

[54] **MINIATURE HEARING AID STRUCTURE**

[75] Inventors: **Erwin M. Weiss**, Chicago; **Richard Brander**, Cicero, both of Ill.

[73] Assignee: **Belton Electronics Corporation**, Chicago, Ill.

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[51] Int. Cl. **H04r 25/02**

[58] Field of Search **179/107 E; 181/23**

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Primary Examiner—William C. Cooper
Assistant Examiner—Thomas L. Kundert
Attorney—Molinare, Allegretti, Newitt & Witcoff

[57] **ABSTRACT**

A hearing aid structure is provided in which all of the components of the hearing aid may be fitted within a person's ear. The structure includes a main housing for a power source and an amplifier and a microphone housing isolated from the main housing and connected to it by a deformable, flexible, skeletal structure. A receiver is compliantly connected to the main housing and an ear seal is rigidly coupled to the receiver and adapted to fit snugly into the ear canal of a person's ear.

5 Claims, 8 Drawing Figures

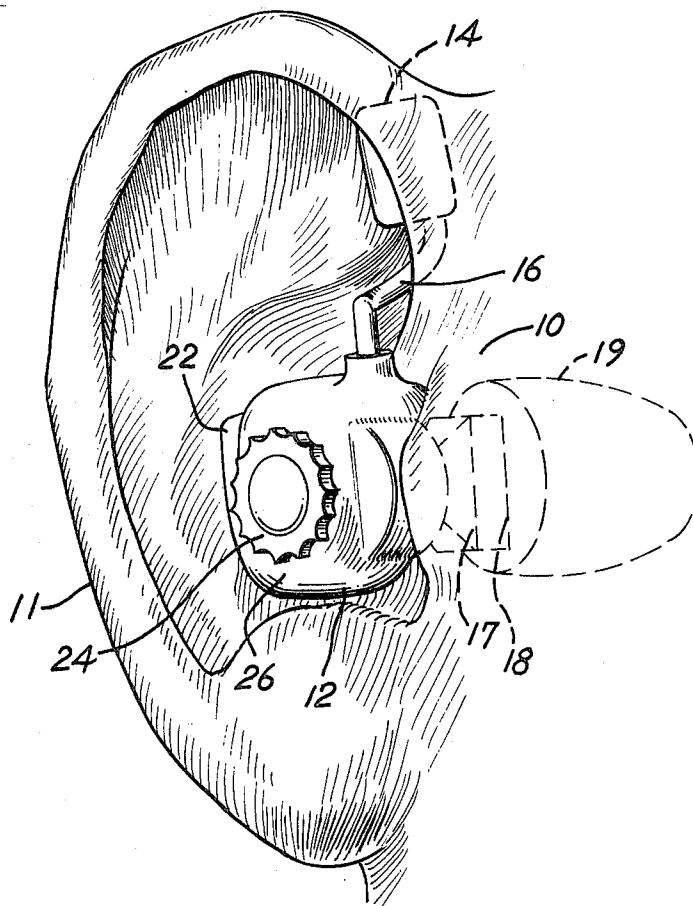


Fig. 1

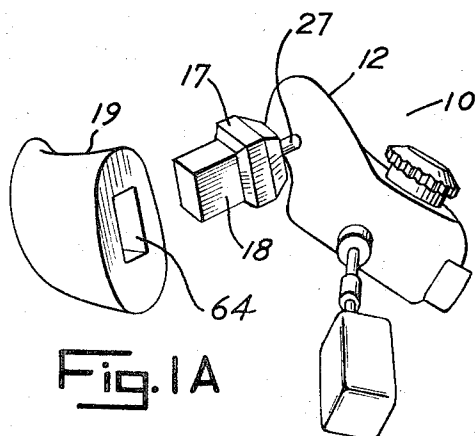
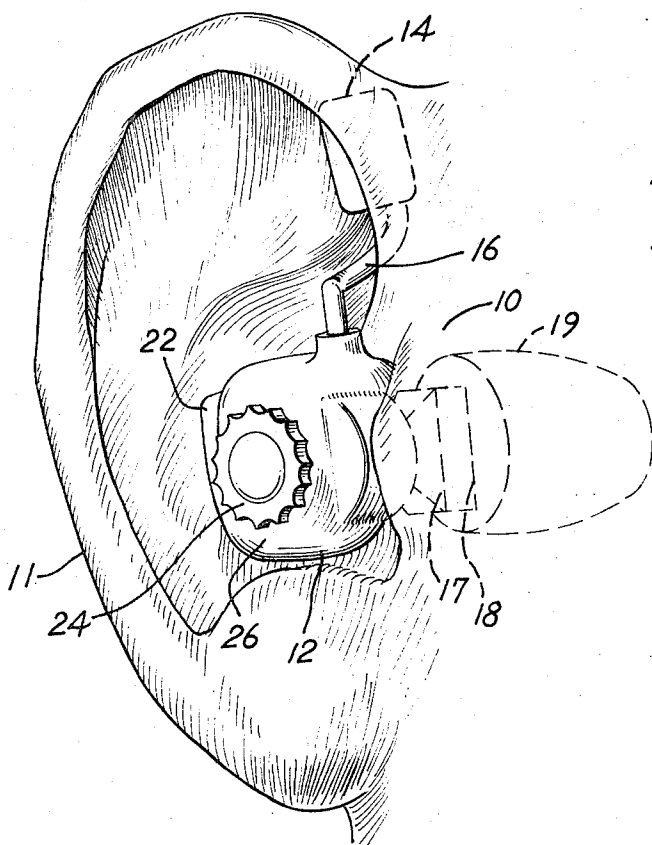
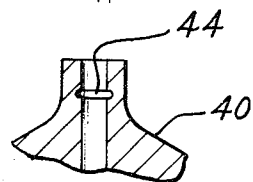
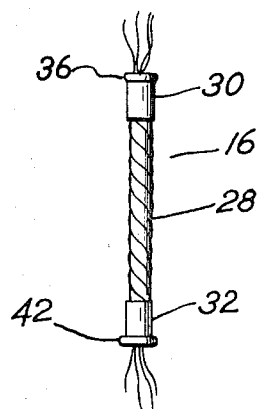
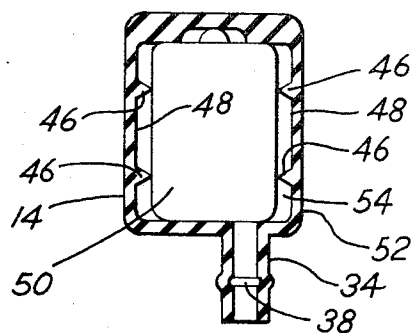
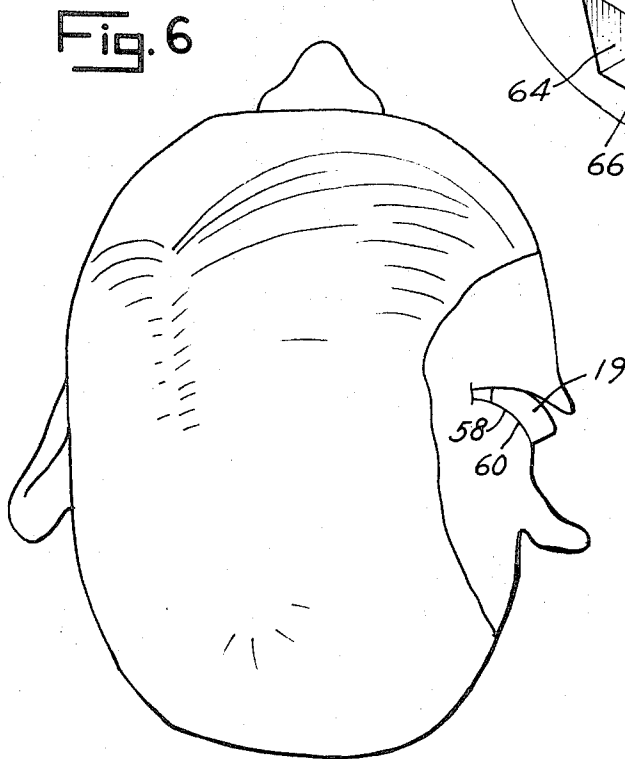
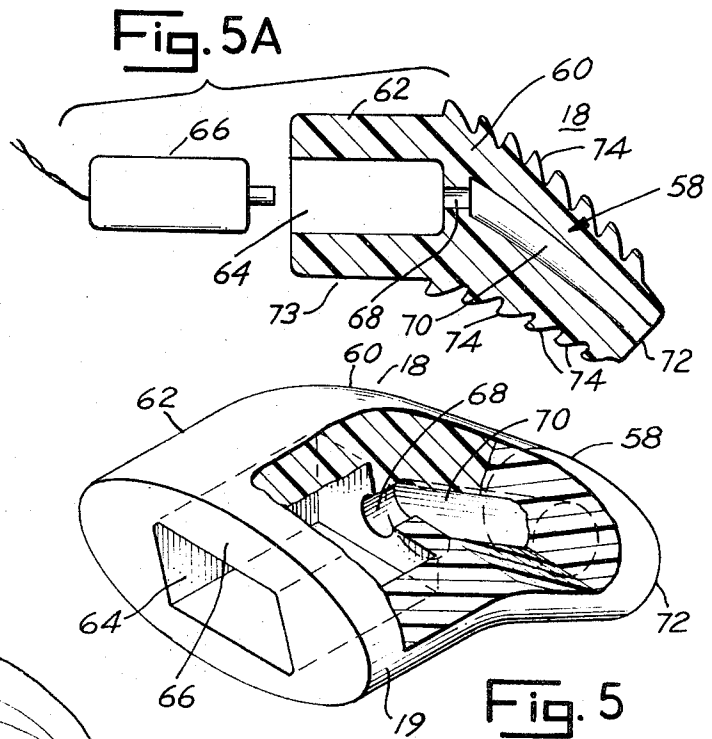
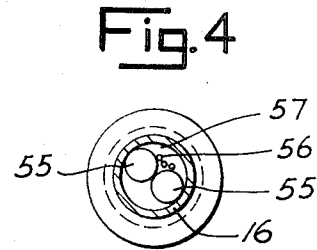
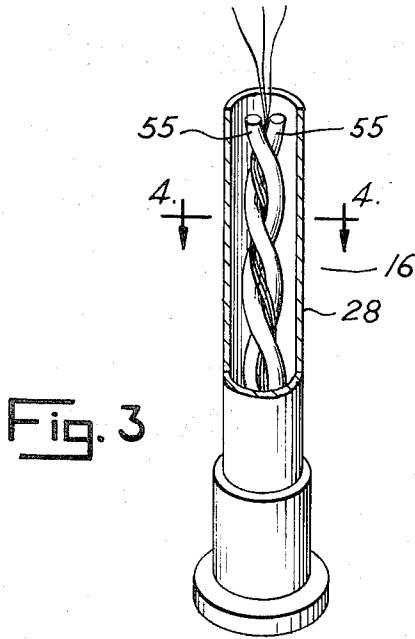


