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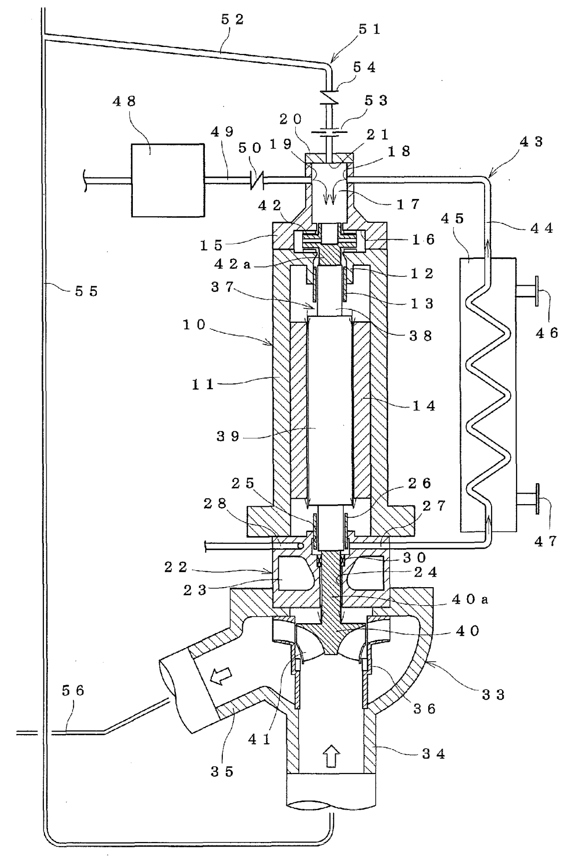
(54) Circulation pump

(57) In a circulation pump for taking in hot water from an intake portion (34) of a pump casing (33) and discharging the hot water from a discharge portion (35) by rotating a rotating shaft (37) to rotate an impeller (40) disposed in the pump casing (33) and for circulating cooling water in a motor casing (10) while cooling the cooling water with a circulating cooling mechanism (43), a hot water inflow preventing means (an external cooling water supply mechanism (48) or a pump (57)) for preventing the hot water in the pump casing (33) from flowing into the motor casing (10) by generating a stream of water in the motor casing (10) at least during warm standby in which the rotating shaft (37) is stopped is provided.

Fig. 1



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Description

Technical Field

[0001] The present invention relates to a circulation pump for circulating and supplying hot water to a boiler in a thermal power generation facility, a nuclear generation facility, and the like.

[Background Art]

[0002] In this type of circulation pump, a pump casing is provided at an upper portion and a motor casing is provided at a lower portion. A rotating shaft passes through these casings and an impeller is disposed at an upper end of the rotating shaft positioned in the pump casing. The circulation pump takes in hot water from an intake portion of the pump casing and discharges it from a discharge portion as a result of rotation of the rotating shaft. In the motor casing, cooling water for cooling heat generated by the rotation of the rotating shaft is circulated while cooled by a circulating cooling mechanism (see Japanese Patent Application Laid-Open No. 2000-338287) .

[0003] However, this circulation pump further requires a space for disposing the motor casing and a space for disposing the circulating cooling mechanism under a space for disposing the pump casing. Therefore, a cost of construction of the facility is extremely high and maintenance operation becomes very complicated. In other words, to dispose the pump so that the pump casing is positioned on the ground, it is necessary to dig a site for disposing the pump deep in order to secure the space for disposing the motor casing and the circulating cooling mechanism. On the other hand, to dispose the pump so that the motor casing and the circulating cooling mechanism are positioned on the ground, it is necessary to construct a foundation and a building for disposing the motor casing, connecting pipes to be connected to the motor casing, and the like at a high level above the ground. As a result, the cost of construction of the facility is extremely high.

[0004] To solve this problem, it is conceivable to install the pump so that the pump casing is positioned below the motor casing (an erected type). In this way, the large-scale foundation and building are unnecessary and the cost of construction can be reduced.

[0005] However, if the circulation pump is erected, the hot water in the lower pump casing and the cooling water in the upper motor casing naturally convect through a shaft insertion portion of a heat barrier at an intermediate position during warm standby in which rotation of the rotating shaft is stopped. Therefore, the hot water in the pump casing enters the motor casing while the cooling water in the motor casing enters the pump casing. As a result, there arises the problem that a temperature of the cooling water in the motor casing rises and a motor mechanism is overheated (thermal damage to a motor insulator) due to this water replacement phenomenon. Furthermore, there arises the problem that the hot water (boiler water) in the pump casing is cooled (a loss of a heat quantity of a boiler). These problems do not occur when the pump is inverted so that the pump casing is positioned above the motor casing. In both of the erected type and the inverted type, these problems do not occur during operation in which the rotating shaft is rotating because of a stream of the cooling water circulated by the circulating cooling mechanism.

Summary of Invention

Technical Problem

[0006] It is an object of the present invention to provide a circulation pump of an erected type which can reduce a cost of construction of a facility, the pump capable of solving the problem caused by the water replacement phenomenon which occurs in this erected type. Solution to Problem

[0007] To achieve the above object, according to the present invention, there is provided a circulation pump for taking in hot water from an intake portion of a pump casing and discharging the hot water from a discharge portion by rotating a rotating shaft disposed from a motor casing positioned at an upper end to the pump casing positioned at a lower end through a shaft insertion portion of a heat barrier to rotate an impeller disposed in the pump casing and for circulating cooling water in the motor casing while cooling the cooling water with a circulating cooling mechanism. A hot water inflow preventing means for preventing the hot water in the pump casing from flowing into the motor casing by generating a stream of water in the motor casing during warm standby in which the rotating shaft is stopped is provided.

[0008] The circulation pump is of an erected type in which the pump casing is positioned below the motor casing. Therefore, large-scale foundation and building for disposing the motor casing and the circulating cooling mechanism are unnecessary in the construction of the facility and therefore the cost of construction of the facility can be reduced.

[0009] In the circulation pump, a hot water inflow preventing means can generate a stream of water in the motor casing during warm standby in which rotation of the rotating shaft is stopped to thereby prevent the hot water in the pump casing from flowing into the motor casing. As a result, it is possible to prevent damage to an electrical insulator due to an abnormal rise in temperature in the motor casing.

[0010] Specifically, preferably, the hot water inflow preventing means includes an external cooling water supply mechanism for supplying external cooling water at higher supply pressure than pressure in the motor casing and a water supply pipe of the external cooling water supply mechanism is connected to the motor casing. In this way, the external cooling water is supplied from the water supply pipe of the external cooling water supply mechanism into the motor casing during the warm standby. Therefore, in the motor casing and in the circulating cooling mechanism connected to the motor casing, the cooling water flows. Surplus cooling water in the motor casing due to supply of the external cooling water flows out into the pump casing through the shaft insertion portion of the heat barrier. Therefore, the hot water in the pump casing does not flow into the motor casing. As a result, it is possible to prevent damage to the electrical insulator due to the abnormal rise in temperature in the motor casing.

[0011] In this case, preferably, a check valve for allowing flow of external cooling water toward the motor casing and preventing flow in an opposite direction is provided to a water supply pipe of the external cooling water supply mechanism. In this way, it is possible to prevent the cooling water in the motor casing from flowing outside due to unexpected pressure fluctuation. As a result, it is possible to reliably prevent the hot water in the pump casing from flowing into the motor casing.

[0012] Alternatively, the hot water inflow preventing means includes a pump for taking the cooling water in the motor casing and circulating and supplying the cooling water and the pump is provided to a connecting pipe of the circulating cooling mechanism, preferably. Specifically, the pump is preferably a canned motor pump. In this way, it is possible to forcibly circulate the cooling water in the motor casing with the pump provided to the connecting pipe of the circulating cooling mechanism. Therefore, the hot water in the pump casing does not flow into the motor casing and the cooling water in the motor casing does not flow into the pump casing. As a result, it is possible to prevent damage to the electrical insulator due to the abnormal rise in temperature in the motor casing. Moreover, it is possible to prevent a loss of a heat quantity of a boiler due to cooling of the hot water in the pump casing.

[0013] In the circulation pump, a discharge pipe for discharging gas in the motor casing to an outside is preferably connected to an upper end of the motor casing. In this way, it is possible to prevent damage caused by an idling state of the rotating shaft due to a solution gas which is one of gasses which can be generated naturally with time in the motor casing.

[0014] In this case, the discharge pipe is preferably connected to an intake-side boiler pipe for supplying the hot water into the intake portion of the pump casing. Here, pressure in the intake-side boiler pipe does not become higher than inner pressure of the motor casing both during operation and during the warm standby. Therefore, flow from the motor casing toward the intake-side boiler pipe is constantly generated to prevent backflow.

[0015] Moreover, a check valve for allowing flow from the motor casing toward the intake-side boiler pipe and preventing flow in an opposite direction is preferably provided to the discharge pipe. In this way, it is possible to reliably prevent flow of the hot water in the intake-side boiler pipe into the motor casing due to unexpected pressure fluctuation.

[0016] Furthermore, in the circulation pump, a flow suppressing mechanism for suppressing flow between the motor casing and the pump casing through the shaft insertion portion of the heat barrier is preferably provided to the shaft insertion portion of the heat barrier. In this way, with the flow suppressing mechanism, it is possible to suppress inflow of the hot water in the pump casing into the motor casing and inflow of the cooling water in the motor casing into the pump casing. As a result, it is possible to prevent damage to the electrical insulator due to the abnormal rise in temperature in the motor casing. Moreover, it is possible to prevent the loss of the heat quantity of the boiler due to cooling of the hot water in the pump casing.

[0017] Specifically, the flow suppressing mechanism includes a labyrinth-shaped shaft seal disposed at an inner peripheral portion of the shaft insertion portion of the heat barrier or an outer peripheral portion of the rotating shaft.

[0018] As another option, the flow suppressing mechanism includes a plurality of annular grooves or annular protruding portions provided to an inner peripheral portion of the shaft insertion portion of the heat barrier or an outer peripheral portion of the rotating shaft.

[0019] In this way, it is possible to reliably suppress natural convection through the shaft insertion portion.

[0020] As yet another option, the flow suppressing mechanism includes a seal member disposed at the rotating shaft and having a greater diameter than an inner diameter of the shaft insertion portion to be elastically deformed and lifted by a centrifugal force during rotation of the rotating shaft and to come down under its own weight to come in contact with an outer peripheral portion of an upper end of the shaft insertion portion when the rotating shaft is stopped. In this way, it is possible to prevent natural convention through the shaft insertion portion. If this structure is combined with the external cooling water supply mechanism or the pump serving as a forcible circulation mechanism (described later), the seal member is brought in close contact with the outer peripheral portion of the upper end of the shaft insertion portion by the stream of water in the motor casing during the warm standby. As a result, it is possible to reliably prevent the natural convection between the motor casing and the pump casing.

