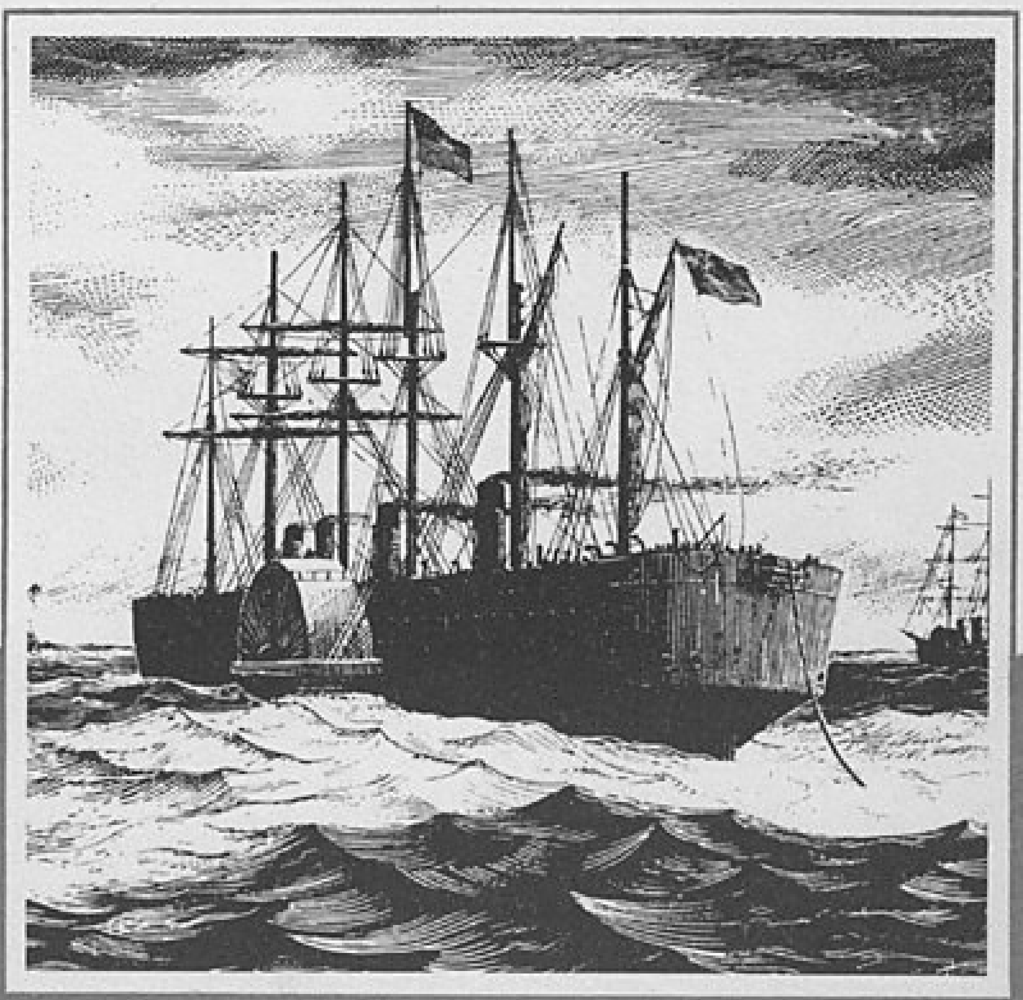
The ATLANTIC CABLE

BERN DIBNER



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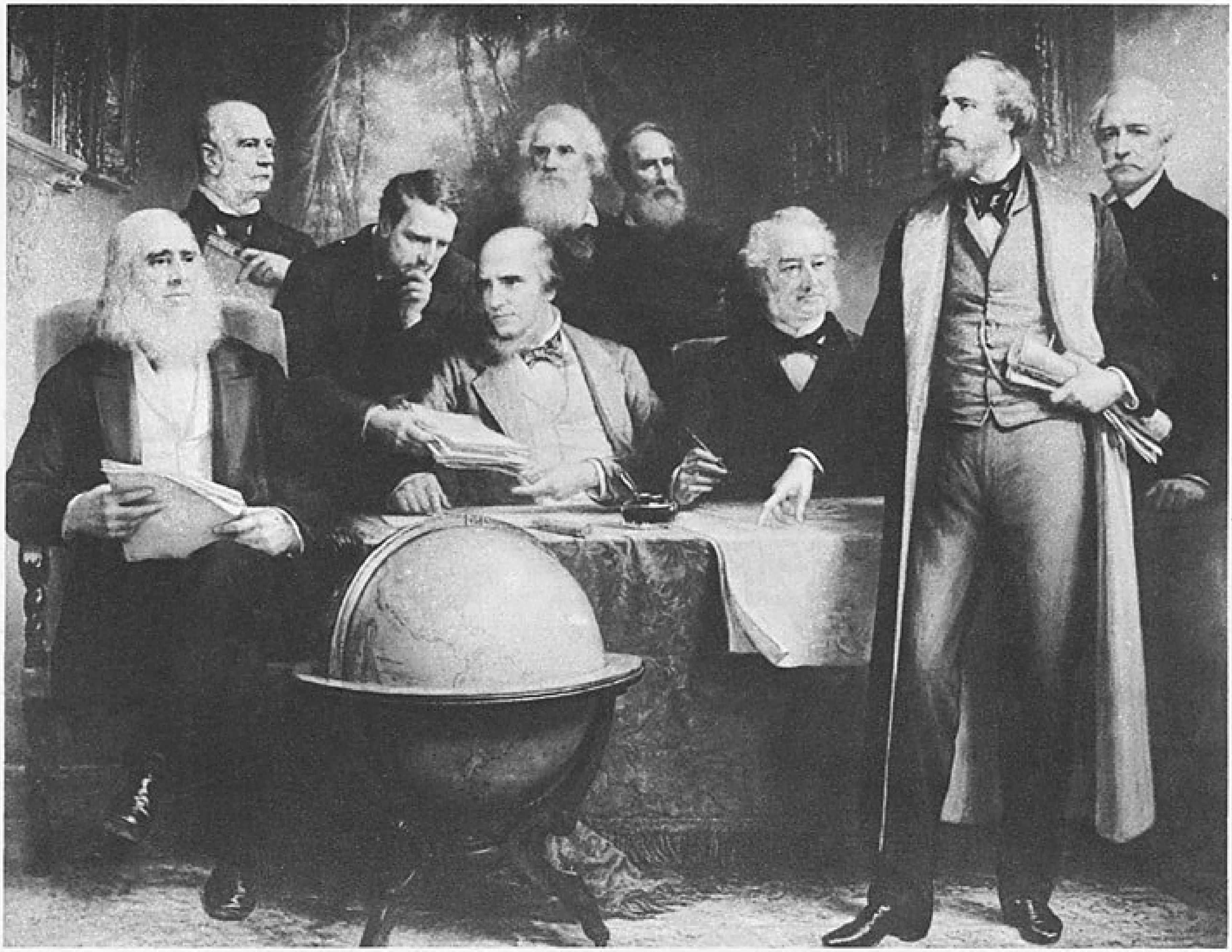
The cover lithograph was adapted from the title-page of W. H. Russel's book, London, 1866.

To

Dr. WILLIAM FONDILLER

Pioneer in electrical communication, in the tradition of Morse, Henry and Pupin.



Painting by Daniel Huntington, courtesy Chamber of Commerce, New York.

D. HUNTINGTON

DAVID D. FIELD — SAMUEL F. B. MORSE, *V. Pres.* — WILSON G. HUNT

CHANDLER WHITE, *Sec'y.* — CYRUS W. FIELD

PETER COOPER, *Pres.* — MARSHALL O. ROBERTS — MOSES TAYLOR, *Treas.*

THE ATLANTIC CABLE PROJECTORS

A meeting at the home of Cyrus Field in New York launched the New York, Newfoundland, and London Telegraph Company on May 8th, 1854. Mr. Field supplied the energy and vision but most of the money and ships and all of the cable came from England.

THE ATLANTIC CABLE

ONE cannot seriously object to those who would arbitrarily identify the recent centuries by such handy labels as calling the 1400s, the century of Discovery (Gutenberg and Columbus); the 1500s, the century of Exploration (Magellan and Copernicus); the 1600s, the century of Reason (Galileo and Newton), and the 1700s the century of Enlightenment (Diderot and Franklin). This brings us to the very threshold of the 1800s which could be aptly termed the century of Science. A true scion of such noble ancestry was Electricity.

In the very year 1800 Alessandro Volta published a paper in the Transactions of the Royal Society describing his invention of the Voltaic pile. This gave the increasing number of experimenters on both sides of the Atlantic a new instrument — a source of constant-flow electricity. By 1820, experimenters had devised an electric arc that shone with extraordinary brilliance, water had been decomposed into oxygen and hydrogen, and electro-plating had been demonstrated. In 1820, Oersted had discovered that a magnetic field surrounded a wire carrying an electric current and thereby linked two major phenomena of Nature — electricity and magnetism — the second an ever-present effect of the first. The invention of the electro-magnet was followed by the invention of the electro-magnetic telegraph demonstrated by Morse in 1837. This invention was as revolutionary as the printing press some 400 years earlier.

The electric telegraph was the first important and large-scale practical application of the new electrical force. It shrank distances across continents to almost nothing, for it took no longer to transmit a message across a continent than it did across a street. The first electric telegraph line was constructed between Washington and Baltimore in 1844 and the highways of both continents were soon lined by poles and cross-arms carrying wires thru which the silent electric messages streamed in ever-increasing numbers.

Professor Morse had spanned the harbor of the city of New York in 1842 by laying down an insulated copper wire thru which he succeeded in sending a telegraph message. This wire was insulated by hemp soaked in tar and pitch and surrounded by a layer of india-rubber. Three years later Ezra Cornell, who afterwards founded Cornell University, connected Fort Lee with New York by an underwater line 12 miles long which stretched across the Hudson River. The telegraph line consisted of two cotton-covered copper wires, insulated by india-rubber and enclosed in a lead sheath. After several months' successful operation the line was broken by an ice floe early in 1846.

As these lines spread out, the world's distances shrank in inverse proportion. It was inevitable that when these networks reached eastward along the Atlantic seaboard across states and provinces, over mountains and under rivers, bays and straits, the easternmost point of land would be reached. Similarly, moving westward, the networks in Europe would stand poised at the western shore of Ireland. There then remained the gap of nearly 2,000 miles of the Atlantic, a challenge to the scientist of vision and to the entrepreneur. Such a challenge did not remain long unheeded in the adventuresome days of the mid-1800s.

And so it was that the long fingers of the telegraph systems stretched eastward from Maine into New Brunswick, and then farther east to Sydney in Nova Scotia. From the easternmost point at Cape Breton, a submarine cable was laid across the Gulf of St. Lawrence's Cabot Strait to Cape Ray, the western point of Newfoundland, with its thriving city of St. John's on its eastern shore. In the late 1800s Newfoundland was an uninviting place with its rocky shores and deep fjords, altogether almost uninhabitated and unexplored. Its great forests stretched in unbroken solitude in which bears, wolves and herds of caribou lived as they had thru countless ages.

The dreamers and designers of systems of submarine telegraphy could draw on the experience of the successful submerged cable between Dover, England and Calais, France laid in 1851 by the brothers Brett. This cable weighed 12,000 pounds to the mile. Another cable was laid in 1854 between Corsica and La Spezia weighing 16,000 pounds to the mile. In the following year yet another was laid from Varna to Balaklava on the Black Sea; this served for military use during the Crimean War; it weighed less than 300 pounds to the mile.*

In 1850 the hope of connecting Newfoundland with the American continent was expressed by J. T. Mullock, a Bishop of Newfoundland, who proposed that some private company, English or American, should undertake to link St. John's by telegraph, crossing the island and Cabot Strait, then on to Cape Breton Island and Nova Scotia.

The same suggestion came from Mr. Frederic N. Gisborne, an English engineer and telegraph operator who, in the winter of 1849-50, proposed a similar link. He had had experience in the construction of telegraph lines in Nova Scotia and New Brunswick. In 1851 Mr. Gisborne visited Newfoundland and placed his proposal before the legislature. His plan included an overland line from Cape Ray to St. John's, a distance of 400 miles, steam-boat connection between Cape Ray and Cape Breton, with the eventual possibility of a submarine cable across the strait. The legislature granted Mr. Gisborne £500 sterling for an exploratory survey. Thereupon Mr. Gisborne resigned his position as chief officer of the Nova Scotia Telegraph Company and organized the Newfoundland Electric Telegraph Company. The survey of the island for such a line required three months to penetrate the wilderness, resulted in the death of one of the party of six and near starvation for the rest.

The energetic Mr. Gisborne visited New York on behalf of his company, received some financial encouragement and then sailed for England to purchase a submarine cable which was laid in November, 1852 from Prince Edward Island to New Brunswick, the first submarine cable of any length in America.

ORGANIZATION BEGINS

In constructing the line from St. John's to Cape Ray, Mr. Gisborne found the terrain so rugged that he decided to place the line underground. However, he managed to cover only a distance of some 30 or 40 miles when his funds were cut off and he was sued and subsequently arrested under the pressure of his creditors. This took all his resources. In the meantime the success of the Dover-Calais line prompted Mr. Gisborne to abandon his original plan for crossing the Gulf of St. Lawrence by boat and carrier pigeon and instead to substitute a submarine cable across Cabot Strait between Cape Ray and Cape Breton.

With Mr. Gisborne's telegraph company in bankruptcy and debts of some $50,000 owing to suppliers and to the construction crew, he left Halifax and again came to New York in January, 1854 to take counsel with his sources of finance. It was here that he met Mr. Matthew

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*FIELD, H. M., *The Story of the Atlantic Telegraph*, London, 1893, page 89. A complete list of references, may be found in the Bibliography on page 94 of this study.

D. Field, a civil engineer, who had been building railroads and suspension bridges in the newly opened South and West. Mr. Field became interested in Mr. Gisborne's plans and decided to speak to his brother, Cyrus W. Field, a successful New York merchant who had retired from active business the year before. Tho only 34 years old and with an ample fortune in reserve, Cyrus Field*, who had just returned from a six-month visit in the mountain areas of South America, was disinclined to begin a new and speculative enterprise. However, the challenge of a telegraph line extending thru Newfoundland appealed to him and he invited Mr. Gisborne to his home. After an evening's conversation, Mr. Gisborne left, and Mr. Field moved leisurely to the globe standing in his library in order to visualize the extension of the telegraph system into this new area. It was then that the idea occurred to him that it would be of enormous advantage to continue the telegraph line across the Atlantic Ocean. Some ten years earlier, Professor Morse had stated that "a telegraphic communication might with certainty be established across the Atlantic Ocean", and others undoubtedly expressed the same conviction, but the idea occurred afresh to Mr. Field as he projected the possibility of such a line upon the globe.

*Cyrus West Field was born in Stockbridge, Massachusetts, in November 1819, of Puritan ancestry, a descendant of Zachariah Field who had left England for America in about 1631. Cyrus was the youngest of seven sons, many of whom attained distinction in law, the ministry, or commerce. His grandfather, Timothy Field, served as a captain in Washington's army and his father studied at Yale for the ministry. He left school at 15, went to New York and began work in a Broadway mercantile office for a dollar a week. After three years he returned to Massachusetts and became a papermaker. In nine exhausting years he had made a fortune, enough to enable him to retire at 33. His energy and dedication made possible the Atlantic Cable in spite of many discouraging difficulties. He died in 1892 at his home at Ardsley, near Irvington, N. Y., and was buried at Stockbridge.

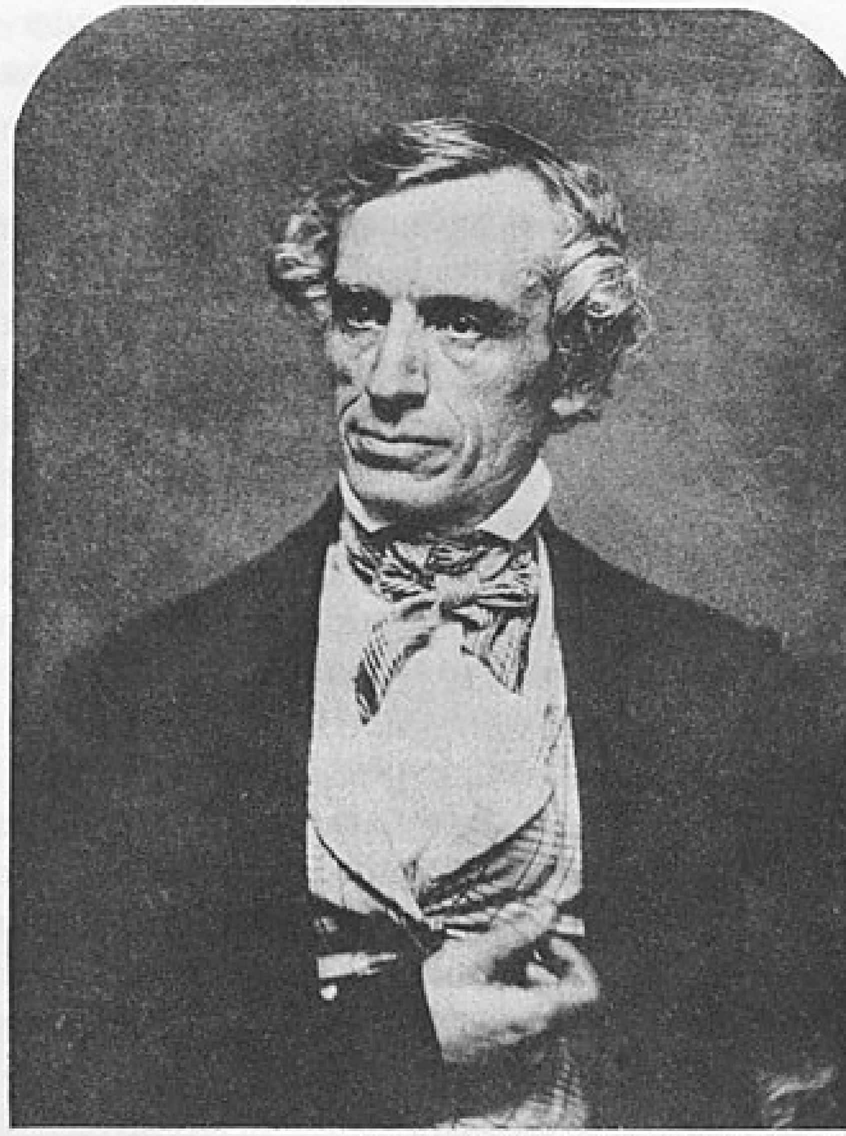


Photo attributed to Daguerre, Paris, 1845.
Courtesy of the Gernsheim Collection, London.

Samuel F. B. Morse* had demonstrated the practicality of telegraphy thru a submarine wire two years before he first sent his epochal message from Washington to Baltimore in 1844. He advised Field on the Atlantic cable and accompanied the expedition of 1857.

*Samuel F. B. Morse (1791-1872) was a painter and founder of the National Academy of Design. In 1832 he conceived the basic idea of an electro-magnetic telegraph while on a ship returning from Europe. Experiments with various kinds of electrical instruments and codes resulted in a demonstration of a working telegraph set in 1836, and the introduction of the circuit relay, making transmission possible for any distance. In the following year a patent application was filed and in 1843 Congress voted $30,000 for an experimental line between Washington and Baltimore. With financial aid from Alfred Vail and Ezra Cornell, the line was completed and, on May 24, 1844, the first historic message "What hath God wrought?" flashed across the line. After much litigation, prosperity finally came to Prof. Morse, altho inventions of his earlier days, such as water-pumps, and marble-carving machines, proved of little worth. Appendix A, page 89, quotes from an early letter of Morse on preliminary plans for the cable.

In merely asking whether such an undertaking was feasible, a host of new questions formed in Mr. Field's mind. Mechanical questions, such as whether a cable of sufficient strength could be built, remained to be answered. There were electrical questions, such as whether a signal could be conveyed over this vast distance under submarine conditions. Geological questions remained to be answered, such as the nature of the ocean's bottom, the possibility of undersea tides and the presence of destructive forces similar to those on the ocean's surface. The nature of the ocean floor had to be determined and also the possibility of underwater volcanic action.

For an alert and inquisitive mind such as that of Mr. Field, adequate answers to these questions had to be found. On the following morning Mr. Field dispatched two letters concerned with these problems to the two foremost authorities of the day. One went to Lieut. Matthew F. Maury*, head of the National Observatory at Washington and an authority on oceanography. The other was sent to Prof. Morse asking if it were possible to telegraph a signal over a distance as vast as that from America to Europe.

The reply from Lt. Maury indicated that Lieut. Commander O. H. Berryman had completed a series of soundings from the shores of Newfoundland to Ireland the year before. He had also investigated the winds and currents of the area. Anticipating the possibility of a submarine telegraph line, it was found that the 1,600 mile stretch between Newfoundland and Ireland was primarily a plateau deep enough to clear icebergs and ships' anchors, yet shallow enough to make a submarine line feasible. Scrapings from the ocean's bottom indicated that the deposit was composed of microscopic shells and that no sand or gravel existed there. Lt. Maury with some hesitation foresaw the practicality of a submarine telegraph line, for he had concluded his report with the words: "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."*

Prof. Morse showed an even deeper interest in the questions raised by Mr. Field, and replied that he would come to New York to visit Mr. Field in a few days. This he did, and there was thus established a friendship that was to continue for their lifetime. Morse explained the basic laws of electrical flow to Mr. Field and said that he felt certain that a transatlantic cable would be practical. He referred to a letter which he had written as long ago as August 10, 1843 (eleven years earlier) to John C. Spencer, then Secretary of the Treasury, which had followed a series of experiments made in the New York Harbor to test the practicality of underwater telegraphy. In it he said, "The practical inference from this law is, that a telegraphic communication on the electro-magnetic plan may with certainty be established across the Atlantic Ocean! Startling as this may now seem, I am confident the time will come when this project will be realized." Following these encouraging reports from Prof. Morse and Lt. Maury, Mr. Field decided that he would speak with a number of his capitalist friends to see if they would support his enterprise to span the Atlantic via Newfoundland.

Thus began one of the great sagas in modern history, touching the fields of science, politics,

*Lt. M. F. Maury (1806-1873) was accidentally lamed at 33 but became head of the U.S. Hydrographic Office. He published *The Physical Geography of the Sea*, New York, 1855, the first textbook of modern oceanography, following his research on ocean depth, winds, temperature and currents in the Atlantic, Pacific and Indian Oceans.

*Quoted in BRIGHT, Charles, *The Story of the Atlantic Cable*, 1903, page 35.

finance and geography. Deep and penetrating as Cyrus Field's vision was, he still did not foresee that this enterprise was to take some 13 years and require over 40 transatlantic crossings, at a time when such crossings were long, hazardous and very uncomfortable. As the project took form in his mind, Mr. Field decided to invite ten capitalists who, together, could carry a financial burden of the magnitude that this enterprise seemed to represent, surely a million dollars or more.

He first called upon his Gramercy Square neighbor, Peter Cooper.* Altho reluctant to enter a speculative enterprise such as this at the age of 63, after a long and very active business career, the challenge and the possibility for the general good that this enterprise promised caught Mr. Cooper's interest and he decided to join the syndicate. This encouraged others to join Mr. Field until, when there were five partners, Mr. Cooper suggested no more were needed. The group consisted of Mr. Field and Mr. Cooper, who were joined by Moses Taylor, Marshal O. Roberts, and Chandler White; in the following year a sixth, Wilson G. Hunt, joined the group.

They met four nights in succession at Mr. Field's home, organizing the company and agreeing on a plan of procedure. It was decided to send Mr. Field and Mr. White to Newfoundland to obtain a new charter. The Newfoundland Electric Telegraph Company agreed to surrender its charter and Mr. Gisborne joined the committee on a steamer headed for St. John's. In St. John's they spoke to Governor Hamilton who convoked the Council and agreed to recommend to the Assembly a guarantee of the interest on £50,000 in bonds as well as grants of land and a right-of-way across the island for the overland telegraph line. This was in March, 1854.

The old Electric Telegraph Company charter was replaced by one granted to the "New York, Newfoundland, and London Telegraph Company." With this change in charter also came a change in mission because the old company had intended to span the Atlantic link by boat and thus hoped to transmit a message from England to America in "only six days." It became the intent of the new company to tie the two continents together directly and *electrically*.

The charter provided exclusive landing rights for Newfoundland and Labrador, was to remain in effect for 50 years, and established the equality of U. S. citizens and British subjects, with meetings of stockholders and directors permissible in New York, Newfoundland or London.

The charter was accepted unanimously by the Assembly of Newfoundland and was confirmed by the Council. The debts of the old company were paid off and the new enterprise began to move in high gear. In early May, the directors assembled in New York where the charter was formally accepted and the company became a corporate entity. To meet the schedules of comings and goings of these busy gentlemen, it was agreed to meet at the home of Mr. Field's brother, Dudley Field, at 6 A.M. on May 6, 1854 for purposes of organization. The charter was accepted, the stock subscribed and the first directors, Messrs. Cooper, Taylor, Field, Roberts and White, were chosen. Mr. Cooper became the first president and, in a few minutes, capital of $1,500,000 was subscribed. It was agreed that the first task was to extend the telegraph line to St. John's, more than a thousand miles from New York.

Even to these practical men, combining in their experience such diverse enterprises as driv-

*Peter Cooper (1791-1883) was born in New York into a humble family. His enterprise led him to establish an iron works in Baltimore and to design and build the first American locomotive for the Baltimore and Ohio Railroad in 1830. He founded, in 1857, Cooper Union, an institute famous for the advancement of science and art.

ing railroads across rivers and over mountains in different parts of the world, building ships and canals, operating mines, mills and factories, this was an incredibly difficult task to undertake. In the new land that faced them there were rugged mountains, impassable jungles and bogs into which a horse and rider could disappear. But there always seemed to rise men of strength and courage to overcome such difficulties. A road was built over the 400 miles of Newfoundland wilderness and desolation with mountains, gorges and rivers that had to be crossed. The eight-foot road crossed the island with bridges of the same width to permit inspection of the telegraph line. Matthew D. Field, brother of Cyrus, was put in charge of the construction of the line, for his engineering experience was of the greatest value. The construction crew grew to be a body of 600 men who had to be supplied by sea because there was not even an Indian trail for them to follow thru the impenetrable wilderness.

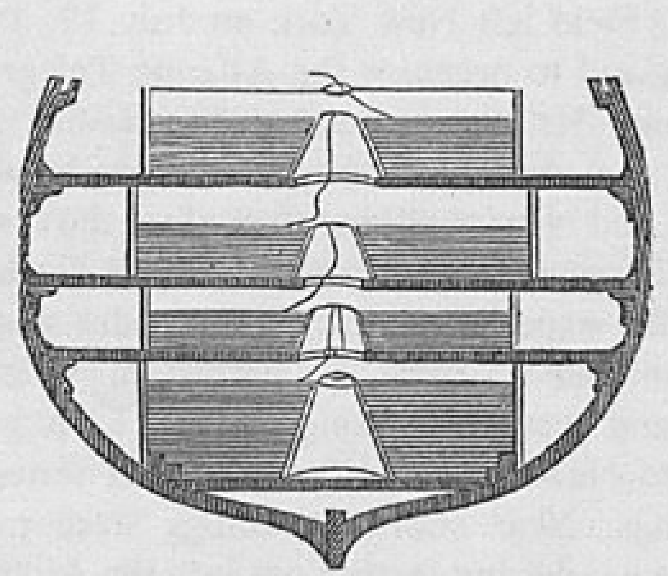
It was expected that the telegraph line across Newfoundland would require one year to be built, and would be completed in the summer of 1855. Mr. Field went to England in the autumn of 1854 to order the cable to span the 85-mile Cabot Strait from Cape Ray to Cape Breton. There he met Mr. John W. Brett who had successfully spanned the English Channel with two submarine telegraph lines and to whom Mr. Gisborne had written about the difficulties of the Newfoundland Company in 1854.

John Watkins Brett and his brother Jacob had, in 1845, proposed to the Prime Minister, Sir Robert Peel, a general system of land and ocean telegraphy. They were referred to the Admiralty and became involved in drawn-out departmental correspondence. After much negotiation between England and France, the Messrs. Brett formed a company to span the English channel from Dover to Calais. The line was laid in 1851 and was 25 nautical miles long. It consisted of No. 14 copper wire, insulated with a half-inch thickness of gutta-percha, and protected by an armor of spirally wound galvanized iron wires. A means of testing the continuity of the wire at that time consisted of applying the electrician's tongue to sense the flow of current. At each shore station a coastal length of wire was installed; it consisted of a No. 10 B.W.G. (Birmingham Wire Gauge) covered by cotton tape soaked in india-rubber solution. This was then encased in a thick lead tube. Mr. Thomas R. Crampton was the engineer in charge of the project.

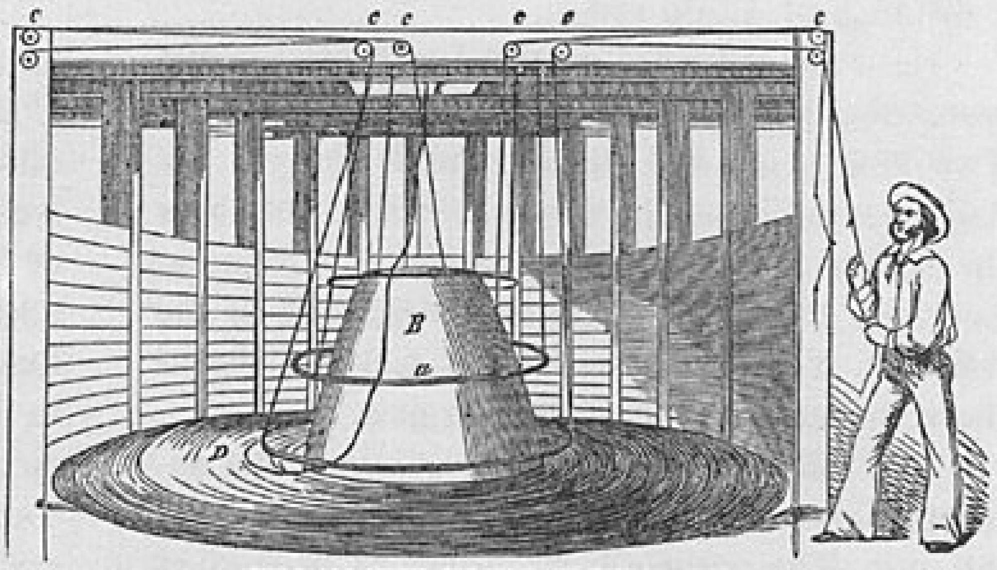
Mr. Brett*, unlike many Englishmen whom Mr. Field met, supported Mr. Field's idea of the Atlantic telegraph and even subscribed to some shares in the Newfoundland line. His enthusiasm was shared by Prof. William Thomson of the University of Glasgow, who, tho only a young man of 31, had already written, in October and November, 1854, to the Secretary of the Royal Society of London, supporting the idea of a transatlantic cable.

The Newfoundland cable was completed and shipped by sailing bark for laying across the Gulf of St. Lawrence. Representatives of the company, scientists and journalists, including Mr. Field, Mr. Cooper, and Prof. Morse, sailed for Newfoundland to watch the submersion of the cable. The party gathered on the ship's deck in clear summer weather with Prof. Morse instructing the assembled group on the operation of the telegraph instrument, an example of which he had brought up with him. After some delay the cable was anchored near Cape Ray and Samuel Canning, the engineer in charge, started to cross the Gulf of St. Lawrence, the steamer Adger towing the bark Sarah L. Bryant on which the cable had been brought from Eng-

*See (WEST, Charles), *The Story of My Life. By the Submarine Telegraph*, London, 1859 and books by Brett.



SECTION OF THE NIAGARA, SHOWING THE STOWAGE OF THE COILS IN THE FOREPART OF THE SHIP.



THE CABLE CIRCUS, THE CONE AND FAIR-LEADERS.

a—Large iron rings for fair-leaders and to prevent kinking.
B—Cone.
c—Pulleys with iron tricing lines for raising fair-leaders.
D—Portion of cone coiled.
E—Hatchway with the cable going up.

The cable was stowed in a "circus" on four decks aboard the Niagara, the top end of each coil connecting to the bottom end of the coil above. A central cone was surrounded by iron rings that kept the cable from kinking.

land. Halfway across the Gulf the calm was broken by a heavy gale which pitched the bark very violently with the danger of losing both ship and cable. To save the bark, the captain ordered the cable cut. Thus 40 miles of cable were lost and the Adger returned to New York. Now, too late, it was realized that a sail-driven vessel was unsuitable for laying cable because it had no motive power and had to be towed by another ship, and was therefore quite unmanageable for the task. It was therefore decided that only a steam vessel would thereafter be used for this work. What had started with so much promise became a severe disappointment to the company directors, and the replacement of the cable had to be postponed for a whole year as the good weather necessary for laying a cable between the capes was seasonally comparatively short. A new cable had to be ordered for manufacture in England and the disappointment caused some of the supporters to wonder whether the enterprise was as sound as was first supposed.

Mr. Field sailed for England to order a replacement cable, which was fabricated and sent out the following summer by a steamer properly fitted for the task. No celebrating party was now invited aboard; the cable was laid without incident and continued to function for nine years. For the first time, a stranded instead of a solid wire formed the core of the conductor.

Much more difficult was the task of spanning the island of Newfoundland by 400 miles of road and telegraph line. But this was accomplished in 1856. The company also joined the ends of the island of Cape Breton with a telegraph line 140 miles long. With these links completed, the telegraph system stretched solidly from St. John's in Newfoundland to New York, a distance of 1,000 miles.

Here was the first successful enterprise of the company, but it had cost over a million dollars. Two long years had passed, much heavy work had been done but there was something to show for it, for the chain of electrical communication now stretched to the very threshold of the Atlantic. Yet the most difficult task still faced the venturesome men of the company.

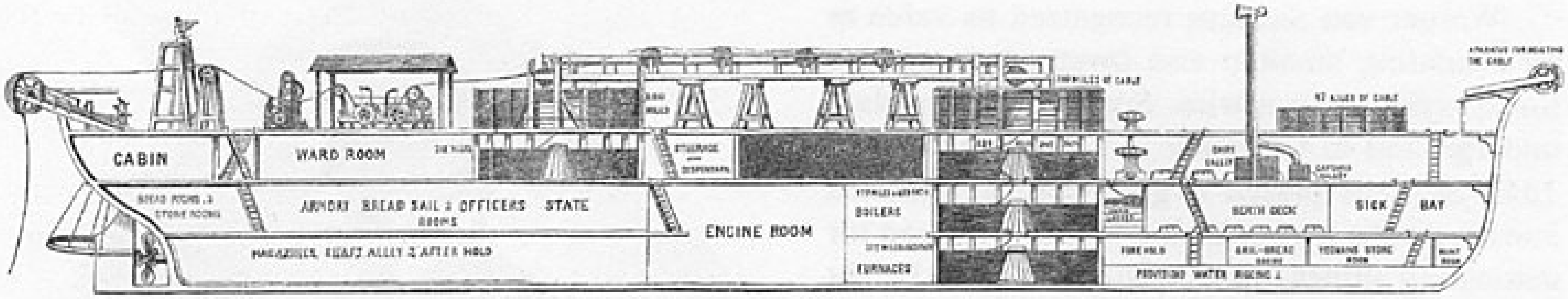
The full attention of the directors of the enterprise was now turned to the problem of the Atlantic. The ocean's bottom had to be studied for the specific task of carrying a slender cable; its character had to be more carefully determined than had already been done by the series of soundings by Lt. Maury. Tests had to be undertaken to learn if the ocean bottom was jagged with sharp rocks and whether ocean tides existed because, as it was then supposed, these would wear thru the soundest armored cable in time; also if the ocean bottom were cut by valleys and chasms, a cable hung across such voids would sag and part because of its weight if the gaps were too wide.

For the facts to be ascertained, sounding apparatus was devised to sample the bottom's depth and test its firmness, as well as to establish its contour. In 1853 Lt. Berryman had taken deep-sea soundings across the Atlantic from Newfoundland to Ireland, which indicated a surprisingly satisfactory gradient and firm bed between these two points. However, Mr. Field went to Washington to request the government to retest the bed on behalf of his company. Lt. Berryman was again assigned to this task and he left New York in July, 1856 on the U.S.S. Arctic. In three weeks the soundings to the coast of Ireland were completed, following the great circle arc, which was intended as the line of the Atlantic cable. The existence of a great plateau, extending from one continent to the other, was confirmed.

Mr. Field left New York on July 19, 1856 for England to organize the Atlantic Telegraph Company. He also requested the British Admiralty to determine its own soundings between Ireland and Newfoundland to confirm the results of Lt. Berryman. The British steamer Cyclops, under the experienced Lt. Commander Joseph Dayman, moved from the harbor of Valentia in Ireland westward along the arc of a great circle to Newfoundland for the third series of soundings. Near shore soundings were made every few miles but farther out into the Atlantic, where the depths were more nearly equal, the line was cast every 20 or 30 miles. Dayman took his soundings a little north of the line of Berryman, but generally confirmed the other's findings. The bottom was a plateau varying in depth from 1,450 to 2,400 fathoms, gradually increasing from the shores of Newfoundland toward Ireland. Lt. Maury had named this the "Telegraphic Plateau".

At its deepest, the ocean in that line was 14,000 feet, or slightly over two and a half miles. A depth variation of 550 fathoms down to 1,750 fathoms was located within the short space of about a dozen miles at a point about 200 miles west of the coast of Ireland. This constituted the chief point of danger along the whole bed of the Atlantic and was carefully watched in subsequent layings of the cable across the ocean, altho it was only a 15% grade. The soundings disclosed that the ocean floor was soft.

In taking stock of the financial status of the company before beginning the final major link in the electrical chain, it was realized that over a million and a quarter dollars had thus far been raised and spent by the half dozen stockholders of the company, all citizens of America. It was now considered time to extend the finan-



A sectional view of the Niagara showing the seven cable coils on the four decks, the guide wheels, issuing machine, dynamometer, sheaves and stern guard.

cial burden and responsibilities to include those in England who could visualize the potential of the Atlantic cable and who might wish to participate in the venture. Mr. Field first turned to Mr. Brett on the advisability of enlarging the corporate structure to include English capital. The risks were understandably great because a line extending some 2,000 miles across the ocean presented many more problems than the underwater lines which had been laid so far, the longest of which had spanned a length of some 300 miles. Mr. Field had not forgotten the unpleasant experience of the previous year in laying the cable across the Gulf of St. Lawrence, a distance of only 85 miles. He therefore called on the firm of Glass, Elliot & Company of London, a firm which had begun to specialize in the manufacture of submarine cables. Their chief engineer, Mr. Canning*, had acquired more experience with this type of cable than anyone else. Mr. Field also consulted Robert Stephenson and Isambard K. Brunel, son of a famous engineer and himself a builder of railroads, tunnels and steamships. The world's largest ship, The Great Eastern, was then under construction and Mr. Brunel invited Mr. Field to see the monstrous hull rising on the banks of the Thames. Said Mr. Brunel, "There is the ship to lay the Atlantic Cable!" Neither of the men realized that in ten years this would be the ship to finally and successfully accomplish the difficult task.

From Mr. Canning, Mr. Field learned of the difficulties of providing the necessary insulation to keep the copper wires, that actually carried the electrical current, insulated from the ocean conductive medium surrounding them. It was only a few years earlier that gutta-percha had been found in Malaya and this substance seemed to have the required properties for insulating the current-carrying wire. The material was produced by evaporating the milky fluid of the gutta-percha tree, coagulating the latex, from which an inelastic, firm insulator resulted, one that softened in hot water. The material was so new and rare that it was shown at the Great Exhibition in London in 1851. It had an advantage over india-rubber because, on cooling, it became hard without becoming brittle. It was ideally suited for underwater use where the cold and pressure improved its insulating qualities. This submersion also avoided exposure to sunlight, which had a deteriorating effect on gutta-percha.

*Charles Canning (1823-1908), an English engineer who had acquired cable-laying experience in the Mediterranean and directed the cable-laying across the Gulf of St. Lawrence. His attention to the performance of the cable machinery on the Niagara in 1857 twice saved the cable from rupture. During the 1858 expedition, he served on the Agamemnon and became chief engineer in the expeditions of 1865 and 1866, for which he was knighted.

Werner von Siemens recognized its value as an insulating medium and invented a machine for applying it to a wire. Such wires were laid underground in Germany in the late 1840s. In 1849 Siemens placed a gutta-percha insulated line across the harbor of Kiel which was used for detonating mines. In England, Charles Bright installed an extensive system of underground telegraph lines for the Magnetic Telegraph Company using improved insulated wires of his own patented design.

In addition to the technical advice sought from Mr. Samuel Statham of the London Gutta Percha Works, Mr. Field was fortunate in getting the help and advice of Mr. Charles T. Bright*, an experienced engineer on telegraph and electrical problems, and Dr. Edward O. W. Whitehouse, formerly a physician, who had become an authority on the application of electricity to the problems of telegraphy, tho he later proved more of a liability than an asset. The problems raised by the possibility of an Atlantic cable were just the type of challenge that was of greatest interest to these two scientists. They were later joined by Prof. Morse to complete the technical staff of the expanded company.

Charles T. Bright, at 20, holder of two dozen patents; at 24, chief engineer of the Atlantic Telegraph Co.; at 26, knighted for his accomplishments.

In the autumn of 1856, both Mr. Field and Prof. Morse were in England, and a communication of Prof. Morse to Mr. Field after a crucial test on a long cable is worth repeating:

London, five o'clock a.m.,
October 3, 1856.

My dear Sir:

As the electrician of the New York, Newfoundland, and London Telegraph Company, it is with the highest gratification that I have to apprise you of the result of our experiments

*Charles Tilson Bright (1832-1888) was another of the Victorians who rose to prominence at a very early age. By 20, he had already patented 24 inventions and become chief engineer of the Magnetic Telegraph Company, engaged in covering England with a network of telegraph lines. In this program he was the first to install gutta-percha-covered telegraph wires in an underground system. In 1853 he successfully laid the first deep water telegraph cable between England and Ireland, which was preceded only by the two cables across the English Channel, laid in 1851 in much shallower water. He was appointed chief engineer of the Atlantic Telegraph Company in 1856 when only 24 years old, and remained a consultant to the enterprise during the expeditions of 1865 and 1866 during which time he was a member of Parliament. Within a few days after the laying of the successful cable across the Atlantic in August, 1858, he was knighted by Queen Victoria, the youngest to be so honored in many generations, and the first electrician to be knighted. Acting with Latimer Clark as consultant to the British Government, he supervised the successful cable laid to India in 1863-4. They also developed a compound for rust-proofing iron cable armor wires. In 1868 he began laying a cable from Havana to the Florida terminus of the Western Union land telegraph system. He was elected president of the Institution of Electrical Engineers for 1887; he died the following year at age 55 leaving a telegraph network covering half the globe as a monument to his brilliance and energy.

of this morning upon a single continuous conductor of more than two thousand miles in extent, a distance you will perceive sufficient to cross the Atlantic Ocean, from Newfoundland to Ireland.

The admirable arrangements made at the Magnetic Telegraph Office in Old Broad street, for connecting ten subterranean gutta-percha insulated conductors, of over two hundred miles each, so as to give one continuous length of more than two thousand miles during the hours of the night, when the telegraph is not commercially employed, furnished us the means of conclusively settling, by actual experiment, the question of the practicability as well as the practicality of telegraphing through our proposed Atlantic cable.

This result had been thrown into some doubt by the discovery, more than two years since, of certain phenomena upon subterranean and submarine conductors, and had attracted the attention of electricians, particularly of that most eminent philosopher, Professor Faraday, and that clearsighted investigator of electrical phenomena, Dr. Whitehouse; and one of these phenomena, to wit, the perceptible retardation of the electric current, threatened to perplex our operations, and required careful investigation before we could pronounce with certainty the commercial practicability of the Ocean Telegraph.

I am most happy to inform you that, as a crowning result of a long series of experimental investigation and inductive reasoning upon this subject, the experiments under the direction of Dr. Whitehouse and Mr. Bright, which I witnessed this morning — in which the induction coils and receiving magnets, as modified by these gentlemen, were made to actuate one of my recording instruments — have most satisfactorily resolved all doubts of the practicability as well as practicality of operating the telegraph from Newfoundland to Ireland.

Although we telegraphed signals at the rate of two hundred and ten, two hundred and forty-one, and, according to the count at one time, even of two hundred and seventy per minute upon my telegraphic register, (which speed, you will perceive, is at a rate commercially advantageous,) these results were accomplished notwithstanding many disadvantages in our arrangements of a temporary and local character — disadvantages which will not occur in the use of our submarine cable.

Having passed the whole night with my active and agreeable collaborators, Dr. Whitehouse and Mr. Bright, without sleep, you will excuse the hurried and brief character of this note, which I could not refrain from sending you, since our experiments this morning settle the scientific and commercial points of our enterprise satisfactorily.

With respect and esteem, your obedient servant,

SAMUEL F. B. MORSE.*

Another letter sent by Prof. Morse to Mr. Field, confirming the ease of telegraphing from Ireland to Newfoundland at commercial speeds, concluded that a cable could carry 14,400 words in a 24-hour day. He added, further, that this number could be increased by adopting a code or system similar to the nautical code, and by this means the transmission speed could be doubled.

