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Geoffrey Hubbard

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## *and the Invention of the Electric Telegraph*

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# *Contents*

# *Illustrations*

FIGURES



PLATES

# *Author's Note*

IN writing this book I have received nothing but help and encouragement from all those whom I have had to approach. I should like therefore, not only to make the customary acknowledgement of the assistance I have received, but also to offer my most sincere thanks to all my friends of the telegraph.

Particularly I should like to thank Dr. E. J. Burge, of King's College, in the Strand; The Secretary, Librarian and staff of The Institution of Electrical Engineers; the Archivist of the British Railways Board and his staff; Mr. G. R. M. Garratt of the Science Museum; Lt. Col. W. J. G. Ruel (Rtd.) who most efficiently tracked down for me W. F. Cooke's descendants, and Mr. F. N. Andrewes, with whom he put me in touch. May I also thank Mr. D. J. Bayliss, formerly of Balliol College, Oxford, who allowed me to use his Prize Essay and bibliography; Mr. Van Riemsdijk, also of the Science Museum, whose more extensive researches into the life of Charles Wheatstone have confirmed my own more superficial conclusion that there is little one can discover about him, and my old friend Mr. G. N. J. Beck, who helped me out with translations from German.

Finally, my gratitude is due to my wife and my two sons, who have long found the telegraph a great bore.

# *Chapter One*

# THE SPECULATIVE FANCY

MAN has always prided himself on being a communicative animal, and has only recently come to suspect that other animals have some slight skill in this regard. Even today, however, it still seems fair to give human speech and language pride of place among the natural media of communication, and certainly the combination of the ability and desire to communicate with the human ability to use tools and to make devices is an important measure of the advance of social organization.

In the Children's Gallery of the Science Museum at South Kensington there is a set of dioramas showing the history of communication in a few well chosen scenes. So well chosen, indeed, that each can be made to point a moral lesson. The first shows a beacon fire burning on a hilltop. In the distance, another beacon flickers. The limit of the unaided voice has been overcome; early man is communicating over a distance. Providing that the meaning of the signal has been pre-arranged, the route chosen and prepared, that the watchers on the hilltops stay alert, the tinder is dry and there is no fog about, a message could be passed with good speed over considerable distances. It was the early warning system of ancient man; it still functioned when the Armada came. It was probably a great deal more efficient at night than in the daytime, when instead of the bright glow of the fire the watchers had to look for the uncertain billow of smoke.

The second diorama shows the heliograph, in which a small mirror is used to reflect the light of the sun to a distant point. Its advantages over the beacon fire are considerable, for by sending sequences of short and long flashes corresponding to a pre-arranged alphabetical code any message could be sent, whereas a beacon can mean only what the watcher expects it to mean. The heliograph was invented by the Moors in the 11th century; it has one disadvantage which they would hardly have taken seriously, it depends for its operation on the sun. It was therefore never of great practical importance in the British Isles, though it had a certain vogue in the Army during the Empire-building phase. To be fair, given the sunshine of India or the Egyptian desert, the heliograph had considerable military merits; it was light and portable, and when it was directed at one particular observer the message could seldom be intercepted by anybody else.

The next system is rather more cumbersome. Once again, it works from hilltop to hilltop. On each hill stands a wooden tower, carrying a crossbeam having fixed on either extremity a rotatable arm like a railway signal. This is the semaphore, which for a hundred years or so was the only apparatus referred to as a telegraph. Like the heliograph, given a pre-arranged letter code, any message could be sent, but it was independent of the sun, though still dependent on good visibility from one station to the next.

There is no diorama as such for the next method. There would be no point, for the next method transcends the narrow limits of human view. Here the whole point is that the sender cannot see the receiver; he is out of sight. Instead of a model then, in place of the little manikins shading their eyes and staring at a distant hill, there is the thing itself; a needle telegraph. The sun need not shine, the code need not be arranged, spies are frustrated, commerce is advanced, and, thanks to the invention of the electric alarum, the custodian of the instrument need not watch over it when no messages are being sent. The range could extend to the ends of the earth; the speed is the speed of light itself.

