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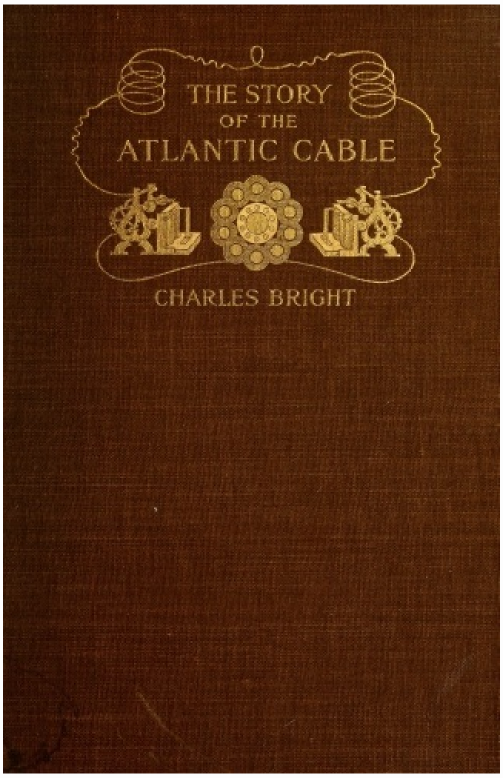

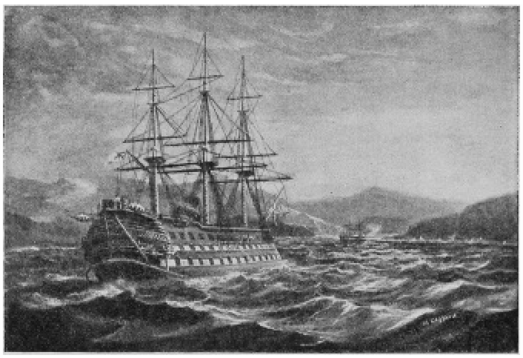

H.M.S. Agamemnon entering Valentia Bay with first Atlantic Cable. Frontispiece.

THE STORY OF THE ATLANTIC CABLE

BY

CHARLES BRIGHT

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AUTHOR OF SUBMARINE TELEGRAPHS, SCIENCE AND ENGINEERING DURING THE VICTORIAN ERA, THE EVOLUTION OF THE ELECTRIC TELEGRAPH, 1837-1897, THE LIFE STORY OF SIR CHARLES TILSTON BRIGHT

WITH FIFTY-FOUR ILLUSTRATIONS

NEW YORK
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PREFATORY NOTE

The jubilee of Submarine Telegraphy having lately been achieved, and that connected with the Atlantic cable being somewhat close at hand, it has been thought a suitable moment for the appearance of this little volume.

In these days when the substitution of submarine cables by wireless telegraphy systems is a subject of common talk, it may be well to pause for a moment and contemplate the period of time covered by the gradual evolution of old and existing methods which at length achieved the result we now enjoy—a practical commercial telegraphic system between all the nations of the world, and notably between the United Kingdom and America.

By a somewhat curious coincidence the engineer of the first Atlantic cable accomplished his achievement at practically the same youthful age (twenty-six) as Mr. Marconi when first transmitting signals across the Atlantic without any intervening wires.

C. B.

21 Old Queen Street, Westminster, S. W.,
October, 1903.

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PART I

INTRODUCTORY

The Electric Telegraph—First Land Telegraphs—First Submarine Cables: Dover to Calais, 1850-'51—Other Early Cables: England to Ireland, 1853, etc.

The Electric Telegraph.—The advances made in electric science are so bold and rapid that our still comparative ignorance of the precise nature of electricity must always seem strange. We are not, however, here directly concerned with electricity as a physical science, but rather with its practical applications to the still present system of telegraphy, by way of introduction to the gradual development of Trans-Atlantic telegraphy. The electric telegraph, together with the railway-train and the steamship, constitute the three most conspicuous features of latter-day civilization. Indeed, it may be truly said that the harnessing of this force of nature (electricity) to the service of man for human intercourse has effected a change in political, commercial, and social relations, even more complete than that wrought by steam locomotion. Like its fellow emblems, the telegraph was the outcome of many years of persevering effort on the part of numerous scientific investigators and inventors; like them also, it was perfected for practical use on both sides of the Atlantic by men of our own race and speech, such as Cooke, Wheatstone, and Morse.

The First Land Telegraphs.—The first practical telegraph-line in the world—namely, that on the Great Western Railway from Paddington to West Drayton, shortly afterward extended to Slough—was within the year of Queen Victoria's accession to the throne, and in the same year as the first trunk line of railway and the first ocean steamer.[1] Improvements and novelties in telegraphic instruments were rapidly made by inventors from all the civilized nations—e. g., Morse, Vail, and Henry in America; Breguet in France; Steinheil and Siemens & Halske in Germany; and Schilling in Russia; besides Alexander Bain, Bright, and Hughes in England. Commercial interests were soon formed to work the new invention, and in England the Electric and International Telegraph Company, the British and Irish Magnetic Telegraph Company, and other large concerns were the means of establishing telegraphic communication throughout the kingdom—only to be absorbed by Government later on. Our theme does not include—even in the course of introduction—a study of the development of land telegraphy. The apparatus and methods employed are, to a great extent, entirely different; indeed, the only point in common between the cardinal principles and submarine telegraphy is that electricity, as generated by a voltaic battery, is the common agent, and consequently the metal conducting-wire is employed in both.[2] But in subaqueous (as well as in subterranean) telegraphy the poles and porcelain insulators require to be substituted by an insulating covering round the entire conductor; and the point of contact in practise between land and marine telegraphy is really, therefore, in the matter of insulation for subterranean or subaqueous wires.

First Submarine Cables.—A Spaniard named Salva appears to have suggested the feasibility of submarine telegraphy as far back as 1795, and in 1811 Sommering and Schilling conducted a series of experiments, more or less practical, when a soluble material—said to have been india-rubber—was first used for insulating the wire.

But the earliest records of practical telegraphy under water of which there are any particulars relate to the experiments conducted by Dr. O'Shaughnessy (afterward Sir William O'Shaughnessy Brooke, F.R.S.) across the River Hugli on behalf of the East Indian Company in 1838.[3] Referring to his practical researches a little later, O'Shaughnessy remarked: "Insulation, according to my experiments, is best accomplished by enclosing the wire (previously pitched) in a split rattan, and then paying the rattan round with tarred yarn; or the wire may—as in some experiments by Colonel Pasley, R.E., at Chatham—be surrounded by strands of tarred rope, and this by pitched yarn. An insulated rope of this kind may be spread across a wet field—nay, even led through a river—and will still conduct the electrical signals, without any appreciable loss." In 1840 Professor Wheatstone (afterward Sir Charles Wheatstone, F.R.S.) explained to a committee of the House of Commons the methods by which he thought it possible to establish telegraphic communication between Dover and Calais. He appears to have been unaware of the prior experiments just alluded to, for his system of insulation, though more fully developed, was practically the same.

Prof. S. F. B. Morse, the well-known inventor of the telegraph apparatus bearing his name, also made a study of this problem in 1842, when he laid down an insulated copper wire across New York harbor, through which he transmitted electric currents. Hemp soaked in tar and pitch, surrounded with a layer of india-rubber, constituted the insulation. Morse was a great letter-writer, and records of his early work are solely based on his own statements at a time when he noted in his diary: "I am crushed for want of means. My stockings all want to see my mother, and my hat is hoary with age." In 1845 Ezra Cornell, who was afterward the founder of Cornell University, laid a cable, twelve miles long, to connect Fort Lee with New York, in the Hudson River. The cable consisted of two cotton-covered copper wires, insulated with india-rubber, and enclosed in a leaden pipe. It worked well for several months, but was broken by ice in 1846. In that year Mr. Charles West paid out by hand an india-rubber insulated wire in Portsmouth harbor, through which he signaled from a boat to the shore. The experiment was intended as the forerunner of the establishment of telegraphic communication between England and France, but for want of the necessary funds was not followed up.

Subaqueous, or marine, telegraphy owed its institution, however, to the introduction of gutta-percha, for insulating purposes. The late Dr. Werner Siemens having invented a machine for applying gutta-percha to a wire—similar in principle to the machine for making macaroni—considerable lengths of gutta-percha-covered subterranean wires were laid in Germany and Prussia between 1846 and 1849; and in 1849 Siemens laid a gutta-percha insulated conductor in the harbor of Kiel which was used for firing mines. Following this came the extensive system of underground lines laid down in England for the Magnetic Telegraph Company by their engineer, Mr. (afterward Sir Charles) Bright, in accordance with a patent of his. Short lengths were also laid, mostly through tunnels, by the Electric Telegraph Company a little later.

On the 10th day of January, 1849, the late Mr. C. V. Walker, F.R.S., electrician to the Southeastern Railway, laid a gutta-percha-covered conductor, two miles long, in the English Channel. The wire was coiled on a drum on board the laying vessel, from which it was paid out as the vessel progressed. Starting from the beach at Folkestone, the line was joined up to an aerial wire, 83 miles in length, along the Southeastern Railway, and Mr. Walker, on board the Princess Clementine, succeeded in exchanging telegrams with London.

On the 23d July, 1845, the brothers Jacob and John Watkins Brett addressed themselves to Sir Robert Peel, as Prime Minister and First Lord of the Treasury, relative to a proposal of theirs for establishing a general system of telegraphic communication—oceanic and otherwise. They were referred to the Admiralty, Foreign Office, etc., and gradually became involved in a departmental correspondence—more academic than useful—in which they were passed backward and forward from one government office to another. After considerable negotiations with both governments concerned, a concession was at last obtained by the Messrs. Brett, and a company formed for instituting telegraphy between England and France by means of a line from Dover to Calais. Twenty-five nautical miles of No. 14 copper wire covered with ½-inch thickness of gutta-percha was then manufactured, the electrician's tongue being the only test applied to some of the lengths. The shore ends for about two miles from each terminus consisted of a No. 16 B.W.G.[4] conductor covered with cotton soaked in india-rubber solution, the whole being incased in a very thick lead tube. The rest of the line was composed of the gutta-percha insulated wire above described, with 30-pound leaden weights fastened to it at 100-yard intervals,[5] the laying vessel having to be stopped each time one was put on. The submersion of the line was successfully effected, but it only lived to speak a few more or less incoherent words—one being a short complimentary communication to Louis Napoleon Bonaparte, shortly afterward Emperor of the French. It subsequently transpired that a Boulogne fisherman had hooked up the line with his trawl, "mistaking it for a new kind of seaweed!" This enterprise excited little attention at the time. It was, in fact, regarded as a "mad freak" and even as a "gigantic swindle." When accomplished, The Times remarked, in the words of Shakespeare, "The jest of yesterday has become the fact of to-day"; and a few hours later it might with equal truth have been said that "the fact of yesterday has become the jest of to-day!" The feasibility of laying such a line and of transmitting electric signals across the Channel had, however, been proved. The signals obtained had, moreover, the effect of eradicating the then very prevalent belief that, even if the line were successfully submerged, the current would become dissipated in the water.[6] It now remained to find a satisfactory method of protecting the insulated conductor from injury during and after laying. The excellence of the insulating material was recently testified to when some portions were recovered.

Though the above line was not, practically speaking, turned to any account, it was by no means abortive, for the signals it had conveyed were sufficient to "save the concession," which was renewed by the French Government on December 19, 1850. But the previous failure had made capitalists distrustful; and only some weeks before the expiration of the time limit the necessary funds had not been raised.

Dover-Calais, 1850-'51.—The undertaking was saved by the energy and talent of one man, Mr. T. R. Crampton, an eminent railway engineer. He raised the necessary capital (£15,000), putting his own name down for half this amount and being joined by Lord de Mauley and the late Sir James Carmichael. He (Mr. Crampton) also settled the type of cable to be laid—based on the iron pit-rope; this, in one form or another, practically remains the type of to-day. The cable contained four copper conducting-wires of No. 16 B.W.G., each one covered with two layers of gutta-percha to No. 1 gage; these four insulated conductors, or "cores," were laid together and the interstices filled up with strands of tarred Russian hemp. The outer covering consisted of ten galvanized-iron wires of No. 1 gage wound spirally round the bundle of cores; this armor was provided "with a view to protecting the insulated conductors from the strains and chafing which had so seriously interfered with the chances of the previous line." The completed cable weighed about seven tons to the mile. It was coiled into the hold of an old pontoon hulk, which was then taken in tow by two steamers. A third tug to stand by, and a small man-of-war steamer to act as pilot, accompanied the laying expedition. The cable was landed at the foot of the South Foreland lighthouse and paid out toward Cape Sangatte, but the weather was less favorable than on the previous occasion; moreover, the weight of the cable—in the absence of efficient holding-back gear—caused it to run out too rapidly, notwithstanding the slight depth (some 30 fathoms) encountered. Added to this, the tugs drifted with the wind and tide. Thus when the vessels arrived within about a mile of the French coast no more cable was left on board, and a fresh length had to be procured and spliced on before the line was complete. This cable proved a lasting success: it underwent numerous and extensive repairs, and it was only quite recently that its abandonment took place.

Other Early Cables.—The success of Crampton's line gave considerable impetus to submarine telegraphy. Similar enterprises sprung up on all sides; but many failures occurred before these operations came to be regarded as ordinary industrial undertakings. In the course of the following year (1852) three unsuccessful attempts were made to establish telegraphic communication between England and Ireland. In the first—between Holyhead and Howth—the cable was not heavy enough to contend with the rough bottom, and strong currents and disturbances from anchors experienced in these waters; but this undertaking is remarkable as being the only instance in which an effort was made to do without any intermediate serving between the insulated conductor and the iron sheathing. In the second attempt—between Port Patrick (Scotland) and Donaghadee (Ireland)—the cable consisted of a central copper conductor covered first with india-rubber, then with gutta-percha, and then hemp outside all. This cable, being far too light, was actually carried away by the strong tidal currents and even broken into pieces during laying. In the third endeavor, between the same two points, the arrangements for checking the cable while paying out being again inadequate, there was not sufficient to reach the farther shore. However, in 1853, a heavy cable, weighing 7 tons per mile, with six conductors, was successfully laid for the Magnetic Telegraph Company by the late Sir Charles Bright.[7] This was in upward of 180 fathoms—the deepest water in which a cable was laid for some time—and proved a permanent success, forming the first establishment of telegraphic communication with Ireland. Only a year elapsed before it became evident that another cable was required to meet the traffic between England and the Continent, and an additional line was laid from Dover to Ostend. Anglo-Dutch and Anglo-German cables followed in due course; and in less than ten years from the commencement of its operations over the first Channel cable, the Submarine Telegraph Company (since absorbed by the state) was working at least half a dozen really excellent cables, varying from 25 to 117 miles in length, connecting England with the rest of Europe. During the next few years submarine communication was established between Denmark and Sweden, as well as between Italy, Corsica, and Sardinia; and between Sardinia and the north coast of Africa; but where successful, the measures adopted were, in the main, similar to those we have already described in connection with the preceding lines, though special conditions were, in some instances, the means of introducing certain modifications and improvements. Several serious failures were, however, experienced in the deep water of the Mediterranean which had a detracting effect—in the public mind—on the chances of the great undertaking which was to follow.

PART II

THE PIONEER LINE

CHAPTER I

EVOLUTION OF ATLANTIC TELEGRAPHY IN AMERICA AND ENGLAND

Gradual Evolution—The Projectors—Survey of the Route—Soundings—Nature of the Ocean Bed—Formation of the Atlantic Telegraph Company—Raising Capital—Critics, “Croakers,” and Crude Inventors.

As has been shown in the introductory chapter, the efforts of the early projectors of submarine telegraphy were at first confined to connecting countries divided only by narrow seas, or establishing communication between points on the same seaboard. The next step forward, with which we are here immediately concerned—that of spanning the Atlantic Ocean between Europe and America—was aptly characterized at the time as “the great feat of the century.” By its means the people of the two great continents were to speak together in a few moments, though separated by a vast ocean.

This was the first venture in transoceanic telegraphy. There was no applicable data to go upon; for the vast difference between laying short cable-lengths across rivers, bays, etc., in shallow water, and that of laying a long length of cable in depths of over two miles across an open ocean will be easily recognized—at any rate, by the sailor and engineer.

The wires of the Magnetic Telegraph Company had already been carried to various points on the west and south coast of Ireland; and, in 1852, Mr. F. N. Gisborne, a very able English engineer, obtained an exclusive concession for connecting St. Johns, Newfoundland, with Cape Ray, in the Gulf of St. Lawrence, by an overhead telegraph-line. The idea was to “tap” steamers coming from London to Cape Race at St. Johns, and pass messages between that point and Cape Breton, on the other side of the Gulf, by carrier-pigeons. A few miles of cables were made in England, and laid between Prince Edward Island and New Brunswick. Mr. Gisborne then surveyed the route for the land-line across Newfoundland, and had erected some forty miles of it, when the work was stopped for want of funds. When in New York in 1854, Gisborne was introduced to Mr. Cyrus West Field, a retired merchant, who became enthusiastic on the subject, and formed a small, but strong, syndicate for the practical realization of Gisborne’s scheme. A cable eighty-five miles in length was made in England, to be laid between Cape Breton and Newfoundland; but after forty miles had been paid out, rough weather ensued, and the undertaking had to be abandoned. A fresh instalment was, however, sent out in 1856, and successfully laid across the Gulf, thus connecting St. Johns with Canada and the American lines. The conductor of this line instead of being a single solid wire was, for the first time, composed of several small wires laid up together in strand form—with a view to avoiding a flaw in any single wire stopping the conductivity, besides affording increased mechanical pliability.

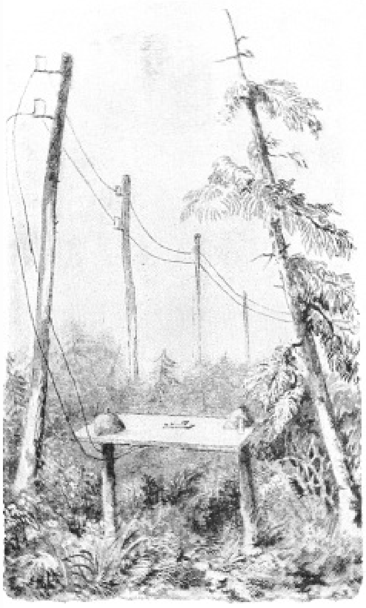


Fig. 1.—Newfoundland Telegraph Station, 1855.

The feasibility of uniting the two vast systems of telegraphy had engaged the consideration of some of those most prominently associated with electric telegraphy on both sides of the Atlantic. It had been already shown that cables could be successfully laid and maintained in comparatively moderate depths in the Mediterranean, Black Sea, etc., but the nearest points between the British Isles and Newfoundland are nearly 2,000 miles apart. The greatest length of submarine line which had hitherto been effectively submerged—110 miles—formed but an insignificant portion of such an enormous distance; and that, too, involving a depth of nearly three miles for a large proportion of the way, instead of about 300 fathoms.

Apart from the engineering difficulties entailed by this vast distance and depth, the question was then undetermined as to the possibility of conveying electric currents through such a length in an unbroken circuit, and at a speed that would enable messages to be passed rapidly enough in succession to prove remunerative. Various researches had been made—by Faraday among others—with a view to determining the law in relation to the velocity of electricity through a conducting-wire.

The retarding effect of the insulating covering had already been discovered; but the exact formula for the working speed of cables of definite proportions and lengths was not correctly arrived at till some years later. The similarity, in principle, of a cable to a Leyden jar was first pointed out by Mr. Edward Brailsford Bright in the course of a paper read before the British Association in 1854. He showed that on charging a gutta-percha-covered wire, the insulating material tended to absorb and retain a part of the charge and to hold back, as a static charge, some of the electricity flowing as current through the conductor—just as the charge (of opposite potential) induced on the outside plate of a Leyden jar statically holds the primary charge on the inner plate, until either are neutralized. The brothers, Edward and Charles Bright, made a series of extensive experiments on long lengths of underground wires; and these investigations were supplemented later by Mr. Edward Orange Wildman Whitehouse (formerly a medical practitioner), who became electrician to the first Atlantic cable. Mr. Whitehouse was a man of very high intellectual and scientific attainments, and a most ingenious and painstaking experimenter.

The retardation of the electric current through an insulated wire due to induction—a phenomenon practically unknown with bare, aerial wires suspended on posts, and of no consequence with quite short cables—was overcome by using a succession of opposite currents. By this means the latter, or retarded, portion of each current was "wiped out" by the opposite current immediately following it; and thus a series of electric waves could be made to traverse the cable, one after the other, several being in the act of passing onward at different points along the conductor at the same time. The Messrs. Bright devised a special key (embodied with a patent for signaling through long cables) for transmitting these alternating currents from the battery; and this was followed by others to effect the same object—one by Professor Thomson (now Lord Kelvin), who became electrical adviser to the enterprise.

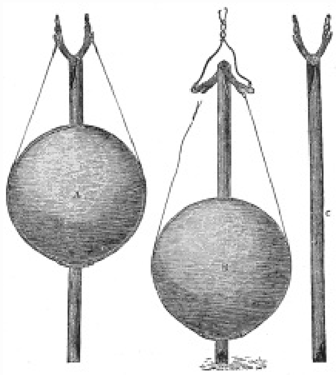


Fig. 2.—The Brooke "Sounder."

A certain degree of knowledge regarding the nature of the bed of the Atlantic Ocean was now available; for in the summer of 1856 a series of soundings had been taken by Lieutenant O. H. Berryman, U.S.N., from U.S.N. Arctic, and also independently by Commander Joseph Dayman, R.N. (H.M.S. Cyclops), showing what was called "a gently undulating plateau extending the whole distance between Ireland and British North America." These depths (averaging about 2½ miles) compared favorably with those that had presented themselves farther southward. The ground was found to shoal gradually on the Newfoundland side, but rose more rapidly toward the Irish shore. The soundings were taken with the ingenious apparatus of Lieut. J. M. Brooke, U.S.N. (Fig. 2), which formed the prototype of all similar deep-sea sounding-tubes of the present day. In this, at the extremity of the sounding-line a light iron rod, C, hollowed at its lower end, passed loosely through a hole in the center of a cannon-ball weight, A, which is fastened to the line by a couple of links. On the bottom being touched, the links reverse position, owing to the weight being taken off, and the cannon-ball, or plummet, B, being set free, remains on the ground, leaving the light tube only to be drawn up with the line.[8] In the act of grounding, however, the open end of the tube presses into the bottom, a specimen of which is consequently obtained—unless it be rock or coral. An oozy bottom was found throughout the soundings. The specimens brought up to the surface were shown under the microscope to consist (Fig. 3) of the tiny shells of *animalculæ*—the indestructible outside skeletons of the animal organisms known as *diatomaceæ* and *globigirenæ* foraminiferæ largely composed of carbonate of lime.[9] No sand or gravel was found on the ocean bed, from which it was deduced that no currents, or other disturbing elements, existed at those depths; for otherwise these frail shells would have been rubbed to pieces. As it was, they came up entire—without a sign of abrasion. The plateau or ridge—which was found to extend for some 400 miles in breadth—was considered a veritable feather-bed for a cable. Indeed, in his subsequent report to the United States navy, Lieut. M. F. Maury, U.S.N., spoke of this "shallow platform or table-land" as having been "apparently placed for the express purpose of holding the wires of a submarine telegraph and of keeping them out of harm's way." Lieutenant Maury concluded his report as follows: "I do not, however, pretend to consider the question as to the possibility of finding *a time calm enough, the sea smooth enough, a wire long enough, or a ship big enough*, to lay a coil of wire sixteen hundred miles in length." These words form amusing reading nowadays, as do also the suggestions of "telegraph plateaus" furnished by Providence as a resting-place for the Atlantic cable. The "plateau" idea was only true to the extent that the bed of the ocean in these regions afforded a smooth surface as compared with the Alpine character prevailing north and south of it. These soundings at something like fifty-mile intervals were not, however, originally undertaken with the Atlantic cable expressly in view. Indeed, for many years—until experience pointed to the absolute necessity—no special surveys were made previous to the laying of a cable.[10]

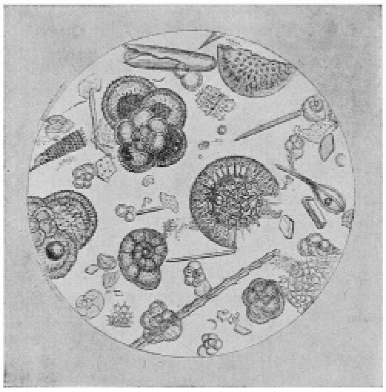
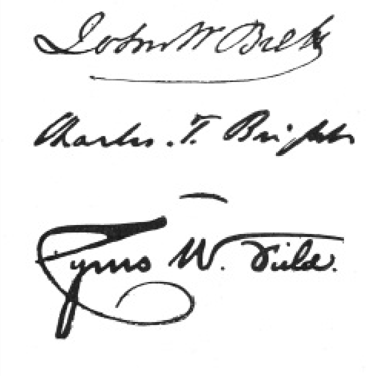


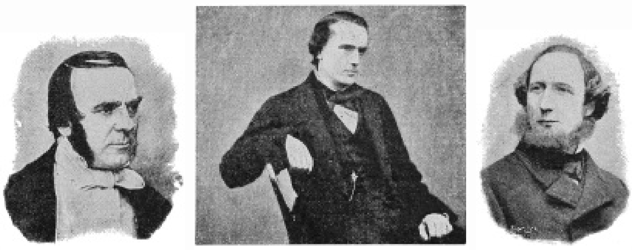
Fig. 3.—Specimen of the Ocean Bed. (Magnified 10,000 times.)

Formation of the *Atlantic Telegraph Company, 1856.*—Cyrus Field, besides being a man of sanguine temperament and intense business energy, also possessed shrewdness and foresight. Thus, he immediately recognized the value of Gisborne's concessions, and determined to turn them to the fullest account. His extraordinary acumen told him that by improving on the exclusive landing rights already obtained in America, he would place himself in the strongest possible position in regard to the big notion of an Atlantic cable. No sooner had he made up his mind to this effect than he set to work to accomplish the idea; and very soon exclusive rights were obtained in his name (Gisborne having entirely dropped out of the negotiations) for practically every important point in connection with the landing of an Atlantic cable on British North American territory. The period for these rights was fifty years, besides which he obtained various grants of land. Thus it will be seen he had assured himself a very strong position in connection with any project for an Atlantic cable without having had (in the words of his brother, Henry Field) "any experience in the business of laying a submarine telegraph." Mr. Field's syndicate was about this time registered as the New York, Newfoundland, and London Telegraph Company, which was now capable of debarring competition for a considerable period, at any rate.

Armed with this apparent monopoly, Mr. Field went over to England, empowered by his associates to deal with the exclusive concession possessed by the above company for the coast of Newfoundland and other rights in Nova Scotia, etc. He had already been over before in connection with the Gulf of St. Lawrence cable. He had, on that occasion, met Mr. John Watkins Brett, who thereupon interested himself financially in the "Newfoundland Company." On his second mission (in July, 1856) he at once put himself into communication with Mr. (afterward Sir Charles) Bright, who was known to be already making various preparations with a view to an Atlantic cable in connection with the Magnetic Telegraph system. On September 26, 1856, an agreement was entered into between Brett, Bright, and Field in the following terms, their signatures being reproduced as they appear at the foot of the document:

"Mutually, and on equal terms we engage to exert ourselves for the purpose of forming a Company for establishing and working of electric telegraphic communication between Newfoundland and Ireland, such Company to be called the Atlantic Telegraph Company, or by such other name as the parties hereto shall jointly agree upon."





John Watkins Brett (Projector). Charles Tilston Bright (Projector and Engineer). Cyrus West Field (Projector).

Let us see now what the united efforts of these three "projectors" had before them. The ground had already been to some extent cleared by their individual exertions when working independently, as well as in other ways. Bright, and also Whitehouse, had already proved the possibility of signaling through such a length of insulated wire as that involved by an Atlantic line. The soundings that had been recently taken showed that the depth was only unfavorable in the sense of being something far—but uniformly—greater than that in which any cable had previously been submerged. Finally, the favorable nature of the landing rights secured by Field on the other side went a long way toward insuring against competition, apart from the actual permission. There yet remained, then, the necessity of obtaining (*a*) Government recognition, and, if possible, Government subsidies; (*b*) the confidence and pecuniary support of the moneyed mercantile class; besides which a suitable form of cable had to be designed and manufactured, as well as all the necessary apparatus for the laying of the same.

As a result of considerable discussion, the two governments concerned eventually came to recognize the importance and feasibility of this undertaking for linking together the two great English-speaking nations, and the benefits it would confer upon humanity. Both the British and United States Governments gave a subsidy, in return for free transmission of their messages, with priority over others.[11] This, however, only jointly amounted to 8 per cent of the capital, and was payable only while the cable worked.[12]

The Atlantic Telegraph Company was registered on October 20, 1856, and the £350,000 decided on as the necessary capital for the work was then sought and obtained in an absolutely unprecedented fashion. There was no promotion money, no prospectus was published, no advertisements, no brokers, and no commissions, neither was there at that time any board of directors or executive officers. The election of a board was reserved for a meeting of shareholders, to be held after allotment by the provisional committee, consisting of the subscribers to the Memorandum of Association. Any remuneration to the projectors was left wholly dependent on, and subsequent to, the shareholders' profits being over 10 per cent per annum, after which the projectors were to divide the surplus.

The campaign was opened in Liverpool, the headquarters of the "Magnetic" Company, the greater proportion of whose shareholders were business men—merchants and shipowners—mainly hailing from Liverpool, Manchester, Glasgow, and London, who appreciated the value of America being connected telegraphically with Great Britain and Europe through their Irish lines.

The first meeting of the "Atlantic" Company was convened for November 12, 1856, at the underwriters' rooms in the Liverpool Exchange. This was called together by means of a small circular on a half-sheet of note-paper, issued by Mr. E. B. Bright, manager of the "Magnetic" Company. The result was a crowded gathering composed of the wealth, enterprise, and influence of Liverpool and other important business and manufacturing centers. Similar meetings were also held in Manchester and Glasgow, and a public subscription list was opened at the "Magnetic" Company's office of each town. In the course of a few days the entire capital was raised, by the issue of 350 shares of £1,000 each, chiefly taken up by the shareholders of the “Magnetic” Company. Mr. Cyrus Field had reserved £75,000 for American subscription, for which he signed, but his confidence in his compatriots turned out to be greatly misplaced. The result has been thus recounted by his brother: “He (Cyrus Field) thought that one-fourth of the stock should be held in this country (the United States), and he did not doubt from the eagerness with which three-fourths had been taken in England, that the remainder would be at once subscribed in America.” In point of fact, it was only after much trouble that subscribers were obtained in the States for a total of twenty-seven shares, or less than one-twelfth of the total capital. Thus, notwithstanding their professed enthusiasm, the faith of the Americans in the project proved to be strictly limited. At any rate, they did not rise to the occasion. Indeed, the undertaking was very much an affair of the Magnetic Telegraph Company, the officers of which led the shareholders to take a lively interest from the first in the Atlantic project as forming the nucleus of a great extension of business.

The first meeting of shareholders took place on December 9, 1856, when a board of directors was elected. This included the late George Peabody, Samuel Gurney, T. H. Brooking, T. A. Hankey, C. M. (afterward Sir Curtis) Lampson, and Sir William Brown, of Liverpool, no less than nine (representing the interests of different towns) being also directors of the “Magnetic” Company, including Mr. J. W. Brett. The first chairman was Sir William Brown, subsequently succeeded by the Right Hon. James Stuart-Wortley, M.P. Two names may be further specially referred to as destined, in different ways, to have the greatest possible influence in the subsequent development of submarine telegraphy. Mr. (afterward Sir John) Pender, who was then a “Magnetic” director, afterward took a leading part in the vast extensions that have followed to the Mediterranean, India, China, Australasia, the Cape, and Brazil, besides several of the subsequent Atlantic lines. Up to the time of his death he was chairman of something like a dozen, more or less allied, cable companies, representing some £30,000,000 of capital, and mainly organized through his foresight and business ability. Then, again, Prof. William Thomson, of Glasgow University, was a tower of scientific strength on the Board. He had been from the outset an ardent believer in the Atlantic line. His acquisition as a director was destined to prove of vast importance in influencing the development of transoceanic communication, for his subsequent experiments on the cable during 1857-’58 led up to his invention of the mirror galvanometer and signaling instrument, whereby the most attenuated currents of electricity, which are incapable of producing visible signals on other telegraphic apparatus, are so magnified by the use of a reflected beam of light as to afford signals readily legible. (A full description of this invention will be found in its proper place—farther on.)

