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

(11) EP 3 348 837 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
04.09.2024 Bulletin 2024/36

(21) Application number: **16844305.9**

(22) Date of filing: **05.09.2016**

(51) International Patent Classification (IPC):
F04C 2/10 *(2006.01)* ***F04C 15/00*** *(2006.01)*
F04C 2/08 *(2006.01)* ***F04C 2/18*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F04C 2/086; F04C 2/10; F04C 2/18; F04C 15/00

(86) International application number:
PCT/JP2016/076012

(87) International publication number:
WO 2017/043444 (16.03.2017 Gazette 2017/11)

(54) ELECTRIC PUMP AND METHOD FOR PRODUCING SAME

ELEKTRISCHE PUMPE UND VERFAHREN ZUR HERSTELLUNG DAVON

POMPE ÉLECTRIQUE ET SON PROCÉDÉ DE PRODUCTION

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **11.09.2015 JP 2015179800**

(43) Date of publication of application:
18.07.2018 Bulletin 2018/29

(73) Proprietor: **AISIN CORPORATION**
Aichi 448-8650 (JP)

(72) Inventors:
- **ANDO Teruya**
  Kariya-shi
  Aichi 448-8650 (JP)
- **NAGATA Kenjiro**
  Kariya-shi
  Aichi 448-8650 (JP)
- **IWASE Shogo**
  Kariya-shi
  Aichi 448-8650 (JP)

(74) Representative: **Kramer Barske Schmidtchen Patentanwälte PartG mbB**
European Patent Attorneys
Landsberger Strasse 300
80687 München (DE)

(56) References cited:
EP-A1- 2 848 813
EP-A2- 2 497 952
JP-A- 2012 072 558
JP-A- 2013 244 649
JP-A- 2014 001 637
JP-A- 2014 001 637
JP-A- S63 227 980
US-A1- 2013 052 058

EP 3 348 837 B1

Description

TECHNICAL FIELD

[0001] The present invention pertains to an electric pump and a method for producing the same.

BACKGROUND ART

[0002] An electric pump is used for supplying hydraulic fluid to various movable mechanisms of a vehicle, for example. The electric pump includes a motor portion and a pump portion. In a case where the electric pump is operated, a rotation drive force of a rotary shaft of the motor portion is transmitted to a gear pump of the pump portion. The electric pump suctions and discharges the hydraulic fluid by a rotation of the gear pump.

[0003] The motor portion and the pump portion of the electric pump are generally separately produced and are thereafter assembled on each other so that displacement between an axis of the motor portion and an axis of the pump portion is minimized, i.e., concentricity serving as a degree of displacement between the two axes is minimized. Complete coaxiality where the concentricity between the two axes is zero is practically not achieved. Nevertheless, in order to efficiently rotate the gear pump (electric pump) by effectively transmitting the rotation drive force of the rotary shaft of the motor portion to the gear pump, the concentricity should be reduced.

[0004] Patent document 1 discloses an electric pump including a motor portion and a pump portion. In the electric pump, the motor portion includes a fitting projection portion made of resin and the pump portion includes a pump housing recess portion made of metal. The electric pump in Patent document 1 includes a spigot structure where the fitting projection portion of the motor portion is fitted into the housing recess portion of the pump portion. As a result, the electric pump with small concentricity between an axis of the motor portion and an axis of the pump portion is assembled.

[0005] Patent document 2 also discloses an electric pump including a motor portion and a pump portion. In the electric pump, the motor portion includes an annular case portion made of resin and the pump portion includes a boss portion made of metal. The electric pump in Patent document 2 includes a spigot structure where, in an opposite manner to the electric pump in Patent document 1, the boss portion of the pump portion is fitted into the annular case portion of the motor portion so that the electric pump with small concentricity between an axis of the motor portion and an axis of the pump portion is assembled.

DOCUMENT OF PRIOR ART

PATENT DOCUMENT

[0006]

Patent document 1: JP2013-217223A
Patent document 2: JP2009-156081A

[0007] US 2013/0052058 A1 discloses a pump unit with a pump body formed of a pump housing and a pump plate provided in front of the pump housing. A motor housing is fixed to a rear end of the pump housing and accommodates a pump driving electric motor.

[0008] EP 2 848 813 A1 discloses an electric pump apparatus with a closing cover integrally including a cover main body and a ventilation cap body.

[0009] EP 2 497 952 A2 discloses an electric pump unit with a motor housing that accommodates a pump-driving electric motor and a controller that controls the electric motor being fixed to a pump body of a pump that sucks and discharges oil.

[0010] JP 2014 001637 A discloses an electric pump device in accordance with the preamble of claim 1.

OVERVIEW OF INVENTION

PROBLEM TO BE SOLVED BY INVENTION

[0011] In each of the electric pumps disclosed in Patent documents 1 and 2, the projection or the recess portion made of resin provided at the motor portion and the recess portion or the projection mad of metal provided at the pump portion are fitted to each other to obtain the spigot structure. The electric pump is accordingly assembled so that the concentricity between the axes of the motor portion and the pump portion is reduced. Nevertheless, because dimensional accuracy of the projection or the recess portion made of resin is smaller than that of the recess portion or the projection made of metal, an issue is raised that decrease of the concentricity between the axes of the motor portion and the pump portion is limited in a case where the projection or the recess portion of the motor portion and the recess portion or the projection of the pump portion are fitted to each other.

[0012] Therefore, an electric pump with small concentricity between an axis of a motor portion and an axis of a pump portion than a known pump is desired.

MEANS FOR SOLVING PROBLEM

[0013] One embodiment of an electric pump according to the present invention includes a pump portion including a pump housing and a gear pump which is housed in the pump housing, the pump portion suctioning and discharging a hydraulic fluid by a rotation of the gear pump, a motor portion arranged adjacent to the pump portion in a direction along an axis of the pump portion and including a rotor which rotates synchronously with the gear pump and coaxially with the axis, the motor portion including a stator which is arranged at an outer periphery of the rotor and disposed coaxially with the axis, the stator applying a rotation drive force to the rotor, and a resin portion integrally surrounding at least an outer periphery of the pump housing and an outer periphery of the stator. The resin portion is provided at outer peripheral surfaces of the stator of the motor portion and the pump housing of the pump portion, and the resin portion and the pump housing are firmly integrated with each other. The pump housing includes a recess portion at an outer surface, the recess portion into which resin of the resin portion is fitted.

[0014] According to the electric pump including the aforementioned construction, the stator and the pump housing are integrally held by the resin portion. Thus, concentricity between an axis of the stator and an axis of the pump housing before the resin portion is formed may be maintained by the resin portion. The resin portion is formed in a state where the concentricity between the axis of the stator and the axis of the pump housing is reduced, so that the concentricity between the axis of the stator and the axis of the pump housing at the electric pump including the resin portion may be greatly reduced as compared to a case where the electric pump is assembled by a spigot structure. In a case where the concentricity between axes of the motor portion and the pump portion decreases, the concentricity between the axis of the stator and an axis of the rotor of the motor portion decreases. Thus, an air gap between the stator and the rotor may decrease to thereby improve driving efficiency of the motor. That is, with the same driving efficiency, an amount of usage of a magnet employed at the motor portion may decrease. According to the electric pump including the aforementioned construction, the resin portion and the pump housing are firmly integrated with each other. The pump housing is inhibited from moving relative to the resin portion. In addition, because of the resin fitted into the recess portion, the hydraulic oil hardly leaks to the outside of the electric pump by flowing through a boundary between the pump housing and the resin portion even if the hydraulic oil leaks from the gear pump.

[0015] In the one embodiment of the electric pump 1, each of the pump housing and the stator includes a circular outermost configuration as viewed in the direction along the axis of the pump portion. The pump housing and the stator include same outermost diameters as each other. At this time, the resin portion desirably includes a constant thickness in a radial direction of the resin portion.

[0016] In a case where each of the pump housing and the stator includes the circular outermost configuration as viewed in the direction along the axis and the pump housing and the stator include the same outermost diameters as each other, flow resistance when the resin fills the forming die is small to thereby increase filling ability when forming the resin portion by insert molding, for example. In addition, a thickness of the resin portion in the radial direction thereof may be easily constant. With the constant thickness of the resin portion in the radial direction, an entire periphery of the resin portion is evenly cooled so that shrinkage of the resin portion may be unlikely to occur and displacement of the axes of the stator and the pump housing may be unlikely to occur after cooling of the resin portion.

