

## **Cooke and Wheatstone, and Morse: a Comparative View**

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### ***1 Introduction***

My story brings together three very different men, a portrait painter, a maker of anatomical models for use in medical teaching, and a musical instrument maker. The only thing they had in common was that they all became interested in the idea of an electric telegraph.

The story is centred on the years 1837 and 1838, and the three men are the American , Samuel Finley Breese Morse (1791-1872), and the Englishmen William Fothergill Cooke (1806-1879), and Charles Wheatstone (1802-1875). I might have included Alfred Vail, Morse's assistant, but have not done so because his role was secondary to Morse's whereas Cooke and Wheatstone were are equally entitled to be called pioneers of the electric telegraph.

Cooke and Morse were essentially visionaries and entrepreneurs who could see the commercial possibilities of electrical communication but who lacked, at first at least, the scientific understanding to bring their ideas to fruition. Wheatstone, on the other hand, had the scientific and technological skills to make a telegraph work; he also saw that it could be useful, but even though he earned his living in the world of business he did not at first see the telegraph as a profitable commercial enterprise.

### ***2 William Fothergill Cooke***

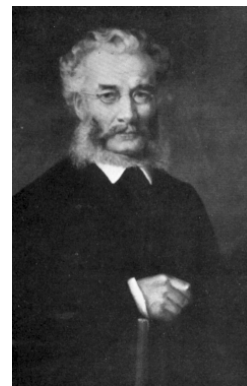
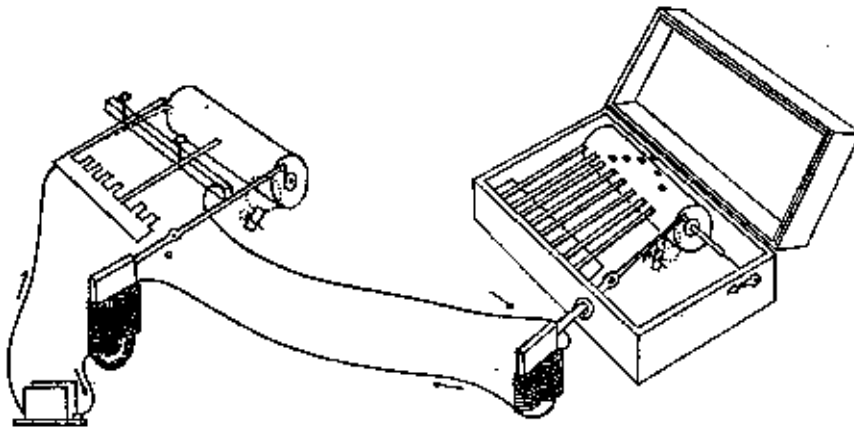


Figure 1

Cooke (**figure 1**), the son of a surgeon and professor of anatomy, was born in Ealing, in 1806. He had served in the Indian Army, been invalided out, and was contemplating a career in anatomical modelling. That would have been a respectable career: there was a demand for wax models of anatomical sections for medical teaching, and he evidently had some skill in making them. He travelled in Europe, attending university lectures on anatomy. At Heidelberg a friend took him to a lecture in which Professor Muncke demonstrated a copy of Schilling's single-needle telegraph. There had been numerous demonstrations of the idea of an electric telegraph, but no one had got near to developing a practical system. Cooke did not understand the technology, but the concept gripped him. He had an impulsive nature, and changed his career plans immediately. He could see in the electric telegraph real commercial potential, and he returned to London and began making his own instruments. The only mechanical device he was already familiar with was the musical box, and his first telegraph (**fig. 2**),



which he made in March 1836, was developed from a musical box.<sup>1</sup> When a musical box is running a drum turns and pins projecting from the drum strike reeds. Cooke's idea was that as the drum turned it should indicate letters in sequence, and the drum should be stopped briefly when the desired letter was indicated.

