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

(11) EP 1 128 705 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.08.2001 Bulletin 2001/35

(51) Int Cl.[7]: **H04R 9/04**

(21) Application number: **01301583.9**

(22) Date of filing: **22.02.2001**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **25.02.2000 JP 2000050197**
25.02.2000 JP 2000050198

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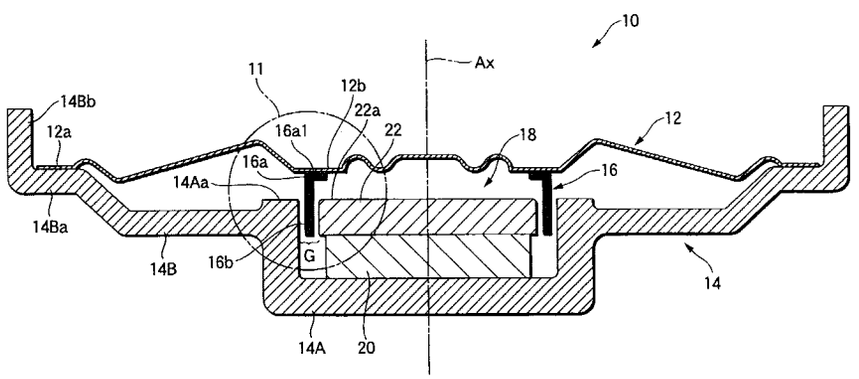
(54) Speaker

(57) By forming a flange portion 16a1 protruding inward in the radial direction at an upper end portion 16a of a voice coil 16, a coiling sectional shape of the voice coil 16 is set to a L-shape. And, the upper end portion 16a of this voice coil 16 is bonded and fixed to a central flat portion 12b of a diaphragm 12. Hereby, by only increasing slightly the weight of the usual voice coil having an I-shaped coiling section, the large bonding area can be obtained between the voice coil 16 and the diaphragm 12, so that separation of the voice coil 16 can be prevented. Further, since other portions of the voice coil 16 than the upper end portion 16a thereof have the usual coil thickness, it is not necessary to expand the width of a cylindrical magnetic gap G in a magnetic circuit unit 18, whereby it is prevented that electroacoustic conversion efficiency of a speaker 10 lowers.

FIG.1



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Description

[0001] The present invention relates to a dynamic speaker, and particularly to a structure for fixing a voice coil to a diaphragm in the dynamic speaker.

[0002] As one type of a speaker, a dynamic speaker has been known heretofore. The dynamic speaker, as disclosed in, for example, JP-A-6-178390, comprises generally a diaphragm, a voice coil of which one end portion is fixed to the diaphragm, and a magnetic circuit unit defining a cylindrical magnetic gap for placing the other end portion of the voice coil therein.

[0003] As the fixing structure of the voice coil to the diaphragm, the following structure is known, as disclosed in the JP publication. One end portion 2a of a voice coil 2 having an I-shaped coiling section as shown in Fig. 14A is bonded and fixed to a diaphragm 4.

[0004] However, in the speaker having such a fixing structure, since the large bonding area cannot be obtained, the fixing strength is insufficient. Accordingly, there is fear that the voice coil 2 peels off and separates from the diaphragm 4 during being used. Particularly, in case that the speaker is mounted on an automobile or the like, since it is used under environment where consideration vibration and shock load are applied, the voice coil 2 is easier to separate from the diaphragm.

[0005] On the other hand, as shown in Fig. 14B, in case that the coiling thickness of the voice coil 2 is set large, the relatively large bonding area between its one end portion 2a and the diaphragm 4 can be obtained, whereby the sufficient fixing strength can be obtained.

[0006] However, in this case, since a width of a cylindrical magnetic gap G of a magnetic circuit unit 6 becomes large, there is a problem that electroacoustic conversion efficiency of the speaker degrades. Further, the larger the coiling thickness of the voice coil 2 is, the larger the weight of the voice coil 2 becomes, whereby the large load acts on the bonding surface. Therefore, there is also a problem that so larger separation preventing effect cannot be obtained as expected.

[0007] The invention has been made in consideration of these circumstances, and an object of the invention is to provide a speaker in which separation of a voice coil can be prevented without worsening acoustic characteristic of a dynamic speaker.

[0008] In order to achieve the object, a coiling sectional shape of the voice coil has been improved by the invention.

[0009] Also, in order to achieve the object, a predetermined coil suporting member is provided in the invention.

[0010] Namely, according to a first aspect of the invention, there is provided a speaker comprising:

a diaphragm;
a magnetic circuit unit defining a cylindrical magnetic gap; and
a voice coil having a first portion bonded to the diaphragm, and a second portion placed in the cylindrical magnetic gap;
wherein a thickness of the first portion of the voice coil is set larger than that of the second portion of the voice coil.

[0011] Further, according to a second aspect of the invention, there is provided a speaker comprising:

a diaphragm;
a magnetic circuit unit defining a cylindrical magnetic gap;
a voice coil having a first portion fixed to the diaphragm, and a second portion placed in the cylindrical magnetic gap; and
a coil supporting member, fixed to the diaphragm, for supporting the first end portion of the voice coil, wherein the coil supporting member is caulked to the diaphragm by subjecting a caulking projection formed in the coil supporting member to a plastic deformation.

[0012] The "coil supporting member" , as long as it support one end portion of the voice coil in a state where it is caulked and fixed to the diaphragm by a plastic deformation of its caulking projection, is not particularly limited in its concrete constitution such as its material, its shape, a supportingmethod of voice coil, or the like. Further, the "caulking projection", as long as the coil supporting member can be caulked and fixed to the diaphragm by its plastic deformation, is not particularly limited in its concrete constitution such as its shape, its size, the number of the projections, arrangement, or the like.

[0013] The "diaphragm" and "magnetic circuit unit" are not particularly limited in their concrete constitution such as their material, shapes, and the like as long as they can be used as a component of the dynamic speaker.

[0014] Further, the "voice coil" is not particularly limited in its concrete coiling sectional shape as long as its coiling thickness at the first portion is set larger than that at other portions.

[0015] As indicated in the constitution, in the speaker according to the first aspect of the invention, one end portion of the voice coil is bonded to the diaphragm. Since the coiling thickness of the voice coil at the first portion is set larger than that at the other portions, the large bonding area between the first portion thereof and the diaphragm can be obtained without considerably increasing the weight of the voice coil. Therefore, it is possible to prevent the large load onto the bonding surface caused by the increase of the weight of the voice coil unlike the case where the coiling thickness of the voice coil is made large in whole, and the sufficient fixing strength of the voice coil in relation to the diaphragm can be obtained.

[0016] Further, according to the first aspect of the in-

vention, since the coiling thickness of the voice coil at the other portions is set relatively small, it is not necessary to expand the width of the cylindrical magnetic gap in the magnetic circuit unit, and the large bonding area can be obtained between the first portion thereof and the diaphragm. Therefore, without lowering electroacoustic conversion efficiency of the speaker, the effects can be obtained.

[0017] In the constitution, as described above, the coiling sectional shape of the voce coil is not limited particularly. In case that the coiling section is substantially L-shaped by forming a flange that protrudes inward in the radial direction at the first portion, the large bonding area can obtained in a state where the increase of the weight of the voice coil is kept to a minimum. Further, without considerably complicating the coiling operation of the voice coil, the coiling thickness of the voice coil at the first portion thereof can be set larger than that at other portions.

[0018] As described in the constitution, in the speaker according to the second aspect of the invention, the coil supporting member that supports the first portion of the voice coil is caulked to the diaphragm by subjecting the caulking projection formed in the coil supporting member to the plastic deformation. Therefore, the following effects that act on the invention can be obtained.

[0019] Namely, since the voice coil is supported by the coil supporting member at the first portion thereof, it is not only directly fixed to the diaphragm by bonding but also indirectly fixed to the diaphragm through the coil supporting member. Therefore, the sufficient fixing strength of the voice coil in relation to the diaphragm can be obtained even if the coiling thickness of the voice coil is not made large and the large bonding area is not obtained between one end portion of the voice coil and the diaphragm unlike the conventional art. Hereby, since it is not necessary to expand the width of the cylindrical magnetic gap between the magnetic circuit unit and the frame, it is possible to previously prevent electroacoustic conversion efficiency of the speaker from lowering.

[0020] Further, since the coil supporting member is caulked to the diaphragm by the plastic deformation of its caulking projection, the diaphragm itself does not receive the excessive load at the caulking time. Accordingly, by providing the coil supporting member, it is possible to previously prevent deformation injurious to the acoustic property from occurring in the diaphragm.

[0021] As described above, according to the invention, the separation of the voice coil can be prevented without worsening acoustic property of the speaker in the dynamic speaker.

[0022] In the constitution, in case that the fixing strength of the voice coil to the diaphragm is sufficiently obtained by only the support of the coil supporting member, the direct fixing between the voice coil and the diaphragm by bonding may be omitted. In this case, since the bonding step or the like required conventionally when the voice coil is fixed to the diaphragm can be eliminated, the working efficiency in manufacture of speaker can be heightened greatly.

[0023] In the constitution, in case that a flange portion protruding inward in the radial direction is formed at the first portion of the voice coil, and a fitting portion that fits to this flange portion is formed in coil supporting member, the voice coil can be surely supported by the coil supporting member, so that the fixing strength of the voice coil to the diaphragm can be sufficiently heightened. Therefore, the direct fixing between the voice coil and the diaphragm by bonding can be readily omitted.

[0024] In this case, the "flange portion" and "fitting portion", as long as the coil supporting member can support the voice coil by their fitting, are not particularly limited in the concrete constitution such as a sectional shape.

[0025] The concrete method of subjecting the caulking projection of the coil supporting member to the "plastic deformationis" not particularly limited. For example, the plastic deformation can be also performed by a mechanical method such as cold caulking. Further, in case that the coil supporting member is composed of a member made of synthetic resin, a method can be also adopted, in which the caulking projection is subjected to a heat deformation by applying the ultrasonic vibration to the caulking projection.

[0026] By adopting the method in which the caulking projection is subjected to the heat deformation by applying the ultrasonic vibration to the caulking projection, even in case that a speaker is a small-sized speaker and a caulking projection of its coil supporting member is very small, caulk-fixing can be performed readily and reliably.

[0027] In this case, since the diaphragm itself does not take direct part in caulk-fixing, it is not necessary entirely to take application of material of two members to fusion-bonding into consideration like a case where the two members are fusion-bonded by an ultrasonic wave. Accordingly, there is not restriction on selection freedom of material of the diaphragm, because the method in which the caulking projection is subjected to the heat deformation by applying the ultrasonic vibration is adopted.

[0028] As described above, the concrete constitution of the coil supporting member is not particularly limited. Further, in case that this coil supporting member is composed of an annular member, the caulking projections are formed at plural places in the coil supporting member at a predetermined interval in the circumferential direction, and plural through-holes into which these caulking projections are inserted are formed in the diaphragm; caulk-fixing can be performed in a state where the coil supporting member is exactly positioned in the predetermined position of the diaphragm.

[0029] As described above, in case that the flange portion protruding inward in the radial direction is formed at the first portion of the voice coil and the fitting portion that fits to this flange portion is formed in coil supporting

member, the voice coil can be reliably supported by the coil supporting member. Therefore, also in case that fixing of the coil supporting member to the diaphragm is performed by other fixing methods than caulk-fixing, for example, by bonding, the fixing strength of the voice coil in relation to the diaphragm can be heightened in some degree.

