

[54] SUBMERSION-SAFE MICROPHONE

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[75] Inventor: George J. Sebesta, Huntington Bay, N.Y.

Primary Examiner—Thomas W. Brown
Attorney, Agent, or Firm—Richard A. Marsen

[73] Assignee: Dyna Magnetic Devices, Inc., Hicksville, N.Y.

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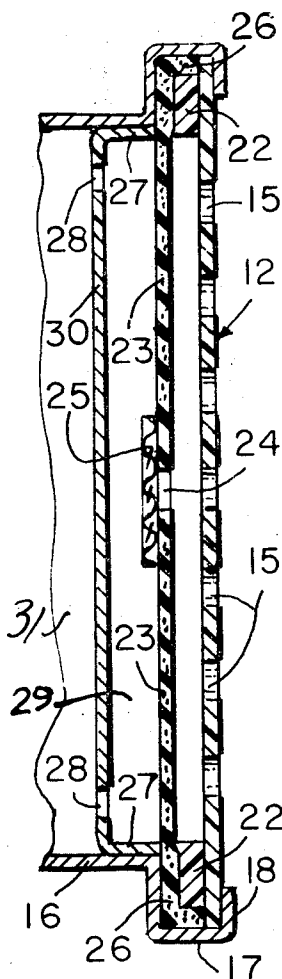
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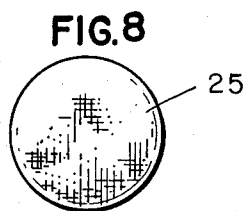
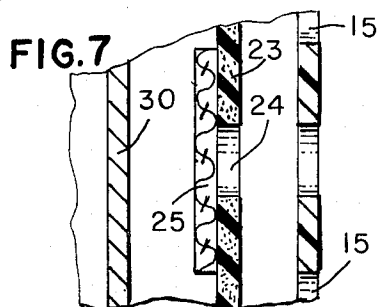
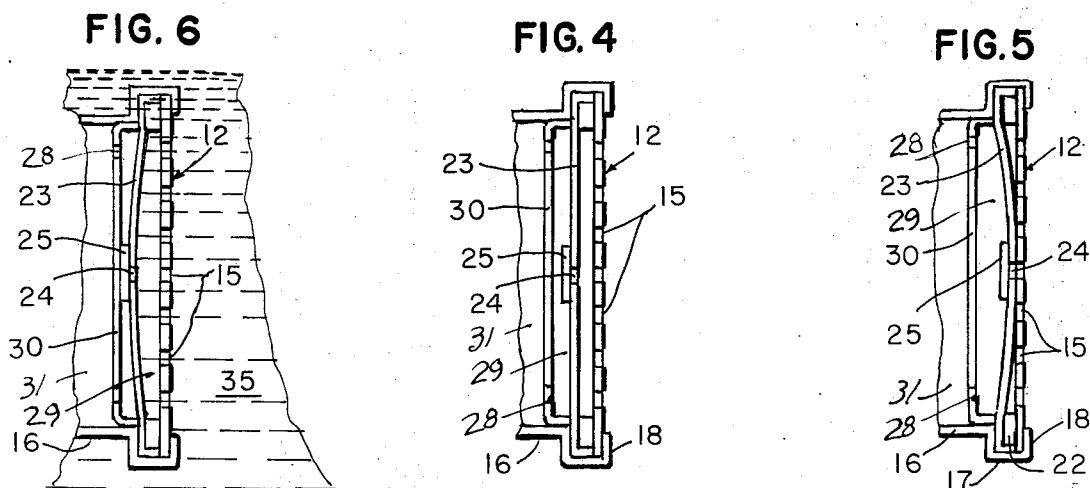
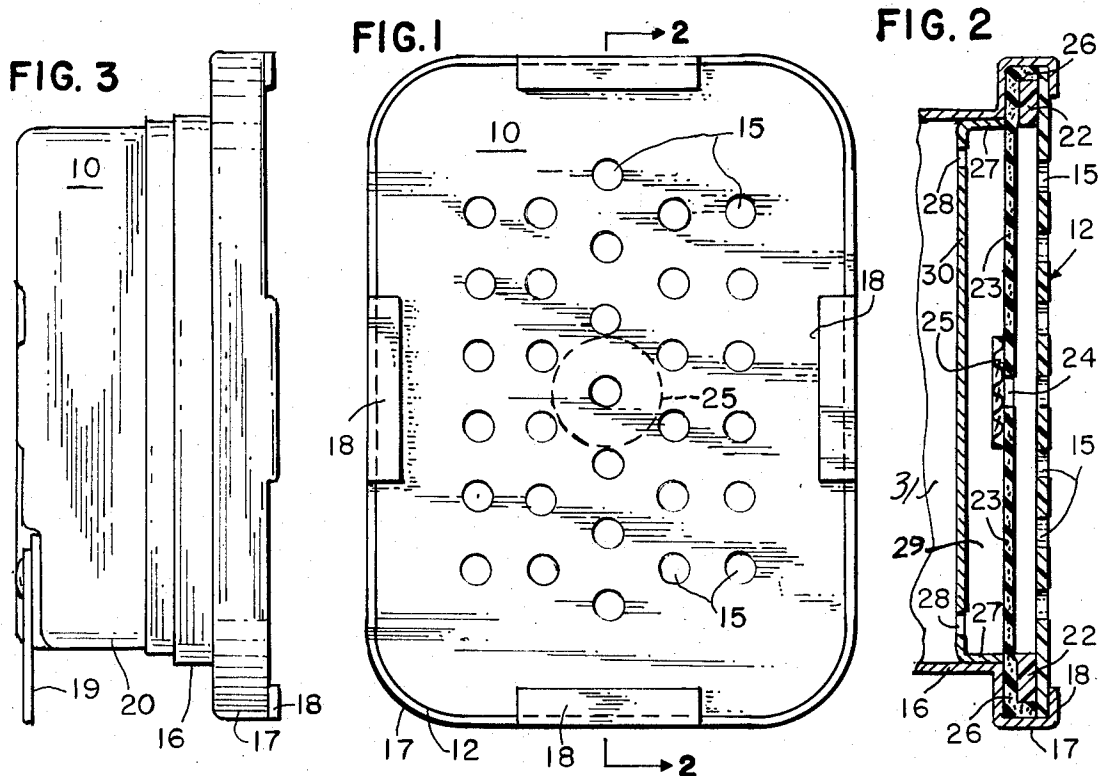
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[57] ABSTRACT

