C. L. CHISHOLM.

MICROPHONIC TRANSMITTER.

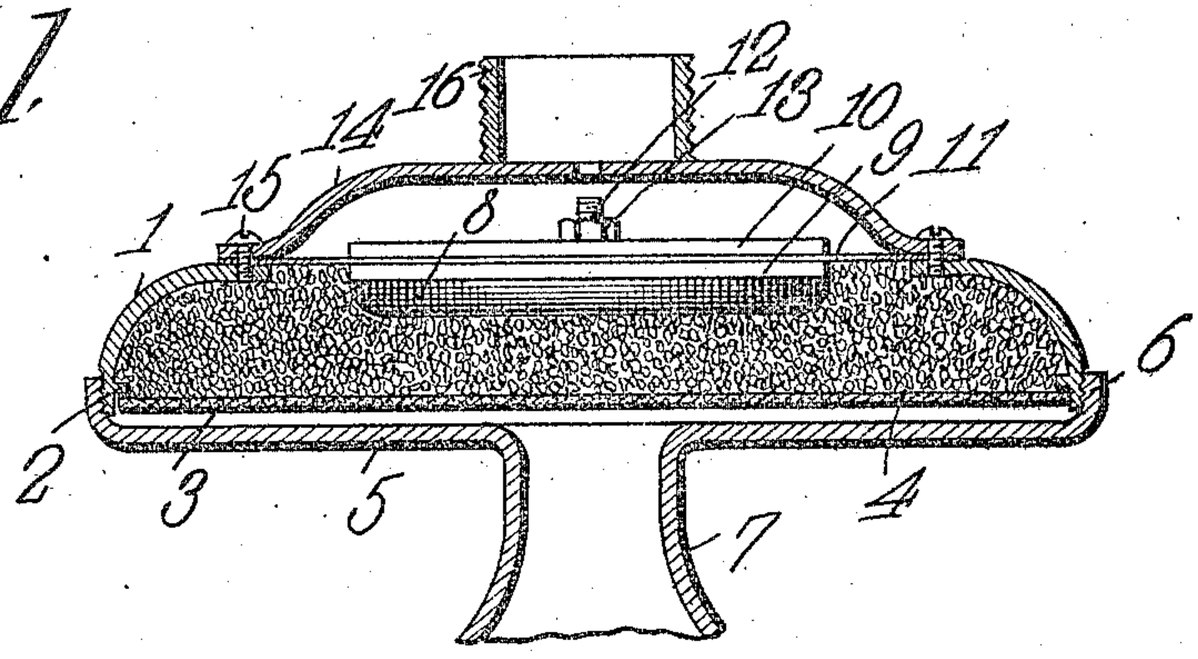
APPLICATION FILED AUG. 5, 1908.

964,145.

Patented July 12, 1910.

2 SHEETS—SHEET 1.

Fig. 1.



