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(54) **METHOD FOR MANUFACTURING A METAL SHELL FOR A HEARING DEVICE**

(57) The present invention provides a method for manufacturing a metal shell for a hearing device, the metal shell comprising a first opening and a second opening, wherein the second opening is smaller than the first opening, the method comprising: fabricating a preform of the metal shell, the preform comprising a main body defining an internal cavity and at least one sacrificial element formed on the main body, the main body having a first position where the first opening is located and a second position where the second opening is located; smoothening a surface of the preform; and finishing the preform to obtain the metal shell, characterized in that finishing the preform comprises removing the at least one sacrificial element. According to the present invention, it is possible to manufacture simply, efficiently and reliably the metal shell for the hearing device.

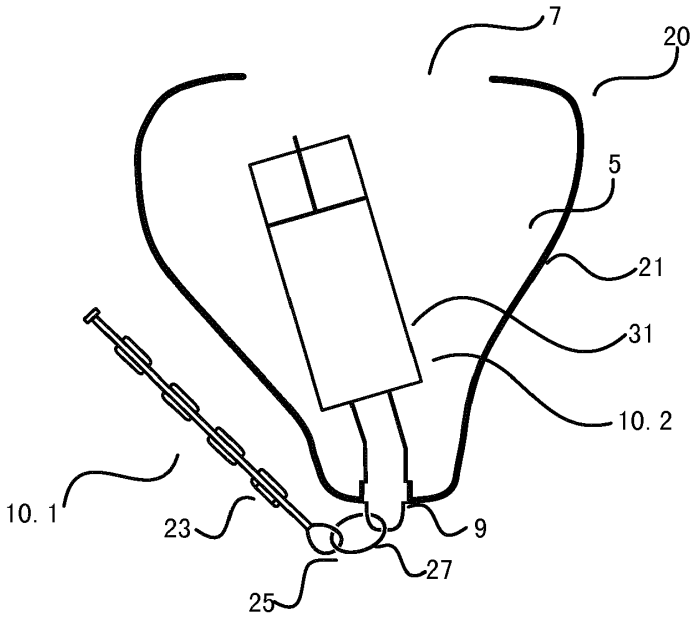

FIG. 2

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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The invention relates to a hearing device, especially to a method for manufacturing a metal shell for a hearing device.

BACKGROUND OF THE INVENTION

[0002] Ear canals of different users have different size and contour. It has been desired for the users to customize a hearing device such as a hearing aid or an earpiece for acoustic coupling, especially a shell for the hearing device. With development of a 3D printing process such as a Selective Laser Sintering (SLS), a customized hearing device becomes a reality because it is cost-effective and time-effective. A metal shell for the hearing device is produced from metal powder using the SLS process. Since metal has a high strength a metal shell may have a thin wall.

[0003] The metal shell for the hearing device generally has at least two openings: a first opening and a second opening. The first opening is usually large and configured for attaching a faceplate or introducing an electronics module or an acoustic component. The second opening is usually small and functions as a sound outlet. The second opening functioning as the sound outlet is positioned at the inner side of the metal shell facing the eardrum of the user when the hearing device is placed into the ear canal of the user. The first opening is positioned at the outer side of the metal shell opposite to the inner side of the metal shell.

[0004] Before manufacturing a metal shell, it is necessary to acquire some data regarding the geometry of the ear canal of the user. This data may be obtained by scanning an impression of the ear canal of the user by means of an ear canal scanner or any other technique. A preform is printed by the SLS process. The surface of the preform is then smoothened by vibratory grinding. Vibratory grinding is contemporarily applied to a multitude of different preforms and smoothens their surfaces. Then, manual polishing of the contour and the openings of the preform is conducted. After sand blasting the preform, the final shell is obtained. The functional components such as the electronics module or the acoustic component may now be assembled into the metal shell to form the complete hearing device.

[0005] In order to distinguish individually customized shells after vibratory grinding, an identification information (ID) such as an identification number is necessary for each shell. The ID has to be legible. Finally a serial number of the final hearing device is applied on the shell surface. The serial number is unique for each single hearing device. After the shell is serialized, the shell ID is not necessary any more. For the shells made of metal such as titanium, the ID is usually printed as a 3D structure on the inside of the metal shell and is not removed by grinding. A litz wire of a functional component may be damaged due to its friction with the ID. Furthermore, it is difficult to read the ID printed on the inside of the metal shell, in particular when the first opening has a small size. Moreover, the ID printed on the inside of the metal shell contains very limited information about the fabricating process. If more information has to be connected to the metal shell, additional writing has to be placed on the metal shell without interfering with any manufacturing step or the appearance of the hearing device.

