Abstract: A bone conduction devise for enhancing the hearing of a recipient comprising a sound input element configured to receive an acoustic sound signal; an electronics module configured to generate an electrical signal representing the acoustic sound signal; a transducer configured to generate mechanical forces representing the electrical signal for delivery to the recipient's skull; one or more extensions mechanically coupled at a first portion to the transducer and further mechanically coupled at a second portion of the one or more extensions to the recipient's bone, wherein the one or more extensions are configured to transfer the mechanical forces from the transducer to the recipient's bone.
PIERCING CONDUCTED BONE CONDUCTION DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0061] The present application claims the benefit of US Provisional Patent Application 61/041,185, filed March 31, 2005, which is hereby incorporated by reference herein.

BACKGROUND

Field of the Invention

The present invention is generally directed to a bone conduction device, and more particularly, to a piercing immiediate bone conduction device.

Related Art

Hearing loss, which may be due to many different causes, is generally of two types, conductive or sensorineural. In many people who are profoundly deaf, the reason for their deafness is sensorineural hearing loss. This type of hearing loss is due to absence, destruction, or damage to the hairs that transduce acoustic signals into nerve impulses in the cochlea. Various prosthetic hearing implants have been developed to provide individuals who suffer from sensorineural hearing loss with the ability to perceive sound. One type of prosthetic implant, referred to as a cochlear implant, uses an electrode array implanted in the cochlea. More specifically, an electrical stimulus is provided via the electrode array directly to the cochlea aerve, thereby inducing a hearing sensation in the implant recipient.

Cochlear hearing loss occurs when the normal mechanical pathways, which conduct sound to hairs in the cochlea, are impaired. This problem may arise from damage to the ossicular chain or ear canal. However, infants may suffer from conductive hearing loss and still have some degree of residual hearing because the hairs in the cochlea are undamaged. For this reason, individuals with sensorineural hearing loss are typically not candidates for a cochlear implant, because insertion of the electrode array into a cochlea results in severe damage or destruction of the most of the bairs within the cochlea.

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Sufferers of conductive hearing loss typically receive an acoustic hearing aid. Hearing aids receive smallest sound in the outer ear, amplify the sound, and direct the amplified sound into the ear canal. The amplified sound reaches the cochlea and causes vibrations of the cochlea hairs, thereby stimulating the hairs in the cochlea.

CB&rtunafeiy, hearing aids do not benefit all individuals who suffer from conductive hearing loss. For example, some individuals are prone to chronic inflammation or sialoegen of the ear canal and cannot wear hearing aids. Other individuals have malformed or absent outer ear canals as a result of a birth defect, or as a result of medical conditions such as Treacher Collins syndrome or Microsis. Hearing aids are also typically unsuitable for individuals who suffer from single-sided deafness (i.e., total hearing loss only in one ear) or individuals who suffer from mixed hearing losses (i.e., combinations of sensorineural and conductive hearing loss). In addition to hearing aids which amplify and direct the amplified sound into the ear canal, some patients receive implanted hearing skis or bursing prostheses which have one or more components implanted in the recipient’s skull or between the skull and tissue. However, some recipients are not suited for bursing hearing aids, due to the size, shape, and particular condition of the recipient or their skull. In other cases, recipients are not diagnostically implanted hearing aids, given their often bulky size or other factors.

Tsose Ksindividuals who cannot benefit from hearing aids or implanted hearing devices may benefit from hearing prostheses that are put into contact with, but sioi implanted or embedded within or between, the skull bone and the recipient’s skin. Such hearing prostheses direct vibrations into the bone, so that the vibrations are conducted into the cochlea and result in stimulation of the hairs in the cochlea. This type of prosthesis is typically referred to as a bone conduction device.