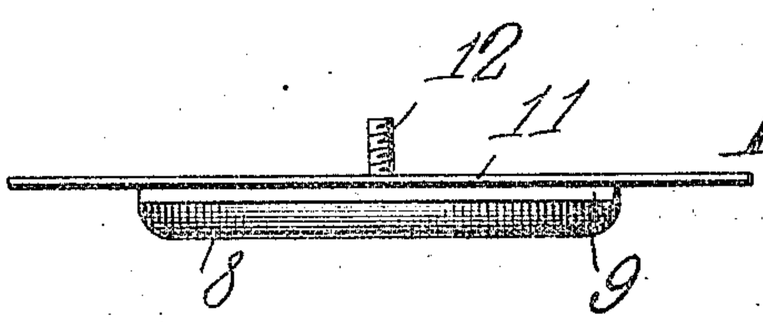
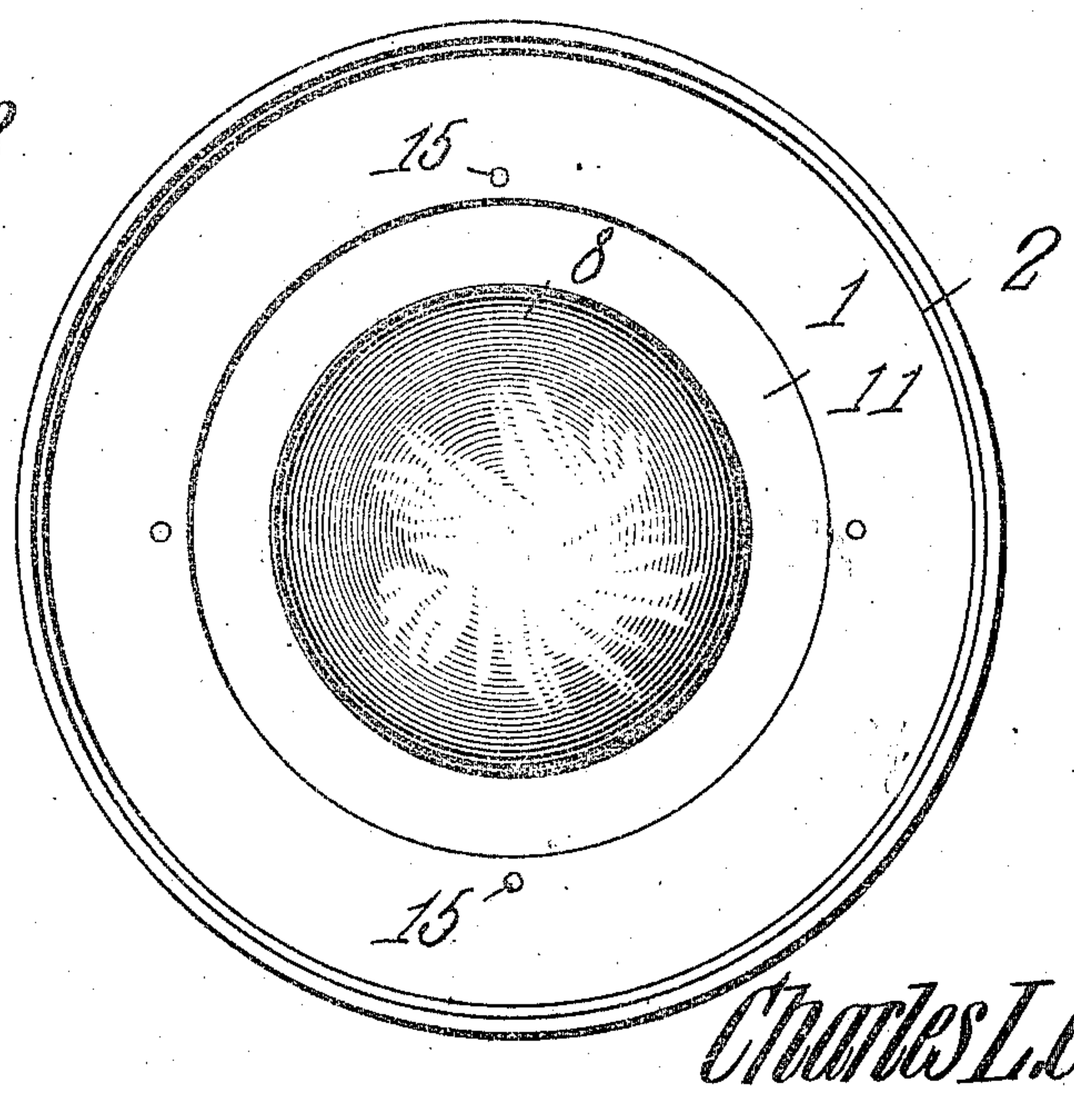


Fig. 2.

Fig. 3.



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2 SHEETS—SHEET 2.

Fig. 4.

