An Improved Transmitter for Operators' Use

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SOME of the operators' transmitters used in the past have already been described in the RECORD.* To this group of progressive developments a transmitter of improved type has been added by the Laboratories. It differs considerably in construction from the earlier forms due to new features introduced as a result of development studies undertaken during the past few years. Among the advantages provided are a materially improved quality of reproduction, and a slightly higher output level. Carbon noise has been practically eliminated, and the amount of room noise picked up by the transmitter has been noticeably reduced. Variations in performance due to thermal effects have also been minimized, while the useful life of the transmitter has been increased, and its construction made more rugged. The appearance of the new transmitter is shown in the illustration at the head of this article.

Every effort has been made in the design of the granular carbon element, which is built as a separate unit, to obtain good quality of reproduction. The moving parts have been designed to respond to a broad range in frequency. This requires both that the mass of the moving parts and the stiffness of the vibrating system as a whole be kept low. These conditions have been met by making the diaphragm of thin sheet aluminum, and

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by supporting its periphery between paper rings in a recess in the front of the unit to obtain the required resiliency. The dimensions are such that the rings occupy a space about fifty per cent greater than the combined thickness of the paper material. This combination provides a light, stiff moving structure capable of vibrating as a piston. The paper rings act as low stiffness springs and add a certain amount of damping. They are punched from stock only four ten-thousandths of an inch thick, and are impregnated to reduce the effect of moisture.

Such a vibrating system differs radically from those of the operators' transmitters previously used, one of which is shown in the accompanying illustration. The effective mass of the moving parts of the new transmitter is approximately half a gram, as contrasted with five grams for the earlier transmitter.

All granular carbon devices operate by the change in resistance of the carbon contacts which occurs when the movable member is displaced in accordance with the sound pressures acting on the diaphragm. The form of carbon chamber used with previous operators' transmitters consists of an essentially cylindrical cavity with a flat conducting electrode at each end, one of which is stationary and the other movable. It has several distinct limitations not present in the carbon chamber of the new transmitter, which is of the "barrier" type.

With the new chamber the electrodes are the inner surfaces of two gold-plated brass cylinders insulated from each other by a ring or barrier of ceramic material. The diaphragm itself serves as the movable front wall of the carbon chamber and its surface is insulated with phenol varnish so that it does not conduct current to the carbon. The movable surface thus merely changes the force on the carbon contacts and does not itself act as an electrode—an arrangement which has been found to improve the useful life of the transmitter. The back wall of the chamber is provided with a capped opening through which the chamber is filled with carbon. The entire microphone element is assembled in a brass shell somewhat larger than one inch in diameter.

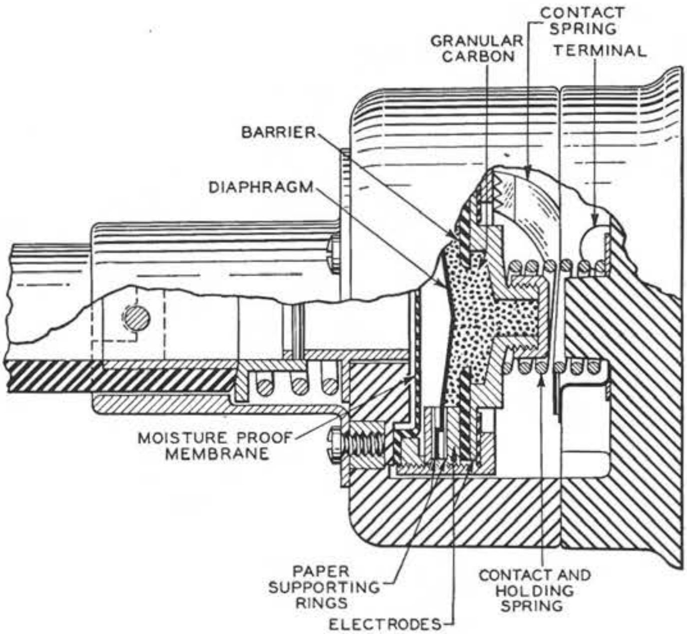

Fig. 1—Cross section of the new transmitter (396A) showing the barrier construction, the moisture proof membrane, and other major structural details

