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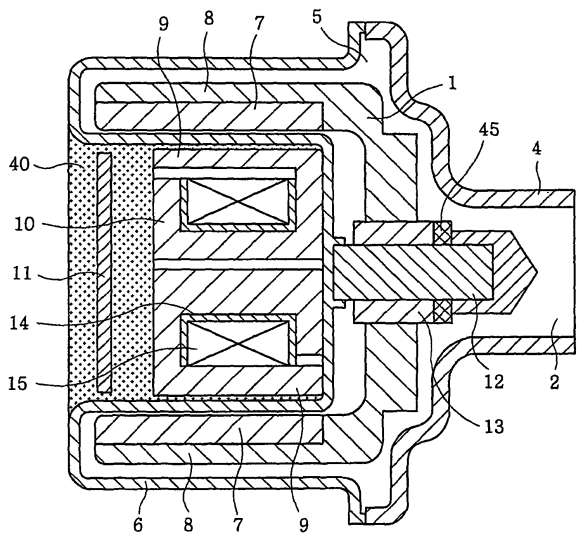
(54) **Pump**

(57) A pump includes an impeller for sucking and discharging liquid, a pump case having a suction port and a discharge port through which the liquid is sucked and discharged, and a partition cooperating with the pump case to form a pump chamber in which the impeller is rotatably received. The pump is further includes a rotor having a magnet for rotatingly driving the impeller and a stator having claw-shaped magnetic poles for applying a rotational driving force to the rotor, the rotor and the stator constituting a claw pole type motor that serves as a driving power source of the pump. At least the stator is entirely coated with a molded resin.

FIG.2



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Description

Field of the Invention

[0001] The present invention relates to a pump incorporating a claw pole type motor and, more particularly, to a technique of increasing a pump efficiency and reducing a pump size.

Background of the Invention

[0002] It is known that a pump for sucking and discharging, e.g., liquid, employs a claw pole type motor with claw-shaped magnetic poles as a motor for rotatingly driving an impeller (see, e.g., Japanese Patent Laid-open Application No. 2003-505648). The claw pole type motor is simple in structure and therefore is advantageous in that it can enjoy enhanced productivity and reduced production costs.

[0003] Typically, the pump includes an impeller for sucking and discharging liquid, a pump case with suction and discharge ports, a partition cooperating with the pump case to form a pump chamber in which the impeller is rotatably received, a rotor having a magnet for rotatingly driving the impeller and a stator having claw-shaped magnetic poles for applying a rotational driving force to the rotor. The rotor and the stator are liquid-tightly isolated from each other by means of the partition.

[0004] In this kind of pump, there have existed a demand for enhancement of a suction and discharge capacity (pump efficiency) and a demand for reduction in size.

Summary of the Invention

[0005] In view of the above, the present invention provides a pump capable of assuring increased efficiency and reduced size.

[0006] In accordance with the present invention, there is provided a pump including: an impeller for sucking and discharging liquid; a pump case having a suction port and a discharge port through which the liquid is sucked and discharged; a partition cooperating with the pump case to form a pump chamber in which the impeller is rotatably received; a rotor having a magnet for rotatingly driving the impeller; and a stator having claw-shaped magnetic poles for applying a rotational driving force to the rotor, the rotor and the stator constituting a claw pole type motor that serves as a driving power source of the pump, wherein at least the stator is entirely coated with a molded resin.

[0007] In order to enhance pump efficiency and to reduce pump size in a pump using a claw pole type motor as its driving power source, a stator is entirely coated with molded resin or is formed of a dust core.

[0008] In accordance with the pump of the present invention, a stator is entirely coated with molded resin, whereby the heat of liquid sucked into a pump case through an suction port and the heat emitted from a motor (a rotor and a stator) are dissipated through the molded resin. This makes it possible to enhance pump efficiency. With the pump of the present invention, the molded resin acts to dissipate heat. This eliminates the need to additionally provide a cooling device, which assists in reducing the size of the pump itself.

[0009] With the pump of the present invention, the stator is formed of a dust core. This makes it possible to suppress generation of an eddy current and to reduce the loss of electric current, consequently increasing pump efficiency. Since the stator is formed of a dust core in the pump of the present invention, it is possible to reduce the thickness of the stator itself and, eventually, to reduce the size of the pump itself.

Brief Description of the Drawings

[0010] The object and features of the present invention will become apparent from the following description of embodiments given in conjunction with the accompanying drawings, in which:

Fig. 1 is a perspective view of a pump in accordance with a first embodiment of the present invention;
Fig. 2 is a section view taken along line A-A in Fig. 1;
Fig. 3 is a section view of a pump in accordance with a second embodiment of the present invention;
Fig. 4 is a section view of a pump in accordance with a fourth embodiment of the present invention;
Fig. 5 is a section view of a conventional pump in which magnetic poles are detected by a hall sensor; and
Fig. 6 is a section view of a pump in accordance with a fifth embodiment of the present invention.

