April 30, 1929. E. A. GRAHAM ET AL 1,711,410

TELEPHONE TRANSMITTER

Filed June 10, 1927 3 Sheets-Sheet 1

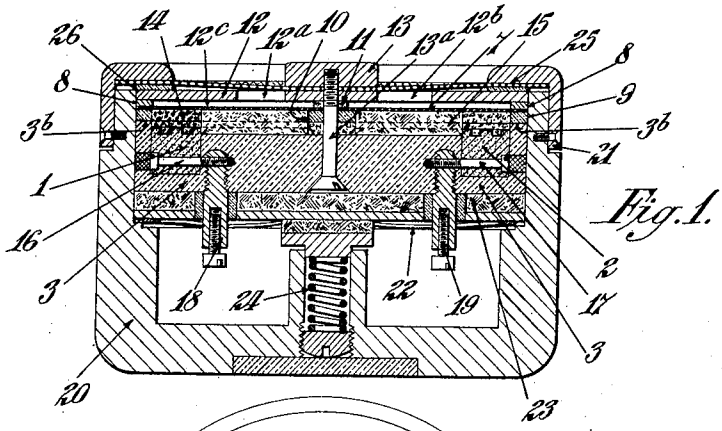


Fig. 1.

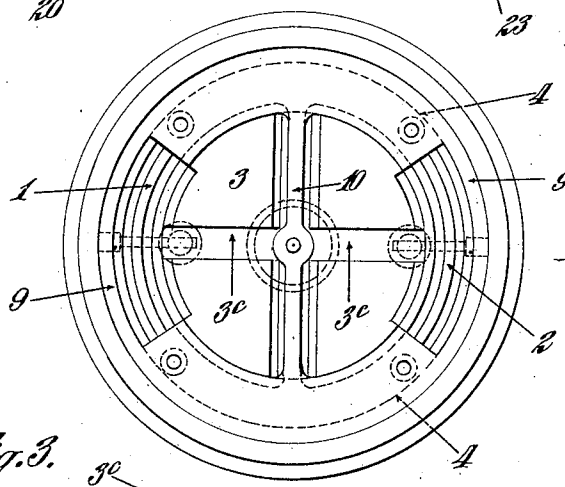
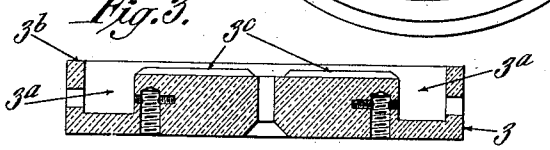


Fig. 2.

Fig. 3.



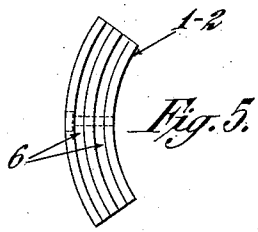


Fig. 5.

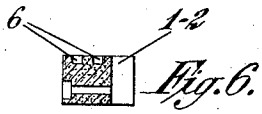


Fig. 6.

Fig. 4.

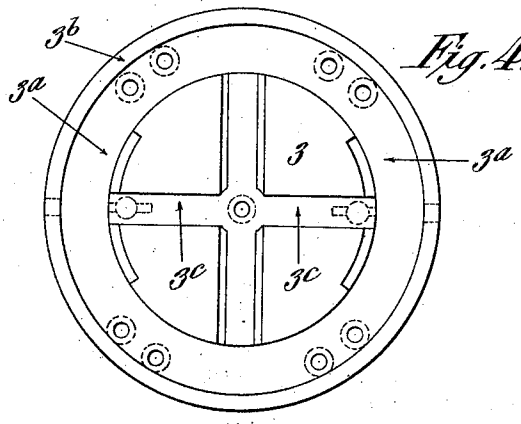


Fig. 7.

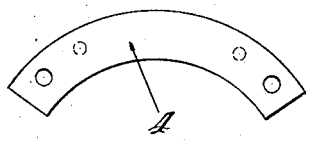


Fig. 8.



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TELEPHONE TRANSMITTER

Filed June 10, 1927 3 Sheets-Sheet 2

Fig. 9.