[0006] Furthermore, during the vibratory grinding of the preform of the metal shell, the grinding material may enter into the inside of the preform of the metal shell and it is difficult or nearly impossible to remove the material from the preform of the metal shell.

[0007] EP2037702 proposes to use a plastic plug for protecting a contour of an opening of a plastic shell during a tumbling process. The plug can be fabricated together with the plastic shell. Supporting members of the plug comprise breakpoints which allow pushing the plug into the opening after fabrication of the plastic shell prior to the tumbling process. After tumbling, the plug is manually removed. Due to the softness of plastic shells a plug can be pushed in the opening and engage with the contour of the opening. With harder materials such as metals this is not possible.

[0008] Thus, there is a need to make improvements on the method for manufacturing a metal shell for a customized hearing device.

SUMMARY OF THE INVENTION

[0009] An objective of the present invention is to overcome at least one of the above-mentioned problems of metal shell production. In particular, according to the present invention, it is possible to manufacture simply, efficiently and reliably a metal shell for a hearing device. Another objective of the present invention is to provide a method for manufacturing a metal shell for a hearing device. According to the method of the present invention, it is possible to provide a label comprising the identification information of the metal shell which can be easily read and does not take up any space in the hearing device.

[0010] A further objective of the present invention is to provide a method for manufacturing a metal shell for a hearing device. According to the method of the present invention, it is possible to provide a protective element for preventing the grinding materials from entering into a preform of the metal shell.

[0011] According to the present invention, it is to provide a method for manufacturing a metal shell for a hearing device, the metal shell comprising a first opening and a second opening, the method comprising:

- fabricating a preform of the metal shell, the preform comprising a main body defining an internal cavity and at least one sacrificial element formed on the

main body, the main body having a first position where the first opening is located and a second position where the second opening is located;
- smoothening a surface of the preform; and
- finishing the preform to obtain the metal shell,

characterized in that finishing the preform comprises removing the at least one sacrificial element.

[0012] Preferably, the second opening is smaller than the first opening and the at least one sacrificial element is located at the second position.

[0013] Preferably, a connection portion between the at least one sacrificial element and the main body of the preform forms breakpoints.

[0014] Preferably, fabricating the preform of the metal shell comprises forming the preform by a 3D printing process.

[0015] Preferably, the 3D printing process is a Selective Laser Sintering (SLS) process.

[0016] Preferably, smoothening the surface of the preform comprises treating the preform by vibratory grinding.

[0017] Preferably, the second opening has a circular form and the second opening is shaped at the same time of fabricating the preform of the metal shell.

[0018] Preferably, the second opening has a circular form and finishing the preform further comprises drilling the second opening.

[0019] Preferably, the method further comprises generating a design of the metal shell based on data related to an ear canal of a user, the preform of the metal shell is fabricated based the design of the metal shell.

[0020] Preferably, the at least one sacrificial element comprises a label, and the label has a three-dimensional structure comprising an identification information of the metal shell.

[0021] Preferably, the label extends outside of the main body of the preform.

[0022] Preferably, the label is movably attached to the main body of the preform.

[0023] Preferably, the label is movably attached to the main body of the preform by a chain.

[0024] Preferably, the label comprises two sides, and the identification information is included on one side of the label and additional information is included on the other side of the label.

[0025] Preferably, the at least one sacrificial element comprises a protective element extending within the internal cavity defined by the main body of the preform.

[0026] Preferably, the protective element has a form similar to that of a functional component of the hearing device which is intended to be disposed inside the internal cavity.

[0027] Preferably, the functional component is a receiver for converting electrical signal into acoustic signal.

