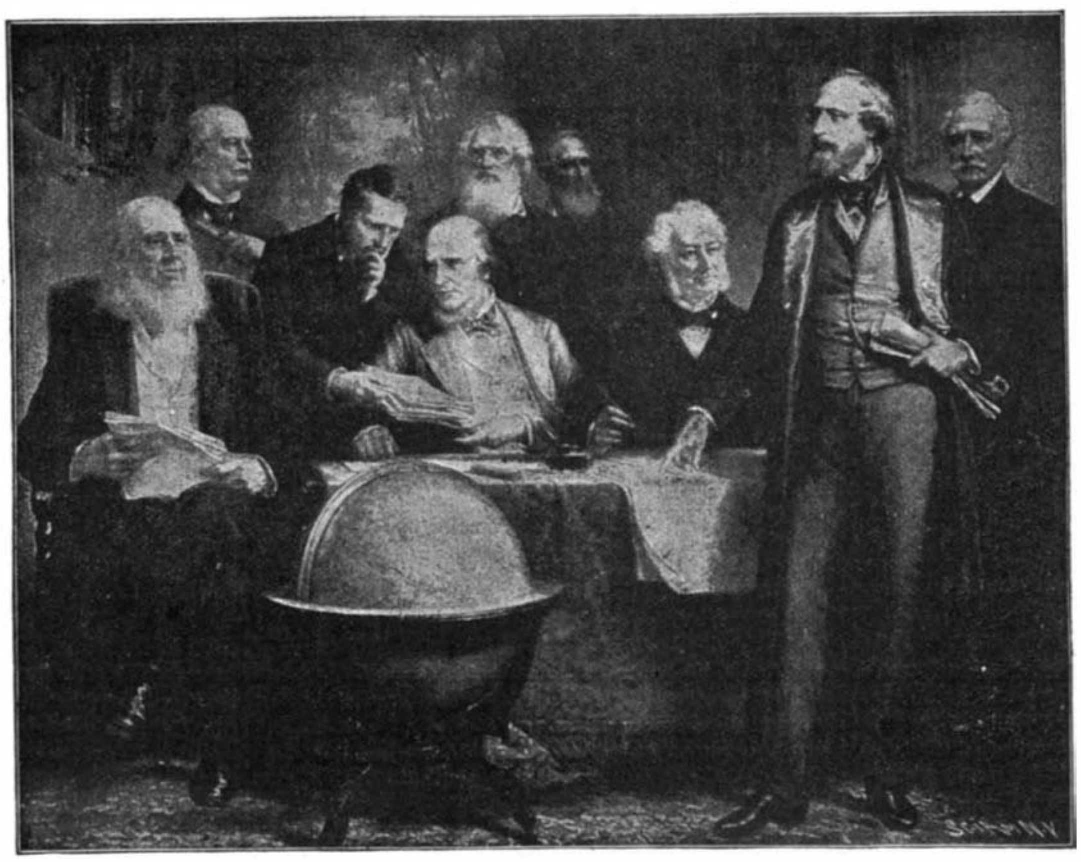
processes of cotton manufacturing is gaged more satisfactorily by the advance that has been made in the improvements in spinning on the ring frame. This machine is peculiarly an American invention, while the mule is not. In 1890, 63 per cent of the number of spindles in the United States belonged to this machine. It asserted its value to manufacturers before 1850, but little was done to it or any machine used in cotton manufacturing till after the late war, more than in perfecting details. In this latter respect, however, the progress was marked, so that by 1865 all the mechanical processes had been brought to a high standard of efficiency, equal, if not superior, to anything of like character observed in other branches of the textile industry. Even since the war the perfecting idea has chiefly engaged the time and attention of machine builders, though of late years the introduction of what is known as the revolving flat card (an English invention), and more particularly the Northrop automatic loom, has given cotton manufacturing a new impetus of great significance.

In the spinning frame the productive capacity and progressive steps of a cotton factory are distinctly noted. The machine has not till quite recently been brought to a sufficiently high state of perfection for spinning fine counts of yarn to bring it into competition with the mule, and especially so in the spinning of fine weft. A very recent invention gives great promise of overcoming difficulties of this kind, and within a few months it has been put into practical operation in one of the fine yarn mills of New England upon weft as fine as number 110, which to a manufacturer means a tremendous advance in this method of spinning, and which to him has much greater significance when it is stated that this weft yarn has all the characteristics of mule yarn, with the front or delivery rolls of the machine speeded at 84 turns per minute and the spindles putting in 28·92 twists per inch. This is probably the greatest advanced step taken in cotton manufacturing within the last quarter of a century or more, with the exception of that in weaving by the Northrop loom, which is a wonderful product of American ingenuity and persistent enterprise. This loom ranks with the self-acting mule and the Crompton fancy cassimere loom as the grandest invention in the textile machinery line within the present century. It is epoch making.