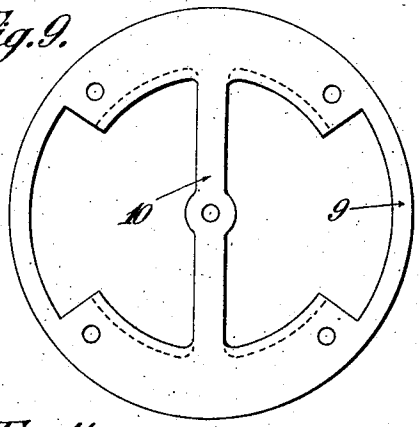


Fig. 10.

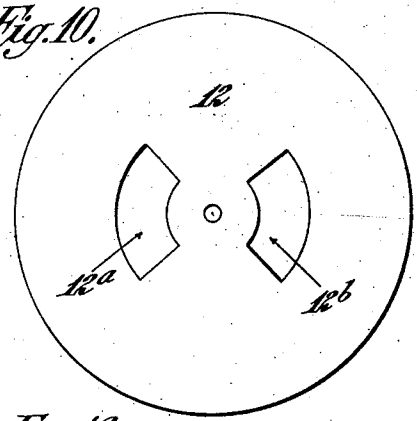


Fig. 11.

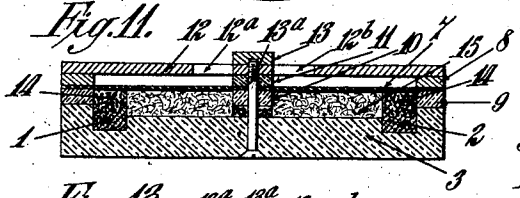


Fig. 12.

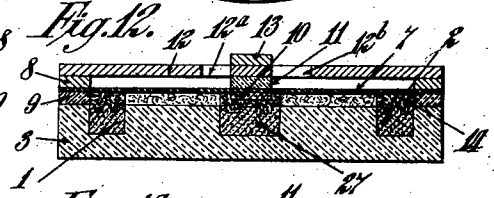


Fig. 13.

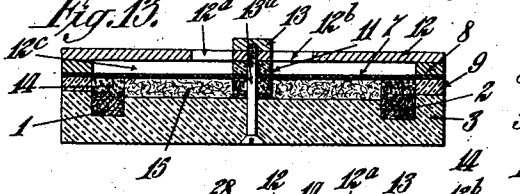
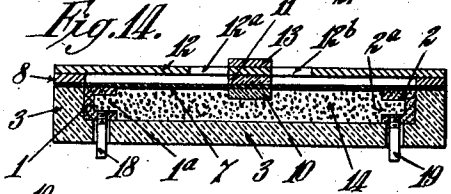


Fig. 14.



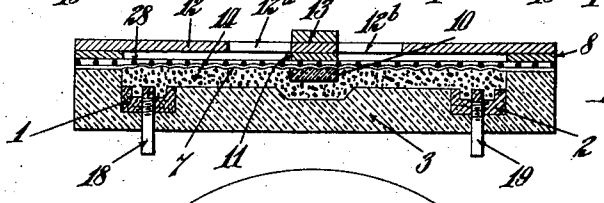


Fig. 15.

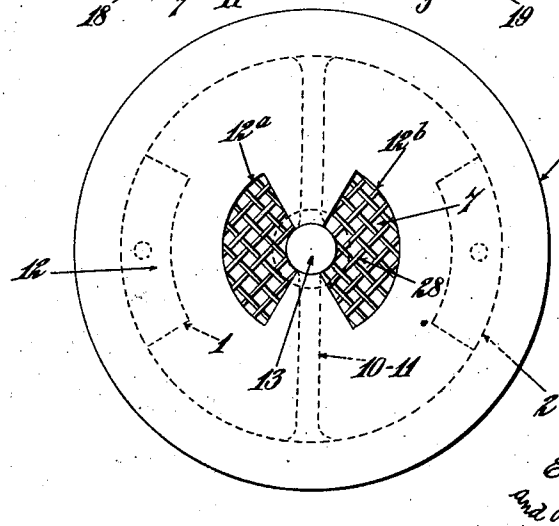


Fig. 16.

