Sept. 5, 1933. L. W. GILES 1,925,659

ACOUSTIC DEVICE

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FIG. 1.

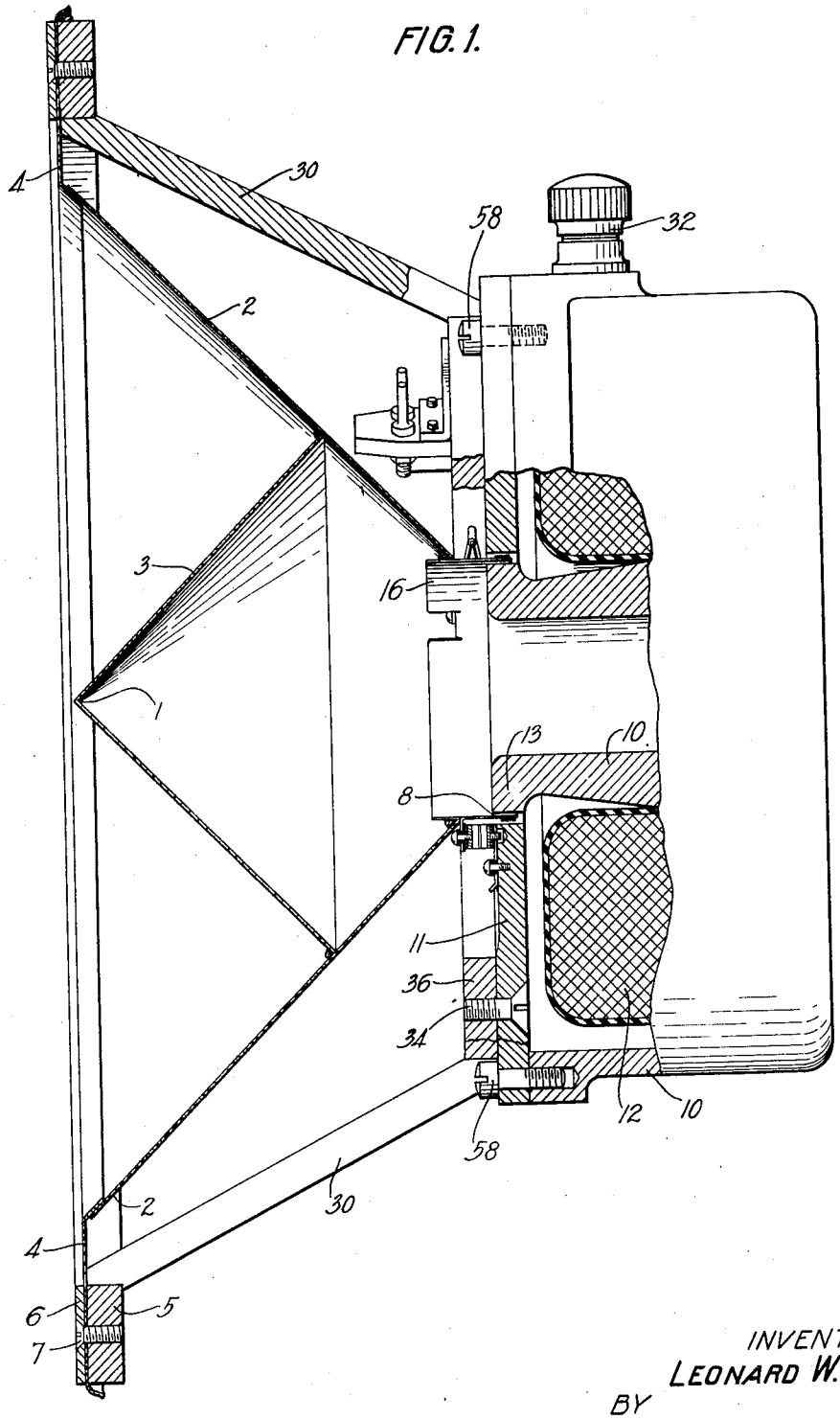

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FIG. 2.

