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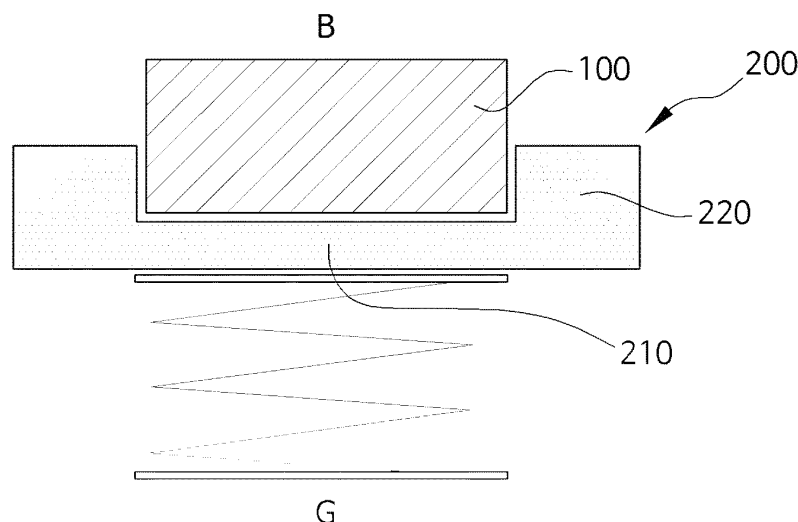
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(54) **BONE-CONDUCTION MOUNT STRUCTURE HAVING SOUND LEAKAGE PREVENTION FUNCTION AND CHANGEABLE RIGIDITY**

(57) The present invention relates to a mount structure of a bone conduction earphone, the structure including: a vibration actuator, a first side of which is arranged in a direction of a bone of a user and a second side of which is arranged in a direction of a structure body, the vibration actuator producing vibration to transmit the vibration to the bone; and a flexible cover provided to surround the second side of the vibration actuator and in-

creased by insertion of the vibration actuator to an inner side of the flexible cover, wherein the flexible cover includes: a compression part to which the vibration actuator is inserted and depressed in the direction of the structure body by the insertion of the vibration actuator; and a flexible part provided on an outer side of the compression part and increased in the direction of the structure body.

FIGURE 1a



Description

CROSS REFERENCE TO RELATED APPLICATION

5 **[0001]** The present application claims priority to Korean Patent Application No. 10-2018-0170979, filed December 27, 2018, the entire contents of which is incorporated herein for all purposes by this reference.

BACKGROUND OF THE INVENTION

10 Field of the Invention

[0002] The present invention generally relates to a bone-conduction mount structure having sound leakage prevention function and changeable rigidity. More particularly, the present invention relates to a bone-conduction mount structure having changeable rigidity, wherein of vibration generated in an actuator, vibration transmitted to a bone of a user is increased and vibration transmitted to a structure body is decreased so as to prevent sound leakage to the outside.

Description of the Related Art

20 **[0003]** Generally, bone conduction refers to sound transmission through the bones of the skull, and the sound transmission via the bone conduction can be used with individuals having normal and impaired hearing. Recently, sound transmission is actively being used in the development of products such as an earphone, beginning with a principle of a hearing aid in the past.

25 **[0004]** The sound transmission method using bone conduction is realized in such a manner that an actuator in which vibration of a predetermined pattern is generated according to an input signal transmits the vibration through the medium of a bone of a user to the eardrum. Since the vibration transmission is realized in any direction relative to an ear of a user, the sound transmission method has high utilization and a position of the actuator attached to the bone is relatively free.

[0005] The actuator used for the bone conduction normally has a characteristic of uniaxial vibration, and generates vibration in a direction of a bone requiring the vibration and in a direction contrary to the direction of the bone.

30 **[0006]** The vibration generated in the contrary direction is transmitted, through a support part supporting the actuator, to a structure body such as glasses, and the vibration transmitted to the structure body causes the sound leakage that a sound signal is leaked to the outside by the vibration.

35 **[0007]** The sound leakage occurring in an earphone using the bone conduction disturbs people in the vicinity of a user of the earphone in a specific place requiring silence such as a library, and further, also in places other than the specific place, sound information to which the user listens leaks to the outside, which prevents privacy from being maintained. Furthermore, deteriorated wearability caused by the actuator vibrating the structure body cannot be ignored.

40 **[0008]** In Korean Patent Application Publication No. 10-2017-0061188, there is disclosed a method for suppressing sound leakage of a bone conduction loudspeaker and the bone conduction loudspeaker. In the Korean Patent Application Publication, at least one sound transmission hole is provided in a housing receiving a vibration plate so as to cause vibration of the housing, and a sound wave in the housing is transmitted through the sound transmission hole to an outside and is interfered by an additional sound wave of sound leakage, whereby the sound leakage is restricted.

45 **[0009]** However, in a structure of producing destructive interference to prevent the sound leakage, it is difficult to realize precise destructive interference according to a vibration pattern reflecting various sound sources, and it is required to generate the additional sound wave of sound leakage. Accordingly, the structure is complicated and energy efficiency is low.

50 **[0010]** In addition, in Korean Patent No. 10-1603983, there is disclosed a bone conduction output apparatus, wherein vibration is transmitted by an additional bone-conduction transmitter protruding from a case and being in contact with a body, and spaces are provided between a magnetic circuit and an elastic body and between the elastic body and the bone-conduction transmitter so as to exclude interference caused by adjacent components during the vibration of the elastic body such that a bone-conduction output is not dispersed through the case.

[0011] However, as for the Korean Patent, vibration of the magnetic circuit is directly transmitted to the elastic body and a structure supporting the magnetic circuit, whereby the effect of sound leakage prevention is low.

