

Aug. 18, 1925.

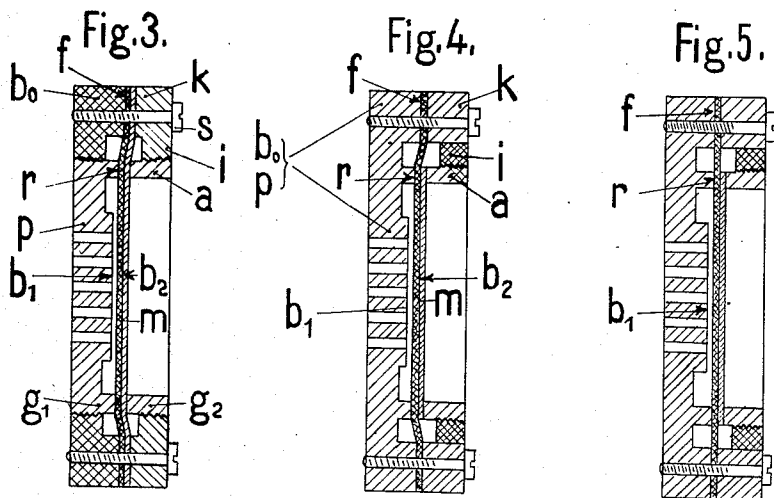
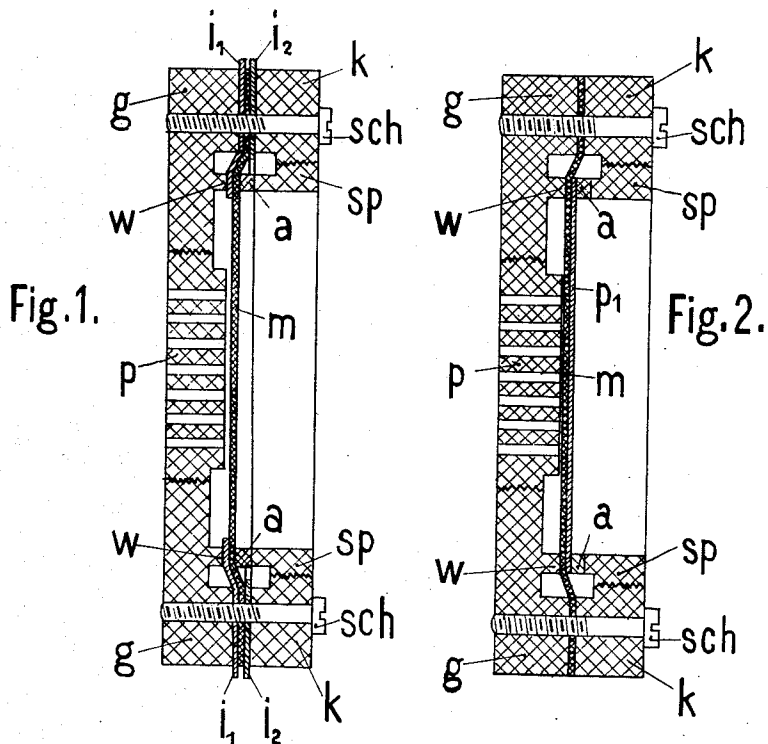
J. MASSOLLE ET AL

1,550,381

ELECTROSTATIC TELEPHONE

Filed Nov. 28, 1921

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

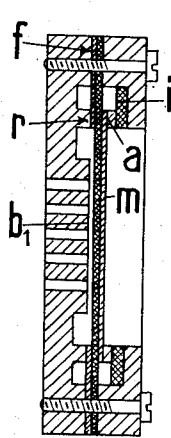


Fig. 6.

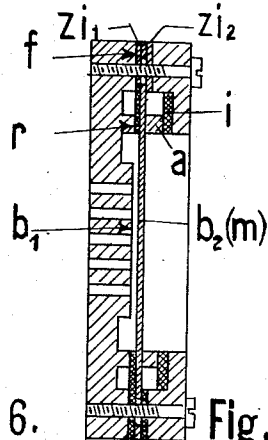


Fig. 7.

