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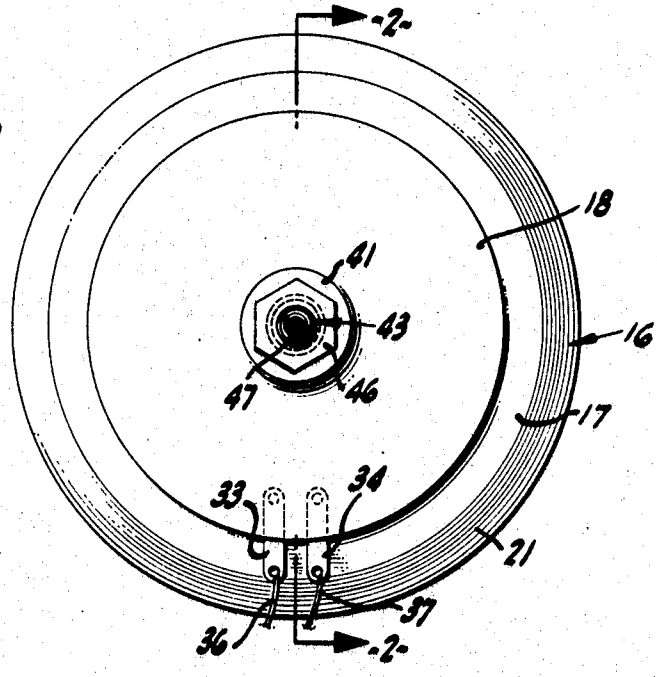
SOUND TRANSDUCER WITH WALL MOUNTED DIAPHRAGM

Filed May 4, 1967

FIG. 1



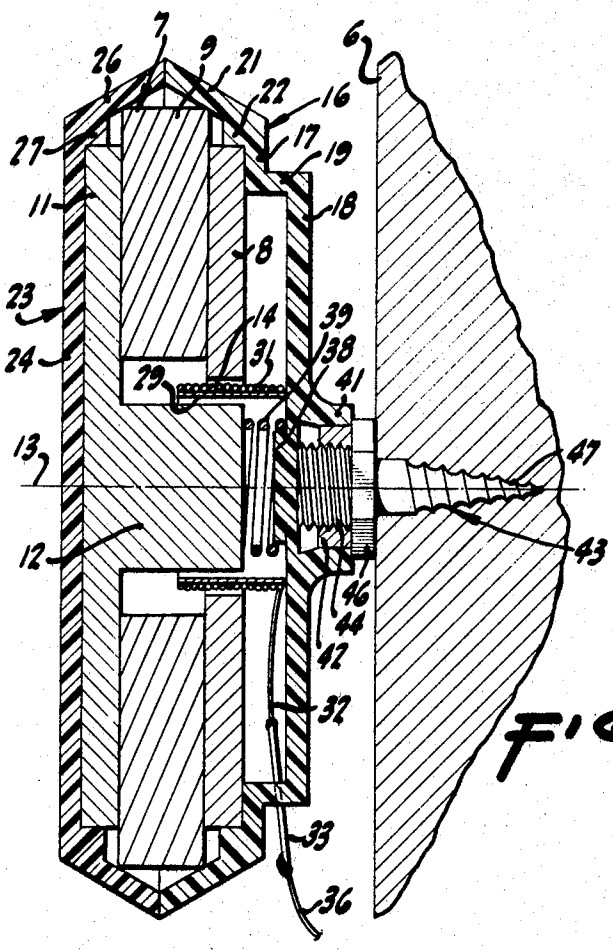
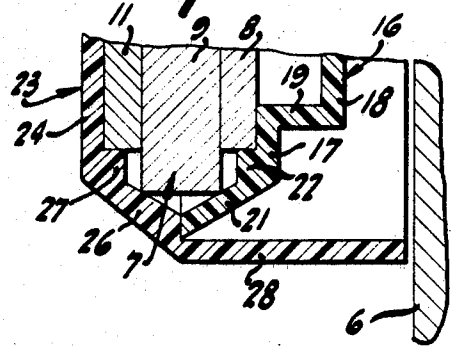


FIG. 2

FIG. 3



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SOUND TRANSDUCER WITH WALL MOUNTED DIAPHRAGM

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ABSTRACT OF THE DISCLOSURE

A sound transducer in a housing including a diaphragm centrally joined to a mount for supporting the transducer on a wall. The transducer comprises a toroidal magnet sandwiched between two pole pieces, said magnet having a larger outside diameter than said pole pieces thereby forming annular grooves. The diaphragm mounting means includes an annular shoulder on said diaphragm disposed within one of said grooves.