[0021] As yet another option, the flow suppressing mechanism includes a seal ring disposed at the rotating shaft to be movable along an axial direction, having a greater diameter than an inner diameter of the shaft insertion portion, and biased by a biasing means against an outer peripheral portion of an upper end of the shaft insertion portion, a flow path passing through the seal ring from an upper end to a lower end of the seal ring is provided, and the seal ring can be moved upward against a biasing force of the biasing means by pressure of the cooling water entering the flow path. In this way, it is possible to reliably prevent the natural convection between the motor casing and the pump casing through the shaft insertion portion.

[Advantageous Effects of Invention]

[0022] The circulation pump of the present invention is of an erected type in which the pump casing is positioned below the motor casing. Therefore, large-scale foundation and building for disposing the motor casing and the circulating cooling mechanism are unnecessary and therefore the cost of construction of the facility can be reduced.

[0023] Since the hot water inflow preventing means generates the stream of water in the motor casing to prevent the hot water in the pump casing from flowing into the motor casing during the warm standby in which the rotating shaft is stopped, it is possible to prevent the damage to the electrical insulator due to the abnormal rise in temperature in the motor casing. Moreover, since the inflow of the cooling water in the motor casing into the pump casing can be prevented, it is possible to prevent the loss of the heat quantity of the boiler due to cooling of the hot water in the pump casing.

[0024] Furthermore, since the flow suppressing mechanism for suppressing the flow is provided to the shaft insertion portion of the heat barrier, it is possible to suppress the inflow of the hot water in the pump casing into the motor casing and the inflow of the cooling water in the motor casing into the pump casing. Therefore, it is possible to reliably prevent the damage to the electrical insulator due to the abnormal rise in temperature in the motor casing and it is also possible to reliably prevent the loss of the heat quantity of the boiler due to cooling of the hot water in the pump casing.

[Brief Description of Drawings]

[0025]

Fig. 1 is a sectional view of a circulation pump in Embodiment 1 according to the present invention;
Fig. 2 is an enlarged sectional view of an essential portion of Fig. 1;
Fig. 3 is a sectional view of an essential portion of Fig. 2;
Fig. 4 is a sectional view of a stream of water during warm standby of the circulation pump;
Fig. 5 is a sectional view of a circulation pump in Embodiment 2;
Fig. 6 is an enlarged sectional view of an essential portion and showing a circulation pump in an Embodiment 3.
Fig. 7 is an enlarged sectional view of an essential portion and showing a circulation pump in Embodiment 4;
Fig. 8 is an enlarged sectional view of an essential portion and showing a circulation pump in Embodiment 5;
Fig. 9 is an exploded perspective view of a flow suppressing mechanism in Embodiment 5;
Fig. 10 is an enlarged sectional view of an essential portion and showing an operating state of the flow suppressing mechanism in Embodiment 5;
Fig. 11 is an enlarged sectional view of an essential portion and showing a circulation pump in Embodiment 6; and
Fig. 12 is an enlarged sectional view of an essential portion and showing an operating state of a flow suppressing mechanism in Embodiment 6.

[Description of Embodiments]

[0026] Embodiments of the present invention will be described below according to the drawings.

(Embodiment 1)

[0027] Figs. 1 to 4 show a circulation pump according to the Embodiment 1 of the invention. The circulation pump includes a motor casing 10 positioned on an upper side, a heat barrier 22 positioned under the motor casing 10, and a pump casing 33 positioned under the heat barrier 22. A rotating shaft 37 is rotatably supported in them, an impeller 40 is disposed at a lower end of the rotating shaft 37, and a cooling water circulating impeller 42 is disposed at an upper end of the rotating shaft 37. A circulating cooling mechanism 43 for cooling and circulating internal cooling water is connected to the motor casing 10. In the embodiment, an external cooling water supply mechanism 48 is connected to the motor casing 10 to be able to continuously supply external cooling water. A flow suppressing mechanism 30 for suppressing movement of a fluid in opposite directions through a clearance between a shaft insertion portion 24 formed in the heat barrier 22 and the rotating shaft 37 is provided in the shaft insertion portion 24.

[0028] The motor casing 10 is formed by closing an upper end of a substantially cylindrical motor casing main body 11 with a cooling water impeller case 15. The motor casing main body 11 is provided with a rotating shaft support portion 12 passing through an upper end closed portion thereof along an axial direction at a center of the upper end closed portion. The rotating shaft support portion 12 is in a cylindrical shape extending toward an inside of the motor casing main body 11 and an upper sleeve 13 is disposed at an inner peripheral portion of the motor casing main body 11. A motor stator 14 is disposed at an intermediate position in the motor casing main body 11.
The motor stator 14 is made up of a cylindrical core block formed by laminating thin electromagnetic steel sheets and a coil bundle formed by winding through a plurality of grooves disposed on an inner diameter side of the core block.

[0029] The cooling water impeller case 15 is in a substantially conical cylindrical shape and a cooling water impeller disposing portion 16 is formed at an opening portion of a lower end of the cooling water impeller case 15. Above the cooling water impeller disposing portion 16, a water injection pocket 17 formed by a substantially circular columnar space is formed. In an outer peripheral portion of the water injection pocket 17, a water injection port 18 to which a connecting pipe 44 of the circulating cooling mechanism 43 is connected is formed and a water supply port 19 to which a water supply pipe 49 of the external cooling water supply mechanism 48 is connected is formed. An opening in an upper end of the cooling water impeller case 15 is closed with a motor cover 20. In the motor cover 20, a discharge port 21 to which a discharge pipe 52 of a gas discharge mechanism 51 is connected is formed.

[0030] The heat barrier 22 includes, in itself, a heat insulating space portion 23 and is disposed in a watertight state under the motor casing 10. As shown in Fig. 2, the heat barrier 22 is provided with the shaft insertion portion 24 made up of a hole passing through the heat barrier 22 in an axial direction to be positioned at a center of the heat barrier 22. An upper portion of the shaft insertion portion 24 is formed as a rotating shaft support portion 25 having an increased diameter. In the rotating shaft support portion 25, a lower sleeve 26 for rotatably supporting a lower portion of the rotating shaft 37 is disposed. The heat barrier 22 is provided with a high-pressure cooling water channel 27 passing through the rotating shaft support portion 25 from an outer peripheral portion of the heat barrier 22 in a radial direction. An outer end portion of the high-pressure cooling water channel 27 forms an injection outlet to which the connecting pipe 44 of the circulating cooling mechanism 43 is connected.

[0031] Furthermore, a low-pressure cooling water channel 28 is provided to the heat barrier 22 to be positioned above the heat insulating space portion 23. As shown in Fig. 3, the low-pressure cooling water channel 28 is made up of a plurality of (four, in the present embodiment) straight through holes 29a to 29d positioned in an outer periphery of the shaft insertion portion 24 without intersecting the shaft insertion portion 24 and the high-pressure cooling water channel 27. For example, one end of the first through hole 29a is formed as an inlet and the other end is closed. The second through hole 29b is formed so as to intersect the first through hole 29a and its opposite ends are closed. The third through hole 29c is formed to intersect the second through hole 29b and its opposite ends are closed. The fourth through hole 29d is formed to intersect the third through hole 29c, one end of the fourth through hole 29d is closed, and the other end is formed as an outlet. In this way, a channel communicating between the inlet at one end of the first through hole 29a and the outlet at the other end of the fourth through hole 29d is formed. By passing the low-pressure cooling water from the low-pressure cooling water supply mechanism (not shown) through this channel, heat insulation between the motor casing 10 and the pump casing 33 is achieved. In Figs. 1 and 2, the high-pressure cooling water channel 27 and the low-pressure cooling water channel 28 are shown at opposed positions for convenience of illustration of them.

[0032] The flow suppressing mechanism 30 for suppressing movement of the fluid is provided to the shaft insertion portion 24 of the heat barrier 22 in the embodiment. The flow suppressing mechanism 30 is for suppressing the flow of the cooling water from the motor casing 10 into the pump casing 33 and the flow of the hot water from the pump casing 33 into the motor casing 10 through the shaft insertion portion 24. To prevent the flow in the opposite directions, as shown in Fig. 2, a labyrinth-type shaft seal 31 is disposed to be positioned at a portion of the shaft insertion portion 24 under the rotating shaft support portion 25 in the present embodiment. The shaft seal 31 is in a cylindrical shape disposed at an inner peripheral portion of the shaft insertion portion 24 and a plurality of annular grooves 32 are formed in annular shapes in an inner peripheral face of the shaft seal 31.

[0033] The pump casing 33 is a substantially hemispherical hollow member and is disposed in a watertight state under the heat barrier 22. The pump casing 33 is provided with a cylindrical intake portion 34 protruding along an axial direction of the motor casing 10 and a cylindrical discharge portion 35 protruding radially outward so as to intersect an axial direction of the intake portion 34. An inside of the pump casing 33 is partitioned with a guide vane 36 for guiding the hot water taken in from the intake portion 34 into the discharge portion 35.

[0034] The rotating shaft 37 is disposed to extend from the inside of the motor casing 10 to the inside of the pump casing 33 which are hollow members through the shaft insertion portion 24 of the heat barrier 22. In the present embodiment, the one rotating shaft 37 is formed by integrally connecting a rotating shaft main body 38 disposed in the motor casing main body 11, a shaft portion 40a formed at the impeller 40 disposed in the pump casing 33, and a shaft portion 42a formed at the cooling water circulating impeller 42 disposed in the cooling water impeller case 15. Therefore, the rotating shaft 37 passing through the shaft insertion portion 24 in the heat barrier 22 is the shaft portion 40a of the impeller 40. It is of course possible to integrally mold the shaft portions 40a and 42a with the rotating shaft main body 38.

[0035] The rotating shaft 37 is rotatably supported by the upper sleeve 13 and the lower sleeve 26. On the rotating shaft 37, a motor rotor 39 is disposed to be positioned radially inside relative to the motor stator 14. The motor rotor 39 is made up of a cylindrical block formed by laminating magnetic steel sheets, a plurality of copper bars passing through an inside of a surface side of the block, and copper rings for connecting all of ends of the respective bars on opposite ends of the bars. The motor rotor 39 is rotated when it is affected by a rotating magnetic field generated by the coil of the motor stator 14, a current due to an electromagnetic induction phenomenon passes through the copper bars, and an electromagnetic force is generated by the interaction with the rotating magnetic field.

