

[54] **ELECTRET EARPHONE**

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[22] Filed: **Oct. 4, 1973**

[21] Appl. No.: **403,573**

[52] **U.S. Cl.** **179/111 E; 307/88 ET**

[51] **Int. Cl.** **H04r 19/00**

[58] **Field of Search** **179/111 E, 111 R, 106; 307/88 ET**

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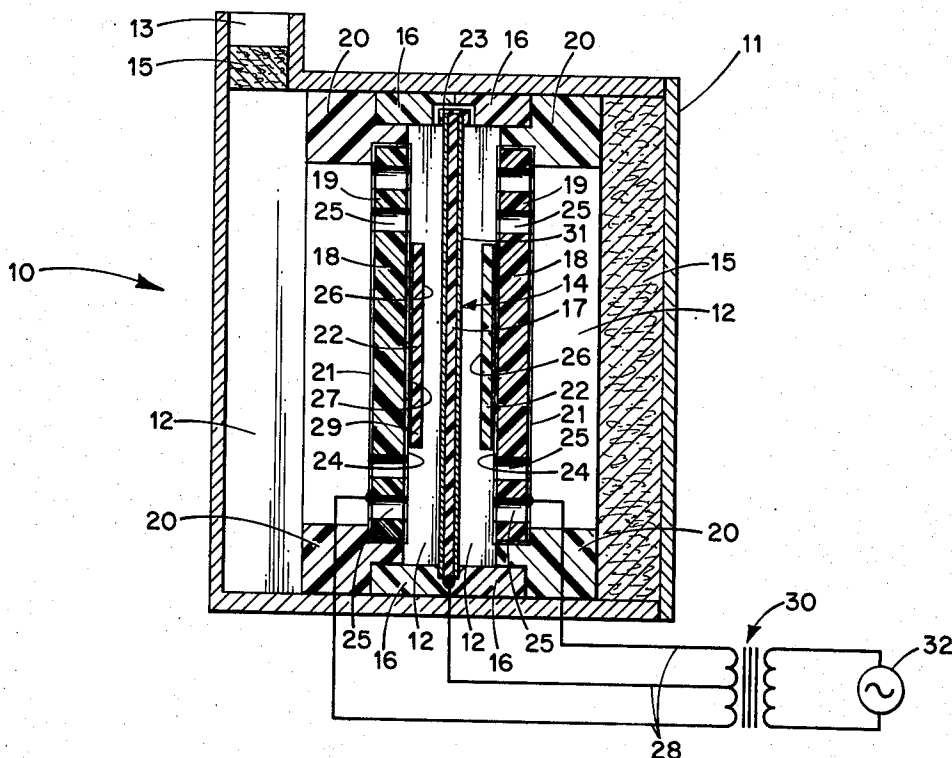
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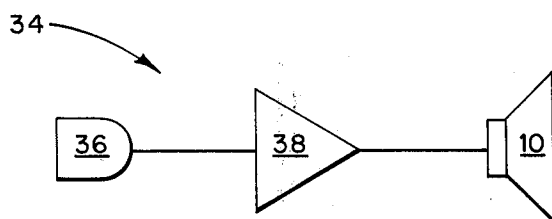
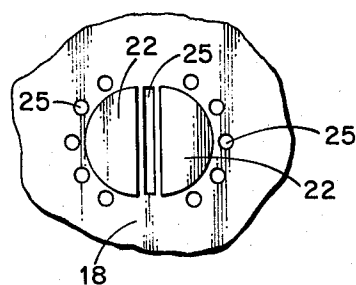
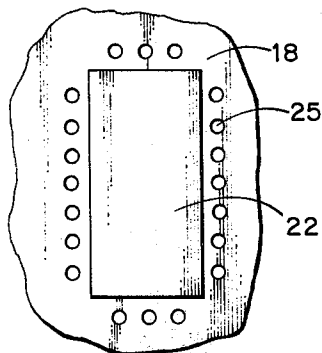
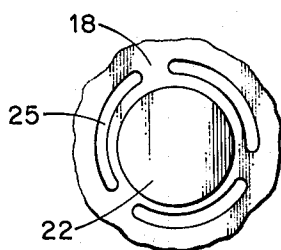
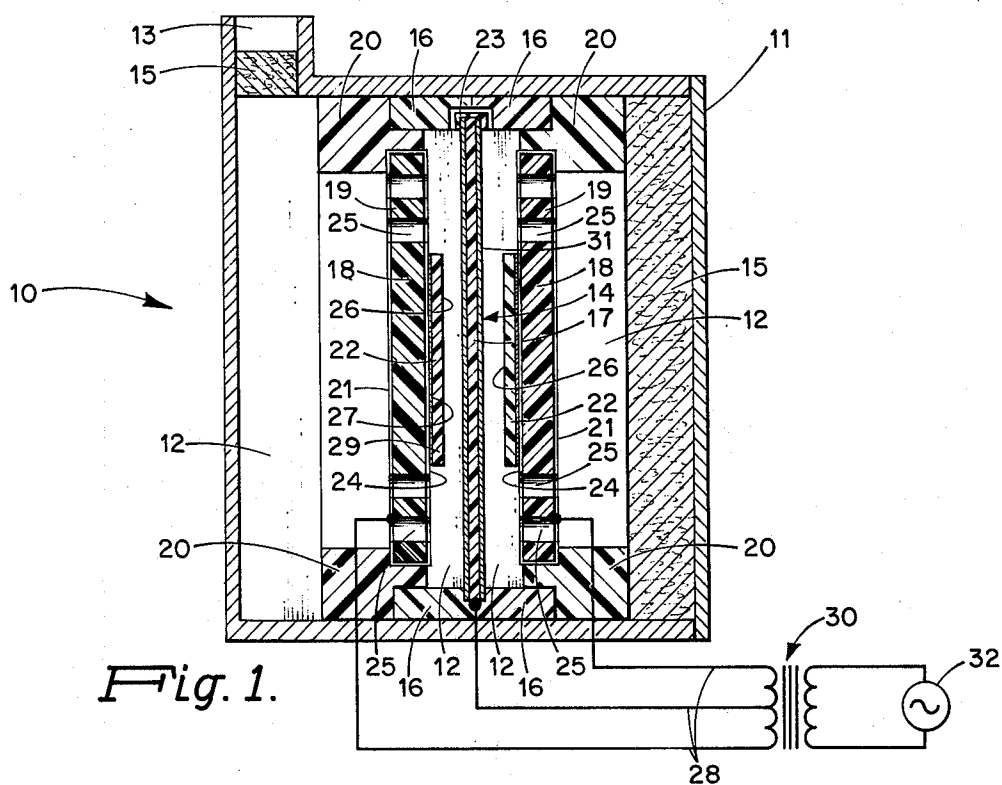
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ABSTRACT

