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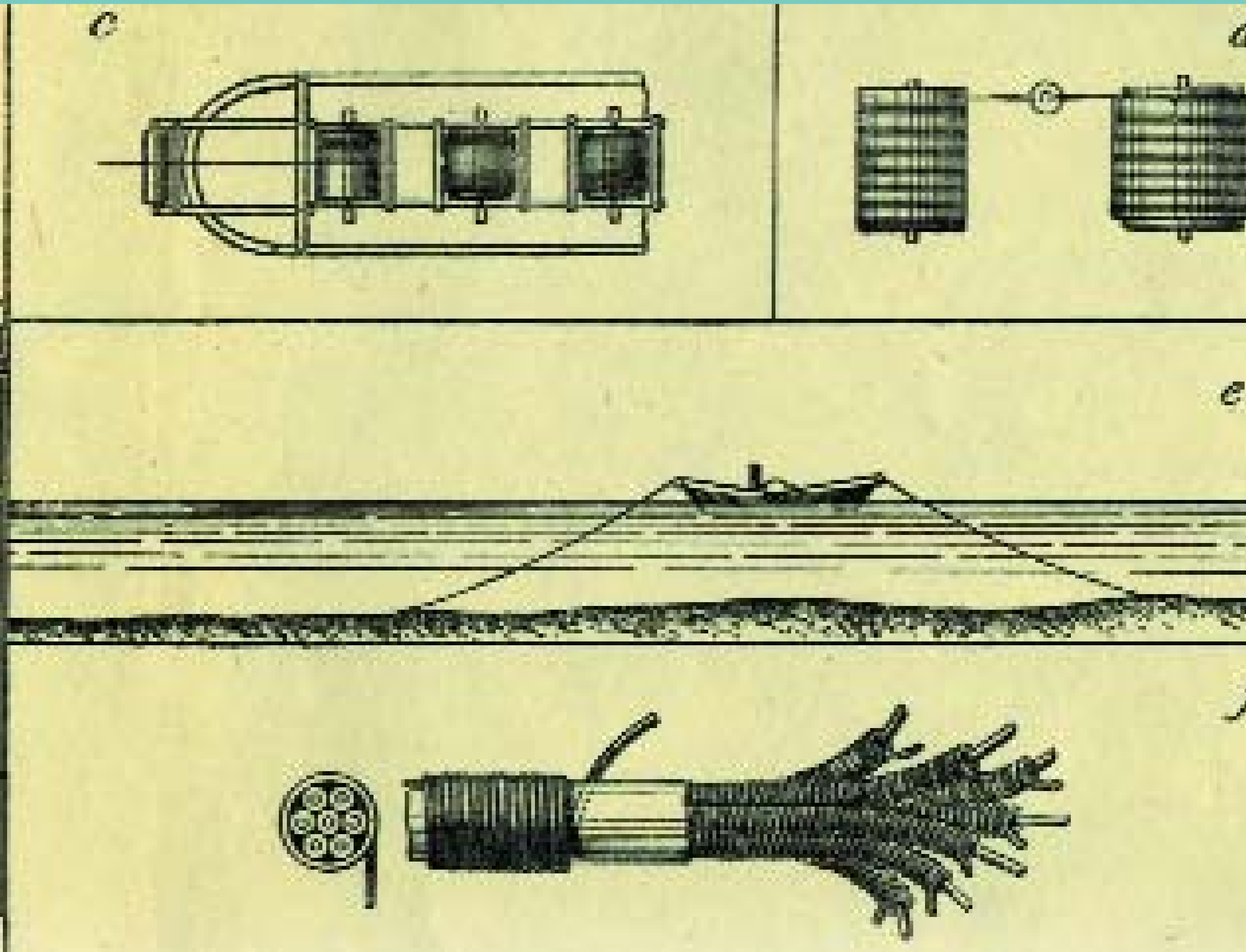

An international forum for the expression of ideas and opinions pertaining to the submarine telecoms industry

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FROM ELEKTRON TO 'E' COMMERCE

150 years of laying submarine cables

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Part 1
Birth of the Industry
1720-1856

The Possibility of Electric Telegraphy

We all know that a magnet will attract iron and a rubbed glass rod will attract a feather, but no one knows at what date the phenomenon of "attraction" was first discovered.

The subject remained a mystery until 1600. In that year William Gilbert, physician to Queen Elizabeth, published his De Magnete in which he described most of the known phenomena to do with attraction and distinguished between magnetic attraction (to do with lodestones and iron) and the attraction associated with amber which he called after its Greek name elektron, thereby giving us the term "electricity".