[0028] These and other objects, features and characteristics of the present invention as well as the economies of manufacture will become more apparent upon consideration of the following description and the appended claims with reference to the accompanying drawings, all of which form a part of this specification, wherein like reference numerals designate corresponding parts in the various figures. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only and are not intended as a definition of the limits of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

FIG. 1 shows schematically a hearing device with a shell according to the invention.
FIG. 2 shows schematically a preform of a shell of the hearing device manufactured using a method for manufacturing a shell for a hearing device according to the present invention.
FIG. 3 is an enlarged view of a part of FIG. 2.
FIGS. 4A and 4B show schematically one side and other side of a label attached to the preform of the metal shell shown in FIG. 2.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0030] FIG. 1 shows schematically a hearing device 1 with a metal shell 3 according to the invention. The metal shell 3 defines an internal cavity 5. The metal shell 3 has at least a first opening 7 and a second opening 9. The hearing device 1 further comprises an electronic module 11 attached to the first opening 7 and a receiver 13 disposed within the internal cavity 5 near the second opening 9. The electronic module 11 converts acoustic signal into electrical signal and amplifies the electrical signal. The receiver 13 converts the electrical signal from the electronic module 11 into the acoustic signal. The acoustic signal emitted from the receiver 13 transmits into the ear canal of a user through the second opening 9. Since the first opening 7 is configured for introducing a part of the electronics module 11 into the internal cavity 5 and attaching the electronics module 11 to the metal shell 3, the first opening 7 is relatively large. The second opening 9 functions as a sound outlet and thus is relatively small.

[0031] The metal shell 3 is made from a metal material such as titanium or titanium alloy and manufactured with a Selective Laser Sintering (SLS) process based on the data regarding the geometry of the ear canal of the specific user. In order to overcome the above mentioned problems, the present invention proposes a method for manufacturing a metal shell for a hearing device. According to the method of the present invention, one or more sacrificial elements 10.1, 10.2 are added to a preform (i.e., an intermediate shell) of the metal shell during manufacturing of the metal shell and removed from the preform prior to the final assembly of the hearing device.

[0032] FIG. 2 shows schematically a preform of a shell of the hearing device manufactured using a method for

manufacturing a metal shell for a hearing device according to the present invention. According to the method of the present invention, one or more sacrificial elements 10.1, 10.2 are printed on a main body of the preform at the same time of printing the main body of the preform. As shown in FIG. 2, the preform 20 of the metal shell 3 generally comprises a main body 21 printed with the SLS. At least the first opening 7 and the second opening 9 are shaped in the main body 21. The preform 20 of the metal shell 3 further comprises a label 23 (i.e. a first sacrificial element 10.1) printed with the SLS on the main body 21 at a position where the second opening 9 is located. The label 23 extends outside of the main body 21.

[0033] The label 23 comprising an alphanumeric code is matched to every printed shell, thus associating the metal shell to a hearing device ordered by the specific user. As shown in FIG 4A, typical code on the label 23 is a 4 digit and/or letter code (i.e. ID of the metal shell), which identifies the metal shell in the batch. Since the label 23 extends outside of the main body 21, there is additional space on the other side of the label 23. Thus, the label 23 may further comprise some additional information such as a size of the openings, surface quality of the metal shell, or other relevant information for manufacturing. As an example, the other side of the label 23 as shown in FIG 4B comprises the diameter of the second opening 9.

[0034] Although the label 23 may be printed directly on the main body 21 of the preform 20, it is preferable that the label 23 is connected to the main body 21 of the preform 20 by a chain 25, thus yielding a movable or flexible connection between the label 23 and the main body 21 of the preform 20. The chain 25 may comprise one or more chain link 27 which is also printed with the SLS and is connected to the main body 21 of the preform 20 at the position where the second opening 9 is located. The movable or flexible connection between the label 23 and the main body 21 of the preform 20 minimizes print time and ensures the label 23 does not interfere with any post-processing steps such as vibratory grinding, sand blasting or polishing steps. The movable or flexible connection also minimizes a space needed in a SLS machine (i.e. a 3D printer) to print the preform because the label 23 may be bent around the preform. If the label 23 would for example extend in the length of the preform, it would require more space.

[0035] The label 23 comprising ID of the metal shell has to be legible at a serializing step, after post-processing steps such as polishing and sand blasting. After the metal shell is serialized, the metal shell ID is not necessary any more. At the serializing step, the serial number is printed on the metal shell. In this context "printing" at the serializing step is not a 3D-printing as the SLS printing, it is a graphical printing process, for example laser-printing, silk-printing or inkjet-printing. After printing of the serial number there is no further grinding/smoothening step. The surface of the metal shell is finished. Preferably, the connection portion between the label 23 or the chain 25 and the main body 21 of the preform 20 forms first fragile breakpoints 29 (as shown in FIG 3) so that the label 23 may be easily cut away or broken away from the preform 20.