Detailed Description of the Embodiments

[0011] Hereinafter, an exemplary embodiment of the present invention will be described with reference to Figs. 1 to 6, which form a part hereof.

(First Embodiment)

[0012] Fig. 1 is a perspective view of a pump in accordance with a first embodiment of the present invention. Fig. 2 is a section view taken along line A-A in Fig. 1.

[0013] The pump in accordance with the first embodiment includes an impeller 1 for sucking and discharging liquid, a pump case 4 with a suction port 2 and a discharge port 3 through which the liquid is sucked and discharged, a partition 6 cooperating with the pump case 4 to form a pump chamber 5 in which the impeller 1 is rotatably received, a rotor 8 having a magnet 7 for rotatingly driving the impeller 1, a stator 10 having claw-shaped magnetic poles 9 for applying a rotational driving force to the rotor 8 and a control circuit board 11 for controlling magnetic field generated by the stator 10. The rotor 8, the stator

10 and the control circuit board 11 constitute a claw pole type motor that serves as a driving power source of the pump.

[0014] The pump of the first embodiment employs, as its driving power source, the claw pole type motor having a socalled outer rotor structure in which the rotor 8 is arranged outside the partition 6 and the stator 10 is arranged inside the partition 6.

[0015] The pump chamber 5 is formed by coupling the partition 6 for liquid-tightly isolating the rotor 8 from the stator 10 (for isolating a pump part from a motor part) to the pump case 4 having the suction port 2 opened at the center of a ceiling surface and the discharge port 3 formed in a sidewall. A seal member (not shown) for water-tightly partitioning the pump part and the motor part is arranged in the coupling portion of the pump case 4 and the partition 6.

[0016] The impeller 1 is rotatably supported through a bearing portion 13 with respect to a fixed shaft 12 provided within the pump chamber 5. When rotated about the fixed shaft 12, the impeller 1 applies a centrifugal force to the liquid sucked into the pump chamber 5 through the suction port 2, thereby discharging the liquid out of the pump through the discharge port 3. The liquid sucked and discharged by the impeller 1 may be, e.g., hot water heated to a temperature of about 80°C. A reception plate 45 is arranged above the bearing portion 13.

[0017] The rotor 8 has a cylindrical body integrally formed with the impeller 1. The magnet 7 forming a magnetic circuit (magnetic flux) is arranged in the inner wall of the cylindrical body of the rotor 8. In between the magnet 7 and the partition 6, there is provided a gap (clearance) enough to keep the magnet 7 and the partition 6 out of contact during rotation of the rotor 8.

[0018] The stator 10 is arranged inside the cylindrical rotor 8 in a mutually facing relationship, with the partition 6 interposed therebetween. The stator 10 includes an iron core having a plurality of claw-shaped magnetic poles (claw poles) 9, and an annular coil (winding) 15 arranged in the iron core via an insulation plate (not shown). The stator 10 and the partition 6 may make surface-to-surface contact with each other. The stator 10 is entirely coated with a molded resin 40 composed of, e.g., unsaturated polyester.

[0019] With this claw pole type stator 10, the magnetic fields generated by energizing the annular coil 15 can be transferred from the claw-shaped magnetic poles 9 to the rotor 8 with increased efficiency.

[0020] The control circuit board 11 is provided at the rear side of the stator 10. In response to a signal issuing from a position detector (not shown), the control circuit board 11 controls the magnetic fields generated from the annular coil 15. The control circuit board 11 and the stator 10 are coated with the molded resin 40.

[0021] In the pump configured as above, as the magnetic fields generated by energization of the annular coil 15 are transferred from the claw-shaped magnetic poles 9 to the magnet 7, the magnet 7 is attracted and repelled so that the impeller 1 integrally formed with the rotor 8 can rotate about the fixed shaft 12. Rotation of the impeller 1 initiates a pumping action whereby liquid is sucked into the pump chamber 5 through the suction port 2 and pressurized within the pump chamber 5. The pressurized liquid is pumped radially circumferentially and discharged out of the pump through the discharge port 3.

[0022] The stator 10 generates heat as the annular coil 15 is energized. The liquid sucked and discharged by the impeller 1 is hot water of about 80°C as mentioned above. Therefore, the motor is heated up, which may lead to reduction in the suction and discharge efficiency (motor efficiency). Since the stator 10 is entirely coated with the molded resin 40 according to the present embodiment, it is possible to dissipate the heat of the motor and the heat of the liquid out of the motor through the molded resin 40. With the pump of the present embodiment, it is therefore possible to cool the motor without having to use an additional cooling device, which assists in enhancing the motor efficiency and reducing the motor size.

[0023] Further, since the stator 10 is entirely coated with the molded resin 40 according to the present embodiment, it is possible for the molded resin 40 to protect the stator 10 and increase the strength thereof.

