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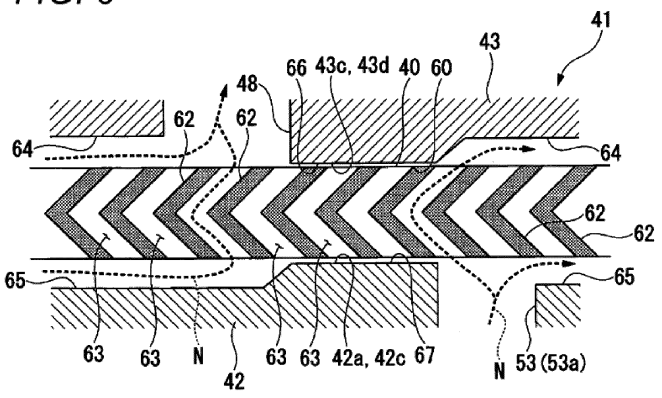
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(54) NON-POSITIVE DISPLACEMENT TYPE PUMP AND LIQUID SUPPLY DEVICE

(57) A pump unit (4), which is a non-positive displacement type pump provided in a liquid supply device (1), has a first seal section (66) and a second seal section (67) provided between an intake port (53) and a discharge port (48) in the circumferential direction of an impeller (40). An angle between the two straight lines connecting the circumferential ends of each seal portion (66, 67) and the center of rotation of the impeller (40) is 43° or more and 47° or less. Each seal portion (66, 67) has a size making it possible to close at least two through flow paths (63) between both ends in the circumferential direction.

FIG. 6



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Description

TECHNICAL FIELD

[0001] The present invention relates to a non-positive displacement type pump and a liquid supply device.

BACKGROUND ART

[0002] A non-positive displacement type pump includes an impeller having a substantial disc shape and a pump case formed in a manner of covering the entire impeller. The impeller is formed with a plurality of blade portions that are arranged in a peripheral direction. A plurality of through flow paths that pass through the impeller in a plate thickness direction of the impeller are formed among the blade portions. The pump case rotatably accommodates the impeller. The pump case includes a suction port and a discharge port disposed at two sides of the impeller.

[0003] Such a non-positive displacement type pump is used as a liquid supply device (fuel pump) for a vehicle such as a motorcycle or a four-wheeled vehicle. This type of liquid supply device is disposed in a fuel tank.

[0004] With such a configuration, when the impeller is rotated, fuel enters the through flow paths of the impeller via the suction port of the pump case. The fuel that entered the through flow paths is sent to the discharge port while being compressed along with the rotation of the impeller. Thereafter, the fuel is discharged from the discharge port. The fuel again enters the through flow paths from which the fuel is discharged, via the suction port along with the rotation of the impeller.

[0005] Here, a portion from the discharge port to the suction port in a rotation direction of the impeller serves as a seal portion so that the discharge port and the suction port do not communicate with each other. The seal portion is provided to suppress the fuel in the discharge port from leaking to the suction port side. A flow rate characteristic of the non-positive displacement type pump is determined by a length of the seal portion in the peripheral direction. That is, when the length of the seal portion in the peripheral direction is short, the amount of the fuel drawn into the through flow paths of the impeller is increased by this amount, and thus a discharge flow rate of the non-positive displacement type pump is increased. On the other hand, when the length of the seal portion in the peripheral direction is long, the amount of the fuel drawn into the through flow paths of the impeller is reduced by this amount, so that a discharge flow rate of the non-positive displacement type pump is reduced.

CITATION LIST

PATENT LITERATURE

[0006]

Patent Literature 1: Japanese Patent No. 4952180
Patent Literature 2: JP-A-2015-86804

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0007] However, in the related art described above, when the fuel cannot be completely discharged from the through flow paths of the impeller at the discharge port and the fuel having a high pressure is sent to the suction port, the fuel is rapidly depressurized at the suction port, and depressurization boiling may occur. Noise may be generated due to the pressure fluctuation of the fuel at this time.

[0008] Therefore, an object of the present invention is to provide a non-positive displacement type pump and a liquid supply device that can reduce noise at the time of driving while ensuring an appropriate discharge flow rate.

SOLUTION TO PROBLEM

[0009] A non-positive displacement type pump according to a first aspect of the present invention includes:

an impeller having a disc shape, and
a pump case that is formed in a manner of covering the entire impeller and that rotatably accommodates the impeller with a center in a radial direction of the impeller serving as a rotation center, in which
the impeller includes:

a plurality of blade portions arranged in a peripheral direction near an outer peripheral portion of the impeller, and
a plurality of through flow paths each of which is formed between the blade portions adjacent to each other in the peripheral direction and each of which passes through the impeller in a plate thickness direction of the impeller,

the pump case includes:

an accommodating portion that accommodates the impeller,
a suction port that passes through the accommodating portion and an outer side of the pump case in the plate thickness direction of the impeller and that communicates with the through flow paths,
a discharge port that is disposed at an opposite side to the suction port with the impeller interposed, that passes through the accommodating portion and the outer side of the pump case in the plate thickness direction, and that communicates with the through flow paths, and
a seal portion provided between the suction port and the discharge port in the peripheral direc-

tion,

an angle between two straight lines respectively connecting two ends of the seal portion in the peripheral direction with the rotation center, is 43° or more and 47° or less, and
the seal portion has a size at which the seal portion closes at least two of the through flow paths between the two ends.

[0010] With such a configuration, it is possible to ensure an appropriate discharge flow rate of the non-positive displacement type pump. In addition, a distance of the seal portion in the peripheral direction can be made appropriate, and depressurization boiling of liquid sent from the discharge port to the suction port can be suppressed. Therefore, noise generated at the time of driving the non-positive displacement type pump can be reduced.

[0011] According to a second aspect of the present invention, in the first aspect,

the pump case includes:

an upper case that is in sliding contact with one surface of the impeller and that covers the one surface, and
a lower case that is in sliding contact with the other surface of the impeller opposite to the one surface and that covers the other surface,

the accommodating portion is defined by the upper case and the lower case,
the upper case includes:

the discharge port, and
an arc-shaped first flow path groove that is provided in a first sliding contact surface facing the impeller and that communicates with the discharge port,

the lower case includes:

the suction port, and
an arc-shaped second flow path groove that is provided in a second sliding contact surface facing the impeller and that communicates with the suction port, and

the seal portion is positioned between the discharge port and the suction port, and is positioned on a rotation trajectory of the through flow paths.

[0012] With such a configuration, it is possible to provide a non-positive displacement type pump that can reduce noise generated at the time of driving while ensuring an appropriate discharge flow rate with a simple structure.

[0013] A liquid supply device according to a third aspect of the present invention includes:

the non-positive displacement type pump according to the first aspect or the second aspect, and
a motor portion that is configured to drive the non-positive displacement type pump, in which
a rotation shaft of the motor portion and the impeller are coupled to each other in a manner in which the rotation shaft and the impeller are not rotated relative to each other.

[0014] With such a configuration, it is possible to provide a non-positive displacement type pump that can reduce noise generated at the time of driving while ensuring an appropriate discharge flow rate.

ADVANTAGEOUS EFFECTS OF INVENTION

[0015] According to the present invention, it is possible to ensure an appropriate discharge flow rate of the non-positive displacement type pump. In addition, a distance of the seal portion in the peripheral direction can be made appropriate, and depressurization boiling of liquid sent from the discharge port to the suction port can be suppressed. Therefore, noise generated at the time of driving the non-positive displacement type pump can be reduced.

BRIEF DESCRIPTION OF DRAWINGS

[0016]

[FIG. 1] FIG. 1 is a perspective view of a liquid supply device according to an embodiment of the present invention.
[FIG. 2] FIG. 2 is a cross-sectional view taken along an axial direction of the liquid supply device according to the embodiment of the present invention.
[FIG. 3] FIG. 3 is a perspective view of an impeller according to an embodiment of the present invention.
[FIG. 4] FIG. 4 is a plan view of an upper case according to the embodiment of the present invention when viewed from a lower case side.
[FIG. 5] FIG. 5 is a plan view of the lower case according to the embodiment of the present invention when viewed from an upper case side.
[FIG. 6] FIG. 6 is a simplified view of a cross section taken along an axial direction of a pump portion according to the embodiment of the present invention.
[FIG. 7] FIG. 7 is a graph showing a comparison between a fuel discharge flow rate in a case where seal portions satisfy a seal condition and a fuel discharge flow rate in a case where the seal portions do not satisfy the seal condition, according to the embodiment of the present invention.
[FIG. 8] FIG. 8 is a graph showing changes of a fuel

discharge flow rate and a fuel sound pressure level according to the embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0017] Next, an embodiment of the present invention will be described with reference to the drawings.

