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W. H. HUTH

3,098,127

HEARING AID

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FIG. 1

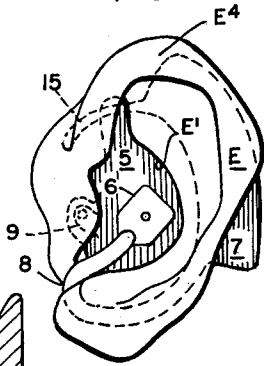


FIG. 2

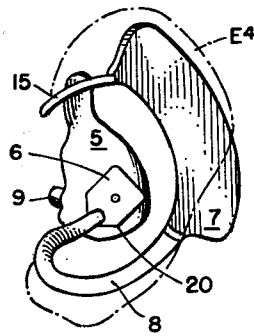


FIG. 3

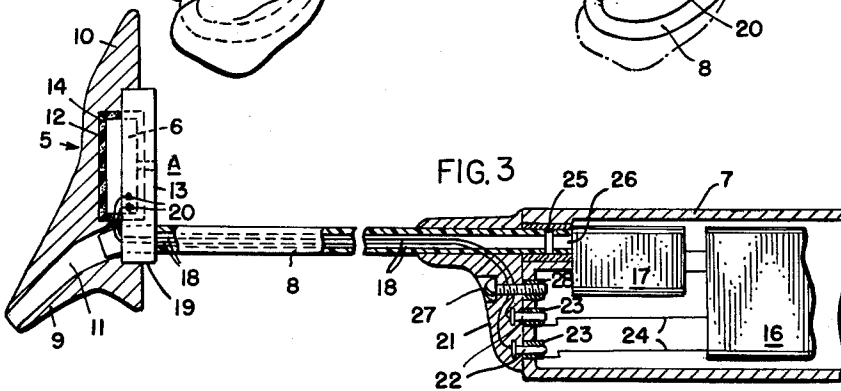


FIG. 4

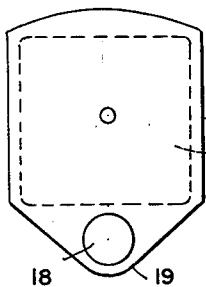
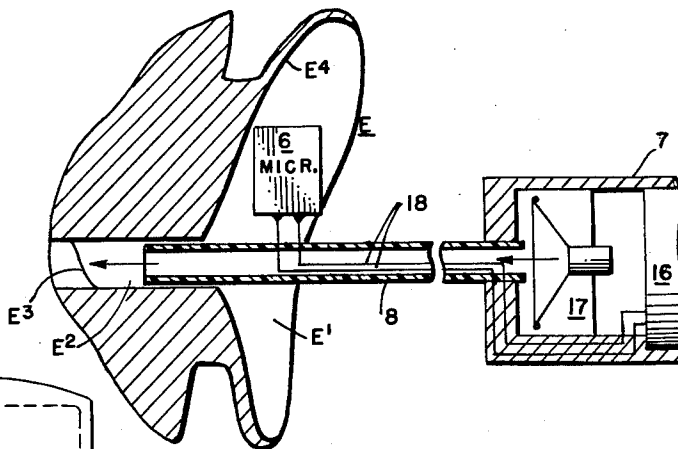


FIG. 5

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HEARING AID

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5 Claims. (Cl. 179-107)

This invention relates to hearing aids and particularly to improvements in such devices adapted to be worn on the ear in such a manner as to be substantially concealed.

Miniaturization of hearing aids to the point where all of the components, including the source of power, can be substantially hidden behind the human ear, and in some cases entirely within the ear, has now been accomplished. This, however, has been done by sacrifice of fidelity and sensitivity and in many cases, particularly when satisfactory amplification for ordinary sound reception is required, there is the added disadvantage of feed back to the microphone which causes distortion and other annoying sounds to be delivered by the speaker. Thus, it is the purpose of this invention to overcome these difficulties and yet retain the advantages of small size and adaptability for concealment.