[0017] In the one embodiment of the electric pump 1, each of the pump housing and the gear pump is made of a ferrous material.

[0018] In order to stably drive the electric pump for a long period of time, each of the pump housing and the gear pump is desirably made of the ferrous material with high strength. As long as the pump housing and the gear pump are made of the same material, thermal expansion coefficients of the pump housing and the gear pump are the same as each other. Thus, in a case where a surrounding temperature varies, a clearance between the pump housing and the gear pump is restrained from changing. At this time, the ferrous material has a problem of being corroded when used in contact with outside air for a long period of time. Nevertheless, according to the electric pump including a construction where the outer peripheral surface of the pump housing is surrounded by the resin portion, the outer peripheral surface of the pump housing is inhibited from contacting air. Thus, the pump housing even made of the ferrous material is inhibited from being corroded. Performance and lifetime of the electric pump are inhibited from decreasing, which may lead to stable performance of the electric pump for a long period of time.

[0019] One embodiment of a method for producing an electric pump includes a step for placing a stator in a cylindrical form onto an outer peripheral surface of a fixed die of a forming die in a state where an inner peripheral surface of the stator makes contact with the outer peripheral surface of the fixed die, the forming die being configured to open and close and including the fixed die and a movable die, a step for placing a pump housing which includes a protruding portion in a cylindrical form in a state where an outer peripheral surface of the protruding portion makes contact with an inner peripheral surface of a dent which is provided at an upper surface of the fixed die, the dent including a circular cross-section in a direction orthogonal to an axis of the fixed die, and a step for forming a resin portion by flowing resin into the forming die to harden the resin after the movable die is pressed against the fixed die to close the forming die, the resin portion integrally surrounding at least an outer periphery of the pump housing and an outer periphery of the stator. The resin portion is provided at outer peripheral surfaces of the stator of the motor portion and the pump housing of the pump portion, and the resin portion and the pump housing are firmly integrated with each other. The pump housing includes a recess portion at an outer surface, the recess portion into which resin of the resin portion is fitted.

[0020] Because the fixed die used for insert molding is processed by cutting, for example, processing accuracy is extremely high. Therefore, dimensional accuracy of an outer diameter of an outer peripheral surface of the fixed die in a column form and an inner diameter of the dent may increase. In addition, the concentricity between an axis of the outer peripheral surface and an axis of the dent is greatly reduced so that the concentricity between the axes of the stator and the pump housing in a case where the stator and the pump housing are placed onto the fixed die may be greatly reduced. In the aforementioned state, the resin portion is formed to thereby integrate the stator and the pump housing while a relative position therebetween is maintained. As a result, the electric pump with the greatly reduced concentricity may be produced.

BRIEF DESCRIPTION OF DRAWINGS

[0021]

[Fig. 1] Fig. 1 is a longitudinal section view illustrating a construction of an electric pump according to an embodiment;
[Fig. 2] Fig. 2 is a cross-sectional view taken along a line II-II in Fig. 1;
[Fig. 3] Fig. 3 is a cross-sectional view taken along a line III-III in Fig. 1;
[Fig. 4] Fig. 4 is a cross-sectional view illustrating a forming process of a resin portion;
[Fig. 5] Fig. 5 is a cross-sectional view illustrating the forming process of the resin portion;
[Fig. 6] Fig. 6 is a cross-sectional view illustrating the forming process of the resin portion;
[Fig. 7] Fig. 7 is a cross-sectional view illustrating the forming process of the resin portion;
[Fig. 8] Fig. 8 is a cross-sectional view illustrating the forming process of the resin portion; and
[Fig. 9] Fig. 9 is a cross-sectional view illustrating the forming process of the resin portion.

MODE FOR CARRYING OUT THE INVENTION

[0022] An embodiment of the present invention is explained below with reference to the attached drawings.

1. Construction and operation of electric pump

[Entire construction]

[0023] As illustrated in Figs. 1 to 3, an electric pump 1 is constructed by a motor portion 30, a pump portion 10 driven by the motor portion 30, a control portion 50 controlling the motor portion 30, and a resin portion 60 provided at outer peripheries of the motor portion 30 and the pump portion 10 to extend from the motor portion 30 to the pump portion 10. The electric pump 1 is employed for pumping lubricant at an engine of a vehicle as hydraulic oil to hydraulic equipment. Alternatively, the electric pump 1 may be applied to a hydraulic device of other than the vehicle. In addition, instead of the hydraulic oil, a medicine or a chemical substance in liquid form may be used as a pumping object, for example. The hydraulic oil serves as an example of hydraulic fluid.

[Construction of pump portion]

[0024] As illustrated in Fig. 1, the pump portion 10 includes a pump housing 11, an internal gear pump 21 and a pump cover 40. The internal gear pump 21 serves as an example of a gear pump.

[0025] The pump housing 11 is made of ferrous metallic material. The pump housing 11 includes a columnar outer configuration. A housing portion 14 including a bottom and a circular cross-section is provided at an end surface of the pump housing 11 facing the pump cover 40. A protruding portion 15 in a cylindrical form is provided at an opposite end surface from the housing portion 14. An oil seal 26 is inserted to be positioned at an inner side of the protruding portion 15. An inlet port 12 and an outlet port 13 are provided at a bottom surface of the housing portion 14. A bearing bore 17 is provided at a center of the pump housing 11. As illustrated in Fig. 2, an axis of the housing portion 14 is eccentric to an axis X of the bearing bore 17. A rotary shaft 25 is inserted to be positioned within the bearing bore 17 in a state penetrating through the oil seal 26, the bearing bore 17 and an inner rotor 22 of the internal gear pump 21. The rotary shaft 25 is rotatably supported at the bearing bore 17. An axis of the rotary shaft 25 and an axis of the inner rotor 22 are both coaxial with the axis X. The rotary shaft 25 and the inner rotor 22 integrally rotate with each other. The "coaxiality" in the embodiment does not only mean that displacement of plural axes (which is hereinafter referred to as concentricity) is zero but also mean that the concentricity is approximately zero including zero.

[0026] The internal gear pump 21 which is housed in the housing portion 14 includes the inner rotor 22 and an outer rotor 23. Each of the inner rotor 22 and the outer rotor 23 is made of ferrous metallic material. As illustrated in Fig. 2, the internal gear pump 21 is constructed so that outer teeth provided at the inner rotor 22 and inner teeth provided at the outer rotor 23 are meshed with one another. With the rotation of the inner rotor 22, the outer rotor 23 rotates around the inner rotor 22 by following the rotation of the inner rotor 22. Plural pump chambers 24 of which volumes increase and decrease depending on the rotation are defined between a teeth portion of the inner rotor 22 and a teeth portion of the outer rotor 23.

[0027] As long as the outer rotor 23 of the internal gear pump 21 and the pump housing 11 are made of the same ferrous metallic material, thermal expansion coefficients of the outer rotor 23 and the pump housing 11 are the same as each other. Thus, in a case where a surrounding temperature varies, a clearance between an inner periphery of the housing portion 14 and an outer periphery of the outer rotor 23 is restrained from changing.

[0028] The pump cover 40 is made of resin and is arranged adjacent to the pump housing 11. The pump cover 40 is joined to the resin portion 60 which is explained later by welding, for example. The pump cover 40 includes the same outer diameter as the resin portion 60. The pump cover 40 and the resin portion 60 are joined and integrated so that the internal gear pump 21 is held within the housing portion 14. The pump cover 40 includes an inlet port 42 at a side opposite to the inlet port 12 relative to the housing portion 14 and an outlet port 43 at a side opposite to the outlet port 13 relative to the housing portion 14. An inlet passage 44 extends outward from the inlet port 42 and an outlet passage 45 extends outward from the outlet port 43.

[0029] As illustrated in Fig. 2, the inlet port 42 is a curved groove and is provided communicating with the pump chambers 24 of the internal gear pump 21 along a range where the volumes of the pump chambers 24 of the internal gear pump 21 increase. In the same manner, as illustrated in Fig. 2, the outlet port 43 is also a curved groove and is provided communicating with the pump chambers 24 of the internal gear pump 21 along a range where the volumes of the pump chambers 24 of the internal gear pump 21 decrease. The inlet port 12 includes the same configuration and the same size as the inlet port 42. The outlet port 13 includes the same configuration and the same size as the outlet port 43.

