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(54) Headphone and sound emitting device

(57) A headphone includes a sound emitting device, a signal supply portion, and either one of an ear hook portion and a headband portion. The sound emitting device includes a body portion and first and second driver units. The body portion has a first air chamber, a second air chamber communicating with the first air chamber, and a duct opened in the second air chamber and opened to an external space. The first driver unit is disposed on the body portion so that an output sound is directly emitted to the external space. The second driver unit is disposed on the body portion so that the output sound is emitted into the first air chamber. The signal supply portion supplies an audio signal to the first and second driver units. The ear hook portion or the headband portion is connected to the sound emitting device.

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Description

BACKGROUND

[0001] The present invention relates to a headphone and a sound emitting device.

[0002] A sound emitting device including a driver unit (having the same meaning as a speaker unit) and emitting sound to the outside is applied to acoustic devices such as a desktop speaker or a body portion of a headphone.

[0003] The headphones are roughly classified by a use mode into an inner ear type in which the body portion which is a sound emitting device is to be attached to the inner side of an auricle, an ear hook type in which an ear hook portion is hooked by the auricle so that the body portion is brought into contact with the auricle, an overhead type to be attached by placing a headband on the head so that the body portion is brought into contact with the auricle or covers the auricle and the like. Any type is used by supporting the body portion including the driver unit by the auricle or the head. Thus, it is actually difficult to mount a large-sized driver unit which might impair a wearing feeling in terms of a size or a mass.

[0004] As described above, headphones have many difficulties in a design for improving a quality of a reproduced sound in a wide sound range from a low range to a high range by using only one drive unit for a full range, for example, while the size of the driver unit or in other words, the size of a diameter of a diaphragm is limited. Particularly, since an increase of a diameter of the diaphragm is difficult, improvement of a sound quality including a sound volume in a low range is in demand all the time.

[0005] Thus, there has been examined a technology for applying, to a headphone, a configuration called a so-called multi-speaker widely used in a large-sized speaker system to be placed on the floor or the like, in which a reproduced range is divided into a plurality of ranges such as a low range, a high range and the like, and a suitable driver unit is applied to each range for performing reproduction.

[0006] As an example of such technology, in Patent Literature 1 (Japanese Utility Model Registration No. 3167130), there is described an overhead type headphone including three driver units for a low range, a medium range, and a high range and a cover having a spherical portion, in which each driver unit is arranged on the spherical portion of the cover so that the respective distances from an inlet of the external auditory canal are the same.

[0007] Moreover, a technology for applying, to a headphone, a bass-reflex structure which is considered to improve reproducing capability of a low range is also examined, and an inner ear type headphone as an example thereof is described in Patent Literature 2 (Japanese Patent Application Laid-Open Publication No. 2006-287674).

[0008] Each of the aforementioned conventional examples is expected to exert some degree of effects but a higher quality of a reproduced sound is in demand from the market.

SUMMARY

[0009] An object to be solved by the present invention is to provide a headphone and a sound emitting device by which a high quality reproduced sound can be obtained.

[0010] According to a first aspect of the present invention, there is provided a headphone comprising: a sound emitting device; the sound emitting device including: a body portion having a first air chamber, a second air chamber communicating with the first air chamber through a sound passing hole, and a duct having one end side opened in the second air chamber and the other end side opened to an external space; a first driver unit disposed on the body portion so that an output sound is directly emitted to the external space; and a second driver unit disposed on the body portion so that the output sound is emitted to the first air chamber; a signal supply portion for supplying an audio signal to the first and second driver units; and either one of an ear hook portion connected to the sound emitting device and to be attached to an auricle so that the sound emitting device itself is attached inside the auricle and a headband portion connected to the sound emitting device and to be attached to the head.

[0011] According to a second aspect of the present invention, there is provided a sound emitting device comprising: a body portion having a first air chamber, a second air chamber communicating with the first air chamber through a sound passing hole, and a duct having one end side opened in the second air chamber and the other end side opened to an external space; a first driver unit disposed on the body portion so that an output sound is directly emitted to the external space; and a second driver unit disposed on the body portion so that the output sound is emitted to the first air chamber.

[0012] According to the present invention, an advantage that a high quality reproduced sound can be obtained is exerted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

FIG. 1 is a perspective view for explaining an example of a headphone according to an embodiment of the present invention.

FIG. 2 is a sectional view for explaining a body portion structure K1 which is a structure of a sound emitting device HS as an example of a sound emitting device according to the embodiment of the present invention.

FIG. 3 is another sectional view for explaining the body portion structure K1.

FIG. 4 is an exploded perspective view for explaining the body portion structure K1.
FIG. 5 is another exploded perspective view for explaining the body portion structure K1.
FIGS. 6(a) to 6(c) are trihedral views for explaining a driver base 16 used in the body portion structure K1.
FIG. 7 is a perspective view for explaining the driver base 16 used in the body portion structure K1.
FIG. 8 is a plan view for explaining a duct joint 21 used in the body portion structure K1.
FIG. 9 is a plan view for explaining the body portion structure K1.
FIG. 10 is a perspective view for explaining the body portion structure K1.
FIG. 11 is a schematic sectional view for explaining the body portion structure K1.
FIG. 12 is a schematic sectional view for explaining a body portion structure K2 which is a structure of a modified example 1 of the sound emitting device HS.
FIG. 13 is a schematic sectional view for explaining a body portion structure K3 which is a structure of a modified example 2 of the sound emitting device HS.
FIG. 14 is a schematic sectional view for explaining a body portion structure K4 which is a structure of a modified example 3 of the sound emitting device HS.
FIG. 15 is a plan view for explaining the body portion structure K4.
FIG. 16 is a schematic plan view for explaining the body portion structure K1.
FIGS. 17(a) to 17(c) are perspective views for explaining an application example of the sound emitting device HS.

DETAILED DESCRIPTION

[0014] A sound emitting device and a headphone according to an embodiment of the present invention will be described by a preferred example with reference to FIGS. 1 to 17(c).

(Example)

[0015] A body portion structure K1 which is a structure of a sound emitting device HS of an example is applied to body portions 1 and 2 each of which is the sound emitting device HS provided in a headphone 51, for example. First, this headphone 51 will be described by referring to FIG. 1. FIG. 1 is a perspective view illustrating an appearance of the headphone 51. The headphone 51 is of an overhead type and has the body portion 1 for the left ear, the body portion 2 for the right ear, and a headband 3 connecting the body portion 1 and the body portion 2 to each other and extended over the head in use. A cord 4 to be connected to an external audio output device is pulled out of the body portion 1. Since the body portion 1 and the body portion 2 basically have the same structure, the body portion 1 will be described as a representative of the body portion in the following explanation. Moreover, each of upper, lower, left, right, front, and rear directions of the body portion 1 in the following explanation is specified by a direction indicated by an arrow in FIG. 1, not in a worn state but on the basis of a sound output direction, with the sound output direction as the front.

[0016] Subsequently, a structure of the body portion 1 (body portion structure K1) will be described in detail by referring to FIGS. 1 to 5. FIG. 2 is a view of the body portion 1 cut at a horizontal (left-and-right, front-and-rear) plane at an S1-S1 position in FIG. 1 and seen from below, and FIG. 3 is a view with an upper half cut on a perpendicular (upper-and-lower, front-and-rear) plane at an S2-S2 position in FIG. 1 and with a lower half cut on a plane inclined by an angle of $\theta 1$ from a perpendicular plane (see FIG. 9). FIG. 4 is a perspective exploded view of the body portion 1 (excluding a body case 11 and an ornament 12). FIG. 5 is a perspective exploded view illustrating the body portion 1 exploded into three major parts.

[0017] The body portion 1 has the cup-shaped body case 11 which is opened at a front side thereof and has a diameter reduced in a substantially stepped state at a rear side thereof, the ring-shaped ornament 12 attached so as to be externally fitted with a rear portion in the body case 11, a baffle plate 13 attached so as to close an opening on the front side of the body case 11, and an ear pad 14 detachably attached to a flange portion 13a of the baffle plate 13. The body case 11 has a ring-shaped opening side wall portion 11a which becomes an opening side, a ring-shaped intermediate wall portion 11b connected to the opening side wall portion 11a and having a small diameter, and a bottom wall portion 11c closing the side opposite to the opening side. The body portion 1 has a connection portion 1J by which one end portion side of the headband 3 is connected to a portion on an upper side in the body case 11. In this connection, the body portion 1 is capable of swing in a right-and-left direction and an upper-lower direction within a predetermined rotational moving range with respect to the headband 3.

[0018] On a rear surface 13b of the baffle plate 13, a ring-shaped peripheral wall portion 13c is installed upright rearward. Inside the peripheral wall portion 13c, a driver unit DU1 is fixed by bonding or the like as a speaker having a diaphragm DU1a. In this example, the driver unit DU1 has a flat disk shape, and the peripheral wall portion 13c is also formed annularly. In the baffle plate 13, in a range substantially facing the diaphragm DU1a, a sound emitting portion 13d in which a plurality of small sound emitting holes is collectively formed is provided in order to emit a sound generated by vibration of the diaphragm DU1a to the outside.

[0019] Moreover, in a region outside the peripheral wall portion 13c in the baffle plate 13, a duct sound emitting portion 13e composed of a pair of through holes 13e1 and 13e2 is formed. To this pair of through holes 13e1

and 13e2, duct joints 21 of duct bodies 19 and 20 which will be described later are connected, respectively. On the rear surface 13b of the baffle plate 13, a substantially cup-shaped cover 15 is attached sandwiching a seal ring 17 so as to surround and cover the peripheral wall portion 13c. The seal ring 17 is formed of a material which has elasticity and is substantially impermeable. An example of the material is urethane foam. The cover 15 is attached so that its end portion is pressed onto the seal ring 17 and a gap between the baffle plate 13 and the cover 15 is sealed. As a result, a space V1 surrounded by an inner surface of the cover 15, the rear surface 13b of the baffle plate 13, and a back surface of the driver unit DU1 is in a sealed state. A chamber forming this space V1 is referred to as an air chamber VA1.

[0020] On the rear surface 13b of the baffle plate 13, a substantially cylindrical driver base 16 is mounted sandwiching the seal ring 17 so as to surround and cover the cover 15.

[0021] Here, the driver base 16 will be described by mainly referring to FIGS. 6(a) to 6(c) and 7. FIG. 6(a) to 6(c) are trihedral views of the driver base 16, in which FIG. 6(a) is a rear view, FIG. 6(b) is a left side view, and FIG. 6 (c) is a top view. Moreover, FIG. 7 is a perspective view and a view when seen from a diagonally rear upper right direction in a state assembled as the body portion 1.

[0022] The driver base 16 is formed having a substantially annular shape in this example. The driver base 16 has an annular base portion 16a and a flange portion 16b formed on a rear side in the base portion 16a and extending outward in a radial direction. On the base portion 16a, an opening portion 16c communicating with inside and outside is formed. In this example, three opening portions 16c1 to 16c3 are formed as the opening portions 16c. Specifically, the opening portion 16c1 is provided on an upper side, and the opening portion 16c2 and the opening portion 16c3 are provided at positions shifted by 90° in a circumferential direction with respect to the opening portion 16c1. Moreover, in this example, the three opening portions 16c are provided as round holes each having a diameter Da equal to each other. On a lower front side in the base portion 16a, a recess portion 16d is formed so as to be dented in an arc shape inward in a predetermined angular range. In the dented space of this recess portion 16d, a duct joint 21 is accommodated.

[0023] Returning to FIGS. 2 to 5, on the outside of the driver base 16, an annular cylinder 18 is fitted in. Specifically, the cylinder 18 is firmly fixed to the driver base 16 by an adhesive or the like so that no gap is generated as much as possible. In the cylinder 18, opening portions 18c1 to 18c3 each having the same shape as that of each of the opening portions 16c1 to 16c3 are formed, respectively, at positions corresponding to the opening portions 16c1 to 16c3 of the driver base 16. Hereinafter, unless particularly noted otherwise, the opening portions 16c1 to 16c3 mean portions opened including the opening portions 18c1 to 18c3, respectively, for convenience.

[0024] In the body portion 1 on an inner peripheral surface of a portion where the flange portion 16b of the driver base 16 is formed, a driver unit DU2 is fixed by adhesion or the like as a speaker having a diaphragm DU2a. The driver base 16 is mounted with its front end portion pressed onto the seal ring 17 so as to seal the gap between the baffle plate 13 and the driver base 16. Since the driver unit DU2 is fixed to the driver base 16, a space V2 surrounded by the driver unit DU2, the driver base 16, the cover 15, and the baffle plate 13 is sealed except the opening portion 16c. A chamber forming this space V2 is referred to as an air chamber VA2. Moreover, a rear end portion of the driver base 16 is firmly fixed to an inner surface of the intermediate wall portion 11b of the body case 11 by an adhesive or the like. As a result, the space V4 surrounded by a rear surface side portion of the driver unit DU2 and the inner surface of the body case 11 is sealed. A chamber forming the space V4 is referred to as an air chamber VA4.

[0025] Regarding the body case 11 and the baffle plate 13, a tip end portion of the opening side wall portion 11a of the body case 11 is fixed to the baffle plate 13 by adhesion or the like.

[0026] The body case 11, the baffle plate 13, the cover 15, and the driver base 16 are formed of a thermoplastic resin material, for example. An example of the resin material is an ABS resin (acrylonitrile butadiene styrene resin). The material is not limited to a resin but may be metal or the like, for example. The ornament 12 is preferably formed of a metal material from a view point of design. An example of the material is aluminum. The cylinder 18 is preferably formed of a material having a specific gravity larger than that of the driver base 16, for example. It is brass, stainless or the like, for example.

[0027] In the body portion structure K1 of the example, the driver unit DU2 has a flat disk shape, and that with a diameter of a movable portion including the diaphragm DU2a larger than a diameter of a movable portion including the diaphragm DU1a of the driver unit DU1 is employed. Moreover, as illustrated in FIG. 2, the driver unit DU2 has its size and an arrangement position set so that it does not protrude outward in a radial direction (upper-and-lower direction, and right-and-left direction) from an outer shape of the ear pad 14. In this example, the outer shape of the ear pad 14 on a rear view is substantially circular, and as illustrated in FIG. 2, a relationship between an outer diameter Dc of the ear pad 14 and an outer diameter Db of the driver unit DU2 is assumed to be Db < Dc. Moreover, in design, a shape line at the outermost position of an outer side surface 11a1 of the opening side wall portion 11a of the body case 11 is set so as to be substantially equal to a shape line of the outer side surface of the ear pad 14. The ear pad 14 has, in a state in which the headphone 51 is worn, a doughnut shaped earmuff portion 14a surrounding the auricle of a user and brought into contact with the head, and a concealing portion 14b made of a thin mesh covering a front surface 13f of the baffle plate 13 immediately in front thereof. The concealing portion 14b does not affect a

sound volume and a sound quality of an emitted sound and is not shown in figures other than FIG. 1.

