to stray “ earth currents,” and very good signalling was estab­lished between the mainland and the rock. Owing to the rough seas sweeping over the Fastnet, the conditions are such that any ordinary submarine cable would be broken by the wearing action of the waves at the rock boundary in a very short time. Another worker in this department of research was C. A. Stevenson, who in 1892 advocated the use of the inductive system pure and simple for communication between the main­land and isolated lighthouses or islands. He proposed to employ two large flat coils of wire laid horizontally on the ground, that on the mainland having in circuit a battery, interrupter and key, and that on the island a telephone. His proposals had special reference to the necessity for connecting a lighthouse on Muckle Flugga, in the Shetlands, and the main­land, but were not carried into effect. Professor E. Rathenau of Berlin made many experiments in 1894 in which, by means of a conductive system of wireless telegraphy, he signalled through 3 m. of water.

Sir Oliver Lodge in 1898 theoretically examined the inductive system of space telegraphy. (See *Jour. Inst. Elec. Eng.,* 27, p. 799.) He advocated and put in practice experimentally a system by which the primary and secondary circuits were “ turned ” or syntonized by including condensers in the circuits. He proved that when so syntonized the circuits are inductively respondent to each other with a much less power expenditure in the primary circuit than without the syntony. He also devised a “ call ” or arrangement for actuating an ordinary electric bell by the accumulated effect of the properly tuned inductive impulses falling on the secondary circuit. A very ingenious call-bell or annunciator for use with inductive or conductive systems of wireless telegraphy was invented and described in 1898 by S. Evershed, and has been practically adopted at Lavernock and Flat Holme. (*Id.,* 27, p. 852.)

In addition to the systems of wireless or space telegraphy de­pending upon conduction through earth or water, and the in­ductive system based upon the power of a magnetic field created round one circuit to induce, when varied, a secondary current in another circuit, there have been certain attempts to utilize what may best be described as electrostatic induction. In 1885 Edison, in conjunction with Gilliland, Phelps, and W. Smith, worked out a system of communicating between railway stations and moving trains. At each signalling station was erected an insulated metallic surface facing and near to the ordinary telegraph wires. On one or more of the carriages of the trains were placed also insulated metallic sheets, which were in connexion through a telephone and the secondary circuit of an induction coil with the earth or rails. In the primary circuit of the induction coil was an arrangement for rapidly intermitting the current and a key for short-circuiting this primary circuit. The telephone used was Edison’s chalk cylinder or electromotograph type of telephone. Hence, when the coil at one fixed station was in action it generated high frequency alternating currents, which were propagated across the air gap between the ordinary telegraph wires and the metallic surfaces attached to one secondary terminal of the induction coil, and conveyed along the ordinary telegraph wires between station and moving train. Thus, in the case of one station and one moving railway carriage, there is a circuit consisting partly of the earth, partly of the ordinary telegraph wires at the side of the track, and partly of the circuits of the telephone receiver at one place and the secondary of the in­duction coil at the other, two air gaps existing in this circuit. The electromotive force of the coil is, however, great enough to create in these air gaps displacement currents which are of magnitude sufficient to be equivalent to the conduction current required to actuate a telephone. This current may be taken to be of the order of two or three micro-amperes. The signals were sent by cutting up the continuous hum in the telephone into long and short periods in accordance with the Morse code by manipulating the key in the primary circuit. The system was put into practical operation in 1887 on the Lehigh Valley railroad in the United States, and worked well, but was abandoned because it apparently fulfilled no real public want. Edison also patented (U.S.A. *Pat. Spec.,* No. 465971, 14th May 1885) a plan for establishing at distant places two insulated elevated plates. One of these was to be connected to the earth through a telephone receiver, and the other through the secondary circuit of an induction coil in the primary circuit of which was a key. The idea was that variations of the primary current would create electromotive force in the secondary circuit which would act through the air condenser formed by the two plates. It has sometimes been claimed that Edison’s proposed elevated plates anticipated the subsequent invention by Marconi of the aerial wire or antenna, but it is particularly to be noticed that Edison employed no spark gap or means for creating electrical high frequency oscillations in these wires. There is no evidence that this plan of Edison’s was practically operative as a system of telegraphy.

A very similar system of wireless telegraphy was patented by Professor A. E. Dolbear in 1886 (U.S.A. *Pat. Spec.,* No. 350299), in which he proposed to employ two batteries at two places to affect the potential of the earth at those places. At the sending station one battery was to have its positive pole connected to the earth and its negative pole to an insulated condenser. In circuit with this battery was placed the second­ary circuit of an induction coil, the primary circuit of which contained a telephone transmitter or microphone interrupter. At the receiving station a telephone receiver was placed in series with another insulated battery, the negative terminal of which was to be in connexion with the earth. There is no evidence, however, that the method proposed could or did effect the transmission of speech or signals between stations separated by any distance. Many other more or less imperfect devices—such as those of Mahlon Loomis, put forward in 1872 and 1877, and Kitsee in 1895—for wireless telegraphy were not within the region of practically realizable schemes.

*Space or Radio-Telegraphy by Hertzian Waves.—*Up to 1895 or 1896 the suggestions for wireless telegraphy which had been publicly announced or tried can thus be classified under three or four divisions, based respectively upon electrical conduction through the soil or sea, magnetic induction through space, combinations of the two foregoing, and lastly, electrostatic induction. All these older methods have, however, been thrown into the background and rendered antiquated by inven­tions which have grown out of Hertz’s scientific investigations on the production of electric waves. Before the classical researches of Hertz in 1886 and 1887, many observers had noticed curious effects due to electric sparks produced at a distance which were commonly ascribed to ordinary electro­static or electro-magnetic induction. Thus Joseph Henry *(Scientific Writings,* vol. i. p. 203) noticed that a single electric spark about an inch long thrown on to a circuit of wire in an upper room could magnetize steel needles included in a parallel circuit of wire placed in a cellar 30 ft. below with two floors intervening. Some curious distance-phenomena connected with electric sparks were observed in 1875 by Edison (who referred them to a supposed new “ aetheric force ”), and confirmed by Beard, S. P. Thompson, E. J. Houston and others.@@1 D. E Hughes made some remarkable observations and experiments in or between the years 1879 and 1886 though he did not describe them till some twenty years afterwards. He dis­covered a fact subsequently rediscovered by others, that a tube of metallic filings, loosely packed, was sensitive to electric sparks made in its vicinity, its electrical resistance being re­duced, and he was able to detect effects on such a tube con­nected to a battery and telephone at a distance of 500 yds.@@2

These distance effects were not understood at the time, or else were referred simply to ordinary induction. Hertz, however, made known in 1887 the experimental proofs that the discharge

@@@1 See *Telegraphic Journal of London,* vol. iv. pp. 29, 46, 61 ; *Proc. Phys. Soc. Lond.,* vol. ii. p. 103.

@@@2 See Fahie, *History of Wireless Telegraphy,* p. 289; also an im­portant letter by D. E. Hughes in *The Electrician,* London, 1899, 43. 40.