Dec. 3, 1968 R. L. GEIB ETAL 3,414,685

IN-THE-EAR HEARING AID

Filed Sept. 23, 1965 2 Sheets-Sheet 1

FIG. 1

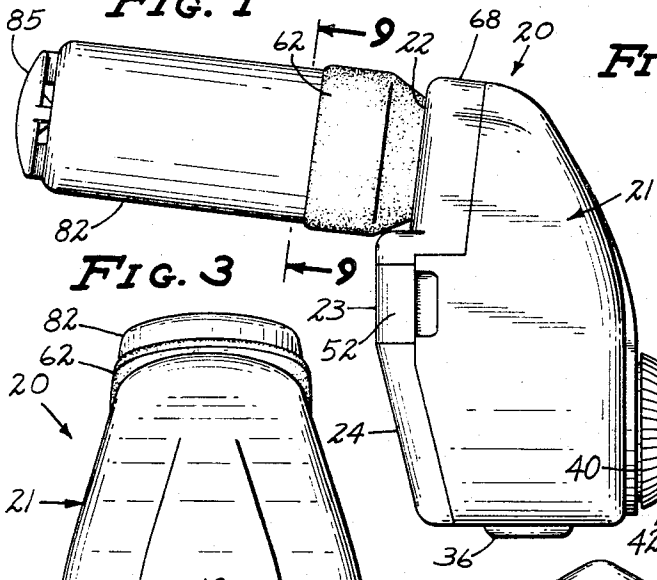

FIG. 2

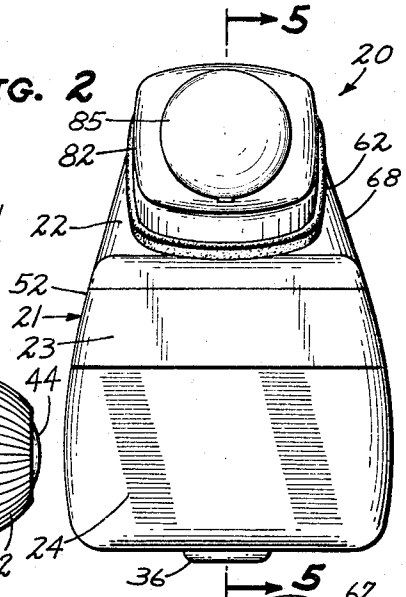

FIG. 3

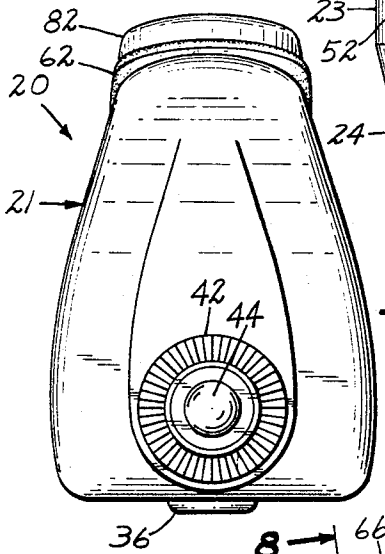