(Liquid Supply Device)

[0018] FIG. 1 is a perspective view of a liquid supply device 1. FIG. 2 is a cross-sectional view taken along an axial direction of the liquid supply device 1.

[0019] The liquid supply device 1 is used as a fuel pump for a vehicle such as a motorcycle and a four-wheeled vehicle. The liquid supply device 1 is a so-called in-tank type fuel pump disposed in a fuel tank (not shown).

[0020] As shown in FIGS. 1 and 2, the liquid supply device 1 includes a substantially cylindrical metal housing 2, a motor portion 3, and a pump portion 4. The motor portion 3 and the pump portion 4 are fitted to an inner peripheral surface of the housing 2 and are arranged side by side in an axial direction of the housing 2. The housing 2, the motor portion 3, and the pump portion 4 are coaxially arranged.

[0021] The liquid supply device 1 is used with the pump portion 4 facing downward in the direction of gravity. Therefore, a motor portion 3 side may be referred to as an upper side and a pump portion 4 side may be referred to as a lower side in the following description. In the following description, an axial direction of the housing 2, the motor portion 3, and the pump portion 4 is simply referred to as an axial direction, a radial direction of the housing 2, the motor portion 3, and the pump portion 4 is simply referred to as a radial direction, and a peripheral direction of the housing 2, the motor portion 3, and the pump portion 4 is simply referred to as a peripheral direction.

[0022] The housing 2 is formed by integrally molding a motor fitting portion 11 to which the motor portion 3 is fitted and a pump fitting portion 12 which is formed to have a smaller diameter than the motor fitting portion 11 via a step and to which the pump portion 4 is fitted. A positioning protrusion portion 13 that protrudes inward in the radial direction is formed on an inner peripheral surface of the pump fitting portion 12. The positioning protrusion portion 13 is formed by pressing the housing 2 from an outer side in the radial direction by press working or the like. The positioning protrusion portion 13 positions the housing 2 and the pump portion 4 in the peripheral direction. The positioning protrusion portion 13 is formed into a rectangular shape that is long in the axial direction when viewed from the radial direction.

[0023] An inner flange portion 12a that extends inward in the radial direction is bent and extended from a lower end of the pump fitting portion 12 in the housing 2. The positioning protrusion portion 13 and the inner flange portion 12a position the housing 2 and the pump portion 4 in the axial direction.

[0024] For example, a brush-equipped motor is adopted as the motor portion 3. The motor portion 3 mainly includes a substantially cylindrical yoke 5, a permanent magnet 8 provided on an inner peripheral surface of the yoke 5, an armature 6 rotatably provided in the yoke 5, an outlet cover 7 that closes an upper opening 5a of the yoke 5, and a brush 25 accommodated in the outlet cover 7. An outer peripheral surface of the yoke 5 is fitted to an inner peripheral surface of the housing 2.

[0025] The yoke 5 serves as a magnetic path through which a magnetic flux of the permanent magnet 8 passes. The upper opening 5a of the yoke 5 is fitted to an outer peripheral surface of a spigot joint portion 31 of the outlet cover 7 to be described later. Positioning of the outlet cover 7 and the yoke 5 in the peripheral direction is performed by recess/projection fitting of a positioning protrusion portion (not shown) formed on the outlet cover 7 and a yoke positioning recessed portion (not shown) formed on the yoke 5.

[0026] Two permanent magnets 8 are provided on an inner peripheral surface of the yoke 5. Each of the permanent magnets 8 is formed into a substantially semicircular shape along the inner peripheral surface of the yoke 5 when viewed from the axial direction. A length in the axial direction of the permanent magnet 8 is set to be longer than a length in the axial direction of an armature core 15. The permanent magnet 8 is disposed such that two ends in the axial direction of the permanent magnet 8 protrude (overhang) from two ends in the axial direction of the armature core 15. A magnetic field orientation of the permanent magnet 8 is along the radial direction (a thickness direction of the permanent magnet 8).

[0027] In this manner, the permanent magnets 8 are arranged to face each other in the radial direction around a rotation shaft 14. Minute gaps are formed between an inner peripheral surface of the permanent magnet 8 and an outer end in the radial direction of teeth 17 of the armature core 15 and between an inner peripheral surface of the permanent magnet 8 and an outer end in the radial direction of a resin mold portion 22. The teeth 17 and the resin mold portion 22 will be described later.

[0028] The armature 6 mainly includes the rotation shaft 14, the armature core 15 fitted and fixed to an outer peripheral surface of the rotation shaft 14, and a commutator 16 fitted and fixed to the outer peripheral surface of the rotation shaft 14 at a position closer to the outlet cover 7 than the armature core 15.

[0029] The armature core 15 has a plurality of teeth 17 extending radially outward in the radial direction. A winding (not shown) is wound around the teeth 17. A terminal portion of the winding (not shown) is connected to the commutator 16.

[0030] The commutator 16 is a so-called disc type commutator having a commutator body 18 formed of resin and formed into a substantial disc shape. A plurality of segments 19 are arranged side by side in the peripheral

direction on a surface 18a of the commutator body 18 opposite to the armature core 15. Risers 21 that are bent and extended toward the armature core 15 over an outer peripheral surface of the commutator body 18 are integrally formed with an outer end in the radial direction of the segment 19. One end of the winding (not shown) is connected to each riser 21.

[0031] Most of the armature 6 formed in this manner is covered with the resin mold portion 22. The resin mold portion 22 is formed into a substantially columnar shape. The resin mold portion 22 extends from a position closer to the pump portion 4 than the armature core 15 to a substantially center portion of the commutator body 18 in the axial direction. Only outer ends in the radial direction (outer peripheral surfaces) of the teeth 17 of the armature core 15 are exposed, and the winding (not shown) is buried in the resin mold portion 22. A round chamfered portion 22a is formed at a corner portion of an end of the resin mold portion 22 that is close to the pump portion 4. Accordingly, the end of the resin mold portion 22 that is close to the pump portion 4 is tapered.

[0032] The outlet cover 7 is formed into a substantially bottomed cylindrical shape having an opening portion 7a at the armature core 15 side. A bearing cylindrical portion 23 protruding toward the armature core 15 is integrally formed with a bottom portion 7b of the outlet cover 7 at a substantially center portion in the radial direction. An upper end portion 14a of the rotation shaft 14 is rotatably supported by the bearing cylindrical portion 23.

[0033] Brush holders 24 are integrally formed at two sides of the bearing cylindrical portion 23 at the bottom portion 7b of the outlet cover 7. Each of the brush holders 24 is formed into a box shape having an opening at the commutator 16 side. The brush 25 is accommodated in the brush holder 24 in a slidable manner along the axial direction. A coil spring 26 is accommodated in the brush holder 24 in a compressed and deformed state. The brush 25 is biased toward the commutator 16 by the coil spring 26. A tip end of the brush 25 protrudes from the brush holder 24 and is in sliding contact with the segment 19.

[0034] A terminal 27 that passes through the bottom portion 7b in an upper-lower direction is provided in the bottom portion 7b of the outlet cover 7. The brush 25 is connected to the terminal 27 via a pigtail (not shown). An external power supply (not shown) is connected to the terminal 27. Accordingly, external power is supplied to the winding (not shown) via the terminal 27, the pigtail (not shown), the brush 25, and the segment 19.

[0035] A discharge port 28 protruding upward is integrally formed with the bottom portion 7b of the outlet cover 7. The discharge port 28 is a portion from which fuel pumped up by the liquid supply device 1 is discharged, and is connected to a fuel flow path (not shown). An inner side and an outer side of the outlet cover 7 communicate with each other via the discharge port 28.

[0036] A positioning piece 32 extending downward is integrally formed with a peripheral wall 7c of the outlet cover 7. The positioning piece 32 is interposed between the permanent magnets 8 and positions the permanent magnets 8 (yoke 5) and the outlet cover 7.

[0037] The peripheral wall 7c of the outlet cover 7 is formed with a fitting ridge portion 29 extending outward in the radial direction over the entire outer peripheral surface. An outer diameter of the fitting ridge portion 29 is set to be substantially the same as an inner diameter of the motor fitting portion 11 of the housing 2. An outer peripheral surface of the fitting ridge portion 29 is fitted to an inner peripheral surface of the motor fitting portion 11. An upper opening edge portion 11a of the motor fitting portion 11 is crimped inward in the radial direction from above the fitting ridge portion 29 of the outlet cover 7. A lower side of the fitting ridge portion 29 on the peripheral wall 7c of the outlet cover 7 serves as the spigot joint portion 31 to be spigot fitted to the yoke 5.

(Pump Portion)

[0038] A lower end portion of the rotation shaft 14 is inserted into the pump portion 4.

[0039] A non-positive displacement type pump having an impeller 40 is used as the pump portion 4. The pump portion 4 includes the impeller 40 and a pump case 41 formed in a manner of covering the entire impeller 40. The pump case 41 is fitted to the pump fitting portion 12 of the housing 2.