The invention relates to means for converting electrical energy into sound energy and is particularly concerned with a transducer loudspeaker effective for use in sound or music systems such as address or background systems and in other environments in which sound is to be dissipated throughout a substantial volume. Devices of related character are disclosed in the copending applications of John L. Jamison filed July 28, 1964 with Ser. No. 385,592 and David E. Thielen filed Mar. 16, 1966 with Ser. No. 539,250.

In the dissipation of sound such as music or voice thorughout a volume such as a living room, office, hotel lobby or comparable space, it has been found useful to include part of the room construction in the system itself. In the Jamison application this is accomplished by including part of the room construction, such as a wall, in the transducer mechanism. This gives a general rather than a focal source. The Thielen application accomplishes a similar end by providing a transducer which is small in size and which may be readily mounted on any vibratile panel such as a cabinet, wall, desk top, room ceiling or the like. Because of its small size and ease of mounting, it can be mounted in a concealed position or in an exposed but unobtrusive position. Because of the variety of surfaces against which such a transducer may be fastened, difficulties may arise in the frequency response of such a system. Furthermore, difficulties in installation may still result because a given transducer may only be supplied with one type of mounting member, such as a wood screw, because of the size and shape of the transducer or because of the manner of attachment of the leads.

It is therefore an object of the invention to provide a sound transducer for connection with vibratile panels, as indicated above, having an increased frequency response.

A further object of the invention is to provide a sound transducer which is more easily installed because of decreased size.

Another object of the invention is to provide a less conspicuous sound transducer.

Another object of the invention is to provide a sound transducer to which electrical connections may be more easily made.

Another object of the invention is to provide a sound transducer having a generally simpler configuration.

Another object of the invention is to provide a sound transducer more readily mounted on a large variety of surfaces.

Still another object of the invention is to provide a generally improved sound transducer.

Other objects together with the foregoing are attained in the embodiment of the invention described in the accompanying description and illustrated in the accompanying drawing, in which:

FIG. 1 is an end elevation of the sound transducer of the invention;

FIG. 2 is a cross section on an enlarged scale on a diametrical plane through the axis of the sound transducer of the invention, the plane of section being indicated by the line 2—2 of FIG. 1; and

FIG. 3 is a cross section similar to that of FIG. 2 of a portion of a modified form of the invention.

The sound transducer pursuant to the invention can readily be embodied in a variety of different ways and mounted on a variety of supports. In the form disclosed and claimed herein it is used in conjunction with what will be referred to as a wall. A representative wall 6 or panel for convenience is considered as a normal building wall, usually fabricated of studding and a covering sheet such as gypsum board or lath and plaster or the like, but the wall 6 may even be a solid member such as a plank or any other comparable member.

Designed to cooperate with the wall 6 is the transducer itself. This includes a permanent magnet assembly 7 usually formed of ferrous material, although a magnetic ceramic material may be utilized. In the embodiment shown the assembly 7 includes a first pole piece 8, a toroidal magnet 9 and a second pole piece 11 having a cylindrical boss 12 thereon. The toroidal magnet 9, coaxial with a transducer axis 13, has a rectangular cross section and an inside diameter larger than the diameter of the boss 12. The first pole piece 8 is also toroidal with a rectangular cross section and with an outside diameter less than the outside diameter of the toroidal magnet 9 and an inside diameter less than the inside diameter of the toroidal magnet 9 but greater than the diameter of the boss 12. It is secured to one side of the toroidal magnet 9 with an adhesive such that it is also coaxial with the transducer axis 13 and such that an annular groove is formed between the toroidal magnet 9 and the first pole piece 8. The second pole piece 11 also has a diameter less than the outside diameter of the toroidal magnet 9, and it is coaxially secured to the other side of the toroidal magnet 9 with an adhesive so as to form an annular groove between the second pole piece 11 and the toroidal magnet 9. The boss 12, also coaxial with the transducer axis 13, passes through the holes in the toroidal magnet 9 and the first pole piece 8, forming an annular gap 14 between the boss 12 and the first pole piece 8. All of these parts are magnetically permeable and one or more, such as the toroidal magnet 9, in the embodiment shown, are magnetized so as to provide a radial magnetic field in the annular gap 14.