In Cooke's telegraph the electric current had to produce enough force to move a lever which allowed a clockwork powered mechanism at the receiving station to run, or stop, as desired. There was a similar mechanism at the sending end. Letters were indicated one by one as the mechanisms turned. At the sending end the person operating the system sent a signal to start

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1 Cooke's telegraph work is well described in Geoffrey Hubbard, *Cooke and Wheatstone and the Invention of the Electric Telegraph*, London, 1965. The prime source is Cooke's letters and the publications arising from his dispute with Wheatstone, which are in the Cooke Papers in the Archives of the Institution of Electrical Engineers, Special Collection MS 7. Many of the main letters are reprinted in F.H. Webb (Ed), *Extracts from the letters of the late Sir William Fothergill Cooke, 1836-1839, relating to the Invention and Development of the Electric Telegraph*, London, 1895. Earlier telegraph experiments are described in J.J. Fahie, *History of the Electric Telegraph to the Year 1837*, London, 1884.

the indicators turning and then to stop them when the desired letter was indicated. The recipient merely had to note the letter indicated each time the mechanism was stopped. The idea was quite simple and would be effective provided the clockwork mechanisms at each end of the line could be kept accurately in step. It worked across a room.

Unfortunately when Cooke tried the system through a mile of wire he found that the receiving instrument would no longer respond. That mile of wire was strung up in the office of his solicitor Burton Lane, who must have been a very understanding friend. Cooke described the experiment in a letter, and his disappointment and disheartenment when the instruments which had worked across a room would not respond through the longer length of wire is evident in his account.

Knowing he had a scientific problem he sought scientific advice. I shall return to this point but, for the moment, just observe that it would have been better for all concerned - and better for the development of the telegraph - if Cooke had accepted that although he did understand business he did not understand the science he was working with.

### 3 Charles Wheatstone



Wheatstone (**fig. 3**) was born in Gloucestershire in 1802, into a family of music publishers and musical instrument makers.<sup>2</sup> He loved mechanical gadgets and developed great skill in the design of intricate mechanisms. He must have been aware of the semaphore telegraph and it would have been entirely in character for him to have made one, though there is no evidence that he ever did.

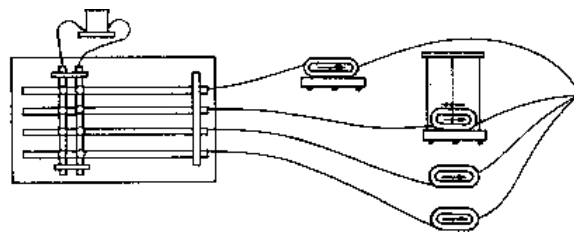
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2 Brian Bowers, *The Life and Work of Sir Charles Wheatstone (1802-1875) with particular reference to his contributions to electrical science*. University of London PhD thesis, 1974; Brian Bowers, *Sir Charles Wheatstone, FRS*, London, 1975.

He was especially interested in the physics of musical instruments, and the way in which the sound of a violin, for example, was transmitted from the vibrating string, through the bridge, to the soundboard. From that he studied the transmission of sound through solid rods and stretched wires. The family moved to London when he was a child, and later he set up demonstrations in his father's shop, including his 'Enchanted Lyre', a reproduction of a classical Greek lyre hanging from the ceiling on a brass wire 'as thick as a goose quill'. Unseen musicians in the room above played instruments whose sounding boards were connected to the brass wire, and the public actually paid to hear concerts which appeared to come from the lyre. Contemporary press accounts, which must have emanated from Wheatstone himself, carry the speculation that sounds might be carried for miles through stretched wires, or wooden rods, that concerts might be 'broadcast' to people's homes, and that Parliamentary debates might similarly be transmitted to a wider audience!<sup>3</sup>

Wheatstone soon concluded that it was not realistic to transmit sound far in this way, though he apparently tried many experiments and also took an interest in speaking machines, presumably in the hope that a speaking machine could send louder sounds along the wire. It was known that sound travelled more faithfully through those solids through which it travelled fastest, and that probably prompted Wheatstone to ask what travelled fastest. The answer was electricity. He conducted experiments to measure the speed of an electric current through a long wire. He achieved limited success, but these experiments, together with others on optics, brought him scientific recognition and in 1834 he became professor of experimental philosophy at the new King's College London. The professorship was a part-time position, and he continued in the family musical business, but the college gave him some research facilities. He obtained a grant of £50 from the Royal Society to buy several miles of wire and arrange it in the basement corridors of the College.<sup>4</sup> He also made a speaking machine which he demonstrated to visitors at the College - including a young Scot, who later emigrated to North America, called Alexander Graham Bell.