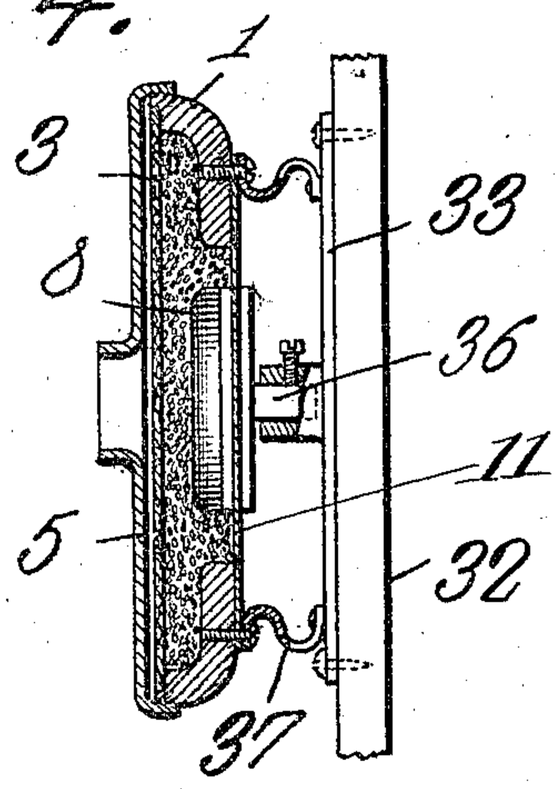


Fig. 5.

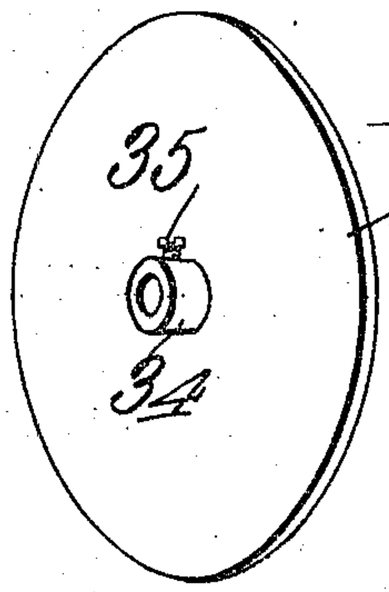
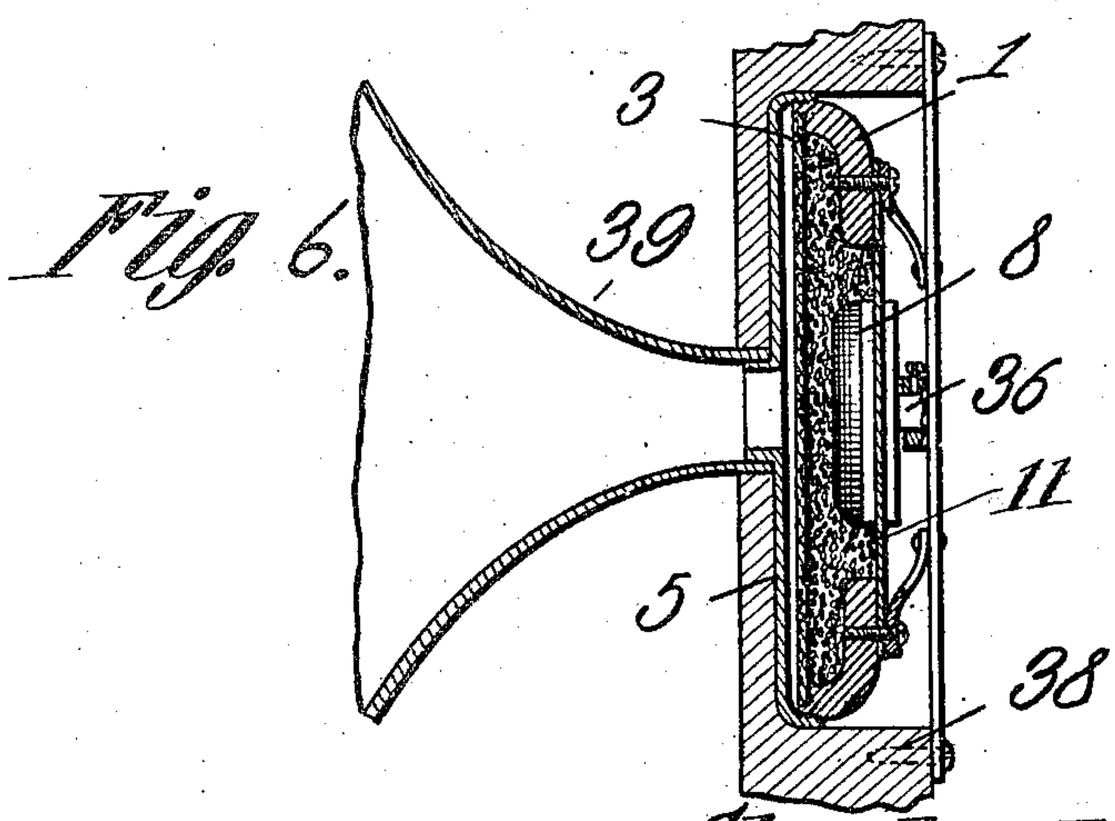


Fig. 6.