(Impeller)

[0040] FIG. 3 is a perspective view of the impeller 40.

[0041] As shown in FIGS. 2 and 3, the impeller 40 is formed of a resin material and is formed into a substantial disc shape. An insertion hole 61 through which the lower end portion 14b of the rotation shaft 14 can be inserted is formed at a substantially center portion in the radial direction of the impeller 40. Here, the lower end portion 14b of the rotation shaft 14 is formed to have a substantially D-shaped cross section orthogonal to the axial direction. The insertion hole 61 of the impeller 40 is formed into a substantially D shape when viewed in the axial direction so as to correspond to the cross-sectional shape of the lower end portion 14b of the rotation shaft 14. When the lower end portion 14b of the rotation shaft 14 is inserted into the insertion hole 61, the rotation shaft 14 and the impeller 40 are rotated integrally and cannot be rotated relative to each other.

[0042] A plurality of blade portions 62 (also see FIG. 6) having a substantially L-shaped cross section along the axial direction are formed near an outer peripheral portion of the impeller 40. The blade portions 62 are arranged at equal intervals in the peripheral direction so that peripheral directions of the blade portions 62 are the same. A through flow path 63 is formed between blade portions 62 adjacent to each other in the peripheral direction. The through flow path 63 passes through the impeller 40 in a plate thickness direction.

(Pump Case)

[0043] As shown in FIG. 2, the pump case 41 that covers the entire impeller 40 includes an upper case 43, a middle case 44, and a lower case 42.

[0044] FIG. 4 is a plan view of the upper case 43 when viewed from the lower case 42 side (lower side).

[0045] As shown in FIGS. 2 and 4, the upper case 43 is disposed on the impeller 40 at a side close to the motor portion 3. The upper case 43 is formed into a substantial disc shape in a manner of covering an upper surface of the impeller 40. The middle case 44 is joined to an outer peripheral portion of the upper case 43. An outer diameter of the upper case 43 is set to be slightly smaller than an outer diameter of the yoke 5.

[0046] An insertion hole 46 through which the lower end portion 14b of the rotation shaft 14 can be inserted is formed at a center portion in the radial direction of the upper case 43. The rotation shaft 14 is rotatably supported in the insertion hole 46 via a slide bearing 59.

[0047] A recessed portion 47 having a substantially annular shape when viewed in the axial direction is formed in an upper surface 43a of the upper case 43 in a manner of surrounding a periphery of the insertion hole 46. On the upper surface 43a of the upper case 43, an outer peripheral side of the recessed portion 47 serves as a contact surface 43b that is brought into contact with the yoke 5. Since a sufficient space is ensured for the contact surface 43b, even when a lower end of the yoke 5 is brought into contact with the contact surface 43b, buckling deformation of the contact surface 43b or the yoke 5 is suppressed.

[0048] A discharge port 48 that passes through the upper case 43 in the upper-lower direction is formed in the upper surface 43a of the upper case 43 near an outer peripheral portion of the recessed portion 47. On a lower surface 43c of the upper case 43, a recessed portion 48a that expands an opening of the discharge port 48 is formed at a peripheral edge of the discharge port 48. The recessed portion 48a is formed in a manner of expanding toward the lower surface 43c of the upper case 43.

[0049] The lower surface 43c of the upper case 43 serves as a first sliding contact surface 43d that is in sliding contact with the impeller 40. A first flow path groove 64 having a substantial arc shape (a substantial C shape) when viewed from the axial direction is formed on the first sliding contact surface 43d at a position facing the through flow path 63 of the impeller 40 in the axial direction. One end in the peripheral direction of the first flow path groove 64 communicates with the discharge port 48 (the recessed portion 48a). A tapered portion 64a is formed at the other end in the peripheral direction of the first flow path groove 64 in a manner of being tapered when viewed in the axial direction.

[0050] The middle case 44 is formed into a substantial ring shape in a manner of surrounding an outer peripheral surface of the impeller 40. The middle case 44 is formed integrally with the upper case 43. An outer diameter of the middle case 44 is set to be slightly larger than the outer diameter of the upper case 43. The middle case 44 aligns a center in the radial direction of the impeller 40 with an axial center C of the rotation shaft 14. A thickness of the middle case 44 in the axial direction is substantially the same as or slightly larger than a plate thickness of the impeller 40. Accordingly, predetermined clearances are respectively formed between the impeller 40 and the upper case 43 and between the impeller 40 and the lower case 42.

[0051] FIG. 5 is a plan view of the lower case 42 when viewed from the upper case 43 side (from above). For the convenience of description, FIG. 5 shows the lower case 42 in a manner in which a position in the peripheral direction of a first seal portion 66 provided in the upper case 43 shown in FIG. 4 substantially coincides with a position in the peripheral direction of a second seal portion 67 provided in the lower case 42 shown in FIG. 5.

[0052] As shown in FIGS. 2 and 5, the lower case 42 is disposed below the impeller 40. The pump case 41 includes the upper case 43 integrally formed with the middle case 44 and the lower case 42, and covers the entire impeller 40. The lower surface 43c of the upper case 43 and the upper surface 42a of the lower case 42 form an accommodating portion 60 that accommodates the impeller 40.

[0053] The lower case 42 is formed into a substantial disc shape. An outer diameter of the lower case 42 is set to be substantially the same as an outer diameter of the middle case 44.

[0054] A substantially cylindrical suction port 53 protruding downward is formed at an outer peripheral side of the lower surface 42b of the lower case 42. A tapered hole portion 53a is formed in an inner peripheral surface of the suction port 53 at the upper surface 42a side of the lower case 42 in a manner in which an opening area gradually increases toward the upper surface 42a.

[0055] A step portion 49 is formed on an outer peripheral edge of the lower surface 42b of the lower case 42. The step portion 49 is formed by reducing a diameter of the lower surface 42b of the lower case 42. The step portion 49 is formed at a position overlapping with the inner flange portion 12a of the housing 2 when viewed in the axial direction.

[0056] The upper surface 42a of the lower case 42 serves as a second sliding contact surface 42c that is in sliding contact with the impeller 40. A bearing accommodating recessed portion 54 that faces the lower end portion 14b of the rotation shaft 14 is formed in the upper surface 42a of the lower case 42 at a substantially center portion in the radial direction. A thrust bearing 55 is accommodated in the bearing accommodating recessed portion 54. The lower end portion 14b of the rotation shaft 14 is rotatably supported by the lower case 42 in a state where the lower end portion 14b is brought into contact with the thrust bearing 55. The thrust bearing 55 receives a thrust load of the rotation shaft 14.

[0057] A second flow path groove 65 having a substan-

tial arc shape (substantial C shape) when viewed in the axial direction is formed on the second sliding contact surface 42c of the lower case 42 at a position facing the through flow path 63 of the impeller 40 in the axial direction and facing the first flow path groove 64 of the upper case 43. One end in the peripheral direction of the second flow path groove 65 communicates with the suction port 53 (tapered hole portion 53a). A tapered portion 65a is formed at the other end in the peripheral direction of the second flow path groove 65 in a manner of being tapered when viewed in the axial direction.

[0058] In the second flow path groove 65, a vent hole 68 is formed in a manner of passing through the lower case 42 in a plate thickness direction of the lower case 42 at a position slightly closer to the suction port 53 than a center between the suction port 53 and the tapered portion 65a. The vent hole 68 is a hole for discharging vapor (air bubbles) generated in the pump case 41.

[0059] Here, the discharge port 48 that communicates with one end in the peripheral direction of the first flow path groove 64 and the tapered portion 64a formed at the other end in the peripheral direction of the first flow path groove 64, and the suction port 53 that communicates with one end in the peripheral direction of the second flow path groove 65 and the tapered portion 65a formed at the other end in the peripheral direction of the second flow path groove 65, are alternately arranged. That is, the discharge port 48 faces the tapered portion 65a of the second flow path groove 65 in the axial direction. The suction port 53 faces the tapered portion 64a of the first flow path groove 64 in the axial direction.

[0060] A portion of the first sliding contact surface 43d of the upper case 43 between the discharge port 48 (the recessed portion 48a) and the tapered portion 64a of the first flow path groove 64 serves as the first seal portion 66 for suppressing leakage of fuel from the discharge port 48 to the tapered portion 64a. A portion of the second sliding contact surface 42c of the lower case 42 between the suction port 53 (tapered hole portion 53a) and the tapered portion 65a of the second flow path groove 65 serves as the second seal portion 67 for suppressing leakage of fuel from the tapered portion 65a to the suction port 53. A range (length) in the peripheral direction of the first seal portion 66 and a range (length) in the peripheral direction of the second seal portion 67 coincide with each other. The first seal portion 66 and the second seal portion 67 will be described in detail later. As can be seen from FIG. 6, the first seal portion 66 and the second seal portion 67 are positioned between the discharge port 48 and the suction port 53 and are positioned on a rotation trajectory of the through flow path 63.