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TELEPHONE TRANSMITTER

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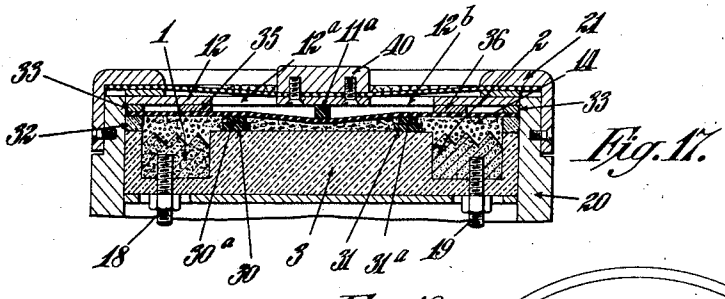


Fig. 17.

Fig. 18.

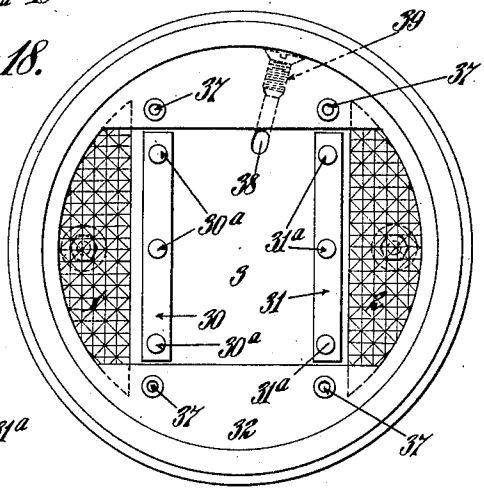


Fig. 19.

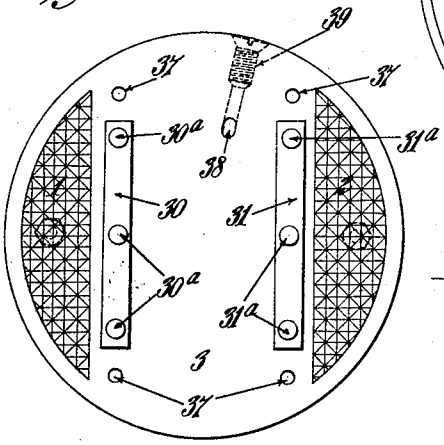


Fig. 20.

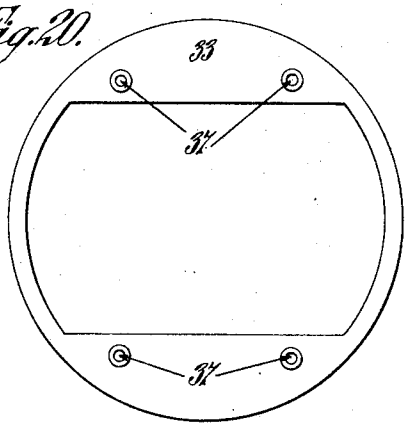
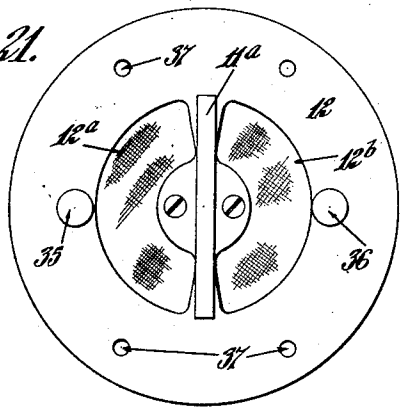


Fig. 21.



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Patented Apr. 30, 1929. 1,711,410

UNITED STATES PATENT OFFICE.

EDWARD ALFRED GRAHAM, DECEASED, LATE OF CROFTON PARK, BROCKLEY, ENGLAND, BY MARIA GRAHAM, EXECUTRIX, OF BECKENHAM, ENGLAND, AND ALFRED GRAHAM, EXECUTOR, OF FOREST HILL, ENGLAND, AND LESLIE HAROLD PADDLE, OF CROFTON PARK, BROCKLEY, ENGLAND, ASSIGNORS TO GRAHAM AMPLION LIMITED, OF LONDON, ENGLAND.

