Feb. 4, 1930. C. KYLE 1,745,937

ACOUSTIC DEVICE

Filed March 12, 1928

Fig. 1.

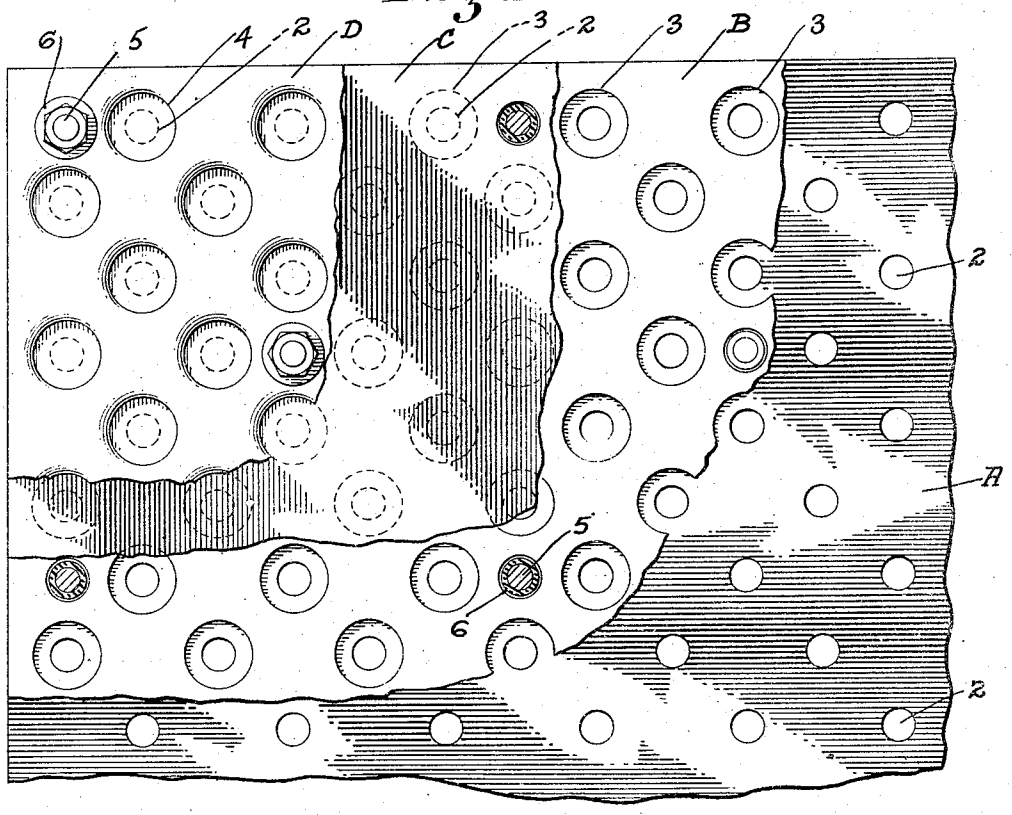


Fig. 2.

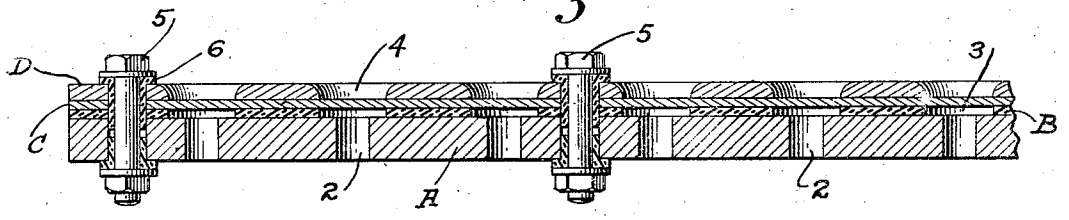
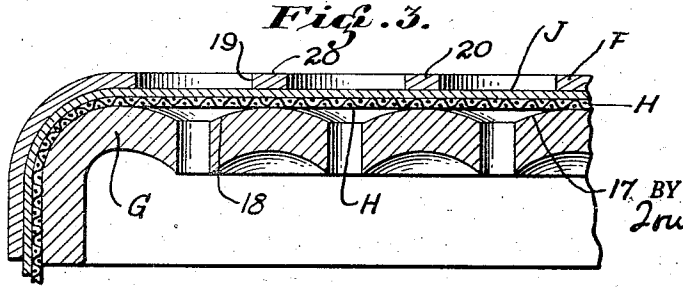


Fig. 3.



