Appendix A

Thomson, Brunel and the Atlantic cables of 1865 and 1866

I.S. Ruddock
Department of Physics, University of Strathclyde, United Kingdom.

1 Introduction

When the attempt to lay a working trans-Atlantic telegraph cable was renewed in 1865 after the failure of the 1858 cable, the Atlantic Telegraph Company and its contractor, the Telegraph Construction and Maintenance Company, decided to use only one ship instead of starting mid-ocean with two and laying the cable in opposite directions. William Thomson’s connection with the enterprise was as a member of the five-strong Scientific Consulting Committee, which also included Charles Wheatstone and Joseph Whitworth.

By 1865, more than 50 submarine cables had been laid worldwide since 1851 with the longest being that of over 1500 miles connecting Malta and Alexandria. But the challenges now faced were greater on account of the ocean’s depth and the resulting strain on the cable during laying, as well as the natural navigation hazards encountered by any ship crossing an ocean. The new Atlantic cable consisted of a core of a single strand of copper wire with six more wound around it within four layers of gutta-percha insulation, each in turn separated by a layer of Chatterton’s Compound – a waterproof adhesive. The insulated core was next covered with jute padding before being protected by a spiral sheath of 10 iron wires wound covered in manila yarn saturated with a preservative. Although the planned route from the west of Ireland to Newfoundland was around 1600 nautical miles, the finished cable had a total length of over 2400 nautical miles to allow for the profile of the seabed.

With a mass of over 4000 tons and a correspondingly large volume, the cable demanded the use of a very large vessel, a requirement that could only be satisfied by Isambard Kingdom Brunel’s SS Great Eastern which had been launched in 1858. It was not only the largest ship at the time, but it would remain so beyond its scrapping in 1890 until the White Star liners RMS Oceanic and RMS Celtic exceeded its length and gross tonnage in 1899 and 1901, respectively. Great Eastern’s career as a passenger ship was short lived because there was insufficient traffic to justify its use on the intended Far East trade, whereas on Atlantic service, it suffered a series of accidents and was the victim of a price war with rival shipping companies. Brunel died in 1859 as preparations for the first revenue earning voyage were being made, but despite Great Eastern being a commercial failure, the ship was an engineering success.
and its seaworthiness during cable laying vindicated its designer’s vision that ships would steadily increase in size.

At the time of its charter to the Telegraph Construction and Maintenance Company, Great Eastern had been purchased by the Great Eastern Steamship Company from the Great Ship Company. Sir Daniel Gooch, a director of the Great Western Railway, and previously Brunel’s prodigy as locomotive superintendent, was the company’s chairman and as such sailed in 1865.

2 The images

Most of images in this Story in Pictures are watercolours painted during the 1865 voyage by Robert Charles Dudley (1826–1900), a popular Victorian artist. They were bequeathed to the Metropolitan Museum of Art, New York by Cyrus Field (American businessman, financier, telegraph entrepreneur and director of the Atlantic Telegraph Company) on his death in 1892. Lithographs based on the watercolours were used to illustrate William Howard Russell’s The Atlantic Cable published in 1865 [1]. Russell (1820–1907), a journalist who had recently reported from Crimea for The Times, was on board Great Eastern under contract by the Telegraph Construction and Maintenance Company to write an account of the voyage. Detailed accounts of the 1865 and 1866 cabling attempts can be found in [2-4].

3 Preparations

Figures 1–5 and their captions show and describe Great Eastern being prepared for the voyage and then leaving Ireland.

Figure 1: The cable being wound into one of the storage tanks in the works at Greenwich. It was completed at a rate of about 100 miles per week by the Telegraph Construction and Maintenance Company, an organisation recently formed by the merger of Glass, Elliott & Co. and the Gutta Percha Company; the iron wire for the armour was supplied by Webster & Horsfall, Birmingham. From its manufacture to eventual laying, the cable was kept underwater in tanks, both at the factory and while being stored and transported in the hulks. (Metropolitan Museum of Art, New York: Robert Charles Dudley collection.)
Kelvin, Brunel and the Atlantic cables of 1865 and 1866

Figure 2: Left: the cable being transferred into one of two Royal Navy hulks at Greenwich. (Metropolitan Museum of Art, New York: Robert Charles Dudley collection.)