Because the granular carbon contact is sensitive to forces acting on it, the expansion and contraction of the component parts of the chamber —produced by the temperature increase when power is dissipated in the carbon—influence it to a rather exceptional degree. These thermal effects cause relatively slow changes in resistance and sensitivity, which with many of the older types of instrument are erratic and a source of trouble. In operators' service the transmitter is connected in the circuit for relatively long intervals of time and it is desirable that over most of this period the resistance should remain steady. In the new transmitter the expansion of the walls of the chamber causes a steady increase in resistance during the first few minutes in which temperature equilibrium is being established. Thereafter, variations due to thermal effects are inappreciable. The diaphragm itself has little effect, because its temperature is fairly uniform and it is free to expand radially without displacing the center.

When a potential in excess of about a volt is impressed on a granular carbon contact, under forces ordinarily employed in transmitters, a "frying" noise is apt to be introduced in the electrical output. The barrier type of chamber has an inherent advantage over the older form in that the applied voltage is quite uniformly distributed over the chain of granules between the electrodes, whereas with the earlier type the potential is likely to become concentrated at the vibrating electrode because of its motion. The noise caused by excessive potentials has been practically eliminated in the new transmitter because of this inherent advantage of the barrier type of construction.

An excessive potential is also likely to cause overheating of the minute contact areas of the carbon granules. If maintained on a transmitter for a considerable period of time, this injures the surface of the granules and raises its resistance—an effect that increases the carbon noise. Because of the more uniform distribution of potential among the granules of the barrier type transmitter these effects

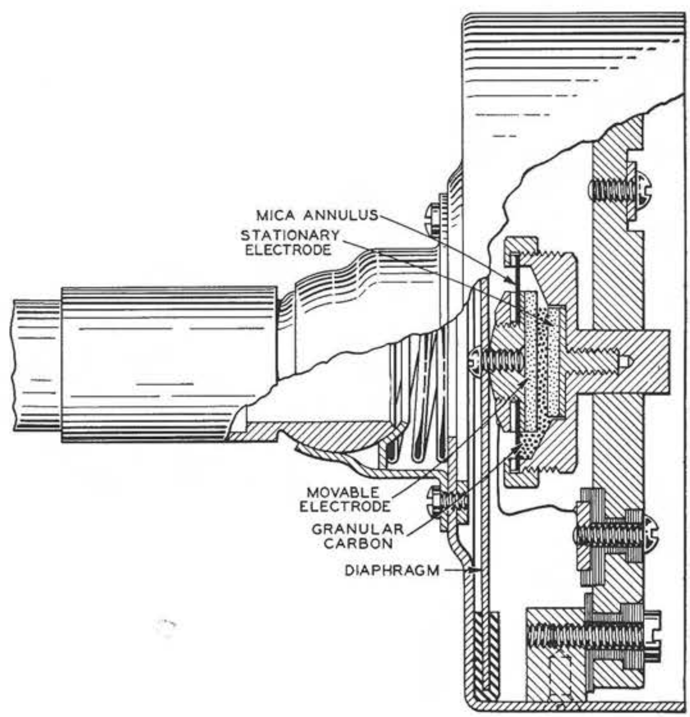

Fig. 2—The greater mass of the moving parts of the older transmitter (234) is evident in this cross-section

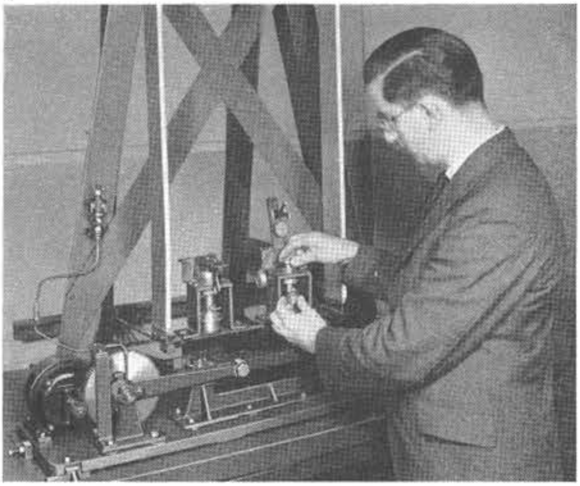

Fig. 3—G. F. Schmidt filling one of the new transmitters with granular carbon. The machine vibrates the transmitter while it is being filled. This settles the carbon and leaves very little free space in the chamber so that movement of the carbon granules, and consequently aging, is reduced

also are minimized and the useful life of the transmitter is substantially lengthened.

