Aug. 9, 1938. R. N. MARSHALL 2,126,566

ACOUSTIC DEVICE

Filed Dec. 29, 1934 5 Sheets-Sheet 1

FIG. 1

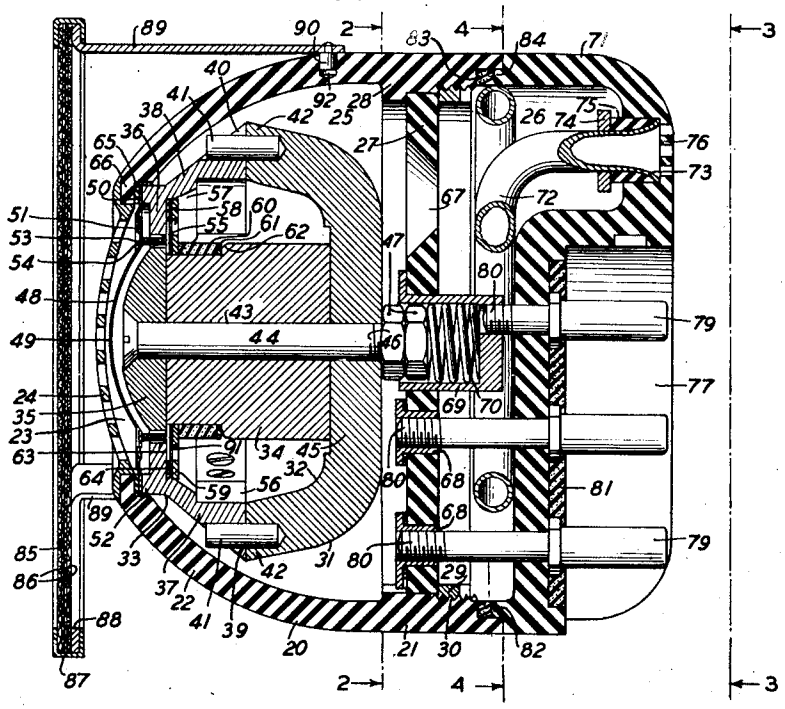
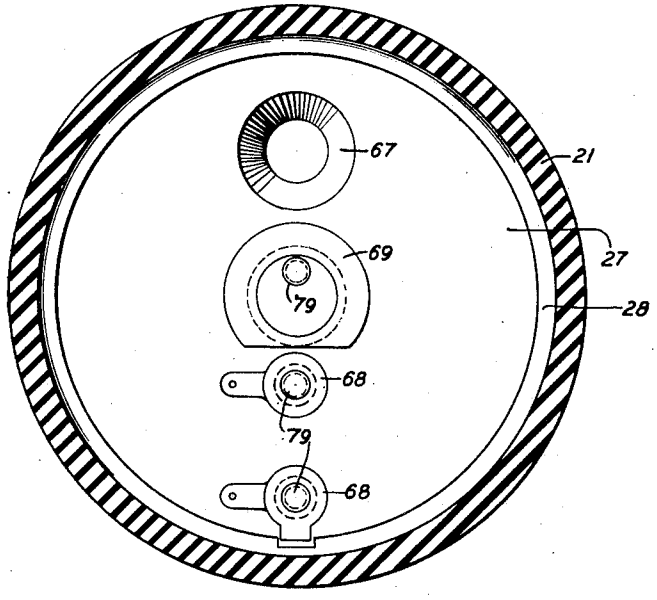