[0028] As a result, between the driver base 16 and the body case 11, a space V3 in a doughnut shape or an arc shape as a part of a doughnut shape can be formed. In the example, the space V3 of substantially one round, that is, the space V3 having a substantially doughnut shape is formed. Specifically, the space V3 is formed surrounded by an inner surface 11d of the body case 11, an outer peripheral surface 16e of the driver base 16, an outer peripheral surface 18a of the cylinder 18 if the cylinder 18 is provided, and the rear surface 13b of the baffle plate 13. A chamber forming this space V3 is referred to as an air chamber VA3.

[0029] The space V3 in the air chamber VA3 and the space V2 in the air chamber VA2 communicate with each other only through the opening portion 16c. On the other hand, the space V3 in the air chamber VA3 and an external space V5 communicate with each other by a duct portion DT. In the body portion structure K1 in the example, the duct portion DT is formed of a pair of arc-pipe shaped duct bodies 19 and 20 each formed in an arc shape. In the body portion structure K1, the duct body 19 and the duct body 20 are formed and arranged with the shape and layout of planar symmetry. Volumes of the space V2 and the space V3 are not limited. For example, the shapes of the air chamber VA2 and the air chamber VA3 are determined so that the volume of the space V3 is larger than the volume of the space V2.

[0030] Here, the duct bodies 19 and 20 will be described in detail by mainly referring to FIG. 4. The duct body 19 has a base portion 19a which is an arc-shaped tube having a through hole 19a1 (see FIG. 9) and a duct joint 21 mounted on one end side of the base portion 19a and converting a direction of a flow of air flowing through the through hole 19a1 by 90°. The duct body 20 similarly has a base portion 20a and a duct joint 21. On one end sides of the base portions 19a and 20a, linear portions 19a2 and 20a2 which are bent to a side of a center of curvature of the base portions 19a and 20a and become linear are formed, respectively. The duct joints 21 are mounted on tip ends of the linear portions 19a2 and 20a2, respectively. This mounting is made by fitting through firm fitting, fixing by an adhesive or the like.

[0031] Each of the base portions 19a and 20a is formed so that an outer shape of a cross sectional plane presents a circular shape, for example. The material is not limited, and a resin, rubber, metal or the like can be used for forming them. A specific example is silicone rubber. The duct joint 21 is formed by injection molding of a thermoplastic resin. An example of the resin material is PP (polypropylene).

[0032] The duct joint 21 is, as illustrated in FIG. 8, made of a substantially cylindrical main body 21a and is formed having a joint portion 21c protruding from a side surface of the main body 21a, a through hole 21b which is an air passage bent by approximately 90° in the main body 21a, and a stepped portion 21e protruding from one end surface of the main body 21a. The one end side of the through hole 21b is opened to a tip end surface of the joint portion 21c. Moreover, the other end side is opened as an outlet 21d in a tip end surface of the stepped portion 21e. The duct body 19 is formed by fitting the joint portion 21c in the through hole 19a1 of the linear portion 19a2 in the base portion 19a. As a result, the through hole 19a1 communicates with the through hole 21b which is an air passage of the main body 21a, and the air passage becomes a passage leading to the outlet 21d with its direction deflected by 90°. The duct body 20 has also the similar structure.

[0033] The duct bodies 19 and 20 which constitute the duct portion DT are arranged in the space V3. This arrangement will be described by referring also to FIGS. 9 and 10. FIG. 9 is a rear view illustrating a part of the headband 3 and the body portion 1 and illustrates a state in which the body case 11, the ornament 12, the driver unit DU2, and the driver base 16 are removed. FIG. 10 is a perspective view illustrating only the headband 3 and the body portion 1, excluding the body portion 2 from the headphone 51. The body portion 1 is illustrated in a state in which the ear pad 14 and the baffle plate 13 are removed.

[0034] The duct bodies 19 and 20 are arranged so as to follow an outer peripheral wall of the driver base 16 (if the cylinder 18 is provided, so as to follow the outer peripheral surface 18a of the cylinder 18). The duct bodies 19 and 20 may be or do not have to be in contact with the outer peripheral surface 16e of the driver base 16 (if the cylinder 18 is provided, the outer peripheral surface 18a of the cylinder 18). In more detail, the duct bodies 19 and 20 are arranged plane-symmetrically with respect to a upper-and-lower and front-and-rear plane passing through a center axis CL16 of the driver base 16, for example. In this arrangement, the duct bodies 19 and 20 are accommodated and held between the baffle plate 13 and a rib 11e protruding from the body case 11. In the body portion structure K1, the center axis CL16 is set so as to accord with a driving axis CLDU2 of the driver unit DU2. This accordance is not limiting but the center axis 16 and a driving axis CLDU1 and the driving axis CLDU2 of the driver unit DU1 may cross each other. However, if all accord with each other or are in parallel with each other, the outer shape of the body portion 1 can be set in a more compact manner.

[0035] As can be seen also from FIGS. 9 and 10, the duct bodies 19 and 20 are arranged in the space V3, and inlets 19a3 and 20a3 which are one end side openings of the through holes 19a1 and 20a1 are opened into this space V3. Moreover, the stepped portion 21e of the duct joint 21 on the other end side is engaged with and connected to the duct sound emitting portion 13e of the baffle plate 13 (see FIG. 3). That is, the space V3 communicates with the external space V5 (see FIG. 3) only through the through hole 19a1 and the through hole 21b in the duct body 19 and the through hole 20a1 and the through hole 21b of the duct body 20. Therefore, a sound output-

ted from a front side of the driver unit DU2 sequentially passes through the space V2, the opening portion 16c, and the space V3 and then, is outputted into the external space V5 through either of two paths, that is, the duct body 19 and the duct body 20.

[0036] In the body portion 1 in the body portion structure K1, the inlets 19a3 and 20a3 of the duct bodies 19 and 20 are, as illustrated in FIG. 9, set at positions inclined by angles θ3 and θ4, respectively, with respect to the upper-and-lower direction. Moreover, the angles θ3 and θ4 are set equal. Similarly, each of the outlets 21d of the duct bodies 19 and 20 is, as obvious from FIGS. 9, 10 and the like, arranged at positions inclined by angles θ1 and θ2, respectively, with respect to the upper-and-lower direction. Moreover, the angles θ1 and θ2 are set equal.

[0037] The driver unit DU1 and the driver unit DU2 are wired so that an audio signal coming from a cord 4 is supplied in the same phase and in parallel. That is, the cord 4 functions as a signal supply portion for supplying the audio signal to the driver units DU1 and DU2.

[0038] FIGS. 9 and 10 illustrate a substrate 22 in an arc strip shape not illustrated in the other figures. The substrate 22 does not necessarily have to be provided in the headphone 51 but is used when a wireless reception circuit if the headphone 51 handles wireless communication, a circuit if noise-canceling is handled, a circuit if a speaker network circuit is needed, or the like is mounted. The substrate 22 is fixed to the rear surface 13b of the baffle plate 13. If wireless communication is handled, the wireless reception circuit functions as a signal supply portion for supplying an audio signal to the driver units DU1 and DU2.

[0039] The body portion structure K1 described above in detail is schematically illustrated as a longitudinal sectional view in FIG. 11. The body portion structure K1 has the two driver units DU1 and DU2.

[0040] The driver unit DU1 is attached in an attitude in which the diaphragm DU1a faces the front side, and a driving system driving the diaphragm DU1a is arranged on the rear side thereof. In a sound generated by vibration of the diaphragm DU1a, only a sound S11 emitted to one side (front side) is emitted into the external space V5. This emission of the sound S11 into the external space V5 is directly made not through the air chamber. That is, the sound S11 is emitted as a direct sound into the external space V5. A sound S12 emitted to the other side (rear side) is emitted into the space V1. Since the air chamber VA1 forming the space V1 is sealed, the sound S12 is not emitted into the external space V5.

[0041] The driver unit DU2 is attached in an attitude in which the diaphragm DU2a faces the front side, and a driving system driving the diaphragm DU2a is arranged on the rear side thereof. In a sound generated by vibration of the diaphragm DU2a, only a sound S21 emitted to one side passes through the air chamber VA2 and the air chamber VA3 provided in series in this order and is emitted into the external space V5 from the duct body 19 and the duct body 20 provided in parallel in the air chamber VA3 as a sound S21A and a sound S21B, respectively. That is, the sound S21 is emitted into the external space V5 not as a direct sound but as an air-chamber passing sound having passed through the air chamber. The air chamber VA2 and the air chamber VA3 are air chambers connected through the opening portion 16c which is a sound passing hole, and in terms of a progress order of the sound S11, the air chamber VA2 is a first stage and the air chamber VA3 is a second stage. On the other hand, the sound S22 emitted to the other side is emitted into the space V4. Since the air chamber VA4 forming the space V4 is sealed, the sound S22 is not emitted into the external space V5.

[0042] In the body portion structure K1, the air chamber VA2 is provided at a center portion including the center axis CL16 of the driver base 16. On the other hand, the air chamber VA3 is formed so as to extend in the circumferential direction and to surround the air chamber VA2, for example, outside in the radial direction with respect to the air chamber VA2. That is, the air chamber VA2 and the air chamber VA3 are provided side by side in the radial direction. Moreover, the air chamber VA3 is provided outside in the radial direction with respect to the driver unit DU1. The sound S21 outputted from the driver unit DU2 passes through the opening portion 16c outward from the inside in the radial direction from the space V2 and enters the space V3.

[0043] A space between the air chamber VA2 and the air chamber VA3 is partitioned by the base portion 16a of the driver base 16 which is a wall extending in the circumferential direction (including the cylinder 18 if the cylinder 18 is provided). Moreover, the space V2 of the air chamber VA2 and the space V3 of the air chamber VA3 communicate with each other through the opening portion 16c having a predetermined opening area. The opening portion 16c may be one opening or may be a plurality of openings. In the present example, the opening portion 16c is composed of the three opening portions 16c1 to 16c3 having the same shape. An opening specification of the opening portion 16c (the number, each opening area, opening positions and the like) is not limited and can be selected and set as appropriate.

[0044] The space V3 and the external space V5 communicate with each other through the duct body 19 and the duct body 20. A specification of the duct body (the number, each sectional area, each length, each arrangement position, materials and the like) is not limited and can be selected as appropriate. The space V2 and the space V3 constitute a so-called double bass reflex structure. Therefore, a sound outputted from the duct body 19 and the duct body 20 first becomes a medium to low rich sound in which a high range is suppressed.

[0045] Moreover, if the air chamber VA2 and the air chamber VA3 are grasped as an integral air chamber, it can be considered that a so-called Kelton-type sound emission structure is constituted by the integral air chamber and the duct bodies 19 and 20. In general, the Kelton-type sound emission structure applies a low-pass filter

action to the sound emitted into the air chamber and emits it from the duct. Thus, in the body portion 1, the double bass reflex type action and the Kelton-type action are exerted as a synergic action. Specifically, the sound S21 outputted from one side of the driver unit DU2 is subjected to a medium to low sound enriching action by the double bass reflex sound emission structure and a low-pass filter action in which a sound of a desired frequency or more is steeply attenuated by the Kelton-type sound emission structure and becomes a low sound enriched sound in which only a low sound component is efficiently extracted and is emitted into the external space V5 as the sounds S21A and S21B from the duct body 19 and the duct body 20, respectively.

[0046] Moreover, the duct sound emitting portions 13e which are outlets of the duct body 19 and the duct body 20 are opened in a front surface 13f of the baffle plate 13 which is the same plane as a plane where the sound S11 of the driver unit DU1 is outputted. As a result, the sound S11 which is a sound from the driver unit DU1 and the low sound enriched sounds S21A and S21B which are the sounds outputted through the double bass reflex type and the Kelton-type sound emission structures from the driver unit DU2 and having passed through the air chambers are mixed in a front space V6 of the baffle plate 13 which is also the external space V5 and become output sounds having characteristics supplementary to each other. A user of the headphone 51 listens to the output sound mixed in the front space V6 as above. Hereinafter, this output sound is referred to as a heard sound ST.

[0047] In this body portion structure K1, the two driver units DU1 and DU2 are juxtaposed in a front-and-rear direction, and the two air chambers VA2 and VA3 through which the sound S21 emitted from the driver unit DU2 on the rear side is made to pass are juxtaposed in a radial direction. Moreover, the air chamber VA3 outside in the radial direction is formed as a chamber extending in the circumferential direction. As a result, the body portion 1 can be formed as compact as possible without making the air chamber or the duct a protruding portion on an appearance.

[0048] The frequency characteristic of the heard sound ST depends on reproduced frequency characteristics of the mounted driver units DU1 and DU2. Particularly, the sound S21 from the driver unit DU2 can be adjusted to a desired characteristic by other plural parameters. That is, the heard sound ST can be set to a desired characteristic as a whole by mainly adjusting the low range. The plural parameters include the volume, shape and the like of each of the spaces V2 and V3, the number of opening portions 16c, each opening area, each shape and the like as well as a sectional area, a shape and the like of each of the duct bodies 19 and 20. Since the space V1 corresponding to back cavity of the driver unit DU1 is sealed, a back pressure of the diaphragm DU1a does not change even if the plural parameters are changed, and a sound quality of the sound S11 from the driver unit DU1 is maintained without a change. Therefore, a sound quality adjusting work in the entirety from the low range to the high range in the heard sound ST can be easily performed.

[0049] The body portion structure K1 employs a speaker exclusively for a medium to high range as the driver unit DU1 and improves a quality of the medium to high range sounds by the sound S11 emitted from the driver unit DU1 as a direct sound. The body portion structure K1 also supplements a low range not covered by the driver unit DU1, by the sounds S21A and S21B tuned to a characteristic with a sufficient volume feeling with selection of the driver unit DU2 and setting of the plural parameters. As the result, the body portion structure K1 can provide the heard sound ST which has a high quality from a low range to a high range to the user.