[0024] In the pump of the present embodiment, the internal pressure of the pump chamber 5 is increased as the impeller 1 rotates. The internal pressure acts against the partition 6. In case that the thickness of the partition 6 is increased to secure a pressure resistance enough to resist the internal pressure, the motor size becomes greater. By employing a structure in which the stator 10 makes surface-to-surface contact with the partition 6, it is possible for the stator 10 to withstand and reduce the pressure applied to the partition 6. In the pump of the present embodiment, it is therefore possible to increase the internal hydraulic pressure of the pump without having to make the partition 6 thick. Further, since the thickness of the partition 6 can be reduced, it is possible to reduce the material cost in the pump of the present embodiment.

(Second Embodiment]

[0025] In a pump in accordance with a second embodiment of the present invention, a stator 10' is formed of a dust core. Other structures of the pump of the second embodiment are the same as those of the outer rotor type pump described above in connection with the first embodiment, except that the stator 10' is not coated with the molded resin 40. Those portions of the second embodiment different from the first embodiment will now be described, and redundant description of the same portions will be omitted.

[0026] Fig. 3 is a section view of the pump in accordance with the second embodiment of the present invention. The pump of the second embodiment employs the stator 10' formed of a dust core which is molded by filling magnetic powder in a cavity of a mold and compressing the same. The dust core is of a structure in which individual iron particles are coated with inorganic insulating films and bound together by resin. The dust core has advantages in that it exhibits a reduced iron loss (eddy current loss) at a high frequency.

[0027] Since the stator 10' is formed of a dust core in the pump of the second embodiment set forth above, it is possible to use the stator 10' in a high frequency band of several hundred kHz in which a stator heretofore made of an electromagnetic steel plate or a ferrite plate cannot be used satisfactorily. In addition, the pump is further reduced in size while exercising the same performance as is available in the conventional case.

(Third Embodiment)

[0028] A pump in accordance with a third embodiment of the present invention is made by the combination of the pumps of the first and second embodiments. The pump of the third embodiment is the same in structure as the pump of the first embodiment shown in Figs. 1 and 2 but is produced by combining the structure (the structure of the first embodiment) in which the stator 10 is entirely coated with the molded resin 40 and the structure (the structure of the second embodiment) in which the stator 10' is formed of a dust core.

[0029] The pump of the third embodiment provides the advantageous effects of the second embodiment as well as those of the first embodiment. Therefore, it is possible to increase the motor efficiency by efficiently dissipating the heat of the motor and the heat of the liquid. It is also possible to reduce the pump size, while allowing the pump to be used in a high frequency band.

[0030] With the pump of the third embodiment, the stator 10' formed of a dust core is relatively low in strength. However, it is possible to protect the stator 10' from external forces by coating the entire stator 10' with the molded resin 40.

(Fourth Embodiment)

[0031] In a pump in accordance with a fourth embodiment of the present invention, not only the entire stator 10 but also the partition 6 is coated with the molded resin 40. Other structures of the pump of the fourth embodiment are the same as those of the outer rotor type pump described above in connection with the first embodiment. Those portions of the fourth embodiment different from the first embodiment will now be described, and redundant description of the same portions will be omitted.

[0032] Fig. 4 is a section view of the pump in accordance with the fourth embodiment of the present invention. In the pump of the fourth embodiment, the partition 6 is entirely coated with the molded resin 40, in addition to the structure (the structure of the first embodiment) in which the stator 10 is entirely coated with the molded resin 40.

[0033] Since the partition 6 is entirely coated with the molded resin 40, the contact surface between the partition 6 and the molded resin 40 is increased in the pump of the fourth embodiment. Therefore, the pump of the fourth embodiment provides not only the advantageous effects available in the first embodiment but also the advantageous effects that it is possible to more effectively dissipate the heat of the motor and the heat of the liquid transferred through the partition 6. Accordingly, the motor efficiency can be further increased with the pump of the fourth embodiment.

[0034] In this kind of pump, it is typical to employ a motor driving method as shown in Fig. 5, in which the magnet 7 is used as a rotor and the timing of supplying an electric current is controlled by detecting the magnetic poles with a hall sensor 41. However, in case of using the hall sensor 41 as in this example, the pump itself is increased in size. For preventing the pump from being increased in size, the magnetic poles of the magnet 7 may be detected from the waveforms of an electric current, thereby eliminating the need to use the hall sensor 41. Detection of the magnetic poles of the magnet 7 from the waveforms of an electric current is applicable to the pumps of the first to third embodiments as well as the pump of the fourth embodiment. This eliminates the need to install the hall sensor 41 near the rotor 8. Therefore, it becomes possible to reduce the size of the pump itself.

(Fifth Embodiment)

[0035] A pump in accordance with a fifth embodiment of the present invention employs as its driving power source a claw pole type motor with an inner rotor structure in which a rotor is arranged inside a partition and a stator is arranged outside the partition. Fig. 6 is a section view of the pump in accordance with the fifth embodiment.

