Operators' Transmitters and Receivers

By H. I. BEARDSLEY
Apparatus Development Department

WITH the institution of the first telephone central office there arose a need for transmitters and receivers which were suitably arranged for operators' use. The requirements for these instruments in central office service were so different from those of use at the homes and offices of subscribers that instruments for the two types of service necessarily were developed along separate lines. The development of operators' instruments has profited by the fundamental studies made upon instruments in general, but at the same time has involved differentiations in physical form to facilitate the work of the operators in handling subscribers' calls.

Succeeding the original "butter stamp" hand telephone the instrument, used by the operators in 1878, was a device serving both as a transmitter and receiver. In appearance slightly resembling a desk stand receiver of today, it is shown in use in Figure 1 of the historical pictures. Developed by Bell and known therefore as Bell's hand telephone, it was a single-pole, permanent magnet instrument. The magnet was a straight bar mounted at right angles to the diaphragm, and bore a coil placed around a soft-iron extension at the end. The earliest of these instruments were enclosed in cases of wood. When one was used as a transmitter, sound waves impinging upon the diaphragm caused it to vibrate and so varied the magnetic field, inducing in the coil varying currents which were electric counterparts of the sound waves. When this instrument was used as a receiver the incoming voice current, by its variations, changed the magnetic field of the coil through which it flowed, thereby vibrating the diaphragm and producing a close approximation to the original sounds.

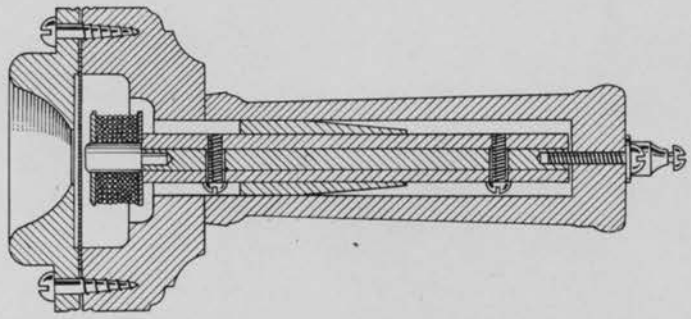
The following year, 1879, there came the instrument shown in Figure 2. The transmitter and receiver units were separate, but were arranged to be held in one hand. The transmitter, of the type developed by Edison, was changed in function; it no longer generated the voice-current, but by changing its resistance in response to the sound waves it varied the current supplied by a battery. A toothed metal ring in contact with the back of the diaphragm pressed against the front electrode, a hard carbon disc. By that construction pressure of the disc against the back electrode, a disc of soft carbon, was varied, and the current was changed correspondingly. The receiver operated on the same principle as the older instrument and was made up of equivalent parts. Instead of being at right angles to the diaphragm however the bar magnet formed the handle on which the transmitter and receiver were mounted.

That same year there was introduced the operator's set of Figure 3, with the transmitter and receiver en-

1, *Bell's hand telephone in use as a transmitter. The same instrument acts as a receiver with incoming voice-currents*; 2, *Transmitter and receiver were mounted at opposite ends of a bar magnet in this operator's handset of* 1879; 3, *An early Blake transmitter and associated receiver, mounted to leave one of the operator's hands free*; 4, *Instruments the same as those of Figure* 3, *supported in a "Gilliland harness" to free both hands*; 5, *Another mounting arrangement keeping both hands free*

6, A White Transmitter, and a Richards receiver mounted on a headband. The set was brought out in 1891; 7, Another supported transmitter, used with a completely enclosed receiver. Compactness of the receiver was obtained by use of a spiral magnet; 8, In this set the transmitter is essentially the same as those of today, and the receiver is of bipolar type, with a horseshoe magnet; 9, Today's set, with receiver held by a swivel yoke to a wire headband

tirely separate. The transmitter derived its name from Francis Blake, Jr., who carried out the original development on which it was based; its operation was by variation in resistance at the contact between the disc of hard carbon and a metal ball supported against the back of the diaphragm by a light spring. A heavier flat spring supporting the disc kept it pressed against the ball, so that vibrations of the diaphragm produced pressure differences at the contact area. To secure the proper range of pressures, adjustment was provided by supporting the spring upon a hinge-like member whose position was controlled by a screw. The transmitter was enclosed in a wooden box having an opening in front of the diaphragm, and was supported before the operator by a vertical rod. The receiver, held in the operator's hand during use, was unchanged in principle, but resembled in appearance the desk stand receivers with external binding-posts; the case was of hard rubber.