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UNITED STATES PATENT OFFICE.

CHARLES LOGAN CHISHOLM, OF MARYSVILLE, NEW BRUNSWICK, CANADA, ASSIGNOR OF ONE-SIXTEENTH TO CHARLES SADLER, OF EDMONTON, CANADA.

MICROPHONIC TRANSMITTER.

964,145. Specification of Letters Patent. **Patented July 12, 1910.**

Application filed August 5, 1908. Serial No. 447,145.

To all whom it may concern:

Be it known that I, CHARLES L. CHISHOLM, a subject of the King of Great Britain, residing at Marysville, in New Brunswick, Dominion of Canada, have invented a new and useful Microphonic Transmitter, of which the following is a specification.

This invention has reference to improvements in microphonic transmitters, and its object is to produce an instrument of this character which will throw upon the line, electrical undulations corresponding not only to the grosser sound waves but also to the higher and more delicate overtones upon which that quality of the sound known as the timbre so largely depends.

Before entering into a detail description of this invention it is deemed advisable to consider the conditions with which the instrument forming the subject-matter of this invention has to deal.

The grosser sound waves represent forces of comparatively considerable magnitude and so are able to overcome without serious effect on themselves opposing forces of commensurate magnitude. The actual power of sound waves is, of course, quite small or minute. When, however, the overtones are considered the forces developed are so small that highly attenuated opposing forces may become great as compared with the forces developed by some of the overtones. Still it is such overtones that determine that quality of the voice or sound which is termed timbre, and it is upon this quality of the voice that the so-called naturalness or recognizability depends, and it is by this quality of the voice that one is able to individualize voices. For these reasons conditions which have heretofore been overlooked or unrecognized are vital to the present invention, and the present invention aims to the elimination of certain conditions which have been found to be detrimental.

One important feature of the invention is the proper setting of the diaphragm which should have no unequal pressure or strain whatsoever at the periphery or adjacent thereto; still the diaphragm should be rigidly held in place and evenly sensitive over its entire area. It is found to be impossible with the ordinary screw cap to get a perfectly even pressure around the periphery of the diaphragm since there will always be more or less unequal stress or tension of the adjacent parts of the surface of the diaphragm nearest the periphery so that there are lines or zones in the surface of the diaphragm which do not respond with equal sensitiveness to the rest of the surface of the diaphragm and consequently the diaphragm may offer very great resistance, comparatively, to the extremely delicate overtones, and the action of these overtones upon the diaphragm will become entirely lost and no electric currents will be developed corresponding to these overtones, so the voice at the receiving end of the line will have an entirely different quality than that of the speaker at the transmitting end of the line because of the obliteration of the overtones which impart to the voice the quality known as timbre. Wax has been used as a means for holding the diaphragm in place in its seat, but this for the purposes of the present invention is useless and impracticable because it is necessary that the periphery of the diaphragm be rigidly held in place and wax will not answer for this purpose.

By the present invention the diaphragm is either cemented in a peripheral seat of the narrowest possible extent by any suitable hard cement which will hold it rigidly in place, or it may be secured in place without the necessity of a seat. Theoretically the seat for the diaphragm should have no area, and while this is feasible, a real seat must have some radial extent. Such seat for the diaphragm is made as slight as is practicable, and the diaphragm is lightly seated therein and then cemented with a hard cement so as to eliminate any strains or distortions such as would occur were the diaphragm clamped in place. With such a diaphragm lightly set in its narrow cemented groove or seat with space enough to allow for any contraction or expansion there is presented a uniform surface under neither strains, pressure, or any other influences which will reduce its extreme sensitiveness to highly attenuated sound waves, or if it be a receiver diaphragm, to highly attenuated electrical undulations producing like magnetic variations which in turn act upon the receiver diaphragm. While the strains or distortions to which the diaphragms are usually subjected by the manner of mounting them in their supports are actually quite

minute, still they become comparatively very great to the highly attenuated forces developed by the overtones.