Pursuant to the invention, there is also provided a diaphragm 16 designed to extend across the assembly 7. The diaphragm 16 is generally circular in shape and has a pair of planar portions 17 and 18 offset from one another by a cylindrical portion 19. A conical portion 21 extends from the rim of the outer planar portion 17, and an annular shoulder 22 extends out of the junction between the outer planar portion 17 and the conical portion 21. The diaphragm 16 is conveniently molded of a plastic material, such as epoxy resin fortified with fiber glass included therewith, so that the diaphragm 16, although capable of flexing at somewhat above and below audible frequencies, is also effective as a mechanical support. The outer planar portion 17 of the diaphragm 16 is designed to abut the first pole piece 8 so that the annular shoulder 22, between the outer planar portion 17 and the conical portion 21

of the diaphragm 16, is received within the annular groove between the first pole piece 8 and the toroidal magnet 9, thus preventing all but axial relative movement between the diaphragm 16 and the assembly 7.

A cover 23, also conveniently formed of plastic, although not necessarily a reinforced plastic, encases the assembly 7. Also generally circular in shape, the cover 23 has a planar portion 24, a conical portion 26 extending from its rim and an annular shoulder 27 extending out of the junction between the planar portion 24 and the conical portion 26. The planar portion 24 is designed to abut the second pole piece 11 so that the annular shoulder 27, between the planar portion 24 and the conical portion 26 of the cover 23, is received within the annular groove between the toroidal magnet 9 and the second pole piece 11, thus preventing all but relative axial movement between the cover 23 and the assembly 7. The conical portion 26 of the cover 23 extends outward until the entire circumference of its outer rim engages the entire circumference of the outer rim of the conical portion 21 of the diaphragm 16. The circumferences of the outer rims of the two conical portions 21 and 26 are then secured together, as by an adhesive, forming an enclosure which holds the diaphragm 16, assembly 7 and cover 23 tightly together and seals the interior of the transducer from the ambient conditions. In the modified form of the invention shown in FIG. 3, the cover 23 has an additional cylindrical portion 28 extending from the rim of the conical portion 26 to a position in close proximity to the wall 6 when the transducer has been installed thereon. The cylindrical portion 28 effectively covers the space between the diaphragm 16 and the wall 6 to isolate the space and to prevent dirt from collecting in this inaccessible area.

Adjacent the central planar portion 18 of the diaphragm 16 is securely mounted a tube 29 of inert material, coaxial with the transducer axis 13 and extending through the annular gap 14. A helical voice coil 31 is wound and securely fastened on the tube 29 such that movements of the voice coil 31 are transmitted to the central planar portion 18 of the diaphragm 16 and vice versa. The voice coil 31 has a pair of leads 32 each of which is secured to an individual one of a pair of conducting terminals 33 and 34 conveniently molded into the cylindrical portion 19 of the diaphragm 16 and extending inwardly and outwardly so that the leads 32 and a pair of external conductors 36 and 37 may be connected thereto by solder joints or the like.

Also adjacent the central planar portion 18 of the diaphragm 16, within the tube 29, is a somewhat thickened portion forming an annular shoulder 38 coaxial with the transducer axis 13. A resilient member 39, such as a spring, which is mounted on the annular shoulder 38, extends from the diaphragm 16 to the boss 12, abutting the boss 12 and applying pressure thereto.

The diaphragm 16 in its central planar portion 18 and preferably coaxial with the transducer axis 13 is enlarged to provide a hub 41 projecting in a direction away from the helical voice coil 31. Embedded in the hub 41 is an internally threaded member 42. The internally threaded member 42 has a plurality of slits disposed circumferentially about the member 42 and extending axially thereof from the end thereof adjacent the helical voice coil 31. The hole through the member 42, which carries the internal threads, is also tapered in the portion thereof through which the slits extend. A mounting member 43 having an externally threaded portion 44 is screwed into the internally threaded member 42 by interaction of a wrench or the like with a noncircular portion 46. When the mounting member 43 has been so installed, the externally threaded portion 44 thereof will interact with the tapered portion of the member 42. The slits therein will allow this portion to expand, under the urgency of the mounting member 43, into the hub 41, thereby more firmly embedding the member 42 therein. In the present instance, the mounting member 43 is also provided with threads 47 comparable to

those of the usual wood screw. Alternatively, the mounting member 43 may be replaced with other mounting members provided with means for adhesive attachment or machine threads or a threaded socket or a nail-like portion or any other means which constitutes a support, fastener and sound transmitter. All of these various mounting members are readily removed and exchanged for installation of the transducer in various configurations.

