United States Patent

Cozart

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[54] LOUDSPEAKER USING WALL AS DIAPHRAGM

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[52] **U.S. Cl.** .....**179/181 W**
[51] **Int. Cl.**.....**H04r 9/06**
[58] **Field of Search**.....179/115.5, 117; 335/231

[56] **References Cited**

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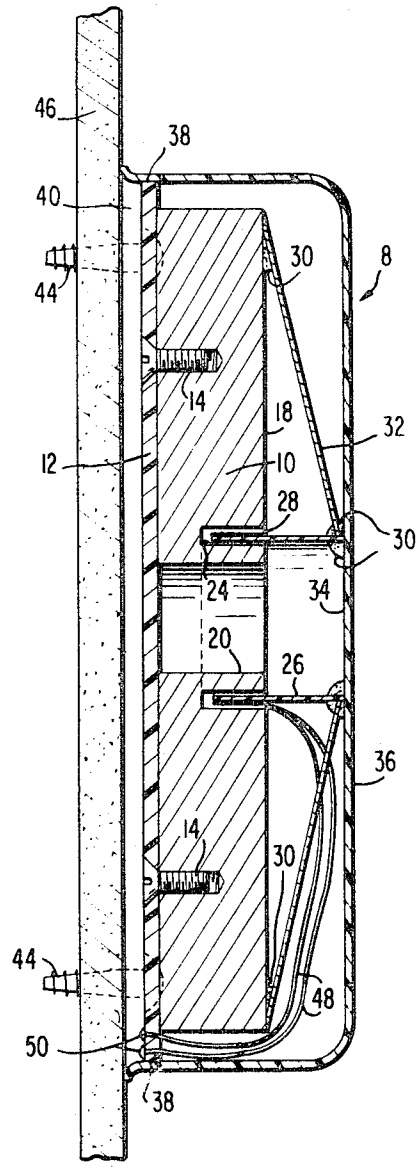
[57] **ABSTRACT**

An electroacoustic transducer including a drive coil mounted within the airgap of an annular permanent magnet. The drive coil is connected to the transducer case which in turn is attached to a suitable support structure such as a wall or ceiling. Electrical signals within the drive coil cause it to move, and this vibration is transmitted to the support structure which then acts as a sounding surface for the transducer.

6 Claims, 3 Drawing Figures



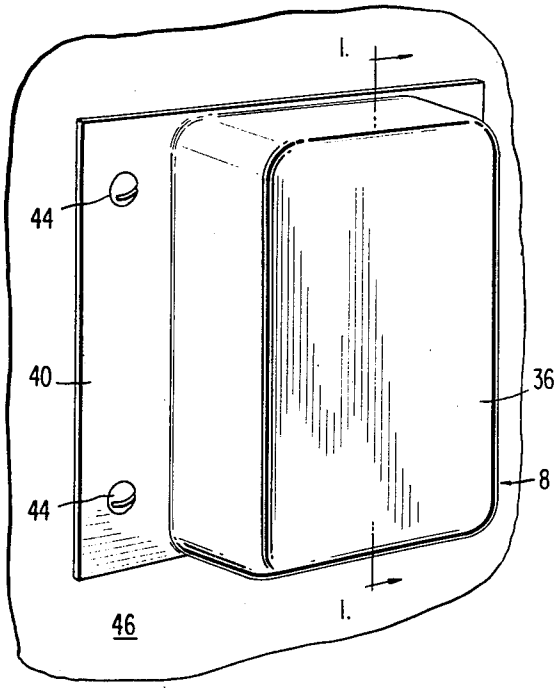


FIG. 2

FIG. 1

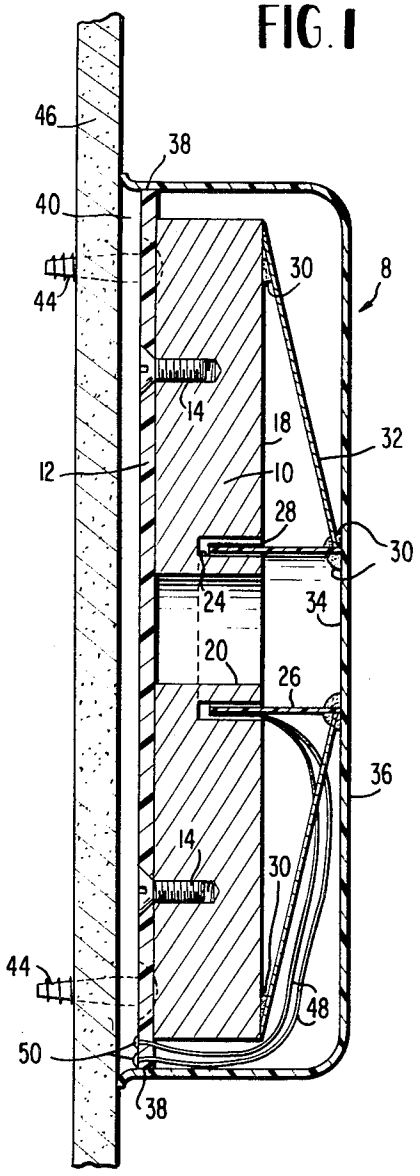
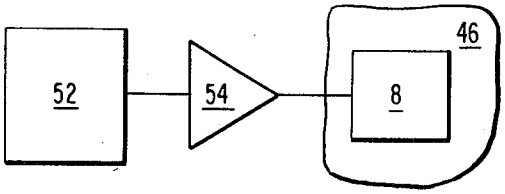