The retardation of the flow of current in a long wire covered by insulation and shielded by metallic wires or tapes involved a new phenomenon that became the subject of research by Faraday, and a paper by Edward B. Bright before the British Association in 1854. Unlike a simple bare wire strung on posts in open air, or a comparatively short insulated wire, long insulated and protected cables introduced an inductive and capacitance effect that tended to retard the flow of current. The laws governing

*Quoted in H. M. FIELD, 1893, page 76.

this retardation were not fully determined until some years after the Atlantic Cable laying (see also page 28).

The enthusiasm of Prof. Morse was unbounded and he saw no difficulty that could not be overcome. Prof. Faraday, in answer to a question as to the time it would take for electricity to pass from London to New York, replied, "Possibly one second!"

Such support from the foremost experimenters and scientists of America and England encouraged Mr. Field to address himself to the British Government. He therefore sent a letter to the Foreign Secretary, Lord Clarendon, outlining his project and inviting participation in an enterprise involving the honor and interest of England. There followed a conference at the Foreign Office attended by Lord Clarendon, Mr. Field and Prof. Morse. Lord Clarendon faced his American visitors with the possibility of failure, such as the loss of the cable in the sea; what would they then do? Mr. Field promptly replied that he would "charge it to profit and loss, and go to work to lay another." This disarming reply resulted in an invitation to spend several days with Mr. James Wilson, influential Secretary of the Treasury. The meeting was followed by a letter from Mr. Wilson to Mr. Field outlining the conditions of support of the English Government. The offer consisted of furnishing naval ships for taking soundings, an agreement to pay at the rate of £14,000 a year (representing 4% on a £350,000 investment), as a government subsidy for future use of the telegraph facilities, and a reservation of priority in the conveyance of messages over all others, except those of the Government of the United States. The above arrangement was to be considered as a guaranteed return on investment and was to continue until the net profits of the company amounted to a dividend of six percent on the capital, when the subsidy was to be reduced to £10,000 per year for 25 years.

With such approval and encouragement, Mr. Field saw the necessity of reorganizing the enterprise into a new corporation, to be called the Atlantic Telegraph Company, whose mission it was "to continue the existing line of the New York, Newfoundland, and London Company to Ireland, by making or causing to be made a submarine telegraph cable for the Atlantic". To this new enterprise, Charles Bright was invited as chief engineer and Dr. Whitehouse as electrician. The new enterprise was now ready for presentation to the British public, and Mr. Field, as Vice President, prepared a circular outlining the purpose and fiscal structure of the venture. It was estimated that to complete the laying of the cable would require £350,000.

Such a speculative and visionary prospect did not immediately bring in the bank notes and Mr. Field, accompanied by Mr. Brett, not only made many calls in London but moved out into Liverpool and Manchester to address influential persons and groups. In a few weeks the whole capital was subscribed; of this Mr. Field's interest was one fourth of the whole capital, making him the largest stock-holder in England or America. The new company was organized on September 26, 1856 by Messrs. Brett, Bright and Field, and to the board of directors of leading bankers and merchants of London and Liverpool was added Prof. William Thomson of Glasgow. The entire capital, consisting of 350 shares of £1,000 each, was thereafter subscribed.

Thus organized, the company turned to its main effort, the fabrication and laying of the cable. Designs and experiments helped determine the form and materials to provide the greatest strength with the lightness and flexibility necessary to handle so long a compound cable under such uncertain and difficult conditions. Mr. Brett recalled the loss of a cable in September, 1855, while it was being laid in the Mediterranean from Sardinia to Algeria. Its size and stiffness had made it unwieldy and troublesome, so that when it broke loose it flew out with such velocity that nothing could stop it, and in a few minutes it was lost in the sea.

The final cable design was submitted to two companies: Glass, Elliot & Co., of London, and R. S. Newall & Co., of Birkenhead, both originally mine cable makers. The specifications for fabrication combined the flexibility of a small rope with the strength to hold six miles of its own weight suspended vertically in water. Without consulting each other, the cable was fabricated at each plant in an opposite lay. Only six months were left for the manufacture of 2,500 miles of complex cable, with no time allowed for experimentation or the determination of long-length cable characteristics. When Prof. Thomson joined the company as a director, the cable specifications were already in the hands of the fabricators, and the directors were determined to have the cable laid during the summer of 1857.

The conducting core was made by the Gutta Percha Company and consisted of seven wires of No. 22 stranded copper "of the best quality", then covered by three separate layers of gutta-percha, thus forming the core of the cable. Around this were wrapped layers of tarred hemp saturated with a preservative composed of pitch, tar, linseed oil and wax. Over this was wound the outside covering armor which consisted of 18 strands of No. 22 iron wire, each strand itself composed of six spirally wound strands about a center wire. Both Faraday and Morse favored a smaller rather than larger conductor diameter, fearing the retarding effect of large charging currents. The wire's capacitance was considered more critical than its resistance. The weight of the cable in air was 2,000 lbs. per nautical mile and in water 1,340 lbs. The cable diameter was slightly larger than five-eighths inch. Twenty-five miles of heavy shore-end cable was also prepared, ten miles intended for the Irish coast and fifteen miles for that of Newfoundland, which had been found to be more rocky. This heavier conductor consisted of twelve wires of No. 0 gauge and weighed 18,000 lbs. to the mile. When completed the entire cable length was tested by a 500-cell voltaic battery.

Prof. Thomson* recognized the importance of the purity of the copper in the core in determining its electrical resistance, which directly affected the speed of transmission of signals. The cable had been fabricated in 1,200 pieces, each about two miles long; these were then joined into eight pieces 300 miles long. During the following year, Prof. Thomson tested 45 specimens of this wire and found variations in conductivity among them (according to his scale) of from 42% to 102%. He thereafter stubbornly insisted on a controlled purity of copper content. Mr. Whitehouse saw no value in all this. Prof. Thomson, tho a director of the company, held no technical position in the enterprise, being subordinate to Messrs. Field, Bright and Whitehouse. His constant courtesy and "laborious humility" never reflected the distasteful situations sometimes forced upon him.

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*William Thomson (1824-1907) was the mathematical physicist who bridged the gap between the theoretical problems that came with long submarine cables and their practical installation and operation. Raised in the academic atmosphere of Glasgow University, where his father was professor of mathematics, he excelled in the classics and in mathematics. At 21 he became Professor of Natural Philosophy at Glasgow. Here he established a physics laboratory, one of the first experimental laboratories of science in the world. He made major contributions in thermodynamics, geophysics and astronomy in addition to electricity, magnetism and optics. He entered the field of telegraphy via a study of transient currents and electric oscillations by mathematical analysis. His improvement of the mariner's compass, and a sense of the minute in the physical world, led to his design of the gyrostatic compass in 1883. He proposed the absolute scale of temperature (degrees Kelvin) and estimated the age of the earth as between 40 and 100 million years. He was the author of over 300 books and papers, was the first scientist to attain the peerage and, while president of the Royal Society (1890-1895), became Lord Kelvin of Largs. His eventful life spanned the technological gap between the first steam locomotive and the first airplane.

William E. Everett was chief engineer of the Niagara and after the poor experience of the 1857 expedition he greatly improved the cable-issuing machinery to be used the following year. It became much smaller, weighed one-fourth as much, and had self-releasing brakes.

Shortly after the return of Mr. Field to New York a few days after Christmas, 1856, he left for Washington. The purpose of this visit was to try to get the American Government to match the support of the British Government in ships and funds which had been promised by the latter. This was to amount to an annual subsidy of $70,000 in return for the future use of the telegraph lines for government messages. Legislation to accomplish this was introduced in Congress but, to Mr. Field's surprise and discomfort, he realized that violent opposition to such a plan had arisen. The President and Secretary of State individually favored the telegraph proposal but there were groups in Congress which saw only their own immediate regional interests instead of the potential for national benefit that the transatlantic cable offered. With the help of Mr. William H. Seward, then Secretary of State, the legislation was prepared and the bills introduced. After a long delay and lengthy debate, the bill passed the Senate by a majority of only one vote! It passed thru the House with a majority of only 19 votes. Mr. Seward not only prepared the bill and introduced it to the Senate, but also participated in the debate, saying, "My own hope is, that after the telegraphic wire is once laid, there will be no more war between the United States and Great Britain. I believe that whenever such a connection as this shall be made, we diminish the chances of war, and diminish them in such a degree, that it is not necessary to take them into consideration at the present moment." Even tho most of the opposition was led by senators from the South, the bill was strongly defended by Senator Thomas J. Rusk of Texas and Senator Judah P. Benjamin* of Louisiana. After such a narrow passage thru Congress it was said that the bill was unconstitutional, but Attorney General Caleb Cushing declared it satisfactory.

The supporting bill was passed and signed by President Pierce on March 3rd, 1857. The signing of the bill by President Pierce, with Mr. Field at his side, was one of his last official acts because he went out of office the following day. The bill provided for a subsidy of $70,000 maximum per year, until the company profits should

*Later, Senator Benjamin (1811-1884) became Attorney General and Secretary of State in the cabinet of the Confederacy.

be equal to six percent of the investment; thereafter the subsidy was to be $50,000. The contract was to last 25 years. With the support of a government on each end of the projected cable, Mr. Field again set to work in full earnestness. The equivalent British act cleared the House of Lords on July 20th, 1857.

THE EXPEDITION OF 1857

THE overcoming of the political difficulties permitted the directors to begin to organize their resources for the final laying of the cable. In addition to the services given by the U.S. Government in preparing the deep-sea soundings from Newfoundland to Ireland, two additional ships of the American Navy were assigned to the enterprise. The first was the U.S.S. Niagara of 5,200 tons, the largest steam frigate in the world, of heavier tonnage than any battleship in the British Navy. She also was one of the fastest, being able to make 10 or 12 knots an hour with her single-screw propeller. Her fine lines showed her origin — George Steers, builder of the yacht America, the masterpiece of marine architecture that had brought the Cup to America.

On her new mission of international fraternity, the armament of the Niagara was removed, exposing her flush deck for installing the cable-laying gear. On April 24th, 1857, with Captain William L. Hudson commanding, the Niagara steamed for England carrying Mr. Field and Prof. Morse with them as well as William E. Everett, the chief engineer, who designed the paying-out machinery for the cable. Altho no press representatives were taken aboard, two observers, officers of the Russian Navy — Captain Schwartz and Lieutenant Kolobnin — were granted permission to accompany the expedition. Prof. Morse had Mr. John Mullaly of the New York Herald assigned to him as secretary.*

The Niagara arrived in the Thames estuary on May 14th and there she was joined by the 3,200 ton British man-of-war Agamemnon, a screw-propelled ship that had won fame as flagship in the bombardment of Sevastopol. A few days later the Niagara was joined by the Susquehanna, the largest sidewheel steamer in the U.S. Navy, ordered to join the enterprise from her station in the Mediterranean. It was intended that the Niagara should carry half of the transatlantic cable and the Agamemnon the other half. But the Niagara proved too large to move up to the Greenwich wharf of Glass, Elliot & Co. The Agamemnon therefore picked up this cable while the Niagara steamed to Liverpool to take on the other half from the works of Newall & Co., at Birkenhead. As an additional precaution, an iron cage was placed over the stern of the Niagara to prevent the cable from becoming entangled in the propeller.

In preparing to take the welcome burden aboard, the insides of the ships had to be opened up, thereby crowding the crew's quarters. Each ship took on nearly 1,300 miles of cable. The work of storing the cable was done by volunteers from among the crew and from these 120 of the most stalwart sailors were selected. They were divided into two gangs of 60 men each and each gang was further sub-divided into two watches of 30 men. It took three weeks of heavy labor to properly berth the cable.

With the cable properly stowed away there was much festivity and speechmaking by members of Parliament, directors of the company and Prof. Morse. Mr. Field read a letter in which President Buchanan invited Queen Victoria to send the first message over the completed cable to inaugurate this great enterprise.

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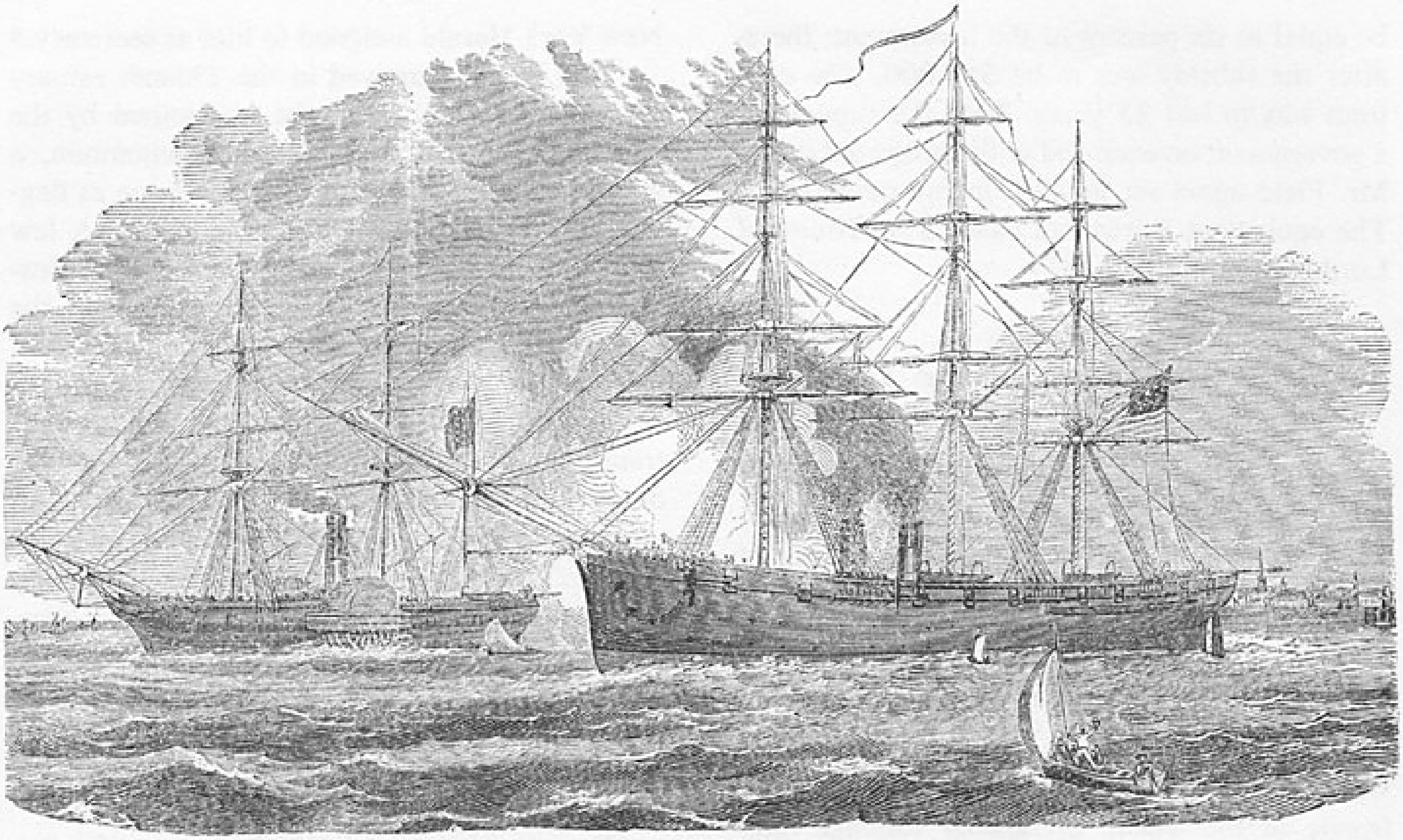
*See Mr. Mullaly's report in the Bibliography listed on page 95. Originally, Lieutenant the Baron Boye had been designated by the Russian Navy to be aboard the Niagara.



NIAGARA AND TENDER.

The U. S. Navy lent the largest man-of-war, the Niagara, to the cable expedition to match the British Agamemnon. With armament removed and decks fitted to hold 1,265 miles of cable, she was accompanied by the Susquehanna on the expedition that began cable-laying in August, 1857.

Speaking at the opening of the Dudley Observatory in Albany, the prominent statesman and educator Edward Everett eloquently expressed what was in the minds of those who projected the full meaning of the slender wire that was to cross the Atlantic and link the two continents. He said, "I hold in my hand a portion of the identical electrical cable, given me by my friend Mr. Peabody, which is now in progress of manufacture to connect America with Europe. Does it seem all but incredible to you that intelligence should travel for two thousand miles, along those slender copper wires, far down in the all but fathomless Atlantic, never before penetrated by aught pertaining to humanity, save when some foundering vessel has plunged with her hapless company to the eternal silence and darkness of the abyss? Does it seem, I say, all but a miracle of art, that the thoughts of living men — the thoughts that we think up here on the earth's surface, in the cheerful light of day — about the markets and the exchanges, and the seasons, and the elections, and the treaties, and the wars, and all the fond nothings of daily life, should clothe themselves with elemental sparks, and shoot with fiery speed, in a moment, in the twinkling of an eye, from hemisphere to hemisphere, far down among the uncouth monsters that wallow in the nether seas, along the wreck-paved floor, through the oozy dungeons of the rayless deep . . ."

As the Susquehanna was to act as consort to the Niagara, so the paddle-steamer Leopard was assigned to accompany the Agamemnon. With the Niagara and Agamemnon anchored about a third of a mile apart in the harbor of Queenstown, where all four ships were to rendezvous (it was July 30, 1857), the electricians recognized an opportunity to test the integrity of both sections of the cable. One end of each cable was accordingly carried over to the opposite ship and spliced to form a continuous length of 2,500 miles. On the Agamemnon a battery was connected to the cable and a sensitive galvanometer attached to the circuit. This was found to be complete and the signals perfect. The current was maintained for two days but no change was observed. With renewed enthusiasm the squadron therefore moved on to the harbor of Valentia to get on with the main part of the effort.

Two approaches were considered by the engineers and electricians as to the preferred procedure in laying the cable. The first was for one ship to begin paying out its load until the end of the cable was reached. The other cable was then to be spliced to the section already laid and the second ship would then proceed westward until the Newfoundland shore was reached. The second possible procedure would be for both ships to move to the middle of the ocean, the cable ends spliced, the cable gently lowered to the ocean bed and then the ships would move in opposite directions, one eastward, the other westward, until their respective shores were reached. The electricians favored the first method and the engineers the second method; the former procedure prevailed.

The accepted plan then was to have the Niagara lay the first half of the cable from Ireland to the mid-Atlantic where it would be spliced to the cable on the Agamemnon which would then proceed to Newfoundland. The four vessels were to move together and the course of progress was to be constantly reported back to Valentia thru the very cable being laid, using "ground" as the return leg of the circuit.

The departure of the cable-laying squadron was of an importance that warranted the participation of the Earl of Carlisle, Lord Lieutenant of Ireland. The spirit of the occasion and its importance are reflected in his words at one of the numerous festive gatherings: "We are about, either by this sundown or by to-morrow's dawn, to establish a new material link between the Old World and the New. Moral links there have

Courtesy of the New York Historical Society, New York City

A photograph of Cyrus W. Field by Brady taken during his efforts at reorganizing the Atlantic Cable Company.

been — links of race, links of commerce, links of friendship, links of literature, links of glory; but this, our new link, instead of superseding and supplanting the old ones, is to give a life and an intensity which they never had before. Highly as I value the reputations of those who have conceived, and those who have contributed to carry out this bright design — and I wish that so many of them had not been unavoidably prevented from being amongst us at this moment* — highly as I estimate their reputation, yet I do not compliment them with the idea that they are to efface or dim the glory of that Columbus, who, when the large vessels in the harbor of Cork yesterday weighed their anchors, did so on that very day three hundred and sixty-five years ago — it would have been called in Hebrew writ a year of years — and set sail upon his glorious enterprise of discovery."

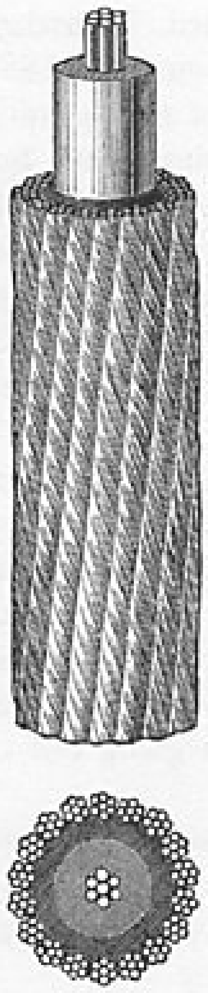
On Tuesday, August 4th, 1857, preparations were made for landing the cable across Valentia harbor. The four ships were joined by several others which came to lend a hand in this unusual task, raising the numbers to two American and five British ships, including the screw-steamer Cyclops under Captain Dayman who had, a month earlier, completed a set of deep-sea soundings across the Atlantic. Off the coast of Newfoundland two American ships, the Arctic under Lt. Berryman and the company's steamer Victoria, awaited the arrival of the fleet on completing the laying of the cable.

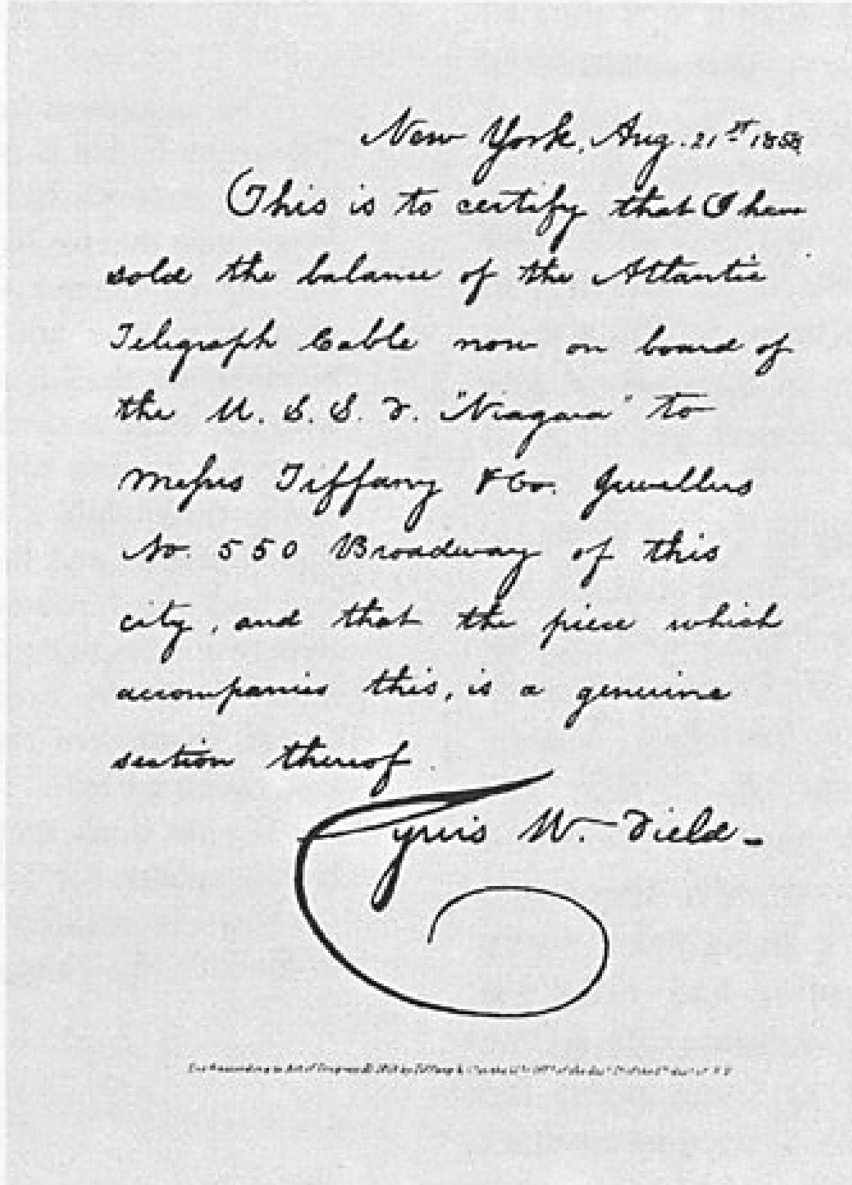
In Valentia Bay it was a festive sight to see not only the group of large ships but innumerable small ones bedecked in gay bunting and cheering the slow work. On shore stood the Lord Lieutenant surrounded by his staff in uniform, directors of railway and telegraph companies and dignitaries in great numbers. When the American sailors waded thru the surf with the hawser attached to the cable, Lord Carlisle was among the first to lend a hand and help pull it ashore, for here was a task equal to the dignity of any peer. By eight o'clock that evening, Capt. Pennock of the Niagara made the formal presentation to the Lord Lieutenant, who replied that the beginning augured well for the completion of a successful enterprise. His enthusiasm reached the high point as he ended with "Let us indeed hope, let us pray that the hopes of those who have set on foot this great design, may be rewarded by its entire success; and let us hope, further, that this Atlantic Cable will, in all future time, serve as an emblem of that strong cord of love which I trust will always unite the British islands to the great continent of America . . . And now, all my friends, as there can be no project or undertaking which ought not to receive the approbation and applause of the people, will you join with me in giving three hearty cheers for it? (Loud cheering). Three cheers are not enough for me — they are what we give on common occasion — and as it is for the success of the Atlantic Telegraph Cable, I must have at least one dozen cheers. (Loud and protracted cheering.)"

Thus, as August 5th closed, the cable had been secured ashore and the ships were ready to begin their westward journey early the following morning.

They were away the next morning, but the Niagara had moved westward only five miles when the cable caught in the deck machinery and parted. The ship returned and, again moving westward, lifted the cable out of the water until the end was reached. The heavy shore section was spliced and the journey was continued, but at a reduced rate of only two miles an hour, to avoid repetition of the previous accident. Among the technical men on board, Mr. Bright was the company engineer; he was assisted by Mr. Everett and Mr. C. W. de Sauty. the electrician, as well as Prof. Morse, who did not with-

*Mr. Field was detained by illness at Valentia, and several of the ships had not arrived.





New York, Aug. 21st 1858

This is to certify that I have sold the balance of the Atlantic Telegraph Cable now on board of the U.S.S.F. "Niagara" to Messrs Tiffany & Co. Jewellers No. 550 Broadway of this city, and that the piece which accompanies this, is a genuine section thereof.

Cyrus W. Field

Burndy Library

The cable used on the expeditions of 1857 and 1858 had a seven-strand copper core covered by three layers of gutta-percha, a tarred yarn sheath and a protective layer of 18 seven-strand iron wires. After the successful laying of the 1858 cable, Tiffany & Co. of New York sold small sections of the surplus cable as souvenirs.

stand the journey well. Prof. William Thomson was requested to replace Mr. Whitehouse who pleaded poor health and preferred to remain on land. Prof. Thomson volunteered to join the expedition without pay.

The staff, and also the crew, adjusted themselves to the muffled rumble of the machinery paying out the cable as it moved out without interruption. Slowly the rate of motion was increased to four, and later to five miles an hour, with a slightly faster speed for the cable to compensate for the unknown conditions at the ocean's bottom. Contact between the Niagara and the Valentia telegraph station was constantly maintained in order to assure the staff that no break occurred in the conductor. Progress reports to America were supplemented by messages from the American officers and directors on board, which were taken by ships leaving from England and were moving westward at a greater speed than the cable-laying vessels. The operation continued without any disturbance and the spirits of the officers and crew mounted as the ships continued to their westward goal. Once or twice the alarm sounded when the cable was thrown off the guide wheels, which had been constructed with insufficient width or depth to accommodate the cable, but this was quickly corrected.

In two days they had moved over 200 miles westward and the log indicated an increase in depth from 550 to 1,750 fathoms within a span of ten miles. Soon they were in the deepest section, with 2,000 fathoms indicated, yet all went well.

On Monday evening, August 10th, the signal crew on board was staggered by a sudden interruption in the current flow. The cable seemed intact but the circuit was dead. The chief electricians, including Mr. de Sauty and Prof. Morse, could do nothing to transmit any signals. The engineers were preparing to cut the cable and reel it in when, quite as suddenly, the signal flashed thru again, thereby making the mystery even deeper, as the interruption had lasted for two and one-half hours. Prof. Morse offered the uncertain explanation that at some point the insulation had been stretched beyond contact while leaving the wheels but had, under the pressure of the ocean depth, been forced together again, thereby restoring the insulation. The uncertainty of cause weighed heavily on the minds of those aboard. The solicitude of the crew for their cable reached touching proportions. Slowly confidence began to be restored, only to be broken again before dawn. To check an excessive rate of pay-out of the cable over the speed of the ship, the engineer had applied the brakes on the drums which, unfortunately, checked too quickly, imposed a heavy strain on the cable, and, as the stern of the ship rose from a trough upwards on a swell, the tension became so great that the cable parted. A shudder ran thru the entire ship. The spirit of the crew sagged with the realization that there was nothing to do but to return to England. In a letter to his family Mr. Field wrote:

H.M. Steamer Leopard, Thursday,
August 13, 1857

The successful laying down of the Atlantic Telegraph Cable is put off for a short time, but its final triumph has been fully proved, by the experience that we have had since we left Valentia. My confidence was never so strong as at the present time, and I feel sure, that with God's blessing, we shall connect Europe and America with the electric cord.

After having successfully laid — and part of the time while a heavy sea was running — three hundred and thirty-five miles of the cable, and over one hundred miles of it in water more than two miles in depth, the brakes were applied more firmly, by order of Mr. Bright, the engineer, to prevent the cable from going out so fast, and it parted . . .

Do not think that I feel discouraged, or am in low spirits, for I am not; and I think I can see how this accident will be of great advantage to the Atlantic Telegraph Company . . .

Your

Cyrus W. Field

Mr. Field then requested that the Agamemnon remain for a few days in this deep part of the Atlantic to try some experiments for instruction and for future use. He also requested a meeting of his directors in London to decide whether to continue with the cable-laying immediately or to postpone it until next year.

The directors met and were faced by the decision of having to order 600 more miles of cable to replace the 300 already lost at sea and also additional uncertainties. Of even greater importance was the necessity to improve the machinery for paying out the cable into the sea, a program that would extend into the late autumn. The directors therefore decided to postpone the operation until the following year.

The cable ships Niagara and Agamemnon brought their cables to Plymouth where they were placed in four large roofed tanks for storage on shore. The ships returned to their home ports and the planners aimed for improvements to be made for the next year's operation.

THE FIRST EXPEDITION OF 1858

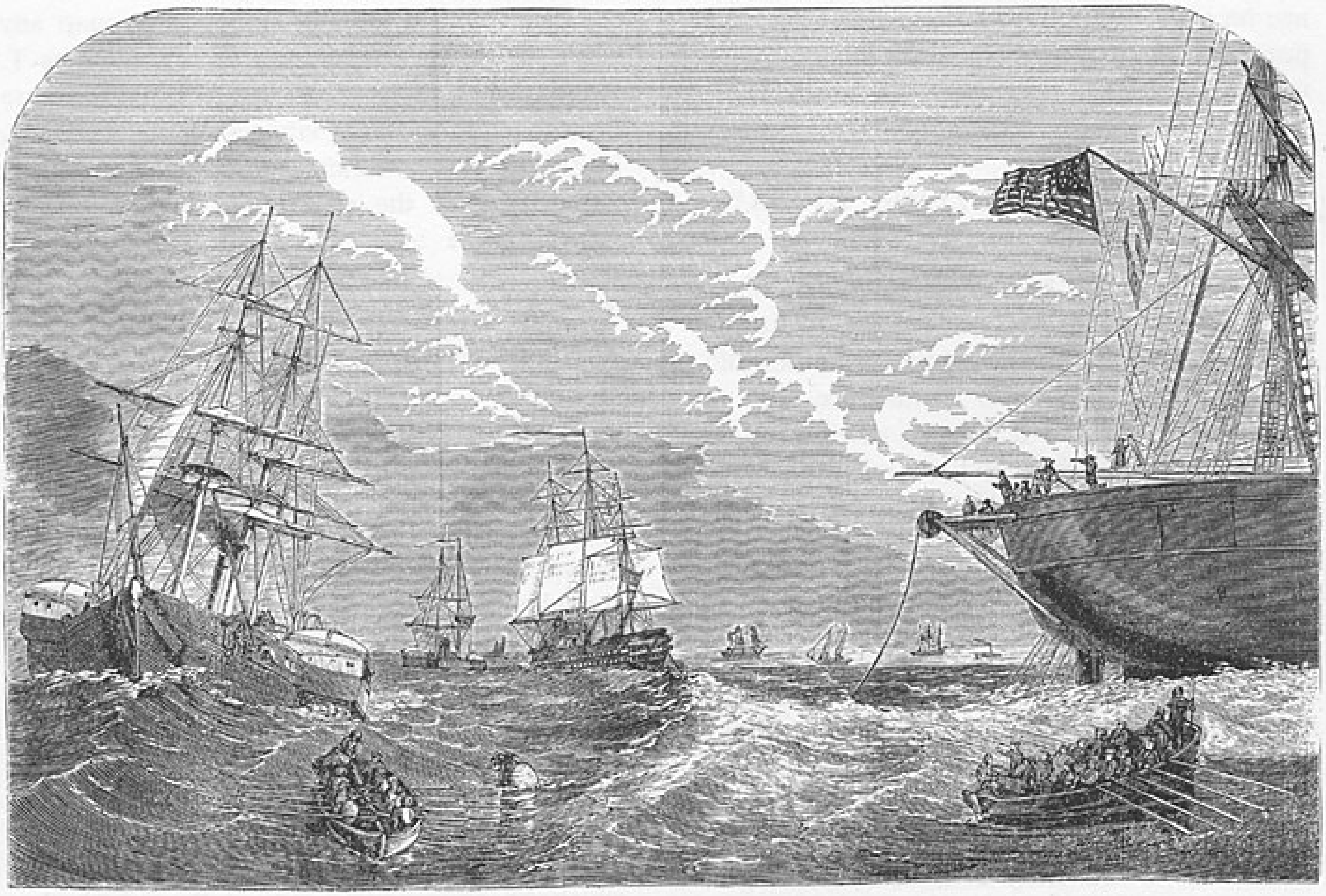
As the new year broke, the promoters of the Atlantic Cable saw that the realization of their dream would be even more difficult than first supposed. Confidence was replaced by doubt and it became essential to introduce improvements in both cable construction and the technique of immersing it. There was no one to blame and the failures were obviously due to inexperience, inadequate equipment and the narrow margins of safety.

Obviously more money to carry on such an improved program would be required, and the need came at a time when the money markets of Europe and America were suffering another of their periodic setbacks. The loss of time and cable with nothing but experience to show for it was also a monetary setback amounting to about £100,000, money more difficult to replace than the original subscription. Venture capital now hesitated to support such an uncertain enterprise. The doubters and the cautious investors spoke out more loudly. The initial enthusiasm was gone and caution permeated financial circles. But the directors decided to proceed and ordered the manufacture of 700 miles of new cable. In addition, there was the continued support promised by the British Government.

Mr. Field returned to America where one of his first tasks was to request from the Government the services of Mr. William E. Everett who had been the chief engineer on the Niagara in 1857. He had watched the working of the paying-out machinery, had observed its inadequacies, its cumbersome operation and the rigidity with which the brakes were slapped on the drum with a severity sufficient to snap any cable. With the cooperation of Mr. Charles T. Bright, Mr. Everett proceeded to London where he was made general manager of the company, in charge of all technical operations including authority over the electricians and engineers. At this time also Mr. Field was made executive head of the company and was offered £1,000 by his directors in compensation for travel and other expenses, an offer which he declined.

In the meantime, Mr. Everett* devoted himself to a thoro study of the cable machinery, taking three months to translate his recommendations into carefully worked out plans and drawings. This resulted in a smaller and lighter assembly requiring only about a third of the deck space and weighing only a fourth of the machine installed earlier on the Niagara. With simpler construction the four main heavy drums were replaced by only two, and new, self-releasing brakes were designed by John G. Appold, a wealthy, amateur mechanician, to eliminate the danger of sudden check. The brakes were adjustable to a limited strain after which they would automatically be released. The settings were made for half of the three-ton strain necessary to break the cable. English and American mechanical skills were combined in this equipment, which, on demonstration, convinced the engineers that many of the laying problems of the first expedition would be eliminated. The concern with the action of the brake, which

*William E. Everett (1826-1881) was a native of Watertown, N.Y., served in the Mexican war on land and in the U.S. Navy, becoming Chief Engineer in the Navy at the close of hostilities. He aided in the construction of the Niagara's engines and became her chief engineer during the laying of the 1857 cable. He designed the cable stowage gear of the Niagara and later the cable handling machinery on her decks. At the urgent request of Mr. Field, he was made available for the 1858 expeditions by the Navy and personally shaped the much improved equipment in the London shops prior to installation. Mr. Woodhouse, his assistant, had laid the Varna-Balaklava cable in 1854.



To avoid the failings of the first expedition, the second telegraph fleet assembled in the Bay of Biscay in late May 1958 to rehearse cable splicing, issuing, retrieving, buoying and testing the newly designed and improved cable-braking machinery and dynamometer.

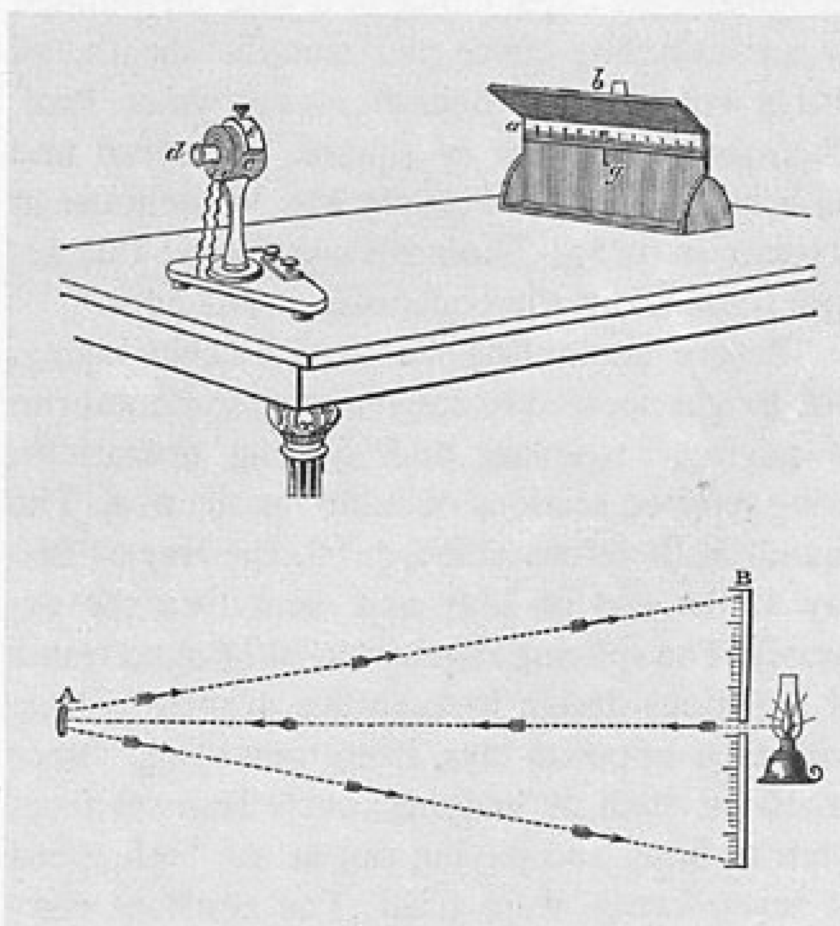
had been held responsible for the 1857 failure, prompted the crew to adopt a tune set to the melody, "Pop goes the weasel":

Pay it out, oh! pay it out,
As long as you are able;
For if you put the darned brakes on,
Pop goes the cable!

On March 9th, 1858, the Niagara again sailed from New York under Capt. Hudson, and at Plymouth took her share of the cable aboard. Gathered there also were the Agamemnon, and the Gorgon, under the veteran Capt. Dayman, which was to replace the Leopard. The Susquehanna, however, could not join the cable squadron because she had been laid up in the West Indies with yellow fever on board. Mr. Field turned to the First Lord of the Admiralty for help in replacing her. The Admiralty gladly obliged by assigning the surveying steamer Porcupine and also the paddle steamer H.M.S. Valorous to replace the Susquehanna. This was an act of unusual cooperation and generosity on the part of the British. Another improvement in this expedition was the method of storing the cables aboard the ships. Instead of lying loosely in the holds, large cones were constructed and the cable was coiled around these cones. As in the previous expedition, the work was now done by a 160-man crew of whom a fourth were workers belonging to the company and the rest volunteer sailors who chose the work. Thus, the work of four gangs of 40 men each went on around the clock, 30 miles of cable being coiled per day. By the middle of May the cable storage was completed and over 3,000 miles of cable, some recovered and some new, lay aboard, equally divided between the Agamemnon and the Niagara, but the hold of the Agamemnon proved too small for her share of the load and 250 tons of cable were stored on her deck. This shifting burden almost spelled disaster to the ship. Experiments were made with some of this cable to determine its breaking strength and to test the working of the cable machinery. More of the experimental part of the cable was used to practice splicing and for passing rapidly thru the immersing machinery.

Unlike the 1857 expedition in which both ships laden with cable moved westward together, one lowering her cable, the other ready to splice her cable in mid-ocean and then to continue, it was decided that for the 1858 expedition the splice would first be made in mid-ocean and the ships would then move apart.

One of the most important innovations of this expedition was the introduction of the newly invented mirror galvanometer developed by Prof. Thomson.* This sensitive instrument became one of the vital links in the eventual successful laying of the cable. Then called a "marine galvanometer", the instrument consisted of a small but exceedingly light steel magnet to which a tiny reflecting mirror was attached. This assembly weighed no more than a grain and was suspended from its center by a filament of silk. Around this was wound a coil of very thin insulated copper wire. When an electric current passed thru the surrounding coil, the suspended magnet would move in proportion to the magnetic field built up by the current in the coil. A ray of light passing from a shaded lamp thru a slot in a screen would be reflected from the mirror upon a graduated scale. A very slight motion of the suspended magnet and mirror would therefore produce a magnified motion upon the scale which could be readily noted



Prof. Thomson's marine galvanometer consisted of a very small steel magnet with a mirror fastened to it suspended by a silk filament within a coil thru which the signal current was passed. A light source from lamp *b* passed thru the slot *g*, was reflected from the galvanometer *c*, upon the scale *a*.

*The Thomson galvanometer brought out the following verse from his electrical contemporary, James Clerk Maxwell, (quoted by Thompson, vol. 1, page 349) in several stanzas, a parody on Tennyson's "Princess".

The lamplight falls on blackened walls,
And streams through narrow perforations;
The long beam trails o'er pasteboard scales,
With slow, decaying oscillations.
Flow, current, flow! Set the quick light-spot flying!
Flow, current, answer, lightspot! flashing,
quivering, dying . . .

and measured by the observer. A combination of direction, from the central zero point, and the magnitude of motion, provided a code. Zero position on the filament and the earth's magnetism would restore the suspended magnet to its neutral point. A thumb-screw placed over the filament would adjust it to its zero position. This instrument was capable of receiving 20 words a minute, compared with a rate of two words a minute with older apparatus. Since an operator could not watch the instrument and record his readings at the same time, a team consisting of a "reader" and a "writer" was necessary to receive a message.

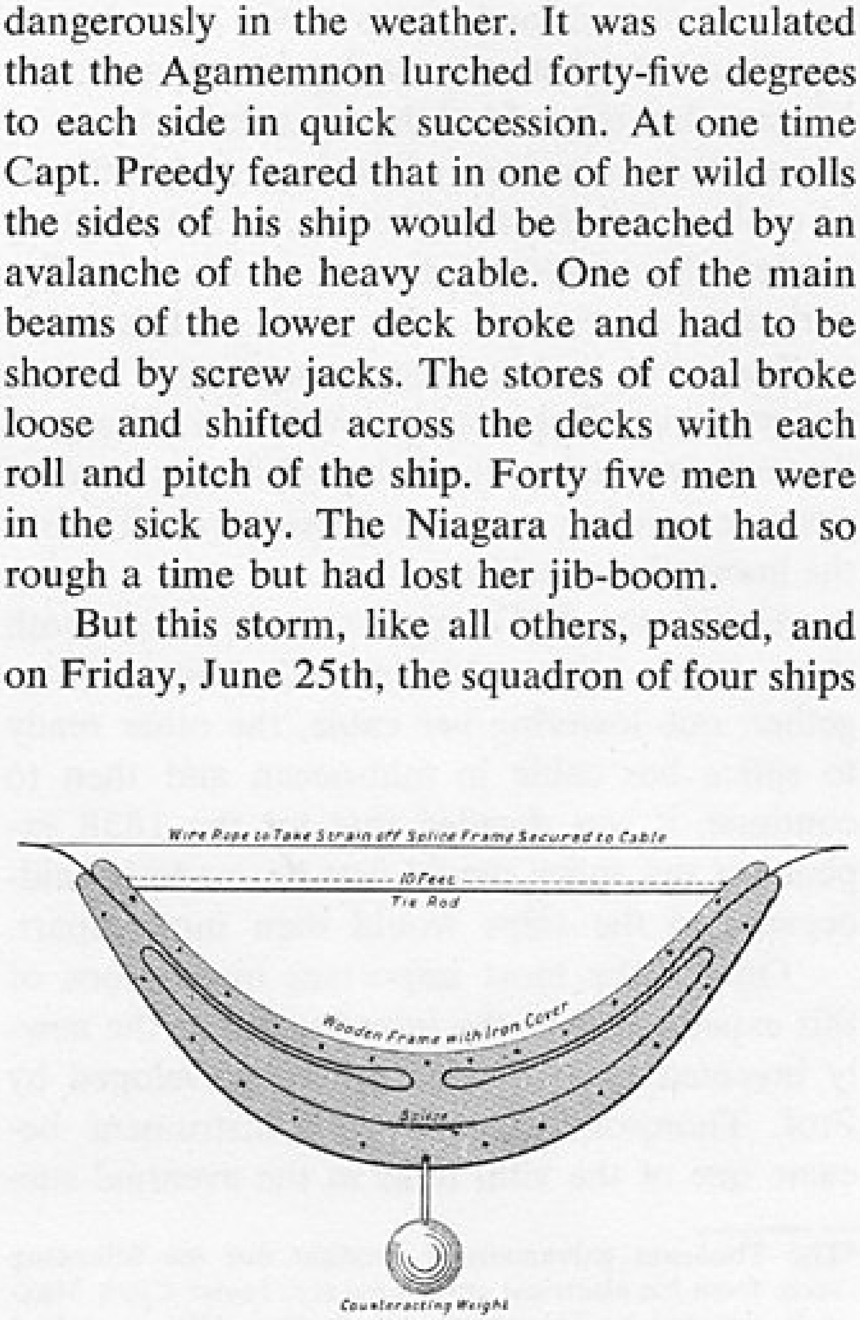
Prof. Thomson formulated a law for the speed of telegraphic sending which stated that for a given conductor diameter, the speed decreased as the square of the cable length increased. This recognized the capacitance of a wire surrounded by an insulating cover and metallic sheath, all laid in a conducting medium — salt water. Prof. Thomson's "doctrine of squares" of speed and cable size was challenged by Mr. Whitehouse in a paper in 1855; Thomson considered this account good, but the conclusions fallacious.*

Before attempting the actual cable laying, Mr. Bright decided to stage an experimental run of paying, retrieving and splicing operations, using rejected sections of cable for the trial. The squadron therefore sailed out to the Bay of Biscay at the end of May and went thru the exercises. The splicing required a 300-pound frame of ingenious design to keep the strained cables, with their opposite lays, from untwisting. Other practices, such as buoying, cable transfer from stern to bow, and paying out at the high speed of seven knots, were tried. The constant electrical testing proved exceptionally successful. The ships returned to Plymouth June 3rd.