Section of Bell's hand telephone which was used as both transmitter and receiver

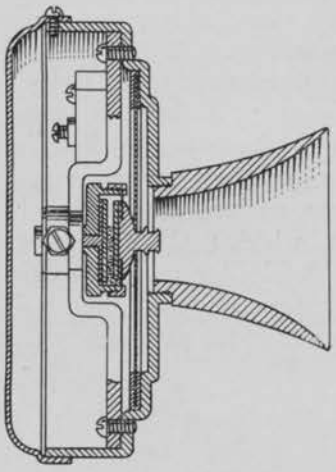
The next year the same instruments were mounted in a structure which freed both the operator's hands. This was the "Gilliland Harness" of Figure 4, an adjustable framework resting on her shoulders and strapped around her waist, supporting the transmitter a short distance in front of her mouth and the receiver at her ear. On account of its weight, almost 6½ pounds when fitted with instruments, this structure was not put into general use. Figure 5 shows another mounting arrangement brought out that year which held the transmitter at a convenient position by a vertical rod, and by a horizontal bracket held the receiver near the operator's ear. Though requiring that she hold her head in a particular position for speaking or listening, it was a noteworthy advance over the harness from the standpoint of comfort.

An important change in design was embodied in operator's transmitters produced in 1888. In accordance with a somewhat earlier development, both electrodes were of carbon and the space between was filled with carbon granules. Change in resistance with vibration of the diaphragm came from variations in pressure at the large number of contact surfaces between the granules, rather than at a single contact surface as before. In 1890 came the "solid back" design of Anthony C. White, not incorporated in operator's instruments however until the following year. The rear electrode was no longer mounted on a spring, but was attached rigidly through a small intermediate part to the back of the case, and the front electrode was held by a metal stud which passed through and clamped the center of the diaphragm. In 1891

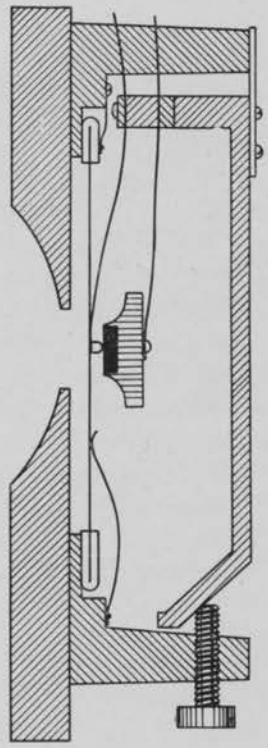
a similar transmitter was made a part of the set shown in Figure 6. It is of interest to note that the mouthpece used resembles that of today's desk stands in size and shape.

The receiver used was designed in 1884 by W. L. Richards, now Consulting Historian of the Laboratories. It was one of the earliest of the thin or watch-case type, suitable for use with a headband. Essential parts corresponded to those of previous designs, but compactness was secured by placing the bar magnet on the outside of the receiver case to form the bracket by which the headband was attached. An extension, consisting of a soft-iron core at right angles to the end of the magnet, ran through the center of the coil inside the case. Small screws near the middle of the bar magnet fastened the receiver to a headband sufficiently large in area to distribute the weight well over the operator's head.

Another adaptation of an independently supported transmitter and



The carbon granules of the White solid back transmitter separating the two carbon discs, gave a large number of contact surfaces for variation in resistance



In Blake's transmitter a carbon disc was pressed by a flat spring against a contact point touching the diaphragm

headband receiver, that of Figure 7, was put into use about the same time. The transmitter was the same in internal structure as that just described, but was supported by a bracket extending from the switchboard. Though still of single-pole construction the receiver was made more compact by the use of a laminated, curved magnet of the so-called spiral type, enclosed within the case. Attachment to the headband was by a thumb nut.

About 1900 came the transmitter which is similar in form to that now used by operators throughout the Bell System. It was mounted on a breastplate supported and held in place by a tape extending around the operator's neck. Adjustment of the tape and movement of the mouthpiece in its ball and socket mounting bring the

opening directly in front of the operator's mouth, and cleaning is facilitated by the ease with which the mouthpiece can be removed. The receiver used with this transmitter was of bipolar type, and a horseshoe magnet was substituted for the spiral magnet. Transmitter and receiver are shown in Figure 8.

The operator's set of today, shown in Figure 9, includes a transmitter similar in form to that just described but incorporating certain important changes, such as an improved carbon button, which make for better operation. A bipolar receiver with horseshoe magnet is used, but it is more efficient than the previous type, and its method of mounting is changed. On the outer periphery of the case are two small lugs, 180 degrees apart, with a hole in each for attachment of the headband. The band is made from a loop spring whose ends are clamped in a bracket; to the bracket is attached a swivel yoke with points for engaging the lugs. By the rotation and the free movement introduced, closer fitting is secured and extraneous noises are thereby excluded. These instruments, as is apparent, signalize a notable improvement over the early types of operators' sets, and embody the necessary electrical functions in a form which facilitates greatly the speedy completion of calls.