In the practical embodiment of the invention the diaphragm is made of carbon and is highly polished on its inner face. The back contact is also made of carbon with rounded edges likewise highly polished. Moreover, the walls of the casing inclosing the diaphragm and back contact are highly polished. The size of the casing for the carbon granules is such as to permit the mass of granules to be coextensive with the inner available face of the diaphragm. The purpose of presenting highly polished surfaces to the granules is to reduce to the lowest minimum, resistance to the movement of the granules under the impulse of sound waves. The resistance to the impact of the fundamental and stronger or lower overtones is not so vital though still to be reckoned with, but every reduction of the resistance to the weaker overtones becomes noticeably apparent in increased richness of the reproduction at the receiver.

The invention will be best understood from a consideration of the following detail description taken in connection with the accompanying drawings forming a part of this specification, in which drawings—

Figure 1 is an enlarged central section through the microphonic element. Fig. 2 is a view showing a slightly different form of mounting for the back contact. Fig. 3 is a face view of the casing and the back contact with the diaphragm and granules omitted. Figs. 4, 5 and 6 are views illustrating the microphonic element in practical form.

Referring to the drawings, and more particularly to Figs. 1 and 3, there is shown a casing 1 having rounded walls in the direction of the axis of the casing, which casing is shown as generally cylindrical or annular, and it is to be understood that the inner wall of this casing is highly polished. The wider end of the casing is provided with an inwardly-directed annular flange or ledge 2 for the reception of a diaphragm 3 designed to receive the direct impact of the sound waves and may therefore be designated as the sound-receiving diaphragm to distinguish it from a diaphragm receiving the sound waves by conduction from connections to the diaphragm directly receiving the sound waves. This diaphragm is preferably made of carbon of such thickness as not to bend under the weight of the granules forming a part of the microphonic element and which granules are indicated at 4, it being understood that these granules may be carbon granules.

It is of vital importance in the practical embodiment of this invention that the diaphragm be secured to the casing without any stresses or strains of any kind, either local or general. For this reason the ledge 2 is made as narrow as is practically possible, and the diaphragm is cemented thereto by some hard firm cement, such for instance as shellac, and this cementing is performed without putting the diaphragm under strain or stress and more especially uneven strains or stresses such as are liable to occur when the diaphragm is clamped in place. The diaphragm is thus peripherally supported without local or general transverse buckling or strain. The inner face of the diaphragm is highly polished, and for sanitary and other reasons the outer face may also be highly polished and for the operation of the microphonic element the polishing of the outer face has an important function which will be referred to further on.

The outer edge of the casing 1 may be screw-threaded and to this screw-threaded portion is applied a cover plate 5 having an annular flange 6 at its periphery internally threaded to receive the outer threaded portion of the casing 1, and the plate 5 may have a central perforation surrounded by a suitable mouth piece 7.

The back contact 8 comprises a circular block of carbon with rounded peripheral edges, with the face and edges highly polished. The back contact block 8 is made fast in any suitable way to a metal block 9, of brass or other suitable material, and between this block 9 and another plate 10 is secured a mica or other suitable insulating plate 11, the plate 11 being clamped between the two blocks or plates 9 and 10 by means of a clamp screw 13 applied to a stud 12 extending from the block or plate 9 through the plate 11 and plate 10. The plate 11 is of such diameter as to extend to and slightly beyond the back edges of the casing 1, and the plate 11 is secured to the casing 1 by suitable screws 15. The back cap 14 may be provided with a central threaded sleeve 16 by means of which the entire microphonic element is secured to a suitable support. The circuit connections will be as usual from the diaphragm 3 and back contact 8, and so it is not deemed necessary to show the circuit connections in the drawings. In Fig. 2, the back metal plate or block 10 is omitted and the plate 9 is cemented or similarly secured to the insulating plate 11. Otherwise the structure is the same as that shown in Fig. 1.

It is to be observed that the carbon granules 4 are shown as filling the space between the diaphragm 3 and back contact 8 and also between the walls of the casing. In practice this space is, of course, not quite filled. All the surfaces with which the carbon granules come in contact are highly polished, thus correspondingly reducing the frictional contact between the surfaces with

which the granules come in engagement. There is therefore less resistance of a mechanical nature to the movements of the carbon granules than is the case where they come in contact with rough surfaces.