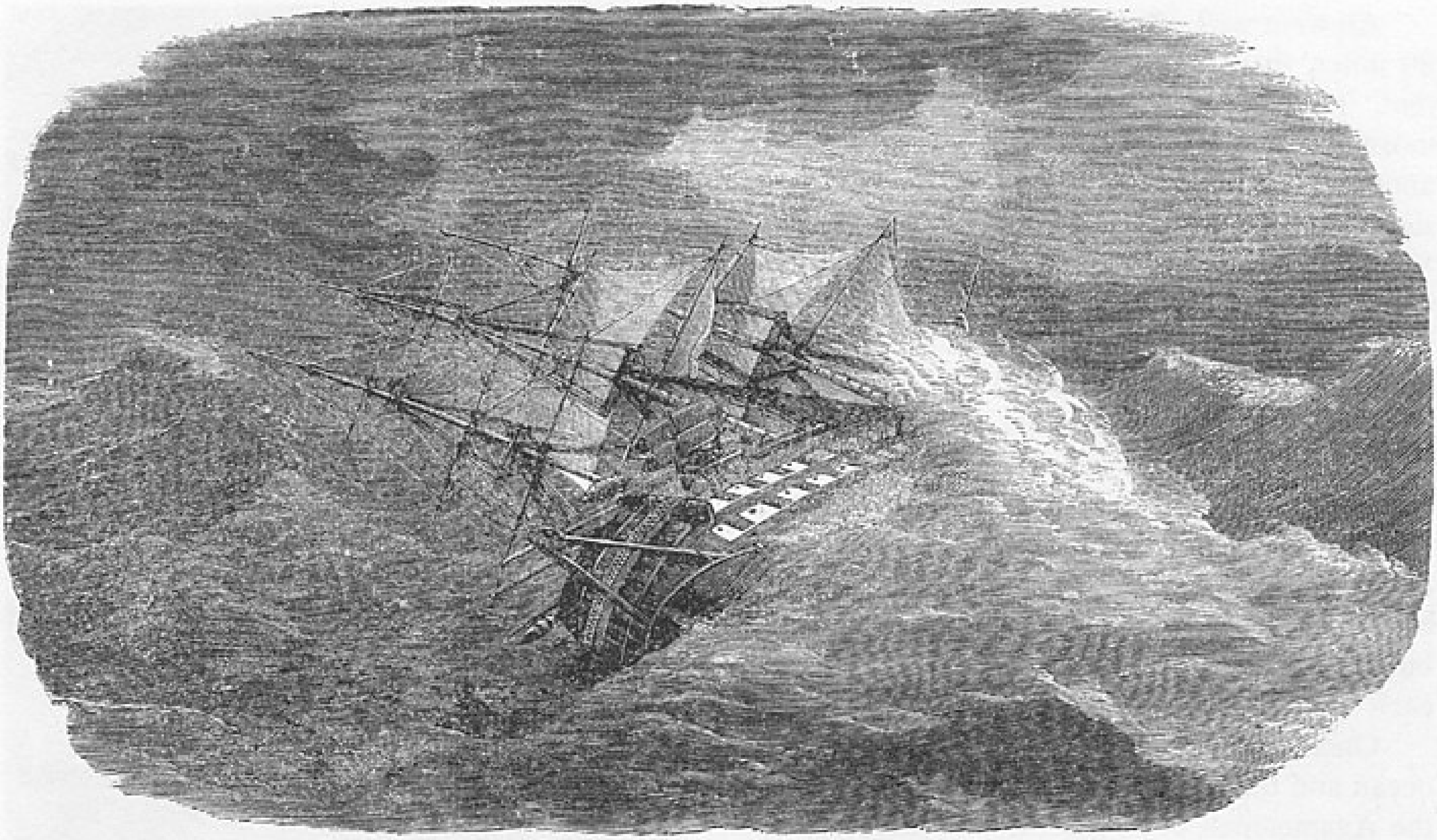
*Quoted by THOMPSON, vol. 1, page 330.

Under fair skies and promising prospects, the new squadron left Plymouth, England, on June 10th, 1858, to begin again. The group now consisted of the main vessels Niagara and Agamemnon, supported by the Valorous and Gorgon. But soon fair skies were turned into a week of gales wherein each day it seemed to blow more violently than the day before. The heavy seas scattered the four ships, and their hundreds of tons of cable burden caused them to roll dangerously in the weather. It was calculated that the Agamemnon lurched forty-five degrees to each side in quick succession. At one time Capt. Preedy feared that in one of her wild rolls the sides of his ship would be breached by an avalanche of the heavy cable. One of the main beams of the lower deck broke and had to be shored by screw jacks. The stores of coal broke loose and shifted across the decks with each roll and pitch of the ship. Forty five men were in the sick bay. The Niagara had not had so rough a time but had lost her jib-boom.

But this storm, like all others, passed, and on Friday, June 25th, the squadron of four ships



The two cable factories supplied cable of opposite lay which had to be joined in an elaborate splice to avoid unwinding. Wooden plates were covered with iron plate, bolted together and kept from turning under tension by a heavy, suspended weight.



To reach the point of meeting in mid-Atlantic, the telegraph fleet sailed from Plymouth in June 1858. On the way, some of the worst storms in Atlantic history were encountered and the Agamemnon suffered severely from a week's gales and the shifting cargo of cable and coal. The engraving is from a drawing by Henry Clifford, expedition engineer.

gathered in the calm mid-Atlantic*, fifteen days out from Plymouth. Both sea and air were still, and small boats passed from ship to ship, the crews swapping experiences of a storm which many veterans declared to be the worst in their long careers. It seemed that the Agamemnon suffered the most shaking, not only the ship itself often "standing on her beam ends", but her burden, the cable, threatened to bash in the ship's sides. A hundred miles of the upper part of the main coil had shifted and had to be untwisted and untangled onto another part of the ship.

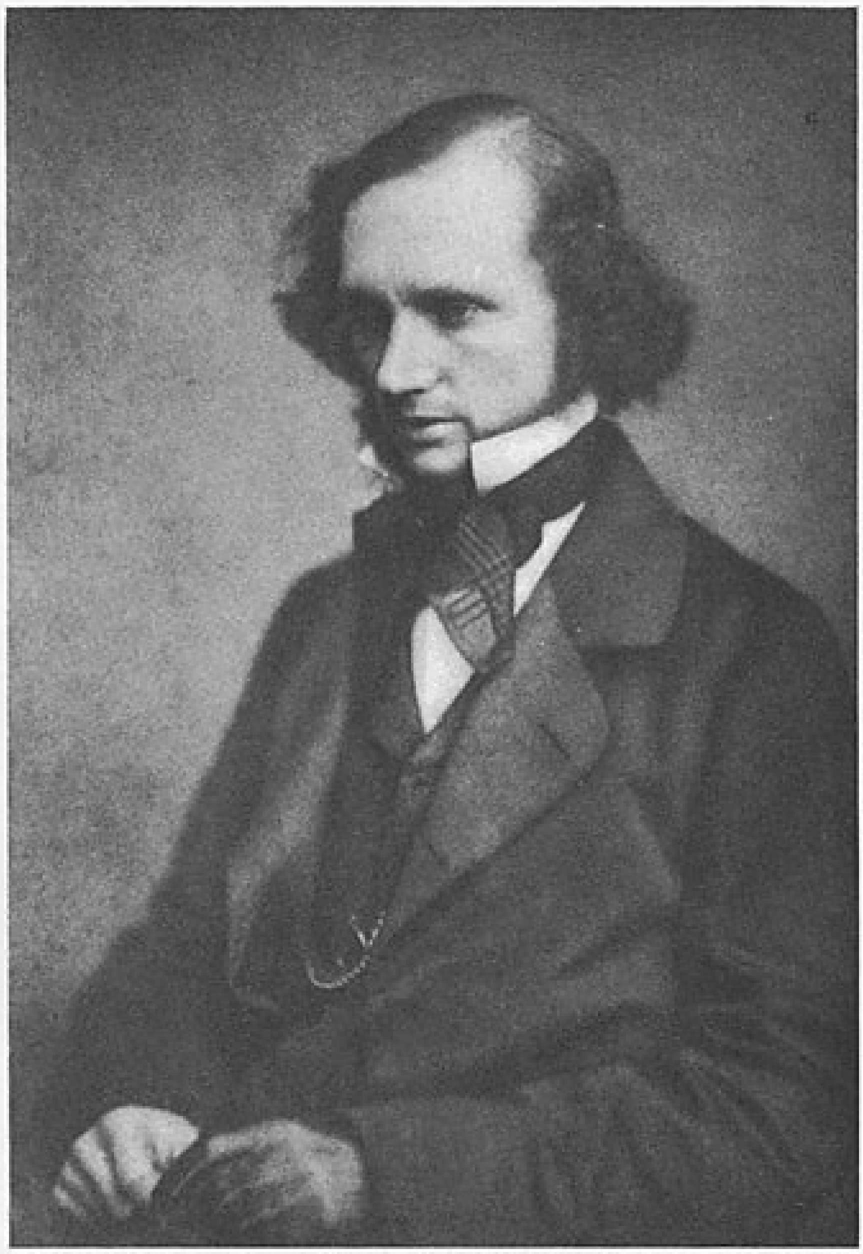
On Saturday, June 26th, the splice between the cables on the Niagara and Agamemnon was made and this center joint was slowly lowered to the bottom of the sea. The ships parted, each moving in its own direction attended by its consort. But they had not separated for more than three miles when the cable caught in the machinery on board the Niagara and broke. Thereupon, by pre-arrangement, both ships returned to their mid-Atlantic point; the cables were again spliced and the ships were again pointed in their opposite directions.

*The meeting occurred at latitude 52° 2′ and longitude 33° 18′. This served as the rendezvous in each of the four attempts that year.

All went well when, at a separation of about 80 miles, there was a sudden break in the current. This happened at 3:00 a.m. on Sunday morning, June 27th, when Prof. Thomson sadly announced a complete break of circuit. The signal gun was fired and a blue light notified the Valorous, attending the Agamemnon, that there was trouble on the Agamemnon. It was thought that the break had occurred on the Niagara, but those on the Niagara thought the break had happened on the Agememnon. The ships were again rejoined; Mr. Field with the electricians from the Niagara joined Prof. Thomson on the Agamemnon and a comparison of the logs was made. This showed the astonishing fact that a break had occurred at exactly the same time but at a distance of not less than ten miles from each ship.

Once again the cables were spliced in mid-ocean and the ships slowly parted. The speed of the Agamemnon of two knots was increased to three, then to four, showing a cable strain of 2,000 lbs. This rate was thereafter maintained. On the Niagara the same cautious condition prevailed. Conversations were prohibited and everyone was silent and alert. Carefully the cables slid over the wheels until a hundred miles of cable lay safely on the ocean bed, then a hundred and fifty, now two hundred miles! Spirits slowly rose, but hardly had another day passed when, on Tuesday, June 29th, the current suddenly again stopped. It seemed that the cable had broken about twenty feet from the Agamemnon stern. The ships then reluctantly headed for Queenstown.

Mr. Field left the Niagara and hurried to meet his directors in London, who had already been briefed on the failure. Disappointment and discouragement were evident on their faces. Mr. Field and Prof. Thomson gave their reports and each re-emphasized his conviction that the project was feasible. Mr. Bright and Mr. W. H. Woodhouse supported that view and pointed out that altho 300 miles of cable had been lost there still remained enough to cross the ocean. Besides, the ships were there, manned, supplied and ready; another attempt was warranted even tho the odds were strongly against success. One director, a vice-chairman, left the room and resigned, while Sir William Brown, the chair-



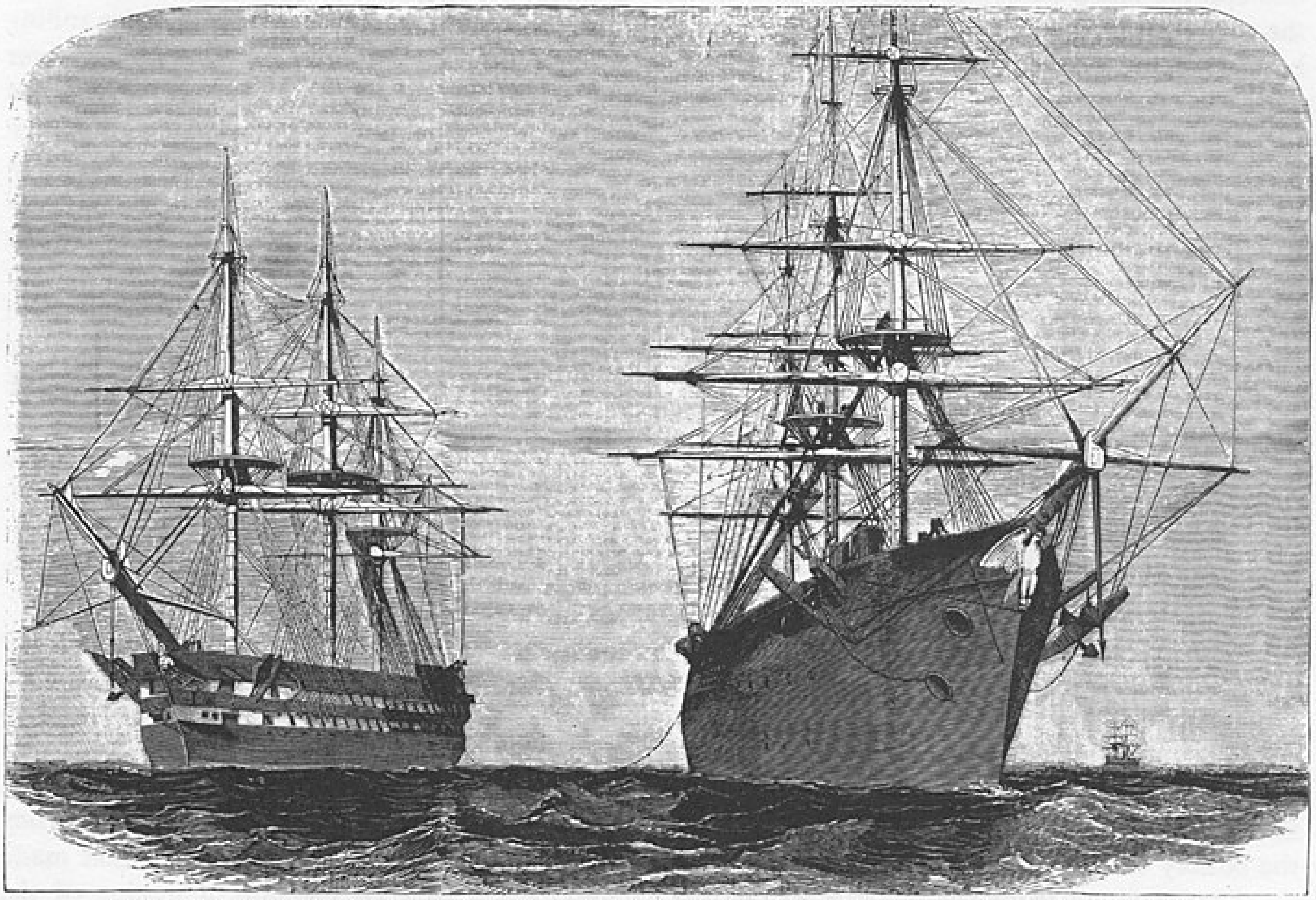
[1852] Yours very truly William Thomson

A director of the Atlantic Cable Company, the shy, scholarly Dr. William Thomson was also the keenest electrician and physicist of the enterprise. He served aboard ship on all five expeditions and contributed that essential electrical instrument, the marine galvanometer, to the Cable's ultimate success.

man, urged the sale of the remaining cable and the abandonment of the enterprise, but the other directors approved another attempt.

THE SECOND EXPEDITION OF 1858

THE directors of the cable enterprise spent little time deploring the failures of their latest expedition. Having determined to try again, no time was lost in getting on with the task. By mid-July, all the vessels had returned to England and busily took on supplies of coal, food and other essentials needed for the new voyage. On Saturday, July 17th, the squadron left Cork for a rendezvous in the mid-Atlantic. The enthusiasm and high expectations with which the crew had made similar departures on the two previous starts was, on this one, replaced by concern and caution. There were no feasting and no grand speeches. The betting was not in favor of a successful mission. Many thought it



THE ATLANTIC TELEGRAPH EXPEDITION—THE "AGAMEMNON" AND "NIAGARA" LAYING THE CABLE IN MID OCEAN.

In the 1857 expedition both cable ships began from the Irish shore planning for one ship to splice her cable after the other's cable had been fully laid. In the 1858 expeditions the splices were made in mid-Atlantic with the ships, as shown above, proceeding in opposite directions.

was foolish, if not insane, to throw good money after so much bad. Eleven days out from Queenstown the squadron of four vessels met at their appointed location in mid-ocean, the Agamemnon arriving last. She had tried to conserve her supply of coal for the return journey and had therefore used sail for a portion of the voyage.

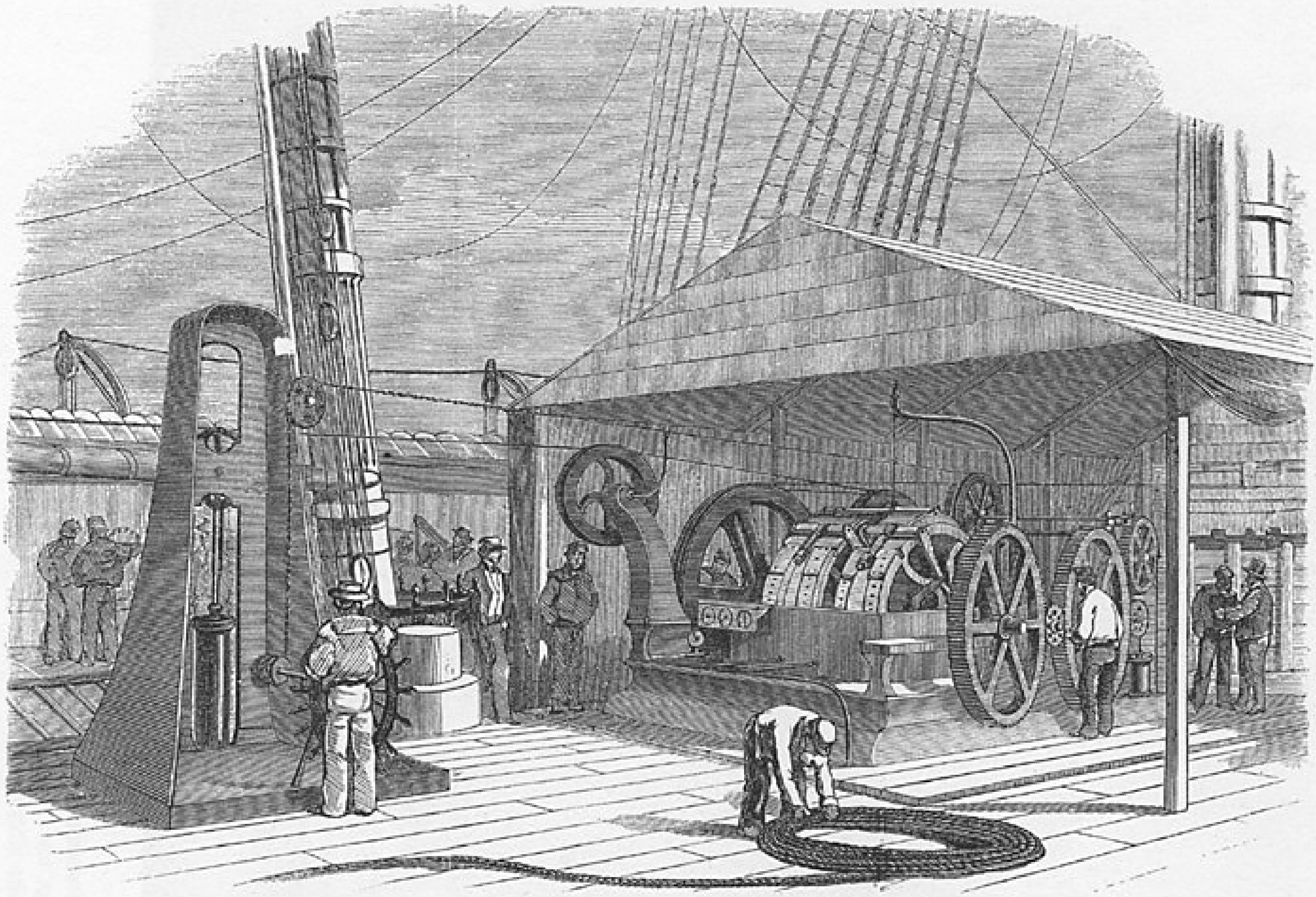
No time was lost and the cables were spliced aboard the Agamemnon. A 32-pound cannonball was commandeered to replace the lead sinker which had fallen overboard. It was fastened to the splice to help in its immersion and the mid-section began its downward journey. When the splice reached a depth of 210 fathoms, the hawser connecting the Niagara and the Agamemnon for the splicing operation was cut, and the two vessels started towards their opposite destinations. The depth at the mid-point was sounded to be 1,500 fathoms. Mr. Field had determined that Valentia harbor was 813 nautical miles from this point and, westward, Trinity Bay lay 882 nautical miles away. The Niagara, facing westward, had 69 miles more to cover than the Agamemnon, then heading for Ireland. Each ship had 1,100 nautical miles of cable on board. As the ships parted there was a tenseness on board with only Mr. Field expressing his usual confidence to his companions on the Niagara. At about sunset of this first day out there was a sudden break in the signals coming from the Agamemnon altho the insulation showed no breakdown. Electrical testing however continued and after an hour and a half the Agamemnon again responded. The cause of the break in signals was not determined, but was probably a break in the battery circuit on the Niagara.

The next day there was another cause for alarm. On checking position it was found that the Niagara had moved some 16 miles off her course as indicated by the sextant and log. Such a percentage of loss meant that the cable could not last for the required distance to Newfoundland. On further careful checking it was discovered that it was the mass of the iron forming the cable covering stored in the ship that had affected the compass and a correction in course had to be made. This was done by having the Gorgon proceed ahead of the Niagara and thus set the course. Not having the mass of iron in the cable aboard, her compass was not affected. No other major incidents disturbed the remainder of the journey.

As the Niagara continued paying out her load of cable, particularly from the lower deck, she began getting lighter and therefore rolling much more. Testing found a fault in the lower end of the cable and this section was cut out of the line. Communication with the Agamemnon continued without interruption. Icebergs were passed as the Niagara approached Trinity Harbor, Newfoundland. She was met by the British steamer Porcupine to pilot her to her anchorage near the telegraph house. At 1:45 in the morning of Thursday, August 5th, the Niagara anchored. She had laid down 1,016 miles of cable. Mr. Field immediately went ashore, woke the watch in the telegraph house and ordered them to prepare to land the cable. In exactly an hour after dropping anchor a signal was flashed to the Agamemnon from the western destination of the line.

With equal dispatch a telegraphic message was addressed to the Associated Press in New York announcing the successful fixing of the cable to its western terminus. At noon a 21-gun salute from the Gorgon made the event official.

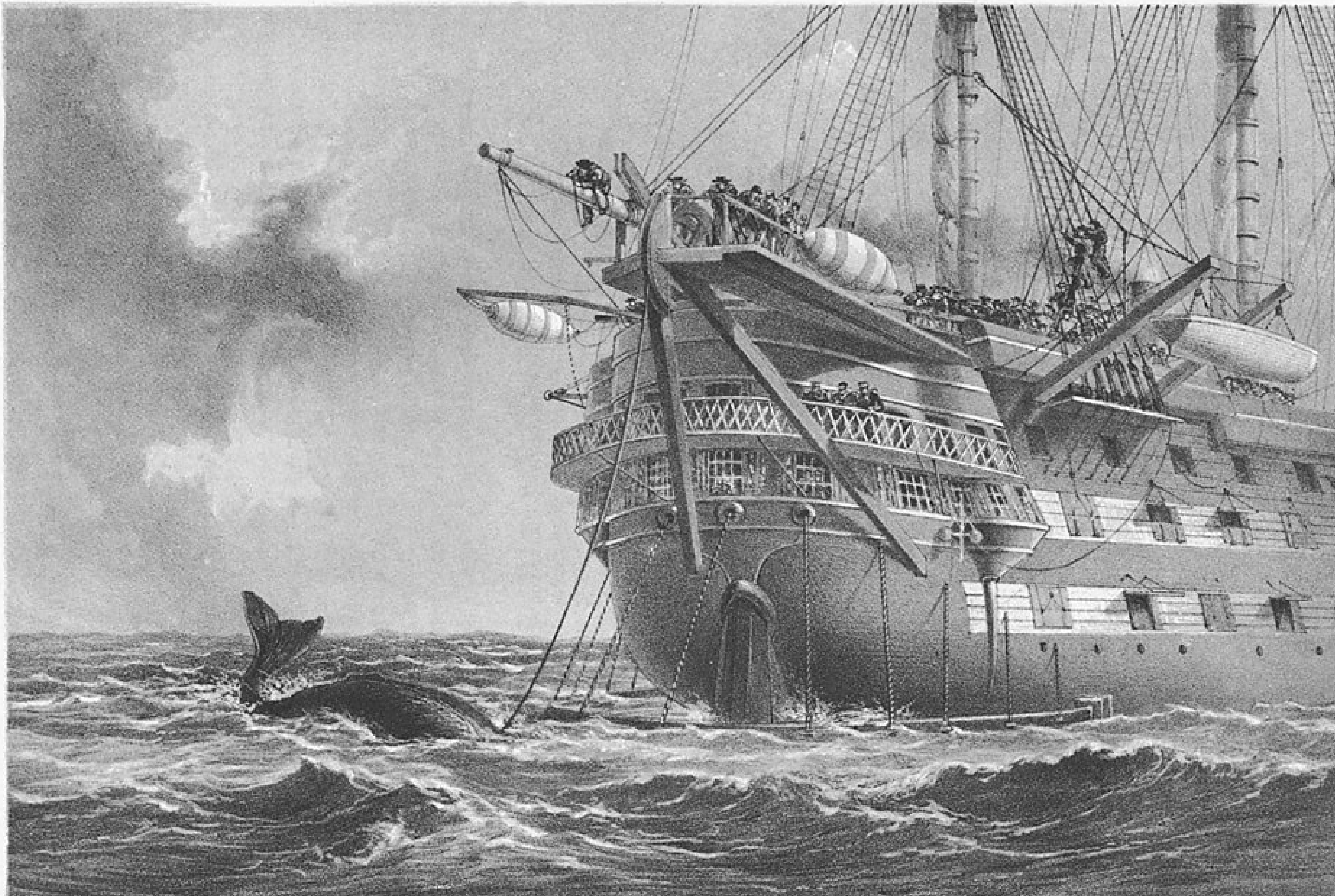
During the first day of her eastward journey the engineers on board the Agamemnon made every effort to keep the rate of motion of the cable from the hold thru the paying machinery at an even rate. The controls were set so that the strain on the cable would never get beyond the



The cable issuing machine on the stern of the Niagara, as installed by William Everett. Designed to pay out and hold as much as five miles of suspended cable, the brake drums revolved in cooling water. The dynamometer, left, indicated the cable strain. A similar machine was on the Agamemnon.

1,700 lbs. indicated on the dynamometer, which would be less than a quarter of the estimated cable-breaking strength. However, in the evening, an injured portion of the cable was discovered at a length of about a mile or two from the portion of the cable being paid out. Knowing that any effort to stop the ship or brake the cable might be disastrous, every effort was made to cut out the injured section and resplice the cable without stopping its rate of issue of about six knots per hour. Mr. Canning, the engineer in charge, realized that he had only about 20 minutes to complete the splice. But just before the lapping had been completed, Prof. Thomson reported a break in the circuit altho the insulation had continued perfect. The new joint was therefore tested but, to everyone's alarm, the tests showed that the break was in a section already overboard, probably at a point some 50 miles from the ship. With this valuable time lost, it became imperative to stop the ship and risk mechanical breakage until the new splice had been properly completed.

Nearly all of the officers of the ship stood



The stern of the Agamemnon with the cable issuing from the sheaves. The crew watches anxiously as a whale crosses the line. The "crinoline" about the rudder post was to keep the cable from being injured by the ship's propeller.

in groups about the coil watching Mr. Canning, who had supervised the original construction of the cable, direct the completion of the joint. But the rate of paying out was faster than the speed of completing the splice so that the order was given that the cable motion be altogether stopped while the ship rose and fell with the motion of the waters. The dynamometer indicated a strain on the cable of over two tons; this was critical and could not be maintained for any length of time. The joint was completed and the signal for the discharge of the cable was given. The cable issue was resumed with everyone relieved of the built-up tension created by the disturbing events.

However, the relaxation was only temporary because tests again indicated that the circuit was not complete. It was therefore decided to slow down on the emission of cable until the circuit was fully restored. A few minutes passed and the last hope was lost when the galvanometer indicated that the insulation had also failed. This meant that the cable had broken, probably near the Niagara.

Three minutes went by when suddenly the instrument became reactivated and contact with the Niagara was re-established. These disturbing results, having come so close to the start, showed that many uncertainties were still to be expected. Normal operations were resumed when, at dawn, another damaged section of the cable was discovered. This, however, was located at a point that provided ample time for proper repairs to be made.

The next day was a normal one with the ship's speed at five knots and the cable moving out at about six knots. The angle formed by the cable was about 15 degrees and the dynamometer strain indicated a maximum of 1,600 to 1,700 lbs. A head-on wind developed so that the ship made very little headway. It brought on the fear that if this continued the coal reserve would be used up and the crew would have to be reduced to burning the wooden fittings — masts, spars and even the decks — to be able to bring the ship to its destination, Valentia. There was a temporary shift in wind but as night came a gale picked up and the heavy seas threatened to tear the cable from the ship as its stern rose. Constant alertness by the technicians attending to the cable machine reduced this hazard. The storm continued and as the stern fell and rose, the operators released the brakes while the stern was at its low point in the trough so that when the stern rose, the cable payed out. There was little sleep that night for all awaited the dreaded sound of the gun, as this would have reported that the cable had broken. Stormy days followed each other and slowly the work continued, the slender wire drifting out from the ship's stern as it rose and fell in the heavy seas.

On the fourth day out there was noted a weakening of the electrical impulses from the Niagara which continued for the better part of an hour. Prof. Thomson believed this to be a weakening of the insulation or a faulty connection on board the Niagara. He notified the Niagara's electrician to this effect, and when the voltage was stepped up by increasing the battery power, the signals improved to normal and were even better than before. As the cable moved down into the cold water, the lower temperature and the increased pressure seemed to improve the insulation characteristics of the gutta-percha so that some of the temporary faults and disturbances were gradually eliminated.

On Tuesday the weather began to improve after nearly a week of storm, but the seas still ran high. As the ship approached the shallower area which separates the telegraphic plateau from the Irish coast, the seas became calmer and the strain on the cable lessened. That evening the soundings showed a depth of only 250 fathoms. This was a help in changing from the main cable below deck to that on the upper deck, and this hazardous operation went by successfully. The next day, Wednesday, August 1st, the day was calm and beautiful, with only 90 miles separating the telegraph station at Valentia from the ship at noon. Everything looked very hopeful. With the Valorous leading the way, the ships moved on so that by daylight of the following morning the welcome heights surrounding Valentia lay ahead. The population on shore soon was awakened by the booming guns of the ships and was ready to welcome the crew and cable.

Signals from the Niagara indicated that they also were preparing to land. A stiff wind delayed the progress but by the afternoon the cable end was safely brought ashore. The Knight of Kerry, Lord of the Isles of that part of the Irish coast, led the party of welcomers and greeted Mr. Bright and Mr. Canning, the chief engineer and his assistant, to whose efforts and diligence the success of this part of the cable-laying was attributable. A royal salute announced that the cable was ready to link the Old World with the New.

CELEBRATING THE CABLE SUCCESS

TWICE, efforts to stretch a telegraph line between the north Atlantic continents had been tried and twice the efforts failed. An expectant public that hungered for the advantages that a transatlantic cable promised, had both times grown skeptical following the disappointments. A little more than a month had gone by since the latest failure had been reported, so that general interest had completely disappeared. Therefore the announcement telegraphically communicated from Newfoundland early that August day took America completely by surprise. The message read:

United States Frigate Niagara
Trinity Bay, Newfoundland, August 5, 1858.

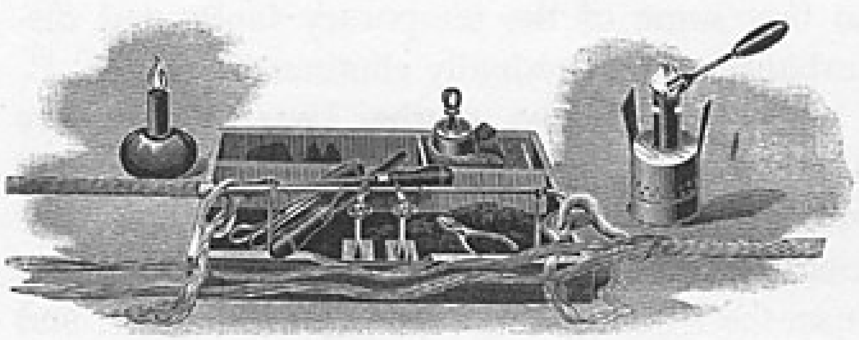
To the Associated Press, New York:

The Atlantic Telegraph fleet sailed from Queenstown, Ireland, Saturday, July seventeenth, and met in mid-ocean Wednesday, July twenty-eighth. Made the splice at one P.M. Thursday, the twenty-ninth, and separated — the Agamemnon and Valorous, bound to Valentia, Ireland; the Niagara and Gorgon, for this place, where they arrived yesterday, and this morning the end of the cable will be landed.

It is one thousand six hundred and ninety-six nautical, or one thousand nine hundred and fifty statute, miles from the Telegraph House at the head of Valentia harbor to the Telegraph House at the Bay of Bulls, Trinity Bay, and for more than two thirds of this distance the water is over two miles in depth. The cable has been paid out from the Agamemnon at about the same speed as from the Niagara. The electric signals sent and received through the whole cable are perfect.

The machinery for paying out the cable worked in the most satisfactory manner, and was not stopped for a single moment from the time the splice was made until we arrived here.

Captain Hudson, Messrs. Everett and Woodhouse, the engineers, the electricians, the officers of the ship, and in fact, every man on board the telegraph fleet, has exerted himself to the utmost to make the expedition successful, and by the blessing of Divine Providence, it has succeeded.



To splice even a simple cable required about half an hour of skilled work by a cable crew, and the equipment shown. The conductors were joined, served and soldered. The gutta-percha insulation was then put on and the protective armor wires restored.

> After the end of the cable is landed and connected with the land line of telegraph, and the Niagara has discharged some cargo belonging to the Telegraph Company, she will go to St. John's for coal, and then proceed at once to New York.
>
> CYRUS W. FIELD.

The message was condensed and flashed to every part of the United States, and enthusiasm reached the state of excitement as tho a war had just been won. New York went wild with rejoicing. A hundred guns were fired on Boston Common and the bells of the city continued their joyous peal for an hour. For weeks the national jubilation continued and the Atlantic Telegraph remained the most important subject of conversation.

As in all such popular demonstrations the national feeling was concentrated on the individual who best represented the enterprise — Mr. Cyrus Field. Every public official sent him congratulations. The President of the United States and the Governor General of Canada telegraphed their pride and approval. Comparisons between the significance of this deed and that of the deeds of the greatest of heroes were made — the discovery of America, the invention of printing — these and similar events were considered as of the order of Mr. Field's accomplishment. The race, the nation, the whole world, were spoken of as the grateful beneficiaries of Mr. Field, the Telegraph Fleet, and the Atlantic Telegraph Company. Mr. Field was overwhelmed but appreciative of the praise heaped upon him. From England congratulations poured in from the First Lord of the Admiralty, from the directors of his company in London, and from those who had supplied the technical equipment. In an address to the Chamber of Commerce at St. John's, when Mr. Field reached there, he showed his appreciation of

Cyrus W. Field initiated the transatlantic cable effort, directed the enterprise for thirteen years and held stoutly to the conviction of ultimate success. The temporary triumph of the cable in 1858 was celebrated in this portrait on the cover of Harper's Weekly for August 21st, 1858.

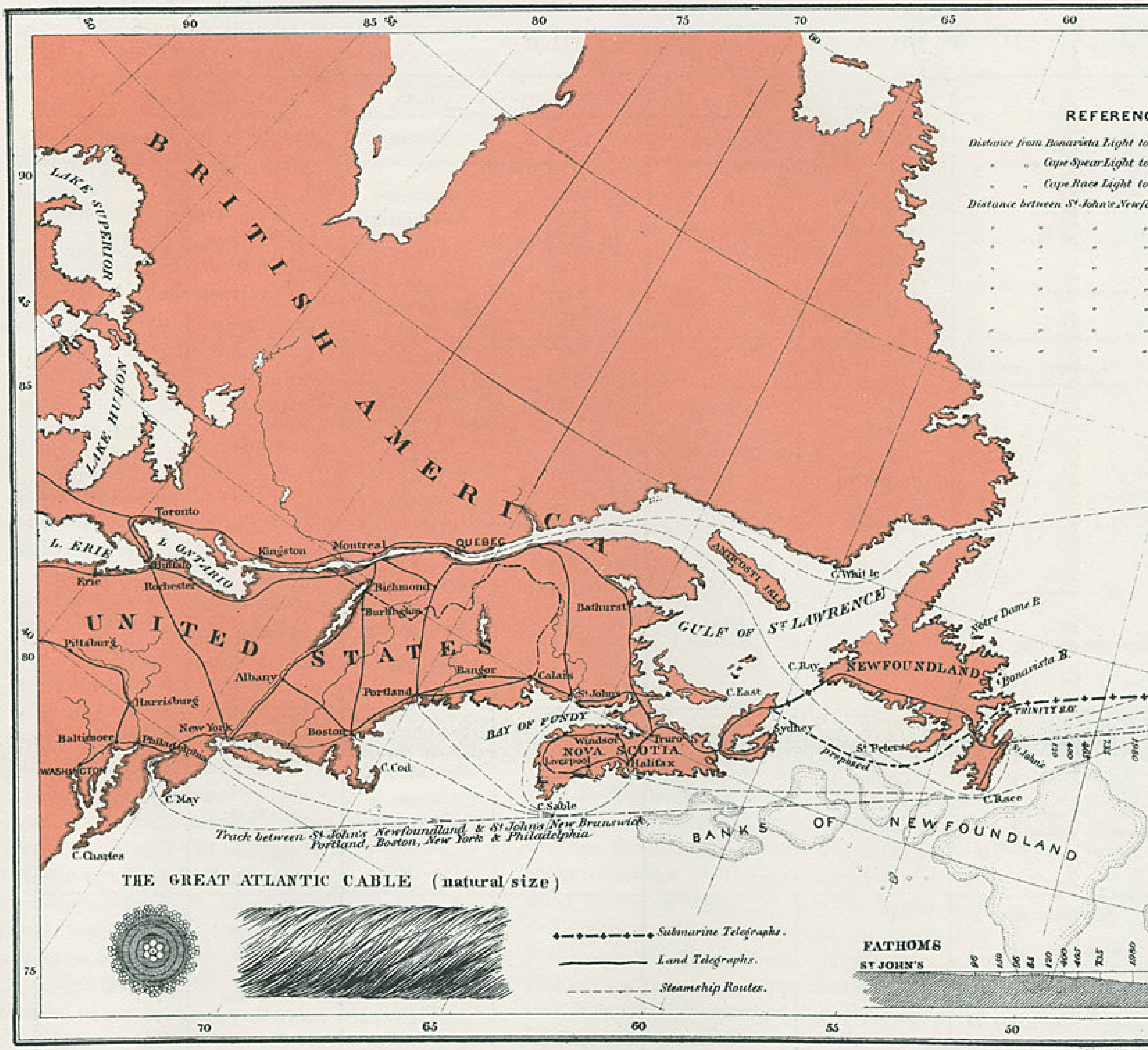
the support he got from the officers and technicians of the Telegraph Fleet. He said, "But it would not only be ungenerous, but unjust, that I should for a moment forget the services of those who were my co-workers in this enterprise, and without whom any labors of mine would have been unavailing. It would be difficult to enumerate the many gentlemen whose scientific acquirements and skill and energy have been devoted to the advancement of this work, and who have so mainly produced the issue which has called forth this expression of your good wishes on my behalf. But I could not do justice to my own feelings did I fail to acknowledge how much is owing to Captain Hudson and the officers of the Niagara, whose hearts were in the work, and whose toil was unceasing; to Captain Dayman of Her Majesty's Ship Gorgon, for the soundings so accurately made by him last year, and for the perfect manner in which he led the Niagara over the great-circle arc while laying the cable; to Captain Otter, of the Porcupine, for the careful survey made by him in Trinity Bay, and for the admirable manner in which he piloted the Niagara at night to her anchorage; to Mr. Everett, who has for months devoted his whole time to designing and perfecting the beautiful machinery that has so successfully paid out the cable from the ships — machinery so perfect in every respect, that it was not for one moment stopped on board the Niagara until she reached her destination in Trinity Bay; to Mr. Woodhouse, who superintended the coiling of the cable, and zealously and ably cooperated with his brother engineer during the progress of paying-out; to the electricians for their constant watchfulness; to the men for their almost ceaseless labor (and I feel confident that you will have a good report from the commanders, engineers, electricians, on board the Agamemnon and Valorous, the Irish portion of the fleet); to the Directors of the Atlantic Telegraph Company for the time they have devoted to the undertaking without receiving any compensation for their services."

In St. John's the Niagara refilled her bunkers with coal and then steamed for New York, arriving there on the 18th. The public hunger for quick overseas news had to wait because it was Mr. Field's determined policy first to thoroly test the performance of the cable, then to permit the exchange of greetings from the Queen of Great Britain and the President of the United States. Eleven days went by before the Queen's message of congratulation was received by President Buchanan. It required sixteen and a half hours to transmit the 98-word message. He replied to the Queen joining her in congratulations "on the success of the great international enterprise accomplished by the science, skill, and indomitable energy of the two countries". The 149-word reply required more than ten hours to transmit.