Gilbert's work sparked off a lot of interest, but little actual progress was made until 1720 when Stephen Gray, a London pensioner, formulated for the first time the principles of electric conduction and insulation. This was quickly followed by Benjamin Franklin in Philadelphia who discovered that electricity consisted of a single "fluid" with "positive" and "negative" aspects. He also worked out the explanation for the Leyden Jar whose ability to store electricity was a mystery.

The first written proposal to suggest employing electricity for the transmission of intelligence appeared in 1753 as a letter to the Scots' Magazine, signed CM. There were other similar proposals, all based on frictional or what today we would call "static" electricity. As late as 1816 Francis Ronalds was successfully demonstrating an electrostatic telegraph in his back garden and experimenting on the velocity of electricity, though by then it was becoming clear that static electricity was unsuitable for public telegraphy. Ronalds also published a detailed proposal for a system of "... electrical conversazione offices communicating with each other all over the kingdom ..." which was the first published work to set down the principles for building and operating a national telegraph network.

By 1800, Alessandro Volta had developed the so-called Voltaic Pile, which was the direct forerunner of today's electric battery. It was subsequently improved by Professor Daniell of King's College, and as a result of the work of Humphrey Davey and Michael Faraday at the Royal Institution, some of the effects of the new electricity, particularly its chemical effects, came to be understood quite rapidly. The Voltaic Pile, which provided a relatively constant source of electric current, seemed to have an advantage over electrostatic generators and was responsible for various telegraphic experiments using frogs legs and its ability to decompose water. But for public telegraphy an easier means of detection was needed.

Although a link between electricity and magnetism had long been suspected, it was not until 1820 that Christian Oersted at the University of Copenhagen announced his discovery of "electromagnetism". He had noticed that a wire in which an electric current was flowing was able to move a compass needle. This discovery provided not only the missing link between electricity and magnetism, but also a simple device which could be used for indicating telegraphic signals. It seems that Oersted did not fully understand his observations and it was left to the French mathematician André-Marie Ampère to provide the theoretical explanations. He also proposed a number of electromagnetic instruments, notably the spiral or helix of wire which would form a vital component in every electric telegraph system.

Later during 1820, by applying Ampère's laws, a chemist in Halle, Johann Schweigger, realised that by increasing the number of turns in his spiral or "coil" the sensitivity of the simple compass needle instrument could be greatly increased. Schweigger's "Multiplier" quickly evolved into the ubiquitous "galvanometer" and is particularly significant as the forerunner of the famous mirror galvanometer which William Thomson (later Lord Kelvin) developed less than 40 years later for long oceanic cables.

By the close of 1820, all the essential components for a basic electric telegraph system had been discovered: the battery would provide a continuous electric current; insulated wires would transmit the current to a remote point; and it could be detected easily via its magnetic effect on a needle.

Cooke & Wheatstone's Electric Telegraph

In 1812 Baron Pawel Lwowitsch Schilling von Canstatt, an attaché of the Russian Embassy in Munich, had succeeded in exploding powder mines with an insulated wire laid across the River Neva, near St Petersburg. By about the mid-1820s he had moved on to the electric telegraph.

Schilling's telegraph used Schweigger's Multiplier to move a magnetic needle to which was attached a little paper disc, black on one side and white on the other, so that, with several discs, combinations of black and white would represent letters of the alphabet and numbers.

It was a clever system. In fact, Professor Müncke of Heidelberg University was so impressed that he had a copy of Schilling's apparatus constructed for his lectures.

Francis Ronalds' eight miles of wire set up on his lawn for experiments on the velocity of electricity.

As the 1830s dawned, new telegraphic inventions started to appear in profusion. In particular, Edward Davey, a chemist, probably came closest to realising a complete, practical telegraph system but unfortunately he had to leave the country due to marital problems, opening the way for his main competitors who were Cooke and Wheatstone. On marine telegraphs, Davey had said in his opposition to Cooke and Wheatstone's 1837 patent application:

"Communications may be effected through, or under, the water by enclosing the conductors in ropes well coated, or soaked, in an insulating and protecting varnish, such as melted caoutchouc ..... we may have an air-tight and water-tight electrical renewing apparatus at each requisite interval."

So, Davey not only had the insulated submarine cable clearly in mind, but he also envisaged relay-type "repeaters" to boost the weak signals before sending them on their way into the next cable section.

In 1836 one of Professor Müncke's physics lectures was attended by an Englishman, William

Fothergill Cooke, an army man who was in Heidelberg to study for a new career in anatomical modelling. Cooke saw Müncke's replica of Schilling's telegraph in operation and immediately embarked on a further change of direction for which he possessed no training at all. Cooke, in reality a businessman, recognised an opportunity when he saw one.