[0036] The pump of the fifth embodiment includes an impeller 21 for sucking and discharging liquid, a pump case 24 with a suction port 22 and a discharge port 23 through which the liquid is sucked and discharged, a partition 26 cooperating with the pump case 24 to form a pump chamber 25 in which the impeller 1 is rotatably received, a rotor 28 having a magnet 27 for rotatingly driving the impeller 21, a stator 30 having claw-shaped magnetic poles (not shown) for applying a rotational driving force to the rotor 28 and a control circuit board 31 for controlling magnetic field generated by the stator 30. The rotor 28, the stator 30 and the control circuit board 31 constitute a claw pole type motor that serves as a driving power source of the pump.

[0037] The pump of the fifth embodiment employs, as its driving power source, the claw pole type motor having a socalled inner rotor structure in which the rotor 28 is arranged inside the partition 26 and the stator 30 is arranged outside the partition 26.

[0038] The pump chamber 25 is formed by coupling the partition 26 for liquid-tightly isolating the rotor 28 from the stator 30 (for isolating a pump part from a motor part) to the pump case 24 having the suction port 22 opened at the center of a ceiling surface and the discharge port 23 formed in a sidewall. A seal member 29 for liquid-tightly partitioning the pump part and the motor part is arranged in the coupling portion of the pump case 24 and the partition 26.

[0039] The rotor 28 has a cylindrical body integrally formed with the impeller 21. The magnet 27 forming a magnetic circuit (magnetic flux) is arranged in the outer wall of the cylindrical body of the rotor 28. The rotor 28 is rotatably supported through a bearing portion 35 about a fixed shaft 34 whose opposite ends are respectively fitted into a shaft supporting portion 32 of the pump case 24 and a shaft supporting portion 33 of the partition 26. The fixed shaft 34 is held against rotation by means of anti-rotation plates 36 and 37 attached to the opposite end portions thereof. In between the magnet 27 and the partition 26, there is provided a gap (clearance) enough to keep the magnet 27 and the partition 26 out of contact during rotation of the rotor 28.

[0040] The impeller 21 integrally formed with the rotor 28 rotates about the fixed shaft 34 and applies a centrifugal force to the liquid sucked into the pump chamber 25 through the suction port 22, thereby discharging the liquid out of the pump through the discharge port 23.

[0041] The stator 30 is arranged outside the rotor 28 in a mutually facing relationship, with the partition 26 interposed therebetween. The stator 10 includes an iron core having a plurality of claw-shaped magnetic poles (claw poles), and an annular coil 38 arranged in the iron core via an insulation plate (not shown). The stator 30 and the partition 26 may make surface-to-surface contact with each other. With this claw pole type stator 30, the magnetic fields generated by energizing the annular coil 38 can be transferred from the claw-shaped magnetic poles to the rotor 28 with increased efficiency.

[0042] The control circuit board 31 is provided at the rear side of the partition 26. In response to a signal issuing from a position detector 39 as a position detecting sensor, the control circuit board 31 controls the magnetic fields generated from the annular coil 38. The stator 30, the control circuit board 31 and the partition 26 are coated in their entirety with a molded resin 40 composed of, e.g., unsaturated polyester.

[0043] In the pump configured as above, as the magnetic fields generated by energization of the annular coil 38 are transferred from the claw-shaped magnetic poles to the magnet 27, the magnet 27 is attracted and repelled so that the impeller 21 integrally formed with the rotor 28 can rotate about the fixed shaft 34. Rotation of the impeller 21 initiates a pumping action whereby liquid is sucked into the pump chamber 25 through the suction port 22 and pressurized within the pump chamber 25. The pressurized liquid is pumped radially circumferentially and discharged out of the pump through the discharge port 23.

[0044] Since the claw pole type motor having the inner rotor structure is entirely coated with the molded resin 40 in the fifth embodiment, it is possible to dissipate the heat of the motor and the heat of the liquid out of the motor through the molded resin 40. It is also possible to cool the motor without having to use an additional cooling device, which assists in enhancing the motor efficiency and reducing the motor size.

[0045] Further, since the pump is entirely coated with the molded resin 40 except for the pump case 24 in the present embodiment, it is possible for the molded resin 40 to protect the entire motor part including the control circuit board 31 and to increase the strength thereof.

[0046] In the pump of the fifth embodiment, the internal pressure of the pump chamber 25 is increased as the impeller 21 rotates. The internal pressure acts against the partition 26. By employing a structure in which the stator 30 makes surface-to-surface contact with the partition 26, it is possible for the stator 30 to withstand and reduce the pressure applied to the partition 26. In the pump of the present embodiment, it is therefore possible to increase the internal hydraulic pressure of the pump without having to make the partition 26 thick. Further, since the thickness of the partition 26 can be thin, it is possible to reduce the material cost in the pump of the present embodiment.

[0047] In the pump of the fifth embodiment, the stator 30 may be formed of a dust core as in the second embodiment. Furthermore, the pump of the fifth embodiment may be of a structure in which the stator 30 is formed of a dust core without coating the same with the molded resin 40.

