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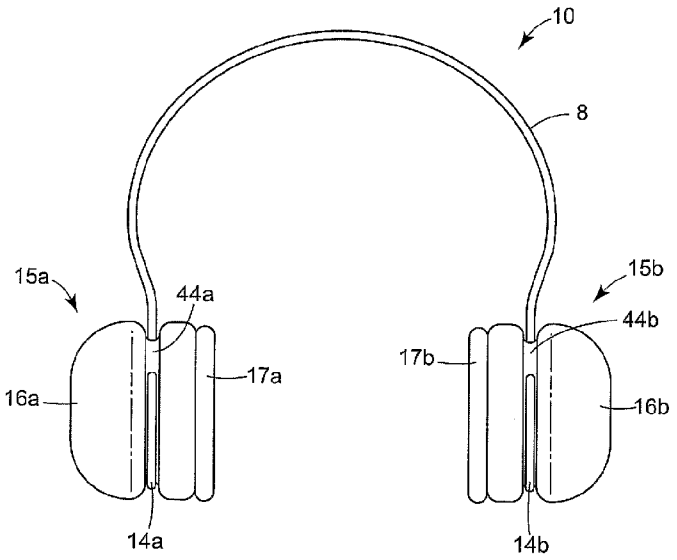
[Continued on next page]

(54) Title: HEARING PROTECTIVE EARMUFF DEVICE HAVING FRICTIONALLY ENGAGEABLE EAR CUPS



(57) Abstract: A hearing protective device (10) that includes a first ear cup (16a) , a second ear cup (16b) , and a headpiece (8) . The first ear cup is maintained in a fixed position in the first end of the headpiece through a frictional engagement, and the second ear cup is maintained in a fixed position in the second end through a frictional engagement. The hearing protection device is beneficial in that the user can easily change the ear cup if damaged or if a different level of sound attenuation is desired. The user does not have to buy a whole new earmuf f apparatus .

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— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

HEARING PROTECTIVE EARMUFF DEVICE HAVING FRICTIONALLY ENGAGEABLE EAR CUPS

BACKGROUND OF THE INVENTION

The invention relates to maintaining ear cups in a headband through a frictional engagement.

Hearing protective devices in the form of earmuffs are widely used in industry to protect workers against environmental noise. Traditional hearing protective earmuffs include a pair of cup-shaped rigid shells that are attached to a headband. The headband is commonly designed for permanent attachment to the ear cups. For these constructions, an attempt to remove the ear cup from the headband can damage or destroy the ear cup, the headband or both.

Some hearing protective earmuff configurations are designed to allow the ear cup to be removed from the headband. In these constructions, mechanical mechanisms such as male-female connectors, prongs, screws, nuts, and bolts can be used to secure and separate the headband and ear cups. These mechanisms often involve relatively difficult manipulations of the connection mechanism or may require additional tools to separate the ear cup from the headband.

SUMMARY OF THE INVENTION

This invention features a hearing protective earmuff device that includes a first ear cup, a second ear cup, and a headpiece. The headpiece has first and second ends extending therefrom. The first ear cup is maintained in a fixed position in the first end through a frictional engagement. The second ear cup is also maintained in a fixed position in the second end through a frictional engagement

The invention features a hearing protective device in which the headband terminates in ends that are capable of maintaining ear cups therein through a frictional engagement between the ear cup and the end. In some embodiments, the nature of the ends of the headband permits the headband to be worn in multiple positions on the head including, e.g., behind the neck, while maintaining the earmuffs in proper position on the ears.

The invention also features a hearing protective device in which the frictional engagement that exists between the ear cup and the headband allows a user to insert and

remove the ear cup from the headband as desired without damaging the ear cups or the headband. The ability of the headband to releasably retain the ear cups facilitates ear cup removal and replacement for a variety of situations including, e.g., when the earmuffs have become damaged or soiled or when a level of sound attenuation is not appropriate for the environment in which the hearing protection device will be used. The earmuffs can be replaced with a second set of earmuffs that provide the requisite sound attenuation.

The invention is also beneficial in that the ear cups can be retained on the headband without the use of additional affixing mechanisms such as adhesives, screws, bolts, and snaps, although such mechanisms can optionally be included.

Other features and advantages will be apparent from the following description of the drawings, the preferred embodiments, and from the claims.

GLOSSARY

The term "frictional engagement" means that resistance to movement exists and that the resistance is such that an external force is required to achieve movement.

The term "headband" means a device constructed to retain an earmuff and assist in compressing an earmuff against the head of a user.

The term "ear cup" means a component that is dimensioned to receive an ear of a user and that is constructed to provide sound attenuation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a headband that includes ends that terminate in a C-shaped hook.

FIG. 2 is a plan side view of an end of a headband in the form of a curved hook.

FIG. 3 is a plan side view of an end of a headband in the form of a square hook.