[0036] According to the present invention, since the label 23 is printed with the SLS, attached to the main body 21 and extends outside of the main body 21, the label is easily read at a serializing step. Further, the label 23 may be easily cut away or broken away after the metal shell is serialized. No space in the metal shell of the hearing device is taken up, thereby preventing the functional components (in particular the litz wires of the functional components) inside the metal shell from being damaged due to friction contact with the label. The label 23 may comprise more information regarding the metal shell since it is printed with digit and/or letter code on both sides. Further, the label 23 has a printed three-dimensional structure and it is possible to prevent the digit and/or letter code on the label from being abrased.

[0037] The preform 20 of the metal shell 3 further comprises a protective element 31 (i.e. a second sacrificial element 10.2) printed with the SLS on the main body 21 at the position where the second opening 9 is located. The protective element 31 extends within the internal cavity 5 defined by the main body 21 of the preform 20. As a result, the internal cavity 5 defined by the main body 21 of the preform 20 is occupied substantially by the protective element 31 and grinding material cannot enter into the internal cavity 5 during smoothening the surface of the preform 20 by vibratory grinding or polishing. The protective element 31 preferably has a form similar to that of a functional component (for example the receiver 13) which is intended to be disposed inside the metal shell during assembly. Thus, the modeling data of the component which is intended to be disposed inside the metal shell during assembly can be used to print the protective element 31.

[0038] The protective element 31 can be accessed and removed from the first opening 7 using a suitable tool, such as tweezers or pliers, after the vibratory grinding. Later, when the components of the hearing device are assembled, a functional element such as the receiver 13 is disposed into the internal cavity 5 and it is acoustically coupled to the second opening 9 directly or by using a connection element 33 such as a small tube. Preferably, the connection portion between the protective element 31 and the main body 21 of the preform 20 forms second fragile breakpoints 35 (as shown in FIG 3) so that the protective element 31 may be easily cut away or broken away from the preform 20.

[0039] The second opening 7 may be shaped in the preform 20 when the preform 20 is printed, or it may be drilled later during finishing the preform. The second opening in the preform may have an equal or smaller diameter than the finished second opening. Drilling creates a precise round hole. What is important is that the position of the second opening 7 is known, even if the second opening 7 is not already formed or doesn't have

the final diameter when the preform 20 is printed.

[0040] Although in the preferred embodiment the preform 20 of the metal shell 3 is shown to comprise both the label 23 and the protective element 31 at the position where the second opening 9 is located, it should be understood that the preform 20 of the metal shell 3 may comprise one of the label 23 and the protective element 31. Further, one or both the label 23 and the protective element 31 may be printed on the main body 21 at a position where any remnants can easily be removed with a tool such as a ball burr other than the position where the second opening 9 is located.

[0041] The preform is fabricated by a Selective Laser Sintering (SLS) process. Direct metal laser sintering (DMLS) or Selective Laser Melting (SLM) are variants of SLS.

[0042] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive. The invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing a claimed invention, from a study of the drawings, the disclosure, and the dependent claims.

[0043] In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are re-cited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

Claims

1. A method for manufacturing a metal shell (3) for a hearing device (1), the metal shell comprising a first opening (7) and a second opening (9), the method comprising:

   - fabricating a preform (20) of the metal shell (3), the preform (20) comprising a main body (21) defining an internal cavity (5) and at least one sacrificial element (10.1, 10.2) formed on the main body (21), the main body (21) having a first position where the first opening (7) is located and a second position where the second opening (9) is located;
   - smoothening a surface of the preform (20); and
   - finishing the preform (20) to obtain the metal shell,

   characterized in that finishing the preform (20) comprises removing the at least one sacrificial element (10.1, 10.2).

2. The method of claim 1, wherein the second opening (9) is smaller than the first opening (7) and the at least one sacrificial element (10.1, 10.2) is located at the second position.

3. The method of claim 1, wherein a connection portion between the at least one sacrificial element (10.1, 10.2) and the main body (21) of the preform (20) forms breakpoints.

4. The method of claim 1 wherein fabricating the preform (20) of the metal shell (3) comprises forming the preform (20) by a 3D printing process.

5. The method of claim 4 wherein the 3D printing process is a Selective Laser Sintering (SLS) process.

6. The method of claim 1 wherein smoothening the surface of the preform (20) comprises treating the preform (20) by vibratory grinding.