[0048] While the invention has been shown and described with respect to the embodiments, it will be understood by those skilled in the art that various changes and modifications may be made without departing from the scope of the invention as defined in the following claims.

Claims

1. A pump comprising:

an impeller for sucking and discharging liquid;
a pump case having a suction port and a discharge port through which the liquid is sucked and discharged;
a partition cooperating with the pump case to form a pump chamber in which the impeller is rotatably received;
a rotor having a magnet for rotatingly driving the impeller; and
a stator having claw-shaped magnetic poles for applying a rotational driving force to the rotor, the rotor and the stator constituting a claw pole type motor that serves as a driving power source of the pump,

wherein at least the stator is entirely coated with a molded resin.

2. A pump comprising:

an impeller for drawing and discharging liquid;
a pump case having a suction port and a discharge port through which the liquid is sucked and discharged;
a partition cooperating with the pump case to form a pump chamber in which the impeller is rotatably received;
a rotor having a magnet for rotatingly driving the impeller; and
a stator having claw-shaped magnetic poles for applying a rotational driving force to the rotor, the rotor and the stator constituting a claw pole type motor that serves as a driving power source of the pump,

wherein the stator is formed of a dust core molded by compressing magnetic powder.

3. The pump of claim 1, wherein the stator is formed of a dust core molded by compressing magnetic powder.

4. The pump of any one of claims 1 to 3, wherein the claw pole type motor has an outer rotor structure in which the rotor is arranged outside the partition and the stator is arranged inside the partition.

5. The pump of any one of claims 1 to 3, wherein the claw pole type motor has an inner rotor structure in which the rotor is arranged inside the partition and the stator is arranged outside the partition.

