United States Patent [19]

Fischer et al.

[11] **3,777,079**

[45] **Dec. 4, 1973**

[54] **DIRECTIONAL MICROPHONE FOR HEAD MOUNTED MIDGET HEARING AIDS**

[75] Inventors: **Detlef Fischer; Johannes G. A. Wittkowski,** both of Hamburg, Germany

[73] Assignee: **Willco-Horgerate Med. Apparatebau G.m.b.H.,** Hamburg, Germany

[22] Filed: **Oct. 21, 1971**

[21] Appl. No.: **191,404**

[52] **U.S. Cl.** ..... **179/121 D,** 179/1 DM, 179/179, 179/107 S

[51] **Int. Cl.** **H04r 1/22**

[58] **Field of Search** ..... 179/121 D, 115.5 R, 179/178, 179, 180, 1 DM; 181/31 R

[56] **References Cited**

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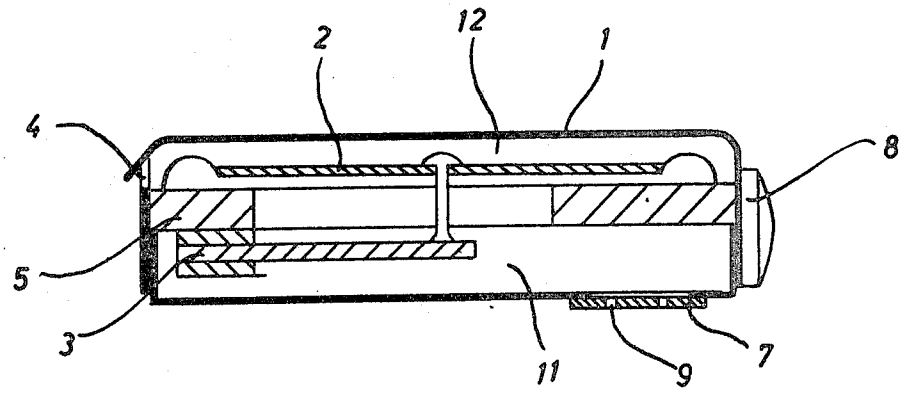
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Primary Examiner—Kathleen H. Claffy
Assistant Examiner—Thomas L. Kundert
Attorney—H. Dale Palmatier

[57] **ABSTRACT**

A miniature microphone for a head-mounted midget hearing aid wherein the diaphragm divides the microphone housing into two separate chambers, the housing having a forward portion with a sound admitting aperture therein which is substantially non-restrictive to passage of sound waves therethrough so that the sound waves may freely enter one of the chambers within the housing; the microphone housing also having a wall portion at the rear of the microphone, said wall portion having a plurality of minute apertures therethrough and defining a transmission time delaying acoustic resistance admitting sound pressure variations into the other chamber of the housing.