Should the chamber containing the granular carbon be subjected to mechanical shock such as jarring or rolling, the surfaces of the granules receive an abrasive treatment which alters their microphonic properties. Resistance is increased and sensitivity is usually lowered. Studies of the carbon transmitter have shown that this tendency for the carbon to "age" with use is greatly reduced by filling the transmitter practically full of carbon instead of partially filling it as in the past. A machine process is employed which leaves very little free space in which the carbon may move when the transmitter is handled, and the abrasive action is thereby reduced.

For protection against moisture and against water condensed from the breath, a membrane of thin molded rubber is placed in front of the diaphragm. The material employed for this membrane was developed by the Chemical Laboratory and has a long life. Its periphery, which is attached to the front of the unit with a special adhesive, is thicker than the rest of the membrane and serves as a sealing gasket to prevent moisture from entering the housing of the transmitter. The introduction of this membrane does not materially affect the operation of the instrument.

The unit is assembled in a housing of molded phenol plastic, and the electrical connections are made by springs, one of which is of helical form and holds the unit in position. The transmitter is equipped with a horn type mouthpiece which is secured by a quickly detachable mechanism. Dimensions of the transmitter, such as the distance between the breastplate and the end of the horn, the angle of the horn opening, and the length of the neck band, are based on an analysis of measurements made on a large number of operators. The dimensions chosen, with the aid of the adjustable features provided, will accommodate the maximum number of operators equally well.

The small microphone element of this transmitter is capable of excellent sound reproduction. In fact, this portion of the transmitter, without the rubber membrane, is used as a high quality microphone in a new public address equipment already described in the RECORD.* Its frequency response characteristic is comparable to that of the stretched-diaphragm

*BELL LABORATORIES RECORD, *January,* 1932.

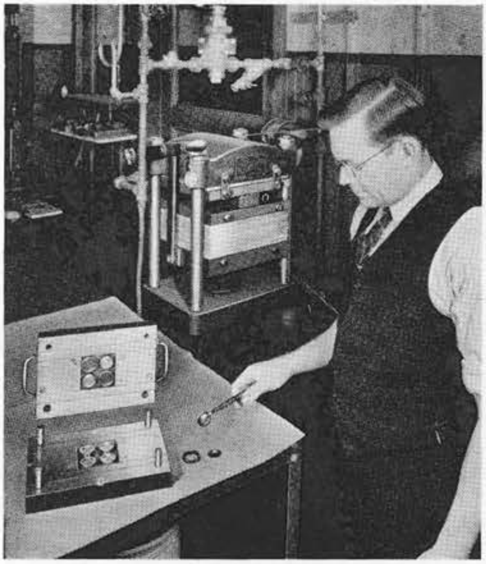

Fig. 4—E. L. Dias of the Chemical Laboratory removing one of the rubber membranes of the new transmitter from the mold

carbon microphone employed in broadcasting. Its output level, however, is not sufficiently high to permit it to be used as a telephone transmitter without the use of a sound collector such as a horn. The horn introduces a certain amount of distortion, but the quality of the transmitter is still materially better than that of previous operators' transmitters, and a substantial gain in intelligibility is effected. One of the methods of measuring the reaction on telephone service which a change in instruments or line condition has brought about, is to observe the number of times it is necessary to repeat a statement or, in the case of the operator, a station number. Observations of repetitions in service show that their rate is greatly reduced when the new transmitter is used.

The housing of the new transmitter is much stiffer than that of the old, and the microphone element, therefore, does not respond as readily to the acoustic pressure of room noise acting on the housing. A background of noise may seriously interfere with the interpretation of speech, so that it is a distinct advantage in the new transmitter that it does not as readily pick up sounds at a distance as the earlier instrument did.

It is anticipated that the longer life and more rugged construction of this transmitter, together with the ease of replacement and repair, will affect material economy in service, quite aside from the substantial improvement in performance which it offers.