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(19) **United States**(12) **Patent Application Publication****Anami et al.**(10) **Pub. No.: US 2008/0260515 A1**(43) **Pub. Date: Oct. 23, 2008**(54) **PUMP**

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F04D 5/00 (2006.01)(52) **U.S. Cl.** **415/55.2**(57) **ABSTRACT**

A pump includes a pumping unit including therein an impeller for sucking and discharging a liquid; and a pump case accommodating therein the pumping unit and provided with an inlet for sucking the liquid into the pump and an outlet for discharging the liquid out of the pump. The impeller has an inlet mouth portion of a cylindrical shape that projects towards the pump case, and the pump case has a case inlet portion and an annular recess portion which the inlet mouth portion of the impeller is movably inserted in and is formed at the vicinity of the case inlet portion.

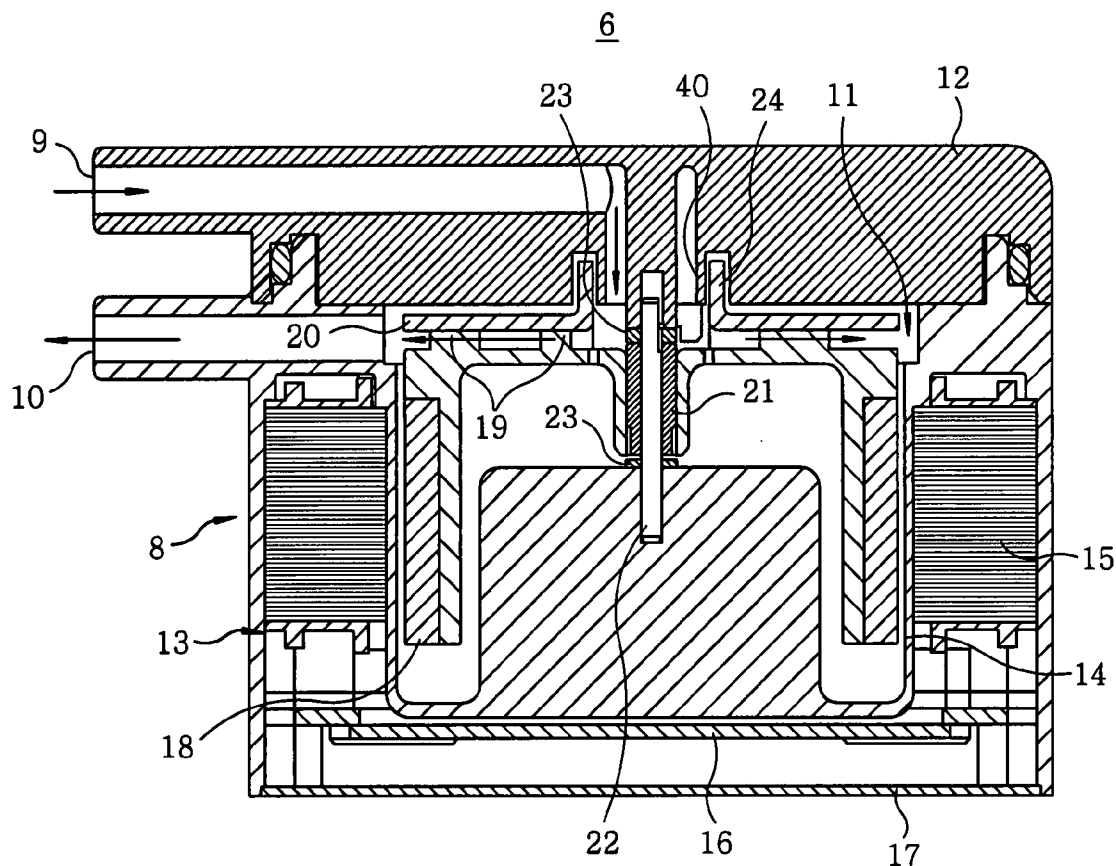


FIG. 1

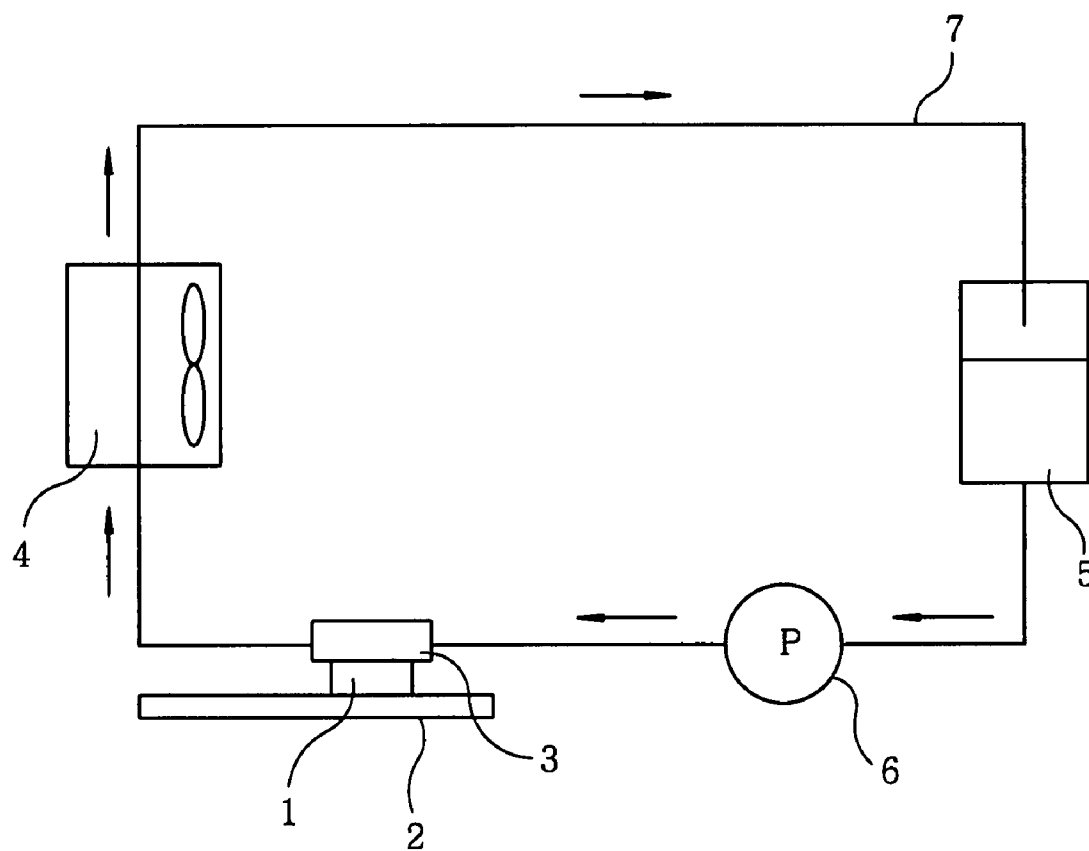
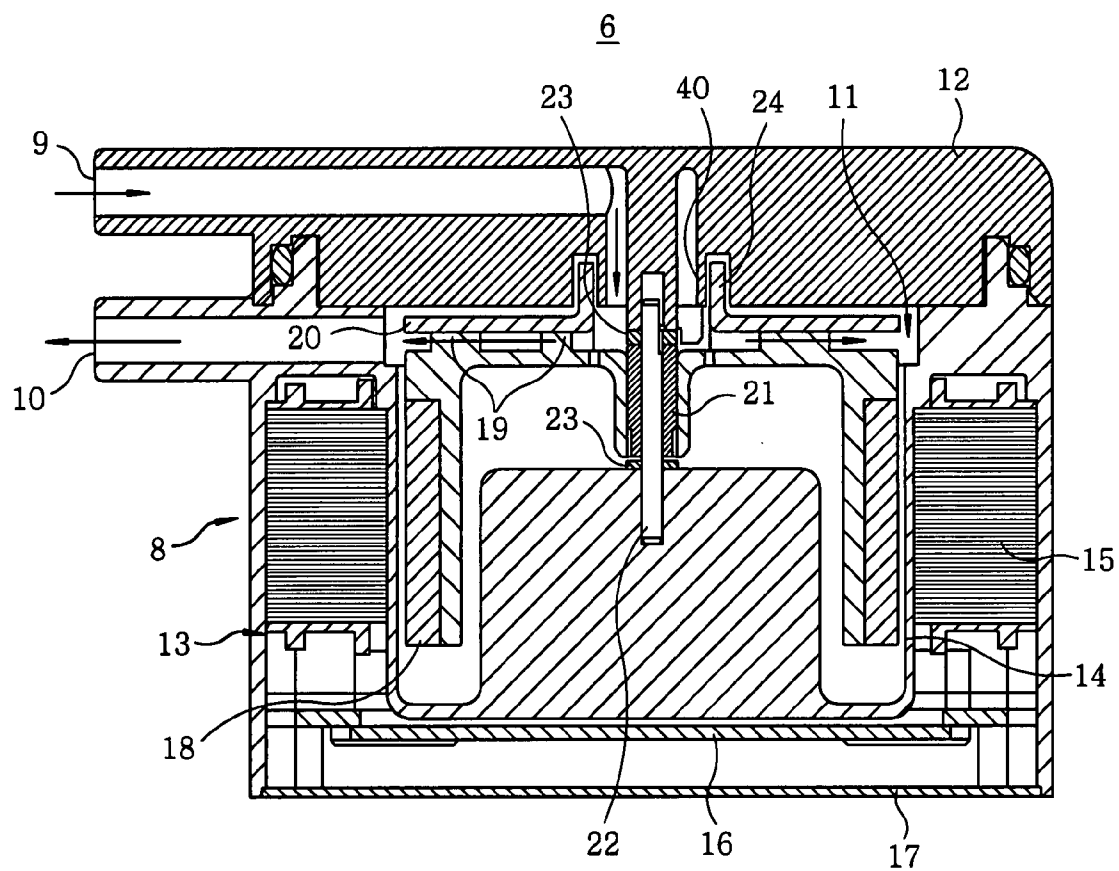