[0050] Moreover, regarding the body portion structure K1, if a full-range small-diameter speaker is employed as the driver unit DU1, by basically improving a quality of a sound from the low range to the high range by the sound S11 emitted as a direct sound from the driver unit DU1 and by supplementing the low range which tends to be insufficient in the driver unit DU1 with a small diameter by the sounds S21A and S21B tuned to the characteristic appropriately supplementing that by selection of the driver unit DU2 whose diameter of the diaphragm is larger than that of the driver unit DU1, for example, or by setting of the plural parameters, the heard sound ST with a high quality from the low range to the high range can be provided to the user.

[0051] In the headphone described in Patent Literature 1, since a plurality of driver units is arranged on a portion having the same spherical shape (corresponding to the baffle plate) in the cover in the body portion, only a small-diameter driver unit which does not interfere with another driver unit can be disposed even if it is a driver unit for a low sound. Thus, it is hard to expect an effect in terms of improvement of a sound volume and a sound quality of a low range. To the contrary, if a large-diameter driver unit for a low sound is employed, the portion corresponding to the baffle plate becomes large and the size of the body portion increases, and there is a concern that a wearing feeling is damaged. On the other hand, in the headphone 51 of this example, since the driver unit DU2 is disposed on the back surface side of the driver unit DU1, the baffle plate does not become large, and the size of the body portion does not increase. Therefore, the wearing feeling is not damaged.

[0052] In the headphone described in Patent Literature 2, a back pressure of the diaphragm changes in accordance with specifications of a space provided in the body portion (air chamber) and a duct (volume, shape and the like) as the bass reflex structure. That is, the direct sound outputted from the driver unit largely depends on the specification of the space (air chamber) provided as the bass reflex structure and the duct. The space (air chamber) provided in the body portion and the duct become protruding portions on appearance, the size of the body portion increases, and there is a concern that the wearing

feeling is damaged. On the other hand, in the headphone 51 of this example, the direct sound outputted from the driver unit DU1 is not affected by the sound outputted from the driver unit DU2 and does not depend on the specification of the air chamber and the duct at all. Moreover, in the headphone 51 of the example, the air chamber VA3 is provided outside in the radial direction with respect to the driver unit DU1, and the air chamber VA2 and the air chamber VA3 are juxtaposed in the radial direction. As a result, the body portion 1 can be constituted in an extremely compact manner. As described above, the body portion structure K1 and the headphone 51 provided with that can reproduce a high quality sound without increasing the size of the body portion 1.

(Modified example 1)

[0053] The body portion structure K1 may be a body portion structure K2 as follows as a modified example 1. That is, arrangement of the air chamber VA2 and the air chamber VA3 through which the sound S21 from the driver unit DU2 passes may be reversed in the radial direction. FIG. 12 is a sectional view schematically illustrating the body portion structure K2 of the modified example 1. The body portion structure K2 has the two driver units DU1 and DU2 in a body portion 1A similarly to the body portion structure K1.

[0054] The driver unit DU1 is disposed with the diaphragm DU1a facing the front side, and a driving system driving the diaphragm DU1a is attached in an attitude disposed on the rear side of the diaphragm DU1a similarly to the example. In a sound generated by vibration of the diaphragm DU1a, only the sound S11 emitted to one side is emitted into the external space V5. This emission of the sound S11 into the external space V5 is directly made not through the air chamber. That is, the sound S11 is emitted as a direct sound into the external space V5. The sound S12 emitted to the other side is emitted into a space V21. Since an air chamber VA21 forming the space V21 is sealed, the sound S12 is not emitted into the external space V5.

[0055] The driver unit DU2 is disposed with the diaphragm DU2a facing the front side, and a driving system driving the diaphragm DU2a is attached in an attitude disposed on the rear side of the diaphragm DU2a similarly to the example. In a sound generated by vibration of the diaphragm DU2a, only the sound S21 emitted to one side passes through an air chamber VA22 and an air chamber VA23 provided in series in this order and is emitted into the external space V5 from duct bodies 29a and 29b provided in parallel in the air chamber VA23 as sounds S21C and S21D, respectively. That is, the sound S21 is emitted into the external space V5 not as a direct sound but as the sounds S21C and S21D which are air-chamber passing sounds having passed through the air chamber. The air chamber VA22 and the air chamber VA23 are air chambers connected to each other, and in terms of a progress order of the sound S11, the air chamber VA22 is a first stage and the air chamber VA23 is a second stage. On the other hand, the sound S22 emitted to the other side is emitted into a space V24. Since an air chamber VA24 forming the space V24 is sealed, the sound S22 is not emitted into the external space V5.

[0056] In the body portion structure K2, the air chamber VA22 is provided so as to form a flat columnar space V22a including the driving axis CLDU2 of the driver unit DU2 and orthogonal thereto and a space V22b connected to a peripheral edge side of the space V22a and extending in a ring shape along the driving axis CLDU2. On the other hand, the air chamber VA23 is provided so as to form a substantially doughnut shaped space V23 inside in the radial direction of the space V22b. That is, the air chamber VA22 and the air chamber VA23 are provided so that at least the air chamber VA23 is located inside in the radial direction from the air chamber VA22. Moreover, the air chamber VA23 is provided outside in the radial direction with respect to the driver unit DU1.

[0057] A space between the air chamber VA22 and the air chamber VA23 is partitioned by a disk-shaped wall 27a orthogonal to the driving axis CLDU2 and a wall 27b connected to a peripheral edge of the wall 27a and extending in a circumferential surface shape around the driving axis CLDU2. Moreover, a space V22 of the air chamber VA22 and the space V23 of the air chamber VA23 communicate with each other through an opening portion 26c having a predetermined opening area provided on the wall 27b. An opening specification of the opening portion 26c (the number, each opening area, opening positions and the like) is not limited and can be selected and set as appropriate. The sound S21 outputted from the driver unit DU2 passes through the opening portion 26c from the space V22 inward from the outside in the radial direction and enters the space V23.

(Modified example 2)

[0058] The body portion structure K1 may be a body portion structure K3 as follows as a modified example 2. That is, an air chamber VA32 and an air chamber VA33 through which the sound S21 from the driver unit DU2 passes may be juxtaposed not in the radial direction but in a direction along the driving axis CLDU2 of the driver unit DU2.

[0059] FIG. 13 is a sectional view schematically illustrating the body portion structure K3 of the modified example 2. The body portion structure K3 has the two driver units DU1 and DU2 in a body portion 1B similarly to the body portion structure K1.

[0060] The driver unit DU1 is attached in an attitude in which the diaphragm DU1a faces the front side, and a driving system driving the diaphragm DU1a is disposed on the rear side of the diaphragm DU1a similarly to the example. In a sound generated by vibration of the diaphragm DU1a, only the sound S11 emitted to one side is emitted into the external space V5. This emission of the sound S11 into the external space V5 is directly made

not through the air chamber. That is, the sound S11 is emitted as a direct sound into the external space V5. The sound S12 emitted to the other side is emitted into a space V31. Since an air chamber VA31 forming the space V31 is sealed, the sound S12 is not emitted into the external space V5.

[0061] The driver unit DU2 is attached in an attitude in which the diaphragm DU2a faces the front side, and a driving system driving the diaphragm DU2a is disposed on the rear side of the diaphragm DU2a similarly to the example. In a sound generated by vibration of the diaphragm DU2a, only the sound S21 emitted to one side passes through an air chamber VA32 and an air chamber VA33 provided in series in this order and is emitted into the external space V5 from duct bodies 39a and 39b provided in parallel in the air chamber VA33, as sounds S21E and S21F, respectively. That is, the sound S21 is emitted into the external space V5 not as a direct sound but as the sounds S21E and S21F which are air-chamber passing sounds having passed through the air chamber. The air chamber VA32 and the air chamber VA33 are connected air chambers, and in terms of a progress order of the sound S21, the air chamber VA32 is a first stage and the air chamber VA33 is a second stage. On the other hand, the sound S22 emitted to the other side is emitted into a space V34. Since an air chamber VA34 forming the space V34 is sealed, the sound S22 is not emitted into the external space V5.

[0062] In the body portion structure K3, the air chamber VA32 is provided so as to form a flat columnar space V32 through which the driving axis CLDU2 of the driver unit DU2 passes orthogonal thereto. On the other hand, the air chamber VA33 is provided so as to form a doughnut shaped space V33 surrounding the driving axis CLDU2 on the front side of the space V32. Moreover, the air chamber VA33 is provided outside in the radial direction with respect to the driver unit DU1.

[0063] A space between the air chamber VA32 and the air chamber VA33 is partitioned by a disk-shaped wall 37 orthogonal to the driving axis CLDU2. Moreover, a space V32 of the air chamber VA32 and the space V33 of the air chamber VA33 communicate with each other through an opening portion 36c provided on the wall 37 and having a predetermined opening area. An opening specification of the opening portion 36c (the number, each opening area, opening positions and the like) is not limited and can be selected and set as appropriate. The sound S21 outputted from the driver unit DU2 passes through the opening portion 36c from the space V32 forward from the rear side along the driving axis CLDU2 and enters the space V33.

[0064] In the body portion structure K2 of the aforementioned modified example 1 and the body portion structure K3 of the modified example 2, outlets of the duct body 29a and the duct body 29b as well as the duct body 39a and the duct body 39b are opened to the front surface 13f of the baffle plate 13 which is a surface where the sound S11 of the driver unit DU1 is outputted. As a result, the sound S11 which is a direct sound from the driver unit DU1 and the low sound enriched sounds S21C and S21D (modified example 1) or sounds S21E and S21F (modified example 2) which are the sounds outputted through the double bass reflex type and the Kelton-type sound emission structures from the driver unit DU2 are mixed in the front space V6 of the baffle plate 13 and become the heard sound ST having characteristics supplementary to each other.

[0065] According to the body portion structure K2 of the aforementioned modified example 1 and the body portion structure K3 of the modified example 2, the air chamber or the duct does not become a protruding portion on appearance but can be formed as compact as possible similarly to the body portion structure K1.

[0066] Moreover, according to the body portion structure K2 and the body portion structure K3, the frequency characteristic of the heard sound ST becomes the one in accordance with the reproduced frequency characteristics of the mounted driver units DU1 and DU2 similarly to the body portion structure K1. Particularly, the sound S21 from the driver unit DU2 can be adjusted to a desired characteristic by other plural parameters. That is, the heard sound ST as a whole can be set to a desired characteristic by mainly adjusting the low range.

[0067] The plural parameters include the volume, shape and the like of each of the spaces V22 and V23 or the spaces V32 and V33, the number, each opening area, each shape and the like of the opening portion 26c or the opening portion 36c as well as a sectional area, a shape and the like of each of the duct bodies 29a and 29b or the duct bodies 39a and 39b, for example.

[0068] Therefore, the body portion structure K2 of the modified example 1 and the body portion structure K3 of the modified example 2 can improve a quality of the heard sound ST which is a reproduced sound without increasing the sizes of the body portion 1A and the body portion 1B similarly to the body portion structure K1.

[0069] In FIGS. 11 to 13, the size of each arrow indicating the sounds S11, S12, S21, S22, S22A, and S22B does not reflect the sound volume.

(Modified example 3)

[0070] The air chamber at the first stage and the air chamber at the second stage in the modified example 1, and the modified example 2 may be partitioned so as to have a plurality of air chambers in the circumferential direction. This modified example 3 will be described as a representative example based on the body portion structure K1 as an original structure. The air chamber VA3 may be partitioned into a plurality of small air chambers in the circumferential direction, and a duct body may be provided in each of the small air chambers.

[0071] A body portion structure K4 of this modified example 3 will be described by referring to FIG. 14 and 15. FIG. 14 is a sectional view at an S3-S3 position in FIG. 11, and FIG. 15 is an outline diagram of a body portion

1C in the body portion structure K4 when seen from a front side in a state in which the ear pad is removed.

[0072] In the body portion structure K4, the air chamber VA3 formed into the doughnut shape in the body portion structure K1 is partitioned at predetermined intervals (equal interval of approximately 120°, here) in the circumferential direction by a plurality of partition walls 48 extending in the radial direction so as to form small air chambers VA3a, VA3b, VA3c. A space V2 of the air chamber VA2 and spaces V3a to V3c of the small air chambers VA3a to VA3c communicate with each other by opening portions 46a1 to 46a3 formed in the base portion 16a of the driver base 16. Moreover, in the small air chambers VA3a to VA3c, duct bodies 49a to 49c are provided, respectively. The duct bodies 49a to 49c do not have to be formed with the same specification but may have specifications different from each other. Moreover, the duct bodies 49a to 49c do not have to be arranged so that opening directions of their inlets 49a3 to 49c3 face the same direction in the circumferential direction but may be arranged so as to face different directions.

[0073] An outline of a layout of a sound emitting side (front side) of the body portion 1C in this body portion structure K4 is illustrated in FIG. 15. In FIG. 15, at a center of a baffle plate 43 corresponding to the baffle plate 13, the driver unit DU1 having the diaphragm DU1a is disposed, and a duct sound emitting portion 43e where the sound having passed through the duct bodies 49a to 49c from the driver unit DU2 is outputted is provided in the periphery of the diaphragm DU1a so as to be opened concentrically at equal angular intervals as through holes 43e1 to 43e3, for example.

[0074] A structure in which the small air chambers illustrated in this modified example 3 are provided is one of structures for optimizing the characteristics of the heard sound ST, and even if this structure is applied, the size of the body portion 1C does not increase.

[0075] Each of the examples and variations of the present invention is not limited to the aforementioned configurations, and it is needless to say that it may be another variation within a range not departing from the gist of the present invention.

[0076] In the example, for example, the number of duct bodies provided at the second stage as the duct bodies 19 and 20 is not limited to two. It may be one or three or more. Moreover, if the plurality of duct bodies has the same specification, a position of the inlet of the through hole of the duct body is preferably set having a predetermined relationship in a distance from a position of the opening portion connecting the air chamber at the first stage and the air chamber at the second stage. A specific example represented by the body portion structure K1 of the example will be described by referring to FIG. 16.

[0077] FIG. 16 is a diagram of the opening portions 16c1 to 16c3 formed separately in the circumferential direction in the base portion 16a of the driver base 16 illustrated by extending the circumferential direction linearly in a right-and-left direction. FIG. 16 also illustrates the duct bodies 19 and 20 schematically by associating the opening portions 16c1 to 16c3 with positions in the circumferential direction.