[0061] A square ring 50 serving as a seal member is mounted to the step portion 49 formed on the lower surface 42b of the lower case 42. The square ring 50 is a member that has a substantially rectangular cross section and is formed of a material having excellent oil resistance such as fluoro rubber. An outer diameter of the square ring 50 is set to be slightly smaller than an outer diameter of the lower case 42. Therefore, outer peripheral surfaces of the upper case 43, the middle case 44, and the lower case 42 are fitted to the pump fitting portion 12 of the housing 2. A minute gap is formed between an outer peripheral surface of the square ring 50 and an inner peripheral surface of the pump fitting portion 12 of the housing 2.

[0062] With such a configuration, when the motor portion 3 and the pump portion 4 are accommodated in the housing 2, the square ring 50 is brought into contact with the inner flange portion 12a of the housing 2. At this time, the positioning protrusion portion 13 of the housing 2 is inserted into a recessed portion (not shown) formed on an outer peripheral surface of the pump case 41. Accordingly, the housing 2 and the pump portion 4 are positioned in the peripheral direction.

[0063] The upper opening edge portion 11a of the motor fitting portion 11 is crimped inward in the radial direction from above the fitting ridge portion 29 of the outlet cover 7 while the square ring 50 is slightly crushed by the step portion 49 of the lower case 42 and the inner flange portion 12a. Accordingly, the pump portion 4 is fitted to the pump fitting portion 12 of the housing 2. The motor portion 3 is fitted to the motor fitting portion 11 of the housing 2. Then, the motor portion 3 and the pump portion 4 are positioned relative to the housing 2, and the housing 2, the motor portion 3, and the pump portion 4 are integrated. Further, a sealing property between the housing 2 and the pump portion 4 is ensured by the square ring 50.

(Operation of Liquid Supply Device)

[0064] Next, an operation of the liquid supply device 1 will be described with reference to FIGS. 2 and 6.

[0065] FIG. 6 is a simplified view of a cross section taken along the axial direction of the pump portion 4.

[0066] As shown in FIGS. 2 and 6, when the rotation shaft 14 of the motor portion 3 is rotated, the impeller 40 is rotated integrally with the rotation shaft 14. Then, fuel N is suctioned into the pump case 41 through the suction port 53. The suctioned fuel N enters the through flow path 63 of the impeller 40, and then enters the first flow path groove 64 of the upper case 43 and the second flow path groove 65 of the lower case 42. Then, a swirling flow occurs between the impeller 40 and the pump case 41. The fuel in the through flow path 63 is pressurized toward the discharge port 48 due to this swirling flow.

[0067] The pressurized fuel N is discharged into the yoke 5 of the motor portion 3 through the discharge port 48. That is, a pressure of the fuel N in the discharge port 48 is higher than a pressure of the fuel N in the suction port 53. The first seal portion 66 and the second seal portion 67 are provided between the discharge port 48 and the suction port 53. Therefore, the fuel N discharged from the discharge port 48 is suppressed from leaking to the suction port 53, the first flow path groove 64, and a portion of the second flow path groove 65 that intersects

with the suction port 53 in the axial direction.

[0068] The fuel N discharged into the yoke 5 is pressure-fed to the discharge port 28 through a minute gap between the permanent magnet 8 and the resin mold portion 22 (an outer end in the radial direction of the teeth 17 of the armature core 15). Thereafter, the fuel is pressure-fed to an engine or the like (not shown) through the discharge port 28.

[0069] When the fuel N is not completely discharged at the discharge port 48 side in the through flow path 63 of the impeller 40 and the fuel N having a high pressure leaks to the vicinity of the suction port 53, specifically, leaks to the suction port 53, the first flow path groove 64, and a portion of the second flow path groove 65 that intersects with the suction port 53 in the axial direction, the fuel N is rapidly depressurized at the suction port 53, and depressurization boiling occurs. Noise may be generated due to a pressure fluctuation of the fuel N at this time. Therefore, in order to suppress such leakage of the fuel N, the range (length) in the peripheral direction of the first seal portion 66 and the range (length) in the peripheral direction of the second seal portion 67 are set as follows.

[0070] That is, as shown in FIG. 4, straight lines respectively connecting two ends in the peripheral direction of the first seal portion 66 with the axial center C of the rotation shaft 14 are defined as L1. Here, the two ends in the peripheral direction of the first seal portion 66 are a position where the straight line L1 that passes through the axial center C is in contact with the tapered portion 64a of the first flow path groove 64 and a position where the straight line L1 is in contact with the recessed portion 48a of the discharge port 48.

[0071] As shown in FIG. 5, straight lines respectively connecting two ends in the peripheral direction of the second seal portion 67 with the axial center C of the rotation shaft 14 are defined as L2. Here, the two ends in the peripheral direction of the second seal portion 67 are a position where the straight line L2 that passes through the axial center C is in contact with the tapered portion 65a of the second flow path groove 65 and a position where the straight line L2 is in contact with the tapered hole portion 53a of the suction port 53.

[0072] A portion of the first sliding contact surface 43d of the upper case 43 that is located between the two straight lines L1 and faces the blade portions 62 and the through flow path 63 of the impeller 40 in the axial direction serves as the first seal portion 66. A portion of the second sliding contact surface 42c of the lower case 42 that is located between the two straight lines L2 and faces the blade portions 62 and the through flow path 63 of the impeller 40 in the axial direction serves the second seal portion 67.

[0073] An angle $\theta 1$ between the two straight lines L1 and an angle $\theta 2$ between the two straight lines L2 satisfy the following formula.

$$\theta 1 \approx \theta 2 = 45° \pm 2° \qquad (1)$$

[0074] In other words, the angles $\theta 1$ and $\theta 2$ are set so as to satisfy $43° \leq \theta 1 \leq 47°$ and $43° \leq \theta 2 \leq 47°$.

[0075] As shown in detail in FIG. 6, the first seal portion 66 and the second seal portion 67 are formed to have a size at which the first seal portion 66 and the second seal portion 67 can close at least two through flow paths 63 between two ends in the peripheral direction of each of the first seal portion 66 and the second seal portion 67. A condition of the seal portions 66 and 67 having a size at which the seal portions 66 and 67 can close the at least two through flow paths 63 and satisfying the above formula (1) is hereinafter referred to as a seal condition.

[0076] Next, effects of the seal portions 66 and 67 that satisfy the seal condition will be described with reference to FIGS. 7 and 8.

[0077] FIG. 7 is a graph showing a comparison between a fuel discharge flow rate in a case where the seal portions 66 and 67 satisfy the seal condition and a fuel discharge flow rate in a case where the seal portions 66 and 67 do not satisfy the seal condition, in which a vertical axis indicates a fuel discharge flow rate [L/h] of the pump portion 4 (hereinafter, simply referred to as a fuel discharge flow rate).

[0078] In FIG. 7, "related art" refers to a case where the angle $\theta 1$ between the two straight lines L1 of the first seal portion 66 is 22° and the angle $\theta 2$ between the two straight lines L2 of the second seal portion 67 is 24°. The angles $\theta 1$ and $\theta 2$ in the "related art" do not satisfy the above formula (1). In FIG. 7, "45° - 1" refers to a case where the angle $\theta 1$ between the two straight lines L1 and the angle $\theta 2$ between the two straight lines L2 of the seal portions 66 and 67 are 45° - 1, and satisfies the above formula (1). In FIG. 7, "45° - 2" refers to a case where the angle $\theta 1$ between the two straight lines L1 and the angle $\theta 2$ between the two straight lines L2 of the seal portions 66 and 67 are 45° - 2, and satisfies the above formula (1). In FIG. 7, "67°" refers to a case where the angle $\theta 1$ between the two straight lines L1 and the angle $\theta 2$ between the two straight lines L2 of the seal portions 66 and 67 are 67°, and does not satisfy the above formula (1).

[0079] As shown in FIG. 7, when the seal portions 66 and 67 satisfy the seal condition, it can be confirmed that a fuel discharge flow rate is slightly reduced as compared with the related art, but a fuel discharge flow rate is increased as compared with "67°".

[0080] FIG. 8 is a graph showing changes of a fuel discharge flow rate and a fuel sound pressure level, in which a vertical axis indicates a fuel discharge flow rate [L/h] and a fuel sound pressure level [dB] in the vicinity of the suction port 53 when the fuel having a high pressure is fed to the suction port 53, and in which a horizontal axis indicates the angle $\theta 1$ [°] between the two straight lines L1 and the angle $\theta 2$ [°] between the two straight lines L2 of the seal portions 66 and 67.