FIG. 4 is a plan side view of an end of a headband in the form of a rectangular hook.

FIG. 5 is plan side view of an end of a headband in the form of a hexagonal hook.

FIG. 6 is plan side view of an end of a headband in the form two parallel tines.

FIG. 7 is plan side view of an end of a headband in the form of a rectangular hook and a portion of an ear cup positioned in the opening defined by the hook.

FIG. 8 is plan side view of an end of a headband in the form of a square hook and a portion of an ear cup positioned in the opening defined by the hook.

FIG. 9 is a side view of a hook-shaped end of a headband and a circular portion of an ear cup positioned in the opening defined by the hook.

FIG. 10 is a side view of a hook-shaped end of a headband and an octagonal portion of an ear cup positioned in the opening defined by the hook.

FIG. 11 is a perspective view of an embodiment of a headband that includes ends that terminate in two parallel tines.

FIG. 12 is a front view of the headband of FIG. 11.

FIG. 13 is a front view of a hearing protective device that includes the headband of FIG. 1.

FIG. 14 is a side view of an end of a headband and an ear cup positioned in the end according to another embodiment.

FIG. 15 is a perspective view of a hearing protective device according to another embodiment.

Like reference symbols in the various figures of the drawing indicate like elements. The elements in the drawings are not to scale.

DETAILED DESCRIPTION

FIG.1 illustrates a hearing protective device 10 that includes a headpiece 8 and earmuffs 15a, 15b that include an ear cup 16a, 16b and a cushion 17a, 17b. The headpiece may be in the form of a headband that includes a generally U-shaped band that terminates in two ends 14a, 14b, each of which is capable of maintaining an ear cup 16a, 16b positioned therein through a frictional engagement. The frictional engagement between the ear cups 16a, 16b and the ends 14a, 14b allows the ear cups to be maintained in a fixed position on the headband without assistance from another source. The frictional engagement can be achieved in various ways including, for example, having the portion of the ear cup that is received by the headband being sufficiently larger than the opening in the ear cup receiving end of the headband. The resistance exhibited by the frictional engagement can be increased by increasing the size of the ear cup or by decreasing the size of the ear cup receiving portion of the headband (relative to one another). At least one of the ear cup or the end can partially deform to accommodate the other and to achieve the frictional engagement.

The ends of the U-shaped headband are shaped and dimensioned to receive an ear cup, and to maintain the ear cup in a fixed position on the headband through a frictional

engagement with the ear cup. The ends can also optionally be shaped and dimensioned to releasably retain the ear cup therein and to permit the insertion and removal of an ear cup without damaging the ear cup or the end. The ear cups 16a, 16b remain in a fixed position in the ends 14a, 14b until moved or removed by the user.

The hearing protective device 10 can be assembled by sliding the ends 14a, 14b of the headband 8 around the ear cups 16a, 16b to frictionally engage the ear cups 16a, 16b or by inserting the ear cups 16a, 16b in the ends 14a, 14b. The headband can be configured to be capable of assuming a variety of positions including, e.g., being positioned under the user's chin, behind the user's neck, and combinations thereof. In some embodiments, the headband position can be altered by constructing the headband and ear cup such that the headband can rotate about the ear cup from a first position to a second position. In such embodiments, the user can rotate the ends 14a, 14b about the ear cups 16a, 16b to achieve a desired headband orientation and position.

In some embodiments, the ear cup 16 includes a channel 44a, 44b for receiving an end 14 of the headband. The channel 45 is defined by two side walls 43a, 43b and a bottom wall 45 extending from a first side wall 43a to a second side wall 43b. The shape defined by a cross section of the ear cup taken at the bottom wall 45 of the channel 44a and the dimension thereof corresponds to the opening defined by the end of the headband such that when the ear cup is positioned in the opening defined by the end of the headband the ear cup remains in position therein through a friction fit. The shape defined by the bottom wall of the channel can correspond to or be different from the shape of the opening defined by the interior wall(s) of the ear cup receiving end of the headband. The shape defined by or partially defined by the interior, ear cup receiving wall(s) of the end of the headband can be different from the shape defined by the cross section of the ear cup taken at the bottom wall of the channel. The bottom wall of the channel can define any of a variety of shapes including, e.g., circle, oval, ellipse, and polygon including, e.g., triangle, square, pentagon, hexagon, heptagon, octagon, nonagon, and decagon.

