Maharajah's palace, and his successful administration of the Bangalore division. Socially he was most unassuming and considerate, and had many friends. The estimation in which he was held may be judged from the fact that, when at one time it was sought in Mysore to replace European by native engineers, Mr. Bayly alone was specially selected for employment.

Mr. Bayly's work consisted in the projecting, construction, and maintenance of important works of irrigation, water-supply, and communications, including canals, aqueducts, reservoirs, and river-dams; also Ghaut roads between the Mysore plateau and the West Coast of India. He was elected a Member of the Institution on the 3rd of February, 1885.

SIR CHARLES TILSTON BRIGHT,[1] whose name is indissolubly connected with the first Atlantic cable, died suddenly of heart disease on the 3rd of May, 1888. He was the youngest son of Mr. Brailsford Bright, of Wanstead, where he was born in 1832, so that at the time of his death he was but fifty-six years of age. He was educated at Merchant Taylor's School, and showed special scientific aptitudes very early in life, particularly in connection with chemistry and electricity.

Charles Bright, who had become acquainted with the late Sir William Fothergill Cooke, was, in 1847, when he was about fifteen, introduced into the service of the Electric Telegraph Company, at that time established to work the patents of Cooke and Wheatstone. From 1847 he was engaged in engineering construction work with the Electric Company until about 1850, when for a short time he was connected with the British Company. The year 1850 was notable in the history of the first-named association, because, owing to its high tariffs, a clamour arose for competition, and Acts of Parliament were granted to the Magnetic Telegraph Company and to the British Electric Telegraph Company, which were afterwards amalgamated under the name of the "British and Irish Magnetic Telegraph Company," generally known as the "Magnetic Company." Charles Bright then joined the Magnetic Company, of which his brother, Edward Bright, had been appointed Manager. Immediately on his appointment he was engaged in constructing new lines of overground telegraph. In 1852 he was

[1] This notice is abridged from the *Electrical Review*, May 11, 1888.

appointed Engineer to the company, and at this time he was occupied in carrying out an extensive scheme of underground wires between London, Manchester, Liverpool, and other places. The Electric Telegraph Company having secured the monopoly of erecting wires on the principal railways of the kingdom out of London, the Magnetic Company carried out, under the superintendence of Charles Bright, a large amount of underground work, in addition to overhead lines on some of the northern railways. Sir Charles speaks of this portion of his work: "Such of the railways in Great Britain as had not been exclusively secured by the Electric Company were eagerly arranged for by the new company (Magnetic), and nearly all in Ireland, which had not been thought worth attention by the Electric Company. In this way, competing lines were established on the Lancashire and Yorkshire, East Lancashire, Leeds Northern, Newcastle and Carlisle, Glasgow and South-Western, and throughout Ireland. To connect up with London, the Magnetic Company laid a line of ten wires in troughs along the high road by Birmingham to Manchester, continuing six wires to Preston, Carlisle, Dumfries, and Glasgow, with a fork from Dumfries to Portpatrick."[1] These lines were laid partly by the Company's staff, and the rest by Messrs. Reid and by Mr. Henley. The great underground system comprised 6,348 miles of wire. All this work, both overground and subterranean, entailed a vast amount of energy and perseverance on the part of Charles Bright, and many are the stories related of the difficulties overcome in the rapid progress of the work.

Perhaps the first thing which brought Charles Bright into public notice was laying the telegraph lines, under the streets of Manchester, in a single night, without disturbing the traffic. This he performed at the age of nineteen. The cables gradually failed, and overhead lines were substituted; but not until the work had proved of great value, as by means of the long underground lines, coupled together, it was demonstrated that telegraphic communication could be thus carried out to a distance exceeding that between this country and America.

The extension of the Magnetic Company's system throughout Ireland was in connection with the successful submersion of a submarine cable of six wires between Portpatrick, in Scotland, and Donaghadee, in Ireland. This was in 1853, and was the first occasion on which Charles Bright took a part in the submergence

[1] Journal of the Society of Telegraph-Engineers and Electricians, vol. xvi. 1887, p. 22.

of a submarine cable. Charles Bright continued as Engineer-in-Chief to the Magnetic Company until 1860, when he became Consulting Engineer, a position which he held until the acquisition of the telegraphs by the State, in 1870.