FIG. 7

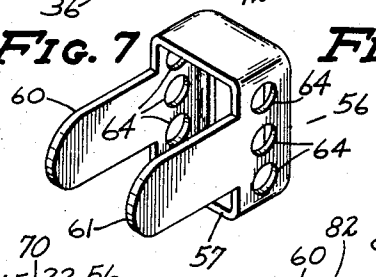

FIG. 6

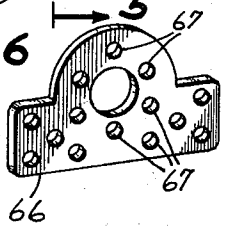

FIG. 5

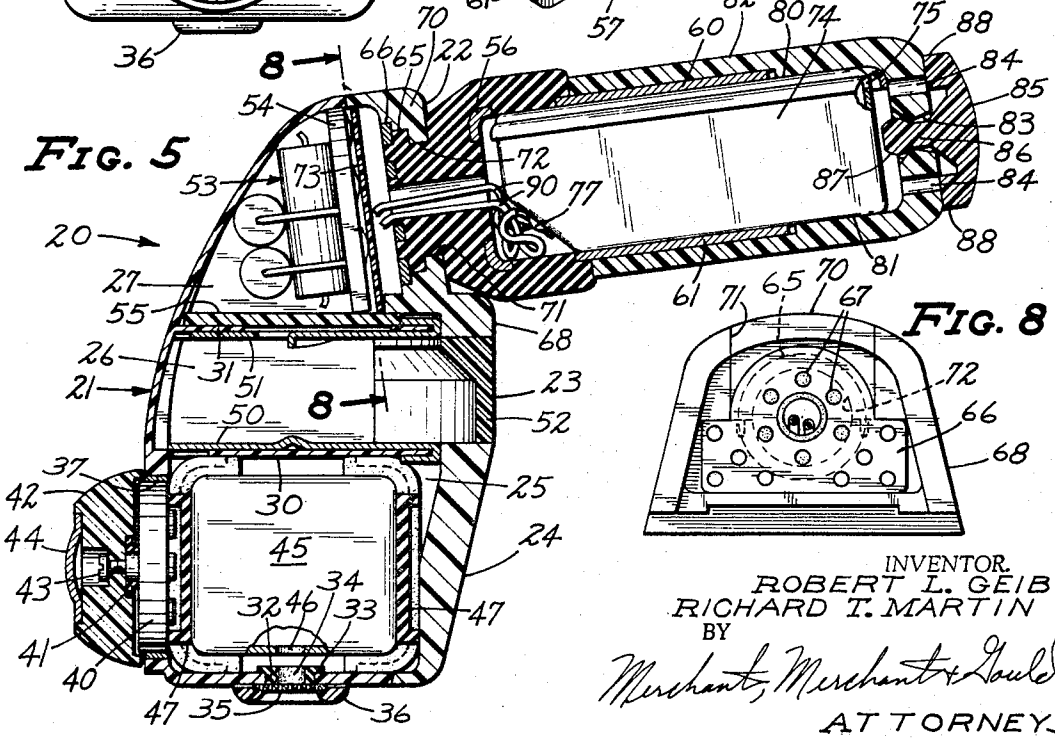

FIG. 8

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Dec. 3, 1968 R. L. GEIB ETAL 3,414,685