The main objects of this invention are to provide an improved form of hearing aid; to provide an improved structuring of a miniaturized hearing aid which eliminates mechanical, electrical, acoustical and magnetic feed back; to provide an improved hearing aid of this kind which receives and directs sound in substantially the natural manner in which they are received and directed in normal hearing; to provide an improved hearing aid of this kind in which the speaker and power unit may be combined with the temple bar of a pair of eye-glasses or suspended on and behind the ear; to provide such a device that can be substantially concealed on the wearer's ear; and to provide an improved form of hearing aid of this kind which is of such simple construction as to make its manufacture exceedingly economical and its use very facile and highly gratifying.

A specific embodiment of this invention is shown in the accompanying drawings in which:

FIGURE 1 is an outline of a side view of a normal-shaped human ear showing suspended in position thereon an improved form of hearing aid constructed in accordance with this invention;

FIG. 2 is a view similar to FIG. 1 but showing in full outline this improved form of hearing aid and in broken outline the supporting ear;

FIG. 3 is a vertical sectional view of the microphone mounting ear plug and a somewhat enlarged and diagrammatic sectional view of the housing for the battery, speaker and amplifier, and the connection with the microphone and sound-conveying tube; and

FIG. 4 is a much-enlarged, diagrammatic sectional view of a human ear, indicating the tympanic membrane (ear drum) in association with an enlarged, diagrammatic sectional view of the connection of the microphone to the amplifier showing how the amplified sound waves generated by the speaker, are directed against the tympanic membrane quite as in the case of normal hearing, and

FIG. 5 is a plan view of the microphone cover showing the opening therethrough for the sound tube.

The essential concept of this invention involves positioning the microphone in a molded ear-plug set into the ear opening, connecting the microphone with a remotely disposed speaker, and transmitting sound from the speaker to the ear by means of a sound tube connecting the speaker with the auditory canal of the ear directly behind the microphone.

In the form shown in the drawings, a hearing aid embodying the foregoing concept comprises a molded chan-

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neled ear-plug 5, a microphone 6 mounted thereon, an instrument housing 7 and an interconnecting sound tube 8 leading through the ear plug to the auditory canal of the ear.

The ear-plug 5 may be of any form that may be found expedient for positioning in the ear E to afford connection therewith of the sound tube 8 leading from the instrument housing 7. Such an ear-plug 5 could be performed of a molded substance and of a shape that would permit proper positioning within the average ear concha E¹ to retain the plug in place. Preferably, however, for this form of hearing aid the ear-plug 5 would be molded from a plastic substance, made from a pattern of the ear concha E¹ of the particular patient in a manner currently well known in the fitting of hearing aids to individual needs, or made directly from a plastic substance formed to shape in the patient's ear and then cured or hardened. Such an ear-plug 5 would have an external contour and cross-sectional form approximating that shown in the drawings and would be made to fit the form of the concha so as to be wholly received therein. As FIG. 3 most clearly shows, such an ear-plug 5 would have an integral stem 9 extending inwardly downward from a vertical body-part 10 and this stem 9, formed with a sound passage or channel 11, extends into the auditory canal E² of the ear to insure a retention of the body-part 10 in the concha E¹ of the ear E. The channel 11 conveys the amplified sound waves from the speaker to the tympanic membrane E³ or ear drum as it is commonly called.

The body part 10, as shown in FIG. 3, is formed with an exteriorly-facing cavity 12 for seating the microphone 6. This cavity is enclosed by a cover 13 for retaining the microphone 6, and, as indicated in FIG. 3, the microphone 6 is floated or cushioned by a suitable soft sponge rubber lining 14 applied to all fine surfaces of the cavity and the inner surfaces of the cover.

The microphone 6 is a miniature unit of the type generally used with conventional hearing aids and as indicated in FIG. 3, is rather thin and flat in form and is adapted to be removably mounted in the cavity 12.