TELEPHONE TRANSMITTER.

Application filed June 10, 1927, Serial No. 197,979, and in Great Britain June 18, 1926.

This invention relates to that type of telephone transmitter in which a diaphragm, when influenced by sound waves or other vibrations, is caused to vary the resistance of contact between a mass of carbon granules situated between stationary electrodes, the arrangement being such that the sound waves or other vibrations impinge on the diaphragm in a direction substantially at right angles to the current-flow through carbon granules disposed between the electrodes and thereby cause an increase or decrease of contact resistance in the current path, in conformity with the acoustic intensities and frequencies of vibration.

Telephonic transmitters such as just referred to, have heretofore possesses the disadvantage that they are extremely insensitive, with the result that when amplification, to any extent, is resorted to, the impediment known as "hiss" becomes very pronounced and results to a certain extent, depending on the strength of the influencing sound waves, in considerably distorting the reproduction of the sound waves.

The object of the present invention is to construct a microphone of the type just mentioned that shall be very sensitive to incoming sound waves and at the same time maintain the purity necessary in amplified reproduction. It will be followed that an advantageous consequence of providing a very sensitive transmitter is that the number of stages of amplification can be reduced, this resulting in a decrease of the distortion which is consequent on the number of stages of amplification generally used with such a transmitter.

For this purpose, in a telephone transmitter according to the invention, two or more stationary electrodes are employed each supported in such a manner in or on a block or bed of insulating material that current can flow from one to the other through a path of granular carbon, or equivalent material (hereinafter referred to as carbon granules) which exists as a layer of convenient depth between the said electrodes. A diaphragm formed of material such for example as empire cloth, mica, thin sheet rubber, or other material having similar characteristics, is placed in such relationship to the carbon granules that it forms a skin which touches the said carbon granules and is adapted either to be firmly or lightly retained along a diametrical portion so that such portion cannot readily vibrate, while other or lateral portions, touching the granules, can freely be influenced by sound vibrations in order to vary the resistance between the contact surfaces of the carbon granules through which a steady electric current from a battery or other source of electric supply is caused to flow in a direction parallel to the diaphragm, such varying resistance conforming to the varying intensities and frequencies of the influencing sound waves.

The lateral vibratory portions of the diaphragm may be adapted to have different natural periods of vibration.

A telephone transmitter embodying the invention can be variously constructed.

In the accompanying illustrative drawings, Fig. 1 shows in vertical section, one construction of telephone transmitter embodying the present invention. Fig. 2 shows the same in plan with the cover and diaphragm removed. Figs. 3 and 4 show respectively in vertical section and plan, a block of insulating material used in the transmitter. Figs. 5 and 6 show respectively in plan and cross section, one of the two carbon electrodes used therein and Figs 7 and 8 are similar views to 5 and 6 of one of two distance pieces for use between the electrodes. Fig. 9 shows in plan, a bottom clamping ring and Fig. 10 shows in plan, a cover plate having sound openings therein, Figs. 11, 12, 13, and 14 are vertical sections showing modified forms of the transmitter, Fig. 15 is a vertical section and Fig. 16 a plan showing another modification of the transmitter. Fig. 17 shows in vertical section, a further modification, Fig. 18 shows the same in plan with the upper plates and diaphragm removed. Fig. 19 is a plan of the insulating block with the electrodes and other parts. Fig. 20 shows in plan an upper clamping plate for the diaphragm. Fig. 21 shows the underside of a plate for retaining the carbon granules within the space between carbon electrodes, block and diaphragm.

According to the example shown in Figs. 1 to 10 inclusive, two diametrically arranged stationary electrodes 1 and 2 of non-oxidizing material, for instance carbon, made in the form of segments of a ring of rectangular section (Figs. 5 and 6) are arranged with their concave faces or sides presented to one another, at a convenient distance apart, in a cylindrical block or bed 3 of suitable insulating material, such for example as ebonite or porcelain, in such manner that their upper or outer surfaces project above the surface of the said block. In the example shown, the electrodes 1 and 2 are fitted into an annular recess 3^a in the block 3 and held in spaced relationship by segmental shaped blocks 4 of insulating material and may be fixed in the recess 3^a by adhesive material, for instance, glue. The block 3 may be made of about one inch in thickness. The peripheral region of the said block or bed is provided with an annular flange 3^b that extends to a suitable height above the level of the electrodes 1 and 2. The electrodes are preferably formed, as shown, with grooves or serrations 6 on their upper ends in order to present a large surface area.

