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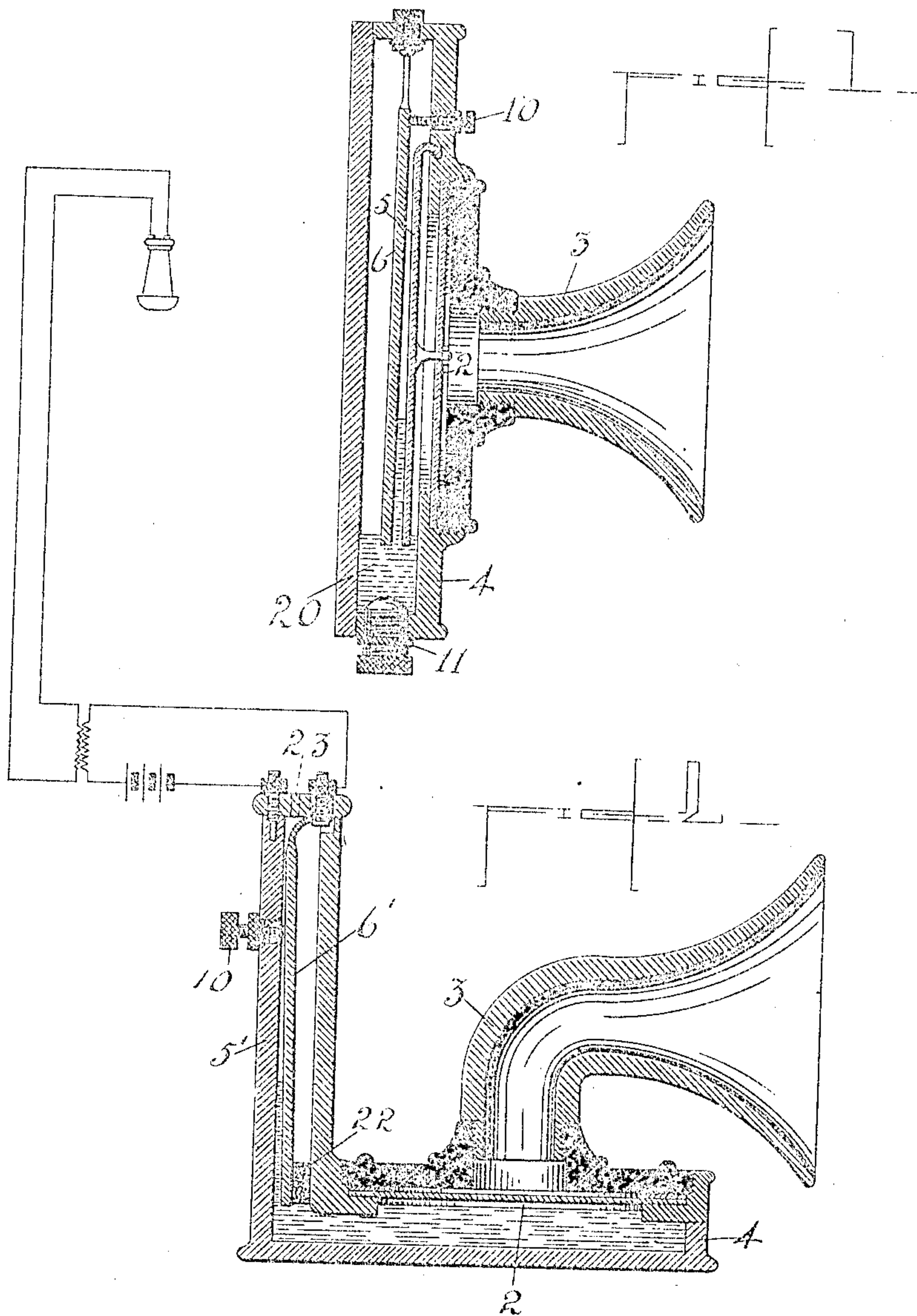
PATENTED NOV. 19, 1907.

E. E. RIES.

TELEPHONE TRANSMITTER.

APPLICATION FILED JAN. 11, 1904.

2 SHEETS--SHEET 1.



WITNESSES:

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E. L. Laster.

