in delicate contact with it. When the sounding board was spoken to or subjected to sound-waves, the mechanical re­sistance of the loose electrode, due to its weight, or the spring, or both, served to vary the pressure at the contact, and this gave to the current a *form* corresponding to the sound-waves, and it was therefore capable of being used as a speaking-telephone transmitter.@@1 The best transmitters now in use are modifications of Hughes’s apparatus. A microphonic apparatus very similar to it is described in the specification of a German patent taken out by Robert Lutdge on 12th January 1878. In this patent the action of the microphone is also described.@@2

The next transmitter of note, introduced by Mr Francis Blake, U.S. (see fig. 13 below), although it does not, like the first microphones, embody anything intrinsically new, is one of the most perfect and convenient forms of micro­phone. It is at present almost universally used in the United States.

It appears to be pretty well established that carbon in one form or another is the best material for one or both of the contacts of a microphone transmitter. When both the contacts are of carbon and the surfaces have consider­able area, say from a quarter to half an inch in diameter, the sounds are loud, but have a tendency to harshness. When, as in the Blake transmitter, one of the contacts is a piece of polished gas carbon and the other a small sphere of platinum about the twentieth of an inch in diameter, the articulation is clear, but less loud. For most purposes, however, the increased clearness more than compensates for the diminished loudness. Many transmitters in actual use—as, for instance, the “Gower,” largely employed in the United Kingdom—have a number of contacts. Some of these when properly adjusted are both loud and clear in their action. Although the Blake instrument is most in vogue in America, in the United Kingdom and on the Continent multiple contact microphones have found more favour. Carbon powder instruments have been to some extent used, and in one or two cases—as, for example, the Hunnings transmitter—with considerable success. The fault in most of them is the tendency of the powder to “ pack,” which causes the instrument to rapidly lose sensi­bility. In the Hunnings transmitter this difficulty is to a large extent overcome by the use of a coarse granular powder in a somewhat large cell (about an inch in diameter and from one-eighth to one-fourth of an inch deep). The front face of the cell is a piece of platinum foil, which serves both as an electrode and as a diaphragm. The cell is placed either on edge or in an inclined position when in use, the action being precisely similar to that in other transmitters. In addition to its freedom from packing, the carbon, in consequence of the inclined position of the cell, is also less liable to fall away from the electrode and break the circuit. Some packing of the powder, however, does occur, and several modifications have been proposed by Blake and others for making the sound vibrations stir the powder and keep it loose. Good results appear to have been got by placing the cell mouth downwards, the carbon powder lying on the platinum foil, and by forming the upper electrode either of wire gauze or of a perforated plate completely immersed in the powder. The sound vibrations are con­veyed to the bottom of the cell by a bent tube communi­cating with a mouthpiece. Instruments of this class are very loud-speaking, and therefore very serviceable for long or disturbed circuits.

The radiophone is an instrument proposed by A. G. Bell

and Sumner Tainter in 1880 for utilizing radiant energy, such as light or radiant heat, for the transmission of sound. The apparatus forms a telephone transmitter of a particu­larly interesting kind. In the earlier papers describing it and the experiments which led to its invention it is called *photophone,* because at that time the effects were supposed to be wholly due to light. Afterwards, in order to avoid ambiguity, Bell changed the name to *radiophone* and sug­gested that, to distinguish between instruments depending on the different kinds of radiation, the names *photophone, thermophone,* &c., should be employed. He also proposed the name *spectrophone* for an application of this instrument to spectrum investigation.@@3 The apparatus is founded on the discovery, made by Mr May while carrying out experi­ments on selenium for Mr Willoughby Smith, that when selenium is exposed to light its electrical resistance is very different from what it is in the dark. This discovery led to a great many interesting experiments by other investi­gators.@@4 In thinking over this discovery in 1878 Bell con­ceived the idea that, if a beam of light proceeding from one station could be made to fall on a selenium plate at another station, and if its intensity could be varied by the voice of a speaker, then by connecting a telephone and a battery in circuit with the selenium plate the words spoken at the distant station would be heard in the telephone. This was found to be the case. At first, to vary the intensity of the beam, it was passed through a small opening, the width of which could be varied by the vibrations of a diaphragm against which the speech was directed. But better results were afterwards obtained when the diaphragm formed a mirror from which the beam of light was reflected. The spreading of the beam, due to the vibrations of the mirror diaphragm, served to vary its intensity (see fig. 18 below).

Edison’s phonograph (see fig. 19 below) is an instrument whose action somewhat resembles that of a telephone trans­mitter and which has been much talked of in regard to its possible applications in telephony. It was invented shortly after the introduction of the telephone for the purpose of recording sounds, and was included in some of Edison’s telephone patents as a means of working a telephone trans­mitter, and thus telephoning sounds which had been pre­viously recorded on the phonograph sheets.

II. Telephonic Instruments.

One of the best-known forms of the Reis telephone is shown in fig. 1. The transmitter consists of a box A, provided with a mouth­piece Μ. In the top of the box a round hole is cut and across it a membrane S of hog’s bladder is stretched. A thin strip of platinum *p* fixed to the box at one side of the hole and extend­ing to the centre of the membrane, supports at that point one foot of a light metal tripod *egf.* One of the feet, *e* or *f,* rests in a cup containing mercury, which is in metallic connexion with the terminal *b,* while

@@@1 See *Proc. Roy. Soc.,* vol. xxvii. p. 362 ; *Proc. Phys. Soc.,* vol. ii. p. 255 ; *Phil. Mag.,* 5th ser., vol. vi. p. 44 ; Preece, *Journ. Soc. Tel. Eng.,* vol. vii. p. 270.

@@@2 Although this patent is dated prior to Hughes’s publications, it does not follow that the descriptions were filed before these.

@@@3 On this subject see A. G. Bell, *Phil. Mag.,* 5th ser., vol. xi. p. 510, and *Journ. Soc. Tel. Eng.,* vol. ix. p. 404 ; Mercadier, *Phil. Mag.,* 5th ser., vol. xi. p. 78 ; Tyndall, *Proc. Roy. Soc.,* vol. xxxi. p. 307 ; Routgen, *Phil. Mag.,* 5th ser., vol. xi. p. 308 ; Preece, *Proc. Roy. Soc.,* vol. xxxi. p. 506 ; Rayleigh, *Nature,* vol. xxiii. p. 274, and *Proc. Roy. Soc.,* 1877; Bidwell, *Phil. Mag.,* 5th ser., vol. xi. p. 302; S. P. Thomp­son, *Phil. Mag.,* 5th ser., vol. vi. p. 276.

@@@4 See W. Smith, *Journ. Soc. Tel. Eng.,* vol. v. p. 183, and vol. vi. p. 423 ; Μ. L. Sale, *Proc. Roy. Soc.,* vol. xxi. p. 283, and *Phil. Mag.,* 4th ser., vol. xlvii. p. 216 ; Draper and Moss, *Proc. Roy. Irish Acad.,* vol. i. p. 529 ; Rosse, *Phil. Mag.,* 4th ser., vol. xlvii. p. 161 ; W. G. Adams, *Proc. Roy. Soc.,* vol. xxiii. p. 535 and vol. xxiv. p. 163 ; W. G. Adams and B. E. Day, *ibid.,* vol. xxv. p. 113 ; Werner Siemens, *Monatsber. kön. Preuss. Akad. der Wissensch. zu Berlin,* 1875, p. 280, and *Phil. Mag.,* 4th ser., vol. i. p. 416 ; Sabine, *Phil. Mag.,* 5th ser., vol. v. p. 401.