[Construction of motor portion]

[0030] As illustrated in Fig. 1, the motor portion 30 is arranged adjacent to the pump portion 10 in a direction along the axis X. The motor portion 30 includes a sensorless brushless DC motor 31. As illustrated in Figs. 1 and 3, the sensorless brushless DC motor 31 is constructed by a rotor 36 in a cylindrical form and a stator 32 in a cylindrical form, the stator 32 being arranged at an outer periphery of the rotor 36 with a small clearance therebetween in a radial direction. The rotor 36 and the stator 32 are both coaxial with the axis X. The stator 32 includes an outermost diameter which is the same value as an outermost diameter of the pump housing 11.

[0031] The rotor 36 is obtained by a magnet 38 embedded and fixed in a rotor core 37 including a cylindrical form, the rotor core 37 being formed by laminated magnetic steel sheets. The rotor 36 integrally rotates with the rotary shaft 25. The stator 32 includes a stator core 33 formed by laminated magnetic steel sheets, a coil support frame 35 formed by an insulator such as resin, for example, which covers teeth of the stator core 33, and a coil 34 wound at the teeth from above the coil support frame 35. The coil 34 constitutes a three-phase winding, each phase of the coil 34 being applied with a three-phase alternating current by an electric power supply from the control portion 50 at an outside which is explained later. The sensorless brushless DC motor 31 does not include a magnetic pole sensor such as a Hall element, for example. The sensorless brushless DC motor 31 detects a rotation position of the rotor 36 by utilizing an induced voltage induced to the coil 34 by the rotation of the rotor 36 and switches the power supply to the phases of the three-phase winding based on magnetic position information obtained on a basis of the rotation position of the rotor 36. The teeth of the stator core 33 magnetized by the power supply to the coil 34 and the magnet 38 are repeatedly suctioned and repelled to thereby rotate the rotor 36. With the rotation of the rotor 36, the inner rotor 22 rotates via the rotary shaft 25. Accordingly, the stator 32 applies a rotation drive force to the rotor 36.

[Construction of control portion]

[0032] The control portion 50 is arranged adjacent to the motor portion 30 in the direction along the axis X. As illustrated in Fig. 1, the control portion 50 is constructed by implementation of an electric power control element, a capacitor, a resistor and a control component such as a motor driver for deciding timing of power control, for example, on a control board 52. The control board 52 is mounted and fixed to the resin portion 60 which is explained later by screwing, for example. The control portion 50 functions to generate a rotating magnetic field by sequentially supplying the electric power to the coil 34 so as to control a rotating speed of the rotor 36 by controlling a rotation speed of the rotating magnetic field. The control portion 50 is covered by a cover member 54 mounted to the resin portion 60 by welding, for example.

[Construction of resin portion]

[0033] As illustrated in Fig. 1, the resin portion 60 is provided at outer peripheral surfaces of the stator 32 of the motor portion 30 and the pump housing 11 of the pump portion 10 to extend from the stator 32 to the pump housing 11. The resin portion 60 surrounds the outer peripheral surface of the pump housing 11 and surrounds the stator core 33 except for a part of the teeth thereof facing the rotor 36, the coil 34 and the entire coil support frame 35. A thickness of resin of the resin portion 60 at a radially outer side of an outermost circumference of the stator 32 and of an outermost circumference of the pump housing 11 is constant. The motor portion 30 and the pump portion 10 are integrated by the resin portion 60. The resin portion 60 is formed by insert molding at the stator 32 and the pump housing 11. In the electric pump 1, because the motor portion and the pump portion are not combined by a spigot structure, a clearance is formed between an outer periphery of the protruding portion 15 of the pump housing 11 and an inner periphery of the resin portion 60 facing the aforementioned outer periphery in the radial direction. Details of forming method of the resin portion 60 by insert molding are explained later.

[0034] Plural groove portions 16 each of which includes an annular form are provided at an outer surface of the pump housing 11. The resin of the resin portion 60 is fitted into the groove portions 16. Thus, the resin portion 60 and the pump housing 11 are firmly integrated with each other. The pump housing 11 is inhibited from moving relative to the resin portion 60. In the present embodiment, the groove portions 16 are provided at the pump hosing 11. Alternatively, instead of the groove portions 16, knurls including shallower groove portions than the groove portions 16, for example, may be provided. The resin of the resin portion 6 is also fitted into the groove portions of the knurls to thereby firmly fix the resin portion 60 and the pump housing 11 to each other. Each of the groove portions 16 and the groove portions of the knurls serves as an example of a recess portion.

[0035] Because of the resin fitted into the groove portions 16, the hydraulic oil hardly leaks to the outside of the electric pump 1 by flowing through a boundary between the pump housing 11 and the resin portion 60 even if the hydraulic oil flows from the internal gear pump 21 through a clearance between the rotary shaft 25 and the bearing 17 and leaks from the oil seal 26. This is because the hydraulic oil leaking from the oil seal 26 reaches the outside of the electric pump 1 via the groove portions 16 when flowing through the boundary between the pump housing 11 and the resin portion 60, a creepage distance by which the hydraulic oil reaches the outside of the electric pump 1 is elongated as compared to a case where the groove portions 16 are not provided. As a result, without usage of a component such as an annular seal, for example, for inhibiting leakage of the hydraulic oil, the leakage of the hydraulic oil to the outside of the electric pump 1 may be effectively inhibited. The electric pump 1 may be constructed at a low cost accordingly.

[Operation of electric pump]

[0036] Next, an operation of the electric pump 1 is explained. The coil 34 of the stator 32 is applied with the three-phase alternating current by a command from the control portion 50 to thereby rotate the rotor 36. With the rotation of the rotor 36, the inner rotor 22 of the internal gear pump 21 rotates via the rotary shaft 25. When the inner rotor 22 rotates, the outer rotor 23 which is meshed with the inner rotor 22 rotates by following the rotation of the inner rotor 22. The volumes of the pump chambers 24 increase within the range where the pump chambers 24 are in communication with the inlet ports 42 and 12 and decrease within the range where the pump chambers 24 are in communication with the outlet ports 43 and 13 based on the rotations of the inner rotor 22 and the outer rotor 23. According to the aforementioned pump operation of the internal gear pump 21, the hydraulic oil which flows through the inlet passage 44 is suctioned to the pump chambers 24 from the inlet port 42 by a negative pressure and is thereafter pumped out to the outlet port 43 from the inlet port 42 by a positive pressure so as to flow through the outlet passage 45 by being discharged from the outlet port 43.

2. Assembly method of electric pump

[0037] Next, an assembly method of the electric pump 1 is explained in detail with reference to the attached drawings. An assembly process of the electric pump 1 is characterized by the resin portion 60 which is formed by insert molding at the stator 32 and the pump housing 11. The other processes such as an assembly of the rotor 36, an assembly of the stator 32, an assembly of the control portion 50 and a mounting of the internal gear pump 21 to the pump housing 11, for example, are known and therefore detailed explanation is omitted.

[Forming method of resin portion]

[0038] Figs. 4 to 8 illustrate a process for forming the resin portion 60 by insert molding at the stator 32 and the pump housing 11. First, as illustrated in Figs. 4 and 5, the stator 32 is placed onto a fixed die 72 of a forming die 70, the forming die 70 consisting of the fixed die 72 and a movable die 78. The fixed die 72 includes a stator contact portion 73 in a column form, a step 74 provided at a lower end of the stator contact portion 73, and a dent 76 provided at an upper surface 75 and including a circular cross-section in a direction orthogonal to an axis of the fixed die 72. Because the fixed die 72 is processed by cutting, for example, processing accuracy is extremely high. Therefore, dimensional accuracy of an outer diameter of the stator contact portion 73 and an inner diameter of the dent 76 may increase. In addition, the concentricity between an axis of the stator contact portion 73 and an axis of the dent 76 is greatly reduced so that the stator contact portion 73 and the dent 76 are coaxial with each other. In the following, each of the axis of the stator contact portion 73 and the axis of the dent 76 is referred to as an axis Y.