FIG. 2



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ACOUSTIC DEVICE

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FIG. 3

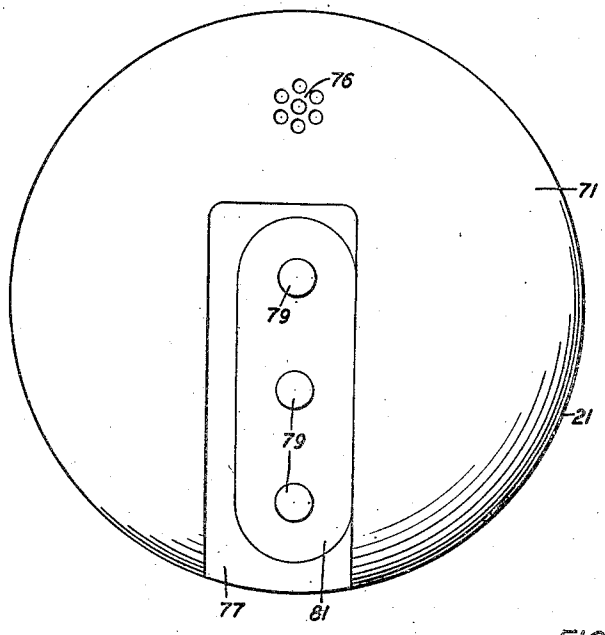

FIG. 4

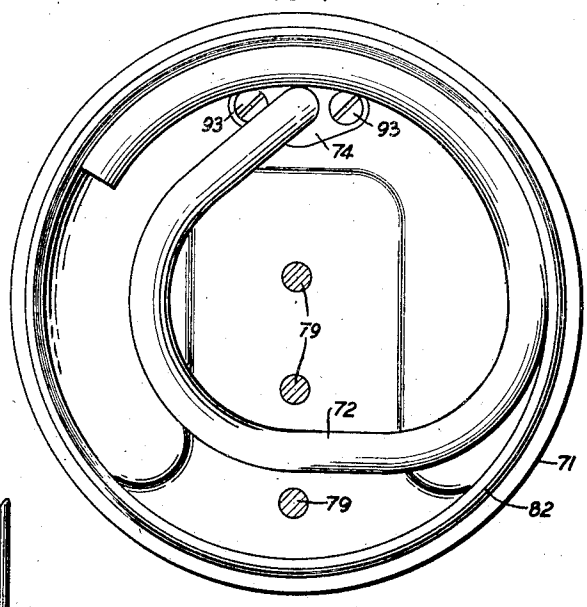

FIG. 5

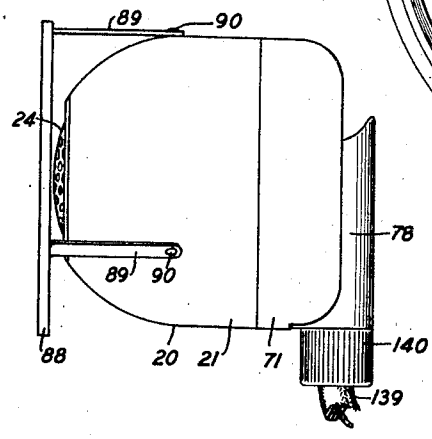

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FIG. 6

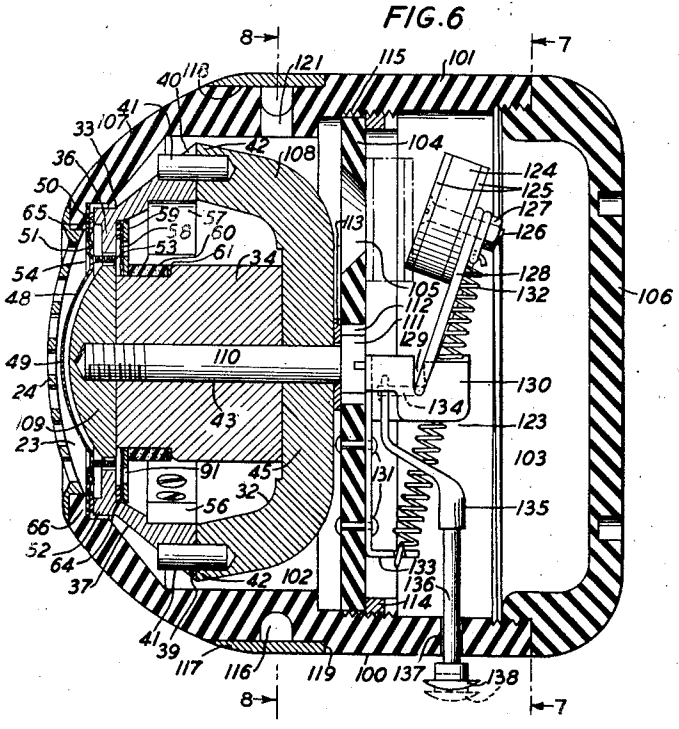
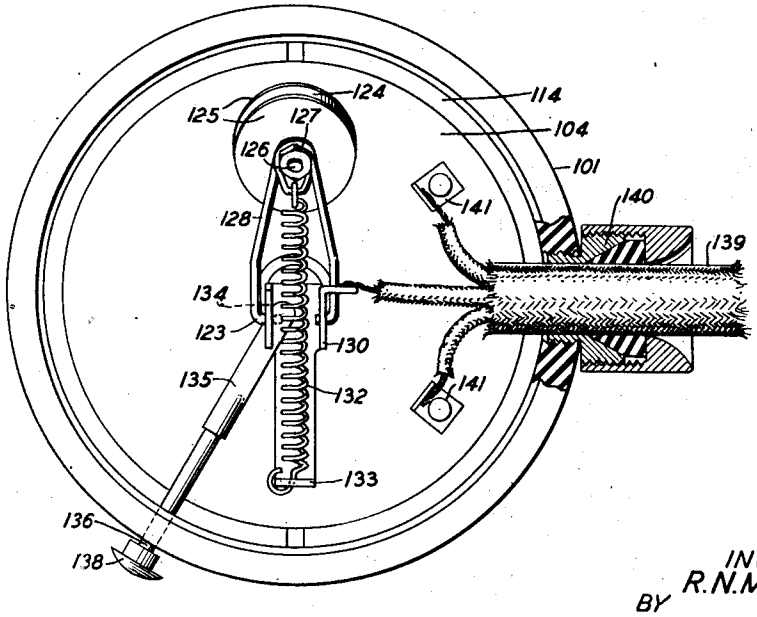