IN-THE-EAR HEARING AID

Filed Sept. 23, 1965 2 Sheets-Sheet 2

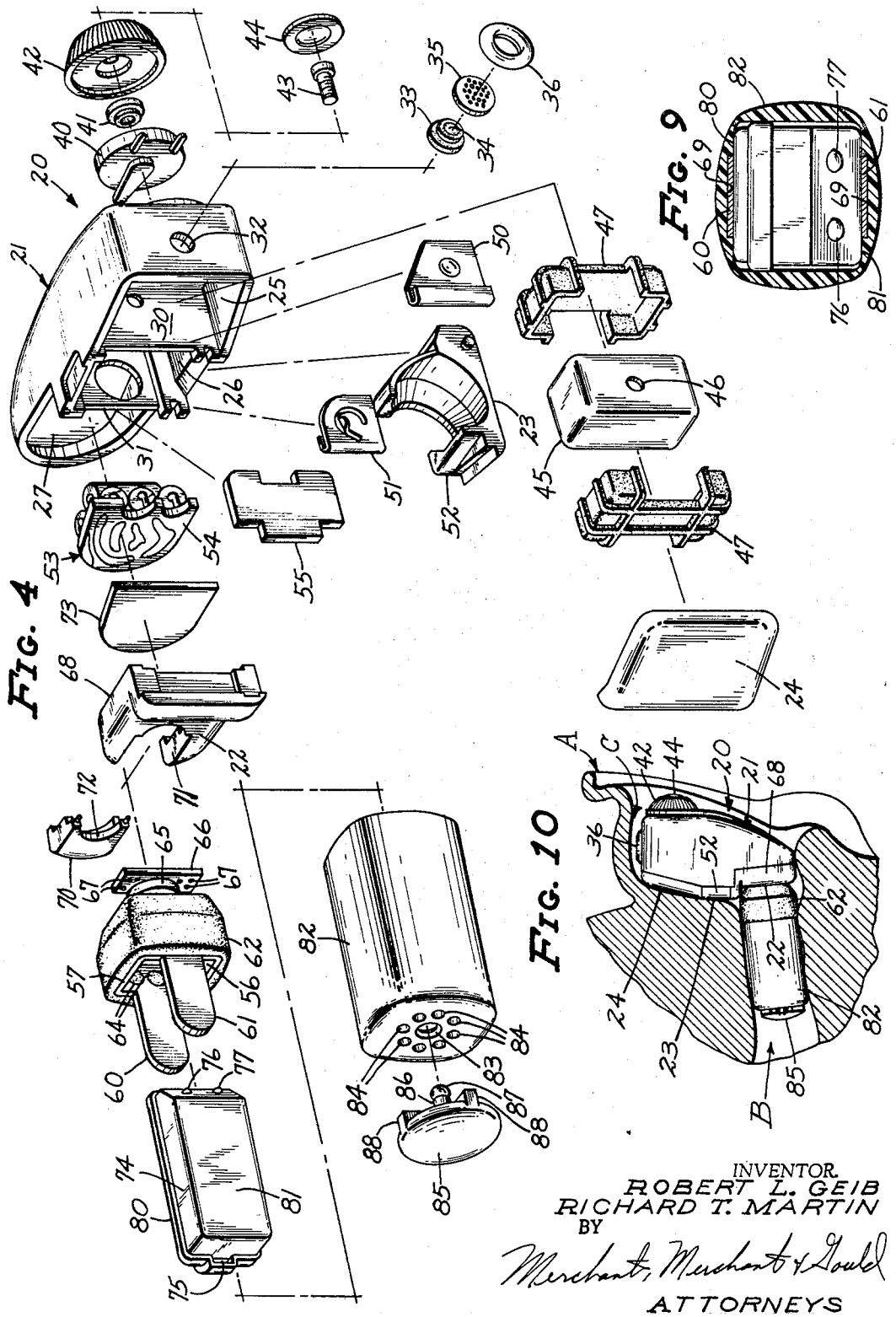

FIG. 4

FIG. 9

FIG. 10

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IN-THE-EAR HEARING AID

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8 Claims. (Cl. 179—107)

ABSTRACT OF THE DISCLOSURE

A hearing aid apparatus having an acoustic receiver member extending outwardly from the upper portion of a front face of a housing, the upper portion of the housing being angulated so that the receiver angle approximates the normal angle of the ear canal with the ear concha. The lower portion of the housing front face being angulated to approximate the angle of the ear concha. The receiver is mounted with respect to the housing by means of a cup-shaped retainer supporting one end of the receiver while a hollow cap member encloses the remainder of the receiver.

This invention pertains to improvements in hearing aids, and more particularly to improvements in an in-the-ear hearing aid which is designed to be worn in the external ear of the user.

A generally similar prior art in-the-ear hearing aid is disclosed in U.S. Patent, Martin, 3,197,576, which is assigned to the same assignee as the present invention.

The in-the-ear hearing aid disclosed in U.S. Patent No. 3,197,576 comprises generally a housing which includes a microphone, amplifier, and a source of energizing potential for the amplifier, preferably a battery. A receiver which has an electrical input and produces an acoustic output has its electrical input connected to the output of the amplifier, and the receiver is mounted within a soft resilient boot, usually of a soft rubber material, and is flexibly attached to the hearing aid housing, the receiver normally extending outwardly from the front face of the housing at a 90° angle. The end of the soft resilient boot has an aperture therethrough adjacent the acoustic output of the receiver so that the acoustic output energy of the receiver always travels in the same acoustic medium, that is, air. In order to prevent earwax from clogging or plugging the output aperture of the receiver, thereby preventing proper operation of the hearing aid, a wax guard such as the wax guard shown in United States Patent, Kuklock, 3,197,577, is mounted in the aperture of the boot to prevent earwax from entering the receiver output.