[0030] Some examples of speakers according to the invention will now be described with reference to the accompanying drawings, in which:-

Fig. 1 is a side sectional view of a speaker according to a first embodiment for carrying out the invention, in which the speaker faces upward.

Fig. 2 is a detailed diagram of a II portion in Fig. 1.

Fig. 3 is a main portion side sectional view showing a process for molding a voice coil in the first embodiment.

Figs. 4A and 4B are diagrams similar to Fig. 2, showing modification of the first embodiment.

Fig. 5 is a side sectional view of a speaker according to a second embodiment for carrying out the invention, in which the speaker faces upward.

Fig. 6 is a detailed diagram of an II portion in Fig. 5.

Fig. 7 is a single member perspective view showing a state before a coil supporting member is caulked and fixed to a diaphragm in the second embodiment.

Figs. 8A and 8B are main portion side sectional views each showing a step for fixing a voice coil to the diaphragm in the second embodiment.

Figs. 9A and 9B are diagrams similar to Figs. 8A and 8B, which show a first modification of the second embodiment.

Fig. 10 is a main portion side sectional view showing a second modification of the second embodiment.

Fig. 11 is a single member perspective view showing a state before a coil supporting member is caulked and fixed to a diaphragm in the second modification.

Fig. 12 is a diagram similar to Fig. 6, which shows a third modification of the second embodiment.

Figs. 13A and 13B are diagrams similar to Fig. 6, which show fourth and fifth modifications of the second embodiment.

Figs. 14A and 14B are diagrams similar to Fig. 6, which show a conventional example.

[0031] The invention will be described below with reference to the accompanying drawings.

First Embodiment

[0032] Fig. 1 is a side sectional view of a speaker 10 according to a first embodiment of the invention, in which the speaker faces upward, and Fig. 2 is a detailed diagram of a II portion in Fig. 1.

[0033] As shown in Fig. 1, the speaker 10 according to the first embodiment is a dynamic speaker comprising a diaphragm 12, a frame 14, a voice coil 16 and a magnetic circuit unit 18. The speaker 10 is a small-sized speaker having an outer diameter of about 30 mm, and used as, for example, a generator of alarm or the like, which is mounted on a base plate in a state where it has been stored in a case (not shown) and loaded on an automobile or the like.

[0034] The diaphragm 12 is a member having a plurality of unevenness formed concentrically, and the diaphragm 12 is formed by applying heat press molding to a synthetic resin film. A peripheral edge flat portion 12a of the diaphragm 12 and a central flat portion 12b are located on the same horizontal annular plane.

[0035] The frame 14 is a steel member, and comprises a bottomed cylinder portion 14A located in the center and an annular mounting portion 14B that extends outward in the diameter direction from the vicinity of the upper end portion on the outer surface of this bottomed cylinder portion 14A. In the mounting portion 14B, a plurality of through-holes (not shown) is formed at a predetermined interval in the circumferential direction. And, at the peripheral edge portion of the mounting portion 14B, there are formed an annular flat portion 14Ba located above an upper end surface 14Aa of the bottomed cylindrider portion 14A and a flange portion 14Bb extending upward from this annular flat portion 14Ba.

[0036] The diaphragm 12, at its peripheral edge flat portion 12a, is bonded and fixed to the annular flat portion 14Ba of the mounting portion 14B of the frame 14. The bond-fixing is performed in a state where the diaphragm 12 and the frame 14 are arranged so as to be concentric with each other in relation to a central axis Ax of the speaker 10.

[0037] The voice coil 16 is arranged so as to be concentric with the diaphragm 12, and an upper end portion 16a (one end portion) of the voice coil 16 is bonded and fixed to the central flat portion 12b of the diaphragm 12. The fixing structure will be described later.

[0038] The magnetic circuit unit 18 includes the bottomed cylinder portion 14A of the frame 14, a magnet 20 and a steel yoke 22. Both of the magnet 20 and yoke 22 are formed in the shape of a disk, placed on a bottom surface of the bottomed cylinder portion 14a in this order so as to be concentric with each other, and bonded and fixed to the frame 14. The magnetic circuit unit 18 is set so that an upper end surface 22a of the yoke 22 has substantially the same height as the upper end surface 14Aa of the bottomed cylinder portion 14A, and a cylindrical magnetic gap G is formed, between the outer surface of the yoke 22 and the inner surface of the bottomed cylinder portion 14a, with the same width in the entire surrounding. And, in the cylindrical magnetic gap G, a lower portion 16b (other end portion) of the voice coil 16 is placed.

[0039] As shown in Fig. 2, a coiling sectional shape of the voice coil 16 is set to a shape of L in which a flange portion 16a1 that protrudes inward in the radial direction

is formed at an upper end portion 16a. Hereby, the bonding area between the upper end portion 16a of the voice coil 16 and the central flat portion 12b of the diaphragm 12 is sufficiently obtained.

[0040] The diaphragm 12 and voice coil 16 move up and down, when the speaker is driven, in a range shown by a two-dots chain line in Fig. 2. The height of the flange portion 16a1 is set so that clearance is provided in some degree between the flange portion 16a1 and the upper end surface 22a of the yoke 22 even when the vibration occurs with the maximum amplitude.

[0041] The voice coil 16 is formed using a coiling press jig 102 and a coiling receiver jig 104.

[0042] The coiling press jig 102 is formed in the shape of a column having the larger diameter than the diameter of the voice coil 16. On the other hand, the outer diameter of the coiling receiver jig 104 is set to the same value as the inner diameter of the voice coil 16, and an upper end portion of the jig 104 is formed as a small-diameter recess portion 104a having the same shape as the inner surface and the lower end surface of the flange portion 16a1. And, in a state where the lower end surface of the coiling press jig 102 and the upper end surface of the coiling receiver jig 104 are brought into contact with each other, a leading end portion of a coil wire C is hung on the small-diameter recess portion 102a of the coiling receiver jig 104. Thereafter, the both jigs 102 and 104 are rotated around the central axis Ax (refer to Fig. 1) and the coil wire C is moved up and down in the predetermined range, whereby the coil wire C is wound on the outer surface of the coiling receiver jig 104 thereby to form the voice coil 16 having the coiling section of the L-shape in which the flange portion 16a1 is formed at the upper end portion 16a.

[0043] As the coil wire C, a wire coated with fusion-bonding synthetic resin is used. And, immediately before the coiling, hot wind is blown against the wire C in order to melt the coating, whereby the wound wire C is fusion-bonded mutually to form the voice coil 16. Further, the coiling number of the coil wire C is set to an even number (for example, the coiling number at the upper end portion 16a is twelve and the coiling number at other portions is four), so that both leading and trailing ends of the wire are drawn out from the upper end portion 16a of the voice coil 16.

[0044] As described above, in the speaker 10 according to the first embodiment, the upper end portion 16c of the voice coil 16 is bonded and fixed to the central flat portion 12b of the diaphragm 12. Since the voice coil 16 has the coiling section of the L-shape in which the flange portion 16a1 is formed at the upper end portion 16a, by only increasing slightly the weight of the usual voice coil having the I-shaped coiling section, the large bonding area can obtained between the upper end portion 16a and the diaphragm 12.

[0045] Therefore, unlike the case where the coiling thickness of the voice coil having the I-shaped coiling section is only made large in whole, it is possible to prevent the large load caused by the increase of the weight of the voice coil from acting onto the bonding surface, and the sufficient fixing strength of the voice coil 16 in relation to the diaphragm 12 can be obtained.

[0046] Further, since other portions of the voice coil 16 than the upper end portion 16a thereof have the usual coiling thickness, it is not necessary to expand the width of the cylindrical magnetic gap G in the magnetic circuit unit 18, whereby without lowering electroacoustic conversion efficiency of the speaker 10, the effects can be obtained.

[0047] Therefore, according to the invention, the separation of the voice coil 16 can be prevented without worsening the properties of the speaker.

[0048] Accordingly, even in case that the speaker 10 according to the first embodiment is used under environment where large vibration and shock load act, for example, even in case that the speaker 10 is used as a speaker mounted on an automobile, it can be sufficiently fit for use.

[0049] Particularly in the emdodiment, since the flange portion 16a1 is formed at the upper end portion 16a of the voice coil 16 so as to protrude inward in the radial direction, when the coiling operation of the voice coil is performed, the predetermined small-diameter recess portion 104a is previously formed at the upper end portion of the coiling receiver jig 104, whereby the voice coil 16 having the L-shaped coiling sectional shape can be readily formed.

[0050] In the first embodiment, the sectional shape of the flange portion 16a1 is set to a rectangular shape. However, the flange portion may have other sectional shapes than this shape, needles to say.

[0051] For example, as shown in Fig. 4A, a flange portion 16a1 can be adopted, which has a wedge-shaped section in which the vertical width becomes gradually narrower inward in the radial direction. By adopting this sectional shape, the increase of the weight of the voice coil 16 is kept to a minimum. Further, the large bonding area can be obtained between its upper end portion 16a and the diaphragm 12 and rigidity of the voice coil 16 itself can be heightened.

[0052] Further, as shown in Fig. 4B, not only the flange portion 16a1 protruding inward in the radial direction but also a flange portion 16a2 protruding outward in the radial direction may be formed at the upper end portion 16a of the voice coil 16, whereby the large bonding area can be obtained between its upper end portion 16a and the diaphragm 12.

[0053] In the first embodiment, the case where the speaker 10 is a small-sized speaker is described. However, even in case that it is a larger speaker, by adopting the similar constitution to that in the first embodiment, the similar effects to those in the first embodiment can be obtained.

Second Embodiment

[0054] Fig. 5 is a side sectional view of a speaker 100 according to a second embodiment of the invention, in which the speaker faces upward, and Fig. 6 is a detailed diagram of a II portion in Fig. 5.

[0055] As shown in Fig. 5, the speaker 100 is a dynamic speaker comprising a diaphragm 12, a frame 14, a voice coil 16 and a magnetic circuit unit 18. Structures and functions of the diaphragm 12, the frame 14, the voice coil 16 and the magnetic circuit unit 18 are the same as those of the speaker 10 described in the first embodiment.

[0056] In the second embodiment, the voice coil 16 is fixed to the diaphragm 12 through a coil supporting member 26.

[0057] Namely, as shown in Fig. 6, at the upper end portion 16a of the voice coil 16, a flange portion 16a1 protruding inward in the radial direction is formed. On the other hand, at a lower end portion of the coil supporting member 26, an engaging portion 26a is formed, which engages with the flange portion 16a1 of the voice coil 16. Further, at an upper end portion of the coil supporting member 26, a caulk-fixed portion 26b is formed, which is caulked to be fixed to the central flat portion 12b of the diaphragm 12. And, the flange portion 16a1 of the voice coil 16 is interposed between the engaging portion 26a of the coil supporting member 26 and the central flat portion 12b of the diaphragm 12 and held by them from upper and lower sides, whereby the voice coil 16 is fixed to the diaphragm 12.

[0058] The diaphragm 12, the voice coil 16, and the coil supporting member 26 move up and down, when the speaker is driven, in a range shown by a two-dots chain line in Fig. 6. The height of the coil supporting member 26 is so set that clearance is provided in some degree between the coil supporting member 26 and the upper end surface 22a of the yoke 22 even when the vibration occurs with the maximum amplitude. And, by thus setting the height of this coil supporting member 26, the usual speaker driving is performed without hindrance. Further, when the vibration occurs with abnormally large amplitude over the maximum amplitude, the coil supporting member 26 comes into contact with the upper end surface 22a of the yoke 22 to restrict the vibration, whereby it is prevented that the diaphragm 12 or the like breaks.