7. The method of claim 1 wherein the second opening (9) has a circular form and the second opening (9) is shaped at the same time of fabricating the preform (20) of the metal shell (3).

8. The method of claim 1 wherein the second opening (9) has a circular form and finishing the preform (20) further comprises drilling the second opening (9).

9. The method of claim 1 wherein the method further comprises generating a design of the metal shell (3) based on data related to an ear canal of a user, the preform (20) of the metal shell (3) is fabricated based the design of the metal shell (3).

10. The method of claim 1 wherein the at least one sacrificial element (10.1) comprises a label (23), and the label has a three-dimensional structure comprising an identification information of the metal shell (3).

11. The method of claim 10 wherein the label (23) extends outside of the main body (21) of the preform (20).

12. The method of claim 10 wherein the label (23) is movably attached to the main body (21) of the preform (20).

13. The method of claim 10 wherein the label (23) is movably attached to the main body (21) of the preform (20) by a chain (25).

14. The method of claim 10 wherein the label (23) comprises two sides, and the identification information is included on side of the label (23) and additional information is included on other side of the label.

15. The method of claim 1 wherein the at least one sacrificial element (10.2) comprises a protective element (31) extending within the internal cavity (5) defined by the main body (21) of the preform (20).

16. The method of claim 15 wherein the protective element (31) has a form similar to that of a functional component of the hearing device which is intended to be disposed inside the internal cavity (5).

17. The method of claim 16 wherein the functional component is a receiver for converting electrical signal into acoustic signal.