[0078] As illustrated in FIG. 16, assume that a spatial distance from an opening position of each of the three opening portions 16c1 to 16c3 between the air chamber VA2 at the first stage and the air chamber VA3 at the second stage, to a position of the inlet 19a3 of the through hole 19a1 of the duct body 19 is a distance LAp (p: an integer of 1 to 3), respectively, and a spatial distance from an opening position of each of the three opening portions 16c1 to 16c3, to the position of the inlet 20a3 of the through hole 20a1 of the duct body 20 is a distance LBq (q: an integer of 1 to 3), respectively. In this case, it is preferable that LBq equal to each distance LAp is present in a one-to-one manner by all means. As a precondition of this relationship, it is necessary that distances from a driving center of the driver unit DU2 to the opening portions 16c1 to 16c3 are substantially equal. This precondition is satisfied in the body portion structure K1 since each of the opening portions 16c1 to 16c3 is provided on the base portion 16a corresponding to a circumference of the driver base 16 having the driving axis CLDU2 of the driver unit DU2 as an axis.

[0079] The relationship of each distance is set such that, as illustrated in FIG. 16, the distance LA1 is equal to the distance LB1, the distance LA2 is equal to the distance LB3, and the distance LA3 is equal to the distance LB2. In order to satisfy this relationship, with respect to a center line CL13 orthogonal to the circumferential direction (right-and-left direction in FIG. 16) passing through the opening portion 16c1, another opening portion 16c2 and the inlet 19a3 as well as another opening portion 16c3 and the inlet 20a3 are arranged symmetrically.

[0080] By means of this symmetrical arrangement, a phase of the sound S21 having passed each of the opening portions 16c1 to 16c3 at the time when it reaches the inlet 19a3 and a phase of the sound S21 having passed each of the opening portions 16c1 to 16c3 at the time when it reaches the inlet 20a3 match with each other. Therefore, the sound S21A emitted into the external space V5 from the outlet 21d of the duct joint 21 of the duct body 19 and the sound S21B outputted into the external space V5 from the outlet 21d of the duct joint 21 of the duct body 20 have the phases matched, and the heard sound ST has a higher quality. This idea can be applied even if the number of the opening portions or the number of duct bodies is different, and in this case, the heard sound ST similarly has a higher quality.

[0081] The opening portion 16c having the air chamber VA2 at the first stage and the air chamber VA3 at the second stage communicating with each other corresponds to a so-called double bass reflex duct. Therefore, a length as the duct is not limited to a plate thickness of the base portion 16a (if the cylinder 18 is provided, its plate thickness is also included) explained in the example and the like. That is, a duct having an arbitrary length,

opening area and the like may be provided as the opening portion 16c.

[0082] The cylinder 18 does not have to be in a fully connected ring shape. The cylinder 18 may be formed as a substantially C-shaped ring member partially having a slit or an arc-shaped member. However, since vibration of the driver base 16 accompanying the operation of the driver unit DU2 is vibration for expanding/contracting the diameter of the base portion 16a of the driver base 16, in terms of vibration suppression, the cylinder 18 is preferably in a fully connected ring shape and can suppress expansion/contraction deformation of the diameter of the base portion 16a of the driver base 16.

[0083] In the body portion structures K1 to K4, the driver unit DU2 may be disposed in an attitude opposite to the described attitude, that is, in an attitude in which the diaphragm DU2a faces the rear side and its driving system faces the front side. In this case, wiring is made such that an audio signal inputted into the driver unit DU2 has a phase opposite to that of the audio signal inputted into the driver unit DU2. Moreover, the driver unit DU2 is disposed in an attitude opposite to this, that is, in an attitude in which the sound S21 is outputted to the rear side, and a layout of a multi-staged air chamber may be set on the basis of the body portion structures K1 to K4 so that the sound S21 is emitted to the front space V6 through the multi-staged air chamber and the duct portion. In this case, wiring is made such that the audio signal inputted into the driver unit DU2 has the same phase as that of the audio signal inputted into the driver unit DU2.

[0084] The sound emitting device HS can be used not only for the aforementioned overhead type headphone 51 but for various types of headphones. For example, the sound emitting device HS can be applied as a body portion 51Aa of an inner ear type headphone 51A as illustrated in FIG. 17 (a) or as a body portion 51Bb of an ear hook type headphone 51B provided with an ear hook portion 51Ba as illustrated in FIG. 17(b). Moreover, the sound emitting device HS can be also mounted not only to the headphone but on an acoustic reproducing device 52 such as a speaker device by connecting a device KT capable of outputting an audio signal such as a PC (personal computer), a portable music reproducing device or a mobile phone as illustrated in FIG. 17 (c) and emitting the audio signal from the device KT as a sound which is spatially propagated and reaches the both right and left ears.

[0085] Each space in the example and each of the modified examples do not have to be fully sealed, and adjacent spaces may communicate with each other through a slight gap in order to improve driving of the diaphragms DU1a and DU2a.

[0086] The aforementioned example and each of the modified examples may be freely combined with each other in a possible range.

Claims

1. A headphone (51) comprising:

a sound emitting device (HS);
the sound emitting device including:

a body portion (1) having a first air chamber (VA2), a second air chamber (VA3) communicating with the first air chamber through a sound passing hole (16c), and a duct (DT) having one end side opened in the second air chamber and the other end side opened to an external space (V5);
a first driver unit (DU1) disposed on the body portion so that an output sound is directly emitted to the external space; and
a second driver unit (DU2) disposed on the body portion so that the output sound is emitted to the first air chamber;

a signal supply portion (4) for supplying an audio signal to the first and second driver units; and
either one of an ear hook portion (51Ba) connected to the sound emitting device and to be attached to an auricle so that the sound emitting device itself is attached inside the auricle, and
a headband portion (3) connected to the sound emitting device and to be attached to the head.

2. The headphone according to claim 1, wherein
the first air chamber, the second air chamber, and the duct constitute a double bass reflex structure.

3. The headphone according to claim 1 or 2, wherein
the second driver unit is disposed on a rear surface side of the first driver unit.

4. A sound emitting device (HS) comprising:

a body portion (1) having a first air chamber (VA2), a second air chamber (VA3) communicating with the first air chamber through a sound passing hole (16c), and a duct (DT) having one end side opened in the second air chamber and the other end side opened to an external space (V5);
a first driver unit (DU1) disposed on the body portion so that an output sound is directly emitted to the external space; and
a second driver unit (DU2) disposed on the body portion so that the output sound is emitted to the first air chamber.

5. The sound emitting device according to claim 4, wherein
the first air chamber, the second air chamber, and the duct constitute a double bass reflex structure.

6. The sound emitting device according to claim 4 or 5, wherein
the second driver unit is disposed on a rear surface side of the first driver unit.

FIG. 1

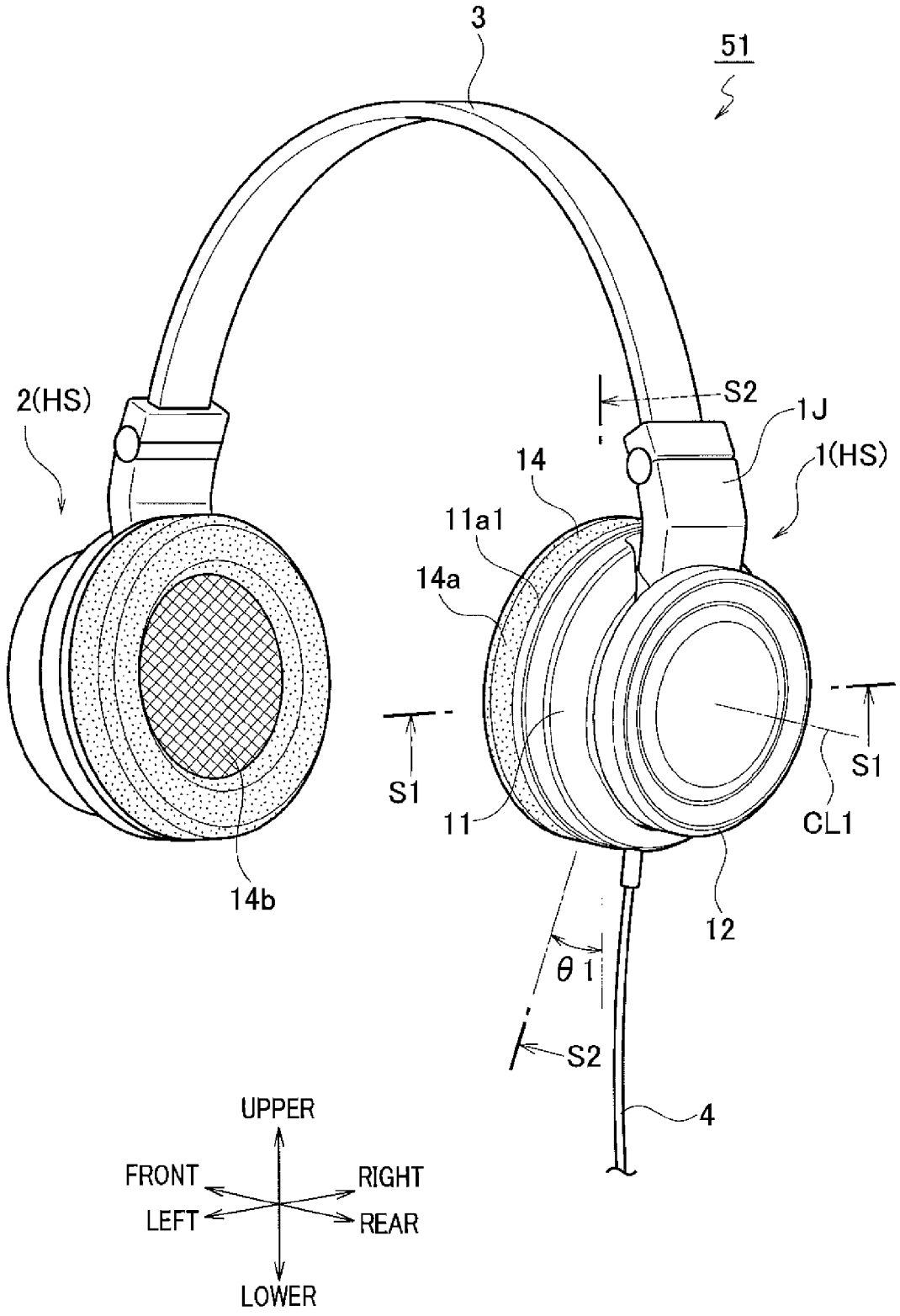

3
51
2(HS)
S2
1J
1(HS)
14
11a1
14a
S1
S1
11
CL1
14b
12
θ1
S2
4
UPPER
FRONT
RIGHT
LEFT
REAR
LOWER

FIG. 2

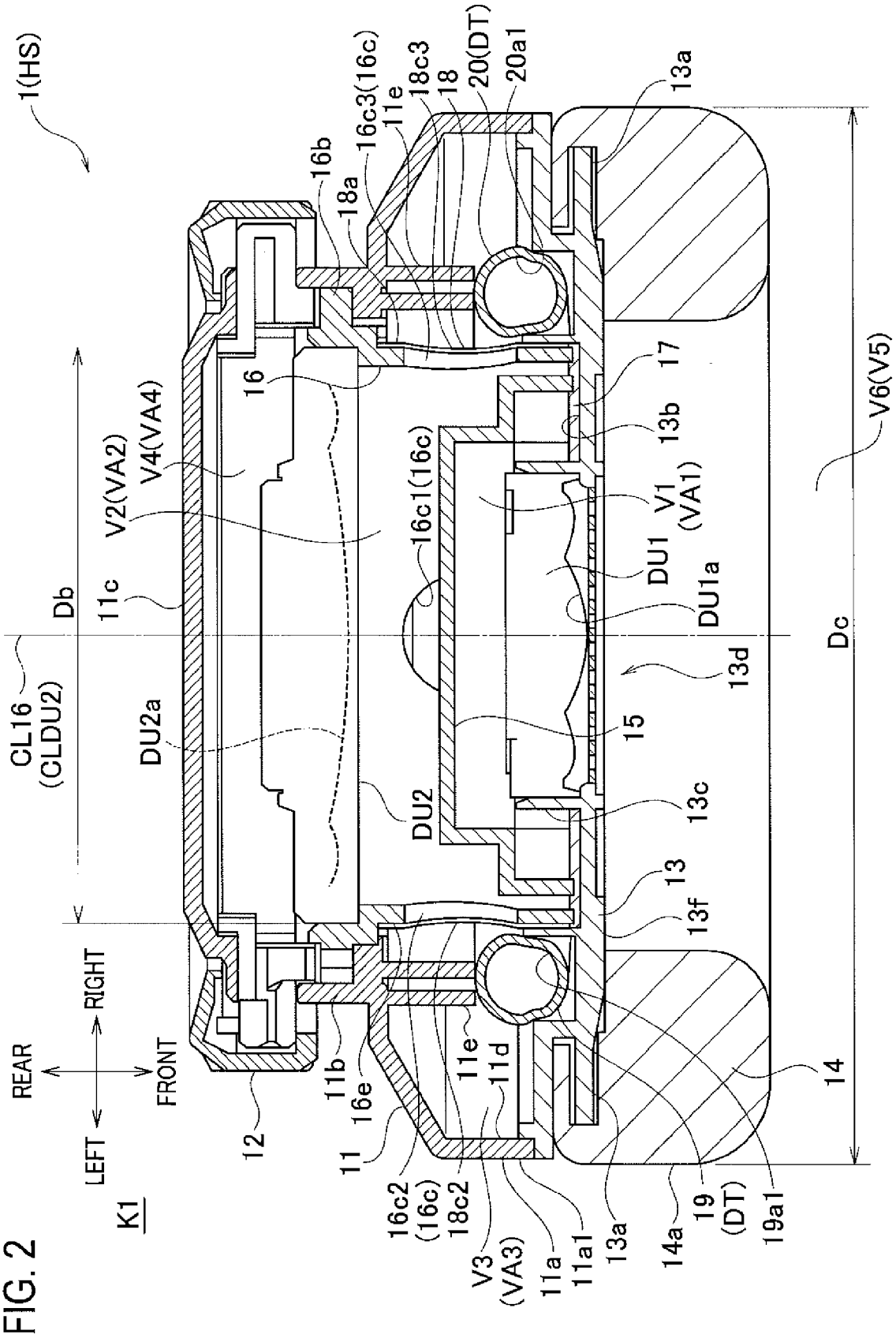

1(HS)
16b
18a
16c3(16c)
11e
18c3
18
20(DT)
20a1
13a
16
17
13b
V2(VA2)
V4(VA4)
16c1(16c)
V1
(VA1)
DU1
DU1a
V6(V5)
Db
11c
CL16
(CLDU2)
DU2a
13d
Dc
15
DU2
13c
13
13f
RIGHT
REAR
FRONT
LEFT
K1
11e
11d
11b
16e
12
11
14
16c2
(16c)
18c2
V3
(VA3)
11a
11a1
13a
14a
19
(DT)
19a1

