewis Carroll in November

December 1870: Met Julia Margaret Cameron

June 1891: Received Kodak no 3 camera for her 42nd birthday

1894: Elected first woman member of Oxford Camera Club

1908-1915: Various expeditions to Madeira, experiments with different & new colour photography methods including Autochrome and Omnicoloure

Self portrait on gelatine negative of Sarah Angelina Acland in 1894. **Image available in the public domain.**





Margaret Hope, photographed on an Autochrome plate (left) and an Omnicolore plate (right), c. 1909. **Image courtesy of the History of Science Museum archives.**

Lady Gertrude Crawford (1868 – 1937): master wood turner

1907: Granted the freedom of the Worshipful Company of Turners; her work was not beaten in any competition held by the company since 1905

1915: Made a Master Turner in recognition of “her eminent ability as a turner and her patriotic efforts in supervising the manufacture of munitions”

1929/1934: Won the company’s Premier Award, which included Freedom of the City of London – barred as a woman

1932: Work was placed in a class of its own “above first class”
1904: ~~class~~ drawing of Lady Crawford with Holztapffel lathe by Mary Ireland, 1904. Image courtesy of the History of Science Museum, Oxford.



Audrey Arnott (1901 – 1974): medical illustrator

Trained at Royal College of Art before employed as a medical illustrator, mostly of surgical subjects by Hugh Cairns, first at the London Hospital and from 1939 onwards at the Radcliffe Infirmary, Oxford