FIG. 7



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ACOUSTIC DEVICE

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FIG. 9

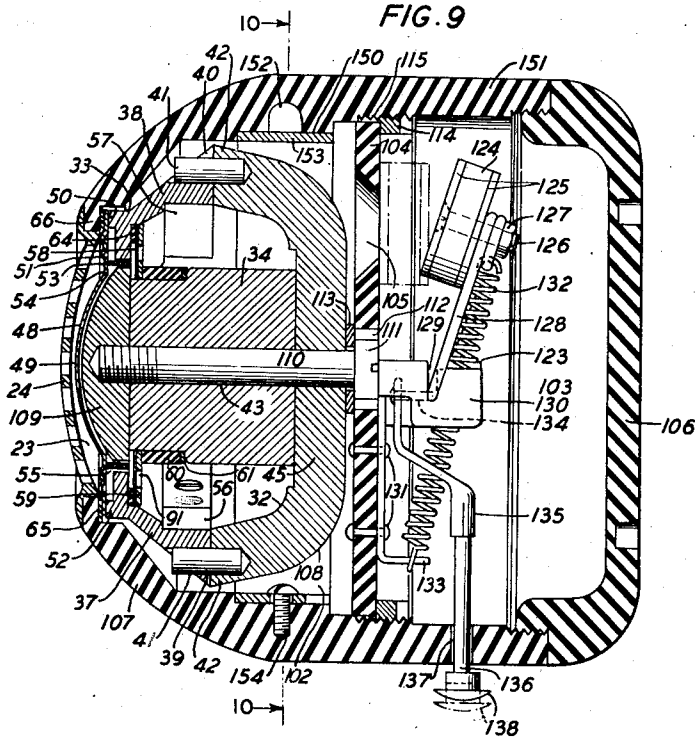

FIG. 8

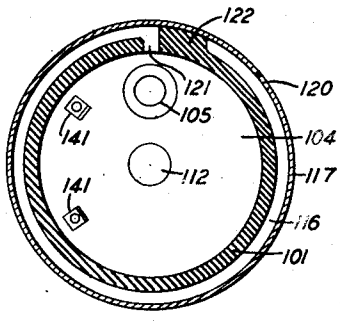

FIG. 10

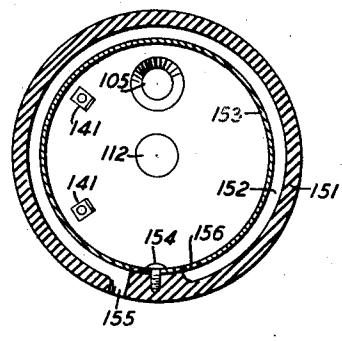

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FIG. 11

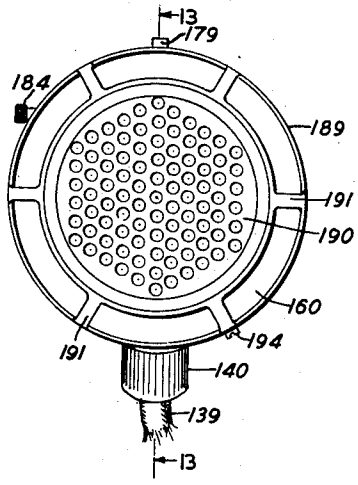

FIG. 12

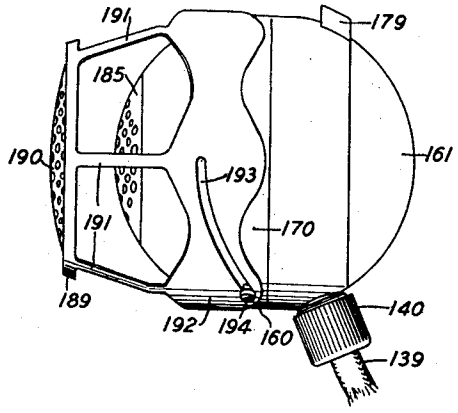

FIG. 13

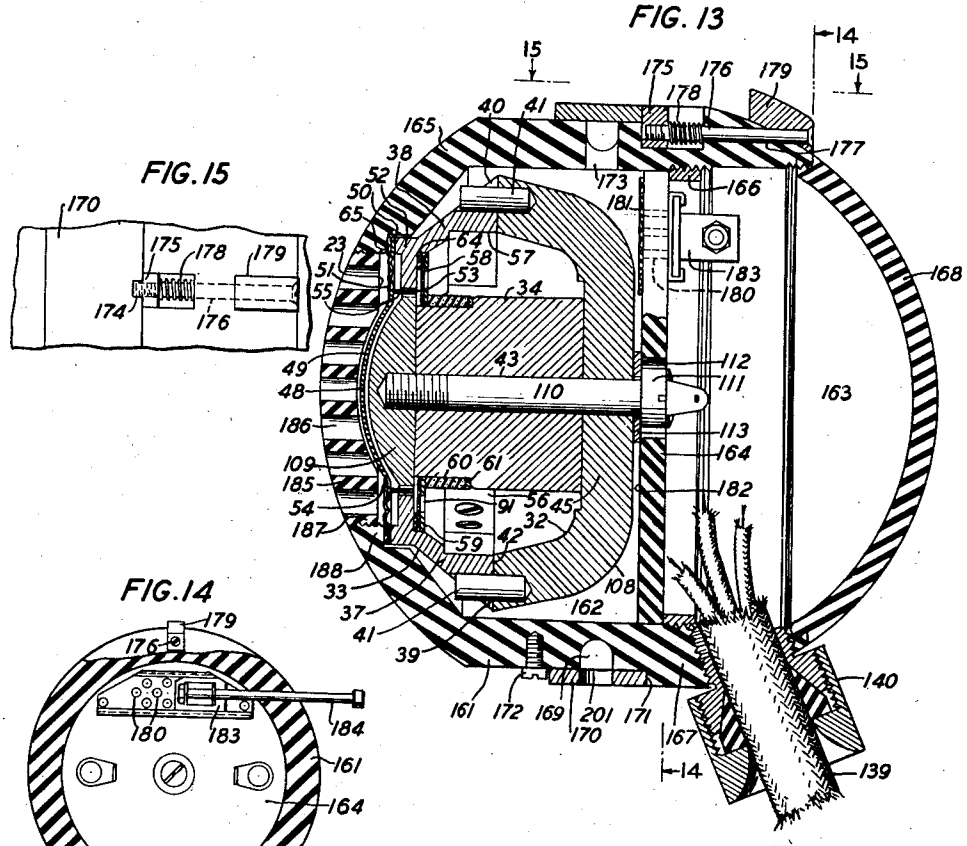

FIG. 15

FIG. 14

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Patented Aug. 9, 1938 2,126,566

UNITED STATES PATENT OFFICE

2,126,566

ACOUSTIC DEVICE

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Application December 29, 1934, Serial No. 759,679

17 Claims. (Cl. 179—115.5)

This invention relates to acoustic devices, and, more particularly, to microphones or transmitters of the moving coil or electrodynamic type.

An object of this invention is to improve the structure and operating characteristics of acoustic devices, particularly those of the electrodynamic type.

A feature of the invention comprises means for adjustably regulating the low frequency response of an acoustic device.

Another feature of the invention comprises a housing, enclosure, container or case for a diaphragm and associated magnet structure of an acoustic device, in which the case wall contains means for enhancing the low frequency response of the device.

Still another feature comprises an enclosure or case for an acoustic device in which the case interior is divided into at least two chambers connected by a passage that may be open or closed at the will of the user to control the effective volume of the case.

Other and further features will be evident from the detailed description which follows hereinafter.

In accordance with this invention, an acoustic device comprises a case open at its ends of different sizes, and enclosing a device comprising a diaphragm, moving coil, and magnet structure, the diaphragm being in alignment with and closing the smaller end of the case. The larger end of the case is closed by a plate or wall member, supporting the magnet structure and diaphragm in position, and containing a passage. A cover member forming part of the case is secured to the remaining portion of the case by a plurality of plug pins, each projecting at one end from the cover and threadably engaging the wall member at the other end. The cover and wall members define another air chamber in which is positioned an