FIG. 3



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LOUDSPEAKER USING WALL AS DIAPHRAGM

The present invention pertains to an electroacoustic transducer. More particularly, the present invention pertains to an electroacoustic transducer suited particularly for use as a loudspeaker and designed for mounting on a wall or other suitable structure to cause that wall to serve as a sounding surface operating in sympathetic vibration with the speaker drive coil, thereby reproducing the desired sounds without a speaker diaphragm.

Numerous applications exist in which it is desired to provide a loudspeaker in an area unsuited for conventional horn or cone speakers. Thus, for example, in many offices and stores it is desired to provide background music or a paging system for the workers and customers. In such locations it is frequently undesirable or even impossible to utilize conventional horn or cone speakers. Horn speakers are not always aesthetically suited for such applications, while structural components such as beams, laths and wire screens interfere with the mounting of cone speakers within walls or ceilings. It is often desired to use a loudspeaker out of doors, for example for a paging system in an automobile sales lot. Conventional horn and cone speakers are unsuited for such applications because they cannot withstand exposure to the outdoors weather conditions.

There recently has been developed a speaker comprising a drive coil mounted within a permanent magnet, with the drive coil coupled directly to a screw or other suitable means which is then inserted into a wall upon which the speaker assembly is mounted. As the drive coil vibrates in response to current through the coil, the direct coupling causes the adjacent wall to vibrate and to serve as a sounding surface for the speaker, thereby eliminating the requirement for a speaker cone or diaphragm. Such speakers suffer from several shortcomings. Since the drive coil is directly mounted to the wall by a single screw or coupling member, considerable stress is put on that coupling member during the operation of the speaker. Because the drive coil is rigidly coupled to the screw which is then rigidly coupled to the adjacent wall, such speaker assemblies have a relatively limited frequency range, typically in the order of 300 to 8,500 Hz. In addition, it has been found that such speakers generally do not have a flat frequency response, but instead the frequency response curve of such speakers includes several peaks and valleys. Furthermore, the sound from such speaker is primarily projected over a relatively small angle. Thus the speaker output can not be readily heard over a very large area.

The present invention is an electroacoustic transducer or loudspeaker assembly suited for attachment to a wall or other mounting surface to utilize that surface as a sounding surface which reproduces the sounds in accordance with the current applied to the speaker drive coil. An annular permanent magnet is mounted to a suitable base member. A drive coil within an airgap in the magnet has its outer end connected to the inner surface of a suitable case which is in turn mounted to a wall or other support structure at a plurality of locations, for example by screws. As the audio output of an amplifier is applied to the drive coil, it moves, causing the outer case to vibrate. This vibration is transmitted to the adjacent support structure which serves as a sounding surface to reproduce the sounds in accordance with the audio amplifier output. Since the drive coil is directly coupled to the relatively light case, this speaker assembly has a relatively wide frequency range. In addition, the coupling of the drive coil to the adjacent structure through the case reduces the stress on the connecting screws, thereby increasing the life of the speaker assembly. It has been found that speaker assemblies in accordance with this invention have a substantially flat frequency response curve which for example, might extend from 100 to 13,000 Hz. The sealed case provides protection from ambient conditions, thereby rendering the speaker suitable for outdoor installation. The resulting speaker is compact and light weight and can withstand high shock, for example an impulse in the order of a 75 g. shock. Since the entire support structure reproduces the sound, the sound is projected over 180° and can be readily heard over a large area.

These and other aspects and advantages of the present invention are apparent in the following detailed description and claims, particularly when considered in conjunction with the accompanying drawings. In the drawings:

FIG. 1 is a vertical sectional view of a transducer assembly in accordance with the present invention and is taken along line 1—1 of FIG. 2;

FIG. 2 is a perspective view of a transducer assembly in accordance with the present invention mounted upon a suitable support structure; and

FIG. 3 is a block diagram depicting operation of the present invention.

As depicted in FIG. 1, electroacoustic transducer **8** includes an annular permanent magnet **10** of conventional design, mounted to a base member **12** by suitable means such as screws **14** which mate within tapped openings in magnet **10**. Base member **12** might be a molded plastic, for example. Annular magnet assembly **10** includes an annular groove or airgap **24** on the surface **18** thereof opposite base member **14** and encircling central opening **20** of annular magnet assembly **10**.