[0036] The impeller 40 is disposed in the guide vane 36 of the pump casing 33. The shaft portion 40a connected the rotating shaft main body 38 protrudes from a disc-shaped main plate of the impeller 40. Impeller blades 41 are provided on a lower face side of the main plate of the impeller 40 and the hot water taken in from the intake portion 34 of the pump casing 33 is discharged from the discharge portion 35 with the impeller blades 41.

[0037] The cooling water circulating impeller 42 forms a portion of the circulating cooling mechanism 43 for circulating and supplying the cooling water in the motor casing 10 during operation in which the rotating shaft 37 is rotating and the cooling water circulating impeller 42 is disposed in a cooling water impeller case 15 of the motor casing 10. The shaft portion 42a connected to the rotating shaft main body 38 protrudes from a disc-shaped main plate of the cooling water circulating impeller 42.

In the cooling water circulating impeller 42, an intake flow path which opens into the water injection pocket 17 and a discharge flow path extending radially outward from a lower end of the intake flow path are formed. With these flow paths, the cooling water circulating impeller 42 takes in, in a downward direction, the cooling water in the water injection pocket 17 above the cooling water circulating impeller 42 and discharges it radially outward to thereby generate a downward stream of water in the motor casing main body 11 through the rotating shaft support portion 12.

[0038] The circulating cooling mechanism 43 includes the connecting pipe 44 connecting the water injection port 18 of the water injection pocket 17 which is the upper portion of the motor casing 10 and the water injection outlet of the heat barrier 22 which is under the motor casing 10 as a bypass. The connecting pipe 44 is provided, at an upward extending portion thereof, with a motor cooler 45. The motor cooler 45 includes a low-pressure cooling water inlet 46 and a low-pressure cooling water outlet 47, the low-pressure cooling water is supplied to the motor cooler 45 from the low-pressure cooling water supply mechanism (not shown), and, in this way, the motor cooler 45 cools the cooling water which flows through the connecting pipe 44 and a temperature of which has been increased.

[0039] The external cooling water supply mechanism 48 supplies the external cooling water at a higher supplying pressure than a pressure in the motor casing 10 and its supply pipe 49 is connected to the water supply port 19 of the motor casing 10. For example, the external cooling water supply mechanism 48 can supply the cooling water at a predetermined temperature at a predetermined pressure with a pump. The water supply pipe 49 is provided with a check valve 50 for allowing flow of the external cooling water toward the motor casing 10 and preventing flow in an opposite direction. The check valve 50 is for preventing backflow of the cooling water in the motor casing 10 toward the external cooling water supply mechanism 48 due to unexpected pressure fluctuation. In this way, it is possible to reliably prevent flow of the hot water in the pump casing 33 into the motor casing 10 as a result of the backflow.

[0040] The circulation pump in the present embodiment is further provided with the gas discharge mechanism 51 for discharging gas generated in the motor casing 10 to the outside. The gas discharge mechanism 51 is made up of the discharge pipe 52 connected to the discharge port 21 in the upper end of the motor casing 10 and an orifice 53 and a check valve 54 provided to the discharge pipe 52. The discharge pipe 52 is inclined upward and has a tip end connected to an intake-side boiler pipe 55 as a branch pipe. The orifice 53 is for stably maintaining an amount of the fluid flowing out of the motor casing 10 at a small amount. The check valve 54 allows flow from the motor casing 10 toward the intake-side boiler pipe 55 and prevents flow in an opposite direction. In this way, by discharging the gas generated in the motor casing 10, damage due to an idling state of the rotating shaft 37 during operation is prevented. With the check valve 54, it is possible to reliably prevent flow of the hot water in the intake-side boiler pipe 55 into the motor casing 10 due to unexpected pressure fluctuation.

[0041] In the circulation pump formed as structured above, the intake-side boiler pipe 55 is connected to the intake portion 34 of the pump casing 33 and a discharge-side boiler pipe 56 is connected to the discharge portion 35 of the pump casing 33. In a power generation facility which is one of examples of use of the circulation pump in the embodiment, the discharge-side boiler pipe 56 is connected to a boiler for superheating water to generate steam and the intake-side boiler pipe 55 is connected to a condenser for turning the steam into high-temperature hot water. The power generation facility rotates a turbine connected to a generator with the steam generated in the boiler. The steam which has rotated the turbine is turned back into the high-temperature hot water by the condenser. The hot water is circulated and supplied by the circulation pump in the embodiment.

[0042] Next, operation of the circulation pump in the Embodiment 1 will be described specifically.

[0043] First, both during operation in which the rotating shaft 37 is rotating and during the warm standby in which the rotating shaft 37 is stopped, the external cooling water is supplied from the external cooling water supply mechanism 48 into the motor casing 10. Similarly, the low-pressure cooling water is constantly supplied from the low-pressure cooling water supply mechanism into the low-pressure cooling water channel 28 in the heat barrier 22 and the motor cooler 45 of the circulating cooling mechanism 43.

[0044] During operation, the impeller 40 and the cooling water circulating impeller 42 rotate due to the rotation of the rotating shaft 37. As a result, the pump casing 33 takes in the hot water from the condenser through the intake-side boiler pipe 55 and circulates and supplies the hot water to the boiler due to the rotation of the impeller 40. In the motor casing 10, the rotation of the cooling water circulating impeller 42 generates a downward stream of the cooling water in the motor casing main body 11. The cooling water in a lower portion of the motor casing 10 is taken into the connecting pipe 44 by a water sending action of the cooling water circulating impeller 42, cooled in the motor cooler 45, and circulated and supplied into the water injection pocket 17.

[0045] At this time, in the shaft insertion portion 24 in the heat barrier 22, because of the circulating and supplying action of the cooling water, a water replacement phenomenon in which the lower hot water and the upper cooling water naturally convect hardly occurs. Moreover, in the embodiment, it is possible to reliably suppress both movement of the fluid from the motor casing 10 toward the pump casing 33 and movement of the fluid from the pump casing 33 toward the motor casing 10 with fluid resistance of the shaft seal 31 forming the flow suppressing mechanism 30 disposed at the shaft insertion portion 24.

[0046] In the circulation pump in the embodiment, surplus cooling water in the motor casing 10 leaks outside due to supply of the external cooling water. The surplus cooling water leaks toward the pump casing 33 through the shaft insertion portion 24 of the heat barrier 22 at the lower end and toward the intake-side boiler pipe 55 through the discharge pipe 52 at the upper end. These amounts of outflow can be regulated by supplying pressure by the external cooling water supply mechanism 48 and settings of the shaft seal 31 and the orifice 53 forming the flow suppressing mechanism 30. Therefore, it is possible to suppress the leakages of the cooling water in the motor casing 10 into the pump casing 33 and the intake-side boiler pipe 55 while reliably preventing the hot water in the pump casing 33 from flowing into the motor casing 10.

[0047] During the warm standby, on the other hand, the rotating shaft 37 is stopped and therefore the impeller 40 and the cooling water circulating impeller 42 are stopped. As a result, the circulation and supply of the hot water are stopped in the pump casing 33. In the motor casing 10, running (circulation) of the cooling water by the cooling water circulating impeller 42 is stopped. Therefore, in the conventional art, the water replacement phenomenon between the motor casing 10 and the pump casing 33 occurs in this warm standby state.

[0048] In the present embodiment, however, the shaft seal 31 forming the flow suppressing mechanism 30 is disposed at the shaft insertion portion 24 in the heat barrier 22 formed between the motor casing 10 and the pump casing 33. Therefore, with the fluid resistance by the shaft seal 31, it is possible to suppress the flow of the cooling water from the motor casing 10 into the pump casing 33 and the flow of the hot water from the pump casing 33 into the motor casing 10.

[0049] Moreover, in the circulation pump in the present embodiment, the external cooling water is supplied into the motor casing 10 by the external cooling water supply mechanism 48 during the warm standby similarly to the case during operation. Therefore, in the motor casing 10, as shown in Fig. 4, if the external cooling water is supplied into the water injection pocket 17, it causes a first flow flowing downward in the motor casing 10 through the cooling water circulating impeller 42, a second flow flowing downward through the connecting pipe 44 of the circulating cooling mechanism 43, and a third flow flowing toward the intake-side boiler pipe 55 through the discharge pipe 52. Out of these flows, the first flow and the second flow merge with each other in the shaft insertion portion 24 of the heat barrier 22 and flow into the pump casing 33 through the shaft insertion portion 24. Therefore, it is possible to suppress the leakage amounts of the cooling water in the motor casing 10 into the pump casing 33 and the intake-side boiler pipe 55 while reliably preventing the hot water in the pump casing 33 from flowing into the motor casing 10.

[0050] In the motor casing 10, a solution gas which is one of gasses may be generated naturally with time. This gas causes an idling phenomenon of the rotating shaft 37 during operation. In the present embodiment, however, the discharge pipe 52 is connected to the upper end of the motor casing 10. The gas generated in the motor casing 10 accumulates in the water injection pocket 17 which is the upper end of the motor casing 10 and is discharged into the intake-side boiler pipe 55 through the discharge pipe 52 both during operation and during the warm standby. Specifically, pressure in the intake-side boiler pipe 55 does not become higher than internal pressure of the motor casing 10 in both during operation and during the warm standby. Therefore, there is always flow from the motor casing 10 toward the intake-side boiler pipe 55 and backflow can be prevented. Moreover, in the present embodiment, the pressure in the motor casing 10 becomes high due to the supply of the external cooling water by the external cooling water supply mechanism 48 and therefore the gas is reliably discharged into the intake-side boiler pipe 55 through the discharge pipe 52.

[0051] As described above, in the circulation pump in the present invention, since the flow suppressing mechanism 30 for suppressing the flow is provided to the shaft insertion portion 24 in the heat barrier 22, the flow of the hot water in the pump casing 33 into the motor casing 10 can be suppressed and the flow of the cooling water in the motor casing 10 into the pump casing 33 can be suppressed. As a result, it is possible to prevent damage to an electrical insulator due to an abnormal rise in temperature in the motor casing 10. Moreover, it is possible to prevent a loss of a heat quantity of the boiler due to cooling of the hot water in the pump casing 33.