INVENTOR

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BY

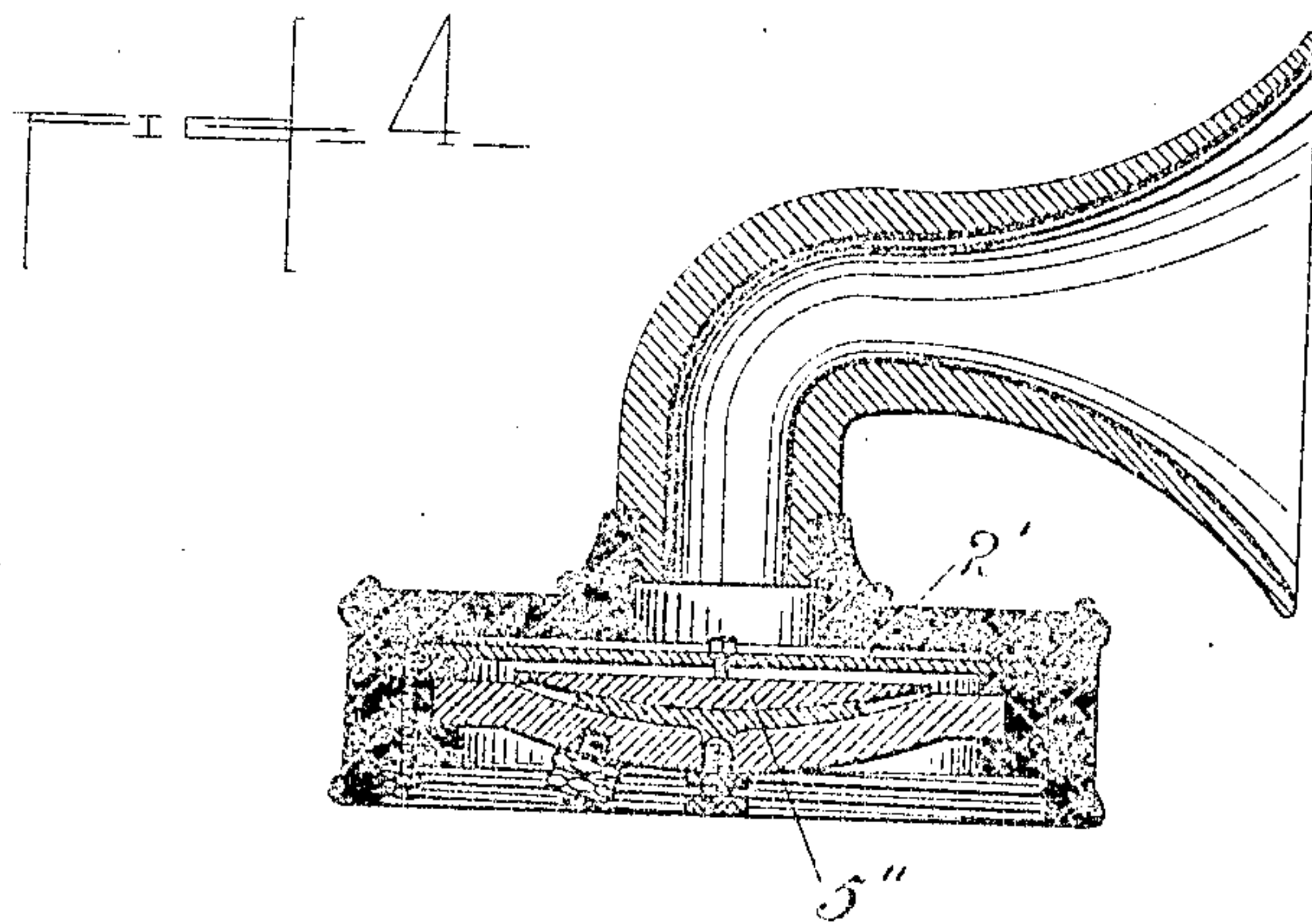
