Dec. 12, 1950 S. ZUERKER 2,534,157

SOUND REPRODUCING DEVICE

Filed June 4, 1949

Fig. 1.

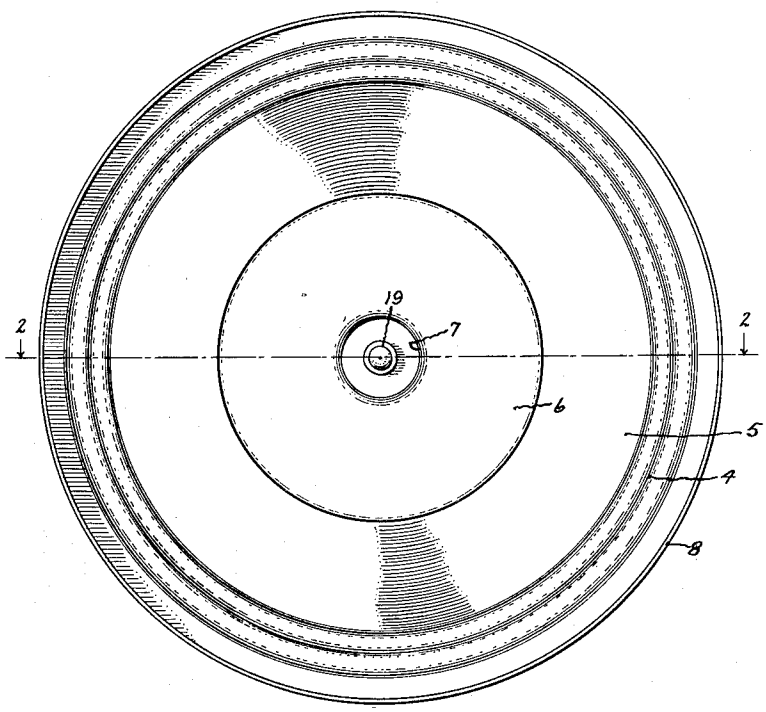
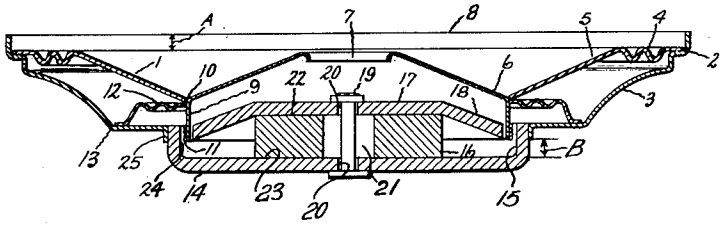


Fig. 2.



Inventor:
Siegfried Zuerker,
by Merton D Morse
His Attorney.

Patented Dec. 12, 1950

2,534,157

UNITED STATES PATENT OFFICE

2,534,157

SOUND REPRODUCING DEVICE

Siegfried Zuerker, Pennellville, N. Y., assignor to General Electric Company, a corporation of New York

Application June 4, 1949, Serial No. 97,234

8 Claims. (Cl. 179—115.5)

1

My invention relates to sound reproducing devices and, more particularly, to sound reproducing devices of the electromagnetic loudspeaker type in which a magnetic field structure provides an air gap for a voice coil connected to the sound emitting diaphragm.

For certain purposes it is desirable to have available a sound reproducing device of the electrodynamic loudspeaker type which is of a conventional diameter and which is extremely shallow, one in which the over-all height of the loudspeaker is as small as possible. Such requirements are found, for example, in small portable radio receivers of the so-called pocket size wherein space is at a premium, and in automobile receivers wherein similar requirements are found. Also, flush wall mounting of loudspeakers may, in many instances, call for an extremely shallow loudspeaker.

