(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 277 321 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
26.08.2015 Bulletin 2015/35

(21) Application number: **09751283.4**

(22) Date of filing: **18.05.2009**

(51) Int Cl.:
H04R 1/10 *(2006.01)* ***H04R 1/26*** *(2006.01)*

(86) International application number:
PCT/US2009/044340

(87) International publication number:
WO 2009/143055 (26.11.2009 Gazette 2009/48)

(54) **Adjustable, dual speaker element in-ear phone**

Einstellbarer Im-Ohr Kopfhörer mit doppeltem Lautsprecherelement

Écouteur intra-auriculaire à deux éléments haut-parleurs ajustables

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK TR

(30) Priority: **19.05.2008 US 54238 P**
06.04.2009 US 334942

(43) Date of publication of application:
26.01.2011 Bulletin 2011/04

(73) Proprietor: **KOSS CORPORATION**
Milwaukee
Wisconsin 53212 (US)

(72) Inventors:
- **PELLAND, Michael, J.**
  Princeton
  WI 54968 (US)
- **SANTIAGO, Ronaldo, J.**
  South Ilgin
  IL 60177 (US)
- **POTTER, James, J.**
  Atlanta, GA 30309 (US)
- **JOHNSON, Mandy**
  Milwaukee
  WI 53204 (US)
- **MLODZIKOWSKI, Allan**
  Muskego
  WI 53150 (US)
- **KOSS, Michael, J.**
  Milwaukee
  WI 53217 (US)

(74) Representative: **Parry, Simon James et al**
Mewburn Ellis LLP
City Tower
40 Basinghall Street
London EC2V 5DE (GB)

(56) References cited:
US-A- 5 147 986
US-A- 5 333 206
US-A- 5 333 206
US-A- 5 729 615
US-A1- 2004 008 855
US-A1- 2004 125 976
US-A1- 2007 104 345
US-A1- 2008 080 704
US-B2- 7 245 737

- **John H. Bickford: "Threads and Their Strength" In: "Introduction to the Design and Behavior of Bolted Joints, Fourth Edition Non-Gasketed Joints", 30 December 2007 (2007-12-30), CRC Press, XP055147864, ISBN: 978-0-84-938176-8 * pages 1-3 ***

EP 2 277 321 B1

Description

PRIORITY CLAIM

[0001] The present application claims priority to U.S. provisional application Serial No. 61/054,238, titled "ADJUSTABLE, DUAL SPEAKER ELEMENT INEAR PHONE," filed May 19, 2008, and to U.S. application Serial No. 29/334,942, filed April 6, 2009, titled "EARPHONE".

BACKGROUND

[0002] The present disclosure generally relates to earphones for sound reproduction with high fidelity and more particularly to adjustable dual element in-ear earphones having one transducer for each ear directed to reproducing higher frequencies and one transducer for each ear directed to reproducing lower frequencies.

[0003] U.S. Patent No. 5,333,206, titled "DUAL ELEMENT HEADPHONE," discloses a dual element headphone including (a) one transducer that is substantially larger than the cavum concha of a typical human ear and (b) one smaller transducer that fits into the cavum concha. Other than the curvature of the headband, however, the headphones disclosed in this patent are not adjustable.

[0004] U.S. Patent No. 5,729,615, titled "IN-EAR TYPE EARPHONE HAVING AN EAR HANGER," discloses an earphone having one in-ear speaker element connected to a shaft. The speaker element is pivotably rotatable with respect to the shaft. Further, the shaft is slidably movable along its axis. Thus, the position of the earphone can be raised or lowered vertically by sliding the shaft. Further, the earphone can be rotated in the roll direction, but in the roll direction only. Therefore, while the earphone disclosed in this patent discloses some mechanisms for adjusting the position and orientation of the earphone, the permitted adjustments are limited. In addition, the earphone of this patent only has one speaker element.

[0005] US2007/0104345 discloses an in-ear type earphone with an ear hanger.

[0006] The foregoing discussion is intended only to illustrate some of the shortcomings present in the field of the invention at the time, and should not be taken as a disavowal of claim scope.

SUMMARY

[0007] In various embodiments, an earphone is provided. In at least one embodiment, the earphone can comprise a first speaker element and a second speaker element extending from the first speaker element, wherein the second speaker element is sized and configured to fit at least partially into a cavum concha of a listener's ear, and wherein the second speaker element is connected to the first speaker element by a pivotable joint; a bridge comprising a first end and a second end, wherein the first speaker element is pivotably connected to the first end of the bridge, and a hanger bar comprising a first portion and a second portion, wherein the first portion is threadingly connected to the second end of the bridge. In these embodiments, the second portion of the hanger bar is configured to rest upon a part of a listener's ear when worn by the listener. The first end of the bridge defines a first axis, wherein the first speaker element may rotate about the first axis. The second end of the bridge defines a second axis. Wherein the first portion of the hanger bar is threadingly connected to the second end of the bridge such that the hanger bar may rotate about the second axis.

[0008] In at least one embodiment, an earphone is provided that can comprise a first speaker element and a second speaker element extending from the first speaker element, a bridge comprising a first end and a second end, wherein the speaker element is pivotably connected to the first end of the bridge, and a hanger bar comprising a first portion and a second portion. In these embodiments, the second end of the bridge comprises a rotatable knob that is accessible to a listener when the earphone is worn by the listener. Further, in these embodiments, the first portion of the hanger bar is operably engaged to the rotatable knob such that rotation of the knob causes the second portion to at least translate relative to the bridge. Additionally, in these embodiments, the second portion of the hanger bar is configured to rest upon a part of the listener's ear when worn by the listener.

[0009] In at least one embodiment, a method of wearing an earphone is provided that can include the steps of providing an earphone comprising a first speaker element and a second speaker element extending from the first speaker element, a bridge comprising a first end and a second end, wherein the first speaker element is pivotably connected to the first end of the bridge and wherein the second end comprises a rotatable knob, and a hanger bar comprising a first portion and a second portion, wherein the first portion is operably engaged to the rotatable knob such that rotation of the knob causes the second portion of the hanger bar to at least translate relative to the bridge.

[0010] In an embodiment the method further comprises the steps of rotating the knob to adjust a distance between the second portion of the hanger bar and the bridge, rotating the first speaker element relative to the bridge, and placing the hanger bar on a part of a listener's ear such that the first speaker element is aligned with the cavum concha of the listener's ear.

[0011] In at least one example an earphone is provided that can comprise a first speaker element and a second speaker element extending from the first speaker element. In these embodiments, the first speaker element can comprise an enclosure having a wall, a first transducer disposed within the enclosure, the first transducer configured to produce a first sound, and a first cavity defined between the wall of the enclosure and the first trans-

ducer. Further, in these examples the second speaker element can comprise a housing sized and configured to fit at least partially into a cavum concha of a listener's ear, the housing having a backing and a sound emanating surface, wherein the sound emanating surface includes first sound openings and second sound openings defined therein, a second transducer disposed within the housing, the second transducer configured to produce a second sound that emanates through the second sound openings but not through the first sound openings, and a second cavity defined between the backing of the housing and the second transducer. Additionally, in these examples the first cavity, the second cavity, and the first sound openings define a sound path for the first sound produced by the first transducer such that the first sound travels through the sound path and emanates through the first sound openings but not through the second sound openings.

[0012] In at least one example an earphone is provided that can comprise a second speaker element configured to fit at least partially into a cavum concha of a listener's ear and a hanger bar operably connected to the speaker element. In these embodiments, the hanger bar is configured to rest upon an upper external curvature of a listener's ear and behind an upper portion of an auricula of the listener's ear. Additionally, in these examples the hanger bar has a shape configured to cause the speaker element to exert a force on the listener's ear, independent of gravity.

[0013] This Summary is intended to briefly outline certain embodiments of the subject application. It should be understood that the subject application is not limited to the embodiments disclosed in this Summary, and is intended to cover modifications that are within its scope, as defined by the claims. It should be further understood that this Summary should not be read or construed in a manner that will act to narrow the scope of the claims.

BRIEF DESCRIPTION OF THE FIGURES

[0014] The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention itself will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

Figure 1 depicts a non-limiting embodiment of an earphone being worn by a listener;
Figure 2 is a side view of the earphone of Figure 1;
Figure 3 is a front view of the earphone of Figure 1;
Figure 4 is a top view of the earphone of Figure 1;
Figures 5-7 shows aspects of a tragel bridge of the earphone of Figure 1;
Figure 8 is an exploded view of the earphone of Figure 1;
Figure 9 is an exploded view of a non-limiting embodiment of an earphone;
Figure 10 is a perspective view of a non-limiting embodiment of an earphone;
Figure 11 is a front view view of the earphone of Figure 10;
Figure 12 is a cross-sectional view of speaker elements of the earphone of Figure 10, taken along line 12-12 in Figure 11 (any electrical wiring has been omitted for clarity); and
Figure 13 is an exploded view of the speaker elements of the earphone of Figure 10 (any electrical wiring has been omitted for clarity).
Figure 14 is a top view of a force diagram showing the forces acting on and exerted by the earphone of Figure 10 with respect to a listener's ear.

DETAILED DESCRIPTION

[0015] Certain exemplary embodiments will now be described to provide an overall understanding of the principles of the structure, function, manufacture, and use of the devices and methods disclosed herein. One or more examples of these embodiments are illustrated in the accompanying drawings. Those of ordinary skill in the art will understand that the devices and methods specifically described herein and illustrated in the accompanying drawings are non-limiting exemplary embodiments and that the scope of the various embodiments of the present invention is defined solely by the claims. The features illustrated or described in connection with one exemplary embodiment may be combined with the features of other embodiments. Such modifications and variations are intended to be included within the scope of the present invention.

[0016] In the following description, like reference characters designate like or corresponding parts throughout the several views. In addition, it is to be understood that such terms as "forward," "rearward," "front," "back," "right," "left," "upwardly," "downwardly," and the like are words of convenience and are not to be construed as limiting terms. The description below is for the purpose of describing various embodiments of the invention and is not intended to limit the invention thereto.

[0017] Various embodiments are directed to an adjustable, dual speaker element earphone, wherein one of the speaker elements (the smaller one) is sized to fit into the cavum concha of the listener's ear and the other element (the larger one) is not. The positioning of the speaker elements may be adjustable so that the user can adjust the positioning of the speaker elements for increased comfort. For example, in one embodiment, by virtue of a hinged joint, the larger speaker element may be rotated about a vertical axis of the hinged joint so that the larger speaker element can be rotated towards or away from the listener's ear. In addition, according to various embodiments, the smaller speaker element may be adjusted relative to the larger speaker element. For example, in one embodiment, the smaller speaker element may be connected to the larger speaker element

by a knuckle-ball joint, a ball joint, or some other similar pivotable joint, that provides multiple degrees of rotational freedom but limits or prevents translational movement for the smaller speaker element relative to the larger speaker element.