A diaphragm 7 of thin stretched rubber is clamped at its periphery between two rings 8 and 9 of insulating material, for instance ebonite, the ring 9, being adapted to be supported by and fixed to the flange 3^b. The diaphragm thus retained at its periphery, is firmly held across a diameter between strips 10 and 11 of insulating material in such manner that the diametrical portion of the diaphragm 7 thus held will be situated substantially at right angles to a line between the electrodes 1 and 2 and cannot vibrate while lateral portions of the diaphragm at opposite side of the said diametrical portion of the diaphragm are comparatively free to vibrate. In the example, the lower clamping strip 10 is formed in one piece with the lower ring 9 (Figs. 1 and 9) and the upper clamping strip 11 is formed of soft flexible material, as for instance, felt or spongy rubber, that is held firmly against the diaphragm and strip 10 by a cover plate 12 under the action of a nut 13 and a screw 13^a extending axially through the block 3 as shown in Fig. 1. The space between the diaphragm 7, strip 10 and the block 3 is filled with a mass of carbon granules 14 which forms an electric current path between and covers the grooved or serrated surfaces of the electrodes 1 and 2 which are parallel to the diaphragm. The mass of carbon granules may, for example be about three-eighths or half an inch in depth over the electrodes. Adapted to extend from the centre of one electrode 1 to that of the other 2 beneath the thin stretched diaphragm and at right angles to the diametrical clamping means 10—11, are narrow aligned strips 15 of damping material, as for instance felt or spongy rubber, which are of sufficient depth to bear on the insulating block 3 and touch the underside of the diaphragm 7, the said strip being held in recesses 3^c in the block 3.

Each electrode 1 and 2 is electrically connected, as by a horizontal screw 16 or 17 to a conducting terminal 18 or 19 screwed into the block 3 and adapted to carry the energizing current and to be connected in any desired circuit.

The diaphragm 7 is protected by the cover plate 12 which is spaced away from it and has two sound inlet openings 12^a, and 12^b situated opposite the two halves of the diaphragm 7 situated at opposite sides of the clamping strips 10 and 11. The size of the said inlet openings 12^a, 12^b and the depth of the space 12^c existing between the diaphragm 7 and the plate 12 has considerable influence on the quality of the sound reproduction. For example, if the size of the openings and the depth of the space be small, the transmitter will respond more readily to notes of high frequency, while if the size of the openings and the depth of the space be large in comparison, notes of low frequency will be reproduced more faithfully. Therefore it will be understood that by providing the protecting disc with means for readily adjusting the relative sizes and dimensions of these openings and space, the quality of reproduction can easily be adjusted.

A convenient method of filling the microphone with the active carbon granules is by means of a hole or holes formed in the block 3 and normally closed by a screw plug or plugs.

The entire unit comprising the insulating block 3, diaphragm 7, and clamping rings 8 and 9 therefore, electrodes 1 and 2, carbon granules 14, diaphragm protection and clamping plate 12 and other parts hereinbefore described, can conveniently be housed in an outer casing 20 and be retained therein, as by a cap ring 21 and supported by a spring 22 and damping material 23. Additional spring means such as a coiled spring 24 (Fig. 1) may be adapted to support the central portion of the underside of the assembled unit mounted in the said casing 20.

A layer 25 of perforated material, as for instance, perforated sheet metal or metal gauze, may be clamped between the nut 13 and cap ring 21 and the perforated plate 12 to protect the diaphragm 7. A ring 26 of soft material, such as rubber, may be arranged between the layer 25 and plate 12.

Fig. 11 shows a modified arrangement in which a diametrical portion of the diaphragm is held between two strips 10 and 11 of rigid material for instance ebonite, instead of being a rigid strip 10 and a soft flexible strip 11 as in Fig. 1.