The ear cup is dimensioned to receive the ear of a user. The ear cup is generally cup-shaped such that the distal exterior surface is generally arcuate in shape and the proximal exterior surface, i.e., the surface closest to the ear, is generally concave and provides an open region in which the ear of a user can reside. The ear cup may be made of any suitable material, now existing or later developed. The ear cup can include a material

capable of attenuating sound. Useful sound attenuating materials include gas filled cellular materials that exhibit acoustic attenuation, mechanical stiffness and formability (e.g., the ability to alter the material, e.g., by cutting, shaping, molding, or a combination thereof). Examples of useful gas filled cellular materials include, e.g., foams (e.g., closed cell foams, open cell foams, slow recovery resilient foams (e.g., pressure molded slow recovery resilient foams), instantaneous recovery foams), bonded fiber structures, aerogels, acoustic composite materials including, e.g., hollow ceramic particles in a matrix of synthetic resin binder, multiple layered acoustic composite materials, and combinations thereof. Examples of suitable cellular bonded fiber structures are described in U.S. Patent 5,841,081 and incorporated herein. Examples of aerogels are described in U.S. Patents 4,954,327 and 6,598,358 and incorporated herein. Examples of suitable acoustic composite materials are described in U.S. Patents 5,813,180 and 5,688,860 and incorporated herein. The cellular material may be an open cell foam. The foam can be a hard foam, a semi-rigid foam, or a flexible foam.

The cells of the foam can have a relatively larger average cross-sectional area at the interior of the foam, and a relatively smaller average cross-sectional at the exterior surface of the foam. The presence of smaller cells at the exterior surface of the ear cup provides a more rigid, stiff exterior layer relative to the interior foam. In some embodiments, the compacted smaller cells at or near the exterior surface of the ear cup form an integral skin on the ear cup, e.g., a film layer that results from the molding process, at the surfaces of the ear cup. The integral skin essentially includes closed cells and can include some open cells to allow the release of gas, e.g., air. Altering various parameters of the manufacturing process can alter the thickness of the integral skin. The mold temperature, for example, can influence the presence and nature of the integral skin. In some foam molding process a relatively thinner skin is formed with increasing temperatures, whereas a thicker, relatively denser skin forms at lower temperatures. One example of a useful mold temperature range for forming an integral skin is from about 35°C to about 70°C. The integral skin can have any desired thickness. One example of a useful range of skin thickness is from about 1 mm to about 5 mm.

Useful compositions from which the foam can be formed include, e.g., polyurethanes, polyvinyl chloride, and combinations thereof. Suitable hard polyurethane foams can be from polyols having a molecular weight less than 800. Suitable semi-rigid

polyurethane foams can be formed from polyols having a molecular weight from about 800 to 2000, and suitable flexible polyurethane foams can be formed from polyols having a molecular weight greater than 2000. Useful foams can have any desired density including, e.g., a density ranging from about 200 kg/m^3 to about 1100 kg/m^3, or even from about 200 kg/m^3 to about 800 kg/m^3. Suitable foams and methods of making the same are also described, e.g., in U.S. Patent 5,979,451 and incorporated herein.

The sound attenuating material can optionally include a coloring agent, e.g., dye, pigment and combinations thereof. The coloring agent can provide a desired aesthetic property, a visible indication of the sound attenuation properties the ear cup, and combinations thereof. The ear cups can also optionally include other indicia of the level of sound attenuation provided thereby including, e.g., markings, colorings, and combination thereof.

Alternatively or in addition the ear cups can include markings in various forms including, e.g., logos, colors, designs, imprints, relief, and combination thereof.

A cushion 17a, 17b is present on the earmuffs 15a, 15b of FIG. 13. A cushion seals the earmuff around the ear of the user and dampens the pressure exerted by the hearing protective device against the user's head. The cushion is preferably annular such that it defines an aperture that accommodates the ear of a user. Useful cushions define a generally rectangular shape with four concave corner segments and four connecting segments defining the aperture. Alternatively, the cushion can be of any suitable shape including, e.g., oval, round, square and rectangular, and can define an aperture having any suitable shape including, e.g., oval, round, square and rectangular. The cushion can be an integral unitary member of the earmuff, e.g., formed simultaneously with the ear cup, or it can be a separate component.

Useful cushions include a cellular material examples of which are set forth above and incorporated herein. Foams suitable for the cushion include, e.g., the foams set forth above including, e.g., closed cell foams, open cell foams, and combinations thereof. The foam for the cushion preferably exhibits viscoelasticity, high resiliency, or a combination thereof. Useful foam compositions include, e.g., polyurethanes, polyvinyl chloride, and combinations thereof. Preferably the foam of the cushion exhibits instantaneous recovery.

The cushion can optionally include an integral skin as described above with respect to the foam ear cup.

Alternatively or in addition, the cushion can include a covering, e.g., a cover, a layer, a film, a coating, and combinations thereof. A covering can protect the integrity of the foam, inhibit soiling of the foam, and enhance the cleaning properties of the cushion. The covering can also provide aesthetic appeal to the cushion including, e.g., texture, color, and combinations thereof. The covering can be continuous or discontinuous. Preferably the covering is present on the foam such that air is allowed to release from the foam. To facilitate release of air, the covering can include micro holes (e.g., puncture holes) or cracks of a size sufficient to allow release of air from the foam. Alternatively the covering can include a single hole of a size sufficient to allow the release of air to conform the cushion to the surface of the user with which it is in contact. The covering can be in the in the form of a film (e.g., a self-supporting film), woven (e.g., fabric) or nonwoven web, and comprised of any suitable composition including, e.g., synthetic polymer, natural polymer, and combinations thereof.