[0081] As shown in FIG. 8, it can be confirmed that the fuel sound pressure level can be reduced while satisfying a range W of a desired discharge flow rate in a range in which the angle θ1 between the two straight lines L1 and the angle θ2 between the two straight lines L2 of the seal portions 66 and 67 satisfy the above formula (1). The range W of the discharge flow rate is determined as a range in which both an allowable sound pressure level and a practically desirable discharge flow rate can be achieved when the liquid supply device 1 of the present type is used in practice.

[0082] When the seal portions 66 and 67 satisfy the seal condition, the sound pressure level can be reduced as compared with that in the related art, and the condition of the flow rate can be satisfied as compared with "67°". Therefore, when the seal portions 66 and 67 satisfy the seal condition, it can be confirmed that a performance balance between the flow rate and the sound pressure level is good.

[0083] Therefore, according to the embodiment described above, when the seal portions 66 and 67 satisfy the seal condition, the pump portion 4 can ensure an appropriate fuel discharge flow rate. Further, when the angles θ1 between the two straight lines L1 and the angle θ2 between the two straight lines L2 of the seal portions 66 and 67 satisfy the above formula (1), the ranges (lengths) in the peripheral direction of the seal portions 66 and 67 can be made appropriate. As a result, depressurization boiling of the fuel fed from the discharge port 48 to the suction port 53 can be suppressed, the sound pressure level of the pump portion 4 can be reduced, and noise generated at the time of driving the pump portion 4 can be reduced.

[0084] The pump case 41 of the pump portion 4 includes the upper case 43 that covers an upper surface of the impeller 40 and the lower case 42 that covers a lower surface of the impeller 40. The upper case 43 includes the discharge port 48 for discharging fuel from the pump portion 4, and the first flow path groove 64 formed in the first sliding contact surface 43d. The lower case 42 includes the suction port 53 for suctioning fuel into the pump portion 4, and the second flow path groove 65 formed in the second sliding contact surface 42c. The first seal portion 66 is formed on the first sliding contact surface 43d of the upper case 43 between the discharge port 48 (the recessed portion 48a) and the tapered portion 64a of the first flow path groove 64. The second seal portion 67 is formed on the second sliding contact surface 42c of the lower case 42 between the suction port 53 (tapered hole portion 53a) and the tapered portion 65a of the second flow path groove 65. With such a configuration, the impeller 40, the first flow path groove 64, and the second flow path groove 65 are used to pressure-feed the fuel to the motor portion 3, and leakage of the fuel can be reliably suppressed by the seal portions 66 and 67, so that the configuration of the pump portion 4 can be simplified.

[0085] The present invention is not limited to the embodiment described above, and includes various modifications of the embodiment described above without departing from the spirit of the present invention.

[0086] For example, the liquid supply device 1 used as a fuel pump for a vehicle such as a motorcycle or a four-wheeled vehicle, is described in the embodiment described above. However, the liquid supply device 1 can be used to pressure-feed various kinds of liquid.

[0087] For example, a brush-equipped motor adopted as the motor portion 3 is described in the embodiment described above. However, the present invention is not limited thereto, and for example, a brushless motor may be adopted as the motor portion 3.

[0088] The pump case 41 including the upper case 43, the middle case 44, and the lower case 42 is described in the embodiment described above. However, the present invention is not limited thereto, and the upper case 43 and middle case 44 that are integrated may be referred to as one upper case 43. Further, as long as the pump case 41 includes the accommodating portion 60 that rotatably accommodates the impeller 40, and the pump case 41 may not be divided into the upper case 43 and the lower case 42. For example, the middle case 44 and the lower case 42 may be integrated, and the middle case 44 and the lower case 42 that are integrated may be referred to as one lower case 42.

[0089] The present application is based on a Japanese Patent Application No. 2019-004877, filed on January 16, 2019, the contents of which are incorporated herein by reference.

INDUSTRIAL APPLICABILITY

[0090] According to the non-positive displacement type pump and the liquid supply device of the present invention, for example, depressurization boiling of liquid that leaks from the discharge port to the suction port can be suppressed while an appropriate discharge flow rate can be ensured. The present invention that has such an effect is useful for, for example, a fuel pump for a vehicle such as a motorcycle or a four-wheeled vehicle.

REFERENCE SIGNS LIST

[0091]

1	liquid supply device
3	motor portion
4	pump portion (non-positive displacement type pump)
14	rotation shaft
40	impeller
41	pump case
42	lower case
42c	second sliding contact surface
43	upper case
43d	first sliding contact surface
48	discharge port

53	suction port
60	accommodating portion
62	blade portion
63	through flow path
64	first flow path groove
65	second flow path groove
66	first seal portion (seal portion)
67	second seal portion (seal portion)
C	axial center (rotation center)
L1, L2	straight line
θ1, θ2	angle

Claims

1. A non-positive displacement type pump comprising:

an impeller having a disc shape; and
a pump case that is formed in a manner of covering the entire impeller and that rotatably accommodates the impeller with a center in a radial direction of the impeller serving as a rotation center,
wherein the impeller includes:

a plurality of blade portions arranged in a peripheral direction near an outer peripheral portion of the impeller, and
a plurality of through flow paths each of which is formed between the blade portions adjacent to each other in the peripheral direction and each of which passes through the impeller in a plate thickness direction of the impeller,

wherein the pump case includes:

an accommodating portion that accommodates the impeller,
a suction port that passes through the accommodating portion and an outer side of the pump case in the plate thickness direction of the impeller and that communicates with the through flow paths,
a discharge port that is disposed at an opposite side to the suction port with the impeller interposed, that passes through the accommodating portion and the outer side of the pump case in the plate thickness direction, and that communicates with the through flow paths, and
a seal portion provided between the suction port and the discharge port in the peripheral direction,

wherein an angle between two straight lines respectively connecting two ends of the seal portion in the peripheral direction with the rotation center, is 43° or more and 47° or less, and
wherein the seal portion has a size at which the seal portion closes at least two of the through flow paths between the two ends.

2. The non-positive displacement type pump according to claim 1,

wherein the pump case includes:

an upper case that is in sliding contact with one surface of the impeller and that covers the one surface, and
a lower case that is in sliding contact with the other surface of the impeller opposite to the one surface and that covers the other surface,

wherein the accommodating portion is defined by the upper case and the lower case,
wherein the upper case includes:

the discharge port, and
an arc-shaped first flow path groove that is provided in a first sliding contact surface facing the impeller and that communicates with the discharge port,

wherein the lower case includes:

the suction port, and
an arc-shaped second flow path groove that is provided in a second sliding contact surface facing the impeller and that communicates with the suction port, and

wherein the seal portion is positioned between the discharge port and the suction port, and is positioned on a rotation trajectory of the through flow paths.

3. A liquid supply device comprising:

the non-positive displacement type pump according to claim 1 or 2, and
a motor portion that is configured to drive the non-positive displacement type pump,
wherein a rotation shaft of the motor portion and the impeller are coupled to each other in a manner in which the rotation shaft and the impeller are not rotated relative to each other.