Air-conduction transducers such as microphones, earphones and loudspeakers for high humidity or high altitude environments. Further, the invention transducers are operable in up to a few feet of water. Also, when immersed to greater depths, as down to 100 feet at sea, means are incorporated therein to keep such transducers bone dry. A contained flexible barrier-diaphragm with a semi-pervious vent serves as pressure flap valve below two or three feet. The invention arrangement permits operation of the transducer up to 10,000 feet in altitude, and keeps it safe up to 50,000 feet.

6 Claims, 8 Drawing Figures





INVENTOR,
GEORGE J. SEBESTA

BY *Richard A. Mason*
ATTORNEY.

SUBMERSION-SAFE MICROPHONE

BACKGROUND AND SUMMARY OF THE INVENTION

Conventional air-conduction transducers generally become inoperative when inadvertently dipped into water, at least until they are dried again. Relatively complex arrangements have heretofore been used to maintain the mechanism in a microphone or earphone dry and operable when submerged. Such prior transducers were bulky, heavier, and of reduced efficiency. The transducer of the present invention contains a simple water barrier-diaphragm between its front grille and interior. A semi-porous disc is arranged behind a central aperture of the diaphragm. When, at say two feet depth in water, the aperture is directly shut thereby, as a flap valve, protecting the transducer and keeping it dry. The invention transducer also permits equalization of ambient air pressure variations due to altitude.