[0059] Fig. 7 is a perspective view showing a state before the coil supporting member 26 is caulked and fixed to the diaphragm 12.

[0060] As shown in Fig. 7, the coil supporting member 26 includes an annular member made of synthetic resin, and functions as a bobbin. At a peripheral surface of the supporting member 26, a different-in-level portion is so formed that a lower half has a large diameter, and its lower half constitutes the engaging portion 26a. Further, column-shaped caulking projections 26b' are formed at twelve points on the upper end surface of this coil supporting member 26 at an interval of 30° in the circumferential direction.

[0061] On the other, in the central flat portion 12b of the diaphragm 12, twelve through-holes 12c into which the caulking projections 26b' are inserted are formed. Each of these through-holes 12c is a circular hole having the substantially same diameter as that of the caulking projection 26b'.

[0062] After each caulking projection 26b' of the coil supporting member 26 is inserted from the lower side into each through-hole 12c of the diaphragm 12, the coil supporting member 26 is caulked and fixed to the diaphragm 12 by subjecting each caulking projection 26b' to a plastic deformation. In this case, the plastic deformation of each caulking projection 26b' is performed by applying ultrasonic vibration to the caulking projection 26b' and subjecting the caulking projection 26b' to a heat-deformation.

[0063] Specifically, as shown in Fig. 8A, after the coil supporting member 26 is set in a caulking receiver jig 202, the diaphragm 12 is set to the coil supporting member 26 in such a manner that each caulking projection 26b' is inserted into each through-hole 12c. Under this state, a horn 204 of an ultrasonic vibration device is brought into contact with the upper end portion of the caulking projection 26b' to apply the ultrasonic vibration to the caulking projection 26b', whereby the caulking projection 26b' is subjected to the heat deformation, so that a caulk-fixed portion 26b is formed.

[0064] The thus formed caulk-fixed portion 26b holds the diaphragm 12 between the caulk-fixed portion 26b and the body portion of the coil supporting member 26 at the surrounding portion of the through-hole 12c, whereby the coil supporting member 26 is firmly fixed to the diaphragm 12.

[0065] The voice coil 16 is formed by coiling a coil wire C around the coil supporting member 26 fixed to the diaphragm 12.

[0066] Specifically, as shown in Fig. 8B, the coil supporting member 26 fixed to the diaphragm 12 is set to a coiling receiver jig 106 having the same outer diameter as that of its engaging portion 26a. Thereafter, the coil supporting member 26 and the central flat portion 12b of the diaphragm 12 are pressed from the upper side by a coiling press jig 208. In this state, a leading end portion of the coil wire C is hung on a small-diameter recess portion adjacent above the engaging portion 26a of the coil supporting member 26, and the coiling receiver jig 106 and the coiling press jig 208 are rotated abount the central axis Ax (refer to Fig. 5) and the coil wire C is moved up and down in the predetermined range, whereby the coil wire C is wound on the outer surfaces of the coil supporting member 26 and the coiling receiver jig 106 thereby to form the voice coil 16 having the coiling section of the L-shape in which the flange portion 16a1 is formed at the upper end portion 16a.

[0067] As the coil wire C, a wire coated with fusion-bonding synthetic resin is used. And, immediately be-

fore the coiling, hot wind is blown against the wire C in order to melt the coating, whereby the wound wire C is fusion-bonded mutually to form the voice coil 16. Further, the coiling number of the coil wire C is set to an even number (for example, the coiling number at the upper end portion 16a is eight and the coiling number at other portions is four), so that both leading and trailing ends of the wire are drawn out from the upper end portion 16a of the voice coil 16.

[0068] As described above, the speaker 100 according to the second embodiment has the coil supporting member 26 caulked and fixed to the diaphragm 12, and the engaging portion 26a of the coil supporting member 26 and the central flat portion 12b of the diaphragm 12 holds the flange portion 16a1 formed at the upper end portion 16a of the voice coil 16 between them, whereby the voice coil 16 is fixed to the diaphragm 12. Therefore, the following effects can be obtained.

[0069] Namely, the voice coil 16 is fixed to the diaphragm 12 physically by engaging with the voice coil to the coil supporting member 26. Therefore, its fixing strength can be improved greatly in comparison with the case where the upper end portion 16a of the voice coil 16 is fixed directly to the diaphragm 12 by bonding like the conventional art.

[0070] Further, though the coiling thickness at the upper end portion 16a of the voice coil 16 is large because the flange portion 16a1 is formed there, since other portions than the upper end portion 16a have the usual coiling thickness, it is not necessary to expand the width of the cylindrical magnetic gap G in the magnetic circuit unit 18, whereby without lowering electroacoustic conversion efficiency of the speaker 100, the effects can be obtained.

[0071] Further, the coil supporting member 26, since its caulking projection 26b' is subjected to the plastic deformation thereby to provide the caulk-fixed portion 26b, is caulked and fixed to the diaphragm 12. Therefore, the diaphragm 12 itself does not receive the excessive load at the caulk-fixing time. Accordingly, by providing the coil supporting member 26, it is possible to prevent deformation injurious to the acoustic property from occurring in the diaphragm 12.

[0072] As described above, according to the invention, the separation of the voice coil can be prevented without worsening the acoustic property of the speaker.

[0073] Accordingly, even in case that the speaker 100 according to the second embodiment is used under environment where considerable vibration and shock load act, for example, even in case that the speaker 100 is used as a speaker mounted on an automobile, it can be sufficiently fit for use.

[0074] In the second embodiment, the upper end portion 16a of the voice coil 16 is not directly fixed to the diaphragm 12 by bonding. Therefore, the bonding step or the like conventionally required when the voice coil 16 is fixed to the diaphragm 12 is not necessary, so that the working efficiency in manufacture of the speaker 100 can be heightened greatly.

[0075] Further, in the second embodiment, the coil supporting member 26 functions also as the amplitude limiting means. Therefore, it is possible to prevent the diaphragm 12 or the like from breaking due to occurrence of the vibration with the abnormal amplitude.

[0076] Further, in the second embodiment, the coil supporting member 26 includes the annular member and the caulking projections 26b' are formed at the plural places in its circumferential direction, while the plural through-holes 12c into which these caulking projections 26b' are inserted are formed in the diaphragm 12. Therefore, caulk-fixing can be performed in a state where the coil supporting member 26 is exactly positioned in the predetermined position of the diaphragm 12. Particularly, in this second embodiment, since the twelve caulking projections 26b' and the twelve through-holes 12c are formed at the interval of 30°, the fixing strength between the coil supporting member 26 and the diaphragm 12 can be made extremely high.

[0077] Further, in the second embodiment, the plastic deformation of the each caulking projection 26b' is performed by applying the ultrasonic vibration to the caulking projection 26' thereby to subject the caulking projection to the heat deformation. Therefore, though each caulking projection 26' is a very small projection, the caulk-fixing can be readily and reliably performed. In this case, since the diaphragm 12 itself is not subject to caulk-fixing, it is not necessary to select the material to be suitable for fusion-bonding. Accordingly, there is no restriction on selection freedom of material of the diaphragm 12.

[0078] Figs. 9A and 9B are diagrams similar to Figs. 8A and 8B, which show a first modification of the second embodiment.

[0079] Also, in the first modification, it is similar to the second embodiment that a voice coil 16 is fixed to a diaphragm 12 through a coil supporting member 26. However, the first modification is different from the second embodiment in a manufacturing method for realizing this fixing.

[0080] Namely, as shown in Fig. 9A, the voice coil 16 is previously formed and the coil supporting member 26 is set to a caulking receiver jig 202 together with this voice coil 16. Thereafter, the diaphragm 12 is set to the coil supporting member 26 in such a manner that each caulking projection 26b' is inserted into each through-hole 12c. Under this state, as shown in Fig. 9B, a horn 204 of an ultrasonic vibration device is brought into contact with the upper end portion of the caulking projection 26b' to apply the ultrasonic vibration to the caulking projection 26', whereby the caulking projection 26b' is subjected to a heat deformation, so that a caulk-fixed portion 26b is formed.

[0081] Also, in a case where the manufacturing method in the first modification is adopted, the similar effects to those in the second embodiments can be obtained.

[0082] Fig. 10 is a main portion side sectional view,

which shows a second modification of the second embodiment; and Fig. 11 is a perspective view of the second modification, which shows a state before a coil supporting member 26 is caulked and fixed to a diaphragm 12.

[0083] The second modification is different from the second embodiment in the caulk-fixing structure of the coil supporting member 26 to the diaphragm 12.

[0084] Namely, in the second modification, an annular rib-shaped caulking projection 26c' is formed at the upper end surface of the coil supporting member 26. On the other hand, in the diaphragm 12, an inward part of its central flat portion 12b in the radial direction is punched out, and a circular through-hole 12d of such a size that it substantially comes into contact with the periphery outside of the caulking projection 26c' is formed.

[0085] And, after the caulking projection 26c' is inserted into the through-hole 12d of the diaphragm 12 from the lower side, the caulking projection 26c' is subjected to a plastic deformation toward the peripheral side in whole to form a caulk-fixed portion 26c, whereby the coil supporting member 26 is fixed to the diaphragm 12. In this case, the plastic deformation of the caulking projection 26c' is performed by applying ultrasonic vibration to the caulking projection 26c' and subjecting the caulking projection 26c' to a heat-deformation.

[0086] The coil supporting member 26 in the second modification is not an annular member but a lid member that covers the whole of the through-hole 12d. Hereby, the upper and lower spaces of the diaphragm 12 are completely partitioned, and acoustic property of a speaker 100 is maintained.

[0087] Also, in case that the constitution in the second modification is adopted, the effects similar to those in the second embodiment can be obtained.

[0088] Further, in the second modification, since the caulking projection 26c' and the through-hole 12d are respectively single, when the caulk-fixing is performed, the diaphragm 12 can be readily set to the coil supporting member 26, whereby working efficiency in manufacture of the speaker 100 can be heightened more.

[0089] Fig. 12 is a diagram similar to Fig. 6, which shows a third modification of the second embodiment.

[0090] The third modification is different from the second embodiment in the fixing structure of a voice coil 16 to a diaphragm 12.

[0091] Namely, in the third modification, a flange portion 16a1 is not formed at an upper end portion 16a of the voice coil 16 unlike in the second embodiment, and an engaging portion 26a is not formed in a coil supporting member 26. And, in the thirdmodification, the voice coil 16 is, at its upper end portion 16a, bonded and fixed to both the outer surface of the coil supporting member 26 and a central flat portion 12b of the diaphragm 12. However, the third modification is the same as the second embodiment in that the coil supporting member 26 is caulked and fixed to the diaphragm 12.

[0092] In the third modification, the upper end portion 16a of the voice coil 16 is not physically fixed to the diaphragm 12 unlike in the second modification. However, in relation to the diaphragm 12, it is fixed not only directly but also indirectly through the coil supporting member. Therefore, in comparison to the conventional example in which the upper end portion 16a of the voice coil 16 is only bonded to the diaphragm directly, its fixing strength can be greatly improved.

[0093] In this case, if the required fixing strength of the voice coil 16 in relation to the diaphragm 12 can be obtained by only bonding and fixing the upper end portion 16a of the voice coil 16 on the outer surface of the coil supporting member 26, bond-fixing of the voice coil 16 to the diaphragm 12 can be omitted thereby to increase working efficiency in manufacture of the speaker 100.

[0094] Figs. 13A and 13B are diagrams similar to Fig. 6, which show a fourth modification and a fifth modification of the second embodiment.