Fig. 1A

Fig. 2



INVENTORS
ERWIN M. WEISS &
RICHARD BRANDER
BY *Molinaro, Allegretti,
Newitt, & Witteoff*
ATTORNEYS



INVENTORS
 ERWIN M. WEISS &
 RICHARD BRANDER
 BY *Molinare, Allegretti,
 Newell, & Witteff*
 ATTORNEYS

MINIATURE HEARING AID STRUCTURE

BACKGROUND OF THE INVENTION

The basic components of a hearing aid include a receiver, a battery, an amplifier, a gain control and a microphone. In the "in-the-ear" hearing air structures in the prior art, all of these components have been contained in a single plastic housing. Such devices are effective for their intended use. However, because of the size requirements for the hearing aid components, the plastic housing which contains all these components cannot be fit entirely into the cavum conchae of a person's ear in an esthetically pleasing manner. Problems with this arrangement also arise from the acoustical and mechanical feedback to the microphone from the other components of the hearing aid which are in close proximity to the microphone and from mechanical vibration emanating from the skin tissue of the cavum conchae. Additionally, acoustical leakage can occur due to a poor fit between the receiver ear seal and the person's ear canal.

Accordingly, it is desirable to provide a miniature hearing aid structure of improved esthetic appearance. It is also desirable to provide such a hearing aid structure which will fit snugly within a person's ear.

It is further desirable to provide a hearing aid structure in which the microphone components of the hearing aid may be isolated acoustically and mechanically from the other components of the hearing aid. Additionally, it is desirable to provide a hearing aid structure that incorporates improvements or improved means of affecting an acoustical seal to the ear canal. It is further desirable to provide such a hearing aid structure including a deformable structure for electrically connecting the microphone to the components of the main housing of the hearing aid.

SUMMARY OF THE INVENTION

In a principal aspect, the present invention relates to a structure for receiving the components of a hearing aid which include a microphone, a power source, an amplifier and a receiver. The structure includes a main housing adapted to receive the power source and the amplifier, a microphone housing isolated from the main housing and a receiver-ear seal module flexibly and compliantly coupled to the main housing. The novel ear seal is contoured to fit snugly within a person's ear canal so as to affect an improved acoustic seal and support the main housing within the person's ear. A deformable maleable structure containing electrical conductive means connects the microphone to the main housing.