In conventional electrodynamic loudspeakers of the moving coil type it is customary to employ a permanent magnet field structure of generally cylindrical configuration in which the air gap for the moving coil is formed adjacent one end thereof, the major portion of the field structure extending rearwardly of the moving coil, thereby increasing the over-all depth of the loudspeaker by a substantial amount. Certain arrangements heretofore proposed have provided a relatively compact loudspeaker structure by placing the permanent magnet field structure inside the concave, or active, side of the vibratory sound diaphragm. However, it would be desirable to have a loudspeaker in which the space in front of the vibratory sound diaphragm is free from all obstructions and resonance producing objects, and still maintain the over-all depth of the loudspeaker at a minimum. Accordingly, it is a primary object of my invention to provide a sound reproducing device of the electrodynamic loudspeaker type which is particularly adapted for use in situations wherein a minimum front to back dimension of the loudspeaker is required.

It is another object of my invention to provide a new and improved reproducing device of the type having a movable voice coil and sound emitting diaphragm in which the front to back dimension of the reproducing device is approximately equal to the active depth of the sound diaphragm and voice coil assembly.

It is still another object of my invention to provide a new and improved sound reproducing device of the type having a movable voice coil and sound emitting diaphragm in which the front to back dimension of the reproducing device is

2

approximately equal to the active depth of the sound diaphragm and voice coil assembly, the diaphragm having a re-entrant portion further to diminish the over-all depth thereof.

It is a further object of my invention to provide a new and improved sound reproducing device of the type having a movable voice coil and sound emitting diaphragm in which the permanent magnet field structure is arranged to conform to the contour of the voice coil and sound diaphragm without substantially contributing to the over-all depth of the sound reproducing device.

It is a still further object of my invention to provide a new and improved sound reproducing device of the type having a movable wire coil and sound emitting diaphragm in which the permanent magnet field structure is positioned on the inactive side of the sound diaphragm and conforms to the contour of the sound diaphragm and voice coil assembly without substantially contributing to the over-all depth of the sound reproducing device.

It is another object of my invention to provide a new and improved sound reproducing device of the electrodynamic loudspeaker type in which a permanent magnet field structure provides an air gap for a voice coil attached to a sound emitting diaphragm, the voice coil being secured in strain free position within the air gap.

According to one phase of my invention, the conical sound diaphragm of a sound reproducing device is provided with a folded re-entrant central portion thereby substantially decreasing the depth of the diaphragm, a large diameter movable voice coil being attached to the diaphragm at the point of fold thereof. The magnetic field structure of the sound reproducing device is positioned on the inactive side of the sound diaphragm substantially within the space defined by the re-entrant portion of the diaphragm and the movable voice coil, the air gap of the magnetic structure being spaced from the bottom thereof by an amount equal to the maximum wire coil displacement so that the over-all depth of the sound reproducing device is substantially equal to the depth of the folded diaphragm and voice coil assembly. The diaphragm housing is provided with a cylindrical flange loosely encircling the top of the permanent magnet field structure and soldered thereto, securely to position the voice coil within the air gap of the field structure.

The features of my invention which I believe to be novel are set forth with particularity in the

appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description, taken in connection with the accompanying drawing in which Fig. 1 is a plan view of the sound reproducing device; and Fig. 2 is a cross-sectional view of the sound reproducing device taken along the line 2—2 of Fig. 1.

Referring more particularly to the drawings, in which similar reference numerals indicate corresponding elements throughout, an electrodynamic loudspeaker constructed in accordance with my invention comprises a sound emitting diaphragm indicated generally at 1, the periphery thereof being supported on a ledge 2 formed in a cone shaped metallic housing 3. The outer portion of diaphragm 1 is provided with corrugations 4 to allow movement of the diaphragm relative to the supported edge thereof, the edge of the diaphragm being secured to ledge 2 by any means, such as cementing, as will be readily understood by those skilled in the art. The diaphragm 1 is provided with an outer frusto-conical portion 5, the central portion of the diaphragm comprising an inner re-entrant frusto-conical portion 6. The center of the diaphragm 1 is provided with an aperture 7 in which may be seated a dust cap (not shown) to maintain the air gap of the loudspeaker free from dust and foreign particles which would be attracted thereto. For reasons explained more fully hereinafter the upper edge of the re-entrant portion 6 is preferably spaced a distance A from the upper lip 8 of the conical housing 3, the distance A being equal to the maximum displacement of the inner re-entrant portion of the diaphragm.

