The lady with the (arc) lamp

It's extremely rare to find a woman electrical engineer, even in these so-called enlightened times. Yet the first woman member of the Institution of Electrical Engineers in London was elected some 80 years ago. The lady was Hertha Ayrton, whose work on the arc lamp had established her as one of the foremost electrical engineers of her time.

by TERENCE McLAUGHLIN

The myth that half the human race consists of so-called "helpless little women", with no grasp of mechanical matters, seems to be so firmly entrenched that it survives in the face of every move towards equality of the sexes. Nowhere is this more true than in the engineering profession. In spite of all the official efforts to encourage women to enter engineering and technology, only five per cent of the girls in British universities take such courses and the woman engineer tends to be regarded by most of her male colleagues as a strange and probably dangerous interloper.

If this is the way things are now, it was a hundred times worse a century ago. Technology was exclusively a man's world; even to be admitted to the fringes of the profession, a woman had to be superlatively brilliant, strong-willed and preferably rich. In spite of all these difficulties, one remarkable woman with no family tradition of engineering or science and with very little money managed not only to get into the electrical engineering profession but to rise to the top of it.

Hertha Ayrton was born in 1854, the daughter of Levi Marks, who had a small business making and repairing clocks in Portsea, part of the large seaport town of Portsmouth. She is reputed to have taken a watch to pieces when she was six, not a remarkable thing for a child to do, but she is said then to have put it together again, a rare feat at that age. She progressed so brilliantly at school that while still in her teens she was able to contribute some earnings to the small family budget by teaching other children.

University education for girls was almost unknown at the time, but fortunately for young Hertha the movement towards it had started. The great educationist Barbara Bodichon succeeded in the late 1860s in getting grudging support for setting up the first women's college, Girton, at Cambridge University, and the bright young teacher from Portsea was an obvious candidate for the new institution. Some of the money for her support probably came from Mary Anne Evans (alias George Eliot, the famous novelist) who also was an enthusiastic campaigner for women's rights and particularly their right to have equal educational opportunities. Even so, there was not much money to spare, but Hertha showed her practical ability by inventing pieces of equipment for engineering drawing and mathematical demonstrations. Her first patent, taken out in 1883, was for a drawing instrument to be used in making scale diagrams.

Having graduated, she moved to London to teach mathematics and science. She was soon fascinated by the new world of engineering that was being opened up by electricity. Most of the important theoretical work had been done earlier in the century, but the spread of power transmission by cable meant that, for the first time, electricity was moving beyond the laboratory. Electric tramways and railways, cranes, lifts, lighting and telegraphy all became practical realities in the 1880s. It was inevitable that Hertha should be drawn into the company of the foremost English electrical engineer, William Edward Ayrton; he was a good-looking and persuasive young widower with a daughter to care for, so it was perhaps equally inevitable that he and Hertha married in 1885.

In spite of her responsibilities of home and family (she had a daughter of her own before very long, christened Barbara Bodichon after her benefactress), Hertha became an active assistant to her husband in his laboratory, learning the new science of electrical engineering almost as it developed. When William took on a long assignment in the USA, she had the opportunity she had been waiting for — to prove that she could carry out some research on her own. She elected to tackle that dragon of the 19th-century electrical engineer, the arc lamp.

The enormous potential of the arc lamp had, in almost equal proportions, fascinated and exasperated Victorian engineers ever since its discovery by Sir Humphrey Davy. When it worked well, it gave a clear, white light far surpassing the smoky flames of oil or gaslight, and much brighter even than the new carbon-filament electrical lamps invented by Swan and Edison.

On the other hand, if it decided not to work properly, the arc could be more recalcitrant than an army mule. It would hiss or hum for no apparent reason, usually a sign that the arc would extinguish itself soon and refuse to light again. Sometimes bits of white-hot carbon rods would fall off, or even explode. Electrical measurements revealed the absurd situation that the arc lamps defied Ohm's law, for the current across the arc increased as the voltage dropped. Electricians of the time, presumably in desperation, took to talking about negative resistance as one of the arc's characteristics.

Young Mrs Ayrton accepted all these problems as her starting point, and in a few weeks work which remains a classic example of logical and scientific thinking, swept away the folklore and provided a clear explanation for nearly all the oddities. She showed that the so-called negative resistance was merely caused by current carried by vaporized carbon: the more carbon vapour, the lower the resistance of the gap between the carbon rods. More impor-

Hertha Ayrton at a suffragette rally in 1913.

tant, she was able to explain some of the practical deficiencies, and suggest ways of eliminating them, so that the arc lamp became a reliable and useful source of illumination.

Her many scientific papers on arc lamps and electric furnaces, and her book *The Electric Arc,* established her as one of the foremost electrical engineers of her time, and in 1899, after much heartsearching, the 3300 men in the British Institution of Electrical Engineers finally elected their first woman member. She subsequently received the Gold Medal of the Institution for her research; one of her fellow recipients was a certain Mr G. Marconi.

Around that time, her attention was attracted to wave theory (apparently while looking at the pattern of ripples left in the sand by the tide, when she was on holiday). By 1904 she had solved the formidable mathematical and practical problems of her theory (at one time, with true economy of means, she studied the motion of particles of black pepper in a tank of water), and wrote a paper which was read at the Royal Society, the first scientific paper by a woman to intrude into that august body. One interesting feature of the paper, which did not assume importance until later, was her suggestion that high-speed motions in water could cause cavitation, a matter which Sir Charles Parsons found significant when he came to study high-speed propellers.

There was a strong recommendation by many of the members that she should actually be elected to the Royal Society, but the entrenched male diehards produced a legal judgement that "the Society under its constitution has no power to elect a woman." She might have pressed her case with more spirit had it not been for the death of William Ayrton in 1904: although she continued her work, she retired somewhat from public life for a time.

The outbreak of war in 1914 found her the leading authority on arc-lighting, and the need for powerful searchlights, especially during bombing raids by Zeppelins, kept her busy. She also found time to use her knowledge of fluid flow when poison-gas attacks

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with chlorine and phosgene began. The authorities were not prepared for the new weapon, the gas masks took time to manufacture. Mrs Ayrton designed a fan which could be used to deflect the heavy poison gases upward and away from the troops in the trenches. After a struggle with the massed forces of obstruction represented by the War Office, her idea was accepted, and 104,000 Ayrton anti-gas fans were made; they saved many lives.

After the war her skills were needed in a very different context. The moving-picture theatres needed arc lamps for their projectors, lamps that would not fail or scatter white-hot particles. With this and other electrical work she was kept fully occupied until her death in 1923.

With the encouragement of her husband, and later the support of her two daughters, both of whom became writers, she was throughout her life a strong advocate of women's rights, not just for women with the power and intelligence to make their way in a man's world, but all of the so-called weaker sex.

Her suffragette activities, although they did not include extreme or violent measures, may have had something to do with her failure to be elected to the Royal Society, an honour which she undoubtedly deserved. Nevertheless, in spite of her formidable intellect and will, she was no hard-faced Amazon — she was remembered by all who worked with her for her unfailing gentleness and courtesy.