FIG. 3

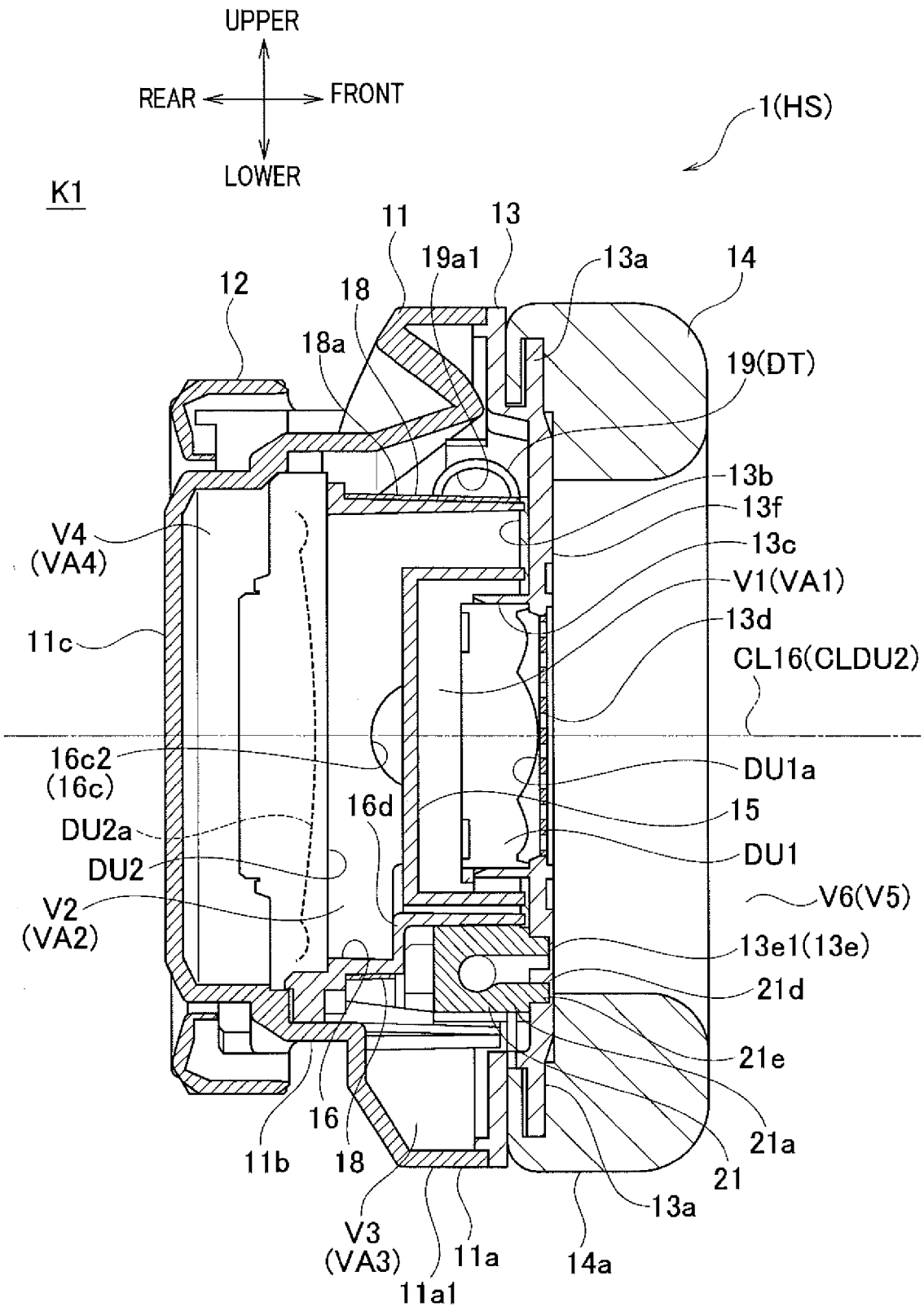

UPPER
REAR
FRONT
LOWER
K1
1(HS)
11
13
19a1
13a
14
12
18
18a
19(DT)
13b
13f
13c
V1(VA1)
13d
CL16(CLDU2)
V4
(VA4)
11c
16c2
(16c)
DU1a
16d
15
DU2a
DU1
DU2
V6(V5)
V2
(VA2)
13e1(13e)
21d
21e
21a
21
16
11b
18
13a
V3
(VA3)
11a
14a
11a1

FIG. 4

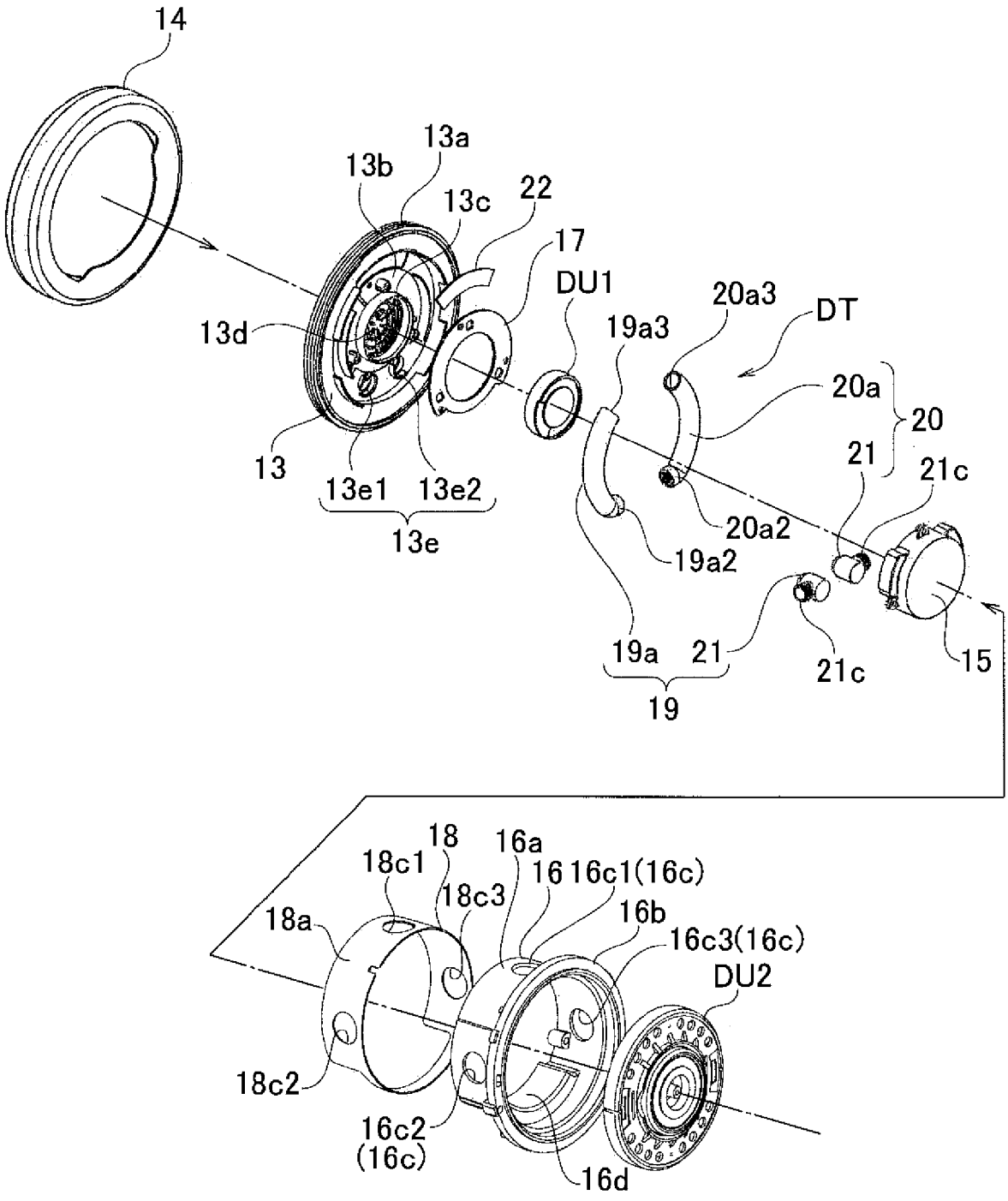

14
13a
13b
13c
22
17
DU1
20a3
DT
13d
19a3
20a
20
21
21c
13
13e1
13e2
13e
20a2
19a2
19a
21
21c
15
19
18
16a
18c1
16
16c1(16c)
18c3
16b
18a
16c3(16c)
DU2
18c2
16c2
(16c)
16d

FIG. 5

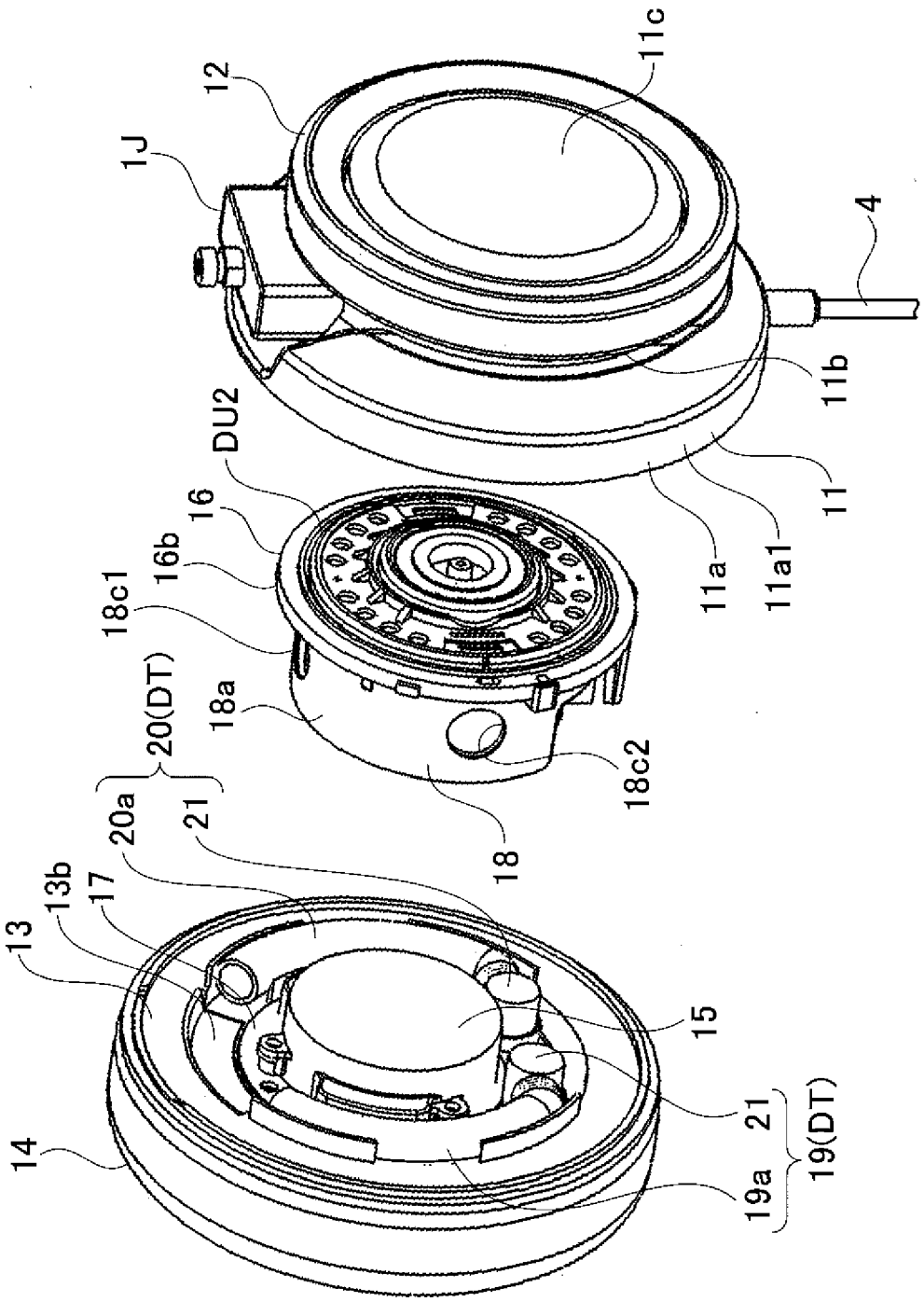

12
11c
1J
4
11b
DU2
16
16b
18c1
20(DT)
18a
11a
11a1
11
18c2
20a
21
18
13b
17
13
15
14
21
19a
19(DT)