To actuate the diaphragm 1 a large diameter coil form 9 is attached to the diaphragm at the junction point 10 of the frusto-conical portions thereof. The lower portion of coil form 9 carries a voice coil 11, which may be in the form of a plurality of turns of wire wound upon the coil form 9 in a manner well known to those skilled in the art.

Coil form 9 is attached to point 10 of the diaphragm by any convenient means. At this point 10 the inner edge of an annular corrugated spider 12 is also cemented to the coil form 9, the outer edge of spider 12 being supported on and cemented to a ledge formed at the appropriate point 13 in the conical housing 3. It will be understood that spider 12 serves as a flexible centering device for the voice call assembly and also serves as a dust protective device in a manner similar to that performed by the dust cap discussed above.

To provide an annular air gap for the voice coil 11, and in order that the space defined by the re-entrant portion 6 of the diaphragm and coil form 9 may be utilized so as to reduce the over-all height of the loudspeaker, I provide a permanent magnet field structure comprising an outer cup-shaped pole piece 14, having an upwardly extending cylindrical side portion 15. A permanent magnet 16 of generally cylindrical configuration is positioned centrally of the cup-shaped outer pole piece 14, the diameter of permanent magnet 16 being substantially smaller than the diameter of pole piece 14. Permanent magnet 16 may be made of any of the well known magnetic alloys having high flux producing qualities, such as, for example, an alloy of aluminum, nickel and cobalt. Seated on the upper surface of magnet 16 is an inner cup-shaped pole piece 17 which is provided with a central flat portion conforming to the contour of the magnet 16 and a downwardly extending side portion 18 which extends toward the bottom of the outer pole piece 14. Pole pieces 14, 17, and magnet 16 are held in concentric stacked relationship by any convenient means such as the rivet 19 which is passed through apertures 20 in the pole pieces and the central aperture 21 of the permanent magnet 16. The surfaces 22, 23 of the permanent magnet 16 are preferably cemented to the upper and lower pole pieces respectively to prevent dislocation of the members when subjected to shock.

The periphery of inner pole piece 17 is spaced from the adjacent side portion of outer pole piece 14 to define an air gap 24 therebetween. While the outer portion 18 of pole piece 17 may be bent at any particular angle so as to define the air gap 24 at any particular point along the side portion 15, I prefer to form the pole piece 17 so that the air gap 24 is spaced from the bottom of outer pole piece 14 by a distance B, this distance being substantially equal to the maximum displacement of the voice coil when energized by the conventional electrical signal.

By spacing the voice coil from the bottom pole piece 14 by an amount equal to, or only slightly greater than, the voice coil displacement and by positioning the upper edge of re-entrant portion 6 and cone 5 a distance A, equal to the voice coil displacement, from the upper edge of the speaker housing 3 it will be evident that substantially the entire depth of the loudspeaker is determined by the dynamic sound diaphragm and voice coil assembly. Thus, while the permanent magnet 16 may be of substantial depth it is positioned on the inactive side of the sound diaphragm, within the pocket formed by the re-entrant portion of the sound diaphragm and the coil form 9 so that the permanent magnet field structure contributes little or nothing to the over-all depth of the loudspeaker.