[0095] These fourth and fifth modifications are different from the second embodiment in the fixing structure of a coil supporting member 26 to the diaphragm 12.

[0096] Namely, as shown in Fig. 13A, in the fourth modification, at the upper end portion of the coil supporting member 26, a projection 26d is formed, which has a little smaller diameter than the diameter of a through-hole 12c of the diaphragm 12. In a state where a flange portion 16a1 of the voice coil 16 is engaged with an engaging portion 26a of the coil supporting member 26, the projection 26d is inserted into the through-hole 12c from the lower side. Under this state, adhesive A is applied to the surroundings of the projection 26d, whereby the coil supporting member 26 is bonded and fixed to a central flat portion 12b of the diaphragm 12.

[0097] Further, as shown in Fig. 13B, in the fifth modification, in a state where a flange portion 16a1 of a voice coil 16 is engaged with an engaging portion 26a of a coil supporting member 26, the upper end surfaces of these voice coil 16 and coil supporting member 26 are bonded and fixed to a central flat portion 12b of a diaphragm 12.

[0098] Also, in case that the constitution as shown in the fourth modification or fifth modification is adopted, in comparison to the conventional example in which the upper end portion 16a of the voice coil 16 is only bonded and fixed to the diaphragm 12, the fixing strength of the voice coil 16 to the diaphragm 12 can be greatly improved.

[0099] In the second embodiment and the first, second, fourth and fifth modifications of the second embodiment, the sectional shape of each of the engaging portion 26a of the coil supporting member 26 and the flange portion 16a1 of the voice coil 16 is set to a rectangular shape. However, if it is possible to prevent the voice coil 16 from separating from the coil supporting member 26 by engaging the flange portion 16a1 with the engaging portion 26a, the engaging portion 26a and the flange portion 16a1 may have other sectional shape than this

shape. For example, it is possible to set the both sectional shapes to a trapezoid or a triangle, or it is possible to set one sectional shape to a fan-shape and to set the other sectional shape to a shape having an arc-shaped recess portion that fits to the fan-shape.

[0100] Further, in the second embodiment and each modification, the coil supporting member 26 includes the member made of synthetic resin. However, in the second embodiment and the first to third modifications, the coil supporting member 26 may be made of other material than the synthetic resin, for example, of aluminum as long as the caulking projections 26b' and 26c' can be subjected to the plastic deformation. Further, in case of using aluminum or the like, the ultrasonic vibration cannot be used. However, each of the caulking projections 26b' and 26C' can be mechanically subjected to the plastic deformation.

[0101] Further, the following constitution may be adopted. The coil supporting member 26 may be formed not as an annular member having the plural caulking projections 26b' are formed but as a small piece having a single caulking projection 26b' is formed. In this case, each of these plural coil supporting members 26 can be caulk-fixed to each of plural through-holes 12 formed at a central flat portion 12b of the diaphragm 12.

[0102] In the second embodiment and each modification, the case where the speaker 100 is a small-sized speaker is described. However, even in case that it is a larger speaker, by adopting the similar constitution to that in the second embodiment and each modification, the similar effects to those in the second embodiment and each modification can be obtained.

Claims

1. A speaker comprising:

a diaphragm;
a magnetic circuit unit defining a cylindrical magnetic gap; and
a voice coil having a first portion bonded to the diaphragm, and a second portion placed in the cylindrical magnetic gap;
wherein a thickness of the first portion of the voice coil is set larger than that of the second portion of the voice coil.

2. A speaker comprising:

a frame having a bottom surface;
a magnet disposed on the bottom surface of the frame;
a yoke disposed on the magnet, a gap being defined between the side surface of the yoke and the frame;
a diaphragm disposed above the yoke; and
a voice coil having a first portion bonded to the diaphragm, and a second portion placed in the gap,
wherein a thickness of the first portion of the voice coil is set larger than that of the second portion of the voice coil.

3. The speaker according to claim 2, wherein the frame has a substantially circular shape and the bottom surface is positioned at the center of the circular shape.

4. The speaker according to any of claims 1 to 3, wherein the first portion of the voice coil has a flange portion protruding inward in the radial direction of the diaphragm, so that the voice coil has a substantially L-shape.

5. The speaker according to any of claims 1 to 3, wherein the first portion of the voice coil has a flange portion protruding outward in the radial direction of the diaphragm.

6. The speaker according to any of claims 1 to 5, wherein the first portion of the voice coil has a tapered side surface.

7. A speaker comprising:

a diaphragm;
a magnetic circuit unit defining a cylindrical magnetic gap;
a voice coil having a first portion fixed to the diaphragm, and a second portion placed in the cylindrical magnetic gap; and
a coil supporting member, fixed to the diaphragm, for supporting the first end portion of the voice coil,
wherein the coil supporting member is caulked to the diaphragm by subjecting a caulking projection formed in the coil supporting member to a plastic deformation.

8. The speaker according to claim 7, wherein a flange portion protruding inward in the radial direction of the diaphragm is formed at the first portion of the voice coil; and

an engaging portion for engaging with the flange portion is formed in the coil supporting member.

9. A speaker comprising:

a frame having a bottom surface;
a magnet disposed on the bottom surface of the frame;
a yoke disposed on the magnet, a gap being defined between the side surface of the yoke and the frame;

a diaphragm disposed above the yoke;
a voice coil having a first portion fixed to the diaphragm, and a second portion placed in the gap,
a coil supporting member, fixed to the diaphragm, for supporting the first end portion of the voice coil,
wherein the coil supporting member is caulked to the diaphragm by subjecting a caulking projection formed in the coil supporting member to a plastic deformation.

10. The speaker according to claim 9, wherein the first end portion of the voice coil has a flange portion protruding in a direction different from a longitudinal direction of the voice coil; and

the coil supporting member has an engaging portion engaged with the flange portion of the voice coil.

11. The speaker according to any of claims 7 to 10, wherein the coil supporting member is made of synthetic resin; and

the plastic deformation is performed by applying ultrasonic vibration to the caulking projection and subjecting the caulking projection to a heat deformation.

12. The speaker according to any one of claims 7 to 10, wherein the coil supporting member is an annular member;

the caulking projection comprises a plurality of caulking projections formed at different positions in the coil supporting member at a predetermined interval in the circumferential direction; and
a plurality of through-holes are defined in the diaphragm, into which the plurality of caulking projections are inserted.

13. A speaker comprising:

a diaphragm;
a magnetic circuit defining cylindrical magnetic gap;
a voice coil having a first portion fixed to the diaphragm and a second portion placed in the cylindrical magnetic gap; and
a coil supporting member, fixed to the diaphragm, for supporting the first portion of the voice coil,
wherein a flange portion protruding inward in the radial direction of the diaphragm is formed at the first portion of the voice coil, and an engaging portion for engaging with the flange portion is formed in the coil supporting member.

14. A speaker comprising:

a frame having a bottom surface;
a magnet disposed on the bottom surface of the frame;
a yoke disposed on the magnet a gap being defined between the side surface of the yoke and the frame;
a diaphragm disposed above the yoke;
a voice coil having a first portion fixed to the diaphragm and a second portion placed in the cylindrical magnetic gap; and
a coil supporting member, fixed to the diaphragm, for supporting the first portion of the voice coil,
wherein the first portion of the voice coil has a flange portion protruding in a direction different from a longitudinal direction of the voice coil, and the coil supporting member has an engaging portion for engaging with the flange portion.

15. The speaker as claimed in claim 13 or claim 14, wherein the coil supporting member is fixed to the diaphragm by bonding.