Bone conduction devices function by converting received sound into a mechanical vibration representative of the received sound. This vibration is then transferred to the bone structure of the skull, causing vibration of the recipient’s skull and serves to stimulate its cochlea hairs, thereby stimulating hearing sensation in the recipient.
SUMMARY

[0009] According to one embodiment of the present invention, a bone conduction device for enhancing the hearing of a recipient is provided. The device comprises an input element configured to receive an acoustic signal; an electronics module configured to generate an electrical signal representing the acoustic sound signal; a transducer configured to generate mechanical forces representing the electrical signal for delivery to the recipient's skull; one or more extensions mechanically coupled at a first portion to the transducer and further sechassiscally coupled at a second portion of the otic or more estesss to the recipient's bone, wherein the one or more extensions are configured to transfer the mechanical forces from the transducer to the recipient's bone.

[0010] According to another embodiment of the present invention, a method for rehabilitating the hearing of a recipient with a bone conduction device having one or more extensions pierced through the recipient's bone, thereby mechanically coupling the one or more extensions to the recipient's bone is provided. The method comprises recognizing an electrical signal representative of an acoustic sound signal; generating mechanical forces representative of the received electrical signal; and delivering the mechanical forces to the recipient's skull via the one or more pierced extensions.

[0011] According to a further embodiment of the present invention, a method for rehabilitating the hearing of a recipient with a bone conduction device configured to generate mechanical forces and having one or more extensions mechanically coupled to the recipient's bone is provided. The method comprises piercing the recipient's bone with the one or more extensions of the bone conduction device to mechanically couple the one or more extensions to the bone; and transferring the bone conduction device to generate and transfer the mechanical forces to the recipient's body via the one or more extensions.

[0012] According to yet another embodiment of the present invention, a device comprises means for receiving an electrical signal representative of an acoustic sound signal; means for generating
mechanical forces representative of the received electrical signal; and means for delivering the isoelectric forces to the recipient's skull via the one or more pierced extensions.

According to another embodiment of the present invention, a device comprising a device comprising means for delivering the isoelectric forces to the recipient's skull via the one or more pierced extensions, is provided. The device comprises means for piercing the recipient's skull employing a mechanism for mechanically coupling to the recipient's skull and means for generating and transferring the mechanical forces to the recipient's bone via the one or more pierced extensions.
BRIEF DESCRIPTION OF THE DRAWINGS

In the embodiments of the present invention, described herein with reference to accompanying drawings, in which:

Fig. 3A is a perspective front view of a recipient with a piercing conducted bone conduction device provided according to one embodiment of the present invention;

Fig. 1B is a perspective top view of a recipient with a piercing conducted bone conduction device provided according to one embodiment of the present invention;

Fig. 2 is a detailed perspective view of a piercing conducted bone conduction device provided according to one embodiment of the present invention;

Fig. 3A is a perspective side view of a piercing conducted bone conduction device according to one embodiment of the present invention;

Fig. 3B is another perspective side view of a piercing conducted bone conduction device according to one embodiment of the present invention;

Fig. 4A is a high-level functional block diagram of a piercing conducted bone conduction device according to one embodiment of the present invention, such as the device of Fig. 1A;

Fig. 4B is a detailed functional block diagram of the piercing conducted bone conduction device illustrated in Fig. 4A;

Fig. 5 is a flowchart illustrating the conversion of an input sound into skull vibrations to a transcutaneous bone conduction device according to one embodiment of the present invention;

Fig. 6A is a perspective side view of a piercing conducted bone conduction device according to one embodiment of the present invention;

Fig. 6B is a perspective front view of the piercing conducted bone conduction device according to the etrifed inser & illustrated in Fig. 6A;
FIG. 7A is a perspective side view of a piercing conducted bone conduction device according to one embodiment of the present invention;

FIG. 7B is a perspective view of the piercing conducted bone conduction device according to the embodiment illustrated in FIG. 7A;

FIG. 8A is a perspective side view of a piercing conducted bone conduction device according to one embodiment of the present invention;

FIG. 8B is a perspective front view of the piercing conducted bone conduction device according to the embodiment illustrated in FIG. 8A;

FIG. 9A is a perspective side view of a piercing conducted bone conduction device according to one embodiment of the present invention;

FIG. 9B is a perspective side view of the piercing conducted bone conduction device according to the embodiment illustrated in FIG. 9A;

FIG. 10A is a perspective side view of a piercing conducted bone conduction device according to one embodiment of the present invention;