[0052] Furthermore, in the present embodiment, the external cooling water is supplied from the supply pipe 49 of the external cooling water supply mechanism 48 into the motor casing 10 and the surplus cooling water in the motor casing 10 flows out into the pump casing 33 through the shaft insertion portion 24 of the heat barrier

22 during the warm standby in which the water replacement phenomenon occurs. Therefore, the hot water in the pump casing 33 does not flow into the motor casing 10. As a result, it is possible to reliably prevent the damage to the electric insulator due to the abnormal rise in temperature in the motor casing 10.

[0053] Since the check valve 50 is provided to the supply pipe 49 of the external cooling water supply mechanism 48, it is possible to prevent the backflow of the cooling water in the motor casing 10 toward the external cooling water supply mechanism 48 due to the unexpected pressure fluctuation. As a result, it is possible to reliably prevent the hot water in the pump casing 33 from flowing into the motor casing 10.

[0054] Furthermore, in the circulation pump in the present embodiment, the discharge pipe 52 is connected to the upper end of the motor casing 10 so that the gas generated in the motor casing 10 can be discharged into the intake-side boiler pipe 55. Therefore, it is possible to prevent damage due to the idling state of the rotating shaft 37 during operation. Moreover, since the check valve 54 is provided to the discharge pipe 52, it is possible to reliably prevent the hot water in the intake-side boiler pipe 55 from flowing into the motor casing 10 due to the unexpected pressure fluctuation.

[0055] Because the circulation pump in the present invention is of an erected type in which the pump casing 33 is positioned below the motor casing 10, large-scale foundation and building for disposing the motor casing 10 and the circulating cooling mechanism 43 are unnecessary in the construction of the facility and therefore the cost of construction of the facility can be reduced.

[0056] Although the external cooling water supply mechanism 48 supplies the external cooling water both during operation and during the warm standby in the Embodiment 1, the external cooling water may be supplied only during the warm standby. If the external cooling water is supplied both during operation and during the warm standby, the cooling water circulating impeller 42 may not be provided. Although the connecting pipe 44 of the external cooling water supply mechanism 48 is connected to the water injection pocket 17 at the upper end of the motor casing 10, a position of the connection may be changed as desired.

(Embodiment 2)

[0057] Fig. 5 shows a circulation pump in the Embodiment 2. The Embodiment 2 is widely different from the Embodiment 1 in that a pump 57 for forcibly circulating the cooling water in the motor casing 10 even during the warm standby is disposed in the connecting pipe 44 of the circulating cooling mechanism 43 in place of the external cooling water supply mechanism 48. Another difference is that the water supply port 19 to which the water supply pipe 49 of the external cooling water supply mechanism 48 is not provided to the cooling water impeller case 15 and the other structures are the same as those in the Embodiment 1. Therefore, the same structures as those in the Embodiment 1 will be provided with the same reference numerals and will not be described in detail.

[0058] The pump 57 is a canned motor pump disposed on an upstream side of the motor cooler 45 in the connecting pipe 44 of the circulating cooling mechanism 43. The pump 57 takes in the cooling water in the upstream motor casing 10 and circulates and supplies it to the downstream water injection pocket 17 through the motor cooler 45. The canned motor pump 57 has a coil of a motor housed in a can to be waterproof so that the pump 57 can be used in water.

[0059] If the circulation pump in the Embodiment 2 operates, similarly to the Embodiment 1, the pump casing 33 takes in the hot water from the intake-side boiler pipe 55 and circulates and supplies it to the boiler as a result of the rotation of the impeller 40. In the motor casing 10, the rotation of the cooling water circulating impeller 42 generates a downward stream of the cooling water and the cooling water is taken in from the connecting pipe 44 at a lower portion, cooled in the motor cooler 45, and circulated and supplied into the water injection pocket 17. This circulating flow of the cooling water by the circulating cooling mechanism 43 prevents natural convection of the cooling water in the motor casing 10 and the hot water in the pump casing 33 through the shaft insertion portion 24. Moreover, with the fluid resistance by the shaft seal 31 forming the flow suppressing mechanism 30 disposed at the shaft insertion portion 24, it is possible to reliably suppress the natural convection.

[0060] During the warm standby, on the other hand, the rotating shaft 37 is stopped and therefore the circulation and supply of the hot water are stopped in the pump casing 33. In the motor casing 10, the running (circulation) of the cooling water by the cooling water circulating impeller 42 is stopped. In this state, the pump 57 disposed in the connecting pipe 44 of the circulating cooling mechanism 43 is driven. In this way, in the motor casing 10, the cooling water in the lower portion of the motor casing 10 is taken into the connecting pipe 44, cooled in the motor cooler 45, and circulated and supplied into the water injection pocket 17 similarly to the case during operation. As a result, during the warm standby, the circulating flow of the cooling water similarly prevents the natural convection of the cooling water in the motor casing 10 and the hot water in the pump casing 33 through the shaft insertion portion 24. Moreover, with the fluid resistance by the shaft seal 31 forming the flow suppressing mechanism 30 disposed at the shaft insertion portion 24, it is possible to reliably suppress the natural convection.

[0061] Similarly to the Embodiment 1, the gas generated in the motor casing 10 is discharged into the intake-side boiler pipe 55 through the discharge pipe 52. Specifically, the intake-side boiler pipe 55 does not become higher than the internal pressure of the motor casing 10 both during operation and during the warm standby similarly to the Embodiment 1. Therefore, there is always flow from the motor casing 10 toward the intake-side boiler pipe 55 and the gas can be discharged. However, in the Embodiment 2, if the gas and a liquid are discharged into the intake-side boiler pipe 55 through the discharge pipe 52, the hot water corresponding to the discharge amount thereof flows from the pump casing 33 into the motor casing 10 through the shaft insertion portion 24. An amount of the inflow thereof is set to be infinitesimal by the shaft seal 31 and the orifice 53. Moreover, the flowing-in hot water does not directly flows into the motor casing 10 but is cooled in the motor cooler 45 through the connecting pipe 44 and injected from the injection pocket at the upper end. Therefore, the temperature of the cooling water in the motor casing 10 does not increase.

[0062] As described above, in the circulation pump in the Embodiment 2, it is possible to obtain, with the shaft seal 31 disposed at the shaft insertion portion 24 of the heat barrier 22, similar operation and effects to those in the Embodiment 1.

[0063] Moreover, in the Embodiment 2, the pump 57 can forcibly circulate the cooling water in the motor casing 10, the hot water in the pump casing 33 does not flow into the motor casing 10 and the cooling water in the motor casing 10 does not flow into the pump casing 33. As a result, it is possible to reliably prevent damage to the electrical insulator due to the abnormal rise in temperature in the motor casing 10 and the loss of the heat quantity of the boiler due to cooling of the hot water in the pump casing 33.

[0064] Similarly to the Embodiment 1, with the discharge pipe 52 connected to the upper end of the motor casing 10, it is possible to prevent damage due to the idling state of the rotating shaft 37 during operation. Moreover, with the check valve 54 provided to the discharge pipe 52, it is possible to reliably prevent the hot water in the intake-side boiler pipe 55 from flowing into the motor casing 10 due to the unexpected pressure fluctuation.

[0065] Although the cooling water circulating impeller 42 is provided as a member of the circulating cooling mechanism 43 and the cooling water is circulated and supplied by the cooling water circulating impeller 42 during operation and circulated and supplied by the pump 57 during the warm standby in the Embodiment 2, the cooling water circulating impeller 42 may not be provided and the pump 57 may circulate and supply the cooling water both during operation and during the warm standby.

(Embodiment 3)

[0066] Fig. 6 shows a circulation pump in the Embodiment 3. In the Embodiment 3, the flow suppressing mechanism 30 is made up of a plurality of annular grooves 58 formed in an inner peripheral portion of the shaft insertion portion 24 in the heat barrier 22 instead of the shaft seal 31. The structure of the Embodiment 3 in which the annular grooves 58 are provided as the flow suppressing mechanism 30 may be employed in the structure of the Embodiment 1 in which the external cooling water supply mechanism 48 is provided and in the structure of the Embodiment 2 in which the pump 57 for forcible circulation is provided.

[0067] In the circulation pump in the Embodiment 3 provided with such a flow suppressing mechanism 30, it is possible to obtain similar operation and effects to those in the Embodiment 1 and the Embodiment 2. In place of the annular grooves 58, annular protruding portions may be provided. The annular grooves 58 or the annular protruding portions may be provided not to the shaft insertion portion 24 of the heat barrier 22 but to an outer peripheral portion of the shaft portion 40a forming the rotating shaft 37.

(Embodiment 4)

[0068] Fig. 7 shows a circulation pump in the Embodiment 4. In the Embodiment 4, the flow suppressing mechanism 30 includes the plurality of annular grooves 58 formed in the inner peripheral portion of the heat barrier 22 and a plurality of annular protruding portions 59 formed on the outer peripheral portion of the shaft portion 40a forming the rotating shaft 37. The annular protruding portions 59 are formed to protrude radially outward from a sleeve 60 which is to be fitted over the outer peripheral portion of the shaft portion 40a. The annular protruding portions 59 are mounted to be positioned inside the annular grooves 58 with predetermined clearances from the annular grooves 58. The structure of the Embodiment 4 in which the annular grooves 58 and the annular protruding portions 59 are provided as the flow suppressing mechanism 30 may be employed in the structure of the Embodiment 1 in which the external cooling water supply mechanism 48 is provided and the structure of the Embodiment 2 in which the pump 57 for forcible circulation is provided.

[0069] In the circulation pump in the Embodiment 4 provided with such a flow suppressing mechanism 30, it is possible to obtain similar operation and effects to those in the Embodiment 1 and the Embodiment 2. The annular grooves 58 may be formed in the outer peripheral portion of the shaft portion 40a forming the rotating shaft 37 and the annular protruding portions 59 may be formed on the inner peripheral portion of the shaft insertion portion 24 of the heat barrier 22.

(Embodiment 5)

[0070] Fig. 8 shows a circulation pump in the Embodiment 5. In the Embodiment 5, the flow suppressing mechanism 30 is made up of an elastically deformable seal member 61. The seal member 61 is in a conical cylindrical member disposed at the shaft portion 40a of the impeller 40 forming the rotating shaft 37. Specifically, as shown in Fig. 9, the seal member 61 is disposed to be positioned in the rotating shaft support portion 25 of the shaft insertion portion 24 and has a lower end portion with an outer diameter greater than an inner diameter of the shaft insertion portion 24. An upper end of the seal member 61 has substantially the same inner diameter as an outer diameter of the shaft portion 40a and is provided with a mounting portion 62 having a groove to be secured to the shaft portion 40a. At the lower end of the seal member 61, weights 63 for elastically deforming and lifting the seal member 61 when a centrifugal force is applied to the weights 63 are disposed at predetermined intervals in a circumferential direction.