[0018] In addition, the earphone may comprise a hanger bar that the listener uses to position the earphone on the listener's ear. In that connection, the hanger bar may comprise a horizontal section that rests upon the upper external curvature of the listener's ear behind the upper portion of the auricula (or pinna). The earphone may comprise a knurled knob that allows the user to adjust finely the distance between the horizontal section of the hanger bar and the speaker elements, thereby providing, in such embodiments, another measure of adjustability for the user.

[0019] In at least one embodiment, an adjustable, dual speaker element earphone is provided, wherein one of the speaker elements is sized to fit into the cavum concha of the listener's ear. Figures 1 through 4 illustrate one embodiment of the earphone 10. Figure 1 is a perspective view of the earphone 10 being worn on the ear 12 of a human listener 14; Figure 2 is a side view of the earphone 10; Figure 3 is a front view of the the earphone 10; and Figure 4 is a top view of the earphone 10. According to the illustrated embodiment, the earphone 10 comprises, among other elements, a first speaker element 20, a second, in-ear speaker element 22, a hanger bar 24, and a tragel bridge 26.

[0020] The terms "proximal" and "distal" are used herein with reference to the listener's head. Accordingly, the proximal components of the earphone 10 are toward the listener's nose, and the distal components are torward the rear of the listener's head. Also, the spatial terms "vertical" and horizontal" are used herein with respect to the drawings. These terms are not intended to be limiting or absolute.

[0021] The first speaker element 20 may be generally circular, as shown in the figures, and may be sized large enough that it does not fit into the cavum concha of the vast majority of human listeners 14. The second speaker element 22 also may be generally circular in shape, and may be extend outwardly from an inner portion 28 of the first speaker element 20. According to one embodiment, the second speaker element 22 may be rigidly fixed to the inner surface 28 of the first speaker element 20 so that there is no relative movement between the first and second speaker elements. In such an embodiment, the second speaker element 22 may be connected to the first speaker element 20 by an arm 23 such that the second speaker element 20 extends generally perpendicularly from the first speaker element 20. According to various embodiments, the inner surface 28 of the first speaker element 20, the arm 23, and the backing 25 of the second speaker element 22 may be made from a single piece of injection molded plastic so that their positions are fixed.

[0022] The hanger bar 24, as shown in the figures, may be substantially L-shaped, having (i) a first, proximal portion 30 that extends generally vertically from the tragel bridge 26, and (ii) a second, distal portion 32, generally perpendicular to the first portion 30, that extends horizontally away from the first portion 30 and is designed to rest upon the upper external curvature of the ear 12 behind the upper portion 13 of the auricula (or pinna). The hanger bar 24 may have a circular cross-section, and may be made out of plastic, metal, or any other suitable material.

[0023] The tragel bridge 26 includes a vertically oriented, distal gudgeon 34 fixedly connected to the first speaker element 20 at a proximal edge of the first speaker element 20. The gudgeon 34 and the tragel bridge 26 may be generally tangential to a proximal edge of the circular first speaker element 20. A slotted retaining bolt or pintle 36 is inserted through the opening defined by the gudgeon 34 to connect hingedly the first speaker element 20 to the tragel bridge 26. That way, the first speaker element 20 can be rotated about the vertical axis of the gudgeon 34 so that the first speaker element 20 can be rotated toward or away from the listener's ear 12. The gudgeon 34 may be made from metal or plastic, for example. In one embodiment, an outer peripheral backing 42 of the first speaker element 20 and the gudgeon 34 may be made from an integrated piece of injection-molded plastic. The height of the tragel bridge 26 may be less than the diameter of the first speaker element 20. For example, the height of the tragel bridge 26 may be approximately one-half the diameter of the first speaker element 20. Alternatively, referring to Figures 10-11, tragel bridge 126 may be larger than one-half the diameter of first speaker element 120, but less than the diameter of the first speaker element 120. In such embodiments, cylindrical knurled knob 148 may be larger than knob 48, described above, such that a listener may have a larger surface area with which to contact and rotate knob 148 to adjust hanger bar 124.

[0024] Figures 5-7 show aspects of the tragel bridge 26 according to various embodiments. Figure 5 is a section view of the tragel bridge 26 showing the gudgeon 34 and the pintle 36. In Figures 6 and 7, the tragel bridge 26 is omitted so that other components in the tragel bridge 26 can be viewed. As shown in these figures, a plastic friction O-ring 38 may be disposed between the head 40 of the pintle 36 and the upper portion of the gudgeon 34. The O-ring 38 may reside inside the tragel bridge 26 so that it cannot normally be seen. The purpose of the O-ring 38 is to provide friction between the gudgeon 34 and the pintle 36 such that rotation of the first speaker element 20 relative to the tragel bridge 26 is resisted and a relative position may be maintained between the first speak element 20 and the tragel bridge 26. The tragel bridge 26 has upper and lower flanges 42, 44 above and below the gudgeon 34, respectively. The pintle 36 is inserted through the upper flange 42, the gudgeon 34, and the lower flange 44, to thereby hingedly connect the gudgeon 34 to the tragel bridge 26.

[0025] As shown in Figures 5-7, the pintle 36 may include a lower slot through which a speaker wire 46 may be feed into the tragel bridge 26 and to the first and second speaker elements 20, 22.

[0026] As shown in Figures 1-7, the tragel bridge 26 may also include a cylindrical knurled knob 48 vertically oriented at a proximal end of the tragel bridge 26. The knurled knob 48 may define a vertical opening therethrough, with threads on the interior of the knurled knob 48 around the opening. The lower end of the first portion 30 of the hanger bar 24 may have corresponding threads, as shown in Figure 5, which mate with the threads of the knurled knob 48. Rotation of the knurled knob 48 about its vertical axis thereby causes the horizontal portion 32 of the hanger bar 24 to be adjusted vertically with respect to the tragel bridge 26 (and hence the speaker elements 20, 22). That is, by rotating the knurled knob 48, a user can adjust the distance H shown in Figure 2, which controls the relative positioning of the speaker elements 20, 22 and/or tragel bridge 26 to the second portion 32 of the hanger bar 24, i.e., the portion of the hanger bar 24 that rests upon the listener's ear, to thereby optimize or enhance the fit of the earphone 10 for the user. In at least one embodiment, the threads of the hanger bar 24 and the knurled knob 48 may be relatively fine, to provide fine adjustment for the user. Alternatively, in at least one embodiment, the threads of the hanger bar 24 and the knurled knob 48 may be relatively coarse, to provide coarse adjustment for the user. The knurled knob 48 may be made from plastic or metal, for example.

[0027] Further, in at least one embodiment, the knob 48 may be rotated relative to the hanger bar 24 to the point where the threads of the hanger bar 24 disengage from the knurled knob 48. Alternatively, in at least one embodiment, the hanger bar 24 may be rotated relative to the knob 48 such that the threads of hanger bar 24 disengage from the knob 48. In such embodiments, another hanger bar (not shown), having different dimensions of a first portion 30 and/or a second portion 32, may then be inserted into the tragel bridge 26 at knob 48. Accordingly, different sized hanger bars may be provided to fit a variety of people having different sized ears.

[0028] According to various embodiments, as shown in Figure 5, the threads of the lower portion of the first portion of the hanger bar 24 may also pass into an opening in a strain relief member 50 that is adjacent to a lower portion of the tragel bridge 26 at its proximal side. The speaker wire 46 may thread up through the strain relief member, through the tragel bridge 26, and through the slot in the pintle 36 to the speaker elements 20, 22, as shown in Figure 5. The strain relief member 50 may be made from plastic, for example.

[0029] In various embodiments, referring to Figures 1-4, hanger bar 24 may be operably connected to the speaker elements 20, 22 by tragel bridge 26. Accordingly, when the earphone 10 is correctly positioned on the listener's ear 12, the tragel bridge 26 usually will be adjacent to the tragus of the listener's ear 12, as shown in Figure 1. The tragel bridge 26 may be generally rectangular in shape, as shown in Figures 1-2, having the gudgeon 34 at its distal end and the knurled knob 48 at is proximal end. The tragel bridge 26 may be made of plastic or any other suitable material.

[0030] Further, with reference to Figures 1 and 14, when earphone 10, 110 is correctly position on the listener's ear 12, the hanger bar 24, 124, as mentioned above, is configured to rest upon the upper external curvature of the listener's ear 12 and behind the upper portion 13 of the auricula of the listener's ear 12. According to various embodiments, the hanger bar 24, 124 may have a shape and size such that the hanger bar 24, 124 is configured to cause the first speaker element 20, 120 and/or the second speaker element 22, 122 to exert a force (F_{in} shown in Figure 14) on the listeners ear.

[0031] Referring now to Figures 1-4, 10-11, and 14, in various embodiments, the shape of the hanger bar may be described as follows. The first portion 30, 130 of the hanger bar 24, 124 may be generally vertical with respect to the second speaker element 22, 122 and/or the listener when the earphone 10, 110 is properly positioned on and/or in the listener's ear. The second portion 32, 132 may be generally horizontal likewise with respect to the second speaker element 22, 122 and/or the listener. The second portion 32, 132 may also slope or curve downward, back toward second speaker element 22, 122 as the second portion 32, 132 extends away from first portion 30, 130. Further, the second portion 32, 132 may also slope or curve horizontally inward, toward second speaker element 22, 122 as the second portion 32, 132 extends away from the first portion 30, 130. Optionally, as best seen in Figure 11, the second portion 132 may connect to the first portion 130 by an intermediate portion 131 of hanger bar 124. Intermediate portion 131 may slope or curve toward second speaker element 122 as intermediate portion 131 transitions from the generally vertical first portion 130 to the generally horizontal second portion 132. In other words, the intermediate portion 131 serves to offset the first portion 130 from the second portion 132 such that the primary longitudinal axis for the first portion 130 does not intersect the primary longitudinal axis for the second portion 132.

[0032] Focusing now on Figure 14, a top view is shown depicting the forces acting on and exerted by the earphone 110 when the earphone is worn on the listener's ear 12. In such embodiments, and without the need for gravitational assistance, the hanger bar 124 and second speaker element 122 may be adjusted relative to each other (as discussed above) such that the hanger bar 124 causes the second speaker element 122 to exert a force toward and/or on the cavum concha 15 and/or the ear canal 16 of the listener's ear 12 (F_{in}). In other words, the hanger bar 124 is sized and configured such that hanger bar 124 acts as a lever and is forced, by the listeners head 17, generally about fulcrum 18 (defined by a contact point between the second portion 132 of hanger bar 124 and the upper portion 13 of the auricula of the listener's

ear 12), to cause the second speaker element 122 to exerts a force F_{in} toward and/or on at least a portion of the listener's ear 12.

