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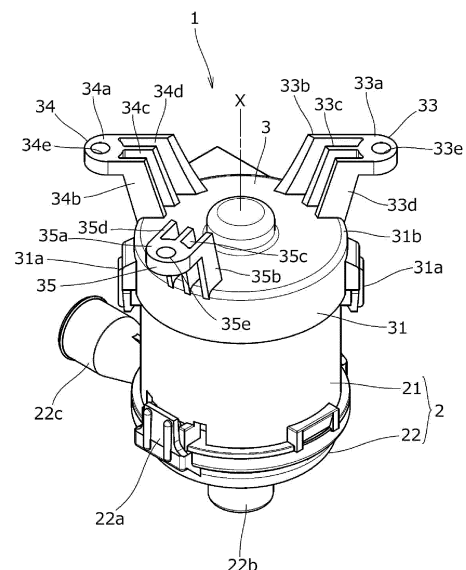
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(54) **DRAINAGE PUMP**

(57) Provided is a drainage pump that can suppress propagation of vibration without increasing a number of components and that may be mounted easily. The drainage pump includes a case accommodating a rotary blade and a motor configured to drive the rotary blade to rotate, wherein the case includes a plurality of leg portions that protrude along a rotational axis direction of the rotary blade, wherein the leg portions include a leg body fixed to an installation portion, and a plurality of plate-shaped portions configured to couple the leg body and the case, and wherein, when viewed through a space between the plate-shaped portions, a first gap is formed between the case and the leg body.

FIG. 1



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Description

[Technical Field]

[0001] The present invention relates to a drainage pump.

[Background Art]

[0002] When cooling operation is performed in an air conditioning unit, moisture in the air is cooled and dew is condensed in a heat exchanger of an indoor unit, such that drops of water drip into a drain pan disposed below the heat exchanger. In the case of a wall hanging-type indoor unit, drain water collected in the drain pan flows through a drain pipe by gravity and is discharged to the exterior of the unit. Meanwhile, in a ceiling embedded-type indoor unit, for example, it is generally difficult to lay the drain pipe to realize drainage using gravity. Therefore, in this type of indoor unit, a drainage pump that realizes drainage using motor as a power source is provided.

[0003] Patent Literature 1 discloses a drainage pump equipped with a motor. In this drainage pump, a leg portion that extends upward from an upper case is disposed, and an upper end of the leg portion is engaged with the indoor unit of the air conditioning unit, by which the drainage pump is attached to the structure.

[Citation List]

[Patent Literature]

[0004] [Patent Literature 1] Japanese Patent application Laid-Open Publication No. 2012-082790

[Summary of Invention]

[Technical Problem]

[0005] According to the drainage pump disclosed in Patent Literature 1, drainage is realized by driving a rotary blade using a motor. The vibration generated during drainage may be propagated to the indoor unit through leg portions of the drainage pump, by which resonance may occur and noise may be generated.

[0006] In order to suppress such noise, one idea is to dispose a rubber vibration insulator between an installation portion of the indoor unit and the leg portions so as to suppress the propagation of vibration of the drainage pump to the indoor unit. However, if there is a need to dispose the rubber vibration isolator and the like when attaching the drainage pump, component costs are increased, and the work related to attaching the drainage pump is also increased.

[0007] The present invention aims at providing a drainage pump that may suppress propagation of vibration without increasing the number of components and that

may be attached easily.

[Means to Solve the Problem]

[0008] In order to achieve the above objects, the drainage pump according to the present invention is

a drainage pump comprising a case accommodating a rotary blade and a motor configured to drive the rotary blade to rotate, wherein the case includes a plurality of leg portions that protrude along a rotational axis direction of the rotary blade, wherein the leg portions include a leg body fixed to an installation portion, and a plurality of plate-shaped portions configured to couple the leg body and the case, and wherein, when viewed through a space between the plate-shaped portions, a first gap is formed between the case and the leg body.

[Effects of Invention]

[0009] According to the present invention, a drainage pump that may suppress propagation of vibration without increasing the number of components and that may be attached easily is provided.

[Brief Description of Drawings]

[0010]

[FIG. 1] FIG. 1 is a perspective view of a drainage pump according to a first embodiment.

[FIG. 2] FIG. 2 is a perspective view of the drainage pump according to the first embodiment.

[FIG. 3] FIG. 3 is a side view of the drainage pump illustrated in a state attached to an installation portion.

[FIG. 4] FIG. 4 is a top view of the drainage pump.

[FIG. 5] FIG. 5 is a side view of a drive unit illustrated in a state detached from a housing.

[FIG. 6] FIG. 6 is a side view of the drive unit illustrated in a state detached from the housing.

[FIG. 7] FIG. 7 is a perspective view similar to FIG. 1 of a drainage pump according to a comparative example.

[FIG. 8] FIG. 8 is an enlarged view illustrating a second leg portion according to the present embodiment in planar view taken along a rotational axis direction.

[FIG. 9] FIG. 9 is an enlarged view illustrating a second leg portion according to a comparative example in planar view taken along a rotational axis direction.

[FIG. 10] FIG. 10 is a graph in which noise according to the present embodiment and that of the comparative example are compared.

[FIG. 11] FIG. 11 is a perspective view of a drive unit according to a second embodiment.

[FIG. 12] FIG. 12 is a view of one of the leg portions of a drive unit according to a modified example of the second embodiment illustrated from an outer side along a radial direction.

[FIG. 13] FIG. 13 is a view illustrating a relationship between an overall value (OA value) of noise generated during driving of the drainage pump having adopted modified example 1 and a size of a first gap (H1 - H2).

[FIG. 14] FIG. 14 is a view similar to FIG. 12 illustrating another modified example.

[Description of Embodiments]

(First Embodiment)

[0011] FIGs. 1 and 2 are perspective views of a drainage pump 1 according to a first embodiment of the present invention, wherein directions from which the views are taken are varied. FIG. 3 is a side view of the drainage pump 1 illustrated in an attached state. FIG. 4 is a top view of the drainage pump 1. A rotational axis of a rotor assembly and a rotary blade disposed in the drainage pump 1 is denoted as X.

[0012] The drainage pump 1 includes a drive unit 3 accommodating a motor, and a housing 2 made of synthetic resin accommodating a rotor assembly and a rotary blade not shown. The housing 2 includes an upper housing 21 having a bottomed cylindrical shape that accommodates the rotor assembly in a rotatable manner, and a lower housing 22 that accommodates the rotary blade in a rotatable manner. The motor is coupled to the rotor assembly in a manner capable of being driven in rotation, and the rotor assembly is coupled to the rotary blade in a manner capable of rotating integrally therewith. The rotor assembly and the rotary blade may adopt those disclosed, for example, in Japanese Patent Application Laid-Open Publication No. 2014-107893, but are not limited thereto. In the present specification, the side in which the drive unit 3 is disposed is referred to as an upper side, and the side in which the lower housing 22 is disposed is referred to as a lower side.

[0013] The lower housing 22 includes a hollow inlet cylindrical portion 22b connected consecutively to a center lower end and a hollow outlet cylindrical portion 22c connected consecutively to a side wall, and in the interior thereof is provided a pump chamber in which the rotary blade is disposed. The pump chamber and an exterior of the lower housing 22 are communicated through the inlet cylindrical portion 22b and the outlet cylindrical portion 22c.

[0014] The upper housing 21 and the lower housing 22 are separable, and in the connected state, the boundary therebetween is sealed by an O-ring or the like. The upper housing 21 may be attached to the lower housing 22 by a snap-fit function using a pair of elastically deformable locking pawls 22a that are formed to protrude from an outer circumference of an upper end of the lower

housing 22.

[0015] FIGs. 5 and 6 are side views of the drive unit 3 illustrating a state detached from the housing 2, wherein FIG. 5 illustrates a state viewed from an arrow A direction of FIG. 4, and FIG. 6 illustrates a state viewed from an arrow B direction of FIG. 4. In FIGs. 4 to 6, the drive unit 3 includes a housing lid portion 31 made of synthetic resin and having a cylindrical shape with a top, and a motor not shown accommodated within the housing lid portion 31. A connector 32 (refer to FIGs. 2 and 3) equipped with a terminal 32a to which a wiring not shown is connected, is mounted on a side surface at an upper portion of the upper housing 21, and power is supplied to the motor within the housing lid portion 31 through the connector 32 from an external power supply (not shown). The housing lid portion 31 is provided with a cutout 31c for avoiding interference with the connector 32.

[0016] An outer circumference of a lower end of the housing lid portion 31 is fit to an inner circumference of the upper end of the upper housing 21. The housing lid portion 31 is attached in an attachable and detachable manner to the upper housing 21 by a snap-fit function using an elastically deformable locking pawl 31a that is formed to protrude from and connected consecutively to an outer circumference of a lower end of the housing lid portion 31. The housing 2 described above and the housing lid portion 31 constitute a case of the drainage pump.

(Configuration of Leg Portion)

[0017] The housing lid portion 31 includes a plurality of (three according to the present example) leg portions 33, 34, and 35 that protrude upward along a rotational axis X direction and that are connected consecutively thereto. In FIG. 4, the first leg portion 33 is equipped with a disk-shaped leg body 33a, and a plurality of (three according to the present example) plate-shaped portions 33b, 33c, and 33d that extend in parallel and at equal intervals from the leg body 33a toward the housing lid portion 31. The plate-shaped portions 33b, 33c, and 33d have an approximately trapezoidal shape with a width that widens toward a lower end side, wherein a length of the plate-shaped portion 33b is longest and a length of the plate-shaped portion 33d is shortest. A hole 33e through which a bolt for fastening (not shown) may be passed is formed at a center of the leg body 33a.

[0018] Side edges near the upper ends of the plate-shaped portions 33b, 33c, and 33d are connected consecutively to an outer circumference of the leg body 33a, and lower ends of the plate-shaped portions 33b, 33c, and 33d are connected consecutively across an upper surface of the housing lid portion 31 and an upper portion of a side surface adjacent to the upper surface (a tapered portion 31b having an arc-shaped cross-section). By integrating the plate-shaped portions 33b, 33c, and 33d and the housing lid portion 31 so that the lower ends of the plate-shaped portions 33b, 33c, and 33d extend across the upper surface of the housing lid portion 31

and the side surface thereof, in a case where the housing lid portion 31 is formed by injection molding etc., releasing of the molded product is facilitated, and the manufacturing costs may be cut down. Alternatively, the lower ends of the plate-shaped portions 33b, 33c, and 33d may be connected consecutively to the upper surface of the housing lid portion 31 alone.