FIG. 10B is a partial perspective view of the piercing conducted bone conduction device according to the embodiment illustrated in FIG. 10A;

FIG. 10C is another partial perspective view of the piercing conducted bone conduction device according to the embodiment illustrated in FIG. 10A.
DETAILED DESCRIPTION

[0036] Embodiments of the present invention are generally directed to a bone conduction device for converting a received acoustic sound signal into a mechaumeal free dlsversd via a piercing securrd to a recipient's bone to the recipient's hearing organs. The piercing or ducted bone conduction device includes a sound kipa component, such as a microphone, to receive the acoustic sound signal, an electronic module configured to convert an electrical signal representing the acoustic sound signal, and a transducer to convert the received signal into a mechanical force for delivery to the recipient's skull.

In certain embodiments of the present invention, the transducer is connected to an extension arm which pierces through and remains in contact with the cartilages bone surface within the ear canal. The force generated by the transducer is ms.ckmk.sily connected via the connected piercing (extension arm), which carries that force to the cartilage bone which it pierces and is in contact with which causes motion of the cochlea fluid and a hearing perception by the recipient.

[0036a] In certain embodiments of the present invention, the transducer may comprise a piezoelectric element. The piezoelectric element converts an electrical signal applied thereto into a mechanical deformation (i.e., expansion or contraction) of the element. The amount of deformation of a piezoelectric element is a response to an applied electrical signal depending on material properties of the element, otiometations of the electric field relative to the polarization direction of the element, geometry of the element, etc.

[0037] The deformation of the piezoelectric element may also be characterized by the linear strain and blocked force of the element. The free stroke of a piezoelectric element refers to the magnitude of deformation induced in the element when a given voltage is applied thereto. Blocked force refers to the force the piezoelectric element is capable of deforming at the given voltage. Generally speaking, piezoelectric elements have a high blocked force, but a low free stroke. In other words, when a voltage is applied to the element, the element will have output a Mg force, but will only a small stroke.

[0038] In some piezoelectric transducers, the maximum available transducer stroke is equivalent to the free stroke of the piezoelectric element. As such, some bone conducti...
devices: utilizing these types of piezoelectric transducer have a limited transducer stroke and correspondingly its sensitivity to the magnitude of the mechanical force that may be provided to the skull.

[Image FIG. 1A] FIG. 1A is a perspective front view of a recipient with a piercing conducted bone conduction device provided according to one embodiment of the present invention. As illustrated, the recipient is shown with piercing conducted bone conduction device 100 fitted with a processor / transducer 117, extension 115 and a probe stud 219, as will be described in further detail below. Extension 115 and stud 219 are positioned adjacent the ear canal (shown in dark blue) is the illustrated embodiment of the present invention. Proximity of stud 219 may be visible from the front of the recipient, but extension 115 and the majority of sound processors / transducers 117 may be hidden from a third-party when the recipient is viewed from their front.

[Image FIG. 1B] FIG. 1B is a perspective top view of a recipient with a piercing conducted bone conduction device provided according to one embodiment of the present invention. As with FIG. 1A, the recipient is shown with one embodiment of the present invention which includes a sound processor / transducer 117 located behind the recipient's ear. Extension 115 pierces or extends through the recipient's ear, preferably through the outer and middle portions, and is terminated with stud 219.

[Image FIG. 2] FIG. 2 is a detailed perspective view of a piercing conducted bone conduction device 200, referred to in FIG. 2 as device 200, provided to a recipient as an embodiment of the present invention. As shown, extension 215 is fitted with a bone conduction device 215 which conducts the vibrations from extension 215 through cartilage 250 of the recipient's skull and is fastened by fixation stud 221. Mechanical forces are generated by the sound processor / transducer 217 and conveyed to extension 215. The vibrations from extension 215 are communicated to cartilage 250 which conducts the vibrations to the recipient's skull. The vibrations are conducted to the recipient's skull and are perceived by the recipient as sound. The sound processor / transducer 217 further comprises various other components such as a microphone 225 and a transducer provided to assist in retaining the device 200 in place against the recipient's head.
Certain embodiments of the present invention may be fitted in place for use by the recipient without having to surgically place various device components under or on the recipient's skin, for exsisp embedding anchors into the skull of the recipient. As described above, cartilage 350 is relatively easy to pierce, as in the ease of ear piercings, and given its limited neural sensitivity, system 215 may go. FIG. 2, shows stud 329 and micropor 325, described above, with the recipient's ear. The cartilage to bring a vibration transfer extension such as extensions 215 into contact with the cartilages surround the recipient's ear is a relatively safe and pain-free method to implement a boss synaptic device of the present invention.