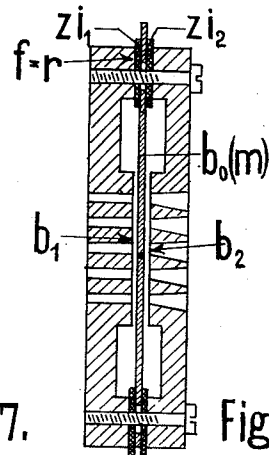


Fig. 8.

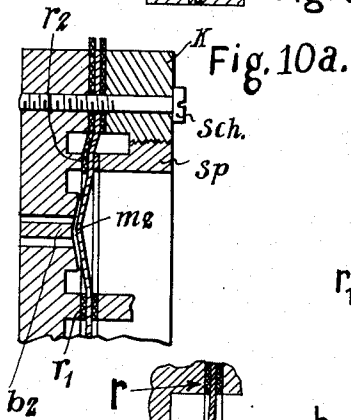


Fig. 10a.

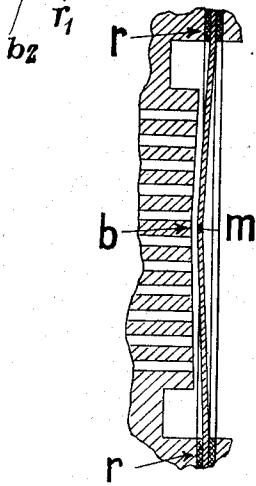


Fig. 9.

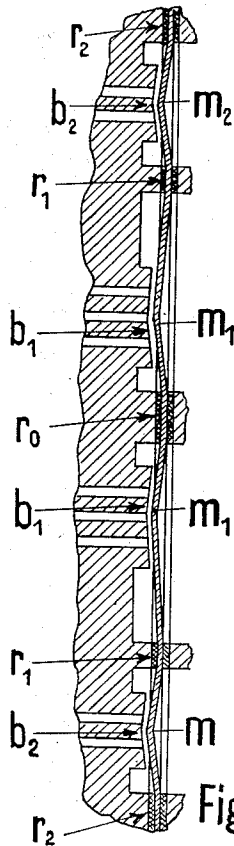


Fig. 10.

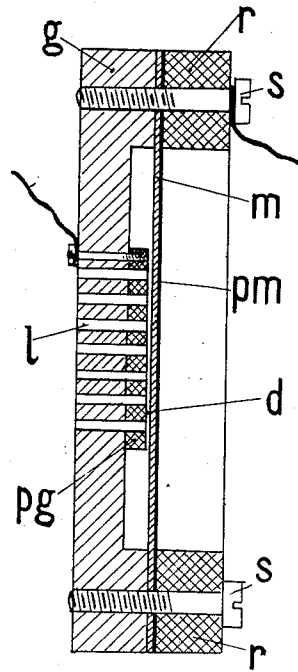


Fig. 11.

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UNITED STATES PATENT OFFICE

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ELECTROSTATIC TELEPHONE.

Application filed November 28, 1921. Serial No. 518,425.

To all whom it may concern:

Be it known that we, JOSEPH MASSOLLE, engineer, residing at Berlin-Grunewald, Germany, and HANS VOGT, engineer, residing at Berlin-Schoneberg, and Dr. JOSEF ENGL, physicist, residing at Berlin-Grunewald, Germany, have invented certain new and useful Improvements in Electrostatic Telephones, of which the following is a specification.

The invention relates to electrostatic telephones, with especial reference to the use of the same for reproducing music and speech. Objects of the invention comprise the provision of means whereby the acoustically-modulated currents, or sounds, operating the same, will cause such operation in a particularly faithful, reliable and efficient manner, and with a minimum of distortion. Other objects comprise the provision of improved combinations of parts and details of construction, all as will be more fully set forth in the following specification, and be particularly set forth in the appended claims.

Various features of the invention permit the operation of such a device, even when the same is of comparatively large size, with a considerable degree of accuracy, reliability and freedom from distortions due to inertia of moving parts, and other causes. Among the features of the invention may be mentioned, means for subdividing the diaphragm into a number of separately-vibrating annular portions, and means for insuring maintenance of exact distance between the diaphragm and the fixed capacity surface.

The distance between the diaphragm and its counter plate is of great importance in electro-static telephones. As both parts must be mutually well insulated the production of a spacing of for instance some hundredths of a millimeter is rather difficult. The well known insulation by plates of ebonite or similar material which is submitted to the effects of heat, moisture and the like is quite insufficient as these substances are submitted to continuous variations of shape.

