BTE HEARING AID WITH CUSTOMIZED SHELL AND EARPLUG

FIELD OF THE INVENTION

The present invention relates generally to hearing aids and to methods of manufacturing hearing aids. The invention, more specifically relates to Behind-The-Ear (BTE) hearing aids and methods of preparing them. The invention, still more particularly, relates to custom-made BTE hearing aids.

BACKGROUND OF THE INVENTION

Behind-the-ear (BTE) hearing aids is a subgroup within the general group of hearing aids worn by the ear. Hearing aid supported entirely by the ear are normally divided into three classes: Behind-The-Ear (BTE) hearing aids; In-The-Ear (ITE) hearing aids and Completely-In-the-Canal (CIC) hearing aids. A BTE hearing aid is the largest type and basically incorporates a housing or a shell that is adapted for being placed partially above and partially behind the users outer ear (the pinna). The housing provides a platform and encapsulation for electronic and acoustic components, such as a battery, a microphone, and an amplifier. In some types, the housing also contains a miniature loudspeaker, in the hearing aid parlance usually referred to as a receiver, that connects to a tube for conveying the receiver output into the ear canal of the user. The tube ends in an earpiece that couples with the ear canal. The earpiece may comprise a soft standard plug or it may comprise a customized plug. In use the housing is placed behind the external ear, partially concealed. In some BTE's the housing extends into a hook that serves the purpose of resting the hearing aid housing.

US 6 228 020 shows a hearing aid with a faceplate and a shell customized to fit in the user's ear canal.

WO-98/47319 shows a hearing aid for arrangement in a user's ear canal and including a shell customized to the users ear canal, components and a faceplate.

BTE hearing aids offer space for large batteries, larger amplifiers, telecoils, dual microphones, push buttons and switches to change between various functions etc. Such features are difficult or impossible to implement in smaller types. BTE hearing

aids also permit the arrangement of a microphone and a receiver with a mutual spacing that better permits controlling acoustic feedback from the receiver to the microphone. Some users may find BTE hearing aids more comfortable in wearing. Thus, many users find good reasons to prefer BTE hearing aids rather than ITE or CIC hearing aids.

The state of the art BTE hearing aid comprises a standard housing that is curved to suit the general contour of the cleft between a pinna (left or right) and the skull of a user. The top part of the housing normally extends into a projecting hook that incorporates a sound conduit and provides a grip around the top part of the cleft between pinna and skull.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a shell for a hearing aid that is comfortable in use.

It is a further object of the invention to provide a hearing aid that is simple in manufacture.

It is a further object of the invention to provide a hearing aid that can be manufactured without requiring capital intensive equipment.

It is a still further object to provide a hearing aid with excellent and comfortable retention on the user.

The invention, in a first aspect provides a hearing aid as defined in claim 1.

Within the context of this disclosure the expression a custom shell signifies a shell that includes structure that has been adapted to an individual.

As far as known to the inventor, within the context of BTE hearing aids, customization has only been extended to the preparation of the earpiece, never to the housing.

This hearing aid shell includes a part that is customized to fit the contour of the cleft between a pinna and the skull of an individual. This part will normally rest against corresponding parts of the cleft, and thereby provides for a shell that is superior in fit and comfort. The shell includes a second part that generally completes the shell but that is not necessarily adapted to rest in direct contact with the cleft of the user.

The two parts may be manufactured integrally or they may be manufactured in separate stages and joined together by conventional means.

According to embodiments, the shell may comprise an outlet. The outlet may be an opening for an acoustic output that can be conveyed by a tube to an ear plug inserted in the users ear canal, or it may be an electric lead or a connector for an electric output, that is fed to a receiver arranged spaced from the housing, e.g. in an earpiece, and close to the users ear canal.

Preferably, the outlet is aranged in the second shell part. Keeping the outlet away from the part of the shell intended to rest against the users avoids compromising the fit.