FIG. 2



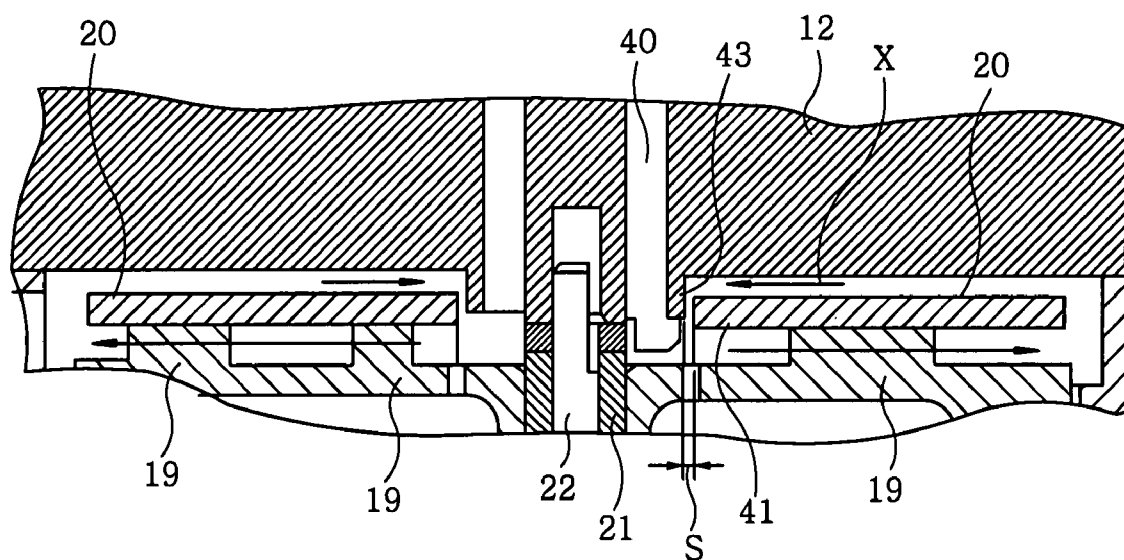


FIG. 4A

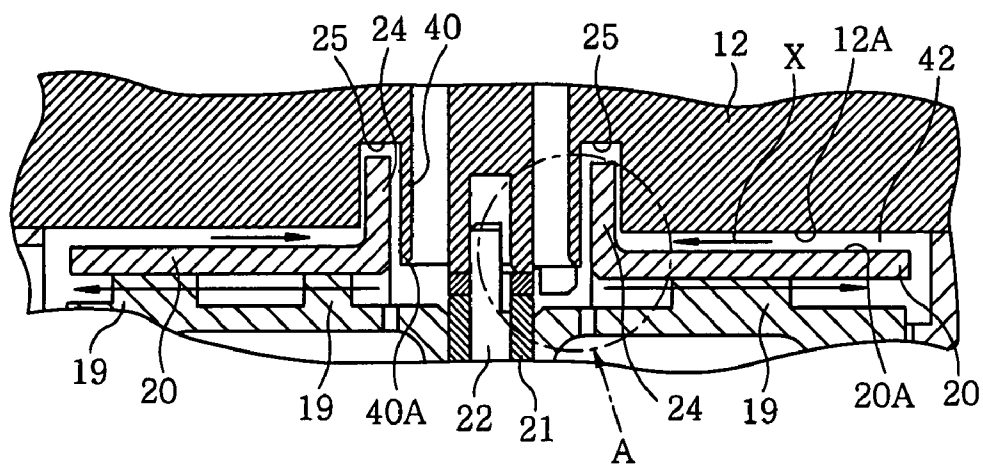


FIG. 4B

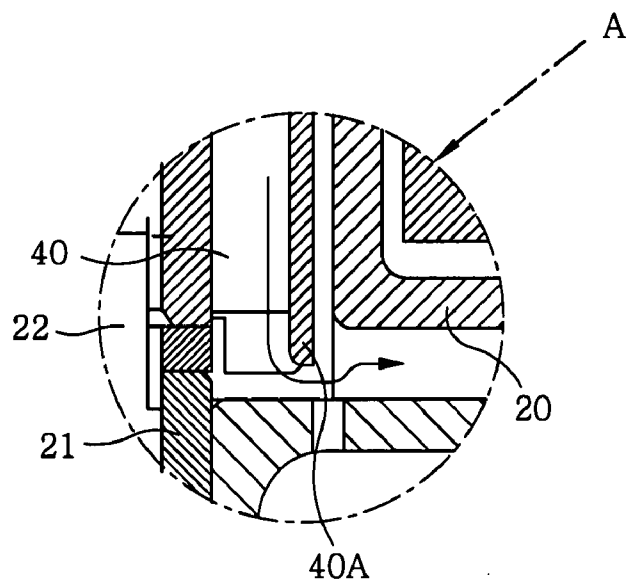


FIG. 5