FIG. 1

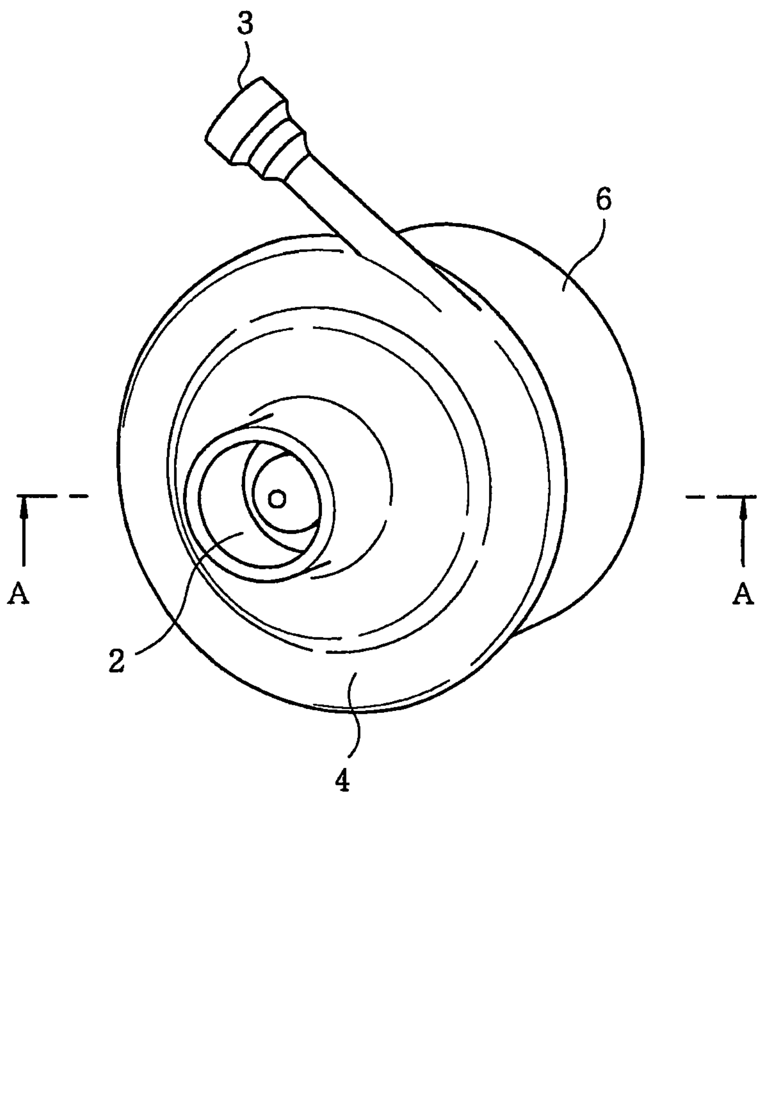


FIG.2

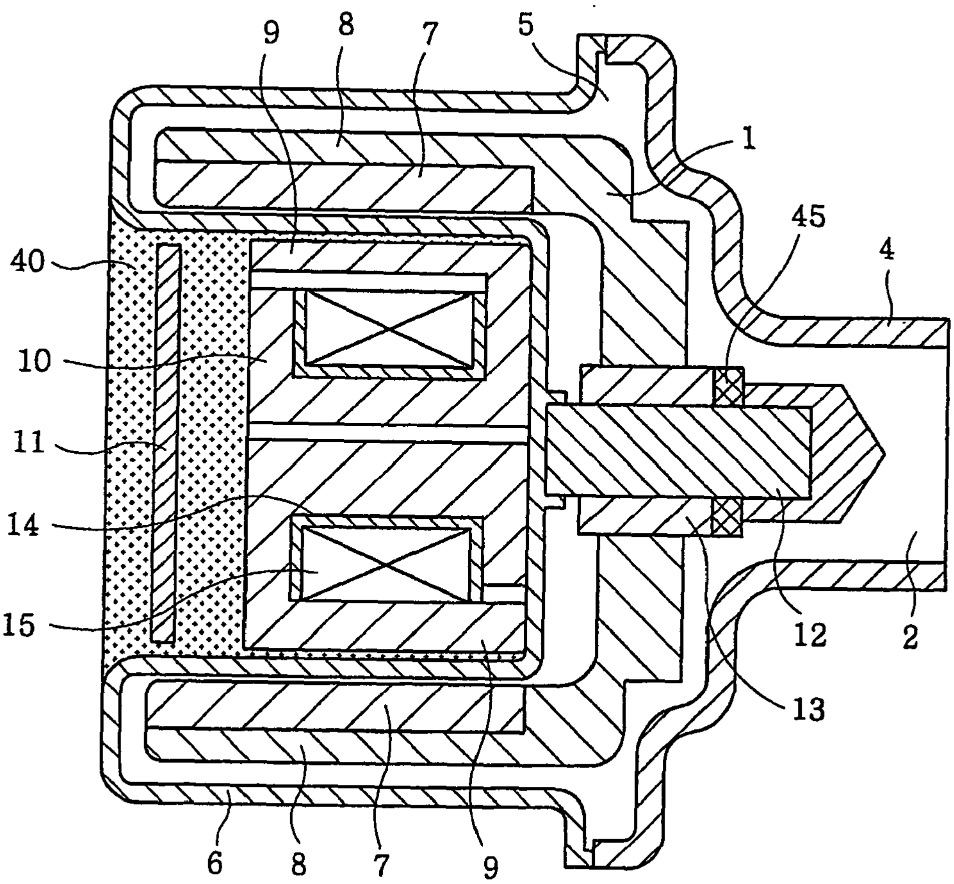


FIG.3