[0033] Mathematically, the force exerted toward and/or on the cavum concha 15 and/or the ear canal 16 (F_{in}) can be determined as follows. At equilibrium and about fulcrum 18, the torque exerted by the listener's head 17 on the second portion 132 of hanger bar 124 ($F_h \cdot D_h$) equals the torque experienced by the first portion 130 of hanger bar 124 ($F_e \cdot D_e$). Accordingly, the force balance equation yields the following:

$$F_h \cdot D_h = F_e \cdot D_e$$

[0034] Solving for the force exerted on the first portion 130 (F_e) yields:

$$F_e = F_H \cdot \frac{D_h}{D_e}$$

[0035] Setting this force, F_e, equal to the force exerted on the ear by the first speaker element 120 (F_c) yields:

$$F_h \cdot D_h = F_c \cdot \left(D_e - \frac{D_l}{\cos(\theta)} \right)$$

[0036] Solving for F_c yields:

$$F_c = \frac{F_h \cdot D_h}{D_e - \frac{D_l}{\cos(\theta)}}$$

[0037] Solving for the force exerted by the second speaker element 122 into the cavum concha 15 and/or ear canal 16 (F_{in}) yields:

$$F_{in} = F_c \cdot \cos(\beta)$$

Making substitutions yields an equation for the force of the second speaker element 122 into the ear cannel (F_{in}) which contains the following as variables: the force exerted from the head on the earphone 110 (F_h), the user defined distances (D_h, D_e, and D_l), and the user configured angles (α and θ). This equation is as follows:

$$F_{in} = \frac{F_h \cdot D_h \cos\left(\alpha - \left(90^\circ - \theta\right)\right)}{D_e - \frac{D_l}{\cos(\theta)}}$$

[0038] Accordingly, the force exerted by the second speaker element 122 on the listener's ear (F_{in}) may be customizable to each listener such that people having different sized ears experience an appropriate amount of force to hold the speaker elements 120, 122 properly in place, independent of gravity and/or any force caused by gravity.

[0039] In various earphones, an in-ear speaker element may be sized and configured such that the element is held in place by forming a snug fit against the walls of the ear canal. However, in various embodiments, the second speaker element 122 may be sized such that the speaker element 122 is larger than the ear canal 122. In such embodiments, the second speaker element 122 may resist insertion into the ear canal and thus may be forced out away from the ear canal and/or the cavum concha by the internal walls of the listener's ear. Accordingly, the ability of the earphone 110 to supply an appropriate amount of force toward the listener's ear may be of further importance in order to maintain the proper position of the first and/or second speaker elements 120, 122 with respect to the listener's cavum concha and/or ear canal.

[0040] Figure 8 is an exploded view of the earphone 10 according to various embodiments. As shown in Figure 8, the tragel bridge 26 may comprise front and back pieces 52, 54, connected together by a screw 56, for example. In other embodiment, other means of connecting the front and back pieces 52, 54 may be utilized, such as a snap fit. In addition, in other embodiments, the tragel bridge 26 may comprise fewer or greater than two separate pieces. In addition, rather than having front and back pieces as shown in Figure 8, a tragel bridge may comprise upper and lower pieces 64, 66, as shown in Figure 9, which shows an exploded view of a tragel bridge according to another embodiment.

[0041] Referring back to the embodiment of Figure 8, the back piece 54 of the tragel bridge 26 may comprise the flanges 42, 44 that are above and below, respectively, the gudgeon 34. The tragel bridge 26 may also comprise, upper and lower proximal flanges 58, 60 that are above and below, respectively, the knurled knob 48. In the illustrated embodiment, the upper proximal flange 58 comprises two pieces, one piece 58a on the front piece 52 of the tragel bridge 26 and one piece 58b on the back piece 54 of the tragel bridge 26. In various embodiments, a plastic friction O-ring 39 may be disposed between the two pieces 58a, 58b of the upper proximal flange 58. The O-ring 39 may reside inside the tragel bridge 26 so that it cannot normally be seen. The purpose of the O-ring 39 is to provide friction between the first portion 30 of hanger bar 24 and the flange 58 of the tragel bridge 26 such that rotation of the hanger bar 24 relative to the tragel bridge 26 is resisted and a relative position may be maintained between the hanger bar 24 and the tragel bridge 26. Further, the O-ring 39 may provide a resistive biasing force such that the second speaker element 22 is biased toward the listener's ear after the hanger bar 24 is rotated

away from tragel bridge 26. For example, the second portion 32 of hanger bar 24 may be rotated away from tragel bridge 26 and toward a listener's ear. Then, after the rotation is finished, the O-ring 39 may store resistive rotational energy such that the second portion 32 of the hanger bar 24 is biased back towards the tragel bridge 26. Accordingly, the second portion 32 of the hanger bar 24 and the second speaker element 22 may be biased toward each other when worn on a listener's ear. Alternatively, in various embodiments, the O-ring 39 may be omitted. In such embodiments, the upper proximal flange 58 may be sized and configured to directly provide rotational friction to the movement of the hanger bar passing therethrough. In any case, because of the rotational friction provided by either O-ring 39 and/or flange 58, a user may rotate the knob 48 such that the second portion 32 of the hanger bar 30 does not substantially rotate (because of the friction), but translates with respect to the tragel bridge 26. The tragel bridge 26 may also comprise a retaining nut 62 on the lower side of the gudgeon 34 that retains the pintle 36 in position.

[0042] Each of the first and second speaker elements 20, 22 may include respective acoustic transducers with dynamic drivers for producing sound waves in the audible range. The transducers may produce sound energy having different (although potentially overlapping) frequency ranges. For example, the first speaker element 20, being larger than the second speaker element 22, may produce low to mid frequencies in the audible range, and the second speaker element 22 may produce mid to high frequencies. According to at least one embodiment, the first speaker element 20 may comprise a transducer that is approximately 20mm in diameter, and the second speaker element 22 may be approximately 12mm in diameter. Alternatively, according to at least one embodiment, the first speaker element 20 may be approximately 20.0mm in diameter and the second speaker element 22 may be approximately 13.5mm in diameter.

[0043] As shown in Figures 3 and 4, the first speaker element 20 may comprise a low frequency transducer enclosure (LFTE) 70 on its inner portion 28 (i.e., the portion facing the ear 12) that may act as low pass acoustical filter for the first speaker element 20, effectively removing the high frequency component from the output of the driver for the first speaker element 20. In addition, the sound may emanate from the proximal surface 72 of the second speaker element 22. Additionally, the openings of the second speaker element 22 may be concentrated on the inner portion of the second speaker element 22 that extends furthest into cavum concha of the listener's ear 12. More details regarding dual element speakers are described in U.S. Patent Nos. 4,418,248 and 5,333,206, both titled "DUAL ELEMENT HEADPHONE".

[0044] Further, in at least one embodiment, referring now to Figures 12-13, a sound path may be provided which delivers sound produced by a first transducer 120a of first speaker element 120 into the listener's concha and/or ear canal through second speaker element 122, for example. In such embodiments, the sound produced by the first transducer 120a may be initially directed into a first cavity 120b defined between an inner wall 170a of LFTE 170 and first transducer 120a. Then, the sound may pass through a channel 123a defined within arm 123 into second cavity 122c, which is defined behind second transducer 122d and in front of backing 125 of the second speaker element 122. From there, the sound produced by the first transducer 120a may emanate from the proximal surface 172 of the second speaker element 122 via first sound openings 122a. Sound produced by the second transducer 122d may likewise emanate from the proximal surface 172 of the second speaker element 122 via second sound openings 122b. Accordingly, the lower frequency sound produced by the first transducer 120a is mixed with the higher frequency sound produced by the second transducer 122d outside the earphone, but within the listener's ear, within his or her concha and/or ear canal, for example. Mixing the higher and lower frequency sound waves outside the earphone may be beneficial by preventing the lower frequency sounds produced by the first transducer 120a from interfering with the production of the higher frequency sounds coming from the second transducer. Therefore, in some embodiments, the second transducer is dampened from the lower frequency sound waves by sealing the second transducer within the housing of second speaker element 122, generally between cavity 122c and proximal surface 172. Accordingly, the sound path may also be configured to prevent the lower frequency sound wave energy from disturbing the second transducer 122d as the second transducer 122d modulates and creates the higher frequency sounds.

[0045] Additionally, again with reference to Figures 12-13, the first cavity 120b, the channel 123a, the second cavity 122c, and/or the first sound openings 122a may be sized and configured with respect to the first transducer 120a such that they define a sound path that acts as a low pass acoustical filter for the first transducer 120a, effectively removing the high frequency component from the output of the driver for the first transducer 120a. Therefore, because the sound path is selected such that it functions as an acoustical filter, in at least one embodiment, the electrical signal delivered to the first transducer 120a, and the signal delivered to the second transducer 122d, may not require an electronic filter. In other words, the earphone's electronic components may be subsequently simplified by removing the necessity for an electronic chip or other electronic parts or circuitry that provide signal filtering for the drivers of the transducers. This simplification is in-part due to sizing and configuring the path for the sound produced by the first transducer such that the sound path itself, and its defining surfaces, act as a low pass acoustical filter.

[0046] In some of the above-described embodiments, the second speaker element 22 may be connected fixedly to the first speaker element 20. According to other embodiments, the second speaker element 22 may be con-

nected hingedly to the first speaker element 20 so that the second speaker element 22 can be rotated pivotably about a vertical axis of the hinge connecting the first and second speaker elements. That is, according to one embodiment, the second speaker element 22 may be rotated relative to the first speaker element 20 along curve C shown in Figure 4.

[0047] According to yet other embodiments, the second speaker element 22 may be connected to the first speaker element 20 by a pivotable joint with multiple degrees of rotational freedom, such as a knuckle-ball joint or a ball joint. In other words, the second speaker element 22 may be rotated about any of three perpendicular axes, e.g. allowing for relative pitch, yaw, and/or roll motions, with respect to the first speaker element 20. In that case, in addition to being able to rotate pivotably along line C in Figure 4, the second speaker element 22 could also be rotated about its horizontal axis (i.e., along curve D in Figure 3) and rotated about a horizontal axis at the joint between the first speaker element 20 and the second speaker element 22 (i.e., along curve E in Figure 3). Such multiple degrees of movement give the user more flexibility to adjust the relative positioning of the speaker elements 20, 22 for increased comfort.

[0048] In addition, in other embodiments, the first speaker element 20 may be connected to the tragel bridge 26 by a joint, such as a knuckle-ball joint or a ball joint, that allows multiple degrees of rotational freedom but limits or prevents translational movement. In other words, the first speaker element 20 may be rotated about any of three perpendicular axes, e.g. allowing for relative pitch, yaw, and/or roll motions, with respect to the tragel bridge 26. That way, the user may adjust the rotational orientation of the first speaker element 20 to enhance further the comfort of the earphone 10.

[0049] The examples presented herein are intended to illustrate potential and specific implementations of the embodiments. It can be appreciated that the examples are intended primarily for purposes of illustration for those skilled in the art. No particular aspect or aspects of the examples is/are intended to limit the scope of the described embodiments.

[0050] It is to be understood that the figures and descriptions of the embodiments have been simplified to illustrate elements that are relevant for a clear understanding of the embodiments. Because such elements are well known in the art and because they do not facilitate a better understanding of the embodiments, a discussion of such elements is not provided herein.

[0051] While various embodiments have been described herein, it should be apparent that various modifications, alterations, and adaptations to those embodiments may occur to persons skilled in the art with attainment of at least some of the advantages. The disclosed embodiments are intended to include all such modifications, alterations, and adaptations without departing from the scope of the embodiments as set forth herein.