Cooke built a number of instruments but, not surprisingly, they did not work very well. Even a consultation with Michael Faraday did not really help him. Nevertheless, with little to sell, he was able to persuade the directors of the Liverpool and Manchester Railway to allow him to experiment on a mile-long tunnel in Liverpool which required a communication system between the stationary engine driver at one end and Lime Street station at the other. Desperate to make his system work, he called upon most of London's scientific community until finally coming across "an extraordinary fellow" called Charles Wheatstone, Professor of Experimental Philosophy at King's College, London. Wheatstone was an established figure in the scientific world and already deeply involved with electric telegraphy.

William Fothergill Cooke

Charles Wheatstone

From the start their relationship was an uneasy one. The businessman and the scientist needed each other, but neither was prepared to recognise the fact. Nevertheless, in March 1837 they agreed to form a partnership.

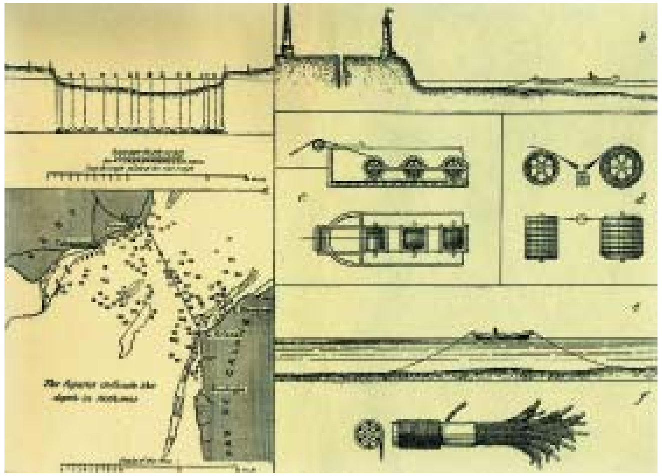
They applied for a joint patent in May which, after Edward Davey's unsuccessful challenge, was sealed on 12th June that year. It was the world's first patent for an electric telegraph. Significantly, when the specification came to be filed some months later, all the instruments cited were Wheatstone's.

Cooke laid on some major demonstrations for railway companies including one between Euston and Camden Town in the autumn of 1837 and another along Brunel's Great Western Railway line from Paddington to West Drayton in May 1838. By 1842 he had persuaded the directors to allow him to extend the system to Slough and offered to carry railway messages free if the railway would lease him the route for a nominal charge. Agreement was reached, and in 1843 Cooke opened his own telegraph service to the public, charging one shilling per message irrespective of length.

The following year the Admiralty signed up with Cooke for a telegraph between London and Portsmouth and in 1845 Cooke's telegraph on the Great Western Railway helped to apprehend the murderer John Tawell to great public astonishment.

In 1840 the London and Blackwall Railway had opened with Cooke's electric telegraph to control its operations, followed soon after by the Yarmouth & Norwich Railway. Gradually the electric telegraph became an indispensable part of every railway system.

Wheatstone's contribution to the partnership was to design instruments and telegraph circuits in the firm knowledge that they would work properly, whilst Cooke supplied the business skills. Despite their personal differences, the Cooke and Wheatstone telegraph system was a commercial success and by 1845 its expansion required the formation of a company - the Electric Telegraph Company (later known as the "Electric") - which Cooke formed with two "influential capitalists", the MP and financier John Lewis Ricardo and his friend George Parker Bidder. The Electric was incorporated during 1846 and grew into the United Kingdom's largest telegraph company before becoming part of the Post Office in 1870 when all the country's telegraph companies were finally nationalised.Wheatstone sold specified parts of his patents to the new company, his partnership with Cooke came to an end, and he continued to develop his many other scientific interests at King's College. One of these was submarine telegraph cables.



One of Wheatstone's drawings for a cross-channel submarine telegraph cable

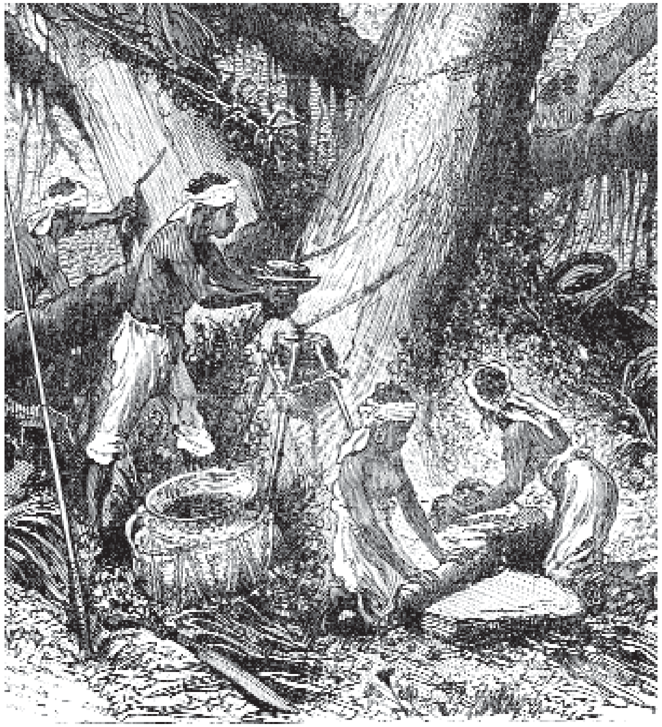
Gutta Percha, Bottle Stoppers and the Problem of Insulation