Mr. (afterward Sir Charles) Bright was appointed engineer-in-chief, with Mr. Wildman Whitehouse (who had become closely associated with the project) as electrician, while Mr. Cyrus Field became general manager.

It must not be supposed that because the capital was raised without great difficulty, and because the project had far-seeing supporters, that there was any lack of “croakers.” On the contrary, the prejudice against the line as a “mad scheme” ran perhaps even higher than in the case of most great and novel undertakings. The critics were many, and with our present knowledge it is difficult to recognize that many of the assertions and suggestions emanated from men of science as well as from eminent engineers and sailors, who, we should say nowadays, ought to have known better. For example, the late Prof. Sir G. B. Airy, F.R.S. (Astronomer Royal), announced to the world: (1) that “it was a mathematical impossibility to submerge a cable in safety at so great a depth”; and (2) that “if it were possible, no signals could be transmitted through so great a length.”

From the very outset of the project the engineer-in-chief (as soon as appointed) had to deal with wild and undeveloped criticisms and suggestions, partly from “inventors,” who desired to reap personal benefit by the scheme, and amateurs in the art generally, all of which appear singularly ludicrous nowadays.

The fallacy most frequently introduced was, perhaps, that the cable would be suspended in the water at a certain depth. Naturally the pressure increases with the depth on all sides of a cable (or anything else) in its descent through the sea, but, as practically everything on earth is more compressible than water, it is obvious that the iron wire, yarn, gutta-percha, and copper conductor, forming the cable, must be more and more compressed as they descend. Thus the cable constantly increases its density, or specific gravity, in going down, while the equal bulk of the water surrounding it continues to have, practically speaking, very nearly the same specific gravity as at the surface. Without this valuable property of water, the hydraulic press would not exist.

The strange blunder here described was participated in by some of the most distinguished naval men. As an instance, even at a comparatively recent period, Captain Marryat, R.N., the famous nautical author, writes of the sea: “What a mine of wealth must lie buried in its sands. What riches lie entangled among its rocks, or remain suspended in its unfathomable gulf, where the compressed fluid is equal in gravity to that which it encircles.”[13]

To obviate this non-existent difficulty, it was gravely proposed to festoon the cable across, at a given maximum depth between buoys and floats, or even parachutes—at which ships might call, hook on, and talk telegraphically to shore!

Others again proposed to apply *gummed cotton* to the outside of the cable in connection with the above burying system. The idea was that the gum (or glue) would gradually dissolve and so let the cable down “quietly”!

As an example of the crude notions prevailing in the mind of one gentleman with a proposed invention, to whom was shown an inch specimen of the cable, he remarked: “Now I understand how you stow it away on board. You cut it up into bits beforehand, and then join up the pieces as you lay.”

Some again absolutely went so far as to take out patents for converting the laying vessel into a huge factory, with a view to making the cable on board in one continuous length, and submerging it during the process!

Finally, one naval expert assured the company that “no other machinery for paying out was necessary than a *handspike* to stop the egress of the cable."

CHAPTER II

THE MANUFACTURE OF THE LINE

Design and Construction—Ships—Testing, Shipment, and Stowage—Paying-out Machinery—Staff—Preparations for the Expedition.

THE construction of the cable was taken in hand the following February (1857).

The distance from Valentia, on the western Irish coast, to Trinity Bay, Newfoundland—the two landing-points selected[14]—being 1,640 nautical miles, it was estimated that a length of 2,500 N.M.[15] would be sufficient to meet all requirements. This would provide sufficient margin for a considerable amount of "slack" cable for accommodating the irregularities of the bottom. The Gutta-Percha Company of London were entrusted with the manufacture of the "core," consisting of a strand of seven No. 22 B.W.G. copper wires (total diameter No. 14 gage) weighing 107 pounds per N.M. insulated, with three coatings of gutta-percha (to ⅜-inch diameter) weighing 261 pounds per N.M., the conductor being, in fact, covered to No. 00 B.W.G.

This formed a far heavier core than had been previously adopted, and on this account the difficulties of manufacture were proportionately increased. The enormous pressure of the ocean at such depths involved also a much severer test for the core.

On the other hand, as we now know, the conductor—and consequently also the insulator—should have been still larger, to a material degree. The engineer of the line strongly urged a conductor weighing 392 pounds per N.M., with the same weight for the insulator;[16] but his fellow projectors (the business element of the undertaking) were all for getting the work done, while the weather permitted, that year; and they were perhaps overquick to recognize the difference in the capital required. Moreover, they were here supported technically by the views of the responsible electrician, as well as by such high authorities as Michael Faraday and Morse. The latter reported that "large coated wires used beneath the water or the earth are worse conductors—so far as velocity of transmission is concerned—than small ones; and, therefore, are not so well suited as small ones for the purposes of submarine transmission of telegraphic signals." Faraday had stated: "The larger the wire, the more electricity was required to charge it; and the greater was the retardation of that electric impulse which should be occupied in sending that charge forward."[17]

Thus it will be seen that although Faraday laid the foundations of a large proportion of the electrical engineering of to-day, his views in this instance did not prove to be correct. The theoretical resemblance of a cable to a Leyden jar—in reference to the effect of charging either—seems to have been prominently in mind, without proper regard to the *resistance* offered by the wire to the electric current—a resistance which becomes less the greater the bulk of the wire. Besides the engineer being overridden in this matter, the word of the electrical adviser on the Board (Professor Thomson) regarding the carrying capacity or working speed that would be obtained with such a core as that decided on—in view of the length involved—was also unavailing.

While no one can fail to appreciate the businesslike manner in which this undertaking was pushed through from the moment of inception—comparing only too favorably with some experiences of to-day—it was, without doubt, a vast pity that more time was not devoted to a fuller consideration of some of the problems, such as that involved over the dimensions of the conductor and insulator. No serious fault could, however, be detected with its actual manufacture, though the methods of those days were primitive as compared with present practise, and a system of efficient electrical testing altogether wanting.

After various experiments had been made with sample lengths of different iron wires made up into cable, the contract for the outer sheathings was, in order to get through the work quickly, divided equally between Messrs. Glass, Elliot & Co., of Greenwich, and Messrs. R. S. Newall & Co., of Birkenhead—both originally pit-rope makers.

The insulated core was first surrounded with a serving of hemp saturated with a mixture of tar, pitch, linseed-oil, and wax; and then sheathed spirally with an armor of eighteen strands, each containing seven iron wires of No. 22 B.W.G., the completed strand being No. 14 gage in diameter.

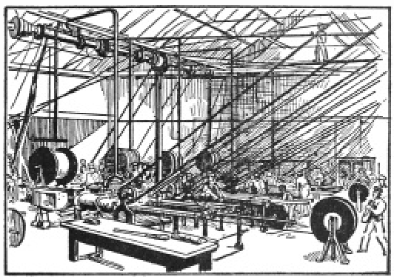


FIG. 5.—Manufacture of the Core.

The cable (Fig. 8) was then finally drawn through another mixture of tar. Its weight in air was 1 ton per N.M., and in water only 13.4 hundredweight, bearing a strain of 3 tons 5 hundredweight before breaking—

equivalent to nearly five miles of its weight in water.

For each end approaching the shore, the sheathing (see Fig. 9) consisted of twelve wires of No. 0 gauge, making a total weight of about nine tons to the mile. This type was adopted for the first ten miles from the Irish coast, and for fifteen miles from the landing at Newfoundland, at both of which localities rocks had been found to abound plentifully—so much so that the armor was insufficient, and present practise provides double the weight under similar conditions.

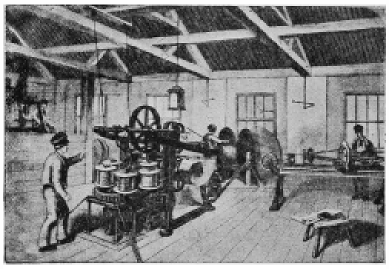


Fig. 6.—Serving the Core with Hemp-Yarn.

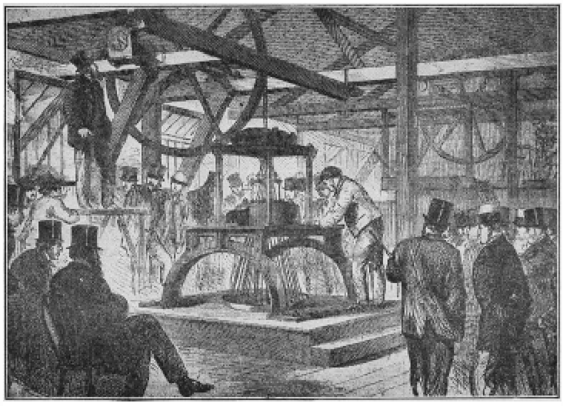


Fig. 7.—Applying the Iron Sheathing.

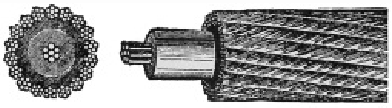


Fig. 8.—The Deep Sea Cable.

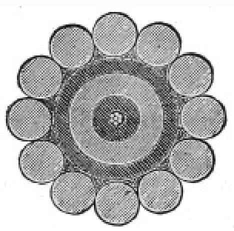


Fig. 9.—The Shore-End Cable.

Only four months was allowed for the manufacture of this 2,500 miles of cable, which had to be delivered in June of that year (1857). This involved the preparation and drawing of 20,500 miles of copper wire (providing for the lay) and stranding into the 2,500 miles of conductor. For the insulation nearly 300 tons of gutta-percha required to be prepared, and the three separate layers of gutta-percha required to be applied to the wire, subsequently followed by the spiral serving of yarn. Finally—and with a due allowance for lay—367,500 miles of wire had to be drawn, from 1,687 tons of charcoal iron, and laid up into 50,000 miles of strand for the outer sheathing. The entire length of copper and iron wire employed was, therefore, 340,500 miles—enough to engirdle the earth thirteen times, and considerably more than enough to extend from the earth to the moon. The work was enormously increased, of course, on account of the sheathing being composed of a number of strands instead of several single wires. While having certain mechanical advantages at the outset, this stranded sheathing is not a durable type of cable—besides being somewhat costly—and is never adopted nowadays. The contract price for the entire cable was £225,000, the core costing £40 and the armor £50 per mile.[18]

As fast as the cable was made at the respective factories, it was coiled into iron tanks ready for shipment.

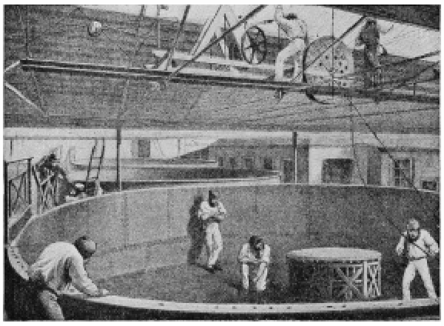


Fig. 10.—Coiling the Finished Cable into the Factory Tanks.

Ships and Paying-out Machinery.—The race against time—resulting from an unfortunate arrangement with American interests—was truly appalling; for, besides the manufacture of the line itself, ships had to be selected and prepared for receiving the cable, and machinery for paying out the line had to be designed and made. So far as the manufacture went, the machinery for that was already in existence, in view of the cables that had previously been laid—apart from the fact that the sheathing machinery was practically the same as had already been used for making ropes with. But this being the first *ocean* line, special apparatus had to be worked out for submerging a cable satisfactorily in deep water. So far as ships were concerned, the British and United States Governments had already expressed willingness to furnish these. The former undertaking took shape by the Admiralty placing H.M.S. Agamemnon (a screw-propelled line-of-battle ship and one of the finest in the British navy) at the company's disposal for the expedition. She had been Admiral Lyons's flagship during the bombardment of Sebastopol a couple of years before; but, in her coming mission, was to do more to bring about the reign of peace—by drawing together in closer commune the several nations of the earth—than any man-of-war was ever called to do, before or after. With a somewhat peculiar construction, she was admirably adapted for her work. Her engines were quite near the stern, while amidships she had a magnificent hold, forty-five feet square and about twenty feet deep. In this capacious receptacle nearly half the cable was stowed from the works at Greenwich. The American Government sent over the largest and finest ship of their navy, the U.S. frigate Niagara (Fig. 11), a screw-corvette of 5,200 tons. As a consort, the U.S. paddle frigate Susquehanna was also detailed for the expedition, while H.M.S. Leopard and H.M. sounding-vessel Cyclops were similarly provided by the British Government. The latter was to precede the fleet—nicknamed the Wire Squadron—to show the way.

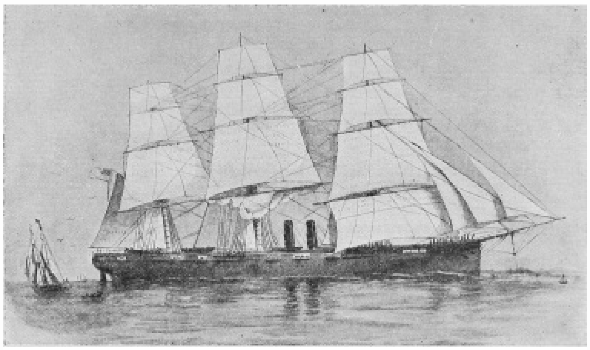


Fig. 11.—U.S.N.S. Niagara.

The paying-out apparatus for the two laying vessels H.M.S. Agamemnon and U.S.N.S. Niagara had to be somewhat hurriedly put together; consequently not as much attention was paid to its design as the novelty of the undertaking really demanded. The previous, and somewhat primitive, gear hitherto used had proved to possess too little strength, the cable—when being laid in anything but quite shallow water—having more than once obtained the mastery, through meeting insufficient restraining force. In the new machine (Fig. 12) there was certainly no lack of holding-back power. It erred, indeed, the other way, being so heavy and powerful that it was liable to break the cable under any material strain. The degree of retardation was regulated by a hand-wheel actuating a frame-clutch surrounding the outside of a brake-wheel. The details of this machine were worked out by Messrs. C. de Bergue & Co., the manufacturers. The engineer-in-chief also furnished external guards to the propelling screws of each laying vessel to prevent a foul with the cable in the case of going "astern." This cage was nicknamed a "crinoline" (then in fashion with ladies), which, indeed, it somewhat resembled. The above screw-guard may be seen in several of the illustrations of either ships farther on. Were it not for the necessity of sounding operations, it would be applied to all telegraph-ships to-day.

Preparations for Starting.—By the third week in July (within the course of as many weeks) the great ships had absorbed all their precious cargo—the Agamemnon in the Thames and the Niagara in the Mersey. The process of coiling the cable on board the Agamemnon is illustrated in Fig. 13.

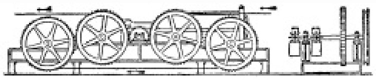


Fig. 12.—The Paying-out Machine, 1857.

Staff.—For such an undertaking the staff had, of course, to be considerable. Besides the engineer-in-chief (Mr. Bright), the engineering department was composed as follows: Mr. (afterward Sir Samuel) Canning, formerly a railway engineer, who had laid the Gulf of St. Lawrence and other cables; Mr. William Henry Woodhouse, who had laid some of the cables in the Mediterranean; Mr. F. C. Webb, with much experience in early cable work; and, finally, Mr. Henry Clifford, a mechanical engineer, destined to be responsibly associated with a large proportion of the cables since laid.

Besides Mr. Whitehouse (whose health, however, did not permit him to accompany the expedition) there were on the electrical staff Mr. C. V. de Sauty, Mr. J. C. Laws, Mr. F. Lambert, Mr. H. A. C. Saunders, Mr. Benjamin Smith, Mr. Richard Collett, and Mr. Charles Gerhardi, all of whom were afterward prominently connected with subsequent submarine cable undertakings. Their respective energies were divided up between the two laying ships.[19] The expedition was to be further strengthened by a representative of The Times, as well as of the Daily News and New York Herald.

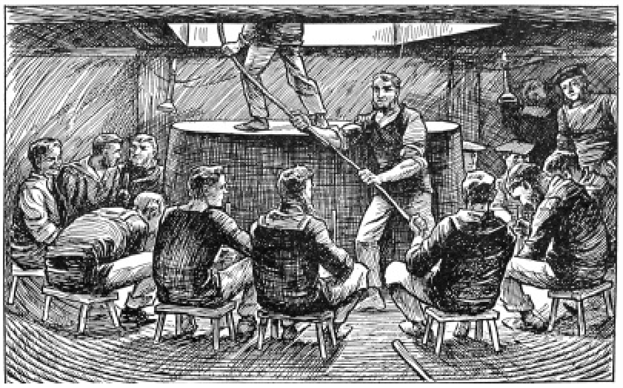


Fig. 13.—Coiling the Cable on Board.

On the vessels being fully loaded ready for the start, “send-off” festivities occurred, in which all classes of those engaged on the work took part. The Times recounted the function on board the Agamemnon as follows:

> The three central tables were occupied by the crew of the Agamemnon, a fine, active body of men, who paid the greatest attention to the speeches, and drank all the toasts with an admirable punctuality—at least, so long as their three pints of beer per man lasted. But we regret to add that with the heat of the day and the enthusiasm of Jack in the cause of science, the mugs were all empty long before the chairman’s list of toasts had been gone through. Next in interest to the sailors were the workmen and their wives and babies, all being permitted to assist. The latter, it is true, sometimes squalled at an affecting peroration, but that rather improved the effect than otherwise, and the presence of their little ones only marked the genuine good feeling of the employers, who had thus invited not only their workmen, but their workmen’s families to the feast. It was a momentary return to the old patriarchal times.

This function having come to an end, the Agamemnon set out for Sheerness. When leaving her moorings, opposite Glass & Elliot’s works, the scene was one of considerable interest. It is recorded that many thousands of persons thronged the riverside as far as Greenwich Hospital. In the immediate neighborhood of the factory a salute was fired as the proud vessel moved away, and a deafening cheer was raised by the assembled crowds. The crew of H.M.S. Agamemnon manned the gunwales, and returned the cheer with lusty lungs, while from the stern gallery, ladies waved their handkerchiefs, and *savants* forgot for a while the mysteries of electricity and submarine-cable work, as they returned the hearty cheers which reached them from the shore.

Similar proceedings took place on board the Niagara, and the two ships met at Queenstown, County Cork, on July 30, 1857. They were moored about three-quarters of a mile apart, and a piece of cable run between the two to enable the entire length of line (2,500 N.M.) to be tested and worked through. The result was all that could be desired, and the Wire Squadron set sail for the rendezvous at Valentia Bay on Monday, August 3d.

Besides the vessels already named, there were H.M. tender Advice and the steam-tug Willing Mind to assist in landing the cable at Valentia, as well as the U.S. screw-steamer Arctic and the paddle-steamer Victoria (Newfoundland Telegraph Company) on duty in Trinity Bay, Newfoundland, to await the arrival of the fleet and assist in landing the cable at that end.

On arrival in harbor the following day, the ships were hospitably welcomed by his Excellency the Lord-Lieutenant of Ireland (the Earl of Carlisle), who had journeyed from Dublin Castle for the purpose. A *déjeuner* banquet was given by the Knight of Kerry (Sir Peter Fitzgerald), the lord of the manor for many miles round, and this little corner of Ireland—“the next parish to America”—was quite *en fête* for the occasion.

CHAPTER III

THE FIRST START

Landing the End—“Godspeed”—A Bad Beginning—Return Home.

Landing the Cable at Valentia, Ireland.—The following day was occupied in landing the massive shore end, which—weighing nearly ten tons to the mile, as already described—was calculated to withstand damage from any anchorage in the bay, besides being proof against disturbance and damage from surf or currents. The landing-place which had been finally selected was a little cove known as Ballycarberry, about three miles from Cahirciveen, in Valentia harbor (Fig. 14). The two small assistant steamers—Willing Mind, a tug with a zeal worthy of her name, and Advice, ready not merely with advice but most lusty help—with several other launches and boats, were employed in the operation, which was thus described in one of the many newspaper reports:

“Valentia Bay was studded with innumerable small craft decked with the gayest bunting. Small boats flitted hither and thither, their occupants cheering enthusiastically as the work successfully progressed. The cable-boats were managed by the sailors of the Niagara and the Susquehanna. It was a well-designed compliment, and indicative of the future fraternization of the nations, that the shore rope was arranged to be presented on the English side of the Atlantic to the representative of the Queen by the officers and men of the United States navy, and that on the American side the British officers and sailors should make a similar presentation to the President of the great republic.

“From the mainland the operations were watched with intense interest. For several hours the Lord-Lieutenant stood on the beach, surrounded by his staff and the directors of the railway and telegraph companies, waiting the arrival of the cable. When at length the American sailors jumped through the surge with the hawser to which it was attached, his Excellency was among the first to lay hold of it and pull it lustily to the shore. Indeed, every one present seemed desirous of having a hand in the great work.”

At half past seven that evening (August 5, 1857) the cable was hauled on shore at Ballycarberry Strand, and formal presentation was made of it by the officer in command of the Niagara to the Lord-Lieutenant, his Excellency expressing a hope that the work so well begun would be carried to a satisfactory completion. The vicar of the parish then offered a prayer for the success of the undertaking.

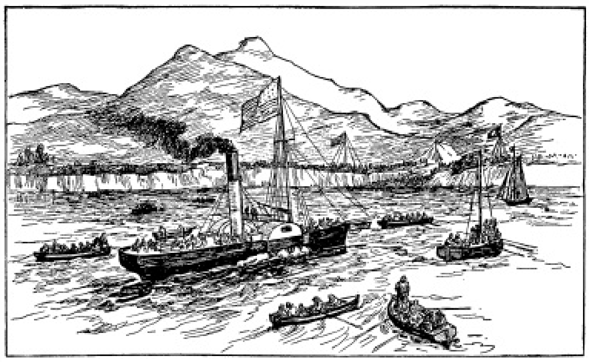


Fig. 14.—Landing the Irish End of the Cable.

The work connected with the landing of the shore end was not actually completed till sunset; so, as it was too late then to set out and start cable-laying, the ships remained at anchor in the bay till daybreak. That night there was a grand ball at the little village of Kingstown, and the day dawn caught the merrymakers still engaged in their festivities.

Laying the First Ocean Cable, 1857.—Owing to the fact that the cable had had to be divided between two ships it was obvious that a mid-ocean splice between the two lengths was involved. The engineer-in-chief (Mr. Bright) was anxious both ships should start laying toward their respective shores from mid-ocean, as by that plan favorable weather for the splice could be waited for, besides halving the time occupied in laying the line, thereby reducing chances of bad-weather experience and getting over the most difficult (deep-water) part of the work first.

The electricians, however, made much of the importance of being in continuous communication with shore during laying operations; and this view appealed to the Board—partly, no doubt, on account of the novelty of being able from headquarters to speak to a ship as she proceeded across the Atlantic. It had, therefore, been arranged for the laying of the cable to be started by the Niagara from the Irish coast, the Agamemnon laying the remaining half from mid-ocean.

The ships got under weigh at an early hour on the morning following the landing of the shore end. Paying out commenced from the Niagara’s forepart; and as the distance from there to the stern was considerable, a number of men were stationed at intervals, like sentries, to see that every foot of the line reached its destination in safety. The machinery did not seem at first to take kindly to its work, giving vent to many ominous groans. After five miles had been disgorged, the line caught in some of the apparatus and parted. The good ship at once put back and the cable was underrun by the Willing Mind, with boats, the whole distance from the shore—a tedious and hard task, as may be imagined. At length the end was lifted out of the water and spliced to the coil on board; and as the bight of the cable dropped safely to the bottom of the sea, the mighty ship steamed ahead once more.

At first she moved very slowly, not more than two miles an hour, to avoid the danger of another accident, but the feeling that they were at last away was in itself a relief. The ships were all in sight, and so near that they could hear each other's bells. The Niagara, as if knowing she was bound for the land out of whose forests she came, bowed her head proudly to the waves.

"Slowly passed the hours of that day," in Mr. Henry Field's words, "but all went well, and the ships were moving out into the broad Atlantic. At length the sun went down in the west, and stars came out on the face of the deep. But no man slept. A thousand eyes were watching a great experiment, including those who had a personal interest in the issue.

"All through that night, and through the anxious days and nights that followed, there was a feeling in the heart of every soul on board, as if some dear friend were at the turning-point of death, and they were watching beside him. There was a strange, unnatural silence in the ship. Men paced the deck with soft and muffled tread, speaking only in whispers, as if a loud or heavy footfall might snap the vital cord. So much had they grown to feel for the enterprise, that the cable seemed to them like a human creature, on whose fate they themselves hung, as if it were to decide their own destiny.

"There are some who will never forget that first night at sea. Perhaps the reaction from the excitement on shore made the impression the deeper. There are moments in life when everything comes back to us. What memories cropped up in those long night hours! How many on board that ship, as they stood on the deck and watched that mysterious cord disappearing in the darkness, thought of homes beyond the sea, of absent ones, of the distant and of the dead.

"But no musings turned them from the work in hand. There were vigilant eyes on deck—Mr. Bright, the engineer-in-chief, was there; also, in turn, Mr. Woodhouse and Mr. Canning, his chief assistants.... The paying-out machinery did its work, and though it made a constant rumble in the ship, that dull, heavy sound was music in their ears, as it told them that all was well. If one should drop asleep, and wake up at night, he had only to hear the sound of 'the old coffee-mill' and, his fears being relieved, he would go to sleep again."

The next was a day of beautiful weather. The ships were getting farther away from land, and began to steam ahead at the rate of four and five knots. The cable was paid out at a speed a little faster than the ship, to allow for inequalities of surface on the bottom of the sea. While it was thus going overboard, communication was kept up constantly with the land, partly by what are known as "continuity signals"—i. e., electrical signals at definite time intervals from ship to shore, as a test of the continuity of the line.

To quote Mr. Field again: "Every moment the current was passing between ship and shore. The communication was as perfect as between Liverpool and London, or Boston and New York. Not only did the electricians telegraph back to Valentia the progress they were making, but the officers on board sent messages to their friends in America to go out by the steamers from Liverpool. The heavens seemed to smile on them that day. The coils came up from below the deck without a kink, and, unwinding themselves easily, passed over the stern into the sea.

"All Sunday (9th inst.) the same favoring fortune continued; and when the officers who could be spared from the deck met in the cabin, and Captain Hudson read the service, it was with subdued voices and grateful hearts that they responded to the prayers to 'Him who spreadeth out the heavens and ruleth the raging of the sea.'

"On Monday (10th) they were over two hundred miles at sea. They had got far beyond the shallow waters off the coast. They had passed over the submarine mountain that figures on the charts of Dayman and Berryman, and where Mr. Bright's log gives a descent from 550 to 1,750 fathoms within eight miles. Then they came to the deeper waters of the Atlantic where the cable sank to the awful depths of 2,000 fathoms. Still the iron cord buried itself in the waves, and every instant the flash of light in the darkened telegraph room told of the passage of the electric current.

"Everything went well till 3.45 P.M. on the fourth day out (Tuesday, August 11th), when the cable snapped, after 380 miles had been laid, owing to mismanagement on the part of the mechanic at the brakes."

Thus the familiar thin line which had been streaming out from the Niagara for six days was no longer to be seen by the accompanying vessels.

One who was present wrote:

"The unbidden tear started to many a manly eye. The interest taken in the enterprise by officers and men alike exceeded anything ever seen, and there is no wonder that there should have been so much emotion on the occasion of the accident."

The following report from Bright gives the details of the expedition up to the time of this regrettable occurrence:

Report to the Directors of the Atlantic Telegraph Company, August, 1857

After leaving Valentia on the evening of the 7th inst, the paying out of the cable from the Niagara progressed most satisfactorily until immediately before the mishap.

At the junction between the shore and the smaller cable, about eight miles from the starting-point, it was necessary to stop to renew the splice. This was successfully effected, and the end of the heavier cable lowered by a hawser until it reached the bottom, two buoys being attached at a short distance apart to mark the place of union.

By noon of the 8th we had paid out 40 miles of cable, including the heavy shore end. Our exact position at the time was in lat. 50° 59′ 36′′ N., long. 11° 19′ 15′′ W., and the depth of the water according to the soundings taken by the Cyclops—whose course we nearly followed—ninety fathoms. Up to 4 P. M. on that day the egress of the cable had been regulated by the power necessary to keep the machinery in motion at a slightly higher rate than that of the ship; but as the water deepened it was necessary to place some further restraint upon the cable by applying pressure to the friction-drums in connection with the paying-out sheaves. By midnight 85 miles had been safely laid, the depth of the water being then a little more than 200 fathoms.

At eight o'clock on the morning of the 9th we had exhausted the deck coil in the after part of the ship, having paid out 120 miles. The change to the coil between decks forward was safely made. By noon we had laid 136 miles of cable, the Niagara having reached lat. 52°, 11´ 40´´ N., long. 13° 0´ 20´´ W., and the depth of the water having increased to 410 fathoms. In the evening the speed of the vessel was raised to five knots. I had previously kept down the rate at from three to four knots for the small cable, and two for the heavy end next the shore, wishing to get the men and machinery well at work prior to attaining the speed which I had intended making. By midnight 189 miles of cable had been laid.

At four o'clock on the morning of the 10th the depth began to increase rapidly from 550 to 1,750 fathoms in a distance of eight miles. Up to this time a strain of 7 cwt. sufficed to keep the rate of the cable near enough to that of the ship; but as the water deepened the proportionate speed of the cable advanced, and it was necessary to augment the pressure by degrees until at a depth of 1,700 fathoms the indicator showed a strain of 15 cwt., while the cable and the ship were running five and a half and five knots respectively.

At noon on the 10th we had paid out 255 miles of cable—the vessel having made 214 miles from the shore—being then in lat. 52° 27´ 50´´ N., long. 16° 15´ W. At this time we experienced an increasing swell, followed later in the day by a strong breeze.

From this period, having reached 2,000 fathoms of water, it was necessary to increase the strain by a ton, by which the rate of the cable was maintained in due proportion to that of the ship. At six o'clock in the evening some difficulty arose through the cable getting out of the sheaves of the paying-out machine, owing to the pitch and tar hardening in the groove,[20] and a splice of large dimensions passing over them. This was rectified by fixing additional guards and softening the tar with oil. It was necessary to bring up the ship, holding the cable by stoppers until it was again properly disposed around the pulleys. Some importance is due to this event, as showing that it is possible to "lay to" in deep water without continuing to pay out the cable, a point upon which doubts have frequently been expressed.

Shortly after this the speed of the cable gained considerably on that of the ship, and up to nine o'clock, while the rate of the latter was about three knots, by the log, the cable was running out from five and a half to five and three-quarter knots.

The strain was then raised to 25 cwt., but the wind and the sea increasing, and a current at the same time carrying the cable at an angle from the direct line of the ship's course, it was found insufficient to check the cable, which was at midnight making two and a half knots above the speed of the ship, and sometimes imperiling the safe uncoiling in the hold.

The retarding force was therefore increased at two o'clock to an amount equivalent to 30 cwt., and then again—in consequence of the speed continuing to be more than it would be prudent to permit—to 35 cwt. By this the rate of the cable was brought to a little short of five knots, at which it continued steadily until 3.45 A.M., when it parted, the length paid out at the time being 380 miles.

