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EAR INSERT HEARING AID

Harold M. Busse, St. Paul, Minn., assignor to Sonotone Corporation, Elmsford, N.Y., a corporation of New York

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This application is a continuation-in-part of my applications Serial No. 615,189, filed October 10, 1956, now abandoned, and Serial No. 634,968, filed January 15, 1957, now abandoned.

This invention relates to transistor amplifier hearing aids wherein electric signals of a microphone are amplified by a transistor amplifier and supplied by it to an earphone or receiver held in the ear of the user for enabling him to hear better.

Among the objects of the invention is a transistor amplifier hearing aid of the foregoing type in which all its elements, including the microphone, receiver, transistor amplifier and the energizing battery are combined in a subminiature ear-insert unit which is small enough to be confined in and fit within the outer ear cavity of the user, wherein the earphone or receiver is eccentric relatively to the more outward assembly, and which eliminates cords or sound-conducting tubes of the type used in prior-art hearing aids.

Among the objects of the invention is such a hearing aid insert unit small enough to fit the outer ear cavity of the user and having at least one movable element which enables the user to control the battery connection to the amplifier, or the volume of the delivered sound, or both the battery connections and the sound volume.

The foregoing and other objects of the invention will be best understood from the following description of exemplifications thereof, reference being had to the following drawings, wherein:

Fig. 1 is an enlarged view of one form of an ear-insert transistor hearing-aid amplifier unit exemplifying the invention;

Fig. 2 is an enlarged exploded isometric view showing all parts of the hearing aid of Fig. 1;

Fig. 3 is an enlarged view of the back side of the amplifier chassis of Fig. 2, from the back side thereof;

Fig. 4 is a circuit diagram of the hearing aid of Figs. 1 to 3;

Fig. 5 is an exploded view similar to Fig. 2, of another form of hearing aid of the invention;

Fig. 6 is a circuit diagram of the hearing aid of Fig. 5;

Fig. 7 shows how an ear-insert hearing aid unit of the invention is held in its operative position within the outer ear cavity of the user;

Fig. 8 is an elevational view of the hearing aid unit of Fig. 7;

Fig. 9 is a top view of the hearing aid unit of Fig. 8;

Fig. 10 is a partially exploded view of the chassis plate of Figs. 7—9, as seen from the bottom side of Fig. 8;

Fig. 11 is a circuit diagram of the hearing aid of Fig. 10;

Fig. 12 is a side view similar to Fig. 8, showing the opposite side thereof;

Fig. 13 is a bottom view of the unit of Fig. 12;

Fig. 14 is a side elevational view similar to Fig. 8, with some of the parts in cross-section, of a modified form of ear-insert hearing aid unit of the invention;

Fig. 15 is an elevational view similar to Fig. 1, of the same ear-insert hearing aid unit, showing it in approximately actual size; and

Fig. 16 is a bottom view of the same ear-insert hearing aid unit, as seen from the bottom side of Fig. 15.

Referring to Figs. 1—4, the hearing-aid insert unit 12 has an ear mold which is individually molded for each person. The ear mold 14 has a portion 16 that fits within the concha of the ear and a channel portion 18 that extends into the ear canal. Channel or duct portion 18 has an outlet opening 20 extending from a wider cavity 22 having a smaller interior cavity 24.

To the right of ear mold 14 is an outer casing 26, which surrounds the amplifier chassis 30, the battery cell 76, the microphone 80, and associated elements. The assembly of Fig. 1 is adapted to fit within the outer ear cavity of the user with only the casing 26 being visible on the front of the ear, and between casing 26 and ear mold 14 are mounted all of the transistor circuit elements, the sound-receiving and reproducing elements, as well as the source of power or battery, thereby enabling the user to carry the entire hearing aid at the ear and without connections to other portions which would require the use of exterior wires or cords.