[0071] The seal member 61 is secured to the shaft portion 40a by a pair of fixing members 64A and 64B in half ring shapes. The fixing members 64A and 64B include frame bodies having substantially the same inner diameters as the outer diameter of the shaft portion 40a. In inner peripheral portions of the fixing members 64A and 64B, mounting grooves 65 into which the mounting portions 62 of the seal member 61 are fitted, pressed, and fixed are formed. Screw holes 66 are formed in end faces of one fixing member 64A facing the other fixing member 64B and screw insertion holes 67 corresponding to the screw holes 66 in the axial direction are formed in the fixing member 64B.

[0072] In the circulation pump in the Embodiment 5 provided with such a flow suppressing mechanism 30, if the rotating shaft 37 rotates by operation, the pump casing 33 takes in the hot water from the intake-side boiler pipe 55 and circulates and supplies it to the boiler as a result of rotation of the impeller 40 similarly to the respective embodiments. In the motor casing 10, the rotation of the cooling water circulating impeller 42 generates a downward stream of the cooling water and the cooling water is taken in from the connecting pipe 44, cooled in the motor cooler 45, and circulated and supplied into the water injection pocket 17. As a result, in the motor casing 10, the circulating flow of the cooling water by the circulating cooling mechanism 43 prevents natural convection through the shaft insertion portion 24. The seal member 61 is elastically deformed and lifts as shown in Fig. 10, if the radially outward centrifugal force is applied to the weights 63 due to the rotation of the rotating shaft 37. As a result, sliding contact with an end face of the shaft insertion portion 24 can be avoided.

[0073] During the warm standby, on the other hand, the rotating shaft 37 is stopped and therefore the circulation and supply of the hot water are stopped in the pump casing 33. In the motor casing 10, running (circulation) of the cooling water by the cooling water circulating impeller 42 is stopped. At the same time, the centrifugal force applied on the seal member 61 is cancelled and therefore the seal member 61 comes down to an outer peripheral portion of the upper end of the shaft insertion portion 24 under its own weight. As a result, it is possible to prevent flow of the cooling water from the motor casing 10 into the pump casing 33 and flow of the hot water from the pump casing 33 into the motor casing 10 through the shaft insertion portion 24.

[0074] Moreover, in the Embodiment 5, by connecting the external cooling water supply mechanism 48 shown in the Embodiment 1 to the motor casing 10 and causing the external cooling water supply mechanism 48 to operate during the warm standby, the stream of water formed in the motor casing 10 brings the seal member 61 into close contact with the outer peripheral portion of the upper end of the shaft insertion portion 24. Similarly by connecting the pump 57 for the forcible circulation shown in the Embodiment 2 to the connecting pipe 44 of the circulating cooling mechanism 43 and operating the pump 57 during the warm standby, the stream of water formed in the motor casing 10 brings the seal member 61 into close contact with the outer peripheral portion of the upper end of the shaft insertion portion 24. As a result, it is possible to reliably prevent the natural convection between the motor casing 10 and the pump casing 33.

[0075] In this way, in the circulation pump in the Embodiment 5, it is possible to obtain similar operation to those in each of the embodiments. Moreover, when the circulation pump is used with (combined with) the external cooling water supply mechanism 48 shown in the Embodiment 1 or the pump 57 for the forcible circulation shown in the Embodiment 2, it is possible to reliably prevent the natural convection during the warm standby. Because the seal member 61 in the Embodiment 5 can be prevented from coming in sliding contact with the end face of the shaft insertion portion 24 by the centrifugal force applied as a result of the rotation of the rotating shaft 37 during operation, it is possible to suppress damage due to wear.

(Embodiment 6)

[0076] Figs. 11 and 12 show a circulation pump in the Embodiment 6. In the Embodiment 6, the flow suppressing mechanism 30 is made up of a seal ring 70 biased by a spring 73 which is a biasing means against the outer peripheral portion of the upper end of the shaft insertion portion 24. The seal ring 70 is fitted from outside over a seal sleeve 68 fixed to the upper end of the shaft portion 40a of the impeller 40 forming the rotating shaft 37 to be movable along the axial direction of the rotating shaft 37. At an upper end of the seal sleeve 68, a spring receiving portion 69 protruding radially outward is formed.

[0077] The seal ring 70 is disposed to be positioned in the rotating shaft support portion 25 of the shaft insertion portion 24 and has a lower end portion with an outer diameter greater than the inner diameter of the shaft insertion portion 24. An inner diameter of the seal ring 70 is greater than an outer diameter of the seal sleeve 68. A water reservoir recessed portion 71 recessed upward is formed in a lower end face of the seal ring 70 and a lifting flow path 72 passing from an upper end to the water reservoir recessed portion 71 (lower end) of the seal ring 70 is formed. Between the seal ring 70 and the seal sleeve 68, the spring 73 for biasing the seal ring 70 toward the outer peripheral portion of the upper end of the shaft insertion portion 24 is disposed.

[0078] In the circulation pump in the Embodiment 6 provided with such a flow suppressing mechanism 30, if the rotating shaft 37 rotates due to the operation, the pump casing 33 takes in the hot water from the intake-side boiler pipe 55 and circulates and supplies it to the boiler as a result of rotation of the impeller 40 similarly to each of the embodiments. In the motor casing 10, the rotation of the cooling water circulating impeller 42 generates a downward stream of the cooling water and the cooling water is taken in from the connecting pipe 44, cooled in the motor cooler 45, and circulated and supplied into the water injection pocket 17. As a result, in the motor casing 10, the circulating flow of the cooling water by the circulating cooling mechanism 43 prevents natural convection through the shaft insertion portion 24. In this state, in the seal ring 70, the stream of the cooling water by the circulating cooling mechanism 43 enters the lifting flow path 72 to increase pressure in the water reservoir recessed portion 71. Then, due to pressure of the cooling water entering the lifting flow path 72, the seal ring 70 moves upward against biasing force of the spring 73. As a result, similarly to the Embodiment 5, the sliding contact between the seal ring 70 and the end face of the shaft insertion portion 24 can be avoided.

[0079] During the warm standby, on the other hand, the rotating shaft 37 is stopped and therefore circulation and supply of the hot water are stopped in the pump casing 33. In the motor casing 10, running (circulation) of the cooling water by the cooling water circulating impeller 42 is stopped. At the same time, the water pressure applied on the seal ring 70 is cancelled and therefore the seal ring 70 is brought in contact with the outer peripheral portion of the upper end of the shaft insertion portion 24 by the biasing force of the spring 73. In this way, it is possible to reliably prevent flow of the cooling water from the motor casing 10 into the pump casing 33 and flow of the hot water from the pump casing 33 into the motor casing 10 through the shaft insertion portion 24.

[0080] In the Embodiment 5, the external cooling water supply mechanism 48 shown in the Embodiment 1 and the pump 57 for the forcible circulation shown in the Embodiment 2 are not necessarily used together. If they are used together, supplying pressure of the external cooling water by the external cooling water supply mechanism 48 and the circulating and supplying pressure (stream of water) of the cooling water by the pump 57 are such pressures that the seal ring 70 does not lift against the biasing force of the spring 73.

[0081] As described above, in the circulation pump in the Embodiment 6, it is possible to obtain the same operation as in each of the embodiments. Because the seal ring 70 in the Embodiment 6 can be prevented from coming in sliding contact with the end face of the shaft insertion portion 24 by water pressure of the circulating flow of the cooling water during operation, it is possible to suppress damage due to wear.

[0082] The circulation pump in the invention is not limited to the structures in the above-described embodiments but can be changed in various ways.

[0083] For example, though the guide vane 36 is disposed in the pump casing 33, the guide vane 36 may not be disposed. Furthermore, the pump casing 33 is not limited to one having the discharge portion 35 protruding radially outward with respect to the axial direction of the intake portion 34 but may be a spiral one having a helical flowing water channel.

[0084] Although the motor mechanism which has the motor stator 14 and the motor rotor 39 and rotates by the action of the rotating magnetic field as the motor mechanism disposed in the motor casing 10 in the above embodiments, the type of the motor mechanism including presence or absence of magnets can be chosen as desired.

[0085] Although the example in which the circulation pump in the invention is used for the power generation facility has been described in each of the embodiments, the use is not limited to the power generation facility.

Claims

1. A circulation pump for taking in hot water from an intake portion of a pump casing and discharging the hot water from a discharge portion by rotating a rotating shaft disposed from a motor casing positioned at an upper end to the pump casing positioned at a lower end through a shaft insertion portion of a heat barrier to rotate an impeller disposed in the pump casing, and for circulating cooling water in the motor casing while cooling the cooling waters with a circulating cooling mechanism,
   wherein a hot water inflow preventing means for preventing the hot water in the pump casing from flowing into the motor casing by generating a stream of water in the motor casing during warm standby in which the rotating shaft is stopped is provided.

2. A circulation pump according to claim 1, wherein the hot water inflow preventing means comprises an external cooling water supply mechanism for supplying external cooling water at higher supply pressure than pressure in the motor casing and a water supply pipe of the external cooling water supply mechanism is connected to the motor casing.

3. A circulation pump according to claim 2, wherein a check valve for allowing flow of external cooling water toward the motor casing and preventing flow in an opposite direction is provided to a water supply pipe of the external cooling water supply mechanism.

4. A circulation pump according to claim 1, wherein the hot water inflow preventing means comprises a pump for taking the cooling water in the motor casing and circulating and supplying the cooling water and the pump is provided to a connecting pipe of the cir-

culating cooling mechanism.

5. A circulation pump according to claim 4, wherein the pump is a canned motor pump.

6. A circulation pump according to any one of claims 1 to 5, wherein a discharge pipe for discharging gas in the motor casing to an outside is connected to an upper end of the motor casing.

7. A circulation pump according to claim 6, wherein the discharge pipe is connected to an intake-side boiler pipe for supplying the hot water to the intake portion of the pump casing.

8. A circulation pump according to claim 7, wherein a check valve for allowing flow from the motor casing toward the intake-side boiler pipe and preventing flow in an opposite direction is provided to the discharge pipe.

9. A circulation pump according to any one of claims 1 to 8, wherein a flow suppressing mechanism for suppressing flow between the motor casing and the pump casing through the shaft insertion portion of the heat barrier is provided to the shaft insertion portion.

