perfect electrical contact between the steel and mercury for low voltage currents, but when electric oscillations were passed through the junction it was pierced and good electrical contact established as long as the oscillations continued. This device was converted into an electric wave detector as follows:—The mercury-steel junction was acted upon by the electromotive force of a shunted single cell and a siphon recorder was inserted in series. The wheel was con­nected to a receiving antenna and the mercury to earth or to an equivalent balancing capacity. When electric waves fell on the antenna they caused the mercury-steel junction to become con­ductive during the time they endured, and the siphon recorder therefore to write signals consisting of short or long deflexions of its pen and therefore notches of various length on the ink line drawn on the strip of telegraphic tape.

An innumerable number of forms of coherer or wave detector depending upon the change in resistance produced at a loose or imperfect contact have been devised. A.. Popoff,@@1 E. Branly,@@2 A. Blondel,@@6 O. Lodge@@4 and J. A. Fleming@@5 invented special forms of the metallic contact or metallic filings sensitive tube. Brown and Neilson,@@6 F. J. Jervis-Smith@@7 and T. Tommasina@@8 tried carbon in various forms. The theory of the action of the coherer has occu­pied the attention of T. Sundorp,@@9 T. Tommasina,@@8 K. E. Guthe,@@10 J. C. Bose,@@11 W. H. Eccles,@@12 and Schäfer.@@13 For details see J. A. Fleming, *The Principles of Electric Wave Telegraphy and Telephony,* p. 416, 2nd ed. 1910.

The next class of wave or oscillation detector is the magnetic detector depending upon the power of electric oscillations to affect the magnetic state of iron. It had long been known that the discharges from a Leyden jar could magnetize or demagnetize steel needles. J. Henry in the United States in 1842 and 1850 investi­gated the effect. In 1895 E. Rutherford examined it very care­fully, and produced a magnetic detector for electric waves depending upon the power of electric oscillations in a coil to demagnetize a saturated bundle of steel wires placed in it (see *Phil. Trans.,* 1897, 189 A, p. 1). Rutherford used this detector to make evident the passage of an electric or Hertzian wave for half a mile across Cambridge, England. In 1897 E. Wilson constructed various forms of electric wave detector depending on this same principle. In 1902 Marconi invented two forms of magnetic detector, one of which he developed into an electric wave detector of extraordinary delicacy and utility (see *Proc. Roy. Soc.,* 1902, 70, p. 341, or *British Pat. Spec.,* No. 10245 of 1902). In this last form an endless band of hard iron wires passes slowly round two wooden pulleys driven by clockwork. In its course it passes through a glass tube wound over with two coils of wire; one of these is an oscillation coil through which the oscillations to be detected pass, and the other is in connexion with a telephone. Two horse-shoe magnets are so placed (fig. 45) that they magnetize the part of the iron band pass­ing through the coil. Owing to hysteresis the part of the band magnetized is not symmetrically placed with regard to the magnetic poles, but advanced in the direction of motion of the band. When the oscillations pass through the coil they annul the hysteresis and cause a change of magnetism within the coil connected to the telephone. This creates a short sound in the telephone. Hence accord­ing as the trains of oscillations are long or short so is the sound heard in the telephone, and these sounds can be arranged on the Morse code into alpha­betic audible signals. When used as a receiver for wireless telegraphy Marconi inserted the oscillation coil of this detector in between the earth and a receiving antenna, and this produced one of the most sensitive receivers yet made for wireless telegraphy. Other forms of magnetic detector have been devised by J. A. Fleming,@@14 L. H. Walter and J. A. Ewing,@@15 H. T. Simon and Μ. Reich,@@16 R. A. Fessenden @@17 and others.

A third class of electric wave detector depends upon the power of electric oscillations to annul the electrolytic polarization of electrodes of small surface immersed in an electrolyte. If in a vessel of nitric acid are placed a large platinum plate and a platinum electrode of very small surface such as that produced when an extremely fine platinum wire is slightly immersed in the liquid, and if a current from a single voltaic cell is passed through the electrolytic cell so that the fine wire is the anode or positive pole, then the small surface will be polarized or covered with a film of gas due to electrolysis (fig. 46). This increases the resistance of the electrolytic cell.. If, however, one electrode of this cell is con­nected to the earth and the other to a receiving antenna and electric waves allowed to fall on the an­tenna, the oscillations passing through the electrolytic cell will remove the polarization and temporarily decrease the resistance of the cell. This may be detected by putting a telephone in series with the electrolytic cell, and then on the impact of the electric waves a sound is heard in the telephone due to the sudden increase in the current through it. Such receivers were devised by R. A. Fessenden,@@18 W. Schloemilcfi@@19 and others, and are known as electrolytic detectors. Discussions have taken place as to the theory of the operations in them, in which some have advocated a thermal explanation and others a chemical ex­planation (see V. Rothmund and A. Lessing, *Ann. der Physik,* 1904, 15, p. 193, and J. E. Ives, *Electrical World* of New York, December 1904).

