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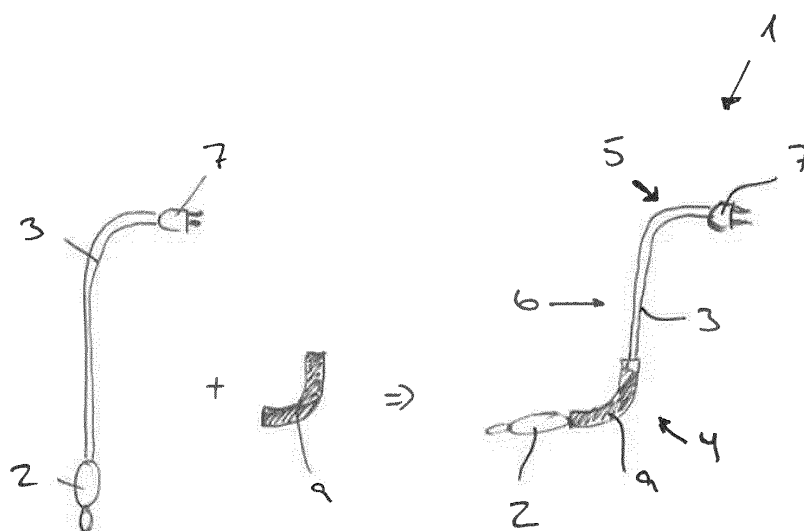
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(54) **A RECEIVER-IN-CANAL ASSEMBLY WITH ADAPTABLE TUBE SHAPE**

(57) The present invention provides a method of manufacturing a receiver-in-canal assembly. The method comprises the steps of providing an elongated tube configured for transfer of a signal; bending the tube to provide a first bent section; arranging a first stiffening

member at the tube to support the tube at the first bent section; and rotating the first stiffening member relative to the tube member to adjust the receiver-in-canal assembly for a right or a left ear of a user.



**Fig. 1**

## Description

### Field of the invention

**[0001]** The present invention relates to a method of manufacturing a receiver-in-canal assembly comprising an elongated tube. Furthermore, the present invention relates to the receiver-in-canal assembly.

### Background of the invention

**[0002]** Traditionally, receiver-in-canal assemblies are manufactured in different sizes and shapes to fit different users. Furthermore, the tubes are manufactured in different shapes dependent on whether the receiver-in-canal assembly is for the left ear or for the right ear of a user. Consequently, the number of configurations has to be multiplied with two, thus doubling the number of different configurations.

### Description of the invention

**[0003]** It is an object of embodiments of the invention to provide an improved method of manufacturing a receiver-in-canal assembly.

**[0004]** It is a further object of embodiments of the invention to provide an improved receiver-in-canal assembly.

**[0005]** It is an even further object of embodiments of the invention to provide a method of manufacturing a receiver-in-canal assembly which reduces the number of different configurations of receiver-in-canal assemblies.

**[0006]** According to a first aspect, the invention provides a method of manufacturing a receiver-in-canal assembly, the method comprising the steps of:

- providing an elongated tube configured for transfer of a signal;
- bending the tube to providing a first bent section;
- arranging a first stiffening member at the tube to support the tube at the first bent section; and
- rotating the first stiffening member relative to the tube to adjust the receiver-in-canal assembly for a right or a left ear of a user.

**[0007]** The method may further comprise a step of providing a receiver housing configured to be positioned in or at the ear canal of a user and being configured to comprise a receiver to output sound, and a step of attaching the receiver housing to a first end of the elongated tube.

**[0008]** Thus, a receiver housing configured to be positioned in or at the ear canal of a user may be provided. The receiver housing is configured to comprise a receiver

to output sound. The receiver housing may comprise a front housing part and a rear housing part. In one embodiment, the receiver may be positioned in the rear housing part. The receiver may be adapted to receive an electrical signal and output a corresponding audio signal.

**[0009]** An elongated tube configured for transfer of a signal is provided. The signal may be provided to the receiver housing. In the context of the present invention, an "elongated tube" should be understood as a hollow tube having a length being considerably longer than the diameter of the tube, such as a length being at least 5 times larger than the largest dimension of the tube in a direction perpendicular to the longitudinal axis. The length of the tube may be in the range of 30-80 mm. The diameter of the tube may be in the range of 0.5-2 mm. The tube may be made from a plastic material, such as a polymer. In one embodiment, the provided elongated tube is straight.

**[0010]** As the signal to be transferred via the tube may be sound and/or an electric signal and/or an optical signal, the elongated tube may comprise at least one wire. The at least one wire may be attached to the inner wall of the tube to ensure that the wire is kept in place both during the manufacturing process and during use of the hearing air. Alternatively, the at least one wire may be moulded into the wall of the tube.

**[0011]** The tube may fulfil the function of a support structure in order to keep the receiver-in-canal assembly on the ear during its use. Thus, the stiffness of the tube may be chosen to fulfil this requirement and also to protect the electrical wires inside the tube.

**[0012]** Furthermore, it may be desirable to use a material having the correct damping-stiffness trade-off in order to both decrease the vibration feedback and to satisfy the minimum stiffness requirements to support the system on the ear.

**[0013]** In addition, the tube material may also fulfil other requirements, such as biocompatibility, transparency, UV stability, chemical stability, and mechanical robustness/flex life and the like.

**[0014]** As an example, the tube may be made of Rilsan (as the main ingredient with other possible ingredients in low ratios), Pebax (as the main ingredient with other possible ingredients in low ratios), or a blend of the two in different percentages.

**[0015]** As an alternative, the tube may be formed as a two-layer tube comprising: an inner polymer layer and an outer barrier layer of a mineral-oil resistant polymer. The inner layer may have a flexural modulus in the range of 200-900 MPa, and a mechanical loss factor between 0.1 and 0.2. A two-layer tube of this type is disclosed in EP 16207544.

**[0016]** The receiver housing may be attached to a first end of the elongated tube.

**[0017]** The method comprises a step of bending the elongated tube to provide a first bent section and a step of arranging a first stiffening member at the tube to support the tube at the first bent section. The first stiffening

member may be made from a material being stiffer than the tube to thereby ensure that the elongated tube is not unbended to form a more or less straight tube. Alternatively or additionally, the stiffening member may due to its material thickness ensure that the elongated tube is not unbended.

**[0018]** Subsequently, the first stiffening member is rotated relative to the tube to adjust the receiver-in-canal assembly for a right or a left ear of a user.

**[0019]** By providing the tube with a bent section and a stiffening member, the tube may be used for both a left and a right ear, as the tube and the stiffening member may rotate relative to each other and thus enable rotating of the tube both toward the right and the left side. This may be achieved as the opposite second end of the tube is rotated with the tube at the first stiffening member, whereby the second end may extend toward two opposite directions when rotating the tube and the stiffening member relative to each other.

**[0020]** In one embodiment, the stiffening member may be releasably attached to the tube. It should however be understood, that the stiffening member may alternatively be fixedly attached to the tube.

**[0021]** The tube may however be able to rotate relative to at least a part of the stiffening member to allow adaptation of the receiver-in-canal assembly to both a right and left ear.

**[0022]** It should be understood, that the elongated tube may be bent to form both a first and a second bent section, where the first bent section is at the first end of the tube being configured for connection to a receiver housing and thus for partly insertion into the ear of a user, whereas the second bent section is at the opposite end of the tube which may be configured for connection to a behind-the-ear part and thus configured for laying on an ear an extending at least partly behind the ear.

**[0023]** In the following, the bent second being closest to the receiver housing will be denoted the first bent section whereas the bent section being further away from the receiver housing will be denoted the second bent section. It should however be understood, that this is a chosen term. The first and second bent sections may just as well be used oppositely, and the chosen terms do not imply any limitation in this regard.

**[0024]** In one embodiment, the step of bending the tube may be carried out by arranging the first stiffening member at the tube thereby provided the first bent section, whereby the two steps are carried out simultaneously.

**[0025]** To facilitate bending of the tube, the shape of the first stiffening member may form the first bent section. Thus, the first stiffening member may have a shape corresponding to the required shape of the first bent section. When arranging the first stiffening member to support the tube at the first bent section, the first bent section may simultaneously form the first bent section.

**[0026]** Consequently, a traditional step of heating a tube to thereby form a bent portion of the tube may be omitted, as the first stiffening member may form the first

bent section.

**[0027]** The method may further comprise a step of providing a connector housing configured to be connected to a behind-the-ear part of a hearing device, and a step of attaching the connector housing to a second end of the elongated tube. The connector housing may comprise a plug part configured for attachment to the elongated tube and a plug base configured for attachment to a behind-the-ear part of a hearing aid.