The chassis disc or plate 30 (Fig. 2) is formed of electrical insulating material, its back side being shown in larger scale in Fig. 3. The insulating chassis plate 30 has printed conductors or a printed electrical circuit, composed of conductive material printed or etched thereon. Mounted on the surface of chassis disc 30 and connected to the printed circuit are the electrical circuit components of the amplifier, shown in circuit diagram of Fig. 4. The operation of this circuit is conventional, and requires no further explanation. The amplifier has three transistors 34, 36 and 38, five resistors 40, 42, 44, 46 and 48, and four capacitors 50, 52, 54 and 56. On the opposite surface of chassis disc 30, as seen in Fig. 2, is mounted an insulating plate 58 having a resistance 60 thereon which is connected to conductor 32, and engages a movable metallic wiper contact arm 62 which is also connected to the amplifier circuit. A pair of circuit leads 64 and 66 extend from chassis disc 30, and from its circuit to a double-pronged plug 68 (Fig. 3) that is adapted to be inserted into an earphone or receiver 70, which may be embodied in the mold recess 22. The receiver 70 is of the conventional electromagnetic type and has a sound outlet projection or duct 72, which may be embodied in the smaller mold recess 24.

To the left of chassis disc 30 (Fig. 2) is secured a sheet metal battery casing 74, providing a compartment housing a small disc-like battery 76. The battery casing 74 makes contact with one battery pole, and is electrically connected to the printed circuit on chassis disc 30. The other pole of battery 76 engages an electric contact 77 on chassis disc 30 which is also connected to the printed circuit in the manner shown in Fig. 4.

To the right of chassis disc 30 (Fig. 2) is a microphone 80 of conventional electromagnetic design having a pair of electrical conductors 82, 84 extending therefrom, which are adapted to be suitably joined to the printed circuit. The microphone 80 is embedded in or separated from the other parts of the insert unit 12 by a layer of sound-dampening material 86, such as foam rubber or the like, which is designed to suppress transmission or feedback of sound vibrations from the receiver 70 to the microphone 80. Microphone 80 is secured on its inward side by a metallic shield plate 88 of magnetic shield material of high permeability. The shield plate 88 is covered with a layer of electric insulating material 86 for insulating it from printed circuit 32 and other electrical components carried on the facing surface of chassis disc 30. Alternatively, the microphone 80 may be enclosed.

The application is a continuation-in-part of serial applications Serial No. 615,189, filed October 10, 1956, now abandoned, and Serial No. 634,968, filed January 15, 1957, now abandoned.
in a casing of magnetic shield material which shields it from the magnetic field of receiver 70 and vice versa.

The hearing aid is assembled as follows: The several transistors, resistors, capacitors, and switch and volume control, are mounted on the chassis plate 30 and are connected with its printed circuit in the manner shown in Fig. 4. The microphone 80 with its plate 88 and the underlying sound insulating layer 86 is then secured to chassis disc 30, as by a pair of rivets 96. The ear mold 14, which may be individually molded to conform to the shape of the ear cavity of the user, has seated therein the receiver 70 which may form an integral part of the mold 14, or may be secured by cement or a bracket, not shown, to the chassis disc 30. The battery holder 74 may be secured to the chassis disc 30 by one or more rivets 96, or it may be secured to the ear mold 14 by cement or screws, not shown. The outer casing 26 is made of thin sheet material and is retained in assembled position by screws or rivets 100 passing through casing holes 98 and secured to the lateral flanges of the metallic microphone mounting plate 88 in the manner seen in Fig. 1. A small opening in the outer casing 26, not shown, permits sound to propagate to the microphone 80.

Fig. 5 shows how the ear-insert hearing aid unit 12 of the invention described above, in connection with Fig. 1, may be modified to provide certain additional features, including a circuit switch 22. To the left side of the chassis disc 30, to be secured, battery and rheostat cover sections 118, 116, respectively. Rheostat cover section 116 has an arcuate slot 132 substantially coincident with the rheostat 120 of the chassis disc 30. A relatively stationary control lever or member 126 is positioned between the rheostat cover 116 and chassis disc 30. Control member 126 has a pivot pin 128 on which is pivotally seated the pivot hole 133 of the rheostat cover section. Between the latter is secured to the chassis disc 30, it may be rotated around the stationary control member pin 128. Control member 126 has a lateral retaining projection 136 passing through arcuate slot 132 of rheostat cover section 116 and seated and affixed in an opening 134 of the ear mold 14 for holding it stationary and affixed to the ear mold 14 while the chassis 30 and other parts carried thereby are rotated around the fixed control-member pivot pin 128.

Control member 126 carries an angular cam 138 with a cam surface shaped so that when the chassis disc 30 is rotated in clockwise direction around pivot pin 128 (as seen on the left chassis side in Fig. 5), the corner portion of cam 138 engages switch arm 104 and moves it from its biased, closed position to open position. In the further clockwise movement of chassis disc 30', the upper region of control arm cam 138 engages and pushes the adjacent edge of battery 76, under the battery cover 71 in a laterally and pivotally, which disconnects and aligns outer edge of the battery 76' may be gripped by the user's fingers for removing or replacing it in the amplifier.