Figure 3: Right: the loading of the cable from a hulk to Great Eastern at Sheerness. (Metropolitan Museum of Art, New York: Robert Charles Dudley collection.)

Figure 4: The Prince of Wales being shown the cable entering Great Eastern’s after tank (one of three) on 24 May 1865. (Metropolitan Museum of Art, New York: Robert Charles Dudley collection.)
The wheels and brakes of the paying-out machinery on Great Eastern’s afterdeck (Fig. 6) regulated the tension on the cable as indicated by a simple dynamometer based on the rising and falling of a heavy pulley resting on it. The tensile strength of the 1865 cable was 11 times its weight per mile in seawater, that is, it could support 11 miles hanging vertically in the ocean, and compared favourably with the 1858 cable’s which was less than five times its weight per mile in seawater. This strength provided a safety factor of about four on the basis that the maximum depth encountered would be two and a half miles.

The ‘electricians’ of the Telegraph Construction and Maintenance Company had a continuous programme of electrical tests using Thomson’s mirror galvanometer to be performed on the cable during laying. William Thomson was on-board on behalf of the Atlantic Telegraph Company as a consulting expert with the remit of reporting on the tests but without the power to interfere or control. Two days into the voyage, on 25 July 1865, contact was lost for the first time between Great Eastern and Valentia with the ship still only 66 miles from shore. The procedure for making a repair was to lash the cable to a wire rope and then cut the cable and allow it to fall into the sea; meanwhile, the ship was turned with the wire rope being transferred from the stern to the bow where it was then brought in through the picking-up apparatus, Fig. 7.

On this first occasion, the fault was identified when 10 miles of cable had been hauled back in and turned out to have been caused by a stray piece of wire that had penetrated the gutta-percha insulation. Once the damaged portion was cut out, a splice had to be made at this point, and again where the cable had originally been cut when being retrieved from the sea, Fig. 8. Communication was lost with Ireland, now 770 miles distant, for the second time on 31 July, Fig. 9.

When the cable failed for the third time on 2nd August and a piece of stray wire was once again found, on-board opinion was divided between those who suspected sabotage and those who...
Figure 6: The cable paying-out machinery. (Metropolitan Museum of Art, New York: Robert Charles Dudley collection.)

Figure 7: The picking-up machinery on the foredeck of Great Eastern. (Metropolitan Museum of Art, New York: Robert Charles Dudley collection.)

Figure 8: The cable being spliced after the repair of a fault. (Metropolitan Museum of Art, Robert Charles Dudley collection: New York.)
Figure 9: The cable being examined for a fault on 31 July, the second time that communication was lost with Ireland, now 770 miles distant. Again the problem was caused by a stray piece of wire that had penetrated the gutta-percha insulation, but on this occasion it was decided (wrongly) that the cable had been deliberately damaged in the holding tank. From now on, crew members handling the cable in the tanks were supervised at all times. (Metropolitan Museum of Art, New York: Robert Charles Dudley collection.)

now thought that the problems were due to poor quality control during manufacture. The latter view became the accepted version when subsequent examination of cable recovered from the seabed showed numerous locations where the armour wire wound on the outside of the insulation had frayed. Although Thomson and Mr. C.F. Varley, Chief Electrician of the Atlantic Telegraph Company, thought that this fault was sufficiently incomplete that the cable could be used and generate a return on investment, the decision to retrieve it was made by Mr. Canning, Principal Engineer of the Telegraph Construction and Maintenance Company and person in overall charge of the operation. He was well aware that, despite what was being said by those around him, the Atlantic Telegraph Company would not accept a cable of marginal quality, even if fully laid and working. Unfortunately when the normal routine for lifting was being followed, the cable broke as Great Eastern was being turned and the end was lost overboard. The only option left was to attempt to grapple for the cable and bring it back to the surface.