55 **[0012]** In a mount structure absorbing the vibration or impact of the actuator, there is required the development of a bone-conduction mount structure, wherein vibration transmitted in a direction of a bone of a user is increased so as to increase an output, and vibration transmitted to the structure is decreased so as to prevent sound leakage.

Documents of Related Art

[0013]

- 5 (Patent Document 1) Korean Patent Application Publication No. 10-2017-0061188 (published on June 2, 2017)
 (Patent Document 2) Korean Patent No. 10-1603983 (registered on March 10, 2016)

SUMMARY OF THE INVENTION

10 **[0014]** Accordingly, the present invention has been made keeping in mind the above problems occurring in the related art, and the present invention is intended to propose a mount structure of a bone conduction earphone, wherein vibration transmitted to a body of a user is increased and vibration transmitted to a structure is decreased so as to improve sound signal transmission and to decrease sound leakage to the outside.

15 **[0015]** In order to achieve the above object, according to one aspect of the present invention, there is provided a bone-conduction mount structure having sound leakage prevention function and changeable rigidity, the structure including: a vibration actuator, a first side of which is arranged in a direction of a bone of a user and a second side of which is arranged in a direction of a structure body, the vibration actuator producing vibration according to an external input signal so as to transmit the vibration to the bone; and a flexible cover provided so as to surround the second side of the vibration actuator and depressed or increased by insertion of the vibration actuator to an inner side of the flexible cover, wherein
 20 the flexible cover includes: a compression part to which the vibration actuator is inserted and depressed in the direction of the structure body by the insertion of the vibration actuator; and a flexible part provided on an outer side of the compression part and increased in the direction of the structure body by the insertion of the vibration actuator, wherein when the vibration actuator is inserted, the compression part has positive rigidity due to compression, and the flexible part has negative rigidity due to tension.

25 **[0016]** In addition, the vibration actuator may be supported by the flexible cover while a part of the vibration actuator protrudes from the flexible cover and may be inserted to the inner side of the flexible cover when an external weight is applied thereto.

30 **[0017]** Furthermore, a force transmitted to the structure body may be a resultant force of a force transmitted through the compression part having the positive rigidity and a force transmitted through the flexible part having the negative rigidity.

[0018] Additionally, the structure may further include: a plate spring provided between the flexible cover and the structure body so as to buffer the force transmitted through the flexible cover.

35 **[0019]** In addition, the plate spring may include: a support body having a ring shape; and a plurality of buffer members provided by being spaced apart from each other, each first side of which is connected to an inner side of the support body, wherein each of the buffer members moves elastically in a direction in which the buffer member moves closer to or away from an inner surface of the support body.

[0020] Furthermore, the plate spring may further include: an assistant body provided at the inner side of the support body by being spaced apart from the support body and connected to a second side of the buffer member.

40 **[0021]** Additionally, the structure may further include: a piezoelectric element being connected to the flexible cover and converting pressure transmitted through the flexible cover to electric energy; and an energy storage part being connected to the piezoelectric element and storing the electric energy converted in the piezoelectric element.

[0022] In addition, the piezoelectric element may be connected to the compression part and convert pressure transmitted to the compression part to the electric energy.

45 **[0023]** According to an embodiment of the present invention, elasticity and flexibility of the flexible cover are used so as to push the vibration actuator in the direction of a bone, whereby a vibration response transmitted to the bone is increased.

[0024] In addition, the equivalent rigidity of the compression part and the flexible part is decreased so as to decrease strength of a vibration response of the structure body, whereby sound leakage is prevented.

50 **[0025]** Furthermore, a contact area of the plate spring with the flexible part is increased more than a contact area of the plate spring with the compression part so as to decrease the vibration response transmitted to the structure body, whereby improved sound leakage prevention is achieved.

[0026] In addition, energy production efficiency is increased due to an arrangement structure of the piezoelectric element receiving vibration from the compression part.

55 BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIGS. 1(a) and 1(b) are cross-sectional views showing a bone-conduction mount structure having changeable rigidity according to an embodiment of the present invention;

FIG. 2 is a concept view of the bone-conduction mount structure having changeable rigidity according to the embodiment of the present invention;

FIGS. 3 and 4 are cross-sectional views showing an arrangement structure of a plate spring according to the embodiment of the present invention;

FIGS. 5(a) and 5(b) are cross-sectional views showing a piezoelectric element according to the embodiment of the present invention; and

FIG. 6 is a block diagram showing the operation state of the piezoelectric element according to the embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0028] In the following description of the present invention, it is to be noted that, when the functions of conventional elements and the detailed description of elements related with the present invention may make the gist of the present invention unclear, a detailed description of those elements will be omitted.

[0029] Reference will now be made in detail to embodiments of the present invention, a specific example of which is illustrated in the accompanying drawings and described below, since the embodiments of the present invention can be variously modified in many different forms. While the present invention will be described in conjunction with the exemplary embodiments thereof, it is to be understood that the present description is not intended to limit the present invention to the exemplary embodiments. On the contrary, the present invention is intended to cover not only the exemplary embodiments, but also various alternatives, modifications, equivalents and other embodiments that may be included within the spirit and scope of the present invention as defined by the appended claims.

[0030] The terminology used herein is for the purpose of describing particular embodiments and is not intended to be limiting. As used herein, the singular forms "a", "an", and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprise", "include", "have", etc. when used in this specification, specify the presence of stated features, integers, steps, operations, elements, components, and/or combinations of them but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or combinations thereof.

[0031] Hereinbelow, the present invention will be described in detail.