INVENTOR.
Colin Kyle
BY
Townsend, Loftus & Hewett
ATTORNEYS.

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UNITED STATES PATENT OFFICE

COLIN KYLE, OF SAN JOSE, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO UNITED REPRODUCERS PATENTS CORPORATION, OF ST. CHARLES, ILLINOIS, A CORPORATION OF NEVADA

ACOUSTIC DEVICE

Application filed March 12, 1928. Serial No. 260,832.

This invention relates to an electrostatic acoustic device for transmitting and receiving purposes, as in radio broadcasting and receiving, etc.

It is known that true sound reproduction, free from disturbing resonant notes and distortions, is best obtained by means of apparatus working on an electrostatic or condenser principle. An electrostatic transmitter or reproducer usually consists of a rigid plate and a flexible plate, the latter serving as a diaphragm. The diaphragm and the plate are placed as closely together as possible, as the efficiency is in direct ratio to the square of the distance or spacing maintained between the same.

While an electrostatic or condenser type of acoustic device is fairly satisfactory, there are objections, as a considerable spacing must be maintained, usually a sixty-fourth of an inch or more, i. e., flexing or bending of the diaphragm when struck by sound waves or when electrically actuated, will otherwise permit the plates to contact. Also due to the flexing of the diaphragm, devices of this character are fairly limited in size. For instance, the average condenser or electrostatic microphone as used is seldom over three inches in diameter and as such is not ideal for low frequency sound-wave transmission or reproduction, nor are devices of this character altogether suitable as receivers or loud speakers, as the area presented is too small for proper air coupling.

The object of the present invention is to generally improve and simplify the construction and operation of acoustic devices of the character described; to provide a flexible diaphragm which may be made, practically speaking, as large as desired; to provide a flexible diaphragm which may be exceedingly thin; to provide a structure which permits close spacing between the diaphragm and the plate; to provide a structure which permits division of a large area diaphragm into a number of cooperating diaphragms of comparatively small area; and further, to provide a structure which permits rigid clamping of the diaphragm to maintain uniform spacing and to prevent mechanical vibrations, etc.

The invention is shown, by way of illustration, in the accompanying drawings, in which:

Figure 1 is a plan view of a portion of the acoustic device, said view being broken away to show the rigid and the flexible plates, the insulating medium and the clamping plate,

Figure 2 is an enlarged transverse cross-section of a portion of the acoustic device,

Figure 3 is a partial section showing a modified form of the structure.

Referring to the drawings in detail, A indicates a rigid plate which is provided with a plurality of holes or perforations, such as indicated at 2. B indicates a plate constructed of a dielectric material. This plate is also provided with holes or perforations 3, but they are considerably larger in diameter than the holes 2. C indicates the diaphragm plate which is thin and flexible. It is disposed on top of the dielectric plate B and is rigidly clamped or secured thereto by means of a clamping plate D. This plate is also provided with holes or perforations such as indicated at 4, the perforations being of a size substantially the same as the holes 3 formed in the dielectric plate.

The plate A may be constructed of any metal desired. For instance, steel, brass, copper, aluminum, etc., and it should be fairly thick or heavy so as to prevent vibration thereof when the acoustic device is in operation.