The terms "piercing" is to be understood to mean that extension 215 enters cartilage 250 at least partially into, and in some cases goes completely through, cartilage 250 such that extension 215 enters on one side of cartilage 250 and exits out another side of cartilage 250. It is not a requirement of the present invention that extension 215 extend completely through cartilage 250; only that extension 215 at least partly enters or is otherwise firmly attached to cartilage 250 such that it may be attached to cartilage 250 by exerted mechanical forces exerted on extension 250 is stably attached. The mechanical forces on extension 215 to cartilage 250. Further, it is understood that various components of the present invention may be implanted underneath the recipient's skin, including embedding one or more components under the recipient's skin.

Furthermore, while various embodiments of the present invention as described herein as having a single extension 215, it is to be understood that other embodiments of the present invention may also incorporate multiple extensions, each attached to the recipient's bone.

FIGS. 3A-3C are perspective side, other side, and front views respectively of a piercing embittered boss conduction device according to the embodiment of the present invention in FIG. 1. As shown, sound processor/transducer 311 is attached to extensions 315 by coupler 313. FIG. 2, shows stud 329 and micropor 325, as described above, with the recipient's ear.
FIG. 4A is a high-level functional block diagram of a piercing conducted bone conduction device according to one embodiment of the present invention, such as the device of FIG. 1A.

A functional block diagram of one embodiment of piercing conducted bone conduction device 106, referred to as piercing conducted base conduction device 400, is shown in FIG. 4A. In the illustrated embodiment, a sound 207 is received by a sound input microphone 425. In some embodiments, sound input microphone 425 is a microphone configured to receive sound 207, and to convert sound 207 into an electrical signal 422. As described below in more detail, electronics module 404 may include a sound processor, a control electronics, transducer drive components, and a variety of other elements.

As shown in FIG. 4A, transducer 406 receives an electrical signal 424 as a sound output force that is directed to the skull of the recipient via external frame 115, shown in FIG. 4A, via a coupling modulator 405, that is coupled to the piercing conducted bone conduction device 400. Delivery of this output force causes one or more of movement or vibration of the recipient's skull, thereby activating the tear cells in the cochlea via cochlear fluid motion.

FIG. 4A also illustrates a power module 410. Power module 410 provides electrical power to one or more components of bone conduction device 400. For ease of illustration, power module 410 has been shown connected only to its associated module 412 and electronic modules 404. However, it should be appreciated that power module 410 may be used to supply power to any electrically powered Gruenewald/compensated piercing conducted bone conduction device 400.

In one embodiment device 400 further includes an interfacable module 412 that allows the device 412 to interact with device 400. For example, interlace module 412 may allow the recipient to adjust the volume, alter the speech processing strategies, power on/off, and other functions.
device, etc. Interface module 412 communicates with electronics module 404 via slgtml line 428.

In other embodiments illustrated in FIG. 4A, sound pickup device 425, electronics module 404, transducer 406, power signals 410 and interface module 412 have all been sk年中国 as integrated in a single housing, referred to as housing 417. However, it should be appreciated that in certain embodiments of the present invention, one or more of the illustrated components may be housed in separate or different housings. Similarly, it should also be appreciated that in such embodiments, direct oosier loss between the various module and device are not necessary and that the components may communicate, for example, via wireless connections.

In other embodiments of the present invention, transducer 406 may be one of any types and configurations of transducers, now known or later developed. In one embodiment of the present invention, transducer 406 may comprise a piezoelectric element which is configured to deform in response to the application of a mechanical signal 424. Piezoelectric elements that may be used in embodiments of the present invention include, for example, piezoelectric crystals, piezoelectric ceramics, or some other material exhibiting a deformation in response to an applied electrical signal. Examples of piezoelectric crystals include quartz (SiO2), Berlende (AIP), Gallium orthophosphate (GaPO4) and Tourmaline. Examples of piezoelectric ceramics include barium titanate (BaTiO3), lead zirconate titanate (PZT), or zirconium (Zr).