In the prior art in-the-ear hearing aid, several problems were encountered in the use of the hearing aid by the wearer, many of these problems resulting from improper treatment or handling of the hearing aid by the wearer. For example, in replacing the wax guard baffle or cleaning the earwax from the baffle, the wearer frequently tears or cuts the soft resilient rubber boot, thereby causing the boot to peel away or split to expose the receiver. In addition, the flexible or resilient neck of the boot which attaches to the housing sometimes is split or broken due to excessive bending or flexing of the receiver when inserting the receiver into the ear canal or when flexing the receiver upwards out of the way of the battery compartment during battery replacement. Furthermore, in order to provide a covering for the receiver which is adequately strong, the resilient boot must be fairly thick so as to provide sufficient mechanical strength. It has been discovered that the thickness of the boot prevents this hearing aid being used by certain people with hearing deficiencies, since their ear canal is too small to receive the boot covered receiver. It has also been found that insertion of the hearing aid housing in the outer ear of the wearer sometimes causes an irritation or soreness due to engagement of the edge of the housing with the concha of the ear.

The present invention provides an in-the-ear hearing aid which, because of its novel construction, is much less susceptible to damage even when mistreated or mishandled by the wearer.

Basically, the present invention comprises a housing which, when the hearing aid is being used, is fitted in the external ear of the user. The housing has a front face having an upper portion which extends downwardly and inwardly toward a vertical plane, and a lower portion which extends downwardly away from the vertical plane. The housing also has a battery compartment door which forms a part of the front face and which is located between the upper and lower portions of the housing face. An elongated receiver is flexibly mounted to the face of the housing and extends outwardly therefrom, the longitudinal axis of the receiver being generally perpendicular to the upper portion of the housing face. The mounting for the receiver comprises a cup-shaped retainer which has a flexible link extending outwardly from the base of the retainer in the direction of the longitudinal axis of the retainer. The receiver member has an electrical input and an acoustic output end, and the electrical input end is mounted within the cup-shaped retainer with the acoustic output end of the receiver extending out of the retainer. The flexible link of the retainer is mounted or connected to the upper face of the housing. An elongated hollow cap member, preferably of plastic, is placed over the portion of the receiver which extends out of the cup-shaped retainer, the hollow cap thereby enclosing the exposed portion of the receiver. The end of the hollow cap adjacent the acoustic output end of the receiver has a plurality of apertures therethrough to allow transfer of the acoustic energy output from the receiver to the user's eardrum. A generally umbrella-shaped tip is mounted in spaced relation to the end of the cap member to cover the apertures through the end of the cap and prevent earwax from plugging the cap apertures, however, as mentioned previously, the tip is spaced from the end of the cap so as to allow transfer of acoustic energy. The hollow cap which encloses the hearing aid receiver, is readily removable so that the entire cap may be replaced in the event of damage. In the event the cap apertures become plugged with earwax, the cap is readily removable for cleaning.

Since the elongated receiver is mounted such that its longitudinal axis is perpendicular to the angulated upper face of the hearing aid housing, the receiver extends outwardly from the housing at an angle. The angle at which the receiver extends from the housing is chosen to closely approximate the approach angle of the human ear canal so as to facilitate insertion of the receiver into the ear canal, and also to minimize any strain on the flexible link or mounting between the retainer and the hearing aid housig. In addition, the amount of angulation of the lower portion of the hearing aid face is chosen to closely approximate the angle of the concha of the ear so as to prevent or minimize engagement of the housing with the ear concha, thereby preventing any soreness of the ear which may be occasioned by the wearing of the hearing aid.

