United States Patent

Johnson

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[45] **Sept. 5, 1972**

[54] **ACOUSTIC EAR MOLD FOR HEARING AID**

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[52] **U.S. Cl.**.....**181/23,** 179/107 BC
[51] **Int. Cl.**.....**G02k 13/00,** H04r 25/00
[58] **Field of Search**.....181/23; 179/107 BC, 107 E

[56] **References Cited**

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2,874,231 2/1959 Wallace .....179/107 E

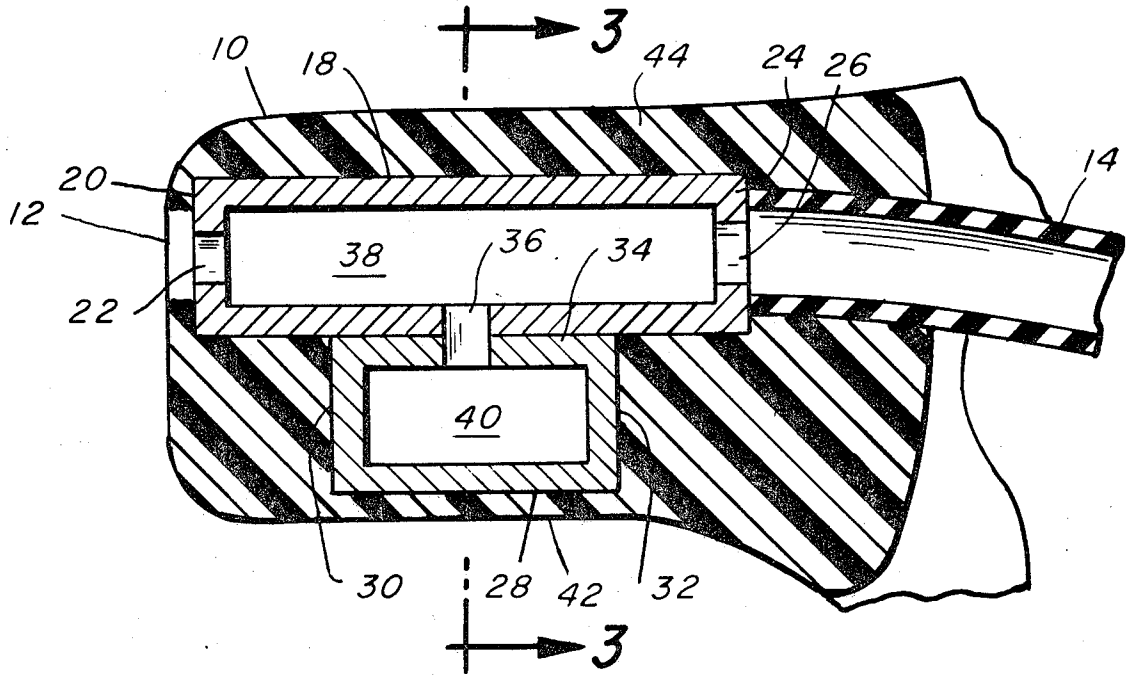
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[57] **ABSTRACT**

An acoustic ear mold insertable into the ear of an individual with impaired hearing, and used in conjunction with a hearing aid amplifier and transducer, incorporates therein reflection chambers. Amplified sound wave energy conducted to the ear mold proceeds to the hearing part of the brain over two separate routes, one route being by way of the tympanic membrance and the second route being by bone conduction through the mastoid process.