The plate C is also constructed of metal, such as steel, brass, aluminum, etc., but it should be as thin as possible as it must be able to flex or bend when struck by sound waves, as when used as a transmitter or when electrostatically attracted by the plate A, when it is used as a reproducer or a loud speaker. Thin shim metal or leaf metal, such as gold leaf, aluminum leaf, etc. may be employed. The flexible plate C is unperforated and as such covers the perforations 2 and 3 formed in the respective plates A and B, and as the perforations 3 are comparatively large a diaphragm is formed over each set of aligned perforations, such as shown at 2 and 3.

The spacing maintained between the flexible plate C and the rigid plate A should be as small as possible. In actual practice a sheet of thin mica, celluloid, or the like, may be employed, the thickness being in most instances a few thousandths of an inch. For instance, 3/1000, or less; the thickness depending more or less upon the size of the holes 3 formed therein. That is, the greater the hole the greater the flexing of the diaphragm portion. The plates A and C must be kept out of contact with each other, and the spacing between them must accordingly be sufficient to prevent contact when the device is in operation. The spacing will, accordingly, be in proportion to the diameter of the holes 3, and in few instances will exceed 3/1000 of an inch.

The plate D merely serves as a clamping plate to secure the diaphragm C and the dielectric plate B in rigid contact with the plate A. Bolts such as indicated at 5 may be employed, these bolts extending through the plates A, B, C and D, and insulating sleeves and washers may be employed as indicated at 6 to prevent short-circuiting of the plates. The plate D may be constructed of any material desired, the material employed being of no importance as long as the plates A and C are insulated with relation to each other. The bolts may be placed at staggered intervals as shown in Figure 1, and any suitable number may be employed. The holes 4 formed in the clamping plate are preferably of the same diameter as the holes 3 in the dielectric plate B. This to insure a rigid support for the diaphragm and also to provide as large a coupling area as possible between the movable portions of the diaphragm and the air.

The device so constructed is ready for use and may be connected with any transmitting or receiving radio set or in any electric circuit where sound is to be transmitted or received. When used as a loud speaker in a radio receiving set, it is preferable to employ power amplification in the audio frequency side of the circuit; the two terminals leading from the audio frequency amplifying power circuit being connected, one with the plate A and one with the diaphragm C. A modulated or varying current potential is in this manner applied to the two plates, and electrostatic attraction, varying according to the degree of applied potential, will cause movement of the flexible belt or diaphragm with relation to the rigid plate, and as the diaphragm makes a direct coupling with the surrounding atmosphere, sound or acoustic vibrations will result. The manner of connecting an electrostatic device of this character in a transmitting circuit is well known, and a detailed description thereof should be unnecessary.

An electrostatic speaker constructed as here illustrated is highly efficient, as an exceedingly small spacing may be maintained between the rigid and the flexible plates. A thin diaphragm or plate may be employed, which may be constructed of leaf metal, shim metal, or the like, and faithful tone reproduction is accordingly the result, as such diaphragms have comparatively little weight or inertia of their own, and furthermore are sensitive both to high and low sound-wave frequencies. The device may be constructed so large as to present an air coupling equal to several square feet. In fact, limits, as far as area is concerned, is unrestricted. Mechanical rattles, buzzing, and other tone distortions are avoided, as the structure is exceedingly rigid and substantial and free of vibrating periods of its own.

If a flexible unperforated diaphragm is employed, such as shown in my Patent No. 1,644,387, issued October 4, 1927 and entitled "Acoustic device", a clamping plate such as indicated at F in Figure 3 may be employed to advantage. In this modification G indicates the rigid perforated plate, H the flexible diaphragm, and J the flexible conductor. The perforated plate G is in this instance preferably punched in such a manner that raised surfaces 17 are formed around each hole or perforation. The diaphragm H rests on the raised surfaces and is slightly elevated or raised with relation to the sloping surfaces indicated at 18. The perforations formed in the clamping plate as indicated at 19, are larger in diameter than the perforations in the plate G. The solid portions of the clamping plate, indicated at 20, will thus only engage the high spots 17 of the plate G and the diaphragm and the flexible conductor will be rigidly clamped to these points with relation to the rigid plate, while the remaining portions of the diaphragm and the flexible conductor will be free to vibrate. This clamping of portions of the diaphragm and the flexible conductor is important when certain diaphragm materials are employed, for instance, paper, mica, celluloid and similar materials present a hard surface to the rigid plate G and as such have a tendency to buzz or rattle, but where materials of this character are rigidly clamped where the high spots are encountered, rattling or buzzing is substantially eliminated.