According to an embodiment, the shell may be extended into a hook, and the hook may accommodate the outlet. The hook may be partially customized to the user or it may be a standard shape, suitably arranged on the housing.

According to an embodiment, the shell comprises a third part, that is adapted to fit a part of an arm of a spectacle frame. This provides a superior fit of the hearing aid for a user who wishes to wear spectacles and hearing aids at the same time.

According to an embodiment, the shell may include a faceplate. The faceplate may be a standard plate with various components, possibly cut to match a contour of the custom shell, in order that the shell and the faceplate together will produce a coherent appearance. The faceplate may preferably be arranged in that part of the shell that is not adapted to contact the user directly.

The invention, in a second aspect, provides a hearing aid as defined in claim 13.

This provides a hearing aid with a very comfortable fit. The shell may be prepared to a minimal size, just sufficient to accommodate components as selected by the individual user, thereby less conspicuous.

The invention, in a third aspect, provides a custom BTE hearing aid as defined in claim 16.

According to an embodiment, the tube, or at least a part of it, is semi-rigid or resilient in order that the tube may also serve the purpose of resting the hearing aid on the external ear of the user. The earpiece is adapted, e.g. through resilience or customization to the users ear, to rest in the meatus of the ear canal.

According to an embodiment, the hearing aid comprises an ear plug for contacting the meatus of the users ear canal, a contact element for resting against an inside of the users tragus, and a fixture for holding the ear plug and the contact element together, the fixture having means for adjusting the spacing between the plug and the contact element. This type of plug provides a comfortable, partial support for the earpiece and is adapted to direct sounds amplified by the hearing aid towards the users ear canal. The support is complemented by the contact element, which rests against another part of the ear. The fixture permits adjusting the spacing between the plug and the contact element and thereby permits adapting the hearing aid to different sizes of ears, or to different preferences regarding pretension. The adjustment facility permits customizing the ear plug in order that it may accommodate a wide variety of users.

The invention, in a fourth aspect, provides a method of preparing a Behind-The-Ear hearing aid for an individual as defined in claim 26.

This provides an effective and accurate method for preparing a hearing aid that excels in fit and user comfort.

The invention, in a fifth aspect, provides a method as defined in claim 28.

Further embodiments will appaer from the dependent claims.

Further objects, embodiments and advantages will appear from the detailed part of the specification.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail with reference to the accompanying drawings, where

Fig. 1 illustrates a first step in preparation of a shell;
Fig. 2 illustrates a hearing aid with a housing arranged in a low position behind the ear;
Fig. 3 illustrates a hearing aid with a housing arranged in a medium position behind the ear;
Fig. 4 illustrates a hearing aid with a housing arranged in a high position behind the ear;
Fig. 5 shows a BTE hearing aid with a hook;
Fig. 6 shows a shell for a BTE hearing aid and a faceplate;
Fig. 7 shows a shell joined with a faceplate;
Fig. 8 shows a BTE hearing aid wherein the faceplate is integrated in the shell;
Fig. 9 shows an embodiment with a shell integrated with the faceplate and with a microphone entrance;
Fig. 10 shows a shell before the electronic components having been mounted;
Fig. 11 shows a hearing system comprising a hearing aid, a tube, a connecting element, and an ear plug;
Fig. 12 shows a hearing aid system arranged adjacent a pair of spectacles;
Fig. 13 shows a hearing aid system according to another embodiment, arranged adjacent a pair of spectacles;
Fig. 14 shows a close-up of a shell with an indentation for spectacles;
Fig. 15 represents a hearing aid according to Figure 12 but placed in the cleft between the scull and pinna; and
Fig. 16 shows a hearing aid housing in longitudinal section.

DETAILED DESCRIPTION

A way of preparation of a shell:

The first step in preparing of a shell comprises providing a cast impression 14 behind the ear i.e. in the cleft between the scull 32 and pinna 26 e.g. as the one illustrated in Figure 1. During the casting it is important not to strain or deform pinna in order that the impression will match the actual space of the cleft behind the ear while the ear and the pinna are relaxed. If the hearing aid user normally wears spectacles, an impression of part of an armature of a spectacle frame can be made in the cast impression 14.