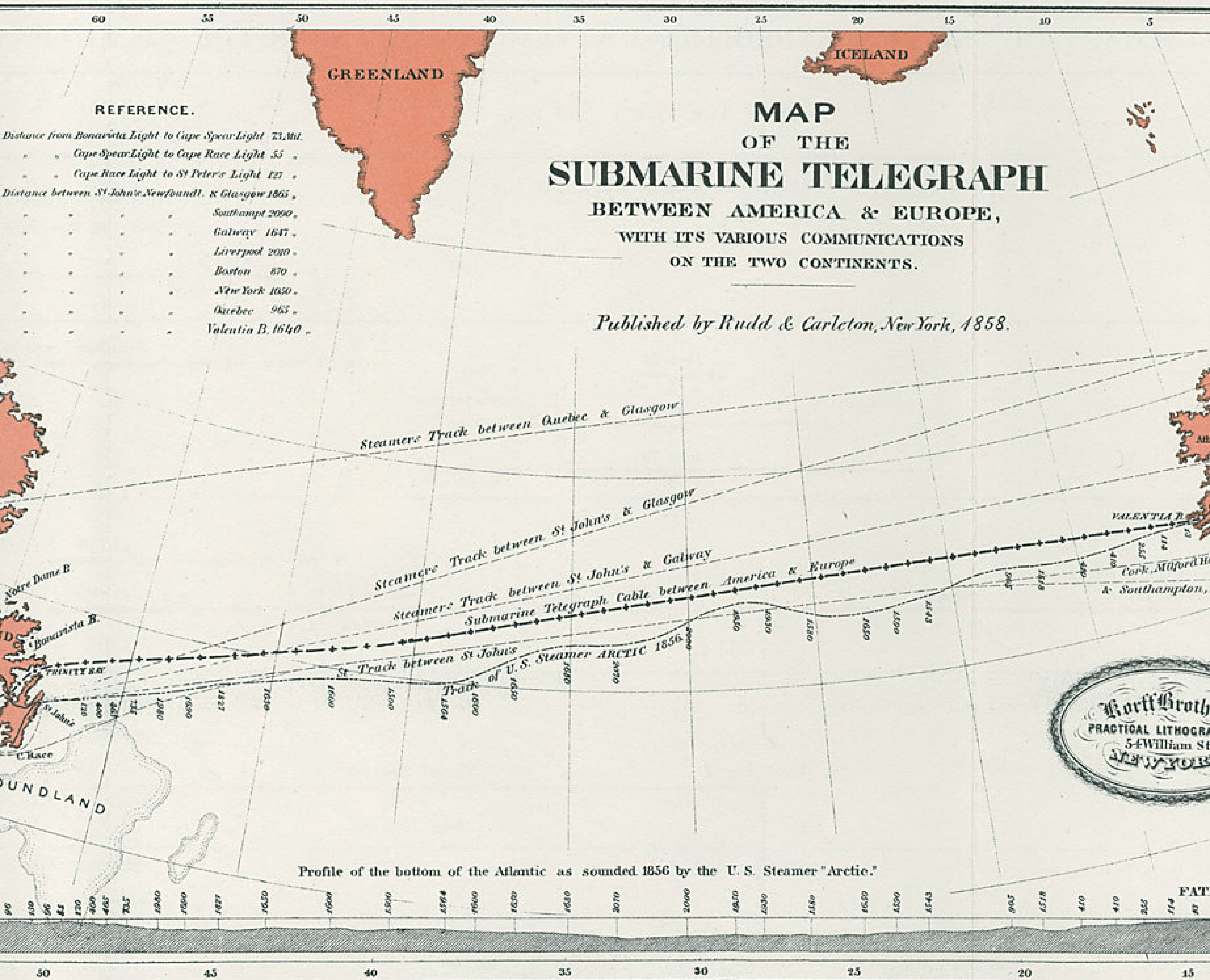
This exchange of messages started a fresh series of demonstrations of general enthusiasm. In New York, a hundred gun salute was fired in City Hall Park at daybreak and another salute was given at noon. Flags flew from all public and many private buildings and bells were repeatedly rung. At night the city was lit by general illumination and bonfires. City Hall became the focus of interest and attention and the illuminating fires on it were so widespread that the famous cupola caught fire and was destroyed; the building itself narrowly escaped similarly being consumed. Wherever people had received the news there were rejoicing and demonstrations. In California as in New York, in the North as in the South, popular rejoicing ran high. Longfellow wrote in his diary: "August 6th. Go to town with the boys. Flags flying and bells ringing to celebrate the laying of the telegraph".

The next day the Niagara dropped anchor in New York and Mr. Field hastened to his home. He felt his mission had been accomplished. He was to regain peace and a well-earned rest and therefore notified the directors of his company in London that he wished to resign. But his associates in England were in no mood to accept resignations because their own enthusiasm was almost as high as that in America. The chief engineer of the enterprise, Mr. Charles T. Bright, was knighted and the captains of the Agamemnon and Valorous received official distinction.

The wave of enthusiasm was followed by more sober thought on the significance and po-

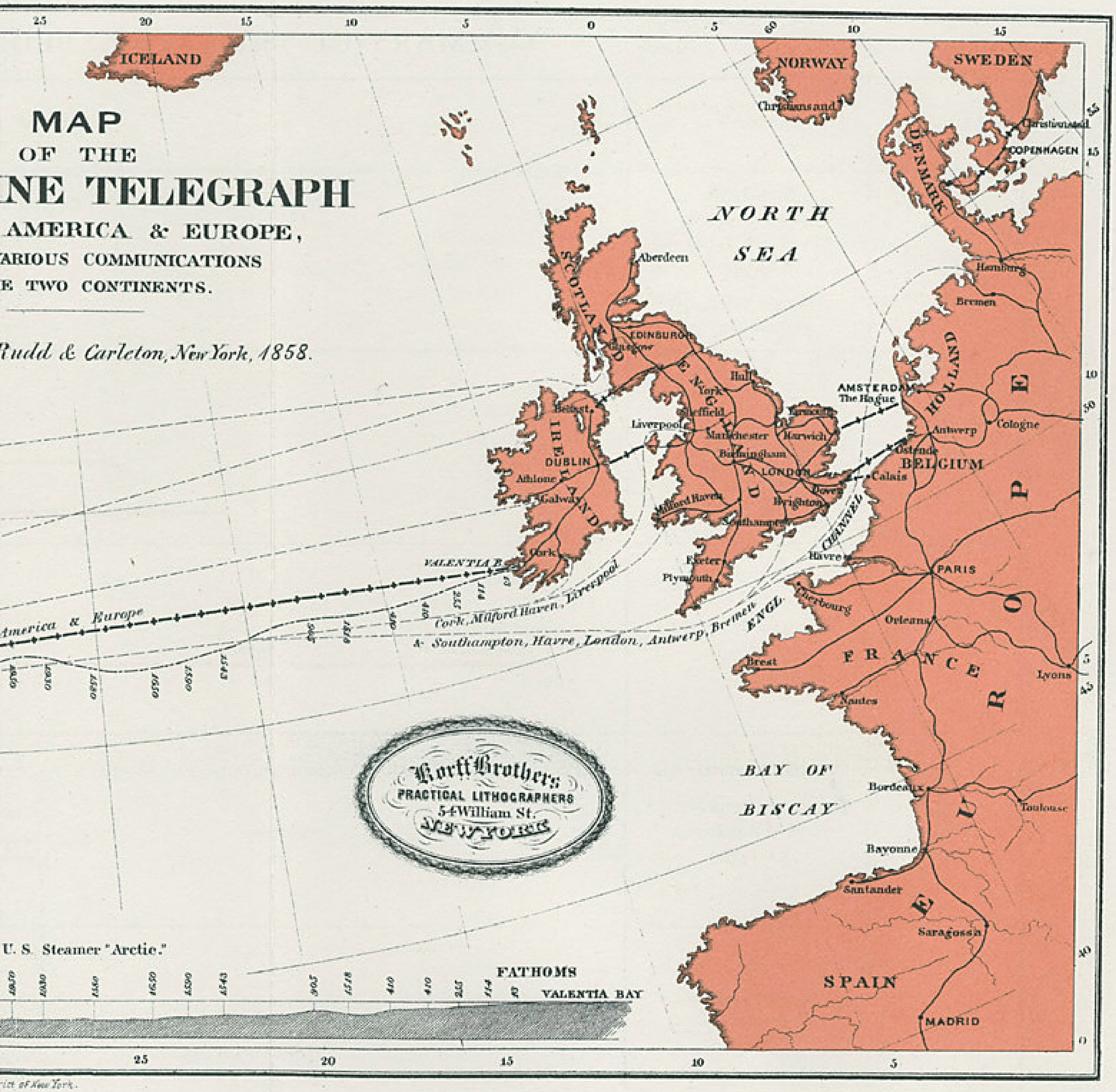


Pamphlets, maps and books supplemented the poems, songs a
the grand tie of two continents by the electric cable of 1858



Entered according to Act of Congress in 1857 by Korff Brothers, in the Clerk's Office of the District Court of the U.S. of the Southern District of New York.

ed the poems, songs and sermons that celebrated electric cable of 1858. This map locates the successful cable between Valentia and Trinity Bays and also the course of Commander Berryman's expedition on the Arctic to sound the ocean's bottom.

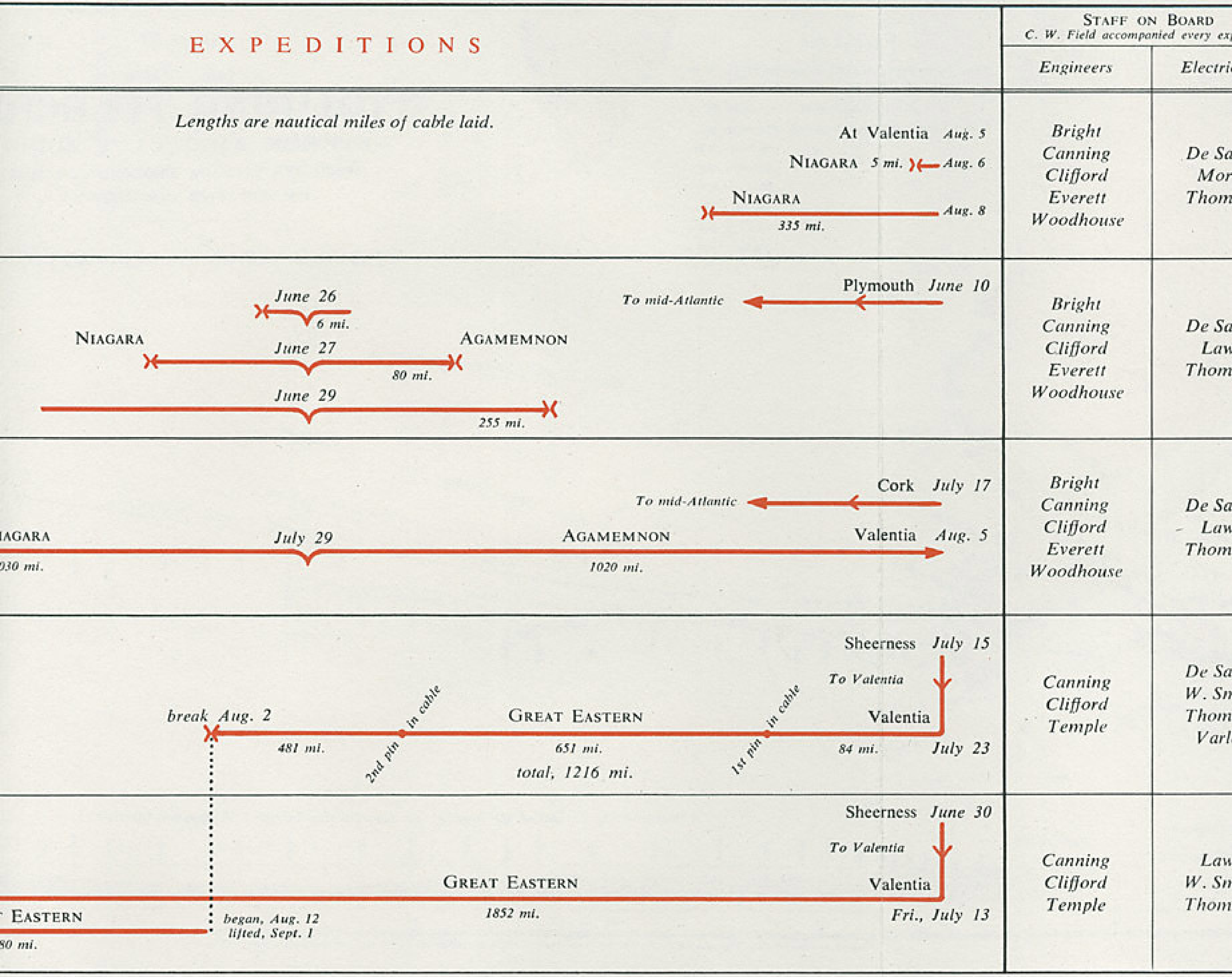


d Trinity Bays and also the course of Commander
c to sound the ocean's bottom.

SUMMARY OF THE FIVE EXPEDITION

Attempt	Sponsor	EXPED
1857	New York, Newfoundland, and London Telegraph Company Atlantic Telegraph Company	*Lengths are nautical*
1858 I	Atlantic Telegraph Company	*June 26* *6 m* Niagara *June 27* *June 29*
1858 II	Atlantic Telegraph Company	Trinity Bay, Newfoundland *Aug. 5* Niagara *1030 mi.* *July 29*
1865	Telegraph Construction and Maintenance Company	*break Aug. 2* *481 mi.*
1866	Anglo-American Telegraph Company	Heart's Content (*Trinity Bay*) *July 27* Great Eastern *Sept. 7* *680 mi.* *began, Aug. 12 lifted, Sept. 1*

HE FIVE EXPEDITIONS ATTEMPTING TO SPAN THE ATLANTIC WITH A TELEGR



ATLANTIC WITH A TELEGRAPH CABLE.

	Staff on Board *C. W. Field accompanied every expedition*		Ships and Commanders		The Cable	
	Engineers	*Electricians*	U.S.	BRITISH	*Weight*	*Tensile Strength*
At Valentia *Aug. 5* AGARA *5 mi.* *Aug. 6* *Aug. 8* *ni.*	*Bright* *Canning* *Clifford* *Everett* *Woodhouse*	*De Sauty* *Morse* *Thomson*	Niagara *Capt.* *Wm. L. Hudson* Susquehanna *Capt. Sands*	Agamemnon *Capt. Noddall* Leopard Cyclops *Capt. Jos. Dayman*	*2,000 lbs. per mile*	*6,500 lbs.*
Plymouth *June 10*	*Bright* *Canning* *Clifford* *Everett* *Woodhouse*	*De Sauty* *Laws* *Thomson*	Niagara *Capt. Hudson*	Agamemnon *Capt.* *Geo. W. Preedy* Gorgon *Capt. Dayman* Valorous *Capt.* *W. C. Aldham*	*2,000 lbs. per mile*	*6,500 lbs.*
Cork *July 17* Valentia *Aug. 5*	*Bright* *Canning* *Clifford* *Everett* *Woodhouse*	*De Sauty* *Laws* *Thomson*	Niagara *Capt. Hudson*	Agamemnon *Capt. Preedy* *Capt. Moriarty* Gorgon *Capt. Dayman* Valorous Porcupine *Comm. H. C. Otter*	*2,000 lbs. per mile*	*6,500 lbs.*
Sheerness *July 15* *To Valentia* Valentia *84 mi.* *July 23*	*Canning* *Clifford* *Temple*	*De Sauty* *W. Smith* *Thomson* *Varley*		Great Eastern *Capt. Jas. Anderson* *Capt. Moriarty* Sphinx *Capt. V. Hamilton* Terrible *Capt. Napier*	*3,575 lbs. per mile*	*15,500 lbs.*
Sheerness *June 30* *To Valentia* Valentia *Fri., July 13*	*Canning* *Clifford* *Temple*	*Laws* *W. Smith* *Thomson*		Great Eastern *Capt. Anderson* *Capt. Moriarty* Albany Medway Terrible *Capt. Commerill*	*3,175 lbs. per mile* *Shore-end 40,000 lbs. per mile*	*16,500 lbs.*

tential of this new instrument which science had placed before mankind. Its blessings to commerce, industry and statesmanship were exceeded only by its promise as a portent of peace. Poems envisioned its happy gift, and sermons and oratory proclaimed it from every rostrum, thus:

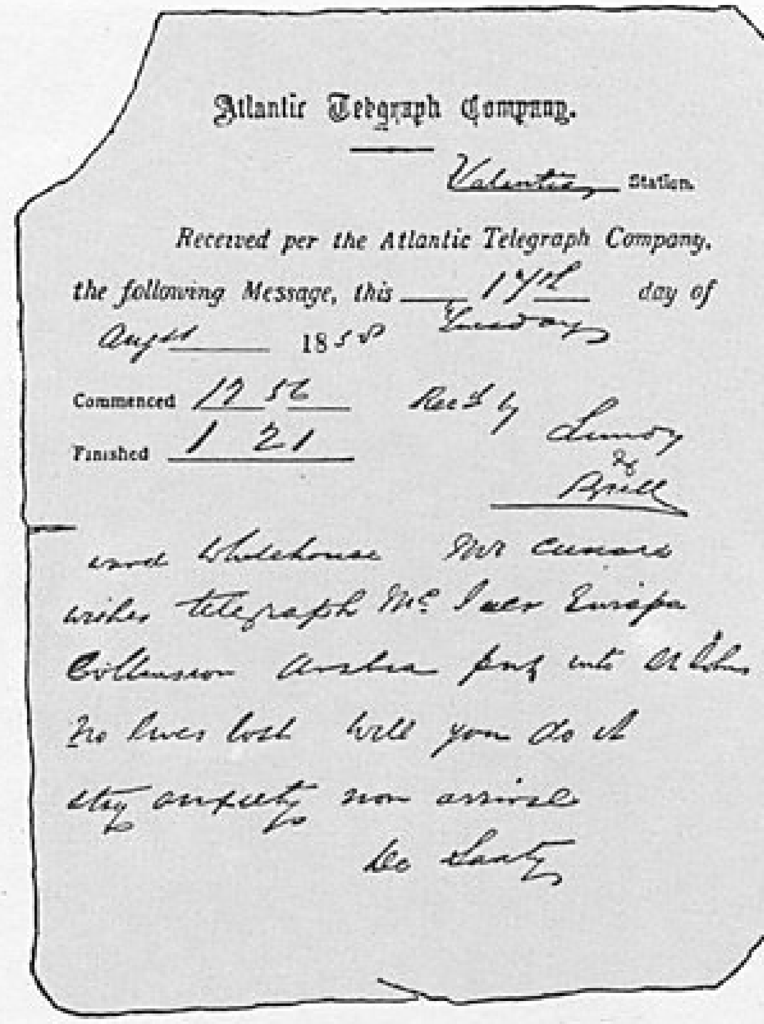
'Tis done! the angry sea consents,
The nations stand no more apart,
With clasped hands the continents
Feel throbbings of each other's heart.
Speed, speed the cable; let it run
A loving girdle round the earth,
Till all the nations 'neath the sun
Shall be as brothers of one hearth.

Songs were especially written to fit the occasion and editorials were endless in their praise and promise; the theme of the telegraph was a dominant one.

Letters from dignitaries in every walk of life flooded into New York. Prof. Joseph Henry, dean of American electricians and Secretary of the Smithsonian Institution, sent a long letter praising the work of Field and his associates, including the sentence, "This is a celebration such as the world has never before witnessed. It is not alone to commemorate the achievements of individuals, or even nations, but to mark an epoch in the advancement of our common humanity". Cyrus Field became "King Cyrus" and "Cyrus the Great". One orator declaimed: "Columbus said, 'There is one world, let there be two'; but Field said, 'There are two worlds, let there be one'."*

New York City, Mr. Field's home, continued as the center of jubilation. Here the City Fathers arranged to have a public assembly to

*William M. Evarts, later Attorney General and Secretary of State, quoted in McDONALD, page 1.


Atlantic Telegraph Company.

Valentia Station.

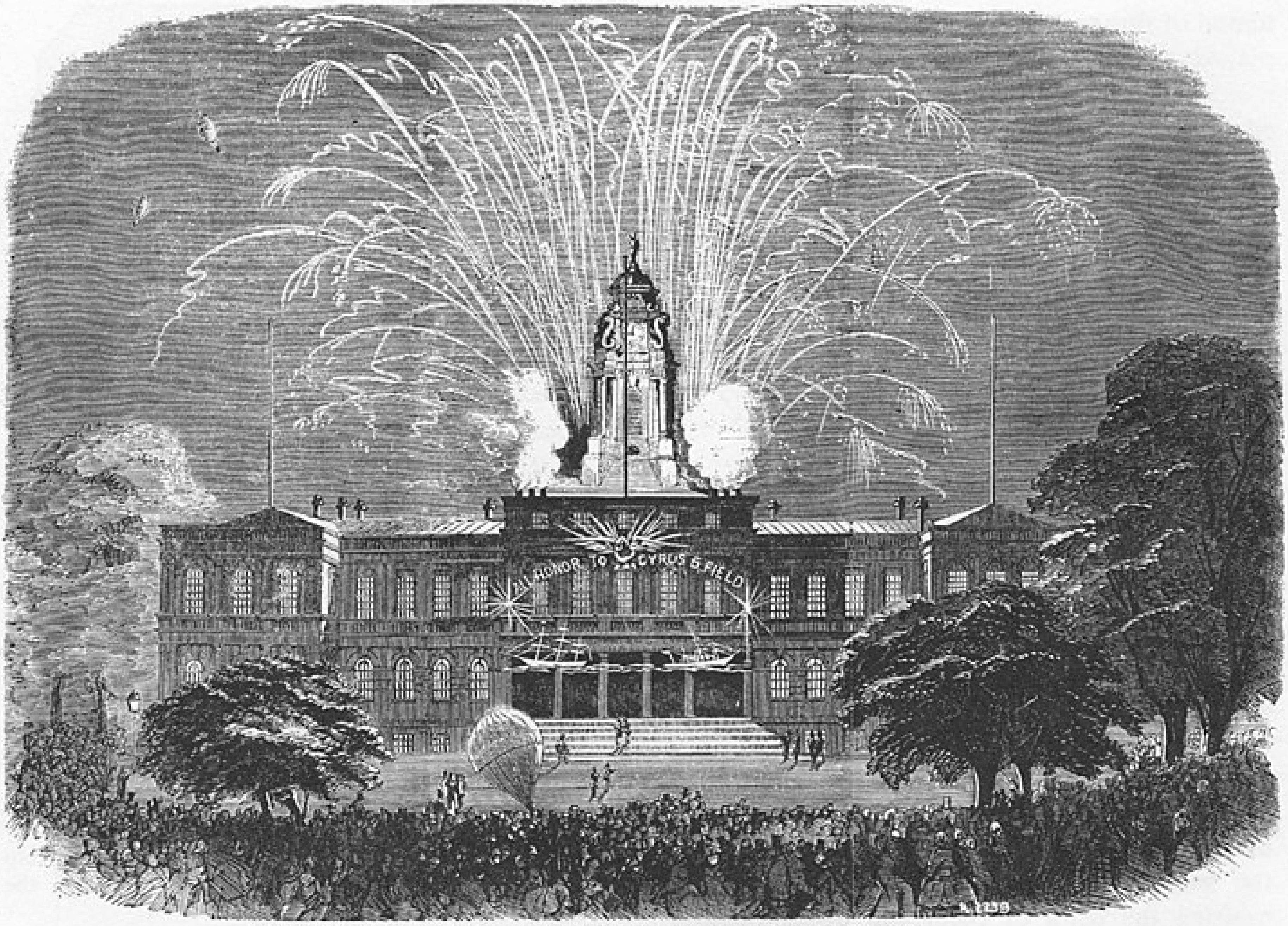
Received per the Atlantic Telegraph Company, the following Message, this 17th day of Augst 1858

Commenced 12 56

Finished 1 21

A record, on August 17th, of one of the messages that crossed the 1858 cable. It reads: "Ward Whitehouse. Mr. Cunard wishes telegraph McIver Europa Collision Arabia put into St. Johns. No lives lost. Will you do it. Stop. Anxiety non arrival. De Sauty." As seen from the time entry, it took 25 minutes to transmit the 25 words.

honor Mr. Field and the officers of the expedition. Mr. Field accepted but made sure that the British officers should receive the same recognition as the American. This official day of celebration; the first of September, was begun with solemn services at Trinity Church which was filled to overflowing. The services began with a procession of 200 clergymen. At noon, Mr. Field and the ships' officers landed at Castle Garden and received a national salute. A procession formed and extended for miles from the Battery to where the Public Library now stands. It included the British Minister and officers representing the Army and the Navy as well as a hundred veterans of the War of 1812. The



CELEBRATION OF THE LAYING OF THE ATLANTIC TELEGRAPH CABLE AT THE TOWNHALL, NEW YORK.

Courtesy, Western Union Telegraph Co.

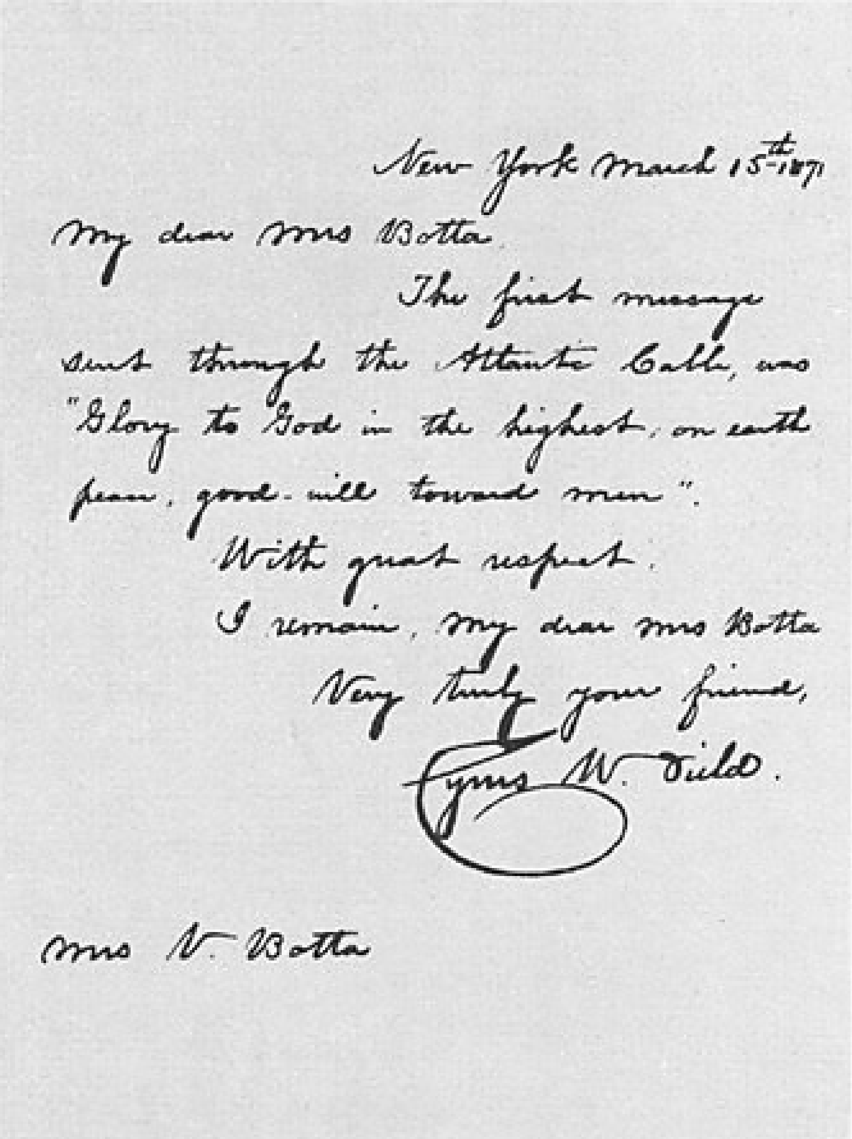
The enthusiasm and celebrations that followed the successful laying of the cable in August 1858 seemed to know no bounds. Mr. Field's home, New York, celebrated more than most communities with church service, parade, banquet, speeches, and finally a fireman's torch-lighted parade. So intense and widespread were the fire-works that the cupola of City Hall burned and the building was almost destroyed.

crowd was so dense that it required five or six hours for the procession to reach its destination, the Crystal Palace, at Fifth Avenue and 42nd Street.

Many addresses were made. One, outlining the history of the Atlantic Telegraph, prompted the mayor to reply by showing how great and good were the deeds which the Telegraph now made possible, adding, "The two greatest and freest nations of the globe, by independent and constitutional legislation, and by the aid of their finest ships and their ablest officers and engineers, combined together to insure success. Capital was liberally subscribed by private citizens in a spirit which put greed to the blush" and "The city of your home delights to honor you; your fellow-citizens, conscious that the glory of your success is reflected back upon them, are proud that your lot has been cast among them." Mr. Field in his address said, "Five weeks ago, this day and hour, I was standing on the deck of the Niagara in mid-ocean, with the Gorgon and Valorous in sight, waiting for the Agamemnon. The day was cold and cheerless, the air was misty, and the wind roughened the sea; and when I thought of all that we had passed through – of the hopes thus far disappointed, of the friends saddened by our reverses, of the few that remained to sustain us – I felt a load at my heart almost too heavy to bear, though my confidence was firm, and my determination fixed. How different is the scene now before me – this vast crowd testifying their sympathy and approval, praises without stint, and friends without number!" After further remarks, he announced that he had just received a telegraphic message from "a little village, now a suburb of New York, which I will read to you: 'The directors are on their way to Valentia, to make arrangements for opening the line to the public. They convey, through the cable, to you and your fellow-citizens, their hearty congratulations and good wishes, and cordially sympathize in your joyous celebration of the great international work'."*

The reception ended with the presentation of a gold medal to Capt. Hudson and similar testimonials to the British captains. The ceremony over, the guests dispersed so that they could witness a New York specialty – a firemen's torchlight parade. "The firemen's torch-light parade concluded the day's festivities. It was exceedingly beautiful, and as the long line moved through Broadway surrounded by an enthusiastic crowd on every side, and lighted by thousands of torches, candles, and colored lanterns, one might easily have imagined himself in a fairyland. It was long after midnight before the great assemblage dispersed, and even then the streets did not resume their wonted as-

*The history of this dispatch is curious. Tho dated at London on September 1st, it was sent from a small town in Ireland. The directors were on their way from Dublin to Valentia, on the morning of the first of September, when Mr. Saward, secretary of the company, remarked: "This is the day of the celebration in New York – we ought to send a dispatch to Mr. Field." Accordingly, at the first stopping-place (Mallow Station) the message was written, forwarded to Valentia, and thence sent across the Atlantic. It was put into Mr. Field's hand as he was getting into his carriage at the Battery.



New York March 15th 1871

My dear Mrs Botta

The first message sent through the Atlantic Cable, was "Glory to God in the highest, on earth peace, good-will toward men".

With great respect,
I remain, my dear Mrs Botta
Very truly your friend,
Cyrus W. Field.

Mrs V. Botta

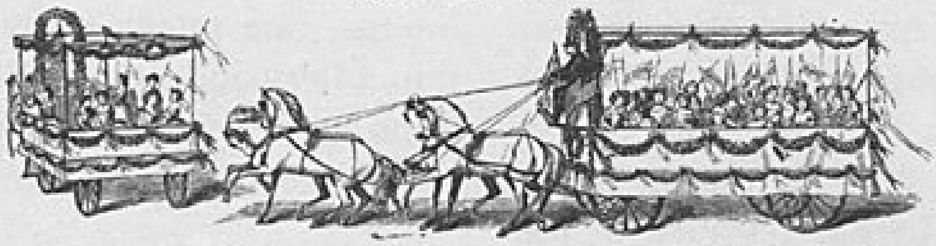
Burndy Library

The first intelligible words crossed from Newfoundland to Valentia on August 10th, 1858, followed by 400 messages most of which were telegraphers' instructions. The first "official" message was the 129th and was sent on the seventh day of transmission, August 16th, from Valentia to Newfoundland. It is shown in this note by Cyrus Field. All the messages are listed in detail in the *Report of the Joint Committee* (see Bibliography).

THE CELEBRATION IN SAN FRANCISCO,

IN COMEMORATION OF THE SUCCESSFUL LAYING OF THE ATLANTIC TELEGRAPH CABLE,

MONDAY, SEPTEMBER 27th, 1858.



[Cars carrying 120 little girls, uniformly dressed in white, and representing all the States, and principal European Nations.]

The success of the most important undertaking of modern times—the laying of the Ocean Telegraph—communicated an electric thrill to the great heart of the people whether of foreign or native birth, who have made their homes this side of the Sierra Nevada. The mere announcement that Cyrus W. Field had accomplished his cherished project of uniting the two continents by means of a submerged cable, to be worked upon the principle originally introduced by our own countryman, Morse, was received with testimonials of joy—one hundred guns being fired in honor of the event, and some of the principal buildings being illuminated. A similar enthusiasm pervaded all parts of the State, thanks to our own telegraph companies, of which there are several in California. Some more suitable testimonial seemed necessary, however, to exhibit the high appreciation in which the project was held by our citizens, and Monday, the 27th of September, was accordingly fixed upon as a day of general rejoicing and festivity in San Francisco.

Ruby Aldrich, just arrived from St. Jo., Missouri!]

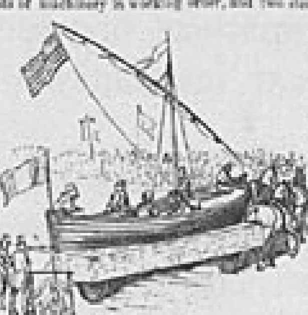
[Adams, with family of Native Californians.]

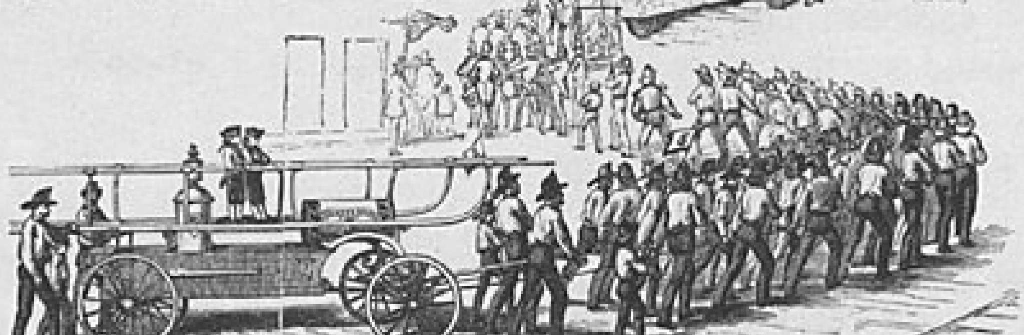
THE CELEBRATION.

The day, which was one of the finest of the year, was ushered in by the ringing of bells and repeated discharges of artillery. At an early hour the streets were thronged with people, and boats were arriving from different parts of the interior, crowded with visitors, eager to witness or participate in the proceedings. Military and Fire companies came from Stockton, Sacramento, Solano and other places, and people from every clime seemed to unite with the utmost cordiality in celebrating the great event of the age, by the greatest civic display ever known in California.

The procession was to have formed in Market street exclusively, but it soon became evident that even that spacious thoroughfare would not contain the multitude that were to compose it, and many other streets in the vicinity were filled with the different military and civic associations. Along the line of march, and, indeed, throughout the city, the buildings were decorated with flags and well painted transparencies, and in many cases with green boughs—adding greatly to the general holiday effect. Among the most attractive features of the day were the Black Hussars, who were followed by the Grand Marshal, Capt. Thos. D. Johns, and his twelve aids, and by a large representation of the military of the city and State. All the trades and professions took a part in the ceremonies. In three immense vans, drawn by gaily decorated horses, rode one hundred and twenty young girls, dressed uniformly in white, with chaplets upon their heads, and decked with blue ribbons. Each bore a flag, those in the first car being inscribed with the name of one of the States or Territories of the Union; those in the second with the names of western nations; and those in the last, with the names of the nations of the continent of Europe. This display was greeted with cheers throughout the entire line of march. In the procession was also a large covered wagon, similar to those used by emigrants, in crossing the plains, and drawn by a team of ten oxen. One side of this wagon bore the device "*Latest Dispatch from Pike: 120 days from St. Jo., Missouri!*"—and the other, "*Give us a Pacific Railroad! Don't wait for the Wagon.*" Several Grizzly bears followed, the terror of all travelers in California. The State Line Telegraph Company, and the Alta Telegraph Co., were conspicuously represented, a cable extending from one to the other of the two wagons in which the attaches were seated. A platform carried a printing press belonging to the *Alta* newspaper, from which, at intervals, a miniature specimen of that sheet was distributed. One of the Overland Mail Stages also attracted much attention. Among the trades the different foundries figured conspicuously—having in their ranks several cars, containing various kinds of machinery in working order, and two steam engines, whose shrill whistles reverberated among the surrounding hills. There were also brewers, who distributed excellent beer to the crowd;—cigar-makers, who manufactured cigars and distributed them as they went along; bakers, who dispersed crackers and cakes to the juvenile spectators; carpenters at work building a frame house, which they had nearly completed during the march of the procession.

[See next.]





Sterett & Butler, Printers, Engravers and Publishers, 145 Clay street, San Francisco.

Nine years after the gold-rush, San Francisco properly celebrated her tie to the overseas nations.

pect. . . . The fact is, that an avalanche of people descended upon us, and New York was crushed for once; but we do not lay Atlantic cables every day".

THE CABLE FAILS

On the very day that all this celebrating took place, some undetermined break in the cable ended its usefulness, for it became silent just as its glory was being celebrated at its highest pitch. A violent lightning storm occurred over Newfoundland at about that time, and this was at first believed to be the direct cause of the failure. More sober analysis lay the break at a point about 270 miles from Valentia, at the location of the range that separates the deep Atlantic from the plateau of the Irish coast. Nothing that could be done restored the transatlantic voice. The cable was dead! Heartbreaking discouragement spread almost as rapidly as the news of its success. All the dreams of its accomplishments – all the visions of the many good and useful purposes which it was to serve – all this was suddenly ended. The waters had swallowed years of labor and millions of capital.

People stopped to ask themselves which was real and which was a dream. There was no shortage of scoffers and those who had known all the time that the whole business was nothing but a hoax and a humbug. One English paper not only derided the entire enterprise but proved that the Atlantic cable was never laid and that such a thing was not even possible. Another journalist wondered, editorially, how much money Mr. Field had made in the stock deal of his company. The Astronomer Royal, Sir George B. Airy had publicly announced: (1) that "It was mathematically impossible 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 its simultaneous landing on both sides of the ocean on the 5th of August, 1858, the operation of the cable had continued until the first of September, one day short of four weeks. In this time some 400** messages were recorded, most of them technical details sent between operators on the operation of the instruments. But the performance of the cable proved uneven and frequently went out of service for hours at a time due to storms, magnetic disturbances, and unknown causes. Peter Cooper, reporting in 1863, stated,"Unfortunately, in the manufacture of the cable, when it was being passed out of the shop into the vat, intended to be kept always overflowed with water, the water was allowed to flow off a little, and a part of it was thus exposed, of a hot day, to the sun, which melted the gutta-percha, leaving but a thin coating to protect the copper. That accounts fully for the cause of the disaster, but for which that cable, in all probability, would be at work successfully to-day."*** Few newsworthy messages were therefore accumulated in this time, not enough to have made a public impression. In mid-August a collision of two steamships had occurred off Cape Race. After clearance, and with special permission of Mr. Field, the news of this collision was telegraphed to London on August 20th and represents the first news message to be flashed across this cable. A second news dispatch crossed on August 25th from Newfoundland to Valentia informing the sailing of the ship Persia and the news that a Mr. Eddy, "the first and best telegrapher in the States, died today". This news

*Quoted in BRIGHT, *The Story of the Atlantic Cable*, 1903, page 43.

**The break was not sudden but rather that of a poor connection followed by worsening ones. Charles Bright in *The Story of the Atlantic Cable*, page 151, (see Bibliography), states that the deterioration was slow, that long interruptions preceded the final break on October 20th, after 732 messages had crossed the line. George Saward added up 271 messages, gathered from the operating diaries.

***Quoted in STEVENS, *Report*, etc., 1863, page 16.

reached Mr. Henry Field, then in Europe, who had known Mr. Eddy, within 48 hours after the latter's death. Notably, a dispatch of news sent on August 27th covering England, France, Prussia, Russia, China, Egypt and India was received in New York and published in the evening papers the same day that it had been dispatched from England.

The probable cause of the breakdown may be summarized as follows: the Niagara carried a battery of 75 cells of the sawdust (Daniell) type; these consisted of zinc and copper plates, each about 14 inches square, immersed in a solution of sulphuric acid and water. To this, sawdust was added to prevent the liquid from slopping over during the ship's tossing. Each cell developed 1.1 volts. Supplementing this source of battery current was the testing apparatus recommended and used by Mr. Whitehouse who strongly believed in the necessity of testing the cable with high potential currents. For this purpose he used a large induction coil, five feet long, energized by a series of up to 500 very large cells, resulting in a charging voltage of approximately 2,000 volts. It was believed by Charles Bright that it was these high voltage tests which ultimately ruined the life of the cable, for as the voltage was stepped up the communication results became poorer. The use of Prof. Thomson's reflecting galvanometer, when used with ordinary Daniell cells, was restored and produced the best results. However, by that time, the harm had already been done, the insulation damaged, and the cable failed. Prof. David E. Hughes, an eminent inventor and electrician, as well as Prof. Charles Wheatstone, confirmed this opinion. Prof. Thomson, writing in 1860, stated, "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 20 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."* Mr. Whitehouse had hoped to operate his improvement of Prof. Morse's electro-magnetic recording instruments by activating relays which demanded considerable line current, whereas the galvanometer of Prof. Thomson required very little energizing current. At another time, Mr. Whitehouse, contrary to the advice of Prof. Thomson, attempted to lift the cable out of the water in order to repair an imagined fault. This he did at Doulas Head near Valentia; the cable was cut and buoyed. The company Board found him stubborn, uncooperative and insubordinate and therewith discharged him.**

The disservice done to the cable and the company thru the machinations of Whitehouse is illustrated by his behavior at Valentia when the 1858 cable was laid. In order to "prove" the effectiveness of his clumsy recording receiver, he had inserted a Thomson galvanometer at the receiving terminus, and had a clerk read this instrument. The signals thus read were repeated on a key at his table, which then recorded the signals on a Morse embossing recorder nearby. The strips from this were sent by Whitehouse to the directors in London, who were led to believe that the signals had arrived directly from Trinity Bay. Unfortunately, in accordance with instructions, no galvanometer, but a recorder, was in use in Newfoundland, so that the Queen's message, which required 16½ hours to transmit, was repeated back from Newfoundland in only 67 minutes.

Examining other difficulties, post mortem, that caused the cable break, it was realized that

*Quoted in BRIGHT, *The Story of the Atlantic Cable*, 1903, page 158.

**A defense of his position, published by Mr. Whitehouse in August, 1858 is reproduced in part in Appendix B, page 91.

the cable itself was far from perfect, and altho made hastily, yet it met the acceptable standards and was made by the best cable fabricators in the world at that time. Its high specific gravity caused it to sink too rapidly and made it rigid in handling. In addition, the cable was a year old when immersed; it had been coiled out of doors, exposed to the sun which had melted the gutta-percha in places. Further, it had been taken on board the ships the previous year, then had been taken ashore and coiled on the Plymouth docks, and again stored in 1858. This meant that the cable had been twisted and untwisted as many as ten times. The violent gale of June, 1858 had done the cable on the Agamemnon little good, requiring many portions to be cut out. Was it any wonder that the cable failed? Or should it be said, was it not a wonder that the cable had operated at all!

The year 1858 had ended quite badly and the following year had offered little improvement. Mr. Field's office and warehouse on Beekman Street in New York burned, with heavy losses of goods and records. The year 1860 ended with a nation-wide depression which caused Mr. Field's private firm to admit bankruptcy and to offer to settle on a 25% basis with the creditors. With the prospect of a nation on the brink of civil war, Mr. Field faced his third financial ruin in 20 years. Yet he felt most optimistic about the future of the Atlantic cable. In 1866, after two cables had operated satisfactorily, he privately sold enough of his stock to repay all his debts plus 7% interest for the six-year period just passed.

THE FUTURE IS PLANNED

To average men seeking to establish a successful enterprise, this was discouragement enough, and called for an end to further effort. But these were not average men. Besides, enough of the sweet that came with the few weeks of success had remained to cause the leaders of the enterprise to analyze the situation and then to try again. At first they took counsel with themselves and then turned to that rock of support, the British Government. The company asked the Government to guarantee the interest on a certain amount of stock in order to raise capital for a new cable; this guarantee was to continue even if the second attempt should not be successful. Unfortunately, this request came concurrently with another event that shook the confidence in every kind of submarine cable, as the one crossing the Red Sea had also failed. In this the British Government had provided an unconditional guarantee. This set-back the Government was not anxious to repeat; so while it increased its subsidy to the Atlantic Telegraph Company from £14,000 to £20,000 per year, and also guaranteed an 8% return on £600,000 of new capital for a period of 25 years, it also imposed one condition, and that was that *the cable should work*. As an additional move to assist the work, a new set of soundings was ordered to be taken off the coast of Ireland in order to clear any doubts about the submarine mountain which was claimed to interfere with ocean telegraph operation. Still further, the British Government ordered an exhaustive series of experiments which were intended to overcome the difficulties experienced in the two previous cable layings.

In the following year, 1859, a committee of the most prominent engineers and scientists in Great Britain was appointed by the Board of Trade, to thoroly investigate these problems. The Government was represented by Capt. Douglas Galton of the Royal Engineers; science was represented by William Fairbairn, president of the British Association for the Advancement of Science; electrical science was represented by Prof. Charles Wheatstone, the celebrated electrician, and Latimer Clark* and his elder brother Edwin, both eminent telegraph engineers; George Saward, the secretary, represented the Atlantic Telegraph Company and, finally, general engineering was represented by George P. Bidder and C. F. Varley, an eminent telegraph mechanician. This committee concerned itself with such problems as the optimum size and form of cables, the required strength and degree of flexibility, the order of electrical current required for such long distances, the type of conductor insulation and protective coverings required for this service and, finally, the expected rate of speed for sending messages over the line. Every mechanical and electrical phase of this intricate problem was carefully examined. After sessions covering two years, the following succinct summary was given out by the committee. This report was followed by the publication of the full testimony of all the experts invited to testify (see *Report of the Joint Committee, etc.*).

London, 13th July, 1863.