[0039] As illustrated in Fig. 5, in a case where the stator 32 is placed onto the fixed die 72 while being fitted therein, an inner peripheral surface of the stator 32 makes contact with an outer peripheral surface of the stator contact portion 73. Accordingly, an axis of the stator 32 and the axis Y of the stator contact portion 73 match each other to achieve positioning in the radial direction. In the stator 32, an inner diameter of the coil support frame 35 is slightly greater than an inner diameter of the stator core 33. The step 74 is provided corresponding to a difference between the aforementioned inner diameters. By the placement of the stator 32, an end surface of the stator core 33 makes contact with the step 74 so that the stator 32 is positioned relative to the fixed die 72 in a direction along the axis Y.

[0040] Next, as illustrated in Figs. 5 and 6, after the stator 32 is placed onto the fixed die 72, the pump housing 11 is placed onto the fixed die 72 so that the protruding portion 15 is fitted in the dent 76. The inner diameter of the dent 76 is substantially equal to an outer diameter of the protruding portion 15 of the pump housing 11. By the placement of the pump housing 11, an outer peripheral surface of the protruding portion 15 makes contact with an inner peripheral surface of the dent 76. Accordingly, an axis of the pump housing 11 and the axis Y of the fixed die 72 match each other to achieve positioning in the radial direction. In addition, by the placement of the pump housing 11, a surface at a radially outer side than the protruding portion 15 in the pump housing 11 makes contact with the upper surface 75 so that the pump housing 11 is positioned relative to the fixed die 72 in the direction along the axis Y.

[0041] In a state illustrated in Fig. 6, the axis of the stator 32 and the axis of the pump housing 11 both match the axis Y of the fixed die 72. The outermost diameter of the stator 32 is the same as the outermost diameter of the pump housing 11.

[0042] Next, as illustrated in Fig. 7, the movable die 78 is pressed against the fixed die 72 so as to close the forming die. Afterwards, as illustrated in Fig. 8, melted thermoplastic resin such as polyphenylene sulfide (PPS) resin, for example, is brought to flow into the forming die 70 from a gate 79. When the inside of the forming die 70 is filled with the thermoplastic resin, the resin is cooled and hardened in the closed die. The hardened thermoplastic resin forms the resin portion 60. Because the outermost diameter of the stator 32 is the same as the outermost diameter of the pump housing 11, flow resistance when the resin fills the forming die 70 is small to thereby increase filling ability. In addition, a thickness of the resin portion 60 in the radial direction thereof may be easily constant. With the constant thickness of the resin portion 60, an entire periphery of the resin portion 60 is evenly cooled so that shrinkage of the resin portion 60 may be unlikely to occur and displacement of the axes of the stator 32 and the pump housing 11 may be unlikely to occur after cooling of the resin portion 60.

[0043] Once the thermoplastic resin is hardened, the forming die 70 is opened to take out an intermediate assembly 80 which is obtained by the stator 32 and the pump housing 11 which are integrated by the resin portion 60 as illustrated in Fig. 9. Even in the state of the intermediate assembly 80, the axis of the stator 32 and the axis of the pump housing 11 maintain matching each other.

[0044] Afterwards, the oil seal 26, the rotor 36 into which the rotary shaft 25 is inserted to be positioned, and the internal gear pump 21 are assembled on the intermediate assembly 80. The pump cover 40 is then joined to an end portion of the resin portion 60 by welding, for example. Finally, the control portion 50 is assembled on the resin portion 60 and the cover member 54 is joined to an end portion of the resin portion 60 by welding, for example. As a result, the electric pump 1 is completed.

[0045] According to the present embodiment, after the stator 32 of the motor portion 30 and the pump housing 11 of the pump portion 10 are placed onto the metallic fixed die 72 in a state where the axis of the stator 32 and the axis of the pump housing 11 match the axis Y of the fixed die 72, the resin portion 60 is formed by insert molding to integrate the stator 32 and the pump housing 11. Thus, in the intermediate assembly 80 obtained after the resin portion 60 is formed, the axis of the stator 32 and the axis of the pump housing 11 are maintained matching each other. As a result, the concentricity between the axis of the stator 32 and the axis of the pump housing 11 at the electric pump 1 is greatly reduced as compared to the concentricity between an axis of a motor portion and an axis of a pump portion in a case where the motor portion and the pump portion are separately produced so that a recess portion and a projection of the motor portion and the pump portion are fitted in a spigot structure.

[0046] In a case where the concentricity between the motor portion 30 and the pump portion 10 decreases, the concentricity between the axis of the stator 32 of the motor portion 30 and an axis of the rotor 36 where the rotary shaft 25 is inserted to be positioned within the bearing bore 17 of the pump portion 10 decreases. Thus, an air gap between the stator 32 and the rotor 36 may decrease to thereby improve driving efficiency of the motor. That is, with the same driving efficiency, an amount of usage of the magnet 38 employed at the rotor 36 may decrease.

[0047] In addition, the outer peripheral surface of the pump housing 11 made of ferrous metallic material is covered by the resin portion 60 so that the outer peripheral surface of the pump housing 11 is inhibited from making contact with air. The pump housing 11 is therefore inhibited from being corroded. Thus, performance and lifetime of the electric pump 1 are inhibited from decreasing, which may lead to stable performance of the electric pump 1 for a long period of time.

[0048] In the present embodiment, the resin portion 60 extends along the axial direction to an end surface of the pump housing 11 at a side facing the pump cover 40. Thus, the pump cover 40 formed by the resin is joined to the resin portion 60 by welding, for example, so that a bolt which is employed for joining a pump cover at a known electric pump is not necessary. As a result, in the motor portion 30 and the pump portion 10, a bore through which the bolt is inserted to be positioned or a protruding portion at a radially outer side where an internal thread is provided for fixing the bolt is not necessary. The electric pump 1 may be produced at a reduced cost and a reduced size.

INDUSTRIAL APPLICABILITY

[0049] The present invention is applicable to an electric pump and a method for producing the same.

EXPLANATION OF REFERENCE NUMERALS

[0050]

1	electric pump
10	pump portion
11	pump housing
15	protruding portion
16	groove portion (recess portion)
21	internal gear pump (gear pump)
30	motor
32	stator

36 rotor
60 resin portion
70 forming die
72 fixed die
76 dent
78 movable die

Claims

1. An electric pump (1) comprising:

a pump portion (10) including a pump housing (11) and a gear pump (21) which is housed in the pump housing (11), the pump portion (10) suctioning and discharging a hydraulic fluid by a rotation of the gear pump (21);
a motor portion (30) arranged adjacent to the pump portion (10) in a direction along an axis of the pump portion (10) and including a rotor (36) which rotates synchronously with the gear pump (21) and coaxially with the axis, the motor portion (30) including a stator (32) which is arranged at an outer periphery of the rotor (36) and disposed coaxially with the axis, the stator (32) applying a rotation drive force to the rotor (36); and
a resin portion (60) integrally surrounding at least an outer periphery of the pump housing (11) and an outer periphery of the stator (32),
the resin portion (60) being provided at outer peripheral surfaces of the stator (32) of the motor portion (30) and the pump housing (11) of the pump portion (10), and the resin portion (60) and the pump housing (11) being firmly integrated with each other,
characterized in that
the pump housing (11) includes a recess portion (16) at an outer surface, the recess portion (16) into which resin of the resin portion (60) is fitted.

2. The electric pump (1) according to claim 1, wherein

each of the pump housing (11) and the stator (32) includes a circular outermost configuration as viewed in the direction along the axis of the pump portion, and
the pump housing (11) and the stator (32) include same outermost diameters as each other.

3. The electric pump (1) according to claim 1 or 2, wherein the resin portion (60) includes a constant thickness in a radial direction of the resin portion.

4. The electric pump (1) according to any one of claims 1 through 3, wherein each of the pump housing (11) and the gear pump (21) is made of a ferrous material.

5. The electric pump (1) according to any one of claims 1 through 4, wherein the stator (32) and the pump housing (11) are integrated by the resin portion (60), and an oil seal (26), the rotor (36) and the gear pump (21) are assembled on the integrated stator (32) and pump housing (11).