[0019] In the present embodiment, the plate-shaped portions 33b, 33c, and 33d are connected to the leg body 33a and the housing lid portion 31, and are not connected to other portions. In other words, when viewed from the side through the plate-shaped portions 33b, 33c, and 33d, first gaps CH1 and CH2 (refer to FIG. 6) sandwiched between plate-shaped portions are formed between the leg body 33a and the upper surface of the housing lid portion 31, and a length H1 of the first gaps CH1 and CH2 in the rotational axis X direction is equal to a distance between the leg body 33a and the housing lid portion 31. Further, the leg body 33a is disposed outward in a radial direction than the outer circumference surface of the housing lid portion 31, and second gaps CV1 and CV2 (refer to FIG. 4) sandwiched between plate-shaped portions are formed between the leg body 33a and the outer circumference surface of the housing lid portion 31. According to this configuration, the rigidity of the first leg portion 33 may be reduced further.

[0020] The second leg portion 34 is also equipped with a disk-shaped leg body 34a, and three plate-shaped portions 34b, 34c, and 34d that extend in parallel from the leg body 34a toward the housing lid portion 31. The plate-shaped portions 34b, 34c, and 34d have an approximately trapezoidal shape with a width that widens toward a lower end side, wherein a length of the plate-shaped portion 34d is longest and a length of the plate-shaped portion 34b is shortest. A hole 34e through which a bolt for fastening (not shown) may be passed is formed at a center of the leg body 34a.

[0021] Side edges near the upper ends of the plate-shaped portions 34b, 34c, and 34d are connected consecutively to an outer circumference of the leg body 34a, and lower ends of the plate-shaped portions 34b, 34c, and 34d are connected consecutively across an upper surface of the housing lid portion 31 and an upper portion of a side surface adjacent to the upper surface (the tapered portion 31b having an arc-shaped cross-section). By integrating the plate-shaped portions 34b, 34c, and 34d and the housing lid portion 31 so that the lower ends of the plate-shaped portions 34b, 34c, and 34d extend across the upper surface of the housing lid portion 31 and the side surface thereof, in a case where the housing lid portion 31 is formed by injection molding etc., releasing of the molded product is facilitated, and the manufacturing costs may be cut down. Alternatively, the lower ends of the plate-shaped portions 34b, 34c, and 34d may be connected consecutively to the upper surface of the housing lid portion 31 alone.

[0022] In the present embodiment, the plate-shaped portions 34b, 34c, and 34d are connected to the leg body

34a and the housing lid portion 31, and are not connected to other portions. In other words, when viewed from the side through a space between the plate-shaped portions 34b, 34c, and 34d, first gaps CH1 and CH2 (refer to FIG. 6) sandwiched between plate-shaped portions are formed between the leg body 34a and the upper surface of the housing lid portion 31, and a length of the first gaps CH1 and CH2 in the rotational axis X direction is equal to a distance between the leg body 34a and the housing lid portion 31. Further, the leg body 34a is disposed outward in a radial direction than the outer circumference surface of the housing lid portion 31, and second gaps CV1 and CV2 (refer to FIG. 4) sandwiched between plate-shaped portions are formed between the leg body 34a and the outer circumference surface of the housing lid portion 31. According to this configuration, the rigidity of the first leg portion 34 may be reduced further. The thickness of the plate-shaped portions 34b, 34c, and 34d is preferably equal to the thickness of the plate-shaped portions 33b, 33c, and 33d. Further, a height from the housing lid portion 31 to the upper surface of the leg body 34a is equal to the height from the housing lid portion 31 to the leg body 33a.

[0023] In FIG. 4, the plate-shaped portion 33b of the first leg portion 33 is opposed to the plate-shaped portion 34d of the second leg portion 34, that is, both surfaces of the plate-shaped portion 33b and the plate-shaped portion 34d exist within approximately the same plane (preferably parallel to the rotational axis X). Further, the plate-shaped portion 33c of the first leg portion 33 is opposed to the plate-shaped portion 34c of the second leg portion 34, that is, both surfaces of the plate-shaped portion 33c and the plate-shaped portion 34c respectively exist within approximately the same plane (preferably parallel to the rotational axis X). Further, the plate-shaped portion 33d of the first leg portion 33 is opposed to the plate-shaped portion 34b of the second leg portion 34, that is, both surfaces of the plate-shaped portion 33b and the plate-shaped portion 34d respectively exist within approximately the same plane (preferably parallel to the rotational axis X).

[0024] As illustrated in FIG. 4, when viewed in the direction of rotational axis X, a center line L0 of the plate-shaped portion 33c and that of the plate-shaped portion 34c are mutually overlapped, do not intersect the rotational axis X, and pass through a center O1 of a hole 33e and a center O2 of 34e. When an angle between a line segment L1 connecting the center O1 of the hole 33e and the rotational axis X and the center line L0 is $\Theta 1$, and an angle between a line segment L2 connecting the center O2 of the hole 34e and the rotational axis X and the center line L0 is $\Theta 2$, the angles $\Theta 1$ and $\Theta 2$ are preferably 0 degrees or greater than 0 degrees and 40 degrees or smaller. By varying the angles $\Theta 1$ and $\Theta 2$, the rigidity of the leg portions 33 and 34 along the circumferential direction may be adjusted.

[0025] The third leg portion 35 is also equipped with a disk-shaped leg body 35a, and three plate-shaped por-

tions 35b, 35c, and 35d that extend in parallel from the leg body 35a toward the housing lid portion 31. The plate-shaped portions 35b, 35c, and 35d have an approximately trapezoidal shape with a width that widens toward a lower end side, and the lengths thereof are approximately equal.

[0026] A hole 35e through which a bolt for fastening (not shown) may be passed is formed at a center of the leg body 35a. When viewed in the direction of the rotational axis X, a center line L3 of the plate-shaped portion 35c passes through a center O3 of the hole 35e and the rotational axis X.

[0027] Side edges near the upper ends of the plate-shaped portions 35b, 35c, and 35d are connected consecutively to an outer circumference of the leg body 35a, and lower ends of the plate-shaped portions 35b, 35c, and 35d are connected consecutively across an upper surface of the housing lid portion 31 and an upper portion of a side surface adjacent to the upper surface (the tapered portion 31b having an arc-shaped cross-section). By integrating the plate-shaped portions 35b, 35c, and 35d and the housing lid portion 31 so that the lower ends of the plate-shaped portions 35b, 35c, and 35d extend across the upper surface of the housing lid portion 31 and the side surface thereof, in a case where the housing lid portion 31 is formed by injection molding etc., releasing of the molded product is facilitated, and the manufacturing costs may be cut down. Alternatively, the lower ends of the plate-shaped portions 35b, 35c, and 35d may be connected consecutively to the upper surface of the housing lid portion 31 alone.

[0028] In the present embodiment, the plate-shaped portions 35b, 35c, and 35d are connected to the leg body 35a and the housing lid portion 31, and are not connected to other portions. In other words, when viewed from the side through a space between the plate-shaped portions 35b, 35c, and 35d, first gaps (not shown) sandwiched between plate-shaped portions are formed between the leg body 35a and the upper surface of the housing lid portion 31, and a length of the gaps in the rotational axis X direction is equal to a distance between the leg body 35a and the housing lid portion 31. Further, the leg body 35a is disposed outward in a radial direction than the outer circumference surface of the housing lid portion 31, and second gaps CV1 and CV2 (refer to FIG. 4) sandwiched between plate-shaped portions are formed between the leg body 35a and the outer circumference surface of the housing lid portion 31. According to this configuration, the rigidity of the leg portion 35 may be reduced further. The thickness of the plate-shaped portions 35b, 35c, and 35d is preferably equal to the thickness of the plate-shaped portions 34b, 34c, and 34d. Further, the thicknesses of the leg bodies 33a, 34a, and 35a are also preferably mutually equal. Further, a height from the housing lid portion 31 to the upper surface of the leg body 35a is equal to the height from the housing lid portion 31 to the leg body 34a.

[0029] As illustrated in FIG. 4, when viewed in the di-

rection of the rotational axis X, the center line L3 of the plate-shaped portion 35c intersects the rotational axis X, but alternatively, the plate-shaped portions 35b, 35c, and 35d may be angled such that the center line L3 does not intersect the rotational axis X.

[0030] The drainage pump 1 may be attached to a top plate (installation portion) CP of a cooling unit, for example, as illustrated in FIG. 3 by bolts (not shown) passed through the holes 33e, 34e, and 35e of the leg portions 33, 34, and 35.

(Operation of Drainage Pump)

[0031] When power is fed from an external power supply through the connector 32 to the motor of the drive unit 3, the rotary blade within the housing 2 is driven to rotate, drain water is sucked into the pump chamber from the inlet cylindrical portion 22b by centrifugal force, discharged through the outlet cylindrical portion 22c, and drained to the exterior of the device through a piping not shown.

(Comparative Example)

[0032] Next, a comparative example to be compared with the drainage pump 1 according to the present embodiment will be described. FIG. 7 is a perspective view similar to FIG. 1 of a drainage pump 1' according to a comparative example. According to the drainage pump 1 illustrated in FIG. 7, the configuration of the drive unit 3' differs from that of the drainage pump 1 of the present embodiment. The components that are common to those of the drainage pump 1 are denoted with the same reference numbers, and descriptions thereof are omitted.

[0033] Specifically, a housing lid portion 31' of the drive unit 3' is also composed by consecutively connecting three leg portions 33', 34', and 35' that protrude upward. The first leg portion 33' is composed by consecutively connecting a leg body 33a' including a hole 33e', two plate-shaped portions 33b' and 33d' that extend in parallel from the leg body 33a' toward a housing lid portion 31', and a side wall 33f' that connects side edges of the plate-shaped portions 33b' and 33d' on the sides that are distant from the rotational axis X in a manner extending across the entire area in the rotational axis X direction. The leg body 33a' is connected to the entire upper ends of the plate-shaped portions 33b' and 33d' and to the entire upper end of the side wall 33f'.