The tendency of cotton manufacturing in the New England States is toward finer yarns and goods, more than what is indicated in the consumption of long-stapled cotton of domestic Sea Island and foreign growth. Still, the latter furnishes the only means of estimating it. The consumption of this kind of cotton is nearly 60,000,000 pounds to-day to less than 16,000,000 pounds seven years ago, when fine spinning by Northern mills received a new vitality due to the competition of Southern mills which had become particularly sharp on coarse yarn spinning. To-day, about six per cent of the consumption of Northern mills consists of long-stapled cotton for specially fine yarns, while in 1889 and 1890 this consumption was somewhat less than two per cent. The progress toward the spinning of extra fine yarns is evident, yet it cannot be said that American mills are more than at the beginning of an era of fine yarn spinning.

The wool manufacturing industry of the United States has always been one of particular solicitude for legislators and others. Wool growing and wool manufacturing have for the last thirty years been mutually supporting in a legislative way. Within the last fifty years the wool manufacturing industry has expanded from an annual product of about $50,000,000, in 1850, to nearly $338,000,000, in 1890. In the forties, and for many years thereafter, the woolen product of this country was mainly broadcloths, flannels and satinets, all honest goods to the extent of using pure wool, very little shoddy or wool substitutes being employed till after 1860, when the practice of using adulterants was largely indulged in, with many examples of creditable success so far as skill in deceptive manufacture was concerned. The tendency toward larger factories and concentration of capital is noted in the census of 1860, which gave 1,476 establishments capitalized at an average of $26,300 per establishment, compared with an average of $145,000, as given in the census of 1890. The changes and progress in the woolen industry may be epitomized thus: plain goods of pure wool, as broadcloths, satinets and flannels, with a tendency to fancy cassimeres, from 1845 to 1860; fancy cassimeres and flannels, with a tendency to worsted fabrics for men's and women's wear, from 1860 to 1880; and since 1880, worsted fabrics for men's and women's wear, with no particular tendency away from these fabrics, all energy being devoted toward their perfection and attractiveness. These changes have been brought about by the mechanical inventions which have made these manufactures possible in a manner that appealed to the taste of the fashionable world. The chief mechanical factors in these changes were the loom and the comb, now brought to a remarkably high state of efficiency. There is probably a third more worsted fabrics made now than in 1890. It is the combing machine, for wool and cotton, that is to act the chief part in determining the character of American textile manufactures for the next ten years or more. It is only within the last fifteen years that any conspicuous advance has been made in combing comparatively short-stapled wool like the merino. The introduction of a class of machinery capable of effecting this has revolutionized the wool manufacturing industry of this country. The value of the worsted manufactures of our mills has increased from $3,701,378 in 1860, per annum, to over $100,000,000, in 1895.

The manufacture of knit goods has increased rapidly within the last few years, of which there are no official statistics, in line with the progress made during the decade of 1880-90, within which period there was an advance in the value of products of 131 per cent, exceeding that of any previous decade. Before 1850, the knitting industry was of small concern, not large enough to excite more than local interest.



David Dudley Field. S. F. B. Morse. Daniel Huntington. Cyrus W. Field. Wilson G. Hunt.
Peter Cooper. Chandler White. Marshall O. Roberts. Moses Taylor.

PROJECTORS OF THE TRANSATLANTIC CABLE.

THE SUBMARINE CABLE.

The history of telegraphy gives an early date to the first conception of a submarine cable, as many of the earliest experiments in telegraphic transmission were made under water with an insulated wire. Morse's experiments of 1842 between Governor's Island and the Battery in New York gave him a basis for his prediction that the Atlantic would yet be crossed by a telegraph cable. In 1845, Ezra Cornell, who, we have seen, is identified with the early progress of the telegraph, laid a cable across the Hudson from Fort Lee to the city of New York, which did good service for a year, when it was destroyed by ice. In Europe, the first genuine submarine cable dates back to 1850, when a gutta percha covered copper wire was laid between Dover and Calais, which lived only a single day, friction against the rocks destroying its insulation. Another one was laid in 1851. This new one was armored with ten galvanized iron wires and operated for many years successfully. Two years later Dover and Ostend were connected.