Claims

1. An earphone (10), comprising:

   a first speaker element (20) and a second speaker element (22) extending from the first speaker element (20), wherein the second speaker element (22) is sized and configured to fit at least partially into a cavum concha of a listener's ear (12), and wherein the second speaker element (22) is connected to the first speaker element (20) by a pivotable joint;
   a bridge (26) comprising a first end and a second end, wherein the first speaker element is pivotably connected to the first end of the bridge; and
   a hanger bar (24) comprising a first portion (30) and a second portion (32), wherein the first portion (30) is threadingly connected to the second end of the bridge, wherein the second portion (32) of the hanger bar (24) is configured to rest upon a part of the listener's ear (12) when the earphone (10) is worn by the listener (14);
   the first end of the bridge defining a first axis, wherein the first speaker element (20) may rotate about the first axis, wherein the second end of the bridge defines a second axis, and wherein the first portion of the hanger bar (24) is threadingly connected to the second end of the bridge (26) such that the hanger bar (24) may rotate about the second axis.

2. The earphone of claim 1, wherein the bridge (26) further comprises a rotatable knob (48) that is accessible to the listener (14), wherein the knob (48) threadingly engages the first portion (30) of the hanger bar (24) such that rotation of the knob (48) causes the second portion (32) of the hanger bar (24) to at least translate relative to the bridge (26).

3. The earphone of claim 2, wherein the second portion (32) of the hanger bar (24) and the bridge (26) are separated by a distance (H) and wherein the rotatable knob (48) is configured such that rotation of the knob (48) causes the distance (H) to change.

4. The earphone of any preceding claim, wherein the pivotable joint is configured to provide three degrees of rotational freedom to the second speaker element (22) in relation to the first speaker element (20).

5. The earphone of any preceding claim, wherein the pivotable joint is a ball joint.

6. The earphone of any preceding claim, wherein the first speaker element (20) is configured to produce a first sound in a first predetermined direction and the second speaker element (22) is configured to produce a second sound in a second predetermined

direction, wherein the first predetermined direction is transverse to the second predetermined direction.

7. The earphone of any preceding claim, wherein the first speaker element (20) is pivotably connected to the first end of the bridge (26) by a ball joint.

8. The earphone of any of claims 1-6, wherein the first speaker element (20) is pivotably connected to the first end of the bridge (26) by a hinged joint.

9. The earphone of claim 8, wherein the hinged joint defines said first axis, the first speaker element (20) may only rotate about the first axis, and the hanger bar (24) may only rotate about the second axis.

10. The earphone of claim 9 as dependant on claim 2 or claim 3, wherein the hinged joint defines said first axis, wherein the first speaker element (20) may only rotate about the first axis, wherein the rotatable knob (48) defines said second axis, and wherein the hanger bar (24) is operably engaged to the rotatable knob (48) such that the hanger bar (24) may only rotate about the second axis.

11. The earphone of claim 2, wherein the rotatable knob (48) defines said second axis, and wherein the hanger bar (24) is operably engaged to the rotatable knob (48) such that the hanger bar (24) may rotate about the second axis.

12. The earphone of any preceding claim, wherein said first axis and said second axis are substantially parallel.

13. The earphone of any preceding claim, wherein said first axis and said second axis are not collinear.

14. The earphone of claim 1, wherein the first portion (30) of the hanger bar (24) comprises threads such that relative rotation of the second portion (32) of the hanger bar (24) to the bridge (26) causes the second portion (32) of the hanger bar (24) to at least translate relative to the bridge (26).

15. The earphone of claim 1, wherein the bridge (26) is configured to rest adjacent to a tragus of the listener's ear (12) when the earphone (10) is worn by the listener (12).

16. The earphone of claim 1, further comprising an O-ring (39) disposed within the bridge (26), wherein the first portion (30) of the hanger bar (24) passes through the O-ring (39), wherein the O-ring (39) is sized and configured to provide rotational friction to the first portion (30) of the hanger bar (24) passing therethrough.

17. A method of wearing an earphone, the method comprising the steps of:

providing an earphone (10) comprising:

a first speaker element (20) and a second speaker element (22) extending from the first speaker element (20), wherein the second speaker element (22) is sized and configured to fit at least partially into a cavum concha of a listener's ear (12);
a bridge (26) comprising a first end and a second end, wherein the speaker element (20) is pivotably connected to the first end of the bridge (26), and
wherein the second end comprises a rotatable knob (48); and
a hanger bar (24) comprising a first portion (30) and a second portion (32), wherein the first portion (30) is operably engaged to the rotatable knob (48) such that rotation of the knob (48) causes the second portion (32) of the hanger bar (24) to at least translate relative to the bridge (26);
rotating the knob (48) to adjust a distance (H) between the second portion (32) of the hanger bar (24) and the bridge (26);
rotating the speaker element (20) relative to the bridge (26);
resting the hanger bar (24) on part of a listener's ear (12) such that the speaker element (20) is aligned with the cavum concha of the listener's ear (12); and
placing the second speaker element (22) at least partially into the cavum concha of the listener's ear (12).

18. The method of claim 17, wherein the step of resting further comprises resting the hanger bar (24) on a portion of a listener's ear (12) such that the bridge (26) sits adjacent to the tragus of the listener's ear (12).

19. The method of claim 17, further comprising the step of rotating the second portion (32) of the hanger bar (24) relative to the bridge (26).

Patentansprüche

1. Kopfhörer (10), umfassend:

ein erstes Lautsprecherelement (20) und ein zweites Lautsprecherelement (22), das sich vom ersten Lautsprecherelement (20) weg erstreckt, worin das zweite Lautsprecherelement (22) so dimensioniert und konfiguriert ist, dass es zumindest teilweise in das Cavum Conchae

eines Zuhörerohrs (12) passt, und worin das zweite Lautsprecherelement (22) mit dem ersten Lautsprecherelement durch ein schwenkbares Gelenk verbunden ist;
eine Brücke (26), die ein erstes Ende und ein zweites Ende umfasst, worin das erste Lautsprecherelement schwenkbar mit dem ersten Ende der Brücke verbunden ist; und
einen Tragebügel (24), der einen ersten Teil (30) und einen zweiten Teil (32) umfasst, worin der erste Teil (30) durch ein Gewinde mit dem zweiten Ende der Brücke verbunden ist, worin der zweite Teil (32) des Tragebügels (24) so konfiguriert ist, dass er auf einem Teil des Zuhörerohrs (12) abgestützt ist, wenn der Kopfhörer (10) vom Zuhörer (14) getragen wird;
wobei das erste Ende der Brücke eine erste Achse definiert, worin sich das erste Lautsprecherelement (20) um die erste Achse drehen kann, worin das zweite Ende der Brücke eine zweite Achse definiert, und worin der erste Teil des Tragebügels (24) durch ein Gewinde mit dem zweiten Ende der Brücke (26) verbunden ist, sodass sich der Tragebügel (24) um die zweite Achse drehen kann.

2. Kopfhörer nach Anspruch 1, worin die Brücke (26) ferner einen Drehknopf (48) umfasst, der dem Zuhörer (14) zugänglich ist, worin der Knopf (48) den ersten Teil (30) des Tragebügels (24) durch ein Gewinde verbindet, sodass die Drehung des Knopfes (48) bewirkt, dass der zweite Teil (32) des Tragebügels (24) relativ zur Brücke (26) zumindest verschoben wird.

3. Kopfhörer nach Anspruch 2, worin der zweite Teil (32) des Tragebügels (24) und die Brücke (26) durch einen Abstand (H) getrennt sind, und worin der Drehknopf (48) so konfiguriert ist, dass die Drehung des Knopfes (48) bewirkt, dass sich der Abstand (H) ändert.

4. Kopfhörer nach einem der vorangegangenen Ansprüche, worin das schwenkbare Gelenk so konfiguriert ist, um dem zweiten Lautsprecherelement (22) in Bezug auf das erste Lautsprecherelement (20) drei Rotationsfreiheitsgrade bereitzustellen.

5. Kopfhörer nach einem der vorangegangenen Ansprüche, worin das schwenkbare Gelenk ein Kugelgelenk ist.

6. Kopfhörer nach einem der vorangegangenen Ansprüche, worin das erste Lautsprechergelenk (20) so konfiguriert ist, dass es einen ersten Ton in einer ersten, vorher festgelegten Richtung erzeugt, und das zweite Lautsprecherelement (22) so konfiguriert ist, dass es einen zweiten Ton in einer zweiten, vorher festgelegten Richtung erzeugt, worin die erste vorher festgelegte Richtung transversal zur zweiten vorher festgelegten Richtung ist.

7. Kopfhörer nach einem der vorangegangenen Ansprüche, worin das erste Lautsprecherelement (20) durch ein Drehgelenk schwenkbar mit dem ersten Ende der Brücke (26) verbunden ist.

8. Kopfhörer nach einem der Ansprüche 1-6, worin das erste Lautsprecherelement (20) durch ein Drehgelenk schwenkbar mit dem ersten Ende der Brücke (26) verbunden ist.

9. Kopfhörer nach Anspruch 8, worin das Drehgelenk die erste Achse definiert, das erste Lautsprecherelement (20) sich nur um die erste Achse drehen kann, und der Tragebügel (24) sich nur um die zweite Achse drehen kann.

10. Kopfhörer nach Anspruch 9, abhängig von Anspruch 2 oder Anspruch 3, worin das Drehgelenk die erste Achse definiert, worin sich das erste Lautsprecherelement (20) nur um die erste Achse drehen kann, worin der Drehknopf (48) die zweite Achse definiert, und worin der Tragebügel (24) mit dem Drehknopf (48) wirkverbunden ist, sodass sich der Tragebügel (24) nur um die zweite Achse drehen kann.

11. Kopfhörer nach Anspruch 2, worin der Drehknopf (48) die zweite Achse definiert, und worin der Tragebügel (24) mit dem Drehknopf (48) so wirkverbunden ist, dass sich der Tragebügel (24) um die zweite Achse drehen kann.

12. Kopfhörer nach einem der vorangegangenen Ansprüche, worin die erste Achse und die zweite Achse im Wesentlichen parallel sind.

13. Kopfhörer nach einem der vorangegangenen Ansprüche, worin die erste Achse und die zweite Achse nicht kollinear sind.

14. Kopfhörer nach Anspruch 1, worin der erste Teil (30) des Tragebügels (24) Gewinde umfasst, sodass die relative Drehung des zweiten Teils (32) des Tragebügels (24) zur Brücke (26) bewirkt, dass der zweite Teil (32) des Tragebügels (24) relativ zur Brücke (26) zumindest verschoben wird.

15. Kopfhörer nach Anspruch 1, worin die Brücke (26) so konfiguriert ist, dass sie angrenzend an den Tragus eines Zuhörerohrs (12) abgestützt ist, wenn der Kopfhörer (10) vom Zuhörer (12) getragen wird.