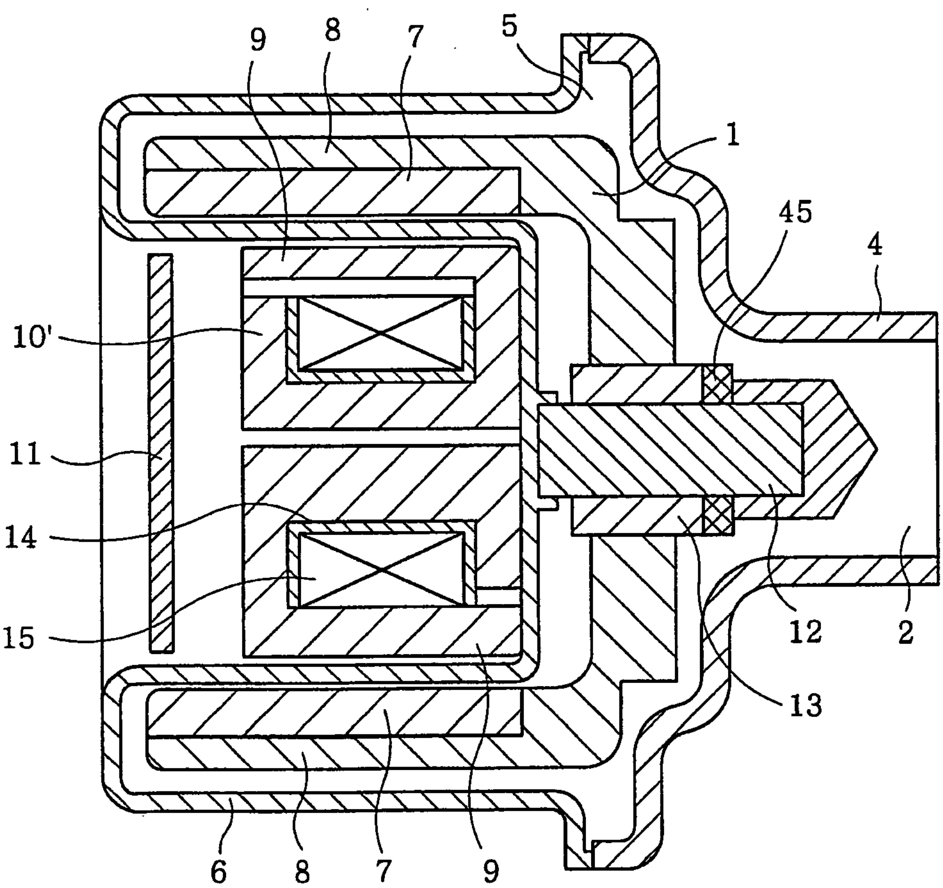


FIG. 4

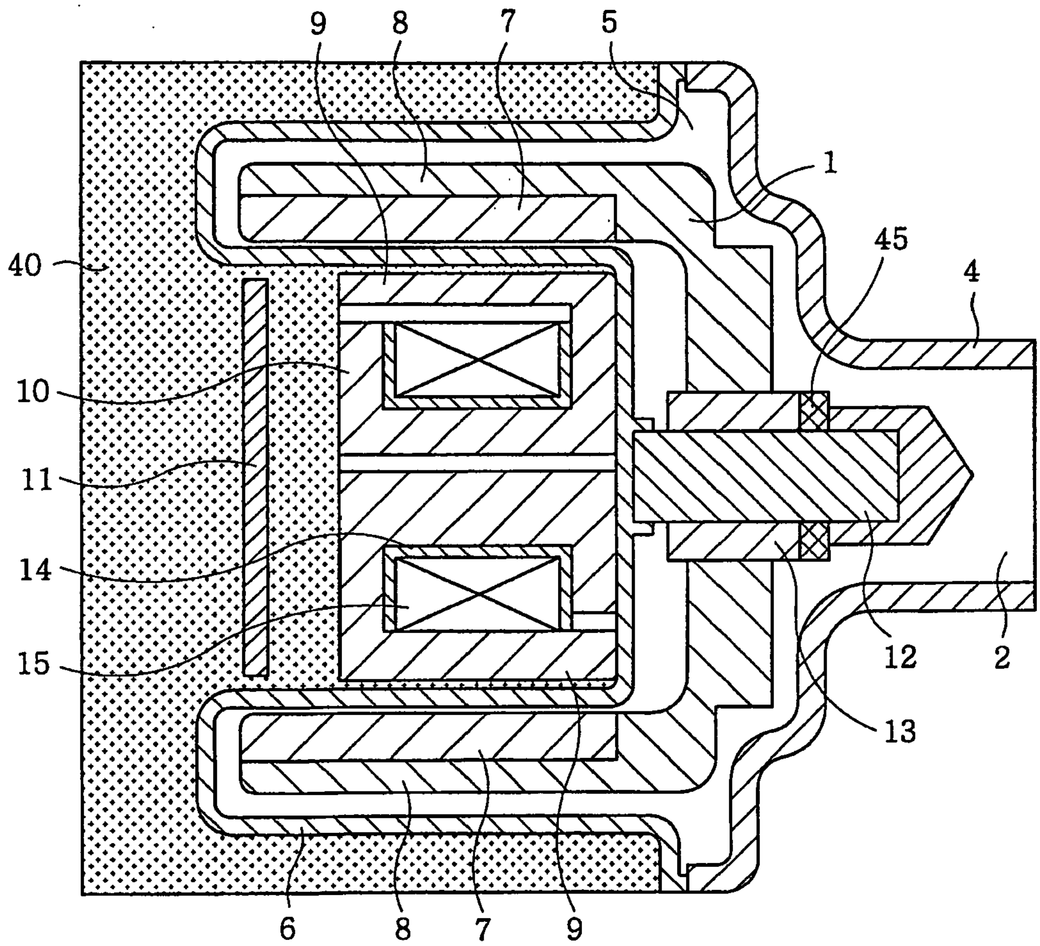


FIG.5

(PRIOR ART)