It now became evident that the time was approaching for carrying out Morse's prophecy. Mr. Brett, of England, had been identified with the Dover-Calais cable. Mr. Cyrus W. Field and other capitalists with Mr. Brett organized a company in 1854, and Mr. Field obtained a franchise from the provincial government for fifty years for landing transatlantic cables in Newfoundland. In 1856 soundings were made between Ireland and Newfoundland, and after several attempts a successful cable was laid between Nova Scotia and Newfoundland. The first attempt at spanning the ocean began on the 7th of August, 1857, when the English ship Agamemnon and the American ship Niagara laying a cable started from Valentia, Ireland, and directed their course for St. Johns, Newfoundland. The cable broke on the third day. A second attempt was made in 1858. This time the work of laying the cable was commenced in mid-ocean, the ships separating and proceeding shoreward, one to the east and one to the west, each laying cable as they separated. Two failures in the cable caused the abandonment of this expedition when about three hundred miles, at the most, of cable had been laid. Again the effort was made, and on the 5th of August, 1858, the third attempt ended, the laying was successfully accomplished, and Cyrus W. Field sent his first telegram across the ocean from America to Ireland on the 7th of August of that year. The insulation soon began to fail, and on the 1st of September the cable broke down entirely. Oliver Wendell Holmes' poem on the subject of De Sauty, the electrician of the company, with his message, "All right, De Sauty," as its refrain, will be recalled in connection with this breaking down of the thin strand on which so many hopes depended.

Between August 13 and September 1, 1858, 129 messages of 1,474 words were sent westward, and 271 messages of 2,885 words were sent eastward, when the cable failed. A message from Queen Victoria to the President of the United States, 99 words long, required 67 minutes for its transmission. Endless trouble was experienced in operating the cable before it ceased to work at all, and up to December 1, 1858, the company had expended $1,834,500 in its failure. The interval that elapsed between this and the successful laying of the next cable was due largely to the civil war, but during the twelve years from 1854 to 1866 Mr. Field never abandoned the subject, and crossed the ocean some fifty times, largely in the prosecution of the plan.

A new company was formed in 1866. A second cable had been laid part way across the ocean and abandoned the year previous, breaking after 1,200 miles were laid. The new company started a new line across the ocean and intended to pick up the abandoned cable and put that to work also. The line was commenced in Ireland, on the 13th of July, 1866, and was finished on the 27th of the same month, and on the 4th of August, 1866, the Atlantic cable was declared open to the public.

The other cable was grappled for and recovered, and it was completed, thus giving two lines between the continents. Cyrus W. Field received great renown from his work. The United States Congress voted him a gold medal, the Paris Exposition of 1867 gave him a gold medal, and he would have received high honors in England, it is said, had he not been a citizen of another country.

The Great Eastern, the most monumental failure in the history of steam navigation, seemed for a time to have found a scope for her abilities in the laying of transatlantic cables, but since her time many special cable ships have been built, with every appliance for successful and cheap prosecution of the work of laying cables, and the Great Eastern has been broken up for old iron. The cable is payed out over the stern of the ship through special apparatus by which any desired strain can be put upon it. The theory is that it has to be laid upon the bottom, no suspension from summit to summit of subaqueous ridges being permissible. Hence it has to be fed out at varying strain and rate according to the slope of the bottom on which it is being deposited. The work has become wonderfully systematized. Cables are laid at sea with the same unconcern that attends any ordinary voyage in a well equipped ship under favorable conditions. The system of buoying the ends of cables has become so perfected that a ship now has no hesitation in dropping the end of the cable, to be picked up at any time convenient in the future. Nevertheless, the early struggles in the laying of the cables form most impressive lessons in the ability of mankind to overcome obstacles.

After the failure of the first European-American cable, a new route was agitated from Labrador to Scotland, by way of Greenland, Iceland and the Faroe Islands. This route is about 1,800 miles long, and the longest water distance is 600 miles. Other deep sea cables between Sardinia, Malta, and Corfu, and one from the mouth of the Red Sea to India were laid shortly after and they failed. A committee of the most eminent electricians was organized by the English Chamber of Commerce and the Transatlantic Company to study the subject, and after eighteen months of labor they issued an elaborate report in 1863. Without waiting for their report a cable between Malta and Alexandria had been successfully laid, in 1861, and in the year succeeding their report, the Persian Gulf cable, about 1,330 miles long, was successfully laid. This was the major part of the work done prior to the laying of the Atlantic cable in 1866. Sir Wm. Thomson (Lord Kelvin) was identified from its earliest days with the cable laying art, and in his works may be found many graphic accounts of difficulties encountered and how they were surmounted. His instruments were used in the earliest days for the transmission of signals. It was found that with a line of such high capacity, worked with ordinary apparatus, endless difficulties were experienced, but Sir Wm. Thomson overcame them at an early period. His reflecting galvanometer was made to give visual signals by movement of its spot of light upon the scale, and when it was desired to have permanent signals, the siphon recorder traced, by means of ink from a capillary orifice, a zigzag line upon a strip of paper and solved the problem, the great scientist recurring to Morse's original written code produced by his old pendulum apparatus.