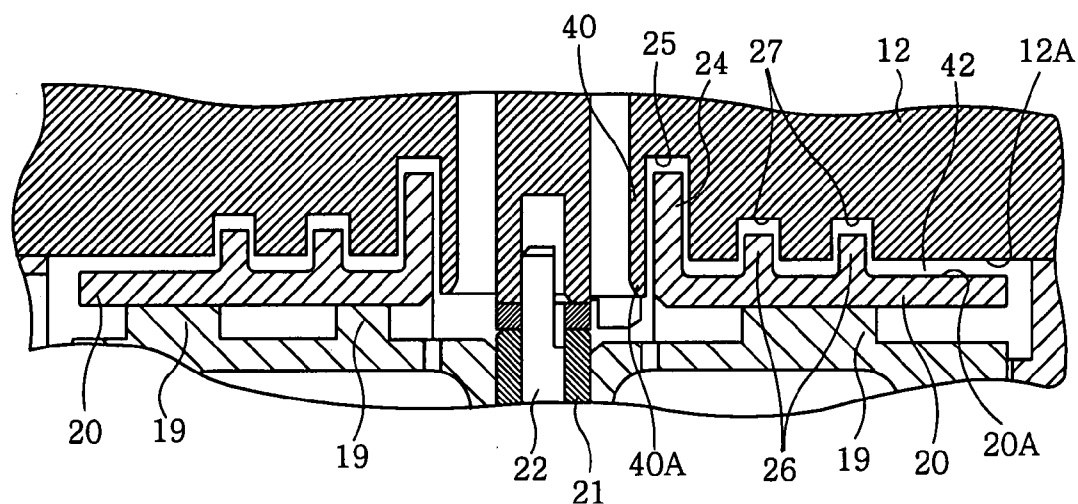


FIG. 6

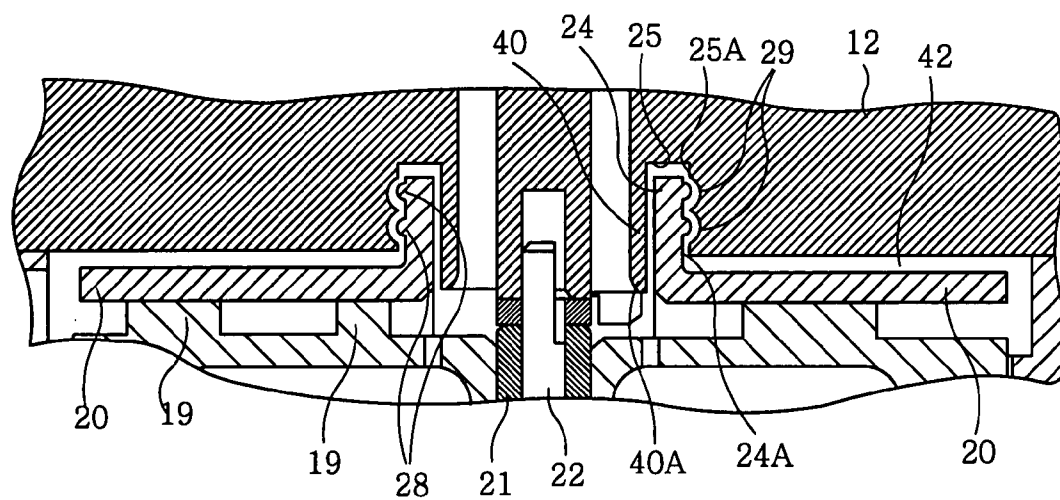
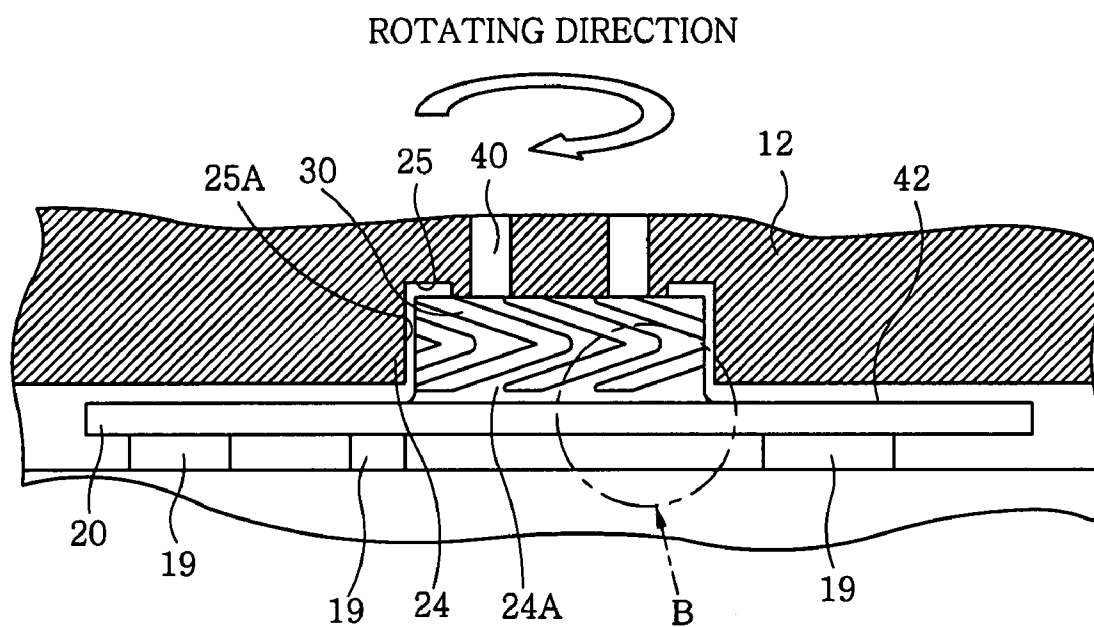
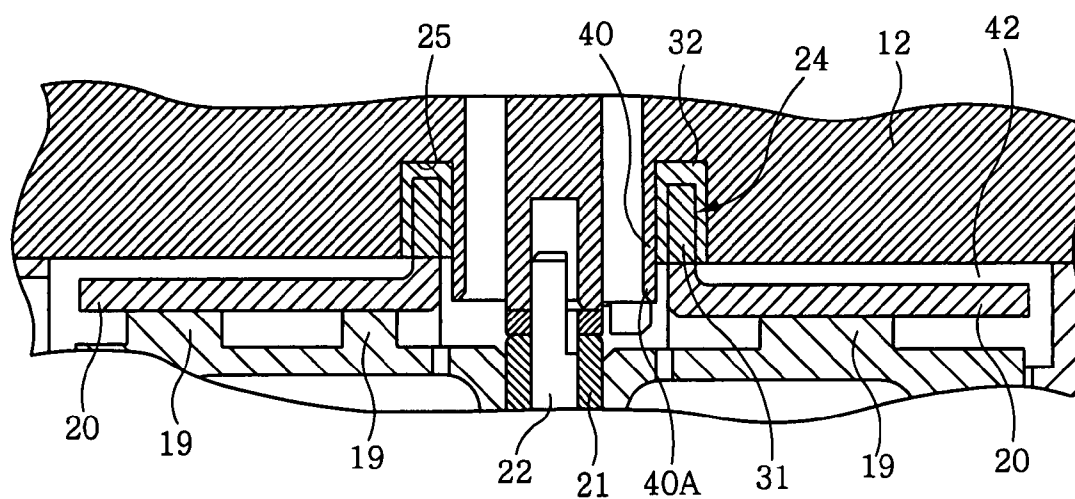