The battery and battery cover sections 116, 118, respectively, are suitably affixed in their aligned position shown, and the adjacent chassis disc 30 for instance by rivet pins, not shown, extending through aligned holes, also not shown, provided in them. The microphone 80 with its sound-damping layer 86' and its magnetic shield 88', are secured to the right side of the amplifier chassis disc 30' (as seen in Fig. 5), together with their surrounding casing 26'. In the same manner as in the hearing aid unit of Figs. 1–3. The earphone 70' may be affixed to the chassis 30' as by securing it with a mounting ring 140 having mounting ears with holes by which it may be secured to the chassis 30', as by the same rivets, not shown, with which the rheostat and battery cover section 118 are secured to the chassis 30. Such arrangement, the earphone 70' will rotate with the chassis plate around control member pivot 128 when adjusting the volume control of rheostat 120 and/or opening the switch 104, and/or actuating the battery when the chassis 30' is turned by the user's grip on the chassis casing 26'. However, the earphone 70' may be secured, as by cement, to and made a stationary part of the ear mold 14', in which case the earphone coil may be connected by flexible leads, such as indicated at 64, 66 in the unit of Figs. 1–5, to the printed circuit earphone terminals 110, 112 of the chassis disc 30'.
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without the earphone secured thereto, for adjusting the volume of the sound and/or cutting off the amplifier without removing any part of the hearing aid from its position within the ear of the user. This arrangement thus permits the user to readily adjust the volume of sound or to open the battery circuit when he prefers silence, thereby also saving on battery usage. It also facilitates easy replacement of the battery when it is worn out.

In the hearing aid amplifier of the invention, all components are combined into a subminiature ear insert of lateral dimensions small enough so that a large or major portion of the earphone, trans- phone elements and other parts thereof, may be held and confined within the outer ear cavity or concha of a human ear, such as shown in Fig. 7. As shown in Fig. 7, in accordance with the invention, the components including the microphone, transistor amplifier elements, and the receiver, are assembled and combined into a unitary hearing aid having its lateral dimensions sufficiently small so as to fit within the concha cavity of the outer ear between the anti-helix and tragus thereof, with the receiver having a sound outlet duct connected through a flexible ear tip fitting within and acoustically sealing the ear canal 160 of the user.

Another form of such hearing aid is shown in Figs. 8 to 13. Referring to the exploded and diagrammatic view of Figs. 10 and 11, it comprises an electromagneti
cromicrophone 111a as in Figs. 1-4, the output of which is impressed on an amplifier operating with three transistors 112a, 113a, 114a, which also deliver the amplifier output to electromagnetic receiver 115a, as in Figs. 1-4. The circuits of all three transistor stages are energized from the same battery 117a. The output of the microphone 111a is delivered through by-pass capacitor 121a and lead 125a to the base and emitter of the first transistor 112a. The output developed between the emitter and collector of the first transistor 112a is delivered through by-pass capacitor 127a to the base and emitter of second transistor 113a. The output developed across the emitter and collector of second transistor 113a is impressed upon a volume control resistance 132a. The output developed at the tap 132a of volume control resistance 132a is delivered through by-pass capacitor 133a to the base and emitter of the third power stage transistor 114a. The output developed across the emitter and collector of the power stage transistor 114a is delivered to the coil of the receiver 115a. The emitters of all three transistors are connected to a common supply lead 139a of battery 117a. The collectors of the three transistors are connected to the opposite pole of the battery 117a through resistor 135a, volume control resistor 131a, and the resistance of the coil receiver 115a, respectively. Proper bias and operating connections are provided by circuits including resistors 136a, 137a and 138a.

In accordance with the invention, the foregoing components of the transistor amplifier hearing aid are combined into a compact amplifier-microphone unit 140a having lateral dimensions which fit within the outwardly opening concha cavity of the human ear between the anti-helix and tragus bordering the sides of the outer ear cavity, with the receiver 115a extending eccentrically inwardly away from the wider amplifier-microphone unit 140a, and having at most half of its cross-sectional area, so that its sound outlet duct opens and transmits sound directly into the ear canal 160 while the microphone 111a is positioned along the outer wall of the unit 140a. As shown in Fig. 7, an ear canal insert 118a of flexible material held on sound outlet duct 119a of receiver ear insert 118a, fits against the walls of the ear canal 160 and forms therewith an acoustic seal for suppressing feedback of sound from the ear canal 160 towards the microphone 111a positioned along the outer wall of the unit 140a.