This invention avoids these inconveniences by making from metal all the parts which are essential for the production of

the gap between the fixed condenser plate and the diaphragm, said parts being insulated at the critical spacing parts by thin disks, for instance of mica, which are clamped in between the metal parts.

In order that the invention may be clearly understood, we shall proceed to describe the same with reference to the different forms of construction shown by way of example on the accompanying drawings, wherein:—

Fig. 1 shows a vertical section through one form of construction.

Figs. 2 to 11 are similar sections of modified forms of construction. Fig. 10^a is a partial edge section through one form of construction, which may be considered as a continuation of Fig. 10 to complete the same.

Referring to the several figures of the drawings *g* is a supporting plate, preferably of metal into which the unitary condenser plate *p* which is made also of metal, is screwed in order to make the distance, between the same and the diaphragm, adjustable. The clamping ring *k*, Figs. 1 to 4, serves to clamp the edge of the diaphragm upon the supporting plate, screws *sch* being extended through ring *k* and the diaphragm and into plate *g*.

The diaphragm *m* consists according to Fig. 1 of a foil of metal or of a non-conducting material which is coated with electrically conducting material either upon one side or upon both sides. The insulation between plate *g* and ring *k* is effected in the form of construction shown in Fig. 1, by interposed rings *i'* and *i''*, for instance of thin mica, or impregnated paper or the like. These insulating rings can extend beyond the edges of plate *g* in order to lengthen the creeping paths. The holes for the screws in the diaphragm are sufficiently wide to allow for creeping. For providing electrical connections from the diaphragm to an outside circuit thin metal foils can be inserted between *i'* and *m* and *i''* and *g*. The electrical connections can be effected in the case of metal diaphragms or with diaphragms which are coated upon one side only, by means of the ring *a* Fig. 1 which is engaged by the clamping ring *sp* made from insulating material, for instance ebonite. The

clamping ring sp is screwed into the metal clamping ring k . The tension of the diaphragm is regulated by the screwing in of the clamping ring sp . An abutment w is preferably arranged upon the supporting plate g for ensuring maintenance of parallelism between p and m , the diaphragm being firmly pressed against this abutment with interposition of the insulating ring i' .

Another form of construction would for instance consist in making ring k also from insulating material, this being possible as the accuracy of distance between plate p and m is ensured by the abutment w . With metallic diaphragms or with such diaphragms which are coated with conducting material upon both sides i' is quite sufficient for insulating. With diaphragms of insulating material which are coated upon one side only no insulating ring is required if the conducting coating is situated at the same side as k .

Fig. 2 shows an even simpler form of construction as in this case the single conducting coating p' upon the side of diaphragm m towards ring k is of the same diameter as the conducting connection ring a . Consequently as the diaphragm itself consists of an insulator, a non-conducting circular ring is situated between g and k . As ring a is insulated from k by sp the diaphragm m can be clamped in between g and k without additional insulation.

With non-uniform distances between the fixed and oscillating condenser coatings, the point on the oscillating coating having the least distance from the fixed coat or plate determines the distance between the coatings. This point oscillates with maximum amplitude and all other points on the diaphragm or movable coat oscillate with a less amplitude. If the point of greatest amplitude is situated outside the center of the diaphragm, the diaphragm will oscillate unsymmetrically. Since the strength of the sound reproduced varies as the square of the distance between the coating of the diaphragm and the plate and as the distance required for the greatest efficiency amounts to only several hundredths of a millimeter, the slightest irregularities have a very important effect upon the result.

The present invention permits the obtaining and maintenance of accurate distances of the diaphragm, or movable condenser coating, from the plate, down to a few hundredths of a millimeter. With this object in view the solid condenser plate made from metal is provided with one or several rings whose end surface is parallel with the surface of the plate, and the diaphragm is securely fixed upon the said ring or upon the rings. The distance between the fixed and movable condenser elements is either produced by these rings or by the intermediate

layers of metal foil, mica, paper or the like which can serve at the same time for insulating metallic diaphragms.