FIG. 7





PUMP

FIELD OF THE INVENTION

[0001] The present invention relates to a pump driven by a motor to suck and discharge liquid.

BACKGROUND OF THE INVENTION

[0002] In a pump mainly used to circulate water while constantly filled up therewith, water may leak through a shaft seal portion. In view thereof, a canned motor pump, for example, has been widely in use, which does not employ a shaft seal structure by adopting a configuration that separates a water flow section having an impeller from a driving mechanism section having a motor.

[0003] The canned motor pump is configured such that a rotor integrated with the impeller is accommodated in a partition wall to be sealed thereby without sealing a shaft. The rotor is rotated by a rotating magnetic force, which is generated by a stator disposed outside the partition wall and, acts on the rotor through the partition wall.

[0004] Besides, there has been also employed a magnet coupling type electromagnetic drive pump in which a disk-shaped or cylindrical magnet is rotated by a motor to be magnetically coupled with a magnet of an inner rotor via a partition wall, thereby driving the pump.

[0005] The above-described pumps, i.e., the canned motor pump and the magnet coupling type electromagnetic drive pump, are referred to as sealless pumps in that a power is delivered to an impeller in a pump case by an electromagnetic force without using a shaft seal structure.

[0006] As for these sealless pumps, there has recently been a market demand for a small-sized pump with a high head and a high reliability, thereby necessitating a highly efficient pump.

[0007] In order to improve the pump efficiency, various structures have been employed. For example, in a self-priming pump, water pumping performance and pump efficiency are enhanced by reducing a gap between an inner diameter of a mouth portion in a partition plate and an outer diameter of an impeller (see, for example, Reference 1).

[0008] Reference 1: Japanese Patent Application Publication No. 2005-48675

[0009] However, in the self-priming pump disclosed in Reference 1, it takes time to adjust the gap because the gap is controlled by finely adjusting the partition plates at a precise location and then being fixed thereat by mechanical screwing. Furthermore, this self-priming pump is configured to reduce the amount of water leaking through a single gap, and does not have a sufficient flow resistance.

SUMMARY OF THE INVENTION

[0010] In view of the foregoing, the present invention provides a pump that can be easily assembled and has a structure for securing a sufficient resistance (flow path resistance or hydraulic resistance) capable of preventing a back flow and leakage of coolant.

[0011] In accordance with one aspect of the present invention, there is provided a pump including a pumping unit including therein an impeller for sucking and discharging a liquid; and a pump case accommodating therein the pumping unit and provided with an inlet for sucking the liquid into the pump and an outlet for discharging the liquid out of the pump. Herein, the impeller has an inlet mouth portion of a cylindrical

shape that projects towards the pump case, and the pump case has a case inlet portion and an annular recess portion which the inlet mouth portion of the impeller is movably inserted in and is formed at the vicinity of the case inlet portion. Further, an end portion of the case inlet portion may project up to such a height as not to impede a suction of the liquid into the impeller. Furthermore, a slanted surface or a curved surface that slopes in a direction from an inner side of the case inlet portion to an outer side thereof may be formed at the end portion of the case inlet portion.

[0012] In the above, that the end portion of the case inlet portion projects up to such a height as not to impede the suction of the liquid into the impeller means the following: a length of the end portion of the case inlet portion is maximized to guide the liquid such as coolant suctioned into the inlet, such that the end portion of the case inlet portion is formed to protrude beyond the height position of upper surfaces of the blades within an extent that does not impede the flow of the liquid such as coolant.

[0013] It is preferable that a protrusion is formed at a front shroud part of the impeller, and a recess in which the protrusion is movably inserted is formed at a casing wall surface of the pump case.

[0014] Further, it is preferable that a rib is formed at an outer peripheral wall surface of the inlet mouth portion of the impeller, and a depression in which the rib is movably inserted is formed at an inner peripheral wall surface of the annular recess portion.

[0015] Further, it is preferable that V-shaped grooves are formed at an outer peripheral wall surface of the inlet mouth portion of the impeller.