[0032] FIGS. 1(a) and 1(b) are cross-sectional views showing a bone-conduction mount structure having changeable rigidity according to an embodiment of the present invention. FIG. 1(a) shows a state that a vibration actuator 100 is not in contact with a bone B of a user, and FIG. 1(b) shows a state that the vibration actuator 100 is in contact with the bone B of a user.

[0033] Referring to FIGS. 1(a) and 1(b), the bone-conduction mount structure having sound leakage prevention function and changeable rigidity according to the present invention includes: the vibration actuator 100, a first side of which is arranged in a direction of the bone of a user, and a second side of which is arranged in a direction of a structure body, the vibration actuator producing vibration according to an external input signal so as to transmit the vibration to the bone; and a flexible cover 200 provided so as to surround the second side of the vibration actuator 100 and depressed or increased by insertion of the vibration actuator 100 to an inner side of the flexible cover.

[0034] The vibration actuator 100 of the present invention is one kind of a device vibrating according to an external input signal and converts an electrical signal to a mechanical vibration so as to transmit the mechanical vibration to the bone of a user. Particularly, the vibration actuator 100 may include a magnet having magnetic flux changing according to the change of electric current of a coil receiving electric current from the outside, and may be composed of a magnetic circuit including the magnet. The magnetic circuit may further include a yoke which is a path through which a line of a magnetic force of the magnet passes and a top plate condensing the magnetic force. In this case, the coil may be provided on an inner part or outer part of the vibration actuator 100.

[0035] The first side of the vibration actuator 100 is arranged in the direction of a bone of a user, and the second side thereof is arranged in the direction of the structure body. Here, the structure body may be a case surrounding outer sides of the vibration actuator 100 and the flexible cover 200 or temples of glasses being mounted on a body of a user, wherein the direction of the structure body may be directions other than the direction of the bone of a user. Hereinbelow, for easy description of the present invention, the direction of the structure body is supposed to be a direction contrary to the direction of a bone of a user.

[0036] A damper may be provided in an inner part or outer part of the flexible cover 200 so as to reduce transmission of vibration, and when provided in the outer part of the flexible cover 200, the damper may be provided between the flexible cover 200 and the structure body.

[0037] The flexible cover 200 of the present invention surrounds a part of the outer side of the vibration actuator 100 so as to protect the vibration actuator 100 from an external impact and to support the vibration actuator 100. The flexible

cover 200 has elasticity and flexibility at the same time, and has a structure in which the vibration actuator 100 is inserted to one side surface of the flexible cover. For example, the flexible cover 200 may be made of a silicone. The one side surface to which the vibration actuator 100 is inserted is preferably arranged in the direction of a bone of a user. Accordingly, while the vibration actuator 100 is inserted to the inner side of the flexible cover 200, one side surface of the vibration actuator may be exposed to the direction of a bone of a user.

[0038] In the embodiment of the present invention, when the vibration actuator 100 is not in contact with the bone of a user, a state in which a part of the vibration actuator protrudes to an outer side of the flexible cover 200 is maintained, and when the vibration of the vibration actuator 100 in the protruding state is transmitted to the bone of a user, the vibration actuator may be inserted to the inner part of the flexible cover 200 while the protruding degree is decreased.

[0039] The flexible cover 200 includes: a compression part 210 to which the vibration actuator 100 is inserted and depressed in the direction of the structure body by the insertion of the vibration actuator 100; and a flexible part 220 provided on an outer side of the compression part 210 and increased in the direction of the structure body by the insertion of the vibration actuator 100.

[0040] When the vibration actuator 100 is inserted to the one side surface of the flexible cover 200 in the direction of the structure body from the direction of a bone, the compression part 210 of the flexible cover 200 is compressed and the flexible part 220 is tensioned. For example, the compression part 210 is in contact with a second side surface of the vibration actuator 100, that is, with a surface arranged in the direction of the structure body, and the flexible part 220 may be in contact with an outer part of the compression part 210, that is, with a left side or a right side of the vibration actuator 100 in the drawings. The compression part 210 and the flexible part 220 may be provided so as to be integral to each other and may refer to positions on which compression or tension occurs.

[0041] In the present invention, while the one side surface of the vibration actuator 100 exposed in the direction of a bone of a user is in contact with the bone of a user, the vibration actuator 100 is inserted into the inner side of the flexible cover 200. While the vibration actuator 100 is pushed to the inner part of the flexible cover 200 by the bone of a user, the compression of the compression part 210 and the tension of the flexible part 220 occur. In this case, although the vibration actuator 100 and the bone of a user may be in direct contact with each other, the vibration actuator 100 and the bone of a user may further include an additional member assisting vibration transmission provided therebetween so as to be in indirect contact with each other.

[0042] As insertion depth of the vibration actuator 100 increases, the compression part 210 of the flexible cover 200 is relatively compressed and has positive rigidity having increased rigidity, and the flexible part 220 is relatively tensioned and has negative rigidity having decreased rigidity. A response according to vibration transmission has relatively a large value in the compression part 210 having the positive rigidity, and has relatively a small value in the flexible part having the negative rigidity.

[0043] The flexible cover 200 having changeable rigidity described above further pushes the vibration actuator 100 in the direction of a bone by the elasticity and the flexibility. Particularly, a restoring force produced by the compression of the compression part 210 positioned under the vibration actuator 100 operates so as to push the vibration actuator 100 positioned on the compression part 210 in the direction of a bone, and a restoring force produced by the tension of the flexible part 220 operates in a direction in which the flexible cover 200 moves away from the bone. Accordingly, a distance between the vibration actuator 100 and the bone is decreased, and a distance between the flexible cover 200 and the bone is increased. In addition, while vibration transmission between the vibration actuator 100 and the bone occurs under a condition of the positive rigidity, vibration transmission between the flexible cover 200 and the bone occurs under a condition of the negative rigidity, whereby strength of vibration transmitted to the bone of a user may be increased.