I had up to this attended personally to the regulation of the brakes, but finding that all was going on well, and it being necessary that I should be temporarily away from the machine—to ascertain the rate of the ship, to see how the cable was coming out of the hold, and also to visit the electrician's room—the machine was for the moment left in charge of a mechanic who had been engaged from the first in its construction and fitting, and was acquainted with its operation.

In proceeding toward the fore part of the ship I heard the machine stop. I immediately called out to relieve the brakes, but when I reached the spot the cable was broken. On examining the machine—which was otherwise in perfect order—I found that the brakes had *not* been released, and to this, or to the hand-wheel of the brake being turned the wrong way, may be attributed the stoppage and consequent fracture of the cable.

When the rate of the wheels grew slower, as the ship dropped her stern in the swell, the brake should have been eased. This had been done regularly whenever an unusually sudden descent of the ship temporarily withdrew the pressure from the cable in the sea. But owing to our entering the deep water the previous morning, and having all hands ready for any emergency that might occur there, the chief part of my staff had been compelled to give in at night through sheer exhaustion, and hence, being short-handed, I was obliged for the time to leave the machine without, as it proved, sufficient intelligence to control it.

I perceive that on the next occasion it will be needful, from the wearing and anxious nature of the work, to have three separate relays of staff, and to employ for attention to the brakes a higher degree of mechanical skill.

The origin of the accident was, no doubt, the amount of retarding strain put upon the cable, but had the machine been properly manipulated at the time, it could not possibly have taken place.

For three days in shallow and deep water, as well as in rapid transitions from one to the other, nothing could be more perfect than the working of the cable machinery. It had been made extra heavy with a view to recovery work. It, however, performed its duty so smoothly and efficiently in the smaller depths—where the weight of the cable had less ability to overcome its friction and resistance—that it can scarcely be said to be too heavy for paying out in deep water, where it was necessary, from the increased weight of cable, to restrain its rapid motion, by applying to it a considerable degree of additional friction. Its action was most complete, and all parts worked well together.

I see how the gear can be improved by a modification in the form of sheave, by an addition to the arrangement for adjusting the brakes, and some other alterations; but with proper management, without any change whatever, I am confident that the whole length of cable might have been safely laid by it. And it must be remembered, as a test of the work which it has done, that unfortunate as this termination to the expedition is, the longest length of cable ever laid has been paid out by it, and that in the deepest water yet passed over.

After the accident had occurred, soundings were taken by Lieutenant Dayman from the Cyclops, and the depth found to be 2,000 fathoms.

It will be remembered that some importance was attached to the cable on board the Niagara and Agamemnon being manufactured in opposite lays.[21] I thought this a favorable opportunity to show that practically the difference was not of consequence in effecting the junction in mid-ocean. We therefore made a splice between the two vessels. This was then lowered in a heavy sea, after which several miles were paid out without difficulty.

I requested the commanders of the several vessels to proceed to Plymouth, as the docks there afford better facilities than any other port for landing the cable should it be necessary to do so.

The whole of the cable remaining on board has been carefully tested and inspected, and found to be in as perfect condition as when it left the works at Greenwich and Birkenhead respectively.

One important point presses for your consideration at an early period. A large portion of cable already laid may be recovered at a comparatively small expense. I append an estimate of the cost, and shall be glad to receive your authority to proceed with this work.

I do not perceive in our present position any reason for discouragement; but I have, on the contrary, a greater confidence than ever in the undertaking.

It has been proved beyond a doubt that no obstacle exists to prevent our ultimate success; and I see clearly how every difficulty which has presented itself in this voyage can be effectually dealt with in the next.

The cable has been laid at the expected rate in the great depths; its electric working through the entire length has been satisfactorily accomplished, while the portion laid, actually improved in efficiency by being submerged—from the low temperature of the water and the increased close texture of gutta-percha thereby effected.

Mechanically speaking, the structure of the cable has answered every expectation that I had formed of it. Its weight in water is so adjusted to the depth that strain is within a manageable scope; while the effects of the undercurrents upon its surface prove how dangerous it would be to lay a much lighter rope, which would, by the greater time occupied in sinking, expose an increased surface to their power, besides its descent being at an angle such as would not provide for good laying at the bottom.

On the other hand, in regard to any further length made, I would take this opportunity of again strongly urging the desirability of a much larger conductor and corresponding increase in the weight of insulation, in accordance with my original recommendation.—I have the honor to remain, gentlemen, yours very faithfully,

Charles T. Bright,
Engineer-in-Chief.

To the Directors of the Atlantic Telegraph Company.

CHAPTER IV

PREPARATIONS FOR ANOTHER ATTEMPT

“Taking Stock”—Further Capital—Alterations in Paying-Out Machinery—Improved Testing and Signaling Apparatus.

This untoward interruption to the expedition was naturally a cause of great disappointment to all connected with the undertaking; for there was not enough cable left to complete the work, nor was there time to get more made and stowed on board to renew the attempt before the season would be too far advanced.

The squadron proceeded to Plymouth to unload the cable into tanks at Keyham (now Devonport) Dockyard, chiefly because some of the ships could not be spared by their respective governments till the following year. In the middle of October (1857), the engineer-in-chief proceeded to Valentia in a small paddle-steamer with the object of picking up some of the lost line from this end. After experiencing a series of gales, over fifty miles of the main cable were recovered, and the shore end buoyed ready for splicing on to in the coming year.

The first expedition had opened the eyes of the investing public to the vastness of the undertaking, and led many to doubt who did not doubt before. Some began to look upon it as a romantic adventure of the sea, rather than as a serious commercial undertaking. This decline of popular faith was felt as soon as there was a call for more money. The loss of 335 miles of cable, with the postponement of the expedition to another year, was equivalent to a loss of £100,000.

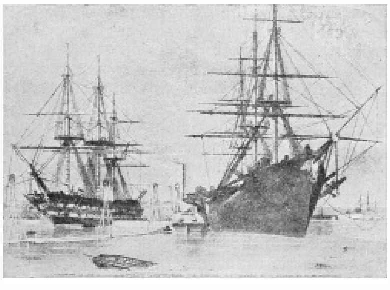


Fig. 15.—Reshipment of the Cable aboard H.M.S. Agamemnon and U.S.N.S. Niagara in Keyham Basin.

Raising Further Capital.—To make the above sum good, the capital of the company had to be increased, and this new capital was not so readily obtainable. The projectors found that it was easy to go with the current of popular enthusiasm, but very hard to stem a growing tide of popular distrust. And it must also be remembered that, from the very first, the section of the public which looked with distrust upon the idea of an Atlantic telegraph was far in excess of that which did not; indeed, the opposition encountered was much on a par with the great popular prejudice which George Stephenson had to overcome when projecting his great railway schemes. But whatever the depression at the untimely termination of the first expedition, it did not interfere with renewed and vigorous efforts to prepare for a second. In the end the appeal to the shareholders for more money was responded to; and the directors were enabled to give orders for the manufacture of 700 miles of new cable of the same description, to make up for what had been lost, and to provide a surplus against all contingencies. Thus, 3,000 nautical miles in all were shipped this time, instead of 2,500 miles.

Alterations in the Paying-Out Gear.—New paying-out machinery was devised with a view to obviating the possibility of a recurrence of the accident on the first expedition. In the new apparatus the brake (Fig. 16) was so arranged that a lever exercised a uniform holding power in exact proportion to the weights attached to it (Fig. 17); and while capable of being *released* by a hand-wheel, it could not be tightened. The general idea of this clever appliance had been originally introduced by Mr. J. G. Appold in connection with the crank apparatus in jails; and it was now especially adapted to the exigencies of cable work by the engineer (Mr. Bright) and Mr. C. E. Amos, a member of the famous engineering firm, Easton & Amos, who constructed the entire machinery. The great future of the apparatus was that it provided for automatic brake-release, upon the strain exceeding that intended. Thus, only a maximum agreed strain could be applied, this being regulated from time to time by weights, according to the depth of water and consequent weight of cable being paid out. In passing from the hold to the stern of the laying vessel, the cable is taken round a drum, or drums. Fig. 18 gives a general view of the apparatus. Attached to the axle of the drum is a wheel fitted with an iron friction-strap (to which are fixed blocks of hard wood) capable of exerting a given retarding power, varying with the weights hung on to the lever which tightens the strap. When the friction becomes great, the wheels have an increased tendency to carry the wooden blocks round with them; thus the lever-bars are deflected from the vertical line and the iron band opened sufficiently to lessen the brake-power.

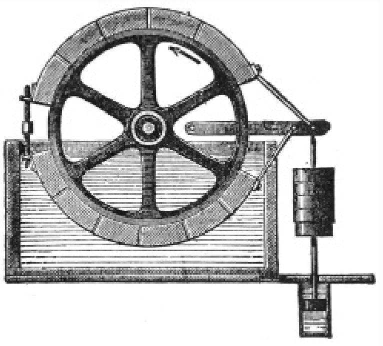


Fig. 16.—The Self-Releasing Brake.

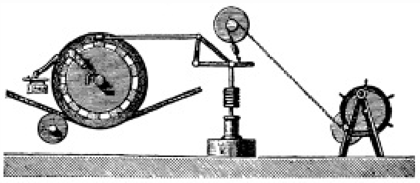


Fig. 17.—The Principle of the Brake.

Bright also introduced a dynamometer apparatus for indicating and controlling the strain during paying out—a vast improvement on that embodied in the previous machines. The working of the entire machine was as follows:

"Between the two brake-drums and the stern of the vessel, the cable was led under the grooved wheel, O, of the dynamometer. This wheel had a weight attached to it, and could be moved up or down in an iron frame. If the strain upon the cable was small, the wheel would bend the cable downward, and its index would show a low degree of pressure; but whenever the strain increased, the cable, in straightening itself, would at once lift the dynamometer-wheel with the indicator attached to it, which showed the pressure in hundredweights and tons. The amount of strain with a given weight upon the wheel, G, was determined by experiments, and a hand-wheel in connection with the levers of the paying-out machine was placed immediately opposite the dynamometer; so that, directly the indicator showed strain increasing, the person in charge could at once, by turning the hand-wheel, lift up the weights that tightened the friction-straps, and so let the cable run freely through the paying-out machine. Although, therefore, the strain could be *reduced*—or entirely withdrawn—in a moment, it could not be *increased* by the man at the wheel. The cable in coming from the tanks, passed under a lightly weighted 'jockey,'[22] J, pulley. This arrangement, while leading the line on to the drums, at the same time checked it slightly. From here it was guided by a grooved pulley, or V-sheave,[23] L, along the tops of both drums, at B, then three times round them, and hence over another V-sheave, F, and on to the dynamometer. From this the cable was led over a second pulley, and so into the sea by the stern-sheaves."[24]

This entire apparatus—simplified as regards the brake—has since been universally adopted for submarine-cable work,[25] with the exception that a single-flanged drum, fitted with a sort of plow, skid, or knife-edge—to guide or “fleet” the incoming turn of cable correctly on to the drum—is now used in place of the grooved sheave, or sheaves.

As soon as the new machinery was constructed, all the engineering staff gathered together for the purpose of thoroughly acquainting themselves with its working. Mr. F. C. Webb, having engagements elsewhere, had been replaced by Mr. W. E. Everett, U.S.A., who had been chief marine engineer of the Niagara. Mr. Everett was to have charge of the machinery on the laying vessel, while Mr. Woodhouse controlled the cable operations.

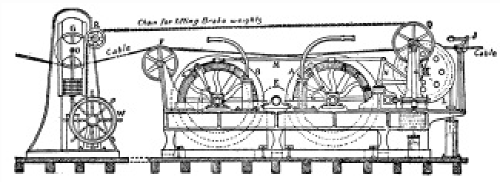


Fig. 18.—Bright’s Paying-out Gear, 1858.

Alterations in the Electrical Apparatus.—Since the manufacture of the cable in 1857, Professor Thomson had become impressed with the conviction that the electric conductivity of copper varied greatly with its degree of purity. As a result of the professor’s further investigations, the extra length of cable made for the coming expedition was subjected to systematic and searching tests for the purity and conductivity of the copper. Every hank of wire was tested, and all whose conducting power fell below a certain value rejected. Here, then, we have the first instance of an organized system of testing for conductivity at the cable factory—a system which has ever since been rigorously insisted on.

Professor Thomson’s Mirror Instrument.—And now, in the spring of 1858, an invention was perfected that was destined to have a remarkable effect on submarine-cable enterprise. For Professor Thomson (now Lord Kelvin) devised and perfected the mirror-speaking instrument, then often described as the marine galvanometer,[26] of which it may be fairly said that it entirely revolutionized long-distance signaling and electrical testing aboard ship.

This most ingenious apparatus consists of a small and exceedingly light steel magnet (*a*) (Fig. 19) with a tiny reflector or mirror fixed to it, both together weighing but a single grain or thereabouts. This delicate magnet is suspended from its center by a filament of silk and surrounded by a coil (*b*) of the thinnest insulated copper wire.

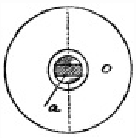


Fig. 19.—The Reflecting Magnet.

A very weak current is sufficient to produce a slight, though nearly imperceptible, movement of the suspended magnet when electricity passes through the surrounding coil. A fine ray of light from a shaded lamp, behind a screen (Figs. 20 and 21) at a short distance, is directed through a slot in the screen, thence to the open center of the coil (*c*) upon the mirror. It is then reflected back to a graduated scale (*f*). As may be seen from Fig. 21, an exceedingly slight angle of motion on the part of the magnet (*a*) is thus made to magnify the movement of the spot of light upon the scale (*f*), and to render it so considerable as to be readily noted by the eye of the operating clerk. The ray is brought to a focus by passing through a lens. By combinations of these movements of the speck of light (in length and direction) upon the index, an alphabet is readily formed. The magnet is artificially brought back to zero with great precision after each signal by the earth’s magnetism, and also both by the natural torsion of the fiber and the controlling action of the adjusting magnet (*e*) (Fig. 20), with the help of the thumb-screw (*d*) for regulation purposes.

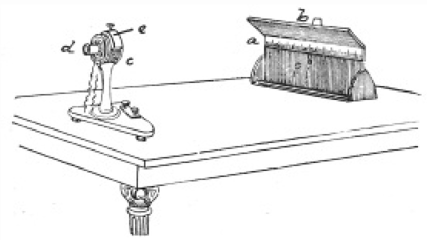


Fig. 20.—Reflecting Galvanometer and Speaker.

In a word, Professor Thomson’s combined mirror-telegraph and marine galvanometer transmitted messages by multiplying and magnifying the signals through a cable by the agency of imponderable light.

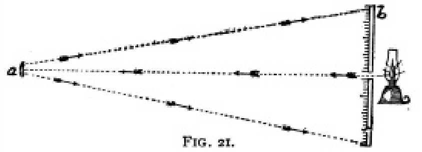


FIG. 21.

It is only to be regretted that the electrician responsible for the subsequent working through operations did not sooner appreciate the great beauties of the above apparatus, and the advantage of a small generating force such as it alone required.

CHAPTER V

THE TRIAL TRIP

Rehearsal of Cable Operations—Successful Experiments and Performances.

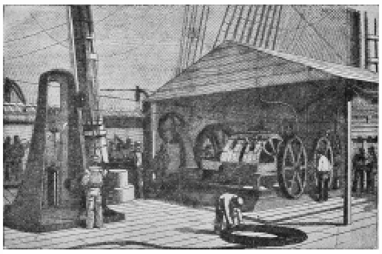


FIG. 22.—Deck of H.M.S. Agamemnon with Paying-out Apparatus.

THE engineer-in-chief (Mr. Bright) arranged that this time an experimental expedition should be first made, during which a complete rehearsal was to be gone through of the various operations to be performed during cable maneuvers. These operations were to consist of making splices, picking up and buoying (besides laying) in deep water, and exercising all hands in their work generally. It was on this occasion also agreed that paying out should start from mid-ocean instead of from either shore. It was further arranged that the main cable should be buoyed at each end, and the connection to it by the heavy cable from shore effected at the earliest opportunity.

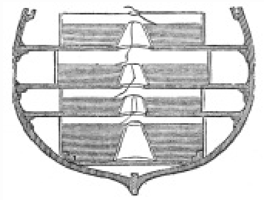


FIG. 23.—Stowage of the Cable Coils on the Niagara.

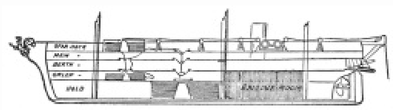


FIG. 24.—The Loading of the Agamemnon.

All the 3,000 miles of cable was coiled into the two large ships by the end of May. Fig. 22 gives a general idea of the paying-out apparatus mounted on the deck of the Agamemnon, and Fig. 23 a view in section of the fore-tanks of the Niagara when loaded with her cargo of cable. The engineer had this time fitted cast-iron cones in the middle of each cable-coil to meet the requirements of safe paying out, besides providing a large margin of space to the hatchway above. Fig. 24 shows the loading of the Agamemnon. The rest of the telegraph squadron was on this occasion made up by H.M. Gorgon, H.M. paddle-steamer Valorous, and H.M. surveying-steamer Porcupine.

The fleet set forth on their second cruise on May 29, 1858—this time without any show of public enthusiasm. Mr. Bright was again assisted by the same engineering staff, but Professor Thomson had agreed to take a more active part in the electrical work. The Bay of Biscay was to be the scene of the experiments—the actual site being about 120 miles northwest of Corunna, where the Gorgon obtained soundings of 2,530 fathoms or nearly three statute miles.

The Agamemnon and Niagara were then backed close together, stern on, and a strong hawser was passed between them. Each ship had on board some defective cable for the experiments about to be conducted. The proceedings may perhaps best be described by extracts from the engineer’s diary:

Monday, May 31st, 10 A.M., hove to, lat. 47° 11′, long. 9° 37′. Up to midday engaged in making splice between experimental cable in fore coil and that in main hold, besides other minor operations. In afternoon getting hawser from Niagara and her portion of cable to make joint and splice. 4 P.M., commenced splice; 5.15 splice completed; 5.25, let go splice-frame (weight 3 cwt.) over gangway, amidships, starboard side.[27] 5.30, after getting splice-frame (containing the splice) clear of the ship and lowering it to the bottom, each vessel (then about a quarter of a mile apart) commenced paying out in opposite directions.

9 P.M., got on board Niagara’s warp and her end of cable to make another splice for second experiment.

June 1st.—1 A.M. (night), electrical continuity gone, the cable having parted after two miles in all had been paid out.[28]

Since 1 A.M., engaged in hauling in our cable. Recovered all our portion, and even managed to heave up the splice-frame (in perfect condition), besides 100 fathoms of Niagara’s cable, which she had parted. Fastened splice to stern of vessel and ceased operations.

9.23 A.M., second experiment. Started paying-out again. Weather very misty.

9.40, one mile paid out at strain 16 cwt.; angle of cable 16° with the horizon: running out straight; rate of ship 2, cable 3.

9.45, changed to lower hold. 9.56, two miles out; last mile in 16½ minutes; strain 17 to 20 cwt.; angle of cable 20°. 10.10, last of the three miles out in 14 minutes.

10.32 A. M., four and a half miles out. Third experiment—stopped ship, lowered guard, stoppered cable.

10.50, buoy let go, strain 16 cwt. when let go, the cable being nearly up and down.

11.6, running at rate of 5½ knots paying out, strain 21 to 23 cwt., varying. Cable shortly afterward parted through getting jammed in the machinery.

The subsequent experiments were mainly in the direction of buoying, picking up, and passing the cable from the stern to the bow sheave for picking up. All of these operations were in turn successfully performed; and finally, in paying out a speed of seven knots was attained without difficulty. During all this time electrical communication had been maintained between the ships; and it is somewhat remarkable that, through this more or less damaged cable, the electricians were able to work a needle-instrument and obtain a deflection on it of 70 degrees.

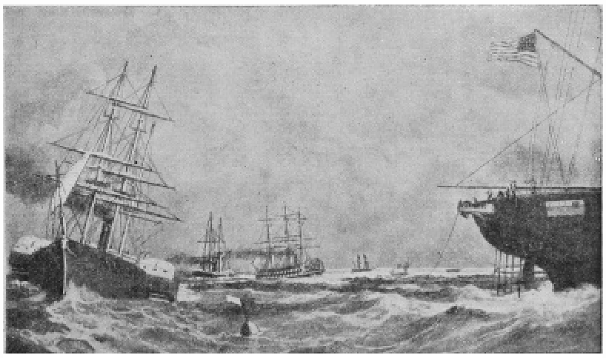


Fig. 25.—Experimental Maneuvers in the Bay of Biscay.

And now, the program being exhausted, the ships returned to Plymouth. On the whole, the trip had proved eminently satisfactory. The paying-out machinery had worked well, the various engineering operations had been successfully performed, and the electrical working through the whole cable was perfect.

CHAPTER VI

THE STORM

The “wire ships” thus additionally experienced arrived at Plymouth on June 3d, and some further arrangements were made, principally connected with the electrical department.

A week later—i. e., on Thursday, June 10th—having taken in a fresh supply of coal, the expedition again left England “with fair skies and bright prospects.” The barometer standing at 30.64, it was an auspicious start in what was declared by a consensus of nautical authorities to be the best time of the year for the Atlantic.

This prognostication was doomed to a terrible disappointment, for the voyage nearly ended in the Agamemnon “turning turtle.” She was repeatedly almost on her beam ends, the cable was partly shifted, and a large number of those on board were more or less seriously injured. The load of cable made all the difference when brought into comparison with an ordinary ship, under stress of weather. It was bad enough to cruise with a dead weight forward of some 250 tons—a weight under which her planks gaped an inch apart, and her beams threatened daily to give way. But when to these evils were added the fear that in some of her heavy rolls the whole mass would slip and take the vessel’s side out, it will be seen that this precious coil was justly regarded as a standing danger—the millstone about the necks of all on board.[29] Oddly enough, owing to the fact that the Agamemnon had scant accommodation left for fuel, every one at the start was bemoaning the entire absence of breeze. There were some even, who, never having been at sea before, muttered rash hopes about meeting an Atlantic gale. Their wishes were soon to be completely realized.

In order that laying operations should be started by the two ships in mid-ocean, it was arranged that the entire fleet should meet in latitude 53° 2′ and longitude 33° 18′ as a rendezvous. As it is impossible to follow the movements of more than one ship at a time, and as the Agamemnon had the more exciting experience, we will confine our attention to her up to the date of the rendezvous.

The day after starting there was no wind; but on Saturday, June 12th, a breeze sprung up, and, with screw hoisted and fires raked out, the Agamemnon bowled along at a rare pace under "royals" and studding-sails. The barometer fell fast, and squally weather coming on with the boisterous premonitory symptoms of an Atlantic gale, even those least versed in such matters could see at a glance that they were "in for it." The following day the sky wore a wretched mist—half rain, half vapor—through which the attendant vessels loomed faintly like shadows. The gale increased; till at four in the afternoon the good ship was rushed through the foam under close-reefed topsails and foresail. That night the storm got worse, and most of the squadron gradually parted company. The ocean resembled one vast snowdrift, the whitish glare from which—reflected from the dark clouds that almost rested on the sea—had a tremendous and unnatural effect, as if the ordinary laws of nature had been reversed.

Very heavy weather continued till the following Sunday (June 20th), which ushered in as fierce a storm as ever swept over the Atlantic. The narrative of this fight of nautical science with the elements may best be continued in the words of the representative of The Times, especially as it is probably the most intensely realistic description of a storm that has ever been written by an eye-witness:

The Niagara, which had hitherto kept close, while the other smaller vessels had dropped out of sight, began to give us a very wide berth, and as darkness increased it was a case of every one for himself.

Our ship, the Agamemnon, rolling many degrees—not every one can imagine how she went at it that night—was laboring so heavily that she looked like breaking up.

The massive beams under her upper-deck coil cracked and snapped with a noise resembling that of small artillery, almost drowning the hideous roar of the wind as it moaned and howled through the rigging, jerking and straining the little storm-sails as though it meant to tear them from the yards. Those in the impoverished cabins on the main deck had little sleep that night, for the upper-deck planks above them were "working themselves free," as sailors say; and beyond a doubt they were infinitely more free than easy, for they groaned under the pressure of the coil with a dreadful uproar, and availed themselves of the opportunity to let in a little light, with a good deal of water, at every roll. The sea, too, kept striking with dull, heavy violence against the vessel's bows, forcing its way through hawse-holes and ill-closed ports with a heavy slush; and thence, hissing and winding aft, it roused the occupants of the cabins aforesaid to a knowledge that their floors were under water, and that the flotsam and jetsam noises they heard beneath were only caused by their outfit for the voyage taking a cruise of its own in some five or six inches of dirty bilge. Such was Sunday night, and such was a fair average of all the nights throughout the week, varying only from bad to worse. On Monday things became desperate.

The barometer was lower—and, as a matter of course, the wind and sea were infinitely higher—than the day before. It was singular, but at twelve o'clock the sun pierced through the pall of clouds and shone brilliantly for half an hour, and during that brief time it blew as it had not often blown before. So fierce was this gust that its roar drowned every other sound, and it was almost impossible to give the watch the necessary orders for taking in the close-reefer foresail, which, when furled, almost left the Agamemnon under bare poles, though still surging through the water at speed. This gust passed, the usual gale set in, now blowing steadily from the southwest, and taking us more and more out of our course each minute. Every hour the storm got worse, till toward five in the afternoon, when it seemed at its height—and raged with such a violence of wind and sea—that matters really looked "desperate" even for such a strong and large ship as the Agamemnon. The upper-deck coil had strained her decks throughout excessively, and though this mass in theory was supposed to prevent her rolling so quickly and heavily as she would have done without it, yet still she heeled over to such an alarming extent that fears of the coil itself shifting again occupied every mind, and it was accordingly strengthened with additional shores bolted down to the deck. The space occupied by the main coil below had deprived the Agamemnon of several of her coal-bunkers, and in order to make up for this deficiency, as well as to endeavor to counterbalance the immense mass which weighed her down by the head, a large quantity of coals had been stowed on the deck aft. On each side of her main deck were thirty-five tons, secured in a mass, while on the lower deck ninety tons were stowed away in the same manner. The precautions taken to secure these huge masses also required attention as the great ship surged from side to side. But these coals seemed secure, and were so, in fact, unless the vessel should almost capsize—an unpleasant alternative which no one certainly anticipated then. Everything, therefore, was made "snug," as sailors call it, though their efforts by no means resulted in the comfort which might have been expected from the term. The night, however, passed over without any mischance beyond the smashing of all things incautiously left loose and capable of rolling, and one or two attempts which the Agamemnon made in the middle watch to turn bottom upward. In all other matters it was the mere ditto of Sunday night, except, perhaps, a little worse, and certainly much more wet below. Tuesday the gale continued with almost unabated force, though the barometer had risen to 29.30, and there was sufficient sun to take a clear observation, which showed our distance from the rendezvous to be 563 miles. During this afternoon the Niagara joined company, and the wind going more ahead, the Agamemnon took to violent pitching, plunging steadily into the trough of the sea as if she meant to break her back and lay the Atlantic cable in a heap. This change in her motion strained and taxed every inch of timber near the coils to the very utmost. It was curious to see how they worked and bent as the Agamemnon went at everything she met head first. One time she pitched so heavily as to break one of the main beams of the lower deck, which had to be shored with screw-jacks forthwith. Saturday, the 19th of June, things looked a little better. The barometer seemed inclined to go up and the sea to go down; and for the first time that morning since the gale began, some six days previous, the decks could be walked with tolerable comfort and security. But alas!

appearances are as deceitful in the Atlantic as elsewhere; and during a comparative calm that afternoon the glass fell lower, while a thin line of black haze to windward seemed to grow up into the sky, until it covered the heavens with a somber darkness, and warned us that, after all, the worst was yet to come. There was much heavy rain that evening, and then the wind began, not violently, nor in gusts, but with a steadily increasing force, as if the gale was determined to do its work slowly but do it well. The sea was "ready-built to hand," as sailors say, so at first the storm did little more than urge on the ponderous masses of water with redoubled force, and fill the air with the foam and spray it tore from their rugged crests. By and by, however, it grew more dangerous, and Captain Preedy himself remained on deck throughout the middle watch, for the wind was hourly getting worse and worse, and the Agamemnon, rolling thirty degrees each way, was straining to a dangerous extent.

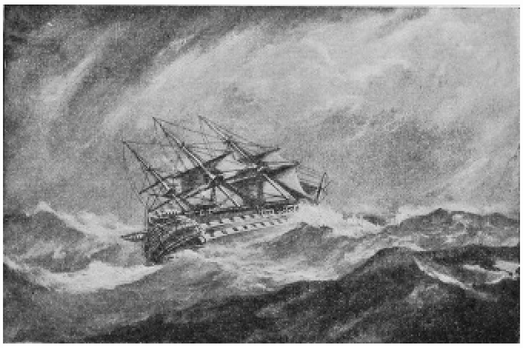


Fig. 26.—H.M.S. Agamemnon in a Storm.

At 4 A.M. sail was shortened to close-reefer fore and main topsails and reefed foresail—a long and tedious job, for the wind so roared and howled and the hiss of the boiling sea was so deafening that words of command were useless, and the men aloft, holding on with all their might to the yards as the ship rolled over and over almost to the water, were quite incapable of struggling with the masses of wet canvas that flapped and plunged as if men and yards and everything were going away together. The ship was almost as wet inside as out, and so things wore on till eight or nine o'clock, everything getting adrift and being smashed, and every one on board jamming themselves up in corners or holding on to beams to prevent their going adrift likewise. At ten o'clock the Agamemnon was rolling and laboring fearfully, with the sky getting darker, and both wind and sea increasing every minute. At about half-past ten o'clock three or four gigantic waves were seen approaching the ship, coming slowly on through the mist nearer and nearer, rolling on like hills of green water, with a crown of foam that seemed to double their height. The Agamemnon rose heavily to the first, and then went down quickly into the deep trough of the sea, falling over as she did so, so as almost to capsize completely on the port side. There was a fearful crashing as she lay over this way, for everything broke adrift, whether secured or not, and the uproar and confusion were terrific for a minute, then back she came again on the starboard beam in the same manner, only quicker, and still deeper than before. Again there was the same noise and crashing, and the officers in the ward-room, who knew the danger of the ship, struggled to their feet and opened the door leading to the main deck. Here, for an instant, the scene almost defies description. Amid loud shouts and efforts to save themselves, a confused mass of sailors, boys, and marines, with deck-buckets, ropes, ladders, and everything that could get loose, and which had fallen back again to the port side, were being hurled again in a mass across the ship to starboard. Dimly, and only for an instant, could this be seen, with groups of men clinging to the beams with all their might, with a mass of water, which had forced its way in through ports and decks, surging about, and then, with a tremendous crash, as the ship fell still deeper over, the coals stowed on the main deck broke loose, and smashing everything before them, went over among the rest to leeward. The coal-dust hid everything on the main deck in an instant, but the crashing could still be heard going on in all directions, as the lumps and sacks of coal, with stanchions, ladders, and mess-tins, went leaping about the decks, pouring down the hatchways, and crashing through the glass skylights into the engine-room below. Still it was not done, and, surging again over another tremendous wave, the Agamemnon dropped down still more to port, and the coals on the starboard side of the lower deck gave way also, and carried everything before them. Matters now became serious, for it was evident that two or three more lurches and the masts would go like reeds, while half the crew might be maimed or killed below. Captain Preedy was already on the poop, with Lieutenant Gibson, and it was "Hands, wear ship," at once, while Mr. Brown, the indefatigable chief engineer, was ordered to get up steam immediately. The crew gained the deck with difficulty, and not till after a lapse of some minutes, for all the ladders had been broken away; the men were grimed with coal-dust, and many bore still more serious marks upon their faces of how they had been knocked about below. There was some confusion at first, for the storm was fearful. The officers were quite inaudible, and a wild, dangerous sea, running mountains high, heeled the great ship backward and forward, so that the crew were unable to keep their feet for an instant, and in some cases were thrown across the decks in a fearful manner. Two marines went with a rush head foremost into the paying-out machine, as if they meant to butt it over the side, yet, strange to say, neither the men nor the machine suffered. What made matters worse, the ship's barge, though lashed down to the deck, had partly broken loose, and dropping from side to side as the vessel lurched, it threatened to crush any who ventured to pass it. The regular discipline of the ship, however, soon prevailed, and the crew set to work to wear round the ship on the starboard tack, while Lieutenants Robinson and Murray went below to see after those who had been hurt, and about the number of whom extravagant rumors prevailed among the men. There were, however, unfortunately but too many. The marine sentry outside the ward-room door on the main deck had not had time to escape, and was completely buried under the coals. Some time elapsed before he could be got out, for one of the beams used to shore up the sacks, which had crushed his arm very badly, still lay across the mangled limb, jamming it in such a manner that it was found impossible to remove it without risking the man’s life. Saws, therefore, had to be sent for, and the timber sawn away before the poor fellow could be extricated. Another marine on the lower deck endeavored to save himself by catching hold of what seemed a ledge in the planks, but, unfortunately, it was only caused by the beams straining apart, and, of course, as the Agamemnon righted they closed again, and crushed his fingers flat. One of the assistant engineers was also buried among the coals on the lower deck, and sustained some severe internal injuries. *The lurch of the ship was calculated at forty-five degrees each way for five times in rapid succession.* The galley-coppers were only half filled with soup; nevertheless, it nearly all poured out, and scalded some of the poor fellows who were extended on the decks, holding on to anything in reach. These, with a dislocation, were the chief casualties, but there were others of bruises and contusions, more or less severe, and, of course, a long list of escapes more marvelous than any injury. One poor fellow went head first from the main deck into the hold without being hurt, and one on the orlop-deck was “chevied” about for some ten minutes by three large casks of oil which had got adrift, and any one of which would have flattened him like a pancake had it overtaken him.