As shown in Fig. 10, the microphone 111a and the re-

ciever 115a each have electromagneti
cromicrophone structures wherein a ferromagnetic core and windings interlinked with the core along a respective magnetic transducer axis of a winding-core section thereof operates to transduce acoustic or sonic signals into electric signals and vice versa. Furthermore, the magnetic transducer axis of the microphone 111a and the magnetic transducer axis of the receiver, thereby materially reducing the magnetic linkage between them and serving to keep the over-all feedback from the receiver 115a to the microphone 111a below the level sufficient to start disturbing sustained feedback oscillations and receiver whistling.

The ear canal insert 118a has a sound outlet passage 118-1e into which opens the sound passage 119-1e of the sound outlet nipple 119a of the receiver ear insert 118a (Figs. 7, 12, 13). The flexible sound outlet ear insert 118a may be made of any of the known synthetic, elastic, rubber-like resin materials. The wider ear insert portion may be formed of a materially stiffer material than its outward narrower end, which should be sufficiently flexible so as to adjust itself to different directional shapes of the ear canal 160.

The circuit components of the hearing aid unit are positioned and assembled along a support chassis plate 141 which forms part of a printed circuit (Fig. 10). Support chassis plate 141 may be made of conventional, strong and electrically insulating material having affixed thereto or therein printed metallic circuit portions of the amplifier circuit. One set of these printed metallic circuit elements 142, 143, 144, 145, 146, 147, 148 and 149, is exposed along the downwardly facing surface of the chassis plate 141 (Fig. 12). The other set of printed metallic circuit elements 151, 152, 153 and 154, is exposed along the upwardly facing surface of the insulating chassis plate 141 (Fig. 12). The rectangular micro-

phone 111a is positioned along the upwardly facing sur-
face of the chassis plate 141 so that its outer microphone wall 111-1a picks up sound through openings 111-2a for generating corresponding electric signals as in the device of Figs. 1-5. The microphone 111a is enclosed in a casing of magnetic shielding sheet material to suppress interlinkage thereof with the receiver 115a by their stray magnetic fields.

Along one border region of the outwardly facing surface are positioned transistors 112a and 114a, resistance elements 136a and 138a, and capacitor 133a. Along the opposite border region of this chassis surface are positioned transistors 113a, capacitors 121a and 127a, and resistors 135a and 137a. As indicated in diagrammatic Fig. 10, the three wire ends of transistor 112a pass through openings in and are soldered to printed circuit portions 145, 147 and 148 of chassis plate 141. The wire lead ends of transistor 114 are similarly joined to printed chassis circuit elements 144, 148 and 149. The two wire ends of resistor 136 are similarly joined to printed chassis circuit elements 148, 149, to which the wire lead ends are joined as by soldering. The wire ends of resistor 136a are similarly joined to printed chassis elements 145, 147. The two lead ends of capacitor 133a are similarly joined to printed chassis circuit elements 148, 152.

Transistor elements 113a, capacitors 121a and 127a, and resistors 135a and 137a have their respective wire ends similarly joined to their associated printed circuit elements and other circuit components, as indicated in wiring diagram of Fig. 10.

Printed circuit element 154 overlaps the printed circuit portion 149 on the other side of chassis 141 and is joined thereto by a wire or molten solder in a chassis perforation. In a similar way, other printed circuit elements are joined to proper overlapping printed circuit portions on the opposite chassis side. Two stiff conductors 156-2, 154-2 pass through chassis 141 and are soldered to printed circuit portions 146, 154 so that they
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7 project in downward direction, as seen in Fig. 10, for making connections from the amplifier circuit to the receiver 11za.

Arcuate volume control rheostat 13a is positioned on the downward side of chassis 141 and it has a pivoting contact arm 13za for varying the volume of the sound output.

The small flat battery 117a is detachably held on the inward side of chassis 141 by an overlying, bendable, springy stiff battery cover 161 of spring metal, having one end suitably secured, as by rivets 162, to the chassis 141. The battery cover arm 161 is electrically connected through one of its connecting rivets 162 to printed chassis portion 153 and connects thereto one flat terminal of battery 117a. The opposite flat terminal battery 117a is held pressed against battery terminal portion 144–1 of the printed circuit chassis 144.