[0016] Further, it is preferable that the inlet mouth portion of the impeller is configured by a magnet, and a magnetic fluid is adhered to the magnet by a magnetic force. Herein, a space between the inlet mouth portion and the annular recess in which the inlet mouth portion is movably inserted is filled up with the magnetic fluid.

[0017] Thus, in accordance with the embodiment of the present invention, it is possible to provide a pump configured to be easily assembled and have a sufficient flow resistance for preventing a back flow or leakage of liquid, thereby enhancing the pump efficiency. Further, by incorporating the aforementioned pump in a liquid supplying apparatus such as a water supplying apparatus, user's convenience in using the liquid supplying apparatus can be improved remarkably.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The above features of the present invention will become apparent from the following description of embodiment given in conjunction with the accompanying drawings, in which:

[0019] FIG. 1 is an overall schematic view of a coolant circulation system in accordance with an embodiment of the present invention;

[0020] FIG. 2 is a cross sectional view of a pump in accordance with the embodiment of the present invention;

[0021] FIG. 3 is a cross sectional view showing main parts of an impeller and a pump case in a conventional pump;

[0022] FIG. 4A is a cross sectional view showing main parts of an impeller and a pump case of a pump in accordance with a modification of the embodiment of the present invention, and FIG. 4B is a partial enlarged view thereof;

[0023] FIG. 5 is a cross sectional view showing main parts of an impeller and a pump case of a pump in accordance with another modification of the embodiment of the present invention;

[0024] FIG. 6 is a cross sectional view showing main parts of an impeller and a pump case of a pump in accordance with still another modification of the embodiment of the present invention;

[0025] FIG. 7 is a partial cross sectional view showing main parts (especially V-shaped grooves formed at an outer peripheral wall surface of an inlet mouth portion) of an impeller and a pump case in a pump in accordance with still another modification of the embodiment of the present invention; and

[0026] FIG. 8 is a cross sectional view showing main parts of an impeller and a pump case of a pump in accordance with still another modification of the embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENT

[0027] Hereinafter, an embodiment of the present invention will be described in detail with reference to the accompanying drawings, which forms a part hereof.

[0028] As shown in FIG. 1, a coolant circulation system includes a heat generation element 1 installed on a substrate 2; and a heat sink unit 3 such as a heat spreader, for cooling the heat generation element 1 by performing a heat exchange with the heat generation element 1 using a coolant (e.g., water).

[0029] The coolant circulation system further includes a radiator 4 for taking heat from the coolant; a reservoir tank 5 for storing the coolant therein; a pump for circulating the coolant; and a pipeline 7 connecting the heat sink unit 3, the radiator 4, the reservoir tank 5 and the pump 6.

[0030] The coolant in the reservoir tank 5 is discharged from the pump 6 to flow into the heat sink unit 3 via the pipeline 7. In the heat sink unit 4, heat is transferred from the heat generation element 1 to the coolant, whereby the temperature of the coolant increases. Then, the coolant is sent to the radiator 5 to be cooled, and the coolant whose temperature is lowered by the radiator 5 is then returned to the reservoir tank 6. The heat sink system as described above serves to cool the heat generation element 1 by circulating the coolant using the pump 6.

[0031] As shown in FIG. 2, the pump 6 has a pump case 12 disposed at an upper side of a pump main body 8, wherein the pump case 12 is made of plastic such as PPS (polyphenylene sulfide) or a metal such as stainless steel, and is provided with an inlet 9 and an outlet 10. The pump case 12 encloses a pumping unit 11 that suctions and discharges the coolant.

[0032] Disposed under the pump case 12 is a waterproof partition wall 14 which accommodates therein a motor unit 13 that drives the pump 6. The waterproof partition wall 14, which is made of, e.g., a metal such as aluminum or a heat resistant plastic, isolates the motor unit 13 from the pumping unit 11, and thus prevents the coolant from leaking from the pumping unit 11 into the motor unit 13.

[0033] The motor unit 13 has a cylindrical stator 15 that generates a magnetic field; a controller 16 that controls the stator 15; and a lid 17 that covers and shields the stator 15 and the controller 16. The stator 15 is installed at a recessed portion formed at an outer part of the partition wall 14. Fur-

ther, the controller 16 is disposed below the stator 15, and has electronic components such as transformers, transistors and the like.

[0034] Further, the pumping unit 11 has a cylindrical rotor 18 which is driven to be rotated by the magnetic field generated by the stator 15. The rotor 18 has permanent magnets fixed at the periphery thereof. The pumping unit 11 also has a plurality of blades 19 fixed to the surface of the rotor 18 to form a single body therewith. Further, a cylindrical impeller 20 made up of a plastic such as PPS is attached to the rotor 18. The impeller 20 serves to suck in and discharge the coolant by means of the blades 19.

[0035] Installed at the rotation center of the impeller 20 is a columnar shaft 22 formed of a metal such as stainless steel to rotatably support the rotor 18 and the impeller 20, and a bearing 21 made of sintered carbon or molded carbon is disposed around the shaft 22.

[0036] Further, hollow disk-shaped bearing plates 23 made of, e.g., ceramic are attached to both end portions of the shaft 22 such that the bearing plates 23 is in slidable contact with the bearings 21. The rotor 18 is arranged to face the stator 15 via the partition wall 15 interposed therebetween.