1 Claim, 8 Drawing Figures



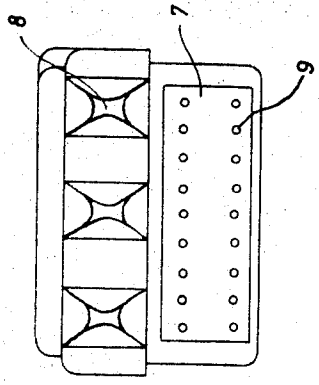


Fig.2

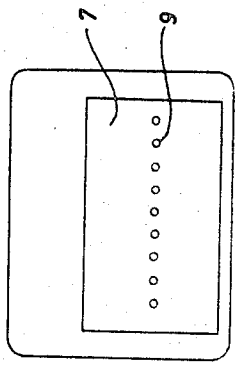


Fig.4

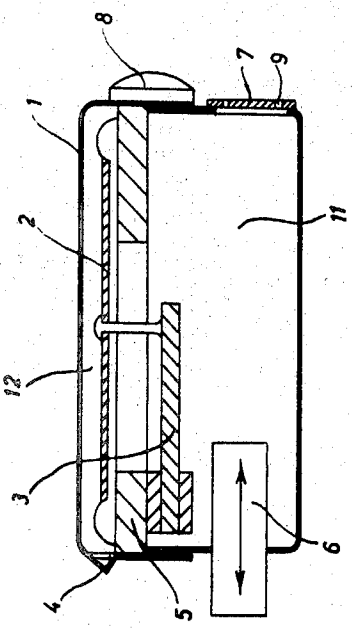


Fig.1

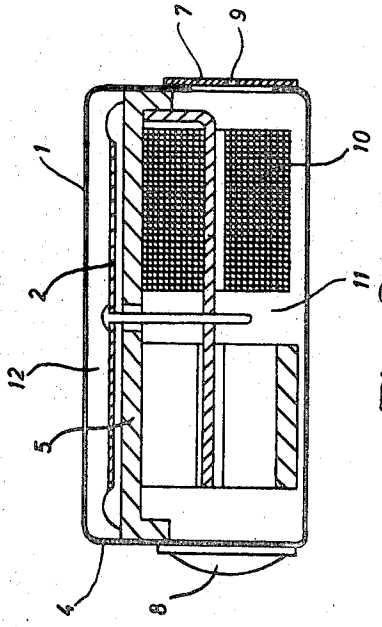


Fig.3

INVENTORS
JOHANNES G.A. WITTKOWSKI
BY DETLEF FISCHER
H. Dale Palmatier
ATTORNEY

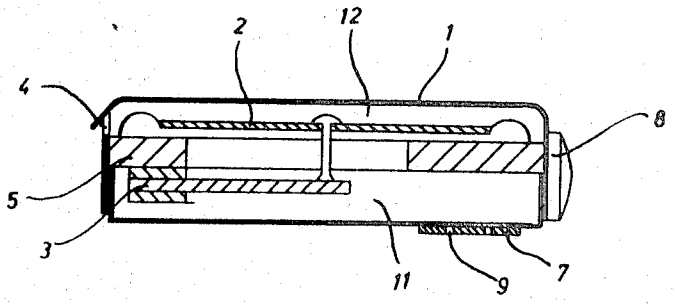


Fig.5

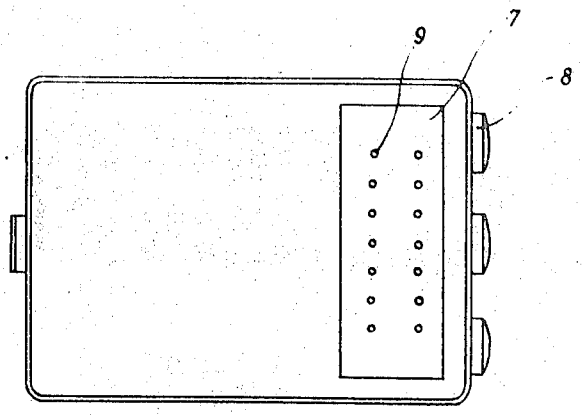


Fig.6

INVENTORS
JOHANNES G.A. WITTKOWSKI
BY DETLEF FISCHER
ATTORNEY

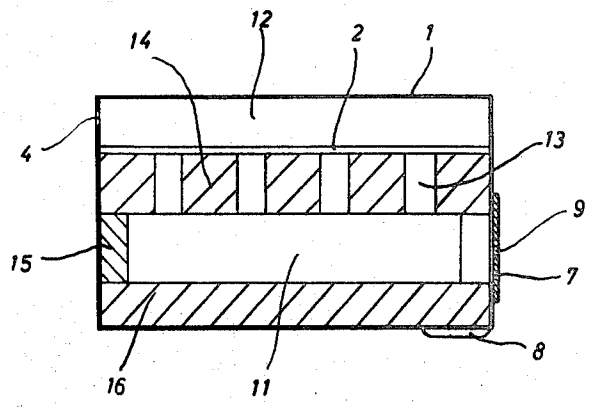


Fig.7

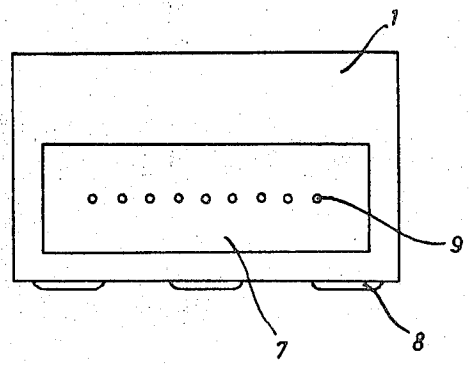


Fig.8

INVENTORS
JOHANNES G.A. WITTKOWSKI
BY DETLEF FISCHER
H. Dale Palmatier
ATTORNEY

DIRECTIONAL MICROPHONE FOR HEAD MOUNTED MIDGET HEARING AIDS

BRIEF SUMMARY OF THE INVENTION

This invention relates to a directional microphone for head-mounted midget hearing aids comprising a casing divided by a diaphragm into two chambers, a front casing wall having an opening communicating with one of these chambers and adapted to admit sound waves impinging from the front on the casing into the one chamber, and a wall portion adjacent the rear casing wall having a transmission time delaying acoustic resistance adapted to admit sound waves impinging from the rear on the casing into the other of these two chambers.