In the installation of this device the appropriate mounting member 43, which may be taken to be one having threads 47 comparable to those of the usual wood screw, is firmly screwed into the internally threaded member 42. The device is taken in hand by a workman and the screw threads 47 are started into the wall 6. The device then is simply rotated as a body about its axis 13 until such time as the noncircular portion 46 is in firm abutment with the surface of the wall 6.

When the mounting has been accomplished, the external conductors 36 and 37, which are joined to any suitable source of audio current, are attached to the terminals 33 and 34. Because of the convenient placement of the terminals 33 and 34 the external conductors 36 and 37 may be readily attached with the transducer installed so that no wires need be present to become tangled while the transducer is being twisted into the wall 6. When this circuit is energized, the audio current in the voice coil 31, being situated in the magnetic field in the annular gap 14, causes the voice coil 31 to move relative to the assembly 7. The mass of the assembly 7 and its associated materials is such with respect to that of the wall 6 that the wall 6 itself vibrates very substantially in response to the movement of the coil 31. While of course the assembly 7 likewise is displaced, nevertheless a large portion of the electrical energy fed into the coil 31 is converted into vibratile energy of the wall 6. Consequently, the wall 6 and any associated structures vibrate with frequencies corresponding to those of the coil 31 vibration, and the wall 6 as a whole serves as a large diaphragm to dissipate the sound into the air.

The range of audible frequencies in the response depends quite a lot on the nature and character of the wall itself. It has been found in practice in normal installations in the customary environments that the wall itself serves as a very satisfactory dissipator of sound energy over a relatively wide range. Voices are easily reproduced with considerable fidelity and music of substantial range is itself reproduced with highly acceptable fidelity. Furthermore, experience has indicated that the fidelity of the sound produced is augmented by the presence of the resilient member 39 in the present device. Since the installation can be made either indoors or outdoors because the unit is entirely protected, and since the installation is made merely by rotating the unit about an axis 13 with a single mounting member 43, the labor of installation is easy and the transmission of the sound waves is readily accomplished in a highly satisfactory way.

Because of the small size of the unit, it is quite unobtrusive even if installed in plain sight, and no structural or decorative changes need be made in its support. The modified form of transducer is particularly useful because the cylindrical portion 28 will serve to hide and keep dirt and dust out of the inaccessible area of the device when installed. Furthermore, the sandwich-type construction of the present device results in considerable economy of space, making the device even more unobtrusive than earlier devices. The unit can also be installed on the far side of a wall or ceiling and so not affect room appearance at all. The small size and readily replaceable mounting member simplifies all such installations.

What is claimed is:

1. A sound transducer for use with a wall comprising a toroidal magnet, a first disk-shaped pole piece of magnetically permeable material coaxial with said toroidal magnet and disposed along one side thereof, a second disk-shaped pole piece of magnetically permeable material co-

axial with said toroidal magnet and disposed along the other side thereof, a cylindrical boss of magnetically permeable material on one of said pole pieces coaxial therewith and extending through said toroidal magnet and the other of said pole pieces to form an annular gap between said boss and said other pole piece, a diaphragm, means for mounting said diaphragm along the periphery of one of said pole pieces, a helical voice coil disposed within said annular gap coaxially with said toroidal magnet, means for mounting said helical voice coil on said diaphragm, a wall mounting member extending from said diaphragm in the vicinity of the mounting of said helical voice coil thereon, and said toroidal magnet has a larger outside diameter than said pole pieces thereby forming annular grooves between said magnet and said pole pieces and in which said diaphragm mounting means includes an annular shoulder on said diaphragm disposed within one of said grooves.

2. A sound transducer as in claim 1 comprising a cover member, means for mounting said cover member on the

other of said pole pieces including an annular shoulder on said cover member disposed within the other of said grooves and means for connecting said cover member to said diaphragm to provide an enclosure.

3. A sound transducer as in claim 2 in which said connecting means seals the volume between said cover member and said diaphragm from the ambient conditions.

4. A sound transducer as in claim 2 in which said enclosure has a cylindrical portion extending to the vicinity of said wall.

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