[0037] Here, as shown in FIGS. 4A and 4B, an inlet mouth portion 24 of a cylindrical shape is formed at the impeller 20 such that it protrudes towards the pump case 12. Further, an annular recess portion 25 in which the inlet mouth portion 24 is movably inserted is formed at the vicinity of a case inlet portion 40 of the pump case 12. An end portion 40A of the case inlet portion 40 protrudes up to such a height as not to impede the suction of the coolant into the impeller 20. Further, formed at the end portion 40A of the case inlet portion 40 is a slanted surface or a curved surface that slopes in a direction from an inner surface of the case inlet portion 40 to an outer surface thereof.

[0038] Moreover, as shown in FIG. 5, one or more protrusions 26 may be further formed at a front shroud part 20A of the impeller 20, and one or more recesses 27 in which the protrusions 26 are movably inserted may be formed at a casing wall surface 12A of the pump case 12. In the illustrated example, two annular protrusions 26 are formed at the front shroud part 20A disposed outside of the inlet mouth portion 24.

[0039] Furthermore, as illustrated in FIG. 6, one or more ribs 28 may be additionally formed at an outer peripheral wall surface 24A of the inlet mouth portion 24 of the impeller 20, and one or more depressions 29 in which the ribs 28 are movably inserted may be formed at an inner peripheral wall surface 25A of the annular recess portion 25. In the illustrated example, two annular projections, each having a semicircular cross section, are formed as the ribs 28 at the outer peripheral wall surface 24A of the inlet mouth portion 24.

[0040] Alternatively, as shown in FIG. 7, a plurality of grooves 30 each having a V-shape may be formed at the outer peripheral wall surface 24A of the inlet mouth portion 24 of the impeller 20. The V-shaped grooves 30 may be arranged in a rotating direction of the impeller 2 such that each of the V-shapes faces sideways.

[0041] Further alternatively, as shown in FIG. 8, the inlet mouth portion 24 of the impeller 20 may be formed of a magnet 31, and a magnetic fluid 32 may be adhered to the magnet 31 by a magnetic force so that a space between the inlet mouth portion 24 and the annular recess portion 25 is filled up with the magnetic fluid 32.

[0042] In accordance with the pump configured as described above, it is possible to implement a pump structure that can be easily assembled and has a sufficient resistance capable of preventing a back flow and leakage of coolant.

[0043] Hereinafter, the operations of the pump and the coolant circulation system including the pump in accordance with the embodiment will be described with reference to FIGS. 1 to 8.

[0044] In the pump 6, when the stator 15 is driven to generate a magnetic field under the control of the controller 16, the rotor 18 is rotated by the magnetic field.

[0045] When the rotor 18 is rotated, the impeller 20 integrated with the rotor 18 is also rotated, thereby driving the pump 6. When the pump 6 is operated, the coolant is sucked in by the impeller 20 through the inlet 9 formed at the upper side of the pump 6.

[0046] The suctioned coolant is forcibly moved out in a circumferential direction, and discharged through the outlet 10 by the blades 19 provided at the rotating impeller 20. Further, the discharged coolant is sent to the heat sink unit 3 via the pipeline 7 connected to the outlet 10. In the heat sink unit 3, heat is transferred from the heat generation element 1 to the coolant, whereby the temperature of the coolant is increased. Then, the coolant is sent to the radiator 4 to be cooled. The coolant whose temperature is lowered by the radiator 4 is then returned to the reservoir tank 5.

[0047] As described above, the coolant is circulated by the pump 6 in the coolant circulation system, and the heat generation element 1 is cooled by the circulating coolant. The coolant path in the heat sink unit 3 has an especially high flow resistance to raise the heat exchange efficiency.

[0048] In accordance with the embodiment of the present invention, the coolant is forcibly sent in the circumferential direction by the blades 19 provided at the rotating impeller 20, and is discharged out of the pump 6 via the outlet 10 at a lateral side of the impeller 20. However, since the vicinity of the area around the inlet mouth portion 24 of the impeller 20 is under a negative pressure, a part of the coolant returns to the inlet mouth portion 20 of the impeller 20 (in other words, the coolant flows back or leaks). The flowing-back coolant moves along a return path 42 formed between the front shroud part 20A of the impeller 20 and the casing wall surface 12A of the pump case 12 as indicated by arrows X in FIG. 4A. The back flow of the coolant causes to deteriorate the pump efficiency.

[0049] FIG. 3 shows a structure of a conventional pump, in which a length of the inlet mouth portion 41 of the impeller 20 and that of a confronting part 43 of the pump case 12 are short. Accordingly, to prevent the coolant from returning (i.e., flowing back or leaking as indicated by arrows X) to the inlet mouth portion 41 of an impeller 20, a gap S between the inlet mouth portion 41 and the confronting part 43 of the pump case 12 that faces the inlet mouth portion 41 was made as small as possible. Hence, in this conventional structure, it was required to adjust the gap when being assembled.

[0050] Referring back to FIG. 4A of the embodiment of the present invention, the inlet mouth portion 24 of a cylindrical shape is provided at the impeller 20 to protrude towards the pump case 12. Further, the annular recess portion 25 in which the inlet mouth portion 24 is movably inserted is provided at the vicinity of the case inlet portion 40 of the pump case 12, and the end portion 40A of the case inlet portion 40 projects up to such a height as not to impede the suction of the coolant into the impeller 20. Further, the slanted or curved surface, which slopes from the inner surface towards the outer surface

of the case inlet portion 40, is formed at the end portion 40A thereof. Thus, the flow path resistance is increased.