6. A method for producing an electric pump (1), comprising:

a step for placing a stator in a cylindrical form onto an outer peripheral surface of a fixed die of a forming die in a state where an inner peripheral surface of the stator makes contact with the outer peripheral surface of the fixed die, the forming die being configured to open and close and including the fixed die and a movable die;
a step for placing a pump housing which includes a protruding portion in a cylindrical form in a state where an outer peripheral surface of the protruding portion makes contact with an inner peripheral surface of a dent which is provided at an upper surface of the fixed die, the dent including a circular cross-section in a direction orthogonal to an axis of the fixed die; and
a step for forming a resin portion by flowing resin into the forming die to harden the resin after the movable die is pressed against the fixed die to close the forming die, the resin portion integrally surrounding at least an outer periphery of the pump housing and an outer periphery of the stator, the resin portion being provided at outer peripheral surfaces of the stator of the motor portion and the pump housing of the pump portion, the resin portion and the pump housing being firmly integrated with each other, and the pump housing including a recess portion at an outer surface, the recess portion into which resin of the resin portion is fitted.

Patentansprüche

1. Elektrische Pumpe (1) mit:

einem Pumpenteil (10) mit einem Pumpengehäuse (11) und einer Zahnradpumpe (21), die in dem Pumpengehäuse (11) untergebracht ist, wobei der Pumpenteil (10) ein Hydraulikfluid durch eine Drehung der Zahnradpumpe (21) ansaugt und ausstößt;
einem Motorteil (30), der in einer Richtung entlang einer Achse des Pumpenteils (10) benachbart zu dem Pumpenteil (10) angeordnet ist und einen Rotor (36) aufweist, der synchron mit der Zahnradpumpe (21) dreht und koaxial mit der Achse ist, wobei der Motorteil (30) einen Stator (32) aufweist, der bei einem Außenumfang des Rotors (36) angeordnet ist und koaxial mit der

Achse angeordnet ist, wobei der Stator (32) eine Drehantriebskraft an den Rotor (36) anlegt; und einem Harzteil (60), der mindestens einen Außenumfang des Pumpenggehäuses (11) und einen Außenumfang des Stators (32) integral umgibt,

bei der der Harzteil (60) bei Außenumfangsflächen des Stators (32) des Motorteils (30) und des Pumpengehäuses (11) des Pumpenteils (10) vorgesehen ist und der Harzteil (60) und das Pumpengehäuse (11) fest miteinander integriert sind,

dadurch gekennzeichnet, dass

das Pumpengehäuse (11) einen Vertiefungsteil (16) bei einer Außenfläche aufweist, in den Harz des Harzteils (60) gepasst ist.

2. Elektrische Pumpe (1) nach Anspruch 1, bei der

das Pumpengehäuse (11) und der Stator (32) in der Richtung entlang der Achse des Pumpenteils betrachtet jeweils eine kreisförmige äußerste Konfiguration aufweisen und

das Pumpengehäuse (11) und der Stator (32) dieselben äußersten Durchmesser aufweisen.

3. Elektrische Pumpe (1) nach Anspruch 1 oder 2, bei der der Harzteil (60) eine konstante Dicke in einer radialen Richtung des Harzteils aufweist.

4. Elektrische Pumpe (1) nach einem der Ansprüche 1 bis 3, bei der das Pumpengehäuse (11) und die Zahnradpumpe (21) jeweils aus einem Eisenmaterial hergestellt sind.

5. Elektrische Pumpe (1) nach einem der Ansprüche 1 bis 4, bei der der Stator (32) und das Pumpengehäuse (11) durch den Harzteil (60) integriert sind und eine Öldichtung (26), der Rotor (36) und die Zahnradpumpe (21) an den integrierten Stator (32) und das Pumpengehäuse (11) gebaut sind.

6. Verfahren zum Herstellen einer elektrischen Pumpe (1), mit folgenden Schritten:

einem Schritt zum Platzieren eines Stators in einer zylindrischen Form auf einer Außenumfangsfläche einer festen Druckgießform einer Form in einem Zustand, in dem eine Innenoberfläche des Stators in Kontakt mit der Außenoberfläche der festen Druckgießform kommt, wobei die Form zum Öffnen und Schließen ausgebildet ist und die feste Druckgießform und eine bewegliche Druckgießform aufweist;

einem Schritt zum Platzieren eines Pumpengehäuses, das einen vorstehenden Teil in einer zylindrischen Form aufweist, in einem Zustand, in dem eine Außenumfangsfläche des vorstehenden Teils in Kontakt mit einer Innenoberfläche einer Ausbuchtung, die bei einer oberen Oberfläche der festen Druckgießform vorgesehen ist, kommt, wobei die Ausbuchtung in einer Richtung orthogonal zu einer Achse der festen Druckgießform einen kreisförmigen Querschnitt aufweist; und

einen Schritt zum Formen eines Harzteils durch Einspritzen von Harz in die Form zum Aushärten des Harzes nach einem Drücken der beweglichen Druckgießform gegen die feste Druckgießform zum Schließen der Form, wobei der Harzteil mindestens einen Außenumfang des Pumpengehäuses und einen Außenumfang des Stators integral umgibt, wobei der Harzteil bei Außenumfangsflächen des Stators des Motorteils und des Pumpengehäuses des Pumpenteils vorgesehen ist, wobei der Harzteil und das Pumpengehäuse fest miteinander integriert sind, und wobei das Pumpengehäuse einen Vertiefungsteil bei einer Außenfläche aufweist, in den Harz des Harzteils gepasst ist.

Revendications

1. Pompe électrique (1) comprenant :

une partie de pompe (10) comprenant un carter de pompe (11) et une pompe à engrenages (21) qui es logée dans le carter de pompe (11), la partie de pompe (10) aspirant et refoulant un fluide hydraulique par la rotation de la pompe à engrenages (21) ;

une partie de moteur (30) disposée à côté de la partie de pompe (10) dans une direction le long d'un axe de la partie de pompe (10) et comprenant un rotor (36) qui tourne de manière synchrone avec la pompe à engrenages (21) et coaxialement avec l'axe, la partie de moteur (30) comprenant un stator (32) qui est disposé à une périphérie extérieure du rotor (36) et coaxialement avec l'axe, le stator (32) appliquant une force d'entraînement en rotation au rotor (36) ; et une partie en résine (60) entourant intégralement au moins une périphérie extérieure du carter de pompe (11) et une périphérie extérieure du stator (32),

la partie en résine (60) est prévue sur les surfaces périphériques extérieures du stator (32) de la partie de moteur (30) et du carter de pompe (11) de la partie de pompe (10), et la partie en résine (60) et le carter de pompe (11) sont fermement intégrés l'un à l'autre,

caractérisé en ce que

le carter de pompe (11) comprend une partie évidée (16) sur une surface extérieure, la partie évidée (16) dans laquelle la résine de la partie en résine (60) est insérée.

2. Pompe électrique (1) selon la revendication 1, dans laquelle

le carter de pompe (11) et le stator (32) présentent chacun une configuration circulaire extérieure vue dans la direction de l'axe de la partie de pompe, et
le carter de pompe (11) et le stator (32) ont les mêmes diamètres extérieurs l'un par rapport à l'autre.

3. Pompe électrique (1) selon la revendication 1 ou 2, dans laquelle la partie en résine (60) comprend une épaisseur constante dans une direction radiale de la partie en résine.

4. Pompe électrique (1) selon l'une quelconque des revendications 1 à 3, dans laquelle le carter de pompe (11) et la pompe à engrenages (21) sont tous deux en matériau ferreux.

5. Pompe électrique (1) selon l'une quelconque des revendications 1 à 4, dans laquelle le stator (32) et le carter de pompe (11) sont intégrés par la partie en résine (60), et un joint d'huile (26), le rotor (36) et la pompe à engrenages (21) sont assemblés sur le stator (32) et le carter de pompe (H) intégrés.

6. Procédé de fabrication d'une pompe électrique (1), comprenant :

une étape pour placer un stator de forme cylindrique sur une surface périphérique extérieure d'une matrice fixe d'une matrice de formage dans un état où une surface périphérique intérieure du stator entre en contact avec la surface périphérique extérieure de la matrice fixe, la matrice de formage étant configurée pour s'ouvrir et se fermer et comprenant la matrice fixe et une matrice mobile ;
une étape pour placer un carter de pompe qui comprend une partie saillante de forme cylindrique dans un état où une surface périphérique extérieure de la partie saillante entre en contact avec une surface périphérique intérieure d'une bosse qui est prévue sur une surface supérieure de la matrice fixe, la bosse comprenant une section transversale circulaire dans une direction orthogonale à un axe de la matrice fixe ; et
une étape pour former une partie en résine en faisant couler de la résine dans la matrice de formation pour durcir la résine après que la matrice mobile est pressée contre la matrice fixe pour fermer la matrice de formation, la partie en résine entourant intégralement au moins une périphérie extérieure du carter de pompe et une périphérie extérieure du stator, la partie en résine étant fournie aux surfaces périphériques extérieures du stator de la partie de moteur et du carter de pompe de la partie de pompe,
la partie en résine et le carter de pompe étant fermement intégrés l'un à l'autre, et le carter de pompe comprenant une partie évidée à une surface extérieure, la partie évidée dans laquelle la résine de la partie en résine est ajustée.