[0044] A force (vibration) transmitted to the structure body from the flexible cover 200 by the vibration of the vibration actuator 100 may be a resultant force of a force transmitted through the compression part 210 having the positive rigidity and a force transmitted through the flexible part 220 having the negative rigidity. A contact area of the structure body with the flexible part 220 is increased more than a contact area of the structure body with the compression part 210 so as to decrease equivalent rigidity of the compression part 210 and the flexible part 220 and accordingly, strength of vibration transmitted to the structure body is decreased, whereby sound leakage is prevented.

[0045] FIG. 2 is a concept view of the bone-conduction mount structure having changeable rigidity according to the embodiment of the present invention.

[0046] More particularly, referring to FIG. 2, to describe a vibration response of the structure body according to the positive rigidity of the compression part 210 and the negative rigidity of the flexible part 220, a 2-degree-of-freedom damped model of the vibration actuator 100, the flexible cover 200, and the structure body will be considered. When in the flexible cover 200, rigidity of the compression part 210 is K_A , rigidity of the flexible part 220 is K_N , the structure body is G , rigidity transmitted to the structure body from the flexible cover 200 is K_G , a vibration response transmitted to a bone is X_A , the vibration response transmitted to the structure body is X_G , and a damping value between the flexible cover 200 and the structure body is CEQ , rigidity KEQ of the compression part 210 and the flexible part 220 may be referred to as $2KN+KA$, and the KEQ has a value smaller than KA . Considering an equilibrium condition of forces, the 2-degree-of-freedom damped model follows the following Equations 1 and 2.

<Equation 1>

$$M_A \ddot{X}_A + C_{eg} \dot{X}_A + K_{eg} X_A = F + C_{eg} \dot{X}_G + K_{eg} X_G$$

<Equation 2>

$$M_G \ddot{X}_G + C_{eg} \dot{X}_G + (K_{eg} + K_G) X_G = C_{eg} \dot{X}_A + K_{eg} X_A$$

[0047] In the Equations, when Laplace transform is used, Equation 1 may be referred to as Equation 3, and Equation 2 may be referred to as Equation 4.

< Equation 3>

$$(s^2 M_A + s C_{eg} + K_{eg}) X_A(s) = F(s) + (s C_{eg} + K_{eg}) X_G(s)$$

< Equation 4>

$$(s^2 M_G + s C_{eg} + K_{eg} + K_G) X_G(s) = (s C_{eg} + K_{eg}) X_A(s)$$

[0048] By using Equations 3 and 4, the vibration response (XG) of the structure body may be referred to as Equation 5 below, and strength of the vibration response (XG) may be known to be in proportion to magnitudes of damping (CEQ) and rigidity (KEQ) other than magnitude of weight.

<Equation 5>

$$X_G(s) = \frac{(s C_{eg} + K_{eg}) F(s)}{(s^2 M_A + s C_{eg} + K_{eg})(s^2 M_G + s C_{eg} + K_{eg} + K_G) - (s C_{eg} + K_{eg})^2}$$

[0049] Here, the magnitude of the weight is subject to hardware performance of the vibration actuator 100 and a value of the damping is also subject to a material of the flexible cover 200. However, as for the rigidity, the equivalent rigidity (KEQ) of the compression part 210 and the flexible part 220 may be decreased so as to effectively decrease the vibration response (XG) of the structure body.

[0050] To decrease the equivalent rigidity (KEQ) of the compression part 210 and the flexible part 220, preferably, vibration transmission between the flexible cover 200 and the structure body is transmitted through the flexible part 220 rather than through the compression part 210, and an additional spring may be provided between the flexible cover 200 and the structure body.

[0051] FIGS. 3 and 4 are cross-sectional views showing an arrangement structure of a plate spring 300 according to the embodiment of the present invention.

[0052] In the embodiment of the present invention, the plate spring 300 may be further provided between the flexible cover 200 and the structure body so as to buffer a force transmitted through the flexible cover 200. A contact area of the plate spring 300 with the flexible part 220 may be larger than a contact area of the plate spring 300 with the compression part 210. For example, the plate spring 300, which is ring-shaped, is open in a middle thereof and accordingly, may have a structure contacting with the flexible part 220 while not contacting directly with the compression part 210.

[0053] Referring to FIG. 3, for another example, the plate spring 300 may include: a support body 310 having a ring shape; and a plurality of buffer members 320 provided by being spaced apart from each other, each first side of which is connected to an inner side of the support body 310, wherein each of the buffer members moves elastically in a direction in which the buffer member moves closer to or away from an inner surface of the support body 310. In this case, the

buffer member 320 receives vibration from the flexible cover 200 while being in contact with the flexible cover 200 and elastically moves within a predetermined range up and down so as to buffer a vibration force, and the support body 310 is fixed to the structure body. The buffer member 320 is arranged along a circumference of the support body 310, and a contact area of the buffer member 320 with the flexible part 220 may be larger than a contact area of the buffer member 320 with the compression part 210.