The springy battery cover 161 provides a nesting space for the battery 117a. By gripping and flexing the free end of battery cover 161, the battery 117a is released for removal or replacing it.

On the inward side of chassis plate 141 is eccentrically mounted the much narrower inwardly projecting receiver 115a so that its center is eccentrically positioned relatively to other circuit parts of the amplifier, and its electromagnetic microphone 111. The receiver 115a may be held mounted in its eccentric position on the chassis 141, for instance, through engagement of its terminal sleeves (not shown), with terminal pins 154–2, 146–2 of chassis 141. The receiver 115a may also be held in its eccentric position on the chassis 141 by making the casing of receiver 115a a protruding part of the wider inner casing wall 171, which is suitably secured to chassis 141, as by securing ear projections to the edge of chassis plate 141 with screws or cement. The inward casing wall 171 is formed of thin sheet metal and has a casing rim portion 172 engaging the peripheral edge of the amplifier chassis plate 141 which is suitably secured thereto.

Battery cover 161 is positioned in an opening 171–1 of casing wall 171 along which the battery cover 161 is exposed. Casing opening 171–1 permits gripping and flexing of battery cover edge 161–1 for releasing the battery 117a from chassis 141. Casing rim 172 has also an opening 172–4 (Fig. 12) for actuating rheostat arm 132a and adjusting the sound output.

The outer side of chassis 141 holding microphone 111a and other circuit parts of the amplifier is encased by outer casing 181 which is secured, as by screws to the rim of inner casing 171 for enclosing the hearing aid assembly.

The outer casing 181 may have opening 181–1 for exposing outer casing wall 111–1a of microphone 111a. A relatively thick layer 183 of sound vibration attenuating material, such as sponge rubber, is placed between the microphone 111a and the adjoining parts of the hearing aid, and particularly its receiver 115a, for suppressing transmission or feedback of disturbing vibrations and sound from the receiver to the microphone that would set up whistling sound generation.

Alternatively, outer casing wall 181 may extend over microphone 111a and have openings through which propagated sound is transmitted to the microphone 111a. In such case, the microphone 111a is held separately in floating condition from the overlying casing wall 181, for instance, by a border of sound-attenuating sponge rubber or the like.

The structure of the hearing aid shown in Figs. 7–13 may be readily designed so that the casing side walls are of D-shape conforming to the shape of the concha.

Figs. 14–16 show how the unitary ear-insert hearing aid shown with Figs. 7–13, may be modified in the manner explained in connection with the hearing aid unit of Figs. 5 and 6, so that rotation of its wider outer amplifier sections relatively to its inward eccentrically mounted receiver imparts a control motion to internal control elements for adjusting the volume of the sound output of the hearing aid unit and/or for selectively energizing of its amplifier circuit by the battery, in the manner explained in connection with the hearing aid unit described above in connection with Figs. 5 and 6. The ear-insert hearing aid unit of Figs. 14–16 comprises an outer wider microphone-amplifier unit 210 and an inward receiver unit 215 positioned eccentrically relatively to the amplifier unit 210 and having a lateral cross-sectional area at most about one-half the lateral cross-sectional area of the amplifier unit 210. The microphone-amplifier unit 210 and the inward receiver unit 215 embody a control of substantially the same elements as the corresponding wider outer amplifier unit 140 and the inward receiver 115a of Figs. 7–13, or as the corresponding outer amplifier unit housed in casing 26 and the inward receiver unit 70 of the instrument of Figs. 5 and 6. The receiver 215 is provided with a relatively long protruding sound outlet duct 217 having an interior sound passage through which sound produced in the receiver is transmitted to the ear canal of the user. An ear canal insert 218, similar to the ear canal insert 118a of Figs. 7–13, is seated over the inner end of the sound outlet duct 217, so that the thread outer surface of sound outlet duct 217 of the receiver 215. The ear canal insert 218 is shaped to fit with its flexible exterior against the walls of the ear canal of the user so as to form therewith an acoustic seal which suppresses feedback of sound from the receiver sound outlet duct 217 toward the microphone positioned behind the outer casing wall 210–1 of the outer microphone-amplifier unit 210.