Mention may here be made of the inventions and improvements introduced by him into the working of the telegraph. There are few who are not familiar with Bright's insulators and shackles, and especially with the acoustic telegraph—so generally known and so largely adopted, and still in use—commonly called "Bright's Bells." The first patent taken out by Charles Bright, in connection with his brother, was on the 21st of October, 1852, when he was but twenty years old, for "Improvements in making telegraphic communications, and in instruments and apparatus employed therein and connected therewith." Amongst these improvements will be found a special system for testing insulated conductors, with the object of localizing the distance of an earth or contact from a station, by the use of a series of resistance-coils mounted in a box. This is the first mention to be met with of resistance-coils specially constructed of different values; and the credit of this system of testing rests entirely with Charles Bright. The same patent includes a standard galvanometer, which appears to foreshadow differential testing. The introduction of "shackling" off wires is also covered by this patent, and the system thus tried, to meet the especial requirements of cutting and terminating wires, has been carried out in substantially the same manner ever since. A novel arrangement of lightning-conductor, with the uses of "an exhausted air-tight glass box," shows that at that early date the effects of lightning in telegraphic work were disastrously felt. A repeater or translator, for relaying and re-transmitting electric currents of either kind in both directions, forms one of the claims. Whilst a "type-printing telegraph," a "centrifugal alarum," "winding coils for telegraphic purposes," are also included. The twelfth claim is for "causing mercury to effect metallic contact by compressing it in a closed vessel by means of air, &c., the points with which it is desired to make contact being within the vessel." The same patent also contains methods of insulating subterranean and submarine wires; in the former plan mention is made of "wires protected by a helically-wound riband of iron," a remarkable instance of foresight as to the class of sheath required for an insulated conductor.

It is stated that in the year 1854, Charles Bright and his brother were engaged with the late Mr. Staite in experiments on the electric light, which was exhibited nightly on the landing-stage

at Liverpool. During the same year Charles Bright devoted some time to experiments on dynamic electricity with Mr. Soren Hjorth, who constructed a dynamo-machine.

During the time referred to, and subsequently, the principal instrument employed by the Magnetic Company was Henley's magneto-electric telegraph, used either as a "single needle" or a "double needle." It was, indeed, the sole adoption of this instrument which gave the Company its name. This system of telegraphing by means of visual signals necessitated the constant and fatiguing attention of one telegraphist, whilst a writer was required to take down the words called out by the receiving operator as he read off the signals forming words. The substitution of aural signals for visual was contemplated by Charles Bright, as a manifest improvement; and, in conjunction with his brother, after numerous experiments, they took out a patent which, amongst other things, specially included what is universally known as "Bright's Bells." The patent is numbered 2,103, September 17th, 1855, "Improvements in electric telegraphs, and in apparatus connected therewith." This invention "consists of improvements in the electric telegraph complete," in which sound is employed as the communicating medium instead of visual indications. "A complete electro-phonetic telegraph instrument" and its necessary arrangements consist of the following parts:[1]—

"1st. The apparatus for and method of transmitting signals; this may also be applied to the telegraphs at present in use.

"2nd. The receiving relay; which has the means of increasing its sensitiveness and of protection from the effects of return currents.

"3rd. The 'phonetic,' a sounding apparatus; this 'may be either used separately as a complete instrument, or applied in part to other telegraph instruments now in use.'"

In this apparatus "the magnet, when acted on by electro-magnetic coils, causes the axle to vibrate or deflect in one direction, thus sounding a bell by means of a hammer-head on one arm; the subsequent reversal of the electric current causes a 'muffler' on the other arm to stop the sound."

It must be noted that this patent includes an arrangement "for enabling signals in opposite directions to be made simultaneously," a plan which was worked successfully between London and Birmingham. In this specification will also be found details for producing working-currents by means of "induction coils," the

[1] Abridgments of Specifications relating to Electricity and Magnetism. Part I. 1766–1857, p. 510.

patent including "an apparatus for obtaining a nearly continuous current from currents induced in secondary coils by the action of a quantity galvanic battery on primary coils." It will be seen, from an examination of these patents, what a large practical and scientific field Charles Bright covered as the result of his experience, his intuitive knowledge, his experimental investigations, and his foresight as to the requirements of telegraphic science.