The headband is generally U-shaped and sufficiently resilient to allow the open end of the U to be splayed apart to fit the device to the head of the user. When the device is in place on the user's head the recovery forces generated in the strained headband bias the earmuffs inwardly against the user's head and foster secure attachment and good acoustic sealing of the earmuffs to the user's head. Various headband configurations are suitable. The headband can be relatively thin and include at least one band, an example of which is illustrated in FIGS. 1 and 13.

The headband can be adjustable in length. Mechanisms for making headbands adjustable in length are well known in the art and include, e.g., a pair of overlapping sliding members with mechanisms for maintaining the members in alignment and mechanisms for securing the overlapped portions at the desired length, a pair of telescoping nested members having mechanisms to secure the nested portions together at the desired length, and a central headband of fixed length that includes a mechanism, e.g., cooperative rack-and-pinion, toothed, interrupted thread or a combination thereof, whereby each end of the headband can be separately adjusted relative to the central headband and secured at the adjusted length. One example of a useful adjustable headband is present in product number 1440 from 3M Company (St. Paul, Minnesota).

The headband can be made from any suitable material. Useful headband materials include, e.g., plastic, and metal, e.g., spring steel, copper-beryllium alloys, composites,

and combinations thereof. Useful plastic materials include, e.g., thermoplastic polymers (e.g., polypropylene, polyethylene, polyamide, e.g., nylon, polyester, and combinations thereof), thermoplastic elastomers, thermoset polymers, and combinations thereof. Useful composites include a polymer matrix and a filler including, e.g., fibers, particulate, and combinations thereof. The surface of an end of the headband that engages an earmuff can be treated to increase its coefficient of friction. Useful surface treatments include, e.g., texturizing (e.g., abrading the surface), coating the surface (e.g., with a composition, particles, and combinations thereof), overmolding (e.g., with a thermoplastic elastomer), and combinations thereof. One useful headband construction includes an end that includes an elastomer (e.g., natural rubber or synthetic elastomer) disposed on (e.g., overmolded on) a thermoplastic or thermoset base.

The ear cup can optionally include a rigid outer shell.

Although the ends 14a, 14b of the headband illustrated in FIGs. 1 and 13 form a C-shaped hook, the ends 14a, 14b of the headband can terminate in any shape or form suitable for releasably retaining an ear cup therein through a frictional engagement with the ear cup. For example, the ends 14a, 14b can be defined by any number of side walls, which at least partially define a variety of configurations including, e.g., a letter (e.g., J, U, C, V, and D), loop, spiral (e.g., curlicue), circle, oval, ellipse, polygon including, e.g., a triangle, square, pentagon, hexagon, heptagon, octagon, nonagon, and decagon.

FIGs. 2-5, 7-10 and 11 illustrate a variety of hook-shaped configurations. FIG. 2, for example, illustrates an end of a headband in the form of a smooth curved backward J-shaped hook. A hook-shaped end that includes three sidewalls that partially define a square-shaped opening is shown in FIG. 3. A hook-shaped end in the form of a partial rectangle defined by three side walls is shown in FIG. 4. A hook-shaped end that includes six side walls partially defining a octagonal-shaped opening is shown in FIG. 5.

The ends of the headband can also terminate in parallel tines 20a, 20b, as illustrated in FIGS. 6, 11 and 12. In some embodiments, the tines 20a, 20b extend downward away from the crown of the headband. In other embodiments the tines 22a, 22b extend upward toward the crown 24 of the headband 30, as shown in FIGs. 11 and 12.

FIG. 7 illustrates an embodiment of the hearing protective device in which a rectangular portion 46 of an ear cup is positioned in the partial rectangular-shaped opening defined by the rectangular hook-shaped end 48 of the headband.

FIG. 8 illustrates an embodiment of the hearing protective device in which a square portion 50 of an ear cup is positioned in the partial square-shaped opening defined by the square hook-shaped end 52 of the headband.

FIG. 9 illustrates an embodiment of the hearing protective device in which a circular portion 56 of an ear cup is positioned in the hook-shaped end 54 of the headband. Arrow A-A indicates the direction of movement of the ear cup when the ear cup is placed in and removed from the hook-shaped end of the headband. Arrow B-B indicates a rotational direction of movement that the hook 54 may undergo when the user exerts a force on the hook 54 while holding the ear cup 56 in a stationary position so as to rotate the hook 54 relative to the ear cup 56. The circular shape of the portion of the ear cup residing in the opening formed by the hook 54 permits a relatively smooth rotation of the hook about the ear cup relative to a more ratchet-type movement that can exist when the portion of the ear cup held by the end has linear side walls.