[0034] Further, the second leg portion 34' is also composed by consecutively connecting a leg body 34a' including a hole 34e', two plate-shaped portions 34b' and 34d' that extend in parallel from the leg body 34a' toward the housing lid portion 31', and a side wall 34f' that connects side edges of the plate-shaped portions 34b' and 34d' on the sides that are distant from the rotational axis X in a manner extending across the entire area in the rotational axis X direction. The leg body 34a' is connected to the entire upper ends of the plate-shaped portions 34b'

and 34d' and to the entire upper end of the side wall 34f'.

[0035] Further, the third leg portion 35' is also composed by consecutively connecting a leg body 35a' including a hole 35e', two plate-shaped portions 35b' and 35d' that extend in parallel from the leg body 35a' toward the housing lid portion 31', and a side wall 35f' that connects side edges of the plate-shaped portions 35b' and 35d' on the sides that are distant from the rotational axis X in a manner extending across the entire area in the rotational axis X direction. The leg body 35a' is connected to the entire upper ends of the plate-shaped portions 35b' and 35d' and to the entire upper end of the side wall 35f'.

[0036] That is, when the leg portions 33', 34', and 35' are viewed from the side through a space between the plate-shaped portions, there is no gap formed between the plate-shaped portions in areas the leg bodies 33a', 34a', and 35' and the housing lid portions 31', and the areas are respectively covered by the side walls 33f', 34f', and 35f'. Further, when viewed in planar view in the rotational axis X direction, the leg bodies 33a', 34a', and 35' and the housing lid portion 31' are overlapped, and there is no gap formed between the plate-shaped portions. Therefore, the leg portions 33', 34', and 35' adopt, in general, a hollow box structure with an opening side. In other words, when cut in any area along the rotational axis X, the leg portions 33', 34', and 35' have an H-shaped or a shape with center bar removed from "E" (C-shaped) cross-section. Since such a structure is adopted, the leg portions 33', 34', and 35' have a high rigidity in the direction of rotation (circumferential direction) of the motor.

[0037] The configurations of the drainage pump 1' other than those described above are similar to the above-mentioned embodiments. The position of a locking pawl 31a' of the drive unit 3' differs from the embodiment described above, but regarding the transmission of vibration, there is no specific difference between the positions of the locking pawl.

[0038] FIG. 8 is an enlarged view in which the second leg portion 34 according to the present embodiment is viewed in planar view along the rotational axis X direction, and FIG. 9 is an enlarged view in which a second leg portion 34' according to the comparative example is viewed in planar view along the rotational axis X direction.

[0039] When the motor is driven and the rotary blade is rotated, vibration is generated in the drainage pump. This vibration is mainly a vibration in a circumferential direction caused by pressure fluctuation within the pump chamber before and after a tip of the rotary blade passes through a vicinity of the outlet cylindrical portion 22c.

[0040] According to the comparative example illustrated in FIG. 9, when the vibration in the circumferential direction is applied, since the plate-shaped portions 34b' and 34d' are specifically reinforced by the presence of the side wall 34f' that extends in the circumferential direction, and therefore, the leg portion 34' has a high rigidity in the circumferential direction and does not deform easily, such that the vibration from the housing lid portion 31' will be transmitted to the top plate CP (FIG. 2) through

the leg portion 34' with little or no attenuation. The same applies for the leg portions 33' and 35'. Therefore, when the vibration being transmitted matches a natural frequency of the top plate CP, resonance is generated, which may be recognized as noise.

[0041] In contrast, according to the present embodiment, the first gaps CH1 and CH2 sandwiched between the plate-shaped portions are formed between the leg body 33a and the housing lid portion 31, that is, the leg body 34a and the housing lid portion 31 are coupled to both ends of the three plate-shaped portions 34b, 34c, and 34d. Therefore, when a vibration in the circumferential direction is applied, a center portion of the plate-shaped portions 34b, 34c, and 34d is deformed so as to be yielded in the plate thickness direction, and energy is consumed thereby, such that transmission of vibration from the housing lid portion 31 to the top plate CP may be suppressed. The same applies for the leg portions 33 and 35. Therefore, it becomes possible to provide the drainage pump 1 that may suppress propagation of vibration and that may be attached easily, without increasing the number of components.

[0042] FIG. 10 is a graph comparing noise according to the present embodiment and that according to the comparative example, wherein the vertical axis indicates a noise level and the horizontal axis indicates a voltage value applied to the motor. In the graph of FIG. 10, it can be recognized that around 13 V, which is a normal working voltage, the drainage pump 1 according to the present embodiment has a noise reduction effect of approximately 7 dB (A) compared to the drainage pump 1' according to the comparative example.

[0043] According to the results of research performed by the present inventors, even in a case where the plate-shaped portions are positioned such that center lines L1 and L2 of the plate-shaped portions 33c and 34c of the leg portions 33 and 34 are arranged to intersect the rotational axis X, it has been found that a reduction effect similar to the embodiment described above may be achieved.

(Second Embodiment)

[0044] FIG. 11 is a perspective view of a drive unit 3A according to a second embodiment. The drive unit 3A may be assembled to the housing 2, similar to the embodiment described above, so that descriptions of the components other than the drive unit 3A will be omitted.

[0045] In the present embodiment, a second leg portion 34A connected consecutively to a housing lid portion 31A is equipped with a disk-shaped leg body 34Aa having a hole 34Ae, three plate-shaped portions 34Ab, 34Ac, and 34Ad that extend in parallel and at equal intervals from the leg body 34Aa toward the housing lid portion 31A, a lower wall portion (also simply referred to as a wall portion or a coupling portion) 34Ag that extends from one of the plate-shaped portions 34Ab and 34Ac toward the other and couples the areas near the lower ends

thereof, and a lower wall portion (also simply referred to as a wall portion or coupling portion) 34Ah that extends from one of the plate-shaped portions 34Ac and 34Ad toward the other and couples the areas near the lower ends thereof. The lower wall portions 34Ag and 34Ah are formed to extend from the housing lid portion 31A toward the leg body 34Aa, but they are terminated before reaching the leg body 34Aa. Therefore, the first gaps CH1 and CH2 are formed between the upper ends of the lower wall portions 34Ag and 34Ah and the leg body 34Aa.

[0046] The surfaces on the side of the lower wall portions 34Ag and 34Ah distant from the rotational axis X are preferably included in the cylindrical surfaces that are common to the side surface of the housing lid portion 31A. Further, the upper end positions of the lower wall portions 34Ag and 34Ah are approximately the same, and a gap between a height H2 from the housing lid portion 31A to the upper ends of the lower wall portions 34Ag and 34Ah and a height H1 from the upper surface of the housing lid portion 31A to the lower surface of the leg body 34Aa should be greater than 0, and in general, better noise reducing effect may be expected as the gap increases.

[0047] Therefore, also according to the second embodiment, when viewed from the side through a space between the plate-shaped portions 34Ab, 34Ac, and 34Ad, gaps CH1 and C2 that are sandwiched between the plate-shaped portions are formed between the leg body 34Aa and the lower wall portions 34Ag and 34Ah. Other configurations of the leg portion 34A are similar to those of the embodiment described above, and the same applies for the first leg portion 33A and the third leg portion 35A, such that the same descriptions are omitted.

[0048] According to the present embodiment, by varying the heights of the lower wall portions 34Ag and 34Ah, the rigidity of the leg portions 33A, 34A, and 35A are varied, and the vibration transmission characteristics thereof may be changed. Therefore, by adjusting the heights of the lower wall portions 34Ag and 34Ah according to the specification of the top plate CP of the cooling unit, a drainage pump in which the resonance of the top plate CP is less likely to occur may be realized.

[0049] For example, if resonance occurs during use of the drainage pump, effective countermeasures against resonance may be taken by replacing the drive unit 3A with that including lower wall portions 34Ag and 34Ah having a different height. In that case, only the drive unit 3A should be replaced, and the housing 2 that has been used may still be used, such that the costs related to replacement may be cut down significantly.

(Various Modified Examples)

[0050] FIG. 12 is a view in which one leg portion of a drive unit according to a modified example of the second embodiment is viewed from an outer side along a radial direction. The configurations other than the leg portion are similar to the embodiment described above, such that

descriptions thereof are omitted.

(Modified Example 1)

[0051] In a modified example 1 illustrated in FIG. 12(a), a second leg portion 34B connected consecutively to a housing lid portion 31B, which is only partially illustrated, is equipped with a disk-shaped leg body 34Ba, three plate-shaped portions 34Bb, 34Bc, and 34Bd that extend in parallel at equal intervals from the leg body 34Ba toward the housing lid portion 31B, a lower wall portion (also simply referred to as a wall portion or a coupling portion) 34Bg that is extended from one of the plate-shaped portions 34Bb and 34Bc toward the other and couples portions thereof together, and a lower wall portion (also simply referred to as a wall portion or a coupling portion) 34Bh that is extended from one of the plate-shaped portions 34Bc and 34Bd toward the other and couples portions thereof together. The other leg portions preferably adopt the same configuration.

[0052] The lower wall portions 34Bg and 34Bh are formed to extend longer from the housing lid portion 31B toward the leg body 34Ba than the second embodiment, but they are terminated before reaching the leg body 34Ba. Therefore, the first gaps CH1 and CH2 are formed between the upper ends of the lower wall portions 34Bg and 34Bh and the leg body 34Ba. Now, if a distance from the housing lid portion 31B to the lower surface of the leg body 34Ba is denoted by H1 and a distance from the housing lid portion 31B to the upper end of the lower wall portions 34Bg and 34Bh is denoted by H2, $H1 - H2 > 0$ is satisfied.

[0053] In the modified example 1 (and the second embodiment), the lower wall portions 34Bg and 34Bh have a common rectangular plate shape, and the distances H2 from the housing lid portion 31B to the lower wall portions 34Bg and 34Bh are also the same.

(Modified Example 2)

[0054] In a modified example 2 illustrated in FIG. 12(b), a second leg portion 34C connected consecutively to a housing lid portion 31C, which is only partially illustrated, is equipped with a disk-shaped leg body 34Ca, three plate-shaped portions 34Cb, 34Cc, and 34Cd that extend in parallel at equal intervals from the leg body 34Ca toward the housing lid portion 31C, a lower wall portion (also simply referred to as a wall portion or a coupling portion) 34Cg that is extended from one of the plate-shaped portions 34Cb and 34Cc toward the other and couples portions thereof together, and a lower wall portion (also simply referred to as a wall portion or a coupling portion) 34Ch that is extended from one of the plate-shaped portions 34Cc and 34Cd toward the other and couples portions thereof together. The other leg portions preferably adopt the same configuration.