16. Kopfhörer nach Anspruch 1, welcher ferner einen O-Ring (39), der innerhalb der Brücke (26) angeordnet ist, worin der erste Teil (39) des Tragebügels (24)

durch den O-Ring (39) hindurchgeht, worin der O-Ring (39) so dimensioniert und konfiguriert ist, dass er dem ersten Teil (30) des Tragebügels (24) Rollreibung bereitstellt, wenn dieser durch ihn hindurchgeht.

17. Verfahren zum Tragen eines Kopfhörers, wobei das Verfahren die folgenden Schritte umfasst:

das Bereitstellen eines Kopfhörers (10), welcher umfasst:

ein erstes Lautsprecherelement (20) und ein zweites Lautsprecherelement (22), das sich vom ersten Lautsprecherelement (20) weg erstreckt, worin das zweite Lautsprecherelement (22) so dimensioniert und konfiguriert ist, dass es zumindest teilweise in das Cavum Conchae eines Zuhörerohrs (12) passt;
eine Brücke (26), die ein erstes Ende und ein zweites Ende umfasst, worin das Lautsprecherelement (20) schwenkbar mit dem ersten Ende der Brücke (26) verbunden ist, und
worin das zweite Ende einen Drehknopf (48) umfasst; sowie
einen Tragebügel (24), der einen ersten Teil (30) und einen zweiten Teil (32) umfasst, worin der erste Teil (30) mit dem Drehknopf (48) so wirkverbunden ist, dass die Drehung des Knopfes (48) bewirkt, dass der zweite Teil (32) des Tragebügels (24) relativ zur Brücke (26) zumindest verschoben wird;
das Drehen des Knopfes (48), um einen Abstand (H) zwischen dem zweiten Teil (32) des Tragebügels (24) und der Brücke (26) einzustellen;
das Drehen des Lautsprecherelements (20) relativ zur Brücke (26);
das Abstützen des Tragebügels (24) auf einem Teil des Zuhörerohrs (12); und
das Platzieren des zweiten Lautsprecherelements (22) zumindest teilweise im Cavum Conchae des Zuhörerohrs (12).

18. Verfahren nach Anspruch 17, worin der Schritt des Abstützens ferner das Abstützen des Tragebügels (24) auf einem Teil eines Zuhörerohrs (12) umfasst, sodass die Brücke (26) angrenzend an den Tragus des Zuhörerohrs (12) liegt.

19. Verfahren nach Anspruch 17, welches ferner den Schritt des Drehens des zweiten Teils (32) des Tragebügels (24) relativ zur Brücke (26) umfasst.

Revendications

1. Ecouteur (10) comprenant :

un premier élément de haut-parleur (20) et un second élément de haut-parleur (22) s'étendant à partir du premier élément de haut-parleur (20), dans lequel le second élément de haut-parleur (22) est dimensionné et configuré pour s'adapter au moins partiellement dans une cavité auriculaire de l'oreille (12) d'une personne qui écoute, et dans lequel le second élément de haut-parleur (22) est raccordé au premier élément de haut-parleur (20) par une articulation pivotante ;
un pont (26) comprenant une première extrémité et une seconde extrémité, dans lequel le premier élément de haut parleur est raccordé de manière pivotante à la première extrémité du pont ; et
une barre de suspension (24) comprenant une première partie (30) et une seconde partie (32), dans lequel la première partie (30) est raccordée par filetage à la seconde extrémité du pont, dans lequel la seconde partie (32) de la barre de suspension (24) est configurée pour s'appuyer sur une partie de l'oreille (12) de la personne qui écoute lorsque l'écouteur (10) est porté par la personne qui écoute (14) ;
la première extrémité du pont définissant un premier axe, dans lequel le premier élément de haut-parleur (20) peut tourner autour du premier axe, dans lequel la seconde extrémité du pont définit un second axe, et dans lequel la première partie de la barre de suspension (24) est raccordée, par filetage, à la seconde extrémité du pont (26) de sorte que la barre de suspension (24) peut tourner autour du second axe.

2. Ecouteur selon la revendication 1, dans lequel le pont (26) comprend en outre un bouton rotatif (48) qui est accessible à la personne qui écoute (14), dans lequel le bouton (48) met en prise, par filetage, la première partie (30) de la barre de suspension (24) de sorte que la rotation du bouton (48) amène la seconde partie (32) de la barre de suspension (24) à effectuer au moins un mouvement de translation par rapport au pont (26).

3. Ecouteur selon la revendication 2, dans lequel la seconde partie (32) de la barre de suspension (24) et le pont (26) sont séparés par une distance (H) et dans lequel le bouton rotatif (48) est configuré de sorte que la rotation du bouton (48) provoque le changement de la distance (H).

4. Ecouteur selon l'une quelconque des revendications précédentes, dans lequel l'articulation pivotante est configurée pour fournir trois degrés de liberté de ro-

tation au second élément de haut-parleur (22) par rapport au premier élément de haut-parleur (20).

5. Ecouteur selon l'une quelconque des revendications précédentes, dans lequel l'articulation pivotante est une articulation sphérique.

6. Ecouteur selon l'une quelconque des revendications précédentes, dans lequel le premier élément de haut-parleur (20) est configuré pour produire un premier son dans une première direction prédéterminée et le second élément de haut-parleur (22) est configuré pour produire un second son dans une seconde direction prédéterminée, dans lequel la première direction prédéterminée est transversale par rapport à la seconde direction prédéterminée.

7. Ecouteur selon l'une quelconque des revendications précédentes, dans lequel le premier élément de haut-parleur (20) est raccordé de manière pivotante à la première extrémité du pont (26) par une articulation sphérique.

8. Ecouteur selon l'une quelconque des revendications 1 à 6, dans lequel le premier élément de haut-parleur (20) est raccordé de manière pivotante à la première extrémité du point (26) par un joint articulé.

9. Ecouteur selon la revendication 8, dans lequel le joint articulé définit ledit premier axe, le premier élément de haut-parleur (20) peut tourner uniquement autour du premier axe et la barre de suspension (4) peut uniquement tourner autour du second axe.

10. Ecouteur selon la revendication 9 dépendant de la revendication 2 ou de la revendication 3, dans lequel le joint articulé définit ledit premier axe, dans lequel le premier élément de haut-parleur (20) peut uniquement tourner autour du premier axe, dans lequel le bouton rotatif (48) définit ledit second axe, et dans lequel la barre de suspension (24) est mise en prise, de manière opérationnelle, par rapport au bouton rotatif (48) de sorte que la barre de suspension (24) ne peut tourner qu'autour du second axe.

11. Ecouteur selon la revendication 2, dans lequel le bouton rotatif (48) définit ledit second axe, et dans lequel la barre de suspension (24) est mise en prise, de manière opérationnelle par rapport au bouton rotatif (48) de sorte que la barre de suspension (24) peut tourner autour du second axe.

12. Ecouteur selon l'une quelconque des revendications précédentes, dans lequel ledit premier axe et ledit second axe sont sensiblement parallèles.

13. Ecouteur selon l'une quelconque des revendications précédentes, dans lequel ledit premier axe et ledit second axe ne sont pas colinéaires.

14. Ecouteur selon la revendication 1, dans lequel la première partie (30) de la barre de suspension (24) comprend des filetages de sorte que la rotation relative de la seconde partie (32) de la barre de suspension (24) par rapport au pont (26) amène la seconde partie (32) de la barre de suspension (24) à effectuer au moins un mouvement de translation par rapport au pont (26).

15. Ecouteur selon la revendication 1, dans lequel le pont (26) est configuré pour s'appuyer de manière adjacente à un tragus de l'oreille (12) de la personne qui écoute lorsque l'écouteur (10) est porté par la personne qui écoute (12).

16. Ecouteur selon la revendication 1, comprenant en outre un joint torique (39) disposé à l'intérieur du pont (26), dans lequel la première partie (30) de la barre de suspension (24) passe à travers le joint torique (29), dans lequel le joint torique (39) est dimensionné et configuré pour fournir la friction rotative à la première partie (30) de la barre de suspension (24) passant à travers ce dernier.

17. Procédé pour porter un écouteur, le procédé comprenant les étapes consistant à :

prévoir un écouteur (10) comprenant :

un premier élément de haut-parleur (20) et un second élément de haut-parleur (22) s'étendant à partir du premier élément de haut-parleur (20), dans lequel le second élément de haut-parleur (22) est dimensionné et configuré pour s'adapter au moins partiellement dans une cavité auriculaire de l'oreille (12) d'une personne qui écoute ;
un pont (26) comprenant une première extrémité et une seconde extrémité, dans lequel l'élément de haut-parleur (20) est raccordé de manière pivotante à la première extrémité du pont (26), et
dans lequel la seconde extrémité comprend un bouton rotatif (48) ; et
une barre de suspension (24) comprenant une première partie (30) et une seconde partie (32), dans lequel la première partie (30) est mise en prise de manière opérationnelle par rapport au bouton rotatif (48) de sorte que la rotation du bouton (48) amène la seconde partie (32) de la barre de suspension (24) à effectuer au moins un mouvement de translation par rapport au pont (26) ;
faire tourner le bouton (48) pour ajuster une distance (H) entre la seconde partie (32) de

la barre de suspension (24) et le pont (26) ;
faire tourner l'élément de haut-parleur (20) par rapport au pont (26) ;
appuyer la barre de suspension (24) sur une partie de l'oreille (12) de la personne qui écoute, de sorte que l'élément de haut-parleur (20) est aligné avec la cavité auriculaire de l'oreille (12) de la personne qui écoute ; et
placer le second élément de haut-parleur (22) au moins partiellement dans la cavité auriculaire de l'oreille (12) de la personne qui écoute.

18. Procédé selon la revendication 17, dans lequel l'étape d'appui comprend en outre l'étape consistant à appuyer la barre de suspension (24) sur une partie de l'oreille (12) de la personne qui écoute de sorte que le pont (26) est installé de manière adjacente au tragus de l'oreille (12) de la personne qui écoute.

19. Procédé selon la revendication 17, comprenant en outre l'étape consistant à faire tourner la seconde partie (32) de la barre de suspension (24) par rapport au pont (26).