A fourth class of electric wave detector comprises the thermal detectors which operate in virtue of the fact that electric oscilla­tions create heat in a fine wire through which they pass. One form such a detector takes is the *bolometer.* If a loop of very fine platinum wire, prepared by the Wollaston process, is included in an exhausted glass bulb like an incandescent lamp, then when electric oscillations are sent through it its resistance is increased. This increase may be made evident by making the loop of wire one arm of a Wheatstone’s bridge and so arranging the circuits that the oscillations pass through the fine wire. H. Rubens and Ritter in 1890 *(Wied. Ann.,* 1890, 40, p. 56) employed an arrangement as follows: Four fine platinum or iron wires were joined in lozenge shape, and two sets of these R and S were connected up with two resistances P and Q to form a bridge with a galvanometer G and battery B. To one of these sets of fine wires an antenna A and earth connexion E is added (fig. 47) and when electric waves fall on A they excite oscillations in the fine wire resistance R and increase the resistance, and so upset the balance of the bridge and cause the galvanometer to deflect. Such a bolometer receiver has been used by C. Tissot *(Comptes rendus,* 1904, 137, p. 846) and others as a receiver in electric wave telegraphy.

Fessenden employed a simple fine loop of Wollas­ton platinum wire in series with a telephone and shunted voltaic cell, so that when electric oscillations passed through the fine wire its resistance was. increased and the current through the telephone suddenly diminished (R. A. Fessenden, *U.S.A. Pat. Spec.,* No. 706742 and No. 706744 of 1902). I. Klemençiç devised a form of thermal receiver depending on thermoelectricity. A pair of fine wires of iron and constantan are twisted together in the middle, and one pair of unlike ends are connected to a galvanometer. If then oscilla­tions are sent through the other pair heat is produced at the junction and the galvanometer indicates a thermoelectric current *(Wied. Ann.,* 1892, 45, p. 78). This thermoelectric receiver was made vastly more sensitive by W. Duddell *(Phil. Mag.,* 1904, 8, p. 91). He passed the oscillations to be detected through a fine wire or strip of gold leaf, and over this, but just not touching, suspended a loop of bismuth-antimony wire by a quartz fibre. This loop hung in a very strong magnetic field, and when one junction was heated by radiation and convection from the heating wire the loop was

@@@1 A. Popoff, *The Electrician,* 1897, 40, p. 235.

@@@2 E. Branly, *Comptes rendus,* 1890, 111, p. 785, and *The Electrician,* 1891, 27, p. 221.

@@@3 A. Blondel, *The Electrician,* 1899, 43, p. 277.

@@@4 O. Lodge, *The Electrician,* 1897, 40, p. 90.

@@@5 J. A. Fleming, *Journ. Inst. Elec. Eng. Lond.,* 1899, 28, p. 292.

@@@6 Brown and Neilson, *Brit. Patent Spec.,* No. 28958, 1896.

@@@7 F. J. Jervis-Smith, *The Electrician,* 1897, 40, p. 85.

@@@8 T. Tommasina, *Comptes rendus,* 1899, 128, p. 666.

@@@9 T. Sundorp, *Wied. Ann.,* 1899, 60, p. 594.

@@@10 K. E. Guthe, *The Electrician,* 1904, 54, p. 92.

@@@11 J. C. Bose, *Proc. Roy. Soc. Lond.,* 1900, 66, p. 450.

@@@12 W. H. Eccles, *The Electrician,* 1901, 47, p. 682.

@@@18 Schäfer, *Science Abstracts,* 1901, 4, p. 471.

@@@14 See J.. A. Fleming, “ A Note on a Form of Magnetic Detector for Hertzian Waves adapted for Quantitative Work,” *Proc. Roy. Soc.,* 1903, 74, p. 398.

@@@15 L. H. Walter and J. A. Ewing, *Proc. Roy. Soc.,* 1904, 73, p. 120.

@@@16 Simon and Reich, *Elektrotech. Zeits.,* 1904, 22, p. 180.

@@@17 R. A. Fessenden, *U.S.A. Pat. Spec.,* No. 715043 of 1902.

@@@18 See R. A. Fessenden, *U.S.A. Pat. Spec.,* No. 731029, and re­issue No. 12115 of 1903.

@@@19 W. Schloemilch, *Elektrotech. Zeits.,* 1903, 24, p. 959, or *The Electrician,* 1903, 52, p. 250.