FIG.1

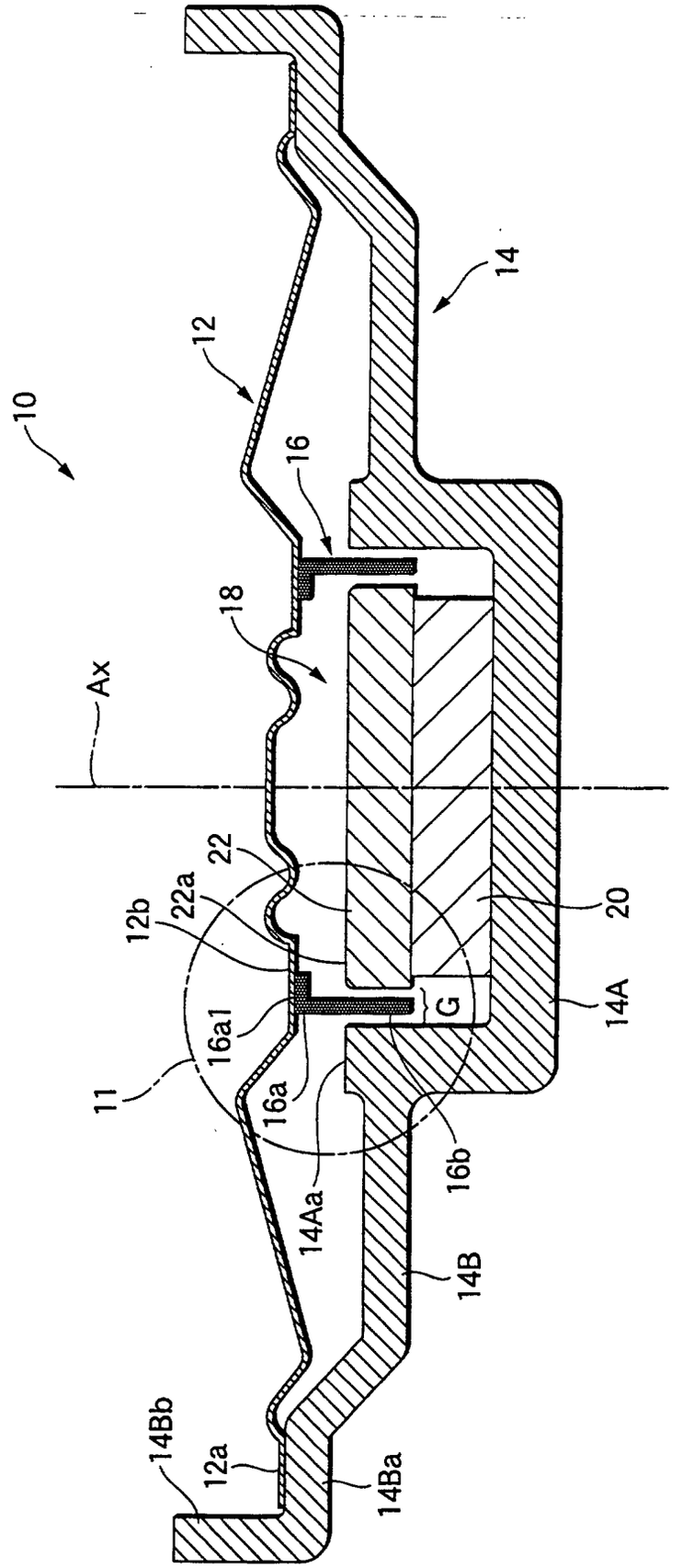

10
12
14
16
18
Ax
22
22a
12b
20
G
14A
16a1
11
16a
16b
14Aa
14B
14Bb
12a
14Ba

FIG.2

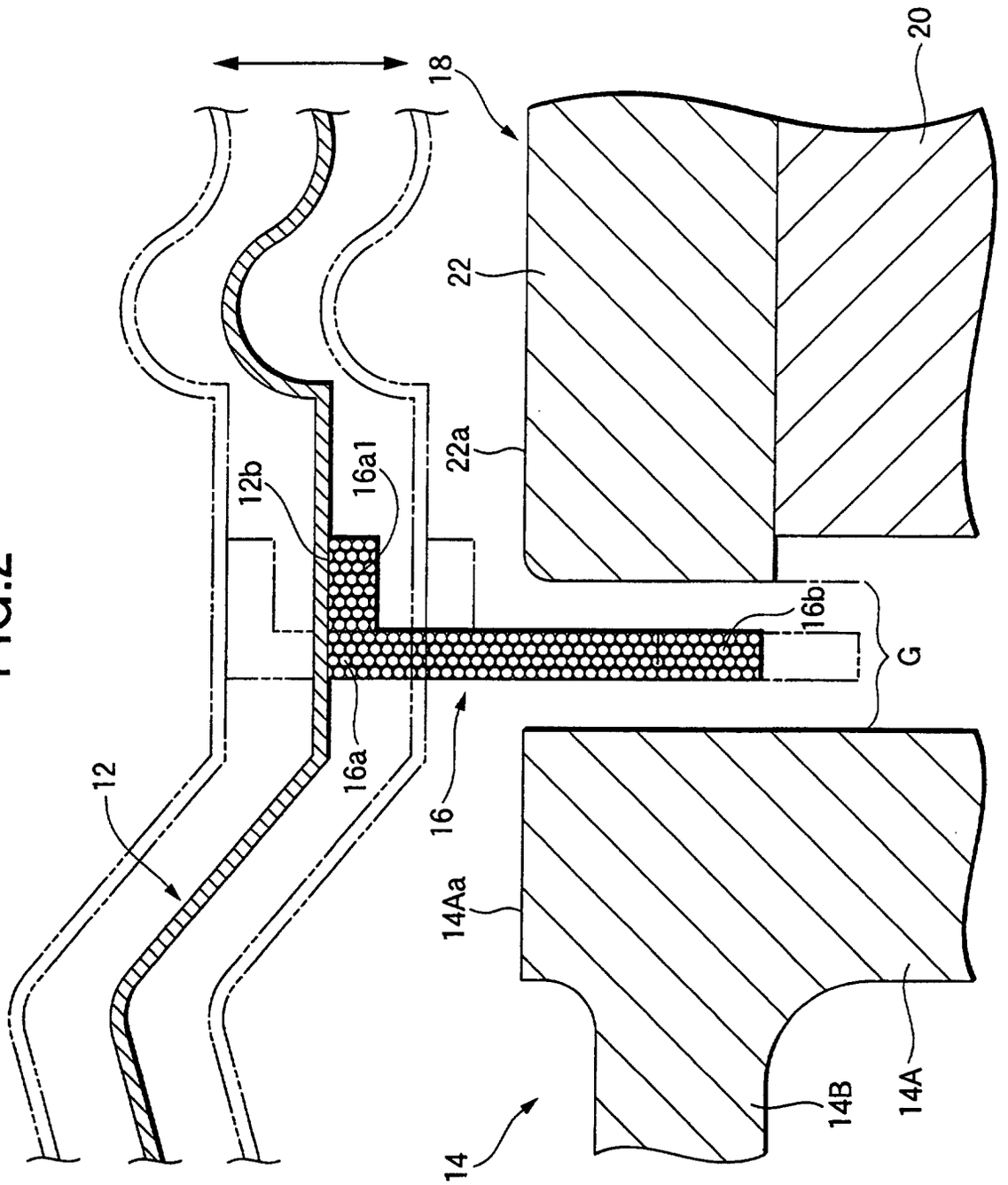


FIG.3

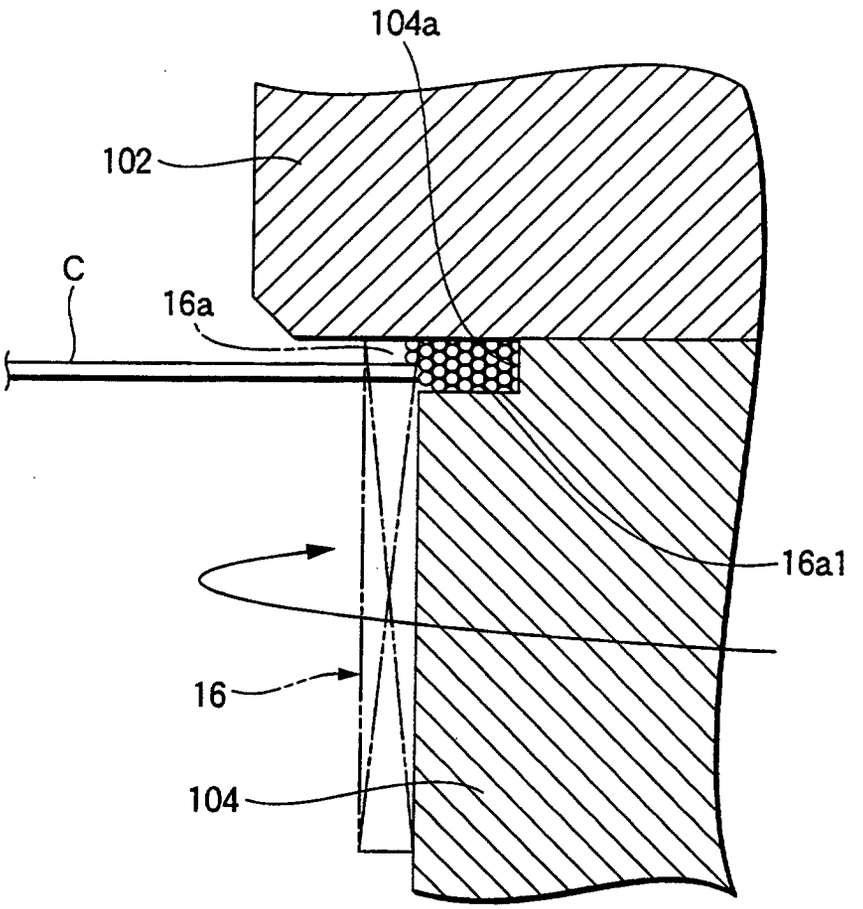


FIG.4B

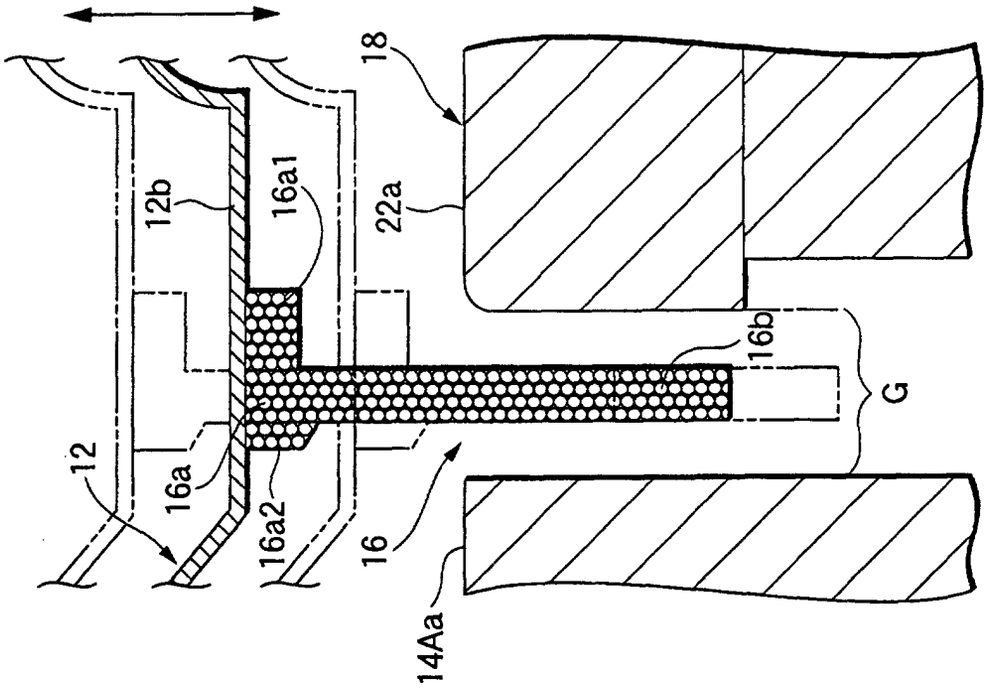

18
12b
16a1
22a
16b
G
12
16a
16a2
16
14Aa

FIG.4A

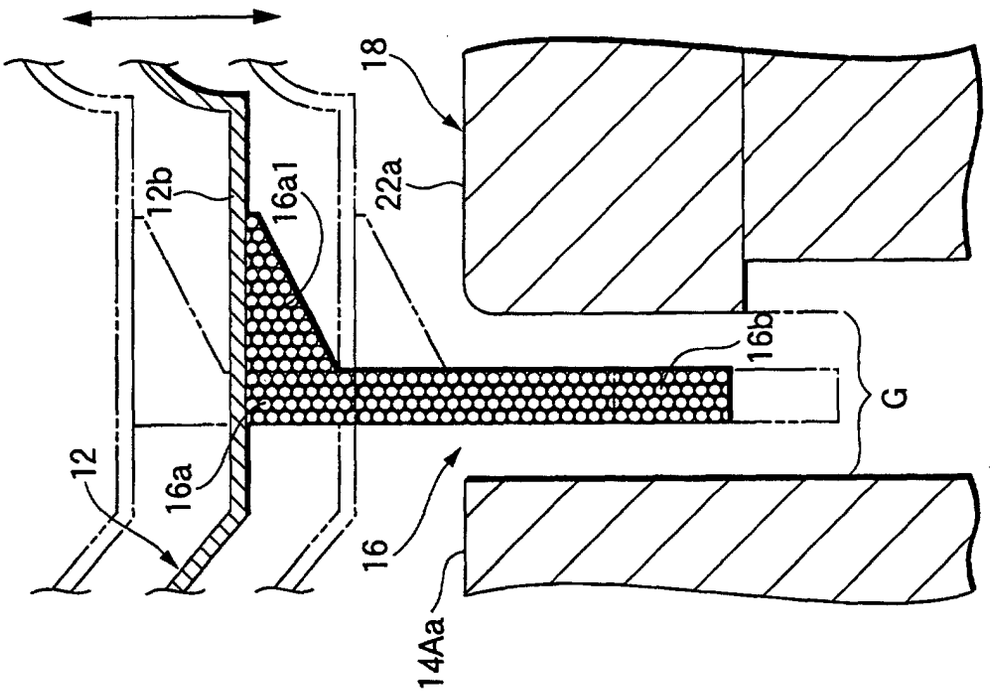
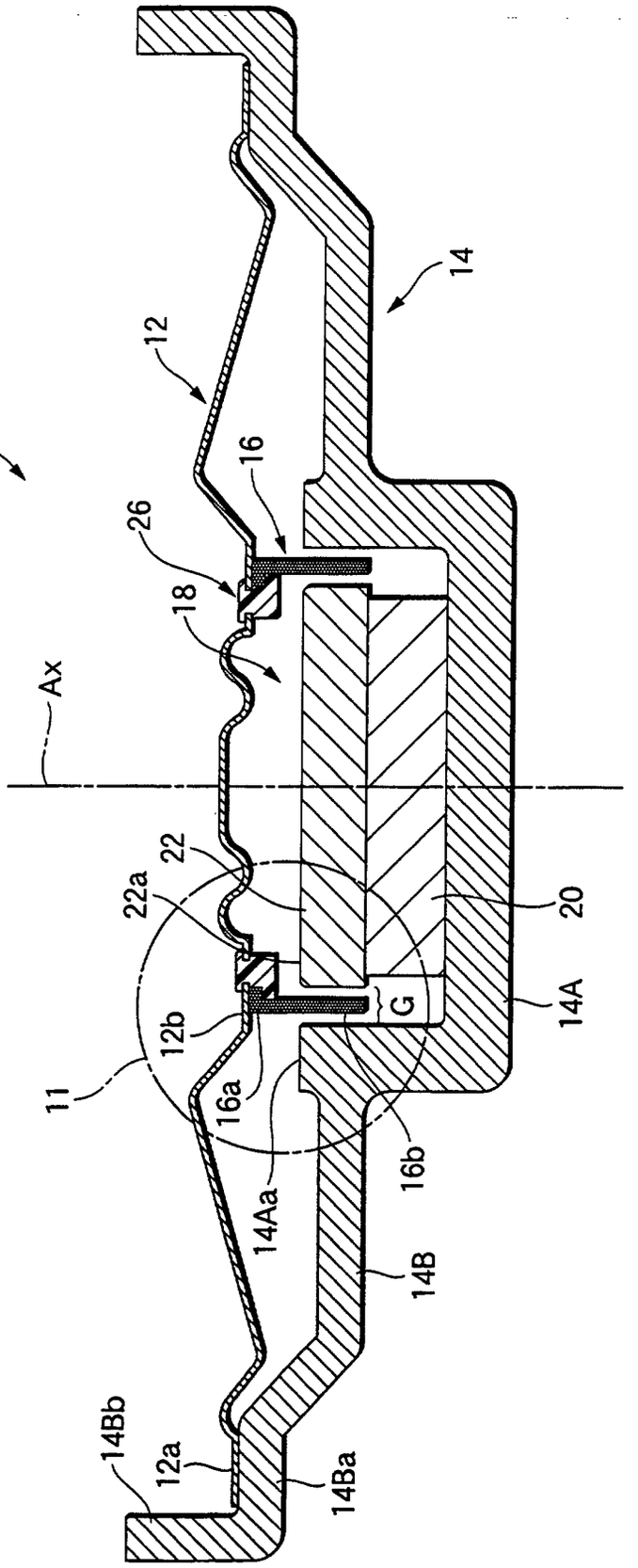