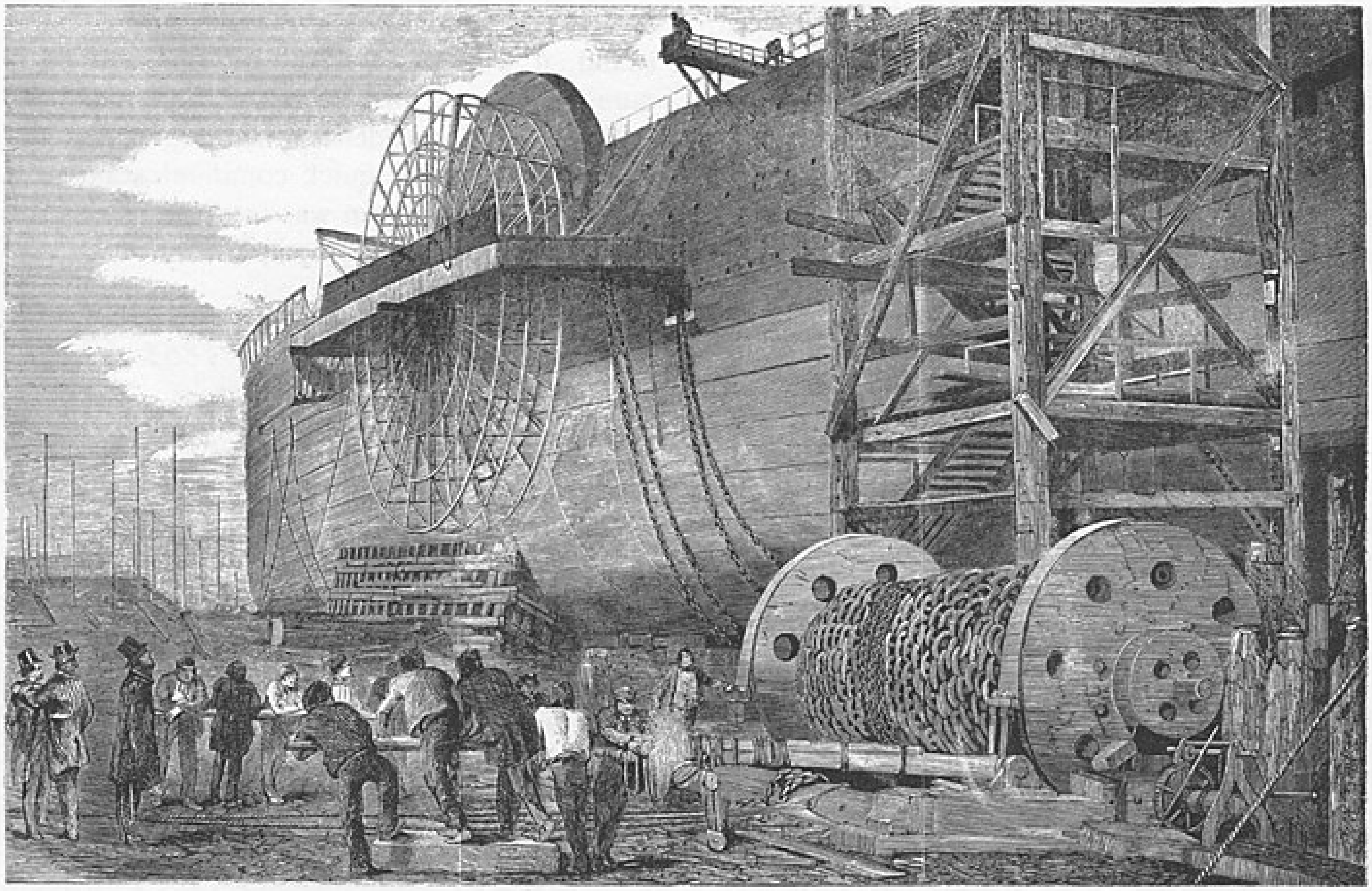
We, the undersigned, members of the Committee, who were appointed by the Board of Trade, in 1859, to investigate the question of submarine telegraphy, and whose investigation continued from that time to April, 1861, do hereby state, as the result of our deliberations, that a well-insulated cable, properly protected, of suitable specific gravity, made with care, and tested under water throughout its progress with the best known apparatus, and paid into the ocean with the most improved machinery, possesses every prospect of not only being successfully laid in the first instance, but may reasonably be relied upon to continue for many years in an efficient state for the transmission of signals.

DOUGLAS GALTON,	CROMWELL F. VARLEY,
C. WHEATSTONE,	LATIMER CLARK,
WM. FAIRBAIRN,	EDWIN CLARK,
GEO. P. BIDDER,	GEO. SAWARD.

The five years between the disruption of the working of the cable and the above report by the committee of experts was time devoted to the reconstruction of the whole enterprise. Once the technicians had demonstrated the feasibility of a transatlantic connection for even as little as one month, they knew that they were on a sufficiently sound foundation to build a more enduring telegraph system. It was a hunt for the weaknesses of the past installations that was uppermost in their minds. One of the surprises in the series of experiments and tests was the determination that the voltage required from the battery to penetrate the 2,000-mile crossing and ground return was much less than presupposed. This radical reduction in voltage indicated a safer operating condition by reducing the chances of electrical penetration of the insulation.

In this period also, progress in the technology of submarine telegraphy was extended. By

*Josiah Latimer Clark (1822-1892) and his brother became head engineers of the Electric Telegraph Company in 1850. Four years later Latimer became chief engineer, a position he held until his retirement in 1870. He first observed Faraday's predicted capacity-effect in long conductors, on the lines of the London, Leeds and Liverpool system, which he demonstrated in 1853 before Faraday, Edwin Clark and Airy. He further proved that speed of transmission of electricity was independent of voltage and that a thimble-sized cell could span the Atlantic. He developed an earthenware insulator for telegraph lines and a cable insulation compound. He joined the Atlantic Telegraph Company in 1859 and later participated in establishing standard electrical units. He directed the laying of the submarine cables to Holland and Belgium and participated in those to India and the transatlantic cables of 1865 and 1866. He became president of the Society of Telegraph Engineers and Electricians (which later became the Institution of Electrical Engineers), and was elected a Fellow of the Royal Society in 1889. In his London home he collected books, pamphlets, letters and portraits relating to the growth of electrical and magnetic science, for nearly 50 years. This invaluable collection was purchased by the American industrialist Schuyler S. Wheeler and presented to the American Institute of Electrical Engineers in 1901. In 1861 Sir Charles Bright and Mr. Latimer Clark proposed the names *ohm, volt* and *farad* as electrical units based on the c.g.s. absolute system. On the initiative of Sir William Thomson the Committee of Electrical Standards was formed and the standards of electrical measurement were begun.



Five times larger than any vessel then afloat, the Great Eastern taxed the mechanical and industrial genius of England in its design and construction. Launched broadside at Millwall on the Thames, the 12,000-ton hull required three months to float. The great drums checked the slide of the cradles on steel rails.

1862 the Gutta Percha Company had fabricated 44 successful submarine cables of a total length of 9,000 miles. Glass, Elliot & Co. had made 30 successful submarine cables from 1854 to 1862. Even tho the crossing of the Red Sea had been a failure, another one across the Mediterranean extended 1,535 miles from Malta to Alexandria. Still another cable, 1,400 miles long, crossed the Persian Gulf, the final link in a telegraphic chain that connected England to India. Slowly the public confidence in the practicability of submarine telegraphy continued to grow. It was during these years that Mr. Field worked to revitalize his company.

The Civil War was raging in America and the lack of telegraphic communication with England was acutely felt in those critical days. Secretary of State Seward informed the British Government that America would participate in a joint effort to replace the ruptured cable. Thus encouraged, the directors approached Messrs. Glass, Elliot & Co. with the proposal that this firm should not only fabricate the conductor but assume the responsibility of laying the cable as well. The cable firm replied, in a letter dated October 20th, 1862, affirming its willingness to undertake this task and to accept, in compensation, 20% of the cost of the line in shares in the company. So confident was the cable firm in its ability to perform its part of the contract that they proposed an immediate subscription of £25,000 sterling in the stock of the telegraph company. They added their advice that the shore ends of the submarine cable should be reinforced by very heavy wires because they were convinced that the only accidents that occurred to any of the cables that had been laid had resulted from breakage by ships' anchors and never to lengths beyond reach of anchors.

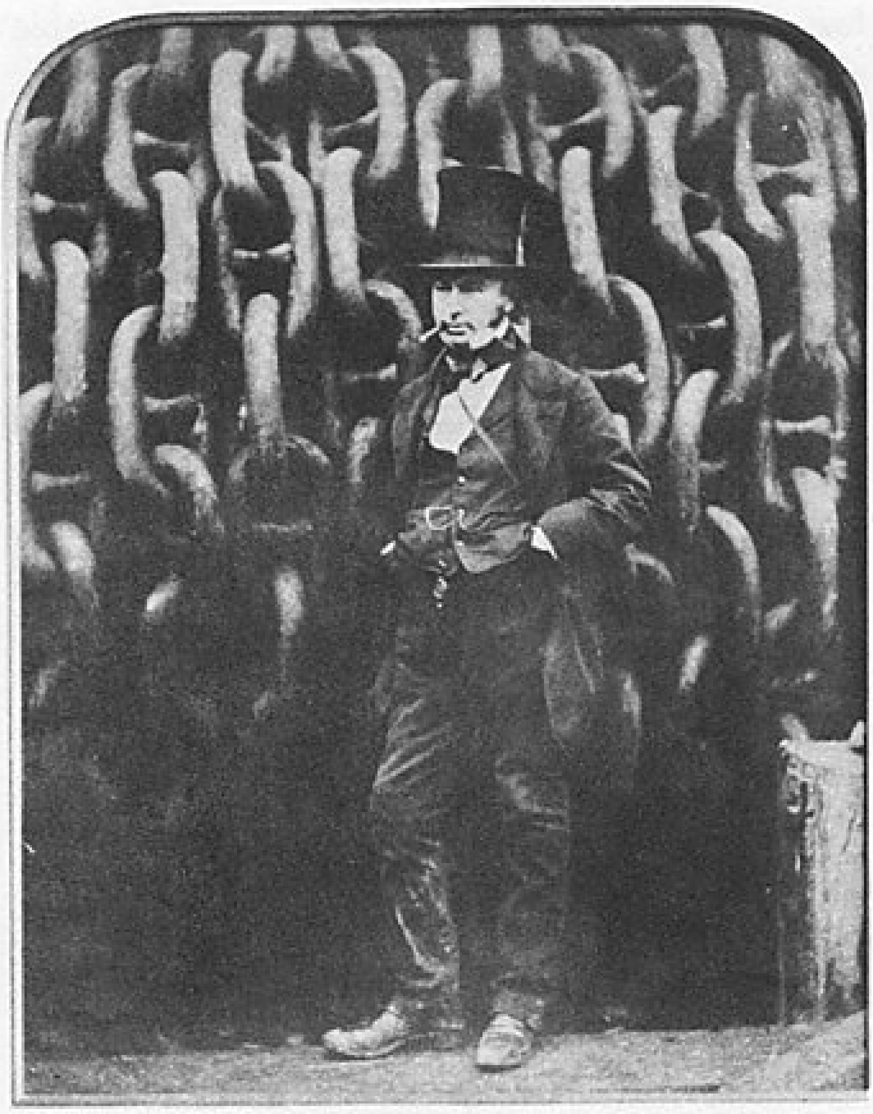
With such an expression of confidence, Mr. Field returned to America in order to raise the additional capital for the new cable. His first visit was with a group of merchants of Boston. They applauded the efforts of Mr. Field, passed a series of resounding resolutions and adjourned without actually having subscribed to a single share of stock. The element of speculation was too strong for their conservative views. New York responded a little better but only after a personal campaign of knocking on door after door. He managed to raise about £70,000, much of it given out of admiration for Mr. Field's indomitable spirit rather than any assurance that the submarine cable could be made to work. Thus Mr. Field saw the income from a new cable: "But estimating it as working sixteen hours a day only, and for 300 days, though it would probably have to work every day in the year, that would give, at the rate fixed, 2s. 6d. a word, a net income on a single cable of £413,000 per annum. The company, if the shareholders should divide all the profits, would pay 40 per cent; but it is recommended that they should receive only eighteen per cent on their investments, the balance to be used as a fund to lay down further cables, without increasing the capital".*

Mr. Field again turned to England where, out of necessity and experience, the British held a high regard for submarine telegraphy. As an island, it was more dependent on such communication as a link with the Continent, its colonies and dependencies. Having tasted the advantages of such quick communication with faraway places, Britain was ready to extend the use of the submarine telegraph.

THE CABLE OF 1865

A MONTH after the committee of experts had presented their recommendations, the Atlantic Telegraph Company advertised its proposals and invited bids for a suitable cable connecting Newfoundland and Ireland. The proposal was of a very general character so as to invite the broadest kind of response and so to include any new ideas which may not yet have been known to the company. Seventeen offers were received and these were then referred to a Consulting Committee composed of former members of the committee of experts which had already advised the company. The new committee consisted of Capt. Douglas Galton, Mr. William Fairbairn, Prof. Charles Wheatstone, William Whitworth, and Prof. William Thomson. This committee carefully examined each proposal, examined the samples of cable submitted with each offer and subjected these cables to a series of exhaustive tests. The committee unanimously concluded that the offer of Glass, Elliot & Co. had the greatest merit and recommended the acceptance of their proposal. However, the committee recommended a review of every element that was to constitute the finished cable with an idea of further improvement that might be made. The cable firm agreed to this procedure and cooperated by supplying whatever conductor, insulation or protective shields the committee recommended. Experiment followed experiment with these elements singly or

*Quoted in STEVENS, *Report*, etc., 1863, page 14.



Courtesy, Gernsheim Collection, London.

I. K. Brunel, F.R.S., was the personification of the industrial dynamism of Imperial England. Builder of tunnels, bridges, railways and gunboats, his greatest effort went into the creation of the leviathan Great Eastern.

in combination. Copper, iron, hemp, gutta-percha, each was studied and the optimum size, shape and composition determined.

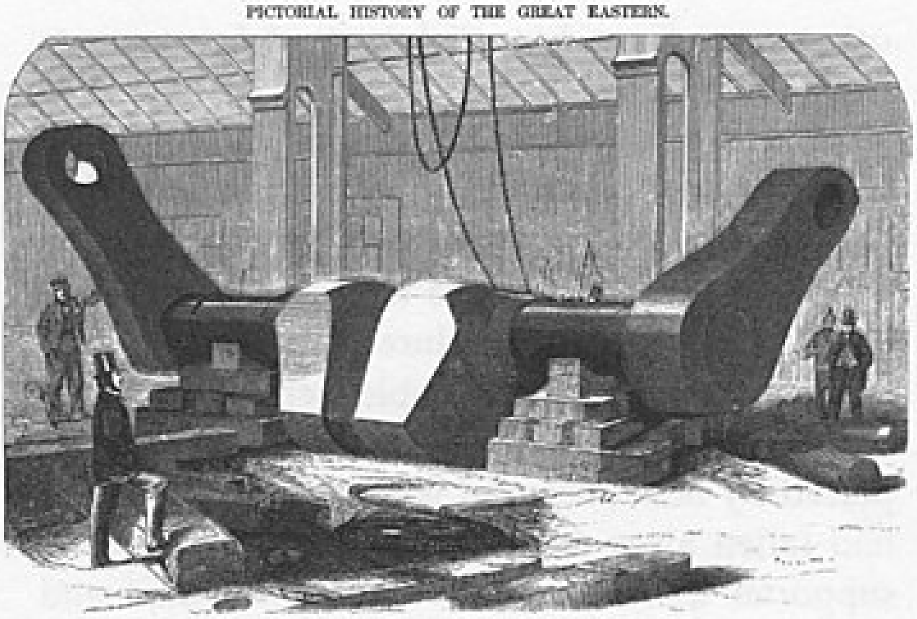
With a bloody war being fought in America, a sense of urgency beset Mr. Field and with the assurance that a satisfactory cable could be made, he saw no reason for further delay. He left England confident that the fabrication of the cable and its laying would be a matter of comparatively few months but he had hardly arrived in America when he was informed by letter that because of the shortage of capital the enterprise would have to be postponed for another year. Even Mr. Field's stout heart began to be discouraged. It had been ten years of constant struggle with many failures and few successes to show for the vast expenditure of effort and money. In January, 1864, Mr. Field sailed once more for England to try again.

The five years of failure since the last discouraging rupture of the cable were moving into a sixth year. Old enthusiasms were not being replaced by new ones and some of the old hands had fallen away from the effort. Such a strong supporter as Mr. John W. Brett had died and Captains Hudson and Berryman were also among the departed. Mr. Field felt the need of new enthusiasm, new blood, fresh capital and a fresh appreciation of a task still to be accomplished. It was then that he met Mr. Thomas Brassey. After their first meeting in London the inspiration that Mr. Field so urgently sought had been fully supplied, for he said, "I do not know whether he was an Englishman, a Scotchman, or an Irishman; but I've made up my mind that he combined all the good qualities of each of them."

Following his example other industrialists joined with new capital. Another strengthening of the enterprise occurred when the firm of Glass, Elliot & Co. was merged with the Gutta Percha Company to form a new concern, specializing in submarine cables. This was known as the Telegraph Construction & Maintenance Company* and had an authorized capital of a million pounds sterling. With this amalgamation the electrical talents of two experienced and competent electricians, Willoughby Smith and John Chatterton (the inventor of Chatterton's Compound for insulation), became available.

To get on with the work, the new company came forward with the offer to absorb all

*This company continues in business and, with its subsidiaries, is the source of more than 90% of the submarine cables in use in the world today.



The intermediate crankshaft for the paddle wheels of the Great Eastern weighed 40 tons, was the largest forging in the world and cost $20,000.

the remaining stock of the Telegraph Company. This represented the difference of a capitalization of £600,000 against which only £285,000 had been subscribed. Their offer to take the additional £315,000 was supplemented by an additional proposal – they were willing to subscribe £100,000 of bonds. They thus set the missing keystone in the arch of requirements necessary for the success of the enterprise.

The stalled machine now began to quiver and move once again. In the customary English manner, this reactivation called for a celebration, and old friends and new gathered in London for a banquet. Mr. Field reminded the guests that ten years had passed since the company had begun operations, and that by this time (March 15th, 1864) he had crossed the Atlantic 31 times in the service of the company.

Guided by the supervision of the Scientific Committee, specifications were prepared to produce a cable as "nearly perfect as human skill could make it," by the Telegraph Construction & Maintenance Company. Their specifications included "That the conductivity of the wire should be fixed at a high standard, certainly not less than eighty-five per cent; that the cable should be at least equal to the best ever made; that the core should be electrically perfect; that it should be tested under hydraulic pressure, and at the highest pressure attainable in the tanks at the company's works; that after this pressure, the core should be examined again, and before receiving its outer covering, be required to pass the full electrical test under water; that careful and frequent mechanical tests be made upon the iron wire and hemp as to their strength; that special care be given to the joints, where different lengths of cable were spliced together; and that, when completed, the whole be tested under water for some length of time, at a temperature of seventy-five degrees." We can smile today at such "tight" specifications. The high temperature of the water test was intended to assure a factor of safety, since the insulation improved at lower temperatures, and that of the test was 40 degrees higher than that of the Atlantic*.

The comparison between the cable to be laid in 1865 and that which spanned the Atlantic in 1858 shows a considerable difference. The conductor core was to be of a cross-sectional area of copper three times that of the old cable; both had seven strands, but the weight per mile had been increased from 107 lbs. to 300 lbs. The conductor was fashioned into the primary core by being set in Chatterton's Compound (gutta-percha softened by Stockholm tar) and thus made highly water-repellent. The core was covered with four layers of gutta-percha which were interlaid with four thin layers of Chatterton's Compound. The new insulation weighed 400 lbs. to the mile, compared to the old 261 lbs. consisting of three layers of gutta-percha, the entire insulation of the old cable. The conductor consisted of seven strands of No. 18 B.W.G. copper wires.

*The report of the Scientific Committee is reported in greater detail in SAWARD, *The Trans-Atlantic Submarine Telegraph*, 1878, pages 50, 51.

Equal attention was given to the outer protective coating that was to guard the inner insulation and conductor, for the disturbing series of breaks in the old cable was not readily forgotten. The outer protection was therefore designed to consist of ten stout wires of No. 13 gauge soft steel, each wire being wound with a layer of manila yarn saturated by a preservative and the covering of the ten wires wound spirally about the central core which had already been wrapped in a layer of hemp saturated by a preservative. The reason for protecting the outer sheath in hemp was to preserve the cable from rust in either air or water exposure, and to reduce its specific gravity when lowered into water. The resulting cable was 1.1 inches in diameter and weighed 3,575 lbs. per mile in air and only 1,400 lbs. in water. The shore ends of the cable had an additional sheathing of 12 strands, each strand consisting of three heavy galvanized iron wires of No. 2 B.W.G. of total weight of 40,000 lbs. per mile. Thirty miles of the shore-type cable connected the Irish coast with the deep-sea cable. Eight miles of the heaviest type stretched from the coast westward, then eight miles of an intermediate type, and finally fourteen miles of a still lighter type which was spliced to the ocean length. For the Newfoundland coast, the reverse arrangement was made, but was condensed into a span of only five miles.

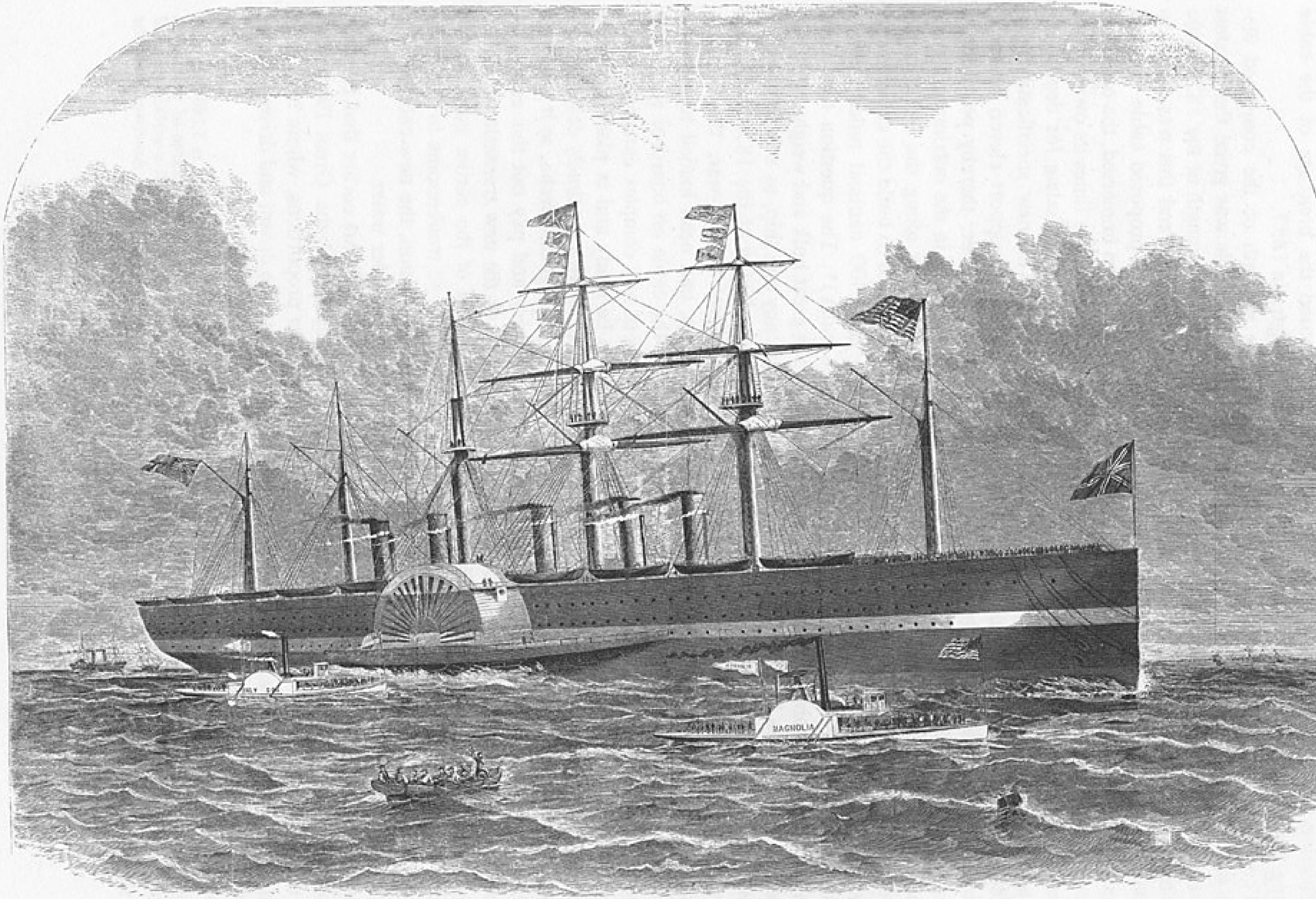
The combination of elements was intended to provide the cable with the maximum combination of strength and flexibility, with lightness of weight and freedom from corrosion in the salt water of the ocean. The increased bulk and increased weight were more noticeable on land altho the specific gravity of the cable was less than that of the old cable. Another advantage in the increased bulk was that when passed overboard, it sank more slowly and therefore could give a better angle of immersion, thereby exposing the cable to less strain as the stern of the ship rose and fell. Just such a maneuver had caused the breakage of the cable leaving the Niagara in 1857.

The tensile strength of the combined elements forming the cable was given the greatest attention. The tensile strength of the 1858 cable had been 6,500 pounds and this was raised to 15,500 pounds for the proposed cable. Looked at in another way, when immersed, the old cable could sustain less than five times its own weight per mile, which made it useless for depths exceeding five miles. The new specifications required that the cable support eleven times its weight per mile in water, thereby providing a factor of safety of four in the maximum sounded depth of 2½ miles along the cable route.

It was also decided to build the cable in one single length of 2,300 nautical miles (nearly 2,700 statute miles)*. The question then rose, how could such great bulk and weight be stored and handled in any one ship, as a practical consideration. In the laying of the 1858 cable, the world's two largest men-of-war, the Niagara and Agamemnon, had been loaded to capacity with only half the cable on board of each. But like the success of any complex enterprise, each element had to be ready and in place to assure its success. Thus, as with the timely development in the technology of gutta-percha, so it was with the means to carry and pay out this enormous bulk and weight of the new transatlantic cable, a weight twice that of the earlier cable which had already proven so troublesome to two companion ships. In addition, the new cable was to be kept constantly under water.

It was only a few years earlier that England saw the construction of the Great Eastern, a ship of enormous proportions, whose iron sides rose in response to the dream and drive of Isam-

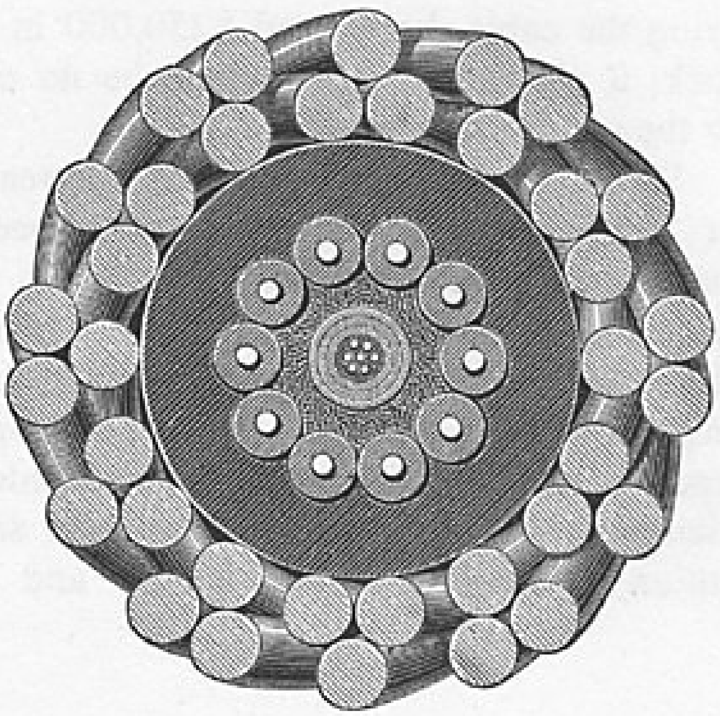
*The statute mile (1,000 Roman paces) is 5,280 feet long, but the nautical mile, 1/60 of one degree of the earth's equator, is 6,076+ feet long. A knot is a surface speed of a nautical mile per hour. When will America adopt the rational metric system!

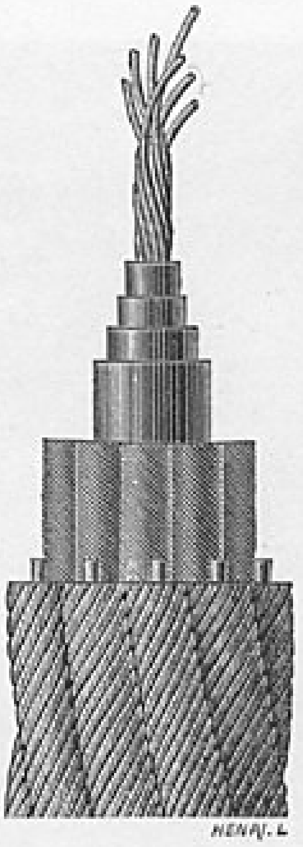


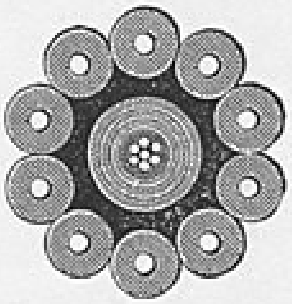
THE GREAT EASTERN - 1860.

Built to sail to Australia and return without refueling, and to carry 10,000 troops, this sea giant bankrupted three corporate owners before being used to lay the Atlantic Cable.

bard Kingdom Brunel* and the experience of the shipbuilder, Scott Russell. Her great silhouette had risen from the water intended for transatlantic passenger service but her very size prevented her use in commercial traffic. For ten years she had been waiting to be put to practical use; now her dimensions and seaworthiness indicated that she could be very suitable to carry and lay the Atlantic telegraph. A partnership was formed by a few of the men connected with the Atlantic Telegraph enterprise to buy her and one among them was chosen to contact the owners of the Great Eastern, headed by Mr. Daniel Gooch. He went to Liverpool and the next day telegraphed his associates that the big ship was theirs and was ready to carry the cable. Mr. Gooch had offered Mr. Field a sporting proposition – if the Great Eastern** succeeded in







The improved cable used in the 1865 and 1866 expeditions. The two illustrations at the left show the main ocean section; the heavy shore-end section is shown above. The seven-strand copper core was covered by four layers of gutta-percha, wrapped in tarred hemp and protected by ten steel wires, each wrapped in impregnated hemp.

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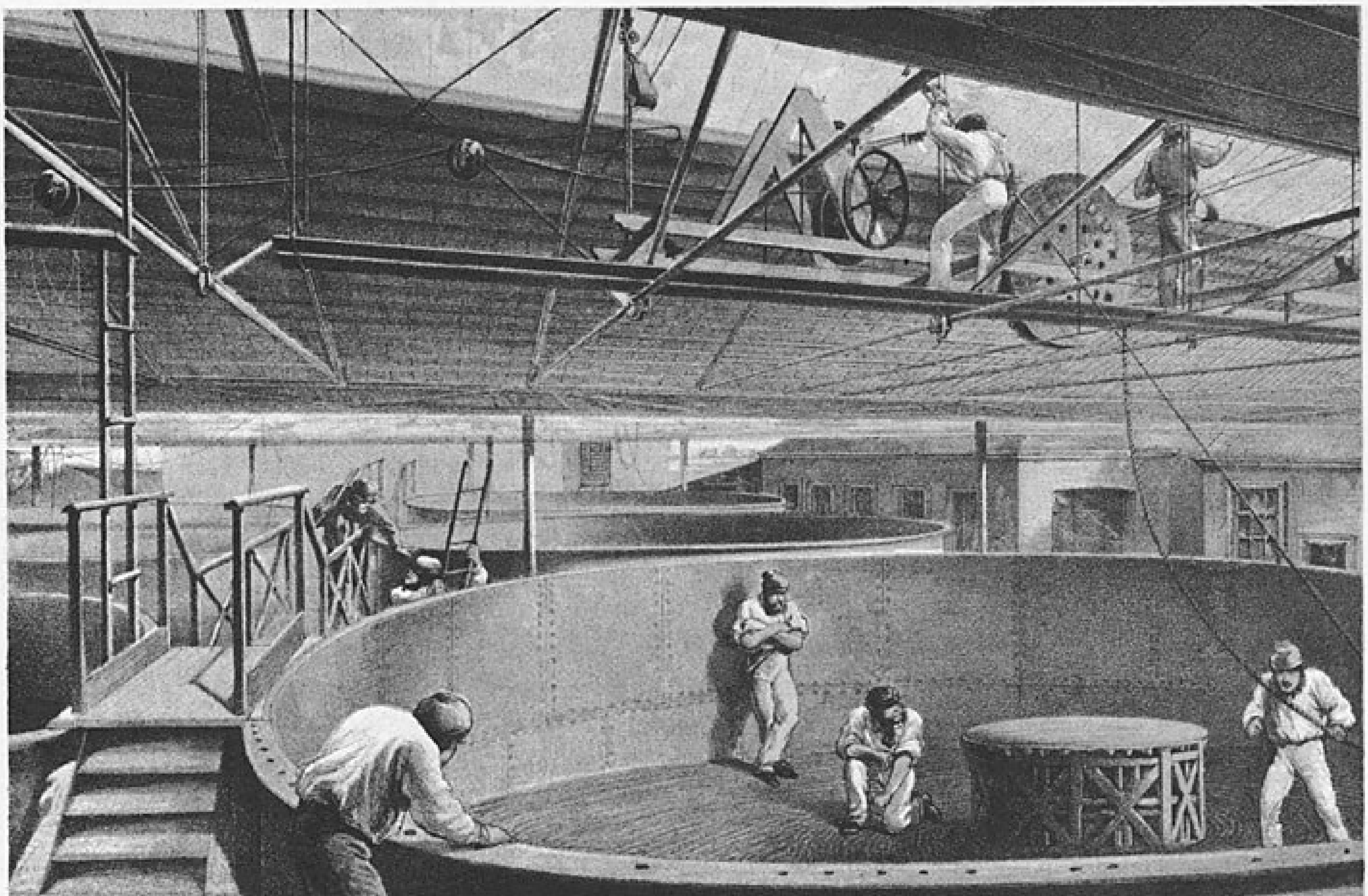
*The son of Sir Marc I. Brunel, French engineer and refugee to New York and London where he had built the Thames Tunnel, I. K. Brunel (1806-1859) had built bridges, tunnels and docks before he undertook the design and construction of the Great Eastern. He had already built the Great Britain, the first ocean screw steamship in 1845, and the Great Western, first steamship for regular transatlantic service, 1838, altho the U.S. Savannah had made the crossing partially using steam in 1819.

**The story of the Great Eastern forms a saga by itself (see Bibliography). When launched in 1858 she was five times the size of the largest ship then afloat, being 693 feet long and 120 feet wide, with a displacement of 22,500 tons. She could carry a burden of 18,000 tons in her double hull. In spite of her great size, with five funnels and six masts, she presented a majestic sight with her clean lines. Her 90-ton paddle wheels were 58 feet in diameter and her cast iron screw of 24 feet weighing 36 tons remains the largest ship propeller ever attempted. She was designed to carry 6,000 passengers or 10,000 troops. Altho she cost more than five million dollars before she made her first trip to New York, she remained a liability to the succession of builders and owners until sold at auction for only £25,000 to a syndicate headed by Daniel Gooch. Her masthead proudly carried an electric arc lamp which "bathed the ship in perpetual moonlight". Her 15,000 tons of coal, bunkered in enormous holds, were enough to carry her to Australia and return without refueling. Her power plant consisted of two sets of engines, one for the paddlewheels and one for the screw, and developed the fantastic might of 11,000 horsepower. It required three months for her to move down the ways for broadside launching. On her maiden voyage to New York in 1860, she carried only 35 paying passengers but had a crew of 418. By 1864, three owning companies had been bankrupted.

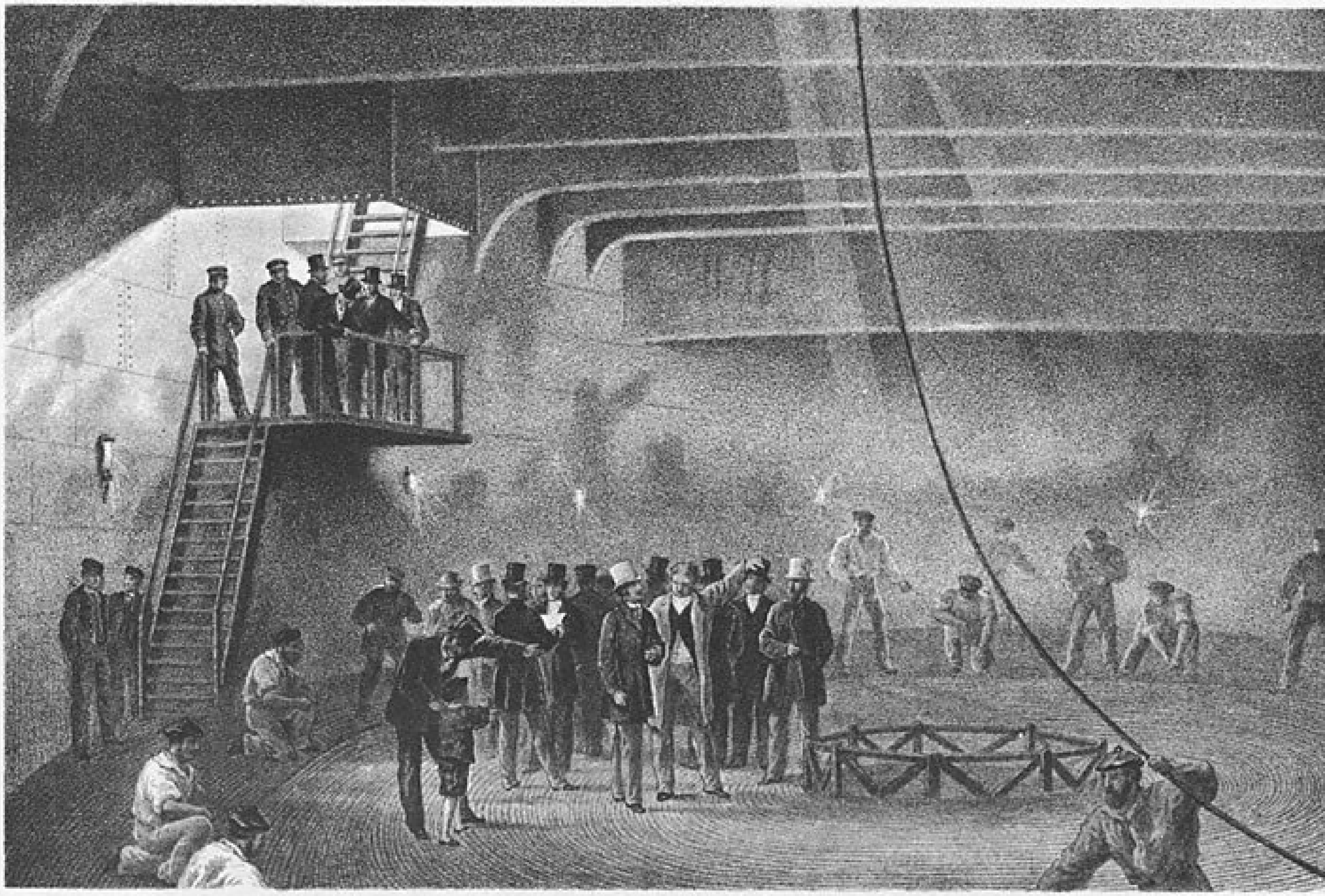
laying the cable, he wanted $250,000 in cable stock; if she failed, there would be no charge for the use of the ship.

Having found the ship, the group searched for a commanding officer of experience and character fitting for such a difficult job. They chose Capt. James Anderson, of long experience with the Cunard Company Atlantic run. In him was combined a quarter century of navigating experience, high intelligence and considerable scientific ability. His constant alertness and attention to detail generated loyalty and confidence in his crews and passengers. He seemed an ideal choice.

With such preparations behind them, the work on the cable was stepped up. As the completed cable left the manufacturing and testing equipment, it was taken to water-filled tanks standing in the yards of the company where the cable was immersed and left thruout the winter to be further tested before use in the following spring. This was a far better means of storing the cable than had been tried under similar conditions with the old cable when it was left lying



After the earlier experience with the abuse and deterioration of cable in air, iron tanks were built on land and aboard ship to keep the cable immersed.

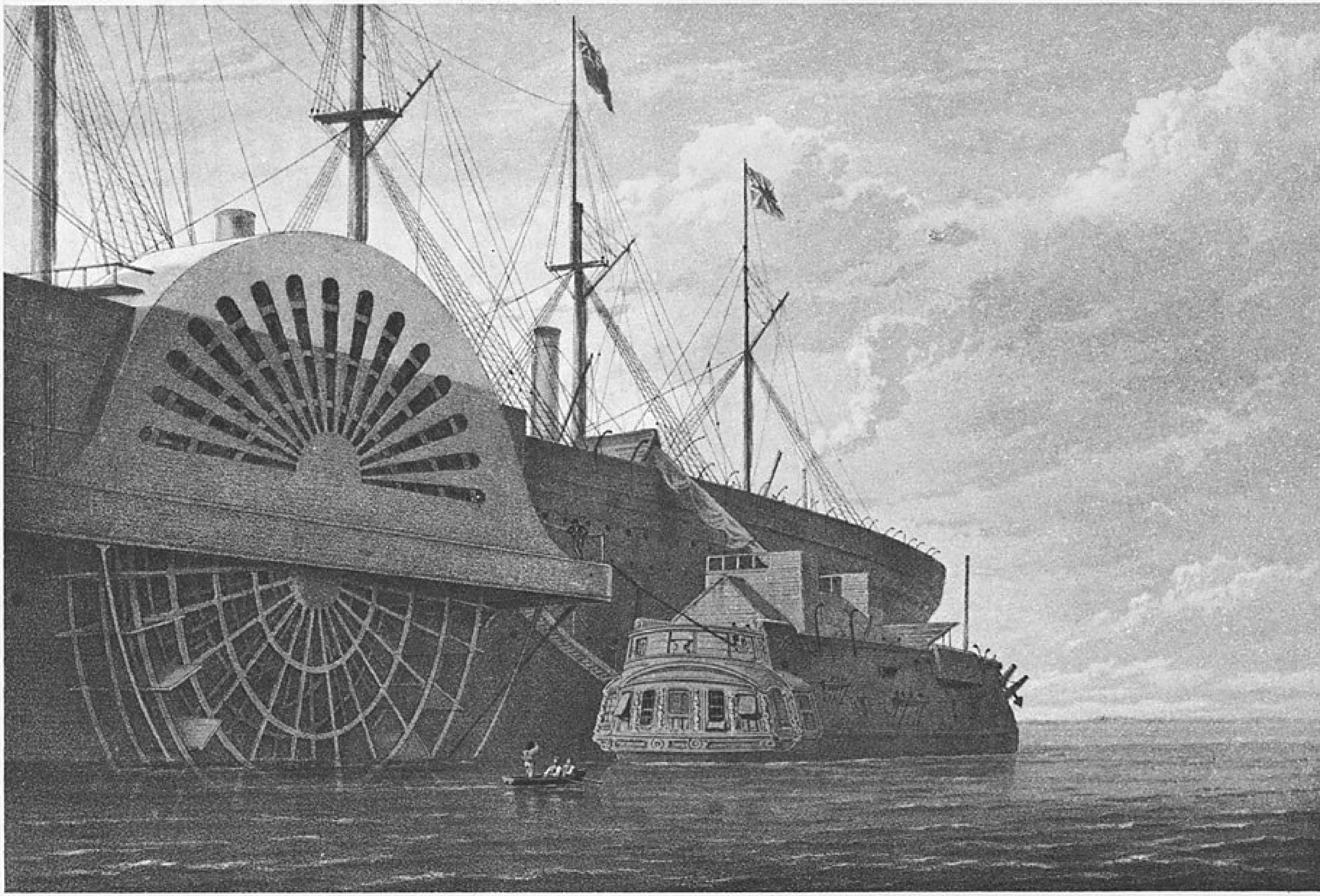


The transfer of the cable from the factory to the Great Eastern tanks was a long and exacting process. Here the Prince of Wales visits the coiling stage.

around in sun and weather for long periods.

In the meantime Mr. Field, as representative of the Chamber of Commerce in New York, attended the opening of the Suez Canal as its official delegate. There he watched the inauguration of a great engineering enterprise that was to serve mankind so well during the coming century. He returned to England on the first of May to find the remainder of the cable almost completed and a large portion of it already coiled in tanks aboard the great ship. It had required eight months to fabricate the cable at the rate of 14 miles a day. By the end of January, some 900 miles of cable had been completed.

The draft of the Great Eastern prevented her from getting close to the cable works at Greenwich so she had to tie up at Sheerness, 30 miles below Greenwich. Two large hulks had been supplied the company by the Admiralty to carry the cable from the wharf to the ship, each of the barges carrying about 250 tons of cable per run. With each load, a tug towed the barge to a position alongside the Great Eastern and



The draft of the Great Eastern kept her distant from the cable works; she had to be supplied by two retired hulls that brought the cable from Greenwich, 30 miles away.

the cable was transferred from the barge to the ship. This was slow work because only 20 miles of cable could be handled a day, and at this rate five months would be needed just for the transfer. It was therefore June before all of the cable had been brought aboard. In the meantime the Great Eastern had been fitted both to receive and to pay out her precious cargo.