FIG. 6

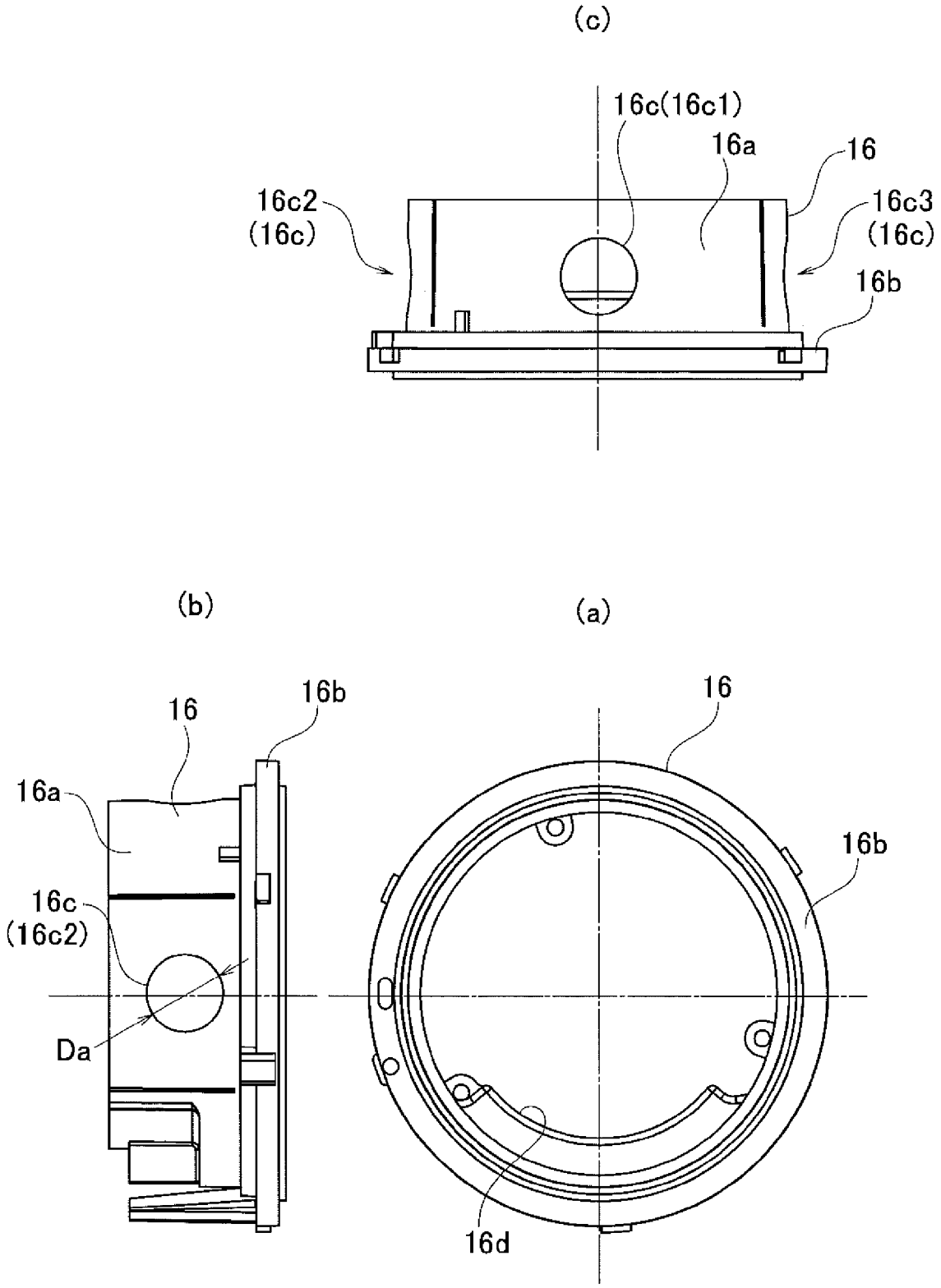

(c)
16c(16c1)
16a
16
16c2
(16c)
16c3
(16c)
16b
(b)
(a)
16
16b
16a
16c
(16c2)
Da
16
16b
16d

FIG. 7

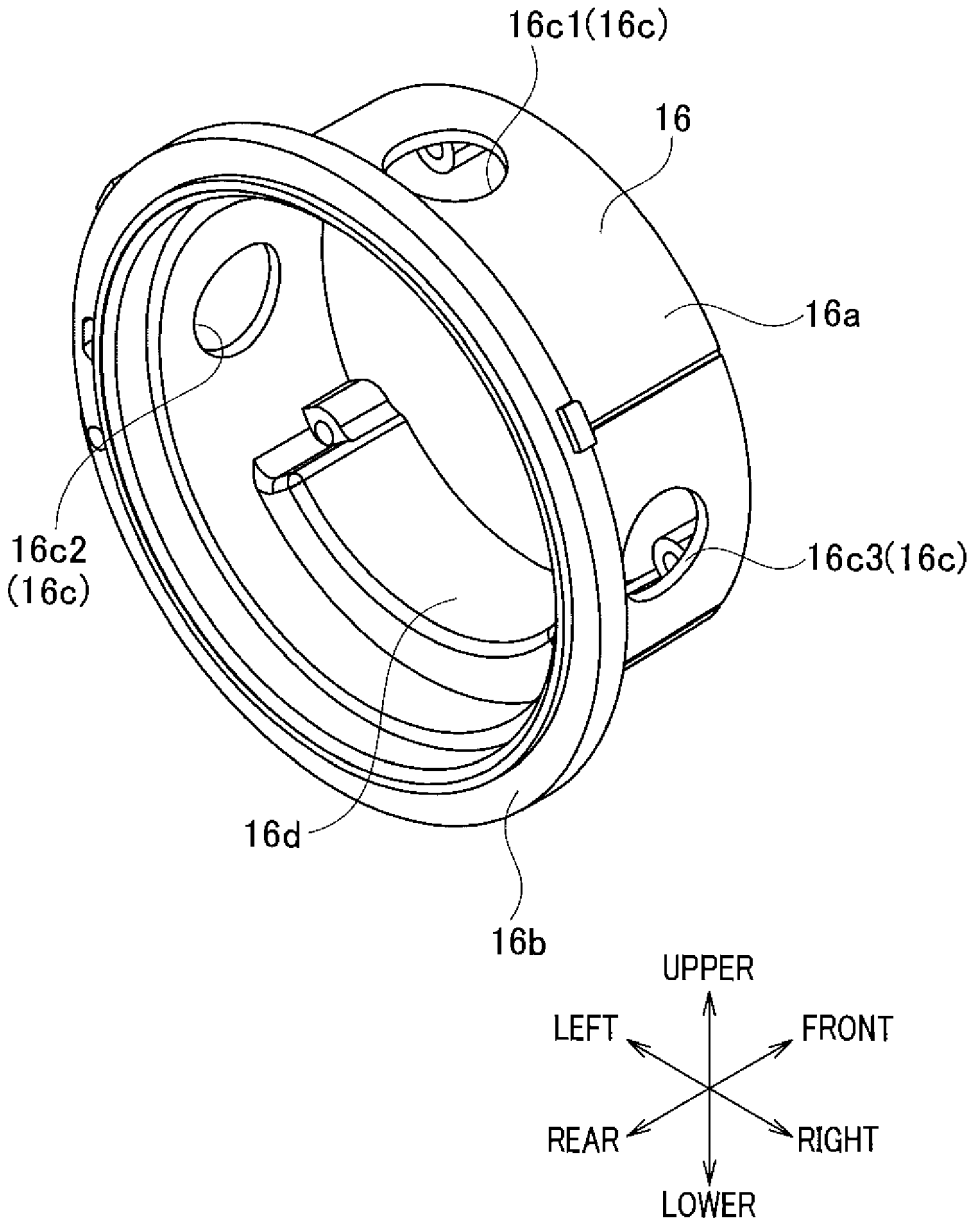

16c1(16c)
16
16a
16c2
(16c)
16c3(16c)
16d
16b
UPPER
LEFT
FRONT
REAR
RIGHT
LOWER

FIG. 8

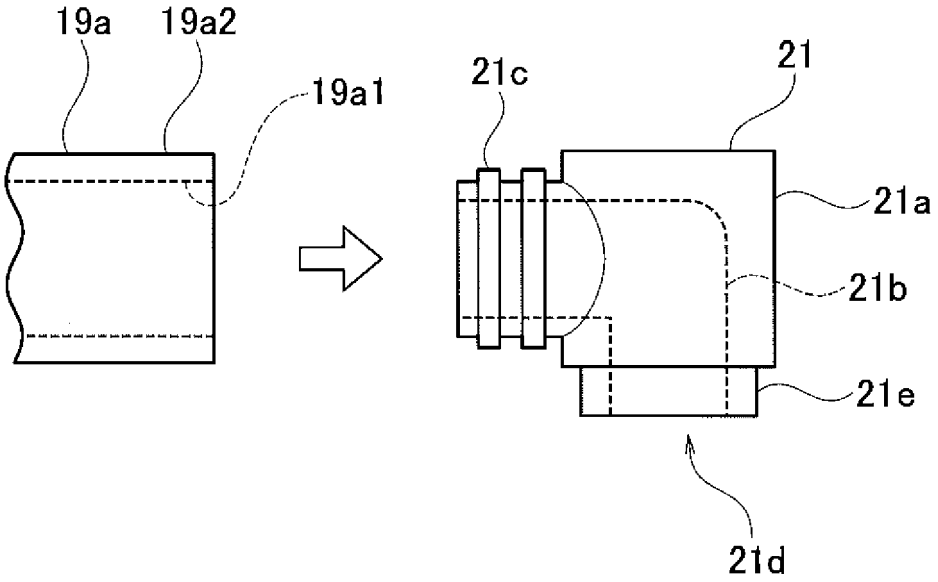


FIG. 9

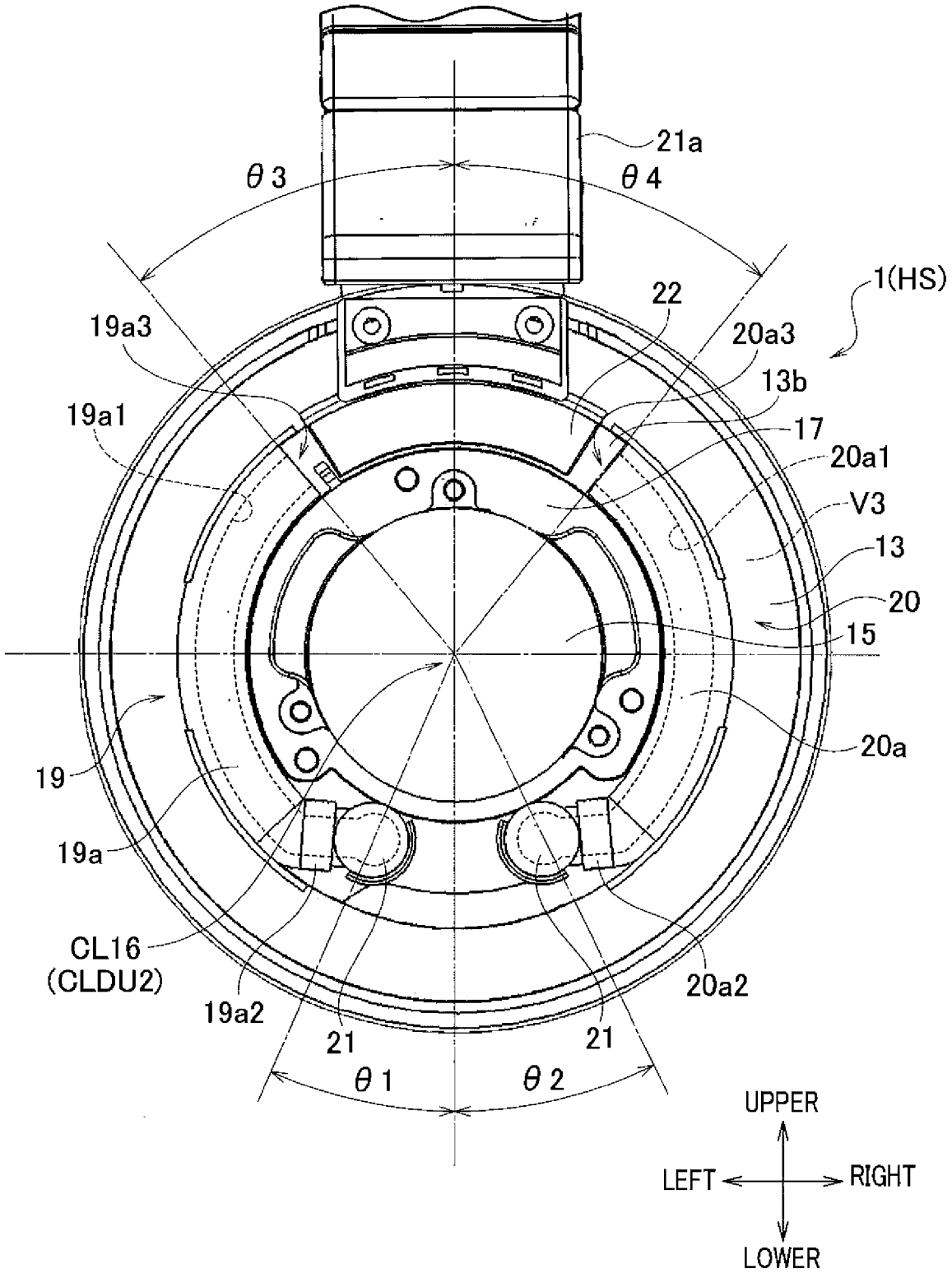

21a
θ3
θ4
1(HS)
22
19a3
20a3
13b
19a1
17
20a1
V3
13
20
15
20a
19
19a
CL16
(CLDU2)
19a2
20a2
21
21
θ1
θ2
UPPER
LEFT
RIGHT
LOWER

FIG. 10

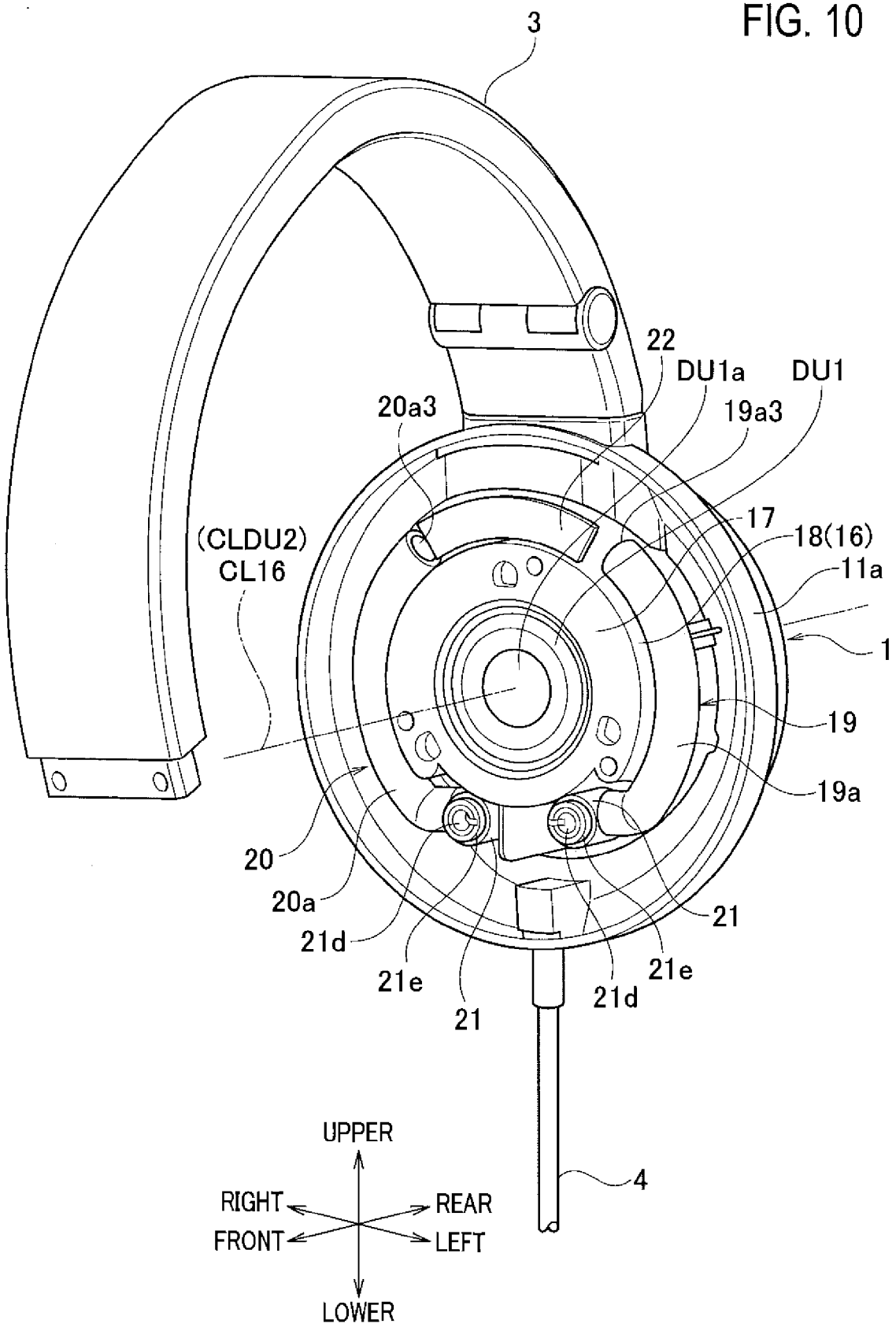

3
22
DU1a
DU1
20a3
19a3
17
18(16)
11a
(CLDU2)
CL16
1
19
19a
20
20a
21d
21e
21
21
21d
21e
4
UPPER
RIGHT
REAR
FRONT
LEFT
LOWER