**[0028]** The behind-the-ear part may comprise electronics, controls, battery, microphone(s), and a receiver, if the receiver is not positioned in the receiver housing. However, an additional receiver may be positioned in the behind-the-ear part, if a receiver is positioned in the receiver housing. As an example, the additional receiver may be a bass receiver.

**[0029]** The behind-the-ear part and the connector housing may be provided with corresponding attachment elements to enable connection of the connector housing to the behind-the-ear part. As an example, these attachment elements may comprise plugs, corresponding inner and outer threading, snap-fit, or other similar attachment means allowing subsequently release of the behind-the-ear part. To enable electrical contact between the two elements, the connector housing may comprise connecting members, e.g. on the outside of the plug base, configured for contact with corresponding connecting members at the behind-the-ear part.

**[0030]** As an alternative, the behind-the-ear part and the connector may be permanently connected to each other after deformation of the tube. This may be achieved by gluing, welding, soldering, or other similar processes.

**[0031]** By positioning the electrical components outside the ear, the risk of moisture and earwax damaging the components can be considerably reduced, which may increase the durability of the hearing aid.

**[0032]** The receiver housing may be made of a soft material, such as silicone, to improve comfort for the user. Alternatively, the receiver housing may be located in a shell made of a soft material, thereby improving the comfort. The receiver housing may be inserted in the shell after permanent deformation of the tube to ensure that the shell is not affected by the heating of the tube.

**[0033]** To improve comfort further, an individual shell may be made for each user to fit the ear of the user. Furthermore, the shell may be provided with a dome to improve comfort. Additionally, the behind-the-ear part may be arc-shaped to facilitate positioning of the hearing aid and the improve comfort.

**[0034]** The receiver housing and the connector housing may be attached to opposite ends of the elongated tube by different processes, such as gluing, welding, soldering, heat shrinking, etc. It should be understood, that the receiver housing may be attached by use of one process, whereas the connector housing may be attached using another process.

**[0035]** The receiver housing and/or the connector housing may be attached before bending the tube. Alter-

natively, the receiver housing and/or the connector housing may be attached after bending the tube.

**[0036]** To facilitate use of the receiver-in-canal assembly at both a right and a left ear, the step of bending the tube may comprise a step of arranging the first bent section and the second bent section in a common plane. The tube may be bended in so that it is symmetrical in the common plane. Thus, the first bent and the second bend may be turned in opposite directions from a straight tube section extending between the two bent sections.

**[0037]** The step of bending the tube may be facilitated by providing a tube which is stiffer at the first and/or second bend sections than at the tube section there between. As this tube section may be substantially straight, it may in the following be denoted a straight tube section. Thus, the Young's modulus at the straight tube section may be lower than at the first and second bent sections.

**[0038]** This may optimise the trade-off between comfort and retention of the receiver-in-canal assembly on the ear of a user by improving comfort without compromising retention.

**[0039]** The application of a substantially straight tube section having a lower stiffness than the first and/or second bent sections may additionally reduce transfer of mechanical vibration through the tube.

**[0040]** To facilitate bending of the elongated tube, the method may comprise a step of modifying the Young's modulus of at least a part of the tube to obtain an uneven Young's modulus at different parts of the tube. Consequently, the elongated tube may be stiffer at the bent section and less stiff at the straight section. The Young's modulus may be modified by either reducing it at at least one part or by increasing it at at least one part of the tube.

**[0041]** Different method steps may be applied to modify the Young's modulus. In one embodiment, the Young's modulus may be modified by chemically treating the tube. As an example, this may be done by saturating the tube material with mineral oil.

**[0042]** In an alternative embodiment, the Young's modulus may be modified by thermally treating the elongated tube or at least a part of it. When thermally treating at least a part of the tube, the crystallinity of this part may be changed whereby the Young's modulus may be reduced or increased at the part in question. Consequently, the bent section may be stiffer whereas the straight section may be less stiff.

**[0043]** In an alternative embodiment, the Young's modulus may be modified by stretching the tube. As an example, the straight section may be less stiff by stretching it and thereby thinning the straight section.

**[0044]** It should be understood, that the different methods of modifying the Young's modulus may be applied alone or in different combinations.

**[0045]** Thus, the method may comprise a step of chemically treating the tube and/or thermally treating the tube and/or stretching the tube to thereby modify the Young's modulus of at least a part of the elongated tube.

**[0046]** In one embodiment, the step of providing the

elongated tube may comprise a step of assembling the tube of a plurality of tube parts. As an example, the first bent section may form part of a first tube part, whereas the second bent section may form part of a second tube part. The straight tube section may likewise be a separate tube part, whereby the elongated tube may be assembled by the first and second tube parts and the straight tube part. It should however be understood, that elongated tube may comprise only two tube parts, or may comprise four or more tube parts.

**[0047]** The different tube parts may be made of different materials and/or with different material thickness thereby providing tube parts having a different Young's modulus.

**[0048]** The step of providing the elongated tube may comprise a step of attaching a plastically deformable element to the tube, where the plastically deformable element is configured to deform upon bending of the tube. The plastically deformable element may counteract the spring back force of the tube when bending the tube.

**[0049]** The plastically deformable element may as an example be attached to a wire or wire bundle within the tube. The plastically deformable element may as example be made from a metal string or wire.

**[0050]** As mentioned above, the step of bending the tube may alternatively or additionally comprise a step of providing and arranging the first stiffening member at the first bent section or the second bent section to support the tube at the first or second bent section. In one embodiment, the method may further comprise a step of bending the tube to provide a second bend, and a step of providing a second stiffening member which may be arranged at the second bent section.

**[0051]** The first and/or second stiffening member may comprise a curved surface whereby the shape of the stiffening member may ensure bending of the tube to thereby provide the first and/or second bent section.

**[0052]** By changing the orientation of the stiffening member relative to the elongated tube, the shape of the tube can be adjusted to fit a right or a left ear thereby adjusting the receiver-in-canal assembly for a right or left ear of a user.

**[0053]** Thus, the possibility of adjusting the shape of the tube by use of a stiffening member may eliminate the need for receiver-in-canal assemblies in separate left and right configurations.

**[0054]** When arranging the first stiffening member to support the first bent section, the distance between the stiffening member and the receiver housing may be varied thereby allowing for adjustment of size of the receiver-in-canal assembly and adjustment of the insertion depth of the receiver housing into the ear of a user.

**[0055]** The step of providing the first stiffening member may further comprise a step of attaching the stiffening member to the tube. It should be understood, that the first and/or second stiffening member may be releasably attached or non-releasably attached to the tube. In one embodiment the stiffening member may be adhesively

attached whereas the stiffening member in an alternative embodiment may be arranged at least partly around the tube and may as an example be kept in place by frictional forces. Other ways of attaching the first and/or second stiffening member to the tube may also be applied.

**[0056]** It should further be understood that the first stiffening member may also be attached to the receiver housing without being attached to the tube itself. Consequently, the first stiffening member may support the first bent section without being attached hereto.

**[0057]** The first and/or second stiffening member may comprise a hollow portion, and the step of bending the tube may comprise a step of inserting the tube through the hollow portion. The hollow portion may circumference a part of the tube or at least partly circumference a part of the tube. Subsequently, the first and/or second stiffening member may be attached to the tube and/or attached to the receiver housing and/or to a connector housing and/or a behind-the-ear part.

**[0058]** The step of attaching the receiver housing to the first end of the tube may comprises a step of fixing the tube to the receiver housing by rotating the tube and the receiver housing relative to each other. The may be achieved by provided the tube and the receiver with a concurrent attachment structure, such as a threaded structure or a bayonet structure. It should be understood, that the concurrent attachment structure of the tube may form part of the first stiffening member configured for attachment of the tube to the receiver housing and configured for supporting the first bent section.

**[0059]** According to a second aspect, the invention provides a receiver-in-canal assembly comprising:

- a receiver housing configured to be positioned in or at the ear canal of a user, and further being configured to comprise a receiver to output sound; and
- an elongated tube configured for transfer of a signal to the receiver housing, the receiver housing being attached to a first end of the elongated tube;

wherein the tube comprises a first bent section supported by a first stiffening member, the first stiffening member being rotatable relative to the tube to enable adjustment of the receiver-in-canal assembly for a left and a right ear of a user.

**[0060]** It should be understood, that a skilled person would readily recognise that any feature described in combination with the first aspect of the invention could also be combined with the second aspect of the invention, and vice versa.