FIG. 1

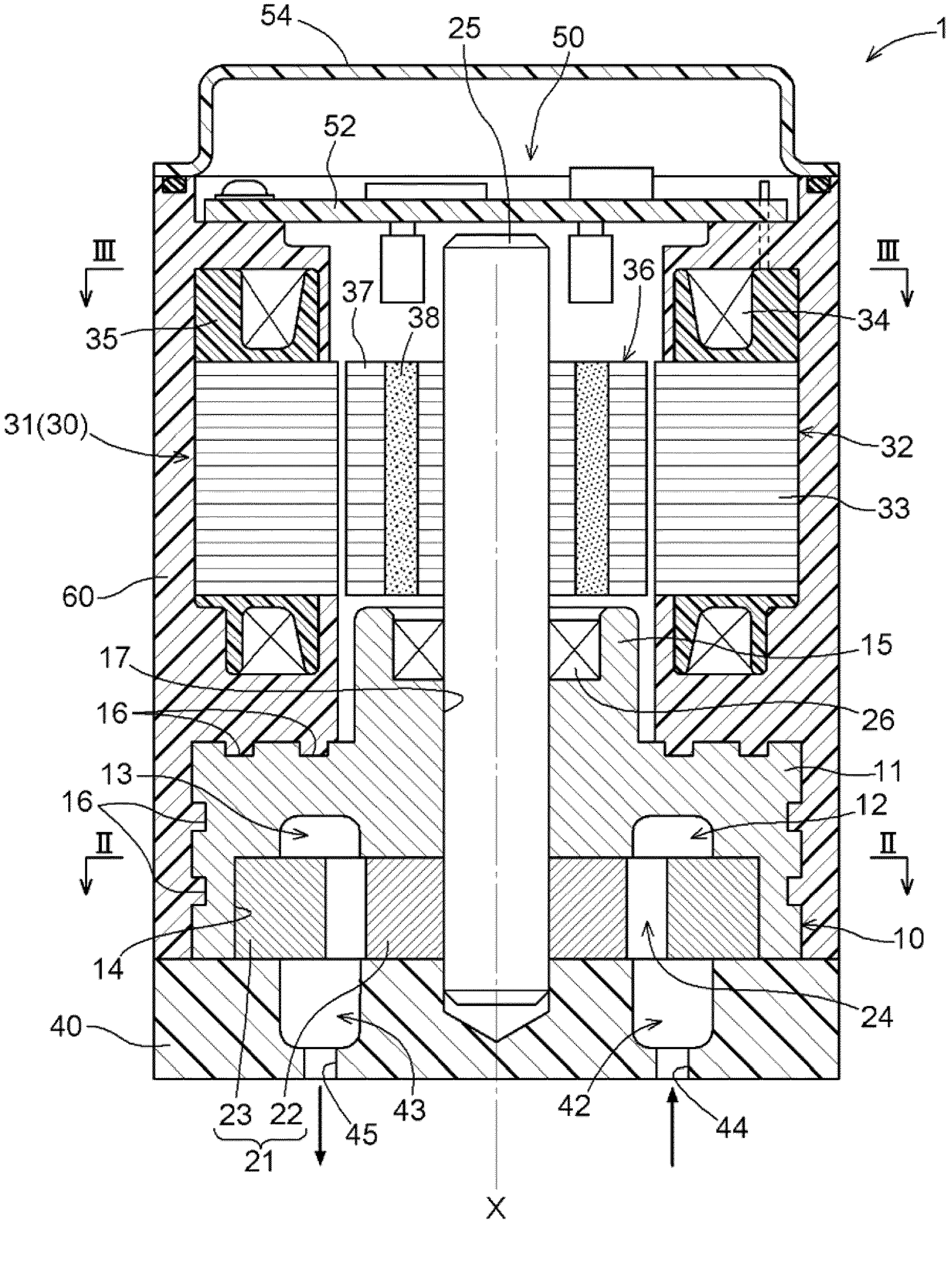

54
25
50
1
52
III
III
37
36
38
35
34
31(30)
32
33
60
15
17
26
16
11
13
12
16
II
II
10
14
24
40
42
43
23
22
45
44
21
X

FIG. 2

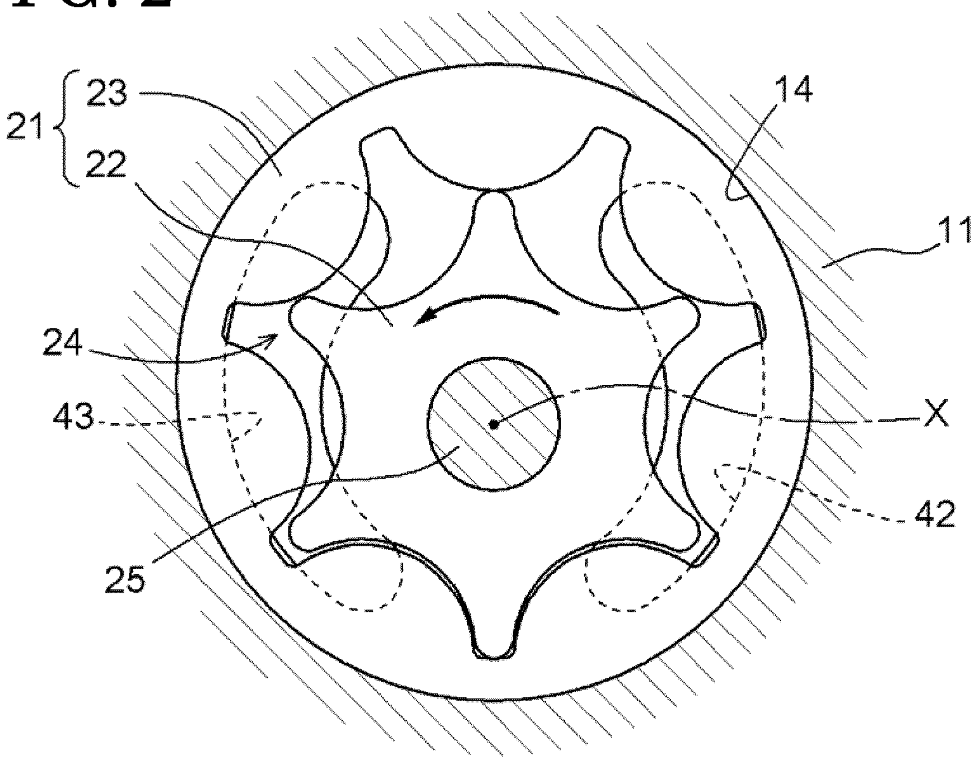


FIG. 3

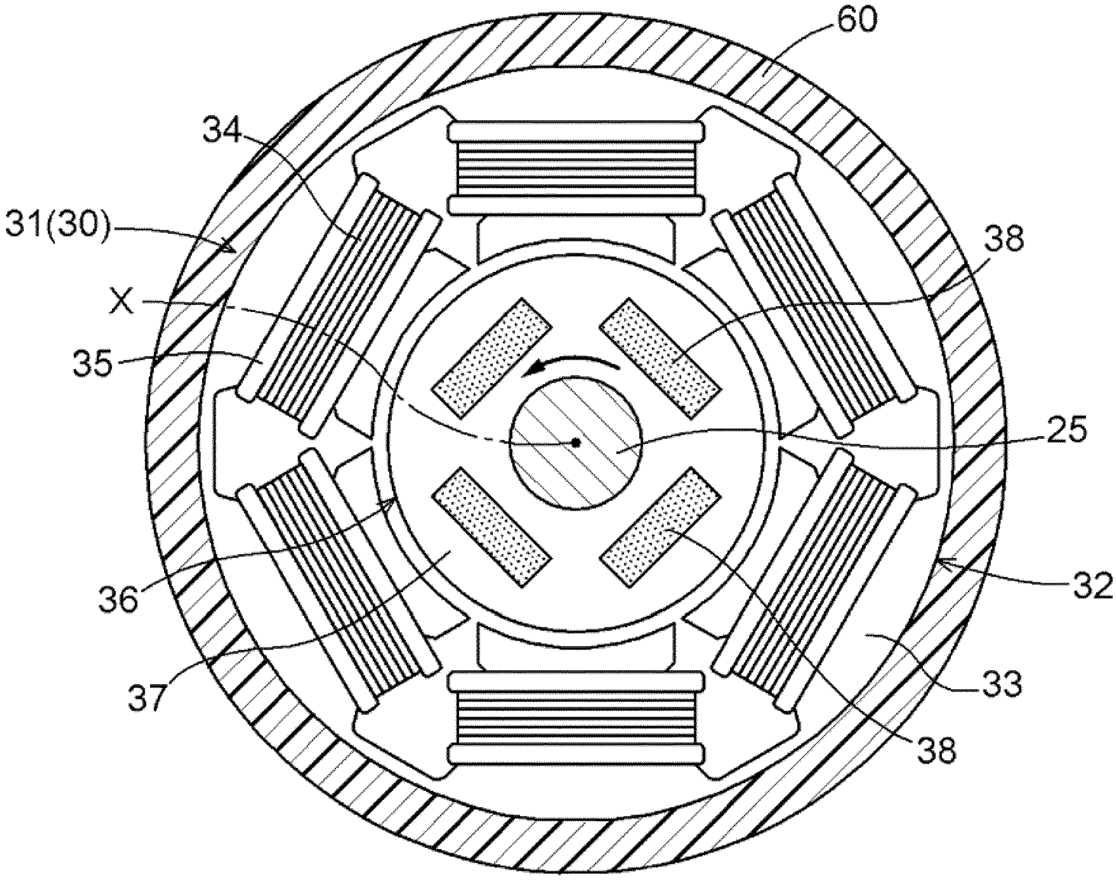