1933-1962: Years active as medical illustrator

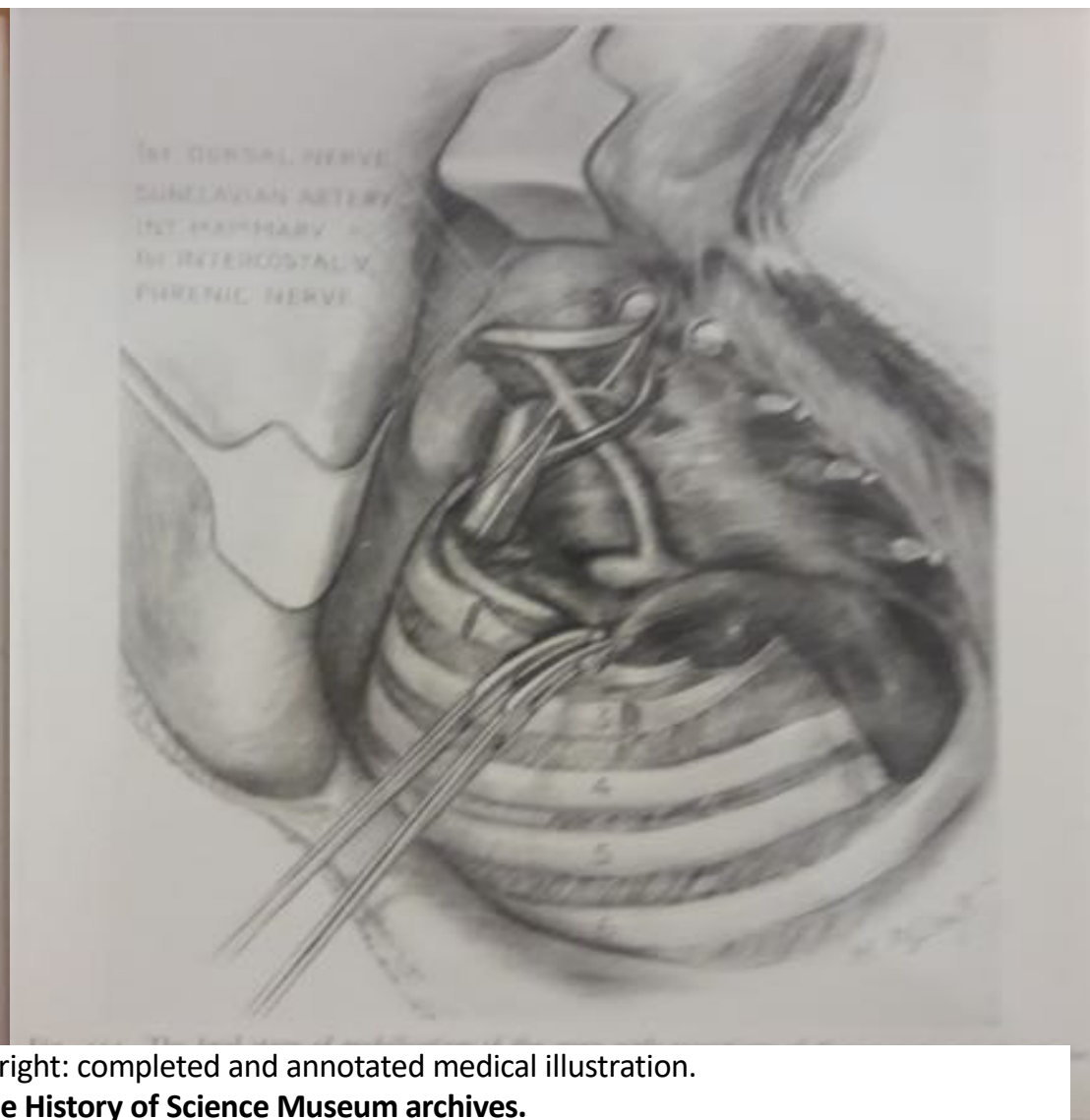
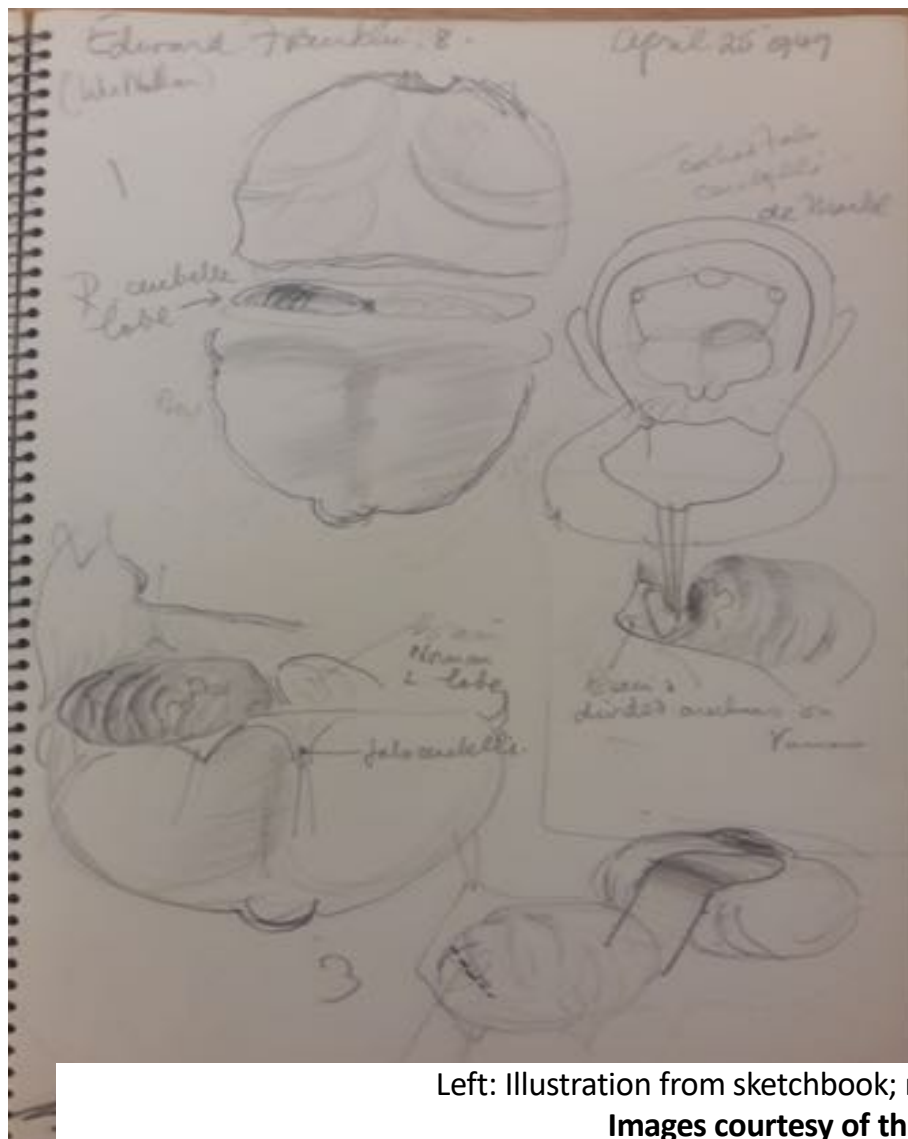
Brilliant combination of technical skill with an anatomic eye and an understanding of the subject matter

Influential in the development of medical illustration in UK and trained numerous artists in the Ross-board technique

1949: Founded Medical Artists Association of Great Britain with fellow medical illustrator Margaret McLarty

Audrey Arnott (1901-1974) in Hugh Cairns' neurosurgery theatres at the Radcliffe Infirmary, Oxford, n.d. **Image source unknown.**





Left: Illustration from sketchbook; right: completed and annotated medical illustration.
 Images courtesy of the History of Science Museum archives.