While certain features of the present invention have been more or less specifically illustrated and described, I wish it understood that various changes may be resorted to within the scope of the appended claims; similarly, that the materials and finishes of the several parts employed may be such as the manufacturer may decide or varying conditions or uses may demand.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. An acoustic device comprising a perforated plate, a dielectric perforated plate disposed in contact therewith, the perforations in the dielectric plate being larger than the perforations in the first-named plate and concentric therewith, and a flexible conductor covering the dielectric plate and forming a diaphragm.

2. An acoustic device comprising a perforated plate, a dielectric perforated plate disposed in contact therewith, the perforations in the dielectric plate being larger than the perforations in the first-named plate and concentric therewith, a flexible conductor covering the dielectric plate and forming a diaphragm, and a clamping plate engaging the diaphragm and maintaining it in contact with the dielectric plate.

3. An acoustic device comprising a perforated plate, a dielectric perforated plate disposed in contact therewith, the perforations in the dielectric plate being larger than the perforations in the first-named plate and concentric therewith, a flexible conductor covering the dielectric plate and forming a diaphragm, and a clamping plate engaging the diaphragm and maintaining it in contact with the dielectric plate, said clamping plate having perforations formed therein substantially of the same size as the perforations in the dielectric plate and aligning therewith.

4. An acoustic device comprising a dielectric perforated plate, a perforated conductor plate disposed on one side, a flexible conductor plate disposed on the opposite side and forming a diaphragm, and means clamping all of the plates together and maintaining the plates in rigid contact with relation to each other.

5. An acoustic device comprising a rigid perforated conductor plate, a flexible conductor plate forming a diaphragm, a dielectric plate interposed between the rigid plate and the diaphragm plate, said dielectric plate being perforated and the perforations being larger than the perforations in the rigid plate and being concentric therewith so as to leave an exposed surface around each perforation in the rigid plate.

6. An acoustic device comprising a rigid perforated conductor plate, a flexible conductor plate forming a diaphragm, a dielectric plate interposed between the rigid plate and the diaphragm plate, said dielectric plate being perforated and the perforations being larger than the perforations in the rigid plate and being concentric therewith so as to leave an exposed surface around each perforation in the rigid plate, said dielectric plate maintaining a fixed spacing between portions of the diaphragm plate and the rigid plate, and means clamping the plates together.

7. An acoustic device comprising a rigid perforated plate, a flexible diaphragm covering the plate, a flexible conductor covering the diaphragm, and a clamping plate engaging the flexible conductor, said clamping plate having perforations formed therein which are larger in diameter than the perforations in the rigid plate.

8. An acoustic device comprising a rigid plate, means for providing a plurality of high points on the plate, said plate having perforations formed therein intermediate the high points, a flexible diaphragm placed in contact with the high points of the rigid plate, a flexible conductor covering the diaphragm, and a clamping plate engaging the flexible conductor and exerting a downward pressure on the conductor and the diaphragm so as to maintain them in rigid contact with the high points of the rigid plate.

9. An acoustic device comprising a rigid perforated plate, a flexible diaphragm covering the plate, a flexible conductor covering the diaphragm, and a clamping plate engaging the flexible conductor and exerting pressure on the conductor and the diaphragm so as to maintain them in rigid contact with the rigid plate.

10. An acoustic device comprising a rigid perforated plate, a flexible diaphragm covering the plate, a flexible conductor covering the diaphragm, and a foraminated clamping plate engaging the flexible conductor and exerting pressure on the conductor and the diaphragm so as to maintain them in rigid contact with the rigid plate.

COLIN KYLE.