8 Claims, 5 Drawing Figures



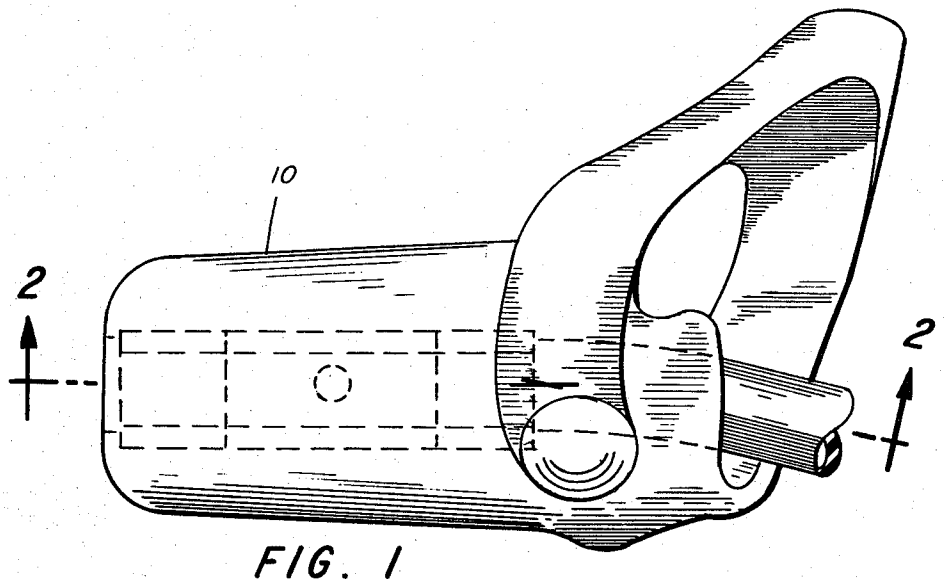


FIG. 1

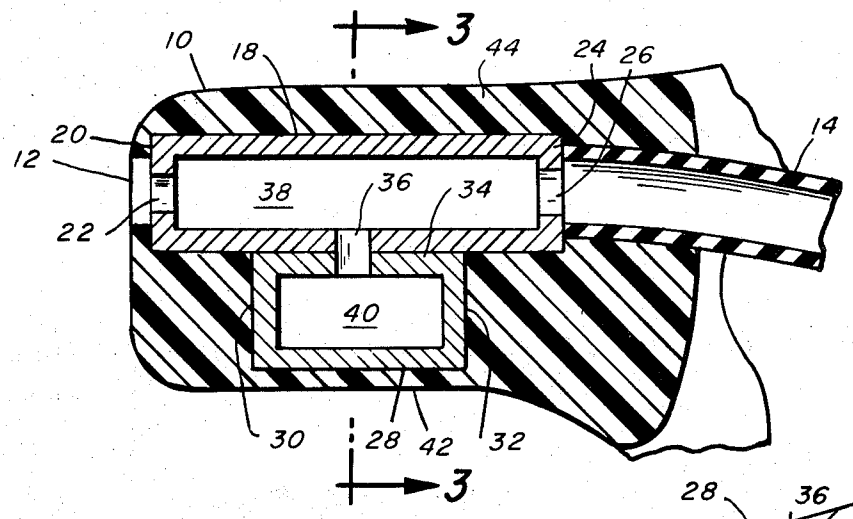


FIG. 2

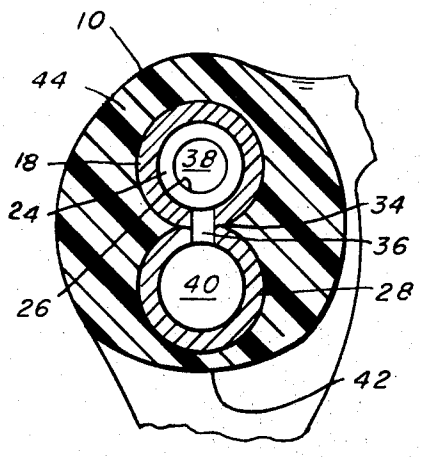


FIG. 3

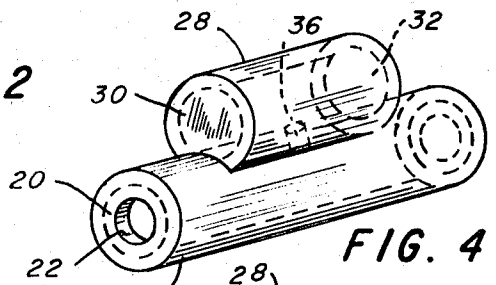


FIG. 4

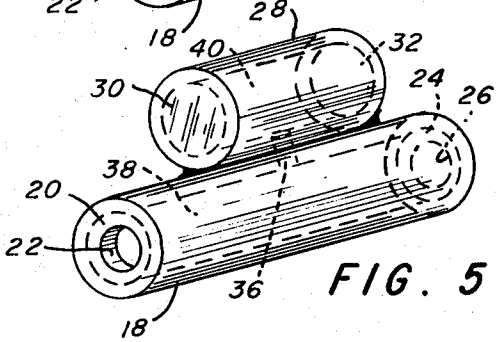


FIG. 5

ACOUSTIC EAR MOLD FOR HEARING AID

CROSS REFERENCE TO RELATED APPLICATION

This invention is related to U.S. Pat. No. 3,602,330 issued Aug. 31, 1971, in the name of Rubein V. Johnson, entitled "Acoustic Ear Mold For Hearing Aid."