[0054] In addition, referring to FIG. 4, the plate spring 300 may further include: an assistant body 330 provided at the inner side of the support body 310 so as to be spaced apart from the support body 310 and connected to a second side of the buffer member 320. The assistant body 330 may be ring-shaped and be connected with each of a plurality of buffer members 320 along a circumference of the assistant body 330 so as to increase the structural stability of the buffer member 320. In this case, the support body 310 and the assistant body 330 are concentric, and the support body 310 is arranged at a position higher than the assistant body 330 and is in contact with the flexible part 220, and the assistant body 330 is fixed to the structure body. While decreasing vibration transmitted to the support body 310, the buffer member 320 transmits the vibration to the assistant body 330.

[0055] According to the present invention provided with the plate spring 300 of the structure described above, while vibration transmitted through the flexible cover 200 to the structure body is decreased, the contact area of the plate spring with the flexible part 220 having the negative rigidity (KN) is increased more than the contact area of the plate spring with the compression part 210 having the positive rigidity KA so as to decrease a value of the equivalent rigidity (KEQ). The vibration response (XG) transmitted to the structure body is decreased by the decreased the equivalent rigidity (KEQ), and accordingly, sound leakage is prevented.

[0056] FIGS. 5(a) and 5(b) are cross-sectional views showing a piezoelectric element according to the embodiment of the present invention, and FIG. 6 is a block diagram showing the operation state of the piezoelectric element according to the embodiment of the present invention.

[0057] Referring to FIGS. 5(a), 5(b), and FIG. 6, in the embodiment of the present invention, the bone-conduction mount structure may further include the piezoelectric element 400 being connected to the flexible cover 200 and converting pressure transmitted through the flexible cover 200 to electric energy; and an energy storage part being connected to the piezoelectric element 400 and storing the electric energy converted in the piezoelectric element 400.

[0058] The piezoelectric element 400, which is a device converting mechanical energy applied from an outside to electric energy or converting electric energy applied from an outside to mechanical energy, may be made of lead zirconate titanate (PZT). The energy storage part 410 is electrically connected to the piezoelectric element 400 and is provided in the inner part or outer part of the flexible cover 200 so as to store the electric energy converted in the piezoelectric element 400.

[0059] The energy storage part 410 provides the stored electric energy to the vibration actuator 100 and accordingly, may compensate for energy consumption caused by vibration or provide the electric energy to a lamp provided on the structure body. The energy storage part 410 may further include a terminal board distributing electric current or a converter provided therein for the provision of the electric energy.

[0060] In the embodiment of the present invention, the piezoelectric element 400 may be provided on the inner part of the flexible cover 200 or be attached on the outer part of the flexible cover 200 so as to convert a pressure caused by vibration of the flexible cover 200 to the electric energy. Spatially, the piezoelectric element 400 may be attached on a surface arranged on the flexible cover 200 in the direction of the structure body.

[0061] In addition, in another embodiment of the present invention, the piezoelectric element 400 may be connected to the compression part 210 so as to receive a pressure according to larger vibration. As described above, the compression part 210 has the positive rigidity occurring thereon by the insertion of the vibration actuator 100 thereto, and under the positive rigidity, the piezoelectric element 400 may receive the larger vibration. In this case, the piezoelectric element 400 may be provided between the vibration actuator 100 and the compression part 210 on the inner part of the flexible cover 200, or may be provided on the outer side of the compression part 210 on the outer part of the flexible cover 200, that is, in the direction of the structure body.

[0062] Due to a pressure transmitted by vibration under the positive rigidity, the piezoelectric element 400 having the arrangement structure may increase the production amount of the electric energy and energy efficiency, compared to the condition of the negative rigidity.

[0063] As described above, according to the present invention, the elasticity and flexibility of the flexible cover 200 are used so as to push the vibration actuator 100 in the direction of a bone such that the vibration response transmitted to the bone is increased, and the equivalent rigidity of the compression part 210 and the flexible part 220 are decreased and the contact area of the plate spring 300 with the flexible part 220 is increased more than the contact area of the plate spring 300 with the compression part 210 so as to decrease the vibration response transmitted to the structure body, whereby sound leakage is prevented. Furthermore, energy production efficiency is increased by the arrangement structure of the piezoelectric element 400 receiving vibration from the compression part 210.

Claims

1. A bone-conduction mount structure having sound leakage prevention function and changeable rigidity, the structure comprising:

a vibration actuator, a first side of which is arranged in a direction of a bone of a user and a second side of which is arranged in a direction of a structure body, the vibration actuator producing vibration according to an external input signal so as to transmit the vibration to the bone; and
a flexible cover provided so as to surround the second side of the vibration actuator and depressed or increased by insertion of the vibration actuator to an inner side of the flexible cover, wherein
the flexible cover includes:

a compression part to which the vibration actuator is inserted and depressed in the direction of the structure body by the insertion of the vibration actuator; and
a flexible part provided on an outer side of the compression part and increased in the direction of the structure body by the insertion of the vibration actuator,
wherein when the vibration actuator is inserted, the compression part has positive rigidity due to compression, and the flexible part has negative rigidity due to tension.

2. The structure of claim 1, wherein the vibration actuator is supported by the flexible cover while a part of the vibration actuator protrudes from the flexible cover and is inserted to the inner side of the flexible cover when an external weight is applied thereto.

3. The structure of claim 1, wherein a force transmitted to the structure body is a resultant force of a force transmitted through the compression part having the positive rigidity and a force transmitted through the flexible part having the negative rigidity.

4. The structure of claim 3, further comprising:
a plate spring provided between the flexible cover and the structure body so as to buffer the force transmitted through the flexible cover.

5. The structure of claim 4, wherein the plate spring includes:

a support body having a ring shape; and
a plurality of buffer members provided by being spaced apart from each other, each first side of which is connected to an inner side of the support body, wherein each of the buffer members moves elastically in a direction in which the buffer member moves closer to or away from an inner surface of the support body.