In order that diaphragms of different depths may be utilized without introducing distortions of any of the critical dimensions of the loudspeaker, the conical housing 3 is provided with a cylindrical, downwardly extending flange portion 25. Flange portion 25 has an inner diameter sufficiently large that it will loosely encircle the side portion 15 of outer pole piece 14, thus allowing considerable lateral and angular movement of the diaphragm and voice coil assembly with respect to the magnetic field structure. By reason of the loose fit between flange portion 25 and the permanent magnet field structure, a perfect alignment between the plane of cone seat 2 and the air gap 24 may be obtained. This position of perfect alignment would be obtained when the plane of cone seat 2 is exactly perpendicular to the axis of the air gap. The provision of a loose fit between flange portion 25 and the permanent magnet field structure also allows a strain-free method of assembly and prevents distortion of any of the critical dimensions of the loudspeaker. With the permanent magnet field structure positioned properly with respect to the cone and voice coil assembly, which may be accomplished by the use of suitable jig members, the flange portion 25 is secured to the outer surface of the field structure by flowing solder therebetween, thereby securing the voice coil 18 in strain-free position within the air gap 24. While the above described strain-free connection between the permanent magnet field structure and the diaphragm speaker housing is particularly adapted to the struc-

ture shown in the drawing, wherein a large diameter of voice coil is utilized, it will be readily appreciated that such strain-free construction may be utilized in many other types of loudspeakers.

From the foregoing description it will be apparent that in the above described structure there is provided an electrodynamic loudspeaker, the permanent magnet field structure of which utilizes an alloy-type permanent magnet of substantial depth without substantially increasing the over-all depth of the loudspeaker from that of the vibratory sound diaphragm and voice coil assembly. This is accomplished by providing a permanent magnet field structure which conforms to the contour of a re-entrant shaped sound diaphragm and voice coil assembly, the permanent magnet field structure comprising cup-shaped pole pieces of substantially larger diameter than the magnet, the outer extremities of the pole pieces defining an air gap which is positioned relatively close to the base portion of one of the pole pieces. The over-all depth of the loudspeaker is thus substantially equal to the active depth of the sound diaphragm and voice coil assembly, the sound diaphragm itself being reduced to substantially one-half the depth of the conventional loudspeaker sound diaphragm by the provision of the re-entrant central section thereof.

While the present invention has been described by reference to a particular embodiment thereof, it will be understood that numerous modifications may be made by those skilled in the art without actually departing from the invention. I, therefore, aim in the appended claims to cover all such equivalent variations as come within the true spirit and scope of the foregoing disclosure.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A permanent magnet field structure for an electrodynamic loudspeaker comprising a permanent magnet, a pair of opposed cup-shaped pole pieces of substantially larger diameter than said magnet and having base portions respectively located in spaced parallel planes, means for holding said magnet between said opposed pole pieces in concentric relation thereto, said pole pieces having interfitting edges located in a third plane located intermediate said parallel planes and spaced to provide an axially disposed annular air gap therebetween.

2. A permanent magnet field structure for an electrodynamic loudspeaker comprising a permanent magnet, a pair of opposed cup-shaped pole pieces of substantially larger diameter than said magnet and having base portions respectively located in spaced parallel planes, means for holding said magnet between said opposed pole pieces in concentric relation thereto, said pole pieces having interfitting edges located in a third plane located intermediate said parallel planes and spaced to provide an axially disposed annular air gap therebetween, said air gap being spaced from the base portion of one of said cup-shaped pole pieces by an amount substantially equal to the maximum travel of a voice coil positioned within said air gap.

3. In an electrodynamic loudspeaker, the combination of a cylindrical permanent magnet, inner and outer cup-shaped pole pieces of substantially larger diameter than said magnet, means for holding said magnet between said opposed pole pieces in concentric relation thereto, said pole pieces having interfitting edges spaced to provide an axially disposed air gap therebetween, said air gap being spaced from the bottom of one of said cup-shaped pole pieces by an amount substantially equal to the maximum travel of a voice coil positioned within said air gap, a frusto-conical housing attached to said outer cup-shaped pole piece at the periphery thereof, and a folded conical diaphragm supported on the periphery of said housing, said diaphragm having an outer frusto-conical portion extending from said air gap substantially to the periphery of said housing and disposed inwardly substantially in conformity with the contour of said housing and said diaphragm also having a reversely-directed inner portion joining said outer portion at said air gap and conforming substantially to the contour of said inner cup-shaped pole piece.