As soon as the Agamemnon had gone round on the other tack the Niagara wore also, and bore down as if to render assistance. She had witnessed our danger, and, as we afterward learned, imagined that the upper-deck coil had broken loose, and that we were sinking. Things, however, were not so bad as that, though they were bad enough, heaven knows, for everything seemed to go wrong that day. The upper-deck coil had strained the ship to the very utmost, but still held on fast. But not so the coil in the main hold, which had begun to get adrift, and the top kept working and shifting over from side to side, as the ship lurched, until some forty or fifty miles were in a hopeless state of tangle, resembling nothing so much as a cargo of live eels, and there was every prospect of the tangle spreading deeper and deeper as the bad weather continued.

Going round upon the starboard tack had eased the ship to a certain extent, but with such a wind and such a sea—both of which were getting worse than better—it was impossible to effect much for the Agamemnon’s relief, and so by twelve o’clock she was rolling almost as badly as ever. The crew, who had been at work since nearly four in the morning, were set to clear up the decks from the masses of coal that covered them; and while this was going forward a heavy sea struck the stern, and smashed the large iron guard-frame which had been fixed there to prevent the cable fouling the screw in paying out. Now that one side had broken, it was expected every moment that other parts would go, and the pieces hanging down either smash the screw or foul the rudder-post. It is not overestimating the danger to say that had the latter accident occurred in such a sea, and with a vessel so overladen the chances would have been sadly against the Agamemnon ever appearing at the rendezvous. Fortunately it was found possible to secure the broken frame temporarily with hawsers so as to prevent it dropping farther, though nothing could hinder the fractured end from striking against the vessel’s side with such force as to lead to serious apprehensions that it would establish a dangerous leak under water. It was near three in the afternoon before this was quite secured, the gale still continuing, and the sea running even worse. The condition of the masts, too, at this time was a source of much anxiety both to Captain Preedy and Mr. Moriarty, the master. The heavy rolling had strained and slackened the wire shrouds to such an extent that they had become perfectly useless as supports. The lower masts bent visibly at every roll, and once or twice it seemed as if they must go by the board. Unfortunately nothing whatever could be done to relieve this strain by sending down any of the upper spars, since it was only her masts which prevented the ship rolling still more and quicker; and so every one knew that if once they were carried away it might soon be all over with the ship, as then the deck coil could not help going after them. So there was nothing for it but to watch in anxious silence the way they bent and strained, and trust in Providence for the result. About six in the evening it was thought better to “wear ship” again and stand for the rendezvous under easy steam, and her head accordingly was put about and once more faced the storm. As she went round she, of course, fell into the trough of the sea again, and rolled so awfully as to break her waste-steampipe, filling her engine-room with steam, and depriving her of the services of one boiler when it was sorely needed. The sun set upon as wild and wicked a night as ever taxed the courage and coolness of a sailor. There were, of course, men on board who were familiar with gales and storms in all parts of the world; and there were some who had witnessed the tremendous hurricane which swept the Black Sea on the memorable 14th of November, when scores of vessels were lost and seamen perished by the thousands. But of all on board none had ever seen a fiercer or more dangerous sea than raged throughout that night and the following morning, tossing the Agamemnon from side to side like a mere plaything among the waters. The night was thick and very dark, the low black clouds almost hemming the vessel in; now and then a fiercer blast than usual drove the great masses slowly aside and showed the moon, a dim, greasy blotch upon the sky, with the ocean, white as driven snow, boiling and seething like a caldron. But these were only glimpses, which were soon lost, and again it was all darkness, through which the waves, suddenly upheaving, rushed upon the ship as though they must overwhelm it, and dealing it one staggering blow, went hissing and surging past into the darkness again. The grandeur of the scene was almost lost in its dangers and terrors, for of all the many forms in which death approaches man there is none so easy, in fact, so terrific in appearance, as death by shipwreck.

Sleeping was impossible that night on board the Agamemnon. Even those in cots were thrown out, from their striking against the vessel’s side as she pitched. The berths of wood fixed athwartships in the cabins on the main deck had worked to pieces. Chairs and tables were broken, chests of drawers capsized, and a little surf was running over the floors of the cabins themselves, pouring miniature seas into portmanteaus, and breaking over carpetbags of clean linen. Fast as it flowed off by the scuppers it came in faster by the hawse-holes and ports, while the beams and knees strained with a doleful noise, as though it was impossible they could hold together much longer, and on the whole it was as miserable and even anxious a night as ever was passed on board any line-of-battle ship in her Majesty’s service. Captain Preedy never left the poop all night, though it was hard work to remain there, even holding on to the poop-rail with both hands. Morning brought no change, save that the storm was as fierce as ever, and though the sea could not be higher or wilder, yet the additional amount of broken water made it still more dangerous to the ship. Very dimly, and only now and then through the thick scud, the Niagara could be seen—one moment on a monstrous hill of water, and the next quite lost to view, as the Agamemnon went down between the waves. But even these glimpses showed us that our transatlantic consort was plunging heavily, shipping seas, and evidently having a bad time of it, though she got through it better than the Agamemnon, as, of course, she could, having only the same load, though 2,000 tons larger. Suddenly it came on darker and thicker, and we lost sight of her in the thick spray, and had only ourselves to look after. This was quite enough, for every minute made matters worse, and the aspect of affairs began to excite most serious misgivings in the minds of those in charge. The Agamemnon is one of the finest line-of-battle ships in the whole navy, but in such a storm, and so heavily overladen, what could she do but make bad weather worse, and strain and labor and fall into the trough of the sea, as if she were going down head foremost. Three or four hours more and the vessel had borne all she could bear with safety. The masts were rapidly getting worse, the deck coil worked more and more with each tremendous plunge, and, even if both these held, it was evident that the ship itself would soon strain to pieces if the weather continued so. The sea, forcing its way through ports and hawse-holes, had accumulated on the lower deck to such an extent that it flooded the stoke-hole, so that the men could scarcely remain at their posts. Everything went smashing and rolling about. One plunge put all the electrical instruments *hors de combat* at a blow, and staved some barrels of strong solution of sulphate of copper, which went cruising about, turning all it touched to a light pea-green. By and by she began to ship seas. Water came down the ventilators near the funnel into the engine-room.

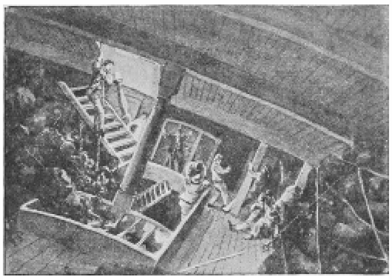


Fig. 27.—The Agamemnon Storm: Coals Adrift.

Then a tremendous sea struck her forward, drenching those on deck, and leaving them up to their knees in water, and the least versed on board could see that things were fast going to the bad unless a change took place in the weather or the condition of the ship. Of the first there seemed little chance. The weather certainly showed no disposition to clear—on the contrary, livid-looking black clouds seemed to be closing round the vessel faster and faster than ever. For the relief of the ship three courses were open to Captain Preedy—one, to wear round and try her on the starboard tack, as he had been compelled to do the day before; another, to fairly run for it before the wind; and, third and last, to endeavor to lighten the vessel by getting some of the cable overboard. Of course the latter would not have been thought of till the first two had been tried and failed—in fact, not till it was evident that nothing else could save the ship. Against wearing round there was the danger of her again falling off into the trough of the sea, losing her masts, shifting her upper-deck coil, and so finding her way to the bottom in ten minutes, while to attempt running before the storm with such a sea on was to risk her stern being stove in, and a hundred tons of water added to her burden with each wave that came up afterward, till the poor Agamemnon went under them all for ever. A little after ten o’clock on Monday, the 21st, the aspect of affairs was so alarming that Captain Preedy resolved at all risks to try wearing the ship round on the other tack. It was hard enough to make the words of command audible, but to execute them seemed almost impossible. The ship’s head went round enough to leave her broadside on to the seas, and then for a time it seemed as if nothing could be done. All the rolls which she had ever given on the previous day seemed mere trifles compared with her performances then. Of more than 200 men on deck, at least 150 were thrown down, and falling over from side to side in heaps, while others, holding on to the ropes, swung to and fro with every heave. It really appeared as if the last hour of the stout ship had come, and to this minute it seems almost miraculous that her masts held on. Each time she fell over her main chains went deep under water. The lower decks were flooded, and those above could hear by the fearful crashing—audible amid the hoarse roar of the storm—that the coals had got loose again below, and had broken into the engine-room, and were carrying all before them. During these rolls the main-deck coil shifted over to such a degree as quite to envelop four men, who, sitting on the top, were trying to wedge it down with beams. One of them was so much jammed by the mass which came over him that he was seriously contused. He had to be removed to the sick-bay, making up the sick-list to forty-five, of which ten were from injuries caused by the rolling of the ship, and very many of the rest from continual fatigue and exposure during the gale. Once round on the starboard tack, and it was seen in an instant that the ship was in no degree relieved by the change. Another heavy sea struck her forward, sweeping clean over the fore part of the vessel and carrying away the woodwork and platforms which had been placed there round the machinery for underrunning. This and a few more plunges were quite sufficient to settle the matter, and at last, reluctantly, Captain Preedy succumbed to the storm he could neither conquer nor contend against. Full steam was got on, and with a foresail and a fore-topsail to lift her head the Agamemnon ran before the storm, rolling and tumbling over the huge waves at a tremendous pace. It was well for all that the wind gave this much way on her, or her stern would infallibly have been stove in. As it was, a wave partly struck her on the starboard quarter, smashing the quarter-galley and ward-room windows on that side, and sending such a sea into the ward-room itself as to literally wash two officers off a sofa on which they were resting on that side of the ship. This was a kind of parting blow; for the glass began to rise, and the storm was evidently beginning to moderate, and although the sea still ran as high as ever there was less broken water, and altogether, toward midday, affairs assumed a better and more cheerful aspect. The ward-room that afternoon was a study for an artist, with its windows halfdarkened and smashed, the sea-water still slushing about in odd corners, with everything that was capable of being broken strewn over the floor in pieces, and some fifteen or twenty officers, seated amid the ruins, holding on to the deck or table with one hand, while with the other they contended at a disadvantage with a tough meal—the first which most had eaten for twenty-four hours. Little sleep had been indulged in though much "lolloping about." Those, however, who prepared themselves for a night's rest in their berths rather than at the ocean bottom, had great difficulty in finding their day-garments of a morning. The boots especially went astray, and got so hopelessly mixed that the man who could "show up" with both pairs of his own was, indeed, a man to be congratulated.

But all things have an end, and this long gale—of over a week's duration—at last blew itself out, and the weary ocean rocked itself to rest.

Throughout the whole of Monday the Agamemnon ran before the wind, which moderated so much that at 4 A.M. on Tuesday her head was again put about, and for the second time she commenced beating up for the rendezvous, then some 200 miles farther from us than when the storm was at its height on Sunday morning. So little was gained against this wind that Friday the 25th—sixteen days after leaving Plymouth—still found us some fifty miles from the rendezvous. So it was determined to get up steam and run down on it at once. As we approached the place of meeting the angry sea went down. The Valorous hove in sight at noon; in the afternoon the Niagara came in from the north; and at even the Gorgon from the south: and then, almost for the first time since starting, the squadron was reunited near the spot where the great work was to have commenced fifteen days previously—as tranquil in the middle of the Atlantic as if in Plymouth Sound.

CHAPTER VII

THE RENEWED EFFORT

THAT evening the four vessels lay together side by side, and there was such a stillness in the sea and air as would have seemed remarkable even on an inland lake. On the Atlantic, and after what had been so lately experienced, it seemed almost unnatural.

The boats were out, and the officers were passing from ship to ship, telling their experiences of the voyage, and forming plans for the morrow. The captain of the Agamemnon had a sorry tale to tell. The strain to which she had been subjected had opened her "waterways."[30] Then, again, one of the crew, a marine, had been literally frightened out of his wits, and remained crazy for some days. One man had his arm fractured in two places, and another his leg broken.

The Niagara, on the other hand, had weathered the gale splendidly, though it had been a hard and anxious time with her, as well as with the smaller craft. She had lost her jib-boom, and the buoys she carried for suspending the cable had been washed from her sides—no man knew where.

After taking stock of things generally, a start was made to repair the various damages; but the shifting of the upper part of the main coil on the Agamemnon into a hopeless tangle entailed recoiling a considerable length of cable, a no light task, occupying several days.

On the morning of Saturday, June 26th, all the preparations were completed for making the splice and once more commencing the great undertaking.

In the words of The Times representative:

> The end of the Niagara's cable was sent on board the Agamemnon, the splice was made, a bent sixpence put in for luck, and at 2.50 Greenwich time it was slowly lowered over the side and disappeared forever. The weather was cold and foggy, with a stiff breeze and dismal sort of sleet, and as there was no cheering or manifestation of enthusiasm of any kind, the whole ceremony had a most funereal effect, and seemed as solemn as if we were burying a marine, or some other mortuary task of the kind equally cheerful and enlivening. As it turned out, however, it was just as well that no display took place, as every one would have looked uncommonly silly when the same operation came to be repeated, as it had to be, an hour or so afterward. It is needless making a long story longer, so I may state at once that when each ship had paid out three miles or so, and they were getting well apart, the cable, which had been allowed to run too slack, broke on board the Niagara owing to its overriding and getting off the pulley leading on to the machine.

The break was of course known instantly, both vessels put about and returned, a fresh splice was made, and again lowered over at half past seven. According to arrangement, 150 fathoms were veered out from each ship, and then all stood away on their course, at first at two miles an hour, and afterward at four. Everything then went well, the machine working beautifully, at thirty-two revolutions per minute, the screw at twenty-six, the cable running out easily at five and five and a half miles an hour, the ship going four. The greatest strain upon the dynamometer was 2,500 lbs., and this was only for a few minutes, the average giving only 2,000 lbs. and 2,100 lbs. At midnight twenty-one nautical miles had been paid out, and the angle of the cable with the horizon had been reduced considerably. At about half past three forty miles had gone, and nothing could be more perfect and regular than the working of everything, when suddenly, at 3.40 A.M. on Sunday, the 27th, Professor Thomson came on deck and reported a total break of continuity; that the cable, in fact, had parted, and as was believed at the time, from the Niagara. The Agamemnon was instantly stopped and the brakes applied to the machinery, in order that the cable paid out might be severed from the mass in the hold, and so enable Professor Thomson to discover by electrical tests at about what distance from the ship the fracture had taken place.[31] Unfortunately, however, there was a strong breeze on at the time, with rather a heavy swell, which told severely upon the cable, and before any means could be taken to ease entirely the motion on the ship, it parted a few fathoms below the stern-wheel, the dynamometer indicating a strain of nearly 4,000 lbs. In another instant a gun and a blue light warned the Valorous of what had happened, and roused all on board the Agamemnon to a knowledge that the machinery was silent, and that the first part of the Atlantic cable had been laid and effectually lost.

The great length of cable on board both ships allowed a large margin for such mishaps as these, and the arrangement made before leaving England was that the splices might be renewed and the work recommenced till each ship had lost 250 miles of wire, after which they were to discontinue their efforts and return to Queenstown. Accordingly, after the breakage on Sunday morning, the ships' heads were put about, and for the fourth time the Agamemnon again began the weary work of beating up against the wind for that everlasting rendezvous which we seemed destined to be always seeking. Apart from the regret with which all regarded the loss of the cable, there were other reasons for not wishing the cruise to be thus indefinitely prolonged, since there had been a break in the continuity of the fresh provisions; and for some days previously in the ward-room the *pièces de résistance* had been inflammatory-looking *morceaux*, salted to an astonishing pitch, and otherwise uneatable, for it was beef which had been kept three years beyond its warranty for soundness, and to which all were then reduced.

It was hard work beating up against the wind; so hard, indeed, that it was not till the noon of Monday, the 28th, that we again met the Niagara; and while all were waiting with impatience for her explanation of how she broke the cable, she electrified every one by running up the interrogatory, "How did the cable part?" This *was* astounding. As soon as the boats could be lowered, Mr. Cyrus Field, with the electricians from the Niagara, came on board, and a comparison of logs showed the painful and mysterious fact that at the same second of time each vessel discovered that a total fracture had taken place at a distance of certainly not less than ten miles from each ship, as well as could be judged, at the bottom of the ocean. The logs on both sides were so clear as to the minute of time, and as to the electrical tests showing not merely leakage or defective insulations of the wire, but a total fracture, that there was no room left on which to rest a moment's doubt of the certainty of this most disheartening fact. That of all the many mishaps connected with the Atlantic telegraph, this was the worst and most disheartening, since it proved that after all that human skill and science can effect to lay the wire down with safety has been accomplished, there may be some fatal obstacles to success at the bottom of the ocean which can never be guarded against, for even the nature of the peril must always remain as secret and unknown as the depths in which it is to be encountered. Was the bottom covered with a soft coating of ooze, in which it had been said the cable might rest undisturbed for years as on a bed of down? or were there, after all, sharp-pointed rocks lying on that supposed plateau of Maury, Berryman, and Dayman? These were the questions that some of those on board were asking.

But there was no use in further conjecture or in repining over what *had* already happened. Though the prospect of success appeared to be considerably impaired it was generally considered that there was but one course left, and that was to splice again and make another—and what was fondly hoped would be a final—attempt. Accordingly no time was lost in making the third splice, which was lowered over into 2,000 fathoms of water at seven o'clock by ship's time the same night. Before steaming away, as the Agamemnon was now getting very short of coal, and the two vessels had some 100 miles of surplus cable between them, it was agreed that if the wire parted again before the ships had gone each 100 miles from the rendezvous they were to return and make another splice; and as the Agamemnon was to sail back, the Niagara, it was decided, was to wait eight days for her appearance. If, on the other hand, the 100 miles had been exceeded, the ships were not to return, but each make the best of its way to Queenstown. With this understanding the ships again parted, and, with the wire dropping steadily down between them, the Niagara and Agamemnon steamed away, and were soon lost in the cold, raw fog, which had hung over the rendezvous ever since the operations had commenced.

The cable, as before, paid out beautifully, and nothing could have been more regular and more easy than the working of every part of the apparatus. At first the ship's speed was only two knots, the cable going three and three and a half with a strain of 1,500 lbs., the horizontal angle averaging as low as seven and the vertical about sixteen. By and by, however, the speed was increased to four knots, the cable going five, at a strain of 2,000 lbs., and an angle of from twelve to fifteen. At this rate it was kept with trifling variations throughout the whole of Monday night, and neither Mr. Bright, Mr. Canning, nor Mr. Clifford ever quitted the machines for an instant. Toward the middle of the night, while the rate of the ship continued the same, the speed at which the cable paid out slackened nearly a knot, while the dynamometer indicated as low as 1,300 lbs. This change could only be accounted for on the supposition that the water had shallowed to a considerable extent, and that the vessel was in fact passing over some submarine Ben Nevis or Skiddaw. After an interval of about an hour the strain and rate of progress of the cable again increased, while the increase of the vertical angle seemed to indicate that the wire was sinking down the side of a declivity. Beyond this there was no variation throughout Monday night, or indeed through Tuesday. The upper-deck coil, which had weighed so heavily upon the ship—and still more heavily upon the minds of all during the past storms—was fast disappearing, and by twelve at midday on Tuesday, the 29th, seventy-six miles had been paid out to something like sixty miles' progress of the ship. Warned by repeated failures, many of those on board scarcely dared hope for success. Still the spirits of all rose as the distance widened between the ships. Things were going in splendid style—in such splendid style that "stock had gone up nearly 100 per cent." Those who had leisure for sleep were able to dream about cable-laying and the terrible effects of too great a strain. The first question which such as these ask on awakening is about the cable, and on being informed that it is all right, satisfaction ensues until the appearance of breakfast, when it is presumed this feeling is intensified. For those who do not derive any particular pleasure from the mere asking of questions, the harmonious music made by the paying-out machine during its revolutions supplies the information.

Then again, the electrical continuity—after all, the most important item—was perfect, and the electricians reported that the signals passing between the ships were eminently satisfactory. The door of the testing-room is almost always shut, and the electricians pursue their work undisturbed; but it is impossible to exclude that spirit of scientific inquiry which will satiate its thirst for information even through a keyhole.

Further, the weather was all that could be wished for. Indeed, had the poet who was so anxious for "life on the ocean wave and a home on the rolling deep" been aboard, he would have been absolutely happy, and perhaps even more desirous for a fixed habitation.

The only cause that warranted anxiety was that it was evident the upper-deck coil would be finished by about eleven o'clock at night, when the men would have to pass along in darkness the great loop which formed the communication between that and the coil in the main hold. This was most unfortunate; but the operation had been successfully performed in daylight during the experimental trip in the Bay of Biscay, and every precaution was now taken that no accident should occur. At nine o'clock by ship's time, when 146 miles had been paid out and about 112 miles' distance from the rendezvous accomplished, the last flake but one of the upper-deck coil came in turn to be used. In order to make it easier in passing to the main coil the revolutions of the screw were reduced gradually, by two revolutions at a time from thirty to twenty, while the paying-out machine went slowly from thirty-six to twenty-two. At this rate the vessel going three knots and the cable three and a half, the operation was continued with perfect regularity, the dynamometer indicating a strain of 2,100 lbs. Suddenly without an instant's warning, or the occurrence of any single incident that could account for it, the cable parted when subjected to a strain of less than a ton.[32] The gun that again told the Valorous of this fatal mishap brought all on board the Agamemnon rushing to the deck, for none could believe the rumor that had spread like wildfire about the ship. But there stood the machinery, silent and motionless, while the fractured end of the wire hung over the stern-wheel, swinging loosely to and fro. It seemed almost impossible to realize the fact that an accident so instantaneous and irremediable should have occurred, and at a time when all seemed to be going on so well. Of course a variety of ingenious suggestions were soon afloat, showing most satisfactorily how the cable must and ought to have broken. There was a regular gloom that night on board the Agamemnon, for from first to last the success of the expedition had been uppermost in the thoughts of all, and all had labored for it early and late, contending with every danger and overcoming every obstacle and disaster that had marked each day, with an earnestness and devotion of purpose that is really beyond all praise.

Immediately after the mishap, a brief consultation was held by those in charge on board the Agamemnon, and as it was shown that they had only exceeded the distance from the rendezvous by fourteen miles, and that there was still more cable on board the two vessels than the amount with which the original expedition last year was commenced, it was determined to try for another chance and return to the rendezvous, sailing there, of course; for Mr. Brown, the chief engineer, as ultrazealous in the cause as a board of directors, guarded the coal-bunkers like a very dragon, lest, if in coming to paying out the cable again, steam should run short, thereby endangering the success of the whole undertaking.

For the fifth time, therefore, the Agamemnon's head went about, and after twenty days at sea she again began beating up against the wind for the rendezvous to try, if possible, to recommence her labors. The following day the wind was blowing from the southwest, with mist and rain, and Thursday, July 1st, gave every one the most unfavorable opinion of July weather in the Atlantic. The wind and sea were both high—the wet fog so dense that one could scarcely see the mastheads, while the damp cold was really biting. Altogether it was an atmosphere of which a Londoner would have been ashamed even in November. Later in the day a heavy sea got on; the wind increased without dissipating the fog, and it was double-reefed topsails and pitching and rolling as before. However, the upper-deck coil of 250 tons being gone, the Agamemnon was as buoyant as a lifeboat, and no one cared how much she took to kicking about, though the cold wet fog was a miserable nuisance, penetrating everywhere and making the ship as wet inside as out. What made the matter worse was that in such weather there seemed no chance of meeting the Niagara unless she ran into us, when cable-laying would have gone on wholesale. In order to avoid such a contretemps, and also to inform the Valorous of our whereabouts, guns were fired, fog-bells rung, and the bugler stationed forward to warn the other vessels of our vicinity. Friday was the ditto of Thursday and Saturday, worse than both together, for it almost blew a gale and there was a heavy sea on. On Sunday, the 4th, it cleared, and the Agamemnon for the first time during the whole cruise, reached the actual rendezvous and fell in with the Valorous, which had been there since Friday, the 2d, but the fog must have been even thicker there than elsewhere, for she had scarcely seen herself, much less anything else till Sunday.

During the remainder of that day and Monday, when the weather was very clear, both ships cruised over the place of meeting, but neither the Niagara nor Gorgon was there, though day and night the lookout for them was constant and incessant. It was evident then that the Niagara had rigidly, but most unfortunately, adhered to the mere letter of the agreement regarding the 100 miles, and after the last fracture had at once turned back for Queenstown. On Tuesday, the 6th, therefore, as the dense fogs and winds set in again it was agreed between the Valorous and Agamemnon to return once more to the rendezvous. But as usual the fog was so thick that the whole American navy might have been cruising there unobserved; so the search was given up, and at eight o'clock that night the ship's head was turned for Cork, and, under all sail, the Agamemnon at last stood homeward. The voyage home was made with ease and swiftness considering the lightness of the wind, the trim of the ship, and that she only steamed three days, and at midday on Tuesday, July 12th, the Agamemnon cast anchor in Queenstown harbor, having met with more dangerous weather, and encountered more mishaps than often falls to the lot of any ship in a cruise of thirty-three days.

Thus ends the most arduous and dangerous expedition that had ever been experienced in connection with cable-work. It, at any rate, had the advantage of supplying the public with some exciting reading in the columns of The Times, whose graphic descriptions were much appreciated.

The Niagara had reached Queenstown as far back as July 5th. Having found that they had run out 109 miles when "continuity" ceased, those in charge considered that, in order to carry out their instructions, they should return at once to the above port, which they did.

On the two ships meeting at Queenstown, discussion immediately took place (1) as to the cause of the cessation of "continuity"; and (2) regarding the course taken by the Niagara in returning home so promptly.

The non-arrival of the Agamemnon till nearly a week later had been the cause of much alarm regarding her safety.

CHAPTER VIII

“FINIS CORONAT OPUS”

Renewed “Stock-Taking”—The Last Start—Successful Termination—General Surprise and Applause

THE sad tale of disaster commenced to spread abroad immediately on the Niagara’s arrival in Queenstown; and when Mr. Field hastened to London to meet the other directors of the company, he found that the news had not only preceded him, but had already had its effect.

The Board was soon called together. It met as a council of war summoned after a terrific defeat to decide whether to surrender or to try once more the chances of battle. Says Field: “Most of the directors looked blankly in one another’s faces.” With some the feeling was one akin to despair. It was thought by many that there was nothing left on which to found an expectation of future success, or to encourage the expenditure of further capital upon an adventure so “completely visionary.” The chairman (Sir William Brown), while recommending entire abandonment of the undertaking, suggested “a sale of the cable remaining on board the ships, and a distribution of the proceeds among the shareholders.”

Bolder counsels were, however, destined to prevail. There were those who thought there was still a chance, like Robert Bruce, who, after twelve battles and twelve defeats, yet believed that a thirteenth *might* bring victory, notwithstanding the prejudice held by some against that number. The projectors made a firm stand for immediate action, as did also Professor Thomson and Mr. Curtis Lampson, who succeeded Mr. Brooking as deputy chairman, at the same time that Mr. Stuart Wortley took the chair in place of Sir W. Brown, on the latter’s resignation. These advocates of non-surrender succeeded at length in carrying an order for the immediate sailing of the expedition for a final effort. It was this effort which proved to the world the possibility of telegraphing from one hemisphere to the other.

The order to advance having been given, the ships forthwith took in coal and other necessaries.

When everything and everybody had been shipped, the squadron left Queenstown once more on Saturday, July 17, 1858. As the ships sailed out of the harbor of Cork, it was with none of the enthusiasm which attended their departure from Valentia the year before, or even the small amount excited when leaving Plymouth on June 10th. Nobody so much as cheered. In fact, their mission was by this time spoken of as a “mad freak of stubborn ignorance,” and “was regarded with mixed feelings of derision and pity.”[33]

The squadron was the same as on the last occasion. It was agreed that the ships should not attempt to keep together this time, but that each should make its way to the given latitude and longitude. The staffs were composed and berthed as before. Moreover, the expedition was again accompanied by the same literary talent.

The Last Start.—Let us now turn to The Times narrative, as given at the conclusion of this final expedition:

As the ships left the harbor there was apparently no notice taken of their departure by those on shore or in the vessels anchored around them. Every one seemed impressed with the conviction that we were engaged in a hopeless enterprise; and the squadron seemed rather to have slunk away on some discreditable mission than to have sailed for the accomplishment of a grand national scheme. It was just dawn when the Agamemnon got clear of Queenstown harbor, but, as the wind blew stiff from the southwest, it was nearly ten o’clock before she rounded the Old Head of Kinsale, a distance of only a few miles. The weather remained fine during the day; and as the Agamemnon skirted along the wild and rocky shore of the southwest coast of Ireland, those on board had an excellent opportunity of seeing the stupendous rocks which rise from the water in the most grotesque and fantastic shapes. About five o’clock in the afternoon Cape Clear was passed, and though the coast gradually edged away to the northward of our course, yet it was nearly dark before we lost sight of the rocky mountains which surround Bantry Bay and the shores of the Kenmare River. By Monday, the 19th, we had left the land far behind us, and thence fell into the usual dull monotony of sea life.

Of the voyage out there is little to be said. It was not checkered by the excitement of continual storms or the tedium of perpetual calms, but we had a sufficient admixture of both to render our passage to the rendezvous a very ordinary and uninteresting one. For the first week the barometer remained unusually low, and the numbers of those natural barometers—Mother Carey’s chickens—that kept in our wake kept us in continual expectation of heavy weather. With very little breeze or wind, the screw was got up and sail made, so as to husband our coals as much as possible; but it generally soon fell calm, and obliged Captain Preedy reluctantly to get up steam again. In consequence of continued delays and changes from steam to sail, and from sail to steam again, much fuel was expended, and not more than eighty miles of distance made good each day. On Sunday, the 25th, however, the weather changed, and for several days in succession there was an uninterrupted calm. The moon was just at the full, and for several nights it shone with a brilliancy which turned the smooth sea into one silvery sheet, which brought out the dark hull and white sails of the ship in strong contrast to the sea and sky as the vessel lay all but motionless on the water, the very impersonation of solitude and repose. Indeed, until the rendezvous was gained, we had such a succession of beautiful sunrises, gorgeous sunsets, and tranquil moonlight nights as would have excited the most enthusiastic admiration of any one but persons situated as we were. But by us such scenes were regarded only as the annoying indications of the calm which delayed our progress and wasted our coals. To say that it was calm is not doing full justice to it; there was not a breath in the air, and the water was as smooth as a mill-pond. Even the wake of the ship scarce ruffled the surface; and the gulls which had visited us almost daily, and to which our benevolent liberality had dispensed innumerable pieces of pork, threw an almost unbroken shadow upon it as they stooped in their flight to pick up the largest and most tempting. It was generally remarked that cable-laying under such circumstances would be mere child’s play.