**[0061]** The method according to the first aspect of the invention is very suitable for manufacturing a receiver-in-canal assembly according to the second aspect of the invention. The remarks set forth above in relation to the method are therefore equally applicable in relation to the receiver-in-canal assembly.

**[0062]** The receiver-in-canal assembly may comprise

a connector housing configured to be connected to a behind-the-ear part of a hearing device. The connector housing may be attached to a second end of the elongated tube. This should be understood, that the second end of the tube may in an alternative embodiment be directly attached to a behind-to-ear part without the use of a connector housing.

**[0063]** The elongated tube may comprise a plurality of tube parts, such as two, three, four, or even more tube parts. As an example, the first bent section may form part of a first tube part, whereas a second bent section may form part of a second tube part. A straight tube section may likewise be a separate tube part.

**[0064]** The different tube parts may be made of different materials and/or with different material thickness.

**[0065]** The receiver-in-canal may further comprise a plastically deformable element attached to the tube, where the plastically deformable element may be configured to deform upon bending of the tube.

**[0066]** As mentioned above, the receiver-in-canal assembly comprises a first stiffening member arranging at the first bent section to support the tube at the first bent section. The receiver-in-canal assembly may further comprise a second stiffening member arranged at the second bent section to support the tube at the second bent section.

**[0067]** The first and/or second stiffening member may be made of a plastic material, such as polycarbonate. It should be understood, that other materials may also be used.

**[0068]** To facilitate attachment of the tube to the receiver housing, the receiver housing may comprise a first locking structure and the tube may comprises second locking structure, where the first and second locking structures are configured for locking of the tube to the receiver housing by engagement between the first and second locking structure.

**[0069]** In one embodiment, the first locking structure and the second locking structure may be configured for releasably engagement of the tube to the receiver housing. This may facilitate replacement of the tube is case of the need for repair.

**[0070]** The first locking structure may form part of the receiver housing. In a specific embodiment, the first locking structure may be formed integrally with the receiver housing. However, in one embodiment, the first locking structure may be attached to an end face of the receiver housing.

**[0071]** Alternatively or additionally, the first locking structure may at least partly cover the receiver housing. As an example, the first locking structure may form a cavity having an inner shape matching a part of the outer shape of the receiver housing and being configured for receipt of at least a part of the receiver housing. By forming the cavity with an inner shape matching the at least a part of the outer shape of the receiver housing rotation and displacement of the first locking structure and the receiver housing may be prevented.

**[0072]** At least one of the first locking structure and the second locking structure may be movable relative to the receiver housing and tube, respectively, to enable fixing of the tube to the receiver housing. As an example, the first or second locking structure may comprise or may form a resilient part which upon compression is receivable in a matching indentation or through hole in the opposite of the first and second locking structure, thereby forming a snap-fit locking. It should be understood, that the first or second locking structure may comprise two or more resilient parts each being receivable in a matching indentation or through hole in the opposite of the first or second locking structure.

**[0073]** In an alternative embodiment, the first locking structure and the second locking structure may be configured for engagement by mutual rotation of the receiver housing and the tube. As an example, the first and second locking structures may comprise a matching threading, where the one may be an outer threading and the other one may be an inner threading for engagement by rotation. In an alternative embodiment, one of the first and second locking structures may comprise at least one protrusion which is receivable in a track formed in the other one of the first and second locking structures thereby forming a bayonet joint. The track may be spiral shaped to facilitate joining of the tube and the receiver housing.

**[0074]** The second locking structure may form part of the first stiffening member. Alternatively, the second locking structure may be a separate element attachable to the first stiffening member or attachable directly to the tube.

**[0075]** In one embodiment, the second locking structure may comprise a flange section extending transverse to the tube at the first end. The first locking structure may comprise an opening to allow the first locking structure to be slid over the second locking structure and tube if the tube has been attached to or engages the second locking structure. The opening may be smaller than the flange section to ensure that the flange section can be fixed by the first locking structure.

**[0076]** It should be understood, that the second locking structure may comprise both a flange section and may comprise a resilient structure or a matching indentation or hole for receiving a resilient structure of the first locking structure thereby forming a two step locking structure.

**[0077]** The second locking structure may be configured to at least partly cover the receiver housing. As an example, the second locking structure may form a cavity having an inner shape matching a part of the outer shape of the receiver housing and being configured for receipt of at least a part of the receiver housing. By forming the cavity with an inner shape matching at least a part of the outer shape of the receiver housing rotation and displacement of the second locking structure and the receiver housing may be prevented.

**[0078]** To prevent contamination of the receiver housing via the attachment of the tube, a space between an outer surface of the tube and an inner surface of the stiff-

ening member may be at least partly filled with a sealing member. The sealing member may be as an example be a high viscous silicone oil, a synthetic oil, or another suitable sealing material.

**[0079]** To facilitate assembling of the receiver-in-canal assembly, the first stiffening member may comprise a transparent section. Alternatively, the at least one stiffening member may be fully made of a transparent material.

**[0080]** According to a third aspect, the invention provides a method of manufacturing a receiver-in-canal assembly, the method comprising the steps of:

- providing an elongated tube configured for transfer of a signal; and
- bending the tube to providing a first bent section and a second bent section, wherein the elongated tube forms a substantially straight tube section from the first bent section to the second bent section.

**[0081]** It should be understood, that a skilled person would readily recognise that any feature described in combination with the first and second aspects of the invention could also be combined with the third aspect of the invention, and vice versa.

**[0082]** The remarks set forth above in relation to the method and the receiver-in-canal assembly are therefore equally applicable in relation to the method of the third aspect.

**[0083]** The method comprises a step of bending the elongated tube to provide a first bent section and a second bent section, wherein the elongated tube forms a substantially straight tube section from the first bent section to the second bent section.

**[0084]** By providing the tube with a straight tube section extending from a first bent section and a second bent section, the tube may be used for both a left and a right ear, as one of the bent section may be configured for connection to a receiver housing and thus for partly insertion into the ear of a user, whereas the other bent section may be configured for connection to a behind-the-ear part and thus configured for laying on an ear an extending at least partly behind the ear.

#### Brief description of the drawings

**[0085]** Embodiments of the invention will now be further described with reference to the drawings, in which:

Fig. 1 illustrates an embodiment of a receiver-in-canal assembly comprising a first stiffening member,

Fig. 2 illustrates an embodiment of a receiver-in-canal assembly comprising a first and a second stiffening member,

Fig. 3 illustrates an embodiment of a receiver-in-ca-

nal assembly comprising a treated straight tube section,

Fig. 4 illustrates an embodiment of a receiver-in-canal assembly comprising a stretched straight tube section,

Fig. 5 illustrates an embodiment of a receiver-in-canal assembly comprising an elongated tube comprising a plurality of tube parts,

Fig. 6 illustrates an embodiment of a receiver-in-canal assembly comprising a plastically deformable element,

Fig. 7 illustrates an embodiment of a receiver-in-canal assembly,

Fig. 8 illustrates an embodiment of a receiver-in-canal assembly,

Fig. 9 illustrates two embodiments of a receiver-in-canal assembly where the first stiffening member is located at different positions,

Fig. 10 illustrates an embodiment of a first stiffening member,

Fig. 11 illustrates an embodiment of a first stiffening member,

Fig. 12 illustrates an embodiment of a first stiffening member,

Fig. 13 illustrates an embodiment of a receiver-in-canal assembly comprising a stiffening member,

Fig. 14 illustrates an embodiment of a receiver-in-canal assembly comprising a stiffening member,

Fig. 15 illustrates an embodiment of a receiver-in-canal assembly comprising a stiffening member,

Fig. 16 illustrates an embodiment of a receiver-in-canal assembly comprising a stiffening member, and

Fig. 17 illustrates an embodiment of a receiver-in-canal assembly comprising a stiffening member.

#### Detailed description of the drawings

**[0086]** It should be understood that the detailed description and specific examples, while indicating embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

**[0087]** Fig. 1 illustrates an embodiment of a receiver-

in-canal assembly 1. The receiver-in-canal assembly 1 comprises a first stiffening member 9. The receiver-in-canal assembly 1 comprises a receiver housing 2 configured to be positioned in or at the ear canal of a user, and further being configured to comprise a receiver to output sound. Furthermore, the receiver-in-canal assembly 1 comprises an elongated tube 3 configured for transfer of a signal to the receiver housing 2. The receiver housing 2 is attached to a first end of the elongated tube 3. **[0088]** The tube 3 comprises a first bent section 4 and a second bent section 5. The elongated tube 3 forms a substantially straight tube section 6 from the first bent section 4 to the second bent section 5.