elongated, open-ended tubular member, one open end of which is secured to the cover and in alignment with an apertured portion thereof. If desired, the tubular member may be replaced by an elongated groove in the case, either on the inner or outer surface thereof, a closure member overlying the groove, the closure member and case containing passages connecting the interior of the case and the atmosphere through the groove. The closure member may be adjustable in position to vary the effective length of the groove. The passage connecting the chambers in the case may be covered with an acoustic resistance material, means being provided to vary the effective area thereof.

A more complete understanding of this invention will be derived from the detailed description which follows, taken in conjunction with the appended drawings, wherein:

Fig. 1 is an enlarged cross-sectional view of an acoustic device constructed in accordance with this invention;

Fig. 2 is a cross-sectional view of the device of Fig. 1, taken along the line 2—2 thereof;

Fig. 3 is an end view of the device of Fig. 1, taken along the line 3—3 thereof;

Fig. 4 is a view of the cover or closure member of the device of Fig. 1, taken along the line 4—4 thereof;

Fig. 5 is a side elevation, substantially actual size, of the device of Figs. 1–4, a jack or connector being shown associated with it;

Fig. 6 is an enlarged cross-sectional view of another acoustic device constructed in accordance with this invention;

Fig. 7 is an end view of the device of Fig. 6, taken along the line 7—7 thereof with the cover or closure member removed, and partially broken away to show the cord;

Fig. 8 is a cross-sectional view, approximately actual size, of the device of Fig. 6, taken along the line 8—8 thereof;

Fig. 9 is an enlarged, cross-sectional view of still another acoustic device constructed in accordance with this invention;

Fig. 10 is a cross-sectional view, approximately actual size, of the device of Fig. 9, taken along the line 10—10 thereof;

Fig. 11 is a front view, substantially actual size, of another acoustic device in accordance with this invention;

Fig. 12 is a side elevational view of the device of Fig. 11;

Fig. 13 is an enlarged, cross-sectional view of the device of Fig. 11, taken along the line 13—13 thereof, and with the front screen and associated frame removed;

Fig. 14 is a cross-sectional view of the device of Figs. 11–13, taken along the line 14—14 of Fig. 13; and

Fig. 15 is a plan view of a fragment of the device of Fig. 11.