10. A circulation pump according to claim 9, wherein the flow suppressing mechanism comprises a labyrinth-shaped shaft seal disposed at an inner peripheral portion of the shaft insertion portion of the heat barrier or an outer peripheral portion of the rotating shaft.

11. A circulation pump according to claim 9, wherein the flow suppressing mechanism comprises a plurality of annular grooves or annular protruding portions provided to an inner peripheral portion of the shaft insertion portion of the heat barrier or an outer peripheral portion of the rotating shaft.

12. A circulation pump according to claim 9, wherein the flow suppressing mechanism comprises a seal member disposed at the rotating shaft and having a greater diameter than an inner diameter of the shaft insertion portion to be elastically deformed and lifted by a centrifugal force during rotation of the rotating shaft and to come down under its own weight to come in contact with an outer peripheral portion of an upper end of the shaft insertion portion when the rotating shaft is stopped.

13. A circulation pump according to claim 9, wherein the flow suppressing mechanism comprises a seal ring disposed at the rotating shaft to be movable along an axial direction, having a greater diameter than an inner diameter of the shaft insertion portion, and biased by a biasing means against an outer peripheral portion of an upper end of the shaft insertion portion, flow path passing through the seal ring from an upper end to a lower end of the seal ring is provided, and the seal ring can be moved upward against a biasing force of the biasing means by pressure of the cooling water entering the flow path.

Fig. 1

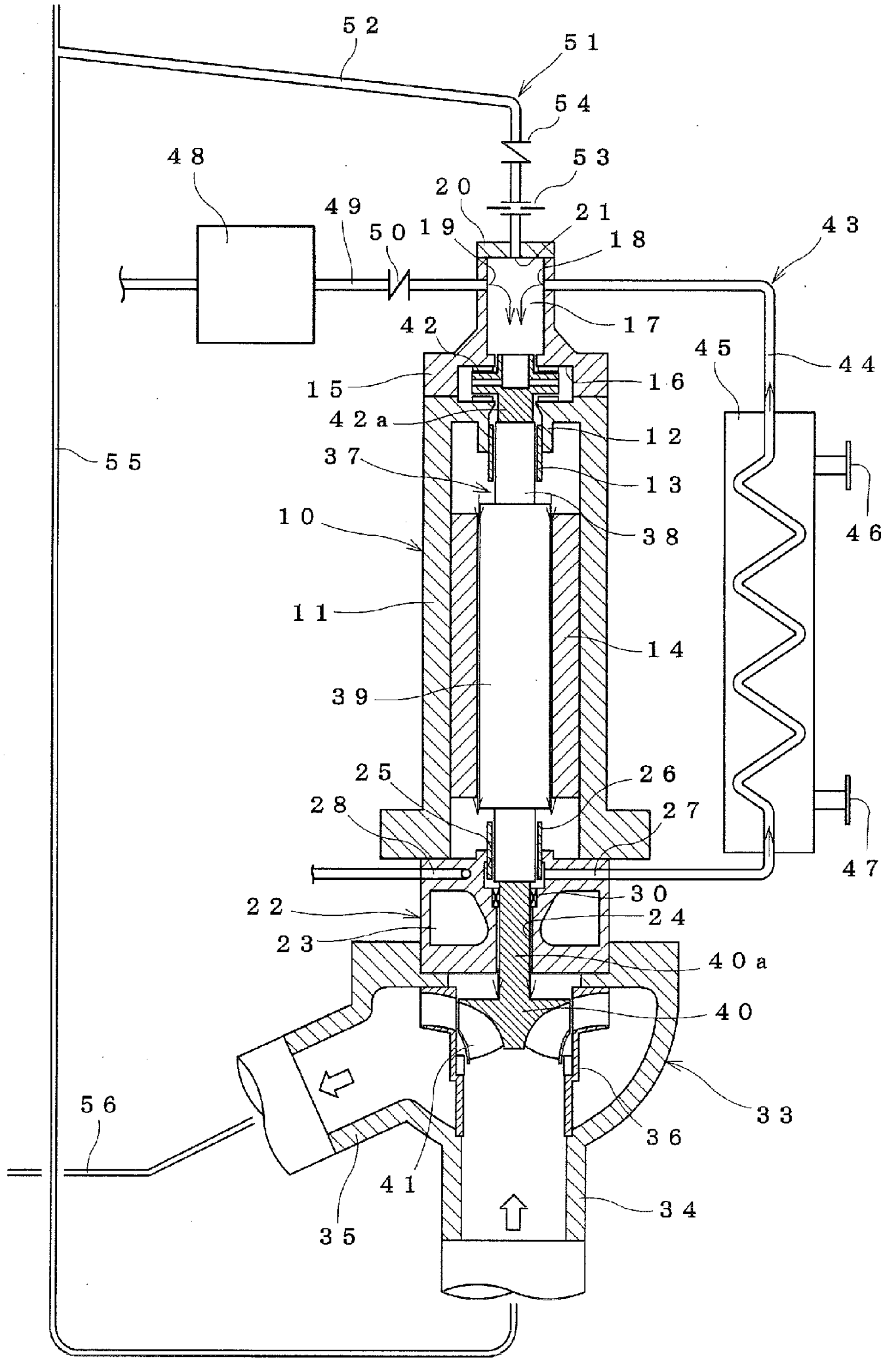
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Fig. 2

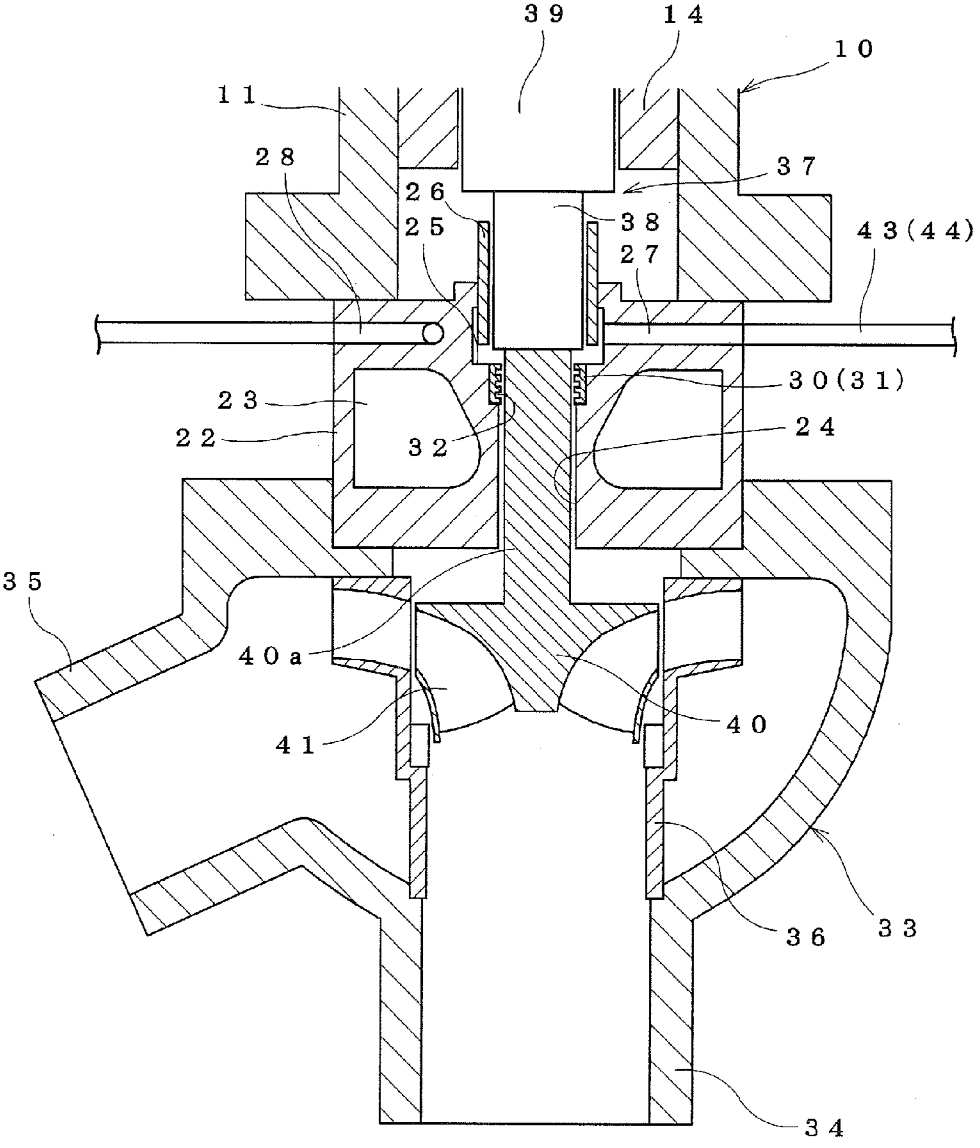
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Fig. 3