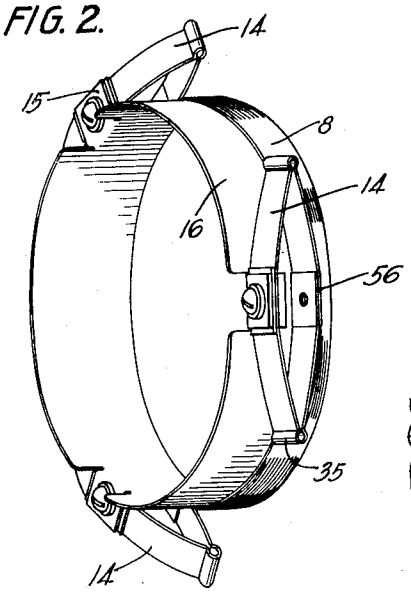


FIG. 3.

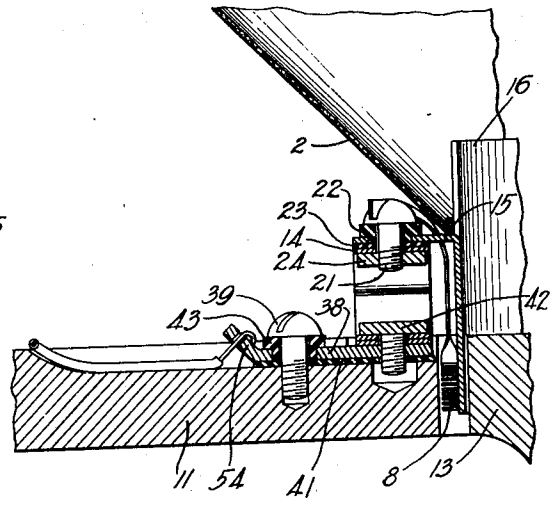
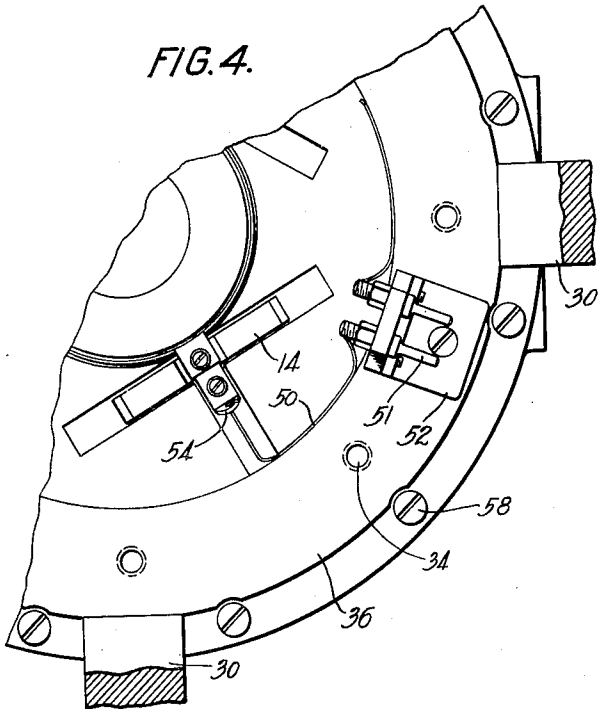


FIG. 4.



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UNITED STATES PATENT OFFICE

1,925,659

ACOUSTIC DEVICE

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12 Claims. (Cl. 179—115.5)

This invention relates to acoustic devices and more particularly to such devices employing an electro-dynamically actuated vibrating element.

In acoustic devices of the type in which a cylindrical coil positioned in an annular magnetic field is employed to drive a piston type diaphragm, it is desirable to have as small a clearance as possible between the poles of the magnet forming part of the magnetic circuit and the coil in order to utilize efficiently the flux in the field. When the coil executes large amplitudes in response to voice currents through the coil, it is essential that the coil move linearly with respect to the axis of the coil, in order that it may not rub against the pole pieces. Difficulty has been experienced hitherto in centering the coil in a magnetic gap of this type, in such a manner as not to impair the free vibration of the coil and the diaphragm attached thereto.

Diaphragms of the piston type, for example, those comprising a stiff central conical portion of light material and a flexible portion for connecting the conical portion to a supporting member, are intended to vibrate as a piston, or as a whole, throughout the audible frequency range. In making frequency response tests of such diaphragm, it has been found, however, that dips in the frequency response curves occur fairly well up in the scale, say at 1800 cycles where a conical diaphragm of light paper and of approximately 8″ in diameter at its base is used. The portion of the curves at which the dips occur will of course vary according to the material used and according to the size of the diaphragm. The dips indicate that, at or around the frequency they occur, the diaphragm ceases to operate as a plunger but operates around that frequency and possibly at higher frequencies as a wave transmission device.