BRIEF DESCRIPTION OF THE DRAWINGS

There follows a brief description of the drawings wherein like numerals refer to like elements and wherein:

FIG. 1 is a perspective view of a preferred embodiment of the miniature hearing aid structure of this invention within a person's ear;

FIG. 1A is a perspective view of the hearing aid shown in FIG. 1 and deformable skeleton connecting the container to the main housing;

FIG. 2 is a cross-sectional view of the microphone housing and deformable structure connecting the housing to the main housing;

FIG. 3 is a perspective view of the structure of FIG. 2 with a portion of the structure broken away;

FIG. 4 is a cross-sectional view of the structure shown in FIG. 3 taken substantially along the lines 4-4;

FIG. 5 is a perspective break-away view of one preferred embodiment of the ear seal of this invention;

FIG. 5A is a cross-sectional view of a second preferred embodiment of the ear seal of this invention;

FIG. 6 is a top, cross-sectional view of a person's head with the ear seal of this invention in place in the person's ear.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 1, a novel miniature hearing aid structure 10 is implaced in a person's ear 11. The structure 10 includes a main housing 12 and a microphone housing 14. The microphone housing 14 is coupled to the main housing 12 by means of a deformable maleable structure 16. The hearing aid structure 10 also includes a receiver mounting member 17 compliantly connected to the main housing 12 and a receiver 18 rigidly connected to the receiver mounting member 17. An ear seal 19 is rigidly connected to the receiver 18.

The main housing 12 includes a battery storage compartment 22 firmly secured to one side of the housing 12 and an adjustable volume control 24 rotatably mounted on the front surface 26 of the housing 12. An amplifier circuit (not shown) is also contained in the main housing 12.

Referring to FIG. 1A, the hearing aid structure 10 includes a complaint coupler 27 connecting the receiver mounting member 17 to the main housing 12. As will be explained more fully later, the ear seal 19 includes a channel or cavity 64 contoured to conform to the shape of the receiver 18. When the components are assembled, the ear seal 19 may be cemented to the receiver mounting member 17.

The novel hearing aid structure shown in FIGS. 1 and 1A serves generally to spread the components of an in-the-ear miniature hearing aid out over the surface of a person's ear. The microphone housing 14 and the deformable maleable structure 16 connecting the microphone housing 14 to the main housing 12 are hidden behind the helix of the person's ear 11. The main housing 12 rests comfortably in the conchae of the person's ear 11 and the flexible ear seal 19 together with the receiver 18 housed within the ear seal 19 rest partially in the ear canal of the person's ear 11.

Referring to FIGS. 2, 3 and 4 the deformable structure 16 includes sleeves 30 and 32 connected to either end of a compliant tube 28. An extension 34 is molded to the microphone housing 14 and adapted to receive the sleeve 30 with the flange 36 of the sleeve 30 fitting snugly into the lateral channel 38 defined in the extension 34. In a similar fashion, an extension 40 is molded to the main housing 12 and adapted to receive the sleeve 32 with flange 42 snugly secured in the lateral channel 44 defined in the extension 40. The tube 28 may be formed of shrink-proof mylar, although any compliant insulating material may be substituted therefore.

Encapsulated within the tube 28 are a pair of solid metal wires 55 twisted throughout their entire length. Electrical conductive means or electrical conductors 56 are inter-twined with the twisted metal wires 55 in

the interstices 57 formed by the wires 55. The structure 16 incorporating the metal wires 55 and conductors 56 can be formed to fit the contour of a person's ear and yet is sufficiently rigid to prevent unintentional deformation.

The microphone housing 14 is a rectangular container of viscoelastic material having a number of formable isolating tabs 46 molded to the inner surface 48 thereof. The tabs 46 are provided to position a microphone 50 within the housing 14 spaced apart from the inner surface 48. With the microphone 50 so spaced, vibrational energy which may be transmitted from the outer surface 52 of the housing 14 to the microphone 50 will be attenuated in the space 54 between the microphone 50 and the inner surface 48 of the housing 14. Thus, the molded tabs 46 serve to isolate the microphone 50 from extraneous vibrations surrounding the housing 14. To be more specific, these tabs 46 isolate the microphone 50 from the skin tissue of a person's ear.

