June 26, 1934. A. L. THURAS 1,964,606

ACOUSTIC DEVICE

Filed April 12, 1932 2 Sheets-Sheet 1

FIG. 1

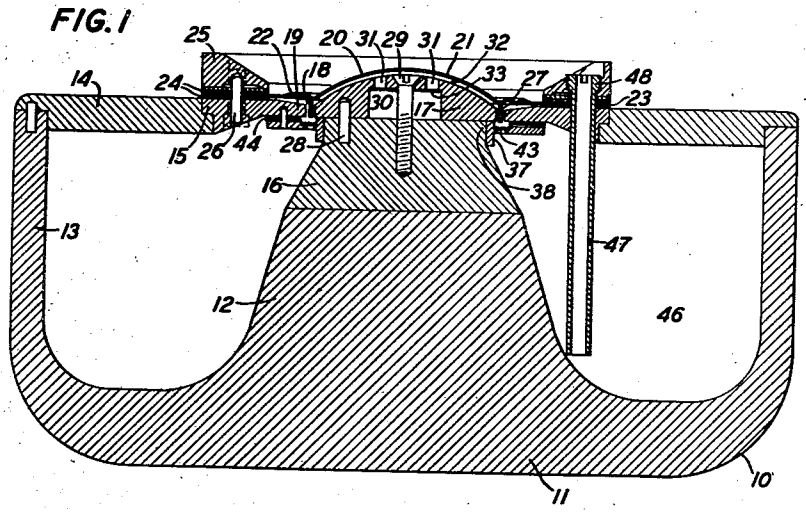
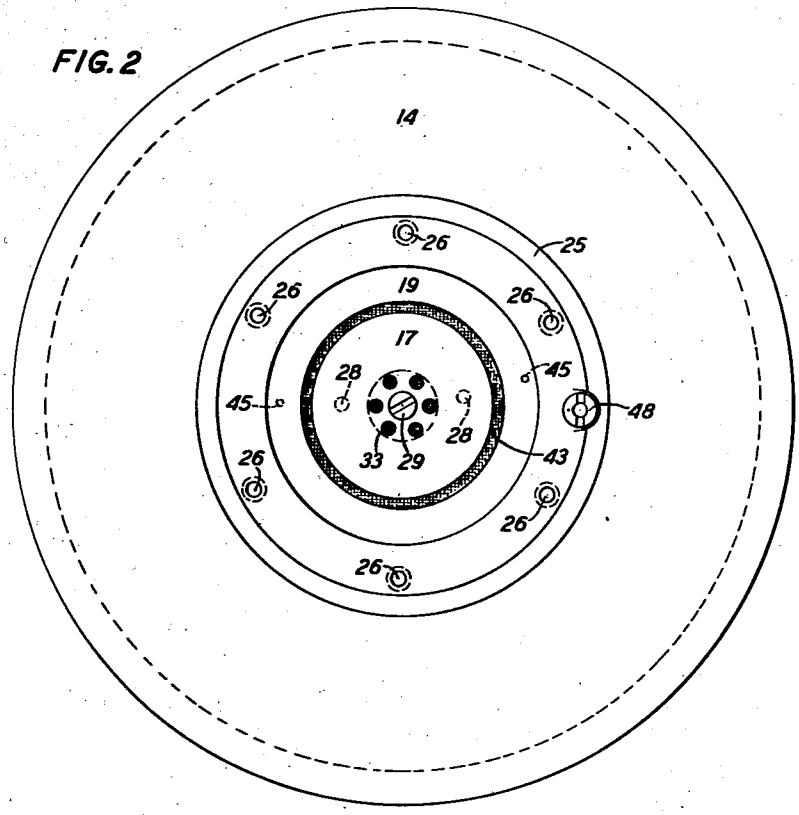