By 1837 Wheatstone had two contributions to practical telegraphy. His 'permutating



principle' (fig. 4),

sender and receiver should be linked by several wires and that letters should be indicated by

the idea that the telegraph

3 Reports in *Ackerman's Repository* (a monthly journal) for September 1821 and March and May 1822.

4 F.J.C. Hearnshaw, *The Centenary History of King's College, London, 1828-1928*, London, 1929.

selecting two wires and sending the current through them. With five wires there are ten ways of selecting two and since the current can be made to flow in either direction twenty distinct signals are possible. Twenty different letters are quite sufficient for intelligible English, and so the well-known five-needle telegraph was born.

Secondly, Wheatstone brought to the telegraph an understanding of what is now known as Ohm's Law. The work of Georg Simon Ohm (1789-1854), which essentially stated that the current flowing in a circuit is proportional to the electromotive force driving it, had been published in German in 1827, and Wheatstone was one of the few English men of science who understood German. He was also a member of a British Association committee appointed in 1838 to arrange the translation of various foreign scientific papers, and they arranged for Ohm's paper to be published in English.<sup>5</sup> The importance of Ohm's work for telegraphy was that it gave Wheatstone an insight into the necessary relationship between the resistance of the windings in the telegraph instruments and the resistance of the line connecting them.

With the benefit of hindsight we know that the use of several wires and several needles was an unnecessary complexity. We can use just a single indicator, such as a magnetic needle, and employ a code such as Morse's. Understanding Ohm's Law, however, was vital. The resistance of the telegraph instrument had to be a significant fraction of the total circuit resistance. Cooke's problem was that when he had a mile of wire in circuit then the resistance of that wire was far greater than the resistance of his instruments. He sought scientific advice from Faraday, but Faraday did not appreciate the point about the resistances. He suggested increasing the battery power, which helped a little. Cooke then approached Peter Mark Roget (1779-1869), the Secretary of the Royal Society. Roget could not help himself, but he knew a man who could: Wheatstone. Roget had been involved in the Royal Society grant to Wheatstone and must have known something about Wheatstone's experiments at the College even though nothing was published at that stage.

Roget advised Cooke to consult Wheatstone, and they met on 27 February 1837. Cooke found that Wheatstone was already operating a telegraph through his four miles of wire in the College, and Cooke has left us drawings of it, including the one just shown (**fig. 4**).

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5 G.S. Ohm, *Die Galvanische Kette Mathematisch Bearbeitet*, Berlin, 1827, translated into English as 'The Galvanic Circuit investigated Mathematically', *Taylor Sci.Mem.*, 1841, 2: 401-506.

## Cooke and Wheatstone

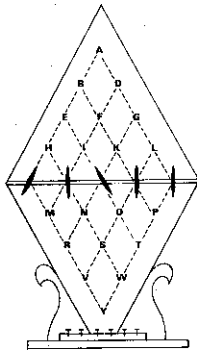


FIG 9.1 The five needle telegraph, indicating the letter E

Figure 5

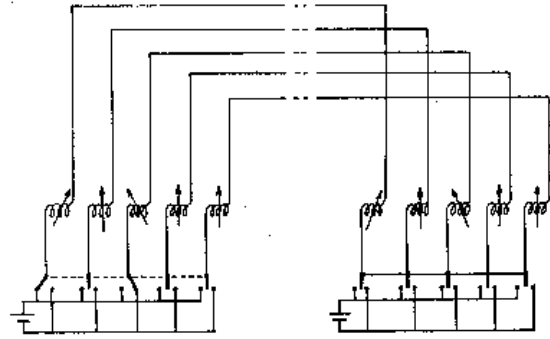


FIG 9.2 Circuit of a pair of five needle telegraphs, sending the letter E

Having been introduced, our two British pioneers entered into a partnership and the rest is history. Cooke and Wheatstone obtained the first patent for a practical electric telegraph system a few months later. The first practical telegraph installation was built the following year, 1838, on the Great Western Railway from Paddington to West Drayton. Cooke negotiated with the railway company and organized the installation, but the telegraph was Wheatstone's system using five needles (**fig. 5**). This telegraph achieved fame in August 1844 when Queen Victoria's son, Prince Albert, was born at Windsor Castle. The news was printed in *The Times* next morning, with the additional information that it had taken a rider on horseback eight minutes from the Castle to the telegraph office at the railway station, and then it took only three minutes to wake the telegraph operator, send the message to London, and receive an acknowledgement. A few months later the telegraph was in the news again when it was used to send a message to London that a murder had been committed, and the suspect had just got on the London train. Thanks to the telegraph, a policeman was waiting when the train arrived in London.<sup>6</sup>