FIG. 1

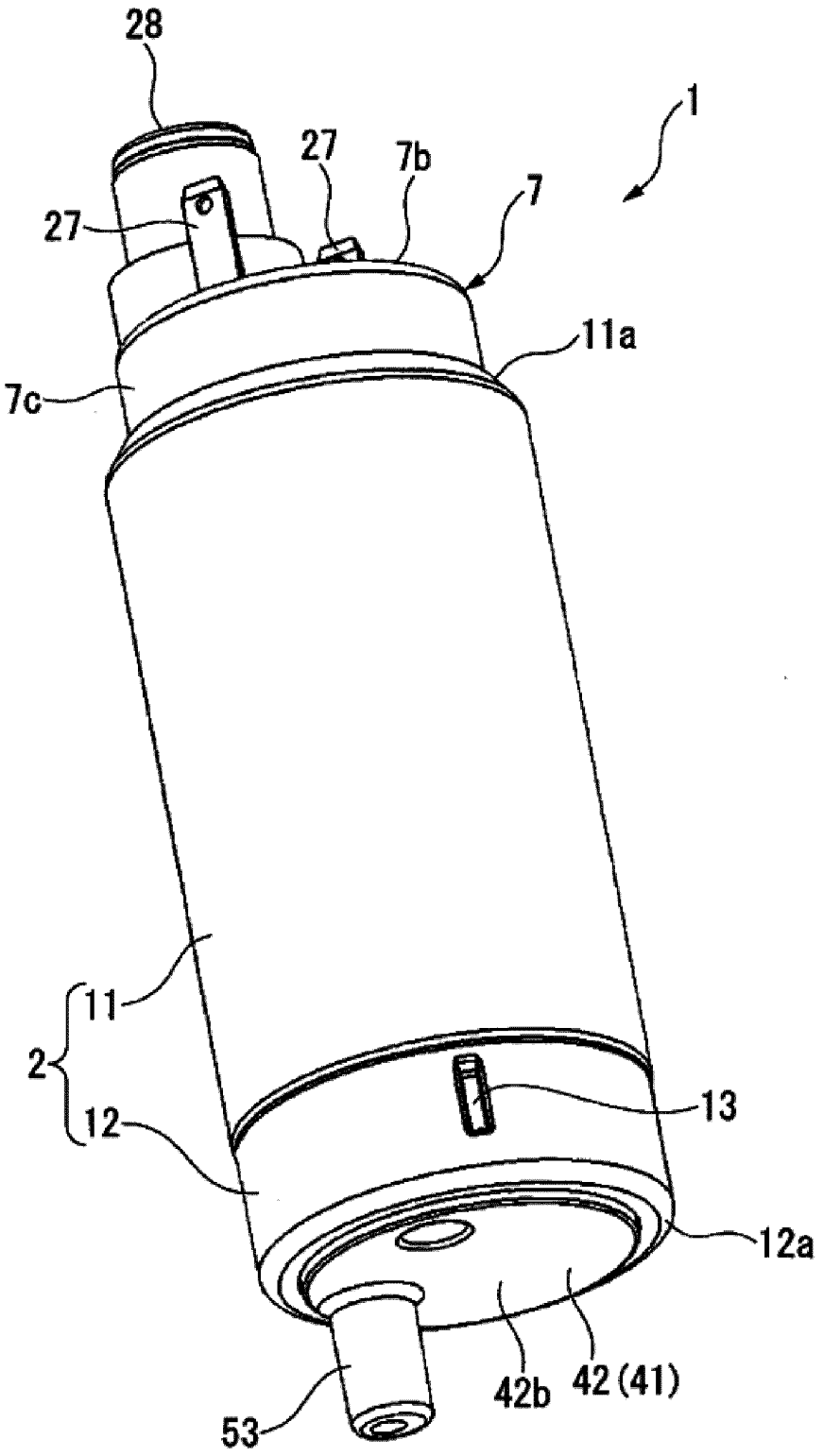


FIG. 2

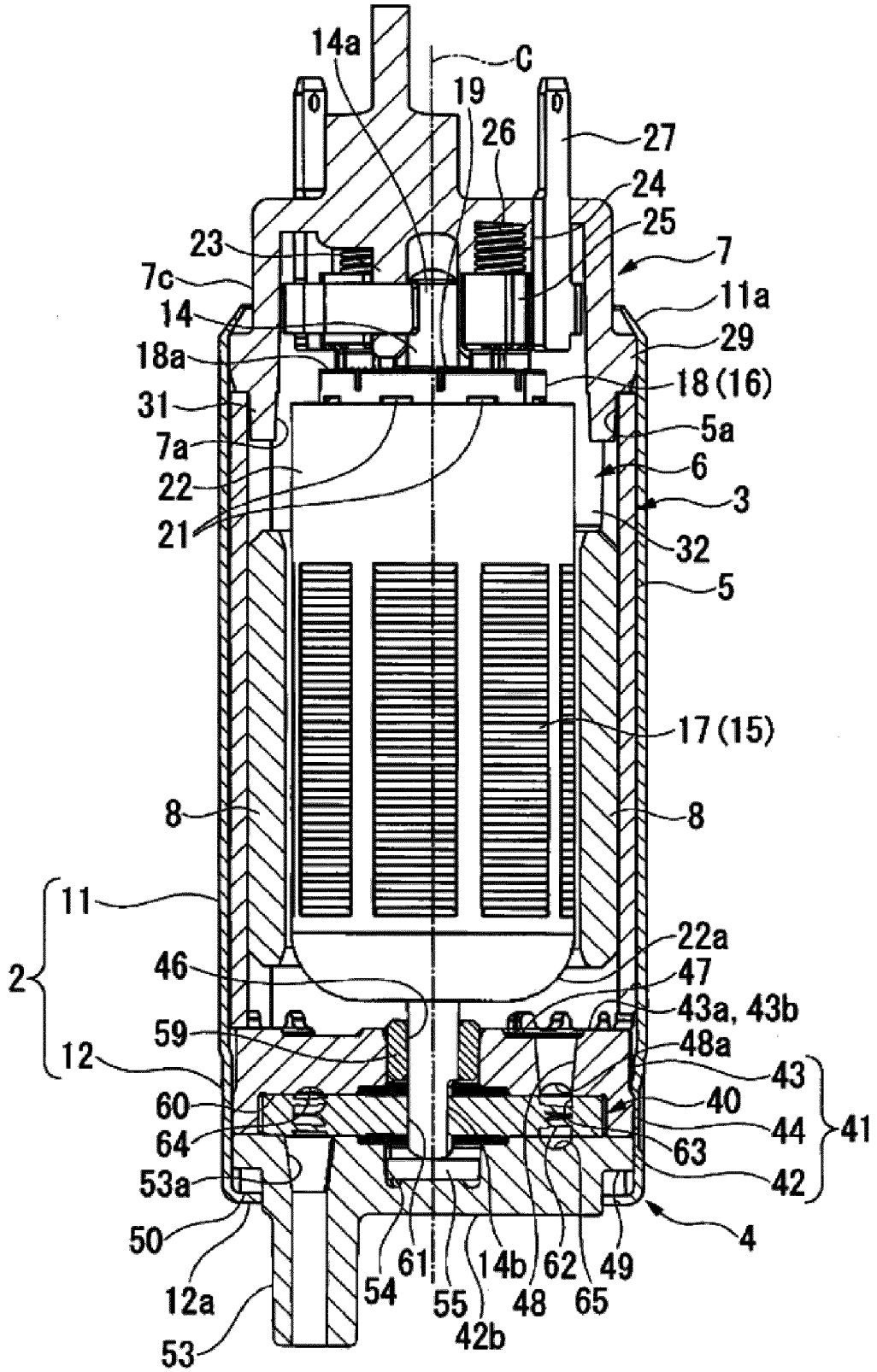

14a
C
19
26
27
24
25
23
7
7c
11a
14
29
18a
18 (16)
31
5a
7a
6
22
3
21
32
5
17 (15)
8
8
11
2
22a
46
47
43a, 43b
59
48a
12
43
60
40
41
64
44
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53a
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12a
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14b
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42b
53