FIG. 2



INVENTOR
A. L. THURAS

BY

Walter C. Kiesel

ATTORNEY

June 26, 1934. A. L. THURAS 1,964,606

ACOUSTIC DEVICE

Filed April 12, 1932 2 Sheets-Sheet 2

FIG. 3

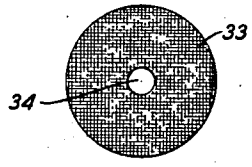


FIG. 5

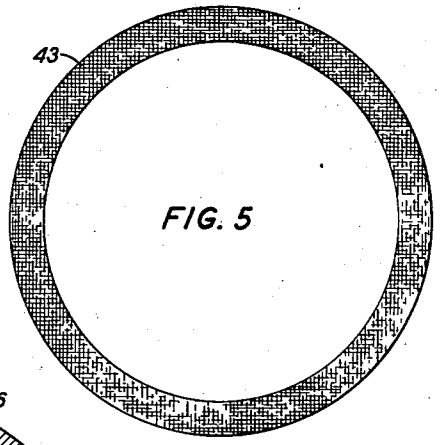


FIG. 4

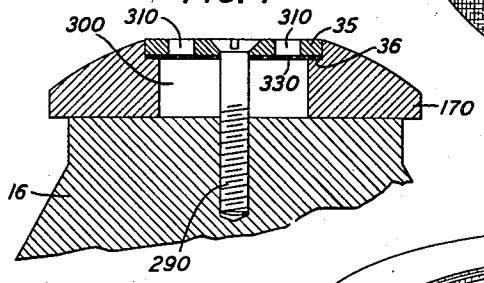


FIG. 6

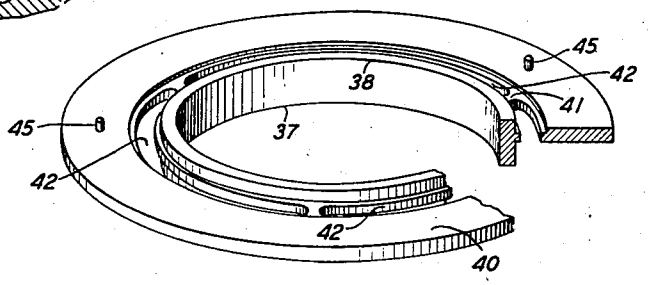
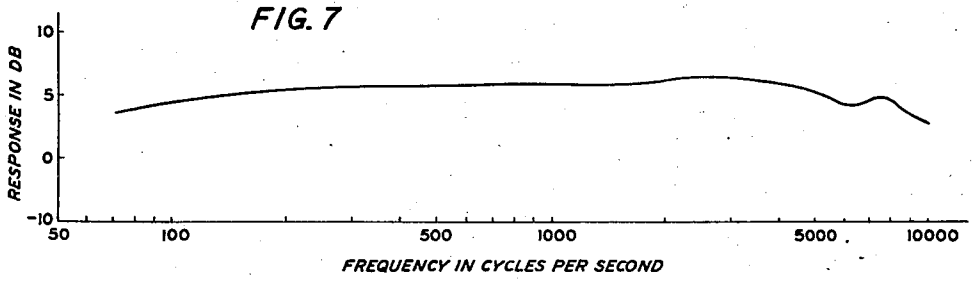


FIG. 7



INVENTOR
A. L. THURAS
BY
Walter C. Kiesel
ATTORNEY

Patented June 26, 1934 1,964,606

UNITED STATES PATENT OFFICE

1,964,606

ACOUSTIC DEVICE

Albert L. Thuras, New York, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application April 12, 1932, Serial No. 604,738

9 Claims. (Cl. 179—115.5)

This invention relates to acoustic devices and more particularly to an acoustic device of the electro-dynamic type.

An object of this invention is to improve the quality and transmission characteristics of an acoustic device, for instance, a telephone transmitter, over substantially the entire frequency range.

Another object of this invention is to include in the acoustic circuit of an acoustic device damping means which enable the use of a simplified and readily manufactured and assembled structure for the device.

Still another object is to control the vibratory characteristics of the diaphragm of an acoustic device by providing one or more damping elements in spaced relation to the diaphragm.

A further object of this invention is to so construct the magnet structure of an acoustic device of the electro-dynamic type that flux densities of a high order are obtained at the faces of the portions thereof defining the magnet air-gap.

A feature of this invention comprises damping means of cloth in an acoustic device, for instance, an electro-dynamic transmitter.

Another feature of this invention comprises the provision of a plurality of damping means adjacent the diaphragm of an acoustic device, one of the damping means being located near the central portion of the diaphragm and another intermediate the diaphragm center and periphery, one or each of the damping means being of cloth.