A directional microphone of this general type is known in the German specification Ser. No. 1,277,347, which has been laid open to publication inspection. In this known directional microphone the transmission time delaying acoustic resistance is formed by a multitude of very narrow channels having relatively great lengths as compared to their diameters. This results in a phase shift of about 180 degrees when addressing the microphone from the front. When addressing the microphone exactly from the rear side thereof there occurs substantially no relative phase shift, since the acoustic resistance and associated cavity will produce a delay substantially equal to the time required for the sound waves to cover a longer path up to the front face of the diaphragm. By making use of this phase shift there is obtained an amplification when addressing the microphone from the front side, and an attenuation when addressing the microphone from the rear side. In the prior art directional microphone, the transmission time delaying acoustic resistance formed by a multitude of narrow channels consists of a block of capillary tubes assembled in a compound block. This block which may be made of a ceramic material for example may be rather difficult to manufacture. Furthermore, this block requires considerable space, and space is very scarce in head-mounted midget heating aids.

In larger directional microphones which are for general use, not in midget hearing aids, it is known to form the resistance at the rear side of the casing by a felt or a fabric having suitable openings therein. Materials of this type are unsuitable in directional microphones for midget hearing aids since with such small dimensions the resistance cannot be consistently reproduced.

It is the object of the present invention to provide a directional microphone of the above-indicated type that is of smaller dimensions than the prior art directional microphones for midget hearing aids, and which may be manufactured more economically and at less cost.

This object is achieved, in accordance with the present invention, in that the transmission time delaying acoustic resistance is formed by a plurality of small apertures in a thin wall portion adjacent the rear casing wall.

It has been found in tests that the number and the depth or length of the apertures in the wall portion adjacent the rear casing wall forming the acoustic resistance must have a predetermined relationship to each other, for a given diameter of the apertures and a given air volume of the chamber disposed at the rear side of the diaphragm.

Thus the present invention is based upon the surprising discovery that the extended channels at the rear side of the diaphragm which are found in the prior ceramic block may be replaced by a smaller number of apertures in that casing wall of the microphone which is remote from the front opening and established communication with the other chamber at the rear of the diaphragm. Merely the above-indicated relationship is critical and must be maintained in a given microphone structure. If the structure of the microphone, i.e., the outer dimensions of the microphone as well as the front opening and the air volumes in the two chambers are fixed, the optimum resistance may always be attained with alike apertures. Therefore all microphones will be of an identical structure so that the desired reproducibility in the manufacturing process is achieved.

The directional microphone of the present invention is not only of a simple structure and may be economically manufactured but is also extremely small.

According to the present invention, the apertures forming the acoustic resistance may be arranged in a discrete plate or panel which may be made of a suitable material such as stainless steel, copper, nickel or other metals or plastics. The apertures or holes in the plate may be formed by any of a number of processes such as etching or electroforming. Forming by etching may result in the holes having a tapered rather than straight shape through the thickness of the plate or panel. As far as could be established, the smallest opening size of the apertures ordinarily represents the critical and measured dimensions.

By suitable means such as a screw or an adjustable pin which may be locked in a certain position it is furthermore possible to influence the air volume in the chamber located at the rear side of the diaphragm, in order to tune the microphone or adjust for optimum performance of the directional microphone after manufacture.

BRIEF DESCRIPTION OF DRAWINGS

In the following, the invention will be explained more in detail with reference to several illustrative embodiments shown in the appended drawings wherein:

FIG. 1 is a cross-sectional view through a directional microphone according to the present invention whereby the microphone is a ceramic type microphone;

FIG. 2 is an end elevational view of the directional microphone shown in FIG. 1;

FIG. 3 is a cross-sectional view through another embodiment of a directional microphone according to the present invention wherein the microphone is a magnetic type microphone;

FIG. 4 is an end elevational view of the directional microphone shown in FIG. 3;

FIG. 5 is a cross-sectional view through a further embodiment of a directional microphone according to the present invention wherein the microphone is a ceramic type microphone, and the acoustic resistance is in the bottom wall of the casing;

FIG. 6 is a bottom plan view of the microphone shown in FIG. 5;

FIG. 7 is a cross-sectional view through a further embodiment of a directional microphone according to the invention wherein the microphone may be a condensor or electrostatic microphone; and

FIG. 8 is an end elevational view of the directional microphone shown in FIG. 7.

DETAILED DESCRIPTION OF THE INVENTION

The microphones shown in these drawings each comprise a casing or housing **1** which is divided by a diaphragm **2** having obverse and reverse sides into two chambers **11** and **12** respectively disposed adjacent the obverse and reverse sides of the diaphragm. A partition wall **5** serves to mount various components.

An opening **4** serves to admit sound waves received from the front and without restriction to the obverse chamber **12** which is disposed on the one side of the diaphragm **2.** In the illustrated form, the rear wall of the casing has a large opening which is substantially closed by a thin plate or panel **7.** Minute apertures **9** in the plate **7** serve to admit sound waves received from the rear of the casing to the reverse chamber **11** and form the transmission time delaying acoustic resistance of the microphone.