A push-pull electrostatic transducer employs impermeate electret elements affixed to the surface of rigid vented backplates mounted on opposite sides of a conductive diaphragm.

11 Claims, 5 Drawing Figures





ELECTRET EARPHONE

BACKGROUND OF THE INVENTION

The bias necessary to obtain satisfactory linearity in an electroacoustic transducer can be provided by an electret, either as a diaphragm or as part of a fixed electrode. When the displacement of the diaphragm is substantial, linearity of operation is further enhanced by the push-pull mode of operation.

One problem encountered with electrets is that they degrade, or lose their charge with time, under the stresses of manufacturing processes or during normal operation. Polarization stability of electrets may be controlled by the choice of manufacturing process, materials, structure, or a combination thereof.

SUMMARY OF THE INVENTION

The invention pertains to electroacoustic electret transducers and particularly to a combination of fixed and vibrating elements as employed in earphones and the like. The general object of this invention is by structural improvement to extend the useful life of the electret elements and to simplify the construction of acoustic devices employing electret elements.

The invention incorporates imperforate electret elements attached to the surface of rigid vented backplates mounted on opposite sides of a conductive diaphragm. The invention has the following specific objects:

1. To maximize electrical discharge pathlengths on the exposed dielectric surface of the electret elements;
2. To simplify assembly procedure; and
3. To eliminate degradation of the electret elements due to perforation during the manufacturing process.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional plane view of a preferred embodiment of the electret earphone of this invention.

FIGS. 2a) through 2c) show a plane view of a number of preferred embodiments of electret elements on suitable backplates.

FIG. 3 is a schematic of the earphone of FIG. 1 embodied in a hearing aid.