[0055] The lower wall portions 34Cg and 34Ch are also formed to extend longer from the housing lid portion 31C

toward the leg body 34Ca and are terminated before reaching the leg body 34Ca, but they are each provided with a V-shaped cutout at the center of the upper end that extends downward. Therefore, the first gaps CH1 and CH2 have a tapered shape toward the lower side. Now, if a distance from the housing lid portion 31C to the lower surface of the leg body 34Ca is denoted by H1 and a distance from the housing lid portion 31C to the upper end of the lower wall portions 34Cg and 34Ch (that have the maximum height of the lower wall portions 34Cg and 34Ch that contact the plate-shaped portions 34Cb, 34Cc, and 34Cd) is denoted by H2, $H1 - H2 > 0$ is satisfied.

(Modified Example 3)

[0056] In a modified example 3 illustrated in FIG. 12(c), a second leg portion 34D connected consecutively to a housing lid portion 31D, which is only partially illustrated, is equipped with a disk-shaped leg body 34Da, three plate-shaped portions 34Db, 34Dc, and 34Dd that extend in parallel at equal intervals from the leg body 34Da toward the housing lid portion 31D, a lower wall portion (also simply referred to as a wall portion or a coupling portion) 34Dg that is extended from one of the plate-shaped portions 34Db and 34Dc toward the other and couples portions thereof together, and a lower wall portion (also simply referred to as a wall portion or a coupling portion) 34Dh that is extended from one of the plate-shaped portions 34Dc and 34Dd toward the other and couples portions thereof together. The other leg portions preferably adopt the same configuration.

[0057] The lower wall portions 34Dg and 34Dh are formed to extend from the housing lid portion 31D toward the leg body 34Da and are terminated before reaching the leg body 34Da. The first gaps CH1 and CH2 are formed between the upper ends of the lower wall portions 34Dg and 34Dh and the leg body 34Da, and since the upper ends of the lower wall portions 34Dg and 34Dh are inclined with respect to the upper surface of the housing lid portion 31D, the lower edges of the first gaps CH1 and CH2 are also inclined in correspondence therewith. Further, since the heights of the upper ends of the lower wall portions 34Dg and 34Dh differ, the sizes of the first gaps CH1 and CH2 also differ. Now, if a distance from the housing lid portion 31D to the lower surface of the leg body 34Da is denoted by H1 and a distance from the housing lid portion 31D to the upper end of the lower wall portion 34Dh (the upper end of the lower wall portion 34Dh that is farthest from the housing lid portion 31D among the portions of the lower wall portion adjacent to the plate-shaped portion) is denoted by H2, $H1 - H2 > 0$ is satisfied.

[0058] As described, by varying the sizes of the first gaps CH1 and CH2, the lengths of the three plate-shaped portions 34Db, 34Dc, and 34Dd that are not bound by the lower wall portions 34Dg and 34Dh (the lengths of the portions serving as vibrating bodies) may be varied, such that it may be possible to realize different natural

frequencies in the respective plate-shaped portions.

[0059] As illustrated in the modified examples described above, various shapes (which may be respectively common shapes or different shapes) may be adopted in the lower wall portions formed between the three plate-shaped portions, but in any of the shapes, it is important that $H1 - H2 > 0$ is satisfied.

(Modified Example 4)

[0060] In modified examples 1 to 3 illustrated in FIGs. 12(a) to 12(c), a lower wall portion had been illustrated as one example of a coupling portion that couples the adjacent plate-shaped portions together. However, in other cases, for example in a modified example illustrated in FIG. 14, a beam (also referred to as a coupling portion) 34Eg that is extended from one of adjacent plate-shaped portions 34Eb and 34Ec in a leg portion 34E toward the other and coupling a portion thereof may be disposed instead of the lower wall portion, and further, a beam (also referred to as a coupling portion) 34Eh that is extended from one of adjacent plate-shaped portions 34Ec and 34Ed toward the other and coupling a portion thereof may be disposed. In that case, gaps CH3 and CH4 having a distance H3 in the rotational axis X direction are also formed between the beams 34Eg and 34Eh and the housing lid portion 31E. The widths of the beams 34Eg and 34Eh in the rotational axis X direction are H2 and are equal, but the widths thereof may also be varied. In that case, it is preferable that $H1 - (H2 + H3) > 0$ is satisfied. The thicknesses of the lower wall portion and the beam described above are preferably uniform. The two leg portions (not shown in FIG. 14) other than the leg portion 34E preferably have a common configuration.

[0061] Further, according to the modified examples illustrated in FIGs. 12(a) to 12(c) and FIG. 14, examples of a case where first gaps are formed between the leg bodies and the coupling portion were described, but the present technique is not limited thereto, and for example, the leg bodies and the coupling portion may be formed integrally, and a first gap may be formed between the coupling portion and the housing lid portion (case). In other words, the coupling portion may be formed as an upper wall portion that extends from the leg bodies toward the housing lid portion. In that case, with reference to FIG. 14, ($H1 - (H2 + H3) = 0$ and $H3 > 0$) is satisfied, and the upper wall portion is formed to extend from the leg body 34Ea toward the housing lid portion 31E, but it is terminated before reaching the housing lid portion 31E. In this state, gaps formed between the lower end of the upper wall portions and the housing lid portion 31E are defined as first gaps CH3 and CH4.

[0062] FIG. 13 is a view illustrating a relationship between an overall value (OA value) of noise generated during driving of the drainage pump having adopted the modified example 1 and a size of a first gap ($H1 - H2$), wherein a graph illustrates an example where $H1 = 12$ mm. According to the graph illustrated in FIG. 13, it can

be recognized that compared to a case where the value of $(H1 - H2) = 0$ (comparative example of FIG. 7), noise may be reduced if the value of $(H1 - H2) > 0$ mm.

[0063] Further, as the value of $(H1 - H2)$ increases, noise tends to be reduced, but a linear relationship is not necessarily realized. That is, in the graph of FIG. 13, if the value of $(H1 - H2)$ is increased from 0 mm, noise is reduced drastically, but noise is increased again at a vicinity of the area where the value of $(H1 - H2)$ becomes 2 mm, which serves as a boundary (point of inflection), and the noise is reduced again at a vicinity of the area where the value of $(H1 - H2)$ becomes 4 mm, which serves as a peak.

[0064] From the viewpoint of reducing noise, it is preferable to set the value of $(H1 - H2)$ to be as high as possible, but from the viewpoint of suppressing internal stress of the leg portion, it is preferable to set the value of $(H1 - H2)$ to be as low as possible. In that case, based on the graph of FIG. 13, it is recognized that both reduction of noise and suppression of internal stress may be realized by setting the value of $(H1 - H2)$ to be 1 mm or greater and 3 mm or smaller, for example.

[0065] As described above, the present invention has been illustrated with reference to the embodiments of the drainage pump, but the present invention is not limited to the embodiments described above, and for example, the housing lid portion having three plate-shaped portions has been described, but the number of plate-shaped portions may be two, or four or more. Further, the plurality of leg portions may extend from the housing toward the installation portion. Further, by setting the number, the shape, and the directions with respect to the rotational axis X of the plate-shaped portions of the respective leg portions to differ, the respective leg portions may be provided with different characteristics, such as different natural frequencies and rigidities.

[Reference Signs List]

[0066]

- 1 drainage pump
- 2 housing
- 3, 3A drive unit
- 31, 31A housing lid portion
- 33, 34, 35, 34A, 34A, 35A, 34B, 34C, 34D, 34E leg portion

Claims

1. A drainage pump comprising a case accommodating a rotary blade and a motor configured to drive the rotary blade to rotate,

wherein the case includes a plurality of leg portions that protrude along a rotational axis direction of the rotary blade,

wherein the leg portions include a leg body fixed to an installation portion, and a plurality of plate-shaped portions configured to couple the leg body and the case, and

wherein, when viewed through a space between the plate-shaped portions, a first gap is formed between the case and the leg body.

2. The drainage pump according to claim 1, wherein the leg body is disposed on an outer side in a radial direction of an outer circumference surface of the case, and wherein a second gap sandwiched between the plate-shaped portions is formed between the outer circumference surface of the case and the leg body.
3. The drainage pump according to claim 1, wherein, in a state where the leg portions are viewed from the rotational axis direction, a center line of the plate-shaped portions of two of the leg portions do not intersect a rotational axis.
4. The drainage pump according to claim 3, wherein, in a state where the leg portions are viewed in the rotational axis direction, center lines of the plate-shaped portions of two of the leg portions approximately correspond.
5. The drainage pump according to claim 1, wherein, in a state where the leg portions are viewed in the rotational axis direction, a center line of the plate-shaped portion of the leg portion intersects a rotational axis.
6. The drainage pump according to claim 1, wherein the leg portion includes a coupling portion configured to couple the plate-shaped portions disposed adjacent one another at an area between the plurality of plate-shaped portions.
7. The drainage pump according to claim 6, wherein the coupling portion is a wall portion that is disposed to extend from the case side toward the leg body.
8. The drainage pump according to any one of claims 1 to 7, wherein the case includes a housing lid portion configured to accommodate the motor, and a housing configured to accommodate the rotary blade and to which the housing lid portion is detachably attached, and wherein the leg portion is connected consecutively to the housing lid portion.