Some piezoelectric materials, such as barium titanate and PZT, are polarized materials. When an electric field is applied across these materials, the polarized molecules align themselves with the electric field, resulting in induced dipoles within the molecular or crystal structure of the material. This alignment of dipoles causes the deformation of the material.

In other embodiments of the present invention, other types of transducers may be used. For example, various Tefor configured to operate in response to electrical signal 424 may be used.

In the embodiment illustrated in FIG. 4A, coupling module comprising an extension 420, as described further below, is configured to be attached to housing 417.
In this embodiment shown in FIG. 4A, transducer 406 is also configured to be attached to housing 417. As such, in this embodiment, vibration from transducer 406 is provided to coupling module 408 through housing 417.

In certain embodiments of the present invention, electronics module 404 includes a printed circuit board (PCB) to electrically connect and mechanically support the components of electronics module 404. Sound input element 425 may comprise one or more microphones (not shown) and is attached to the PCB.

FIG. 4B provides a more detailed view of bone conduction device 400 of FIG. 4A. In the illustrated embodiment, electronics module 404 comprises a sound processor 440, transducer drive components 442 and control electronics 446. As explained above, in certain embodiments, sound input element 425 comprises a microphone configured to convey a received acoustic signal into electrical signal 422. In other embodiments, as described below, sound input element 425 receives sound 20? as an electrical signal.

In some embodiments of the present invention, electrical signal 422 is output into sound input element 425 to sound processor 443. Sound processor 440 uses one or more of a plurality of techniques to selectively process, amplify and/or filter electrical signal 422 to generate a processed signal 424A. In certain embodiments, sound processor 44U may comprise subatsimplified block diagram of sound processor 440 and is used in an embodiment sound processor 440 comprises a digitized signal processor.

Processed signal 424A is provided to transducer drive components 442. Transducer drive components 442 output a drive signal 424B to transducer 406. Based on drive signal 424B, transducer 406 provides the output force to the skull of the recipient through coupling module 408.

For ease of description, the sictrical signal supplied by transducer drive components 442 to transducer 406 has been referred to as drive signal 424B. However, it should be appreciated that processed signal 424B may comprise an unmodified version of received signal 424A.
As noted above, transducer 406 generates an output thermal to the skull of the recipient via coupling module 408. As shown in FIG. 4B, in one embodiment of the present invention, coupling module 408 comprises extension 460 and fixation stud 462. Fixation stud 462 is coupled to couple to extension. 460 is on the other side of the recipient's body, for example cartilage 250, such that extension 460 and fixation stud 462 are on both sides of the recipient's body. One embodiment of the present invention, fixation stud 462 may be one of various types or designs of extensions. For example, fixation stud 462 may comprise a snap component which attaches to a corresponding snap component on the end of extension 460. Alternatively, fixation stud 462 may comprise screw threads which fit corresponding threading provided within the end of extension 460. It will be obvious to persons having skill in the art that other mechanisms are provided on fixation stud 462 and that at the end of extension 460 may be used as part of one embodiment of the present invention.

As previously discussed, extension 460 is mechanically coupled to the recipient's or housing 417. In certain embodiments of the present invention, extension 460 is attached to transducer 406 and vibrotactile 464 is received directly from. Other embodiments, extension 460 is attached to housing 417 and vibration is applied from transducer 406 to housing 417, which in turn transmits distal to the extension 460. According to one embodiment of the present invention, in which coupling 140 comprises extension 460, the vibrotactile received by extension 460 from transducer 406 causes extension 460 to vibrate. The vibration, cohered into extension 460 to transducer module 462 is then transferred from extension. 460 to the recipient's body 250.