DETAILED DESCRIPTION OF THE DRAWINGS

The invention will be described in detail referring to FIG. 1. An earphone 10 includes a casing 11 which forms acoustic chambers 12. An acoustic port 13 is provided for sound output. A sound absorbing material 15 fills a portion of the acoustic chambers 12 to provide acoustic damping and protection against dust intrusion. Within the casing 11, a conductive diaphragm 14 is tautly suspended by elements 16. On each side of the diaphragm 14, an electrically conductive backplate 18 is mounted and isolated from the casing 11 by elements 20. A film electret element 22 is affixed to the inner surface 24 of backplate 18. Acoustic passages 25 in the backplates 18 are provided at locations not obstructed by electret elements 22. A capillary 23 equalizes pressure between acoustic chambers 12. A surface 26 of the electret 22 faces the diaphragm 14. The diaphragm 14 and electrets 22 are electrically insulated from one another by elements 16 and 20. Conductors 28 connect the backplates 18 and the diaphragm 14 to a representative push-pull network 30, shown schematically. The network 30 is connected to a signal source 32.

Operation of the apparatus of FIG. 1 will now be described. A signal from the source 32 is received through the push-pull network 30 via conductors 28 connected to the diaphragm 14 and the electrodes 18. At the electrets 22, the signal is biased by the persisting field in the electrets 22. The signal causes a time-varying electric field to develop between the electrets 22 and the diaphragm 14 which induces the diaphragm 14 to vibrate. The vibration induces sound waves in the acoustic cavity 12. The resultant sound passes through the acoustic port 13.

In a preferred embodiment, the dimensions of the earphone 10 are approximately 10 mm in length by 10 mm in width by 5 mm in depth. The earphone 10 as shown has a metal casing 11. The casing 11 may be plastic if no electrostatic shielding is required or size is not a constraint.

The diaphragm 14 is the sole vibratile element. It is typically 6 microns in thickness and is a plastic film 17 with metallized surfaces 31. Other materials may be used so long as the diaphragm 14 is electrically conductive and sufficiently flexible.

The electret elements 22 are dielectric films typically 10 microns to 25 microns in thickness. A thin electrically conductive backing 27 on the dielectric base 29 of the electret element 22 assures good electrical contact between the electret element 22 and the backplate 18. The electrets 22 are bonded to the backplates 18 by an appropriate adhesive. The spacing between the electrets 22 and the diaphragm 14 may vary depending on the desired acoustic and electrical characteristics. The electret 22 is characterized by a persistent electrostatic charge. The dominant component of the charge, called the homocharge, resides on or near surface of the electret 22. Since the planar electret 22 has no perforations, the ratio of surface area to perimeter length is relatively high, and the electrical discharge path along the surface to any edge is maximized. Several preferred shapes of electrets 22 are shown in FIGS. 2a through 2c. The acoustic air passages 25 in the backplates 18 may be of various shapes and sizes as shown in FIGS. 2a through 2c. More than one electret 22 may be bonded to each backplate 18 as shown in FIG. 2c in order to permit the central location of the air vents 25 and to shape the vibration characteristics of the diaphragm 14.

An electrically conductive backplate having thermal expansion characteristics closely matching those of the electret element affixed thereto is desirable in order to inhibit deterioration of the electret element caused by thermally induced stress. This is accomplished in the backplates 18 by providing a plastic base 19, which has thermal expansion characteristics matching those of the electrets 22, with an electrically conductive coating 21 less than one micron in thickness. A gold coating of 0.06 microns is suitable. Such a coated backplate has essentially the thermal expansion characteristics of the uncoated plastic. Likewise an electrically conductive backing 27 less than 0.15 microns thick on the electret elements 22 does not have a substantial adverse effect on the thermal expansion characteristics of the electret elements 22. If the backplates 18 are not electrically conductive or do not have electrically conductive surfaces 21, electrical connections 28 must be made directly to the electret elements 22.

FIG. 3 illustrates an embodiment of the invention in a hearing aid 34. A microphone 36 is connected to an

appropriate amplifying means 38. The output is connected to the earphone 10 embodying the invention.

The invention herein described has the following advantages:

1. the electrical discharge pathlengths along the surface of the electrets are maximized so that deterioration of the electret is impeded;
2. the assembly procedure has been simplified by avoiding the necessity of critical alignment of elements with holes or the formation of holes in the electret during or subsequent to assembly, and correspondingly
3. deterioration of electrets induced by the manufacturing process is eliminated.

While the invention has been described with respect to the details of a specific embodiment thereof, many changes and variations will be apparent to those skilled in the art, and such can obviously be made without departing from the scope of the invention.