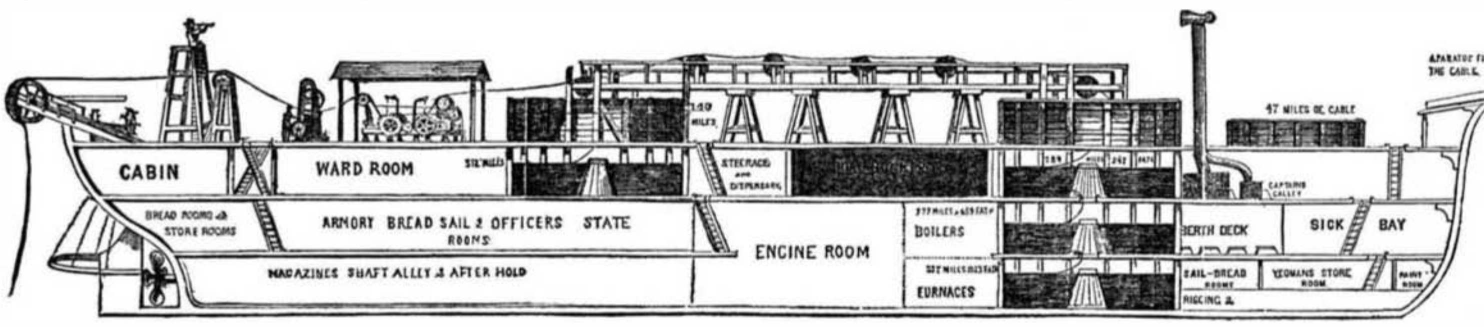
Fleeming Jenkin, the Edinburgh professor (whose life has been so charmingly written by Robert Louis Stevenson, a part of whose interest consists in the reflection of the author's own character, as he was registered as a student under Prof. Jenkin at the University of Edinburgh) gives an excellent account of the difficulties experienced by the early cable layers, in which expeditions Jenkin, great sufferer from seasickness as he was, appeared as an enthusiastic worker. To-day all is changed. There are a whole fleet of cable ships used for cable laying and for repairs, and appliances and methods have become systematized to the last degree. Cables are turned out from the factories in lengths of thousands of miles without imperfection, and the world is almost girdled by electric wire, the great Pacific forming practically the only break in its complete circuit, a break soon to be closed.

We have reproduced for our readers, with the kind assistance of the Postal Telegraph Company, the map of the world on Mercator's projection, on which are drawn the many lines of cable now existing. This map is thoroughly up to date, and shows in a most interesting way the amount of work accomplished. One of the most impressive features is the number of lines across the Atlantic Ocean between Europe and America. Hardly less impressive are the remote lines to New Zealand, Australia, Madagascar, and the Mauritius, while in the opposite sense the great Pacific, as yet uncrossed, marks the present limit of man's achievements. There is at present, however, a plan under way for laying a line across the Pacific from Vancouver to Japan, and the full plans were recently placed before Congress, but up to the present writing the necessary co-operation has not been obtained.