As noted above, the recipient may control various actions of the device via interface module 412. Interface module 412 includes one or more components that allow the recipient to provide inputs to, or receive ischaemic devices as elements of the device 412.
components 442. In one embodiment of the present invention, based on inputs received at interfaces 412, control electronics 446 may provide instructions to, or request information from, other components of bone conduction device 400. In certain embodiments, the absence of user inputs, control electronics 446 control the operation of bone conduction device 40G.

FIG. 5 illustrates the conversion of an input acoustic signal from a mechanical bony conduction to the recipient's skull in accordance with embodiments of piercing conducted bone contacts in device 400. At block 502, piercing conducted bone contacts in device 400 receive an acoustic signal. In other embodiments, the signal is received via microphones. In other embodiments, the signal is received via an electrical input. In still other embodiments, a teacor integrated in or connected to the piercing conducted bone conduction device 400 may be used to receive the acoustic sound signal.

At block 504, the acoustic signal received by piezoelectric conducted bone conduction device 400 is processed by the speech processor in electronics module 404. As explained above, the speech processor may be similar to speech processors used in acoustic hearing aids. In such embodiments, speech processors may selectively amplify, filter, and modify acoustic sound signal. For example, speech processor may be used to include or exclude background or other unwanted noise signals received by piezoelectric conducted bone conduction device 400.

At block 506, the processed sound signal is provided to transducer 406 as an electrical signal. At block 508, transducer 406 converts the electrical signal into a signal configured to be delivered to the recipient's skull via coupling module 408 so as to illicit a perceived perception of the acoustic sound signal.

FIGS. 6A-6B are perspective side and front views of piezoelectric conducted bone conduction device 100, referenced to is FIGS. 6A-6B as device 600, according to one embodiment of the present invention. As illustrated, device 600 comprises housing 617, ooraisr 658 and extension 660 attached to socket 658. In the embodiment illustrated in FIGS. 6A-6B, extension 660 is substantially straight. For the sake of simplicity, housing 617 is shown as having a rectangular configuration. However, it is understood that
housing 617 may be shaped in any number of ways, depending on where on the recipient's body it is to be positioned and worn, in addition to depending on the structures contained therein. For example, sound processor (not shown), transducer (not shown), power module (not shown), among others. Coupler 658 is illustrated in FIGS. 6A-6B as a simple cosinotostic mechanism between extension 650 and housing 617. FIGS. 7A-7B are perspective side and front views of piercing conducted bone conduction device 630 referred to in FIGS. 7A-7B as device 700, according to another embodiment of the present invention. Device 700 illustrated in FIGS. 7A-7B comprise the various components described in conjunction with FIGS. 6A-6B, but in this particular embodiment of the present invention, extension 760 comprises a base 76L. Basis 76L permits alternative designs for device 700 in which coupler 758 may necessarily be positioned in a location on housing 717 at which a straight extension component may not be able to connect to the recipient's bone or be in an optimal operating position.

Although a simple bead 761 is illustrated in FIGS. 7A-7B, it is to be understood that various forms of bend 761, including cystiex or multi-part bends may be incorporated in other embodiments of the present invention.

immi FIGS. 8A-8B are perspective side and front views of piercing conducted bone conduction device 800, referred to in FIGS. 8A-8B as device 800, according to another embodiment of the present invention. Device 800 comprises components similar to those described in conjunction with FIGS. 6A-6B. In addition, the particular embodiment
illustrated as device 90S further comprises translatable extension 960 and stoppers 962A and 962S (collectively referred to as stoppers 962). Coupler 958 is configured similarly to CRLipiss 858 described above in conjunction with FIGS. SA-SB, but is further configured to permit extension 960 to slide or translate through coupler 958, such that extension 960 is capable of both rotating about coupler 958 with respect to bouslag 917 as well as translate through coupler 958. The ability of extension 960 to both rotate and translate allows it to absorb any internal differential isre exerted by the receptacle on extension. 960 and other components of the present invention, for example housing 917. Stopers 962 disposed at opposite ends of extension 960 with respect to coupler 958 are securely coupled to extension 960 and are configured to limit the extent to which extension 960 may translate, so that they do not translate beyond a certain length. Although stoppers 962 are illustrated as being washer-like, it is to be understood that stoppers 962 may take any other form, and may be configured solely to provide the translation limiting function or to overs-ride it also and other features co-currently.