The telegraph was a wonderful invention, and it seemed the more wonderful because it worked by the agency of electricity, which was not widely understood at that time. It was the first invention to bring electricity into the open service of man, and at the same time it was one of the great liberating inventions of the early Victorian period, to be classed with the railway and the steamship as a means of freeing men from the tyranny of wind and the limitations of animal muscle. The telegraph is the true hero of this book, and the men who served it, who invented it and spread it like a spider's web across countries and like an old string bag around the world, are subsidiary characters.

The origins of the electric telegraph can be traced back to ingenious and speculative tracts in Latin which suggest, in the vaguest way, that magnetic sympathy might be employed as a means of sending messages. Magnets, in point of fact, are lacking in sympathy. The universally curious Doctor Thomas Browne took time off from his medical practice and his delightful speculations on Urn burial to enquire into the matter, as he reports in his *Pseudodoxia Epidemica, or Enquiry into Certain Vulgar Errors.* He says:

> The conceit is excellent and if the effect would follow, somewhat divine.... And this is pretended from the sympathy of two needles touched with the same lodestone and placed in the centre of two abecedary circles or rings with letters described round about them, one friend keeping one and another the other, and agreeing upon the hour wherein they will communicate. For then, saith tradition at what distance of place soever, when one needle shall be removed unto any letter the other, by a wonderful sympathy will move unto the same.

Browne, not content with the word of tradition, made the experiment with negative results. Dr. Johnson, in his *Life of Sir Thomas Browne*, paid little respect to the spirit of scientific enquiry.

> Having heard a flying rumour of sympathetick needles . . . he procured two such alphabets to be made, touched his needles with the same magnet and placed them upon proper spindles; the result was that when he moved one of his needles the other, instead of taking by sympathy the same direction, 'stood like the pillars of Hercules.' That it continued motionless will be easily believed, and most men would have been content to believe it without the labour of so hopeless an experiment. Browne might himself have obtained the same conviction by a method less operose, if he had thrust his needles through corks and set them afloat in two basons of water.

One hundred years after Browne's enquiry, while Johnson was toiling through the drudgery of his Dictionary, a letter appeared in the *Scots Magazine* over the initials 'C.M.' It described in outline a workable, if cumbersome, system of electrical telegraphy. Twenty-six wires, all separately insulated, were to be suspended between the sender and the receiver, and each one would correspond to a letter of the alphabet. A static electrical machine could be connected by the sender at will to any one of the lines, and a discharge of electricity sent along it which would indicate the required letter to an observer at the other station by a spark, or by attracting a small piece of paper. Such a system was, in a sense, workable. That is to say, it did not depend on a hypothetical and in fact non-existent property of Nature, as did the sympathetic magnets. It could hardly be called practicable, however, for static electricity, the sort of high voltage, low current, electricity which is generated by stroking a cat or taking off a nylon slip on a dry day, is difficult stuff to control. It will break down all but the best insulation, and indeed in all the experiments made on early electro-static telegraphs the return circuit was provided, without the experimenter being aware of it, by the elusive high voltage slipping quietly away to earth. If there is any moisture in the atmosphere, that in itself is enough to provide the necessary leakage; the cat's fur will not crackle, the nylon slip gives no spark, and nor does the electro-static telegraph.

'C.M.' wrote his letter in 1753; Bozolus, writing some ten years later, described a system similar in principle but using only two wires and sending the messages by the use of code. Thus from the very beginning there were two main systems, the alphabetical which indicated every letter by a separate movement or light at the receiver, and the coded which used combinations of single signals to distinguish letters. The first method was clearer to the uninitiated; the second more economical in wires and equipment. Before the end of the Eighteenth Century another essential was added. An anonymous French inventor used an electrical discharge along one of the wires to ignite a charge of gunpowder and wake the sleeping attendant so that he might observe the message.