BACKGROUND OF THE INVENTION

This invention relates to hearing aids and more particularly to an ear mold for a hearing aid which incorporates a plurality of reflection chambers.

Heretofore, hearing aids have been developed for amplifying sound waves and to conduct the amplified waves to the tympanic membrane of the ear in order to improve the hearing of an individual. Presently manufactured hearing aid apparatus includes an amplifier, transducer and an ear mold, all or parts of which are insertable into the ear.

Amplified sound wave energy created by the amplifier and transducer is usually air conducted to the ear mold, wherein a longitudinal canal or conduit conveys the amplified sound wave and energy to the tympanic membrane of the ear, where the normal hearing process is commenced: that is the sound wave energy strikes the tympanic membrane and then travels on to the malleus, the incus, the stapes, to the oval window and on through the fluid of the sacs of the internal ear where the cochlea contains the organ of the corti with associated nerve endings of the auditory nerve from the brain.

A disadvantage of the presently manufactured ear molds is that improved hearing is contingent solely upon sound wave amplification. If, for example, otosclerosis has rendered immovable or partially immovable the stapes due to ankylosis in the oval window, the effectiveness of a hearing aid is lost.

Also, in many instances where a high level amplification is necessary, sound saturation results, whereby the normal process of hearing becomes traumatized and a degree of hearing is not aided in so far as intelligibility is concerned.

In addition to the normal air conduction process of hearing by way of the tympanic membrane, sound wave energy can also be conducted to the hearing part of the brain by means of bone conduction. In bone conduction hearing, vibratory sound wave energy is transmitted to the brain over a separate and distinct route from the normal hearing process. Sound wave energy directly enters the mastoid process and travels by bone conduction to the hearing part of the brain for discrimination and interpretation. Thus, bone conduction hearing can be beneficial in reinforcing sound wave energy transmitted to the brain by the normal air conduction process.

It is therefore an object of this invention to present an improved acoustic ear mold for bone conduction of sound wave energy.

It is another object of this invention to present an improved ear mold wherein amplified sound waves are conducted to the tympanic membrane of the ear and simultaneously therewith to the bones of the mastoid process, such that sound wave energy is conveyed by two separate routes to the hearing, understanding part of the brain for speech and sound discrimination, interpretation, and understanding.

SUMMARY OF THE INVENTION

Generally, the improved acoustic ear mold of this invention contains as an integral part thereof reflection or resonance chambers, which divert and convert air conduction sound waves into bone conduction sound waves while yet allowing air conduction sound waves to pass to the tympanic membrane for entrance into the normal hearing process. The reflection chambers pass some wave energy into the bone of the mastoid process for conduction to the hearing part of the brain. The bone conducted sound wave energy reinforces the air conducted sound wave energy and increases the sound discrimination, interpretation, and understanding of the amplified sound waves entering the ear mold.

In applicant's prior invention, now U.S. Pat. No. 3,602,330, there is disclosed an improved ear mold which contains reflection chambers for reinforcing the air conduction sound waves through the conduit in the ear mold to the tympanic membrane. There is also a metallic element or strip along the edge of the ear mold which is in contact with the reflection chambers so that acoustic energy inside the chambers is communicated to the metal strip along the outside of the ear mold.

The ear mold is designed so that this metallic strip is exposed to and in contact with the epidermis overlying the bony structure of the auditory meatus of the ear. This epidermis is quite thin and sound energy communicated to the strip or bone contactor bar is transmitted through the epidermis to the bony structure and thence to the mastoid bone process of the ear and by bone conduction to the hearing part of the brain.

In this invention a much simpler and more effective method of intensifying the airborne acoustic energy to the tympanic membrane and of transferring a part of this acoustic energy to the epidermis of the ear over the bony structure is effected.