FIG. 3

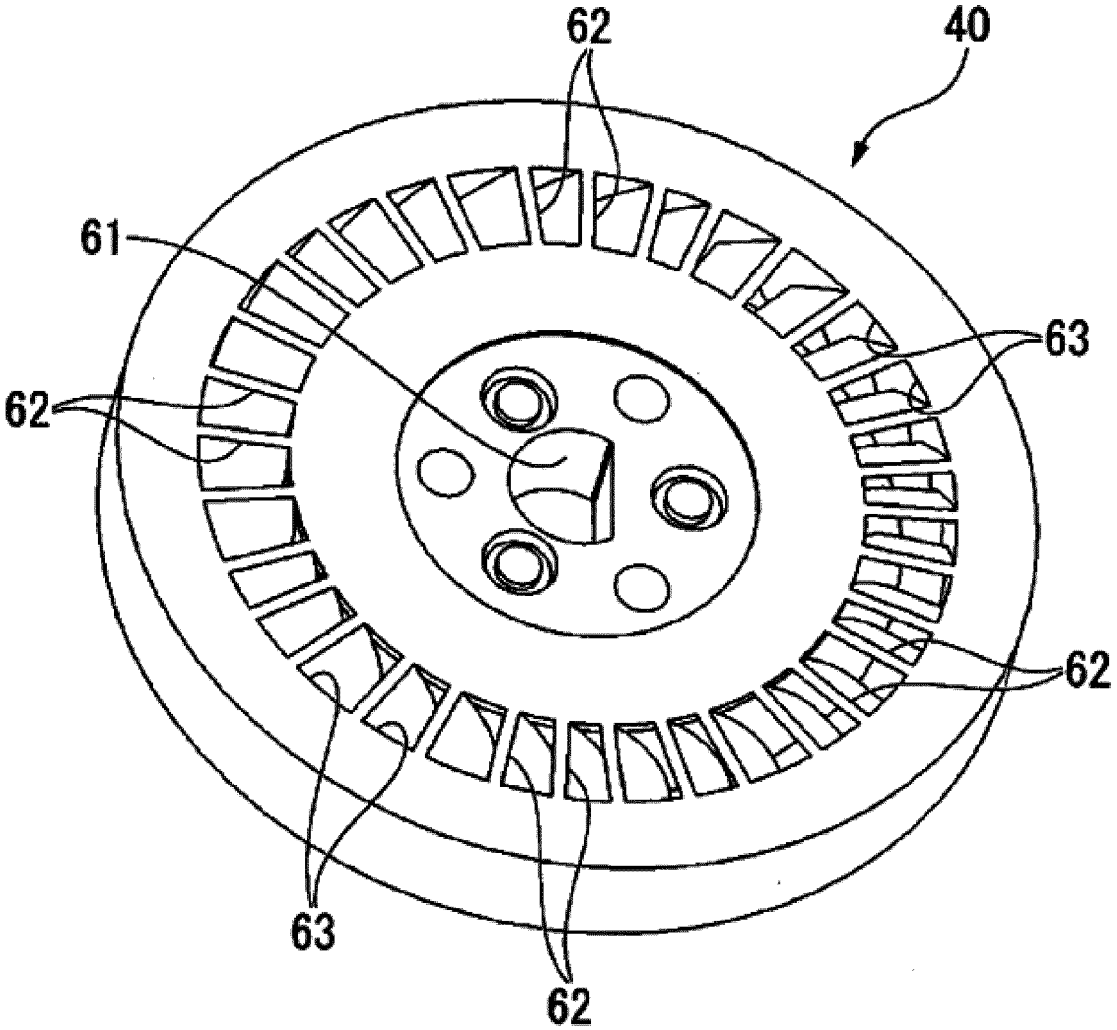


FIG. 4

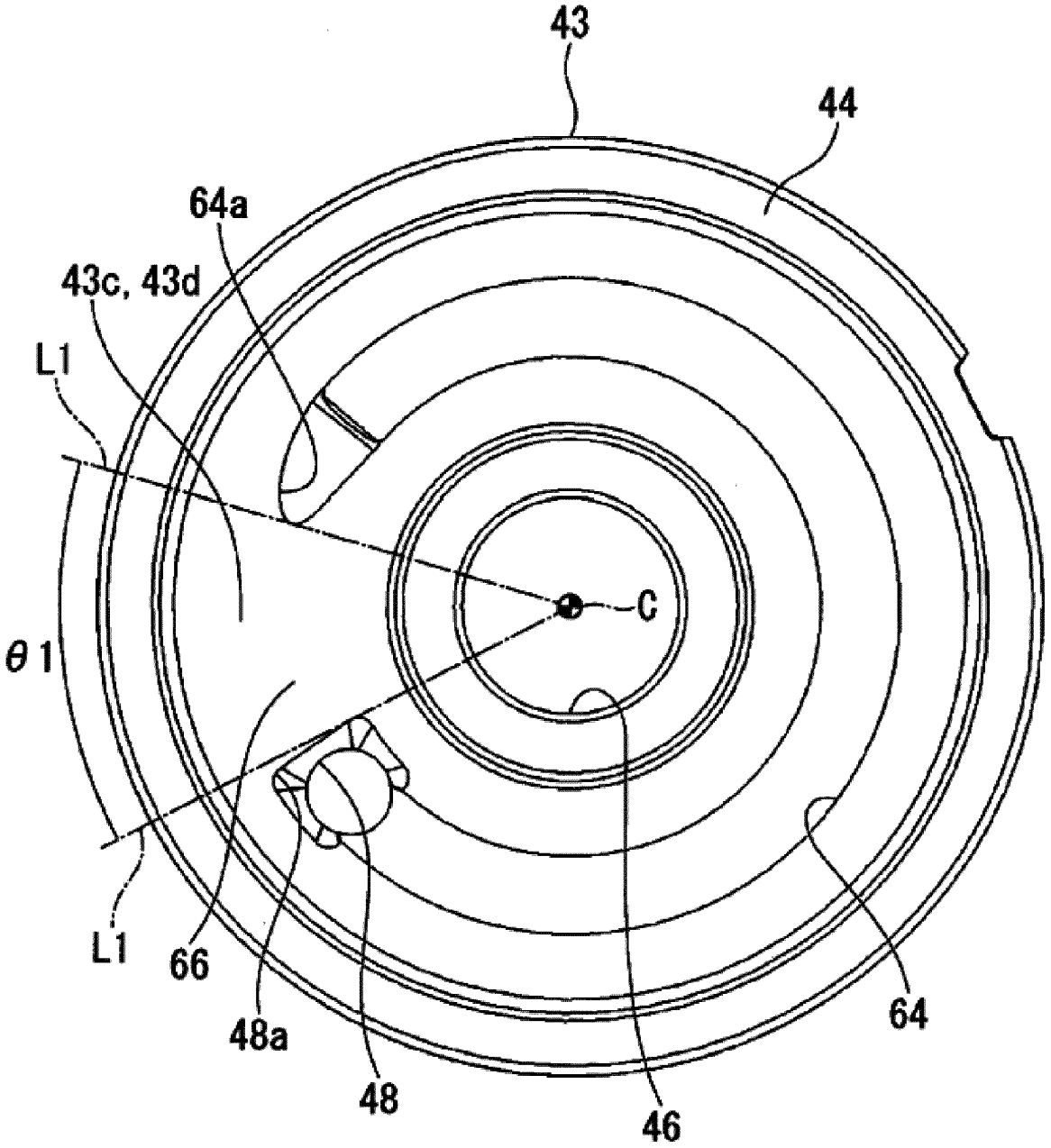


FIG. 5

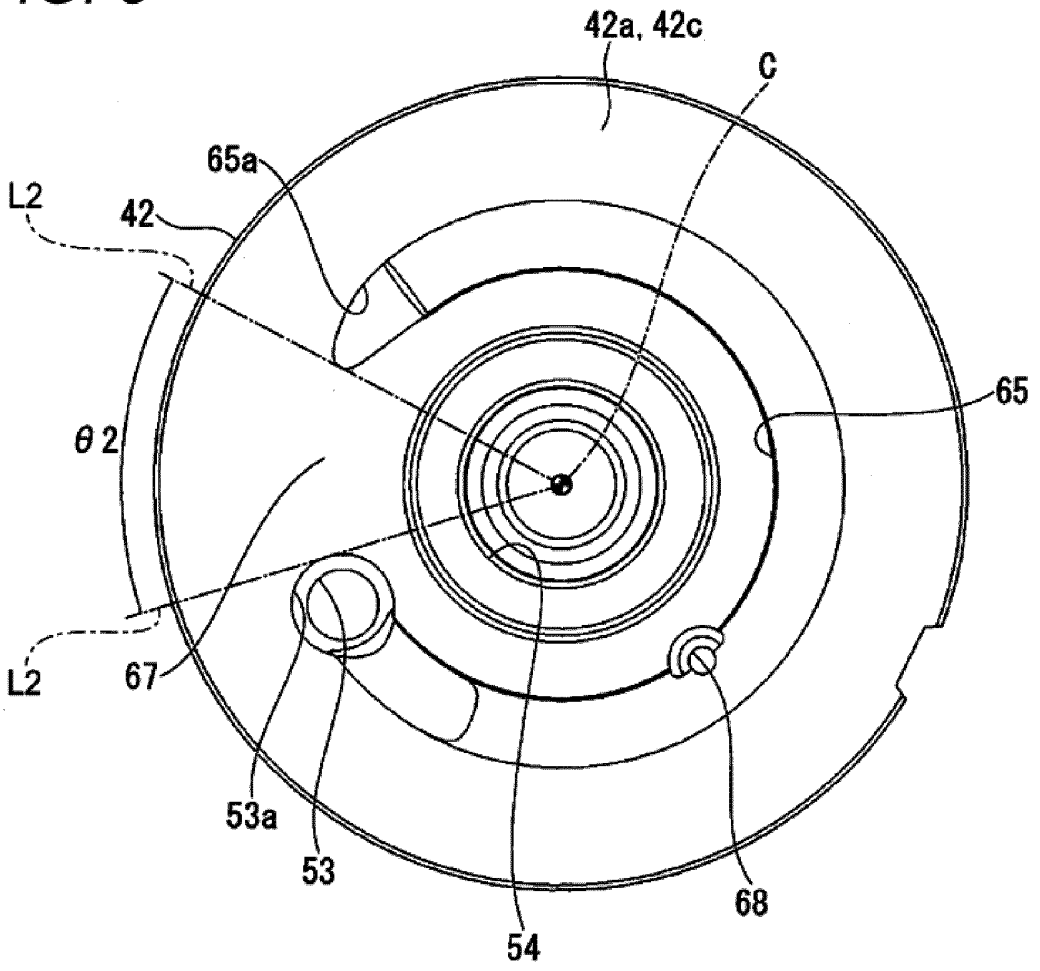

42a, 42c
C
65a
L2
42
65
θ2
L2
67
53a
53
54
68

FIG. 6

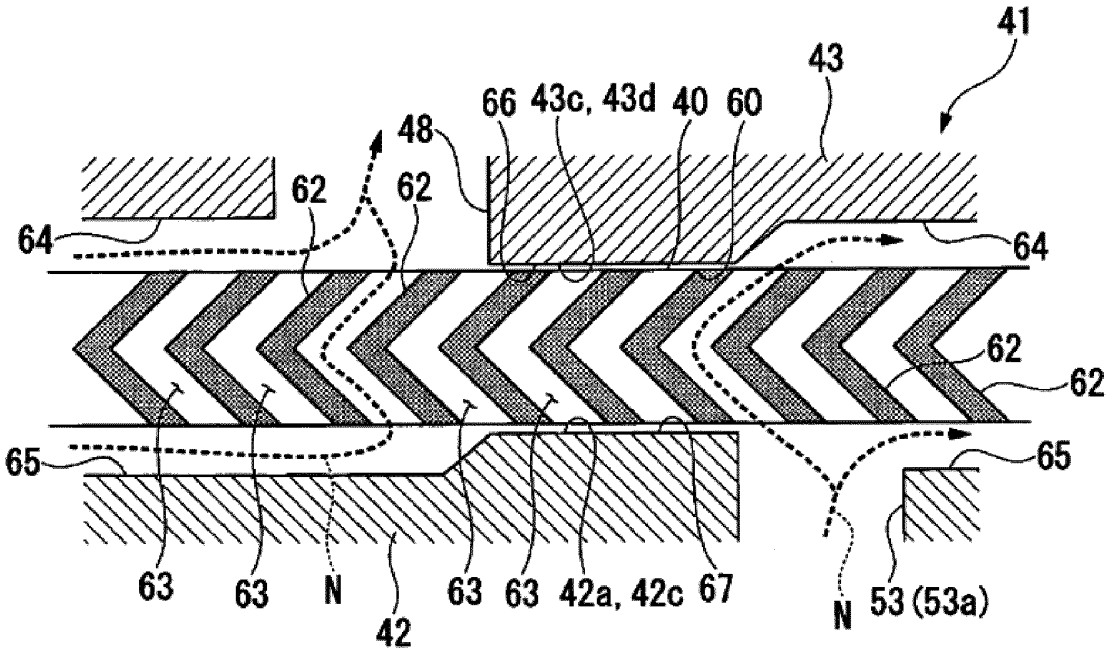

41
43
66
43c, 43d
40
60
48
62
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64
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63
63
N
42
63
63
42a, 42c
67
N
53 (53a)

FIG. 7

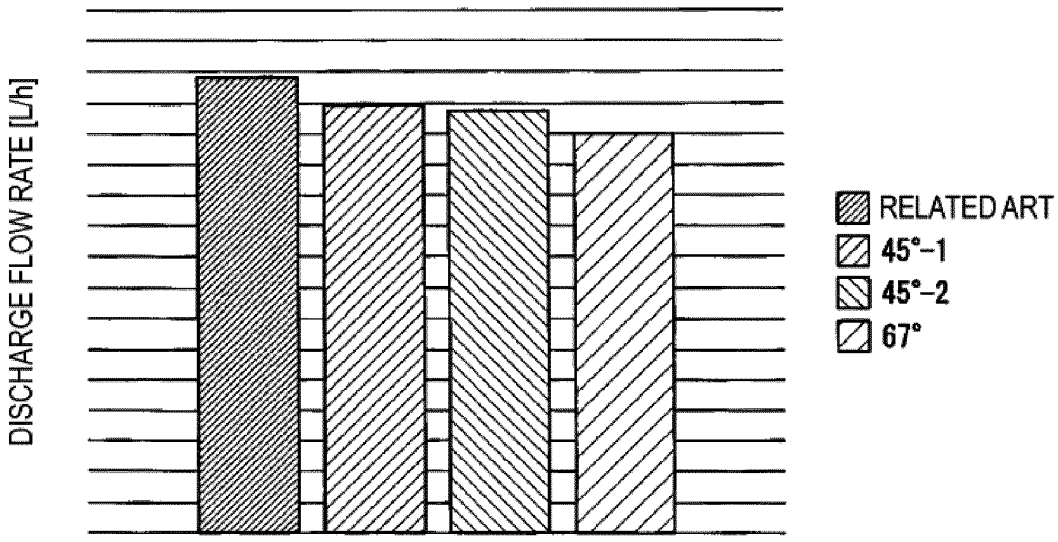
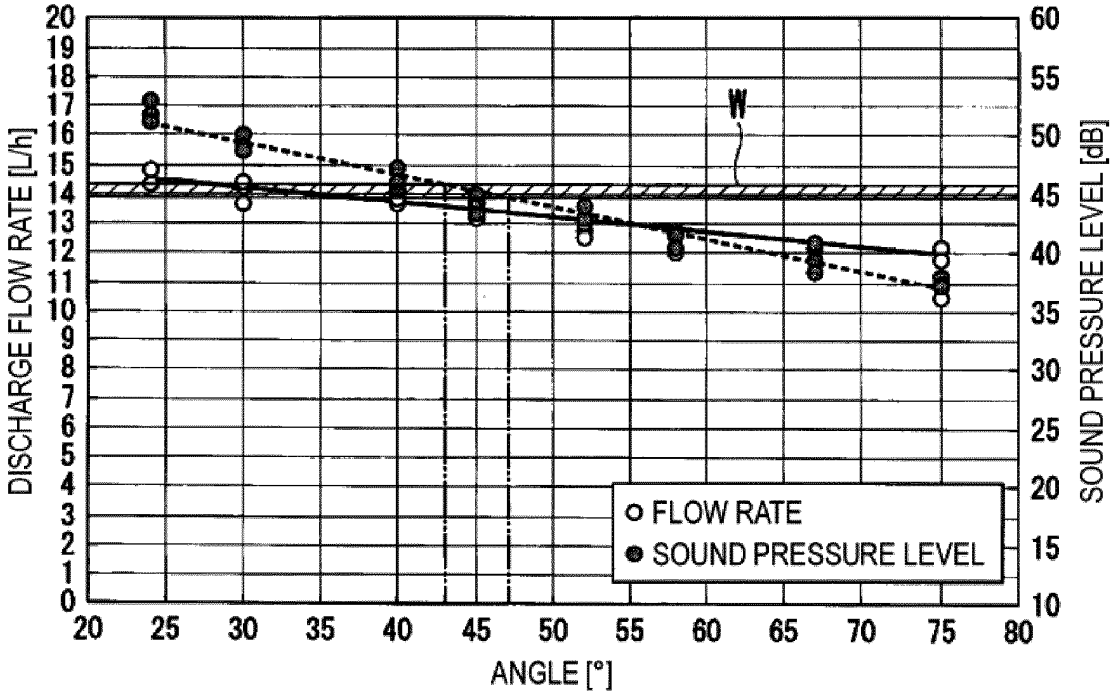

DISCHARGE FLOW RATE [L/h]
RELATED ART
45°-1
45°-2
67°

FIG. 8


DISCHARGE FLOW RATE [L/h]
SOUND PRESSURE LEVEL [dB]
ANGLE [°]
W
FLOW RATE
SOUND PRESSURE LEVEL

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/001379

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F04D5/00(2006.01)i, F02M37/08(2006.01)i, F02M37/10(2006.01)i, F04D29/16(2006.01)i, F04D29/66(2006.01)i
FI: F02M37/10A, F02M37/08E, F04D5/00G, F04D29/16, F04D29/66A
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)
Int.Cl. F04D5/00, F02M37/08, F02M37/10, F04D29/16, F04D29/66

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 1971-2020
Registered utility model specifications of Japan 1996-2020