FIG. 1

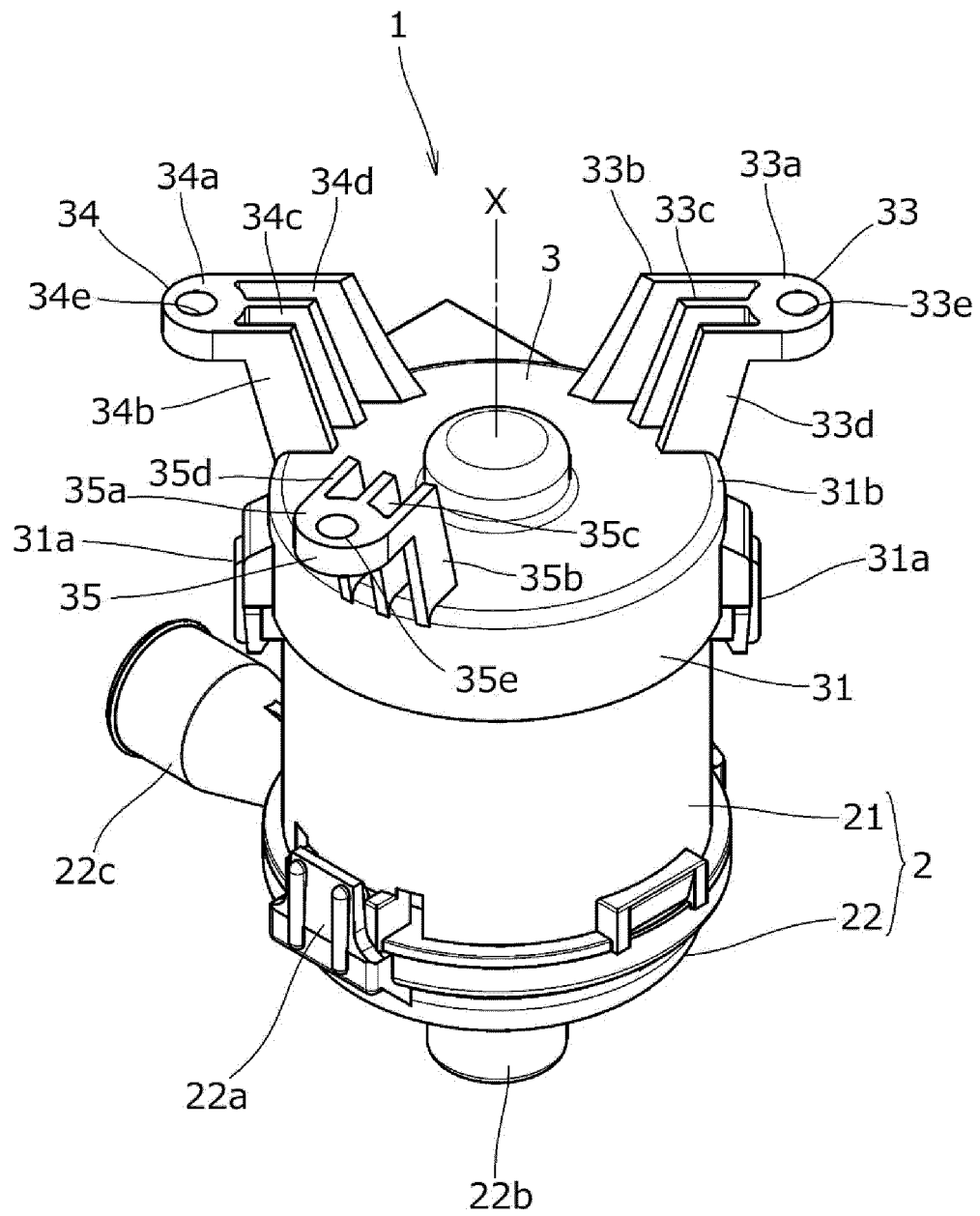


FIG. 2

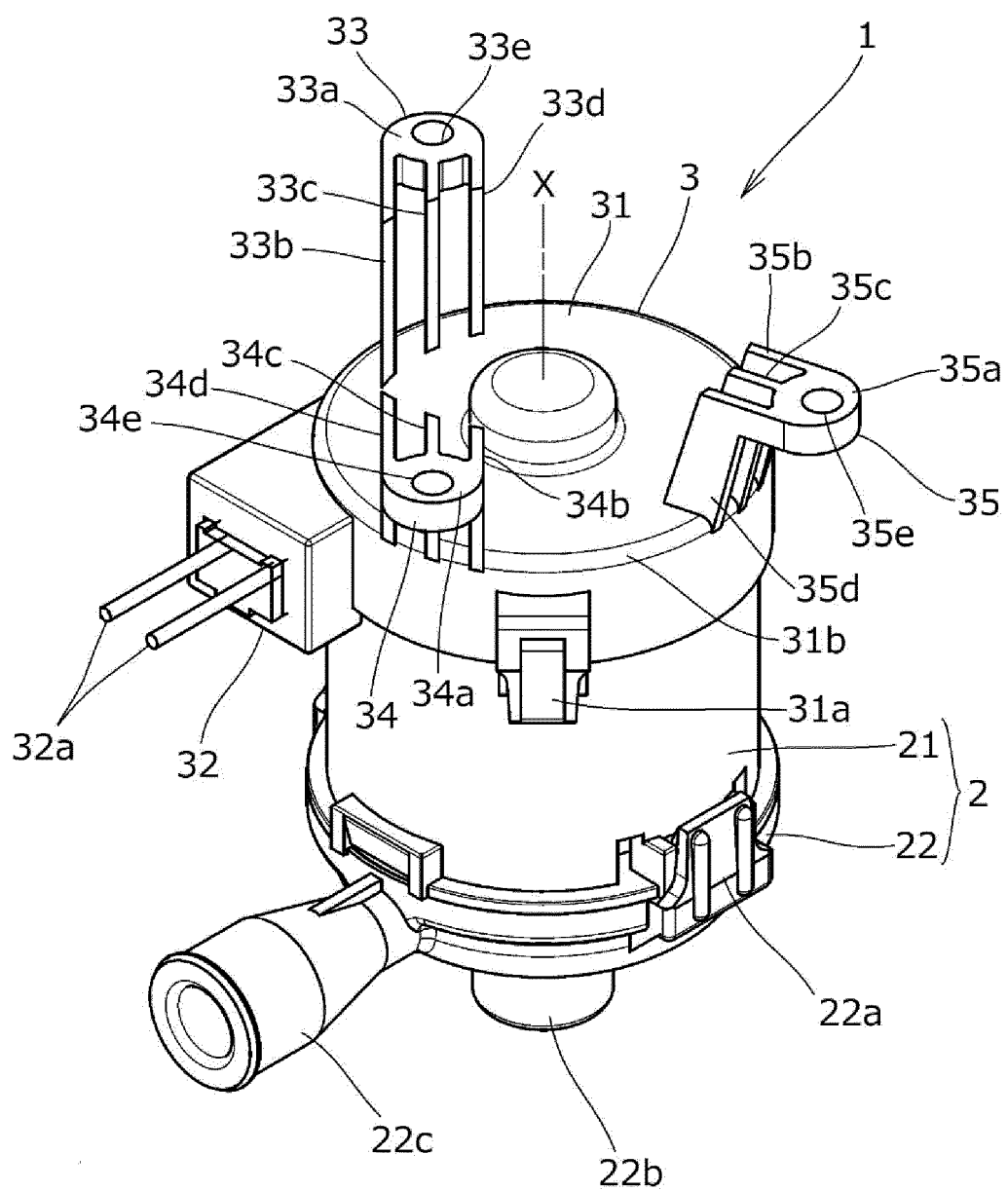


FIG. 3

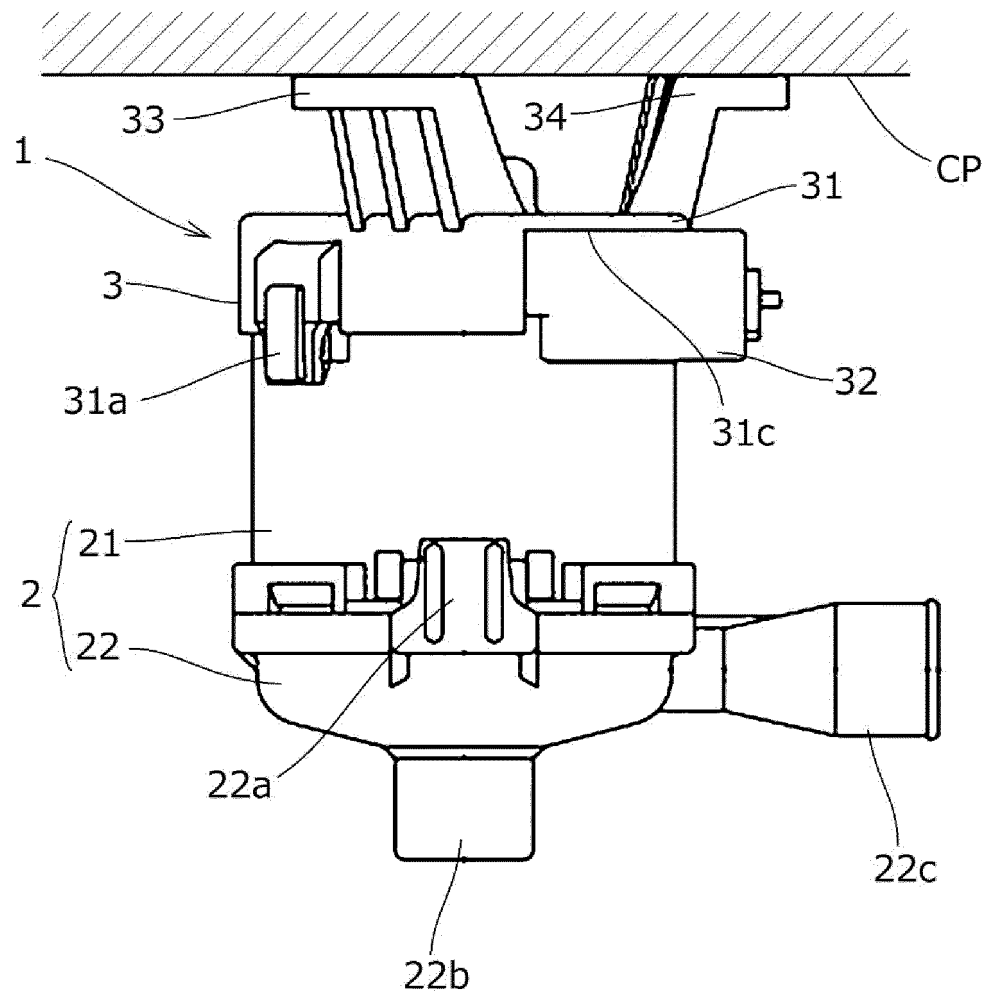


FIG. 4

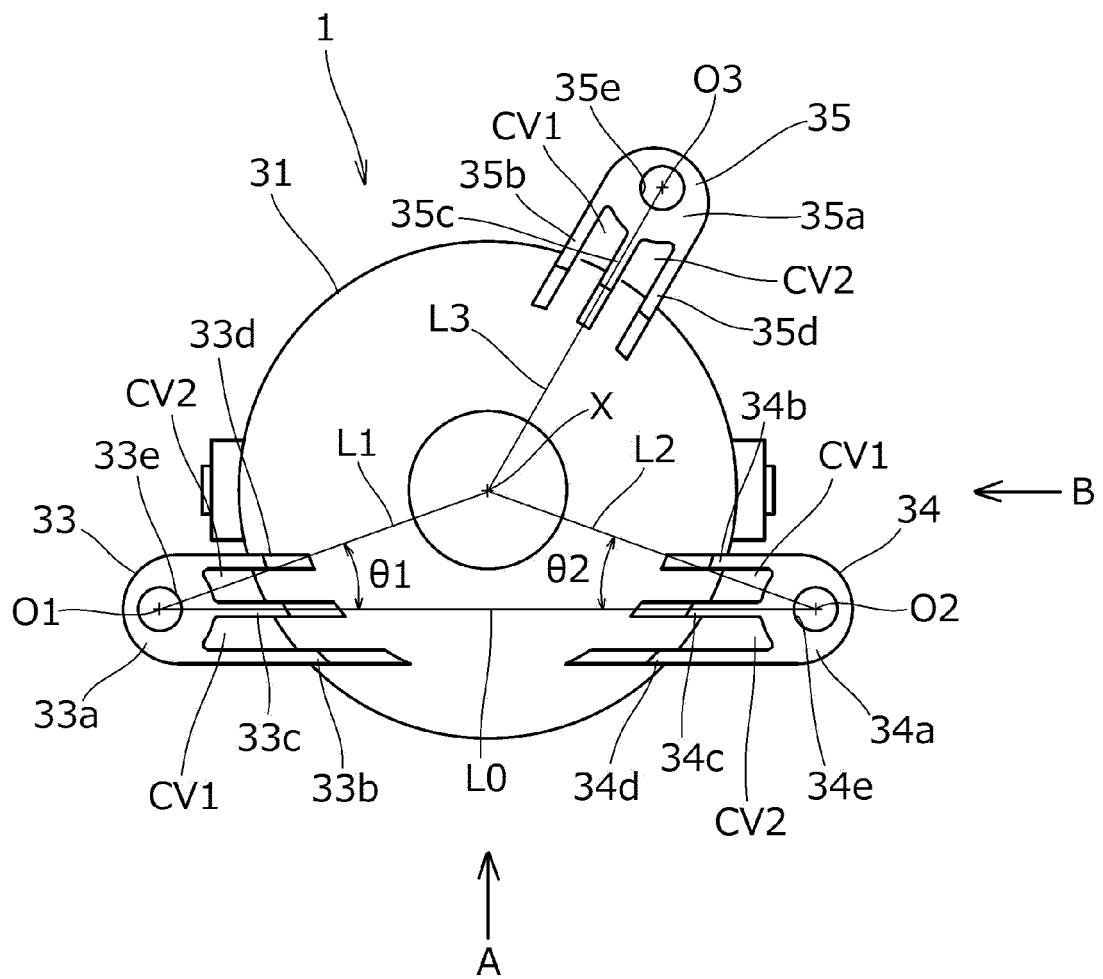


FIG. 5

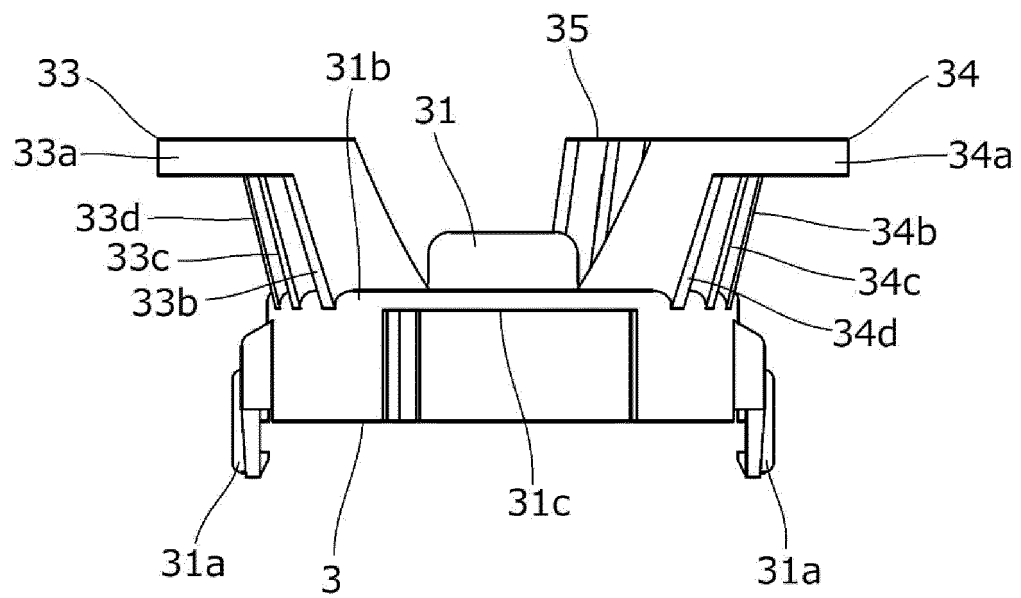


FIG. 6

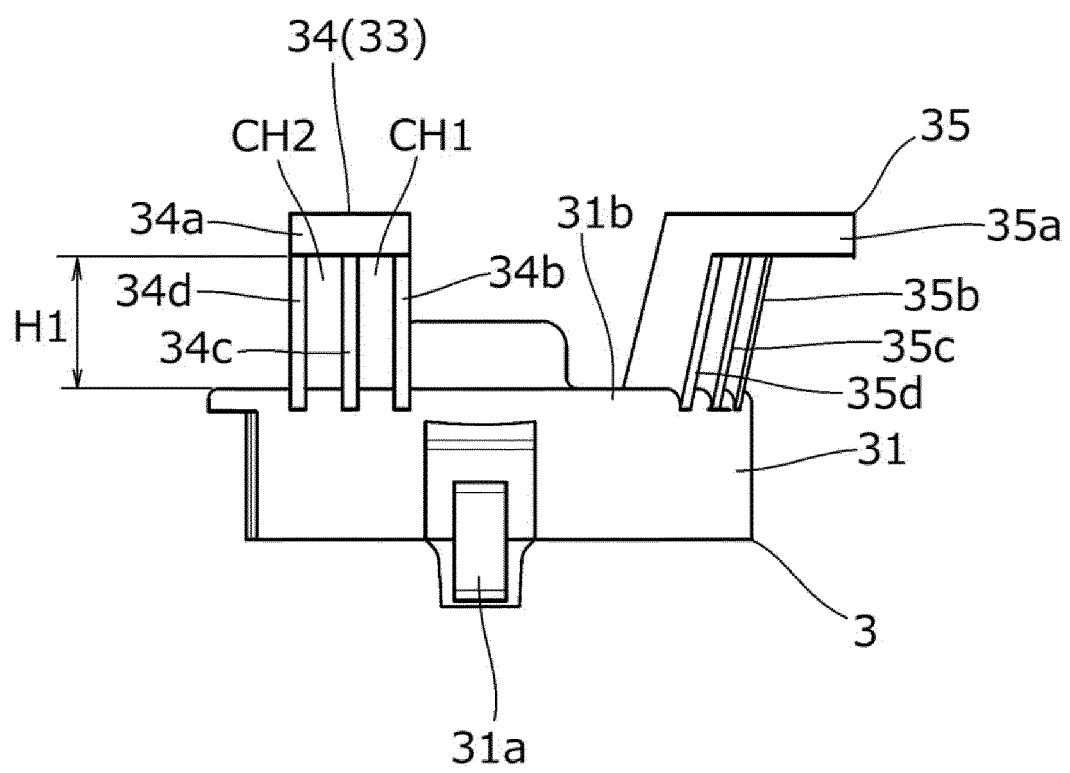


FIG. 7

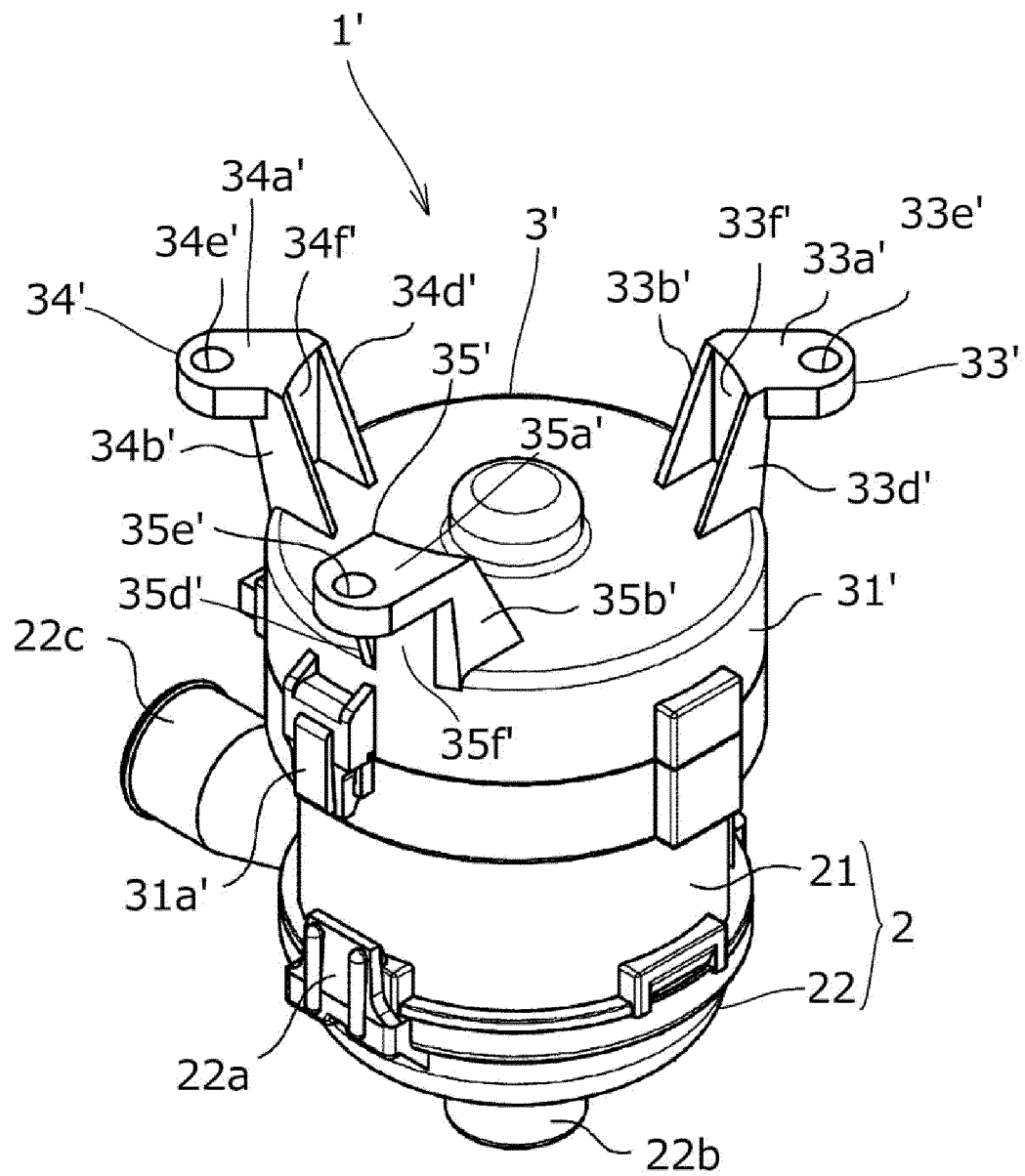


FIG. 8

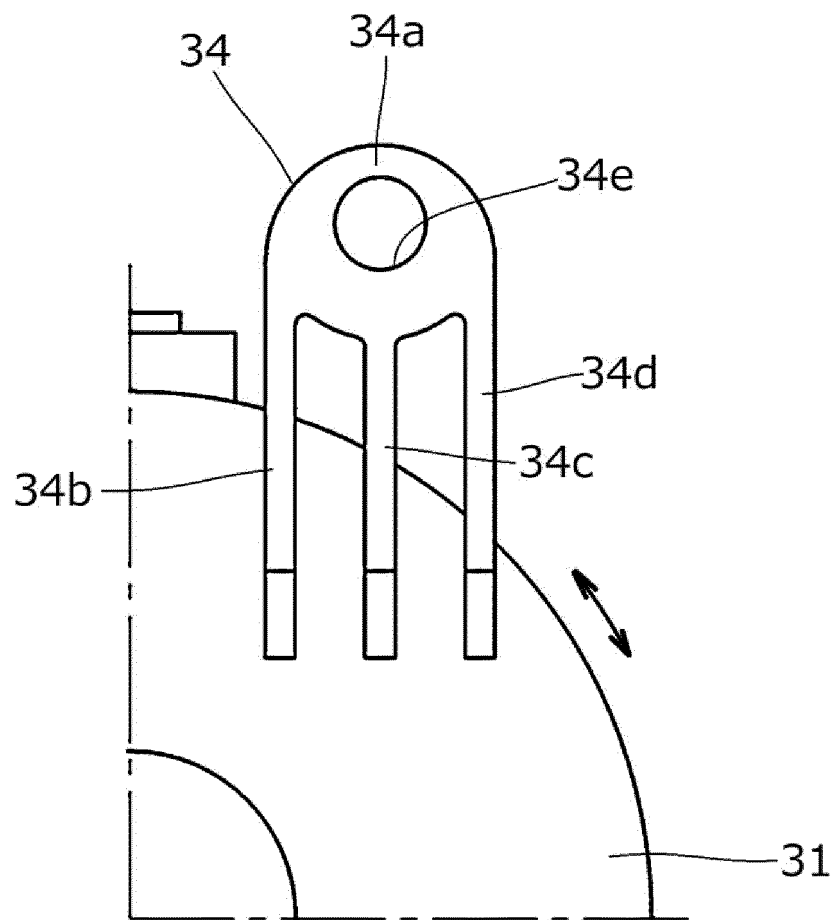


FIG. 9

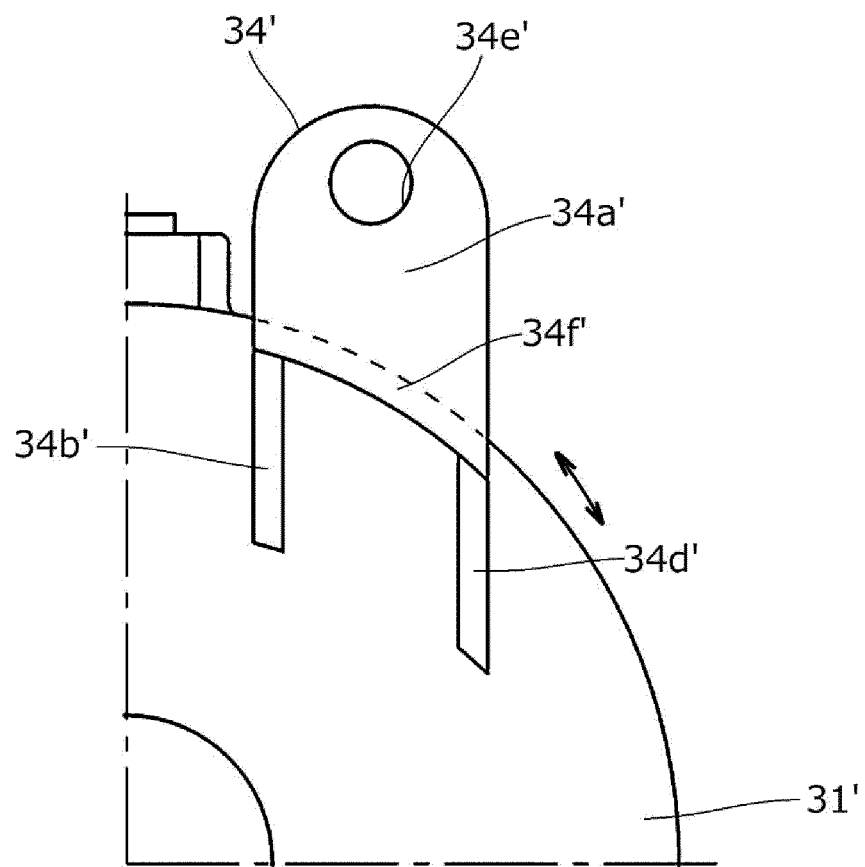


FIG. 10

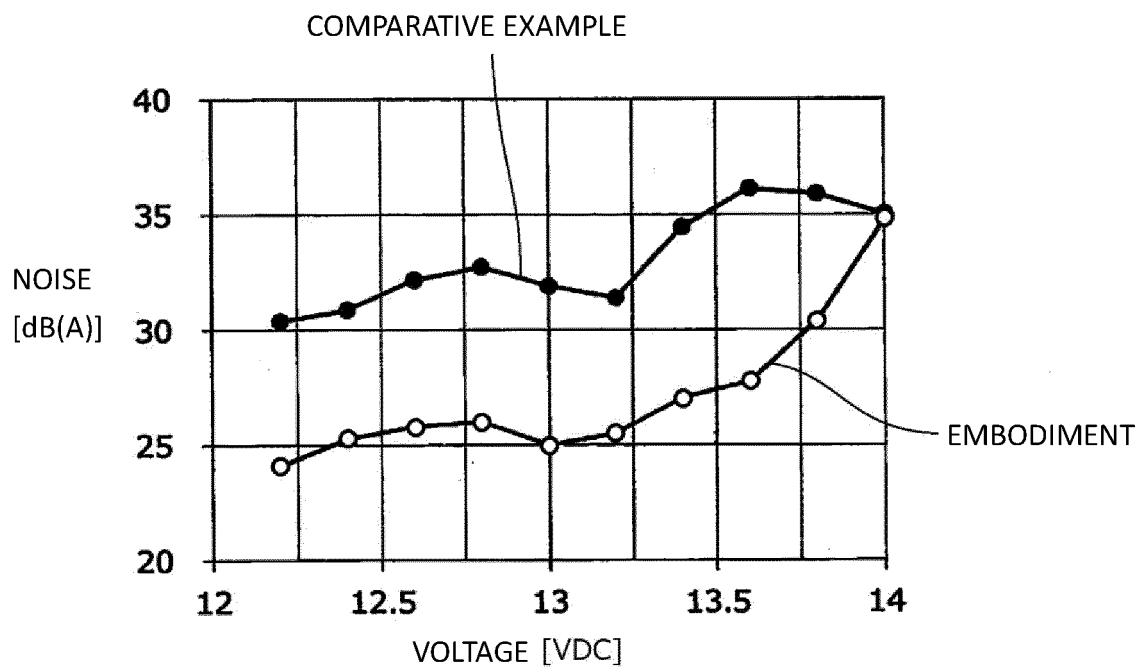


FIG. 11

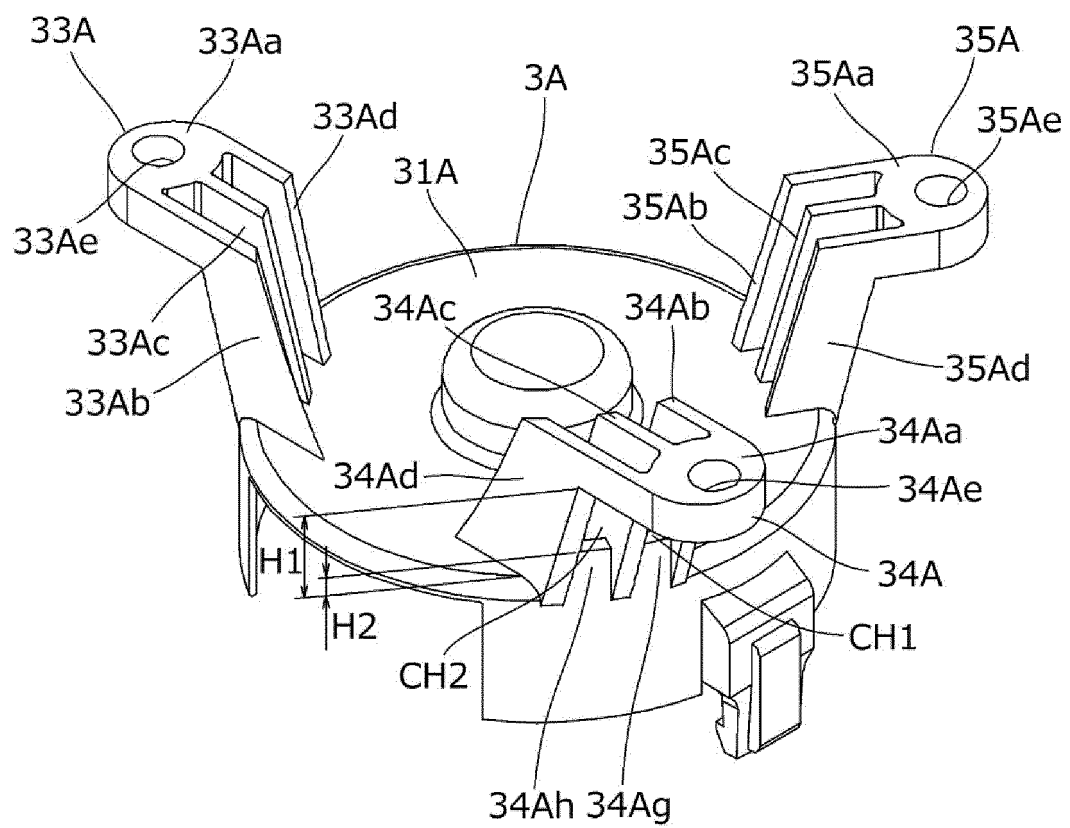


FIG. 12

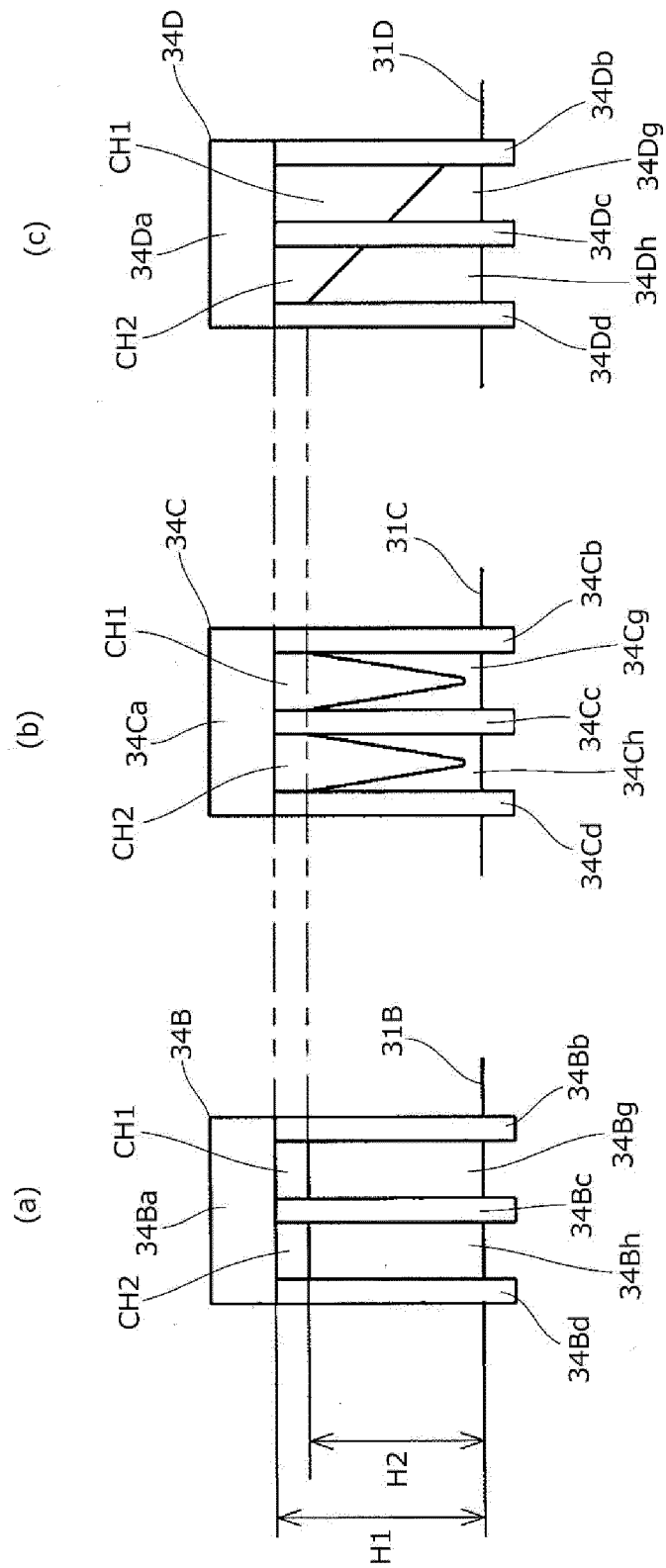


FIG. 13

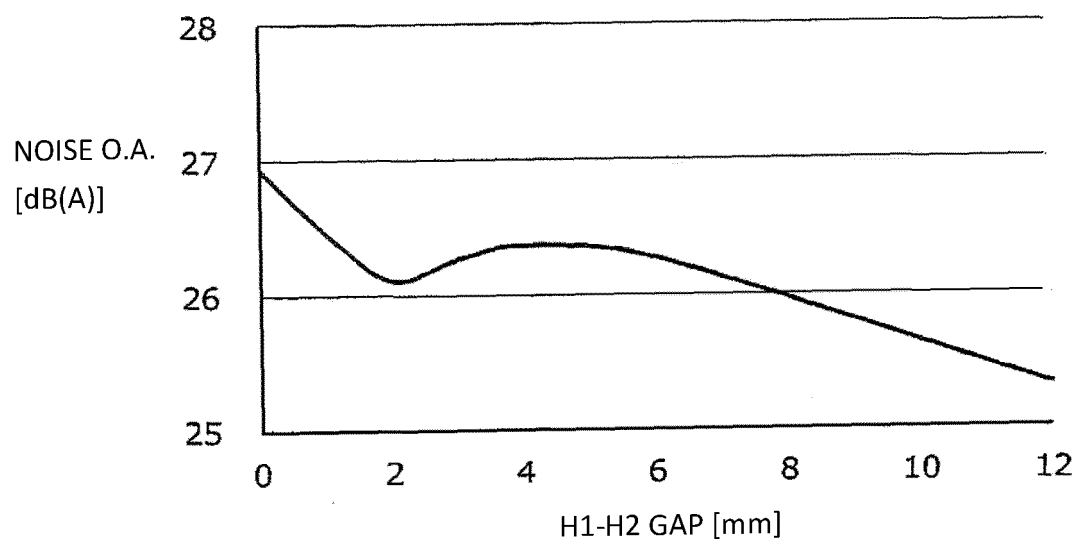
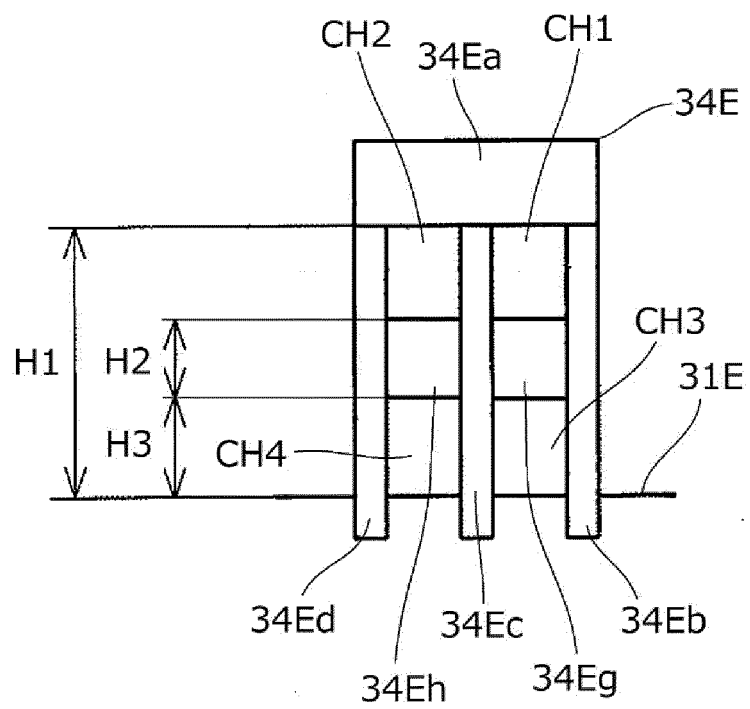