The acoustic device of Figs. 1–5 comprises an electrodynamic microphone or transmitter, designated generally, 20. It comprises a hollow housing, container, enclosure or case 21, of insulating material, for instance, phenol linen, inwardly curved to present a substantially hemispherical outer surface at its front end 22, which contains a circular opening 23 in which an apertured plate

or protective grid 24, for instance, of brass, is positioned. The interior of the case is divided into two air chambers or compartments 25, 26 by a disc, plate or partition member 27, held against the internally projecting shoulder or flange 28 by a lock or clamping ring 29, externally threaded for engagement with the internally threaded annulus 30 of the case.

An electrodynamic unit 31 is mounted in one chamber 25, and comprises a U-shaped permanent magnet 32, preferably of cobalt steel or cobalt-molybdenum steel; an outer pole member 33, preferably of magnetic iron; an inner or central and substantially cylindrical pole member 34, preferably of cobalt steel or cobalt-molybdenum steel; and a dome-shaped or cap member 35, preferably of magnetic iron. The outer pole has an annular, central portion 36, and a pair of radially outwardly, downwardly projecting extensions 37, 38, one extension 37 containing a circular passage 39, and the other a slot 40 extending inwardly from its periphery, the passage and slot receiving pin members 41, for instance, of steel, projecting from the ends 42 of the magnet. Pole member 34 has a central passage 43 for a clamping member or bolt 44, the central pole and the cap member being fastened to the central and straight portion 45 of the permanent magnet by this bolt, the threaded end 46 of which is engaged by a pair of nuts 47.

The diaphragm 48 is of any suitable material, for instance, a light-weight, high-strength material, such as duralumin. It comprises a centrally stiffened, dome-shaped portion 49; an outer, annular peripheral portion 50; and an intermediate, flexible, tangentially corrugated portion 51. The annular portion 50 is secured to the annular ridge or flange 52 of the outer pole, preferably by cement, and such that the coil 53, which may be of edge-wound, insulated, aluminum ribbon or tape and secured to the diaphragm at the junction 54 of the portions 49 and 51 thereof, is centered in the annular air-gap 55 defined by the members 33, 35. The coil leads (not shown) are connected to terminal members (not shown) carried by arcuate-shaped terminal strips 56 of insulating material, that are fastened to the inner surface 57 of the pole member 33.

Acoustic damping means is positioned under the air-gap and comprises an annulus 58 of damping cloth, preferably silk. It is supported by a plate or ring member 59 of non-magnetic material, for instance, brass, containing a plurality of elongated passages 91. The ring 59 is maintained in position by a resilient sleeve or ring 60, preferably of soft rubber, that encircles the central pole and is carried by the ring member 61 supported on the shoulder or ledge 62, and is spaced from the under surface 63 of the outer pole by a resilient washer or ring 64, preferably of soft rubber.

The diaphragm end of the unit 31 closes the case opening 23, a resilient washer 65, for instance, rubber, being interposed between the outer portion of the diaphragm and the radially extending flange portion 66, to provide an airproof seal. It is apparent that the electrodynamic unit 31 is compact and may be mounted in a confined and substantially hemispherical space in such a manner as to utilize the available space to the greatest extent possible.

The partition member 27 is of insulating material and contains a frusto-conical shaped opening or passage 67 connecting the chambers 25, 26, the smaller end opening into chamber 26. It has embedded in it a pair of internally threaded bushings 68, and a cup-shaped member 69, each of which may be of brass. The cup member contains a helical spring 70, for instance, of phosphor bronze. The clamping nuts 47 bear against the spring 70, which with the partition member in place, is under compression, whereby the unit 31 is forced forward to cause the diaphragm outer portion to bear against the washer 65. The bushings 68 are electrically connected by suitable conductors (not shown) with the coil lead terminals on the members 56.

The second chamber 26 is defined by the partition member and a removable portion or cover 71 of the case. This cover supports on its inner surface, an elongated, coiled tubular member 72, open at each end, and one end 73 of which is secured to the cover by a clamping plate 74, screws 93 and gasket 75, in line with the multi-aperture portion 76 thereof. This tubular member is provided in accordance with the teachings of A. L. Thuras Patent 1,869,178, issued July 26, 1932, and in a device constructed in accordance with Figs. 1–5 was approximately six inches long and one-eighth inch in inner diameter.

The cover contains an elongated slot or recess 77 adapted to receive a jack 78 for engagement with three pins or contacts 79 which are supported by the case and project into the slot. The pins have threaded extremities 80, which thread into the bushings and cup member to secure the cover to the remaining portion of the case. Where the pins extend from the cover into the slot, they are surrounded by a suitable sealing compound 81, for instance, sealing wax. A tight seal between the cover and the rest of the case is ensured by providing the cover with sharp-edged annular ridge 82, and inserting between it and the shoulder portion 83 of the case, a resilient ring 84 adapted to be compressed when the cover is united to the rest of the case.