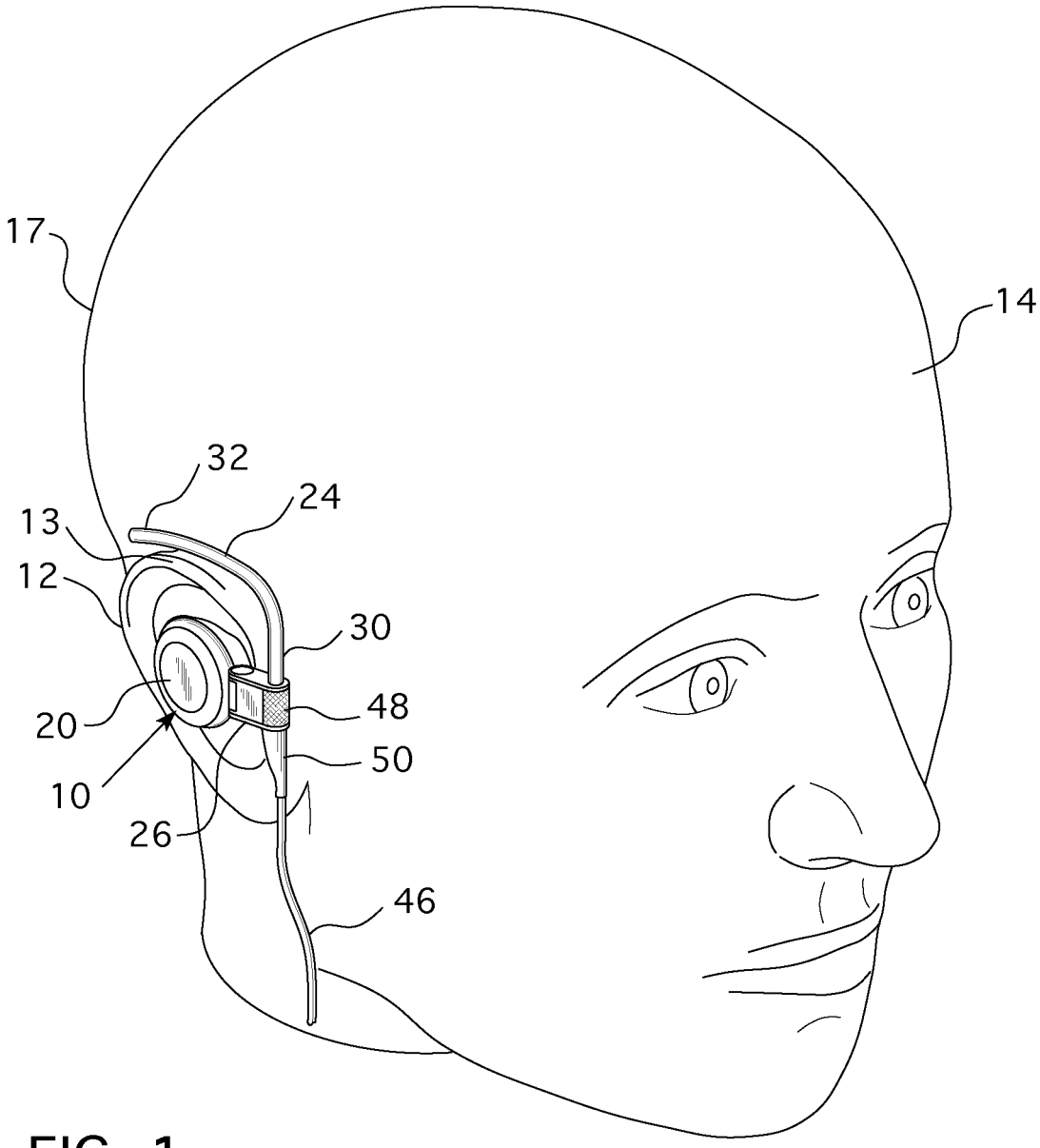

FIG. 1

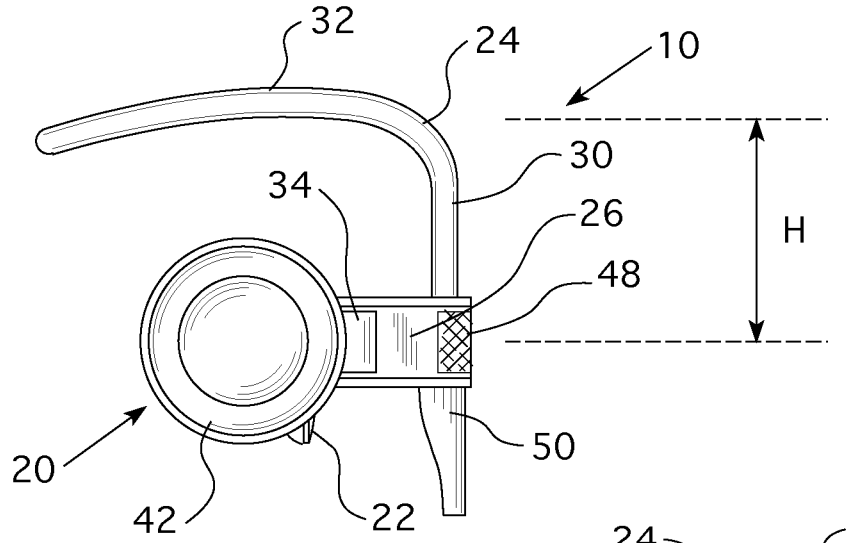

FIG. 2

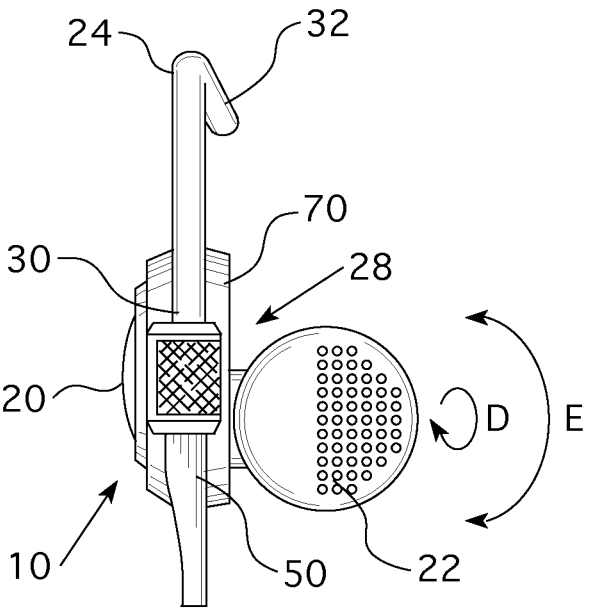

FIG. 3

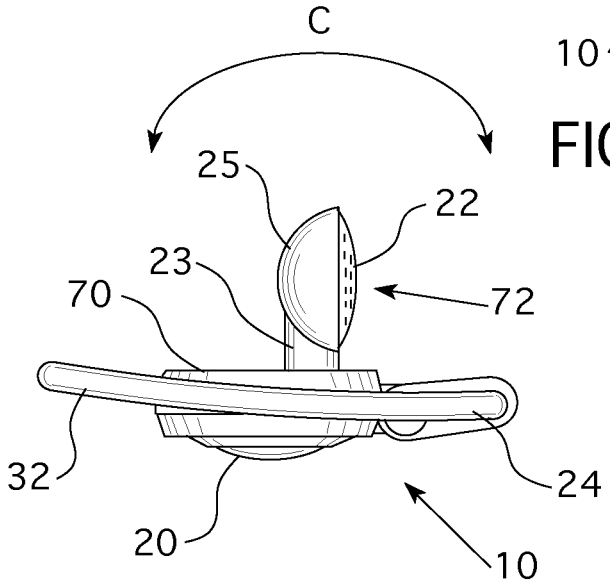

FIG. 4

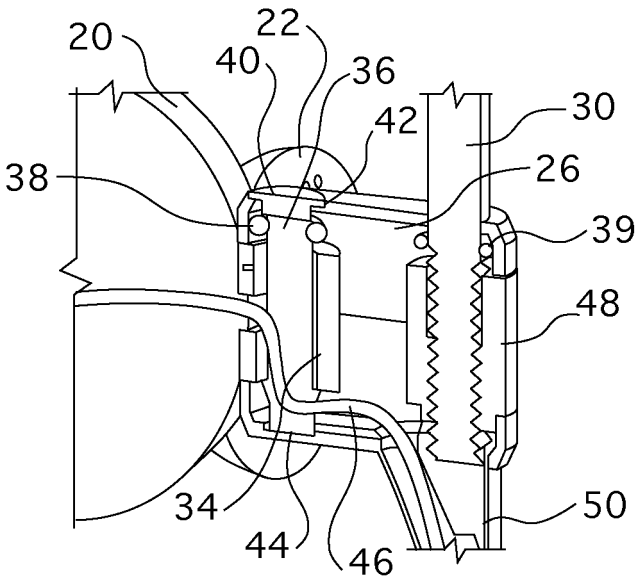

FIG. 5

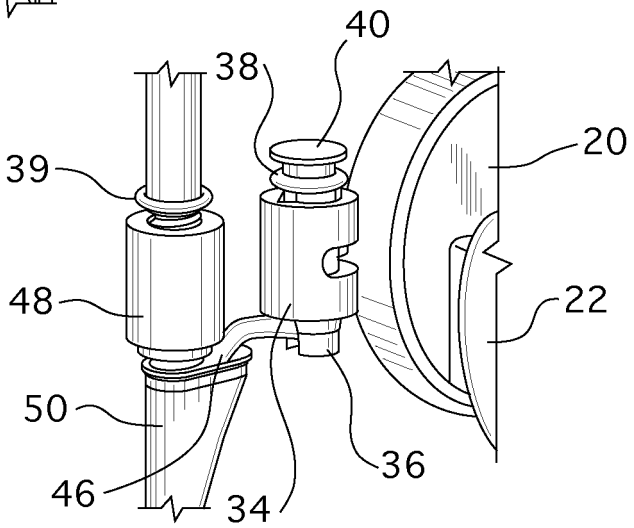

FIG. 6