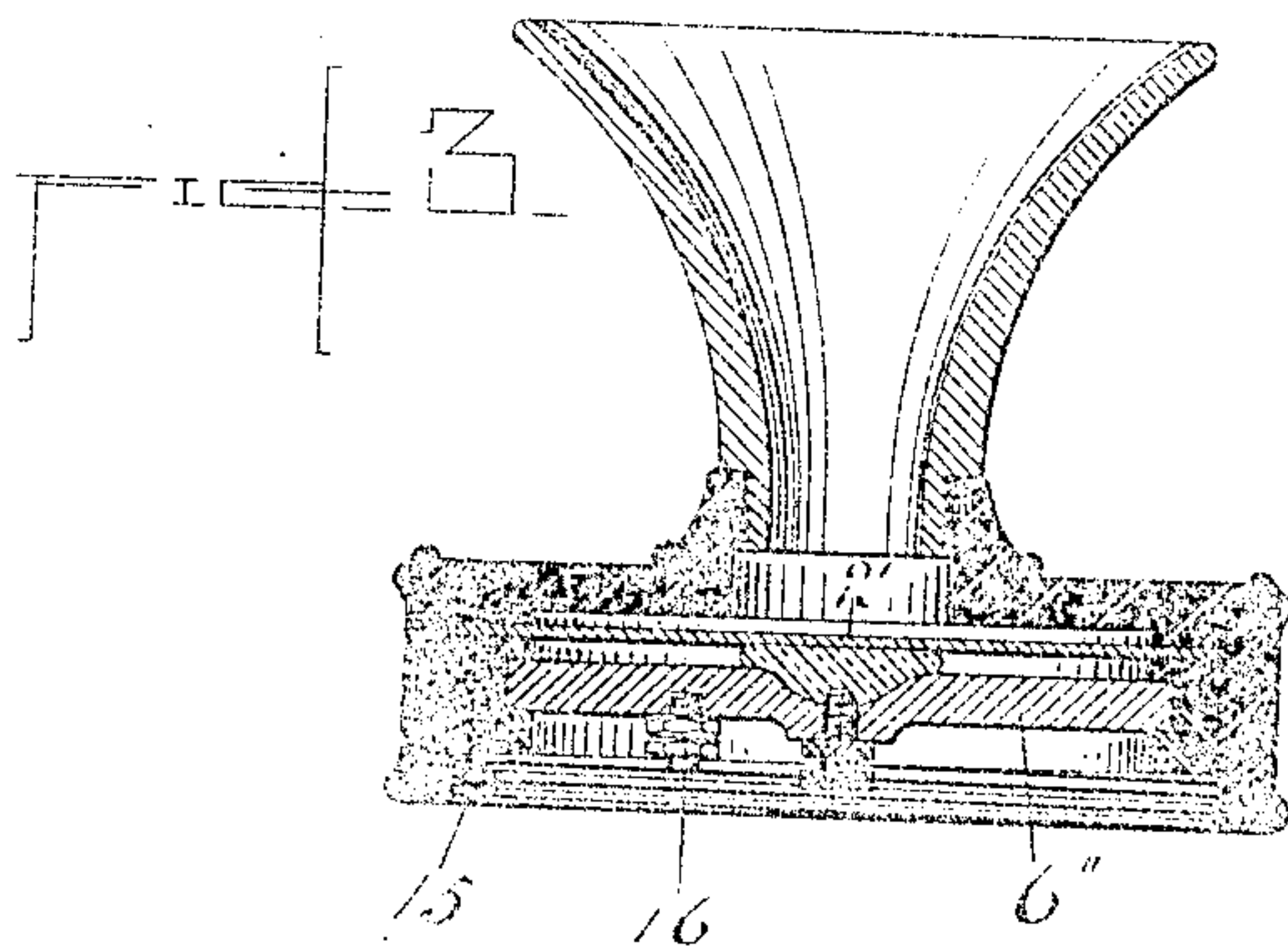
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2 SHEETS—SHEET 2.