The chambers 25, 26 and the passage 67 permit wave propagation from the rear of the diaphragm when the microphone is being used. The tubular member, of course, causes the response of the microphone to be enhanced in the region of the low sound wave frequencies.

Supported on the case and in front of the grid 24, is a screen comprising a double layer 85 of cloth, preferably, silk. It is mounted between a pair of protective brass screens 86, within a channeled ring 87, together with a ring member 88 having three equally spaced projecting portions 89 having rivets 90 at their extremities for engagement with three equally spaced recesses 92 in the case. This screen is provided in accordance with the teachings of the pending application of F. F. Romanow, Serial No. 729,759, filed June 9, 1934, Patent No. 2,106,813, issued Feb. 1, 1938, to render the open field response characteristic of the microphone substantially uniform regardless of the microphone's position with reference to the sound wave source.

The acoustic device of Figs. 6, 7 and 8 comprises an electrodynamic microphone or transmitter, designated generally, 100. It comprises a hollow housing, container, inclosure or case 101, the interior of which is divided into two air compartments or chambers 102, 103 by a disc, plate or partition member 104 containing a frusto-conically shaped passage or opening 105 joining the two chambers. With such a shaped passage, the acoustic mass effect of the air in the passage is substantially negligible. The cham-

ber 103 is defined in part by the removable portion or cover member 106 of the case. The case is curved at one end 107 so as to present a substantially hemispherical outer surface, and contains a circular opening 23 in which the grid 24 is positioned. The electrodynamic unit 108 is substantially the same as the unit 31, like parts bearing like identifying numerals. The magnet 45, pole member 34 and dome-shaped or cap pole-piece 109 are secured together by a screw 110, the head 111 of which fits into the central aperture 112 in the partition member. A sealing washer 113 is interposed between the magnet and partition member. The unit is maintained in position by the partition member, which, in turn, is held in place by a lock or clamping ring 114, externally threaded for engagement with the threaded annulus 115 of the case.

The case contains a circumferentially arranged groove, channel or recess 116 in its outer surface, a closure member or ring 117 being disposed thereover, having a sliding fit with the annular surface portion 118 of the case, and resting against the shoulder or ledge portion 119. The member 117 contains an opening or aperture 120 (see Fig. 8) connecting the atmosphere outside of the case with the groove; the groove at one end connects with the interior of the case, specifically, chamber 102, through a passage or opening 121. These apertures 120, 121 are circular and of approximately the same area as the cross-sectional area of the channel or groove 116. The member 117 is rotatable such that the position of the aperture 120 with reference to the aperture 121 is variable to vary the effective length of the tubular passage. If the member 117 is adjusted so that the aperture 120 is positioned over the portion 122 of the case, the interior of the case is closed, of course, from the atmosphere outside the case. This groove or channel functions, like the tubular member 72, to enhance the low frequency response of the acoustic device and, since its effective length is variable, the low frequency response may be varied at will.

It may be desired to modify the wave propagation in the chambers 102, 103. Closure means 123 is provided for closing the passage 105, and by isolating chamber 103, to reduce the effective volume of air on the rear side of the diaphragm. It comprises a pad 124 of resilient material, such as rubber, between a pair of washers 125, and fastened by a bolt 126 and nut 127 to one end of a wire frame member 128, the other end of which is supported in slideways 129 of a U-shaped frame member 130 secured to the partition member by any suitable means, for instance, rivets 131. A helical spring 132 is connected at one end to the pad end of the member 128, and at its other end to the lug portion 133 of the member 130. The angularly projecting end portion 134 of the member 128 is engaged by one end of a link 135 whose other end 136 projects through an opening 137 in the case wall and terminates in a button member 138 adapted to be engaged by the fingers of user of the device. Normally, the closure means is in the position in which it is shown in Fig. 6. When it is desired to close the passage between the case chambers, a slight outward pull with the fingers on the button 138 causes the pad 124 to be moved down over the opening to occupy the position indicated by the broken lines. A slight pressure on the button 138 returns the closure means to its original position under the restoring action of the spring. A three conductor cord 139 extends through a stuffing-box 140, the conductors being terminated at the terminals 141 and the frame member 130. The latter is engaged by the head of the bolt 110. The terminals 141 are electrically connected by suitable conductors (not shown) with the terminal members on the insulators 56.

The devices of Figs. 6, 7 and 8 and Figs. 9 and 10 are substantially alike, like parts bearing like reference numerals, that of Figs. 9 and 10, however, embodying a different arrangement of the low sound wave frequencies enhancing means. The inner surface 150 of the case 151 contains a groove, channel or recess 152 over which is positioned a ring-shaped closure member 153, preferably secured to the surface 150 by a screw 154. The case contains an aperture or passage 155 at one end of the groove connecting it with the atmosphere outside the case, and the closure member contains an aperture or passage 156 at the other end of the groove connecting the latter with the interior of the casing, specifically, chamber 102. The passages 155, 156 are preferably circular and of approximately the same area as the cross-sectional area of the groove.