A further feature of this invention comprises a magnet structure for an electro-dynamic device which includes a casing of steel alloy having a center pole and an outer pole, the center pole having a dome of iron alloy providing one pole face, the outer pole supporting a plate pole comprising an iron alloy which provides another pole face.

Still another feature of this invention comprises providing an acoustic device of the electro-dynamic type with a perforated plate member under its magnet air-gap, an annulus of cloth being secured thereto and over the perforations therein.

A further feature of this invention comprises regulation of the response of an acoustic device by coupling one or more acoustic circuits to the diaphragm thereof, one or each of the circuits including an acoustic resistance element provided by a piece of cloth.

In one embodiment of this invention, an acoustic device of the electro-dynamic type comprises a magnet structure including a casing of steel alloy, such as hardened cobalt steel, having a center pole and a cylindrical or outer pole. This outer pole supports an annular plate pole, preferably of steel alloy, such as hardened cobalt steel, the plate pole having a central, annular insert, preferably of an iron alloy, such as cobalt iron. The center pole is capped by a block of magnetic iron, which is in turn capped by a dome portion or member of iron alloy, such as cobalt iron, which, with the annular plate pole, defines an annular magnetic air-gap. A diaphragm of a light weight, high strength material, such as an aluminum alloy, having a central stiffened dome or dished portion, a clamped rim portion, and an intermediate flexible portion or annulus, is supported by the annular plate pole. A coil, preferably of the edgewound type, is secured to the diaphragm at the joining edge of its dome and intermediate flexible portions, and is suspended in the magnet air-gap. The dome portion of the center pole contains a cavity forming a chamber with the upper surface of the magnetic iron block. This chamber communicates with the air space between the diaphragm and center pole dome portion through a plurality of passages over one end of each of which is secured damping cloth. The chamber, passages, and damping cloth provide acoustic stiffness, mass and resistance elements, respectively, of an acoustic circuit or network acting to control the response of the diaphragm over a portion of the frequency range, particularly in the high frequencies. Underneath the air-gap is a plate member, preferably annular, non-magnetic, and bridging the space between the poles of the magnet. This member has a collar portion fitting about the center pole; an outer rim portion spaced a slight distance from the under surface of the annular pole, the space being occupied by suitable sealing means; and an intermediate portion, immediately under the air-gap and having a plurality of elongated, arcuately shaped openings or slots leading into a large chamber formed by the casing, an annulus of damping cloth being fastened to the member and over the openings. The air space immediately under the diaphragm, the air-gap, and the cloth annulus provide acoustic stiffness, mass, and resistance elements, respectively, of an acoustic circuit or network acting to control the response of the diaphragm over the entire frequency range translated. To increase the response of the diaphragm at the very low frequencies, the transmitter described is provided with a tube connect-

ing the atmosphere adjacent the exposed surface of the diaphragm with the interior of the casing, in accordance with the disclosure in A. L. Thuras Patent 1,869,178, issued July 26, 1932.

A more complete understanding of this invention will be obtained from the detailed description which follows read with reference to the accompanying drawings wherein:

Fig. 1 is a sectional view of an acoustic device embodying this invention;

Fig. 2 is a plan view of the device of Fig. 1 with the diaphragm removed;

Fig. 3 is an enlarged plan view of the damping cloth provided in accordance with this invention under the central portion of the diaphragm of the device of Fig. 1;

Fig. 4 is a slightly enlarged sectional view of the dome or cap portion of the center pole of the device of Fig. 1 modified to have a removable perforated disc portion;

Fig. 5 is an enlarged plan view of the damping cloth provided in accordance with this invention under the air-gap of the device of Fig. 1;

Fig. 6 is an enlarged perspective of the plate member under the air-gap of the device of Fig. 1 and is partially broken away to bring out details of its structure; and

Fig. 7 is a characteristic response curve for a device such as is shown in Fig. 1.