Individual vs collective work of women...?

- Individual women in technical professions – routes in via family connections or via higher education. Small in number
- No women's professional organisations for photography, medical illustration or science journalism (until later in the 20th century?)
- Rise of professional women's organisations: aftermath of World War 1
- Sex Disqualification (Removal) Act, 1919:
- Professional bodies for women in Law, engineering & architecture
- Contrary sense of Restoration of Pre-war Practices act, 1919
- The Launch of the Women's Engineering Society

The Women's Engineering Society 1919

- Launched on 23rd June 1919 by seven eminent/wealthy women:
- Lady EG Shelley-Rolls, Monmouth; Rachel Parsons, London; Lady Katharine Parsons, Newcastle; Janetta Mary Ormsby, Newcastle; Margaret Rowbotham, Kirkcudbright; Margaret Moir, SW London; Laura Annie Willson, Halifax
- To promote the study and practice of engineering among women; and...
- To enable technical women to meet and exchange ideas
- Rachel Parsons (Univ Cambridge Mech Sciences) as first WES president
- Lady Parsons as W.E.S.'s chief financial sponsor, paying Secretary's wages
- Caroline Haslett as Secretary 1919-1929, editor of *The Woman Engineer*

Caroline Haslett: campaigner, organiser, Secretary.

- Suffragette in 1913, in WW1 Haslett trains for secretarial work
- Join Cochran Boiler Co. as junior clerk drawing up specifications
- Manages London office in 1918, supplying boilers to the War Office.
- Moves to Cochran's Scottish factory to learn practical boiler making: designed and sold some using genderless name 'C.Haslett'
- After WW1 Haslett kept on, while many women forced out in 1919
- Engineering journals advertise February 1919:
'Required: Lady with some experience in Engineering Works an
Organizing Secretary for a Women's Engineering Society'
- Lady Parsons hires Haslett: experience of shorthand & running an
engineering works



Laura Willson
Halifax house builder

Caroline Haslett
WES Secretary

Margaret Partridge
Consulting engineer

Margaret Partridge among dozens of women recruited by Haslett in early days of WES.



Early patrons and Presidents: Rachel Parsons (above)

Lady Margaret Moir
'engineer by marriage'

Common themes
WW1, suffrage, cars...



Why did the UK have the first Women's Engineering Society?

- Compare UK – WES founded 1919
- Germany - Verein Deutsche Ingenieure (1856) women's section 1933
- USA - Society of Women Engineers, founded 1950
- Germany & USA: formal professional education requirements in engineering
- UK: unlike Medicine, no legally-required engineering qualifications
- WES Focus on engineering (vs. engineers)
- More inclusive of experience (vs. training)
- Finance from philanthropic women when membership recruitment stagnant

Haslett's move to domestic technologies 1924

- Recruiting new members to WES proves difficult given economic climate
- WES members focus on domestic technology e.g. vote on the most important engineering initiative in home efficiency: a dishwasher machine.
- Haslett meets US time & motion specialist, Dr Lillian Gilbreth at the first World Power conference London
- Paper on women's domestic uses of electricity offered by WES member Mrs M.L. Matthews:
- 'the thrift of one's energies is often more important than thrift of money. It is by this form of thrift that electricity is going to help women'.
- Matthews proposed formation of a Women's Electrical Association to reduce drudgery for women at home via electricity
- Haslett enthusiastic for an EAW – Lady Parsons is not

The First International Conference of Women in Science, Industry and Commerce, Wembley, 1925