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ELIAS E. RIES, OF NEW YORK, N. Y.

TELEPHONE-TRANSMITTER.

No. 871,737.

Specification of Letters Patent.

Patented Nov. 19, 1907.

Original application filed June 23, 1900, Serial No. 21,322. Divided and this application filed January 11, 1904. Serial No. 188,633.

To all whom it may concern:

Be it known that I, ELIAS E. RIES, a citizen of the United States, and a resident of New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in Telephone-Transmitters, of which the following is a specification.

My present invention relates to devices suitably constructed for the utilization of the principle of capillary attraction employed to control the resistance of an electric circuit according to the method set forth in my application filed June 23rd, 1900, Serial No. 21,322, of which application my present application is a division.

As set out in the specification of my original application, it is well known that when two surfaces of glass or other material having an affinity for a given liquid or fluid in which both are partially immersed, are brought closely together without actually touching each other, the fluid will rise between them of its own accord to a height considerably above that of its normal level or of its general surrounding level, and in doing so will spread over a considerable area of the surface between which it rises. On the other hand, when the surfaces are separated, the column of liquid between them, being no longer capable of self-support, will descend until it has reached the general level when the plates or surfaces have been sufficiently separated, and in doing so, greatly reducing the surface area over which it spreads. This is especially the case when the lower edges of the surfaces are nearly in contact and the motion of one or both plates is such as to cause their upper edges to approach and diverge respectively. When the surfaces instead of being vertical or approximately so, are both horizontal and close together and a drop or small quantity of the fluid is placed at the center of the lower surface, which may be in the form of a plate or disk, it will assume the shape of a flattened bead or film spreading over both surfaces through its chemical affinity or capillary action, and if the upper surface of the disk be slightly lifted the bead will tend to rise with it and in doing so become elongated, and at the same time contracted in width to a considerable extent so that the portions of the surfaces bridged by the fluid, as well as the cross section of the bead itself, is relatively small. This action,

as already stated, takes place without pressure upon the fluid.

My present invention consists of improved forms of apparatus wherein the above-named principle is utilized to vary the electrical resistance of a circuit in accordance with the vibrations of a suitable diaphragm operated upon by the sound waves, and the invention consists in the novel constructions of devices and combinations of parts hereinafter set forth and more particularly specified in the claims.

Figure 1 shows in vertical section a form of instrument in which the two plates which include the capillary fluid between them, are arranged in vertical position. Fig. 2 shows a modification in which the sound waves communicate motion to the liquid instead of to the electrode. Figs. 3 and 4 show forms wherein the electrodes or plates are arranged horizontally.

Referring to Fig. 1, 2 is a diaphragm designed to receive the sound waves directed upon it by the mouth-piece 3 of the instrument. The diaphragm and mouth-piece may be mounted together after the manner usual with telephone transmitters and as clearly shown. 4, is the support or casing of the instrument and is made to form a chamber containing the liquid and the electrodes. 5, is one electrode hung by a suitable pivotal or pendulous suspension and mechanically connected with the diaphragm by a pin or other connection so as to partake of the motion of the diaphragm when subjected to the influence of sound waves. In Fig. 1, it is shown as provided with a pendulous suspension consisting of a hook at one end of the plate or one electrode and a cavity in the front of the case into which the hook enters. The electrode may be included in the electric circuit by the electric connection formed between the hook and casing when the latter is of metal, or through the diaphragm or in any other desired way. Obviously also the electrode might be mounted and connected with the diaphragm in other ways so as to partake of the motions thereof. 6, is another plate or rod electrode suspended or supported in close proximity to 5, so as to form a very narrow space between them in which the liquid in the casing rises by capillary attraction. Electrode 6 may be supported in the manner indicated from the casing 4, by an insulated support

so that the electrodes 5, 6, may form terminals of an electric circuit leading from a suitable generator as well understood in the art, and as fully shown in Fig. 2. The support for electrode 6 is preferably of such character as to permit it to be adjusted towards and away from the opposite electrode by means of an adjusting screw 10, which latter should be, in this particular form of instrument, also insulated from the casing. By means of this adjustment the initial or normal extent of wetted surface covered by the capillary film upon the opposing faces of the electrodes may be adjusted. The electrodes are so arranged by preference that the space between them narrows gradually in an upward direction so that, the amplitude of the variations in the electrical resistance will be increased in a more pronounced degree with an increase in vibration of the electrode 5 through the operation of the diaphragm 2. When the electrode 5 approaches the electrode 6, under the action of the sound waves, the liquid rises still further in the space between them, through capillary attraction, thus increasing the wetted surface upon the electrodes and thereby diminishing the electric resistance interposed in the circuit of the generator by the liquid. When the diaphragm recedes, thus increasing the space between the electrodes, the liquid falls away and the resistance increases. An adjusting device such as indicated at 11 may be employed to vary the cubical contents of the liquid containing chamber and to thereby adjust the initial extent of wetted surface.