The Electric Telegraph Company was set up in 1846, but by then Cooke and Wheatstone had parted on bad terms, arguing, it seems, about who was entitled to what credit. The quarrel between Cooke and Wheatstone was quite unnecessary. Their differences were referred to formal arbitration by Marc Brunel (1769-1849) and John Frederic Daniell (1790-1845) who produced a 'statement of award' in April 1841, which apparently satisfied both parties at the time. It was in fact a bland statement of the obvious and could be regarded as an attempt to bang their heads together like silly children:

Whilst Mr Cooke is entitled to stand alone, as the gentleman to whom this country is indebted for having practically introduced and carried out the Electric Telegraph as a useful undertaking, promising to be a work of national importance; and Professor

6 The stories are recounted in Geoffrey Hubbard, *Cooke and Wheatstone and the Invention of the Electric Telegraph*, 1965, pp. 101-112.

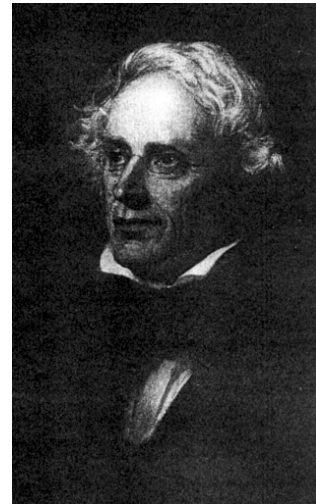
Wheatstone is acknowledged as the scientific man, whose profound and successful researches have already prepared the public to receive it as a project capable of practical application; it is to the united labours of two gentlemen so well qualified for mutual assistance, that we must attribute the rapid progress that this invention has made during the five years since they have been associated.

Their telegraph was a great triumph, but a triumph marred by the ill feeling between its inventors. For historians, however, there is the consolation that the arbitration proceedings generated a wealth of documents on its early history.

#### *4 Samuel Finley Breese Morse*



Figure 6



Morse (**fig. 6**), the eldest of my trio, was born in Massachusetts in 1791, so he was the same age as Michael Faraday (1791-1867). Morse was one of the first Honorary Members of the Society of Telegraph Engineers - later the Institution of Electrical Engineers - founded in 1871, and the following year he achieved the distinction of being the subject of the first obituary in the *Society's Journal*.<sup>7</sup> Trained in the fine arts, he was destined for a career as a painter. He visited Europe several times, and on a visit in 1829-32 became acquainted with the idea of an electric telegraph and, like Cooke, was 'hooked' on the possibilities he could see. He conducted his own telegraphic experiments, and devised a workable telegraph for which obtained a United States patent in 1840.

In 1838 Morse was again in England seeking an English patent. The application was opposed by Cooke and Wheatstone, among others, on the grounds that he was seeking to patent ideas which were already published, in *Silliman's Journal*. Morse did not appreciate the difference between English and US patent law at that time. In England a patent had to be applied

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7 W.H. Preece, obituary of S.F.B. Morse, *J.Soc.Tel.Eng.*, 1872, 1: 93-95.

for before the idea was published. In the USA it was possible to get a patent after the idea was published if you could prove that you had the idea at an earlier date. Morse failed to get an English patent, which he regarded as most unjust, though he found some consolation in getting a seat in Westminster Abbey for the coronation of Queen Victoria (1819-1901). He returned to the USA and successfully promoted electric telegraphs there, using the code known ever since by his name.