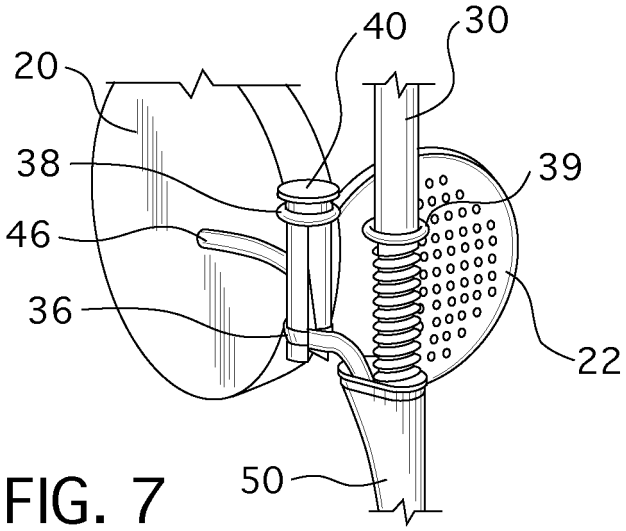

FIG. 7

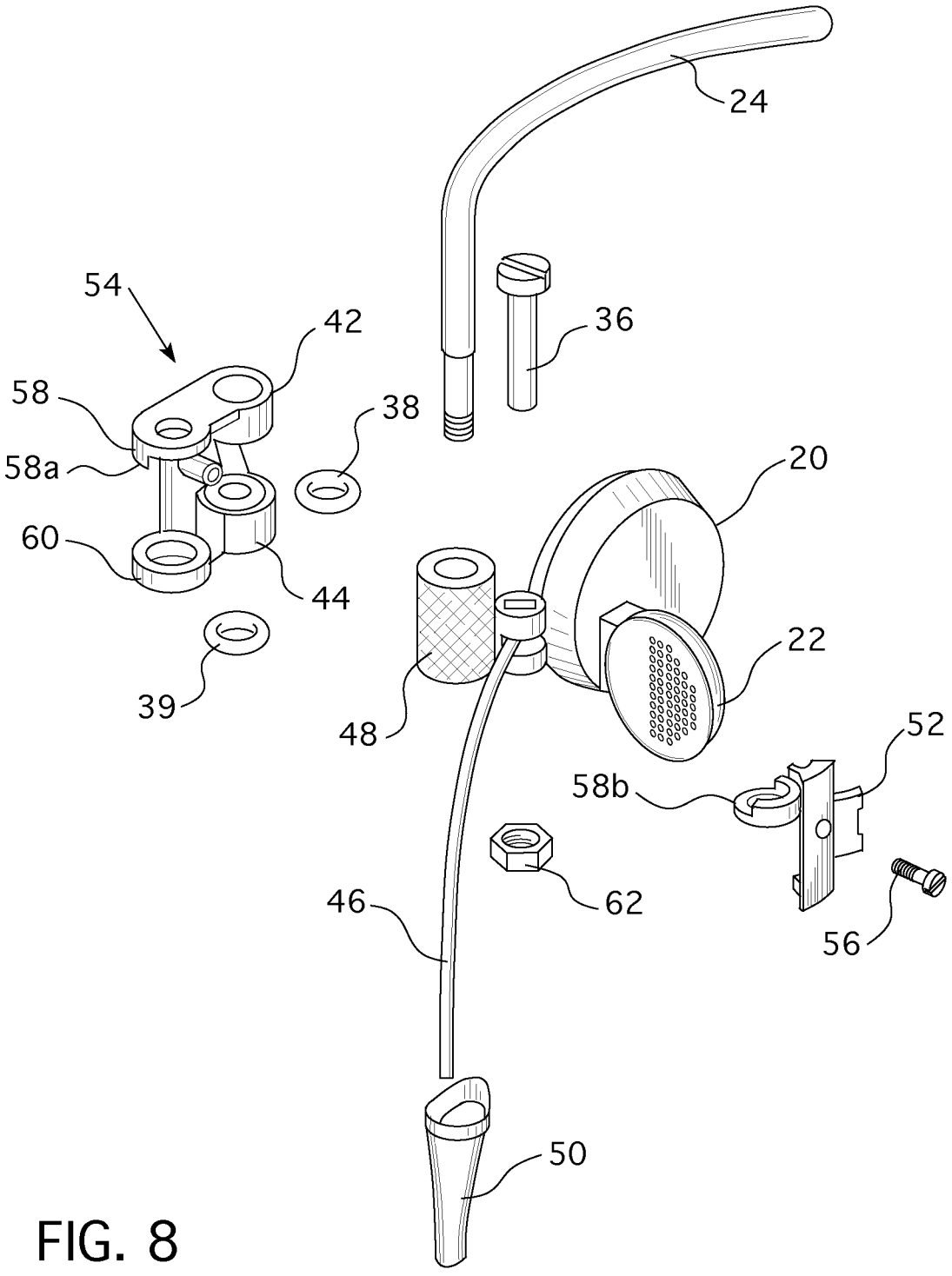

FIG. 8

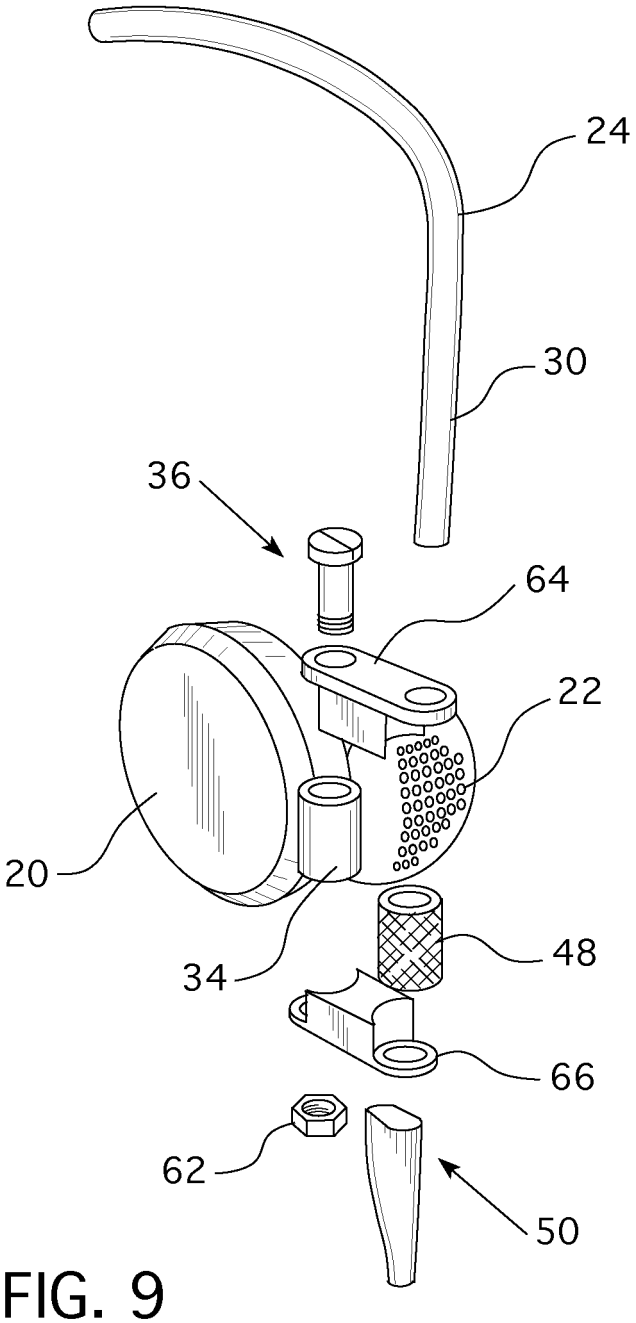

FIG. 9

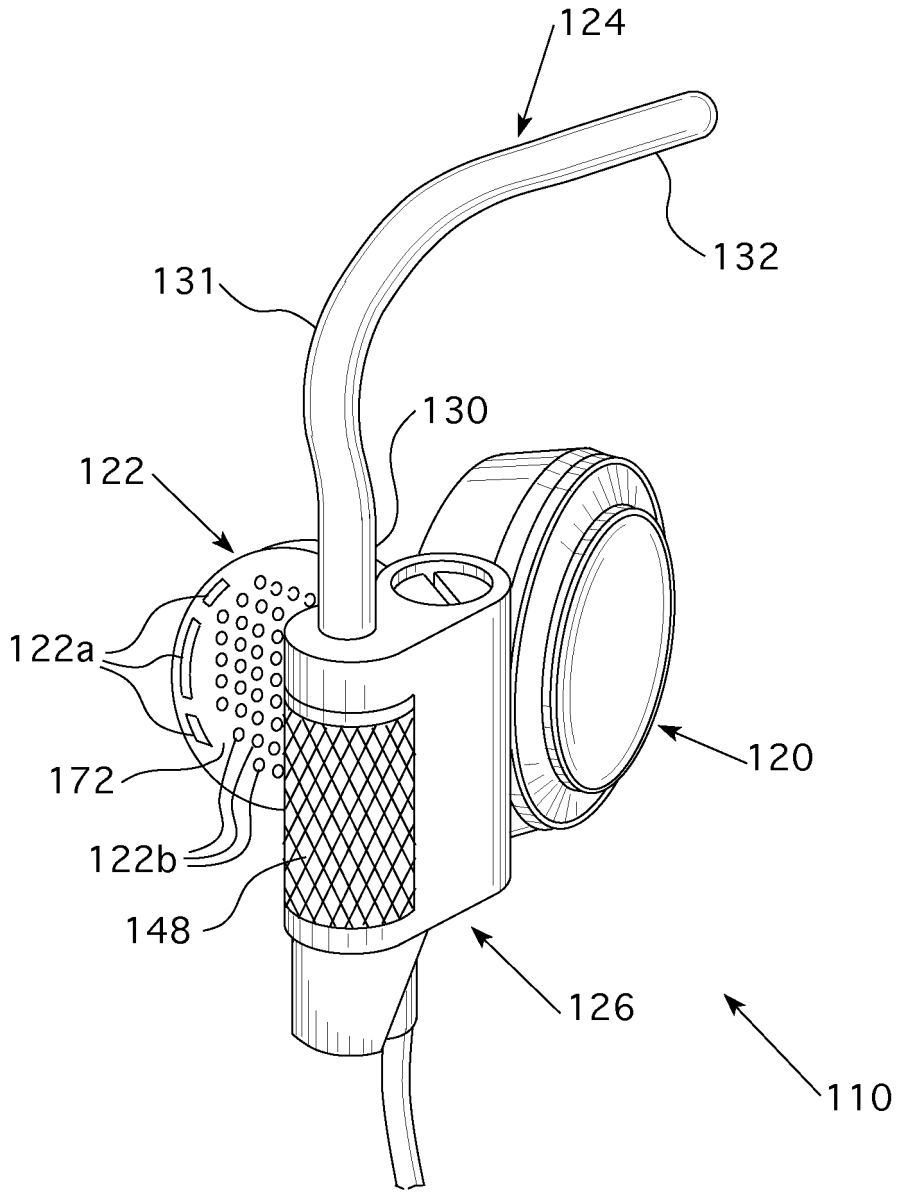

FIG. 10

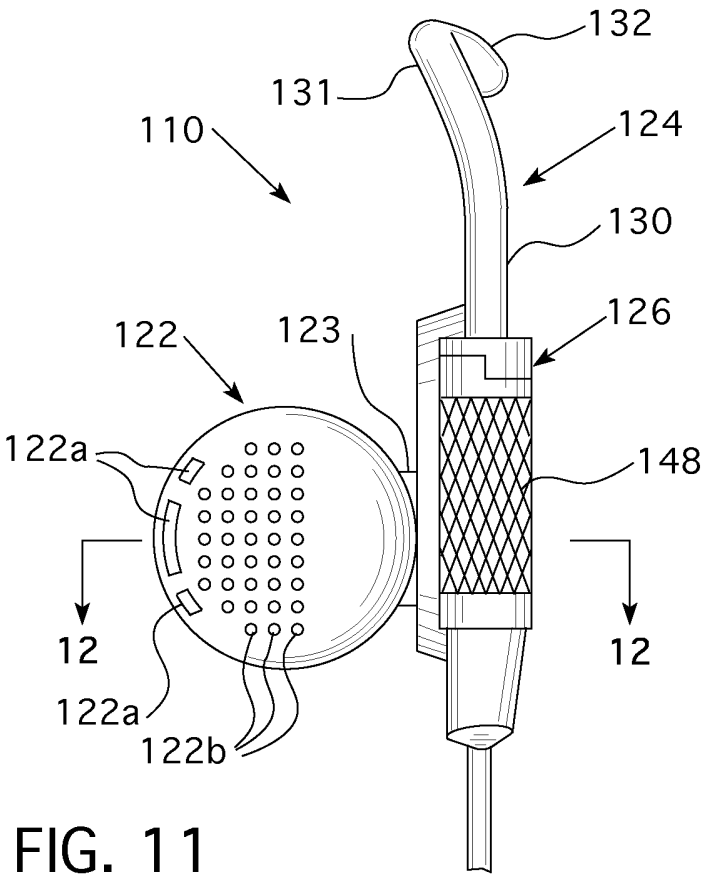
132
131
110
124
130
126
122
123
122a
148
12
12
122a
122b