Whether the theory advanced that the highly polished surfaces reduce the mechanical resistance to the movement of the carbon particles be true or not, it is nevertheless a fact, demonstrated by many tests, that when the inner surface of the diaphragm and the surface of the back contact 8 and the inner surface of the casing are highly polished the overtones are transmitted to the line to such an extent as to sensibly increase the richness of reproduction and the naturalness of the tones reproduced. I also find that by making the receptacle for the carbon granules coextensive with the diaphragm, there is also marked improvement in the transmission of the sound including the overtones.

It will be understood in this connection that the showing of Fig. 1 is greatly enlarged and that the practical embodiment of the invention may be from one-quarter to one-third the size shown in the said Fig. 1 or even less; that is to say, the actual size of the instrument need not exceed one and one-half inches in diameter and if desired may be materially smaller.

The damping effect of the carbon granules engaging practically the entire surface of the diaphragm is found to be practically negligible unless the instrument is entirely inverted so that the weight of the granules lies against the diaphragm, while the impulses from practically the total vibratory surfaces of the diaphragm are utilized and the disturbance of the granules is thereby augmented, and this, and also the polished surfaces of the inner face of the diaphragm and of the back contact and of the curved walls of the casing, all contribute to increase the power and purity of transmission of the instrument. The adjustments of the instrument are exceedingly simple and the instrument is practically indestructible in ordinary handling.

Instead of using an all carbon diaphragm a mica diaphragm may be used with a fine carbon electrode consisting of a mere film of highly polished carbon on the working face of the diaphragm, that is the face adjacent to the granules. Since the practical instrument is of small diameter the quantity of granules used does not exceed, or at least does not much exceed, the quantity used in many types of microphones. Small metal diaphragms with a silver or platinum wash for the electrode or contact, have been found practicable and can be used instead of carbon or mica.

The transmitter is particularly adapted to a great variety of uses, for instance, the transmitter may be embedded in the lock or the casings of a safe, and will then respond to the slightest scratch or any sound-producing movement made on the safe wall or safe lock.

By having the microphone connected up to a central point, say police headquarters or some other suitable station with a delicate relay or other means responsive to the receiver, then an alarm would be given of any surreptitious attempt to gain entrance to the safe or other protected device. This would be particularly valuable in country districts, or in small towns, or in cities even. Such a device is of extreme simplicity and at the same time thoroughly reliable and would readily replace the elaborate electrical connections that are installed for protecting banks, and houses and other places. If it should be desired to have the system respond to the slightest noise or disturbance then the relay at the central station would be necessary, but ordinarily the great sensitiveness of the transmitter and receiver, causes the latter to respond with great vigor the instant that any tampering is attempted in the neighborhood of the transmitter. Again, the extreme sensitiveness and also the reduced size of the transmitter permits the same to be fastened to the larynx of a person or upon the chest, and the voice is readily transmitted over long distances and may then be recorded at the receiving end. Such a use of the instrument has both physiological and commercial value.

By polishing of the outer face of the diaphragm, especially a carbon diaphragm, which is quite porous and may readily admit moisture from the breath to the granules and thereby interfere with the use of the instrument because of dampness of the granules, the pores are effectually closed and dampness whether condensed from the breath or otherwise is positively excluded from access to the interior of the instrument.

In this connection it may be stated that the invetnion is not necessarily limited to the use of carbon granules in the interior of the microphonic element and it is possible to use other conducting particles with good results.

It has already been stated that from theoretical considerations the diaphragm should have a seat of no area and when the seat is provided it should be of the smallest possible area. It has been found in practice that a seat for the edges of the diaphragm not exceeding one-sixty-fourth of an inch in radial extent is ample for the purpose. When carbon diaphragms are used it is possible to electroplate the peripheral edge of the diaphragm and then solder the same to the metal casing. This provides a seat of no radial area and both faces of the diaphragm are left free and under

no stresses or strains or interference on either side of the same. Furthermore, the electrical connections are practically perfect. However, I do not wish to limit myself to either means of securing the diaphragm to the casing.

Figs. 4 and 6 show actual embodiments of the invention and Fig. 5 illustrates a portion of the structure employed in connection with the embodiment of Fig. 4.

The microphonic element of Figs. 4 and 6 is substantially that already described with relation to Fig. 1 and need not be again described with reference to these figures.