FIGS. 10A-10G are perspective views and close-up views of piercing conductive housing device 10D, referred to in FIGS. 10A-10C as device 1000, according to another embodiment of the present invention. Device 1000 comprises components skilar to those described above in conjunction with PIGS. 6A-6B. Is the another embodiment illustrated in FIGS. 10A-10C, extension cos 1060A and 1060B are two separate components which are joined together into extension 1060 prior to operation of device 1000. FIG. 10E illustrates a close-up view of the connection point between extension component 1060A and 1060B in which a bimale receptacle 1059 and a male projection 1061 are in a joined configuration. Additionally, insert 1070 and groove 1072 are illustrated in an interlocking configuration. In the other embodiment, internals receive and secure 1059 and male projection 1061 cooperate to provide an anti-bend feature to the combined extension components 1060A and 1060B. Furthermore, in the illustrated embodiment of the present invention, insert 1070 and groove 1072 cooperate to provide an anti-rotation feature described above as only exemplary embodiments of such mechanisms and other mechanisms may be incorporated into embodiments of the present invention to provide the described and other features.
By having extensions 106Q comprise; separate components 106OA and 106OB, it is possible for the recipient to fix extension component 106OB using a fixation stud (not shown) to the recipient's hand as described above. When the recipient is desirous of using 1017 housing 1017 from their body, the recipient can operate coxspousits 1059, 106-U 1070, 1972 or other similar coxspousits to separate 1017 with extension component 106OA still attached thereto. Lsm extension component 106OB which rexsai π sitach ed to the recipient's bone. This may be particularly useful where fixation stud (not shown) is a screw-type as described above. Wmcfc may take sigBiilca at tkoe and 13gδδhal dexterity to bases.

While VSHOUs embodiments of the present invention have been described above, it should be understood that they have been presented by way of example only, and not Sßhssio n. It will be apparent to persons skilled in the relevant art that various changes in form and details may be made therein without departing from the spirit and scope of the invention. Thus, the breadth and scope of the present invention is not limited by any of the above-described exemplary embodiments. hut should be defined only in accordance with the following ek ππς and their equivalents. All patents and publications discussed hersisi src incorporated m their entirety by reference thereto.
CLAIMS

What is claimed is:

1. A buns conduction device for enhancing the bearing of a recipient, comprising:
   - a sound input element configured to receive an aemstic sound signal;
   - an electronics module configured to generate an electrical signal representing said acoustic signal;
   - a transducer configured to generate mechanical forces representing said electrical signal for delivery to the recipient's skull;
   - one or more extensions acoustically coupled at a first portion of said transducer and further mechanically coupled at a second portion of said one or more extensions to the recipient's bone.

   Wherein said one or more extensions are configured to transfer said mechanical forces from said transducer to the recipient's bone.

2. The device of claim 1, wherein said one or more extensions are configured to mechanically couple to the recipient's stigmas adjacent the ear canal.
3. The device of claim 1, wherein said transducer comprises a piezoelectric element.

4. The device of claim 1, wherein said one or more extensions are configured to rotate with respect to said transducer.

5. The device of claim 1, wherein said one or more extensions are configured to translate with respect to said transducer.

6. The device of claim 5, wherein said one or more extensions are further configured to move with respect to said transducer.

7. The device of claim 1, wherein said one or more extensions comprises one or more bends.

8. The device of claim 1, wherein said one or more extensions comprise two or more sections of a piece of metal.

9. The device of claim 1, further comprising:
   - one or more fixation studs each configured to be coupled to one end of said one or more sections of metal.

10. The device of claim 9, wherein said one or more fixation studs comprises a snap lock mechanism each configured to engage said one or more sections of metal.

11. The device of claim 9, wherein said one or more fixation studs comprise screw threads configured to be screwed to said one or more extensions.
12. A method for rehabilitating the hearing of a recipient with a bone conduction device having one or more extensions pierced through the recipient’s bone, thereby mechanically coupling the one or more extensions to the recipient’s bone, comprising:

- receiving a signal representing an acoustic sound signal;
- generating mechanical forces representative of the received electrical signals; and
- delivering said mechanical forces to the recipient’s skull via the one or more pierced extensions.