It is one object of the present invention to provide an improved in-the-ear hearing aid.

Another object of the present invention is to provide an in-the-ear hearing aid, wherein the hearing aid receiver is mounted at an angle closely approximating the approach angle of the human ear canal.

A further object of the present invention is to provide an in-the-ear hearing aid having an improved receiver mounting and cover.

These and other objects of the present invention will become apparent to those skilled in the art upon consideration of the accompanying specification, claims, and drawings.

Referring to the drawings, wherein like characters indicate like parts throughout the several views:

FIG. 1 is a side elevation of a hearing aid of the present invention;

FIG. 2 is a front elevation of a hearing aid of the present invention;

FIG. 3 is a rear elevation of a hearing aid of the present invention;

FIG. 4 is an exploded view in perspective of the structure of the present invention;

FIG. 5 is a view in vertical section as seen from the line 5—5 of FIG. 2;

FIG. 6 is a perspective view of the retainer mounting plate utilized in the present invention;

FIG. 7 is a perspective view of the retainer housing utilized in the present invention for mounting the receiver and receiver cap;

FIG. 8 is a sectional view as seen from the line 8—8 of FIG. 5;

FIG. 9 is a sectional view as seen from the line 9—9 of FIG. 1; and

FIG. 10 is a view showing the hearing aid of the present invention in operable position within the ear of the user.

Referring to the drawings, there is shown an in-the-ear hearing aid **20** comprising a housing **21** adapted to be worn in the external ear of the user, housing **21** having a front face with an upper portion **22**, an intermediate portion **23**, and a lower portion **24**. The intermediate portion **23** of the front face of housing **21** is generally parallel to a vertical plane, while the upper portion **22** of the front face of housing **21** extends downwardly and inwardly toward the vertical plane, and the lower portion **24** of the front face of housing **21** extends downwardly and away from the vertical plane. The upper portion **22** of the front face of housing **21** is at an angle of approximately 7° with the vertical plane of the intermediate portion **23** of the front face, while the lower portion **24** is at an angle of approximately 15° with the vertical plane through the intermediate portion **23** of the front face of housing **21**.

The housing **21** is divided into a first end compartment **25**, a center compartment **26**, and a second end compartment **27**. End compartment **25** is separated from center compartment **26** by a wall **30**; while end compartment **27** is separated from center compartment **26** by a wall **31**.

An aperture **32** extends through an outer wall of housing **21** into end compartment **25**, aperture **32** having a grommet **33** fitted therein. Grommet **33** in turn has an aperture **34** therethrough. A microphone grill plate **35** is positioned over aperture **32** on the outside of housing **21** and is held in place by means of a cap **36**.

An aperture **37** extends through a wall of housing **21** into end compartment **25**, aperture **37** having a volume control potentiometer **40** fitted therein. A seal ring **41** and an adjustment wheel **42** are attached to potentiometer **40** by means of a screw **43**, as shown in FIGS. 4 and 5, and a cap **44** is fastened to the adjustment wheel **42** to cover the end of the screw **43**.

A microphone **45** having an acoustic output aperture **46**, is shock-mounted by means of rubber or other suitable resilient supporting members **47** and is positioned in end compartment **25** so that the microphone aperture **46** is adjacent aperture **34** of grommet **33**. End compartment **25** is sealed by means of the lower portion **24** of the front face of housing **21**.

A first conducting plate **50** is clipped over wall **30** and extends along the face of wall **30** in center compartment **26**, while a second conducting plate **51** is clipped over wall **31** and extends along wall **31** in the center compartment **26**. A generally arcuate, wafer-type battery holder **52** is pivotally mounted between walls **30** and **31** and swings closed into center compartment **26** of housing **21**. Battery holder **52** is adapted to hold a wafer-type battery (not shown) which makes electrical contact with the conducting plates **50** and **51** when the battery compartment **52** is in a closed position within the center compartment **26** of housing **21**. The front face of the battery holder **52** forms the intermediate portion **23** of the front face of the housing **21**.