In the embodiment shown in FIGS. **1, 2** and **5, 6,** ceramic or respectively piezoelectric type microphones with a corresponding ceramic transducer **3** are used. In the embodiment shown in FIGS. **3** and **4** a magnetic microphone with a corresponding transducer **10** is used. In the embodiment shown in FIGS. **1** and **2** there is provided an adjustable device **6** for varying the air volume in the reverse chamber **11.** The device **6** may be an adjustable plunger to be moved in the direction of the arrow, or may be a screw. The device fits tightly in the casing **1** so that when originally positioned, it will remain fixed in location. The same adjustment device **6** may also be used in the microphones shown in FIGS. **3–6.**

In the embodiment shown in FIGS. **7** and **8** a condensor microphone or an electrostatic microphone is used. In these directional microphones the chambers **11** and **12** are likewise separated by a diaphragm **2.** Connecting passages **13** communicate the lower side of the diaphragm **2** with the chamber **11.** These connecting passages **13** pass through a counterelectrode **14.** A spacer ring **15** serves to maintain a desired spacing to an amplifier board **16.** The apertures **9** are here likewise formed in a discrete plate **7.**

In the various embodiments, the electrical connectors are generally designated by the reference numeral **8.**

In the following, practical examples of microphone dimensions and sizes of etched apertures **9** will be indicated.

The microphone shown in FIGS. **1** and **2** was constructed with a length of 8.4 mm, a width of 5.6 mm and a height of 4 mm. By these dimensions the air volume of the chambers **11** and **12** is substantially fixed.

An optimum performance was obtained in trials with three apertures **9** having a diameter of 0.12 mm, and a thickness of the plate **7** of 0.06 mm; or with eighteen apertures **9** having a diameter of 0.070 mm and a plate thickness of 0.07 mm.

The directional microphone shown in FIGS. **3** and **4** has a length of 8.6 mm, a width of 5.5 mm and a height of 4.1 mm. An optimum performance was obtained with nine apertures **9** having a diameter of 0.096 mm and with a plate thickness of 0.07 mm.

The still smaller microphone of the embodiment shown in FIGS. **5** and **6** in which the plate **7** with the apertures **9** is mounted at the bottom of the casing **1** had a length of 8.4 mm, a width of 5.6 mm and a height of 2.4 mm.

With the latter microphone an optimum performance in tests was obtained for fourteen apertures **9** having an aperture diameter of 0.06 mm and for a plate thickness of 0.07 mm; as well as for three apertures **9** having a mean aperture diameter of 0.092 mm and with a plate thickness of 0.07 mm.

The directional microphone shown in FIGS. **7** and **8** has a length and a width of 7 mm and a height of 4 mm. This microphone is provided with nine apertures having a diameter of 0.062 mm, and the thickness of the plate is 0.07 mm.

In all of these examples, the very thin plates are similar to metal foil. Because of the extreme thinness, and the tapered shape of the apertures due to formation by etching, the smallest dimension of each aperture is believed to be the important consideration as contrasted with the less significant material thickness or length of aperture.

It will be seen that we have provided a new and improved directional microphone for head-mounted hearing aids wherein the transmission time delaying acoustic resistance is provided by minute apertures or holes in a panel or plate forming a portion of the casing wall for admitting sound pressures to the chamber at the rear of the diaphragm.

We claim:

1. A directional microphone for head-mounted eyeglass and behind-the-ear hearing aids, comprising:

a rigid metal casing of box-like configuration, the casing having front and rear portions including rigid walls with exterior and interior surfaces and the walls defining front and rear access openings into the casing, the front access opening in the wall of the front portion providing substantially unrestricted sound access into the casing, the rear access opening in the wall of the rear portion being many times larger than required to provide sound access into the casing,

a vibratable diaphragm in the casing and dividing the interior of the casing into two chambers, said diaphragm being disposed between said access openings and restricting air communication across the interior of the casing and between said two chambers, the diaphragm being coupled to transducer means in one of the chambers to produce electric signals in response to vibration of the diaphragm, and

a discrete plate larger than said rear access opening and constructed of thin foil-like metal in contrast to the rigid metal walls of the casing, said discrete plate overlying and obstructing the entire rear access opening in the wall of the rear portion of the casing and continuously secured around the entire periphery of the plate to the exterior surface of the casing, said discrete plate having a multiplicity of minute apertures therethrough, each of said apertures having substantially the same size as adjacent apertures and each of said apertures providing open communication from the exterior of the casing and directly and linearly through the rear access opening and into the adjoining chamber within the casing, and said multiplicity of minute apertures cumulatively defining the sole acoustic resistance coordinated with the volume of the chamber between the discrete foil plate and the diaphragm to cooperatively produce a time delay for sounds entering the minute apertures to the time at which the sounds are effective for moving the diaphragm, and the peripheries of the minute apertures in the discrete foil plate being tapered in a direction through the thickness of the foil plate to minimize the effect of the thickness of the foil plate upon the resistance offered to passage of sound.

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