An important application of the relatively simple and effective immersion safe transducers hereof is in handheld radio survival kits for pilots. If one parachutes into a sea the microphone and/or earphone of the radio kit will not be damaged by the dunking. Air pressure equalization also occurs therein. Radio contact is assured to the pilot in distress.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a face view of a microphone embodying the present invention.

FIG. 2 is a cross-sectional view through the front part of the microphone, taken along the line 2—2 of FIG. 1.

FIG. 3 is an elevational view, of the FIG. 1 microphone.

FIG. 4 is a schematic drawing corresponding to FIG. 2 of the microphone, in a sea level environment.

FIG. 5 is a schematic drawing corresponding to FIG. 4, when the microphone is at a high altitude.

FIG. 6 is a schematic showing of the microphone when substantially submerged in water.

FIG. 7 is an enlarged cross-sectional view of the central region of the barrier control arrangement in the exemplary microphone.

FIG. 8 is a plan view of the semi-pervious disc of the invention arrangement.

DETAILED DESCRIPTION OF THE INVENTION

FIGS. 1, 2 and 3 are respective front, partial cross-sectional and side elevational views of the exemplary immersion-safe microphone 10. It is useful in a pilot's survival radio kit. It may be combined as a loudspeaker as well, or a separate one may be used therefor. The front plate-grille 12 contains apertures 15, 15 for acoustic waves into (or out of) unit 10. Housing 20 of the microphone has a rim 16 extending about the front bezel-diaphragm assembly as surround 17 which has four ears 18, 18 that are folded-over onto grille 12, held together as an integral transducer unit 10. Connection lugs 19 electrically connect into unit 10, and extend from case 20. The transducer mechanism within unit 10 may be one of a number of constructions well known in the art: for operation as a microphone, earphone, loudspeaker, or in combination.

A flexible barrier diaphragm 23 is supported just interior of grille 12 via annular spacer 22, and parallel thereto. The exemplary diaphragm 23 is a thin disc of

silicone rubber, the order of 0.005 inch thick, with an integral outer mounting ring 26. An aperture 24 is centrally of diaphragm 23. A disc 25 of semi-pervious material overlies aperture 24 on the interior side opposite to grille 12. Disc 25 permits gas to pass through it, yet becomes a closure valve by the action of water pressure on its arrangement herein as will be set forth. Towards this end a bezel-diaphragm 30 of solid material is mounted somewhat spaced from flexible diaphragm 23, and parallel to it, through an integral annular rim 27 attached with housing section 16. Two spaced apertures 28, 28 are set in diaphragm 30, to permit ready acoustic transfer into the transducer 10 interior, at the left in FIG. 2 for the microphone mode; or from it into space 29, towards diaphragm 23 and grille 12 in the loudspeaker mode.

The semi-pervious "bleeder" disc 25 is shown enlarged in FIGS. 7 and 8. In an exemplary transducer 10 of the order of 1 inch in diameter, disc 25 is the order of 0.20 inch in diameter and made of 0.007 inch stock. The exemplary disc is a filter type material with a surface that resists wetting by water while readily letting gases as air through. A practical material for the bleeder disc (25) hereof is called "Aqualap," a Trademark of its manufacturer Millipore Corporation, Bedford, Massachusetts.

FIG. 4 is a schematic diagram per FIG. 2, corresponding to sea-level operation. The transducer mechanism (not shown) is in compartment 31 within unit 10, as aforesaid. In the microphone mode sound waves enter unit 10 via apertures 15 of grille 12. They pass through central aperture 24 in flexible diaphragm 23, through semi-pervious disc 25, and into inter-diaphragm region 29. The acoustic waves cause corresponding pressure variations in region 29. Such acoustic pressure variations are transmitted to the sensitive microphone mechanism within unit 10 across apertures 28, 28 and into region 31, as will now be understood by those skilled in the art. The contained microphone type may be electromechanical, carbon granules, crystal, ceramic bar, and the like. It is electrically connected to the exterior by lugs 19.