In spite of the unusual calmness of the weather in general, there were days on which our former unpleasant experiences of the Atlantic were brought forcibly to our recollection, when it blew hard and the sea ran sufficiently high to reproduce on a minor scale some of the discomforts of which the previous cruise had been so fruitful. Those days, however, were the exception and not the rule, and served to show how much more pleasant was the inconvenient calm than the weather which had previously prevailed.

The precise point of the rendezvous—marked by a dot on the chart—was reached on the evening of

Wednesday, July 28th, just eleven days after our departure from Queenstown. The voyage out was a lazy one. Now things are different, and we no longer hear of the prospects of the heroes and heroines of the romances and novels which have formed the staple food for animated discussion for some days past. The rest of the squadron were in sight at nightfall, but at such a considerable distance that it was past ten o'clock on the morning of Thursday the 29th, before the Agamemnon joined them. Some time previous to reaching the rendezvous the engineer-in-chief (Mr. Bright) went up in the shrouds on the lookout for the other ships, and accordingly had to "pay his footing"—much to the amusement of his staff. Most of them being more advanced in years would not probably have been so equal to the task in an athletic sense.

After the ordinary laconic conversation which characterize code flag-signals, we were as usual greeted by a perfect storm of questions as to what had kept us so much behind our time, and learned that all had come to the conclusion that the ship must have got on shore on leaving Queenstown harbor. The Niagara, it appeared, had arrived at the rendezvous on Friday night, the 23d, the Valorous on Sunday, the 25th, and the Gorgon on the afternoon of Tuesday, the 27th.

The day was beautifully calm, so no time was to be lost before making the splice in lat. 52° 9´ N., long. 32° 27´ W., and soundings of 1,500 fathoms. Boats were soon lowered from the attendant ships; the two vessels made fast by a hawser, and the Niagara's end of the cable conveyed on board the Agamemnon. About half-past twelve o'clock the splice was effectually made, but with a very different frame from the carefully rounded semi-circular boards which had been used to enclose the junctions on previous occasions. It consisted merely of two straight boards hauled over the joint and splice, with the iron rod and leaden plummet attached to the center. In hoisting it out from the side of the ship, however, the leaden sinker broke short off and fell overboard. There being no more convenient weight at hand a 32-lb. shot was fastened to the splice instead, and the whole apparatus was quickly dropped into the sea without any formality—and, indeed, almost without a spectator—for those on board the ship had witnessed so many beginnings to the telegraphic line that it was evident they despaired of there ever being an end to it.

The stipulated 210 fathoms of cable having been paid out to allow the splice to sink well below the surface, the signal to start was hoisted, the hawser cut loose, and the Niagara and Agamemnon start for the last time at about 1 P.M. for their opposite destinations.

The announcement comes from the electrician's testing-room that the continuity is perfect, and with this assurance the engineers go on more boldly with the work. In point of fact the engineers may be said to be very much under the control of the electricians during paying out; for if the latter report anything wrong with the cable, the engineers are brought to a stand until they are allowed to go on with their operations by the announcement of the electricians that the insulation is perfect and the continuity all right. The testing-room is where the subtle current which flows along the conductor is generated, and where the mysterious apparatus by which electricity is weighed and measured—as a marketable commodity—is fitted up. The system of testing and of transmitting and receiving signals through the cable from ship to ship during the process of paying out must now be briefly referred to. It consists of an exchange of currents sent alternately every ten minutes by each ship. These not only serve to give an accurate test of the continuity and insulation of the conducting-wire from end to end, but also to give certain signals which it is desirable to send for information purposes. For instance, every ten miles of cable paid out is signalized from ship to ship, as also the approach to land or momentary stoppage for splicing, shifting to a fresh coil, etc. The current in its passage is made to pass through an electromagnetometer,[34] an instrument invented by Mr. Whitehouse. It is also conveyed in its passage at each end of the cable through the reflecting-galvanometer and speaking-instrument just invented by Professor Thomson; and it is this latter which is so invaluable, not only for the interchange of signals, but also for testing purposes. The deflections read on the galvanometer, as also the degree of charge and discharge indicated by the magnetometer, are carefully recorded. Thus, if a defect of continuity or insulation occurs it is brought to light by comparison with those received before.

For the first three hours the ships proceeded very slowly, paying out a great quantity of slack, but after the expiration of this time the speed of the Agamemnon was increased to about five knots, the cable going at about six, without indicating more than a few hundred pounds of strain upon the dynamometer.

Shortly after four o'clock a very large whale was seen approaching the starboard bow at a great speed (Fig. 28), rolling and tossing the sea into foam all round; and for the first time we felt a possibility for the supposition that our second mysterious breakage of the cable might have been caused, after all, by one of these animals getting foul of it under water. It appeared as if it were making direct for the cable; and great was the relief of all when the ponderous living mass was seen slowly to pass astern, just grazing the cable where it entered the water—but fortunately without doing any mischief. All seemed to go well up to about eight o'clock; the cable paid out from the hold with an evenness and regularity which showed how carefully and perfectly it had been coiled away. The paying-out machine also worked so smoothly that it left nothing to be desired. The brakes are properly called self-releasing; and although they can, by means of additional weights, be made to increase the pressure or strain upon the cable, yet, until these weights are still further increased (at the engineer's instructions), it is impossible to augment the strain in any other way. To guard against accidents which might arise in consequence of the cable having suffered injury during the storm, the indicated strain upon the dynamometer was never allowed to go beyond 1,700 lbs. or less than one-quarter what the cable is estimated to bear. Thus far everything looked promising.

But in such a hazardous work no one knows what a few minutes may bring forth, for soon after eight o'clock an injured portion of the cable[35] was discovered about a mile or two from the portion paying out. Not a moment was lost by Mr. Canning, the engineer on duty, in setting men to work to cobble up the injury as well as time would permit, for the cable was going out at such a rate that the damaged portion would be paid overboard in less than twenty minutes, and former experience had shown us that to check either the speed of the ship or the cable would, in all probability, be attended by the most fatal results. Just before the lapping was finished, Professor Thomson reported that the electrical continuity of the wire had ceased, but that the insulation was still perfect. Attention was naturally directed to the injured piece as the probable source of the stoppage, and not a moment was lost in cutting the cable at that point with the intention of making a perfect splice.

To the consternation of all, the electrical tests applied showed the fault to be overboard, and in all probability some fifty miles from the ship.

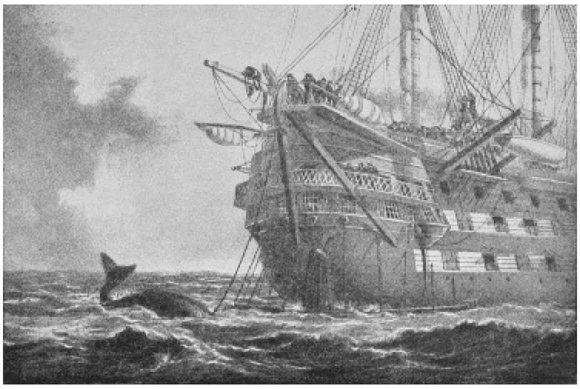


Fig. 28.—In Collision with a Whale while Cable-Laying.

Not a second was to be lost, for it was evident that the cut portion must be paid overboard in a few minutes; and in the meantime the tedious and difficult operation of making a splice had to be performed. The ship was immediately stopped, and no more cable paid out than was absolutely necessary to prevent it breaking. As the stern of the ship was lifted by the waves a scene of the most intense excitement followed. It seemed impossible, even by using the greatest possible speed and paying out the least possible amount of cable, that the junction could be finished before the part was taken out of the hands of the workmen. The main hold presented an extraordinary scene. Nearly all the officers of the ship and of those connected with the expedition stood in groups about the coil, watching with intense anxiety the cable as it slowly unwound itself nearer and nearer the joint, while the workmen worked at the splice as only men could work who felt that the life and death of the expedition depended upon their rapidity. But all their speed was to no purpose, as the cable was unwinding within a hundred fathoms; and, as a last and desperate resource, the cable was stopped altogether, and for a few minutes the ship hung on by the end. Fortunately, however, it was only for a few minutes, as the strain was continually rising above two tons and it would not hold on much longer. When the splice was finished the signal was made to loose the stoppers, and it passed overboard in safety.

When the excitement, consequent upon having so narrowly saved the cable, had passed away, we awoke to the consciousness that the case was yet as hopeless as ever, for the electrical continuity was still entirely wanting.

Preparations were consequently made to pay out as little rope as possible, and to hold on for six hours in the hope that the fault, whatever it was, might mend itself, before cutting the cable and returning to the rendezvous to make another splice. The magnetic needles on the receiving-instruments were watched closely for the returning signals, when, in a few minutes, the last hope was extinguished by their suddenly indicating dead earth, which tended to show that the cable had broken from the Niagara, or that the insulation had been completely destroyed.

Nothing, however, could be done. The only course was to wait until the current should return or take its final departure. And it *did* return—with greater strength than ever—for in three minutes every one was agreeably surprised by the intelligence that the stoppage had disappeared and that the signals had again appeared at their regular intervals from the Niagara[36] It is needless to say what a load of anxiety this news removed from the minds of every one, but the general confidence in the ultimate success of the operations was much shaken by the occurrence, for all felt that every minute a similar accident might occur.

For some time the paying out continued as usual, but toward the morning another damaged place was discovered in the cable. There was fortunately time, however, to repair it in the hold without in any way interfering with the operations, beyond for a time reducing slightly the speed of the ship. During the morning of Friday, the 30th, everything went well. The ship had been kept at the speed of about five knots, the cable going out at six, the average angle with the horizon at which it left the ship being about 15°, while the indicated strain upon the dynamometer seldom showed more than 1,600 lbs. to 1,700 lbs.

Observations made at noon showed that we had made good ninety miles from the starting-point since the previous day, with an expenditure—including the loss in lowering the splice, and during the subsequent stoppages—of 135 miles of cable. During the latter portion of the day the barometer fell considerably, and toward the evening it blew almost a gale of wind from the eastward, dead ahead of our course. As the breeze freshened the speed of the engines was gradually increased, but the wind more than increased in proportion, so that before the sun went down the Agamemnon was going full steam against the wind, only making a speed of about four knots.

During the evening, topmasts were lowered, and spars, yards, sails, and indeed everything aloft that could offer resistance to the wind, were sent down on deck. Still the ship made but little way, chiefly in consequence of the heavy sea, though the enormous quantity of fuel consumed showed us that if the wind lasted, we should be reduced to burning the masts, spars, and even the decks, to bring the ship into Valentia. It seemed to be our particular ill-fortune to meet with head-winds whichever way the ship's head was turned. On our journey out we had been delayed and obliged to consume an undue proportion of coal for want of an easterly wind, and now all our fuel was wanted *because* of one. However, during the next day the wind gradually went round to the southwest, which, though it raised a very heavy sea, allowed us to husband our small remaining store of fuel.

At noon on Saturday, July 31st, observations showed us to be in lat. 52° 23´ N., and long. 26° 44´ W., having made good 120 miles of distance since noon of the previous day, with a loss of about 27 per cent of cable. The Niagara, as far as could be judged from the amount of cable she paid out—which by a previous arrangement was signaled at every ten miles—kept pace with us, within one or two miles, the whole distance across.

During the afternoon of Saturday, the wind again freshened up, and before nightfall it blew nearly a gale of wind, and a tremendous sea ran before it from the southwest, which made the Agamemnon pitch and toss to such an extent that it was thought impossible the cable could hold through the night. Indeed, had it not been for the constant care and watchfulness exercised by Mr. Bright and the two energetic engineers, Mr. Canning and Mr. Clifford, who acted with him, it could not have been done at all. Men were kept at the wheels of the machine to prevent their stopping (as the stern of the ship rose and fell with the sea), for had they done so, the cable must undoubtedly have parted. During Sunday the sea and wind increased, and before the evening it blew a smart gale.

Now, indeed, were the energy and activity of all engaged in the operation tasked to the utmost. Mr. Hoar and Mr. Moore—the two engineers who had the charge of the relieving-wheels of the dynamometer—had to keep watch and watch alternately every four hours, and while on duty durst not let their attention be removed from their occupation for one moment; for on their releasing the brakes every time the stern of the ship fell into the trough of the sea entirely depended the safety of the cable, and the result shows how ably they discharged their duty.

Throughout the night there were few who had the least expectation of the cable holding on till morning, and many lay awake listening for the sound that all most dreaded to hear, viz., the gun which should announce the failure of all our hopes. But still the cable—which in comparison with the ship from which it was paid out, and the gigantic waves among which it was delivered, was but a mere thread—continued to hold on, only leaving a silvery phosphorescent line upon the stupendous seas as they rolled on toward the ship.

With Sunday morning came no improvement in the weather, still the sky remained black and stormy to windward, and the constant violent squalls of wind and rain which prevailed during the whole day served to keep up, if not to augment, the height of the waves.

But the cable had gone through so much during the night that our confidence in its continuing to hold was much restored. At noon observation showed us to be in lat. 52° 26´ N., and long. 23° 16´ W., having made good 130 miles from noon of the previous day, and about 350 from our starting-point in mid-ocean. We had passed by the deepest soundings of 2,400 fathoms, and over more than half of the deep water generally, while the amount of cable still remaining in the ship was more than sufficient to carry us to the Irish coast, even supposing the continuance of the bad weather, should oblige us to pay out nearly the same amount of slack cable as hitherto.

Thus far things looked promising for our ultimate success. But former experience showed us only too plainly that we could never suppose that some accident might not arise until the ends had been fairly landed on the opposite shores.

During Sunday night and Monday morning the weather continued as boisterous as ever. It was only by the most indefatigable exertions of the engineer upon duty that the wheels could be prevented from stopping altogether as the vessel rose and fell with the sea; and once or twice they did come completely to a standstill in spite of all that could be done to keep them moving. Fortunately, however, they were again set in motion before the stern of the ship was thrown up by the succeeding wave. No strain could be placed upon the cable, of course, and though the dynamometer occasionally registered 1,700 lbs., as the ship lifted, it was oftener below 1,000 lbs., and was frequently nothing, the cable running out as fast as its own weight and the speed of the ship could draw it. But even with all these forces acting unresistingly upon it, the cable never paid itself out at a greater speed than eight knots at the time the ship was going at the rate of six knots and a half. Subsequently, however, when the speed of the ship even exceeded six knots and a half, the cable never ran out so quickly. The average speed maintained by the ship up to this time, and, indeed, for the whole voyage, was about five knots and a half, the cable, with occasional exceptions, running some 30 per cent faster.

At noon on Monday, August 2d, observations showed us to be in lat. 52° 35´ N., long. 19° 48´ W. Thus we had made good 127½ miles since noon of the previous day and had completed more than half-way to our ultimate destination.

During the afternoon, an American three-masted schooner, which afterward proved to be the Chieftain, was seen standing from the eastward toward us. No notice was taken of her at first, but when she was within about half a mile of the Agamemnon, she altered her course and bore right down across our bows. A collision which might prove fatal to the cable now seemed inevitable; or could only be avoided by the equally hazardous expedient of altering the Agamemnon’s course. The Valorous steamed ahead and fired a gun for her to heave to, which as she did not appear to take much notice of, was quickly followed by another from the bows of the Agamemnon, and a second and third from the Valorous. But still the vessel held on her course; and, as the only resource left to avoid a collision, the course of the Agamemnon was altered just in time to pass within a few yards of her. It was evident that our proceedings were a source of the greatest possible astonishment to them, for all her crew crowded upon her deck and rigging. At length they evidently discovered who we were and what we were doing, for the crew manned the rigging, and, dipping the ensign several times, they gave us three hearty cheers. Though the Agamemnon was obliged to acknowledge these congratulations in due form, the feeling of annoyance with which we regarded the vessel—which (either by the stupidity or carelessness of those on board) was so near adding a fatal and unexpected mishap to the long chapter of accidents which had already been encountered—may easily be imagined.

To those below—who, of course, did not see the ship approaching—the sound of the first gun came like a thunderbolt, for all took it as a signal of the breaking of the cable. The dinner-tables were deserted in a moment, and a general rush made up the hatches to the deck; but before reaching it their fears were quickly banished by the report of the succeeding gun, which all knew well could only be caused by a ship in our way or a man overboard.

Throughout the greater part of Monday morning the electrical signals from the Niagara had been getting gradually weaker, until they ceased altogether for nearly three-quarters of an hour. Then Professor Thomson sent a message to the effect that the signals were too weak to be read; and, in a little while, the deflections returned even stronger than they had ever been before. Toward the evening, however, they again declined in force for a few minutes.[37]

With the exception of these little stoppages, the electrical condition of the submerged wire seemed to be much improved. It was evident that the low temperature of the water at the immense depth improved considerably the insulating properties of the gutta-percha, while the enormous pressure to which it must have been subjected probably tended to consolidate its texture, and to fill up any air-bubbles or slight faults in manufacture which may have existed.

The weather during Monday night moderated a little; but still there was a very heavy sea on, which endangered the wire every second minute.

About three o'clock on Tuesday morning all on board were startled from their beds by the loud booming of a gun. Every one—without waiting for the performance of the most particular toilet—rushed on deck to ascertain the cause of the disturbance. Contrary to all expectation, the cable was safe; but just in the gray light could be seen the Valorous—rounded to in the most warlike attitude—firing gun after gun in quick succession toward a large American bark, which, quite unconscious of our proceedings, was standing right across our stern. Such loud and repeated remonstrances from a large steam-frigate were not to be despised; and evidently without knowing the why or the wherefore she quickly threw her sails aback, and remained hove to. Whether those on board her considered that we were engaged in some filibustering expedition, or regarded our proceedings as another outrage upon the American flag, it is impossible to say; but certain it is that—apparently in great trepidation—she remained hove to until we had lost sight of her in the distance.

Tuesday was a much finer day than any we had experienced for nearly a week, but still there was a considerable sea running, and our dangers were far from past; yet the hopes of our ultimate success ran high. We had accomplished nearly the whole of the deep portions of the route in safety, and that, too, under the most unfavorable circumstances possible; therefore there was every reason to believe that—unless some unforeseen accident should occur—we should accomplish the remainder. Observations at noon placed us in lat. 5° 26´ N., long. 16° 7´ 40´´ W., having run 134 miles since the previous day.

About five o'clock in the evening the steep submarine mountain which divides the steep telegraphic plateau from the Irish coast was reached, and the sudden shallowing of water had a very marked effect upon the cable, causing the strain and the speed to lessen every minute. A great deal of slack was paid out,[38] to allow for any greater inequalities which might exist, though undiscovered by the sounding-line.

About ten o'clock the shoal water of 250 fathoms was reached. The only remaining anxiety now was the changing from the lower main coil to that upon the upper deck; and this most dangerous operation was successfully performed between three and four o'clock on Wednesday morning.

Wednesday was a beautiful, calm day; indeed, it was the first on which any one would have thought of making a splice since the day we started from the rendezvous. We therefore congratulated ourselves on having saved a week by commencing operations on the Thursday previous.

At noon we were in lat. 52° 11´; long. 12° 40´ 2´´ W., eighty-nine miles distant from the telegraph station at Valentia. The water was shallow, so that there was no difficulty in paying out the wire almost without any loss by slack; and all looked upon the undertaking as virtually accomplished.

At about one o'clock in the evening the second change from the upper-deck coil to that upon the orlop-deck was safely effected; and shortly after the vessels exchanged signals that they were in 200 fathoms water.

As night advanced the speed of the ship was reduced, as it was known that we were only a short distance from the land, and there would be no advantage in making it before daylight in the morning. At about twelve o'clock, however, the Skelligs Light was seen in the distance, and the Valorous steamed on ahead to lead us in to the coast, firing rockets at intervals to direct us, which were answered by us from the Agamemnon, though—according to Mr. Moriarty, the master's, wish—the ship, disregarding the Valorous, kept her own course, which proved to be the right one in the end.

By daylight on the morning of Thursday, the 5th, the bold rocky mountains which entirely surround the wild and picturesque neighborhood of Valentia rose right before us at a few miles distance. Never, probably, was the sight of land more welcome, as it brought to a successful termination one of the greatest, but at the same time most difficult, schemes which was ever undertaken. Had it been the dullest and most melancholy swamp on the face of the earth that lay before us, we should have found it a pleasant prospect; but as the sun rose behind the estuary of Dingle Bay, tingeing with a deep, soft purple the lofty summits of the steep mountains which surround its shores, illuminating the masses of morning vapor which hung upon them, it was a scene which might vie in beauty with anything that could be produced by the most florid imagination of an artist.

Successful Termination.—No one on shore was apparently conscious of our approach, so the Valorous went ahead to the mouth of the harbor and fired a gun. Both ships made straight for Doulas Bay, the Agamemnon steaming into the harbor (see Frontispiece) with a feeling that she had done something, and about 6 A.M. came to anchor at the side of Beginish Island, opposite to Valentia.

As soon as the inhabitants became aware of our approach, there was a general desertion of the place, and hundreds of boats crowded round us—their passengers in the greatest state of excitement to hear all about our voyage. The Knight of Kerry was absent in Dingle, but a messenger was immediately despatched for him, and he soon arrived in her Majesty's gunboat Shamrock.

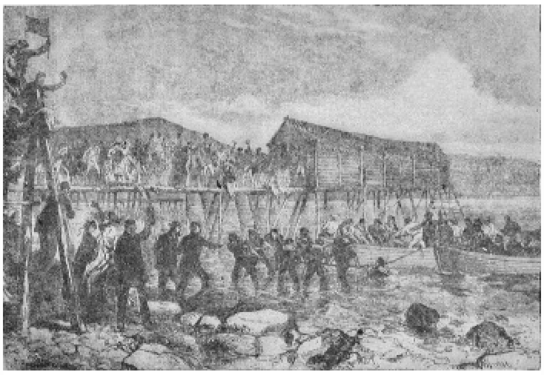


Fig. 29.—Landing the American End.

Soon after our arrival a signal was received from the Niagara that they were preparing to land, having paid out 1,030 nautical miles of cable, while the Agamemnon had accomplished her portion of the distance with an expenditure of 1,020 miles, making the total length of the wire submerged 2,050 geographical miles.

Immediately after the ships cast anchor, the paddle-box boats of the Valorous were got ready, and two miles of cable coiled away in them, for the purpose of landing the end. But it was late in the afternoon before the procession of boats left the ship, under a salute of three rounds of small arms from the detachment of marines on board the Agamemnon, under the command of Lieutenant Morris.

The progress of the end to the shore was very slow, in consequence of the stiff wind which blew at the time; but at about 3 P.M. the end was safely brought on shore at Knight's Town, Valentia, by Mr. Bright, to whose exertions the success of the undertaking is attributable. Mr. Bright was accompanied by Mr. Canning and the Knight of Kerry. The end was immediately laid in the trench which had been dug to receive it; while a royal salute, making the neighboring rocks and mountains reverberate, announced that the communication between the Old and New World had been completed.

The cable was taken into the electrical room by Mr. Whitehouse, and attached to a galvanometer, and the first message was received through the entire length now lying on the bed of the sea.

Too much praise can not be bestowed upon both the officers and men of the Agamemnon for the hearty way in which they have assisted in the arduous and difficult service they have been engaged in; and the admirable manner in which the ship was navigated by Mr. Moriarty materially reduced the difficulty of the company's operations.

It will, in all probability, be nearly a fortnight before the instruments are connected at the two termini for the transmission of regular messages.

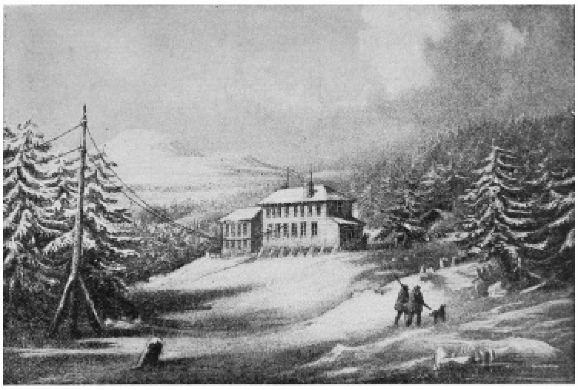


Fig. 30.—Newfoundland Telegraph Station, 1858.

It is unnecessary here to expatiate upon the magnitude of the undertaking which has just been completed, or upon the great political and social results which are likely to accrue from it; but there can be but one feeling of universal admiration for the courage and perseverance which have been displayed by Mr. Bright, and those who acted under his orders, in encountering the manifold difficulties which arose on their path at every step.[39]

The American End.—In contradistinction to the heavy seas and difficulties the Agamemnon had to contend with, her consort, the Niagara, experienced very quiet weather, and her part of the work was comparatively uneventful, with the exception of a fault near the bottom of the ward-room coil. This was detected during the operations on the night of August 2d, but was removed before it was paid out into the sea. About four o'clock the next morning the continuity and insulation was accordingly restored, and, says Mr. Mullaly (the New York Herald correspondent on board), "all was going on as if nothing had occurred to disturb the confidence we felt in the success of the expedition."

When nearing the end, various icebergs were met with—some a hundred feet high. Mullaly dilates on their castle-like form and the effective appearance of the sun's rays thereon. Shortly after entering Trinity Bay, Newfoundland, the Niagara was met by H.M.S. Porcupine, which had been sent out from England at the very beginning of the 1858 expedition to await her arrival and render any assistance which might be required. The Niagara anchored about 1 A.M. on August 5th, having completed her work, and, during the forenoon of that day, the cable was landed in a little bay, Bull Arm,[40] at the head of Trinity Bay, when they "received very strong currents of electricity through the whole cable from the other side of the Atlantic."[41]

The telegraph-house at the Newfoundland end was some two miles from the beach, and connected to the cable by a land-line.

CHAPTER IX

THE CELEBRATION

Engineer's Report—Jubilations—Banquets—Speeches—Honor to the Engineer-in-Chief.

On landing at Valentia, the engineer-in-chief at once sent the following startling but welcome message to his Board, which was at once passed on to the press:

Charles Bright, to the Directors of the Atlantic Telegraph Company.

Valentia, *August 5th*.

The Agamemnon has arrived at Valentia, and we are about to land the end of the cable.

The Niagara is in Trinity Bay, Newfoundland. There are good signals between the ships.

We reached the rendezvous on the night of the 28th, and the splice with the Niagara cable was made on board the Agamemnon the following morning.

By noon on the 30th, 265 nautical miles were laid between the ships; on the 31st, 540; on the 1st August, 884; on the 2d, 1,256; on the 4th, 1,854; on anchoring at six in the morning in Doulas Bay, 2,022.

The speed of the Niagara during the whole time has been nearly the same as ours, the length of cable paid out from the two ships being generally within ten miles of each other.

With the exception of yesterday, the weather has been very unfavorable.[42]

On the afternoon of Thursday, August 5th—as already described in The Times report—Bright and his staff brought to shore the end of the cable, at White Strand Bay, near Knight's Town, Valentia, in the boats of the Valorous, welcomed by the united cheers of the small crowd assembled.

Taken entirely by surprise, all England applauded the triumph of such undaunted perseverance and the engineering and nautical skill displayed in this victory over the elements. The Atlantic Telegraph had been justly characterized as the "great feat of the century," and this was reechoed by all the press on its realization. The following extracts from the leading article of The Times the day after completion is an example of the comments upon the achievement:

Mr. Bright, having landed the end of the Atlantic cable at Valentia, has brought to a successful termination his anxious and difficult task of linking the Old World with the New, thereby annihilating space. Since the discovery of Columbus, nothing has been done in any degree comparable to the vast enlargement which has thus been given to the sphere of human activity.

The rejoicing in America, both in public and private, knew no bounds. The astounding news of the success of this unparalleled enterprise, after such combats with storm and sea, "created universal enthusiasm, exultation, and joy, such as was, perhaps, never before produced by any event, not even the discovery of the Western Hemisphere. Many had predicted its failure, some from ignorance, others simply because they were anti-progressives by nature. Philanthropists everywhere hailed it as the greatest event of modern times, heralding the good time coming of universal peace and brotherhood."

In Newfoundland, Mr. Field, together with Mr. Bright's assistant engineers, Messrs. Everett and Woodhouse, and the electricians, Messrs, de Sauty and Laws, received the heartiest congratulations and welcome from the Governor and Legislative Council of the colony. While acknowledging these congratulations, Mr. Field remarked. "We have had many difficulties to surmount, many discouragements to bear, and some enemies to overcome, whose very opposition has stimulated us to greater exertion."[43]

It was a curious coincidence that the cable was successfully completed to Valentia on the same day in 1858 on which the shore end had been landed the year before. Moreover, it was exactly one hundred and eleven years since Dr. (afterward Sir William) Watson had astonished the scientific world by sending an electric current through a wire two miles long, using the earth as a return circuit. It is also worthy of note that the first feat of telegraphy was executed by order of King "Agamemnon" to his queen, announcing the fall of Troy, 1,084 years before the birth of Christ, and that the great feat which we have narrated was carried out by the great ship Agamemnon, as has been here shown.

Mr. Bright and Messrs. Canning and Clifford and the rest of the staff, as well as Professor Thomson and the electricians, were absolutely exhausted with the incessant watching and almost unbearable anxiety attending their arduous travail. Valentia proved a haven of rest indeed for these "toilers of the deep"—completely knocked up with their experiences on the Atlantic, not to mention their previous trials and disappointments.

Then came a series of banquets, which had to be gone through. Soon after his duties at Valentia were over, Bright made his way to Dublin. Here he was entertained by the Lord Mayor and civic authorities of that capital on Wednesday, September 1st. On this occasion Cardinal Wiseman, who was present, made an eloquent speech; and the following account of the proceedings from the Morning Post may be suitably quoted:

The banquet given on Wednesday, the 1st, by the Lord Mayor of Dublin, to Mr. C. T. Bright, Engineer-in-Chief to the Atlantic Telegraph Company, was a great success. The assemblage embraced the highest names in the metropolis—civil, military, and official. Cardinal Wiseman was present in full cardinalite costume. The usual toasts were given, and received with all honors.

The Lord Mayor, in proposing the toast of the evening, "The health of Mr. Bright," dwelt with much eloquence on the achievements of science, and paid a marked and merited compliment to the genius and perseverance which, in the face of discouragement from the scientific world, had succeeded in bringing about the accomplishment of the great undertaking of the laying of the Atlantic telegraph. His lordship's speech was most eloquent, and highly complimentary to the distinguished guest, Mr. C. T. Bright.

Mr. Bright rose, amid loud cheers, to respond. He thanked the assemblage for their hearty welcome, and said he was deeply sensible of the honor of having his name associated with the great work of the Atlantic Telegraph. He next commented upon the value of this means of communication for the prevention of misunderstanding between the Governments of the great powers, and then referred to the services of the gentlemen who had been associated with him in laying the cable, with whom he shared the honors done him that night. (Mr. Bright was warmly cheered throughout his eloquent speech.)

His Eminence the Cardinal descanted in glowing terms on the new achievement of science, brought to a successful issue under the able superintendence of Mr. Bright. He warmly eulogized that gentleman's modest appreciation of his services to the world of commerce and to international communication in general.

Charles Bright was honored with a knighthood within a few days of landing. As this was considered a special occasion, and as Queen Victoria was at that time abroad, the ceremony was performed there and then by his Excellency the Lord-Lieutenant of Ireland on behalf of her Majesty. Bright was but twenty-six years of age at the time, being the youngest man who had received the distinction for generations past, and no similar instance has since occurred. Moreover, it was the first title conferred on the telegraphic or electrical profession, and remained so for many years.