In the modification of my invention shown in Fig. 2, one electrode 5' is formed by the back plate of the metallic casing for the instrument, and the other 6' is suitably mounted, as before described, and is preferably capable of adjustment towards and away from 5'. The electrodes are so arranged that the space between them narrows upwardly so that if by any external means the height of the liquid film is raised the capillary attraction will produce a further spreading of the film owing to the greater proximity of the surfaces, and thereby vary the resistance. In this form of instrument the sound waves operate hydrostatically to raise the level of the liquid in the space between the electrodes so that capillary action will come into place to vary the electric resistance, as before explained. For this purpose the diaphragm may operate directly or indirectly in a manner to reduce the cubic capacity of the liquid holding space and thereby raise its level, but preferably it is made to act as shown upon a body of air or gas interposed between it and the liquid, so as to permit freer movement of the diaphragm than would be the case if the diaphragm formed a wall of the liquid containing space.

The diaphragm 2 is made, preferably, of rubber or suitable elastic material and is disposed horizontally over the liquid in a chamber which communicates with that in which the electrodes are disposed, so that when the liquid is forced out of the first chamber by the action of a sound wave operating on the diaphragm, it will be caused to assume a higher level in the other chamber.

Preferably, the cross-sectional area of the vertical chamber or space containing the electrodes, is made small as compared with that of the diaphragm, so that the movement of the diaphragm will result in an amplified movement of the liquid column in which electrodes are contained, according to well known principles of hydrostatics. To better realize this condition an elastic seal or washer 22 may be placed in the smaller vertical chamber as indicated, so that the liquid shall be free to rise only in the space between the electrode 6', and electrode 5'. The elastic seal or cushion 22, while closing the space as shown, permits an adjustment of the electrode 6' by means of the screw 10. An air vent may be provided as indicated at 23.

I do not limit myself to any particular means for communicating the sound waves to the liquid.

In many cases it may be preferable to use a solid, horizontally disposed lower disk, or base piece, forming one electrode and having a slight central cavity of such shape as to tend to confine to such center a small quantity of conducting or semi-conducting fluid. Above this disk and substantially parallel with it and having its periphery seated upon an insulating cushion forming a closed chamber of the two disks, is the vibrating diaphragm, over which is a curved mouthpiece leading to the outside of the transmitter box. The diaphragm forms the other electrode, and it, together with the inner surface of the lower or back plate, is preferably plated with gold, aluminium or other non-oxidizable metal having the necessary affinity or attraction for the fluid employed, which may be of any desired nature capable of readily spreading itself over the two surfaces in the manner described and is sufficiently mobile, such as an ordinary battery solution of the requisite degree of conductivity.

Fig. 3 illustrates a modification in which the electrodes are disposed horizontally. The casing of the instrument in this instance is of non-conducting material, and the electrode 6'' rests upon an insulating screw-ring by which it is clamped against an insulating washer which holds the diaphragm 2' in place. The diaphragm constitutes the other electrode. Connection with the diaphragm electrode 2' is made by the screw 15, and with electrode 6'' by a screw 16. The distance between the electrodes as shown is exaggerated, and in practice the electrodes

would be very much closer together, and in any case sufficiently close to cause the liquid to spread out between the electrodes by capillary attraction, when one electrode is caused to approach the other by the action of sound waves operating directly or indirectly upon one or both of the electrodes.

In the modification in Fig. 4, the electrode 5" is attached to the diaphragm 2, and the upper electrode is shown as conformed to the dished or concave outline of the lower electrode. In practice the surface of the upper electrode preferably departs in outline from that of the lower in such manner that the space between them shall gradually decrease towards the periphery, thereby producing a large increase in the wetted surface or fluid-covered area for a comparatively smaller movement of the electrodes towards one another, and thereby causing a great amplitude of variation in the resistance in the circuit when the excursions of the diaphragm 2 are large.