Big as the ship was, still an additional load of some 5,000 tons was something to be concerned about. To pile such a great mass in one coil would certainly injure the bottom cable layers. Further, a rolling ship would cause the load to shift dangerously. Someone computed that if the cable were to be coiled into one cylinder it would form a pile 58 feet in diameter and 60 feet high, enough to fill one of London's largest theatres from the floor to the roof. To make the storage of such a weight practical, it was decided to distribute the mass in three tanks, one placed forward, one amidships and one in the aft part of the ship. These three tanks were made of water-tight wrought iron plates, the forward one holding 633 miles of cable, the other two carrying 800 miles each; they were filled with 2,000 tons of water to keep the cables immersed until sent out into the ocean.

Month followed month as the barges brought their load of cable from the works to the ship. Yet so enormous was the space within the vessel that she devoured the cable with hardly any signs of decreased space. Some who were permitted aboard could hardly find the coils of the cable. Those who came in small boats and were not permitted aboard circled the great ship and marvelled at the blending of two such mysteries – the Great Eastern and the Atlantic cable! Distinguished visitors and dignitaries did come aboard and these included the Prince of Wales, members of Parliament and leaders in the world of business and statecraft.

By the end of May, 1865, the work of fabricating the cable was completed and for the first time in eight months the winding and coiling machines were shut down. It required another six weeks to transport all of the cable to the ship, to tune up the driving and cable-handling complexes of machinery before the ship was ready to weigh anchor. To the 5,000 tons of cable there were added some 8,000 tons of coal. The provisions needed for a crew of 500 men were laid by for the several weeks that might be required for so uncertain a journey. The stores and provisions were not only boxed and crated, but live food, a cow and a dozen oxen, 20 pigs and 120 sheep made the top deck look like a country farmyard. In addition there were flocks of ducks, turkeys, geese and 500 chickens to supplement an almost equal store of beef, pork and 18,000 eggs. There were hundreds of barrels of flour, fruit and vegetables. When fully laden for her voyage, the combined weight of machinery, cable and provisions totalled 21,000 tons, enough for a whole fleet or a small army.

A project so newsworthy brought requests for representation from every newspaper of consequence in America, England and the Continent. The choice was a difficult one, in fact an impossible one; it was therefore decided to exclude every one of the journalists. To be consistent in the eyes of those who would be offended by such a policy, those in charge applied the same rule even to themselves so that none of the directors of the company was taken aboard, except those who were indispensable. Since the responsibility for the expedition was no longer with the Atlantic Telegraph Company but instead had been transferred by contract to the Telegraph Construction & Maintenance Company, the latter could be less concerned with political or public relations displeasures. The choice of ship, cable, staff and crew was made on the basis of essential contribution to the success of the enterprise. The strictly business character of the expedition soon became apparent to the many who had no business there.

The three companies which had a direct ownership interest in the ship and cable were represented by only two men – Mr. Field and Daniel Gooch, a promoter and member of Parliament who was also a director of the cable company and chairman of the syndicate that owned the Great Eastern.

Only strict discipline could make such a complex operation manageable, and Capt. Anderson was a disciplinarian. The eminent electricians, Prof. Thomson and Mr. Varley, representing the Atlantic Telegraph Company, were instructed not to interfere with the operations, but could only give advice, and that had to be in writing. Their duties were to test the cable as it was laid, and when completed, to transmit messages from Newfoundland to Ireland. Strict rules required every man to be at his place and to complete his specified duties. When no longer required for a specific task, he was required to go below decks so as to leave them clear for the operating personnel. The ship's officers and management were determined to minimize every risk.

Altho the company had rejected the applications of the many journalists who wanted to accompany the expedition, it was still aware that this historic event should be properly covered and recorded. It therefore engaged Dr. W. H. Russell*, correspondent of the London Times, to be the expedition historian. He was assisted by two artists, Mr. Henry O'Neill and Mr. Robert Dudley, as was customary in recording special occasions in those days. The public had to wait a little longer for the details of the expedition but eventually these were satisfactorily prepared by Dr. Russell and his artists.

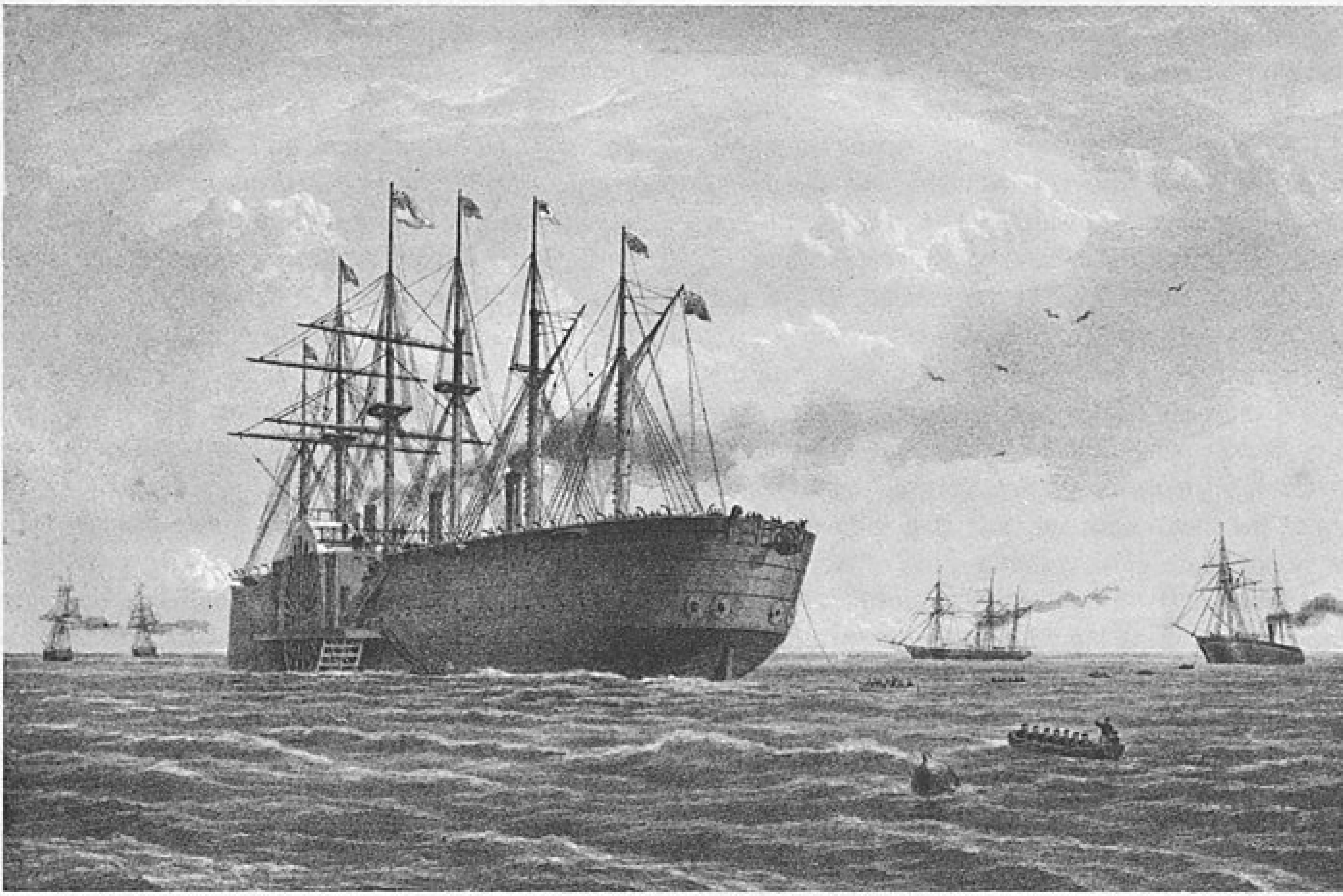
To assist Capt. Anderson, a veteran of the Expedition of 1858, Capt. Moriarty, who had been on the Agamemnon, was assigned by the Admiralty to the Great Eastern. The chief engineer in charge of the cable-laying was Mr. Samuel Canning and he was assisted by Mr. Henry Clifford; both had been on the Agamemnon during both trials of 1858. Since then they had also acquired additional experience in cable-laying across the Mediterranean.

The electrical department was placed in charge of Mr. de Sauty, who had also acquired considerable experience in submarine telegraphy between the Atlantic trials. Responsible to him were Prof. Thomson and Mr. Varley, whose duty it was to see that the high performance standards built into the cable in the production plant were maintained during the laying operations. As was reported later, "The result of their repeated tests was to demonstrate that the cable was many times more perfect than the contract required. With such marvellous delicacy did they test the current of electricity sent through it, that it was determined that of one thousand parts, over nine hundred and ninety-nine came out at the other end!" Of the 500 men aboard the Great Eastern when she sailed there was only one American – Mr. Cyrus Field.

On Saturday, July 15, 1865, the great chain holding the anchor of seven tons was drawn up by the strength of nearly 200 men. Every link in that chain weighed 70 lbs. A gun was fired and the huge paddlewheels began to turn. A rousing cheer rose from the throats of the men on the fleet of small boats surrounding the Great Eastern as she slowly began to move by following the lead of the little steamer, the Porcupine, that had previously guided the Niagara into Trinity Bay on that successful voyage in 1858.

The two ships passed the cliffs of Dover beyond which the Great Eastern moved alone until she was joined by the Caroline, carrying the heavier shore-end of the cable on board. The Great Eastern took her in tow and the two pass-

*See RUSSELL, W. H., *The Atlantic Telegraph*, London, (1866).



The Great Eastern out of Valentia begins releasing the cable, accompanied by the Terrible, the Sphinx, the Hawk and the Caroline.

ed on to the coast of Ireland into Valentia Bay. The place for landing the cable had, however, been changed from Valentia Harbor to a location five or six miles further to Foilhummerum Bay. Here the heavy cable was dragged from the deck of the Caroline across a pontoon of boats onto the beach and taken up the cliffs with the help and the shouted encouragement of the local people. Fastened on shore, the remainder of the cable was slowly uncoiled from the deck of the Caroline until the 30 miles of shore-end cable had been laid. Its water end was then fastened to a buoy in 75 fathoms of water. This was close to midnight and on the following morning the Great Eastern appeared with the ocean section of cable. The splice between this section and the shore section was immediately begun and satisfactorily finished by evening.

It was the early evening of Sunday, July 23rd, when the Great Eastern with her escort of two warships turned westward. This Sabbath was a day suitable in every respect, for not only was it considered an exceptionally good omen to the sailors, but if plans worked well, it would mean a full moon for the landing operations in Newfoundland, should that be required. It also meant that the prevailing westerly wind would steady the great bulk of the ship.

As the squadron picked up speed, the cable machinery was eagerly watched and found to be performing admirably. The sea could not have been smoother and a general feeling of satisfaction pervaded the personnel. Those not on duty slept easily.

Shortly past midnight the boom of a gun, the signal of disaster, aroused the crew. There was a rush on board deck to learn what was wrong. Attention focussed on the electrical section, and there the electrician on duty had seen the light of his delicate galvanometer slide off the end of the scale and vanish. It was not a complete break, for a weak signal could be transmitted to the shore station. This signal gave notice that repairs would be undertaken, for a partial leak was indicated. The ship was 73 miles from shore and 84 miles of cable had been paid out. The electrical tests showed that the fault must be at a point 10 to 12 miles from the stern of the ship. It seemed necessary to recover the cable and cut out the defective section; there was nothing else to do.

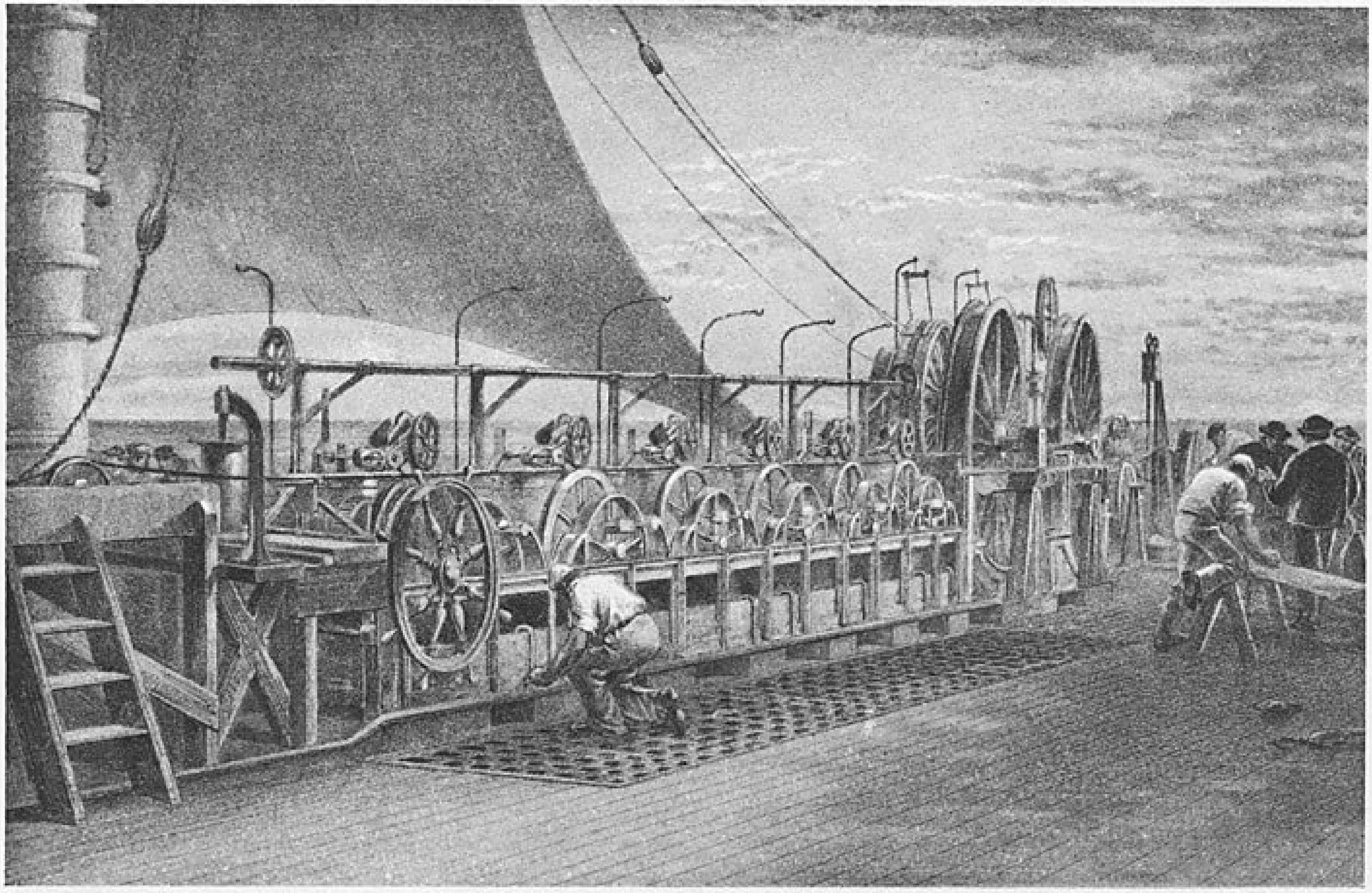
In preparing for the necessity of picking up the cable at sea, machinery for such in-gathering was placed on the bow of the ship while the paying-out equipment was at the stern. This meant first cutting the cable, then transferring the cut end to the forward position across the long deck of the ship, inserting the end into the take-up machine and having the cable stored during the process. It was no simple matter, for the ship's deck was an eighth of a mile long, broken up by structures and equipment, with huge wheel-houses at the sides over which the cable had to be dragged. But difficult as it was, there was no other course, and this was finally done. Once gripped by the pulling-in machine, the ship moved eastward bringing in the cable from the ocean bottom. The strain was not great because the depth of water was only four or five hundred fathoms. But the operation of the machinery was not efficient and after an hour only a mile of cable had been brought in.

It was not before Tuesday morning, and the gathering of over ten miles of cable, that the cause of the trouble was brought on the deck. It was found that a small piece of iron wire, about the size of a needle, had pierced the insulation and touched the core. Tho small, the penetration was deadly to the working of the cable.

The anger expressed by many did not help the wound; it was cut out and the good ends were spliced. A full day and a half had been lost as a result of this intrusion and it was not before Tuesday afternoon, July 25th, that the ship turned westward again.

Continual testing was carried on between the electricians on board ship and those at the Ireland station. Each hour was divided into four sections. The insulation was tested during the first half of the hour and the second half was devoted to the conductor characteristics by subdividing it into three ten-minute periods. Tests were made for conductor resistance and continuity. The tests clearly indicated an improvement in the insulation quality as the cable descended into the higher pressures of the ocean bottom and its lower temperatures. During the first half hour while the insulation was being tested, no attempts were made to communicate with the shore. The above procedure, which prevailed during the 1865 expedition, was improved later.

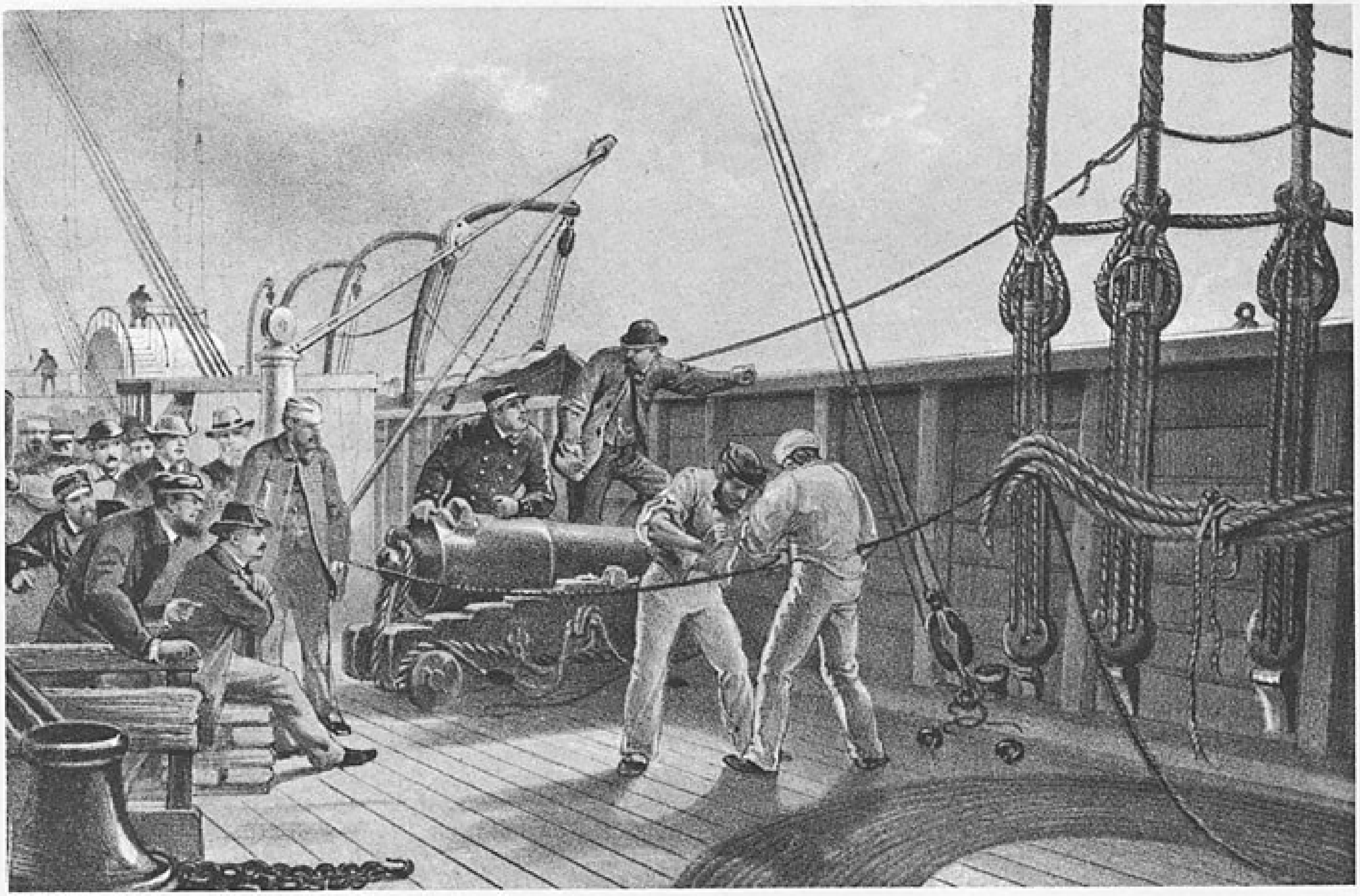
The pain that came with the discovery of a metal pin piercing the insulation, and the loss of time that it caused, was soon forgotten as the heavy ship steadily moved westward. However, after four days had rolled by, the trouble signal was again sounded and sudden anxiety again re-



Designed by Henry Clifford, the improved paying-out machinery used on the Great Eastern incorporated the automatic release mechanism and jockey wheels. The dynamometer is at the right.

turned because the cable instruments indicated "full ground", but this time no signal passed thru. It was again necessary to reverse the ship's course and retrieve the defective section of the cable from the ocean bottom. But this repetition of Monday's trouble was more difficult because it was not a depth of 500 fathoms now, but two miles of ocean from which the cable had to be drawn. At 10:00 that night the faulty section came aboard, was excised and spliced. Another full day was lost.

With the miles of cable that had been dragged from the ocean now lying about on deck, a careful inch-by-inch examination was begun on Monday, July 31st. Soon the fault became apparent. As in the previous fault, a pin was found driven thru the insulation connecting the shield with the conductor core. This immediately aroused suspicion. An immediate check disclosed that the same crew was on duty in the cable tank at the time that both faults occurred. Mr. Canning assembled the gang and showed them the two faulty sections. The men all agreed that this could not have been accidental but



On two occasions it seemed that sabotage had damaged the cable by someone having driven steel pins thru the insulation. It was later believed to be chips from the brittle armor. A splice is shown being made.

must have been the result of *intent*, thus throwing suspicion on themselves. Such perfidious action seemed impossible in a situation like this, but there must have been a traitor among them. Someone remembered a similar instance when a nail had been driven thru the insulation of a cable being laid across the North Sea. One of the workmen had confessed to having been hired by a rival company to destroy the cable. With stakes so high, it might be understandable that the commensurate rewards might drive one to sabotage, for, as a contemporary report had it, "Here was a temptation such as betrays bold, bad men into crime".*

Since no one admitted to having done this destructive work, it was decided to post guards to watch the work in the tank. Unpleasant as it was, the men cooperated gladly in the hope of finding the traitor among them. This was not the last such set-back, where sharp pieces of

* FIELD, H.M., *Story of the Atlantic Telegraph*, 1893. The "confession" concerned the laying of the England-Holland line in 1858 by Glass, Elliot & Co. in which a rival cable manufacturer was said to have introduced a "spy" workman instructed to commit sabotage by driving a nail into the cable. Subsequent analysis tends to throw doubt of malevolence on the whole affair.

wire shorted the insulation, but after several years experience it became generally accepted as an unfortunate but unavoidable hazard, resulting from the unevenly brittle iron armor.

No further incidents marred the next three days when 500 additional miles of ocean were covered. All the machinery ran smoothly and even at its maximum depth, the dynamometer indicated no greater strain than 1,400 pounds. The electrical tests were constant and very satisfactory. The mid-point of the ocean had now been reached and, like going over a hill, things should be easier and better for the remainder of the journey. At the telegraph station on shore it was noted by the electricians that the stability of the electrical system had become such that the very rolling of the Great Eastern was indicated on the sensitive galvanometer. This was explained by the fact that the moving cable, during such heaving and rolling, caused induced currents in the cable by the earth's magnetic field, which became visible on the instrument.

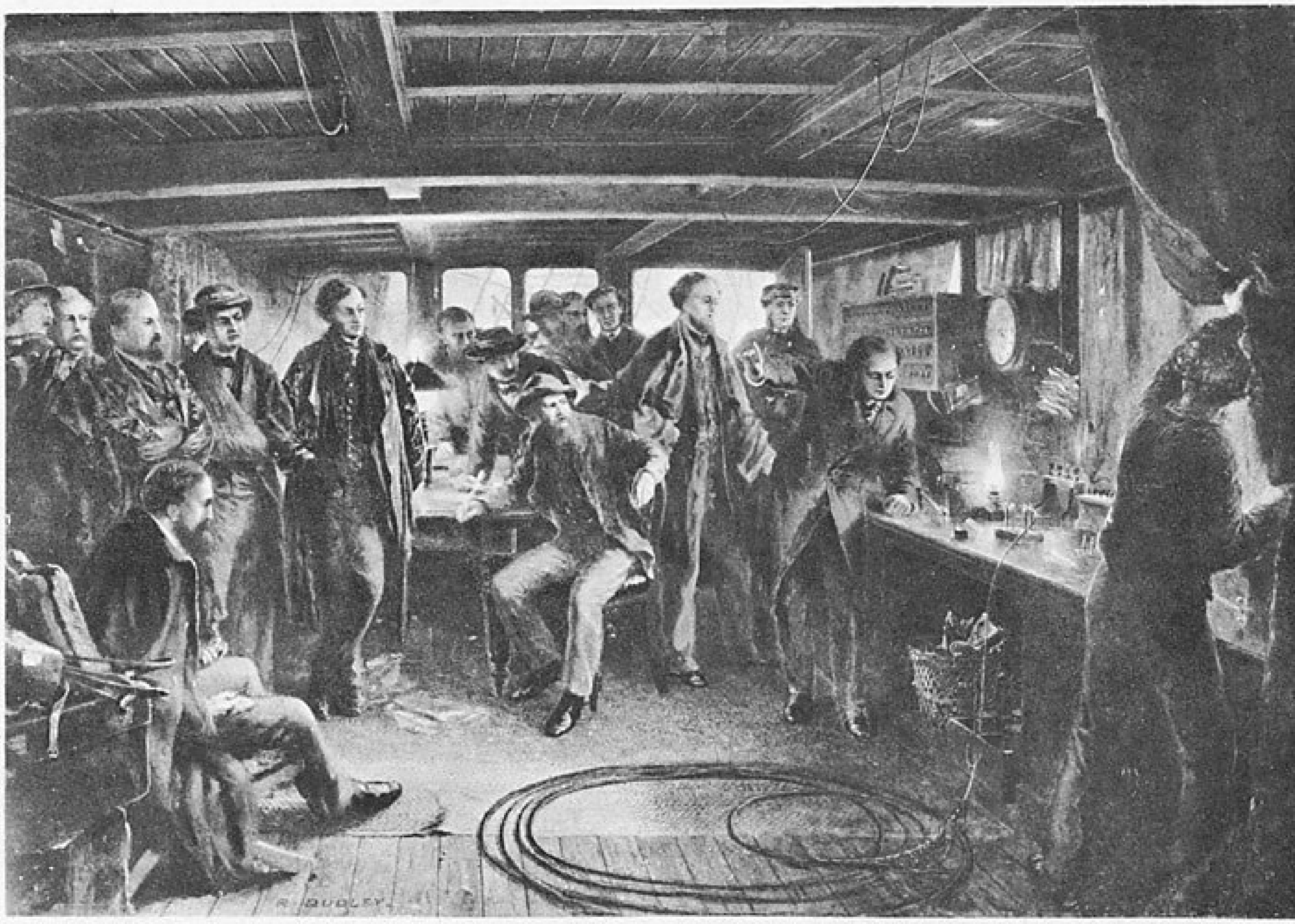
On Monday they passed over the section of the ocean where, in June of 1858, three unsuccessful attempts had been made to lay cables from mid-ocean. Even this unfortunate area was now well behind them; they had successfully put down 1,200 miles of conductor and had only 600 miles to lay before reaching the welcome shore of Newfoundland. This meant that only two additional days separated them from the safer and shallower banks where all their troubles would be behind them. But events do not always conform to even the best laid plans. It was Wednesday, August 2nd, and Mr. Field was on watch in the cable tank. The crew on duty was the same as had twice before brought trouble to the cable. Suddenly a grating sound was heard as if the machinery had enmeshed a piece of wire. A signal was flashed to be on the alert, which was quickly passed up the line, but not in time, for the faulty section had passed over the stern and into the sea. This was not enough to interrupt communication with Valentia but they were not notified before the order to cut the cable and to haul it aboard had been sounded.

Once again the cable was to be drawn aboard, but evidently not as much engineering talent had been spent on the hauling engine as that on the one to pay out the cable. The underpowered donkey engine pulled and puffed but the burden was too great. In the meantime, with the ship's motive power cut off, she began to drift over the cable and, such a large exposed side being less manageable, the cable became badly chafed. As the injured section was being hauled in over the bow, it suddenly broke and the sea end dropped into the water. This disaster came so unexpectedly and suddenly that there were few on deck to witness it. But the white faces of Mr. Canning and Mr. Field, who had neglected the luncheon table to stand by during the hauling operation, showed that they were in serious trouble. Mr. Canning staggered into the saloon announcing that it was all over! It was gone!

There having been no communication with the American shore, they were unaware of the cable break and the bad news that this meant. However, there had been constant rapport with Valentia, and the sudden, maintained silence indicated a serious mishap. Some among them thought it must be a temporary magnetic storm that caused the interruption, one such storm having been reported by astronomical observers at that very time at the Greenwich observatory. Others at Valentia were also deeply concerned but stood by for renewal of signals.

On board the Great Eastern a decision had to be made and Mr. Canning made it. He announced his intention of grappling for the cable, an experience never attempted at this great depth, here two and a half miles down. Such a contingency had not been provided for, but five miles of wire rope had been stored for a possible situation in which the cable was to be lashed and tied to buoys, should it have to be so marked during a storm. The grapnels were quickly brought on deck. These were five-armed anchors especially designed for grappling. Their flukes were sharply curved and were tapered like a biting tooth. The giant grapples were shackled to the iron ropes and lowered from the bow to fish for a million-dollar prize. It took two hours before their weights touched bottom.

The cable break had occurred shortly after noon so that, in a clear sun, observations taken by Captains Anderson and Moriarty had fairly well established the break point. The ship was now a dozen miles from this point which could be plotted within a half-mile certainty. After moving the ship a few miles eastward to miss the cable end, and a few miles south in order to cross perpendicularly to the cable, the ship slowly moved northward, beginning about five in the afternoon. All of that long night she crisscrossed the area where the cable lay on the ocean bed but it was not until morning that the long iron rope



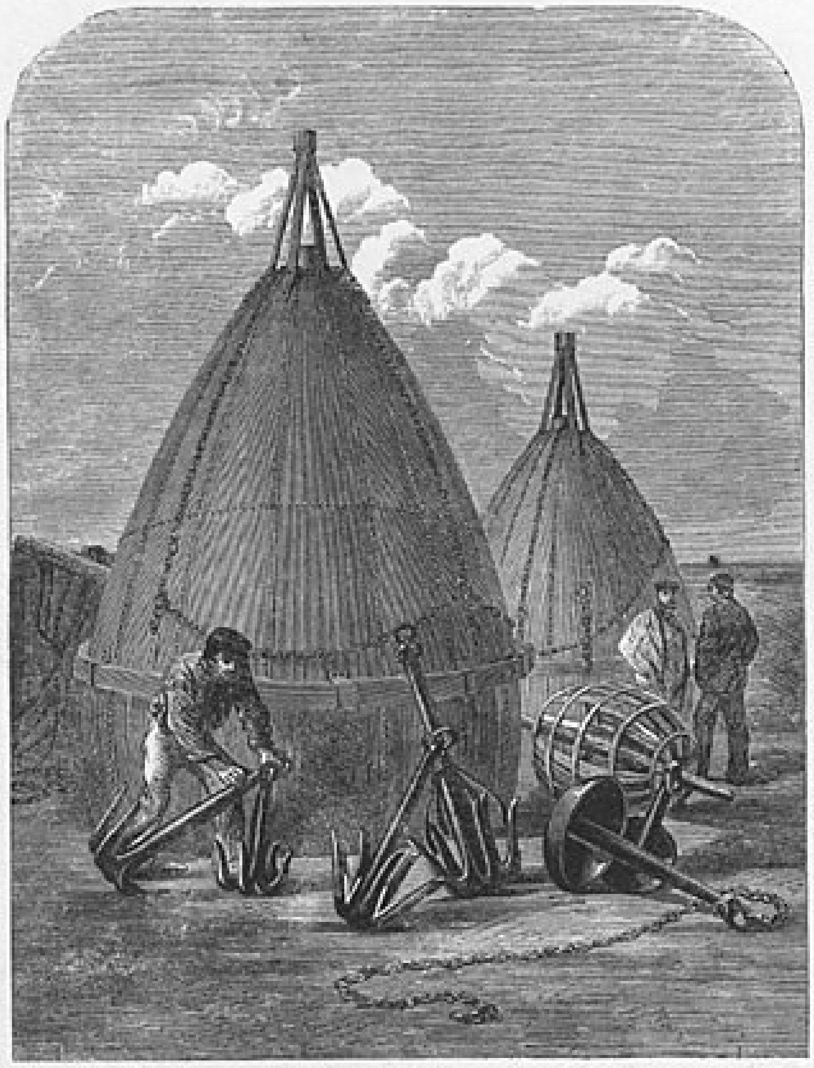
Courtesy, Metropolitan Museum of Art, Gift of Cyrus W. Field, 1892.

In the electrician's room of the Great Eastern, a reply to a signal sent to Valentia is being awaited on Thomson's marine galvanometer.

stiffened and quivered to indicate a load on the grapple, but with no indication as to what the grapple had caught. This uncertainty was dispelled by the dynamometer which showed an increasing strain as the take-in continued. Had it been some heavy loose object, the strain would have registered as decreasing as the grapple rose. The point of contact location also checked closely with that calculated by Capt. Anderson as that of the cable position.

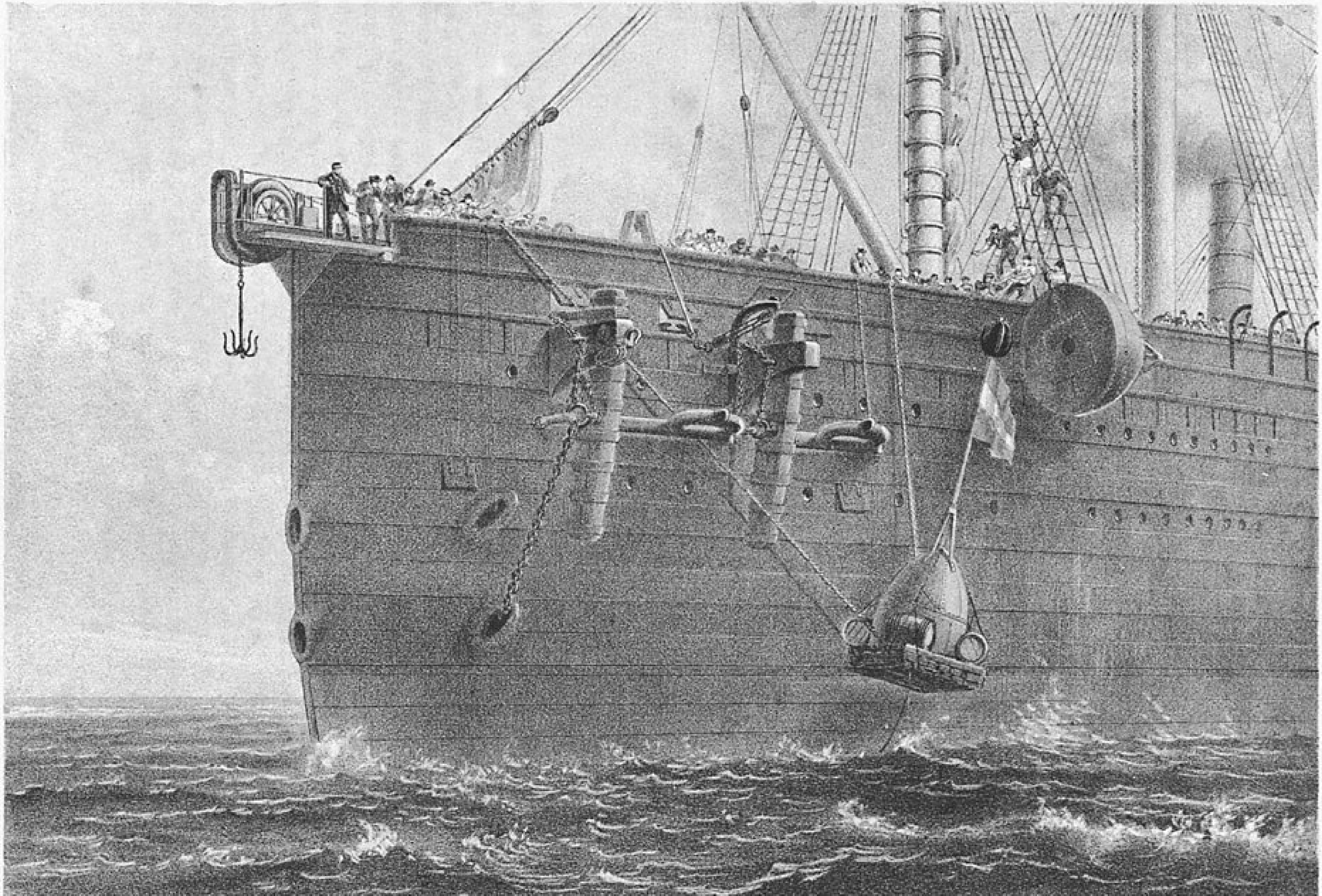
As the cable rose, so rose the hopes of those on board the ship. When the grapple had risen three quarters of a mile an iron swivel failed and the cable returned to the ocean bottom, carrying nearly two miles of iron rope with it.

Having successfully caught the cable once, it was decided to try again, but fogs delayed the preparation until the following Monday. Again the grapnel caught the cable and engine wheels turned all night in the bright moonlight and calm sea, while the cable rose a mile above the ocean bed. This was progress, but not enough, because another swivel failed and the telegraph cable again settled down to the ocean bottom. Evidently the lifting cable was not strong enough, and means were devised to strengthen it. To anticipate hoisting machinery failure, the capstan was reinforced by large iron plates, increasing its diameter by four feet in order to accommodate the lifting rope. Shackles and swivels were replaced by heavier bolts. The wire rope holding the grapnel was not one continuous line but an assembly of 25 lengths of a hundred fathoms each, joined to one another by shackles and swivels. Under the uncertain strains of a rising and falling ship, it was no wonder that the weakest connection would open. When the broken grapnel rope sank, the spot was marked with a big red buoy that carried a black ball and a red flag. Three miles of the cable itself connected the buoy with a mushroom anchor.



Grapples, anchors and buoys helped in marking the location of lost cable ends and dragging the ocean bottom for lost sections.

Anticipating a return to the position where the cable lay, two such marker buoys had been lowered overboard, spaced about ten miles apart. On Tuesday morning, August 8th, all was ready for the third attempt at grappling for the cable. On this passage no contact was made and when the grapple was raised for inspection it was found that one of the flukes had caught in the chain and therefore had scraped over the cable. This trouble was cleared and the gear was once again readied for the fourth and final attempt. By four o'clock on Friday, August 11th, the cable was caught and the dragging-in machinery began to operate. At 800 fathoms of lift the rope again broke with a loss of two miles of iron lifting cable. This loss was final and



Buoy No. 3 being launched from the Great Eastern to mark the spot where the cable had been grappled.

critical. Insufficient gear remained for another trial. There was nothing to do but to give up and return to home port.

The effort of nine days and nights to recapture the cable and continue their work had failed. Three times the cable had been caught and raised and each time the lifting rope was too weak for its burden, yet the telegraph cable itself showed that its mechanical strength was enough to permit its being raised from the ocean bottom.

Once again a cable-laying ship turned eastward with her mission not accomplished. Yet, with each failure, the difficulties of the task became clearer and the steps to assure success became more apparent. The goal, tho still not attained, showed itself to be yet attainable.

THE EXPEDITION OF 1866

ANOTHER battle had been lost, but in the eyes of the men on the bridge, the war was not only unfinished, it was certain to be won. The weeks spent at sea by the Great Eastern had clearly demonstrated the dependable elements of the expedition; they also showed the number of weaknesses that were still to be corrected. After discussing these points, those in charge of the expedition summarized their findings in a communication signed by those who had officially taken part in the expedition aboard the Great Eastern. Quoting the report:

1. It was proved by the expedition of 1858, that a Submarine Telegraph Cable could be laid between Ireland and Newfoundland, and messages transmitted through the same.

By the expedition of 1865 it has been fully demonstrated:

2. That the insulation of a cable improves very much after its submersion in the cold deep water of the Atlantic, and that its conducting power is considerably increased thereby.

3. That the steamship Great Eastern, from her size and constant steadiness, and from the control over her afforded by the joint use of paddles and screw, renders it safe to lay an Atlantic Cable in any weather.

4. That in a depth of over two miles four attempts were made to grapple the cable. In three of them the cable was caught by the grapnel, and in the other the grapnel was fouled by the chain attached to it.

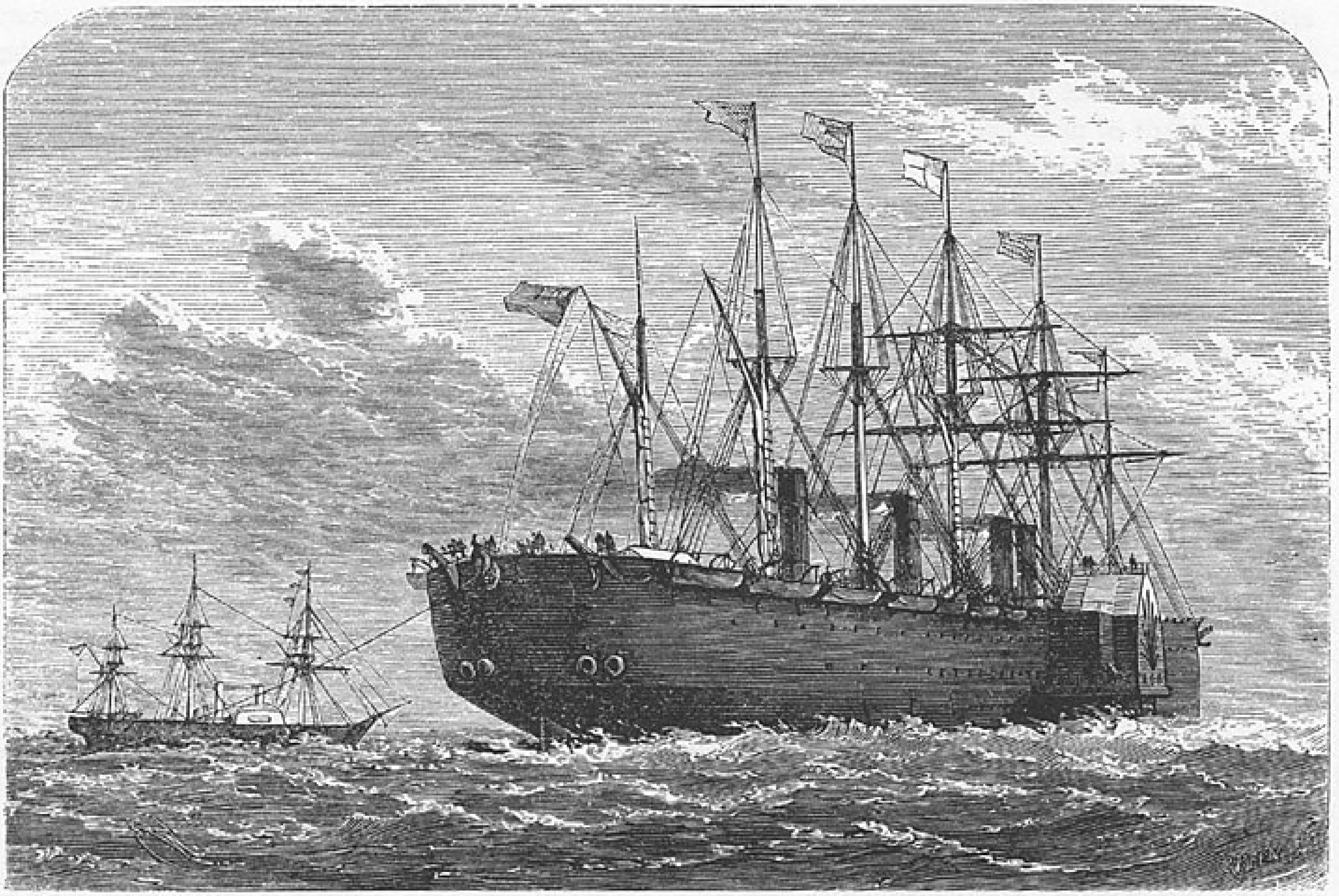
5. That the paying-out machinery used on board the Great Eastern worked perfectly, and can be confidently relied on for laying cables across the Atlantic.

6. That with the improved telegraphic instruments for long submarine lines, a speed of more than eight words per minute can be obtained through such a cable as the present Atlantic between Ireland and Newfoundland, as the amount of slack actually paid out did not exceed fourteen per cent, which would have made the total cable laid between Valentia and Heart's Content nineteen hundred miles.

7. That the present Atlantic Cable, though capable of bearing a strain of seven tons, did not experience more than fourteen hundredweight in being paid out into the deepest water of the Atlantic between Ireland and Newfoundland.

8. That there is no difficulty in mooring buoys in the deep water of the Atlantic between Ireland and Newfoundland, and that two buoys even when moored by a piece of the Atlantic Cable itself, which had been previously lifted from the bottom, have ridden out a gale.

9. That more than four nautical miles of the Atlantic Cable have been recovered from a depth of over two miles, and that the insulation of the gutta-percha-covered wire was in no way whatever impaired by the depth of water or the strains to which it had been subjected by lifting and passing through the hauling-in apparatus.