The cast impression includes a surface portion directly cast by contact with the user and another surface portion that completes the impression and that has not been in direct contact with the user.

The second step in the preparation is to trim the impression to a desired form. During this second step the impression is waxed and a silicone control form is made. The control form is used to trim the impression further in order to make the final version of the impression. A dummy may be used to determine where the impression should be trimmed. The third step in the preparation is to wax and trim the final impression and the fourth step is to fill the form with an acrylic e.g. beige photoplast and irradiate the form with ultraviolet light, so that the acrylic hardens to a shell. In a fifth step the un-hardened acrylic in surplus is removed and the remaining shell is cut so as to leave a shell of a suitable size with a view to the desired size of the BTE housing and with a planar aperture.

In a further step, a faceplate is adhered to an edge of the aperture and any protruding parts of the faceplate are cut off.

Further steps may be added in the preparation of the shell, such as a step of drilling a sound outlet.

Examples of the BTE hearing aids with housings that are positioned various places behind the ear are shown in the Figures 2-5. The size of housing and thus the shell is selected with a view to the electronics to be mounted inside. If e.g. the hearing aid is to be used for mild to moderate hearing losses, electronic components corresponding to those available for Completely-In-the-Canal, CIC, hearing aids can be used.

The electronic components, e.g. microphone, signal processor and receiver, may be mounted through the battery opening. A sound tube may be connected by one end to a receiver while the other end is pulled through a sound outlet in the shell and connected to an earplug. Alternatively, if e.g. the hearing aid is to be used for high hearing losses, the BTE housing may be connected by an electrical wire to a receiver in an earplug, thereby permitting a higher sound output without causing feedback.

In Figure 2-4 the housing is connected with a connecting element 8 on a tube 9, the tube 9 having a first bend 18 around the top of the pinna of the users ear directing it into the concha of the ear and a second bend 19 to direct an end of the tube into the ear canal of the user. The tube is resilient and assists to keep the housing in a fixed position behind the ear and the earplug 20 in a fixed position in the ear canal.

Figure 5 shows a custom made BTE hearing aid wherein the forward part of the housing is formed as a hook 12 around the top of the ear and a tube 9 is fitted through the outlet opening of the housing.

Figure 6 shows a shell 25 for a BTE hearing aid with a corresponding faceplate 3. The shell 25 has an aperture 1 and an outlet opening 2. The faceplate 3 has a prefabricated entrance opening 4 for mounting a battery compartment, and the dotted line 5 indicates the final contour of the faceplate 3 when mounted onto the shell 25. The faceplate 3 may e.g. be mounted by gluing the faceplate 3 and the shell 25 together. After gluing, the faceplate is trimmed by cutting away the parts protruding beyond the shell aperture. The electronic components are mounted in the shell through the entrance opening after trimming, e.g. as described in WO 98/47319. Figure 7 shows the shell 25 joined with the faceplate 3, a battery door 6 in the faceplate, and the electronic components, such as a microphone, a receiver 7, a signal processor and a telecoil 37. The shell 25 is connected to a tube 9 via a connecting element 8.

The shell comprises a first part 23 that matches a surface of the user and a second part 24, distinguished from the first part by demarcation line 36, that completes the shell. The second part generally includes a faceplate and a transition area connecting the faceplate to the first part. Thus, the first part is fully costumized to the user, the

second part is customized to match the first part along a selected contour, and the faceplate may be a standard shape.

In an alternative embodiment the receiver is placed in the ear plug 20 and connected to the other electrical components in the shell 25 by a wire 29 in the tube 9, thereby allowing a higher sound output (Figure 13). Another design option for adapting the hearing aid for a high sound output is by creating a larger shell 25 and arranging the microphone and the receiver with a mutual spacing so as to decouple feedback inside the housing.