During the time that the underground system of wires was growing under his hands, Charles Bright was carrying out numerous experiments as to the effects of the transmission of signals through long distances. Some of these experiments were detailed in a Paper read by Mr. Edward Bright, on "The Retardation of Electricity through long Subterranean Wires," before the British Association, at their meeting at Liverpool in 1854. In 1849 Werner Siemens observed the electric charge in underground line wires, and in 1852 Latimer Clark noticed the phenomenon of the slow transmission of electric currents through submerged wires; whilst, in 1854, Professor Faraday communicated two Papers on the same subject, one in January, relating to the speed of electric currents in submerged wires, and the other in May, to the effect that the speed was not affected by the power of the current employed. In his inaugural address as President of the Society of Telegraph-Engineers, in 1887, Sir Charles Bright thus alluded to his experimental researches:[1] "Having a great length of underground gutta-percha covered wire under my control as Engineer of the Magnetic Company, I carried out a long series of experiments by having the wires connected up backwards and forwards between London and Manchester, so as to form a continuous circuit of a length equal to that of a telegraph cable between Ireland and Newfoundland, or more than 2,000 miles. My method was to use a succession of opposite currents, which I had previously found to be successful with the magneto-electric currents used by that Company. I could only try my experiments at night, or on Sundays, when the traffic on the line was small." Mr. E. O. W. Whitehouse, who had been experimenting in the same direction with a cable, was, by means of Mr. Brett, brought into acquaintance with Charles Bright, "the result being that we continued our researches thereafter conjointly until the beginning of the Atlantic line, when we had to divide our labours, he becoming the Electrician, and I the Engineer of the Company."

[1] Journal of the Society of Telegraph-Engineers and Electricians. Vol. xvi. 1887, p. 27.

The commencement and formation of the first Atlantic Company will be told in Sir Charles Bright's own words, the question of the Atlantic having been discussed in 1855 between Mr. Brett, Mr. Cyrus Field, and himself. "On the 29th of September, 1856, an agreement was entered into between Mr. Brett, Mr. Cyrus Field, Mr. Whitehouse, and myself, by which we mutually engaged to exert ourselves, 'with the view and for the purpose of forming a company for establishing and working electric telegraph communication between Newfoundland and Ireland, such company to be called the Atlantic Telegraph Company, or by such other name as the parties hereto shall jointly agree upon.' Professor Morse, the Electrician of the Newfoundland Company, had also arrived in London, and Mr. Whitehouse and I showed him one night—the 9th October, 1856—at the office of the Magnetic Company in Old Broad Street, that signals could be sent at the rate of 210, 241, and, in one experiment, at the rate of 272 signals per minute, through the continuous circuit of 2,000 miles of the Company's underground wires between London and Manchester. The wires were joined backwards and forwards at Manchester and London; in each loop at both ends a galvanometer being inserted in the circuit to prove that the currents really passed through. By this the resistance, though not the retardation of the line, was largely increased. On the 20th October, 1856, the Atlantic Telegraph Company was registered, Mr. Brett heading the subscription list with £25,000, Mr. Field following him for the same amount. We then held meetings in Liverpool, Manchester, and Glasgow, which were addressed by all of us the Founders, and nearly the whole of the capital, consisting of 350 shares of £1,000 each, was subscribed for in a few days, principally by shareholders in the Magnetic Company."

The details of the Atlantic Cable, its construction and submersion, are matters of history. The manufacture of the cable was equally divided between the firms of Glass, Elliot and Co., and R. S. Newall and Co., both well known as the most experienced cable manufacturers of the day. Ably assisted by experienced colleagues, the two ships were fitted out for the work to be accomplished, with all the necessary appliances, for the great attempt of laying a cable in such deep water. An unsuccessful attempt was made in the year 1857, a failure having taken place soon after paying out from the two ships had commenced. This necessitated a postponement until the following year, when, with renewed hopes and improved machinery, a fresh departure was made, and on August 5th, 1858, the end of the first Atlantic cable was landed at Valentia,

and connection with America successfully accomplished. Charles Tilston Bright was immediately after the completion of this great undertaking knighted, as a recognition of the services rendered by him to the country and to science. At the unprecedentedly early age of twenty-six, he received this memorable honour. By those alone who are acquainted with submarine telegraphy, the enormous amount of energy required for the organization and fitting out of such an expedition in those early days, can the difficulties of such an undertaking be conceived. To the after failure of the cable, and the causes which led to it, it is unnecessary to refer. The result of the exertions of Sir Charles Bright was to prove that Atlantic telegraphy was an accomplished fact, and that communication electrically between the two Continents could be easily and satisfactorily maintained over a distance which science had now proved to be possible.

In 1858 Sir Charles assisted Mr. Robert Stephenson, M.P., Past President Inst. C.E., in advising the Government upon the best type of cable to be adopted for the Rangoon-Singapore Cable Expedition. In 1860 he was commissioned by the Spanish Government to lay submarine cables connecting the Balearic Islands with each other, and with Barcelona and St. Antonio on the main land. These cables were manufactured and successfully laid under his immediate superintendence, a work of some difficulty, as the depth of water in this portion of the Mediterranean was very considerable —1,400 fathoms.