FIG. 10 illustrates an embodiment of the hearing protective device in which an octagonal portion 60 of an ear cup is positioned in a hook-shaped end 62 of a headband. Arrows C-C indicate the direction of movement through which the ear cup travels when the ear cup is inserted in and removed from the hook-shaped end of the headband. The ear cup can also be moved in the direction of C-C to position the ear cup as desired on the user's head, which effectively lengthens and shortens the headband. Arrows D^1-D^1, D^2-D^2 indicate the rotational direction of movement of the hook about the ear cup. The octagonal shape of the ear cup can result in a ratcheted-type rotation of the hook about the ear cup.

FIG. 14 illustrates an embodiment of the hearing protective device in which the interior walls of an end 70 of the headband form a surface that includes a series of rounded protuberances 72 and the ear cup 74 positioned in the end includes a complimentary series of rounded protuberances 76 on the surface thereof. The configuration allows a ratcheting-type rotation of the end about the ear cup when a force is applied to the end or the ear cup to rotate one of the end or the ear cup relative to the other.

FIG.15 illustrates another embodiment of the hearing protective device 100 in which the headpiece 102 is a head covering in the form of a helmet. The ends 104a, 104b of the headpiece are affixed to the exterior surface of the helmet 102 and extend from the helmet 102 to the ear of a user. Earmuffs 106a, 106b are positioned in an opening in the

ends 104a, 104b and the ends 104a, 104b bias the earmuffs 106a, 106b inwardly against the user's head. The ends are moveable between a first position in which they are biased against the user's head and a second position in which they are held away from the user's head. Examples of mechanisms that attach an extension to a helmet and permit movement of the extension from a first position to a second position can be found in U.S. Patent 5,546,610 and incorporated herein.

Although the device has been described as having a frictional engagement between an end and an ear cup, the frictional engagement can exist with any part of the earmuff including, e.g., the cushion.

All patents and patent applications cited above including those in the Background section are incorporated into this patent application in total.

The invention may take on various modifications and alterations without departing from its spirit and scope. Accordingly, this invention is not limited to the above-described but is to be controlled by the limitations set forth in the following claims and any equivalents thereof.

This invention also may be suitably practiced in the absence of any element not specifically disclosed herein.

What is claimed is:

1. A hearing protective device that comprises:

a first ear cup;

a second ear cup; and

a headpiece comprising a first end extending from the headpiece and a second end extending from the headpiece,

the first ear cup being maintained in a fixed position in the first end through a frictional engagement with the first end, and

the second ear cup being maintained in a fixed position in the second end through a frictional engagement with the second end.

2. The hearing protective device of claim 1, wherein each of the ends defines a C-shaped hook.

3. The hearing protective device of claim 1, wherein each of the ends defines a J-shaped hook.

4. The hearing protective device of claim 1, wherein each of the ends defines a U-shaped hook.

5. The hearing protective device of claim 1, wherein each end comprises a hook defined by a plurality of side walls.

6. The hearing protective device of claim 5, wherein the side walls are curved.

7. The hearing protective device of claim 1, wherein at least one end comprises at least three side walls that partially define a polygon.

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8. The hearing protective device of claim 1, wherein at least one end comprises at least three side walls that partially define a polygon selected from the group consisting of a square, triangle, pentagon, hexagon, heptagon, octagon, nonagon and decagon.

9. The hearing protective device of claim 1 wherein each of the first and second ends comprise at least two tines.

10. The hearing protective device of claim1, wherein the ear cups comprise foam.

11. The hearing protective device of claim1, wherein the ear cups comprise an exposed exterior foam surface.

12. The hearing protective device of claim1, wherein the ear cups comprise a foam interior and an exterior skin, the exterior skin being integral with the foam interior.

13. The hearing protective device of claim1, wherein the ear cups comprise rigid plastic.

14. The hearing protective device of claim 1, wherein the headpiece comprises a helmet.

15. The hearing protective device of claim 1, wherein the headpiece comprises a headband.

16 The hearing protective device of claim 1, wherein the earmuffs comprise indicia as to the level of sound attenuation provided thereby.

17. A hearing protective device comprising:

a first ear cup;

a second ear cup; and

a headpiece comprising

a first means for maintaining the first ear cup in a fixed position in the first means through a frictional engagement with the first ear cup, and

a second means for maintaining the second ear cup in a fixed position in the second means through a frictional engagement with the second ear cup.

18. The hearing protective device of claim 17, wherein the distal exterior surfaces of the first and second ear cups comprise exposed foam.