An object of this invention therefore is to increase the operating efficiency of electro-dynamic acoustic devices and to transmit sound with high and substantially uniform efficiency over a wide frequency range.

Another object of the invention is to enable the coil in devices of this type to move with substantially no restraint in a linear direction with respect to the axis of the coil and the air gap in which the coil oscillates.

Another object of the invention is to simplify and improve the method of carrying the lead-in wires from the coil to the circuit terminals therefor.

In accordance with one feature of the invention, the coil is centered in the annular magnetic gap by means of substantially elliptically shaped spring-like members which offer substantially no restraint to axial movements of the coil but offer great resistance to transverse movements of the coil.

In accordance with another feature of the invention the diaphragm is made up of a conical portion with a reinforcing member joined to the inner side of the conical portion intermediate its base and its top.

A further feature of the invention resides in utilizing the springs which center the coil as a link in the electrical circuit connecting the movable coil to a fixed terminal, thereby incorporating all flexural leads in the springs themselves.

The invention and the features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawings, in which:

Fig. 1 is a side elevational view, partly in cross-section, of a loudspeaker illustrative of one embodiment of this invention;

Fig. 2 is a perspective view of the driving coil and the supports therefor;

Fig. 3 is an enlarged detail view in cross-section showing the electrical connection between the driving coil and a terminal of the loudspeaker; and

Fig. 4 is a fragmentary view showing the tangential disposition of the centering springs with respect to the driving coil and the association of one of the springs with a terminal.

Referring now to Fig. 1 of the drawings, there is shown a diaphragm 1 comprising a frusto-conical section 2 and a conical section 3, the conical section being invertedly disposed within and secured at its base to the frusto-conical section, intermediate the base and the smaller end of the frusto-conical section. The diaphragm may be made of paper or other light material. One function of the conical section is to stiffen or reenforce the diaphragm so that it will be capable of vibrating as a whole through the audible frequency range. It is believed that the conical section of the diaphragm also serves to prevent interference or to act as a baffle between the air pressures at the top and bottom of the inside surface of the frusto-conical section. Whatever the function of the conical section may be, it has been discovered that the addition of it to the diaphragm improves the efficiency of the device by causing a substantially even response throughout the audible frequency range. It will be understood that instead of using a

conical section for stiffening the diaphragm, this member may assume other shapes and may even be flat.

The outer edge or base of the diaphragm 2 is secured between supporting ring 5 and clamping ring 6 by means of a ring 4 of flexible material such as silk, rubber, thin leather or the like, which may be glued or joined to the diaphragm in any suitable manner.

The actuating means for the diaphragm includes a coil 8 surrounding a light thin cylindrical member 16 having integral therewith or secured thereto a plurality of lugs 15. In the particular embodiment of the invention illustrated in the drawings, the member 16 is a metallic member. It will be understood, however, that it may be of insulating material, for example, bakelite or other similar material. The member 16 may be secured to the top of the frusto-conical section 2 of the diaphragm in any suitable manner, for example, by a cement, such as Du Pont's cement. The coil is disposed in the annular air gap formed by concentric pole pieces 11 and 13. The pole piece 13 is integral with the core 10, which is surrounded by a coil 12 through which direct current may be supplied for producing a strong magnetic field in the annular area. If desired a permanent magnet may be used to supply the flux in the air gap. Terminals such as 32 may be used for connecting the direct current from a suitable source to the ends of the coil 12. The pole piece 11 is detachable from the core 10 to permit assembling the winding 12 on the core 10 and is secured to core 10 by screws such as 58. A ring 36 is secured to the pole piece 11 by means of screws 34, and has a plurality of arms 30 preferably integral therewith. The supporting ring 5 is preferably integral with the arms 30. It will be understood, however, that the rings 36 and 5 and the arms 30 may be separate pieces suitably secured together. In response to variable currents supplied to the coil 8, the coil and diaphragm will be caused to vibrate substantially as a whole. In order to efficiently use the flux in the air gap it is desirable that the coil and its support fill substantially all of the space in the gap. Due to the diaphragm being flexibly supported at its edge, there is a tendency for lateral movement of the coil. To center the coil and to insure a linear movement of the coil with respect to its axis and the axis of the air gap, a plurality of substantially elliptically shaped light springs such as 14, shown in Figs. 2 and 3, are spaced equally and tangentially around the coil. One end of spring 14 is fastened to the lug 15 and the other end to the annular pole piece 11. The springs 14 are preferably made of a single piece of thin bronze or the like with curved portions 35 at their ends, and with their extremities folded over as shown at 56. One end of the spring 14 is insulatably mounted on the lug 15 by means of the screw 21, insulating bushing 22, insulating washer 23, metallic washer 14 and nut 24. The bottom of spring 14 is mounted on terminal 54 by screw 42. The terminal 54 is insulatably mounted on pole piece 11 by screw 39, insulating bushing 43 and insulating member 41. The two ends of the coil 8 are soldered to slots in screws 21 of two of the springs. If desired the ends of coil can of course be placed under the head of screw 21. The springs thus form a link in the electrical circuit of the movable coil. This method of bringing out the ends of the coils avoids bends and consequently breakage due to crystallization in the fragile electrical conductor of the coil. From the terminal 54 wires 50 are run to contacts 51 mounted on angle iron 52 which is in turn mounted on ring 36.