As shown in Fig. 12, an additional electrode 27 situated between the two electrodes 1

and 2, and having its upper surface substantially in the same plane as the upper surfaces of the latter electrodes, may be incorporated in the transmitter according to the requirements of the external circuit with which the transmitter is to be used.

According to the modification shown in Fig. 13, instead of holding a diametrical portion of the diaphragm between two strips of rigid and flexible insulating material (Fig. 1), or between two strips of rigid material (Fig. 11), it is acted upon from the outside by one such strip 11, the diametrical portion of the inner side of the diaphragm, opposite the strip being held against the carbon granules 14 by the outer strip 11 of flexible or rigid material.

Fig. 14 shows a modification, wherein the segmental electrodes 1 and 2 are formed with grooves 1^a and 2^a, and the diaphragm 7 bears at its outer portion on such electrodes and its diametrical portion is clamped between two strips 10 and 11 of rigid insulating material, the lower of which is held in recesses in the annular wall of the block 3 of insulating material.

According to a further modification, shown in Figs. 15 and 16, the outer side of the diaphragm 7 may be wholly or partly covered with a layer 28 of material of a stiffer or more rigid nature than that of which the diaphragm is formed and which has a large number of openings or perforations therein so that the outer surface of the diaphragm, or that portion thereof covered by the said layer of material, presents a large number of separate zones or areas to the external air. The said outer layer of comparatively rigid material may be composed of wire gauze or net, or of textile fabric of an openwork nature and be stiffened by the application thereto of a stiffening substance, as for instance, dope, or a phenolic condensation product. Or it may be composed of thin sheet material, as for example, thin sheet metal, celluloid, mica or the like, formed with a large number of apertures. The size of the mesh in recticulated material, or the size of the openings in perforated sheet material, may vary, but usually will be comparatively small, say for example, not exceeding an area of about one quarter inch square. The reticulated or perforated layer of material is or may be made of such stiffness that it will deaden or minimize vibrations of the portion of the diaphragm against which it bears while leaving the portions of the diaphragm opposite the openings in the said material free to vibrate under the action of external sound waves. The layer 28 of reticulated or perforated material may merely be arranged to bear or press against the diaphragm, or it may be attached to the diaphragm by a suitable adhesive.

In come cases, the inner surface of such a sectionalized diaphragm, or a portion thereof, may be provided with a layer of reticulated or perforated material such as referred to, applied in a similar way.

In the modified construction shown in Figs. 17 to 20 inclusive, the segmental electrodes 1 and 2 are fixed in segmental recesses formed in the ebonite or like blocks 3 of insulating material. To the upper side of the block are secured, as by adhesive material, two strips 30 and 31 of relatively soft insulating material, for instance rubber, arranged at right angles to a diametrical line between the central portions of the electrodes and each of which is provided with short studs 30^a and 31^a of like material. The diaphragm 7 is clamped at its peripheral portion between clamping plates 32 and 33 and bears upon the studs 30^a and 31^a, the two plates having large openings therein as shown in Figs. 18 and 20. The opening in the bottom plate 32, which is of insulating material, serves to confine the carbon granules 14 in place between the block 3 and diaphragm 7 and over the electrodes. The upper plate 33, may be of metal. 12 is a cover plate formed with two oppositely arranged sound openings 12^a and 12^b. To its underside is secured a diametrically arranged clamping strip 11^a, preferably of soft material such as rubber, that bears against a diametrical portion of the diaphragm 7 arranged at right angles to the diametrical line joining the central portions of the electrodes 1 and 2 and serves to depress the said portion of the diaphragm and hold it firmly against the adjacent mass of carbon granules 14. The said plate 12 is also preferably provided on its underside with two diametrically arranged studs 35 and 36 that also bears against the diaphragm 7 and press the latter against the carbon granules. The plates 32, 33 and 12 are firmly secured together and to the block 3 by screws passing through holes 37 in these parts. 38 is a hole in the block 3 through which the carbon granules 14 can be introduced. It is normally closed by a screw plug 39. 18 and 19 are terminals connected to the electrodes 1 and 2. The openings 12^a and 12^b in the cover plate 12 may be protected by a layer 25 of perforated material clamped between the central portion of the said plate 12 and a disc 40 and between the peripheral portion of the said plate and a cap ring 21 fixed to a casing 20 as in Fig. 1.