4. In an electrodynamic loudspeaker, the combination of a cylindrical permanent magnet, a pair of opposed cup-shaped pole pieces of substantially larger diameter than said magnet, means for holding said magnet between said opposed pole pieces in concentric relation thereto, said pole pieces having interfitting edges spaced to provide an axially disposed air gap therebetween, said air gap being spaced from the bottom of one of said cup-shaped pole pieces by an amount substantially equal to the maximum travel of a voice coil positioned within said air gap, a frusto-conical housing attached to said outer cup-shaped pole piece, a folded conical diaphragm supported on the periphery of said housing and disposed inwardly substantially in conformity with the contour of said housing and said inner cup-shaped pole piece, and a voice coil assembly attached to said diaphragm at the point of fold thereof and extending into said air gap, said voice coil when at a point of maximum displacement being adjacent the bottom of said outer cup-shaped pole piece.

5. In an electrodynamic loudspeaker, a magnetic field structure comprising an outer cup-shaped pole piece having a base portion and upwardly extending side portions, a permanent magnet of substantially smaller diameter than the diameter of said outer pole piece and positioned centrally on the base portion thereof, a cup-shaped inner pole piece of smaller diameter than said outer pole piece and positioned on said magnet, said inner pole piece having an outer frusto-conical portion extending downwardly around the outside of said magnet and defining an air gap in a plane located intermediate the upper and lower faces of said inner and outer pole pieces, said air gap being spaced from the base portion of said outer pole piece by an amount substantially equal to the maximum travel of a voice coil positioned within said air gap.

6. In an electrodynamic loudspeaker, the combination of a permanent magnet field structure having an outer cylindrical surface and having an axially extending annular air gap located therein, a cone-shaped housing provided with a cylindrical flange portion at the small end thereof adapted loosely to encircle said cylindrical surface, said housing being adapted to have a diaphragm and voice coil assembly attached thereto at the periphery thereof, whereby said voice coil is positioned relative to said flange portion so as to enter said air gap when said cylindrical surface and said cylindrical flange are interfitted, and a bonding material filling the space between said cylindrical flange and said cylindrical surface, thereby to secure said flange and surface together in strain-free position concentric with said air gap.

7. In an electrodynamic loudspeaker, the com-

bination of a frusto-conical housing, a cup-shaped pole piece attached to said housing, a permanent magnet and pole plate assembly positioned within said cup-shaped pole piece and defining an air gap with an inner surface thereof, a diaphragm having an outer frusto-conical section and an inner reentrant frusto-conical section, said diaphragm being supported at the perimeter thereof in said housing, a voice coil assembly attached to said diaphragm at the junction of said inner and outer sections thereof and positioned within said air gap, said air gap being spaced from the bottom of said cup-shaped pole piece by an amount substantially equal to the maximum displacement of said voice coil, whereby the overall height of the loudspeaker is approximately equal to the height of said outer diaphragm section and said voice coil assembly when at a point of maximum displacement.

8. In an electrodynamic loudspeaker, the combination of a frusto-conical housing, a cup-shaped pole piece attached to said housing, a cylindrical permanent magnet of substantially smaller diameter than said pole piece, an inverted dish-shaped pole plate, means for holding said magnet between said pole piece and said pole plate in concentric relation thereto, said pole piece overlapping said pole plate and forming an air gap therebetween, a diaphragm having an

outer frusto-conical section and an inner reentrant frusto-conical section, said diaphragm being supported at the perimeter thereof in said housing, a voice coil assembly attached to said diaphragm at the junction of said inner and outer sections thereof and positioned within said air gap, said air gap being spaced from the bottom of said cup-shaped pole piece by an amount substantially equal to the maximum displacement of said voice coil and said reentrant diaphragm section being spaced from the upper edge of said housing by an amount substantially equal to the maximum displacement of said inner diaphragm section, whereby the overall height of the loudspeaker is approximately equal to the height of said outer diaphragm section and said voice coil assembly when at a point of maximum displacement thereof.

SIEGFRIED ZUERKER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,197,649	Neuschotz	Apr. 16, 1940
2,400,662	Roberton	May 21, 1946