An amplifier circuit shown generally at **53** is mounted on a printed circuit board **54**. Amplifier **53** can be of any conventional audio-amplifier design and the details of a particular amplifier design are not shown. Amplifier **53** and printed circuit board **54** are mounted in end compartment **27** and are insulated from the conducting plate **51** by means of an insulating spacer **55**. Suitable conducting means (not shown) connect the microphone **45** to the input of amplifier **53**, and in addition connect the battery plates **50** and **51** to amplifier **53** to provide an energizing source for the amplifier.

A hollow generally cup-shaped retainer **56** is formed from soft drawn brass, or other suitable material, and has a lip **57**. A first finger **60** extends outwardly from one side of the lip **57** of retainer **56** in generally the same direction as the longitudinal or depth axis of the retainer **56**. Similarly, a second finger **61** extends outwardly from an opposite side of the lip **57** of retainer **56**; finger **61** being generally parallel to finger **60**.

The retainer **56** is covered by any suitable soft resilient material **62**, such as silicone rubber, which is vulcanized directly to the retainer **56** itself. Retainer **56** has a plurality of apertures **64** therethrough which improves the vulcanizing bond between the silicone rubber covering and the retainer **56**.

A portion of the silicone rubber covering of the retainer **46** extends outwardly from the base of retainer **56** in generally the same direction as the longitudinal axis of the retainer and forms a flexible link **65**. The end of the flexible link **65** is vulcanized to an anchor plate **66** which has a plurality of apertures **67** therethrough to increase the bonding between the silicone rubber of link **65** and the anchor plate **66**.

The upper portion **22** of the front face of housing **21** comprises a cover **68** and a clamp **70**. The cover **68** has a groove **71** therein, groove **71** having generally straight side walls and a generally semicircular bottom. The clamp **70** has a generally semicircular groove **72** therein, while the width of the clamp **70** is approximately the same as the distance between the generally straight side walls of the groove **71** in cover **68**.

The flexible link **65** is positioned in the semicircular bottom of the groove **71** of cover **68** and the clamp **70** is then inserted into the groove **71** of the cover **68** adjacent the straight side walls thereof, and is sealed to the cover **68**, the semicircular bottom of groove **71** and the semicircular groove **72** of the clamp **70** thereby forming a generally circular aperture through the upper portion **22** of the front face of housing **21**, the generally circular aperture containing the flexible link **65**. Removal of the flexible link **65** from the generally circular aperture in the upper portion **22** of the front face of housing **21** is prevented by the anchor plate **66** which is bonded to the end of the flexible link **65**. The upper portion **22** is then sealed to the housing **21** and thereby encloses the compartment **27** of housing **21**. A suitable insulating material **73** is positioned between the amplifier **53** and printed circuit board **54** and the upper portion **22** of the front face of housing **21**.

An elongated receiver member **74** has an acoustic output aperture **75** at one end thereof; receiver member **74** being capable of producing an acoustic output when energized,

The electrical input end of receiver **74** is located opposite the acoustic output end, and contains electrical input terminals **76** and **77**. Receiver **74** further has opposite side walls **80** and **81**. The electrical input end of the elongated receiver **74** is mounted in the cup-shaped retainer **56** with the finger **60** of retainer **56** contacting side **80** of receiver **74** and finger **61** of retainer **56** contacting side **81** of receiver **74** to hold the electrical input end of receiver **74** within retainer **56**.

An elongated thin-walled hollow cap member **82** is positioned over the receiver **74** and encloses the portion of receiver **74** which extends out of retainer **56**. Opposite inside walls of the cap **82** are provided with grooves **69** which receive each one of the fingers **60** and **61** of retainer **56** and thereby hold the cap **82** in position enclosing receiver **74**. Cap **82** has a double tapered central aperture **83** in the end thereof adjacent the acoustic output **75** of receiver **74**, and further has a plurality of apertures **84** spaced radially outwardly from the central aperture **83**.