The casing of the eccentrically positioned receiver 215 has a relatively rigid pivot arm 221 which is pivotally mounted on a pivot pin 222 with which its pivot is pivotally secured to an inwardly protruding wall section 223 of the inner casing wall 224 of the outer microphone-amplifier unit 210. The casing of receiver 215 and its pivot arm 221 are of metal and one end of the receiver winding is electrically connected to the receiver casing and its metallic pivot arm 221 and therethrough to the metallic casing of amplifier unit 210, corresponding to the connection of receiver 115a of Fig. 11 to the negative terminal of battery 117a. The pivot pin 222 of the receiver pivot arm 221 is likewise of metal and it, together with its two metallic clamping heads 225, are electrically connected to the metallic connector of unit 210. The pivot pin 221 and the metallic casing wall 223 of the amplifier unit 210, as by an insulating sleeve 226 surrounding the metallic pivot pin 222 and two insulating washers 227 interposed between the metallic heads 225 of the pivot pin 222 and the underlying metal portions of the receiver pivot arm 210 and casing wall 223. The other end of the receiver coil that is not connected to the receiver casing and its pivot arm 221, is connected through an insulated conductor 228 to the pivot pin 222. A contact spring arm 231 having one end secured as by a rivet to a metallic circuit portion of printed circuit chassis plate 141, has its free end contact portion 232 biased into contact engagement with the adjacent pivot pin head 225, thereby completing the connection of the winding of receiver 215 to the amplifier circuit, for instance, to the collector of transistor 114a of the amplifier of the circuit diagram of Fig. 11.

The pivot pin 222 is arranged to permit pivotal movement of the casing of the microphone-amplifier unit 210 relatively to the eccentric receiver 215 when it is held fixed in sealing engagement with the ear canal of the user, as described above. The printed circuit amplifier chassis plate 141 is provided with an arcuate rheostat element 132a and a cooperating pivotally mounted rheostat arm 132a pivotally mounted on the chassis plate as by a pivot pin 243, for adjusting the amplifier gain in
the manner explained, for instance, in connection with the circuit diagram of Fig. 11 or Fig. 6.

The rheostat arm 132' is moved along its rheostat 131' by the control motion of a control rod 245 extending from the receiver 215 through an arcuate slot 246 of the amplifier casing wall 224 into coupling engagement with a coupling portion of the rheostat arm 132'. The control rod 245 is relatively rigid, and another is formed of insulating material such as nylon, or it has an exterior insulating coating, so that it provides only a mechanical motion-transmitting link between the receiver 215 and the rheostat control arm 132', without making any electrical connections between them. With this arrangement, a casing wall portion of the microphone amplifier unit 210 exposed along the open side of the wider ear cavity, may be gripped by fingers of the user and rotated on pivot 222 relatively to the fixed control rod 245 of the receiver 215 for imparting to the rheostat arm 132' a control motion which adjusts the gain of the amplifier and the sound output of the receiver 215 in the same manner as explained above in connection with the embodiments of Figs. 8-13, Figs. 1-4, and Figs. 5 and 6.

The amplifier of the hearing aid units of Figs. 14-16 may have an amplifier circuit such as described in connection with Fig. 6, or the amplifier circuit may include an energizing switch 104' cooperating with a fixed switch contact, not shown but similar to 108, such as shown in Fig. 6, for selectively energizing or deenergizing the amplifier circuit by pivotal motion of the switch arm 104'. The movable switch arm 104' and its stationary contact are suitably mounted on the printed-circuit chassis plate 143' of Figs. 14-16 in the manner described in connection with the corresponding elements of the hearing aid unit of Figs. 5 and 6, wherein the movable arm 104' is biased, as by spring action, to a closed circuit position of the switch arm 104' arranged to come in engagement with the fixed insulating control pin 245 of the receiver 215 near the end of the pivotal volume-reducing movement of the amplifier unit 210 so that at the end portion of this volume-reducing movement, the receiver control pin 245 comes into engagement with energizing switch arm 104' for moving it to the circuit opening position in which the battery 276 is disconnected from the transistor-amplifier circuit.