The reflection chambers of this invention comprise a first longitudinal tubular chamber with end walls which are pierced by drilled holes of less diameter than the chamber. There is a second chamber which is attached longitudinally to the first chamber and which is shorter in length. The second chamber has closed ends and there is an opening communicating through the walls of the first and second chambers where they are in contact, that connects the interior space of the second chamber to the interior space of the first chamber. These chambers are designed in length and diameter to reinforce particular frequencies in the sound spectrum. The first chamber is placed axially in the conduit through the ear mold. This places the second chamber offcenter and therefore the covering of the ear mold plastic material is thinner over this second chamber. By properly orienting this second chamber in azimuth around the axis of the conduit, the sound wave energy trapped in the second chamber can progress directly to the epidermis over the bony structure of the ear. By this means part of the acoustic energy passes through the conduit into the reflection chambers is converted into vibratory energy which passes into the bony structure of the ear and then by a bone conduction to the brain.

These and other objects of this invention and a clear understanding of the principles of the invention will be evident from the following description taken in conjunction with the appended drawings, in which:

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of the ear mold for use in conjunction with an amplifier and transducer of a hearing aid and incorporating the improvements of this invention.

FIG. 2 is a cross-sectional view of FIG. 1 taken along line 2—2.

FIG. 3 is a cross-sectional view of the ear mold of this invention taken along line 3—3 of FIG. 2.

FIGS. 4 and 5 show two embodiments of the reflection chambers, one of which is shown, in inserted form, in FIGS. 1, 2, and 3.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to the drawings and in particular to FIGS. 1, 2, and 3, there is shown an ear mold incorporating the improvements of this invention. The exterior design and contour of the ear mold, generally noted as the numeral **10**, is merely one of the many types commercially available to the industry, and the exact configuration thereof in no way limits the application of the improvements of this invention.

Ear mold **10** is insertable over the external auditory meatus portion of the ear includes a longitudinal canal **12** in which is received a pliant plastic tube **14** which conducts amplified sound waves from the amplifier and transducer of the hearing aid (not shown) but which can be similar to commercial units which are well known in the art. By way of example, the amplifier may be contained in the template of a pair of glasses, or in other instances, may be a solid state device carried by the ear mold itself. Canal **12** conducts amplified sound waves received from the amplifier and the transducer through the ear mold and presents the same to the tympanic membrane of the ear where the normal hearing process is initiated.

As shown in FIGS. 2 and 3, there is inserted into the longitudinal conduit between the tubing **14** and the opening **12** a reflection chamber assembly shown in more detail in FIGS. 4 and 5. One embodiment of this reflection chamber is indicated as being made up of a first chamber with inner space **38** and outer cylindrical shell **18**. The ends of this shell **18** are closed off by end walls **20** and **24** which have central openings, respectively, **22** and **26**.

Although there are central openings there is sufficient annular area of the end plates **20** and **24** available so that there will be internal reflection and resonance within the first chamber **18**. Attached to the side of the chamber **18** is a second reflection chamber which comprises a cylindrical shell **28** with two closed end walls **30** and **32**. This is attached longitudinally to the tube **18** along the seam **34**. There is an opening **36** drilled through both of the walls of the first and second chamber which communicates between the internal volume **40** of the second chamber and the volume **38** in the first chamber.

As acoustic wave energy travels down the tubing **14** into opening **26** and into chamber **38**, it reflects and resonates and the energy is again fed up out through opening **22** and conduit **12** into the ear and against the tympanic membrane, causing oscillation thereof and transmission from the ear of the electrical signals to the brain. At the same time, part of the energy in the chamber **38** passes into the second chamber **40** where it resonates, and certain frequencies are accentuated and others are weakened, so that the acoustic wave energy passing from the canal **12** to the ear can be strengthened in those frequency components to be desired.

It will be noted that the chamber **38** is placed substantially coaxial with the conduit **12** through the ear mold. This places the second chamber **40** on the side, so that there is a thinner wall **42** adjacent the chamber **40** than the wall **44** surrounding the central chamber **38**.