6. The structure of claim 5, wherein the plate spring further includes:
an assistant body provided at the inner side of the support body by being spaced apart from the support body and connected to a second side of the buffer member.

7. The structure of claim 3, further comprising:

a piezoelectric element being connected to the flexible cover and converting pressure transmitted through the flexible cover to electric energy; and
an energy storage part being connected to the piezoelectric element and storing the electric energy converted in the piezoelectric element.

8. The structure of claim 7, wherein the piezoelectric element is connected to the compression part and converts pressure transmitted to the compression part to the electric energy.

FIGURE 1a

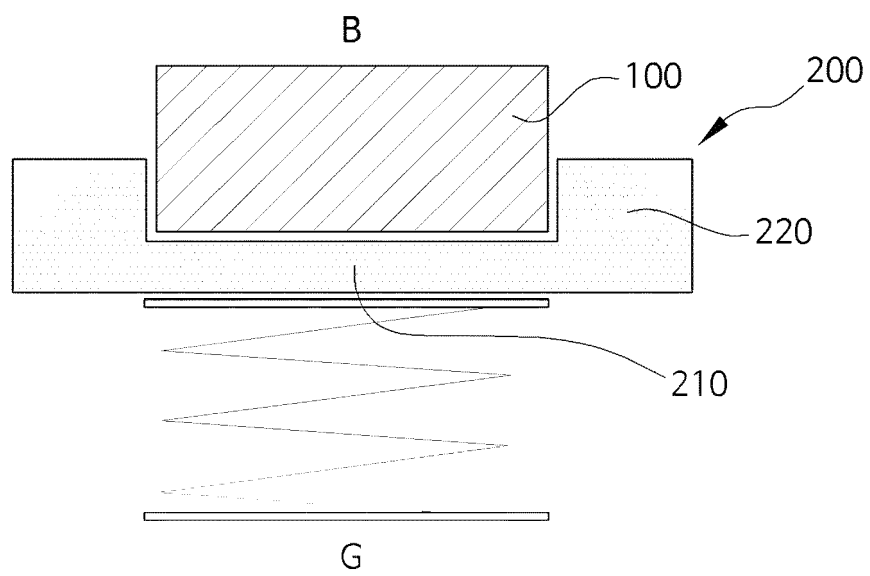


FIGURE 1b

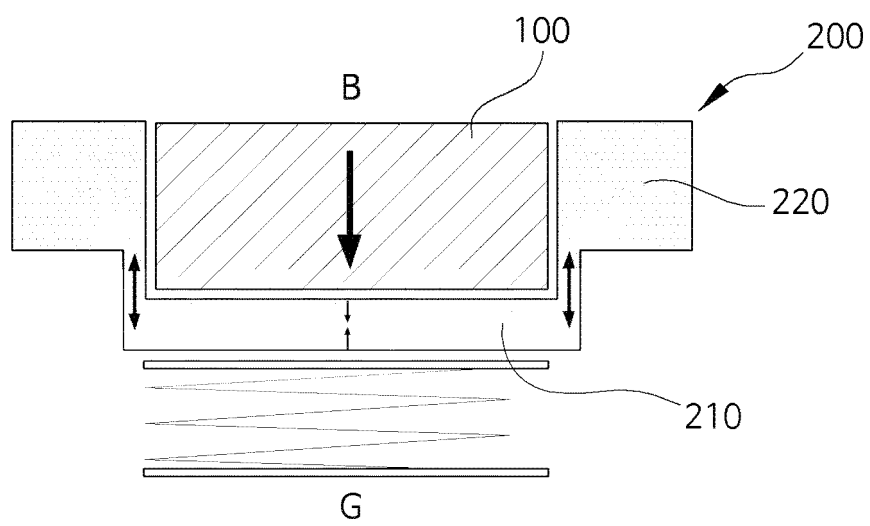


FIGURE 2

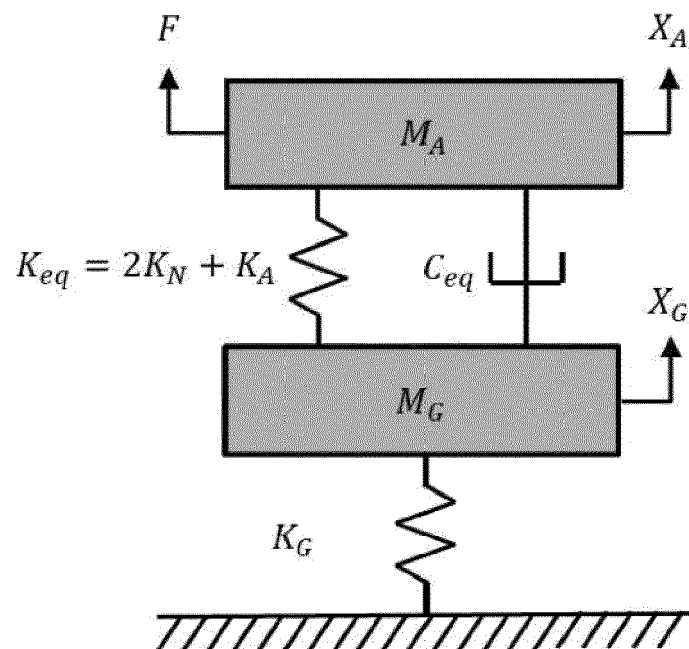


FIGURE 3

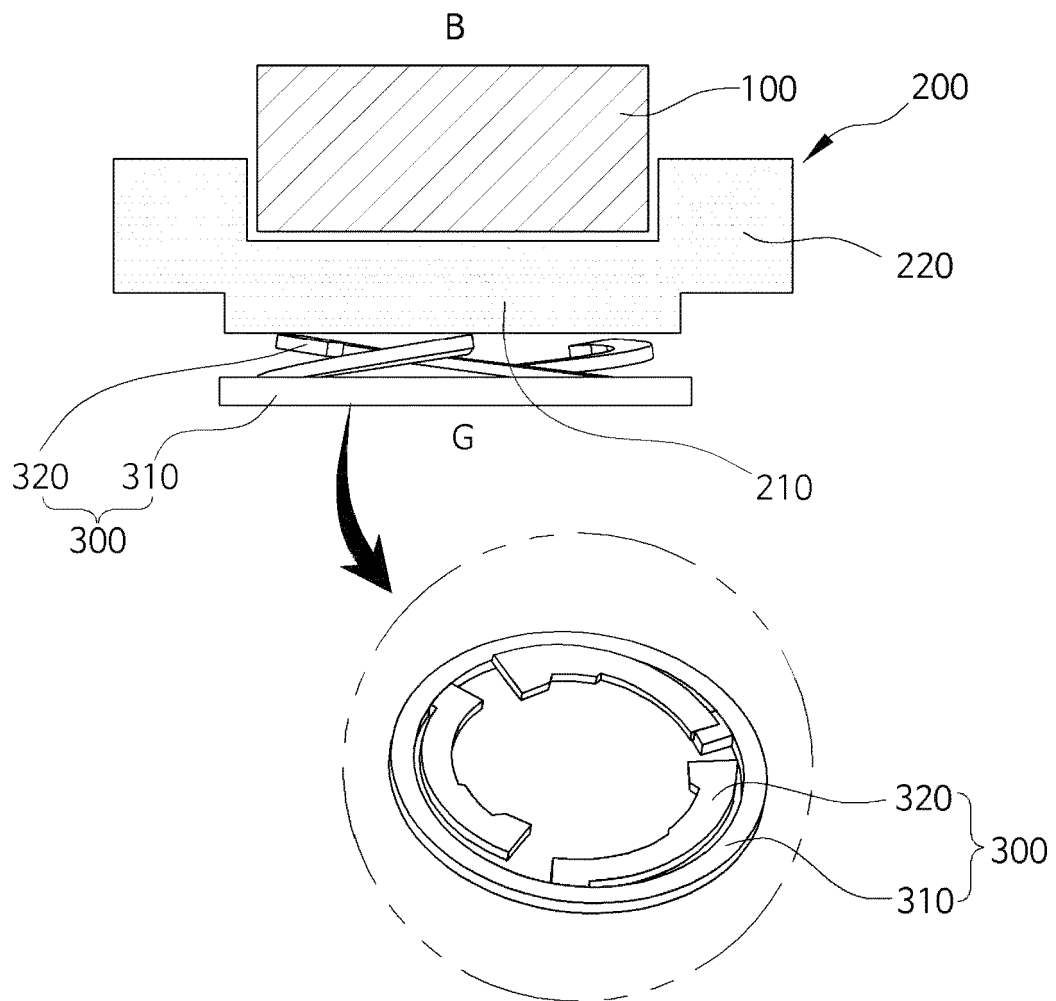


FIGURE 4