Published registered utility model applications of Japan 1994-2020

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	KR 10-0893143 B1 (HYUNDAM INDUSTRIAL CO., LTD.) 16.04.2009 (2009-04-16), paragraphs [22]-[63], fig. 1, 2, 6	1-3
Y	JP 2014-206065 A (NIPPON SOKEN INC.) 30.10.2014 (2014-10-30), paragraphs [0012]-[0019], fig. 1-7	1-3
Y	JP 2006-291802 A (AISAN INDUSTRY CO., LTD.) 26.10.2006 (2006-10-26), paragraphs [0012]-[0027], fig. 1-6	1-3
A	JP 2000-230492 A (AISAN INDUSTRY CO., LTD.) 22.08.2000 (2000-08-22), paragraphs [0005]-[0018], fig. 1-13	1-3
A	JP 8-49683 A (ROBERT BOSCH GMBH) 20.02.1996 (1996-02-20), paragraphs [0011]-[0018], fig. 1-3	1-3

☐ Further documents are listed in the continuation of Box C.
☒ See patent family annex.

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05.03.2020	17.03.2020

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/001379

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JP 8-49683 A	20.02.1996	DE 4427874 A1 FR 2723405 A1 KR 10-0366521 B1

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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- JP 4952180 B **[0006]**
- JP 2015086804 A **[0006]**
- JP 2019004877 A **[0089]**