The second half of the Eighteenth Century is scattered with projected telegraphs, all of them of necessity using the elusive static electricity. Roughly equal numbers used multiple wires and sent messages alphabetically, or single wires and sent the messages in code. But the telegraph which actually made progress at that time, which was built and improved and operated, was the semaphore.

Claude Chappe has an unusual place in this history. He would be worthy of note as the first inventor to have hit on an ingenious plan for sending alphabetical messages with only a single wire, had he not earned greater fame as the man who nearly stopped all further development by bringing the semaphore to such a successful and effective state that it seemed to some users to leave nothing to be desired. Chappe's electrical system was certainly simple and ingenious. At each end of the wire there was to be a dial, driven by clockwork, bearing on its face the letters of the alphabet. These dials were to be synchronized, so that on each dial a given letter passed a fixed index at the same instant of time. The electrical part of the system consisted of the sending station transmitting a signal—for example by connecting the wire to an electrical machine so that there was a spark discharge at the receiving end—as each successive letter of the desired message passed the index on the dial. The recipient had then only to note down the letter against his index each time he saw a spark in order to record the message.

From a practical point of view, however, the semaphore was the greater success. The French Government installed it, and the British Admiralty depended on a similar system for communications with Portsmouth. The Admiralty were particularly well pleased with the peculiar design of wooden shutters they employed, and did not find it a great inconvenience to be cut off from the fleet when, as frequently happened, the fog was sufficiently thick to prevent one semaphore station from seeing the next.

All over Europe, military gentlemen engaged in the improvement of semaphores and their codes. Corrupt politicians in France used the advance information obtained through the Government system for speculations on the exchange, as one may read in Stendhal's *Lucien Leuwen*, though men of affairs like Mr. Reuter preferred carrier pigeons which were outside the control of Governments. Dreamers and cranks played with their sparks, their wires and their pith balls suspended on silken threads and grappled with the elusive electric fluid.

The names of the early inventors of near-telegraphs read like a roll-call; Alexandre, Böckmann, Cavelle, Le Sage, Lomond, Lullin, Ritchie, Reusser and Salvá, to list but a few, and all of their inventions were ingenious but impracticable. One must, perhaps, make an exception for Salvá. He worked in Spain, out of the mainstream of European science, and he may have built a telegraph which worked, not from room to room, but over miles of the hot, dry, Spanish countryside. But no description of his work was published, and nothing grew from it; indeed it was more than a hundred years before anybody else knew anything about him.

# *Chapter Two*

## THREE PRECURSORS

THE pleasures of a trip on the Thames are enhanced or marred, according to one's personal predelictions, by a loudspeaker relaying a commentary on some places of interest along the route. Going downstream, the commentary always includes the story that Wren lived in the house by Cardinal Cap Passage so that he could watch over the building of St. Pauls. It is a nice old house, but it was probably built after Wren died and St. Pauls had been completed. Going upstream, one is offered an even more unlikely piece of history. Just above Hammersmith Bridge, the commentator points out a small building by St. Paul's School Boathouse as the place from which Marconi made his first tests of wireless telegraphy to the General Post Office in St. Martins-le-Grand. But the house achieved its modest fame long before that quite imaginary incident. It is the house William Morris once occupied, the house of the Doves Press, and in 1816, Francis Ronalds erected in the garden the first effective electric telegraph in England.

Ronalds, who had a private income, was later to become the Director of the Royal Observatory at Kew for many years. In the National Portrait Gallery there is an engraving of a meeting of the Royal Institution which shows him as a young man, a slim elegant figure among the solid engineers of the industrial revolution. They represent the age of steam; he was the advance party of electricity, which was ultimately to make the assured progressiveness of the steam age obsolete. He was also, fortunately, a lively and engaging writer.