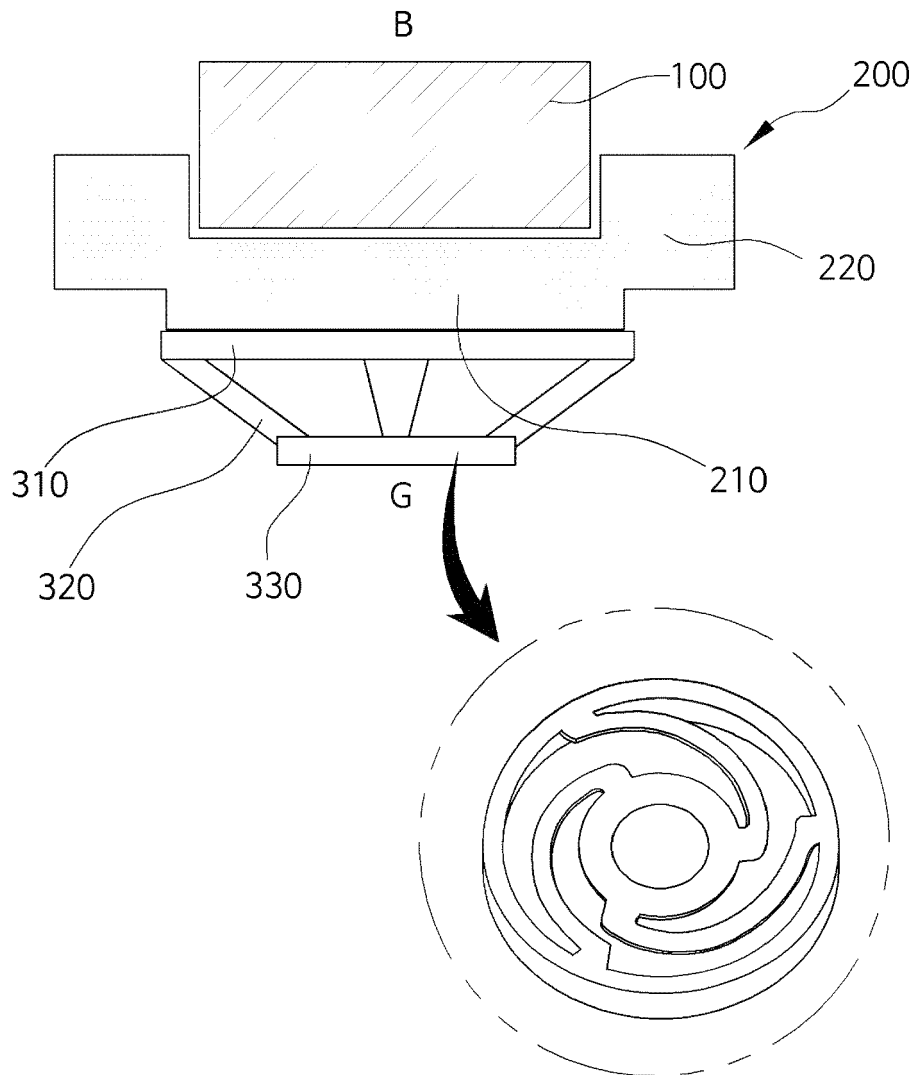


FIGURE 5a

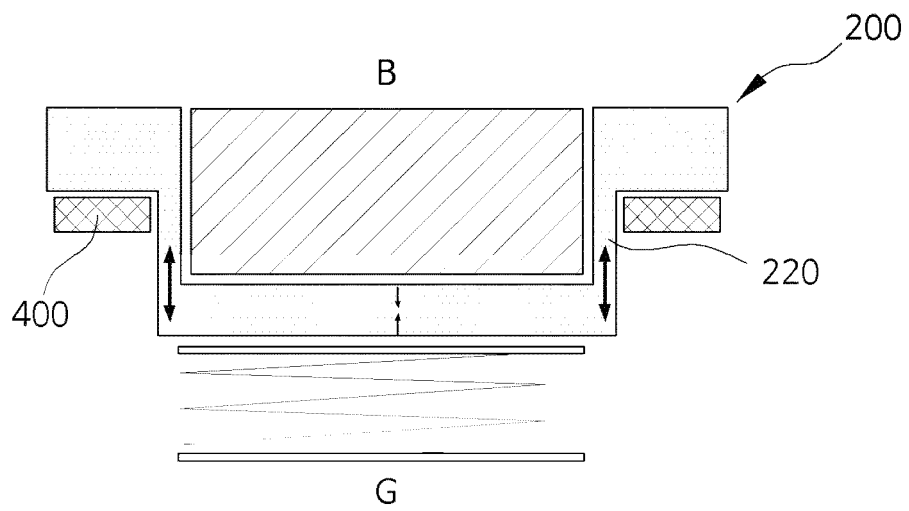


FIGURE 5b

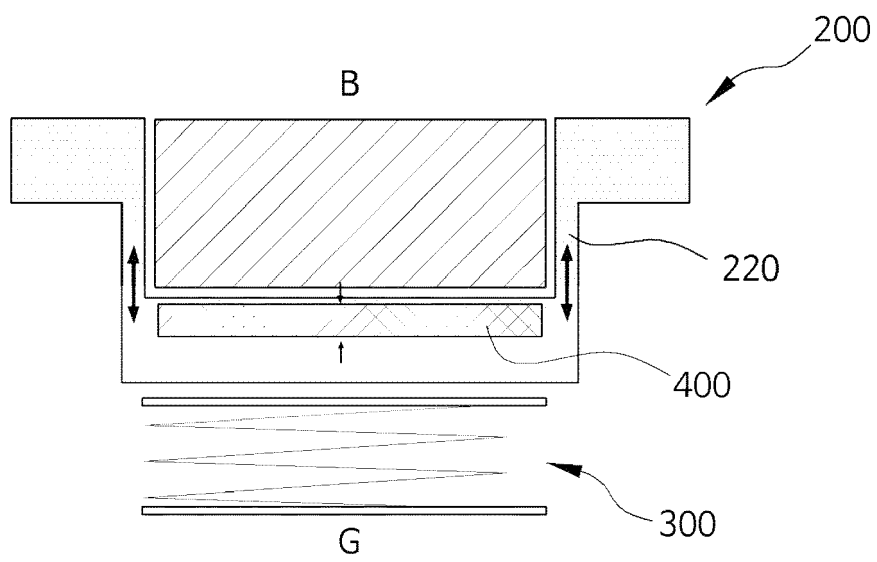
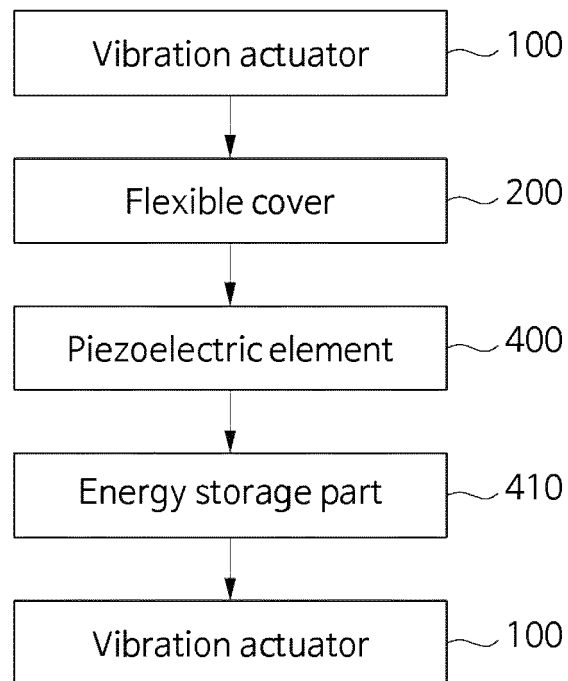


FIGURE 6





EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 22 January 2020	Examiner Moscu, Viorel
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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REFERENCES CITED IN THE DESCRIPTION

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