analogous to the action of the state in the cases referred to is the action taken by municipal authorities with the authority of the legislature in competing with or superseding private companies for the supply of electric light, gas, water, tramways and other public services. . . . The service which the govern­ment and the colonies desire is one which neither the Eastern Telegraph Company nor any other private enterprise is prepared to undertake on terms which can be considered in comparison with the terms upon which it can be provided by the associated governments.”

In November 1899 a committee was appointed by the Colonial Office for the further examination of the scheme, and towards the end of 1900 a tender was accepted for the manufacture and laying of a submarine cable between the Island of Vancouver and Queensland and New Zealand for the sum of £1,795,000, the work to be completed by the 31st of December 1902. A board was constituted to supervise the construction and working of the cable, composed of representatives of the several govern­ments, with offices at Westminster. Under the Pacific Cable Act 1901 the capital sum of £2,000,000 was provided in the following proportions:—

United Kingdom, 5∕18ths with 3 representatives including the chairman.

Canada, 5∕18ths with 2 representatives.

Australia, 6/18ths with 2 representatives.

New Zealand, 2∕18ths with 1 representative.

In these proportions the respective contributing governments are responsible for the losses made in the working of the under­taking. The annual expenses of the board include £35,000 for cable repairs and reserve and a fixed payment to the National Debt Commissioners of £77,544 as sinking fund to amortise capital expenditure in fifty years. The deficiency on the working for the year ended 31st March 1907 was £54,924, and the approximate number of messages transmitted during the year was 96,783 with 1,126,940 words. There was in addition a considerable inter-colonial traffic between Australia, New Zealand and the Fijis.

Since the early days of international telegraphy, conferences of representatives of government telegraph departments and companies have been held from time to time (Paris 1865, Vienna 1868, Rome 1871 and 1878, St Petersburg 1875, London 1879, Berlin 1885, Paris 1891, Buda Pesth 1896, London 1903). In 1868 the International Bureau of Telegraphic Administra­tions was constituted at Berne, and a convention was formulated by which a central office was appointed to collect and publish information and generally to promote the interests of inter­national telegraphy. International service regulations have been drawn up which possess equal authority with the con­vention and constitute what may be regarded as the law relating to international telegraphy. The total lengths of the land lines of the telegraphs throughout the world in 1907 were 1,015,894 m. aerial, and 11,454 m. underground, and the total lengths of submarine cables of the world were 39,072 nautical miles under government administration and 194,751 nautical miles under the administration of private companies.

Bibliography.—*Reports to the Postmaster-General upon proposals for transferring to the Post Office the Telegraphs throughout the United Kingdom* (1868); *Special Reports from Select Committee on the Electric Telegraphs Bills* (1868, 1869); *Report by Mr Scudamore on the reorganization of the Telegraph system of the United Kingdom* (1871); *Journ. Statistical Society* (September 1872, March 1881); *Report of a Committee appointed by the Treasury to investigate the causes of the increased cost of the Telegraphic Service, &c.* (1875); *Reports of the Postmaster-General for* 1895, &c.; *Journ. Inst. Elec. Eng.* (November 1906); H. R. Meyer, *The British State Telegraphs* (London, 1907); *The ‘‘Electrician” Electrical Trades Directory;* E. Garcke, *Manual of Electrical Undertakings.* On submarine cables see also the works of Sir Charles Bright's son, Mr Charles Bright, F.R.S.E., A.M.Inst.C.E., M.I.E.E.; *e.g.* his *Life* of his father (1898), his *Address* to London Chamber of Commerce on "Imperial Telegraphic Communication" (1902), *Lecture* to Royal United Service Institution on "Submarine Telegraphy" (1907), *Lectures* to Royal Naval War College (1910) and R.E. Military School (1908) on “Submarine Cable Laying and Repairing," and articles in *Quarterly Review* (April 1903) on "Imperial Telegraphs,” and in *Edinburgh Review* (April 1908) on "The International Radio­Telegraphic Convention.” (E. Ga.)

Part II.—Wireless Telegraphy

The early attempts to achieve electric telegraphy involved the use of a complete metallic circuit, but K. A. Steinheil of Munich, however, acting on a suggestion given by Gauss, made in 1838 the important discovery that half of the circuit might be formed of the conducting earth, and so discovered the use of the *earth return,* since then an essential feature of nearly every telegraphic circuit. Encouraged by this success, he even made the further suggestion that the remaining metallic portion of the circuit might perhaps some day be abolished and a system of wireless telegraphy established.@@1

Morse showed, by experiments made in 1842 on a canal at Washington, that it was possible to interrupt the metallic electric circuit in two places and yet retain power of electric communication (see Fahie, *loc. cit.,* p. 10). His plan, which has been imitated by numerous other experimentalists, was as follows:—On each side of the canal, at a considerable distance apart, metal plates *e e* (fig. 35) were sunk in the water; the pair on one side were connected by a battery B, and the pair on the other by a galvanometer or telegraphic receiver R. Under these circumstances a small portion of the current from the battery is shunted through the galvanometer circuit, and can be used to make electric signals. Morse and Gale, who assisted him, found, how­ever, that the distance of the plates up and down the canal must be at least three or four times the width of the canal to obtain successful results. Numerous investigators followed in Morse’s footsteps. James Bowman Lindsay of Dundee, between 1845 and 1854, reinvented and even patented Morse’s method, and practically put the plan into operation for experimental purposes across the river Tay. J. W. Wilkins in 1849, and H. Highton in experiments described in 1872, also revived the same suggestion for wireless telegraphy.

The invention of the magneto-telephone put into the hands of electricians a new instrument of extraordinary sensitiveness for the detection of feeble interrupted, or alternating, cur­rents, and by its aid J. Trowbridge in 1880, in the United States, made a very elaborate investigation of the propagation of electric currents through the earth, either soil or water (see “ The Earth as a Conductor of Electricity,” *Amer. Acad. Arts and Sci.,* 1880). He found, as others have done, that if a battery, dynamo or induction coil has its terminals connected to the earth at two distant places, a system of electric currents flows between these points through the crust of the earth. If the current is interrupted or alternating, and if a telephone receiver has its terminals connected to a separate metallic circuit joined by earth plates at two other places to the earth, not on the same equipotential surface of the first circuit, sounds will be heard in the telephone due to a current passing through it. Hence, by inserting a break-and-make key in the circuit of the battery, coil or dynamo, the uniform noise or hum in the telephone can be cut up into periods of long and short noises, which can be made to yield the signals of the Morse alphabet. In this manner Trowbridge showed that signalling might be carried on over considerable distances by electric conduction through the earth or water between places not metallically connected. He also repeated the suggestion which Lindsay had already made that it might be possible to signal in this manner by conduction currents through the Atlantic Ocean from the United States to Europe. He and others also suggested the applicability of the method to the inter-communication of ships at sea. He proposed that one ship should be provided with the means of making an interrupted current in a circuit formed partly of an insulated metallic wire connected with the sea at both ends by plates, and partly of the unlimited ocean. Such an arrangement would distribute a

@@@1 For a history of the discovery of the earth return, see Fahie, *History of Electric Telegraphy to the Year 1837,* ρρ. 343-348.