**[0089]** In the illustrated embodiment, the receiver-in-canal assembly 1 further comprises a connector housing 7 configured to be connected to a behind-the-ear part (not shown) of a hearing device. The connector housing 7 is attached to a second end of the elongated tube 3.

**[0090]** The embodiment is similar to the embodiments illustrated in Figs. 1 and 2 except for the two stiffening members attached to the tube 3 at opposite ends hereof to support the tube 3 at the ends and to stiffen the first and second ends, respectively. In the illustrated embodiment, the first stiffening member 9 and the second stiffening member 10 are both provided as a pre-bent tubing; i.e. a hollow element through which the tube 3 is inserted. Consequently, the tube 3 is stiffer at both ends than at the straight tube section 6 extending there between.

**[0091]** Fig. 2 illustrates an embodiment of a receiver-in-canal assembly 1 comprising a first stiffening member 9 and a second stiffening member 10. Except for the second stiffening member 10, the embodiment in Fig. 2 is similar to the embodiment in Fig. 1.

**[0092]** Fig. 3 illustrates an embodiment of a receiver-in-canal assembly 1 comprising a treated straight tube section 6. The straight tube section 6 has been chemically and/or thermally treated as illustrated by the hatching. When thermally and/or chemically treating at least a part of the straight tube section, the Young's modulus of the straight tube section may be modified. Consequently, the bent sections 4, 5 may be stiffer whereas the straight section 6 may be less stiff.

**[0093]** Fig. 4 illustrates an embodiment of a receiver-in-canal assembly 1 comprising a stretched straight tube section 6. The straight tube section 6 has been stretched whereby the Young's modulus has been modified to provide a straight section which may be less stiff.

**[0094]** Fig. 5 illustrates an embodiment of a receiver-in-canal assembly 1 comprising an elongated tube 3 comprising a plurality of tube parts 4', 5', 6'. In the illustrated embodiment, the first bent 4 section forms a first tube part 4', whereas the second bent section 5 forms a second tube part 5'. The straight tube section 6 likewise forms a separate tube part 6'. The different tube parts may be made of different materials and/or with different material thickness thereby providing tube parts 4', 5', 6' having a different Young's modulus.

**[0095]** Fig. 6 illustrates an embodiment of a receiver-

in-canal assembly 1 comprising a plastically deformable element 8. The plastically deformable element 8 is attached to wires within the tube 3, and is configured to deform upon bending of the tube 3. The plastically deformable element 8 may counteract the spring back force of the tube when bending the tube.

**[0096]** Fig. 7 illustrates an embodiment of a receiver-in-canal assembly 1 in a top view (upper part of Fig. 7) and in a side view (lower part of Fig. 7). The receiver-in-canal assembly 1 comprises a receiver housing 2 configured to be positioned in or at the ear canal of a user, and further being configured to comprise a receiver to output sound. Furthermore, the receiver-in-canal assembly 1 comprises an elongated tube 3 configured for transfer of a signal to the receiver housing 2. The receiver housing 2 is attached to a first end of the elongated tube 3.

**[0097]** Fig. 8 illustrates a similar embodiment of a receiver-in-canal assembly 1 comprising a receiver housing 2, a connector housing 7, and an elongated tube 3. In Fig. 2 the first and second bent sections 4, 5 are in the same direction, still providing a tube 3 being symmetrical in one plane as illustrated in the upper view (the top view).

**[0098]** Fig. 9 illustrates two embodiments of a receiver-in-canal assembly 1 where the first stiffening member 9 is located at different positions. The embodiment is similar to the embodiment illustrated in Fig. 1. By varying the distance between the stiffening member 9 and the receiver housing 2, it is possible to adjust the size of the receiver-in-canal assembly 1 and to adjust the insertion depth of the receiver housing 2 into the ear of a user. At the left part of Fig. 9 the distance is X, whereas the distance at the right part of Fig. 9 is only half the distance; i.e.  $\frac{1}{2} X$ .

**[0099]** Figs. 10, 11, and 12 illustrate three different embodiments of a first stiffening member 9. The first stiffening member 9 comprises a second locking structure 11 configured for fixing the stiffening member 9 to the receiver housing 2 (not seen in these figures). The second locking structure 11 is configured to partly cover the receiver housing 2. In the illustrated embodiments, the second locking structure 11 forms a cavity 12 having an inner shape matching a part of the outer shape of the receiver housing 2 and being configured for receipt of a part of the receiver housing. Consequently, rotation and displacement of the second locking structure 11 and thereby the tube relative to the receiver housing 2 can be prevented. The second locking structure 9 further comprises a partly open tube 13 forming a track for the tube 3 (not shown). The partly open tube 13 is fixed to the tube by frictional forces. Furthermore, the partly open tube 13 provides support to the first bent section 4 by stiffening the tube 3 at the first bent section.

**[0100]** In Fig. 10 the partly open tube 13 is formed by a tube provided with a slit. The stiffening member 9 illustrated in Fig. 11 is similar to the stiffening member in Fig. 10. However, the locking structure 11 comprises a through hole through which the tube 3 has to be inserted. The stiffening member in Fig. 12 comprises a

partly open tube 13 comprising a number of teeth 14 for attachment of the tube 3 to the stiffening member 9.

**[0101]** Fig. 13 illustrates an embodiment of a receiver-in-canal assembly 1 comprising a stiffening member 9. The first stiffening member 9 comprises a second locking structure 15 in the form of a flange section extending transverse to the tube 3 at the first end. The first locking structure 16 comprises an opening to allow the second locking structure 15 to be slid into the first locking structure 16 transverse to the tube end.

**[0102]** The second locking structure 15 further comprises a resilient structure 17 configured to be received in a matching hole 18 of the first locking structure 16 for receiving the resilient structure 17 of the second locking structure 15 thereby forming a two step locking structure.

**[0103]** Fig. 14 illustrates an embodiment of a receiver-in-canal assembly 1 comprising a stiffening member 9. The first stiffening member 9 comprises a second locking structure 15 in the form of a flange section (not shown) extending transverse to the tube 3 at the first end. The first locking structure 16' comprises a cap with an opening 19 to allow the first locking structure 16' to be slid onto the stiffening member 9.

**[0104]** The second locking structure 15 further comprises a resilient structure 17 configured to be received in a matching hole 18 of the first locking structure 16 for receiving the resilient structure 17 of the second locking structure 15 thereby forming a two step locking structure.

**[0105]** It should be understood, that the embodiments in Fig. 13 and Fig. 14 can be combined into a common embodiment, where the cap 16' forms a cover for the embodiment illustrated in Fig. 13.

**[0106]** Fig. 15 illustrates an embodiment of a receiver-in-canal assembly 1 comprising a stiffening member 9. The receiver housing 2 comprises a first locking structure 20 in the form of two protrusions extending transverse to the tube end. The first stiffening member 9 comprises a second locking structure 21 in the form of a track into which the protrusions 20 are receivable, thereby forming a bayonet joint. The track (not shown) is spiral shaped to facilitate joining of the stiffening member 9 and thus the tube 3 and the receiver housing 2.

**[0107]** Fig. 16 illustrates an embodiment of a receiver-in-canal assembly 1 comprising a stiffening member 9. The first and second locking structures 15, 16 are similar to the locking structures 15, 16 illustrated in Fig. 13. The first stiffening member 9 comprises a second locking structure 15 in the form of a flange section extending transverse to the tube 3 at the first end. The first locking structure 16 comprises an opening to allow the second locking structure 15 to be slid into the first locking structure 16 transverse to the tube end. The first locking structure further comprises a cap 22 comprising a side opening 23 to allow the first locking structure 22 to be slid onto the second locking structure 15 transverse to the tube end.

**[0108]** Fig. 17 illustrates an embodiment of a receiver-in-canal assembly 1 comprising a stiffening member 9.



The first locking member 16" comprises a rear insert with an opening 24 configured to receive the flange section 15' of the second locking structure. The first locking member 16" further comprises an opening 18 configured to receive a resilient structure 17 of the stiffening member 9 of the second locking structure 15. The second locking structure 15 further comprises a flange section 15' extending transverse to the tube 3 at the first end, where the flange section 15' is configured to be received in the opening 25 of the rear insert 16". The first locking structure further comprises a cap 25' with an opening 19 to allow the first locking structure 16" to be slid onto the stiffening member 9.

## Claims

1. A method of manufacturing a receiver-in-canal assembly, the method comprising the steps of:

- providing an elongated tube configured for transfer of a signal;
- bending the tube to providing a first bent section;
- arranging a first stiffening member at the tube to support the tube at the first bent section; and
- rotating the first stiffening member relative to the tube to adjust the receiver-in-canal assembly for a right or a left ear of a user.