The contour and dimension of the instrument housing 7 is determined to fit behind the ear so as to be substantially concealed by the auricle or pinna E⁴. In FIGS. 1 and 2 the housing 7 is shown in the form of thin, flat, arcuate-shaped element adapted to fit behind the ear with an extension or finger 15 adapted to seat over the top edge of the ear, where it joins the head, to suspend the housing 7 behind the ear. In FIG. 3 the housing 7 is shown schematically for convenience of illustration of the connection with the sound tube 8 and the leads from the microphone 6.

Such a housing 7, regardless of its contour, would be formed of light molded substance—as, for example, thermosetting plastic—in two pieces so that it could be easily assembled or disassembled for initially arranging therein or later replacing the conventional amplifier 16, a speaker 17 and a battery (not here shown). This completed unit often is referred to as a "power pack."

The sound tube 8 is formed of flexible plastic or rubber-like material such as is conventionally used for hearing aids and is of a length to permit one end to be secured to the ear-plug 5 in alignment with the channel 11 in the stem 9 and have the other end secured to the housing 7 in alignment with the speaker 17. If the housing 7 were designed to be suspended from the ear as shown in FIGS. 1 and 2, the tube 8 would ordinarily lead from the forward end of the housing 7, down under the ear lobe and up to the ear-plug 5. The tube 8 may, however, extend upwardly from the other end of the housing 7, over the top of the ear and thence downwardly to the ear-plug connection if for any reason such an arrangement

were desired. In the latter instance the tube 8 could replace the suspension finger 15.

In the form shown, the wires 18, which lead from the microphone 6 to the amplifier 16, are associated with the sound tube 8 so that the tube 8 serves the dual function of connecting the microphone with the power unit 7 and conveying the sound waves from the speaker 17 to the ear-plug 5. Thus, as shown, the wires 18 enter the tube 8 through its side wall directly behind an extension 19 of the cover 13, which has an opening there-through to receive and hold the sound tube 8 on the ear-plug 5 with the end of the sound tube extending into the ear-plug channel 11. Preferably the wires 18 run through the tube 8 to the power unit 7 so that they are enclosed and free from possible entanglement. The sound tube 8 is preferably secured firmly in the extension 19, and the ends of the wires 18, after emerging from the tube, are soldered or otherwise fixed to respective terminals 20 on the inside of the cover 13 where they are disposed and arranged for frictional electrical contact engagement with corresponding contact elements on the sidewall of the microphone 6.

In the form shown, the opposite end of the sound tube 8 is attached to, and extends through, a connector plug 21 adapted for detachable, plug-in, connection with the power unit 7. Preferably the connector plug 21 is molded onto the tube 8 with a portion of the tube projecting beyond the plug 21 for reception in a suitable cushion means within the power unit housing. Also the wires 18 are lead through the wall of the tube 8, within the connector plug, and are connected to respective contact pins or terminals 22, also molded into the plug 21 so as to project therefrom for reception in suitable sockets 23 in the power unit housing end wall. The sockets 23 are directly connected with the amplifier 16 by suitable leads 24.

As shown, the projecting end of the sound tube 8, which connects with the housing 7 is received in a soft rubber bushing 25 which also receives the output tube 26 of the speaker 17 and provides an enclosed passage for the transmission of sound waves from the speaker to the tube 8. The speaker is thus insulated from the tube 8 to obviate the transmission of mechanical vibrations thereto and, as will be understood, the speaker itself is mounted in a suitable cushioning material to insulate it from the housing 7.

The connector plug 21 thus serves as a detachable electrical and acoustical connecting means between the microphone-ear-plug and the amplifier-speaker power unit and, in the form shown, to obviate any inadvertent disconnect, the plug 21 is fastened to the power unit housing by means of a screw 27 which has threaded engagement with a receptacle 28 molded into the end of the housing which serves as a terminal block for the electrical connections 22-23. The connector plug could also be attached by means of a pin and a frictional socket instead of the screw 27 and receptacle 28.