With Professor Thomson and other colleagues, Sir Charles Bright was right royally entertained in Dublin, Killarney, and elsewhere, the Lord-Lieutenant taking a prominent part in the celebrations. On the occasion of the Killarney banquet, his Excellency made the following remarks *à propos* of the cable and its engineers:[44]

When we consider the extraordinary undertaking that has been accomplished within the last few weeks; when we consider that a cable of about 2,000 miles has been extended beneath the ocean—a length which, if multiplied ten times, would reach our farthest colonies and nearly surround the earth; when we consider it is stretched along the bed of shingles and shells, which appeared destined for it as a foundation by Providence, and stretching from the points which human enterprise would look to; and when we consider the great results that will flow from the enterprise, we are at a loss here how sufficiently to admire the genius and energy of those who planned it, or how to be sufficiently thankful to the Almighty for having delegated such a power to the human race, for whose benefit it is to be put in force. (Cheers.) And let us look at the career which this telegraph has passed since it was first discovered. At first it was rapidly laid over the land, uniting states, communities, and countries, extending over hills and valleys, roads and railways; but the sea appeared to present an impenetrable barrier. It could not stop here, however; submarine telegraphy was but a question of time, and the first enterprise by which it was introduced was in connection with an old foe—and at present our best friend—Imperial France. (Hear, hear.) The next attempt which was successful was the junction of England and our island, and which was, I believe, carried out by the same distinguished engineer (Sir Charles Bright), whose name is now in the mouth of every man. (Hear, hear.) Other submarine attempts followed: the telegraph paused before the great Atlantic, like another Alexander, weeping as if it had no more worlds to conquer; but it has found another world, and it has gained it—not bringing strife or conquest, but carrying with it peace and good-will. (Applause.) I feel I should be wanting if I did not allude in terms of admiration to the genius and skill of the engineer, Sir Charles Bright, who has carried out this enterprise, and to the zeal and courage of those who brought it to a successful termination. (Applause.) It is not necessary, I am certain, to call attention to the diligence and attention shown by the crew of the Agamemnon—(cheers)—because I am sure there is no one here who has not read the description of the voyage in the newspapers. The zeal and enterprise were only to be equaled by the skill with which it was carried out. I believe there was only a difference of twelve miles between the two ends of the cable when it came to the shore. There are some questions with regard to the date at which the work was carried out to which I wish to call attention. It was on the 5th August, 1857, that this enterprise was first commenced under the auspices of my distinguished predecessor, who I wish was here now to rejoice in its success—I mean only in a private capacity. (Cheers and laughter.) It was on the 5th August, 1858, it was completed, and it was on the 5th August, more than three hundred years ago, that Columbus left the shores of Spain to proceed on his ever-memorable voyage to America. It was on the 5th of August, 1583, that Sir Hugh Gilbert, a worthy countryman of Raleigh and Drake, steered his good ship the Squirrel to the shores of Newfoundland and first unfurled the flag of England in the very bay where this triumph has now taken place—(applause)—and it was on the same 5th of August that your sovereign was received by her imperial friend amid the fortifications of Cherbourg, and thereby put an end to the ridiculous nonsense about strife and dissension. (Applause.) Let the 5th August be a day ever memorable among nations. Let it be, if I may so term it, the birthday of England. (Applause.) Among the many points which must have given every one satisfaction was the manner in which this great success was received in America. (Hear.) There appears to have been but one feeling of rejoicing predominant among them; and I can not but think that that was not only owing to their commercial enterprise—which they shared along with us—but also, I trust, more to the feelings of consanguinity and affection which I am sure we share, though occasionally disturbed by international disputes, and by differences caused by misrepresentations or hastiness. It must still burn as brightly in their breasts as in ours. (Applause.) I trust that, not only with our friends across the Atlantic, but with every civilized nation, this great triumph of science will prove the harbinger of peace, good-will, and friendship; and that England and America will not verify the first line of the stanza,

Lands intersected by a narrow firth
Abhor each other,

but that they will, by mutual intercourse, arrive at the last line of that stanza, and "like kindred drops, be mingled into one." (Warm applause.)

CHAPTER X

WORKING THE LINE

Tests—Apparatus—First Messages—Gradual Failing—The "Last Gasp"—Engineering Success—Electrical Failure.

Continuity Tests during Laying.—As previously mentioned, two descriptions of instruments were used on board the ships for testing and working through while laying the cable. These were the "detector" of Mr. Whitehouse and Professor Thomson's reflecting-apparatus.

The process of testing consisted in sending from one to the other vessel alternately, during a period of ten minutes, first a reversal every minute for five minutes, and then a current in one direction for five minutes. The results of these signals to test the continuity of the line were observed and recorded on board both ships. There was also a special signal for each ten miles of cable paid out between the vessels.

When the splice was made on July 29th, 72 degrees deflection were obtained on the Agamemnon, from seventy-five cells of a sawdust (Daniell's) battery on board the Niagara, which had previously given 83 degrees. On arrival at Valentia at 6.30 A.M., on August 5th, the deflection on the same instruments (detector and marine galvanometer being both in circuit as before) was 68 degrees, while the sending-battery power on the Niagara had fallen off at entry to 62½ degrees through the marine galvanometer on board that vessel. These figures show that the insulation of the cable had considerably improved by submersion, and when the engineers had accomplished their part of the undertaking, on August 5th, the cable was handed over in perfect condition to Mr. Whitehouse and his electrical assistant.

Apparatus Used in Working.—Unfortunately for the life of the cable, Mr. Whitehouse was imbued with a belief that currents of very high intensity, or potential, were the best for signaling; and he had enormous induction-coils, *five feet long*, excited by a series of very large cells, yielding electricity estimated at about 2,000 volts potential. The insulation was unable to bear the strain, and thus the signals began to gradually fail.[45]

For something like a week the efforts to work through the cable with the above apparatus proved ineffectual, the power being constantly increased to no purpose. Professor Thomson's reflecting galvanometer, which had worked so well during the voyage, was then used again with ordinary Daniell cells.

Messages.—In this way communication was resumed, the first clear message being received from Newfoundland on August 13, 1858, and—after considerable delay in getting the American receiving-apparatus ready—on the 16th the following was got through from the directors in England to those in United States:

> Europe and America are united by telegraphy. Glory to God in the highest, on earth peace, good-will toward men!

Then followed:

> From her Majesty the Queen of Great Britain to his Excellency the President of the United States:
>
> The Queen desires to congratulate the President upon the successful completion of this great international work, in which the Queen has taken the greatest interest.
>
> The Queen is convinced that the President will join with her in fervently hoping that the electric cable, which now already connects Great Britain with the United States, will prove an additional link between the two nations, whose friendship is founded upon their common interest and reciprocal esteem.
>
> The Queen has much pleasure in thus directly communicating with the President, and in renewing to him her best wishes for the prosperity of the United States.

This message was shortly afterward responded to as follows:

> Washington City.
>
> The President of the United States to her Majesty
> Victoria, Queen of Great Britain:
>
> The President cordially reciprocates the congratulations of her Majesty the Queen on the success of the great international enterprise accomplished by the skill, science, and indomitable energy of the two countries.
>
> It is a triumph more glorious, because far more useful to mankind than was ever won by a conqueror on the field of battle.
>
> May the Atlantic Telegraph, under the blessing of Heaven, prove to be a bond of perpetual peace and friendship between the kindred nations, and an instrument destined by Divine Providence to diffuse religion, civilization, liberty, and law throughout the world.
>
> In this view will not all the nations of Christendom spontaneously unite in the declaration that it shall be forever neutral and that its communications shall be held sacred in passing to the place of their destination, even in the midst of hostilities?
>
> James Buchanan.

Throughout the United States the arrival of the Queen's message was the signal for a fresh outburst of popular enthusiasm.

Says Field:

> The next morning, August 17th, the city of New York was awakened by the thunder of artillery. A hundred

guns were fired in the City Hall Park at daybreak, and the salute was repeated at noon. At this hour flags were flying from all the public buildings, and the bells of the principal churches began to ring, as Christmas bells signal the birthday of One who came to bring peace and good-will to men—chimes that, it was fondly hoped, might usher in, as they should, a new era.

Ring out the old, ring in the new,
Ring out the false, ring in the true.

That night the city was illuminated. Never had it seen so brilliant a spectacle. Such was the blaze of light around the City Hall that the cupola caught fire and was consumed, and the hall itself narrowly escaped destruction. But one night did not exhaust the public enthusiasm, for the following evening witnessed one of those displays for which New York surpasses all the cities of the world—a firemen's torchlight procession. Moreover, several wagon-loads (each containing about twelve miles) of the cable left on board the Niagara were drawn through the principal streets of the city.

Similar demonstrations took place in other parts of the United States. From the Atlantic to the Valley of the Mississippi, and to the Gulf of Mexico, in every city was heard the firing of guns and the ringing of bells. Nothing seemed too extravagant to give expression to the popular rejoicing.

The English press were warm in their recognition of those to whom the nation were "indebted for bringing into action the greatest invention of the age," expressing belief that "the effect of bringing the three kingdoms and the United States into instantaneous communication with each other will be to render hostilities between the two nations almost impossible for the future." And further, "more was done yesterday for the consideration of our empire than the wisdom of our statesmen, the liberality of our legislature, or the loyalty of our colonists could ever have effected."[46]

The sermons preached on the subject, both in England and America, were literally without number. Enough found their way into print to fill over one volume. Never had an event more deeply touched the spirit of religious enthusiasm.

With further reference to the active life of the cable, the following communications have some interest:

First of all three long congratulatory messages were transmitted, one on August 18th from Mr. Peter Cooper, president of the New York, Newfoundland, and London Telegraph Company, to the directors of the Atlantic Telegraph Company; another from the Mayor of New York to the Lord Mayor of London, his reply in acknowledgment following. Then two of the great Cunard mail-steamers, the Europa and Arabia, had come into collision on August 14th. Neither the news nor the injured vessels could reach those concerned on either side of the Atlantic for some days; but as soon as it became known in New York a message was sent by the cable, a facsimile of the original of which is shown on p. 150. This first public *news* message showed the relief given by speedy knowledge in dispelling doubt and fear.

Subsequently messages giving the news on both continents were transmitted and published daily. Among others, on August 27th, a despatch was sent by the secretary of the Atlantic Telegraph Company that was remarkable for the amount of important information contained in comparatively few words. It read as follows:

To Associated Press, New York.—News for America by Atlantic cable:—Emperor of France returned to Paris, Saturday. King of Prussia too ill to visit Queen Victoria. Her Majesty returns to England, August 30th. St. Petersburg, August 21st—Settlement of Chinese Question: Chinese Empire opened to trade; Christian religion allowed; foreign diplomatic agents admitted; indemnity to England and France.

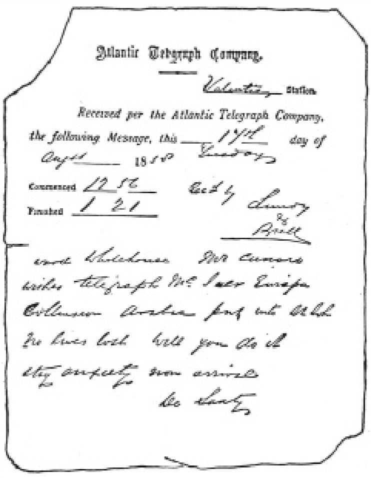

Atlantic Telegraph Company.
Valentia Station.
Received per the Atlantic Telegraph Company, the following Message, this 17th day of Augst 1858
Commenced 12 56
Finished 1 21

Fig. 31.—Facsimile of the First Public News Message Received through the Atlantic Cable.

Alexandria, August 9th.—The Madras arrived at Suez 7th inst. Dates Bombay to the 19th, Aden 31st. Gwalior insurgent army broken up. All India becoming tranquil.

The above was published in the American papers the same day.

Further, as exemplifying the aid the cable afforded to the British Government, mention may be made of two messages sent from the commander-in-chief at the Horse Guards, on August 31st. Following the quelling of the Indian mutiny, they were despatched for the purpose of canceling previous orders which had already gone by mail to Canada.

The first, to General Trollope, Halifax, ran as follows: "The Sixty-second Regiment is not to return to England." The other, to the officer in command at Montreal: "The Thirty-ninth Regiment is not to return to England." From £50,000 to £60,000 was estimated by the authorities to have been saved, in the unnecessary transportation of troops, by these two cable communications.

But the insulation of the precious wire had, unhappily, been giving way. The high-potential currents from Mr. Whitehouse's enormous induction-coils were too much for it; and the diminished flashes of light proved to be only the flickering of the flame that was soon to be extinguished in the external darkness of the waters. After a period of confused signals, the line ultimately breathed its last on October 20th, after 732 messages in all had been conveyed during a period of three months.[47] The last word uttered—and which may be said to have come from beyond the sea—was "forward."

The line had been subject to frequent interruptions throughout. The wonder is that it did so much, when we consider the lack of experience at that period in the manufacture of deep-sea cables, the short time allowed, and, more than all, the treatment received after being laid. It is, indeed, extremely doubtful whether any cable, even of the present day, would long stand a trial with currents so generated, and of such intensity.[48] An unusually violent lightning-storm occurred at Newfoundland shortly after the cable had been laid. This was considered a part cause of the actual failure of the line.

When all the efforts of the electricians failed to draw more than a few faint whispers—a dying gasp from the depths of the sea—there ensued, in the public mind, a feeling of profound discouragement. But what a bitter disappointment for those officially concerned in the enterprise! In all the experience of life there are no sadder moments than those in which, after much anxious toil in striving for a great object, and after a glorious triumph, the achievement that seemed complete becomes a wreck.

Engineering Demonstration.—Still the engineer of this great undertaking had the satisfaction of knowing that he had demonstrated (1) the possibility of laying over 2,000 miles of cable in one continuous length across a by no means calm ocean at depths of two to three miles; and (2) that, by the agency of an electric current, distinct and regular signals could be transmitted and received throughout an insulated conductor, even when at such a depth beneath the sea, across this vast distance. The feasibility of either of these had been scouted at on all sides.[49]

Of course the gutta-percha coverings as then applied can not be compared with the methods and materials of later days, though a great advance on that of previous cables. It was a pity that—owing to the precipitation with which the undertaking was rushed through, and the fear of failure for want of capital—more time was not given to the consideration of Bright's recommendation for a conductor four times larger, with a corresponding increase in the gutta-percha insulator. Under such conditions, it is highly improbable that high potentials would have ever been applied to the line. Unhappily—besides Faraday and Whitehouse—Professor Morse (when advising the Board in this matter) promulgated views directly opposed to the above, as has already been shown. In the course of his report Morse had said:

> That by the use of comparatively small-coated wires, and of electro-magnetic induction-coils for the exciting-magnets, telegraphic signals can be transmitted through two thousand miles, with a speed amply sufficient for all commercial and economical purposes.

Still the cable, inadequately constructed as it was from an electrical point of view, would probably have worked for years—though slowly, of course—had the fairly reasonable battery-power employed between the ships and up to the successful termination of the expeditions been continued in connection with Professor Thomson's delicate reflecting-apparatus. The electrician, however, not only used much higher power immediately he took the cable in hand—for working his specially devised relay and Morse electromagnetic recording-instrument in connection with his enormous induction-coils—but actually increased the power from time to time up to nearly 500 cells, till the five-foot coils yielded a current urged by a potential of something like 2,000 volts. Hence, when signaling was resumed, as shown by the comparatively mild voltaic currents, for actuating the Thomson apparatus, a fault (or faults) had been already developed, necessitating a far higher battery-power than had been employed during the continuous communication between the ships while paying out.

The wounds opened farther under the various stimulating doses; the insulation was unable to bear the strain, and the circulation gradually ceased through a cable already in a state of dissolution.

CHAPTER XI

THE INQUEST

Expert Trials—Expert Evidence

THE great historical sea-line having collapsed, some of the foremost of the electrical profession were called in—first to determine the nature of the interruption with a view to possible remedy, next to elicit *the cause*.

Expert Opinions on the Failure.—Mr. Cromwell Fleetwood Varley, the electrician to the Electric Telegraph Company, Mr. E. B. Bright, the chief of the "Magnetic" Company; and Mr. W. T. Henley, the well-known telegraph inventor, were severally requested by the "Atlantic" Company to report on the subject in conjunction with Sir Charles Bright and Professor Thomson.

First of all the dead line was subjected to a series of tests. For this, resistance-coils and Messrs. Bright's apparatus for ascertaining the position of a fault were employed. There was every evidence of a serious electrical leakage about 300 miles from Valentia, but there did not appear to be any fracture in the conductor, as exceedingly weak currents still came through fitfully. According to the above location, the main leak through the gutta-percha envelope was in water of a depth of about two miles. At that time means were not devised for grappling and lifting a cable from such depths. But from independent tests by Thomson and Bright, it appeared likely that the Valentia shore end was also especially faulty. Accordingly, it was underrun from the catamaran-raft (previously used in 1857) for some three miles, but, on being cut at the farthest point at which it was found possible to raise the cable, the fault still appeared on the seaward side. The idea of repairs had, therefore, to be abandoned, and the cable was spliced up again.

The conductor being again intact, efforts were made to renew signals with the curb-key recently invented by Messrs. Bright. By means of this, currents of opposite character were transmitted so that each signaling current was followed instantly by one of opposite polarity, which neutralized, by a proportionate strength and duration, all that remained of its predecessor. Though this was the right principle on which to work, the "patient" was too far gone, and all efforts proved unavailing; for signaling purposes the poor cable was defunct.

Having dealt with the nature of the interruption, we now come to the *cause*. It was first of all abundantly clear from the station-diaries kept by the electricians at Valentia and Newfoundland, and by other irrefragable evidence, that when the laying was completed, and the cable ends were handed over to them from the ships on August 5th, all was in good working order.

The authorities were unanimous in their opinion. Mr. C. F. Varley declared that "had a more moderate power been used, the cable would still have been capable of transmitting messages." In giving extra force to the above opinion, Mr. Varley described an experiment he had made on the cable in conjunction with Mr. E. B. Bright:

> We attached to the cable a piece of gutta-percha-covered wire, having first made a slight incision, by a needle-prick, in the gutta-percha to let the water reach the conductor. The wire was then bent, so as to close up the defect. The defective wire was then placed in a jar of sea-water, and the latter connected with the earth. After a few momentary signals had been sent from the five-foot induction-coils into the cable, and, consequently into the test-wire, the intense current burst through the excessively minute perforation, rapidly burning a hole nearly one-tenth of an inch in diameter, afterward increased to half an inch in length when passing the current through the faulty branch only. The burned gutta-percha then came floating up to the surface of the water, while the jar was one complete glow of light.

Professor Hughes, the inventor of the type-printing telegraph, and, subsequently, of the microphone, considered that "the cable was injured by the induction-coils, and that the intense currents developed by them were strong enough to burst through gutta-percha." Professor Wheatstone gave a similar opinion.

Some one inquired of the electrician whether, if any one touched the cable at the time when the current was discharged from the induction-coil, he would receive a shock sufficiently strong to cause him to faint. It was admitted in reply that "those who touched the bare wire would suffer for their carelessness, though not if discretion be exercised by grasping the gutta-percha only."

The chairman of the company (the Right Honorable J. Stuart Wortley, M.P.), in the course of a deputation to Lord Palmerston later on, stated that "far too high charges of electricity were forced into the conductor. It was evidently thought at that time by certain electricians that you could not charge a cable of this sort too highly. Thus they proceeded somewhat like the man who bores a hole with a poker in a deal board; he gets the hole, to be sure, *but the board is burned in the operation*."

Professor Thomson (now Lord Kelvin), writing in 1860, expressed the following opinion:

> It is quite certain that, with a properly adjusted mirror-galvanometer as receiving-instrument at each end, twenty cells of Daniell's battery would have done the work required, and at even a higher speed if worked by a key devised for diminishing inductive embarrassment; and the writer—with the knowledge derived from disastrous experience—has now little doubt but that, if such had been the arrangement from the beginning, if no induction-coils and no battery-power exceeding twenty Daniell cells had ever been applied to the cable since the landing of its ends, imperfect as it then was, *it would be now in full work day and night, with no prospect or probability of failure*. [50]

Summing up the *cause* of the untimely ending to the ill-used cable, perhaps the concisest verdict would be, in mechanical-engineering *parlance*, that "high-pressure steam had been got up in a low-pressure boiler."

PART III

INTERMEDIATE KNOWLEDGE AND ADVANCE

CHAPTER XII

OTHER PROPOSED ROUTES

North Atlantic Telegraph Project—Exploring Expedition—Ice Troubles—South Atlantic Telegraph Project.

THE gradual failure of the 1858 cable after a short period of working, and the slow rate at which messages were capable of being transmitted, naturally deterred capitalists from providing the means for another cable of such length in deep water.

Several schemes, however, for a fresh line on other routes were brought forward; and there was an alternative route between Great Britain and America by which the transmission of the electric current could be subdivided into four comparatively short sections. This was known in 1860 as the North Atlantic Telegraph project, in which the route was from the extreme north of Scotland to the Faroe Islands, thence to Iceland; from there to the southern point of Greenland, and so on to Labrador or Newfoundland. The distances were (varying a little according to landing-places selected) approximately:

	Miles
From the north of Scotland to Faroe Islands	225
From the Faroe Islands to Iceland	280
From Iceland to Greenland, S. W. Harbor	700
From Greenland to Labrador	550
Total	1755

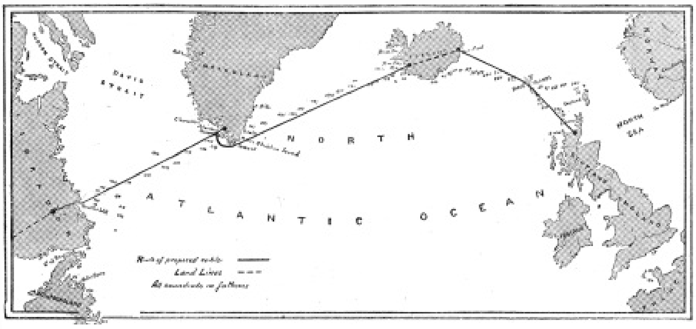


Fig. 32.—The North Atlantic Telegraph Project, 1860.

From the electrician’s point of view, these subdivisions were extremely favorable as compared with the long continuous length entailed by an Atlantic cable between Ireland and Newfoundland. Then, again, the soundings (except for a section between Greenland and Labrador) did not yield anything approaching the more southern depths. But against these obvious advantages there was the engineering objection—which at first seemed insurmountable—that the Greenland coast was bound up by ice for a great part of the year, in addition to the risk of injury to the cable from the grounding of icebergs. This latter was of less moment, for it could be provided against by keeping the cable when approaching shore in the middle of any inlet, and thus away from the shallow sides where the icebergs “ground.” There was also the probable difficulty of obtaining a trained staff to work a line when laid to such inhospitable regions. However, having regard to the anxiety exhibited by many to get to the North Pole, this did not present an insuperable obstacle.

This bold project, with a route across the coldest and iciest regions of the Atlantic, was originally brought to the notice of the Danish Government by Mr. Wyld, the geographer, even before the Atlantic Telegraph Company had been established. It was again introduced in a different form by Colonel T. P. Shaffner, an American electrician of some note. Colonel Shaffner made a strong case of the series of short stages geographically afforded by the North Atlantic deviation. After the 1858 cable had ceased working, to back up his belief in the advantages of the route, which he characterized as having “natural stepping-stones which Providence had placed across the ocean in the north,” he actually chartered a small sailing vessel, and, with his family on board, put forth from Boston on August 29th, 1859, for the purpose of making the preliminary survey. He landed in Glasgow in November of that year, and presented to the public the results of his voyage. During the voyage, Colonel Shaffner sounded the deep seas to be traversed between Labrador and Greenland and between Greenland and Iceland. His first object was to convince the public that there were no insuperable difficulties in the way. He found a warm supporter in Mr. J. Rodney Croskey, of London, who advanced the “caution” money to the Danish Government for the concessions requisite in the Faroes, Iceland, and Greenland.[51]

On May 15th, Lord Palmerston granted an audience to an influential deputation, headed by the Right Honorable Milner Gibson, M.P., and four other members of the House of Commons, to solicit the assistance of Government in sending out ships and officers to make the necessary official survey for ascertaining the practicability of the proposed route. The Premier appeared fully to appreciate the advantages of the north-about scheme, and in a very short time the Admiralty were directed to send out an expedition for the purpose of making the required survey.

The Admiralty selected for this duty Captain M’Clintock, R. N.,[52] an officer of great experience in the navigation of the Arctic seas, and H.M.S. Bulldog was placed under his command. This distinguished officer was directed to take the deep-sea soundings, and he sailed from Portsmouth on his mission in June, 1860. In the meantime, the promoters of the enterprise purchased the Fox, the steam-yacht formerly employed in the successful search for the remains of the Franklin expedition, and fitted her out for the purpose of making surveys of the landing-places of the respective cables. The Fox was placed under the command of Captain Young,[53] of the mercantile marine, an officer well known for his distinguished labors under M’Clintock in the Franklin search. At the same time, Dr. John Rae, F.R.G.S., an intrepid Arctic explorer, volunteered his services to join the Fox, and take charge of the overland expeditions in the Faroe Isles, Iceland, and Greenland. Colonel Shaffner, as concessionaire—besides two delegates on the part of the Danish Government, Lieutenant von Zeilau and Arnljot Olafsson—also accompanied the Fox expedition, to take part in the necessary surveys.

Before the departure of the Fox, which sailed on July 18, 1860, her Majesty Queen Victoria, the Prince Consort, and other members of the royal family, honored the enterprise by a visit to that vessel, while lying off Osborne, and showed a lively interest in the details of the expedition.

On the return of the expedition, Sir Leopold M'Clintock wrote a full report to Sir Charles Bright, the consulting engineer of the project. In this, Sir Leopold favored the route as perfectly practicable, pointing out that the ice would not really prove a difficulty, and strongly approving of the original intention of a land-line across Iceland to Faxe Bay, "as by so doing you will avoid the only part of the sea where submarine volcanic disturbances may be suspected."

The results of the voyages of H.M.S. Bulldog and the steam-yacht Fox were brought before a crowded meeting of the Royal Geographical Society on January 28, 1861. Sir Leopold M'Clintock then gave the first public account of his numerous and careful soundings along, and in the vicinity of, the proposed course of the cable, interspersed with many useful remarks and hints as to ice, the best time for laying the line, etc., as well as the probable sphere of volcanic action in and off the south of Iceland. The above was followed by an exhaustive paper by Sir Charles Bright, giving a synopsis of Captain Young's report on his voyage in the Fox, including the examination of various estuaries and harbors, so as to enable a decision to be arrived at as to the best landing-places, the climatic conditions, etc.

From both sets of soundings it was shown that, as a rule, the bottom was of ooze. Dr. Wallich, the naturalist of the expedition, had brought up brightly colored starfish from depths of over a mile, whereas it had previously been believed that nothing could possibly live under such an enormous pressure of water.

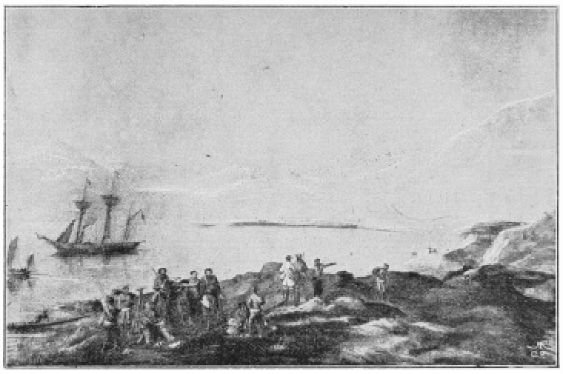


Fig. 33.—The North Atlantic Exploring Expedition, 1860.

Then came a highly instructive paper by Dr. Rae. He gave a number of interesting particulars of his land surveys, the population, price of food, wages, etc. He also described the ride of the Fox party across Iceland, while making important suggestions as to the route for the land-line with a view to avoiding the geysers.

Captain R. B. Beechey, R.N., afterward made a beautiful oil-painting of the party, including some of the Eskimos on the occasion of landing to explore the inland ice at Igaliko Fiord (see Fig. 33).[54]

At this time, however (1861), there was still too much discouragement owing to the stoppage in working of the first Atlantic cable, and to other causes with which we are about to deal. Moreover, there were those who still feared the ice-floes; and in the end the public did not respond sufficiently. Thus, after all, the "Grand North Atlantic Telegraph" project, which had been worked out with so much trouble and expense, was never actually realized.

Another scheme which attracted some attention about the same time was described as the "South Atlantic Telegraph." This was for a long length of cable between the south of Spain and the coast of Brazil, touching at Madeira, the Canary Islands, Cape de Verde Isles, Don Pedro, and Fernando de Noronha Isles on the way, and stretching out to the West Indies and the United States. Then there was a project for a cable on an intermediate route from Portugal to the Azores, and thence to America, via Bermuda and the Southern States. Being, however, to a great extent foreign in their scope, these latter schemes found little favor in this country at the time. They have, however, since been realized in some shape or form.

CHAPTER XIII

EXPERIENCE, INVESTIGATION, AND PROGRESS

The Red Sea Line—Government Inquiry—Electrical Standards and Units—Further Cables—Improvements in Manufacture, Testing, and Working—Completion of Pioneer Stage.

The Red Sea Line.—Mr. Lionel Gisborne had obtained powers from the Turkish Government to carry a telegraph-line across Egypt and lay a cable down the Red Sea. The importance of this line to Great Britain led the Government to give definite assistance.

The first portion of the proposed cable—from Suez to Aden, with intermediate landings—was laid in 1859. The different sections broke down one by one. They were all laid very taut, the slack in some cases being less than one per cent, though the bottom was in certain parts very uneven. The second portion of the line, from Aden to Kurrachee, with intermediate stations, was laid during 1860, the slack working out at 0.1 per cent only. Faults developed very quickly in all the sections of both portions of the line. Apart from the small allowance for slack, the type of cable adopted was of far too fragile a nature for some of its rough, reef-like resting-spots; indeed, the undertaking was spoken of as "like running a donkey for the Leger"! The promoters of this enterprise, having neither specially qualified men nor the necessary materials for carrying out repairs, were obliged to abandon it before any commercial work had been effected. This was a most unfortunate line in every way, for a complete message was never got through the entire length, but only through each section separately. Nevertheless, until quite recently, it cost Great Britain £36,000 per annum.

Inquiry on the Construction of Submarine Telegraphs.—Aroused more especially by the above failure, the Government, in 1859, before undertaking further responsibility, resolved to thoroughly investigate the construction of cables. It was also felt that the ultimate failure of the Atlantic line was possibly due, in part, to weak joints and general defects in the manufacture of the insulating envelope. This committee—under the direction of the Board of Trade, with Captain, afterward Sir Douglas, Galton, R.E., in the chair—devoted twenty-two sittings (covering a considerable period of time) to questioning engineers, electricians, professors, physicists, manufacturers, and seamen, who had taken part in the various branches of cable-work and whose knowledge or experience might throw light on the subject. Investigations were instituted concerning the structure of all cables previously made, and the quality of the different materials used, as to special points arising during manufacture and laying, on the routes taken, electrical testing, and on sending and receiving instruments, speed of signaling, etc. Actual experiments were also made in connection with this inquiry, to ascertain (1) the electrical and mechanical qualities of copper, pure and alloyed; also of gutta-percha and other insulating substances; (2) the chemical change in their condition when submerged; (3) the effects of temperature and pressure on the insulating substances employed; (4) the elongation and breaking strain of copper wires; of iron, steel, and tarred hemp separately and combined; (5) the phenomena connected with electrically charging and discharging conductors; (6) methods of testing conductors and of locating faults; besides the whole science and practise of cable-making and laying.