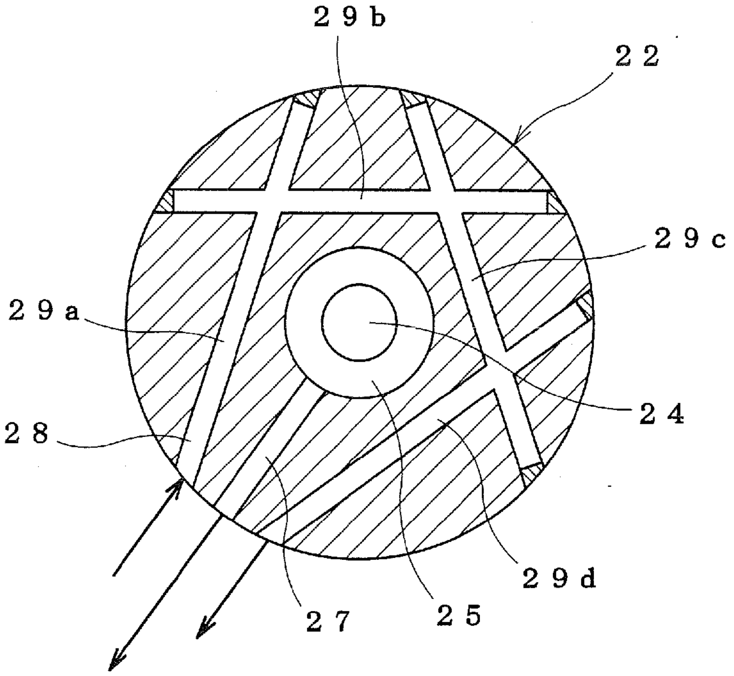

Fig. 4

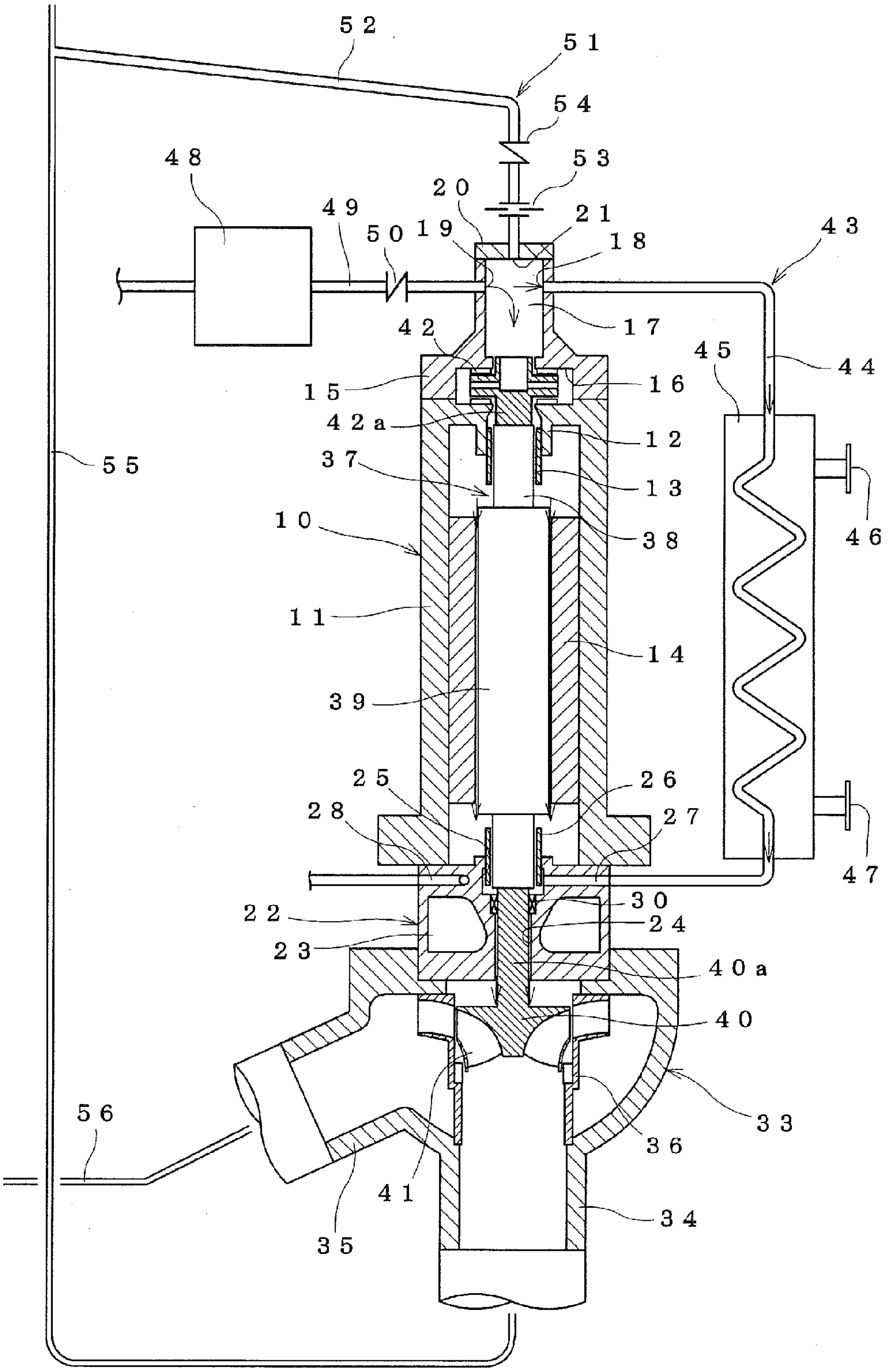
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Fig. 5

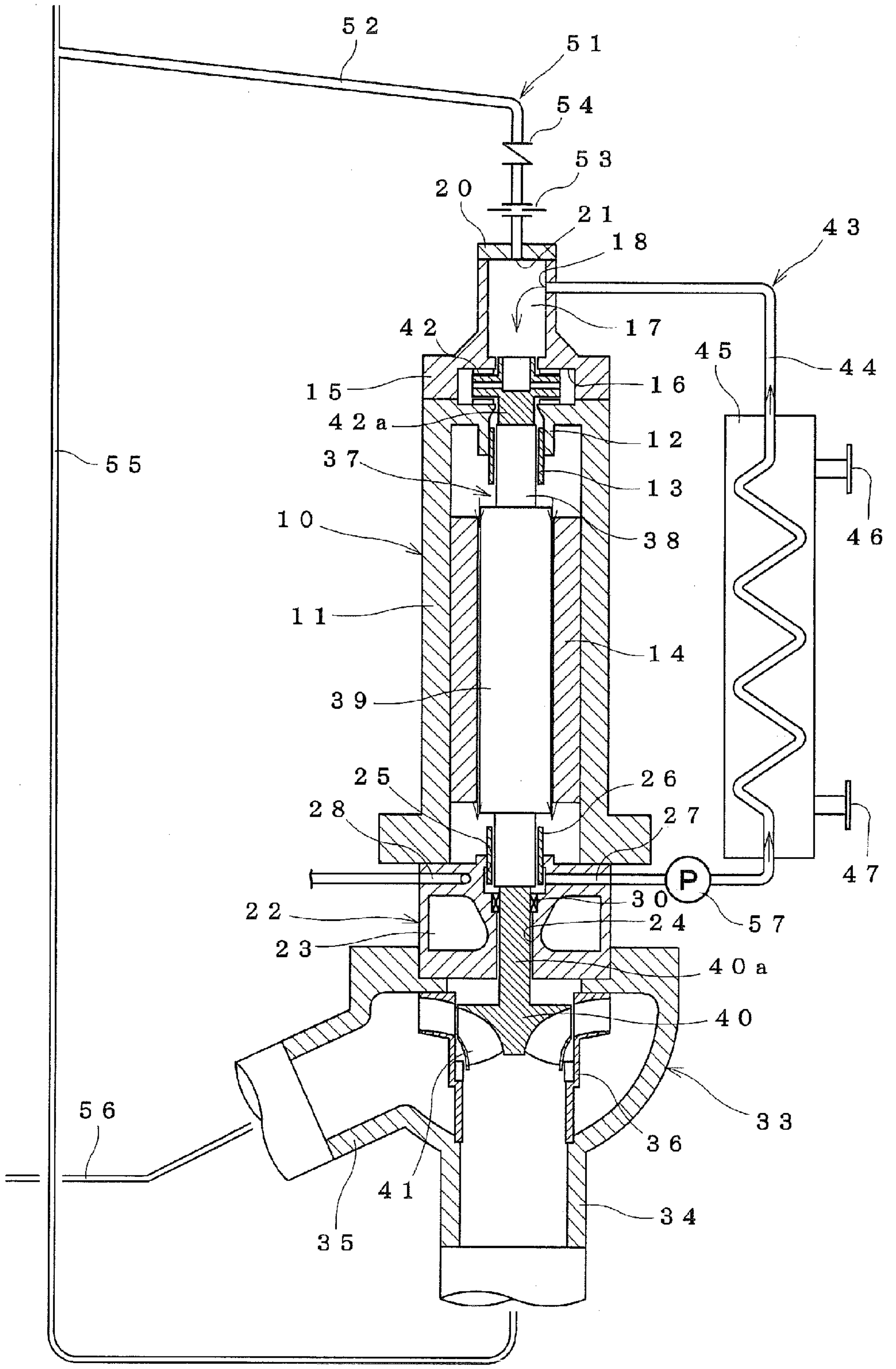
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Fig. 6