In each arrangement the two portions of the diaphragm at oppoiste sides of the diametrically held portion of the diaphragm is or may be stressed to different degrees so that they shall have different periods of vibrations. Also, the peripheral portion of the diaphragm may, in some cases, be clamped between a peripheral portion of the insulating block and an upper clamping ring, as in Figs. 14 and 15, instead of between two clamping rings fixed to the peripheral portion of the block.

The upper surfaces of the electrodes may, as shown in Figs. 17, 18 and 19, be provided with a plurality of projections for instance, of pyramidal shape, and provide a large area of contact with the layer of granular conducting material bearing against them.

What we claim is:—

1. A telephonic transmitter comprising a support of insulating material, oppositely and laterally arranged electrodes carried by said support, a layer of granular conducting material extending over the face of said support and between said electrodes through which and the layer of conducting material an electric current can flow, a sound sensitive diaphragm formed of thin substantially non-resonant, non-conducting material forming a skin touching the layer of granular material and means adapted to hold said diaphragm along a diametrical portion thereof so that such portion cannot vibrate freely while portions of the diaphragm at opposite sides of such held portion are, under the action of sound waves of varying intensity and frequency, impinging thereon, capable of free vibration in contact with said layer of conducting material and thereby vary the electrical resistance thereof, for the purpose set forth.

2. A telephone transmitter according to the preceding claim, characterized thereby that the vibratory portions of the diaphragm at opposite sides of the diametrically held portion and touching the layer of granular material, have different natural periods of vibration.

3. A telephone transmitter according to claim 1, wherein the vibratory portions of the diaphragm at opposite sides of the diametrically held portion of the diaphragm are stressed to different degrees so that they have different periods of vibration.

4. A telephone transmitter according to claim 1, wherein the diametrically held portion of the diaphragm is arranged at right angles to the direction of current flow through the layer of granular conducting material between the electrodes.

5. A telephone transmitter according to claim 1, wherein the diametrically held portion of the diaphragm is held against the layer of granular conducting material, by a strip of soft or yielding material.

6. A telephone transmitter according to claim 1, wherein the diametrically held portion of the diaphragm is held against the layer of granular conducting material.

7. A telephone transmitter according to claim 1, wherein the support of insulating material is of circular shape and the peripheral portion of the diaphragm is secured to such support, the diametrically held portion of the diaphragm being arranged at right angles to a line between the electrodes.

8. A telephone transmitter according to claim 1, wherein the layer of granular conducting material extends over the electrodes.

9. A telephone transmitter according to claim 1, wherein a cover plate having sound inlet openings therein is secured over but spaced from the diaphragm.

10. A telephone transmitter comprising a block of insulating material, oppositely and laterally arranged electrodes carried thereby, a layer of granular conducting material carried by said block and arranged between said electrodes, a diaphragm of thin substantially non-resonant and non-conducting material forming a skin touching the layer of conducting material and secured at its periphery to said block, strip material holding said diaphragm along a diametrical portion thereof, arranged at right angles to a line joining the electrodes, against said granular material while portions of the diaphragm at opposite sides of said held portion are capable of vibration, under the action of external sound waves, in contact with said granular material, and a cover plate secured over but spaced from said diaphragm and having sound inlets therein opposite the vibratory portions of the diaphragm, said cover plate being to press the strip holding means inward against said diaphragm.

11. A telephone transmitter comprising a block of insulating material, oppositely and laterally arranged electrodes carried thereby, a layer of granular conducting material carried by said block and arranged between said electrodes, a diaphragm of thin substantially non-resonant and non-conducting material forming a skin touching the layer of conducting material and secured at its periphery to said block, strip material holding said diaphragm along a diametrical portion thereof, arranged at right angles to a line joining the electrodes, against said granular material while portions of the diaphragm at opposite sides of said held portion are capable of vibration, under the action of external sound waves, in contact with said granular material, rows of studs of yielding material carried by said block, arranged parallel to the said strip holding material for said diaphragm and in contact with the inner surface of said diaphragm, additional studs arranged outside of and bearing against the diaphragm and a cover plate secured over but spaced from said diaphragm and having sound inlets therein opposite the vibratory portions of the diaphragm, said cover plate being arranged against the strip holding means and outer studs and pressing these parts inward.