2. A method according to claim 1, wherein the step of bending the tube is carried out by arranging the first stiffening member at the tube thereby providing the first bent section.

3. A method according to claim 1 or 2, wherein a shape of the first stiffening member forms the first bent section.

4. A method according to any of the preceding claims, further comprising a step of providing a receiver housing configured to be positioned in or at the ear canal of a user and being configured to comprise a receiver to output sound, and a step of attaching the receiver housing to a first end of the elongated tube.

5. A method according to any of the preceding claims, wherein the step of providing the elongated tube comprises a step of attaching a plastically deformable element to the tube, the plastically deformable element being configured to deform upon bending of the tube.

6. A receiver-in-canal assembly comprising:

- a receiver housing configured to be positioned in or at the ear canal of a user, and further being configured to comprise a receiver to output

sound; and

- an elongated tube configured for transfer of a signal to the receiver housing, the receiver housing being attached to a first end of the elongated tube;

wherein the tube comprises a first bent section supported by a first stiffening member, the first stiffening member being rotatable relative to the tube to enable adjustment of the receiver-in-canal assembly for a left and a right ear of a user.

7. A receiver-in-canal assembly according to claim 6, further comprising a second stiffening member arranging at a second bent section to support the tube at the second bent section.

8. A receiver-in-canal assembly according claim 6 or 7, wherein the receiver housing comprises a first locking structure and the tube comprises second locking structure, the first and second locking structures being configured for locking of the tube to the receiver housing by engagement between the first and second locking structure.

9. A receiver-in-canal assembly according to claim 8, wherein the first locking structure is attached to an end face of the receiver housing.

10. A receiver-in-canal assembly according to claim 8 or 9, wherein the first locking structure at least partly covers the receiver housing.

11. A receiver-in-canal assembly according to any of claims 8-10, wherein at least one of the first locking structure and the second locking structure is movable relative to the receiver housing and tube, respectively, to enable fixing of the tube to the receiver housing.

12. A receiver-in-canal assembly according to any of claims 8-11, wherein the first locking structure and the second locking structure are configured for engagement by mutual rotation of the receiver housing and the tube.

13. A receiver-in-canal assembly according to any of claims 8-12, wherein the second locking structure comprises a flange section extending transverse to the tube at the first end.

14. A receiver-in-canal assembly according to any of claims 6-13, wherein a space between an outer surface of the tube and an inner surface of the first stiffening member is at least partly filled with a sealing member.

15. A receiver-in-canal assembly according to any of

claims 6-14, wherein the at least one the first and second stiffening member comprises a transparent section.

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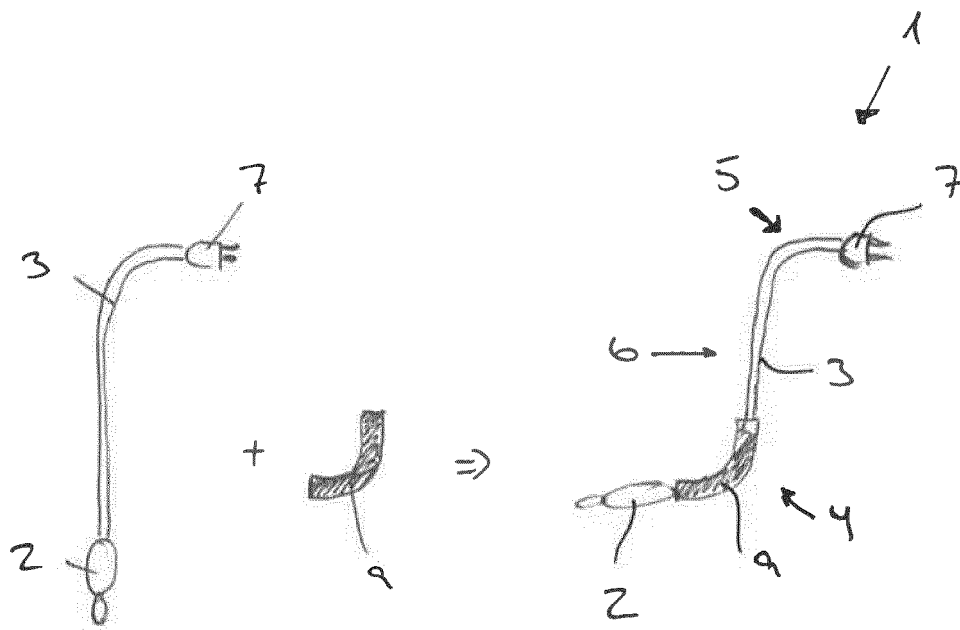