The acoustic device of Figs. 11 to 15 comprises an electrodynamic transmitter or microphone, designated generally, 160. It comprises a substantially spherical hollow case 161 of insulating material, the interior of which is divided into two air chambers 162, 163 by a partition member 164 of insulating material. This member 164 maintains the electrodynamic unit 108 in place against the front end 165 of the case so that the diaphragm closes the opening 23 therein. The partition member, in turn, is retained in place by a lock or clamping ring 166, externally threaded for engagement with the threaded portion 167 of the case. A removable portion or cover 168 defines, in part, the chamber 163. The case outer surface contains a groove 169, similar to the groove 116 of the device of Figs. 6–8, a ring-shaped closure member 170 being slidably positioned thereover and bearing against the shoulder or ledge 171 of the case. A retaining member or screw 172 prevents the closure member from shifting toward the front of the transmitter. The closure member contains an aperture 201 similar to the aperture 120 of the closure member 117; the aperture or passage 173 connects the groove 169 and the interior of the case, specifically, chamber 162. To ensure that the closure member will remain in its adjusted position, one edge is provided with spaced notches 174 adapted to be engaged by the stepped-end 175 of a finger-operable rod 176. This rod extends through a passage 177 in the upper part of the case, and is encircled for a portion of its length by a helical spring 178, normally under compression. Normally, therefore, the rod cooperates with the closure member. When it is desired to adjust the position of the aperture in the closure member with reference to the aperture leading from the groove to the case interior and, thereby, to vary the effective length of the path between the exterior and interior of the case, the finger engageable member 179 on the rod 176 is pushed rearwardly to move the end of the rod out of the notch against the restoring action of the spring. The closure member is then turned to the desired degree, the pressure on the member 179 is released, and the rod engages again with a notch in the closure member.

The partition member contains a plurality of

spaced passages 180, preferably of less diameter than the thickness of the partition member and connecting the air chambers 162, 163. A strip 181 of damping material, for instance, silk, is secured to one surface 182 of the partition member and across these passages. A slide 183 is supported on the other surface of member 164 and is adapted to be adjusted in position manually from outside the case by means of a rod 184, so that some or all of the passages 180 are obstructed. Not only is the effective volume of air on the rear or inner side of the diaphragm thus controllable, but the case resonance is eliminated by the provision of the right number of passages or holes 180 and/or damping material 181. In small microphone design, in which large cases in comparison with the size of the electrodynamic unit are required, uncontrolled case resonance has been found undesirable.

The opening 23 is closed by a multi-apertured plate or grid 185 which fills the cavity in front of the diaphragm and increases the normal range of the electrodynamic unit at high frequencies by preventing resonance by the air in the opening 23 until, for example, about 12,000–15,000 cycles per second, or by leaving unaffected the normal resonant effect of the air of the opening, but adding another resonance at a higher frequency. The passages or holes 186 in the grid are shown of greater length than diameter although they may be of greater diameter than length, and, since the effect of a particular grid is critical with its distance from the diaphragm, the high end response of the transmitter may be made variable by providing the grid with an externally threaded portion 187 for engagement with the internally threaded portion 188 of the case.

Supported on the case 161 and in front of the grid 185, is a frame member 189. It comprises an apertured plate member 190 behind which a strip of damping cloth, silk (not shown), is positioned in accordance with the disclosure of the application of F. F. Romanow, Serial No. 729,759, filed June 9, 1934, Patent No. 2,106,813, issued Feb. 1, 1938. The member 190 is integral with a plurality of spaced supporting arms 191, integral at their other ends with a ring member 192 which contains an elongated slot 193. A guide member or screw 194 projects from the case, specifically, from the closure member 170. When it is desired to adjust the position of the cloth screen with reference to the case, the screw is loosened, the frame member turned with the screw acting as a guide in the slot, and the screw tightened to fasten it in its new position.

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

What is claimed is:

1. An acoustic device comprising a case having an open end, a sound wave translating unit in said case and including a diaphragm and a magnet, said diaphragm closing said open end, means in said case between said magnet and the other end of said case dividing it into two chambers and bearing against said magnet to hold it in position so that the diaphragm closes said case open end, said means containing a restricted, small area passage connecting said chambers, and means constituting a restricted sound wave passage for enhancing the low frequency response of the device, connecting one of said chambers with the atmosphere outside of the case.

2. An acoustic device comprising a case having an open end, a diaphragm in said case and closing said open end, and means supported by said case and defining with the case a variable length, restricted sound wave passage connecting the interior of the case and the atmosphere, for enhancing the low frequency response of said diaphragm.

3. An acoustic device comprising a case having an open end, a diaphragm in said case and closing said open end, said case having a groove on its outer surface and a passage connecting said groove with the interior of said case, and a closure member for said groove containing a passage connecting the groove with the atmosphere, said closure member being adjustable in position whereby the distance between said passages may be varied.

4. An acoustic device comprising a case having an open end, a diaphragm in said case and closing said open end, said case having an elongated groove in one surface, and a closure member over said groove, said member and said case containing passages for connecting the interior of the case and the atmosphere through said groove.