Figs. 3 to 10 show forms of construction. In Fig. 3 b_0 and k are rings between which the diaphragm m is clamped at its edge with the aid of the screws s . The thickness of the diaphragm is shown on the drawing on an exaggerated scale. Ring b_0 is preferably made from insulating material and k can be made of metal. The diaphragm is also an insulator consisting for instance of mica and having a conducting coating b^2 upon one side only. The solid condenser plate p of metal with the coated surface b' of an electric conductive material is screwed by means of threads g' into b_0 and it is provided according to the invention with a ring r whose front surface is parallel with b' and projects forwardly beyond surface b' for an amount which is equal to the distance to be produced between b' and m . The diaphragm is in close contact with ring r , being for instance pressed upon the same by ring a which, if k is an insulator, is made of metal in order to establish the electric connection of the coating of the diaphragm. Owing to the deflection which it will undergo in use, a tension is given to the diaphragm which can be regulated by means of the screw threads g' and g^2 .

Fig. 4 differs from Fig. 3 by b_0 and p being united to form a body which is entirely made of metal so that the tension of the diaphragm is no longer adjustable but determined by the difference of height between f and r . The insulation between b' and b^2 is produced by the ring i and the diaphragm m , the latter being coated with conducting material only up to the outer diameter of a .

In the form of construction shown in Fig. 5 the diaphragm is not tensioned when the ring a is being screwed home as r and f are of equal height. The diaphragm must therefore be inserted, if it is not sufficiently rigid, in tensioned state, for instance with the aid of a separate tensioning device. This form of construction is otherwise the same as that shown on Fig. 4.

In Fig. 6, r , f , and b' are of the same height. The distance of the diaphragm from the surface b' of the plate is in this case determined by the intermediate rings z which can be made of metal. The conducting ring a and insulator i are modified in so far as a is not screwable but clamped in by i when the screws s are being screwed home. The member i is preferably made from elastic material for instance soft rubber, whereby the intimate contact of m and z upon r is ensured. z determines the distance between the diaphragm and the solid plate.

The form of construction shown on Fig. 7 differs from the previously described

forms of construction only with regard to the diaphragm which is either made entirely of metal or of an insulator coated with a conducting coat upon one or both sides up to the edge. The intermediate rings z_1' and z_2' are consequently made of insulating material for instance of mica or paper, the latter being preferably impregnated with insulating material.

Fig. 8 shows the form of construction of Fig. 7 for a telephone of the bilateral action type. b' and b^2 are the outer coatings, and $b_0(m)$ is the diaphragm between said coatings. No separate rings r are provided and the surface f is parallel to b' and replaces r .

Fig. 10 shows the use of the ring r in connection with sub-divided diaphragms or with such diaphragms which are fixed at the center. r_0 is the central support, r' and r^2 are subdividing rings. With telephones acting at one side only the diaphragm is deflected always towards one side. If the plate surface b' is straight the distance between this surface and the diaphragm will therefore get narrower towards the center. This deflection can be compensated by making b' or b^2 concave as shown on Figs. 9 and 10. It is not necessary that b' and r be made of one metal piece, they could be composed also of two metallic parts.

In the electro-static telephone in accordance with this invention the diaphragm can be tensioned radially so that thin and light diaphragms can be used. For diaphragms of this type the net weight and the pitch of the tone at a given diameter are critical, specially if such telephones are to be utilized for reproducing musical or talking currents. Owing to the high pitched frequencies which are to be reproduced the diaphragm itself must possess a comparatively high natural rate of vibration as otherwise the high pitched frequencies would be reproduced at unduly low sound intensity in comparison to the deep pitched frequencies.

In order to reduce its inertia the weight of the diaphragm must be as moderate as possible. For these objects the materials which have been hitherto commonly used for diaphragms in apparatus such as is here described are not well adapted as they are rather heavy and can besides not be tensioned sufficiently.

According to the invention thin mica is used as material for diaphragms and the diaphragms made from this material have a sufficiently low weight and sufficient capability of tension. Diaphragms of this type, utilized in this invention having a thickness of some hundredths of a millimeter and having a diameter up to one half meter, and can be put under sufficiently strong tension. The tensioning of the diaphragm is preferably effected in such a man-

ner that the diaphragm is gradually tensioned more and more and that after each tensioning the natural pitch of tone is ascertained. The use of mica diaphragms presents the further advantage that the elastic limit is quite close to the limit of the tensile strength, as can be proved by controlling the pitch of tone while the tensioning is proceeding, whereas the hitherto used materials for diaphragms begin to deform before the rupture if the elastic limit is exceeded. Therefore, mica diaphragms can be subjected to high tensions. The diaphragm described possesses as another advantage a large time constancy, owing to the low elasticity of the mica so that its tension will be preserved for a long time. The mica is further, owing to the hardness of its surface, a material which is specially adapted for the production of sound and which is much superior to, for instance paper or thin skins, being besides not hygroscopic.