FIG. 11

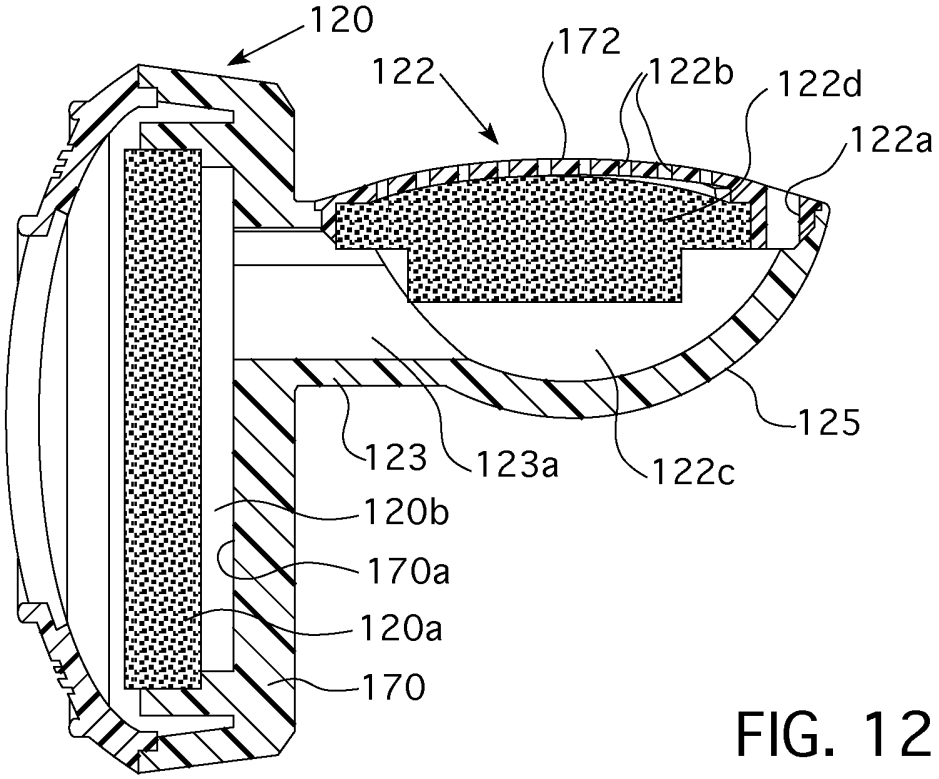
120
172
122
122b
122d
122a
125
123
123a
122c
120b
170a
120a
170

FIG. 12

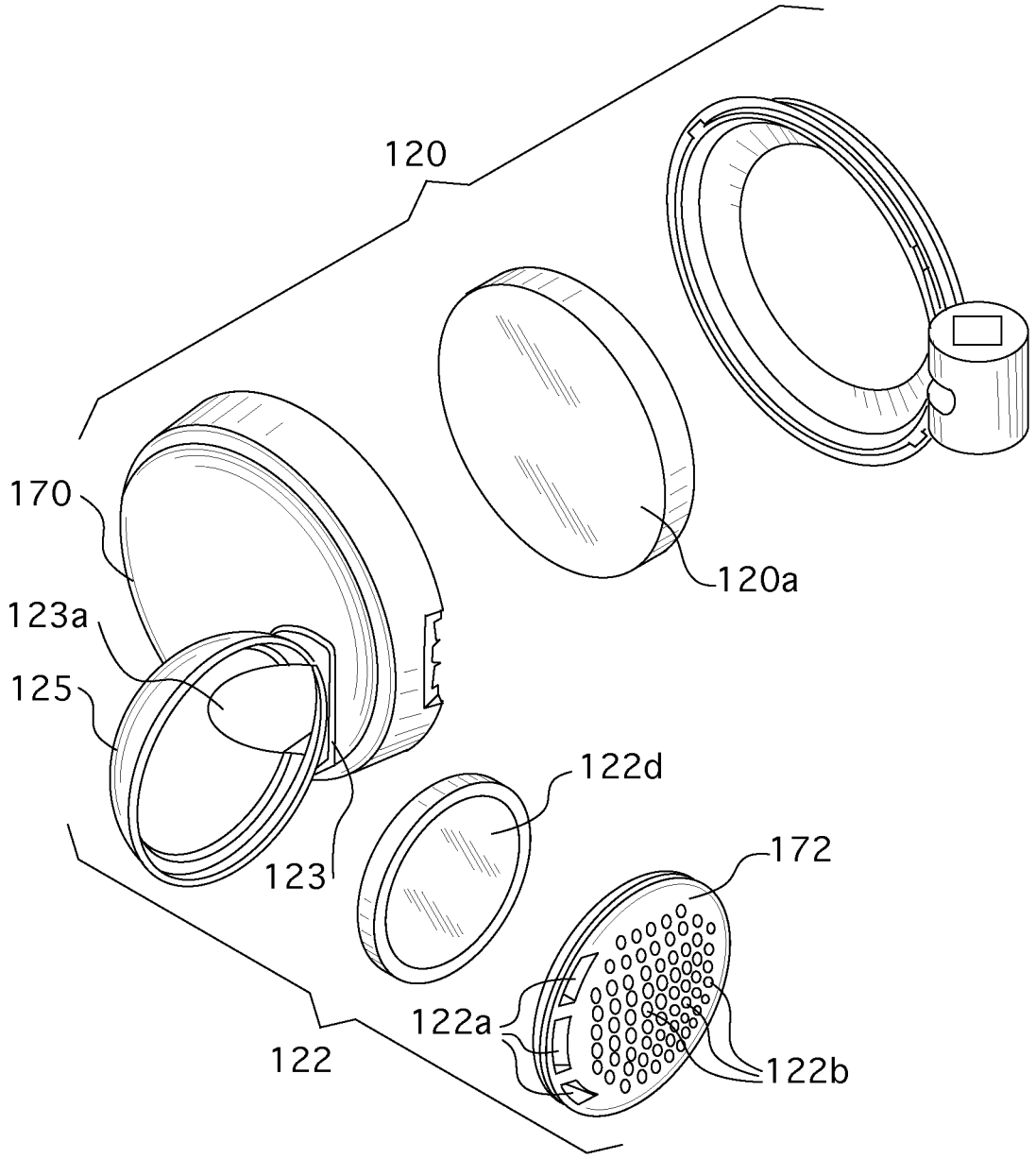

FIG. 13

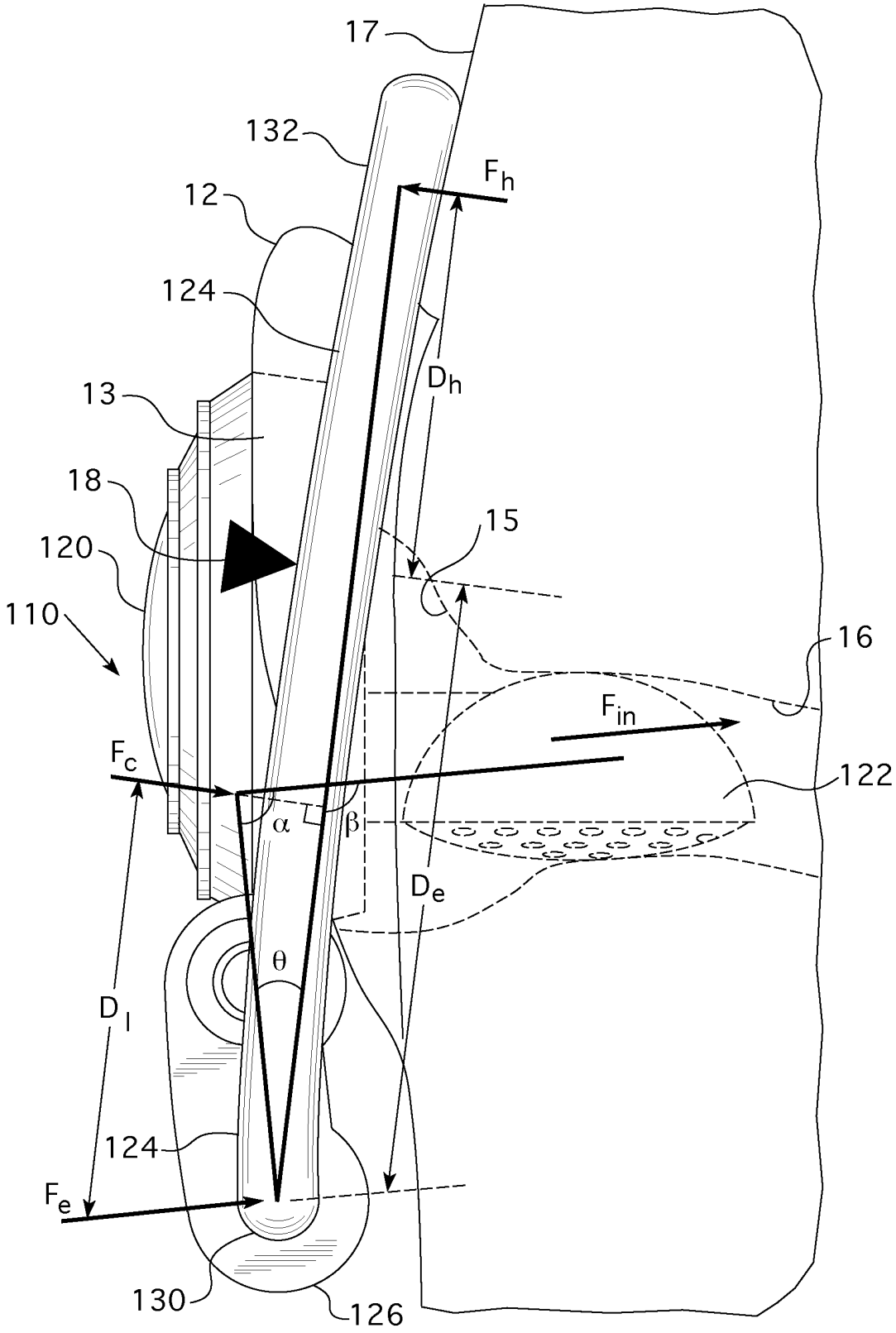
17
132
12
124
13
18
120
110
15
16
122
F_h
D_h
F_{in}
F_c
α
β
D_e
θ
D_l
124
F_e
130
126

FIG. 14

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 61054238 A **[0001]**
- US 33494209 F **[0001]**
- US 5333206 A **[0003] [0043]**
- US 5729615 A **[0004]**
- US 20070104345 A **[0005]**
- US 4418248 A **[0043]**