Having thus described the invention, what is claimed is:

1. An electroacoustic transducer comprising:
 - a thin, substantially flexible electrically conductive diaphragm;
 - a pair of rigid backplates positioned on opposite sides of said diaphragm;
 - a separate imperforate electret bonded to each said backplate along the surface thereof confronting said diaphragm, each said electret being imperforate to provide a single continuous surface uninterrupted by perforations, thereby to maximize the ratio of surface area of perimeter length;
 - each said backplate being vented at locations not obstructed by the electret bonded thereto;
 - said diaphragm and each of said electrets being electrically insulated from one another;
 - means for supporting said diaphragm between said electrets with sufficient clearance for said diaphragm to vibrate; and
 - means for electrically connecting individually to said diaphragm and to each of said electrets.
2. An electroacoustic transducer as defined in claim 1, wherein said electrets are substantially circular.
3. An electroacoustic transducer as defined in claim 1, wherein said device is a receiver.
4. An electroacoustic receiver as defined in claim 3, wherein said device is an earphone.
5. An electroacoustic receiver comprising:
 - a thin, substantially flexible electrically conductive diaphragm;
 - a pair of rigid electrode backplates positioned on opposite sides of said diaphragm;
 - a separate imperforate electret bonded to and covering a portion of each of said electrode backplates along the surface thereof confronting said diaphragm, each said electret being imperforate to provide a single continuous surface uninterrupted by perforations, thereby to maximize the ratio of surface area to perimeter length;
 - each of said imperforate electrets being substantially planar and having a ratio of the longest line along the surface which would pass through the center of gravity to the shortest line along the surface which would pass through the center of gravity not exceeding three;
 - each said electrode backplate being vented for acoustic airflow at locations not obstructed by the electret bonded thereto;

said diaphragm and each of said electrets being electrically insulated from one another;

means for supporting said diaphragm between said electrets with sufficient clearance for said diaphragm to vibrate; and

means for electrically connecting individually to said diaphragm and to each of said electrets.

6. An electroacoustic receiver as defined in claim 5, wherein said electrets are substantially circular.

7. An electroacoustic receiver as defined in claim 5, wherein said device is an earphone.

8. A hearing aid comprising:

microphone means;

amplifier means;

push-pull driving means;

an electrostatic receiver comprising:

a casing;

acoustic ports;

a thin, substantially flexible electrically conductive diaphragm;

a pair of rigid backplates positioned on opposite sides of said diaphragm;

a separate imperforate electret, each said electret being imperforate to provide a single continuous surface uninterrupted by perforations, thereby to maximize the ratio of surface area to perimeter length;

said backplates being vented at locations not obstructed by said electrets;

said diaphragm and each of said electrets being electrically insulated from one another;

means for supporting said diaphragm between said electrets with sufficient clearance for said diaphragm to vibrate; and

means for electrically connecting individually to said diaphragm and to each of said electrets.

9. An electroacoustic transducer comprising:

an electrically conductive vibratile diaphragm;

a pair of rigid backplates positioned on opposite sides of said diaphragm, said backplates having plastic bases with an electrically conductive coating thereon, said coating not exceeding one micron in thickness;

a separate imperforate electret bonded to each said backplate along the surface thereof confronting said diaphragm, each electret comprising an electrically non-conductive member having thermal expansion characteristics similar to the thermal expansion characteristics of said base and being imperforate to provide a single continuous surface uninterrupted by perforations, thereby to maximize the ratio of surface area to perimeter length, an obverse surface of said member confronting said diaphragm, an electrically conductive backing on the reverse surface of said member, said backing bonding said member to said backplate in surface to surface contact, each said electret and its associated backplate having similar thermal expansion characteristics;

each said backplate being vented at locations not obstructed by the electret bonded thereto;

said diaphragm and each of said electrets being electrically insulated from one another;

means for supporting said diaphragm between said electrets with sufficient clearance for said diaphragm to vibrate; and

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means for electrically connecting individually to said diaphragm and to each of said electrets.

10. An electroacoustic transducer as defined in claim 9 wherein said electrically conductive surface of said electret does not exceed 0.15 microns in thickness. 5

11. An electroacoustic transducer comprising:
a closed container;
a thin, substantially flexible electrically conductive diaphragm mounted at its perimeter inside said container, thereby dividing said container into two sections; 10
a pair of rigid backplates mounted inside said container on opposite sides of said diaphragm with sufficient clearance for said diaphragm to vibrate, 15

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each said backplate together with the walls of said container forming an acoustic chamber;
a separate imperforate electret bonded to each said backplate along the central portion of the surface thereof confronting said diaphragm;
said backplate having holes through it at locations surrounding said electret for providing acoustic passageways between said diaphragm and said acoustic chambers; and
an opening in said container for providing an acoustic port communicating with at least one of said acoustic chambers.

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