The dielectric required in the condenser telephone, is, further, in the preferred form of the invention, rigidly connected with the diaphragm or movable condenser plate, the mica diaphragm itself constituting the dielectric which carries the metallic or conducting coating, which constitutes the movable plate of the condenser, said dielectric being already known for electro-static telephones as insulation between the diaphragm and its counter plate. By the rigid connection of the dielectric with the diaphragm the advantage of an easy and exact adjustment of the distance between the dielectric and the fixed condenser plate is ensured and this adjusting is facilitated for very large diaphragms or rendered possible in such case.

Fig. 11 shows a form of construction of this arrangement. g is the supporting plate made for instance from insulating material upon which the condenser plate $p-g$ is fixed. The edge portion of the diaphragm is clamped upon the annular projection of the plate g by the clamping ring r and the screw s . The diaphragm is preferably made from mica, glass, paper, gold-beater's skin or similar substances. The diaphragm has upon one side a coating $p m$ of conducting material which may be produced in various ways, as by a galvanizing process (for instance by silver-plating). In this method the silver coating is preferably deposited on the diaphragm from a solution comprising silver nitrate and other substances. The diaphragm is mounted in such a manner that it is situated as dielectric between $p m$ and $p g$. $p g$ can have a number of perforations l for reducing the damping of the air gap d . For producing the contact with the diaphragm coating the clamping ring r can for instance be made of metal and it can have a connecting screw.

We claim:—

1. In an electrostatic telephone, the combination of a fixed condenser plate, a diaphragm closely adjacent thereto, and means for clamping said diaphragm in position under tension, comprising rings engaging the diaphragm to divide the latter into a plurality of concentric annular separately-vibratory portions, each of uniform width, but said portions being of different width each from the other.
2. In an electrostatic telephone, the combination of a fixed condenser plate, a diaphragm closely adjacent thereto, and means for clamping said diaphragm in position under tension, comprising a member opposite the center of the diaphragm and ring-members concentric therewith, to provide annular separately-vibratory diaphragm portions of different widths one from the other, said plate having seating portions between which and said members the diaphragm will be clamped.
3. In an electrostatic telephone, the combination of a fixed condenser plate, a diaphragm closely adjacent thereto, and means for clamping said diaphragm in position, comprising a plurality of members engaging the diaphragm to divide the latter into a plurality of separately-vibratory portions, said plate having correspondingly shaped seating portions between which and said members the diaphragm is clamped, said plate having slightly concaved faces opposite the said separately-vibratory portions of said diaphragm.
4. In an electrostatic telephone, the combination of a fixed condenser plate, a diaphragm closely adjacent thereto, and means for clamping said diaphragm in position under tension, comprising rings engaging the diaphragm to divide the latter into a plurality of concentric annular separately-vibratory portions, each of uniform width, but said portions being of different width each from the other, said plate having forwardly extending seating portions between which and said clamping means the diaphragm is clamped, and having accurately faced portions intermediate said seating portions, separated by a slight gap from said diaphragm.
5. In an electrostatic telephone, the combination of a diaphragm, a fixed condenser plate having an accurately faced seating portion and another accurately faced portion, both integral with said plate, said second portion being set back somewhat from said seating portion, and means for clamping said diaphragm upon said seating portion, the face of said second-named plate portion being thereby spaced from said diaphragm by a predetermined slight distance, said plate and clamping means being both of similar metal.
6. In a telephone, the combination of a diaphragm, a plate, and means for clamping said diaphragm to the plate, in spaced relation thereto, in such manner as to provide vibratory annular portions of different widths, and having different natural rates of vibration.
7. In a telephone, the combination of a diaphragm, a plate, and means for so clamping the diaphragm to the plate as to provide vibratory ring-shaped diaphragm portions having different widths one from the other.

In testimony whereof we have signed this specification.

JOSEPH MASSOLLE.
HANS VOGT.
Dr. JOSEF ENGL.