[0051] As described above, by forming the end portion 40A of the case inlet portion 40 to project up to the height not to hinder the suction of the coolant into the impeller 20, a total length of the flow path becomes greater to increase the resistance of the flow path through which the coolant may return back (i.e., flow back or leak as indicated by the arrows X in FIG. 4). Further, by forming the slanted or curved surface that slopes from the inner surface to the outer surface at the end portion 40A of the case inlet portion 40, the flow of the coolant from the inlet to the blades is smoothened.

[0052] In this manner, the presence of the inlet mount portion 24 in a cylindrical shape causes to increase the flow path resistance of the coolant that returns to the inlet mouth portion 24 along the return path 42 formed between the front shroud part 20A of the impeller 20 and the casing wall surface 12A of the pump case 12. Therefore, it is possible to prevent a back flow or a leakage of the coolant.

[0053] If the end portion 40A of the case inlet portion 40 extends towards the motor 13 as shown in FIG. 4B, it might impede the coolant flow to thereby deteriorate the pump efficiency. In this respect, the end portion 40A of the case inlet portion 40 is formed with the height as not to impede the coolant flow.

[0054] Likewise, in FIG. 5, the protrusions 26 are formed at the front shroud part 20A of the impeller, and the recesses 27 are formed at the casing wall surface 12A of the pump case 12 such that the protrusions 26 are movably inserted in the recesses 27, thereby making it possible to increase the resistance of the return path 42.

[0055] In a similar manner, in FIG. 6, the ribs 28 are formed at the outer peripheral wall surface 24A of the inlet mouth portion 24 of the impeller 20 and the depressions 29 are formed at the inner peripheral wall surface 25A of the annular recess portion 25 such that the ribs 28 are inserted in the depressions 29, thereby making it possible to increase the resistance of the return path 42. Alternatively, the ribs 28 may be formed at the inner peripheral wall surface 25A of the annular recess portion 25, and the depressions 29 may be formed at the outer peripheral wall surface 24A of the inlet mouth portion 24.

[0056] Likewise, in FIG. 7, the V-shaped grooves 30 are formed at the outer peripheral wall surface 24A of the inlet mouth portion 24 of the impeller 20, so that a dynamic pressure is formed at a space between the outer peripheral wall surface 24A of the inlet mouth portion 24 and the inner peripheral wall surface 25A of the annular recess portion 25 of the pump case, whereby the resistance of the return path 42 is increased. Alternatively, the V-shaped grooves 30 may be formed at the inner peripheral wall surface 25A of the annular recess portion 25 instead of the outer peripheral wall surface 24A of the inlet mouth portion 24, or both of the outer peripheral wall surface 24A and the inner peripheral wall surface 25A.

[0057] Further, referring to FIG. 8, the inlet mouth portion 24 of the impeller 20 is formed of the magnet 31, the magnetic fluid 32 is adhered to the magnet 31 by the magnetic force, so that the space between the inlet mouth portion 24 and the inlet recess portion 25 is sealed with the magnetic fluid 32, whereby the coolant is prevented from returning (i.e., flowing back or leaking).

[0058] Accordingly, in accordance with the present embodiment, it is possible to provide a pump configured such

that a gap adjustment is not required when being assembled, and the pump is easy to assemble and has a sufficient resistance for preventing a back flow and leakage of liquid.

[0059] Although, the coolant circulation system was exemplified in the embodiment of the present invention, the present invention can be applied to other kinds of liquid supply system such as a well pump system, a hot water supplying system, a water drainage pump system or the like.

[0060] While the invention has been shown and described with respect to the embodiment, it will be understood by those skilled in the art that various changes and modification can be made without departing from the scope of the invention as defined in the following claims.

What claimed is:

1. A pump comprising:

a pumping unit including therein an impeller for sucking and discharging a liquid; and

a pump case accommodating therein the pumping unit and provided with an inlet for sucking the liquid into the pump and an outlet for discharging the liquid out of the pump,

wherein the impeller has an inlet mouth portion of a cylindrical shape that projects towards the pump case, and the pump case has a case inlet portion and an annular recess portion which the inlet mouth portion of the impeller is movably inserted in and is formed at the vicinity of the case inlet portion.

2. The pump of claim 1, wherein a protrusion is formed at a front shroud part of the impeller, and a recess in which the protrusion is movably inserted is formed at a casing wall surface of the pump case.

3. The pump of claim 1, wherein a rib is formed at an outer peripheral wall surface of the inlet mouth portion of the impeller, and a depression in which the rib is movably inserted is formed at an inner peripheral wall surface of the annular recess portion.

4. The pump of claim 1, wherein V-shaped grooves are formed at an outer peripheral wall surface of the inlet mouth portion of the impeller.

5. The pump of claim 1, wherein the inlet mouth portion of the impeller is configured by a magnet, and a magnetic fluid is adhered to the magnet by a magnetic force, and

wherein a space between the inlet mouth portion and the annular recess in which the inlet mouth portion is movably inserted is filled up with the magnetic fluid.

6. The pump of claim 1, wherein an end portion of the case inlet portion projects up to such a height as not to impede a suction of the liquid into the impeller.

7. The pump of claim 1, wherein a slanted surface or a curved surface that slopes in a direction from an inner side of the case inlet portion to an outer side thereof is formed at the end portion of the case inlet portion.

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