Tubular coil support **26** is centered within airgap **24** and has a multiturn drive coil **28** wrapped about its first end which is within the airgap. The outer end of support **26** is connected by suitable means **30** such as glue to centering member **32** which attaches to the periphery of magnet **10** on the surface **18** thereof opposite base member **14**, likewise for example by glue **30**. Centering member **32** provides substantially no support for coil support **26** but only serves to center support **26** within annular airgap **24**.

The outer end of coil support **26** is also connected by the means **30** to the inner surface **34** of case member **36** which for example might be a molded plastic case. Case member **36** is connected to base member **12** at the periphery **38** thereof by suitable means such as an epoxide resin glue, and so all the components of transducer **8** are enclosed by case member **36** and base member **12**, providing protection against ambient weather conditions. Case member **36** flares outwardly from base **12** to form flange surfaces **40**. A number of openings are provided through the flanges **40** to accommodate suitable means for mounting transducer **8** to an adjacent support structure such as a wall or ceiling. Thus, as illustratively depicted in the figures, four openings are provided, through each of which a screw **44** is inserted to couple the transducer assembly to the adjacent support structure **46**. The two ends of drive coil **28** are coupled by means of wires **48** to terminals **50** on the exterior of base member **12** to permit attachment of drive coil **28** to the output of a suitable audio amplifier.

Transducer assembly **8** is mounted to a supporting surface **46** as depicted in FIG. 2, and drive coil **28** is connected to an appropriate audio amplifier output by means of terminals **50** and wire lines **48**. As the amplifier output causes current fluctuations within drive coil **28**, the drive coil moves axially with respect to permanent magnet **10**. As a result coil support **26** moves laterally to cause case member **36** to vibrate. This vibration is transmitted to flanges **40** and in turn is coupled by means of flanges **40** and screws **44** to the adjacent support structure **46**. As a consequence, the support structure vibrates in accordance with the audio signal applied to drive coil **28**, and serves as a sounding surface for the speaker. Low- and middle-frequency vibrations are made audible by support structure **46**. High-frequency vibrations are made audible by case member **36**, and so the loudspeaker system has a higher upper frequency limit than would be possible if only support structure **46** were utilized to make the vibrations audible, for example an upper frequency limit in the order of 13,000 Hz. Since the vibrations are transmitted to wall structure **46** by the several screws **44**, no one screw is subjected to excessive stress. The damping provided by base member **12** results in the speaker having a relatively low lower frequency limit, typically in the order of 100 Hz.

FIG. 3 depicts operation of the electroacoustic transducers of the present invention. A sound source **52** is connected to

the input of amplifier **54** which has its output connected to transducer **8**. By way of example sound source **52** might be a microphone for a paging system or a source of music such as a radio, a record changer, or a magnetic tape playback head. Signals from source **52** are amplified by amplifier **54** which applies them to speaker **8** via terminals **50**. Speaker **8** makes the sounds audible, utilizing sounding surface **46**.

What is claimed is:

1. An electroacoustic transducer comprising:

enclosure means including:

a unitary case member having a planar surface, each edge of the planar surface flared to form a side surface extending transverse and substantially at right angles with the planar surface and having a first edge opposite the junction of the side surface and the planar surface and lying in a plane substantially parallel with the plane of the planar surface and having second and third edges transverse the planar surface, each side surface extending in the same direction from the planar surface, the second edge of each side surface smoothly joined to the third edge of an adjacent side surface, the first edge of each side surface flared to form a flange surface, all flange surfaces lying in the same plane substantially parallel with the plane of the planar surface and adapted for attachment to a supporting surface;

a planar base member lying in a plane substantially parallel with the plane of the planar surface and joined to the side surfaces to define an enclosed area;

the enclosed area having therewithin:

a. magnet means connected to said base member and including an airgap;

b. coil means;

c. connecting means for connecting said coil means to an electronic amplifier; and

d. coil support means having a first end with said coil means attached thereto and having a second end;

said coil support means movably supporting said coil means within the airgap of said magnet means;

said coil support means second end connected to the planar surface at substantially the center thereof to enable the planar surface, said coil support means and said coil means to move together with respect to said base member and said magnet means;

whereby when the flange surfaces are attached to a supporting surface and said connecting means is connected to an electronic amplifier to cause audio frequency electrical signals to flow through said coil means within the airgap, corresponding audio frequency vibration signals are caused in the planar surface, said flange surfaces and the supporting surface, with the planar surface providing audio reproduction of higher audio frequency signals and the supporting surface providing audio reproduction of lower audio frequency signals.

2. A transducer as claimed in claim **1** further comprising means for locating said coil support means with said coil means centered within said airgap.

3. A transducer as claimed in claim **2** further comprising a plurality of attachment means and a supporting surface having said enclosure means case member flared surface attached thereto by said plurality of attachment means.

4. A transducer as claimed in claim **3** further comprising a sound source and an electronic amplifier having an input connected to said sound source and having an output connected to said connecting means.

5. A transducer as claimed in claim **4** in which said sound source is a microphone.

6. A transducer as claimed in claim **4** in which said sound source is a music source.

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