The more buoyant cable used in the 1865 and 1866 expeditions made a sharper angle with the water and reduced the cable strain as the great ship rose.

10. That the cable of 1865, owing to the improvements introduced into the manufacture of the gutta-percha core, was more than one hundred times better insulated than cables made in 1858, then considered perfect and still working.

11. That the electrical testing can be conducted with such unerring accuracy as to enable the electricians to discover the existence of a fault immediately after its production or development, and very quickly to ascertain its position in the cable.

12. That with a steam-engine attached to the paying-out machinery, should a fault be discovered on board whilst laying the cable, it is possible that it might be recovered before it had reached the bottom of the Atlantic, and repaired at once.

S. Canning, Engineer-in-Chief, Telegraph Construction and Maintenance Company.

James Anderson, Commander of the Great Eastern.

Henry A. Moriarty, Staff Commander, R. N.

Daniel Gooch, M.P., Chairman of "Great Ship Co."

Henry Clifford, Engineer.

WILLIAM THOMSON, LL.D., F.R.S., Prof. of Natural Philosophy in the University of Glasgow.

CROMWELL F. VARLEY, Consulting Electrician, Electric and International Telegraph Co.

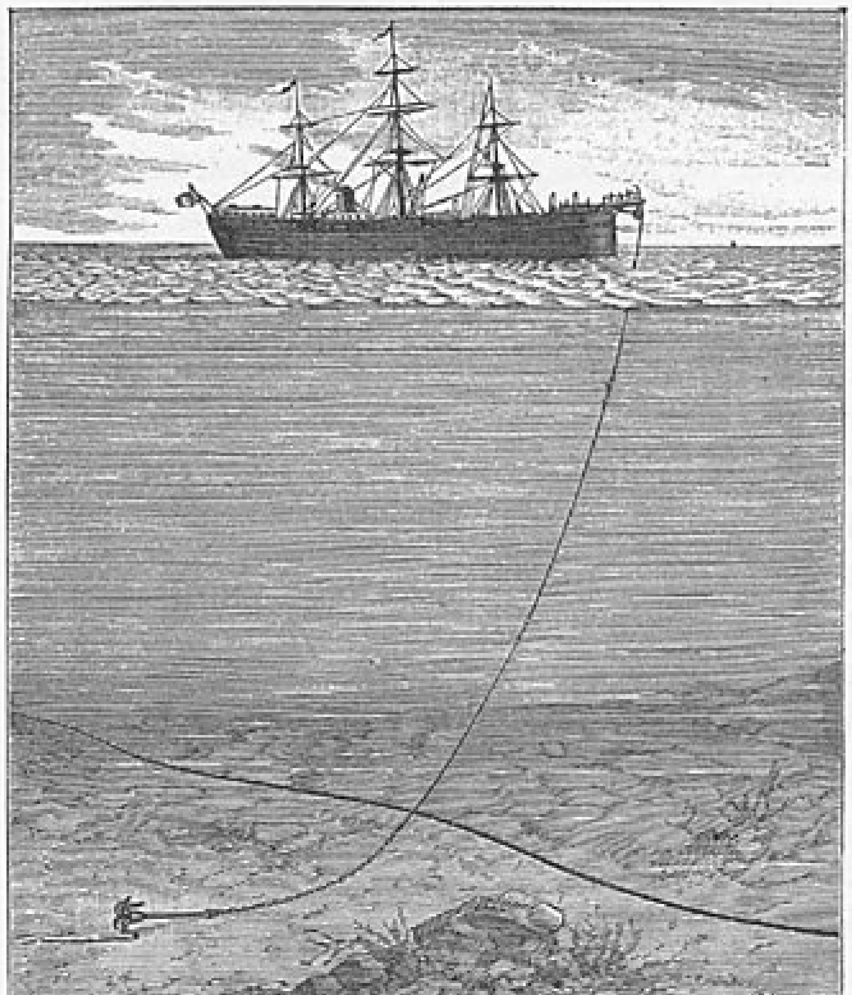
WILLOUGHBY SMITH.

JULES DESPECHER.

This report, written after an apparent failure, certainly reflected a buoyancy and confidence quite opposite to that of failure. This spirit was not limited to the technicians of the enterprise but was rather general in the entire organization. At the first meeting of the directors following the return of the Great Eastern, it was agreed that not only was the broken cable to be lifted and repaired and thereafter extended to Newfoundland, but,that in addition, another line was to parallel the one to be repaired and commissioned. When this was proposed to the contractors who had assumed responsibility for both the manufacture and laying of the cable, they expressed their own confidence in the success of the next try by improving the terms under which they proposed to operate. Their new proposal was to fabricate and lay a new telegraph cable, estimated at an actual cost of £500,000 sterling, and in addition they were prepared to demand no payment unless the cable operated successfully.

In the event that they performed their part of the contract satisfactorily, meaning that the cable would be properly laid and operated in accordance with expectations, they were then to receive 20% of the cost, or £100,000, to be paid in shares in the company. They also proposed to make it part of their responsibility to raise the end of the cable now lying broken in the western Atlantic, to splice and to complete this second circuit to Newfoundland; then there would be two operating cables in commission. The contractors assumed all the risks, and stipulated further that, in the absence of adequate capital to finance the next undertaking, they would provide whatever funds were still required.

In preparing a budget of costs of the next phase of the enterprise it was found to require £600,000 of new capital. This called for the authorization of 120,000 shares at £5 each which were to be preferred shares entitled to a dividend of 12% before the 8% dividend which was to be paid on the former preferred shares, and the 4% on the older common shares. This was thought to be stock that would influence the public to participate in an enterprise of such general interest. With the financing phase



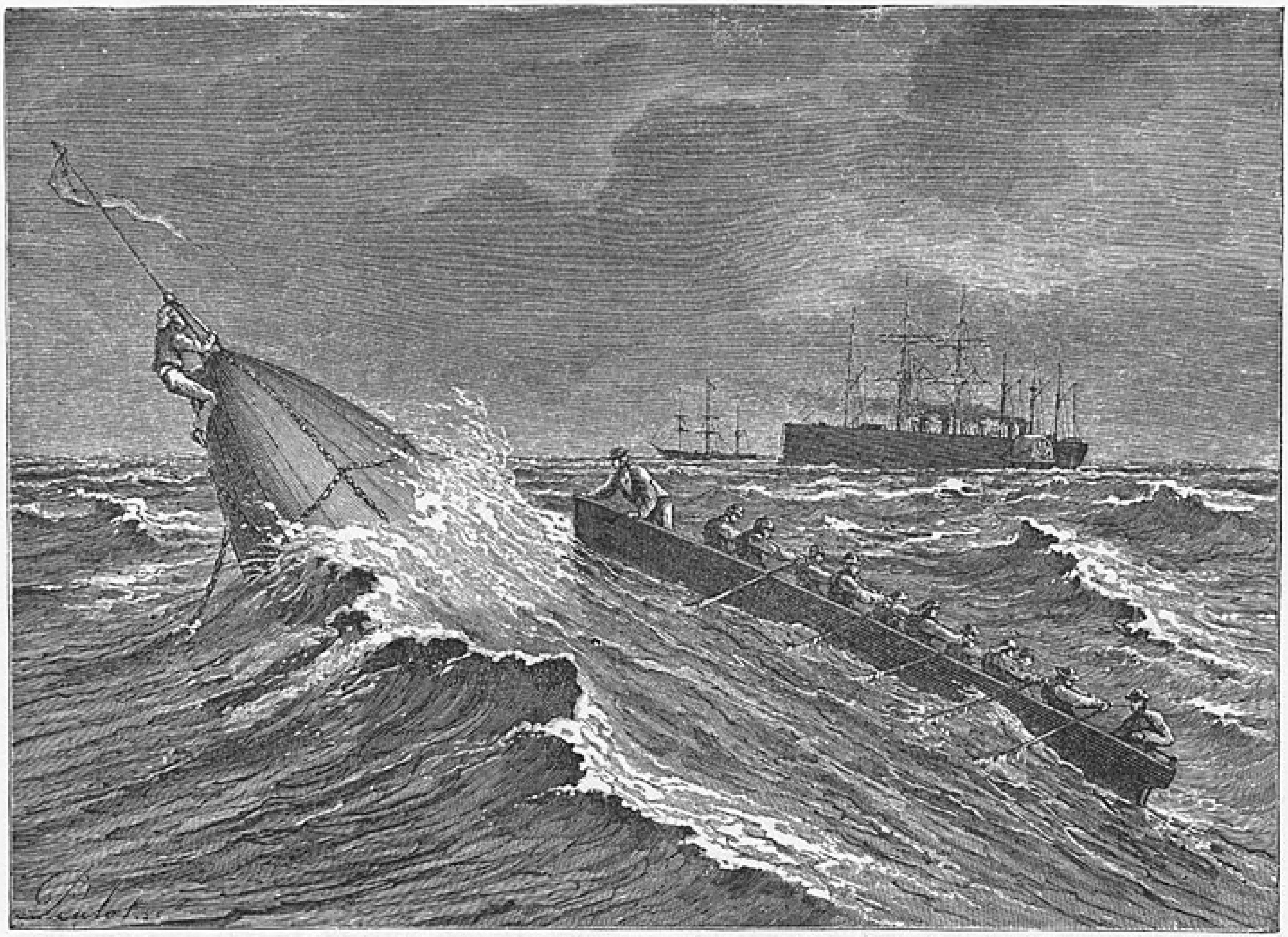
With the loss of the 1865 cable the skill of grappling for a thread 2½ miles beneath the ocean called for excellent navigation and equipment. The swivelled rope lengths were found inadequate.

of the new project agreed upon, the directors also accepted the proposal of the cable manufacturers, and the green light was given to those who were to execute the new plans.

Mr. Field returned to America in September, continued the promotion of his project, and returned to London in the last week of 1865. There he was met by the upsetting decision of the attorney general of England that the company had had no legal right to issue the 12% preferred stock, a right vested only with Parliament. This had reversed the earlier decisions of attorneys and solicitors who had approved the stock issue. The work on the cable was immediately stopped and the money was refunded to those who had subscribed. Parliament was in holiday recess, and a private act was much more difficult to introduce than one sponsored by the Government. Mr. Field once more began removing the roadblocks that held up the progress of his enterprise. He called on Mr. Daniel Gooch, his staunch supporter and participant in the 1865 expedition, in addition to being a member of Parliament, civil engineer and capitalist. Tho originally skeptical about the success of the cable, Mr. Gooch was highly impressed by what he saw on the Great Eastern during the 1865 expedition. He therefore proposed that the way to circumvent the present difficulty was to organize a new company which would be free to issue its own shares, raise its own capital and assume the work of laying the cable. Whereas Mr. Gooch had owned no stock in the existing company, he offered to subscribe £20,000 in the new company. Mr. Field seconded this with a subscription of £10,000. Mr. Field next visited Mr. Thomas Brassey who, altho he had just learned of the failure of the latest telegraph effort, said he was prepared to subscribe to one tenth of the shares of the new company.

Several meetings were called by the directors of the Atlantic Telegraph Company and the Telegraph Construction & Maintenance Company which resulted in the formation of a new organization — the Anglo-American Telegraph Company, with a capital of £600,000. The new company then contracted with the Atlantic Telegraph Company for the manufacture and laying of a cable in the summer of 1866. For this effort it was to be paid the equivalent of a preferred dividend of 25%, to come from the revenues of telegraph operations amounting to £125,000 per year. The old New York, Newfoundland, and London Telegraph Company contracted to contribute an annual sum of £25,000 per year from its revenue, on condition that the cable should be in operation in 1866. Mr. Field had agreed to this condition and had dispatched a memorandum to the directors in New York. As soon as this had been confirmed, the fiscal arrangements were to have been completed and invitations to subscribe were opened. The Telegraph Construction & Maintenance Company immediately subscribed to £100,000 of stock. Ten individuals then subscribed £10,000 each, followed by several smaller contributors. In a fortnight the public subscription was opened by J. S. Morgan & Co., and the whole capital of £600,000 had been underwritten. It was now March and no time was to be lost in proceeding with the work.

If the schedule of work were to assure the laying of the cable in the summer, then there were 1,660 nautical miles of cable to be fabricated in the four months ahead. The general cable design was retained but it was decided to galvanize the iron wires which would protect them from the salt water and extend their life. This also would replace the troublesome brittle protective covering of the previous cable. Instead of the black coating of the hemp saturant, the new cable had the bright outer appearance of the freshly galvanized zinc. This



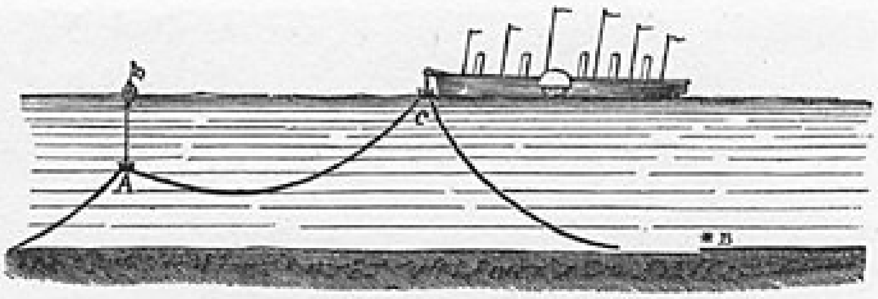
The Great Eastern and convoy stand by as a boat crew attempts to recover a marker buoy that indicated the end of a lost cable. Some buoys had black balls and lamps as well as flags.

also reduced the possibility of small chips and wires adhering to the otherwise tarry surface. The resulting cable was lighter in weight by 400 pounds per mile and yet, because of the greater number of wires and galvanizing, its tensile strength was increased by a thousand pounds.

This preparation period also gave the construction people an opportunity to improve the grappling and lifting machinery for hauling in the cable. The machinery improvements simplified the tedious process of changing from the paying-out equipment at the stern to the hauling-in gear at the bow. This hauling gear was strengthened with spur-wheels and pinion-gearing. Its two drums were worked by a pair of 70 horsepower engines, considered sufficiently powerful for any eventuality.

An important electrical improvement developed by Mr. Willoughby Smith made possible the continuous testing of the cable without the constant interruptions of the previous year. In the older system half of each hour was occupied with a minor series of tests during which time the insulation tests were suspended. It was during this half-hour interval that a fault might develop and move out from the ship for many miles before subsequent tests would discover and indicate it. The new system of continual testing detected an insulation fault before it reached the emitting machinery.

The improved testing procedure was applied daily to the broken line that stretched westward from Valentia for a length of 1,216 miles and was found to be in excellent condition. Similarly, the 1,070 miles of cable still on board the Great Eastern continued in its equally good condition.



A, Point where cable was buoyed to *east* by Great Eastern.
B, Point where cable was broken by *Medway*.
C, Bight of cable brought to surface.

The cable lost in 1865 was recovered the following year by raising the end section in several places, buoying a length near the surface and finally lifting one bight above the surface.

FINAL SUCCESS

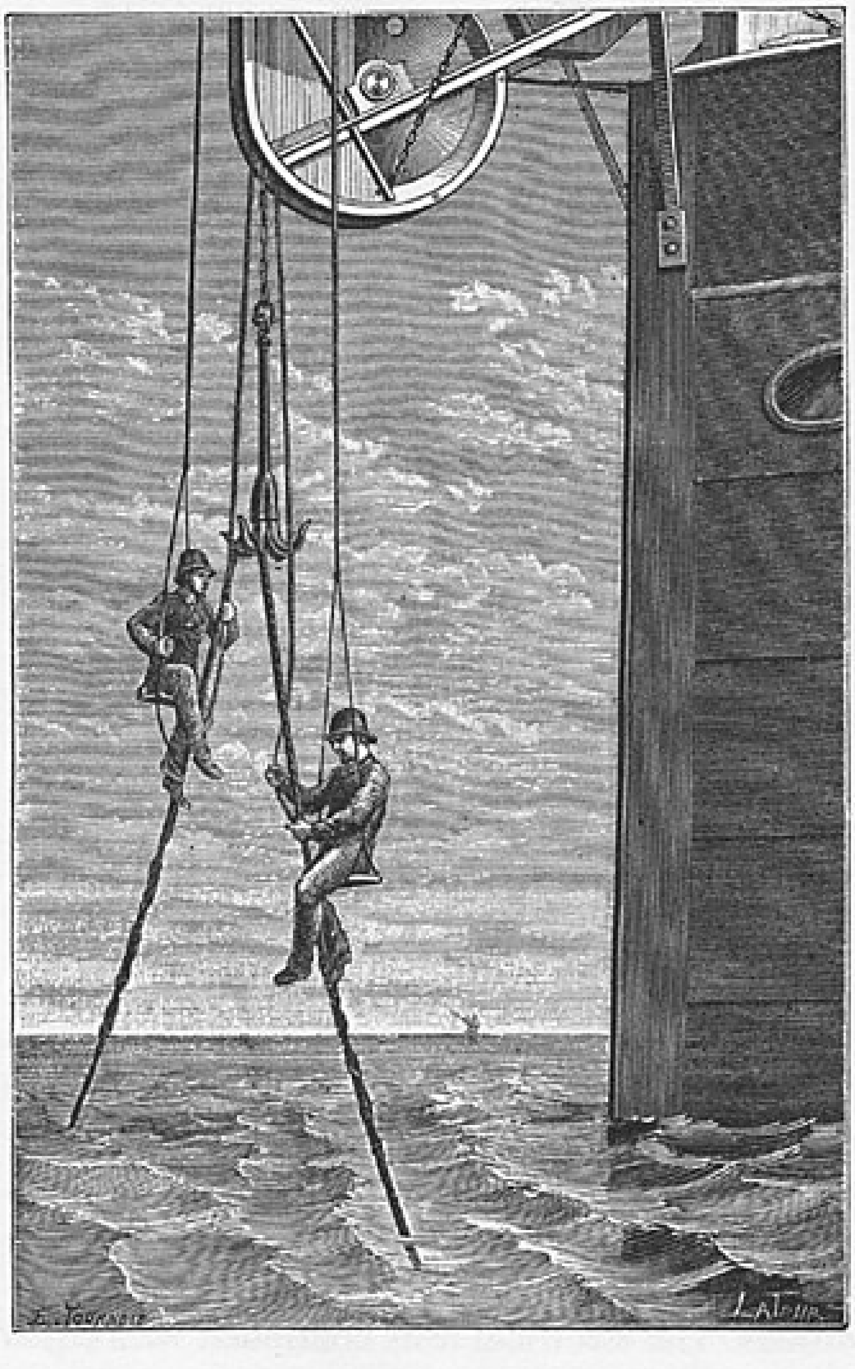
As those responsible for the preparation of the fifth and final expedition to lay a telegraph line across the Atlantic took stock of their enterprise, it seemed that every error and misfortune that could befall them had, in the previous twelve long years, actually left its imprint upon them. They were now doubly ready for success.

The Great Eastern had acquired a very heavy coating of barnacles that fouled her hull to a thickness of two feet; long seaweed trailed from her flanks. She was therefore properly raked and scrubbed in preparation for her next mission. This steadied her and added more than a knot an hour to her speed. Her paddle-wheels were improved, her boilers overhauled, and her engines modified so that the ship could be quickly turned around in an emergency. A cage was built around the propeller to prevent cable fouling. For grappling the cable, there was now stowed aboard 20 miles of strong, iron rope, sufficient to carry a strain of 30 tons. Buoys of different shapes and sizes were stowed; the largest could support a load of 20 tons.

The new telegraph cable was manufactured at the rate of 20 miles a day, then tested and transferred to the big ship's tanks. When completed, the total length of cable aboard the ship added up to 2,400 miles. Of this 748 miles was the remainder of the 1865 cable. The weight of the cable and tanks exceeded 5,000 tons, of which the cable weighed 4,000 tons and the tanks and water in them, over 1,000 tons. In addition the ship was loaded with 8,500 tons of coal and 500 tons of telegraph gear and batteries. To this total of 14,000 tons plus that of the engines and rigging, there was the burden of supplies and provisions. It was therefore no wonder to discover that the ship's draft was nearly 32 feet.

The Great Eastern left her home port on the 30th of June, 1866, and moved on to Valentia where she awaited the laying of the heavier shore-end of cable that stretched 30 miles westward from the Irish coast. There the Great Eastern was joined by the Albany and the Medway, ships that were chartered by the company to escort the Great Eastern. The Medway was loaded with several hundred miles of the 1865 cable plus an additional, heavier length of 90 miles that was intended to be stretched across the mouth of the Gulf of St. Lawrence. Ready hands and a pontoon of boats helped bring the very heavy and stiff cable across the bay and up the cliff to the telegraph station. The 30 miles were then unrolled and the sea-end of the cable was buoyed in 100 fathoms of water.

The occasion had been often repeated and all the novelty was gone. It was a solemn occasion without speechmaking or cheers or public congratulations.

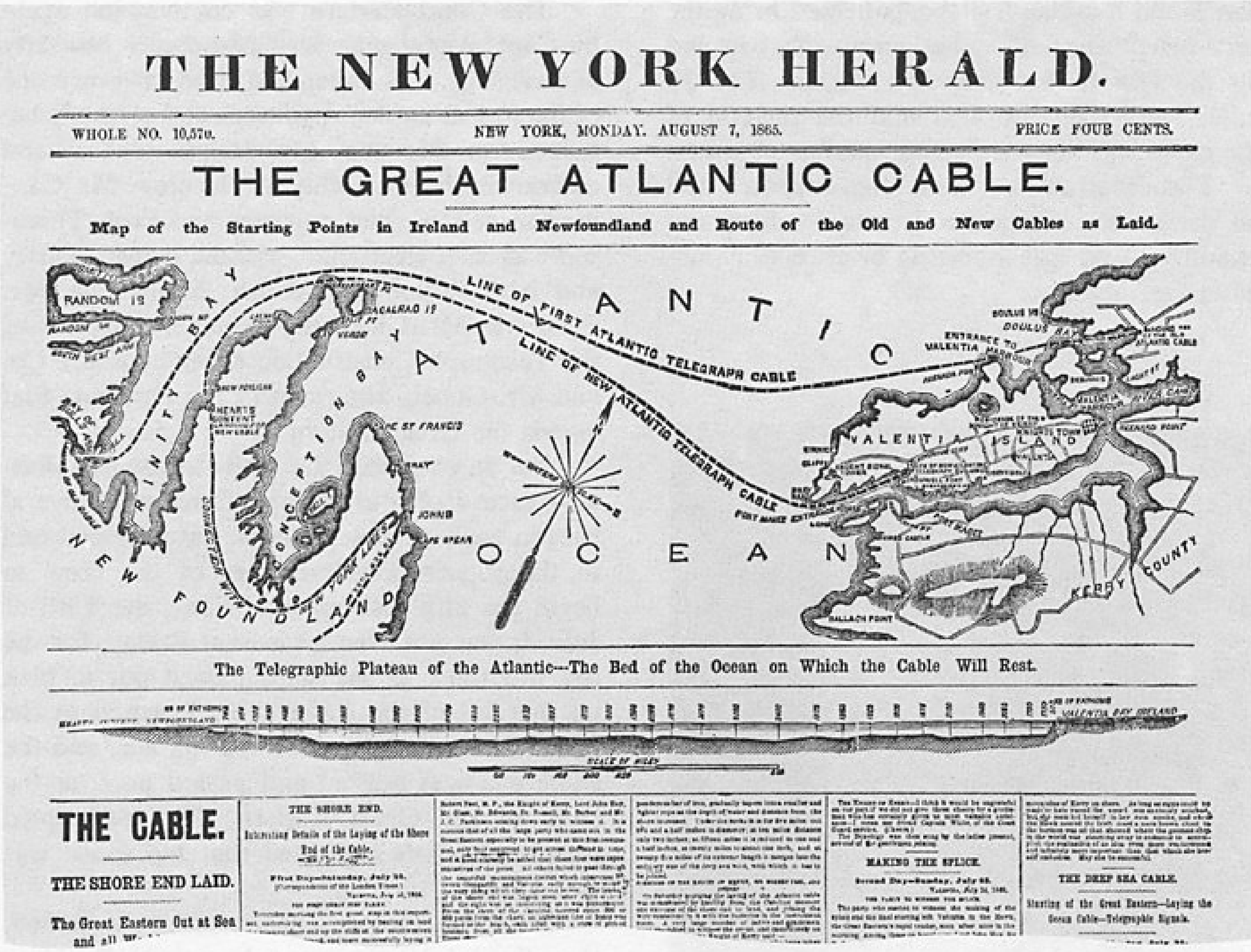


Raising the bight of the 1865 cable above the surface came only after 30 unsuccessful attempts. Once caught and surfaced, it was lashed and raised by auxiliary ropes.

The Great Eastern was commanded again by Capt. Anderson with Commander Moriarty as navigator. The latter had been on every one of the former cable expeditions and certainly belonged on this one. Mr. Halpin was second officer with responsibility for the crew. Mr. Canning served as chief engineer and Prof. Thomson was chief electrician, assisted by Mr. Varley and Mr. Willoughby Smith. Supporting Mr. Field was Mr. Glass, the managing director of the Telegraph Construction & Maintenance Co. and Mr. Gooch, chairman of the syndicate that owned the Great Eastern.

For an enterprise that had already established a record of four major failures with several tries in each of these, it must have seemed odd to the superstitious members of the crew to begin the fifth attempt on Friday, the 13th of July. It was not even a pleasant Friday, for the fog was thick as the ships moved out to pick up the end of the shore cable fastened to the buoy. The Albany sighted the marker, and the cable end was hoisted and passed on over the stern of the Great Eastern. The interrupted signals on shore indicated that the splice was being made.

First the copper conductors were joined, then the insulation restored, and finally came the protective covering of galvanized shield wires. With this completed, the signalling was restored but the messages went eastward to the station at Valentia thru the entire length of cable stored in the tanks of the Great Eastern, a total of 2,440 nautical miles. By three o'clock on that memorable July afternoon the paying out began as the ships moved westward in formation. Leading the convoy was the Terrible, charged with the task of clearing the way of vessels that might cross the oncoming ships. The Medway was on the port side of the Great Eastern and the Albany on the starboard quarter. All the ships were to maintain their relative positions and keep within signalling distance of



THE NEW YORK HERALD.

WHOLE NO. 10,570. NEW YORK, MONDAY, AUGUST 7, 1865. PRICE FOUR CENTS.

THE GREAT ATLANTIC CABLE.

Map of the Starting Points in Ireland and Newfoundland and Route of the Old and New Cables as Laid.

The Telegraphic Plateau of the Atlantic—The Bed of the Ocean on Which the Cable Will Rest.

THE CABLE.

THE SHORE END LAID.

The Great Eastern Out at Sea

THE SHORE END.

MAKING THE SPLICE.

THE DEEP SEA CABLE.

The end of the Civil War and seven years of preparation marked the importance of an omen of peace when the Atlantic Cable was again undertaken in August, 1865.

the mother ship, ready to close in for instructions when the signal gun was fired. A line across the ocean was laid out 30 miles south of the position of the 1865 cable, so that when the old cable was to be grappled, there would be no chance of interfering with the new cable being laid. Covering this expedition as historian was Mr. John C. Deane, secretary of the Anglo-American Company.

An average speed of about five knots was maintained over a continually quiet sea in rather good weather. Altho concern for the unforeseen and an awareness of the previous failures were constantly in the minds of the executive personnel, still their reports and diaries were short in their entries, and repetitive, reflecting the monotony of smooth working under favorable conditions. The electrical tests continued with equal monotony to reflect optimum conditions. On the fifth day out, the sea was so calm that the masts of the convoy were seen reflected on the surface of the sea.

However, during the first half hour of Wednesday, July 18th, the only serious disturbance of the voyage occurred. It seems that in reeling out the cable from the after-tank, the cable fouled and some half-dozen turns became enmeshed. Fortunately, both ship and reeling machinery were quickly stopped. In the dark of the night and in a thick rain, with wind picking up, the crew set to untangling a seemingly hopeless jumble of cable stretching from tank to deck. It took two hours of constant searching and passing of parts of the cable forward and aft before some order was restored and the signal given to continue the paying operation.

Thru it all the electrical signalling continued, with Valentia probably unaware of any disturbance aboard. The day went by, and by the end of the following day the aft tank was emptied of cable. The additional cable was next to come from the forward tank, which was connected to the paying-out machinery by a trough connecting the tank with the stern; this trough was 495 feet long. A watch of men was stationed from the forward tank to the issuing machinery, aft, with many lamps placed at short distances to watch the progress of the cable. For each mile that was brought up from the tank, a green lamp appeared and passed along the length of the ship toward the stern, where its passage was recorded. During the day flags were used.

Again the convoy passed the mid-ocean point which also was the graveyard of the cables of 1858. West of this, there rose a heavy wind and sea which again proved the strength and steadiness of the big ship. The blow did not last long and, in the subsequent calm, the evenness of the operation permitted the men's minds to turn to the constant flow of news maintained between the instrument room and the operators in the Valentia station. This constant signalling back and forth improved the technique and speed of the operators and maintained their confidence in their work. Altho on the high seas, they were kept informed of parliamentary debates, the quotations of the London Stock Exchange and important events in England and abroad. Of the last there was plenty to report because a war had broken out between Austria, Prussia and Italy in which battle followed battle. Like the reporting of the London Times, news bulletins were posted on deck twice daily. Important events were signalled to other members of the convoy, using flags by day and flash signals at night. In the meantime the cable continued to pass at the rate of six miles an hour.

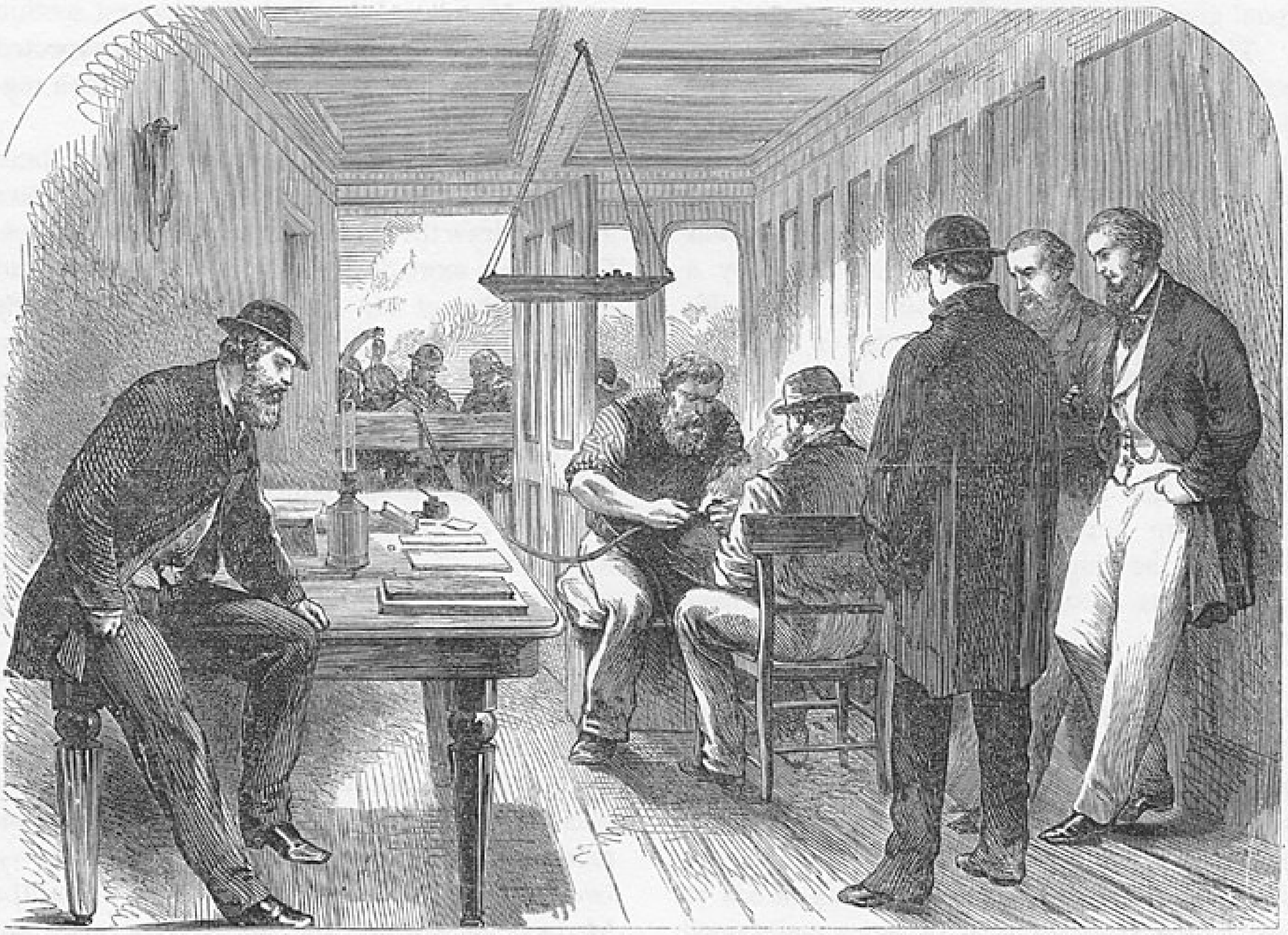
On Monday, July 23rd, the deepest section of the course was traversed with no unexpected strain indicated by the dynamometer, which registered a maximum of 1,400 pounds.

On the eleventh day out the forward tank was beginning to empty and preparations were made to draw the cable from the tanks amidships. Only a few more days of sea travel remained and the thoughts of Mr. Field looked ahead to the period of landing. He therefore requested Valentia to gather all of the latest news in Europe, Africa and Asia so that it might be immediately put on the telegraph lines from Newfoundland to the Canadian and American systems. Otherwise the operation continued as described by Mr. Deane, "Cable going out merrily. Electrical tests and signals perfect, and this is the history of what has taken place from noon yesterday to noon to-day. May we have three days more of such delightful monotony!"

Even the fogs on the Newfoundland Banks were welcome, because this indicated shallower seas. Altho the convoy was lost in the fog, contact was maintained by a system of whistles — two blasts from the Terrible, three from the Medway, and four from the Albany, each answered by one long blast from the mother ship.

As the western shore was approached, the signs that gladdened the heart of Columbus were equally welcome to the crews of the convoy. They were greeted by sea birds and floating things. By arrangement with the British Admiralty a ship was to meet them 30 miles from the entrance of Trinity Bay. Capt. Anderson therefore signalled the Albany to move ahead to meet the welcoming ship. The other two ships of the convoy were also ordered ahead to establish a line thru the heavy fog.

On Friday, July 27th, in the afternoon, signals were received from the Terrible, informing Capt. Anderson that H. M. S. Niger was the receiving ship and that another was stationed at the entrance of Trinity Bay. The Albany also signalled that she had passed an iceberg standing 60 feet out of the water. At four in the afternoon, the crew of the Niger welcomed the Great Eastern with three cheers which were as lustily returned by most of the 502 men aboard. The ships then headed for Trinity Bay with signals arranged to be guided towards Heart's Content.



The final and eminently successful Atlantic cable link was completed in 1866 in the fifth expedition. Above, the splice is being made linking the Valentia end and the ocean length.

Courtesy, Metropolitan Museum of Art, Gift of Cyrus W. Field, 1892.

Many hands were needed to unload the 30 miles of heavy shore-end cable from the auxiliary cable ship William Corry at Valentia on July 7th, 1866.

By eight o'clock in the morning of Saturday, the 28th of July, the fog lifted and exposed both shores of Trinity Bay and the entrance of Heart's Content. The good news had preceded the arrival of the vessels because the community on shore was in festive mood. British and American flags floated from such high points as the church steeple and the telegraph station. Again quoting Mr. Deane, "We had dressed ship, fired a salute, and given three cheers, and Captain Commerill of H.M.S. Terrible was soon on board to congratulate us on our success. At nine o'clock, ship's time, just as we had cut the cable and made arrangements for the Medway to lay the shore end, a message arrived giving us the concluding words of a leader in this morning's Times: 'It is a great work, a glory to our age and nation, and the men who have achieved it deserve to be honored among the benefactors of their race' — 'Treaty of peace signed between Prussia and Austria!' "

Preparations were made to splice the shore-end cable and Mr. Field had hurried ashore to engage a vessel to repair the break in the cable connecting Cape Ray, Newfoundland and Cape North, in Breton Island. Heart's Content was an inlet of the large bay known as Trinity Bay which is some 65 miles long and 20 miles broad. The village consisted of about 60 houses but it was chosen as the terminus of the Atlantic cable by Mr. Field because of its still, deep waters, favorable for cable laying.

The reception of the fleet did not compare with preparations made for earlier expeditions; there had been too many previous disappointments. However, those that did venture out were glad they were there to share in the unforgettable event. Mr. Field in his anxiety to get the many messages and items of news to the telegraph system was mortified to find that the cable crossing the Gulf of St. Lawrence, which had parted the year before, was still not fixed or replaced. This meant a 24-hour delay in getting thru to New York. Mr. Field's instruction to the company in New York to repair the 10-year-old cable had been disregarded because they were not ready to spend any more money on the uncertain venture, unless it was absolutely necessary. A ship had to gap the communications break.

Again Mr. Field took the initiative, chartered a steamboat and had the broken cable lifted, spliced where it had been broken by an anchor, and then relaid. In the meantime Mr. Field's packet of news reached New York on Sunday morning instead of Friday, the 27th of July. The first message read:

Heart's Content,
July 27.

We arrived here at nine o'clock this morning. All well. Thank God, the cable is laid, and is in perfect working order.

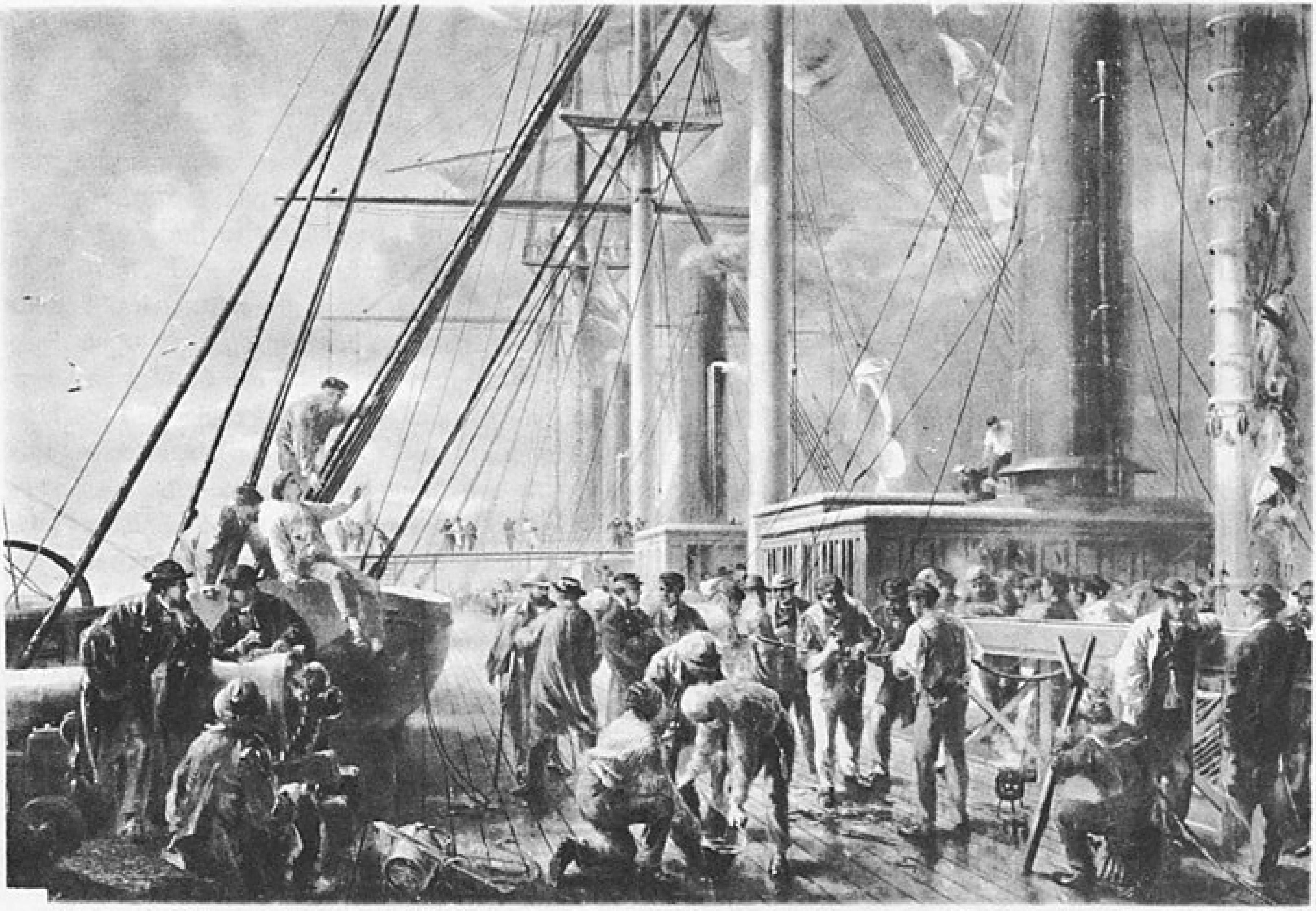
CYRUS W. FIELD

This was followed by a dispatch to the Associated Press which described the voyage and ended with the typical tribute to those who supported his effort. He said: "I cannot find words suitable to convey my admiration for the men who have so ably conducted the nautical, engineering, and electrical departments of this enterprise, amidst difficulties which must be seen to be appreciated. In fact, all on board of the telegraph fleet, and all conected with the enterprise, have done their best to have the cable made and laid in a perfect condition; and He who rules the winds and the waves has crowned their united efforts with perfect success."

This and other messages initiated a shower of congratulations and felicitations to Mr. Field. Letters from sovereign heads, heads of state, and leaders of government, industry and education poured in simultaneously. With a message from San Francisco, was one from M. de Lesseps from Alexandria, Egypt, where he had completed the Suez Canal. These electrically linked the most ancient kingdom in the east, with the most recently established large settlement in America's expanding West.

RETRIEVING THE LOST CABLE

THE let-down that so often accompanies success must soon have been felt by the officers and crew of the expedition, because their thoughts immediately turned to retrieving the cable lost the previous year in the western part of the Atlantic. After five days of resting and rejoicing in Trinity Bay, the Albany and Terrible steamed back to mid-ocean on August 1st; the Great Eastern followed a week later, because her immense store of coal had to be replaced. This coal supply had been dispatched from Wales weeks before on board six ships. One of these was lost at sea and the other five arrived shortly



Courtesy, Metropolitan Museum of Art, Gift of Cyrus W. Field, 1892.

Thirty miles from Valentia, Ireland, the cable is spliced to the ocean section on the deck of the Great Eastern on July 13, 1866.

after the Great Eastern had anchored. When she moved out to rejoin her two companions, the big ship carried 8,000 tons of coal in her hold. She also carried 600 miles of the cable of 1865 which the Medway had carried from England. On Thursday, August 9th, the Great Eastern and the Medway sailed eastward.

The rendezvous was reached in three days at a point just over 600 miles from Newfoundland. The Albany and Terrible were already there and had marked the line of the cable with buoys. The Albany signalled that she had already hooked the cable but that it had been lost in rough weather. Capt. Moriarty, who had watched the cable-end lost from the Great Eastern the year before, had maintained that he could spot its position within half a mile. He was now on board the Albany and had evidently made good his boast. The Albany had raised the cable several hundred fathoms and had buoyed it, but a subsequent storm had torn the buoy away, carrying two miles of iron rope with it. Before again attempting to grapple, the leaders of the expedition met aboard the Great Eastern; these included Capt. Moriarty and Mr. Temple from the Albany.

The cable end lay in two and a half miles of water, but a few minutes preceding the break in August, 1865, the day had been clear and observations for location had been made by the sun's position. This fixed the break-point quite accurately and made at least this part of the retrieving task simpler. It was the mechanical handling of the cable which proved quite difficult.

Prof. Thomson had calculated that raising the cable at a depth of two and a half miles meant the suspension of about ten miles of cable length. The resulting weight was considered much too great for an ordinary grappling rope. It was therefore decided to distribute the load among two or three ships, each thus lifting only a portion of the burden.

The crew next went about locating and marking the course of the sunken line with buoys, so that its position would be known by day or by night. These were placed a few miles apart and were held in position by heavy mushroom anchors. Each buoy was numbered and carried a long staff with a flag. Those buoys placed over active cross grappling positions had a lantern attached to the staff at night.