FIG. 11

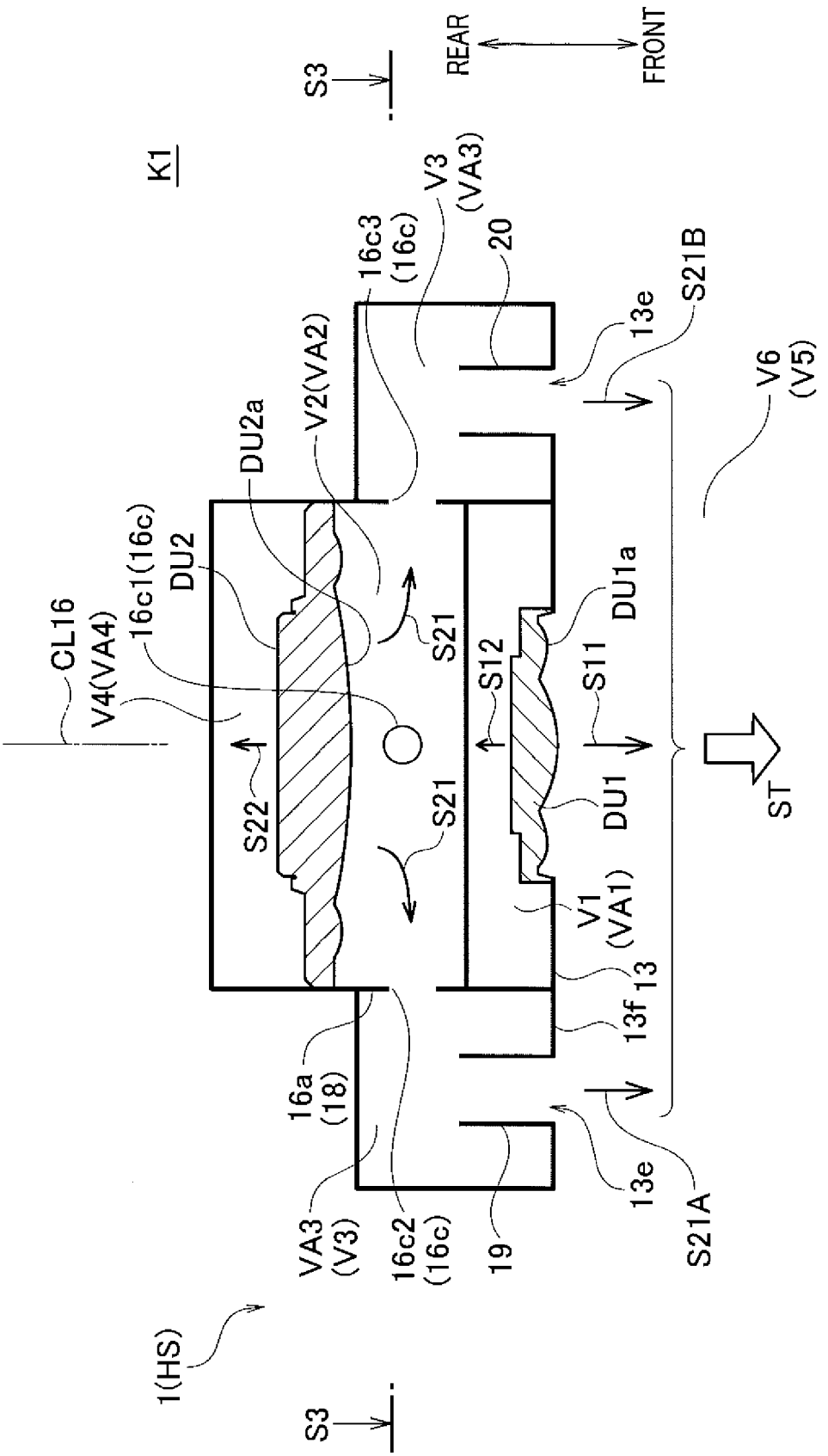

K1
S3
REAR
FRONT
V3
(VA3)
16c3
(16c)
20
S21B
13e
V6
(V5)
V2(VA2)
DU2a
CL16
V4(VA4)
16c1(16c)
DU2
S21
S12
S11
DU1a
S22
S21
DU1
ST
V1
(VA1)
13
13f
16a
(18)
VA3
(V3)
16c2
(16c)
19
13e
S21A
1(HS)
S3

FIG. 12

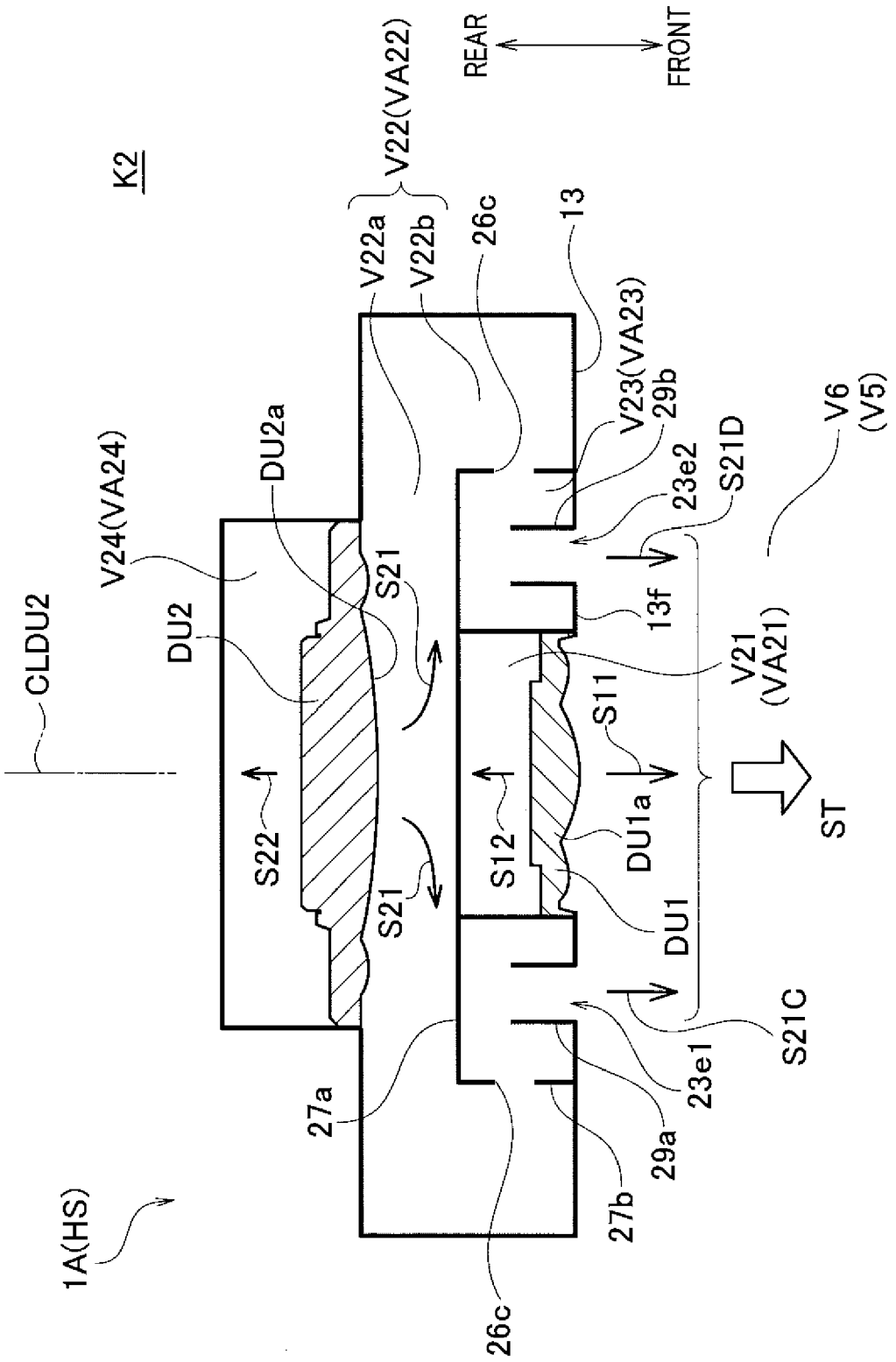

K2
REAR
FRONT
V22(VA22)
V22a
V22b
26c
13
V23(VA23)
29b
23e2
S21D
V6
(V5)
V24(VA24)
DU2a
S21
CLDU2
DU2
13f
V21
(VA21)
S11
S22
S12
DU1a
ST
S21
DU1
S21C
23e1
27a
29a
1A(HS)
27b
26c

FIG. 13

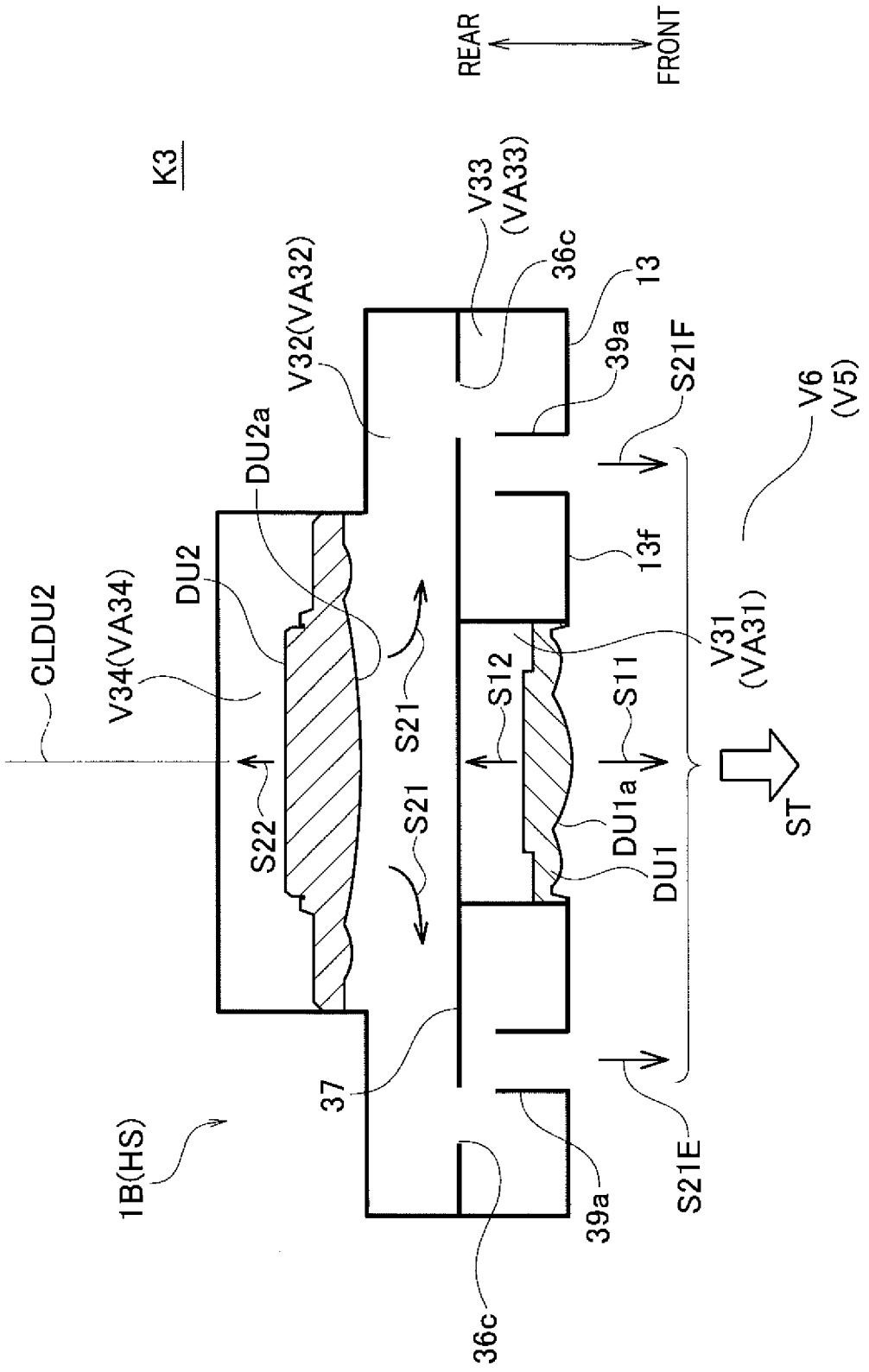

REAR
FRONT
K3
V33
(VA33)
36c
13
V32(VA32)
39a
S21F
V6
(V5)
DU2a
13f
DU2
CLDU2
V34(VA34)
S21
S12
S11
V31
(VA31)
S22
S21
DU1a
DU1
ST
37
1B(HS)
39a
S21E
36c