Referring now to FIGS. 5 and 6, the ear seal 19 includes a tapered section 58, a curved section 60 and a receiver section 62, each section having a generally oval cross-sectional shape. The outer periphery of the tapered section 58 has successive sections of smaller ovals forming a tapered shape. The receiver section 62 of seal 19 contains a cavity 64 defined therein and contoured to secure a receiver 18 therewithin. The end 66 of receiver section 62 may be connected to the receiver mounting member 17 shown in FIG. 1A. Acoustical channels 68 and 70 are defined within the ear seal 19 to acoustically link the receiver 18 to the outlet end 72 of the ear seal 19 so that sound may be transmitted to a person's ear 11.

The ear seal 19 is designed to fit relatively deep in the ear canal of the ear 11. The ear seal 19 incorporates the curved section 60 to allow the seal 19 to follow the natural bend of a person's ear and increase the surface area contact with the ear canal. The tapered section 58 of the ear seal 19 is provided to accommodate a large range of ear canal sizes. Thus, the ear seal 19 of this invention may be inserted into a person's ear canal to a comfortable position with the ear seal 19 conforming to the shape of the person's ear canal.

It has been found that the formation of the ear seal 19 having an outer periphery approximately conforming to the shape of a super-ellipse defined by the equation $(x/a)^n + (y/b)^n = 1$, wherein $n = 2.4$, is particularly suitable for a comfortable and snug fit of the ear seal 19 within the person's ear canal. With the flexible ear seal 19 and receiver 18 contained therein secured in a person's ear canal, the main housing 12 can rest snugly against the tissue of a person's ear 11 in the area of the cavum conchae. The ear seal 19 may be formed of silicone rubber such as the material sold by DOW CORNING under the trade name SILASTIC. The seal may also be formed of any other flexible material which allows it to conform to variations in the ear canal shape of a person's ear.

A second preferred embodiment of an ear seal 73 is shown in FIG. 5A. The ear seal 73 includes a tapered section 58, a curved section 60 and a receiver section 62 with each of the sections having a general oval cross-sectional shape which are substantially identical to the sections of seal 19 bearing the same numerals. Seal 73 also includes a receiver channel 64 and acoustic channels 68 and 70 defined therein and substantially

identical to the channels of seal 19 shown in FIG. 5. The channel 64 of receiver 73 is contoured to conform to the shape of a receiver 66a. The ear seal 73 contains saw-tooth serrations 74 defined along the tapered and curved sections 58 and 60 of the seal 73. These serrations 74 are angled outwardly from the seal 73 and away from the sound outlet end 72. When the seal is placed in the ear canal of the person's ear 11, the serrations 74 provide improved frictional contact with the ear canal and prevent the seal 73 from creeping out of the ear 11. Because of the angle of the serrations 74 with respect to the seal 73, the serrations 74 cause the seal 73 to move even deeper into the ear canal with bodily movements.

It is to be understood that the present embodiments of this invention described above are merely illustrative of applications of the principals of this invention. A variety of other arrangements could similarly be employed to instrument this invention without departing from the true spirit and scope thereof.

What is claimed is:

1. A miniature hearing aid structure comprising, in combination:

a main housing including a power source and an amplifier, said main housing adapted to rest in the concha of a user's ear;

means remote from said main housing for housing a microphone, said microphone housing means adapted to fit behind the upper, frontal portion of the helix of the user's ear;

means for coupling said microphone housing means to said main housing comprising a deformable, malleable structure containing electrical conductive means and support means;

a flexible ear seal having a sound outlet at one end thereof, said flexible ear seal fitting within and substantially filling the ear canal of the user;

a receiver, said receiver being rigidly coupled to said flexible ear seal;

and means for compliantly coupling said receiver to said main housing.

2. The miniature hearing aid structure of claim 1 wherein said support means comprises a plurality of metal wires, said metal wires being interstitially wound with said electrical conductive means,

3. The miniature hearing aid structure of claim 1 wherein said deformable, malleable structure includes a compliant tube for encapsulating said electrical conductive means and said support means.

4. The miniature hearing aid structure of claim 1 wherein said flexible ear seal comprises, in combination:

a receiver section having a cavity contoured to conform to the shape of said receiver;

a curved section conforming to the bend in the ear canal of the user's ear;

a tapered section;

and an acoustic channel defined within said curved section and said tapered section between said receiver cavity and said sound outlet such that said receiver cavity is acoustically coupled with the user's ear.

5. The miniature hearing aid structure of claim 1 including a plurality of saw-toothed serrations defined along said flexible ear seal and angled away from said sound outlet whereby said flexible ear seal is securely retained within the ear canal of the user's ear.

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