Morse's first telegraph receiving instrument (**fig. 7**) was built around a frame for stretching canvas. It was a printing telegraph, recording the dots and dashes of what was subsequently called Morse Code. A hanging pencil made a continuous mark on a paper tape which was pulled slowly through the device. The message signal was applied to an electromagnet which pulled the pencil to one side - briefly for a dot and longer for a dash. According to Morse it was the fact that his telegraph left a printed record which really distinguished his telegraph from Cooke and Wheatstone's. Morse said his own instrument was a 'telegraph' whereas Cooke and Wheatstone's was a 'semaphore'. In Morse's own words a semaphore conveys an *evanescent* signal and a telegraph conveys a *permanent* sign.<sup>8</sup>

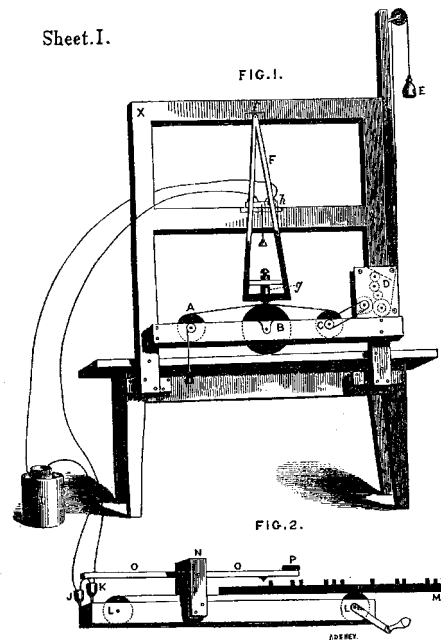


Figure 7

In 1840 Cooke and Wheatstone wrote to Morse suggesting that they join forces but, after consulting friends, Morse rejected the proposal.<sup>9</sup>

It is good to be able to record that Morse bore no grudge against Wheatstone over the patent. After the hearing at which his application was refused Morse wrote to his daughter:

Professor Wheatstone and Mr Davy [another British telegraph inventor] were my opponents. They each have very ingenious inventions of their own, particularly the former, who is a man of genius and one with whom I was personally much pleased.<sup>10</sup>

8 Samuel F.B. Morse, *Modern Telegraphy*, 1867, p.37.

9 Edward Lind Morse, *Samuel F. B. Morse, Letters and Journals*, Boston and New York, 1914, vol 2, p. 158.

10 *Ibid*, p.101.



Morse returned to the USA and continued working on his telegraphs. He is known to have consulted Joseph Henry, and it is interesting to reflect that Henry had also been in London in 1837 where he conducted experiments jointly with Faraday and Wheatstone. It is pure speculation, but I wonder whether Henry learned about Ohm's Law while he was in London, and so was better able to advise Morse. Eventually the United States Congress were persuaded to fund the building of a telegraph line from Washington to Baltimore. This was the line over which, on 24 May 1844, Morse sent the famous message with the Biblical quotation 'What God hath wrought'.<sup>11</sup>

## **5 Conclusions**

In later years Morse also became embroiled in litigation, to the ultimate benefit of the historian, but I do not want to end with the conclusion that inventors who wish to ensure their names get in the history books should go to law!

None of our three heroes originated the *idea* of communicating by electricity, and none devoted their lives solely to the telegraph, but all played an important role in its development and in its practical application. All three made a lot of money from the telegraph, though Cooke ended his days in poverty. Cooke, the impetuous one, became interested in another venture which he was sure would make a fortune. He invested his money in a quarry in North Wales, and in 1865 he obtained a patent for slate cutting machinery, but the business failed and he lost all his money.

Wheatstone's musical instrument inventions, especially the concertina, and Morse's work as a painter would have assured both men a place in the history books even if they had never become involved with the telegraph.

In later life Wheatstone developed both his ABC telegraph, for use on private lines, and the high-speed automatic telegraph, which was widely used in the public telegraph service. The world's public telegraph services all needed a code to send their messages, and the code that bears Morse's name continued to be used as long as the telegraph itself remained in service.

If Cooke, Wheatstone and Morse were with us now I am sure they would have moved on to email which, after all, is only a logical development of what they were all doing. All three are entitled to a place of honour in the history that we are celebrating in this Conference. But we cannot extract a recipe for success. All three possessed originality and drive, but they were otherwise so different in background and character that it is quite impossible to draw any conclusions about who will, or will not, succeed in a new venture.

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11 Trevor I. Williams, *Biographical Dictionary of Science*, 1969, entry 'Morse'. The quotation is from *Numbers* 23, v. 23.