It is intended that the ear-plug 5 be a custom made article onto which the microphone cover-sound tube-connector plug assembly will be attached after the ear-plug has been made to fit the patient's ear. Thus a soft mold or impression is first made directly on the patient's ear and for such purposes a dummy microphone and cover unit is provided so that the soft impression can be formed and shaped to not only precisely fit the patient's ear but also have a properly located cavity for the microphone and cover with the sound tube outlet exactly in line with the channel 11 in ear-plug stem 9. When the soft impression is completed it may be cured to permanent form or, with the dummy microphone-cover unit removed, a mold of the impression may be made and a final ear-plug cast or otherwise formed from a suitable plastic material that will retain a permanent shape.

The power units will be standard factory assembled units as will be the microphone cover-sound tube-connector plug assemblies. The latter assemblies, however,

will be made with sound tubes of several lengths to accommodate patients having different requirements.

The hearing aid construction of the present invention has material advantages over prior hearing aid devices, wherein the microphone is incorporated in the same structure as the amplifier and battery, particularly in that locating the microphone remotely from the power unit serves to obviate all mechanical, electrical, acoustical and magnetic feed back problems usually present in the prior devices. Also by locating the microphone, remote from the power unit, in the concha of the wearer's ear, all sound is received in the most natural manner at the acoustical focal point of the ear as nature has formed it. Thus the wearer is less conscious of the hearing aid and has a substantially normal sense of the direction from which the sound originates.

Other advantages of this invention reside in the fact that hearing in the substantially natural manner can be had with greater fidelity of sound and with greater volume due to utilization of the behind-the-ear space for the power unit and speaker whereby extreme miniaturization of these elements as has in some cases been done, is rendered unnecessary.

Although but one specific embodiment of this invention has been herein shown and described, it will be understood that details of the construction shown may be altered or omitted without departing from the spirit of the invention as defined by the following claims.

I claim:

1. A hearing aid comprising a sound channeled ear plug, an amplifier, a separate housing enclosing a receiver powered by the amplifier, means for operatively connecting the receiver and amplifier, a flexible sound tube connecting the receiver with the ear plug channel, a microphone mounted on the ear plug, and connecting wires extending along the sound tube for completing an operating circuit between said microphone and said receiver.

2. A hearing aid comprising, an ear plug having a sound channel therethrough, a separate housing enclosing an amplifier and a receiver powered by the amplifier, means operatively connecting the amplifier and receiver, a sound tube connecting the housed receiver with the ear plug channel, a microphone mounted on the ear plug, and connecting wires within the sound tube for completing an operating circuit between the microphone and the amplifier.

3. A hearing aid comprising, an ear plug having a sound channel therethrough and being recessed on its outer face to form a cavity, a separate housing enclosing an amplifier and a receiver and means operatively connecting the amplifier and receiver, a sound tube acoustically connecting the receiver with the ear plug channel, and a microphone seated in the ear plug cavity and having connecting wires leading therefrom into the sound tube and therealong to said housing for connection with said amplifier.

4. A hearing aid comprising an ear plug molded to fit the wearer's ear and having a centrally disposed cavity in its outer face, said ear plug having a channelled portion adapted to enter the auditory channel of the ear, a separate housing enclosing an amplifier and a receiver powered by said amplifier, means for operatively connecting said receiver and amplifier, a flexible sound tube leading from the receiver in said housing and connected directly to the channelled portion of the ear plug, a microphone seated in the ear plug cavity and cushioned from the walls thereof, and wires leading along the interior of said sound tube for completing an operating circuit between said microphone and said amplifier.

5. A hearing aid comprising a sound channelled ear plug, a separate housing enclosing an amplifier and a receiver powered by the amplifier, means for operatively connecting said receiver and amplifier, a sound tube connecting the receiver in said housing with the ear plug

channel, a microphone mounted on the ear plug and having connecting wires leading from the microphone along the sound tube to the said housing, and a connecting element on said sound tube adapted for separable connection with said housing to provide acoustical connection of said sound tube with said receiver and electrical connection of said wires with said amplifier.

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