The report of the committee was not published till some time afterward. It expressed a conviction that submarine telegraphy might be made sure and remunerative in the future, based on the evidence adduced regarding the proper manufacture and working of submarine telegraphs.

Formulation of Electrical Standards and Units.—This inquiry was shortly followed by an important paper before the British Association for the advancement of science by Sir Charles Bright and Mr. Latimer Clark (then in partnership), which put the practise of electrical testing on a systematic basis, thereby considerably forwarding all electrical work connected with submarine telegraphy. A committee was formed shortly afterward, which gave the suggestions then brought forward the seal of universal officialdom.

Further Cables.—About this time a number of other cable enterprises were set afoot, some in shallow water and others in comparatively great depths. Though few of them were able to benefit by the information obtained in the inquiry, they were, in the main, more or less successful. These projects included cables between Malta and Alexandria, besides others in the Mediterranean and elsewhere. Sir Charles Bright, Mr. (afterward Sir C. W.) Siemens, Mr. Lionel Gisborne, and Mr. H. C. Forde were mainly associated with them as engineers and electricians. The line which met, however, with the most complete and lasting success was the first cable to India, laid (by Sir Charles Bright) in several sections along the Persian Gulf in 1863-’64. In this undertaking Messrs. Bright & Clark (engineers to the Government) introduced a complete system of electrical and mechanical testing. Every joint was, for the first time, efficiently tested, and the insulated core submitted to a hydraulic pressure representative of that which it would experience when laid.[55] A formula was also arrived at by an elaborate series of experiments for the effect of temperature on the insulation, which showed how enormously the resistance of gutta-percha increased by consolidation when submitted to the low temperatures of the bottom of the ocean. Chatterton’s compound had been already introduced for adhering the gutta-percha envelope to the wires, as well as for cementing together the different insulating coats; but Bright & Clark’s preservative composition for the iron armor was first used in this enterprise. This mixture not only evades the oxidation that iron wires, even when galvanized, are subject to, but resists the attacks of the teredo and other objectionable animal life. Moreover, besides the type of cable being eminently suitable, the manufacture was carried out with extreme care and with all the advantage of experience and improved methods.[56]

Completion of Pioneer Stage.—With the successful termination of the above enterprise, forming the first telegraphic connection between the United Kingdom, Europe, and India, the science of constructing and laying submarine telegraphs was pretty definitely worked out, and no very striking departure has since been introduced. The pioneer stage may, indeed, at this juncture, be said to have reached completion.

For this reason the rest of our narrative on the Atlantic cable will be told more briefly—though at greater length than the contents of this chapter, recounting only the stepping-stones to what was to follow.

PART IV

COMMERCIAL SUCCESS

CHAPTER XIV

THE 1865 CABLE AND EXPEDITION

Fresh Efforts and Funds—The Contractors’ Share—Design and Construction—Provisions for Laying—S.S. Great Eastern—Sailing Staff—Landing the Irish End—Another Bad Start.

Fresh Efforts and Funds.—Though their cable had ceased to work, the Atlantic Telegraph Company was kept alive by the promoters.

In 1862 the Government was prevailed on to despatch H.M.S. Porcupine to further examine the ocean floor 300 miles out from the coasts of Ireland and Newfoundland, respectively.

It took a considerable time to raise the full amount of capital required for another Atlantic cable, for this could only be done gradually. The great civil war in America stimulated capitalists to renew the undertaking. One of the main advantages adduced was, on this occasion as before, the avoidance of misunderstandings between the two countries. Another—intended by Mr. Cyrus Field as a special inducement to his fellow countrymen—was the improvement of the agricultural position of the United States, by extending to it the facilities already enjoyed by France of commanding the foreign grain-markets.[57] On this account the project was warmly supported by John Bright and other eminent free-traders.

Mr. Field, however, met with as little success in obtaining pecuniary support in the States as he had in connection with the previous line. His brother, Mr. H. M. Field, writes:

> The summer of this year (1862) Mr. Field spent in America, where he applied himself vigorously to raising capital for the new enterprise. To this end he visited Boston, Providence, Philadelphia, Albany, and Buffalo, to address meetings of merchants and others. He used to amuse us with the account of his visit to the first city, where he was honored with the attendance of a large array of "the solid men of Boston," who listened with an attention that was most flattering to the pride of the speaker addressing such an assemblage in the capital of his native State. There was no mistaking the interest they felt in the subject. They went still further; they passed a series of resolutions, in which they applauded the projected telegraph across the ocean as one of the grandest enterprises ever undertaken by man, which they proudly commended to the confidence and support of the American public. After this they went home feeling that they had done the generous thing in bestowing upon it such a mark of their approbation. *But not a man subscribed a dollar.*

In point of fact, as before, the cable of 1865—as well as that of 1866—was provided for out of English pockets. Let us now substantiate this statement by a glance at events. The late Mr. Thomas Brassey was the first to be appealed to in England, and he supported the venture nobly. Then Mr. Pender[58] was applied to, and here also substantial aid was forthcoming. Both these gentlemen had joined the board of the Telegraph Construction and Maintenance Company, which had just been formed (in April, 1864) as the result of an amalgamation of the Gutta-Percha Company and Messrs. Glass, Elliot & Co. Mr. Pender, who had been largely instrumental in effecting this combination, became the first chairman.

The Contractors' Share.—Shortly after the first Atlantic cable was laid, Messrs. Glass, Elliot & Co. availed themselves of the services of Mr. Canning and Mr. Clifford, whose engagements on Sir Charles Bright's staff for the "Atlantic" Company had terminated. Thus, with an additional staff of electricians, they had placed themselves in a position to undertake direct contracts for laying, as well as manufacturing, submarine telegraphs. They had, indeed, carried out work of this character in the Mediterranean during the year 1860; and on the amalgamation of the two businesses above mentioned into a limited liability company, their position was still further strengthened.

The capital raised for the new cable by the Atlantic Telegraph Company was £600,000; and, by agreeing to take a considerable proportion of their payment in "Atlantic" shares, the contractors practically found more than half of this amount. In the result, the undertaking became a contractors' affair from first to last.

Design and Construction.—It will be seen that the new cable was to be an expensive one as compared with that of 1857-'58. It was the outcome of six years' further experience, during which several important lines, referred to in the last chapter, had been laid. It also followed upon the exhaustive Government inquiry to which allusion has been made.

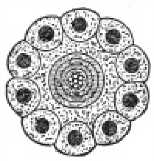


Fig. 34.—The Main Cable, 1865-'66.

The actual type adopted (Fig. 34), on the recommendation of Sir Charles Bright and other engineers who were additionally consulted, was much the same in respect to the conductor and insulator—300 pounds copper to 400 pounds gutta-percha per nautical mile—as that which the former had suggested for the previous Atlantic line. This combination for the length involved was based on Professor Thomson's law for the working speed of a cable, as depending inversely on the resistance of the conductor as well as on the electrostatic capacity of the core. The armor consisted of a combination of iron and hemp, each wire being enveloped in manila yarns. The object of incasing the separate wires in hemp was (1) to protect them from rust due to exposure to air and water, and (2) to reduce the specific gravity of the cable, with a view to rendering it more capable of supporting its own weight in water. This form of cable, bearing a stress of about eight tons,[59] and suspending eleven miles of itself, was considered by most of the authorities at that period to perfectly fulfil the conditions required for deep-sea lines.[60] The claims of light hempen cables, without any iron, had been urged for meeting the difficulty of lay and recovery in deep water; and this type formed a sort of compromise, its total diameter being 1.1 inch, weighing 1 ton 16 hundredweight in air, and only 14 hundredweight in water. The shore end was to have a further outer sheathing of twelve strands, each strand containing three stout galvanized-iron wires of No. 2 B.W.G., bringing the weight up to 20 tons per mile. This was to be joined on to the main deep-sea type by a gradually tapering length of twenty-five fathoms.

Arrangements for Laying.—It was determined that this time the cable must be laid in one length, with the exception of the shore ends, by a single vessel. There was but one ship that could carry such a cargo. This ship was the Great Eastern, the conception of that distinguished engineer, Isambard Kingdom Brunel. She was in course of construction by the late Mr. Scott Russell at the time of the first cable, and it was a subject for regret that she was not then available. An enormous craft of 22,500 tons, she did not prove suitable at that time as a cargo-boat; and the laying of the second Atlantic cable was the first piece of useful work she did, after lying more or less idle for nearly ten years.[61] It is sad to think of the way this poor old ship was metaphorically passed from hand to hand. Even at this period three separate companies had already been formed one after another to work her. As promoter and chairman of one of these, Mr. (afterward Sir Daniel) Gooch took an active part in arranging for her charter on this undertaking, and it was in this way that he became a prominent party in the enterprise.

All the cable machinery was fitted to the Great Eastern, on behalf of the Telegraph Construction Company, by Mr. Henry Clifford to the designs of Mr. Canning and himself. It was constructed and set up by the famous firm of engineers, Messrs. John Penn & Son, of Greenwich. In the main principles the apparatus employed was similar to that previously adopted in 1858 on the Agamemnon and Niagara. There were, however, several modifications introduced, as the result of the extra experience gained during the seven years' interval. The main point of difference was the further application of jockeys to the paying-out gear in a more complete form.

As it was not practicable to moor so enormous a vessel off the works at East Greenwich, the cable had to be cut into lengths and coiled on two pontoons, and thence transferred to the big ship.

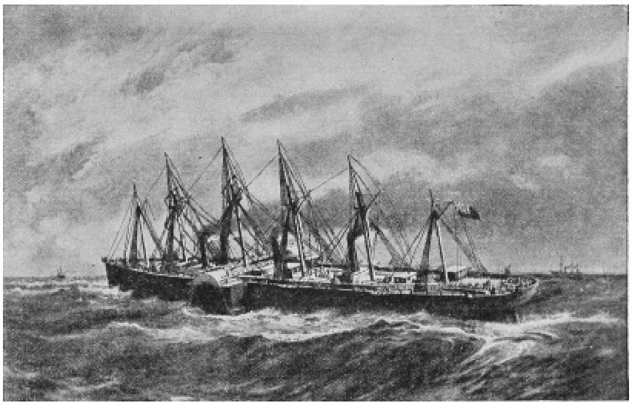


Fig. 35.—The Great Eastern at Sea.

Landing the Irish End.—At length all the cable having been manufactured and shipped from the Greenwich works, the Great Eastern, under the command of Captain (later Sir James) Anderson,[62] left the Thames on July 23, 1865, with a total dead weight of 21,000 tons, and proceeded to Foilhommerun Bay, Valentia. Here she joined up her cable to the shore end, which had been laid a day earlier by S.S. Caroline, a small vessel chartered and fitted up for the purpose. The great ship then started paying out as she steamed away on her journey to America, escorted by two British men-of-war, the Terrible and the Sphinx.

The Sailing Staff.—On behalf of the contractors, Mr. (afterward Sir Samuel) Canning was the engineer in charge of the expedition, with Mr. Henry Clifford as his chief assistant. As we have seen, both these gentlemen had been engaged with Sir Charles Bright on the first line, besides having much experience in mechanical engineering as well as in cable work. On the contractors' engineering staff there were also Mr. John Temple and Mr. Robert London. Mr. C. V. de Sauty served as chief electrician, assisted by Mr. H. A. C. Saunders and several others. By arrangement with the Admiralty, Staff-Commander H. A. Moriarty, R.N., acted as the navigator of the expedition. Captain Moriarty was possessed of great skill in this direction, a fact which had been made clear in the previous undertaking.

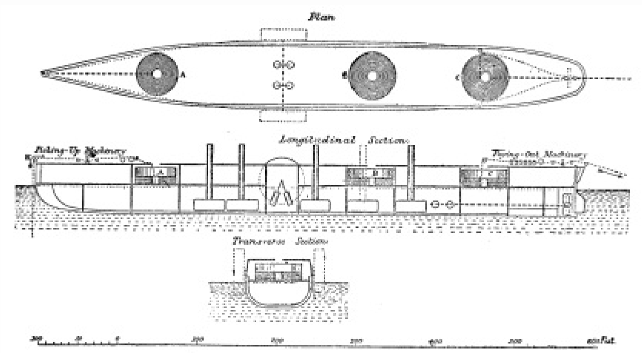


Fig. 36.—Cable and Machinery aboard S.S. Great Eastern.

The Atlantic Telegraph Company was represented on board by Professor Thomson and Mr. C. F. Varley as electricians, the former acting mainly as scientific expert in a consultative sense. Mr. Willoughby Smith, the electrician to the Gutta-Percha Works, was also on board at the request of the contractors, though holding no exact official position. Both Mr. Field and Mr. Gooch accompanied the expedition, the former as the initial promoter of the enterprise, and the latter on behalf of the Great Eastern Company. Representing the press there were also on board Dr. (afterward Sir W. H.) Russell, the well-known correspondent of The Times, as the historian of the enterprise, and Mr. Robert Dudley, an artist of repute, who produced several excellent sketches of the work in its different stages for the Illustrated London News.

A Bad Start.—Unfortunately trouble soon arose. The first fault declared itself the day after starting, when eighty-four miles had been paid out. It was decided to pick up back to the fault, which was discovered after ten and a half miles had been brought on board. A piece of iron wire was found to have pierced the cable diametrically, so as to make contact between the sea and the conductor. The faulty portion was cut out, and the paying out resumed as soon as the cable was spliced up again. On July 29th, when 716 miles had been laid, another and more serious fault appeared. The arduous operation of picking up again commenced. After nine hours' work the fault was safe inboard, and the necessary repair effected. On stripping the cable another piece of iron wire was discovered sticking right through the core. Anxiety and misgivings were now felt by all on board, for it seemed that such reverses could only be attributed to malevolence. On August 2d yet a further fault was reported; they were now two-thirds of the way across, 1,186 miles of cable being already laid. Again they had to pick up, and this time in a depth of 2,000 fathoms. One mile only had been recovered, when an accident of some kind happened to the machinery. The great ship, having stopped, was at the mercy of the wind and swell, and heavy strains were brought on the cable, which consequently suffered badly in two places. Before the two injured portions could be secured on board the cable parted and sank. Mr. Canning at once decided to endeavor to recover the cable, notwithstanding the fact that it lay in 2,000 fathoms. After maneuvering in this way for about fifteen hours, 700 fathoms of rope had been hove in, when one of the connecting links gave way, and all beyond it sank to the bottom. The work was recommenced with hempen ropes, two miles farther west, in a depth of 2,300 fathoms, and on August 8th the cable was again hooked; but when raised to within 1,500 fathoms of the surface, yet another connecting link parted, the strain being about nine tons. Two more attempts were made, but both were doomed to end in failure. The store of rope being now quite exhausted, the work had to be abandoned, and on August 11, 1865, the fleet of ships parted company to return home—shattered in hopes as well as in ropes!

CHAPTER XV

SECOND AND SUCCESSFUL ATTEMPT

Further Funds—Fresh Provisions—New Picking-up Machine—Staff—Cable-Laying again—Success.

The results of the last expedition, disastrous as they were from a financial point of view, in no wise abated the courage of the promoters of the enterprise. During the heaviest weather the Great Eastern had shown exceptional "stiffness," while her great size and her maneuvering power (afforded by the screw and paddles combined) seemed to show her to be the very type of vessel for this kind of work. The picking-up gear, it was true, had proved insufficient, but with the paying-out machinery no serious fault was to be found. The feasibility of grappling in mid-Atlantic had been demonstrated, and they had gone far toward proving the possibility of recovering the cable from similar depths.

Further Funds.—To overcome financial difficulties, the Atlantic Telegraph Company was amalgamated with a new concern, the Anglo-American Telegraph Company, which was formed, mainly by those interested in the older business, with the object of raising fresh capital for the new and double ventures of 1866. The ultimate capital of this company amounted (as before) to £600,000. In raising this, Mr. Field first secured the support of the late Sir Daniel Gooch, M.P., then chairman, and previously locomotive superintendent of the Great Western Railway Company, who, after what he had seen on the previous expedition, promised, if necessary, to subscribe as much as £20,000. On the same conditions, Mr. Brassey expressed his willingness to bear one-tenth of the total cost of the undertaking. Ultimately, the Telegraph Construction Company led off with £100,000, this amount being followed by the signatures of ten directors interested in the contract (as guarantors) at £10,000 apiece. Then there were four subscriptions of £5,000, and some of £2,500 to £1,000, principally from firms participating in the subcontracts. These sums were all subscribed before even the prospectus was issued or the books opened to the public. The remaining capital then quickly followed.

The Telegraph Construction Company, in undertaking the entire work, were to receive £500,000 for the new cable in any case; and, if it succeeded, an extra £100,000. If both cables came into successful operation, the total amount payable to them was to be £737,140. In fact, it was, if possible, even more of a contractor's enterprise than that of 1865.

It was now proposed not only to lay a new cable between Ireland and Newfoundland, but also to repair and complete the one lying at the bottom of the sea. A length of 1,600 miles of cable was ordered from the contractors. Thus, with the unexpended cable from the last expedition, the total length available when the expedition started would be 2,730 miles, of which 1,960 miles were allotted to the new cable, and 697 to complete the old one, leaving 113 miles as a reserve.

Fresh Provisions.—The new main cable was similar to that of the year before, but the shore-end cable determined on in this case was of a different description. It had only one sheathing, consisting of twelve contiguous iron wires of great individual surface and weight; and outside all a covering of tarred hemp and compound. That part of the line which was intended for shallow depths was composed of three different types. Starting from the coast of Ireland, eight miles of the heaviest was to be laid, then eight miles of an intermediate type, and lastly fourteen miles of a lighter type, making thirty miles of shoal-water cable on the Irish side. Five miles of shallow-water cable, of the different types named, were considered sufficient on the Newfoundland coast.

The previous paying-out machinery on board the Great Eastern was altered to some extent by Messrs. Penn to the instructions of Messrs. Canning & Clifford. Though different in detail, the main improvement over the 1865 gear consisted in the fact that a 70-horse-power steam-engine was fitted to drive the two large drums in such a way that the paying-out machinery, as in 1858, could be used to pick up cable during the laying, if necessary, thereby avoiding the risk incurred by changing the cable from the stern to the bows. This addition of Penn trunk-engines, as well as the general strengthening of the entire machinery, was made in accordance with the designs of Mr. Henry Clifford.

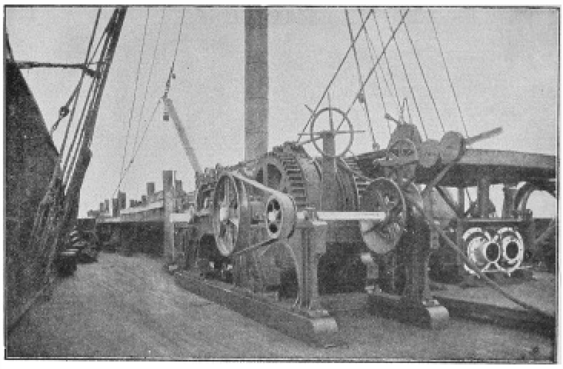


Fig. 37.—The Picking-up Machine, 1866.

The picking-up machinery forward (Fig. 37) after the previous expedition was considerably strengthened and improved with spur-wheels and pinion-gearing. It had two drums worked by a similar pair of 70-horse-power engines. This formed an exceedingly powerful machine, and reflected great credit on those who devised and constructed it.

Similar gear was fitted up on board the two vessels—S.S. Medway and S.S. Albany—chartered to assist the Great Eastern.

For the purpose of grappling the 1865 cable, twenty miles of rope were manufactured, which was constituted by forty-nine iron wires, separately covered with manila hemp. Six wires so served were laid up strandwise round a seventh, which formed the heart, or core, of the rope. This rope would stand a longitudinal stress of 30 tons before breaking.

In addition, five miles of buoy-rope were provided, besides buoys of different shapes and sizes, the largest of which (Fig. 38) would support a weight of twenty tons. As on the previous expedition, several kinds of grapnels were put on board, some of the ordinary sort, and some with springs to prevent the cable surging, and thus escaping while the grapnel was still dragging on the bottom; others, again, were fashioned like pincers, to hold (or jam) the cable when raised to a required height, or else to cut it only, and so take off a large proportion of the strain previous to picking up. Most of this apparatus was furnished by Messrs. Brown, Lenox & Co., the famous chain, cable, anchor, and buoy engineers, several of the grapnels being to their design, as well as the “connections.”

The propelling machinery of the Great Eastern had similarly received alteration and improvement in the intervals of the two expeditions. Moreover, the screw propeller was surrounded with an iron cage, to keep the cable and ropes from fouling it, as had been provided for the Agamemnon and Niagara in 1857.

Fig. 38.—Buoys, Grapnels, Mushrooms—and Men.

The testing arrangements had been perfected by Mr. Willoughby Smith in such a way that insulation readings could be continuously observed, even while measuring the copper resistance, or while exchanging signals with Valentia. Thus there was no longer any danger of a fault being paid overboard without instant detection. On this occasion also condensers were applied to the receiving-end of the cable, having the effect of very materially increasing—indeed, sometimes almost doubling—the working speed.

On June 30, 1866, the Great Eastern, steaming from the Thames—followed by the Medway and Albany—arrived at Valentia, where H.M.S. Terrible and Racoon were found, under orders to accompany the expedition. The Medway had on board forty-five miles of deep-sea cable in addition to the American shore end.

The principal members of the staff acting on behalf of the contractors in this expedition were the same as in that of the previous year. Mr. Canning was again in charge, with Mr. Clifford and Mr. Temple as his chief assistants. In the electrical department, however, the Telegraph Construction Company had since secured the services of Mr. Willoughby Smith as their chief electrician, while he still acted in that capacity at the Wharf Road Gutta-Percha Works. Mr. Smith, therefore, accompanied the expedition as chief electrician to the contractors. Captain James Anderson and Staff-Commander H. A. Moriarty, R.N., were once more to be seen on board the great ship, the former as her captain, and the latter as navigating officer. Professor Thomson was aboard as consulting electrical adviser to the Atlantic Telegraph Company, while Mr. C. F. Varley was ashore at Valentia as their electrician. Sir Charles Bright (then M.P. for Greenwich) was at this period serving on various committees of the House of Commons;[63] but his partner, Mr. Latimer Clark, took up quarters at Valentia to personally represent the firm as consulting engineers to the Anglo-American Telegraph Company. Mr. J. C. Laws and Mr. Richard Collett[64] being respectively aboard and ashore at the Newfoundland end in the same interests. Mr. Glass, the managing director of the Telegraph Construction Company, was ashore at Valentia for the purpose of giving any instructions to his (the contractor's) staff on board, while Mr. Gooch and Mr. Field were aboard the Great Eastern as onlookers and watchers of their individual interests.

Cable-Laying again.—On July 7th the William Cory—commonly known as the Dirty Billy—landed the shore end in Foilhommerum Bay, and afterward laid twenty-seven miles of the intermediate cable. On the 13th, the Great Eastern took the end on board, and having spliced on to her cable on board, started paying out. The track followed was parallel to that taken the year before, but about twenty-seven miles farther north. There were two instances of fouls in the tank, due to broken wires catching neighboring turns and flakes, and thus drawing up a whole bundle of cable in an apparently inextricable mass of kinks and twists quite close to the brake-drum. In each case the ship was promptly got to a standstill and all hands set to unraveling the tangle. With a certain amount of luck, coupled with much care, neither accident ended fatally; and, after straightening out the wire as far as possible, paying out was resumed.

Fig. 39.—"Foul in Tank" while Paying out.

Successful Completion.—Fourteen days after starting the Great Eastern arrived off Heart's Content,[65] Trinity Bay, where the Medway joined on and landed the shore end partly by boats, thus bringing to a successful conclusion this part of the expedition. The total length of cable laid was 1,852 nautical miles; average depth, 1,400 fathoms. Rejoicings then took place during the coaling of the Great Eastern—to provide for which as many as six coal-laden steamers had left Cardiff some weeks before. The rejoicings were somewhat damped by the fact that the cable between Newfoundland and Cape Breton (Nova Scotia) still remained interrupted, and that consequently the entire telegraphic system was not even now completed. However, in the course of a few days this line was repaired, and New York and the east of the United States and Canada were once more put into telegraphic communication with Europe.

The telegraphic fleet put to sea again on August 9th.

CHAPTER XVI

RECOVERY AND COMPLETION OF THE 1865 CABLE

Prospects and Plans—Setting to Work—Repeated Failures—Ultimate Triumph—Electricians Ashore—"Spot-watching"—"Putting-through"—Pioneering—Working the Lines.

Prospects and Plans.—It now remained to find the end of the cable lost on August 2, 1865, situated about 604 miles from Newfoundland, to pick it up, splice on to the cable remaining on board, and finish the work so unfortunately interrupted the year before. The difficulties to be overcome can be readily imagined, the cable lying 2,000 fathoms without mark of any kind to indicate its position. The buoys put down after the accident had long since disappeared, either their moorings having dragged during various gales of wind, or the wire ropes which held them having chafed through, owing to incessant rise and fall at the bottom. The position of the lost end had to be determined by astronomical observations. These necessitate clear weather, and can then only give approximate results on account of the variable ocean currents, which sometimes flow at the rate of three knots. Moreover, for grappling and raising the cable to the bows, the sea must be tolerably smooth; and in that part where the work lay a succession of fine days is rare, even in the month of August. However, they still had on board Captain Moriarty, one of the ablest navigators in the world. Added to this, the greater portion of the cable in deep water had been paid out with about 15 per cent slack.

The chiefs of the expedition, fully confident of success, hastened their preparations, and on August 9, 1866, the Great Eastern again put to sea, accompanied by S.S. Medway. On the 12th the vessels arrived on the scene of action, and joined company with H.M.S. Terrible and S.S. Albany, these vessels having left Heart's Content Bay a week in advance to buoy the line of the 1865 cable and commence grappling.

The plan decided on was to drag for the cable near the end with all three ships at once. The cable when raised to a certain height, was to be cut by the Medway stationed to the westward of the Great Eastern, so as to enable the latter vessel to lift the Valentia end on board. This was, of course, before the days of cutting and holding grapnels as we now have them, which render it possible for a single ship to effect repairs—even where it is out of the question to recover the cable in one bight.

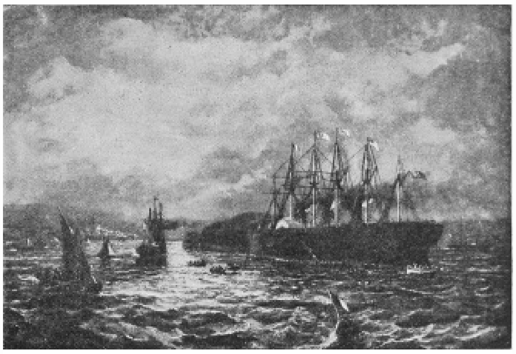


Fig. 40.—S.S. Great Eastern Completing the Second Atlantic Cable.

Setting to Work: Repeated Failures.—When the Great Eastern arrived on the grappling ground, the Albany (with Mr. Temple in engineering charge) had already hooked and buoyed the cable, but the buoy-chain having been carried away, they not only lost the cable, but 2,000 fathoms of wire rope besides. On August 13th the Great Eastern made her first drag, about fifteen miles from the end, and, after several vain attempts, the cable was finally hooked and lifted about 1,300 fathoms. During the operation of buoying the grappling rope, a mistake occurred which resulted in the rope slipping overboard and going to the bottom.

The Great Eastern now proceeded six miles to the eastward, and commenced a new drag, for raking the ocean bed with 2,400 fathoms of wire rope. About eleven o'clock at night the grapnel came to the surface with the cable caught on two of the prongs. Boats were quickly in position alongside the grapnel. Shortly afterward they were endeavoring to secure the cable to the strong wire rope, by means of a nipper, when the grapnel canted, allowing the line to slip away from the prongs—like a great eel—and disappear into the sea. On the 19th the cable was once more hooked, and raised about a mile from the bottom, but the sea was too rough for buoying it. During the following week all three vessels dragged for the cable at different points, according to the plan previously arranged, but the weather was unfavorable, and the cable was not hooked—or, if hooked, had managed to slip away from the grapnels. The ship's company about this time became discouraged—in fact, more and more convinced of the futility of their efforts.

On the 27th the Albany signaled that they had got the cable on board with a strain of only three tons, and had buoyed the end, but it was soon discovered that her buoy was thirteen miles from the track of the cable, and that she had recovered a length of three miles which had been purposely paid overboard a few days before. Shifting ground to the eastward about fifteen miles, the vessels were now working in a depth of 2,500 fathoms. As the store of grappling rope was diminishing day by day, and the fine season rapidly coming to an end, it was decided to proceed at once eighty miles farther east, where the depth was not expected to exceed 1,900 fathoms, and there try a last chance.

Ultimate Triumph.—After the above repeated failures, the cable was hooked on August 31st by the Great Eastern (when the grapnel had been lowered for the thirtieth time), and picking up commenced in very calm weather. The monster vessel did her work admirably. To quote the words of an eye-witness: "So delicately did she answer her helm, and coil in the film of thread-like cable, that she put one in mind of an elephant taking up a straw in its proboscis." When the bight of cable was about 900 fathoms from the surface, the grappling-rope was buoyed. The big ship then proceeded to grapple three miles west of the buoy (Fig. 41), and the Medway (with Mr. London on board) another two miles or so west of her again. The cable was soon once more hooked by both ships, and when the Medway had raised her bight to within 300 fathoms of the surface she was ordered to break it. The Great Eastern having stopped picking up when the bight was 800 fathoms from the surface, proceeded to resume the operation as soon as the intentional rupture of the cable had eased the strain, which, with a loose end of about two nautical miles, at once fell from 10 or 11 tons to 5 tons. Slowly, but surely, and amid breathless silence, the long-lost cable made its appearance at last (see opposite), for the third time above water, a little before one o'clock (early morn) of September 2d.[66]

Two hours afterward the precious end was on board, and signals were immediately exchanged with Valentia. This was at once led into the testing-room, where Mr. Willoughby Smith, in the presence of all the leaders on board, applied the tests which were to determine the important question regarding the condition of the cable, and whether it was entirely continuous to each end. In a few minutes all suspense was relieved, the tests showed the cable to be healthy and complete, and immediately afterward (in response to the ship's call) the answering signals were received from the Valentia end, which were received with loud cheers that echoed and reechoed throughout the great ship.

Electricians Ashore: "Spot-watching."—Let us now look at those patiently watching day after day, night after night, in the wooden telegraph cabin on shore, the experience of whom may be taken as a fair sample of that of the electrician ashore during repairing operations in the present day.

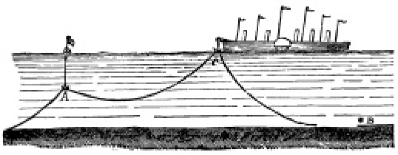


Fig. 41.—Diagram Illustrative of the Final Tactics Adopted for Picking up the 1865 Cable.

A—Point where cable was buoyed by the Great Eastern.
B—Point where cable was broken by the Medway.
C—Bight of cable ultimately brought to surface by Great Eastern.

Such a length of time had elapsed since the expedition left Newfoundland that the staff at Foilhommerum, under the superintendence of Mr. James Graves, felt they were almost hoping against hope. Suddenly, on a Sunday morning at a quarter to six, while the tiny ray of light from the reflecting instrument was being watched, the operator observed it moving to and fro upon the scale. A few minutes later the unsteady flickering was changed to coherency. The long-speechless cable began to talk, and the welcome assurance arrived, "Ship to shore; I have much pleasure in speaking to you through the 1865 cable. Just going to make splice." Glad tidings were also sent from the ship via Valentia to London, and, by means of the 1866 cable, to Newfoundland and New York. Thus it happened that those being tossed about in a stormy sea held conversation with Europe and America at one and the same time.[67]

"*Putting Through.*"—The recovered end was spliced on without delay to the cable on board, and the same morning at seven o'clock the Great Eastern started paying out about 680 nautical miles of cable toward Newfoundland. On September 8th, when only thirteen miles from the Bay of Heart's Content, just after receiving a summary of the news in The Times of that morning, the tests showed a fault in the cable. The mischief was soon found to be on board the ship, and caused by the end of a broken wire, which, bending at right angles under the weight of the men employed in the tanks, had been forced into the core. This occurrence explained the probable cause of the faults (of same character) which had shown themselves during paying out the year before, tending to remove all suspicion of malicious intent. The faulty portion having been cut out, and the splice made without delay, paying out again proceeded, finishing the same day at eleven o'clock in the forenoon. The Medway immediately set to work laying the shore end, and that evening a second line of communication across the Atlantic was completed. The total length of this cable, commenced in 1865, was 1,896 miles; average depth, 1,900 fathoms.