19. The hearing protective device of claim 17, wherein the headpiece comprises a helmet.

20. The hearing protective device of claim 17, wherein the headpiece comprises a headband.

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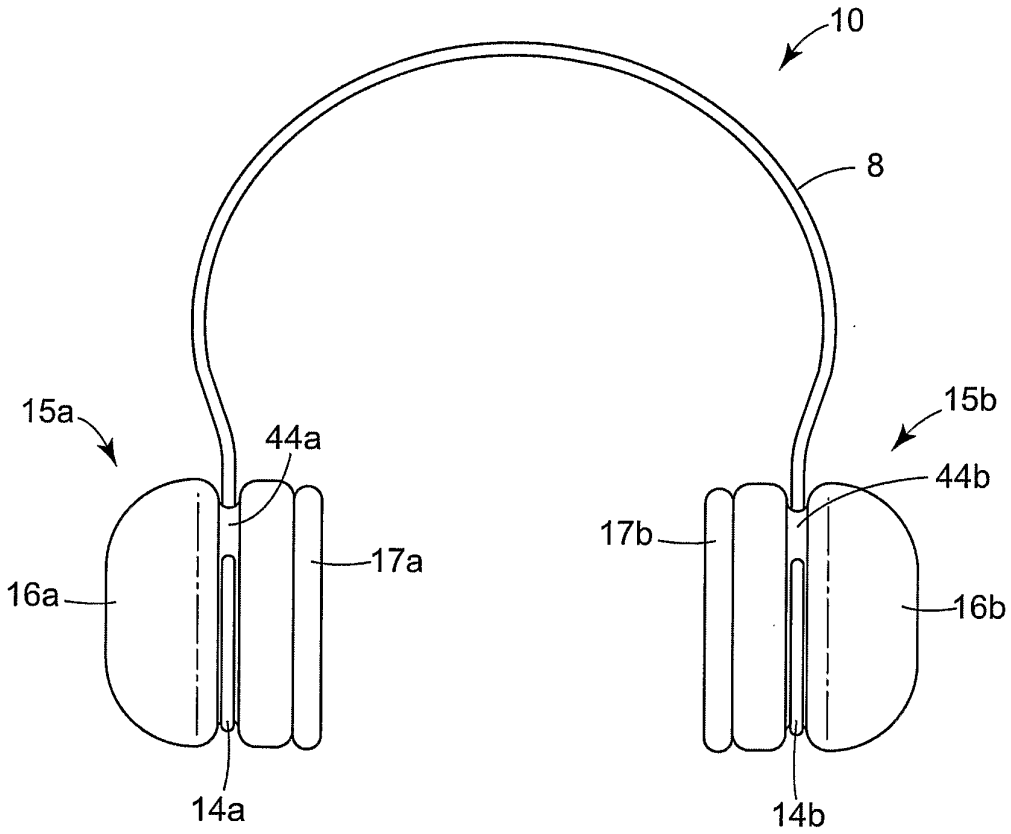

FIG. 1

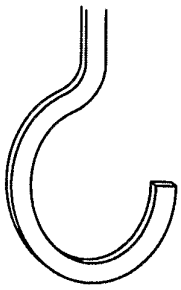

FIG. 2

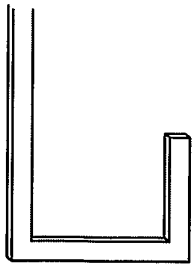

FIG. 3

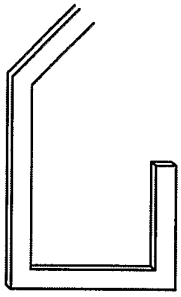

FIG. 4

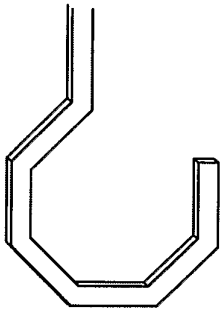

FIG. 5

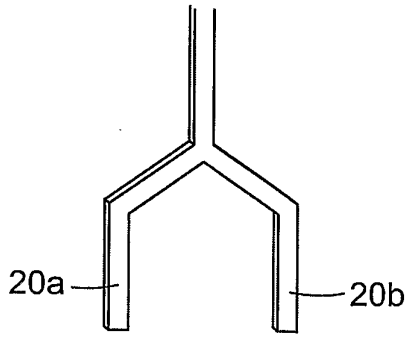

FIG. 6

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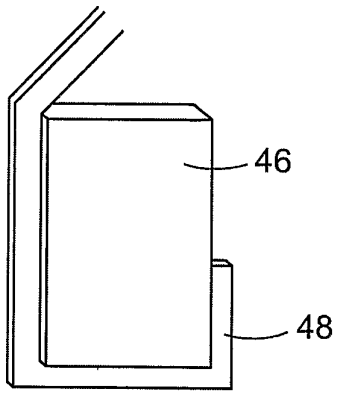