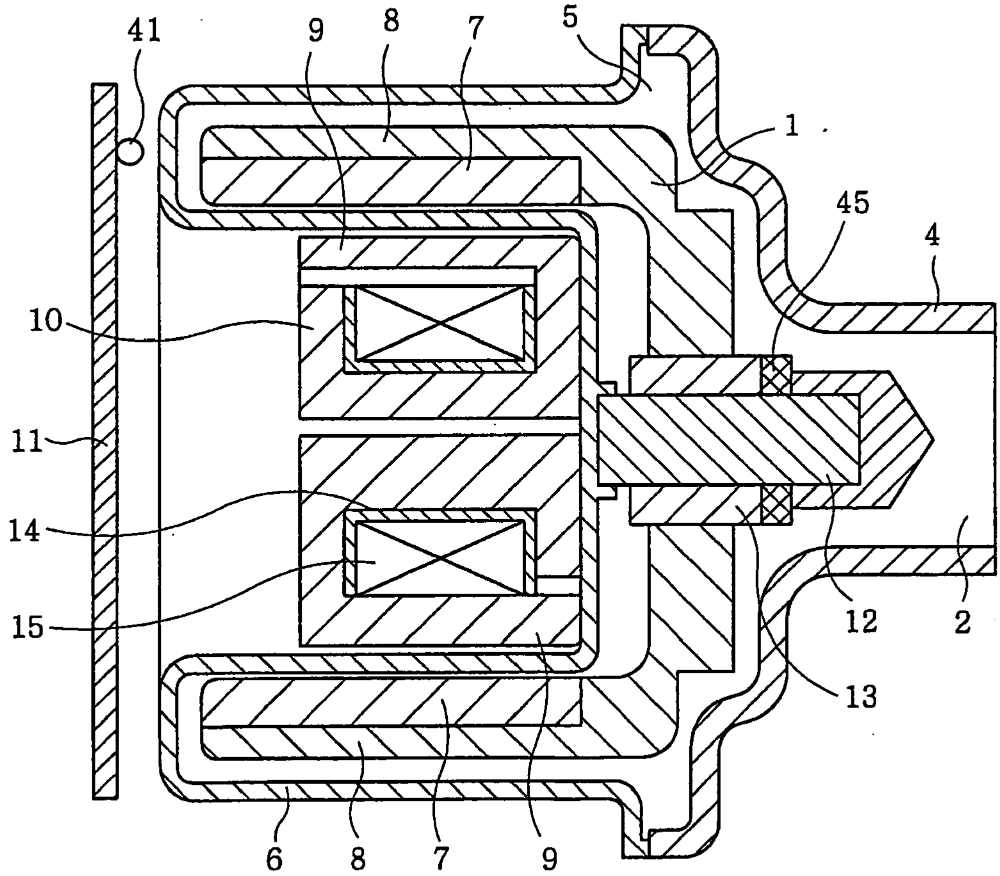
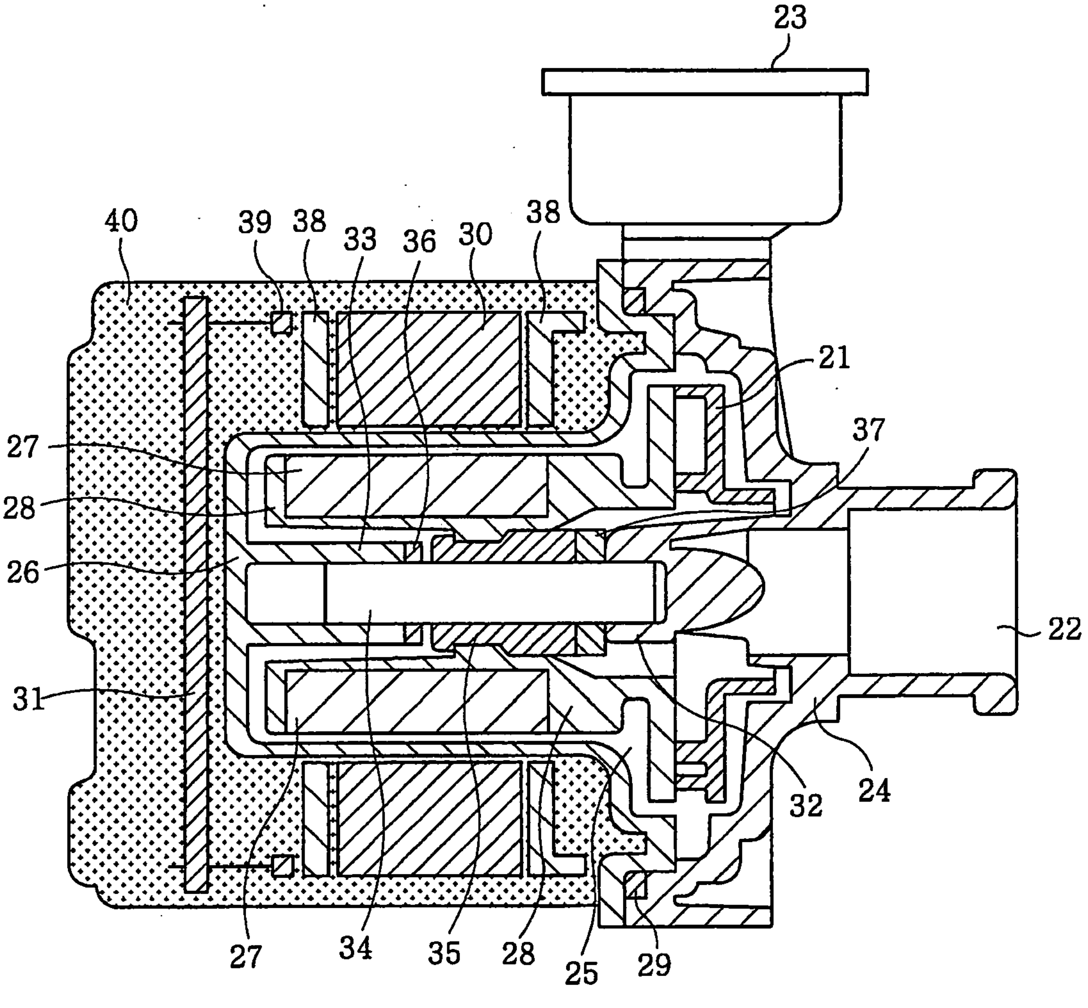


FIG. 6



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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