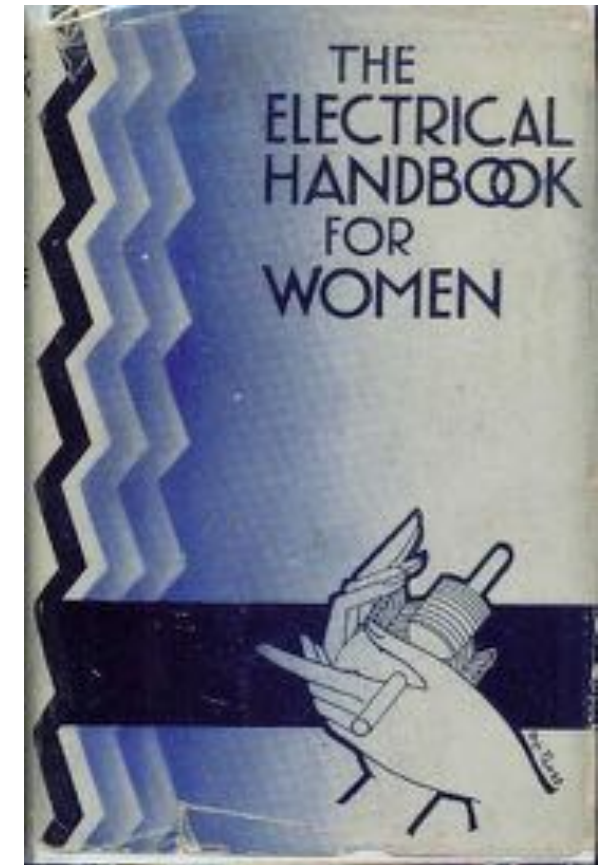


EAW growth – trade-offs

- After Haslett's 1925 lecture, requests came in for EAW public lectures and visits to Power stations, managers of electricity departments
- Rapid EAW expansion with branches opening in Glasgow and Manchester
- Immediate support from British and Allied Cable Manufacturers Association and the Minister of Transport
- Haslett secures funding for EAW from the electrical industry which needed her to bring them more female customers (winning their hearts & minds)
- By contrast she (initially) promises the WES membership emancipation by participation:
 - ‘I do not think that the women's world has yet realised that the machine has really given women complete emancipation. With the touch of a switch she can have five or six horsepower at her disposal; in an aeroplane she has the same power as a man’.

EAW growth - training schemes 1925-34

- EAW branches discuss design efficiency of electric cookers, etc
- What of emancipation? Career structure for EAW women to become professional trainers of 'housewives'
- EAW Electrical Housecraft School - lecture courses for 'housewives', teachers, and for 'Junior Demonstrators'.
- The Electrical Development Association and Electrical Lamp Manufacturers Association sponsor training courses
- EAW's Certificate Examinations as professional qualifications
- 1934: *The Electrical Handbook for Women* – 9 editions to 1983
- By 1986 EAW wound up – industry removes sponsorship



Laura Annie Willson, WES President 1926-28

From Halifax textile worker to suffragette and union activist

From engineering spouse to independent builder

First woman member of the Federation of House Builders

EAW supporter, committed to building electrified houses

**WORKMEN'S
HOUSES.**

*Modern.
Attractive.
Durable.*

Can be built in
quantities of 48.



Price £400 each (Freehold).

ENQUIRIES SOLICITED.

LAURA A. WILLSON, M.B.E., Jumps, Halifax.



Amy Johnson/Mrs Mollison WES President, 1935-37

- Sheffield Economics graduate
- Successful qualified pilot by 1929
- Won many flight competitions
- Promoted aeronautics to women
- Opportunities for women in a new growing industry
- Elected President 1935 as a role model (not as an engineer)
- Marital status as 'Mrs James Mollison' - divorced in 1938
- As Amy Johnson dies on ATA service 1941 transporting planes
- Legacy supports women's scholarship



Miss Johnson shortly after her return from her first flight.



Mrs. J. A. Mollison, C.B.E.

Amy Mollison, be re-elected for the coming year.

WES's new generation of graduate women

- **Margaret Partridge** - University of London, BSc Mathematics, 1914
- **Hilda Lyon** - University of Cambridge Mathematics, 1918
- **Gertrude Entwisle** - Manchester College of Technology... engineering evening class
- **Verena Holmes** - Loughborough Engineering College, BSc Engineering 1922
- **Beatrice Shilling** - University of Manchester, Electrical Engineering 1932
MSc Mechanical Engineering 1933

Hilda Lyon (1896 –1946)

1918 Air Ministry course in
aeroplane stress-analysis &
technical assistant

1925 Royal Airship Works: R101
rigid airship

1930 Royal Aeronautical Society
prize "The Strength of Transverse
Frames of Rigid Airships'

1932, MIT Masters thesis on 'The
Effect of Turbulence on the Drag
of Airship Models'



Hilda Lyon and the 'Lyon Shape'

- 1930s Principal Scientific Officer at Royal Aircraft Establishment
- Worked on wind tunnels, boundary layers suction and stability
- Joins the Aeronautical Research Council
- Posthumously in USA the 'Lyon shape' adapted from airships to submarines



USS *Albacore* launched in 1955

Longer term view of WES

- World War 2 brings only short-term opportunities for women in engineering
- Post World war 2 Britain gave less prestige to engineers than scientists
- Secrecy over Bletchley Park decryption obscures much women's work
- Caroline Haslett drawn in to many other roles, moving away from WES
- Several famous WES figures die young - notably Johnson and Lyon
- BUT collegial support for WES members essential for dispersed practice
- Unlike the EAW, WES continues to exist as body of professional women engineers, adapting to ever new technologies, with strong collegial bonds, and largely self-financing – less reliant on industrial sponsorship than EAW