This invention is embodied in an acoustic device of the electro-dynamic type, for instance, a transmitter, comprising a magnet structure 10 having a casing 11 of steel alloy having a center pole 12 and a cylindrical or outer pole 13. A suitable alloy has been found to be hardened cobalt steel containing approximately 35% cobalt. The outer pole supports or carries an annular plate pole 14, preferably of the same material as the casing. The plate pole has a central, annular insert 15 preferably of an iron alloy. A suitable alloy has been found to be cobalt iron containing approximately 50% cobalt. The center pole 12 is capped by a block 16 of magnetic iron which is in turn capped by a dome portion or member 17 of an iron alloy preferably of the same material as the insert 15. The plate pole and the member 17 are spaced apart to define an annular air-gap 18, the portion 19 of the insert 15 being tapered. The magnet structure described has been found to allow very high flux densities to be obtained at the pole faces of the air-gap. The diaphragm 20, of a light weight, high strength material, such as aluminum alloy, has a stiffened, dome or dished central portion 21, an annular, concentrically corrugated, intermediate flexible portion 22, and a rim portion 23. The diaphragm at its rim portion is mounted between a pair of insulating washers 24, 24 and is secured to the magnet structure between the shallow mouthpiece 25 and the insert 15 by securing members or pins 26. A current coil 27, preferably of the edgewound type, is fastened to the diaphragm at the junction or joining edge of the diaphragm dome and flexible annular portions and is suspended in the air-gap 18.

The member 17 is centered on the block 16 by pins 28 and is secured thereto by the fastening member or screw 29. It contains a central cavity forming a chamber 30 with the upper surface of the block 16 and has passages or openings 31 connecting the chamber with the shallow space or chamber 32 between the central portion of the diaphragm and the member 17. Fastened by a suitable adhesive to the upper defining surface of the chamber 30 and extending across the openings 31 is a circular piece of damping cloth or fabric 33. The cloth 33 has a central opening 34 through which the fastening member 29 may extend. The chamber 30, the passages 31 and the cloth 33 define acoustic stiffness, mass and resistance elements, respectively, in an acoustic network, mesh, or impedance controlling the vibratory characteristics of the diaphragm and to prevent distortion in the response thereof in a band of frequencies between approximately 2000 and 5000 cycles per second.

A modification of the upper portion of the center pole of the magnet is shown in Fig. 4. It comprises an annular member 170 of cobalt alloy fastened to the magnetic iron block 16 by suitable fastening means, such as the screw 290, which holds a circular plate or disc member 35 on the shelf portion 36 of the member 170. The member 35 has a plurality of passages 310 and has fastened to one surface by a suitable adhesive a circular piece of damping cloth 330. A chamber 300 is defined by the plate member, the annular member and the magnetic iron block.

Under the air-gap and supported by the block 16 is a plate member 37 of non-magnetic material having an annular, central, collar portion 38 encircling the upper and cylindrical portion 39 of block 16, a rim portion 40, and an intermediate slotted portion 41. Fastened to the member 37 over the elongated, arcuately shaped slots or openings 42 therein is a damping cloth or fabric annulus 43. This cloth annulus and the slots, preferably, are directly under the air-gap 18. The space between the rim portion 40 and the under surface of the insert 15 contains a sealing means 44 held in position by pins 45 projecting from the member 37 and extending into suitable recesses in the insert 15. The sealing means comprises, preferably, a plurality of washers and insures that air flowing through the air-gap from or to the space under the diaphragm will be confined to a path including the slots 42 and the cloth 43, only. The chamber 32, the air-gap 18, and the cloth annulus 43 provide acoustic stiffness, mass and resistance elements, respectively, of an acoustic network, mesh or impedance, controlling the vibratory characteristics of the diaphragm over the entire frequency range translated by the acoustic device.

The chamber 46, and consequently, the rear or inner surface of the diaphragm, is connected with the atmosphere outside the casing and adjacent the peripheral portion of the diaphragm by a tube 47 which extends through aligned apertures in the mouthpiece, diaphragm, insulating washers, and insert 15. The outer end of the tube is provided with a threaded, screw-head portion 48 threadably engaging the mouthpiece whereby the tube may be readily removed. The response at the low frequencies of a device provided with this tubular arrangement is greatly increased over the response of the same device without it. It provides an acoustic network connecting the front and the rear or inner surfaces of the diaphragm and comprising the acoustic stiffness of the chamber 46 and the acoustic mass and resistance provided by the tube 47.