It is obvious that my invention may be carried out in very many forms of apparatus, and that it is not limited to the special form shown.

By graduating the space between the electrodes as explained so that it diminishes from one side or edge of the electrodes toward the other, I introduce an automatic compensation for the dampening action or greater mechanical resistance to vibrate recurring with the larger excursions or vibrations of the diaphragm when the same is operated by louder sounds, and hence am enabled to transmit sounds with great fidelity. In ordinary telephones the dampening of the diaphragm arising from its now naturally increasing resistance to vibration as the amplitude of its movement increases prevents it from responding faithfully to the sound vibrations in respect to amplitude, but with the automatic compensation referred to the diaphragm, as it approaches the end of its excursion, works upon a capillary film or interval that is narrower or thinner and will hence produce a greater change of resistance for a given movement of the diaphragm, thereby producing changes of resistance that are a more faithful reflex of the actuating sound wave. In other words, the changes of resistances produced by the diaphragm as it nears the end of its excursion where it is dampened, are made proportionately greater for a given movement, and by proper graduation of the capillary space, the variation of resistance while disproportionate to the movement of the diaphragm may be made exactly proportionate to the actuating sound wave.

With these various forms of instrument I have obtained excellent results by employing a number of different fluids, including

mercury. I have also used a non-conducting and non-freezing liquid such as glycerin containing a quantity of powdered carbon or other conductor. In this case the amount of solid material must not be sufficient to interfere with the fluidity or capillary tendency of the liquid. In any case the surface of the electrodes should be such, according to the liquid used, that there will be an affinity (capillary) between the electrode and liquid.

In the foregoing description the term "wetted" is used to express the idea that the contact surface of the electrode is in contact with the liquid which lowers the resistance by embracing a greater surface area of the electrode.

What I claim as my invention is:

1. In a telephone transmitter, two plate electrodes and a liquid included in an electric circuit between them, such elements being sufficiently near together to cause variations in the extent of the wetted surface by capillary action when an electrode is operated in accordance with the sound waves to be transmitted.
2. In a telephone transmitter, two plates or electrodes and a film of liquid included in a circuit between them and adapted to vary the resistance of the circuit through capillary action when a plate is vibrated, as and for the purpose described.
3. In a telephone transmitter, two plate electrodes separated from one another by a narrow space which gradually diminishes towards the edge and an interposed liquid, said electrodes being sufficiently close together to cause variations of resistance in an electric circuit by variations of wetted surface due to capillary action.
4. In a telephone transmitter, electrodes normally separated from one another, and a connecting film or body of liquid adapted to vary the resistance of the circuit by capillary action when the instrument is subjected to the influence of sound waves.
5. A telephone transmitter having electrodes separated by a capillary space graduated or varying in its dimensions so as to cause an amplification of effect and a liquid contained in said space, as and for the purpose described.
6. A telephone transmitter comprising a horizontally disposed base-piece forming one electrode and having a slight central cavity, a conducting liquid contained therein, and an opposite vibratory electrode in the circuit of the liquid adapted to displace the liquid and thereby vary the superficial area of electrode surfaces wetted by the liquid.
7. In a telephone transmitter, the combination of an electrode having a slight cavity adapted to contain a liquid, and an opposing electrode carried by a vibratory diaphragm and adapted to confine the liquid in a con-

cavo-convex space whose thickness gradually decreases toward the periphery as and for the purpose described.

5 8. In a telephone transmitter, the combination of an electrode having a cavity adapted to hold a conducting liquid, of an opposed convex electrode and a capillary film of liquid confined in the space between them as and for the purpose described.

10 9. In a telephone transmitter the combination of a pair of solid electrodes separated

by a conducting liquid, and means for varying the area of wetted surface on said electrodes to vary the resistance in response to the action of sound waves.

Signed at New York in the county of New York and State of New York this 1st day of December A. D. 1903.

ELIAS E. RIES.

Witnesses:

E. L. LAWLER,

ARTHUR FUCHS.