FIG. 4

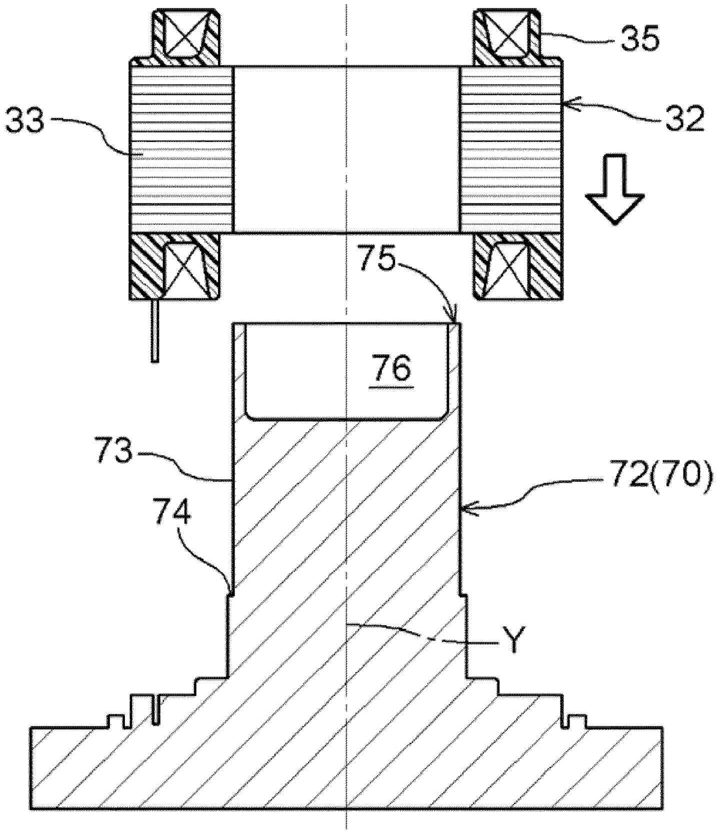


FIG. 5

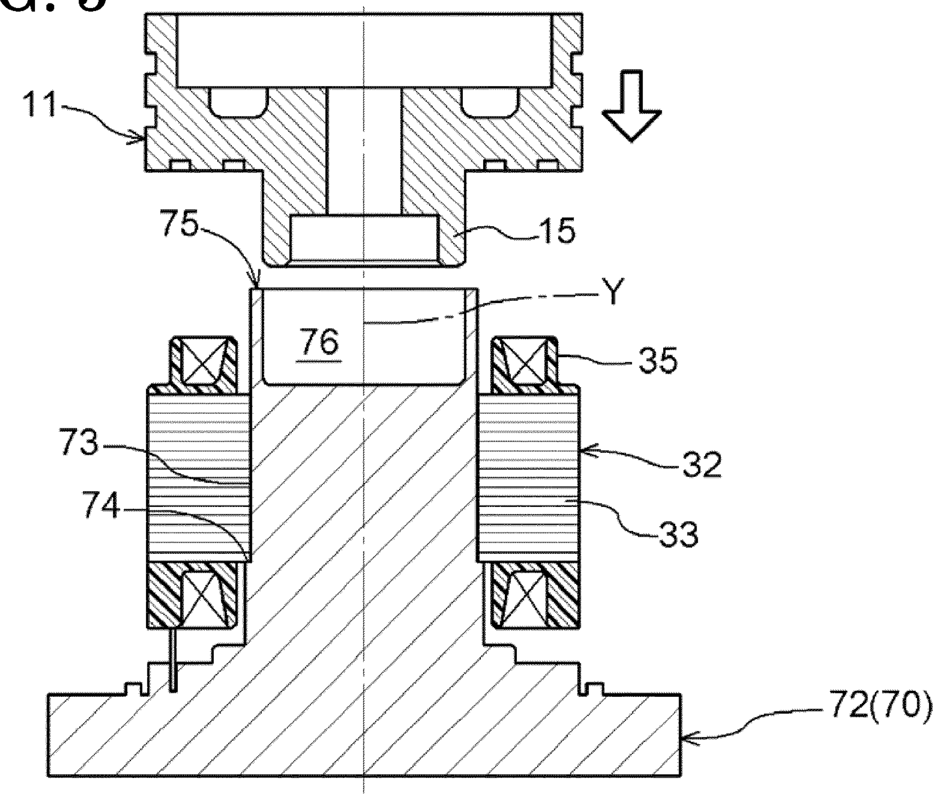


FIG. 6

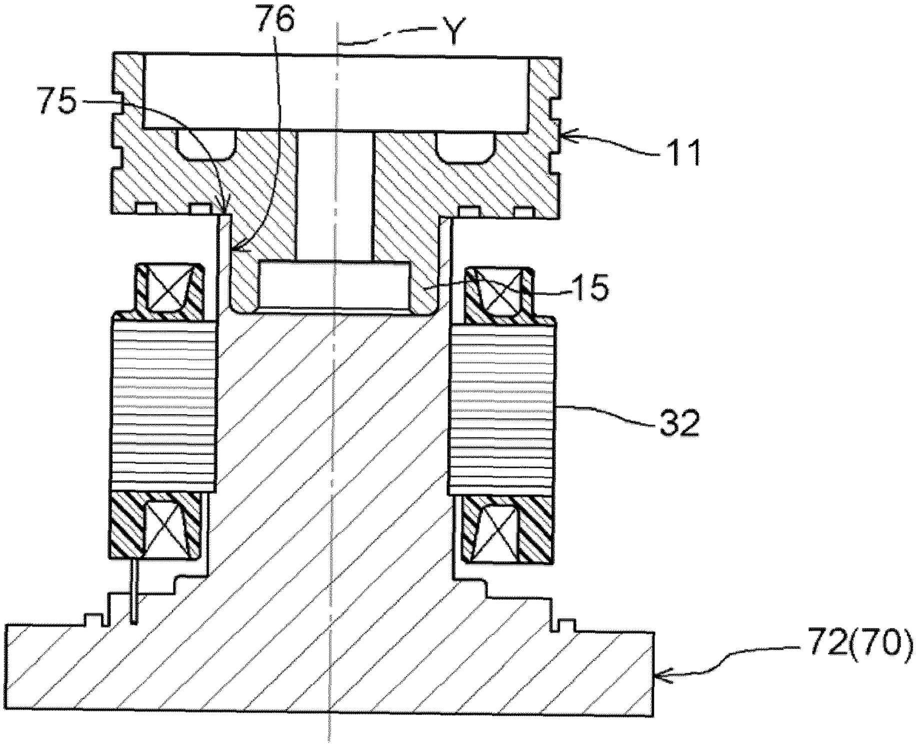
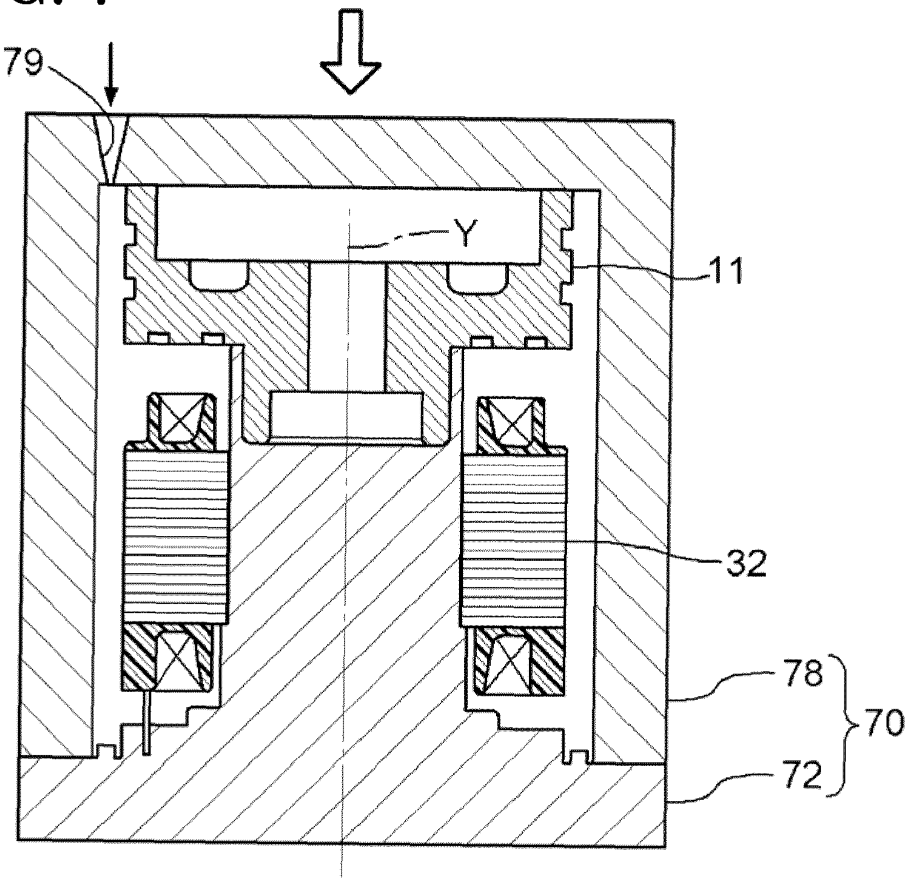
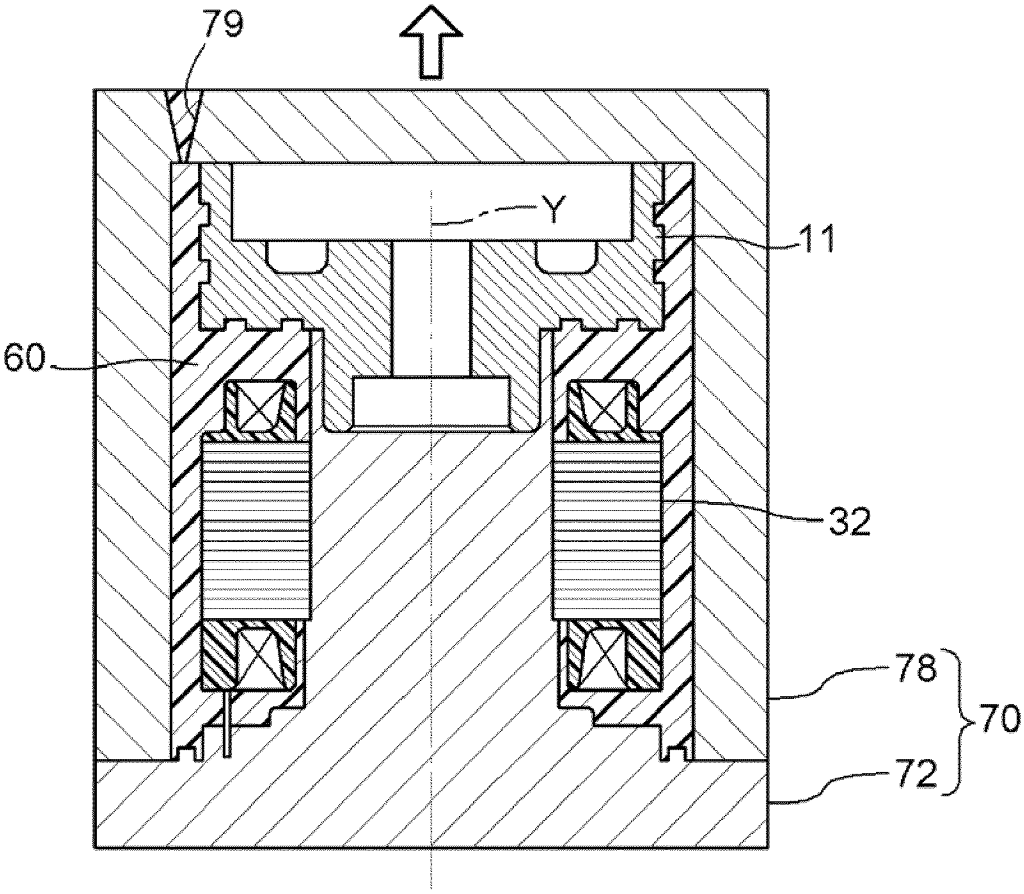


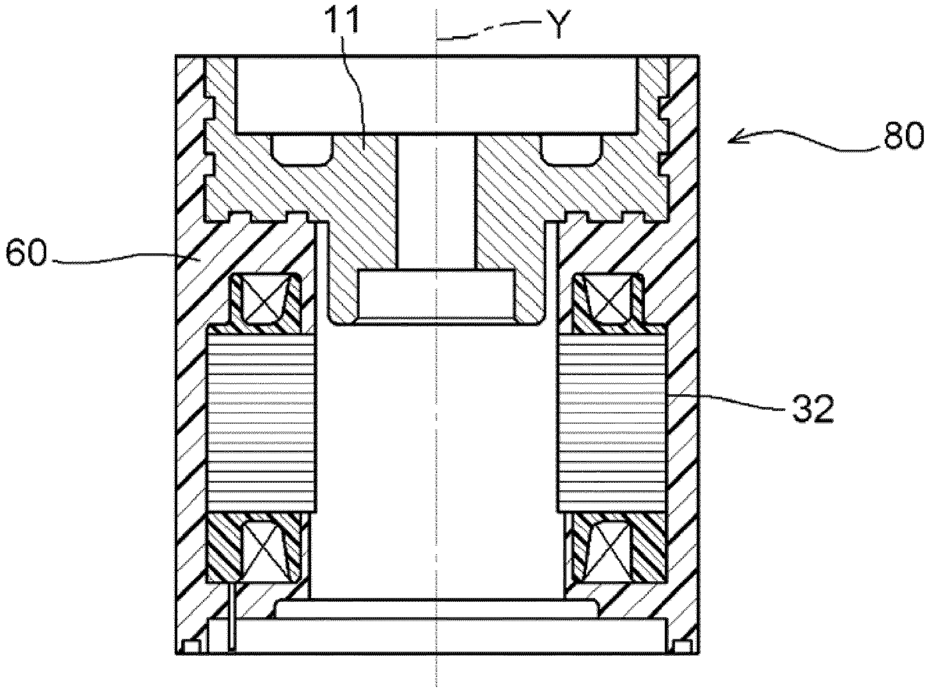
FIG. 7



F I G. 8



F I G. 9



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2013217223 A **[0006]**
- JP 2009156081 A **[0006]**
- US 20130052058 A1 **[0007]**
- EP 2848813 A1 **[0008]**
- EP 2497952 A2 **[0009]**
- JP 2014001637 A **[0010]**