12. A telephone transmitter comprising a circular block of insulating material having diametrically arranged recesses therein, electrodes arranged in said recesses, a layer of granular conducting material extending over the face of said block and between and over said electrodes and through which electric

current can flow, a sound sensitive diaphragm formed of thin non-resonant non-conducting material forming a skin touching the layer of granular material, rings between which and the peripheral portion of said block the peripheral portion of said diaphragm is clamped, a second ring secured a diametrical strip of material arranged opposite to and bearing against a diametrical portion of said diaphragm at right angles to a diametrical line passing through said electrodes, and a plate adapted to press said rings and peripheral portion of the diaphragm against said block and the diametrical strip against the diaphragm and having openings therein opposite the portions of diaphragm between the clamping rings and strip.

13. A telephonic transmitter comprising a circular block of insulating material having oppositely arranged lateral arc shaped recesses therein, electrodes having irregular upper surfaces secured in said recesses, a layer of granular conducting material extending over the face of said block and between and over the upper surfaces of said electrodes, a ring of insulating material extending around the electrodes and forming with said block a receptacle for the layer of conducting material, a second ring arranged above the first mentioned one, a sound sensitive diaphragm extending over the layer of conducting material and electrodes and having its peripheral portion clamped between said rings, a third ring bearing at its periphery against the second ring and having a diametrically arranged portion, and a strip of material arranged between such diametrically arranged portion of said third ring and a diametrical portion of said diaphragm and bearing firmly against the latter in a direction at right angles to a diametrical line passing through the electrodes, said third ring having sound inlet apertures therein opposite the unclamped lateral portions of said diaphragm at each side of the diametrically held portion of the diaphragm.

14. The combination with a telephone transmitter according to claim 13, of a casing and an inwardly flanged cap ring secured to said casing and adapted to press the third ring and clamping rings with interposed peripheral portion of the diaphragm against said block and the diametrical strip of material against said diaphragm.

15. A telephone transmitter comprising a circular block of insulating material, oppositely and laterally arranged segmental shaped electrodes fixed in said block, a layer of granular conducting material extending over the face of said block and between and over said electrodes, a ring of insulating material surrounding said electrodes and forming with the face of said block, a receptacle for the conducting material, a second ring arranged adjacent to the first one, a diaphragm formed of thin sheet rubber clamped at its periphery between said rings, a plate arranged adjacent to the second ring and provided with a diametrically arranged member and with sound inlet apertures at opposite sides of said member said rings and plate being secured to said block, a diametrically arranged strip of yielding material arranged between the diametrical member of said plate and said diaphragm and bearing firmly against a diametrical portion of said diaphragm, two strips of relatively soft insulating material arranged adjacent to said electrodes and parallel to said diametrically arranged strip of yielding material and each provided with a series of studs bearing against the inner side of said diaphragm, and two diametrically arranged studs arranged between the said plate and diaphragm and acting to press said diaphragm against the layer of conducting material.

16. A telephone transmitter comprising a circular block of insulating material having diametrically arranged recesses therein, electrodes arranged in said recesses, a layer of granular conducting material extending over the face of said block and between and in contact with said electrodes, a circular sound sensitive diaphragm formed of thin non-resonant non-conducting material forming a skin touching the layer of conducting material and extending over the peripheral end portion of said block, a ring bearing against the peripheral portion of said diaphragm, a strip of material arranged to bear against a diametrical portion of said diaphragm at right angles to a diametrical line passing through said electrodes, so as to leave portions of the diaphragm between said ring and strip free to vibrate independently of each other and a plate adapted to press said ring and strip against said diaphragm and having openings therein opposite the portions of the diaphragm that are free to vibrate.

Signed at 1 & 2 Gracechurch Street, in the city of London, this twenty-sixth day of May, 1927.

MARIA GRAHAM,
Executrix of Edward Alfred Graham, Deceased.

ALFRED GRAHAM,
Executor of Edward Alfred Graham, Deceased.

LESLIE HAROLD PADDLE.