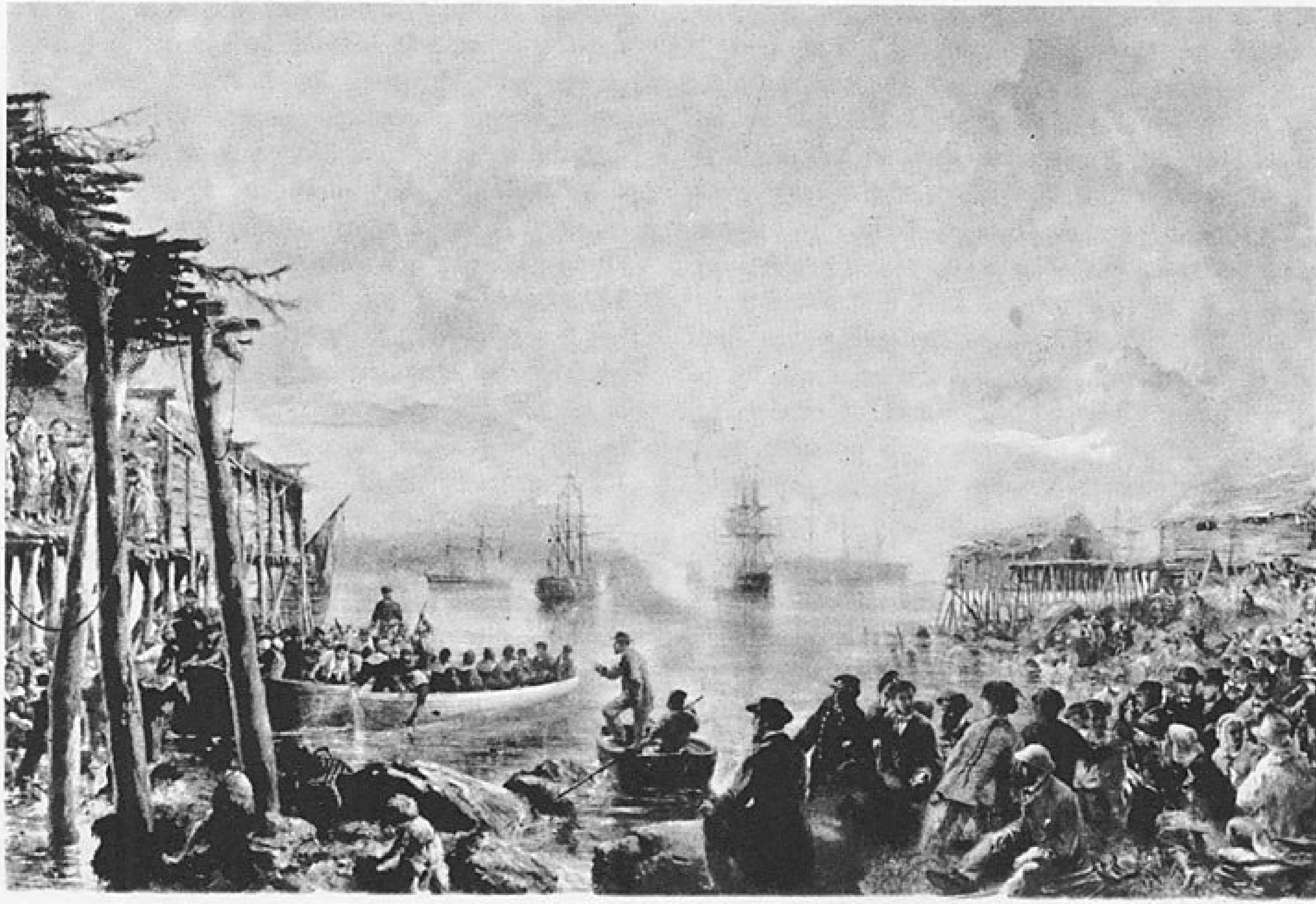
Remembering the disappointing experience of the previous year's grappling, the squadron now came well supplied with heavy grapnels and plenty of hauling ropes. This rope was six and a half inches in diameter and was composed of twisted hemp and 49 galvanized iron wires, each manila-protected; it had a tensile strength of 60,000 lbs. Each of the grappling ships had its share of this heavy rope. The Great Eastern and the Medway each carried seven and a half miles of it and the Albany five miles, making a total of 20 miles of rope. Strong as this rope was, it must be realized that at 2,000 fathoms, its own weight amounted to six or seven tons; to this had to be added the weight of the telegraph cable it had hooked.

To further illustrate the scale of operations of this gigantic fishing expedition it must be realized that it required about two hours for the grapnel to descend in order to reach the bottom of the ocean before any real dragging began. Similarly, it required several hours to pull up the rope, frequently to find nothing attached to the grapnel.

Much was learned of the nature of the ocean bottom as these grapnels continued to be dragged and brought up. Altho the bottom was generally a soft ooze, frequently rocks and boulders were encountered. One grapnel was once brought up with two of its giant hooks bent, indicating that they had caught on some shelf or huge rock. Altho contact with the cable had been made, it was only on Friday, August 17th, that the cable was hooked and slowly brought to the surface where it was plainly visible. Altho in sight for a few minutes, evidently the strain concentrated on the cable bight at the grapnel was too great; the strands parted and the cable splashed back into the sea. It was agreed that the techniques of raising the cable had still to be improved.

Delays were caused by more poor weather and rough seas, and the two subsequent weeks passed with an occasional successful contact, raising and buoying, but the cable was not brought on board. Stiff winds blew the ships off their course and at other times these winds tore the buoys from their moorings. These had then to be followed and retrieved. In general, it was the poor weather that kept the work from being done.

Once it seemed that success had arrived at last. It was shortly after midnight that the gun from the Albany signalled that she had caught and hobbled the cable to a buoy. The crew could hardly wait for the following morning to lay hold of the cable. Morning did come and the cable was pulled up, but it proved to be only



Courtesy, Metropolitan Museum of Art, Gift of Cyrus W. Field, 1892.

Twenty days after landing the eastern end of the cable on the Irish shore, the Great Eastern anchored in Heart's Content, Newfoundland, to unload the western cable end.

a fragment, a couple of miles long. It was pulled on board and served as a consolation prize.

The end of August had arrived and the constant effort was beginning to tell on the men. Mr. Temple had become very ill and Capt. Commerill of the Terrible reported that his supplies were nearly exhausted, his coal almost gone and his men on half rations. He had to return to restore fuel and provisions.

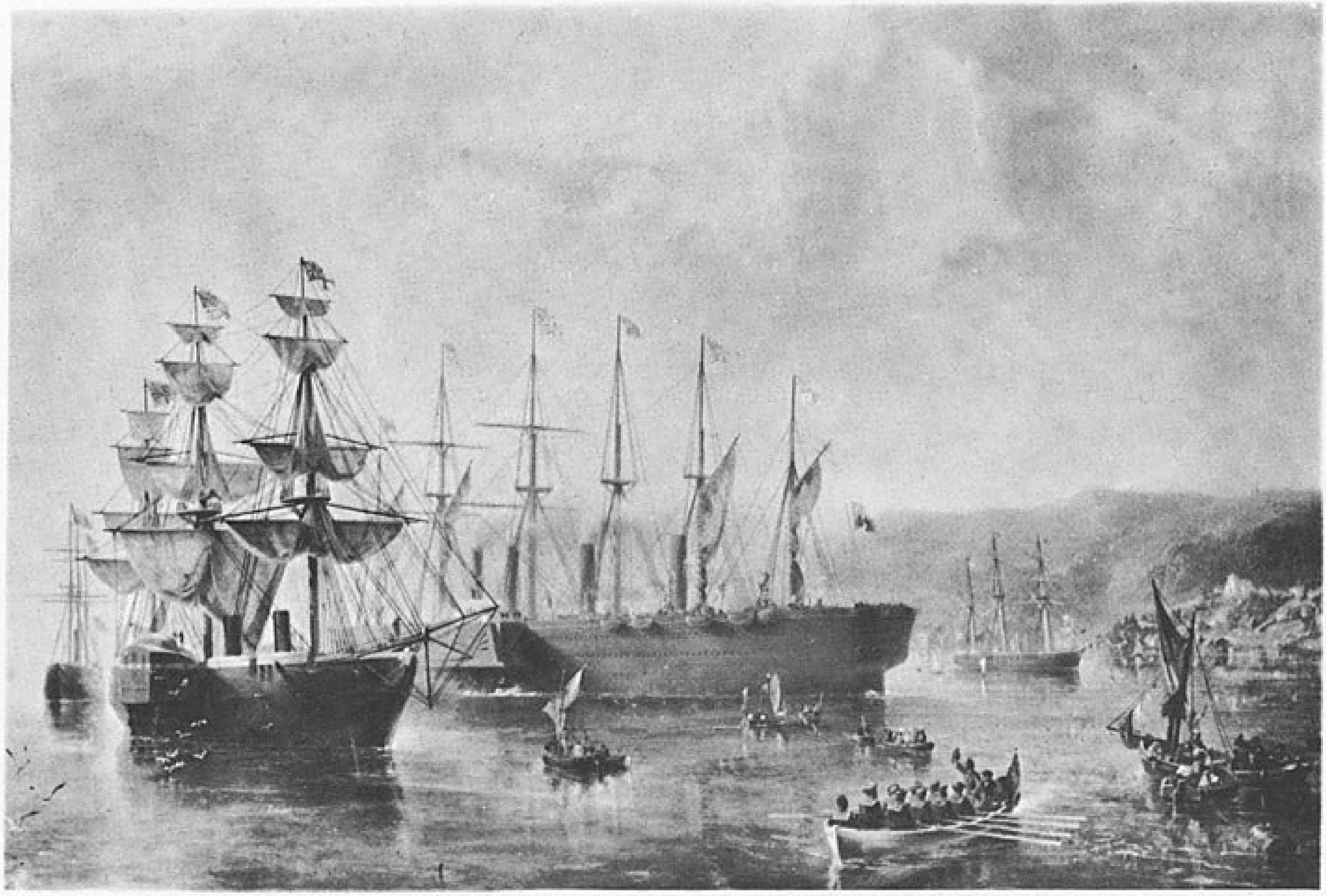
A final attempt was made by the Great Eastern, the Medway and the Albany, on the last day of August, a clear, windless day. This was their thirtieth attempt to find the cable, and at ten minutes past midnight contact was made. Slowly the reels wound up the heavy rope and the dynamometer showed increasing weight as the grapnels rose. First it was eight tons, then nine, ten. It took five hours to lift the cable to within 1,000 fathoms of the surface of the water. The engineers knew that with each lift the strain on the cable increased and with this came the danger of breaking. To further spread the strain, the Great Eastern buoyed its section and then moved out two or three miles for a fresh grip at a new location. The Medway was ordered also to try to grip and to haul the cable aboard even if it meant breakage. At a depth of 300 fathoms the cable did break but the eastern section continued resting on the grapnels of the other ships. The Great Eastern then gently raised her section of the cable and in an operation that lasted from midnight of Friday, when the cable was first gripped, to Sunday morning, the prize was finally clinched, surfaced for the third time, and brought on board. To make this possible, two veterans of the crew were lashed by rope and lowered over the bow to fasten the cable by rope. As the long-sought-for cable rose from the water they latched on to it and made it secure. To the crew it did not seem possible that so slender a thread had taken so much labor to locate. The effort had been so great that no cheering followed as the slender black serpent lay coiled on the deck. Thirteen months had gone by since this cable had first been in the hands of the crew and thirty attempts to grapple and raise it had now finally been rewarded by success.

The first item of concern was to see how the retrieved cable functioned electrically. Its end was brought into the test room and Mr. Field, Mr. Gooch and Prof. Thomson looked on as Mr. Willoughby Smith and his brother Oliver cut the shield and insulation to the conducting core, and connected it with the instruments. If no signal got thru there could be many reasons for it, including that of no attendance at the Valentia end of the cable, dead for more than a year. However, in the words of Mr. Deane, "Suddenly Willoughby Smith's hat is off and the British hurrah bursts from his lips, echoed by all on board with a volley of cheers, evidently none the worse for having been 'bottled up' during the last three hours. Along the deck outside, over the ship, throughout the ship, the pent-up enthusiasm overflowed; and even before the test-room was cleared, the roaring bravos of our guns drowned the huzzas of the crew, and the whiz of rockets was heard rushing high into the clear morning sky to greet our consort-ships with the glad intelligence." The message received was "Canning to Glass. — I have much pleasure in speaking to you through the 1865 cable. Just going to make splice."

It seemed that for more than a year an electrician* had attended the telegraph instruments at the eastern terminus, night and day, waiting for the very signal that had just come thru the 1,240 miles of cable, confirming its sound conductor and insulation. Finally, on Sunday morning, the galvanometer which had only been activated by induction of magnetic storms over the line during these many months, happily spelled out the intelligible words, "Canning to Glass", three simple words which could hardly tell the story of trial and effort that had made their transmission possible. With the cable brought into the test room, the scene was best described by Mr. Field himself, "One of the most interesting scenes I have ever witnessed was the moment when, after the cable had been recovered on the Great Eastern, it was brought to the electrician's room to see whether it was alive or dead. Never shall I forget that eventful moment when, in answer to our question to Valentia whether the cable of 1866, which we had a few weeks previously laid, was in good working order, and the cable across the Gulf of St. Lawrence had been repaired, in an instant came back those six memorable letters, 'Both O.K.' I left the room, went to my cabin and locked the door; I could no longer restrain my tears – crying like a child . . ."

The electrical performance of battery and cable indicated that no high voltages were re-

*The signal was first noticed by Mr. Crocker, telegrapher on duty at Valentia, on Sunday morning, at 5:45, September 1st, 1866.

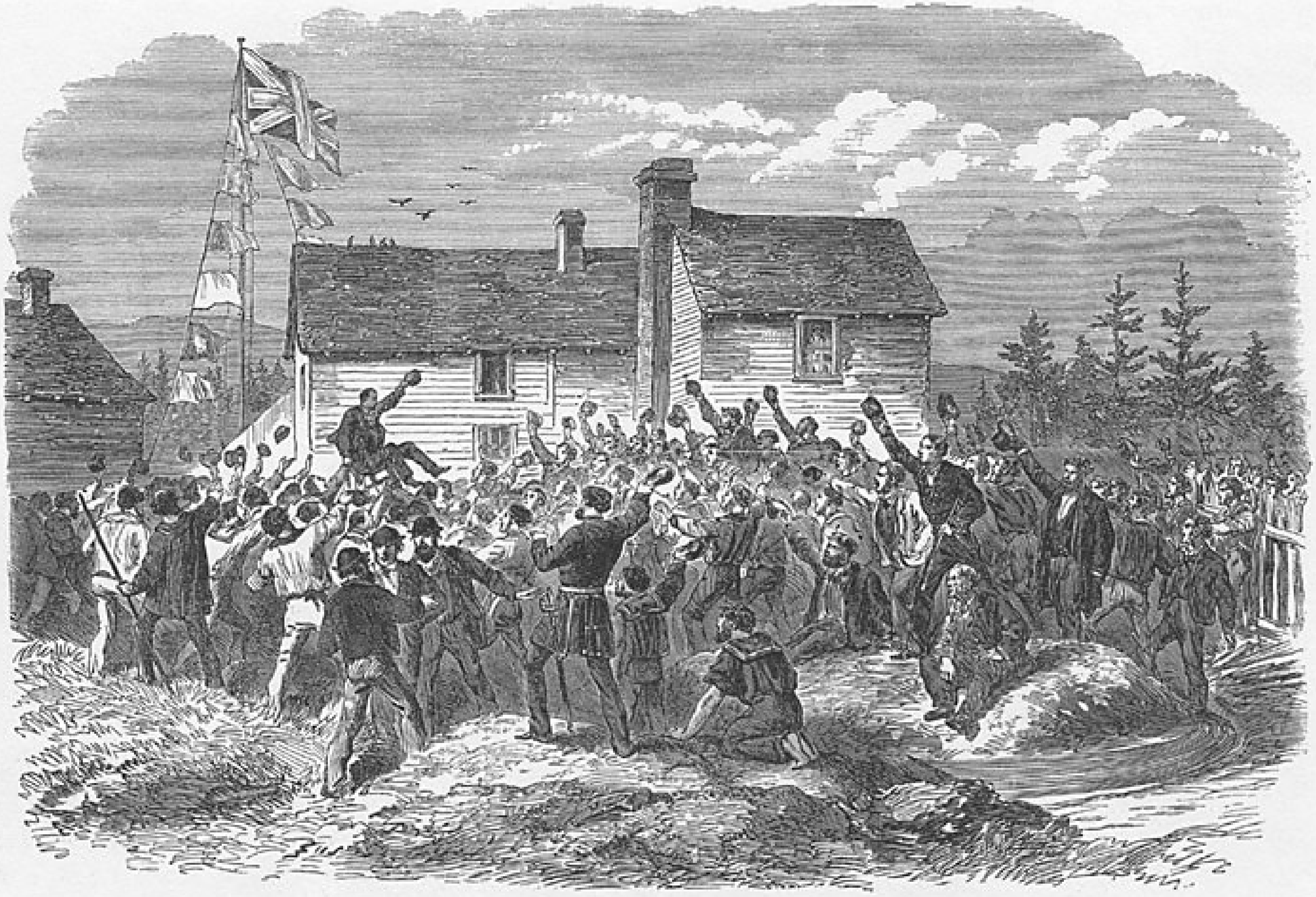


Courtesy, Metropolitan Museum of Art, Gift of Cyrus W. Field, 1892.

Triumphantly laying the western end of the 1866 cable on shore at Heart's Content, the Great Eastern, with Cyrus Field on board, leaves the Terrible and Medway to return to the mid-Atlantic to hunt the lost cable of 1865.

quired to traverse the Atlantic distances. A short time later, Mr. Richard Collett sent a message from Newfoundland to Valentia with the electric power of a battery composed simply of a copper percussion-cap and a small strip of zinc, using no more than the salt water of a tear as an electrolyte. Mr. Latimer Clark, who was stationed at Valentia at that time, ordered that the two successfully laid conductors be joined at their Newfoundland end, thus forming a continual length of 3,700 miles of circuit. Using a primary cell consisting of a silver thimble borrowed from the daughter of the Knight of Kerry (the Irish county nearest America), he added a fragment of zinc and some pure sulphuric acid. This was sufficient to signal thru the entire circuit, with the galvanometer registering a deflection of some twelve inches on the scale.

The splice completed, the Albany was assigned the mission of picking up the buoys and sailing for England. The Great Eastern, accompanied by the Medway, turned westward, paying out 680 miles of cable as she sailed. This completed the 1,896-mile second transatlantic cable.



When the telegraph fleet reached Heart's Content, Newfoundland, in 1866 the crew celebrated their success by "chairing" their chief engineer, Sir Samuel Canning.

With the re-establishment of contact with the outside world, Mr. Field was able to learn, via Valentia, that his family at Ardsley* was well. A storm rose that lasted for 36 hours and brought on heavy seas that caused all aboard to worry over the slender thread dangling from the stern of the big ship. Saturday, September 7th, saw the three vessels entering Trinity Bay, and the second cable was brought ashore. The reception of this second signal of success of the great enterprise was thus described: "As the ships came up the harbor it was covered with boats, and all were wild with excitement; and when the big shore-end was got out of the Medway, and dragged to land, the sailors hugged it and almost kissed it in their extravagance of joy; and no sooner was it safely landed than they seized Mr. Field, Mr. Canning and Mr. Clifford in their arms, and raised them over their heads, while the crowd cheered with tumultuous enthusiasm."

It was hard to realize that the work was over, and that the time for parting had come. There

*Mr. Field chose this name for his country home because it was the name of the home of John Field, noted English astronomer, whose son, Zachariah, left this home in Yorkshire to emigrate to America in about 1631. He later settled in Hartford, Conn.

were other tasks for men and ships in different parts of the world. The Great Eastern prepared to return to England and the Medway was being readied to lay the cable across the Gulf of St. Lawrence, work that would keep her in the area for another two or three weeks. The Terrible volunteered to help the Medway. Mr. Field took leave of his friends who were to return to England.

THE TRIUMPH

DOUBLY crowned with success, the Atlantic cable perpetually bound the Old World with the New. Many men gave more than a dozen years of their lives to this enterprise while others invested £2,500,000 ($12,000,000) to see this work successfully concluded. Mr. Field summed it up by saying: "It has been a long, hard struggle. Nearly thirteen years of anxious watching and ceaseless toil. Often my heart has been ready to sink. Many times, when wandering in the forests of Newfoundland, in the pelting rain, or on the deck of ships, on dark, stormy nights – alone, far from home, I have almost accused myself of madness and folly to sacrifice the peace of my family, and all the hopes of life, for what might prove after all but a dream."*

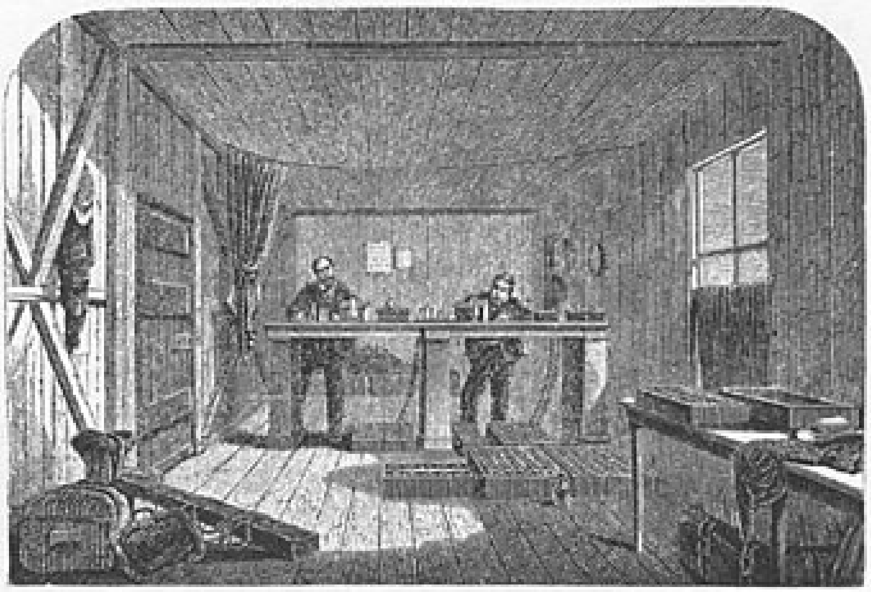
In celebration of this great accomplishment it was England that now grew enthusiastic and heaped praise on those who had participated in the laying of the cable. Mr. Curtis M. Lampson, vice-chairman of the Atlantic Telegraph Company, and Mr. Daniel Gooch who held the same position in the Anglo-American Telegraph Company were created barons by Queen Victoria. Richard Glass, who devoted 16 years to the science of submarine telegraphy, was knighted, as were Prof. Thomson, Mr. Samuel Canning and Capt. Anderson.

The American mood had been made serious by four years of terrible war, and therefore did not repeat the wild demonstrations that followed the success of the 1858 cable. At the end of September 1866, the Earl of Derby, as prime minister, addressed a letter to Sir Stafford Northcote in which he said: "I am commanded by the Queen to make known to you, and through you to those over whom you are to preside, the deep interest with which Her Majesty has regarded the progress of this noble work; and to tender Her Majesty's cordial congratulations to all of those whose energy and perseverance, whose skill and science have triumphed over all difficulties, and accomplished a success alike honorable to themselves and to their country, and beneficial to the world at large", and further, "and Her Majesty has accordingly been pleased to direct that the honor of knighthood should be conferred upon Capt. Anderson, the able and zealous commander of the Great Eastern; Prof. Thomson, whose distinguished science has been brought to bear with eminent success upon the improvement of submarine telegraphy; and on Messrs. Glass and Canning, the manager and engineer respectively of the Telegraph Maintenance Company, whose skill and experience have mainly contributed to the admirable construction and successful laying of the cable."

Mr. Field could not be on the list of honors, as Americans could not accept such honors from foreign governments – not that these were lacking either from his fellow citizens or from his associates. At a dinner held in testimony to those who successfully completed the enterprise, Sir Charles Bright toasted Mr. Field by, "Mr. Cyrus Field, to whom the world was more indebted than to any other person for the establishment of the line."

Sir William Thomson, later Lord Kelvin, wrote: "My dear Field, I cannot refrain from putting down in black and white my hearty con-

*Address made at the New York Chamber of Commerce dinner, November 15, 1866.



The primitive character of the telegraph cable outposts is shown by this instrument room at the eastern terminus, Foilhummerum, Valentia, Ireland.

gratulations on your great success. Few know better than I do how well you deserve it." Eight months later he wrote from Scotland: "I am sorry I had not an opportunity of saying in public how much I value your energy and perseverance in carrying through the great enterprise, and how clearly you stand out in its history as its originator and its mainspring from beginning to end."

The governments of Italy and France conferred honors on Mr. Field. His fellow stockholders at their annual meeting in New York passed a lengthy resolution praising the work of Mr. Field and concluded:

> That a copy of this resolution, certified by the Chairman and Secretary of this meeting, be delivered to Mr. Field as a recognition, by those who best know, of his just right to be always regarded as the first projector, and most persistent and efficient promoter of the Atlantic Telegraph.
>
> PETER COOPER, Chairman
> WILSON G. HUNT, Secretary.

At the grand banquet which was tendered him by the New York Chamber of Commerce in mid-November much praise was duly given Mr. Field. He replied by reviewing the difficulties encountered, and praising in highest terms the contributions of the government of England in supplying capital, ships, officers and crew to man them. Also provided were men of science, engineers, electricians and the perseverance that saw the task thru. He continued, "Of the results of this enterprise – commercially and politically – it is for others to speak. To one effect only do I refer as the wish of my heart – that, as it brings us into closer relations with England, it may produce a better understanding between the two countries. Let who will speak against England – words of censure must come from other lips than mine. I have received too much kindness from Englishmen to join in this language. I have eaten of their bread and drunk of their cup, and I have received from them in the darkest hours of this enterprise, words of cheer which I shall never forget; and if any words of mine can tend to peace and good will, they shall not be wanting." He then ended with: "I close with this sentiment: ENGLAND AND AMERICA – CLASPING HANDS ACROSS THE SEA, MAY THIS FIRM GRASP BE A PLEDGE OF FRIENDSHIP TO ALL GENERATIONS!" (To which the whole assembly responded by rising, and by prolonged and tumultuous cheers.)*

Present at this banquet were many honored guests, including General Meade, who, as "the hero of Gettysburg", was called upon to speak. He replied that there was but one hero that evening, and Meade had travelled a hundred miles so that he might honor him. Present also was Admiral David Farragut, representing the Naval service. Letters from the President, the Chief Justice and from General Grant were read. There also were messages of praise from the British Minister, from senators, ambassadors, members of the cabinet, from the Governor-General of Canada and from the Governor of

*Quoted by H. M. FIELD, 1893, page 384.

Congress unanimously voted a gold medal to Cyrus W. Field on March 2, 1867, to honor his part in realizing a successful Atlantic Cable.

Newfoundland. By telegraph a message arrived from Capt. Sir James Anderson, sent from London that very day.

Recognition from the American people was embodied in the official thanks of Congress, an honor rarely bestowed. By unanimous vote of both houses, a resolution of thanks was presented to Mr. Field. In addition, a gold medal* was struck and presented to Mr. Field, "for his foresight, courage, and determination in establishing telegraphic communication by means of the Atlantic cable, traversing mid-ocean and connecting the Old World with the New." This was approved by President Andrew Johnson on March 2nd, 1867.

*A similar gold medal and commendation was also unanimously voted by Congress in August, 1958 to Admiral Hyman G. Rickover for his part in the design and construction of the submarine Nautilus, and her first traversal of the Arctic Ocean. Thus the momentous feat of the first nuclear-propelled submarine was linked to the first successful submarine cable by the neat passage of a century.

When Mr. Field again sailed for London in 1868, an imposing banquet was prepared for him in London on July 1st. Among the 400 guests were again included prominent men of affairs, the military services, men of science, engineers, electricians and inventors. The Duke of Argyll presiding, addresses were made by ministers of state, ambassadors, and by M. de Lesseps, who had come expressly to honor Mr. Field, journeying from Egypt for the occasion.

Slowly at first, but with increasing tempo, the value of the transatlantic telegraph became apparent daily. When Mr. Field arrived at his desk every morning he found spread before him the noon quotations of the Royal Exchange in London. Only minutes now separated the two great capitals. On July 31, 1866, Mr. Franklyn, Mayor of Vancouver in Western Canada, cabled the Lord Mayor of London: "The infant colony Vancouver, eight thousand miles distant, sends telegraphic cordial greetings to Mother England". It was now possible to telegraph from San

Francisco eastwards to Ceylon, crossing three continents and two oceans.

The economic advantages of the telegraph were reflected in reduced inventories that merchants had to carry, because they were made more clearly aware of world market conditions by the quick exchange of information. Due to this awareness, traders could take advantage of lower prices in more abundant markets and thereby pass on these economies to wider circles of customers. Better knowledge replaced the speculation and hoarding that always went hand-in-hand with ignorance and uncertainty.

The rate of communication began with about eight words a minute transmitted by the operator. As the staff became better acquainted with the conditions of the line, the speed was increased up to fifteen, sixteen and seventeen words a minute, an improvement helped by the installation of condensers added to the circuit. At $5.00 a word, the difference in transmission rate became very important in the economics of the service. A modern cable can handle a rate of 400 words a minute.

Mr. Field became a prominent national figure, for one who had attained such a prominent industrial position was eagerly sought, for advice and for participation in the rapidly growing industrial center of New York. He did participate in some such projects, as the construction of the elevated railroad system in New York, but shunned many others. Mr. Field died at Ardsley on July 12th, 1892, mourned by a grateful nation and a world which had benefitted so greatly from his genius.

At the time of his death no less than ten cables spanned the Atlantic, carrying their ever-increasing load of messages.

"This is a celebration such as the world has never before witnessed. It is not alone to commemorate the achievements of individuals, or even nations, but to mark an epoch in the advancement of our common humanity."

—JOSEPH HENRY
in celebration of the 1858 cable

Morse on early Transatlantic cable projects.

The following letter from Prof. S. F. B. Morse to Gen. Horatio Hubbell contains several elements of importance to the history of the Atlantic Cable. It is reproduced from the letter-press copy retained by Prof. Morse, now in the Burndy Library. Dated June 12, 1854, it was written during the very earliest days of the formation of the Cable company, by one of the true Projectors. Its patient exposition is a review of the events leading up to the undertaking, and of the early scramble for priority of credit for the grand scheme. It contains the famous prediction that "the time will come when this project will be realized". It also outlines the respective roles of the inventor-dreamer and he who reduces an idea to practice. The proposal by Gen. Hubbell seems to have been one of the many impractical notions that plagued the Cable company technical staff.

Po'keepsie
June 12th, 1854.

Dear Sir,
Your favor of the 3rd inst is just received, and finds me much engaged with various demands on my time, so that I can scarcely find a moment to reply; yet I cannot let your communication pass without a few remarks. —

I have now for the first time read and with much interest your memorial to Congress in 1849. You will not feel offended if I give you facts, (so long as they are *facts*,) though they may be fatal to your honest supposition that "whatever has been done towards an Ocean Telegraph has only been a *following up of your ideas*", or that you can claim priority in the suggestion of a *Telegraph across the Atlantic*.

You will discover from the position which I hold in relation to the Telegraph that it was quite natural that the extension of my system throughout the world should occupy my thoughts with some degree of intensity, from its inception, and that in view of this anticipated world wide extension, the connection of Europe and America was at least a possible if not *probable* subject of thought and speculation with me. Now this, Sir, is a subject which occupied my mind at least as early as the year 1842, as printed documents before Congress elucidate. At that period there were certain problems bearing on such a project necessary to be solved before an Ocean Telegraph could assume anything like a practicable shape. Like the project of aerial navigation, as it now exists, it rested as a brilliant but impracticable, a rather unsolved conception, and ingenious minds like your own might well entertain the thought and devise ingenious modes of solving it, yet without demonstrating the means of a successful solution.

A claim for the original barren thought, however brilliant, is comparatively of little account in the eyes of the world. It is he who first combines facts, plans and means to carry out a brilliant thought to a successful result, who in the judgment of the world is most likely to receive the greatest credit, while, nevertheless an impartial posterity will award to each one whose mind has been employed in elaborating any part of a useful project, his just share of honour in bringing it to a result. Whatever may be said and proved adverse to your claim of priority, your memorial of 1849 must be noted by the historian of the Telegraph as worthy of honorable mention in its history. —

The difficulties at that early date (1842,) which were in the way of realizing such a project, were, first, Can Electricity by means of a single electric motor be propelled to a distance so great as the width of the Ocean? This was a problem which my experiments of 1842, 1843, were intended to solve, and which was so far satisfactorily solved to my own mind, as to lead me to declare the law of propulsion, or rather the law of battery construction, in my Report of the Results of those experiments, to the Secretary of the Treasury, in a letter which will be found on the files of the Department dated New York August 10th, 1843. In this letter I say "The practical inference from this law is, that a telegraphic communication on my plan, may with certainty be established across the Atlantic! Startling as this may *now* seem, the *time will come when this project will be realized*."

You will perceive that there is here "a point of time earlier than yours" by five years, and as "high and solemn a record" of the project of a Telegraphic communication *across the Atlantic* in the Archives of the Treasury Department, as if recorded in the Archives of the Senate, and it bears on its face the evidence that my mind was at that time engaged in elaborating this project. But the difficulty I had overcome and thus announced to the Government was not the only one in the way for

Second; What is the character of the bed of the Ocean? This bed had not then been sounded, and, therefore, its character whether suitable or not, from its depth, its regular or irregular bottom, its freedom or not from currents, or other disturbing agents, for the reception of a proper conductor, was not known.

This important part of the problem I conceive to have been solved by Lieutenant Maury and Lieut. Berryman, so far as it is solved. —

Third; Can a cable conductor of such a length be laid and to such a depth as is required?

This is resolved only by conjecture, and the experience of comparatively very short distances in successful submarine crossings of rivers and wide channels. The first attempt of this kind for telegraphic purposes, was made, so far as I believe, by me across the East River between Castle Garden and Governor's Island in the autumn of 1842. Long subsequent to this submarine experiment, English companies have laid the conductors beneath the Irish and English Channels. I have no doubt of the same success in crossing the Ocean.

Fourth: Is it possible to interest Government or companies to aid in such an enterprize?

You have tried the Government for your plan, and the effort is unattended with success, on the plea that "the world was not yet prepared for the project." No action has been had, and it has laid dormant for five years. —

Means, however, are as essential to the project before it can be made of practical value, as all other parts of it. A Company formed originally for a more limited purpose, has been persuaded favorably to entertain the project of an Oceanic Telegraph first suggested by me, and a sub-oceanic conductor proposed by me. This design is formally embraced in the Charter of a land Telegraph from St. John's Newfoundland to New York.

In regard to your proposal to be a Director in this Company, your request arises doubtless from a misconception of its nature. While it would truly give me pleasure to see you in that position, it does not rest with me to appoint the Officers. The Gentlemen who procured the Charter from the Government of Newfoundland, for this Company, are men of great Capital, who have been at great trouble & expense in procuring their present Charter. They have invested in the enterprize a large capital; they invited me to join them, and to invest a large sum, which has constituted me a joint owner with them, and no others can now be admitted but by *unanimous* consent of the present stockholders. Should you wish to become interested by investing your proportion of capital in the company, I will cheerfully give you my vote as a Stockholder, but as you will perceive I cannot control the vote, and it must remain with the other gentlemen to decide even if you can be admitted as a Stockholder, and then a majority of the Stockholders must decide who shall be of their Board of Directors. —

I have no time to read of the merits of your plan proposed in your memorial. I think however, that any plan of buoys for anchoring the conductor cable, is liable to several obvious objections. The buoys being on the surface of the sea, must be exposed to all the disturbing and disastrous agencies of Storms, currents, Ice, and malevolence from which a submarine cable once laid upon "Maury's Telegraph plateau" would be free.

Believe me Sir with respect

Yr Ob. Serv.t Sam. F. B. Morse.

Gen. Horatio Hubbell—
Philadelphia.

Po'keepsie July 22, 1854.

Sir
Your communication of the 29th of June is this day received. I have examined with care my reply to your first letter, to discover in it anything by which I could have given occasion to so discourteous, and acrimonious a rejoinder. As I was conscious while reviewing my reply to yours of only the most respectful and kindly feeling, I am wholly at a loss to account for the tone & temper which you have manifested in addressing me, in a correspondence of your own seeking, and while I was honestly endeavoring to give you facts in answer to queries of your own proposing. Since the facts I gave you remain unchanged. I see no necessity for continuing the correspondence, which in view of your letter, unexplained, could not be continued on my part but at the sacrifice of my own self respect.

Respectfully your Servant

Sam. F. B. Morse.

Gen. Hor. Hubbell–
Philadelphia.

Defense of Dr. Whitehouse after his dismissal.

In his *Reply to the Statement of the Directors of the Atlantic Telegraph Company* (see Bibliography, page 95), Dr. E. O. W. Whitehouse published his defense after dismissal by the company in a 27-page pamphlet written on September 27, 1858. Of the 47 paragraphs of text, the following 13 paragraphs have been selected for reprinting because the statements made are of historic interest. They help illustrate the difficulties of this early venture in electrical technology, and the conflict of ideas and personalities in the colorful language of a century ago.

REPLY TO
THE STATEMENT OF THE DIRECTORS OF
THE ATLANTIC TELEGRAPH COMPANY.

Unconscious of the blow which has been secretly endeavoured to be struck against my character and conduct — engaged in peaceful and philosophical pursuits — unwilling to enter the arena of hostile controversy, and desirous only to deprecate an obloquy undeserved; urged by a just respect for the public of two worlds, who are interested in the success of the mightiest of undertakings, and discomfited by its failure: I come forward openly and boldly to answer all the accusations that have been untruly and unjustly brought against me, and to declare, that if Science — as has often been the case — must have its victims, I will not fall the butt of unrefuted slander and detraction. I had long been aware that sinister and unseen influences were at work. There is a feeling in the mind of every man, which tells him of forthcoming evil; yet here, at least, in this enterprise, it might have been hoped that unity and sincerity would have gone hand in hand, and that pretended friends should not have been so suddenly perverted into foes.

. . . . .

Feeling and reasoning like men whose only standard is that of money, the Directors now, ungenerously and most disingenuously, for the first time put forward as a plea for my dismissal, my inability from illness to accompany the ships, one of the duties for which it is said I was "engaged" and "paid," and which now is called "by far the most important," though at midsummer no sort of objection was offered to my remaining at home: and I was even confidentially advised by their secretary to do so. The state of my health was at that time well known to him, it was known also that it was due solely to continuous over-application to the details of the electrical operations under my charge. I was not bound to accompany the expedition; my personal services were not needed, my place being efficiently supplied; and to make this after-thought the subject of a serious charge against their officer, is futile and fallacious.

. . . . .

We have next a fact stated in few words, but so disingenuously put, as to convey an impression the very opposite of the truth. It is implied that my operations upon the cable had positively injured its condition. Professor Thomson had tested the cable before his departure from Valentia *on the 10th,* at a period, that is, when the injury close at home, though existing, was so slight as not to have been recognised by him, though suspected by myself, and mentioned to him. The gradual increase of this injury led first to the embarrassment, then to the entire interruption of intercommunication, — an interruption temporarily remedied by the removal of a portion of this defect, but gradually accruing again from the same causes. Could Professor Thomson then expect to find the condition of the cable on the 21st as good as it had been on the 10th? — when for eleven days it had been subjected to these destructive influences, which might have been counteracted, but for the neglect of the Directors to protect the fragile cable, lying on the most exposed part of the coast of the United Kingdom, by the use of the massive shore-end constructed for the purpose.

. . . . .

It is contrary to fact that Professor Thomson at that time "pointed out to me" the existence of a "variable defect" in the cable, at a distance of from 240 to 300 miles. The Professor stated boldly, as the result of careful investigation, that he believed there was *"dead earth at 600 miles."* I went through his experiments with him, and clearly his mode of reasoning admitted of no other deduction. I essayed to offer another explanation; but no; his confidence in the result remained unshaken. It has since been stated to be 500 miles, and now with equal confidence is placed at 240 to 300 miles.

. . . . .

There was not at that time, nor had there ever been, "continuous difficulty and disappointment" in my attempt to adjust the instruments. And the very messages received from Newfoundland, and laid before the Directors, did themselves bear testimony to the utter fallacy of the latter part of the sentence, having reference to the amount of electric force. The superintendent at that station was, in consequence of the loss of current at our end of the line, as he reported to us by telegraph, reading our signals by a movement of only half a degree upon his best detector, and even that indication was only obtained by the greatest care and management.

. . . . .

On the receipt and recognition of coil currents from Newfoundland, to quote the entry made in the signals' diary, by the superintendent on duty at the time, August 9, my "relay was put in circuit, and worked splendidly," and then "received V.'s and B.'s (adjustment letters) very distinctly;" from this period, every slip printed and sent up daily to the Board was received *upon my instruments solely,* until, for comparison, I made use of a finger-key, in order to record at the same time the signals visible upon Professor Thomson's galvanometer. I have in my possession upwards of twenty duplicate message slips, in which these two modes of recording were used by adjacent styles, and thus their respective records stand side by side upon the same slip of paper for comparison. The currents from Newfoundland *were communicated direct* to my own apparatus, and it was in no way necessary in the working off those messages to have recourse to the galvanometer of Professor Thomson; it was used at the same time simply and solely for the purpose of strict comparison of the respective instruments under like conditions. Can stronger evidence be required of the adequacy of my instruments, or of the care which I took to compare them with others? At a later period, indeed, when, owing to the injury of our cable, the strength of signals began seriously to fail, Thomson's galvanometer was, from its exceeding delicacy, preferred by me, and usually employed alone under those circumstances.

From the period of the cessation of ship signals to the time of my leaving Valentia, the currents received from Newfoundland, possessed such features as could be immediately recognised as due to coil currents alone; and were identified as such by the whole staff. No voltaic battery at Newfoundland could have transmitted an equal number of currents in the same space of time. I have also in my possession evidence incontrovertible (both in writing and by telegram) that the messages from Newfoundland were transmitted solely by the use of my apparatus at that station. I now assert, without fear of contradiction, that from the cessation of ship signals up to and including the President's reply to her Majesty, every message sent from Newfoundland was worked off at that station solely by the use of my instruments, and was received at Valentia in the manner I have already described. I may go further, and state that every message from Newfoundland has been so worked off. I will not, however, do so till time affords me the additional testimony required. Yet the Directors have the hardihood to affirm that it has not been possible for my "apparatus to work off, unaided, a single complete message."

. . . . .

Thus, before midnight on the fourth day after the landing of the cable, the special instruments for speaking (designed by me, and constructed under my own patent), which had been taken out on board the Niagara, had been landed in the wilderness at the head of Trinity Bay, Newfoundland, had been put together, adjusted, and during the night brought into speaking order; nay, further, had even then proved their capability of speaking at a rate adequate to ensure the commercial success of our great enterprise.

Within a few hours from the transmission of this report to the head office, I received from the Directors the following telegram:—

"The Directors think it possible that the cable might be injured by the application of too much battery power; before applying any such power to the wires direct, they would be glad to have a report as to its strength and mode of application."

To this telegram I made no reply. There were no batteries on the island except such as had always been at Professor Thomson's or my own disposal, either at Keyham or on board the Agamemnon. I felt it, moreover, useless to contend against the utter childishness of expecting that our great work, in all its vastness, and yet multiplicity of detail, could be minutely regulated and governed by those at a distance from the seat of operations. This, if it be true at all, must be more specially so in reference to scientific details, with which it was not to be expected the Directors should be conversant, but rather that they should leave them to the judgment of their officers. But if it were not childishness — what was it? — that animus of evil influence, which knowing that it took a period of five days for postal intercommunication between themselves and their officers, affected to misdoubt, and desired to limit, the use of a battery-power that had been in constant operation.

. . . . .

With respect to Mr. Brett, I have very little to say, except to give him the full benefit of the ingenious problem which he says he submitted to me, namely, "If such a charge is retained in 300 miles, what may be the resistance in 2000 miles?" As to the question of registrations, concessions, and precedence of dates — I also admit his accuracy. I did not think necessary to refer to his earlier and unsuccessful efforts — terminating, as he well knows, in lapsed concessions. I gave that, which as I believed, was his first successful project. From the tone of Mr. Brett's letter, one would suppose that he, and he only, had contemplated the possibility of an Atlantic line — while he only in self-jubilation seems to emulate the frantic fooleries of the Americans in the person of Mr. Cyrus Field.

. . . . .

I had reason to believe that a great effort would at that time be made to induce the Directors to purchase the patent-right or licence to use the instrument, (Hughes' Printing Instrument) and at an exorbitant price. I stated to the Board and to Mr. Hughes frankly what I thought of it, and of its capabilities of adaptation to our purpose, offering, at the same time, to do my best to render it practically available to the Atlantic Telegraph; stipulating only that no extra premium should be received from the Company in virtue of any improvements introduced into the instrument by myself, but that I should participate in these advantages, if used upon other and non-competing lines. My offer was refused. I now find from Mr. Field's letter, already alluded to, that "it was expected that Hughes' printing telegraph instrument would be placed at Trinity Bay and Valentia on or about the 20th or 21st instant, and from the experiments made while the cable was at Plymouth, there was no reasonable doubt that Professor Hughes will be able to transmit intelligence through the cable reliably, and at the rate of about 300 words per hour"! The most exaggerated expectations are thus promulgated by Mr. Field, and fostered by bombastic articles in some of the American papers known to be immediately under his influence; to one of which, indeed, Mr. Field's private secretary, during the expedition, was special correspondent.

. . . . .

I have thus at length replied to the garbled manifesto of the Directors of the Atlantic Telegraph Company. I do it as a duty to myself, my profession, and the public. I am a supplanted man, as others will be after me; sacrificed to private and personal considerations. I know — have proved it — but do not resent it. I make no appeal *ad misericordiam,* I seek for no sympathy on scientific grounds — sufficient for me that I have been identified, and from the first, with that prodigy of this age, which may become a new starting-point in history till the end of time. The effect of even this defeat has been to awaken in America a feeling which was unknown before. Two nations, naturally united, but historically estranged, have instantaneously clasped the hand of brotherhood. A great responsibility rests upon those who have in any way contributed to the failure of this enterprise; but for my own part, I can safely say, that neither zeal, labour, caution, nor anxiety, was wanting upon the part of

EDWARD ORANGE WILDMAN WHITEHOUSE

ROYAL INSTITUTION, ALBEMARLE STREET,
September 27, 1858.

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