Figure 8 shows a BTE hearing aid wherein the faceplate is integrated in the shell 25. All the electronic components are mounted through a hole in the shell 25 corresponding to the entrance opening in Figure 8.

Figure 9 shows another embodiment of the invention wherein the shell is integrated with the faceplate and has a microphone entrance 10 to which the microphone 11 is mounted to the shell 25. All the electronic components 35 are mounted through an opening in the shell 25 corresponding to the entrance opening 4 in Figure 6.

Figure 10 shows a shell 25 before the electronic components are mounted through the entrance opening 4. The entrance opening 4 corresponds to an opening for a battery compartment and for other details, e.g. as shown in WO 98/47319. In Figure 11 a hearing system 30 comprising a hearing aid 17 a tube 9 and a connecting element 8 and an ear plug 20. A receiver may be arranged in the hearing aid 17 or it may be arranged in the earplug 20. If the receiver is arranged in the earplug 20, a higher output can be achieved without feedback, especially if a closed earplug 20 is used, in this case the receiver may be connected to the electronic components in the hearing aid 17 by a wire 29 in the tube 9.

Figure 12 shows a hearing aid system 30 comprising a hearing aid 17, a tube 9 and an open earplug 20. The hearing aid 17 is adapted for a user wearing spectacles by an indentation 16 in the shell 25. Likewise the hearing aid system 30 showed in Figure 13 also comprises a shell 25 with an indentation 16 for an arm 27 of a pair of

spectacles, the hearing aid system 30 futher has a receiver in the earplug 20 which is connected to the hearing aid by a wire 25.

Figure 14 shows a close-up of a shell 25 with an indentation 16 for spectacles. In this embodiment, the shell comprises a first part 23 customized to the pinna and the skull of the user, a part, i.e. the indentation 16, customized to a shape of the spectacles, and a part, generally designated the second part 24, that completes the shell.

Figure 15 represents a hearing aid 17 according to Figure 12 when placed in the cleft between the scull 32 and pinna 26. In the detailed picture a dotted line connects the first lobe 33 and the second lobe 34, the line indicates the contour of the scull. An indentation 16 like the one for the hearing aid system shown in Figure 13 appears if lobe 33 is removed. Other forms of an indentation 16 in the shell 25 appear by e.g. removing lobe 34 or both lobe 33 and lobe 34.

Figure 16 shows a shell 25 joined with a connecting element 8 and a tube 9 via a bushing 13. The connecting element 8 has interaction means 21 for joining the shell to the bushing 13. Alternatively the connecting element 8 may be connected directly to the shell 25 e.g. by gluing the connecting element 8 to the shell 25. In another embodiment the bushing 13 is integrated in the shell 25.

CLAIMS

1. A custom shell for a BTE hearing aid, said shell comprising

a first part, and

a second part, wherein said first part is adapted to fit the contour of the cleft between a pinna and the skull of an individual.

2. The custom shell according to claim 1, wherein said shell comprises an outlet.

3. The custom shell according to claim 2, wherein said outlet is arranged at least partially in said second part.

4. The custom shell according to claim 2, wherein said outlet is arranged in said second part.

5. The custom shell according to claim 1, said shell comprising

a projection shaped as a hook, said projection accommodating said outlet.

6. The custom shell according to any of the preceding claims, comprising a third part, said third part adapted to fit a part of an arm of a spectacle frame.

7. The custom shell according to any of the preceding claims, wherein said second part comprises a faceplate.

8. The custom shell according to any of the preceding claims, wherein said first part and said second part are manufactured integrally.

9. The custom shell according to any of the preceding claims, wherein said second part comprises an entrance opening.

10. The custom shell according to any of the preceding claims, wherein said outlet comprises an acoustic opening.

11. The custom shell according to any of the preceding claims, wherein said outlet comprises an electric cable.

12. The custom shell according to any of the preceding claims, wherein said outlet comprises an electric connector.

13. A hearing aid, comprising
a battery compartment,
an acoustic output transducer, and
a housing comprising
an aperture,
an outlet,
an amplifier assembly,
a microphone and
a shell, said shell having a part customised to fit the contour of the cleft between a pinna and the scull of an individual.