A generally umbrella-shaped, or spherical segment-shaped, tip **85** has a stud **86** extending outwardly from one face thereof, stud **86** being centrally located on the axis of tip **85**. The end of stud **86** terminates in a ball **87** which is frictionally held in the double tapered central aperture **83** in the end of cap **82**. The tip **85** is held in a spaced relationship from the end of cap **82** by means of a plurality of uniformly spaced protrusions **88** formed on the surface of tip **85** facing the end of cap **82**. A pair of electrical leads **90** are connected from the output of amplifier **53** to the electrical input terminals **76** and **77** of receiver **74**.

FIG. 10 shows a view of the hearing aid **20** mounted in the ear A of a user. As shown in FIG. 10, the housing **21** is worn in the exterior ear while the angulated receiver **74** covered by the cap **82** is in the ear canal B of the user. As can be seen in FIG. 10, the angle of the receiver closely approximates the approach angle of the ear canal B so that a minimum amount of stress or flexing is imparted to the flexible link **65** thereby preventing excessive flexing to the link **65** and also reducing the pressure applied to the user's ear canal. It can also be seen from FIG. 10 that the angulation of the lower portion **24** of housing **21** closely approximates the angle of the concha C of the ear A so that any contact of the hearing aid housing with the external ear A which is distributed over the lower portion of the front face **24** of housing **21** is not concentrated at a relatively sharp corner of the housing. This prevents soreness of the user's ear A due to contact of the hearing aid housing **21** with the ear concha C.

It is to be understood that while we have shown a specific embodiment of our invention, that this is for the purpose of illustration only, and that our invention is to be limited by the scope of the appended claims.

We claim as our invention:

1. In an in-the-ear hearing aid the improvement comprising:

(a) a housing adapted to be fitted into the ear of the user and having a front face;

(b) said front face having an upper portion extending downwardly and inwardly toward a perpendicular plane, said front face having a lower portion extending downwardly and away from said perpendicular plane;

(c) a cup-shaped retainer having a flexible link extending outwardly from the base thereof in the direction of the longitudinal axis of said retainer, said retainer further having fingers extending outwardly from opposite sides of the lip of the cup-shaped retainer in generally the same direction as said longitudinal axis;

(d) means connecting the flexible link of said retainer to said housing with the longitudinal axis of said retainer generally perpendicular to the upper portion of the front face of said housing;

(e) an elongated received member having an acoustic output end and an electrical input end, said electrical input end being positioned in said cup-shaped retainer with the fingers of said retainer contacting opposite sides of said receiver member;

(f) an elongated hollow cap member enclosing the portion of said receiver extending out of said retainer, said hollow cap member having opposite inner walls engaging the fingers of said retainer; and

(g) said hollow cap member having at least one aperture through an end thereof adjacent the acoustic output of said receiver.

2. In an in-the-ear hearing aid the improvement comprising:

(a) a housing adapted to be fitted into the ear of the user and having a front face;

(b) said front face having an upper portion extending downwardly and inwardly toward a perpendicular plane;

(c) a cup-shaped retainer having a flexible link extending outwardly from the base thereof in the direction of the longitudinal axis of said retainer, said retainer further having fingers extending outwardly from opposite side of the lip of the cup-shaped retainer in generally the same direction as said longitudinal axis;

(d) means connecting the flexible link of said retainer to said housing with the longitudnal axis of said retainer generally perpendicular to the upper portion of the front face of said housing;

(e) an elongated receiver member having an acoustic output end and an electrical input end, said electrical input end being positioned in said cup-shaped retainer with the fingers of said retainer contacting opposite sides of said receiver member;

(f) an elongated hollow cap member enclosing the portion of said receiver extending out of said retainer, said hollow cap member having opposite inner walls engaging the fingers of said retainer; and

(g) said hollow cap member having at least one aperture through an end thereof adjacent the acoustic output of said receiver.