The reflection assembly comprising the two chambers **38** and **40** is so positioned in azimuth about the conduit **12** that the thin wall portion **42** (when in use) lies adjacent the thin layer of epidermis covering the bony structure of the ear. Thus, the acoustic wave energy reflecting and resonating within the chambers **38** and **40** is communicated to the wall **28** of the chamber **40** and thence through the thin portion **42** of the ear mold and into the bony structure of the ear, where it is communicated to the mastoid process and by bone conduction to the brain. Thus, by making this wall thickness **42** thin enough, it is possible to do away with the metal bar which was used in U. S. Pat. No. 3,602,330, and still get acoustic wave energy transmitted into the bony structure of the ear.

Referring now to FIGS. **4** and **5**, there are shown two embodiments of the reflecting assembly of this invention. FIG. **5** illustrates the type of structure which is shown in FIGS. **2** and **3** which comprises two cylindrical elements **18** and **28** fastened together along their edges. The ends **30**, **32** of the second chamber **28** are completely closed off and the two chambers communicate through an opening **36** through the two walls from the chamber space **40** into the chamber space **38**. The first chamber **18** has annular segments of end walls **20** and **24** which contribute to the internal reflection and the central openings **22** and **26** permit passage of the acoustic wave energy from the tube **14** into the opening **26** and out of the opening **22** through conduit **12** into the ear.

In FIG. **4** a similar construction is used, except that a portion of the circumference and the end walls of the second chamber **40** are cut away so that the chamber casing **28** will fit snugly over the outside wall of the first chamber **38**. There is only one wall separating the two chambers now, that of the tube **18**, which has the opening **36** cut into it, which provide the communication required.

The tubes which form the assembly of the reflection chambers can be of any desired size, but because of the practical limitations of the human ear, etc., the optimum size of these tubes is approximately 8 gauge for the tube **18** and 8 or 10 gauge for the tube **28**. The first reflection chamber with tube **18** may be of length 0.4 to 0.5 inches approximately, and the second chamber with exterior wall **28** may be from 0.2 to 0.3 inches in length.

The end opening facing the tubing **14** is approximately one-fourteenth inch diameter. The end opening facing the ear is approximately one-sixteenth inch diameter, as is the opening **36** communicating between the two chambers. The opening **36** may be placed in the center of the long dimension or near one end or the

other, there being some difference in the resonance frequencies dependent on the position.

It is preferred that the material of which these reflection chambers are made by gold and that they be gold-soldered to form a rigid unitary construction without leaks through which acoustic energy can be dissipated.

While the invention has been described with a certain degree of particularity, it is manifest that many changes may be made in the details of construction and the arrangement of components. It is understood that the invention is not to be limited to the specific embodiment set forth herein, by way of exemplifying the invention, but the invention is to be limited only by the scope of the attached claim or claims, including the full range of equivalency to which each element or step thereof is entitled.

What is claimed:

1. In a hearing aid ear mold insertable into the auditory meatus of the ear and having a longitudinal canal for passage of sound wave energy to the tympanic membrane of the ear, the improvement comprising:

a. a first cylindrical reflection chamber disposed in said ear mold substantially coaxial with said canal, said chamber having end walls pierced by openings of smaller diameter than said chamber;

b. a second cylindrical reflection chamber attached longitudinally, side by side, to said first chamber, an opening drilled through the area of attachment communicating between said first and second chambers, the ends of said second chamber closed; and

c. the orientation of said second chamber about the axis of said ear mold being such that when said ear mold is in use said second chamber will be oriented toward the epidermis overlying the bony structure of the auditory meatus;

whereby part of the sound wave energy passing through said canal into said first chamber is reflected into said second chamber, and through the thin covering of said ear mold and said epidermis into the bony structure of the ear.

2. The ear mold as in claim 1 in which said first and second chambers are circular cylinders.

3. The ear mold as in claim 2 in which said circular cylinders are joined in tangential contact.

4. The ear mold as in claim 2 in which said second cylinder is cut away over a longitudinal portion of its cylindrical shell so as to fit the outer surface of said first cylinder.

5. The ear mold as in claim 4 in which said longitudinal portion comprises approximately 25 percent of the outer circumference of said second chamber.

6. The ear mold as in claim 1 in which said first chamber is made of 8 gauge tubing, and said second chamber is made of 10 gauge tubing.

7. The ear mold as in claim 1 in which said first chamber is in the range of 0.4 to 0.5 inches in length and said second chamber is in the range of 0.2 to 0.3 inches in length.

8. The ear mold as in claim 1 in which said first and second chambers are constructed of gold.

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