The acoustic networks described above for controlling the vibratory characteristics of a diaphragm and making the response of an acoustic device more uniform have already been disclosed in A. L. Thuras Patent 1,847,702 granted March 1, 1932. In the device of the patent, the resistance elements of the networks of the air-gap and center pole were obtained by providing narrow, re-

stricted slots or passages defined by spaced members. In the acoustic device of this invention, the resistance element, as pointed out above, is obtained by utilizing the cloth members 33 and 43. The use of cloth permits a simplified construction and reduction in the number of parts of an acoustic device employing these networks, allows greater tolerances in the formation and machining of the openings to the chamber in the center pole piece, and enables a high damping constant to be easily obtained thereby aiding greatly the obtaining of a smooth upper frequency response by the device. The only limitation on the material that may be used is that it shall have such thickness and mesh that the ratio of resistance to mass reactance thereof is high over the frequency range translated. Silk cloth is a satisfactory material to use.

Fig. 7 is a typical response characteristic of a transmitter in which the invention has been embodied. It will be noted that it is substantially flat over the entire frequency range translated.

While the features of this invention have been disclosed with reference to a specific embodiment, it is to be understood, of course, that various modifications may be made in the details thereof without departing from the scope of this invention as defined in the appended claims.

What is claimed is:

1. An acoustic device comprising a diaphragm, a structure adjacent one surface of said diaphragm, said structure having a plurality of cavities therein each connecting with the fluid adjacent said one surface of the diaphragm through an opening, and a piece of damping cloth disposed over each of said openings.

2. An acoustic device comprising a diaphragm exposed to sound waves on one surface thereof and substantially enclosed on the other surface thereof, said diaphragm comprising a central stiffened portion and a flexible portion connected to the periphery of the central portion, and means spaced from said latter surface and forming a shallow air space therewith, said means comprising a piece of damping cloth adjacent the center part of the stiffened portion, and a second piece of damping cloth adjacent the junction of the flexible and stiffened portions of the diaphragm.

3. An acoustic device comprising a diaphragm, a structure adjacent one surface thereof, said structure defining a plurality of air chambers, said chambers being connected through a plurality of air passages, and cloth damping means in each of said passages.

4. An acoustic device comprising a transmitter of the electro-dynamic type, a magnet structure defining an air-gap, a diaphragm, a coil attached to said diaphragm and supported in the air-gap, means to control the vibratory characteristics of the diaphragm, said means being disposed adjacent the central portion of the diaphragm and under the air-gap, one of said means comprising a damping member of cloth in spaced relation to the diaphragm.

5. An acoustic device comprising a diaphragm, means responsive to impulses of sound wave frequency attached to said diaphragm along a line intermediate its center and periphery, and an acoustic circuit coupled to said diaphragm to control the vibratory characteristics thereof, said circuit comprising acoustic mass, stiffness and resistance elements, the resistance elements being provided by a cloth strip supported adjacent said means.

6. An acoustic device comprising a diaphragm having a central stiffened portion, a structure in spaced relation to said diaphragm, said structure having an air chamber therein and a passage connecting with the space between said central portion of the diaphragm and said structure, and a strip of damping cloth extending across said connecting passage.

7. An acoustic device of the electro-dynamic type comprising a diaphragm, a coil attached to the diaphragm, a magnet structure defining an air-gap in which the coil is positioned, a non-magnetic annular member supported by said magnet under said air-gap, said member having an elongated slot therein, and a cloth strip carried by said member and covering said opening.

8. An acoustic device of the electro-dynamic type comprising a diaphragm, a coil attached to the diaphragm, a magnet structure defining an air-gap in which the coil is positioned, a plate supported by said magnet structure and under said air-gap, said plate having a plurality of openings therein, and a cloth annulus carried by said plate and covering said openings.

9. An acoustic device of the electro-dynamic type comprising a diaphragm, a coil attached to the diaphragm, a magnet structure defining an air-gap in which said coil is positioned, said structure comprising a center pole and a plate pole, an apertured plate member under said air-gap and carried by said center pole, a portion of said member being adjacent to but spaced by a plurality of paper washers from the plate pole, and a cloth damping strip carried by the plate member over the aperture thereof.

ALBERT L. THURAS.