In 1840 and 1841 Wheatstone visited Brussels and Paris to discuss a cross-Channel submarine telegraph cable. His drawings for the project are impressive. The cable was to contain seven conductors, insulated with yarn saturated in boiled tar and protected by iron wire. He showed the cable design, the cable-making machine, a profile of the seabed, depth soundings between Dover and Cap Gris-Nez, cable-laying machinery and its installation on a barge. It is clear that he had given it all a lot of thought. When in 1843 Wheatstone assigned most of his patent rights to Cooke in exchange for royalties, he took care that the assignment did not prevent him from "establishing electric telegraph communication between the coasts of England and France ... for his own exclusive profit".

In 1843, Samuel Morse was able to send electric currents through a cable insulated with hemp soaked in tar and pitch surrounded by a layer of India rubber across New York harbour. In 1844, Wheatstone conducted experiments with submarine cables in Swansea Bay and in 1845 Ezra Cornell laid a twelve-mile cable in the relatively sheltered waters of the River Hudson to connect Fort Lee and New York which worked well until broken by ice the following year.

In the race to lay a cable across the Channel, Wheatstone had a competitor - Charles West - who held a patent for the insulation of wires with India rubber. He conducted trials in Portsmouth harbour of a cable insulated with India rubber made by Messrs S W Silver & Co. They were originally garment makers in Greenwich, who from 1844 began making waterproof clothing, vulcanised products and rubber-covered electrical conductors. The trials worked well, but the project fell through when the Electric declined to support it. By 1845 Wheatstone was thinking of insulating his Channel cable with a new material from Malaya called Gutta Percha that had recently been discussed at the Society of Arts, but he could not obtain enough of it and let his plans lapse.

Gutta Percha is the dried sap from an immense tree, the Isonandra Gutta, which occurs in many parts of South-East Asia. It is closely related to caoutchouc or rubber with the unusual property that it can be shaped by softening in hot water, hardening again when cool. It seems to have been brought to the West by at least three people round about 1843. One of these, Dr William Montgomerie, a surgeon working for the East India Company, sent samples to the Society of Arts, pointing out its properties and possible uses. The following year he brought back more samples, one of which found its way to an artist and inventor called Charles Hancock who incorporated the



The collection of Gutta Percha from the Isonandra tree

new material into a patent specification for bottle stoppers. Not long afterwards, Hancock was approached by a Dublin chemist, Henry Bewley, who was experimenting with bottling fizzy water and needed a good stopper. So on 4th February 1845, Hancock and Bewley agreed to work Hancock's patent for their joint benefit. This date fixes the birth of the Gutta Percha Company which later became the heart of an industry supplying the world with submarine cables.

Wheatstone had probably heard the original suggestion to use Gutta Percha for insulating cables which came from Michael Faraday to William Siemens. Siemens had arrived in London in 1843 to represent the Berlin firm of Siemens & Halske. They quickly adopted the idea and were soon installing great lengths of insulated telegraph wire underground in Germany and Prussia.

The Gutta Percha Company prospered and, in addition to insulated telegraph wire, supplied Victorian society with a tremendous range of domestic products such as picture frames, soles for shoes and conversation tubes for noisy railway journeys. After a while Hancock and Bewley fell out over a patent dispute, and since Bewley's backers were providing most of the funds, Charles and his brother Walter were paid off and left.

In 1848 the Gutta Percha Company received its first order for a submarine cable (a two-mile length) from C V Walker, a Fellow of the Royal Society and telegraphic engineer to the South Eastern Railway Company. He had used Gutta Percha insulation on telegraphic wires through all the wet railway tunnels for which he was responsible and now wanted to experiment in the Channel.

On 10th January 1849, using a small vessel, the Princess Clementine, Walker laid the cable from the beach at Folkestone out in a loop. One end was connected via a telegraph line to London whilst Walker remained on board the Princess Clementine where he was able to exchange messages a total distance of 85 miles, of which two miles were under water.

Gutta Percha proved to be an ideal insulator and for about a century would remain the prime material for insulating submarine cables. India rubber was also used, but never as widely.

This history is continued in our next issue.