18
12b
16a1
22a
16b
G
12
16a
16
14Aa

FIG.5


100
12
14
16
26
18
Ax
22
22a
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14A
G
12b
11
16a
16b
14Aa
14B
14Bb
12a
14Ba

FIG.6

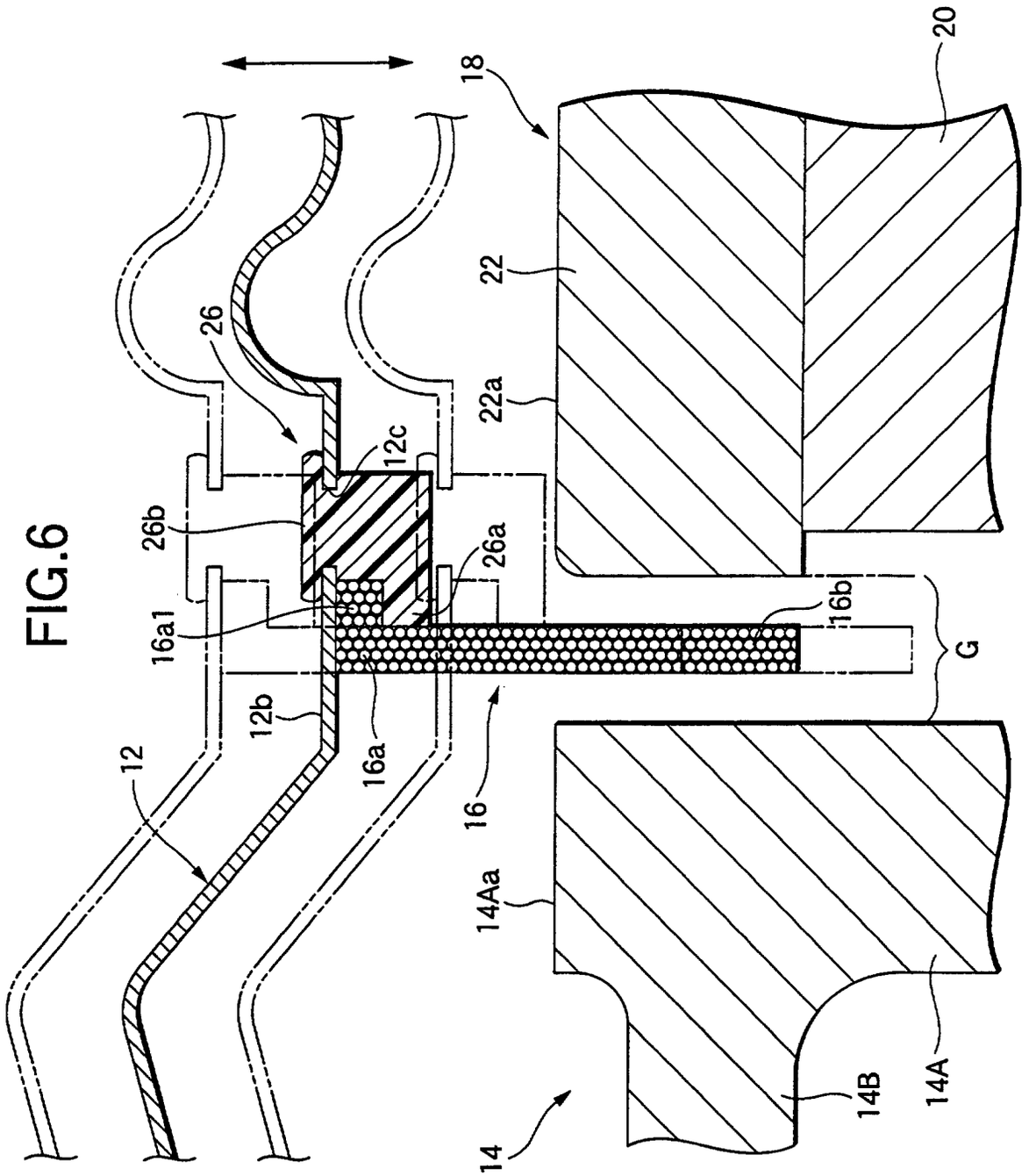
20
18
22
26
22a
12c
26b
26a
16a1
16b
G
12b
16a
12
16
14Aa
14B
14A
14

FIG.7

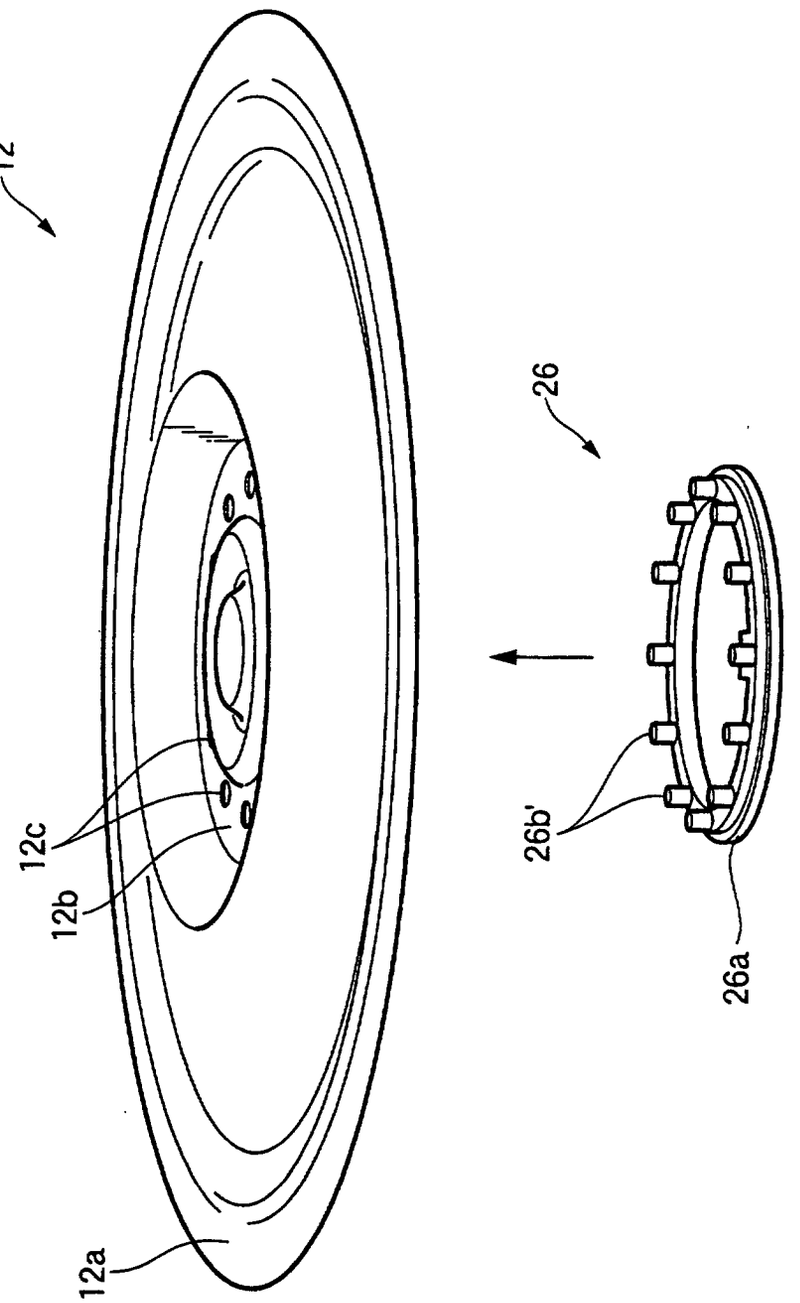

FIG.8B

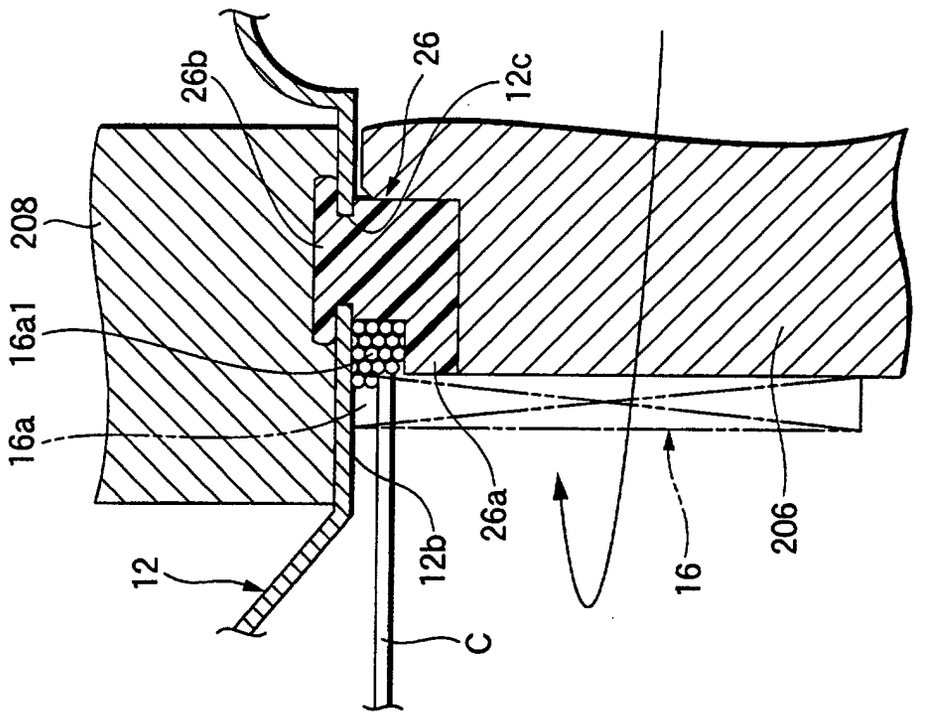
26b
26
12c
208
16a1
16a
12
12b
26a
16
206
C