In Fig. 4 the part 32 may be taken as illustrative of any suitable or convenient support. To this support there is secured a plate 33 by screws or bolts or otherwise and this support 33 has a central socket 34 provided with a set screw 35. The socket 34 receives the stem 36 projecting from the back contact 8 and the screw 35 serves to clamp the back contact in said socket. Between the back of the casing 1 and the plate 33 are interposed a suitable number of legs 37 secured at the plate 33 in any suitable manner and made of light spring material appropriately bent to form an elastic cushion support for the body of the microphonic element. The legs 37, while of light spring material, are comparatively rigid, though yielding. The back contact is fixed, therefore the mica plate 11 will vibrate in unison with the diaphragm and more powerful undulations are thus generated, it being understood that the whole instrument, diaphragm, casing and back, is in vibration. However the very small opening leading to the diaphragm protects the latter from all sounds not entering through the mouthpiece.

In the ordinary microphonic element it becomes necessary to clamp the diaphragm with powerful springs to avoid the effect of extraneous sounds entering through the large openings in the casing, and to hold the diaphragm in place. I have found that, in practice, a michrophonic element consructed as described, with the diaphragm superficially free and unobstructed, and the entire structure of small size, provides an extremely sensitive device capable of producing electrical undulations of markedly greater purity, and faithfulness to the original sounds than is possible with the best commercial microphone or transmitter.

In Fig. 6 the microphonic element is shown as completely embedded in its support which in this figure is designated by the reference numeral 38, and is to be taken as typical of any support of sufficient thickness to completely house microphonic elements. In the drawings is shown a flaring mouth piece 39 which may or may not be used as desired. In the particular structure shown in Fig. 6, the microphonic element is well protected against all sound waves except those entering through the mouth piece, if this be desirable, but the microphonic element may be made sensitive to sound waves set up in the support 38, or to other vibrations which if transmitted to the ear would result in the production of sound.

In the following claims where the term carbon granules is used to designate the conducting granules between the diaphragm and back contact, it is to be understood that this term is intended to include not only carbon granules but other conducting granules which may be adapted to the purposes of the invention.

What is claimed is:—

1. An acoustical instrument having a sound receiving diaphragm and a peripheral support for the diaphragm of inconsiderable area to which the diaphragm is firmly united by an unyielding cement without stress or strain.

2. A microphonic transmitter comprising a casing inclosing a granule chamber co-extensive with the interior of the casing, a sound receiving diaphragm at one end of the casing and attached thereto peripherally by an unyielding cement without stress or strain, a back contact in the casing, and conducting granules between the diaphragm and back contact, the said diaphragm, back contact and walls of the casing where engaging the granules being polished.

3. A microphonic transmitter, comprising a casing having walls curved in the direction of the axis of the casing and polished on the inner face, a conducting sound-receiving diaphragm peripherally supported and cemented to the support without stress or strain, said diaphragm also being polished on its inner face, and a back contact supported by the casing and provided with a rounded periphery which latter together with the face of the back contact is polished, the said casing, diaphragm, and back contact inclosing a chamber coextensive with the diaphragm for receiving carbon granules.

4. An acoustical instrument having a sound receiving diaphragm and a support therefor to which the diaphragm is cemented at the periphery by an unyielding cement, said diaphragm having both faces throughout substantially the entire area unobstructed.

5. An acoustical instrument having a carbon diaphragm metal plated on its peripheral edge, and a support for said diaphragm to which it is united by a metallic cement.

6. A microphonic transmitter having its back contact rigidly supported, and its body portion including the sound receiving diaphragm and the inclosing casing elastically mounted.

7. A microphonic transmitter comprising a sound receiving diaphragm, a casing to

which the diaphragm is rigidly secured, a back contact, a rigid support for said contact, and elastically yielding supports between the casing carrying the diaphragm and the support for the back contact.

8. A microphonic transmitter comprising a casing, a carbon sound receiving diaphragm secured at its periphery to the casing by an unyielding cement, a carbon back contact, a rigid support for said back contact, and an elastic support interposed between the casing and the support for the back contact.

In testimony that I claim the foregoing as my own, I have hereto affixed my signature in the presence of two witnesses.

CHARLES LOGAN CHISHOLM.

Witnesses:

CHAS. T. SULLIVAN,

ALBERT E. OTTEWELL.