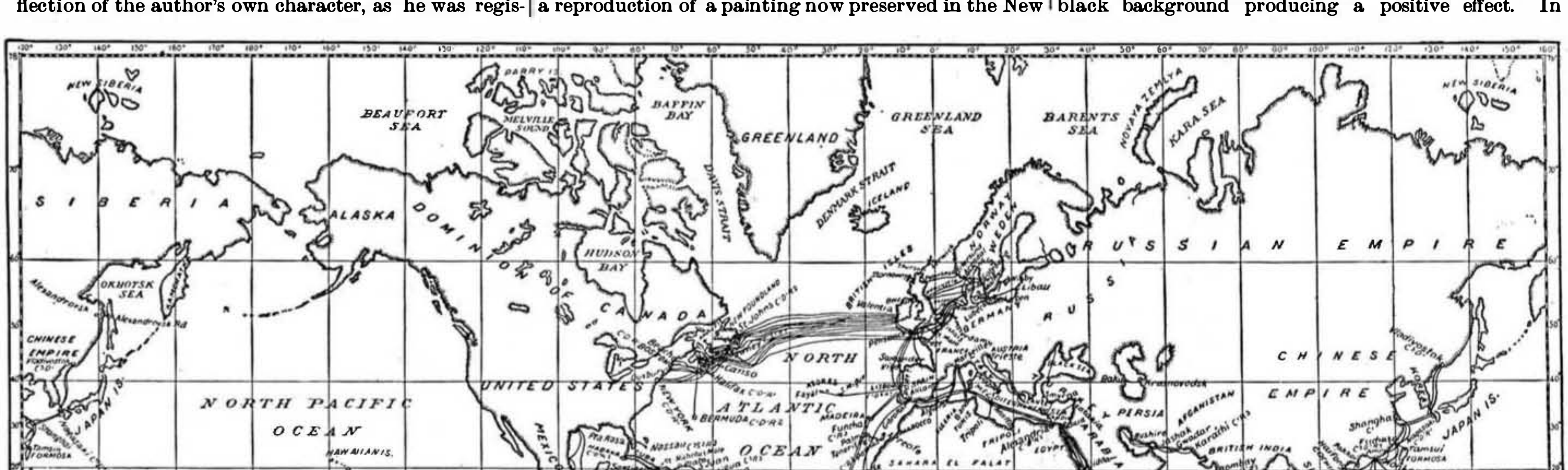
In the electrical outfit of the cable system, the principal progress has been in the adoption of a more delicate type of instruments for the transmission and reception of messages. The cables are generally worked on the condenser system, there being no through metallic circuit. The Thomson and Varley transmission apparatus increased the old speed eight fold. Thomson's siphon recorder quadrupled the speed of the systems used before its advent.

The cuts accompanying this article are of special value. The section of the Niagara is reproduced from a contemporaneous wood cut which appeared in the SCIENTIFIC AMERICAN in 1858. The portrait group is a reproduction of a painting now preserved in the New York Chamber of Commerce, and represents the incorporators of the Atlantic cable of 1858 assembled in the library of Cyrus W. Field, the philanthropist-inventor Peter Cooper presiding. In the background the artist, the great American portrait painter, Daniel Huntington, has introduced his own portrait. The cost of the painting alone was $20,000, and a long list of donors subscribed for its production.

Finally, the map gives the authoritative presentation of the world's network of cables corrected up to date specially for the SCIENTIFIC AMERICAN.



SECTION OF THE STEAMSHIP NIAGARA ARRANGED FOR LAYING THE TRANSATLANTIC CABLE OF 1858.



SUBMARINE CABLES OF THE WORLD, WITH THE PRINCIPAL CONNECTING LAND LINES, ALSO COALING, DOCKING AND REPAIRING STATIONS.

FIFTY YEARS OF PHOTOGRAPHY.

In the entire range of invention and discovery nothing shows a more brilliant series of successes than the art of photography.

A hundred and fifty years ago, copies of writing had been made by the action of light on sensitive paper. Giambattista Porta had invented the camera obscura; and more recently Niepce and Daguerre by different methods had succeeded in making sun pictures; and Fox Talbot had invented the calotype or talbotype; Herschel had given to the impression made from the object the name "negative" and to the print from the negative the name "positive."

Fifty years ago, in 1846, Schonbein discovered gun cotton, and soon after collodion was produced by making a solution of gun cotton in alcohol and ether. It was almost immediately adopted by Archer for a film in lieu of albumen and gelatine. Pictures produced on the sensitive film having collodion as the basis superseded the calotype and daguerreotype, and were made almost exclusively after this discovery up to within fifteen or sixteen years. This film is still used by many photographers for special purposes, but more particularly in photo-engraving, and for transparencies and lantern slides. The collodion film was used for making negatives as well as positives; some of the best photographic pictures ever produced were made by means of wet plate collodion film negatives, albumenized paper being used in making the positive prints. Prior to the use of albumenized paper sensitized with the silver salts, glass positives, called ambrotypes, were introduced by making a very thin negative image and backing the plate with asphaltum varnish or black velvet, the black background producing a positive effect. In some cases they were bleached by means of a solution of mercuric chloride. Collodion positives are still made upon thin japanned iron, commonly called tintypes.

After a great many experiments the modern dry plate was produced, not in its present state of perfection, but in a way which indicated its capabilities. The gelatine dry plate could not be made in perfection until after the gelatine itself had been improved so as to render it suitable for this purpose. It is to the perfection of the extremely sensitive dry plate that the great popularity of photography is to be attributed.