FIG. 14

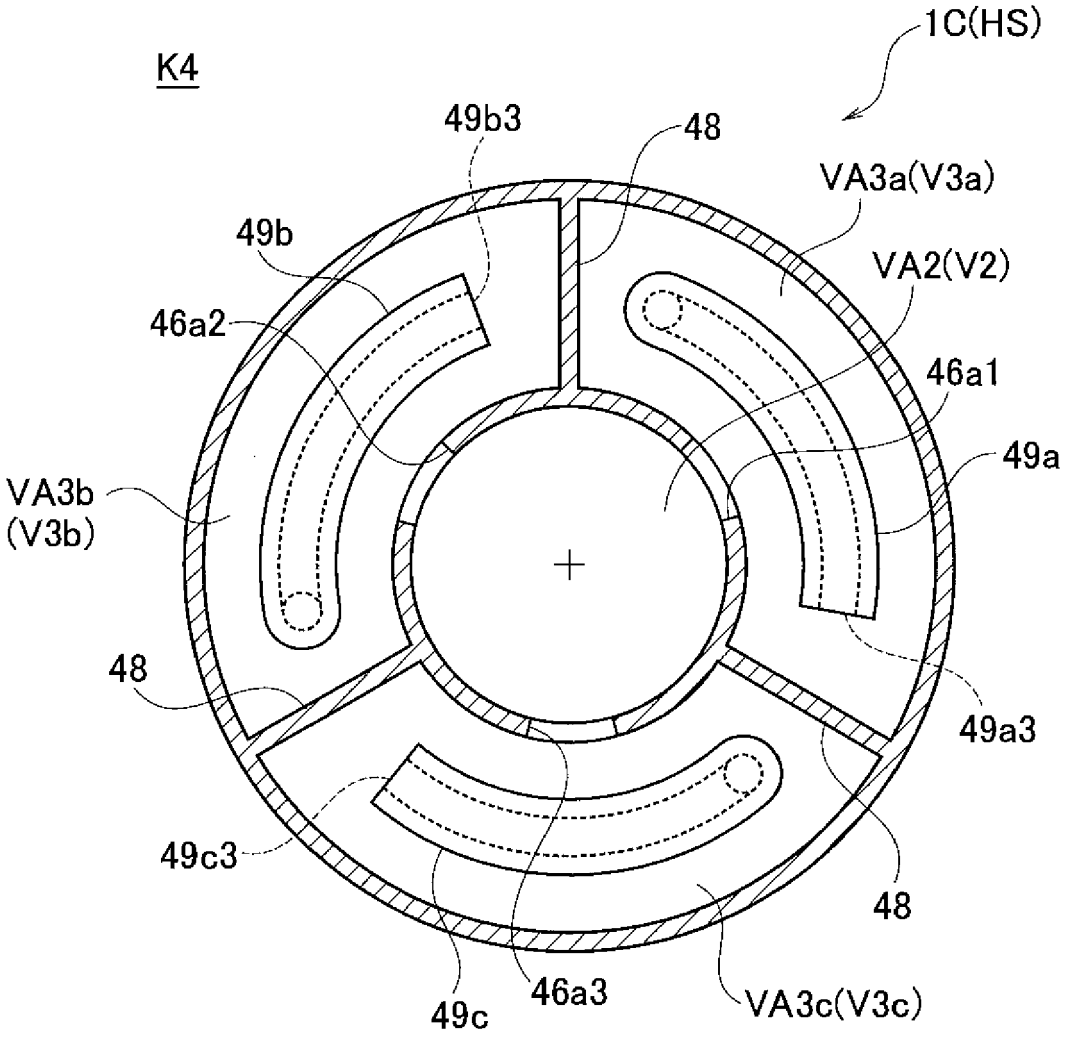

1C(HS)
K4
49b3
48
VA3a(V3a)
49b
VA2(V2)
46a2
46a1
49a
VA3b
(V3b)
48
49a3
49c3
48
49c
46a3
VA3c(V3c)

FIG. 15

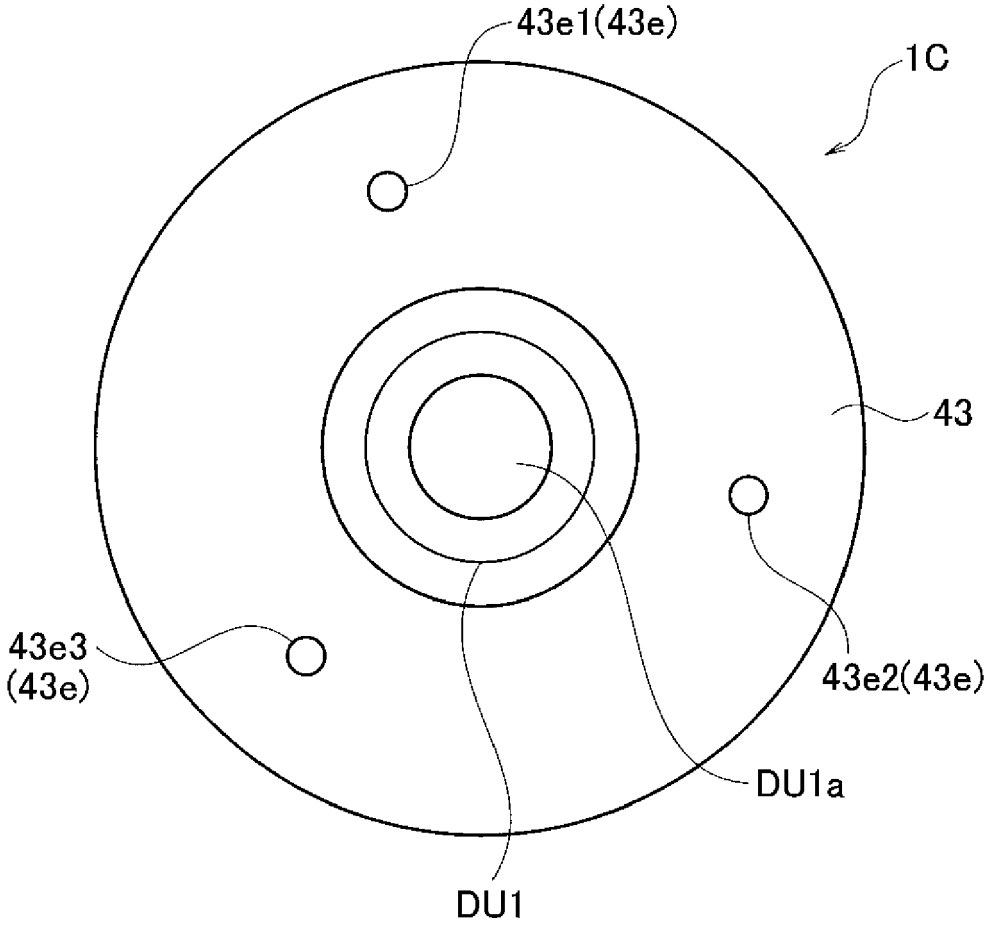


FIG. 16

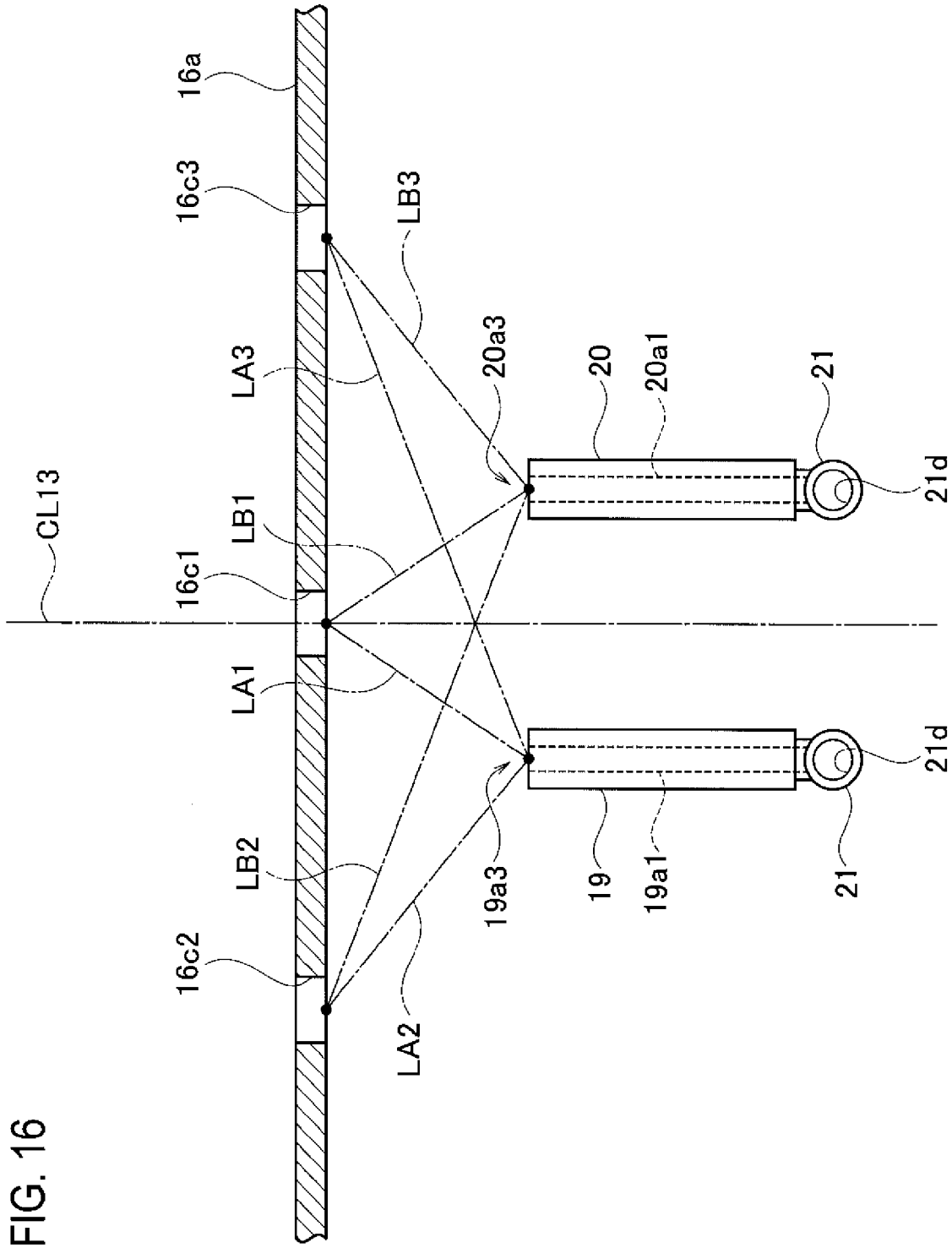
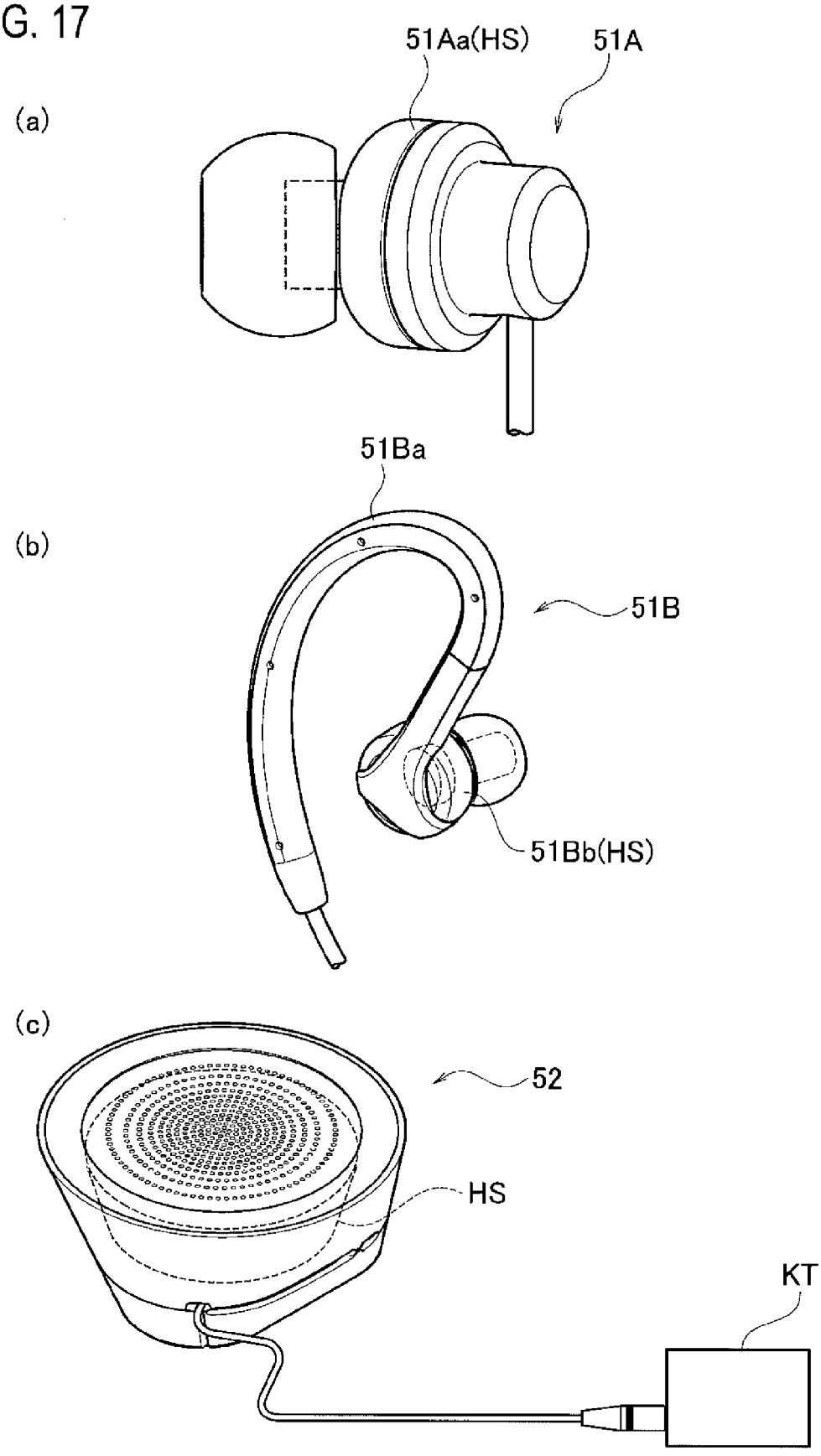

16a
16c3
LB3
LA3
20a3
20
20a1
21
21d
CL13
LB1
16c1
LA1
21d
LB2
19a3
19
19a1
21
16c2
LA2

FIG. 17



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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	4 April 2014	Borowski, Michael

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