3. In an in-the-ear hearing aid the improvement comprising.

(a) a housing adapted to be fitted into the ear of the user and having a front face;

(b) said front face having an upper portion extending downwardly and inwardly toward a perpendicular plane;

(c) a cup-shaped retainer having a flexible link extending outwardly from the base thereof in the direction of the longitudinal axis of said retainer;

(d) means connecting the flexible link of said retainer to said housing with the longitudinal axis of said retainer generally perpendicular to the upper portion of the front face of said housing;

(e) an elongated receiver member having an acoustic output end and an electrical input end, said electrical input end being mounted in said cup-shaped retainer;

(f) an elongated hollow cap member enclosing the portion of said receiver extending out of said retainer;

(g) said hollow cap member having at least one aperture through an end thereof adjacent the acoustic output of said receiver.

4. In an in-the-ear hearing aid the improvement comprising:

(a) a housing adapted to be fitted into the ear of the user, said housing having a front face;

(b) said front face having an upper portion and a lower portion, said lower portion extending downwardly and away from a perpendicular plane; and

(c) an elongated receiver member flexibly mounted to said housing and extending outwardly therefrom, the longitudinal axis of said elongated receiver being generally perpendicular to the upper portion of the front face of said housing.

5. In an in-the-ear hearing aid the improvement comprising:

(a) a housing adapted to be fitted into the ear of the user and having a front face;

(b) said front face having an upper portion extending downwardly and inwardly toward a perpendicular plane, said front face having a lower portion extending downwardly and away from said perpendicular plane;

(c) a cup-shaped retainer having a flexible link extending outwardly from the base thereof in the direction of the longitudinal axis of said retainer;

(d) means connecting the flexible link of said retainer to said housing with the longitudinal axis of said retainer generally perpendicular to the upper portion of the front face of said housing;

(e) an elongated receiver member having an acoustic output end and an electrical input end, said electrical input end being mounted in said cup-shaped retainer;

(f) an elongated hollow cap member enclosing the portion of said receiver extending out of said retainer;

(g) said hollow cap member having at least one aperture through an end thereof adjacent the acoustic output of said receiver.

6. In an in-the-ear hearing aid the improvement comprising:

(a) a housing adapted to be fitted into the ear of the user, said housing having a front face;

(b) said front face having an upper portion extending downwardly and inwardly toward a perpendicular plane; and

(c) an elongated receiver member mounted to extend outwardly from said housing, the longitudinal axis of said elongated receiver being generally perpendicular to the upper portion of the front face of said housing.

7. In an in-the-ear hearing aid the improvement comprising:

(a) a housing adapted to be fitted into the ear of the user;

(b) a cup-shaped retainer having a flexible link extending outwardly from the base thereof in the direction

of the longitudinal axis of said retainer, said retainer further having fingers extending outwardly from opposite side of the lip of the cup-shaped retainer in generally the same direction as said longitudinal axis;

(c) means connectig the flexible link of said retainer to said housing;

(d) an elongated receiver member having an acoustic output end and an electrical input end, said electrical input end being positioned in said cup-shaped retainer with the fingers of said retainer contacting opposite sides of said receiver member;

(e) an elongated hollow cap member enclosing the portion of said receiver extending out of said retainer, said hollow cap member having opposite inner walls engaging the fingers of said retainer; and

(f) said hollow cap member having at least one aperture through an end thereof adjacent the acoustic output of said receiver.

8. In an in-the-ear hearing aid the improvement comprising:

(a) a housing adapted to be fitted into the ear of the user and having a front face;

(b) said front face having an upper portion extending downwardly and inwardly toward a perpendicular plane, said front face having a lower portion extending downwardly and away from said perpendicular plane; and

(c) an elongated receiver member mounted to extend outwardly from the front face of said housing, the longitudinal axis of said elongated receiver being generally perpendicular to the upper portion of the front face of said housing.

References Cited

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