Great Eastern was first moved to the windward side of the line of the cable and then, with a grappling hook resting on the seabed, was allowed to drift while the dynamometer monitored the tension in the wire rope. Although the cable was lost at a depth of 2500 fathoms or 15,000 feet, it was found the next day, 3rd August. The lift progressed well until about 1000 fathoms of the grappling rope had been wound in, but then the swivel coupling between two of the constituent 100 fathom lengths making up the wire rope fractured allowing the grappling iron and cable to sink back to the seabed.

After marking the line of the cable by a buoy, Figs 10 and 11, the second attempt to grapple started on the 7th August but with a similarly disastrous outcome; another grappling iron and over 1000 fathoms of wire rope were lost when the cable was about halfway to the surface. Canning immediately marked the position with yet another buoy and decided to make a final attempt with the remaining lengths of rope.
This buoy was lost for over a day until the afternoon of 9th August due to a sudden gale that came up in the evening and caused Great Eastern to shift its position by 35 miles. By mid-morning of the following day, a grappling iron and rope had been prepared and at 10.30 a.m. it was thrown over the bow and allowed to sink for the next 48 minutes. Despite the tension in the grappling line increasing a couple of times, it was clear by mid-afternoon that the route of the cable had been crossed without it being found. The line and hook were brought back in overnight and prepared again for what turned out to be the final attempt on 11th August. With much of the wire rope in poor condition due to unravelling, the replacement included over 700 fathoms of various hemp ropes. Although this bid was being made out of a sense of duty, the dynamometer indicated an increased tension during the tracking across the route of the cable, but it came as no surprise to the assembled witnesses that the line parted during recovery. As a result, the 1865 cable expedition was over for the time being with only 600 miles still to be laid.
5 The 1866 voyage

On 12 October 1865, at an Extraordinary General Meeting, the Atlantic Telegraph Company resolved to seek additional investment to make another attempt at laying a cable using Great Eastern and to recover and complete the recently abandoned cable. In reaching this decision, the board was encouraged by the demonstrated ability to lay a cable in the deepest part of the Atlantic, to transmit signals through it despite the enormous hydrostatic pressure, and to successfully retrieve and repair a faulty or broken cable.

The new cable was ready by the early summer of the following year and was loaded again onto Great Eastern in the Thames. This time, the general public was allowed to inspect the ship at a cost of a shilling each, but William Thomson felt compelled to write to a nephew to make it clear that he was not to be asked for if visiting because he would be too busy. On 7 July 1866, Great Eastern sailed for the west of Ireland with the new cable and improved laying and picking-up machinery (Figs 12 and 13) together with the unlaid portion of the previous year's cable.

The new shore-end was picked up off Valentia on 13th July and after the new cable was spliced to it, the voyage began westwards; Thomson was on-board again having joined the previous day. In contrast with the events of August 1865, the operation proceeded according to plan and Heart’s Content, Trinity Bay, Newfoundland, was reached on 27th July with the shore-end being successfully landed the next day, Fig. 14.

After being refuelled with 8000 tons of Welsh coal delivered from Cardiff in the preceding weeks, Great Eastern set sail again as a cable ship on 9th August. Three days later, it and an escort vessel joined two other ships that had left earlier to mark the line of the lost 1865 cable near the break but by the time they arrived one of the crews had already managed to find and lift the cable, although their grappling rope broke in the attempt. Although the cable was subsequently brought to the surface on 17th August, it was not until 2nd September that Great Eastern and two of the other ships working together to share the strain lifted it and brought it on-board. There now followed a few tense hours when the end was prepared and connected to

Figure 12: The 1866 paying out machinery on Great Eastern viewed from the stern. The cable is visible leaving the machinery and passing under the wheel of the dynamometer en route to the stern. (Photograph courtesy of the IET Archives.)
Kelvin, Brunel and the Atlantic cables of 1865 and 1866

433

signalling apparatus. Confirmation that the cable had not suffered its year of immersion was obtained when contact was made with Valentia where telegraphists had been standing by since the 1866 cable had started transmitting at the end of July. Great Eastern then sailed west for the second time and completed the 1865 cable on 8th September.

References