What is claimed is:

1. An acoustic device comprising a diaphragm, a coil secured thereto, an annular magnetic air gap, and means for centering said coil in said gap comprising a plurality of elliptical shaped spring members arranged to limit the movement of the coil to a rectilinear motion in the axial direction of the air gap.

2. An acoustic device comprising a diaphragm, a coil secured thereto, an annular magnetic air gap, and means for centering said coil in said gap comprising a plurality of elliptical shaped flexible members having their fulcra so disposed as to confine the movement of the coil to a truly rectilinear motion in the axial direction of the air gap, said members being equally spaced around the coil.

3. An acoustic device comprising a diaphragm, an annular magnetic air gap, a coil secured thereto and positioned in said gap, and means for centering said coil in said gap comprising a plurality of spring-like members tangentially positioned with respect to said coil.

4. An acoustic device comprising a diaphragm, a coil secured thereto, an annular magnetic air gap in which said coil is positioned, and means for centering said coil in said gap comprising a plurality of spring-like members equally spaced around said coil and tangentially positioned with respect to said coil.

5. An acoustic device comprising a diaphragm, a coil secured thereto, an annular magnetic air gap in which said coil is positioned, and means for centering said coil comprising a plurality of substantially elliptically shaped spring-like members.

6. An acoustic device comprising a relatively light and stiff diaphragm, a pair of rings, a flexible coupling between said diaphragm and said rings to permit relatively large amplitudes of the diaphragm, an annular magnetic air gap, a cylindrical coil secured to said diaphragm and positioned in said gap, and means for centering said coil in said gap comprising a plurality of substantially elliptically shaped spring-like members, said members being equally spaced and tangentially arranged around said air gap.

7. An acoustic device including a diaphragm, electro-dynamic means including a coil for vibrating it, said diaphragm comprising two conical shaped members of different altitudes, the base of one of said members being secured to the inner side of the other of said members and bowed springs secured together in pairs and disposed around one end of said diaphragm to prevent movement of the coil transversely to its axis and to permit free movement in an axial direction of the coil.

8. An acoustic device including a diaphragm, electro-dynamic means including a coil in an annular magnetic air gap for driving it, said diaphragm comprising a frusto-conical member, a conical member having its base secured to said frusto-conical member intermediate its top and bottom, and means at the smaller end of said frusto-conical member for centering said coil in said air gap.

9. In an acoustic device, a diaphragm, a coil secured thereto, concentric circular shaped pole pieces spaced apart and forming an annular

magnetic gap, and a plurality of substantially elliptically shaped springs for centering said coil in said gap, a portion of said springs being insulatably mounted on said pole pieces and serving as part of the electrical circuit of said coil.

10. In an acoustic device, an air gap, a diaphragm, a coil connected to said diaphragm and positioned in said gap for driving said diaphragm, and means comprising a spring for centering said coil in said gap comprising a single strip of light flexible metal bent to form an ellipse.

11. An acoustic device comprising a frusto-conical diaphragm, pole pieces forming a magnetic gap, a coil positioned in said gap for driving said diaphragm, a member secured to one end of said diaphragm for supporting said coil, said member having lugs extending therefrom, and bowed springs arranged around the periphery of said member having their center portions fixed to said lugs for centering said coil in said gap.

12. An acoustic device comprising a diaphragm, a driving coil secured thereto, pole pieces spaced to form a magnetic gap, and means including a plurality of spring members disposed in pairs around said coil and secured together at corresponding ends for supporting said coil in said gap.

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