In 1861 a partnership was formed between Sir Charles Bright and Mr. Latimer Clark, who had been for many years Engineer of the Electric and International Telegraph Company. During its existence experiments were undertaken on the insulation of gutta-percha covered wire. An exhaustive series of tests was compiled, obtained from a definite length of gutta-percha covered wire, specially prepared, and which was subjected to the influence of temperatures varying from freezing point to above 75°, from which a reliable result was derived, and a table of coefficients worked out, that is in constant use at the present time. In the same year a joint Paper was read by Sir Charles Bright and Mr. Latimer Clark before the British Association meeting held at Manchester, on "The formation of standards of measurement of electrical quantities and resistances." This subject attracted so much attention that a special committee was formed, of which Sir Charles was a member.

In 1862 the Government of India determined upon uniting the Turkish system of land telegraph at the head of the Persian Gulf,

and the Persian land telegraphs at Bushir by means of a submarine cable from those points down the Persian Gulf to Kurrachee.

A cable of great strength and durability was designed by Messrs. Bright and Clark, who were appointed engineers to the work. This cable, its construction and laying, was fully described in a Paper by Sir Charles Bright, read before this Institution in 1865,[1] and for which he received a Telford medal. The work was of a most important character, and was carried out with that thoroughness which had uniformly distinguished Sir Charles Bright. He proceeded to India, and the entire work from beginning to end was carried out under his immediate and personal supervision.

At the General Election of 1865, Sir Charles Bright was returned to Parliament as member for Greenwich, and retained his seat until the General Election in 1868, when he declined to stand again.

In 1862 he patented (No. 466) an improved method of applying asphalt composition to the outside of submarine cables—a composition originally patented by Mr. Latimer Clark. This system of protecting the outside of submarine cables had not up to that time been largely adopted, as on account of the heat employed, it was found to damage the insulation. The result of Sir Charles Bright's improved method was a plan which has been universally followed, and the composition called "Bright and Clark's compound" became a necessity.

In 1868, being Engineer to the Malta and Alexandria Company, he was out in the East, and in the following year was engaged in probably that which proved the most arduous of his many laborious cable experiences. This consisted of the large network of submarine cables submerged between the various West Indian Islands, and also the connections with the mainland of South America and Panama; besides erecting the telegraph lines on land, and establishing the telegraph stations, upwards of 4,000 miles of cable were laid. This expedition told very severely on Sir Charles Bright, as the continued stay in such a climate had a bad effect upon his health. Many of his staff died, and others were invalided home.

This was the last great work which had the advantage of his personal supervision. The remainder of his life was passed partly in following some commercial pursuits—mining being one of his particular quests—and in various electrical matters. In many

[1] Minutes of Proceedings Inst. C.E. vol. xxv. p. 1.

things his brother and himself were identified as regards their electrical connections. In 1881 he was appointed by the British Government as one of the Commissioners at the International Exhibition at Paris, and was nominated by the French Government an officer of the Legion of Honour. Sir Charles Bright was elected a Member of the Institution of Civil Engineers on the 4th of February, 1862. He was also from its foundation a Member of the Society of Telegraph Engineers and Electricians, and was elected President of that Society for the year 1886–1887. His inaugural address will long be remembered for its early recollections and history of the telegraph, and will now be doubtless considered as an "autobiography." His year of office had barely expired when Sir Charles himself passed to his rest.

MARK WILLIAM CARR died suddenly at Morelia, in Mexico, on the 5th of February, 1888, whither he had gone to examine and report on some silver-mines, on behalf of parties in England. Mr. Carr was born in the year 1822, at North Shields, and was the son of the late John Thomas Carr, who became Russian Consul and Sheriff of Newcastle-on-Tyne. He was educated at the Grammar-school in Newcastle, and in the year 1837 he entered the works of Messrs. Robert Stephenson and Co., where he served an apprenticeship of six years in the shops and drawing-office of that establishment. He then proceeded to the University of Glasgow, where, under the guidance of Professor Gordon, he prosecuted scientific studies bearing on engineering.

On leaving Glasgow he obtained an appointment as Resident Engineer for the construction of the Syston and Peterborough Railway, under Messrs. Liddell and Gordon, who were the Engineers of the Company. He afterwards, under the same gentlemen, became Resident Engineer of the Newport, Abergavenny, and Hereford Railway, which included the construction of the well-known Crumlin Viaduct, one of the most novel constructions of the time, being entirely of iron, including the piers, and about 200 feet in height over the valley. Mr. Carr remained on this line after it was opened, occupying the positions of Resident Engineer and of Locomotive Superintendent, for which his early training admirably fitted him.

In 1858 he was appointed Chief Engineer of the Great Southern of India Railway, on the recommendation of Mr. George B. Bruce, President Inst. C.E., Consulting Engineer of that railway. Five