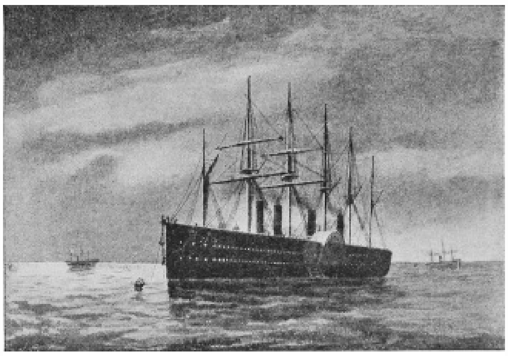


Fig. 42.—S.S. Great Eastern with 1865 Cable at Bows; Depth, 2 Miles.

Pioneering.—The main feature and accomplishment in connection with the second and third Atlantic cables of 1865 and 1866 was, without doubt, the recovery of the former in deeper water than had ever been before effected, and in the open ocean; just as in the first 1858 line it was the demonstration of the fact that a cable could be successfully laid in such a depth and worked through electrically. In the interval between the two undertakings cable repairs had certainly been carried out in the Mediterranean in 1,400 fathoms. Moreover, the recovery and repair of a cable from the depths of the open ocean are now matters of ordinary every-day occurrence, forming part and parcel of cable operations generally. These facts should not, however, in any way detract from the greatness of the achievement at that time in so vast and boisterous an ocean.

Working the Two Lines.—Professor Thomson's reflecting-apparatus for testing and signaling had been considerably improved since the first cable. In illustration of the degree of sensibility and perfection attained at this period in the appliances for working the line, the following experiment is of striking interest: Mr. Latimer Clark, who went to Valentia to test the cable for the "Atlantic" Company, had the conductor of the two lines joined together at the Newfoundland end, thus forming an unbroken length of 3,700 miles in circuit. He then placed some pure sulfuric acid in a silver thimble,[68] with a fragment of zinc weighing a grain or two. By this primitive agency he succeeded in conveying signals twice through the breadth of the Atlantic Ocean in little more than a second of time after making contact. The deflections were not of a dubious character, but full and strong, the spot of light traversing freely over a space of twelve inches or more, from which it was manifest that an even smaller battery would suffice to produce somewhat similar effects. Again, in testing these cables it was found that if either was disconnected from the earth and charged with electricity, it required more than an hour for half of the charge to escape through the insulating material to the earth. This speaks well for the electrical components assigned to the two lines, and for the arrangements adopted in working them. It also shows the benefit derived from seven years' extra experience in manufacture, backed up by the previously mentioned exhaustive Government inquiry thereon.

Notwithstanding the dimensions of the core, these cables were worked slowly at first, and at a rate of about eight words per minute. This, however, soon improved as the staff became more accustomed to the apparatus, and steadily increased up to fifteen—and even seventeen—words per minute on each line, with the application of condensers.

Unfortunately both these cables broke down a few months later, and one of them again during the following year. The faults were localized with great accuracy from Heart's Content by Mr. F. Lambert on behalf of Messrs. Bright & Clark, engineers to the "Anglo-American" Company.

Unlike the 1858 line, however, these last cables had not been killed electrically, and, being worthy of repairs, they were maintained for a considerable time.

CHAPTER XVII

JUBILATIONS

Banquets—Speeches—Honors

On the return of the 1866 Expedition a banquet was given to the cable-layers by the Liverpool Chamber of Commerce, as soon as the Great Eastern was safely moored in the Mersey.

The following from The Times will be of some interest here:

The chair was occupied by the Rt. Hon. Sir Stafford Northcote, Bart.,[69] President of the Board of Trade. The following were among the invited guests: the Rt. Hon. Lord Stanley, M.P., Secretary of State for Foreign Affairs; the Rt. Hon. Lord Carnarvon; the Rt. Rev. the Lord Bishop of Chester; the Rt. Hon. W. E. Gladstone, M.P.; Sir Charles Bright, M.P., original projector of the Atlantic cable, and Engineer to the Anglo-American Telegraph Company; Prof. W. Thomson, electrical adviser to the Atlantic Telegraph Company; Mr. Latimer Clark, coengineer with Sir Charles Bright; Mr. R. A. Glass, managing director to the Telegraph Construction Company (contractors); Mr. Samuel Canning, engineer to the contractors; Mr. Henry Clifford, assistant engineer to the contractors; Mr. Willoughby Smith, electrician to the contractors; Captain James Anderson, commander of the Great Eastern; Mr. William Barber, chairman of the Great Ship Company; Mr. John Chatterton, manager of the Gutta-Percha Works; Mr. E. B. Bright, Magnetic Telegraph Company; Mr. T. B. Horsfall, M.P.; and Mr. John Laird, M.P.

After proposing toasts to Her Majesty the Queen, to the President of the United States, and to the Prince of Wales, the chairman (Sir S. Northcote) again rose amid applause, and said it was a maxim of a great Roman poet that a great work should be begun by plunging into the middle of the subject. He would therefore do so by proposing a toast to the projectors of the Atlantic Telegraph—Sir Charles Bright and Mr. Cyrus Field, Mr. J. W. Brett having since unfortunately died. When they came in after years to relate the history of this cable, they would find many who had contributed to it, but it would be as impossible to say who were the originators of the great invention as it was to say who were the first inventors of steam. He begged to couple with the toast the name of Sir Charles Bright, as, perhaps, the foremost representative from all points of view up to the present time (applause). The greatest honor is due to the indomitable perseverance and energy of Sir Charles Bright that the original cable was successfully laid, though, through no fault of his, it had but a short useful existence (great cheering).

Sir Charles Bright, M.P., after acknowledging the compliment paid to the "original projectors" and to himself personally, said that the idea of laying a cable across the Atlantic was the natural outcome of the success which was attained in carrying short lines under the English and Irish Channels, and was a common subject of discussion among those concerned in telegraph extension prior to the formation of the Atlantic Telegraph Company.

About ten years ago the science had sufficiently advanced to permit of the notion assuming a practical form. Soundings taken in the Atlantic between Ireland and Newfoundland proved that the bottom was soft, and that no serious currents or abrading agencies existed, for the minute and fragile shells brought up by the sounding-line were perfect and uninjured.

There only remained the proof that electricity could be employed through so vast a length of conductor. Upon this point and the best mode of working such a line, he had been experimenting for several years. He had carried on a series of investigations which resulted in establishing the fact that messages could be practically passed through an unbroken circuit of more than 2,000 miles of insulated wire, a notion derided at that time by many distinguished authorities. Mr. Wildman Whitehouse, who subsequently became electrician to the company, had been likewise engaged. On comparing notes later, it was discovered that we had arrived at similar results, though holding somewhat different views, for his (Sir C. Bright's) calculations, using other instruments, led him to believe that a conductor nearly four times the size of that adopted would be desirable with a slightly thicker insulator. It was this type which the new cables just laid had been furnished with.

In 1856, Mr. Cyrus Field—to whom the world was as much indebted for the establishment of the line as to any man—came over to England upon the completion of the telegraph between Nova Scotia and Newfoundland. He then joined with the late Mr. Brett and himself (Sir C. Bright) with the view of extending this system to Europe, and they mutually agreed, as also did Mr. Whitehouse later, to carry out the undertaking. A meeting was first held in Liverpool, and in the course of a few days their friends had subscribed the necessary capital. So that in greeting those who had just returned from the last expedition—Mr. Canning, Mr. Clifford, Captain Anderson, and other guests of the evening—Liverpool was fitly welcoming those who had accomplished the crowning success of an enterprise to which at the outset she had so largely contributed (applause).

The circumstances connected with the first cable would be in the recollection of every one, and, although the loss was considerable, the experience gained was of no small moment. A few months after the old line had ceased to work, their chairman (Sir S. Northcote) consulted him on behalf of the Government as to the best form of cable for connecting us telegraphically with Gibraltar, and he (Sir C. Bright) did not hesitate to recommend the same type of conductor and insulator which he had himself before suggested for the Atlantic line—a higher speed being desirable. This class of conductor in the newly laid Atlantic cable appeared likely to give every satisfaction, he was happy to say, and the mechanical construction of the cable, also the same as that he had previously specified for the Gibraltar line, appeared to have admirably met some of the difficulties experienced in cable operations.

The credit attached to these second and third Atlantic cables must mainly rest with the Telegraph Construction Company (formerly Messrs. Glass, Elliot & Co.) and their staff, inasmuch as in this case the responsibility rested with them throughout. The directors—including Mr. Glass, Mr Elliot, Mr. Gooch, Mr. Pender, Mr. Barclay, and Mr. Brassey—deserved the reward which they and the shareholders would no doubt reap. To Mr. Glass, upon whom the principal responsibility of the manufacture devolved, the greatest praise was due for his indomitable perseverance in the enterprise. Then the art of insulating the conducting-wire had been so wonderfully improved by Mr. Chatterton and Mr. Willoughby Smith, that, nowadays, a very feeble electrical current was sufficient to work the longest circuits, an enormous advance on the state of affairs nine years previously. Again, they must not forget how much of the success now attained was due to Professor Thomson and his delicate signaling-apparatus, the advantages of which have since 1858 been more firmly established. Mr. Varley had also done most useful work since becoming electrician to the “Atlantic” Company. Moreover, he (Sir C. Bright) hoped the active personal services of his partner, Mr. Latimer Clark, would not be forgotten.

It was satisfactory to find that the cables were already being worked at a very large profit. This system would doubtless be quadrupled within a short period, when the land-lines on the American side were improved (hear, hear, and applause). With this commercial success—combined with the improvements introduced into submarine cables, and the power of picking up and repairing them from vast depths—there was a future for submarine telegraphy to which scarcely any bounds could be imagined. A certain amount had already been done, but China and Japan, Australia and New Zealand, South America and the West India Islands, must all be placed within speaking-distance of England. When this last has been accomplished, but not till then, telegraphic engineers might take a short rest from their labors and ask with some little pride:

Quœ regio in terris nostri non plena laboris? (loud applause).

Then followed speeches from Lord Stanley, the American Consul (on behalf of Mr. Cyrus Field), and others.

Honors were subsequently bestowed on some of the various gentlemen most immediately concerned in these—at last—wholly successful undertakings of 1865 and 1866, which left their results behind in complete and lasting form.

CHAPTER XVIII

SUBSEQUENT ATLANTIC LINES

As a natural sequence other Atlantic cables followed in course of time.

Thus in 1869 France was put into direct telegraphic communication with America by means of a cable from Brest to the island of St. Pierre, and another from St. Pierre to Sydney, U.S.A.[70] The former length was manufactured by the Telegraph Construction and Maintenance Company, and the latter by Mr. W. T. Henley. The Telegraph Construction Company were the contractors for laying the whole cable on behalf of the French Atlantic Cable Company (Société du Câble Trans-Atlantique Français).[71]

This work was successfully accomplished from the Great Eastern (Captain Robert Halpin) by the same staff as had laid the 1866 cable. Owing to the route, this line was materially longer than the previous Atlantic cables, its length (from Brest to St. Pierre) being as much as 2,685 nautical miles. The working-speed attained on the French Atlantic cable was ten and a half words per minute. The conductor of the Brest-St. Pierre section was composed of seven copper wires stranded together, weighing 400 pounds per nautical mile, covered with a gutta-percha insulator of the same weight. The core of the St. Pierre-Sydney section was made up as follows: Copper = 107 pounds per nautical mile; gutta-percha = 150 pounds per nautical mile. Like the previous lines, this cable has been “down,” electrically speaking, for some years. It proved a very costly one in repairs, one expedition alone having run into as much as £95,000.

In 1873 the Direct United States Cable Company was formed, being the first competitor—from this country—with the “Anglo-American” Company.[72] Messrs. Siemens Brothers, who had taken an active part in the promotion of the scheme, were the contractors, both for manufacture and for submersion. It was, indeed, the first really important length with which this firm had been concerned as manufacturers. The laying was attended with complete success, and the line opened to the public in 1875. Later on, in 1877, the “Direct United States” Company was reconstructed, their system entering into the “pool” or “joint purse.”

The latter was established shortly after the 1869 Atlantic cable had been laid, constituting one great financial combination.

In 1879 another French company was formed to establish independent communication between France and the rest of the European Continent on the one hand, and the United States of America on the other. The, to English ears and lips, somewhat cumbersome title of this concern was La Compagnie Française du Télégraphe de Paris à New York, but it soon became styled in England the "P. Q. Company," after M. Pouyer-Quertier, its presiding genius. The cable was made and laid in the same year by Messrs. Siemens Brothers, though the scheme had taken three years to reach contract point. The "P. Q." Company in 1894 amalgamated with La Société Française des Télégraphes Sous-marins, under the title of La Compagnie Française des Câbles Télégraphiques.

In 1881 an American company was formed, under the guidance of the late Mr. Jay Gould, entitled The American Telegraph and Cable Company, with a view to partaking in the profits of transatlantic telegraphy by establishing another line of communication between the United States and Great Britain, and thence to the rest of Europe. This cable was also constructed and laid (in the course of that year) by Messrs. Siemens Brothers, who were part promoters of the enterprise, as well as another cable for the same system in the following year, 1882. This company's cables are leased by the Western Union Telegraph Company, which was practically Jay Gould's property, and remained so up to close on the time of his death, a few years ago. In 1883 the above system entered the "Pool"—the happy destination for which, maybe, it was originally launched into existence.

A fresh competitor arrived in 1884 in the person of the Commercial Cable Company. Two cables were laid across the Atlantic for this company in the same year, its promoters wisely foreseeing that, in view of the continual chance of a breakdown, this was the only way in which they could safely attempt to compete with their more firmly established rivals. The "Commercial" Company was mainly promoted by two American millionaires, Mr. J. W. Mackay, the celebrated New York financier, and Mr. Gordon Bennett, the proprietor of the New York Herald; with them were associated Messrs. Siemens Brothers, who afterward became the contractors for the enterprise. These cables, like the Jay Gould lines, stretch from the extreme southwest point of Ireland (which is connected by special cable with England) to Nova Scotia, and thence to the United States, one of them direct to New York. The system is directly connected with that of the Canadian Pacific Railroad Company, thus affording ready communication with the Dominion.

Neither the "Commercial" Company's system nor that of the Compagnie Française des Câbles Télégraphiques is at present in the "Atlantic Pool."

In 1894 yet two more additions were made to the list of Atlantic cables—one on behalf of the Commercial Cable Company, and the other for the "Anglo-American" Company. The new "Commercial" line was constructed and laid by Messrs. Siemens Brothers, and the "Anglo" cable by the Telegraph Construction Company. Fig. 43 shows the type adopted for the deepest water of the latter, and Fig. 44 that for the shore ends. Here the wires, besides being of a very large gauge, are applied with an extremely short lay (hence the elliptic appearance, though circular in reality), in order to increase the weight of iron, and thereby avoid shifting and abrasion. This type is now in constant use where rocks, ice-floes, strong currents, or rough weather are experienced. Special arrangements were made in the design of both these cables to meet the requirements of increased speed. Since the successful application to submarine cables of various modifications of Wheatstone's automatic transmitter, the limit to the speed attainable only depends, practically speaking, upon the type of cable employed. On these principles the core of the new "Commercial" cable was composed of a copper conductor weighing 500 pounds per nautical mile, covered with a gutta-percha insulating-sheath weighing 320 pounds per nautical mile, while the new "Anglo" has a core with conductor weighing 650 pounds per nautical mile, and gutta-percha insulator 400 pounds per nautical mile, involving a completed cable (main type) nearly double the weight of previous corresponding lines.

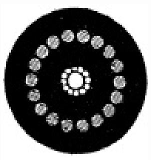


Fig. 43.—Anglo-American Atlantic Cable (1894): deep-sea type.

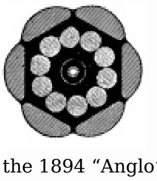


Fig. 44.—Shore-end of the 1894 "Anglo" Cable. Reduced size.

The actual speed obtained by automatic transmission with the latter cable is as high as forty-seven (or even up to fifty) five-letter words per minute. On the previous, lighter, Atlantic cores twenty-five to twenty-eight words per minute was the usual maximum speed attainable; the former, say, by average transmission and average receiving, and the latter by automatic transmission—other circumstances corresponding. Practically all submarine cables between important points—and certainly all those across the Atlantic—are now "duplexed"—a system of electrical working (instituted by Messrs. Muirhead in 1875) which enables messages to be sent in both directions at the same time. The result of this is nowadays to practically double the carrying capacity and earning power of the line, the effective speed in either direction remaining virtually the same as in “simplex” working, provided the cable is in good condition.[73] The armor of this cable (Fig. 43) is also a good example of present-day practise, each wire (usually covered with compounded tape) butting against the next; this is found to be the most durable form for a deep-sea cable.

In 1898 another French Atlantic line of a similar type to the above was laid. This involved the longest Atlantic cable-section in existence, i.e., 3,174 nautical miles, from Brest to Cape Cod, and was the first Atlantic line made and laid by Frenchmen, with the active assistance, as regards laying, of the Silvertown Company.

Recently, too, a German Atlantic cable has been laid by the Telegraph Construction Company from Emden to the Azores, and hence to New York.

The various proprietary companies here named have had duplicating lines laid for them from time to time, but these it is not necessary to further allude to.

Neither has it been thought necessary to give particulars regarding the methods of construction, laying, testing or working of any of these later lines following on the pioneer undertakings, except where special novelties were introduced. For similar reasons—and seeing that the responsibility of these later lines rested with contractors—the names of their permanent staff acting for them have not been introduced.

CHAPTER XIX

ATLANTIC CABLE SYSTEMS OF TO-DAY

Connecting Links—Tariff—Revenue

As a part of the union between the old world and the new, there are altogether fifteen cables now working across the North Atlantic Ocean (see Fig. 45), such as are usually termed “Atlantic cables.” Some of the Atlantic companies have special cables of their own from the landing place on the coast of Ireland to points on the Continental coasts. The figure on page 221 suggests one of the difficulties any wireless system would have to contend with in attempting at transatlantic telegraphy on a commercial basis.[74] Some of these cables at each end of the corresponding main section contain more than one insulated conductor.

Tariff.—In the early pioneer days of ocean telegraphy the Atlantic Telegraph Company started with a minimum tariff of £20 for twenty words, and £1 for each additional word. This was first reduced to £10 for twenty words, and was further altered later on to £5 for ten words. After this it stood for a long time at a minimum of 30s. for ten words of five letters each. Subsequently, in 1867, the Anglo-American Company tried a word-rate of £1 for the 1865 and 1866 Atlantic cables; but it was not until 1872 that Mr. Henry Weaver, their able manager, first instituted a regular word-rate system (without any minimum) of 4s. per word. At the present time (1903), thanks to competition, to technical improvements in the plant, and increased traffic—bringing in its train those economies in the working which are always possible in a larger scale of operation—the rate stands at 1s. a word with all the Atlantic companies. Some day we may, perhaps, see a sixpenny transatlantic tariff in permanent force.

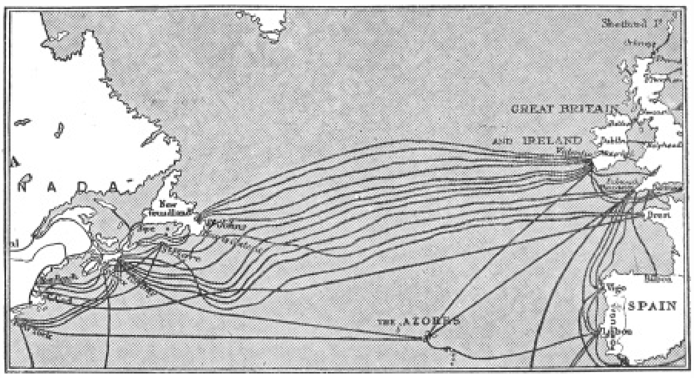


Fig. 45.—Atlantic Cable Systems, 1903.

Revenue.—The fifteen Atlantic cables now in use represent a total capital of well over £20,000,000 sterling. A knowledge of the profits derived from each system is not readily arrived at; but from a comparison of the traffic receipts or “money returns” of the oldest existing Atlantic company at different periods, we are bound to conclude that the “takings” are, roughly speaking, very much the same now as they were twenty-five years ago. This is explainable by the fact that, although the number of messages now passing is much greater, the reduction of the rate (with the ever-increasing competition of rival lines) just about cancels the advantage, so far as receipts are concerned. Roughly speaking, however, the annual gross traffic on transatlantic telegraphy stands at about £1,200,000, divided among two English companies, two American, one French, and one German company. Both the two latter are materially subsidized by their respective Governments, who now foresee the desirability of being independent of cables under English control.

FOOTNOTES:

[1] For particulars regarding preelectrical telegraphy and previous researches in electrotelegraphy, the reader is referred to A History of Telegraphy to the year 1837, by J. J. Fahie, M.I.E.E. (E. and F. N. Spon, 1884).

[2] A certain knowledge regarding electric and magnetic science has to be assumed here; and, for further particulars on this subject, the reader is referred to another volume of this series, The Story of Electricity, by John Munro.

[3] Submarine Telegraphs: Their History, Construction, and Working, by Charles Bright, F.R.S.E., A.M. Inst. C.E., M.I.E.E. (London: Crosby Lockwood & Son, 1898.)

[4] B.W.G.—Birmingham Wire Gage.

[5] It was gravely suggested by a prominent naval officer to thread the line through old cannonades lying idle, at Portsmouth harbor. This notion was not taken up; but a light chain twined round the insulated conductor throughout its length would certainly have served the purpose better than the leaden weights, inasmuch as it would have protected the line from chafing, besides being less liable to damage the core.

[6] Some critics had actually supposed that the method of signaling was that of *pulling* the wire after the manner of mechanical house-bells; and were at pains to point out that the bottom of the channel was too rough for that.

[7] For further particulars, see the Life Story of Sir Charles Tilston Bright. (London: Archibald Constable & Co., 1898.)

[8] It will be readily understood that without this weight, the line would not for certain descend to the bottom—and certainly not in a straight line—in any considerable depths. On the other hand, it would be impossible to recover an effective weight without great risk of breaking the line. For this reason the weight is abandoned, and a considerable number may be found at the bottom of the sea in every quarter of the globe.

[9] These live near the surface of the ocean in myriads upon myriads, incessantly sinking to the bottom as their short life is ended. Thus, in the course of ages, there grows constantly upward a formation similar to the chalk cliffs of England, which contain the identical shells, deposited when this country was submerged far below sea-level thousands of years ago.

[10] In the present day, however, soundings are taken at intervals of about ten miles along the proposed route, and even then submarine hills and valleys are frequently encountered. This is effected by means of the Thomson steam sounding-apparatus, the great feature of which is a fine steel wire (the same as that in the treble notes of a piano) in place of a hempen line of enormous bulk. Nowadays, taking a sounding in the Atlantic occupies well under an hour of time, where by the old method it took at least six hours.

[11] The full particulars of the agreement with the English Government were embodied in a letter from the Treasury (see Life Story of Sir Charles Bright) and form instructive reading even at the present time.

[12] Submarine Telegraphs.

[13] The Pirate, p. 2.

[14] Valentia is the Irish terminus of several of the present Atlantic lines.

[15] N.M.—Nautical miles.

[16] Though such a core would have been a great novelty at the time, it closely approximates to present-day practise.

[17] Mins. Proc. Inst. C. E., vol. xvi.

[18] An Atlantic cable of the present day runs into about half a million sterling. Gutta-percha was, in those days, less scarce; on the other hand, its manufacture was more of a novelty, and there was comparatively little competition in cable-making.

[19] Professor Morse (who held a sort of watching brief for the United States Government) also took passage, but had to retire to his berth as soon as the elements asserted themselves, and was scarcely visible again till all was over.

[20] The sheaves had several grooves which the cable fitted into in its passage. Though possessing some merits, this plan was never again adopted, owing partly to the above risk.

[21] This was owing to the two halves of the cable being made at different factories, without any communication passing between them on the subject.

[22] This apparatus first gained its name from the nature of the part it plays in machinery, being similar to that of a human jockey.

[23] So called on account of the form of grooving adopted for taking the under side of the table.

[24] Submarine Telegraphs.

[25] It is partly for this reason that so full an account is given here.

[26] In those days all such instruments were spoken of as galvanometers, no matter for what purpose they were employed. Moreover, this instrument was also used sometimes for testing. That which goes by the name of the marine galvanometer in the present day was not invented by Lord Kelvin till some years later.

[27] This splice-frame was an ingenious arrangement for neutralizing the untwisting tendency of two opposite lays when spliced together, but is never required in present-day practise.

[28] This, of course, did not in any way come as a surprise, for the length of cable employed for these experiments had long since been condemned as imperfect.

[29] And so it is sometimes with telegraph-ships—as regards the dead weight of cable—even in the present day, when compared with the risks run by ordinary seagoing vessels.

[30] When these part to any extent a ship is always considered in a dangerous condition.

[31] By subsequent tests it was clear that at any rate the cable remaining on board was perfect. But after com paring notes with the Niagara, a strong belief was held that the cable probably parted at the bottom.

[32] This was from the last turn in the coil, and subsequently it was discovered that owing to the disturbance in the flooring of the tank during the storm, the cable had been damaged here.

[33] Life-Story of Sir Charles Bright.

[34] Though bearing this somewhat cumbersome and elaborate title, this instrument was practically nothing more nor less than an ordinary "detector," its capacity for actually measuring the electric current being of an extremely limited character.

[35] This was some of the cable damaged during the storm, like that which had been broken at the end of the previous attempt. The bottom of the hold here was found afterward to be in a very disordered state.

[36] Later on it was made clear that this mysterious temporary want of continuity, accompanied by an apparent variation in the insulation, was due to a defect in the more or less inconstant sand-battery used aboard the latter vessel.

[37] It subsequently transpired that the trouble had been due to a fault in the Niagara's ward-room coil. As soon as the electricians discovered this, and had it cut out, all went smoothly again.

[38] The amount of slack paid out had already been almost ruinous. Luckily its continuance was not necessary, or it would have been impossible to reach Ireland with the cable on board.

[39] The Times, Wednesday, August 11, 1858.

[40] This spot had been selected on account of its seclusion from prevailing winds, and owing to the shelter it afforded from drifting icebergs.

[41] Engineer's log, U.S.N.S. Niagara.

[42] The Times, second edition, August 5th, 1858.

[43] The Times, August 6, 1858.

[44] Daily News, August 20, 1858.

[45] "The Life-Story of Sir Charles Bright," *ibid.*

[46] The Times, August 6, 1858.

[47] Submarine Telegraphs.

[48] In his work on the Electric Telegraph, the late Mr. Robert Sabine said: "At the date of the first Atlantic cable, the engineering department was far ahead of the electrical. The cable was successfully laid—mechanically good, but electrically bad." Its electrical failure was, of course, bound to spell commercial failure, no matter how great its success as an engineering feat.

[49] In his presidential address to the Institution of Electrical Engineers in 1889, Lord Kelvin (the Professor Thomson referred to in these pages) said: "The first Atlantic cable gave me the happiness and privilege of meeting and working with the late Sir Charles Bright. He was the engineer of this great undertaking—full of vigor, full of enthusiasm. We were shipmates on the Agamemnon on the ever-memorable expedition of 1858, during which we were out of sight of land for thirty-three days. To Sir C. Bright's vigor, earnestness, and enthusiasm was due the successful laying of the cable. We must always feel deeply indebted to our late colleague as a pioneer in that great work, when other engineers would not look at it, and thought it absolutely impracticable."

[50] Encyclopædia Britannica, 8th edition, 1860. Article on The Electric Telegraph, by Prof. W. Thomson, F.R.S.

[51] Mr. Croskey also subsequently found the bulk of the capital for the exploring expeditions.

[52] Later Admiral Sir Leopold M'Clintock, K.C.B., LL.D., F.R.S.

[53] Now Sir Allen Young, C. B.

[54] The reproduction given here is from a photograph kindly lent by Sir Allen Young.

[55] In consolidating the texture of the gutta-percha, pressure increases its electrical resistance, unless a flaw exists such as would then be immediately brought to light.

[56] See Submarine Telegraphs.

[57] Mr. Field compassed land and sea incessantly for the purpose of agitating the subject. He is said to have crossed the Atlantic altogether sixty-four times—suffering from sea sickness on each occasion—in connection with this great enterprise in which he formed so prominent a figure.

[58] Afterward Sir John Pender, G.C.M.G., M.P.

[59] The increased breaking strain here afforded over that of the first Atlantic line was partly due to the great improvement made in the manufacture of iron wire during the interval.

[60] Experience has since taught us, however, that such a type lacks durability, owing to the rapid decay of the hemp between the iron wires and the sea.

[61] The Great Eastern, in point of size, was only a little before her time. In the present day, with improved engines, she could be usefully and profitably employed, had she not been broken up.

[62] Afterward the able manager of the Eastern Telegraph Company.

[63] Life-Story of Sir C. T. Bright.

[64] At a later period—after both the 1865 and 1866 cables were in working order—Mr. Collett sent a message from Newfoundland to Valentia with a battery composed of a copper percussion-cap and a small strip of zinc, which were excited by a drop of acidulated water—the bulk of a tear only.

[65] This is situated on the opposite side of Trinity Bay to Bull Arm, where the 1858 cable had been landed, and not so far up. It was supposed to be even more protected than Bull Arm, from which it is some eighteen miles distant.

[66] Submarine Telegraphs.

[67] This is, of course, nowadays quite an ordinary occurrence, and by means of wireless telegraphy likely to

become still more so. Then, however, it was a complete novelty.

[68] Mr. Clark borrowed the thimble—which was a very small one—from Miss Fitzgerald, the daughter of the Knight of Kerry, living at Valentia.

[69] Afterward the first Earl of Iddesleigh, G.C.B.

[70] This enterprise, although mainly on behalf of France and the rest of the European continent, was principally advanced by financiers in England; the working of the cable was also chiefly under British direction and management.

[71] Afterward, in 1873, merged with its cable into the Anglo-American Telegraph Company and its system.

[72] This company had just had two fresh cables laid for them (1873 and 1874) by the Telegraph Construction Company with some of their usual staff. The laying of the 1874 Atlantic was the last piece of telegraph work performed by the Great Eastern. She has since been broken up, after being employed, among other things, as a sort of variety show. New cables were first rendered necessary—according to the joint-purse agreement previously referred to—by the final breakdown, after several repairs, of the 1866 cable in 1872. Later on (in 1877) the 1865 also succumbed, and another "Anglo" cable was laid by the same contractors in 1880. The Telegraph Construction and Maintenance Company laid this 1880 cable without any hitch or stoppage within the surprisingly short space of twelve days, the record up to date in Atlantic cable-laying.

[73] Thus the Atlantic cable of to-day may be credited with an "output" of 100 words a minute as compared with a single word in the same period, such as was at first obtained in the pioneer days of one cable worked by one company.

[74] Wireless telegraphy is at present a comparatively slow working affair; and if it is to successfully compete with our Atlantic cables, this means a great multiplication of transatlantic circuits all more or less close together, and, in consequence, all more or less liable to interfere with each other under existing conditions. Probably, however, any new company formed for the purposes of telegraphic communication between different countries would not confine itself—either in name or practise—to cables, but would also cultivate the "wireless" system of telegraphy.