FIG.8A

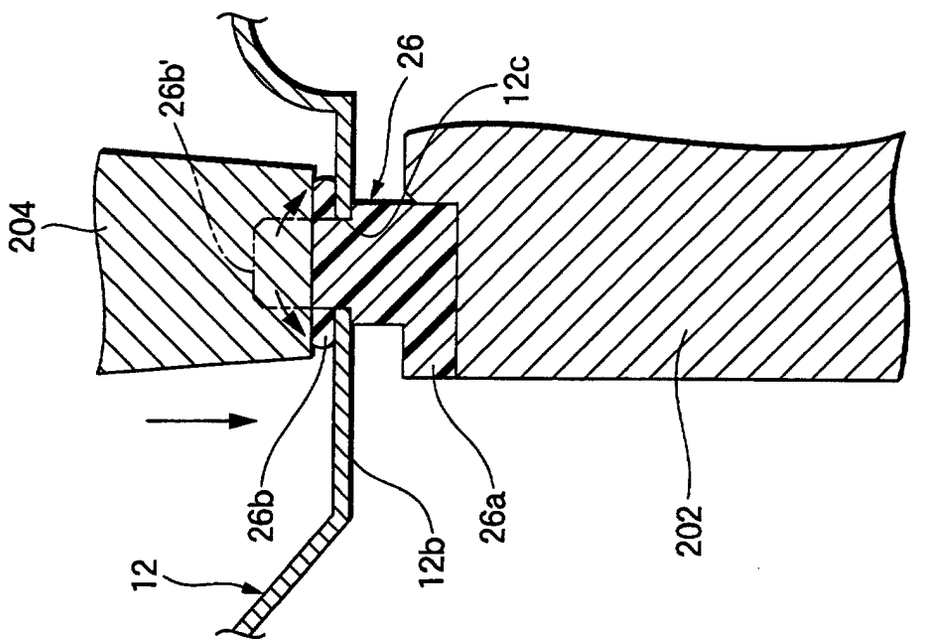
26b'
26
12c
204
26b
12b
26a
202
12

FIG.9B

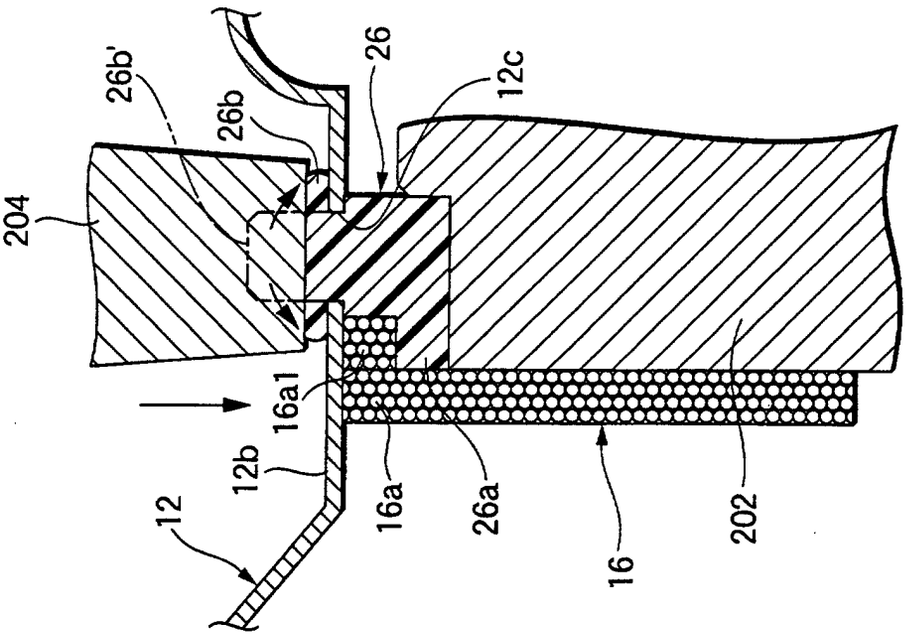
204
26b'
26b
26
12c
16a1
12b
12
16a
26a
16
202

FIG.9A

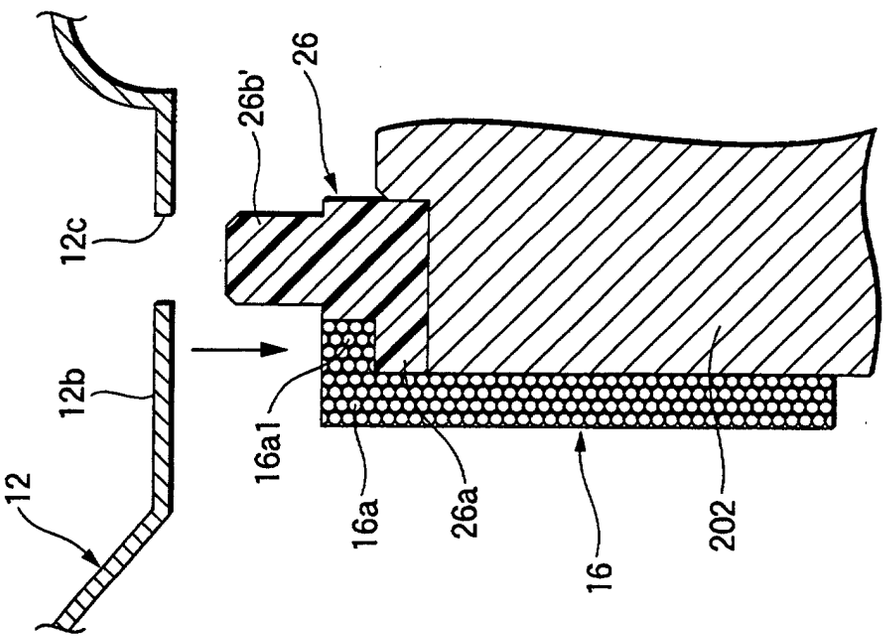
12c
26b'
26
12b
16a1
12
16a
26a
16
202

FIG.10

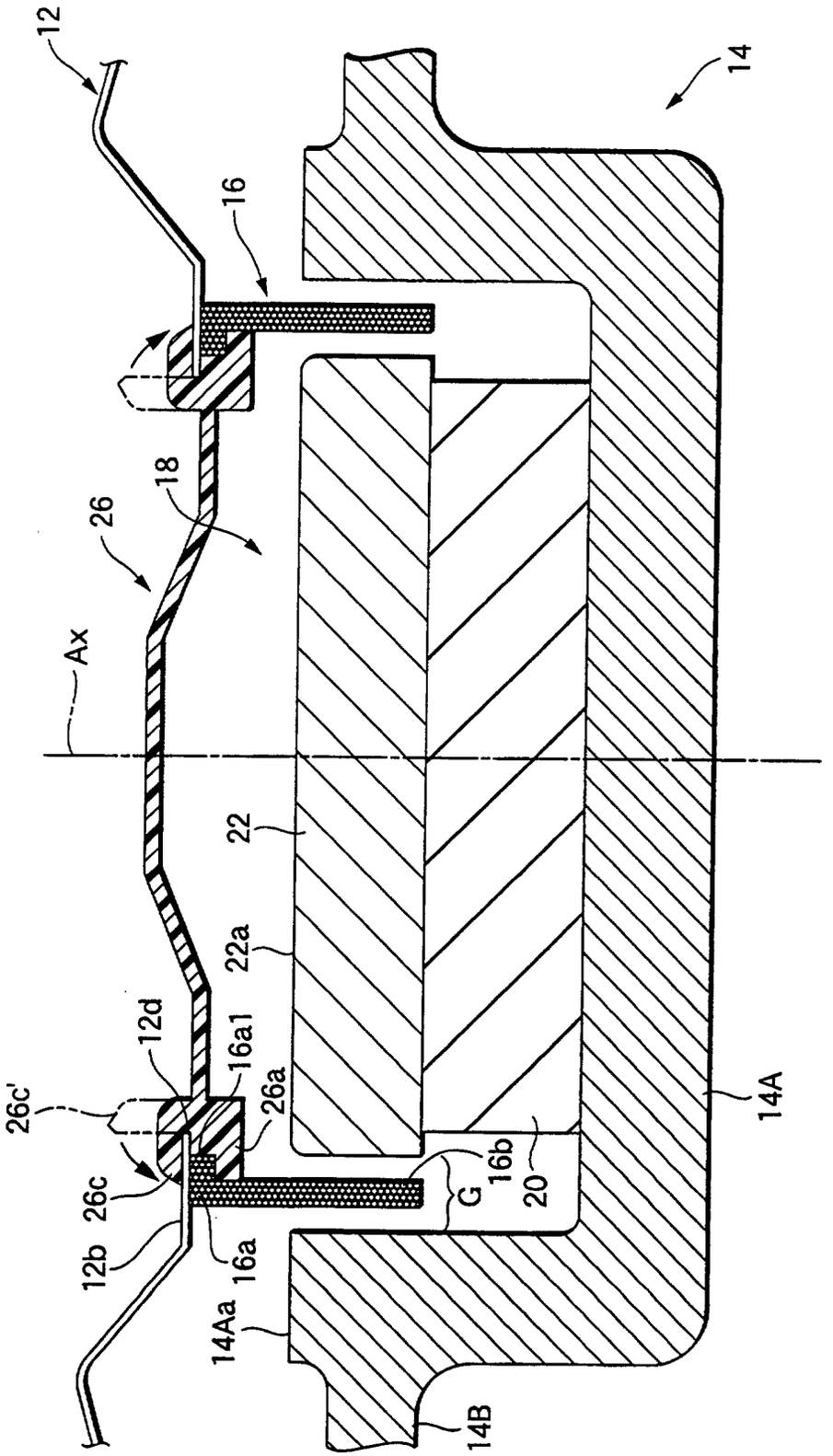
12
14
16
18
26
Ax
22
22a
12d
16a1
26a
26c'
26c
12b
16a
14Aa
G
16b
20
14A
14B