Fig. 1

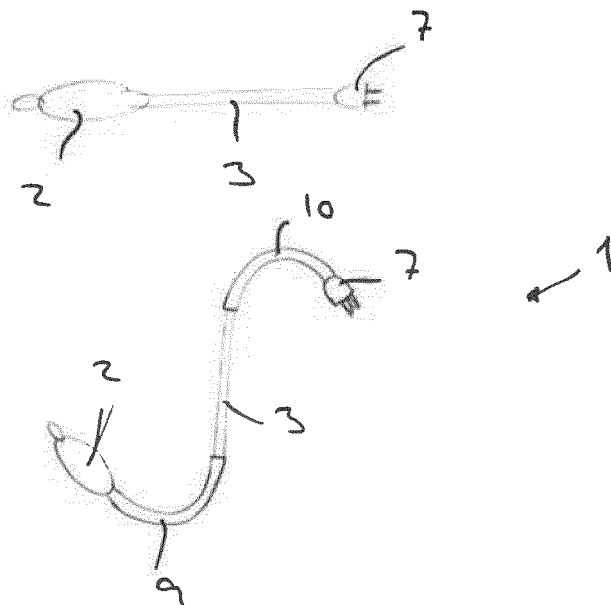


Fig. 2

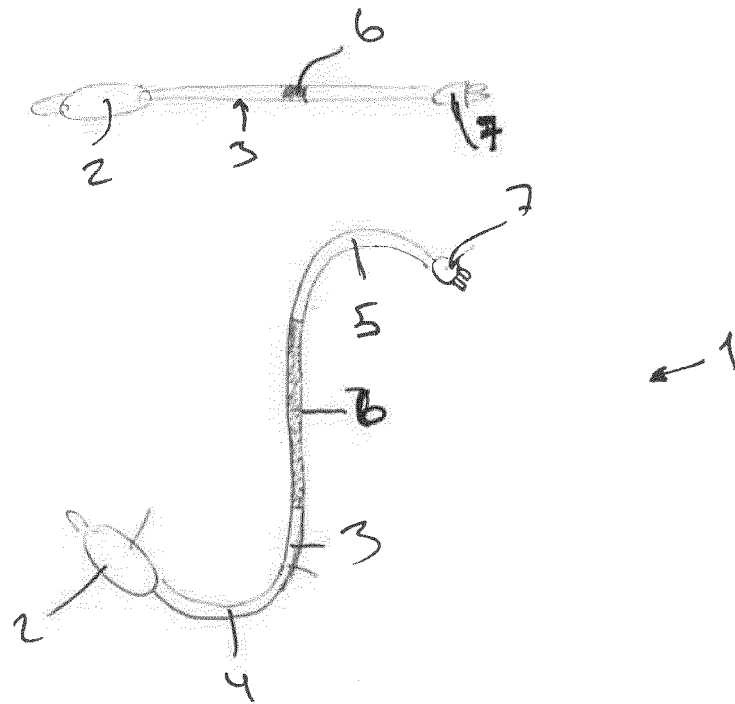


Fig. 3

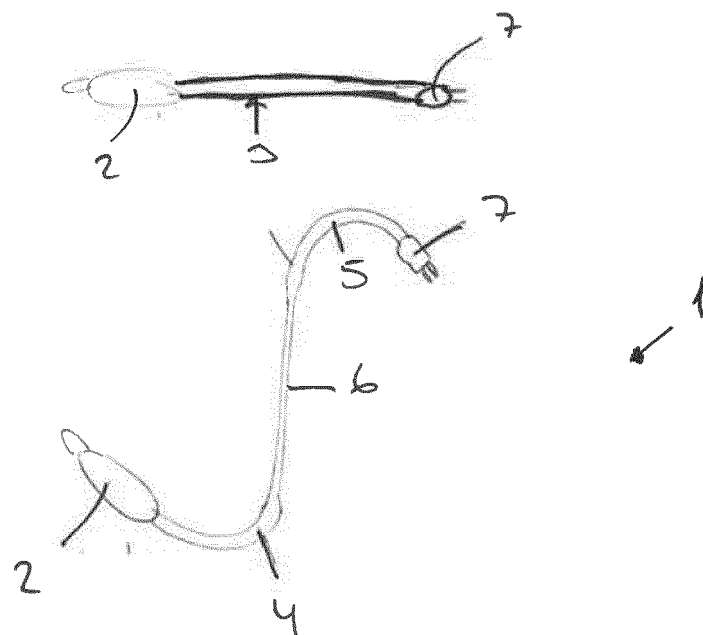


Fig. 4

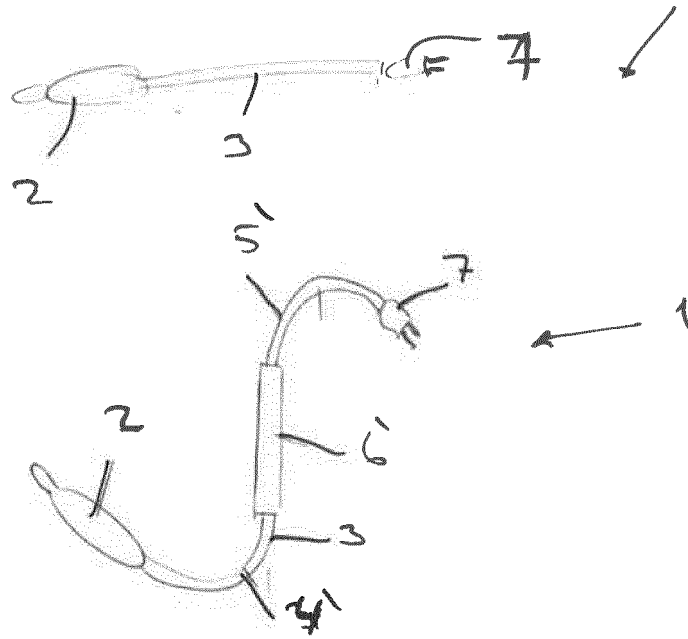


Fig. 5

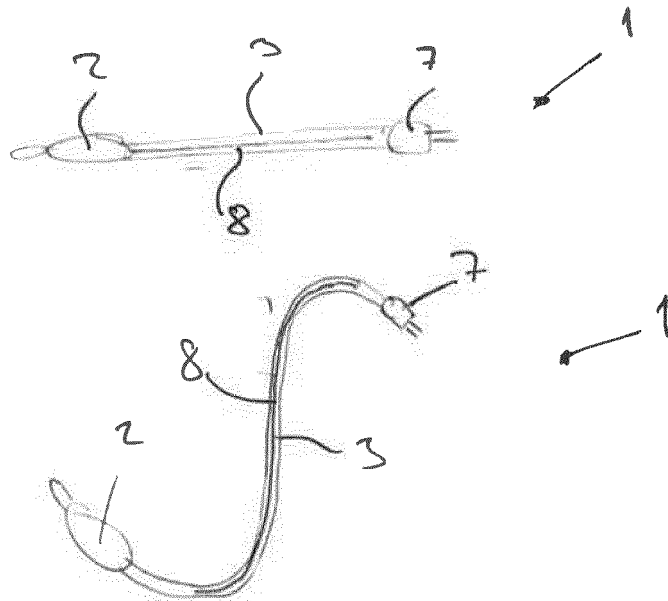


Fig. 6

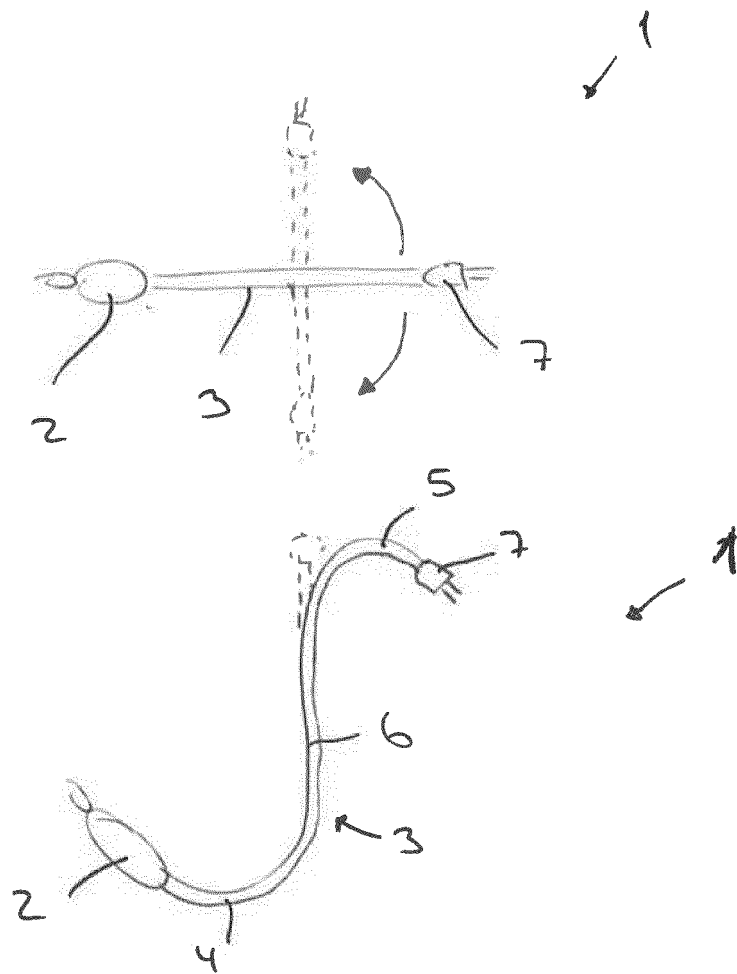


Fig. 7

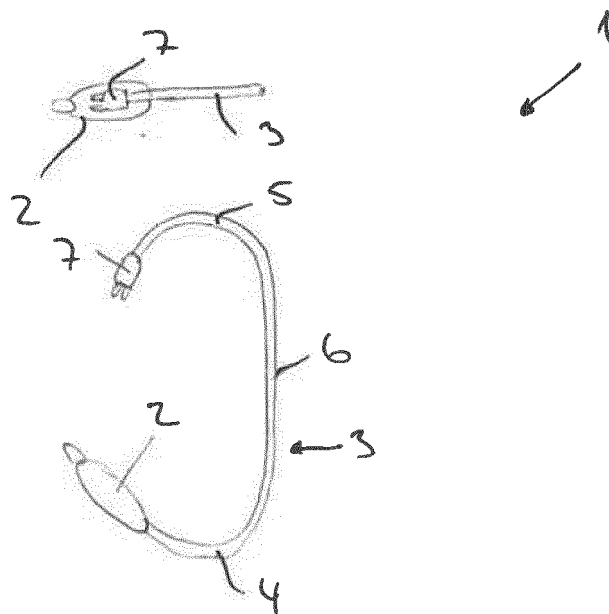


Fig. 8

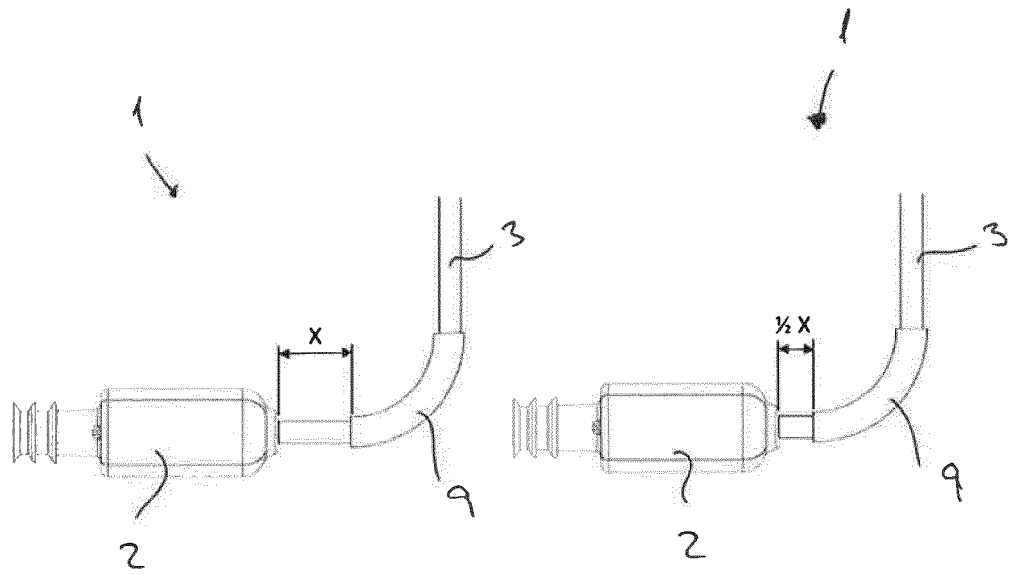


Fig. 9

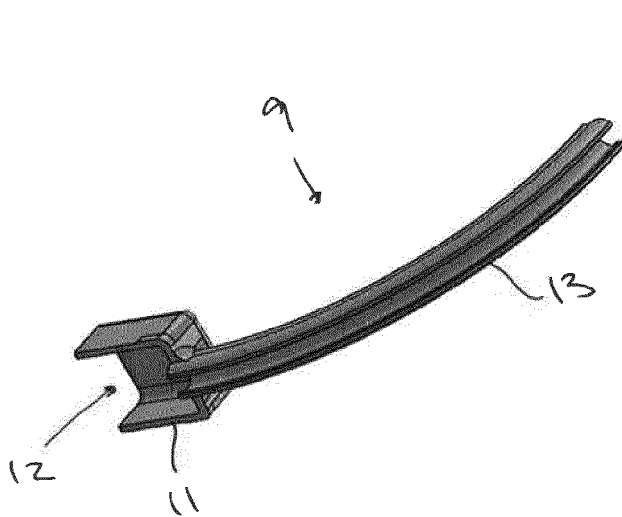


Fig. 10

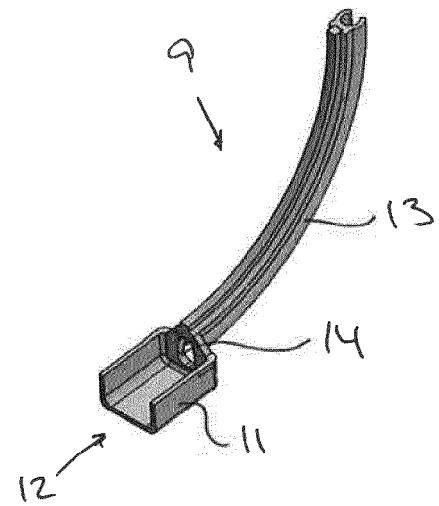


Fig. 11

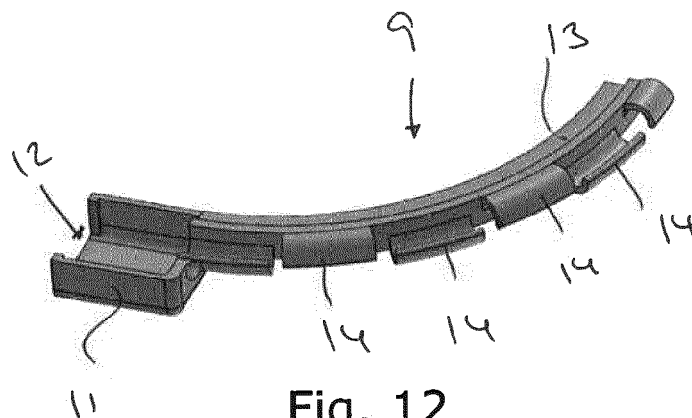


Fig. 12

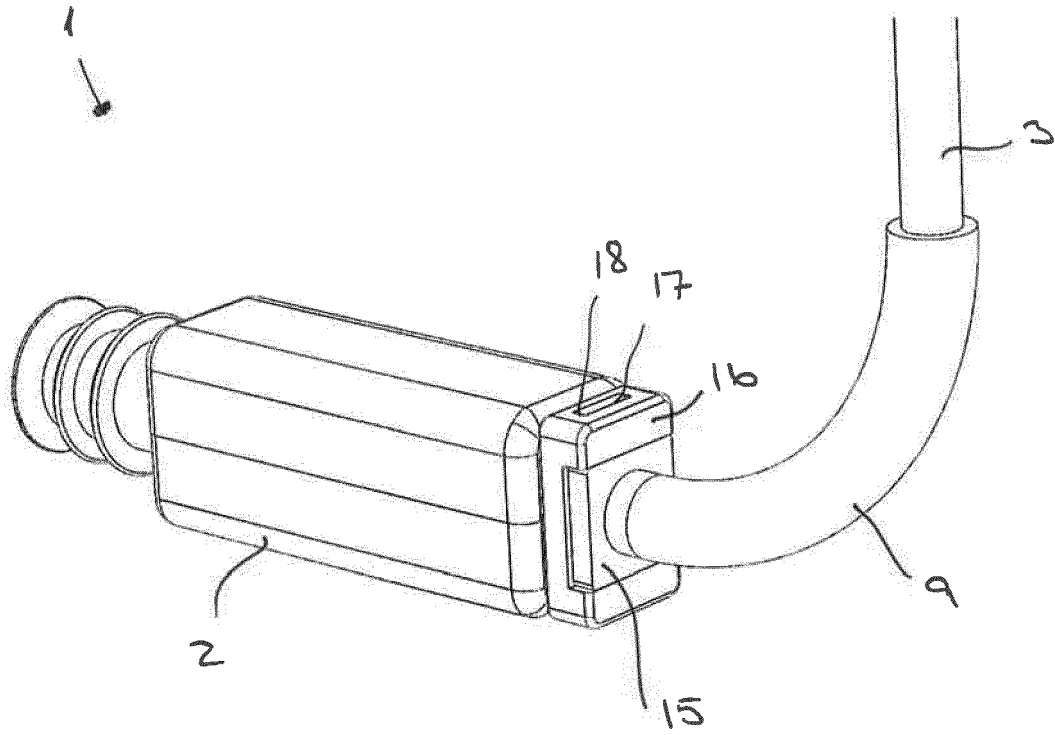


Fig. 13

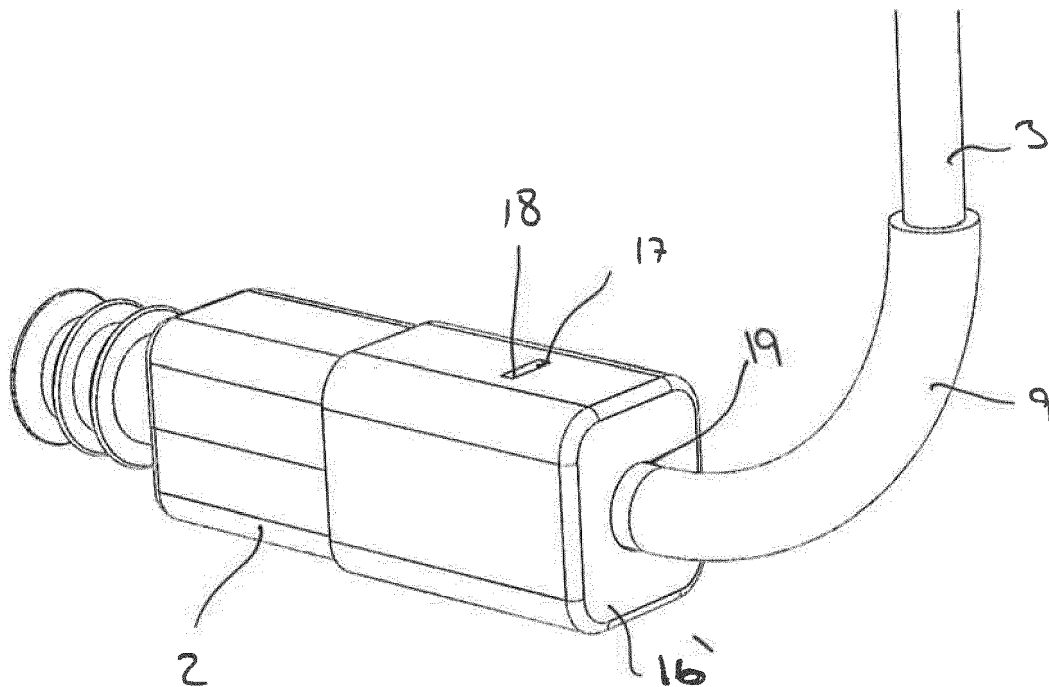


Fig. 14



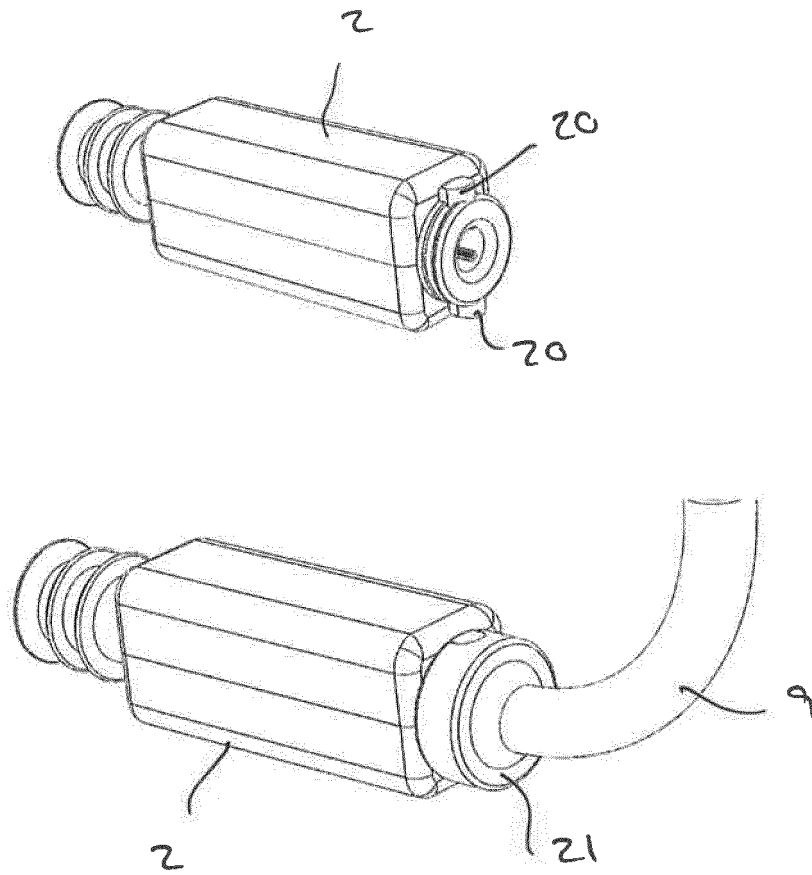


Fig. 15

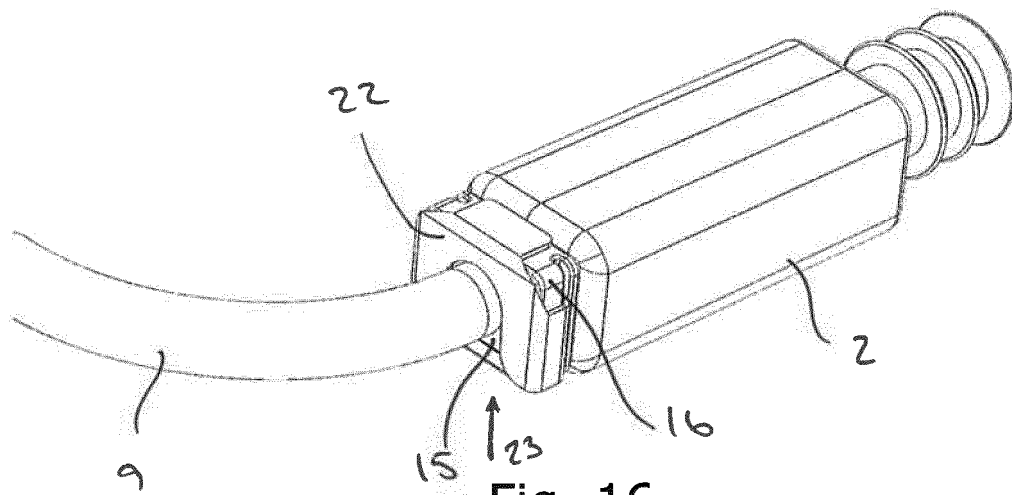
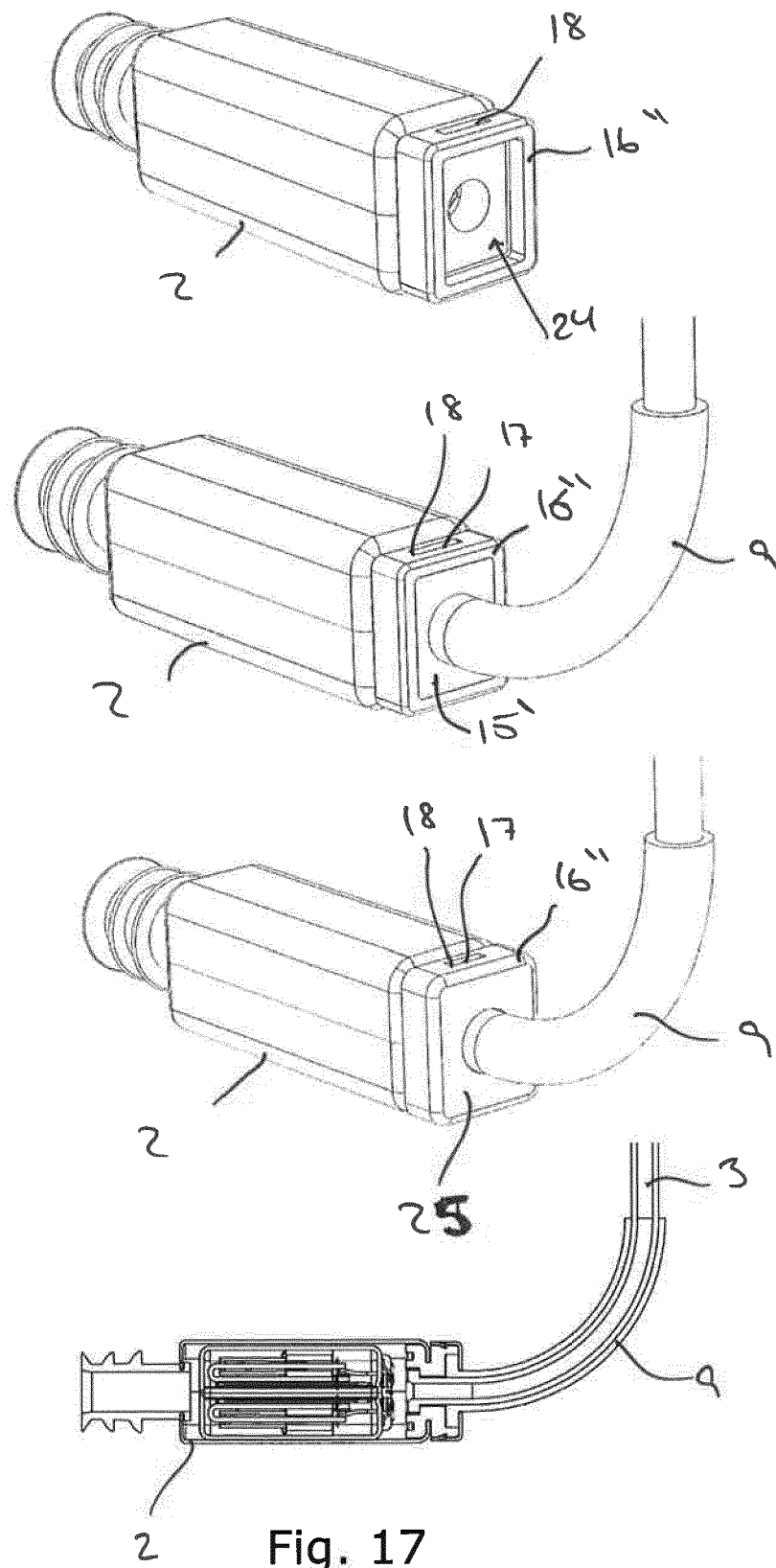


Fig. 16





## EUROPEAN SEARCH REPORT

Application Number  
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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                           |                                  |                                         |                                 |
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| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Citation of document with indication, where appropriate, of relevant passages                                                                                                                                                                                                             | Relevant to claim                | CLASSIFICATION OF THE APPLICATION (IPC) |                                 |
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| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                           |                                  |                                         |                                 |
| Place of search                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                           | Date of completion of the search | Examiner                                |                                 |
| The Hague                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                           | 12 April 2018                    | Valenzuela, Miriam                      |                                 |
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Application Number

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**CLAIMS INCURRING FEES**

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

**LACK OF UNITY OF INVENTION**

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



**LACK OF UNITY OF INVENTION**  
**SHEET B**

Application Number

EP 17 17 9036

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-7, 14, 15

The subject-matter of claims 1-7, 14 and 15 relates to an improved adaptation of the tube shape to the user.

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2. claims: 8-13

The subject-matter of claims 8-13 relates to an improved connection between the tube and the earpiece of a receiver-in-canal hearing aid.

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
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