FIG. 7

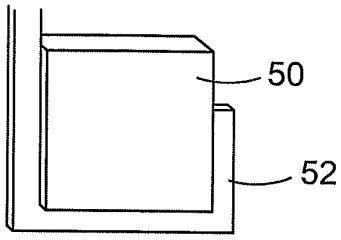

FIG. 8

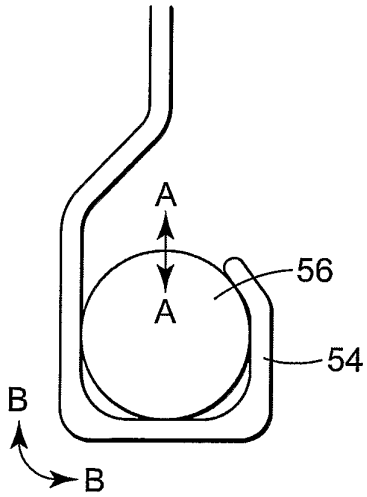

FIG. 9

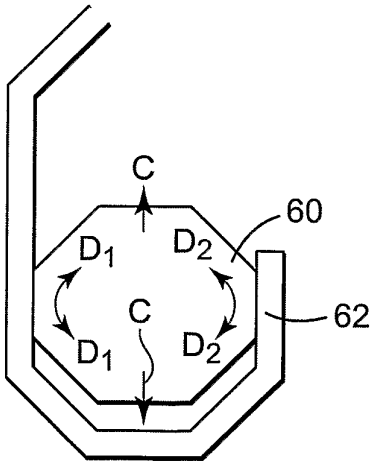

FIG. 10

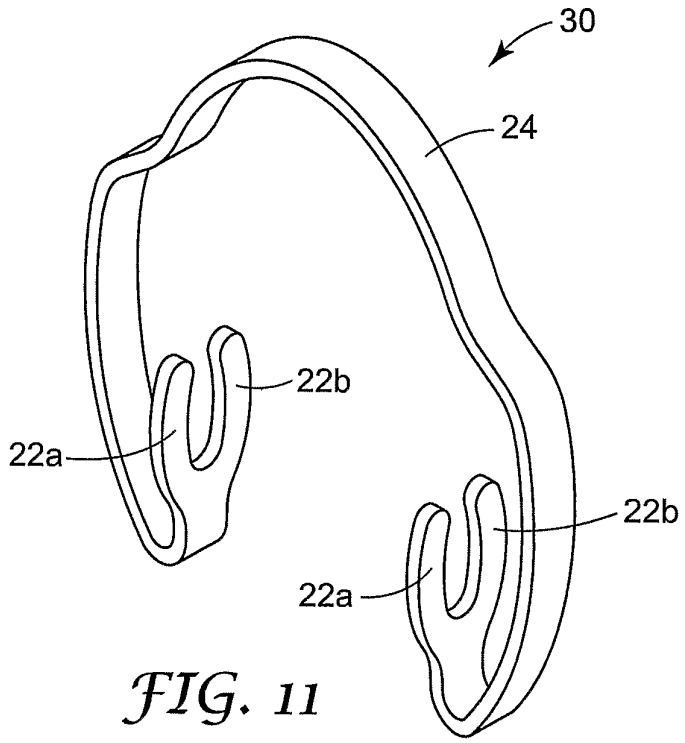

FIG. 11

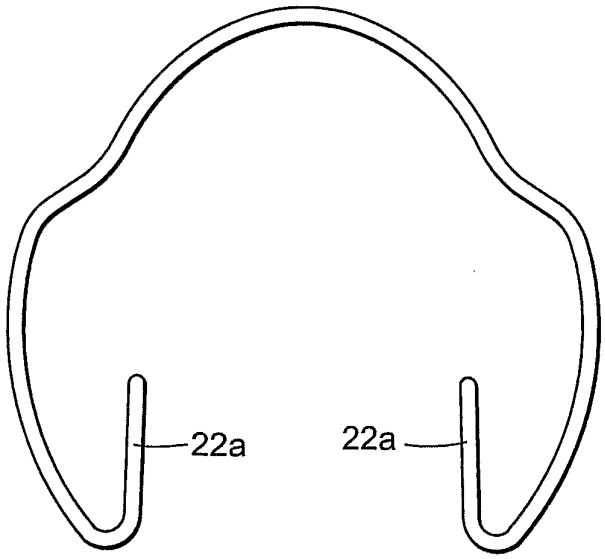

FIG. 12