FIG.11

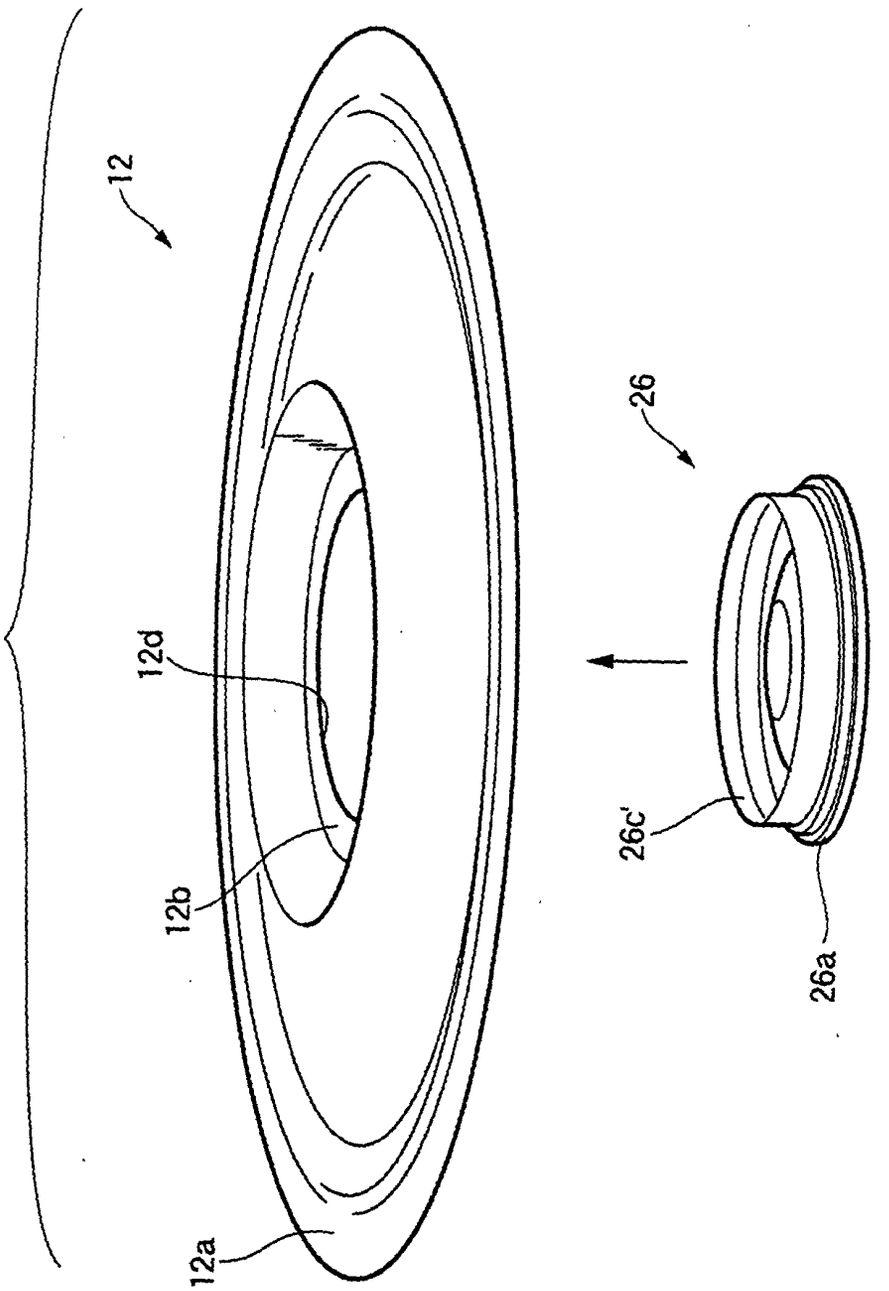

FIG.12

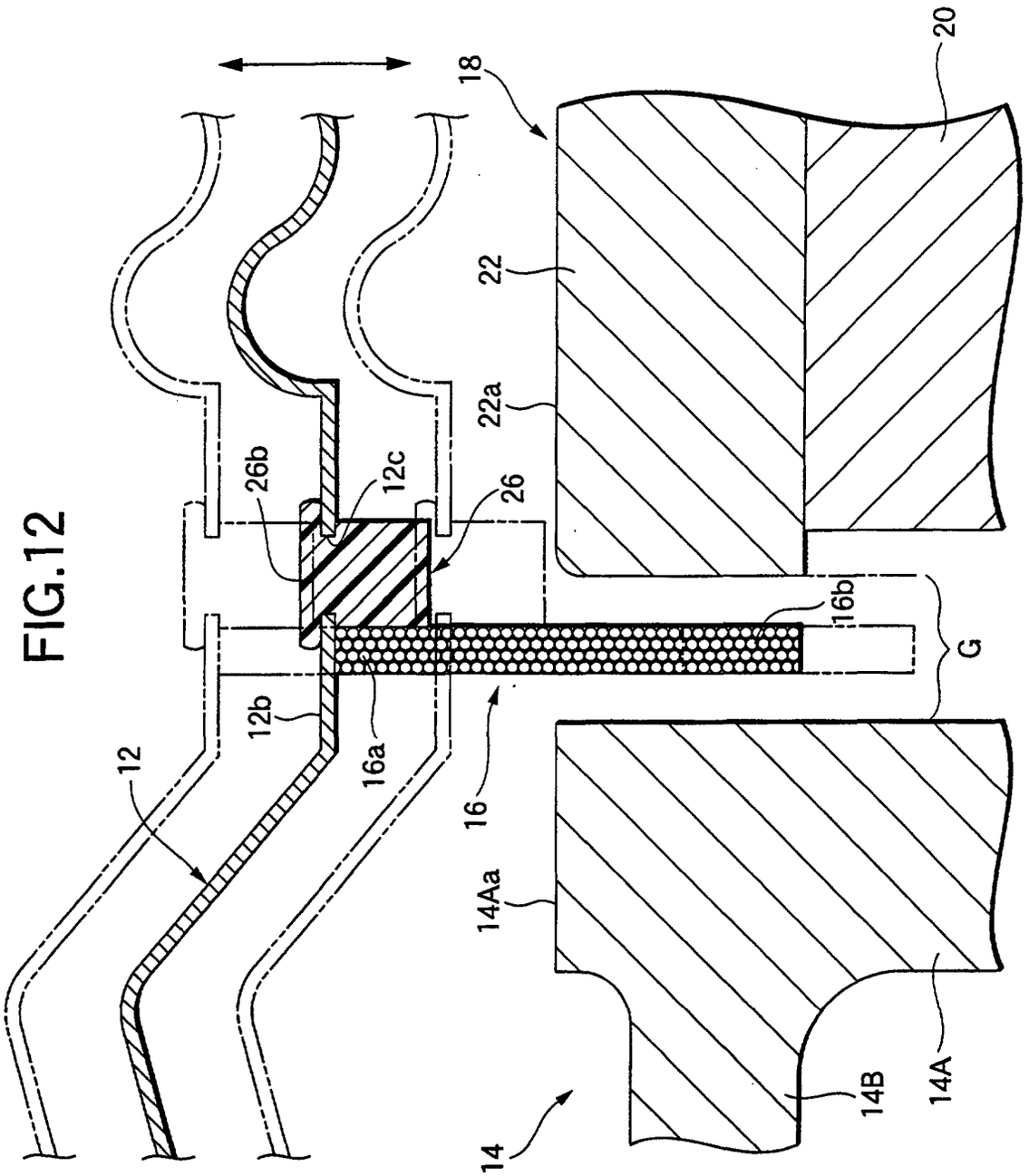

FIG.13B

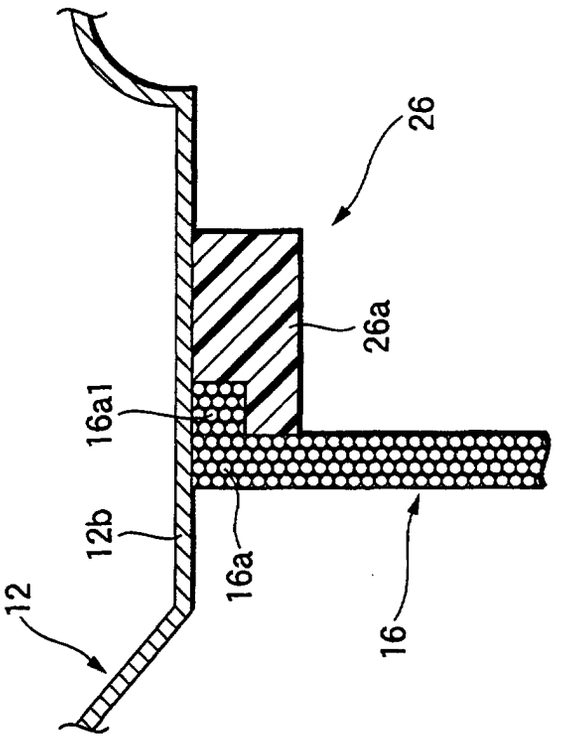

FIG.13A

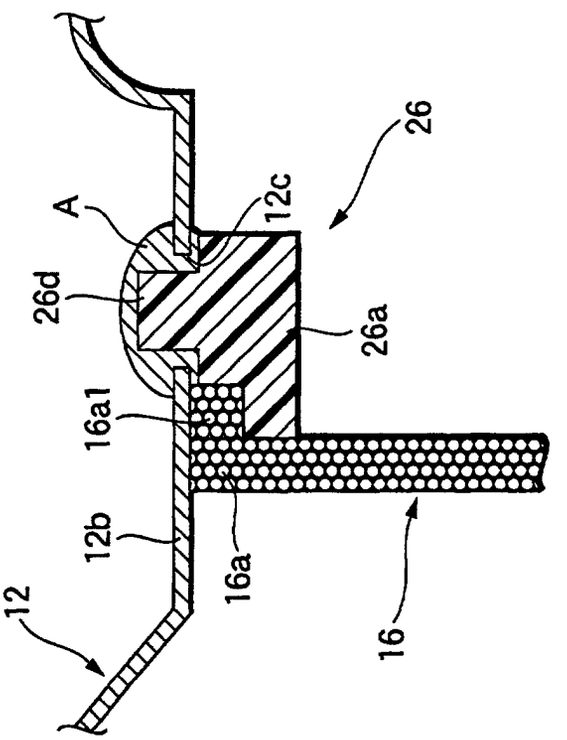

FIG.14B

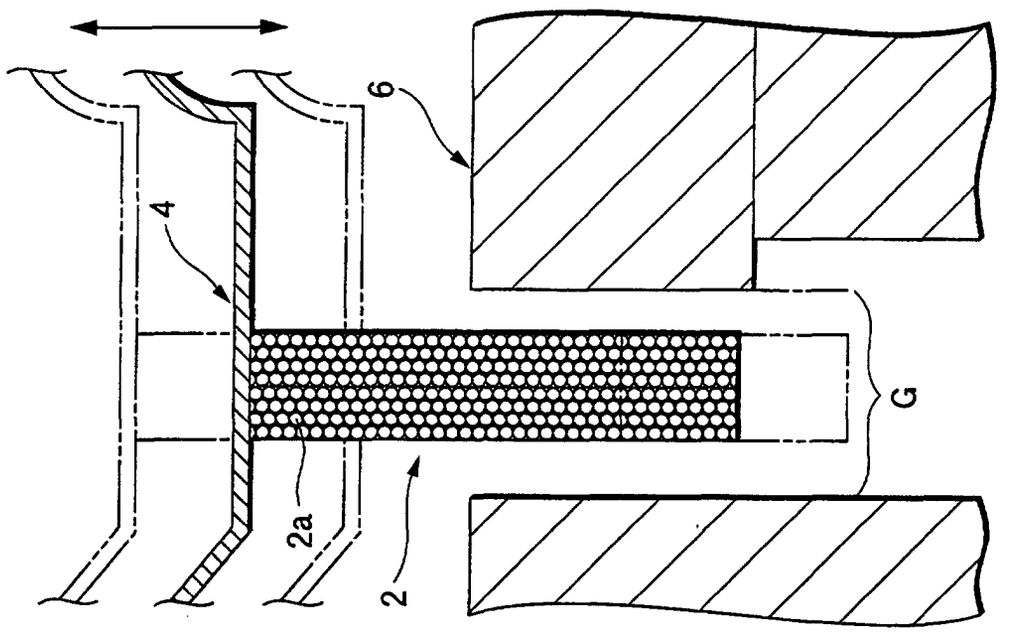

FIG.14A