Such operation of the transducer 10 occurs practicably while immersed even in three feet of water. The flexibility of diaphragm 23 is maintained therefor, and the disc 25 has not yet contacted plate 30. The water repelling surfaces of disc 25 together with barrier-diaphragm 23 keep the transducer interior of region 31 bone dry. The casing 20 and rim 17 are properly bonded and sealed. If a loudspeaker or ear-phone device is in unit 10 at region 31, the sound generated therein varies the air pressure thereat correspondingly, which in turn conducts through apertures 28, 28 to vibrate diaphragm 23 and also pass through disc 25 and aperture 24, with the so transmitted sound passing through the grille (12).

The transducer 10 operates satisfactorily at altitudes up to the order of 10,000 feet. At such altitudes the diaphragm 23 flexes outwardly, towards the right in FIGS. 4, 5. It is not pressed onto grille 12 at 10,000 feet, and remains operative as aforesaid. At higher altitudes the diaphragm becomes too stretched to function as a sound carrier, and in effect freezes against grille 12 as shown in FIG. 5. The exemplary transducer 10 safely withstands altitudes up to 50,000 feet, and higher. The semi-permeable bleeder disc 25 and bleeder hole 24 together provide relief for normal changes in atmo-

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spheric pressure. This function prevents acoustic rectification by which the sealing membrane 23 is drawn to an extreme excursion per FIGS. 5 or 6, generally inwardly per FIG. 6. The air equalization occurs through the bleeder disc and hole that are proportioned to effect it under reasonable pressure changes in a few seconds; and from sea level to 10,000 feet or vice versa within 15 minutes. FIG. 5 illustrates membrane 23 against grille 12 at high altitude, before equalization.

FIG. 6 illustrates the transducer submerged in water. It is noted that the chamber region between grille 12 and barrier membrane 23 directly fill with water. The water-repellant surface of disc 25 resists water entry beyond, into region 29. At say 30 feet water level, a 15 psi overpressure occurs on membrane 23, due to the water. The Silicone diaphragm 23 is shown extended towards plate 30, with disc 25 pressed thereagainst. This action seals the aperture 24, as the pressure on disc 25 serves as a flap valve. The depth of its closure is determined by the design parameters of the membrane 23, its relative position from plate 30, and the like, well known to those skilled in the art. The transducer 10 is not intended for operation below 3 feet; the arrangement hereof serving to maintain its interior dry for direct operation at the design ambient conditions. The transducer 10 may be safely submerged to 100 feet; at the deeper locations membrane 23 is pressed to seal even apertures 28,28.

I claim:

1. An acoustic transducing system comprising a housing, a flexible water impermeable membrane arranged across an acoustic opening in the housing, a gas-pervious member that is water-repellent attached to said membrane across an aperture thereof whereby acoustic pressure variations normally pass through said

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aperture and member, and a plate arranged between said membrane and an electro-acoustic transducer contained within said housing, said plate having a hole through which acoustic pressure variations are transmitted, the hole in said plate being positioned away from the location of the membrane aperture, whereby effective acoustic transducing action is maintained between the transducer and the opening of the housing through the membrane aperture with attached member and the plate hole while the system is submerged down to a predetermined level in water, said membrane being pressed against said plate when the system is submerged below said level to effect a water seal at its aperture and member and thereby protect the transducer therein.

2. A transducing system as claimed in claim 1, in which both said membrane and said plate extend across the housing, and thereby maintain its interior dry when the said water seal is effected by the membrane and plate.

3. A transducing system as claimed in claim 1, further including an acoustic grille at one end of said housing, being set adjacent to said membrane.

4. A transducing system as claimed in claim 3, in which said grille is generally parallel to said membrane and spaced therefrom, whereby the membrane is pressed against the grille when the system is above a predetermined altitude.

5. A transducing system as claimed in claim 1, in which said member and its companion aperture are arranged centrally on the membrane.

6. A transducing system as claimed in claim 2, in which said member and its companion aperture are arranged centrally on the membrane.

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