Francis Ronalds was born in 1788 and was thus about 27 years old when he started his work. His first experiment was to take up some earlier demonstrations that electricity, still the elusive static electricity, could be sent through long wires. He built two large rectangular wooden frames, which were erected facing each other at a distance of twenty yards. Across each frame ran nineteen horizontal bars, so that the whole thing looked like the parallel bars of a gymnasium. A continuous wire ran backwards and forwards between the two frames, thirty-seven times on each bar, making a total of seven hundred and three journeys of twenty yards each, or nearly eight miles in all. He then took a Leyden jar, a simple condenser made from a glass jar partly coated inside and out with tinfoil, and charged it with electricity from a frictional machine; that is, a machine in which a glass cylinder is rotated against a silk rubber to generate high voltage electricity. On applying the charged jar to one end of the long wire, a spark would jump from the other end. He thus showed that electricity would travel through eight miles of wire in an imperceptible interval of time and without any apparent diminution.

After this admirable and academic experiment, Ronalds built a real telegraph. For this he used a shorter line of five hundred and twenty five feet threaded through glass tubes. The joints between tubes were covered by larger tubes, each joint being sealed with soft wax. The whole line was set in wooden troughs filled with pitch and was buried in the ground.

Through this line he signalled by the use of clockwork dials run synchronously; the wire was kept permanently charged so that two pith balls hung on silk threads from the end of it repelled each other, and as the sender's dial showed the letter he wished to send he earthed the line so that the two pith balls fell together. The observer noted the indication on his dial at the instant of collapse, and then the line was recharged for the next letter. It was a slow method of signalling, much like Chappe's early scheme, but Ronalds went a long way towards setting out the way in which a practical system could be operated. He devised routines for ensuring that the clock dials were in step, and he drew up pamphlets showing how the wires could be laid under the public roads and what methods should be used to secure them against evilly intentioned rogues who might dig them up for the value of the metal:—'. . . . render their difficulties greater by cutting the trench deeper, and should they still succeed in breaking the communication by these means, hang them if you catch them, damn them if you cannot, and mend it immediately in both cases.'

Ronalds' demonstration line was not very long, but it was a practical telegraph; it operated out in the moist cold of an English garden and not in the protection of a lecture room. He presented



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a memorandum to the Admiralty, and for a while it seemed as if My Lords were going to give the new invention a chance to prove itself. Luckily, before such a dangerous step could be taken, the Secretary to the Admiralty got hold of the papers and Ronalds received a smug reply assuring him that:—'. . . telegraphs of any kind were then wholly unnecessary, and that no other than the one then in use would be adopted.' 'I felt' said Ronalds 'very little disappointment and not a shadow of resentment because every-one knows that telegraphs have long been great bores at the Admiralty.'

So Ronalds gave up the telegraph and turned to meteorology. The plaque commemorating his experiments does not record the interesting fact that they were watched by Mr. Cooke, a surgeon then resident in Ealing, and also, it is believed, by a young musical instrument maker named Charles Wheatstone. Mr. Cooke was not accompanied by his son William. The relevance of these facts will become apparent later in our story.

Ronalds' telegraph was the highest form reached by the static, or very high voltage, telegraph. But already there were new discoveries that made Ronalds' ideas obsolete. Batteries were being constructed which gave low voltage currents of considerable power; batteries roughly similar to the dry batteries of today, which provided a convenient and compact source of electric power on a scale much greater than could be provided by a frictional machine. These could give a spark, or deflect a pith ball hung on a silk thread, or pick up a fragment of paper, but they could do no more. They had not the power to do any real amount of work. They could be made to store their energy in condensers, or Leyden Jars, but then it would all discharge in a sudden useless surge. Moreover, the very high voltages were difficult to control, and all too often would break through the materials which were intended to control and insulate them.

The battery, on the other hand, supplied a gentle, steady and controllable flow of current at a modest voltage. Its power was not only in the strength of the current but also in its ability to flow continuously. This enabled certain of the effects of electricity to be clearly observed, and hence applied to practical ends, for the first time.

Four years after Ronalds' experiments, in 1820, the Danish physicist Oersted published a paper in which he showed that a magnetic needle could be deflected by a wire carrying an electric