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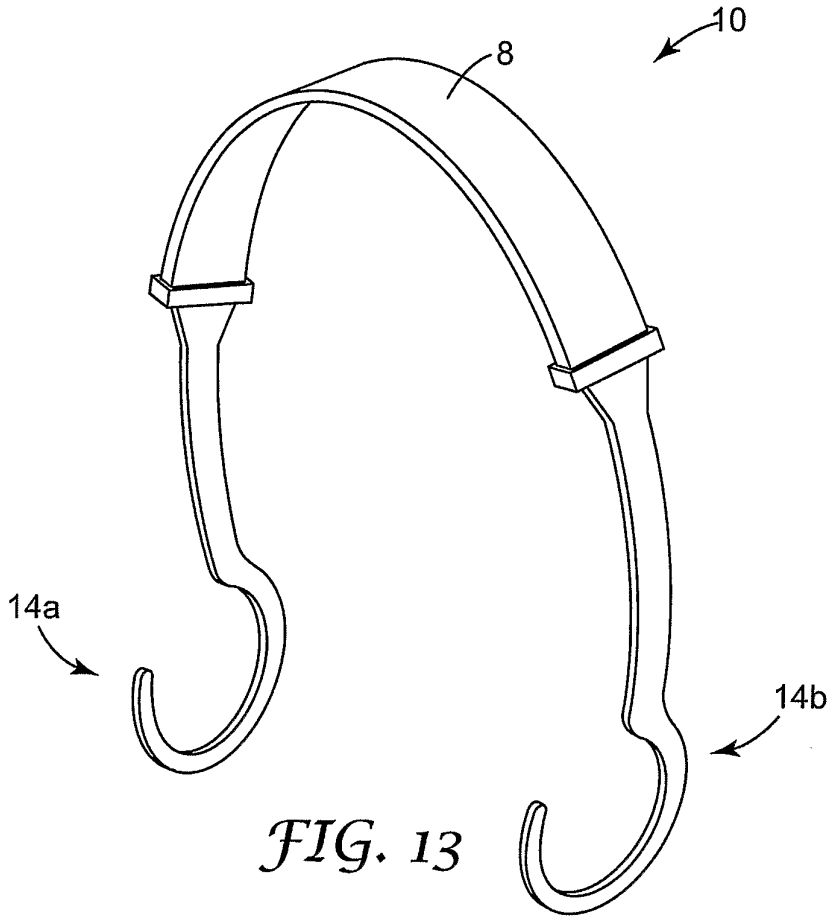

FIG. 13

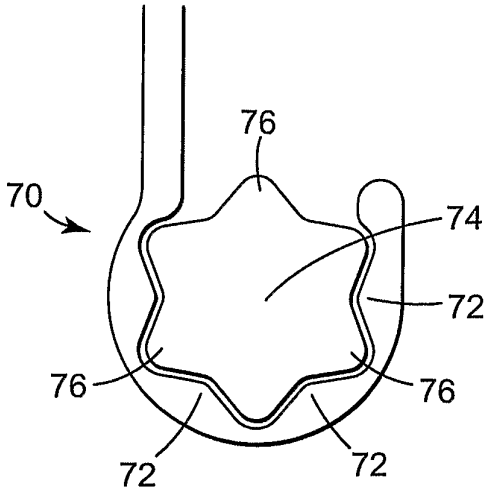

FIG. 14

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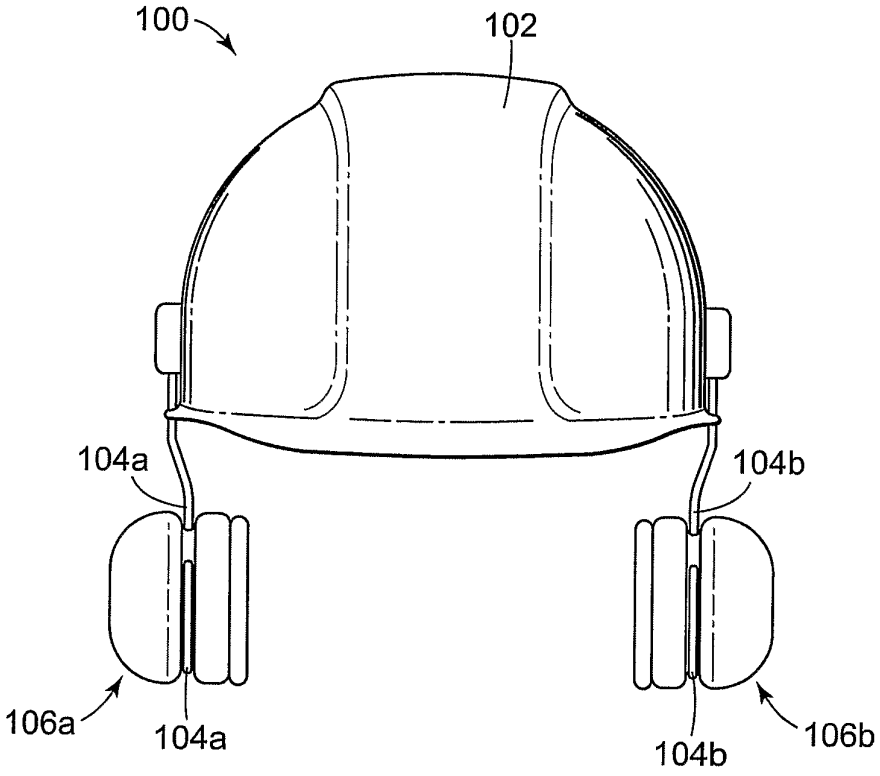

FIG. 15