5. An acoustic device comprising a hollow enclosure having an open end, a diaphragm closing said open end, said enclosure having a groove in one surface, and a closure member over said groove, said member and enclosure containing passages of substantially the same area as the cross-sectional area of the groove for connecting the interior of the enclosure and the atmosphere through said groove.

6. An acoustic device comprising a hollow enclosure having an open end, and a diaphragm closing said open end, said enclosure comprising a wall containing an elongated, restricted sound wave passage and having an aperture connecting the passage with the atmosphere outside the enclosure and another aperture connecting the passage with the interior of the enclosure on the inner side of the diaphragm.

7. An acoustic device as claimed in the preceding claim in which the effective length of said passage is variable.

8. An acoustic device comprising a hollow enclosure having an open end, a diaphragm closing said open end, said enclosure comprising a wall containing an elongated, restricted sound wave passage and having an aperture connecting the passage with the atmosphere outside of the enclosure and another aperture connecting the passage with the interior of the enclosure on the inner side of the diaphragm, a partition member in said enclosure dividing it into two chambers with one of which said passage connects, said partition member containing a passage connecting said chambers, and means for closing said last-mentioned passage.

9. An acoustic device comprising a hollow case having an open end, an electrodynamic unit in said case and including a diaphragm closing said open end but exposed to sound waves therethrough, means for varying the effective volume of the case on the rear side of the diaphragm, means for varying at will the response of the device at the lower end of the audio frequency range, and means to vary at will the response of the device at the upper end of the audio frequency range.

10. An acoustic device comprising a hollow case having an open end, a sound translating unit in

said case and including a diaphragm closing said open end and being exposed therethrough to sound waves on one side, said case having a groove in its outer surface connected through an aperture in the case with the interior of the case on the other side of the diaphragm, and a closure member on said case and disposed over said groove, said member having an aperture therein connecting the groove with the atmosphere outside the case and being slidable relative to the case to vary the distance between the two apertures.

11. An acoustic device comprising a hollow case having an open end, a sound translating unit in said case and including a diaphragm closing said open end and being exposed therethrough to sound waves on one side, said case having a groove in its outer surface connected through an aperture in the case with the interior of the case on the other side of the diaphragm, and a closure member on said case and disposed over said groove, said member having an aperture therein connecting the groove with the atmosphere outside the case and being slidable relative to the case to vary the distance between the two apertures, and means to hold said closure member against movement after adjustment of the closure member for the desired spacing of the aperture.

12. An acoustic device comprising a hollow case having open ends, a diaphragm within the case in alignment with and closing one of said open ends, a coil attached to said diaphragm, magnet structure for said coil, said case including a cover member for its other end and supporting an elongated open ended tubular member in the case, one open end of the tubular member being in alignment with an apertured portion of the cover, and a single wall member in said case dividing it into two chambers and supporting the magnet structure, diaphragm and coil in one chamber, said wall member having a restricted aperture defining a passage connecting said chambers.

13. An acoustic device comprising a hollow case having an open end, a sound wave translating unit in said case and including a diaphragm, a disc partition member slidably insertable in said case and dividing it into two chambers and having its central portion only bearing against said unit to hold the latter in position so that the diaphragm closes the case open end, means engaging the interior surface of said case and bearing against the peripheral portion of said partition member to maintain the latter in position, said partition member containing a small area, off-center passage connecting said chambers, and means independent of said partition member constituting a restricted sound wave passage for enhancing the low frequency response of the device, connecting one of said chambers with the atmosphere outside of the case.

14. An acoustic device comprising a case having open ends, a diaphragm within the case closing one open end, a coil attached to said diaphragm, a magnet structure for said coil, said case including a cover member for its other end and supporting an elongated open ended tubular member in the case, one open end of the tubular member being in alignment with an apertured portion of the cover, and a wall member in said case dividing it into two chambers connected by a passage in the wall member, one of said chambers containing the diaphragm, coil and magnet structure and the other chamber containing said tubular member.

15. An acoustic device comprising a hollow case having a substantially hemispherical section having an apertured wall portion extending across its region of greatest diameter, and containing a sound wave passing opening in its curved surface portion, a diaphragm closing said opening, a cover member defining an air chamber with said wall portion, said member containing a passage connecting the chamber with the air outside the case, and a tubular member between said wall portion and cover member constituting a continuation of the passage.

16. An acoustic device comprising a casing having openings at its front and back ends, a transmitter including a diaphragm and a magnet disposed within said casing, said diaphragm being positioned adjacent the front end of said casing, an apertured partition within said casing between said magnet and the back end of the casing, and a tubular member entirely within the chamber nearest the back end of the casing and cooperating with an opening in the rear of the casing to acoustically connect the open air with the back side of the diaphragm solely via the apertured partition.

17. An acoustic device comprising a casing having an opening at its front and back ends, an apertured partition within said casing, dividing the interior into two chambers, a transmitter unit disposed in the chamber adjacent the front end of the casing, a tubular sound passageway member disposed in the chamber adjacent the back end of the casing and supported thereon, and means on said partition for holding said unit in place.

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