FIG. 14



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/041658

A. CLASSIFICATION OF SUBJECT MATTER		
F04D 29/66 (2006.01)i; F04D 1/14 (2006.01)i; F04D 29/42 (2006.01)i; F04D 29/62 (2006.01)i FI: F04D29/66 D; F04D1/14; F04D29/42 E; F04D29/62 A		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) F04D29/66; F04D1/14; F04D29/42; F04D29/62		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Published examined utility model applications of Japan 1922-1996 Published unexamined utility model applications of Japan 1971-2022 Registered utility model specifications of Japan 1996-2022 Published registered utility model applications of Japan 1994-2022		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2020-016175 A (FUJI KOKI CORP.) 30 January 2020 (2020-01-30) paragraphs [0019]-[0029], fig. 1-3	1-8
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 087850/1976 (Laid-open No. 005301/1978) (MATSUSHITA ELECTRIC IND. CO., LTD.) 18 January 1978 (1978-01-18), specification, page 4, lines 14-19, fig. 1-4	1-8
A	WO 2012/172614 A1 (HITACHI, LTD.) 20 December 2012 (2012-12-20) paragraphs [0016]-[0021], fig. 2-6	1
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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Date of the actual completion of the international search	Date of mailing of the international search report	
02 December 2022	20 December 2022	
Name and mailing address of the ISA/JP	Authorized officer	
Japan Patent Office (ISA/JP) 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915 Japan		
	Telephone No.	

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/041658

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2020-016175 A	30 January 2020	WO 2020/022030 A1 paragraphs [0019]-[0029], fig. 1-3 CN 112469905 A KR 10-2021-0034634 A	
JP 53-005301 U1	18 January 1978	(Family: none)	
WO 2012/172614 A1	20 December 2012	US 2014/0234100 A1 paragraphs [0041]-[0046], fig. 2-6 CN 103608594 A	

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REFERENCES CITED IN THE DESCRIPTION

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