14. The hearing aid according to claim 13, wherein said acoustic output transducer is arranged in said housing.

15. The hearing aid according to any of the claims 13-14, wherein said aperture is positioned in said shell.

16. A custom BTE hearing aid, comprising
a battery compartment,
an acoustic output transducer, and
a housing comprising
an outlet,
an amplifier assembly,
a microphone,
a shell according to any of the claims 1-12.

17. The hearing aid according to claim 16, wherein said shell comprises a microphone entrance wherein said microphone is arranged.

18. The hearing aid according to any of the claims 16-17, wherein said housing comprises a faceplate, said faceplate.

19. The hearing aid according to claim 18, wherein said faceplate carries said amplifier assembly.

20. The hearing aid according to any of the claims 18-19, wherein said faceplate comprises a battery compartment, arranged in an entrance opening in said housing.

21. The hearing aid according to claim 16, comprising an ear plug for contacting the meatus of the users ear canal, a contact element for resting against an inside of the users tragus, and a fixture for holding the ear plug and the contact element together, the fixture having means for adjusting the spacing between the ear plug and the contact element.

22. The hearing aid according to claim 16, comprising a module comprising said electronic amplifier assembly and said battery compartment, where said module can be inserted and secured into said entrance opening.

23. The hearing aid according to claim 22, wherein said module comprises said microphone.

24. The hearing aid according to any of the claims 16-23, wherein said housing comprises at least two microphones.

25. The hearing aid according to any of the claims 16-23, wherein said outlet is an opening adapted for mounting a tube through.

26. A method of preparing a Behind-The-Ear hearing aid for an individual, said method comprising the steps of

- establishing a representation of the contour of a part of the cleft between the scull and a pinna of said user,
- preparing a housing based on said representation wherein a part of said housing is adapted to fit into said cleft,

- arranging a group of electronic components in said housing, and
- providing a battery compartment,

thereby establishing a Behind-The-Ear hearing aid for the individual.

27. The method according to claim 26, wherein at least one of the electronic components is mounted through an entrance opening in the housing.

28. A method of preparing a Behind-The-Ear hearing aid for an individual, said method comprising the steps of

- establishing a representation of the contour of a part of the cleft between the scull and a pinna of the individual,
- preparing a housing based on said representation wherein a part of said housing is adapted to fit into said cleft,
- arranging at least one microphone, an electronic amplifier assembly and a battery compartment in the housing,
- providing an acoustic output transducer connected to said electronic amplifier assembly,

thereby establishing a behind-the-ear hearing aid for the individual.

29. The method according to claim 28, comprising a step of arranging an acoustic output transducer in the housing.

30. The method according to any of the claims 28-29, comprising a step of connecting a sound tube to said housing.

31. The method according to any of the claims 28-30, wherein said providing step comprises providing a sound tube that is connected to the acoustic output transducer out through an outlet opening in the housing.

32. The method according to any of the claims 28-31, wherein said step of establishing a representation comprises establishing a representation of a part of an armature of a spectacle frame, and said housing is created with a indentation adapted to fit a part of the armature of the spectacle frame.

33. The method according to any of the claims 28-32, comprising a step of connecting a faceplate to the edges encircling an aperture in the shell.

34. The method of preparing a shell for a custom BTE hearing aid, said method comprising the steps of

- establishing a representation of the contour of a part of the cleft between the scull and a pinna of the individual,
- preparing a shell based on said representation wherein a part of said shell is adapted to fit into said cleft.

35. The method according to claim 34, wherein said establishing step comprises establishing said representation with a contour of a part of an arm of a spectacle frame, and said preparing step comprises preparing a shell comprising an indentation for a part of the spectacle arm.