13. A method for rehabilitating the hearing of a recipient with a bone conduction device configured to generate mechanical forces and having one or more extensions piercing mechanically coupling to the recipient’s bone, comprising:

- piercing the recipient’s bone with the one or more extensions of the bone configured device to mechanically couple the one or more extensions to the recipient’s bone, thereby operating the one or more extensions of the bone configured device to generate and transfer mechanical forces to the recipient’s bone via the one or more extensions.

14. The method of claim 13, wherein said pierced one or more extensions are partially into the recipient’s bone.

15. The method of claim 13, wherein said one or more extensions comprise two or more extensions, comprising:

- joining the two or more extensions together to form a mechanically stable extension.

16. A device configured to rehabilitate the hearing of a recipient with a bone conduction device having one or more extensions piercing through the recipient’s bone, thereby mechanically coupling to the recipient’s bone, comprising:

- means for receiving an electrical signal representative of an acoustic sound signal;
- means for generating mechanical forces representative of the received electrical signals; and
- means for delivering said mechanical forces to the recipient’s skull.
17. The device of claim 16, wherein said means for delivering said mechanical forces to the recipient's skull comprises one or more extensions configured to mechanically couple to the recipient's caulk adjacent the ear canal.

18. The device of claim 16, wherein said means for delivering said mechanical forces comprises a piezoelectric element.

19. The device of claim 16, wherein said means for delivering said mechanical forces to the recipient's skull are configured to rotate with respect to said transducer.

20. The device of claim 16, wherein said means for delivering said mechanical forces to the recipient's skull are configured to translate with respect to said transducer.

21. The device of claim 16, wherein said means for delivering said mechanical forces to the recipient's skull are further configured to rotate with respect to said transducer.

22. The device of claim 16, wherein said means for delivering said mechanical forces to the recipient's skull comprises one or more mechanical end components configured to couple to the recipient's skull.

23. The device of claim 16, further comprising:

means for sit&eg said means for delivering said mechanical forces to the recipient's skull
24. A device configured to rehabilitate the hearing of a recipient with a bone conduction device configured to generate mechanical forces and having one or more extensions for inserting the recipient's bone, comprising:

- means for piercing the recipient's bone to mechanically couple the bone with one or more extensions to the bone; and
- means for generating and transmitting the mechanical forces to the recipient's bone via one or more extensions.
FIG. 5

502
RECEIVE AN ACOUSTIC SOUND SIGNAL

504
PROCESS THE ACOUSTIC SOUND SIGNAL

505
SUPPLY THE PROCESSED ACOUSTIC SOUND SIGNAL TO A PIEZOELECTRIC TRANSDUCER AS AN ELECTRICAL SIGNAL

508
GENERATE A MECHANICAL FORCE TO ILLEGITIMATE A HEARING PERCEPTION BY THE RECIPIENT
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.
H04R 25/00 (2006.01) H04R 25/02 (2006.01) A61F 11/00 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
ECLA H04R 25/00E2
UCLA 38.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPODOC & WPI: IPC & EC H04R 1/-, 25/-; A61N 1/-; A61B 18/-; A61F 1V- & keywords (bone 3d conduct+; hearing aid, cochlear; vibrate, mechanical, oscillate, translate; extension?, plug?, limb?, arm?, stud?, spike?, anchor; pierce, perforate, penetrate, hold, bore, puncture, rend, spear) and similar terms.
USPTO & ESPACE: (bone 3d conduct+) and (hearing aid, cochlear) and (vibrate, mechanical, oscillate, translate) and (pierce, perforate, penetrate, hold, bore, puncture, rend, spear) and (extension?, plug?, limb?, arm?, stud?, spike?, anchor) and similar terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Date of the actual completion of the international search

11 June 2009

Date of mailing of the international search report

19 JUN 2009

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
E-mail address: pct@ipaustralia.gov.au
Facsimile No. +61 2 6283 7999

Authorized officer

KAREN VIOLANTE

AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
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