With this arrangement, and assuming that the casing of the amplifier unit 210 is in a position in which the energizing switch 104' is retained in its open position, the initial part of the rotary movement imparted by fingers of the user to an exposed casing portion of the microphone-amplifier unit 210 in a gain-increasing direction will first release the energizer energizing switch 104' to its energizing position in which it makes contact with its fixed switch contact and energizes the transistor amplifier. Further movement of the amplifier unit 210 in the same gain-increasing direction will cause the receiver control rod 245 to move the rheostat control arm 132' over its rheostat element 131' for adjusting increasing the gain of the amplifier and the sound output of the receiver to the level desired by the user. A similar opposite gain-decreasing rotary movement imparted by the finger of the user, to an exposed casing wall portion of the microphone-amplifier unit 210, will cause the receiver control rod 245 to move the rheostat control arm 132' in opposite direction for adjusting reducing the gain and sound output of the amplifier, the end portion of this gain-reducing movement imparted by the receiver control rod 245 to bring switch arm 104' from the closed-circuit position to the open-circuit position in which the battery cell 276 is disconnected from the amplifier circuit, as explained in connection with Figs. 5 and 6.

Otherwise, the ear insert hearing aid unit described above in connection with the same construction as the ear insert hearing aid unit of Figs. 8-13, or Figs. 5 and 6, or 1-4.

It will be apparent to those skilled in the art that the novel principles of the invention disclosed herein in connection with specific exemplifications thereof, will suggest various other modifications and applications of the same. It is accordingly desired that in construing the breadth of the appended claims, they shall not be limited to the specific exemplifications of the invention described above.

I claim:

1. In a hearing aid device, an inward housing section with a sound outlet duct projecting inwardly toward the user's ear canal and an outward housing section joined to and extending from the outward side of said inward housing section and being opposite said sound outlet duct, said inward housing section having a lateral cross-sectional area materially smaller than said outward housing section and said two housing sections forming together an integral unit having laterally dimensions fitting the outer ear cavity between the anti-helix, tragus and anti-tragus, said inward housing section having mounted therein a receiver comprising an electromagnetic acoustic transducer having a sound outlet space connected to said outlet duct, said outward housing section having mounted therein a battery cell, a microphone with an electromagnetic transducer exposed to exterior sound and a transistor amplifier means electrically connected to said cell between the transducers of said microphone and said receiver for supplying to said receiver amplified microphone signals, each of said electromagnetic transducers comprising a ferromagnetic core and windings interlinked with said core along a winding-core section and a transducing axis thereof, the winding-core section of said receiver being laterally displaced in an eccentric position relatively to the winding-core section of said microphone, a magnetic shield element of magnetic sheet metal interposed between the core and winding of the microphone and receiver transducers, said receiver having a transducing axis extending transversely to the transducer axis of said microphone for suppressing in conjunction with said shield element magnetic signal feedback from the receiver transducer to the microphone transducer and maintaining the over-all feedback between them below a level sufficient to start sustained electric feedback oscillations.

2. In a hearing aid device having dimensions fitting within a user's outer ear cavity between its anti-helix, tragus and anti-tragus, an inward housing section and an outward housing section including an outer wall, said outward housing sections mechanically joined in a side-to-side relationship in which an outward section is rotatable with respect to said inward section, a receiver mounted within said inward housing section and directed toward the user's ear canal through a sound outlet duct, an interior space between said inward housing section and the outside wall of said outward housing section, said interior space having mounted therein a battery cell, a transistor amplifier having at least two transistors and a microphone exposed to exterior sound, said battery cell electrically connected to said amplifier which is electrically connected between said receiver and said microphone, said amplifier including amplifier current control means having a movable control element mechanically coupled to said inward housing section and moved by relative rotation between said inward and outward housing sections.

3. In a hearing aid device as claimed in claim 2, said receiver and said microphone are electro-magnetic and have axes eccentric with respect to each other.

4. In a hearing aid device as claimed in claim 3, a magnetic shield element interposed between said receiver and said microphone.

5. In a hearing aid device as claimed in claim 2, said current control means including volume control means and an open-close circuit switch between said battery cell and said transistor amplifier, said switch...
operated by movement of said control element outside of a volume control range of movement.

6. In a hearing aid device as claimed in claim 2, said control element having a volume control range of movement and said battery cell is movably mounted in and is ejected from said outward housing section by movement of said control element outside of its volume control range of movement.

7. In a hearing aid device as claimed in claim 2, said movable control element having a volume control range of movement and two separate ranges of movement outside its volume control range of movement, the first separate range of movement operates an open-close circuit switch between said battery cell and said transistor amplifier and the second separate range of movement ejects said battery cell from said outward housing section in which said battery cell is movably mounted.

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