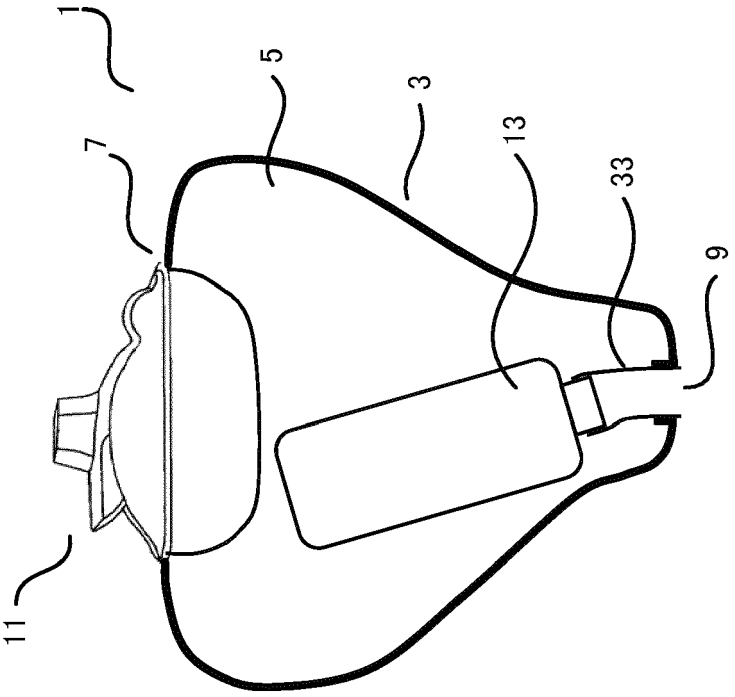

FIG. 1

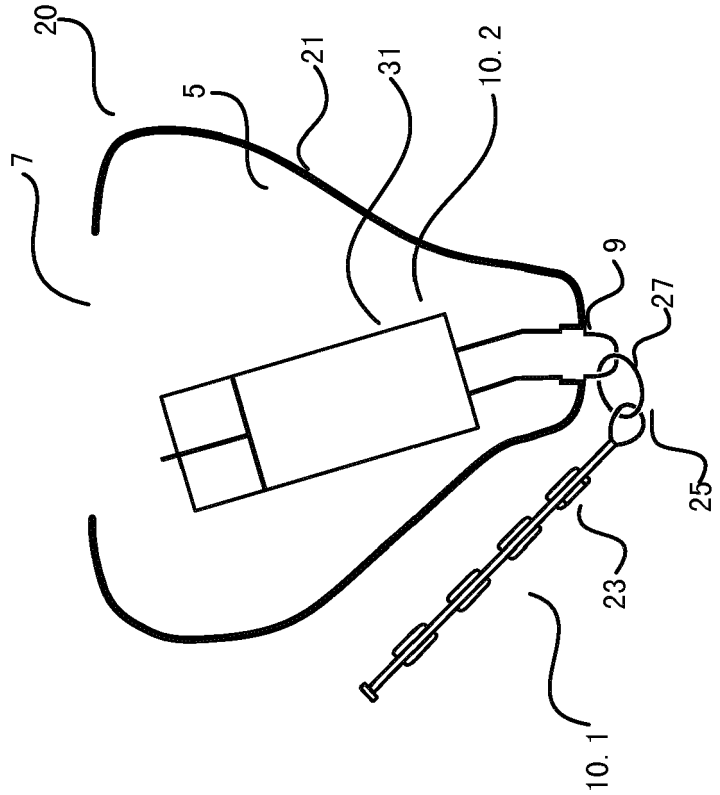

FIG. 2

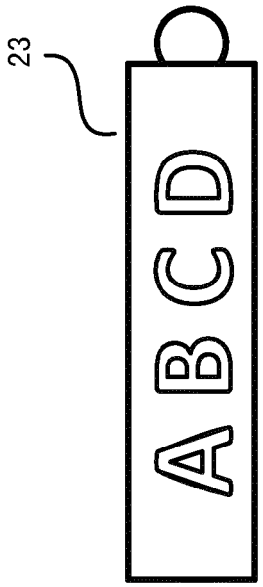

FIG. 4A

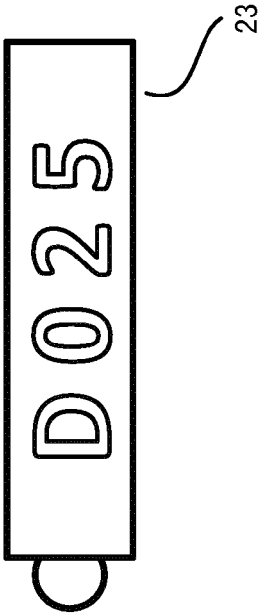

FIG. 4B

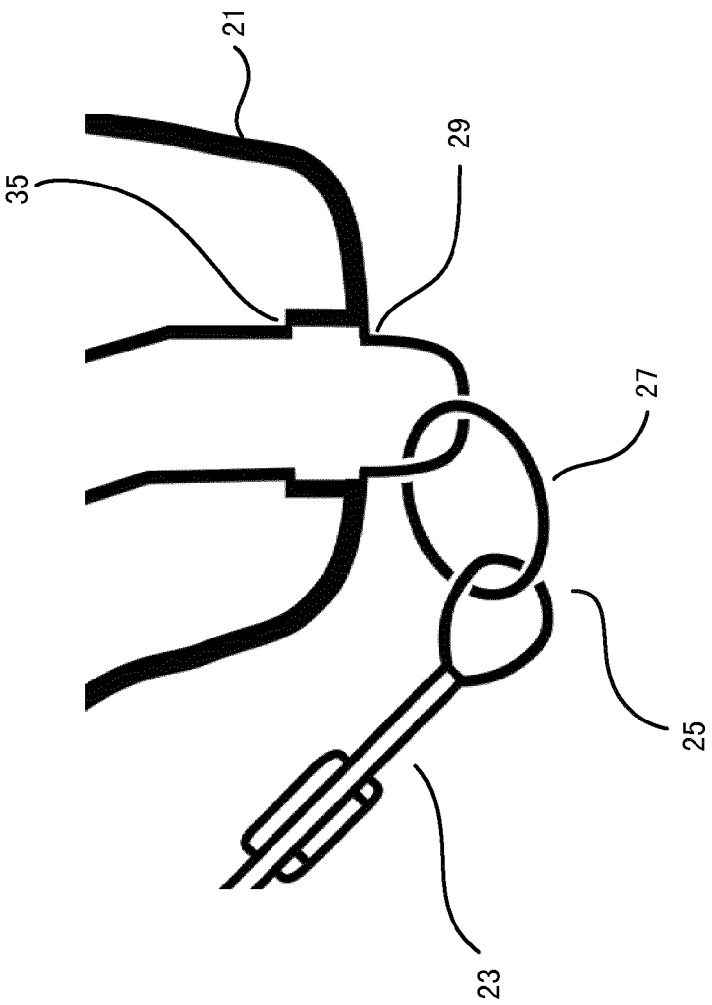

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 18 17 8959

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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
Munich	16 October 2018	Peirs, Karel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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REFERENCES CITED IN THE DESCRIPTION

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