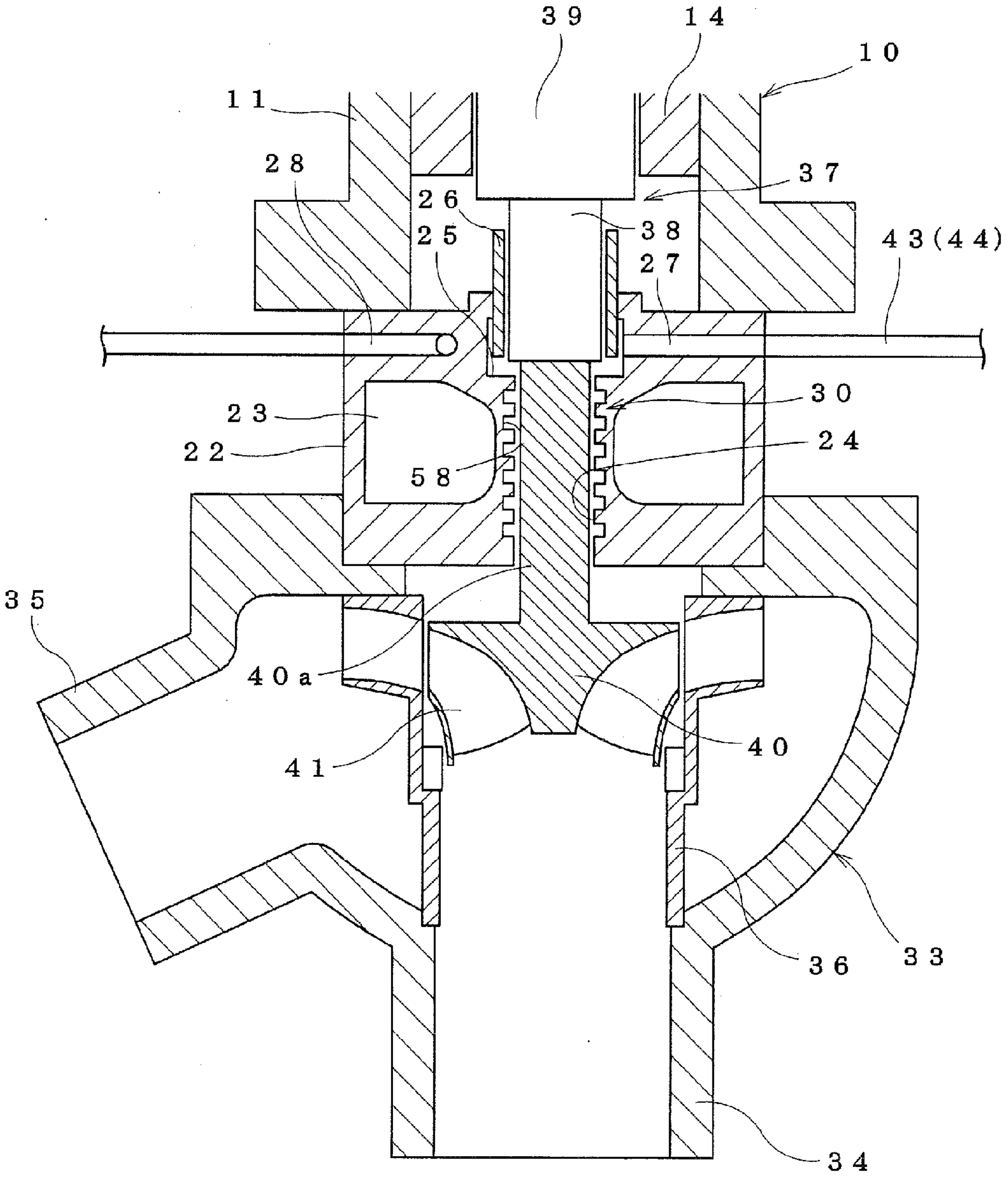

Fig. 7

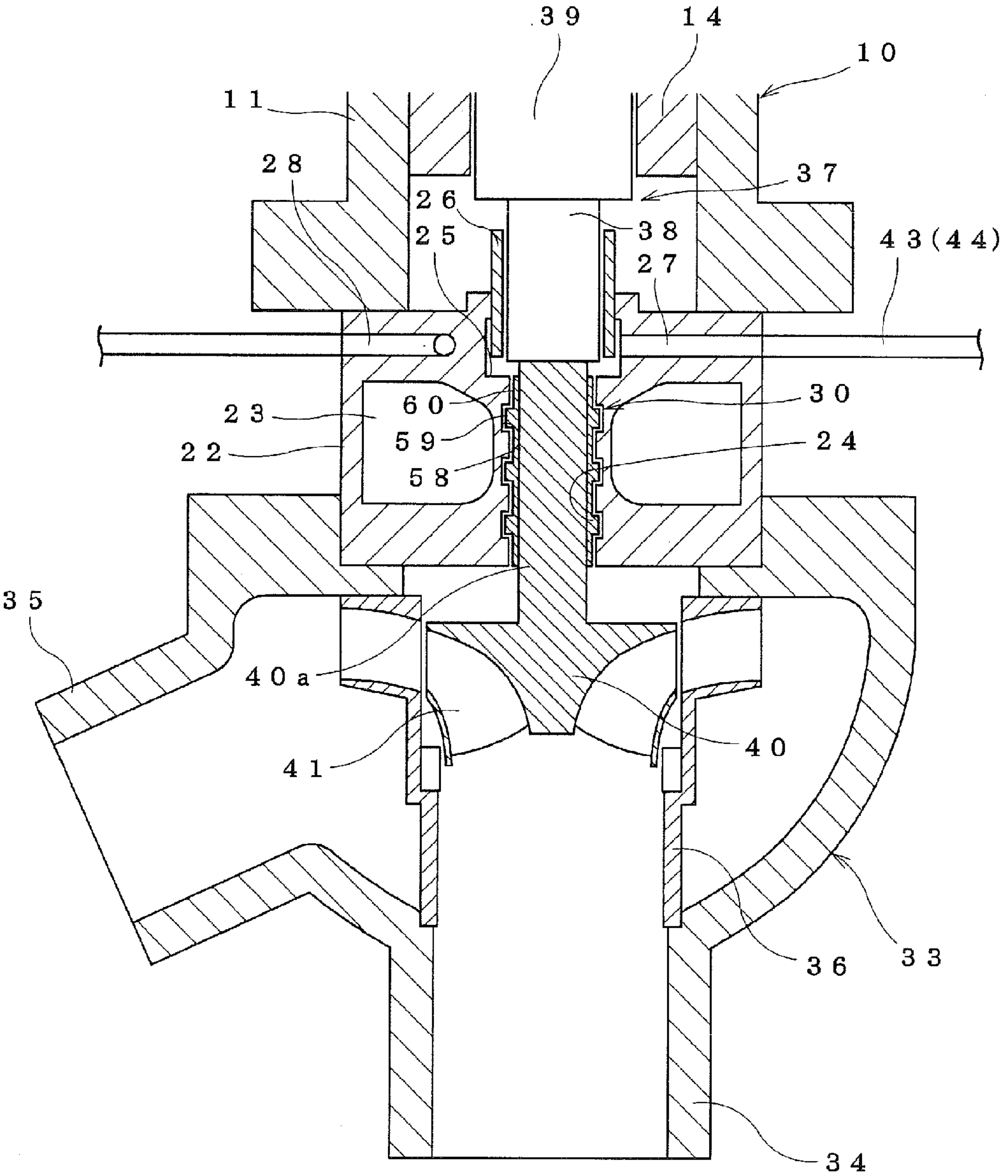
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Fig. 8

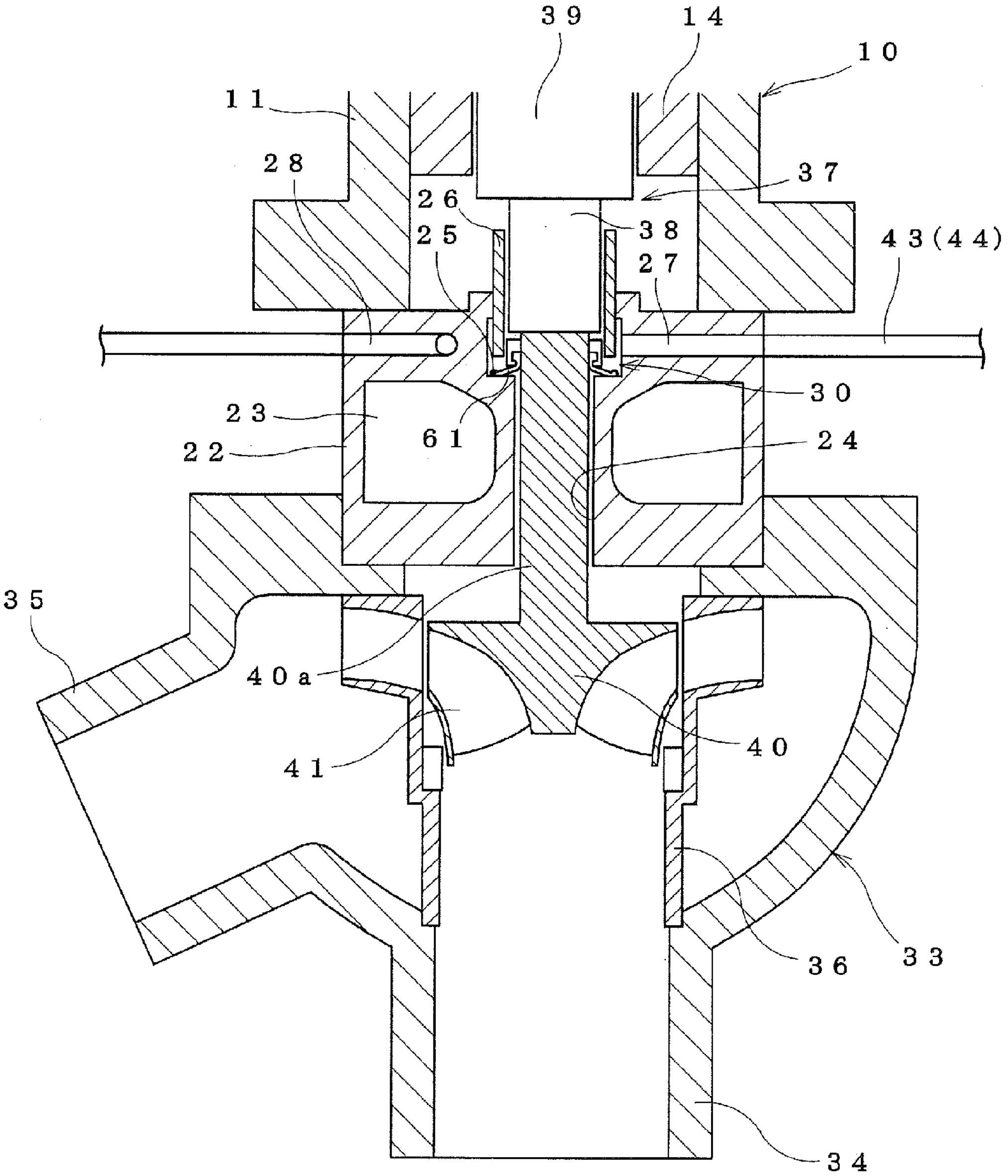

Fig. 9

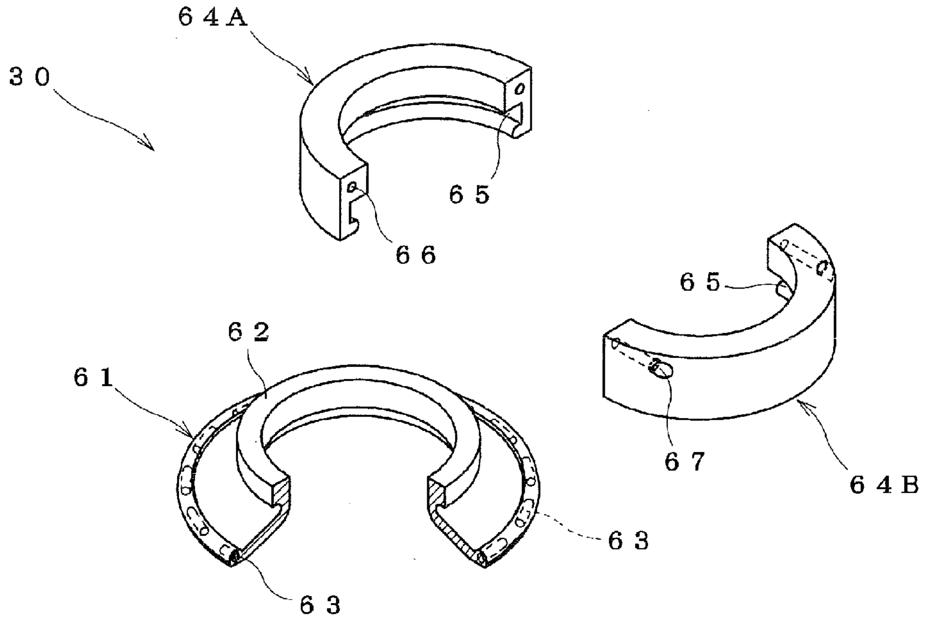
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Fig. 10

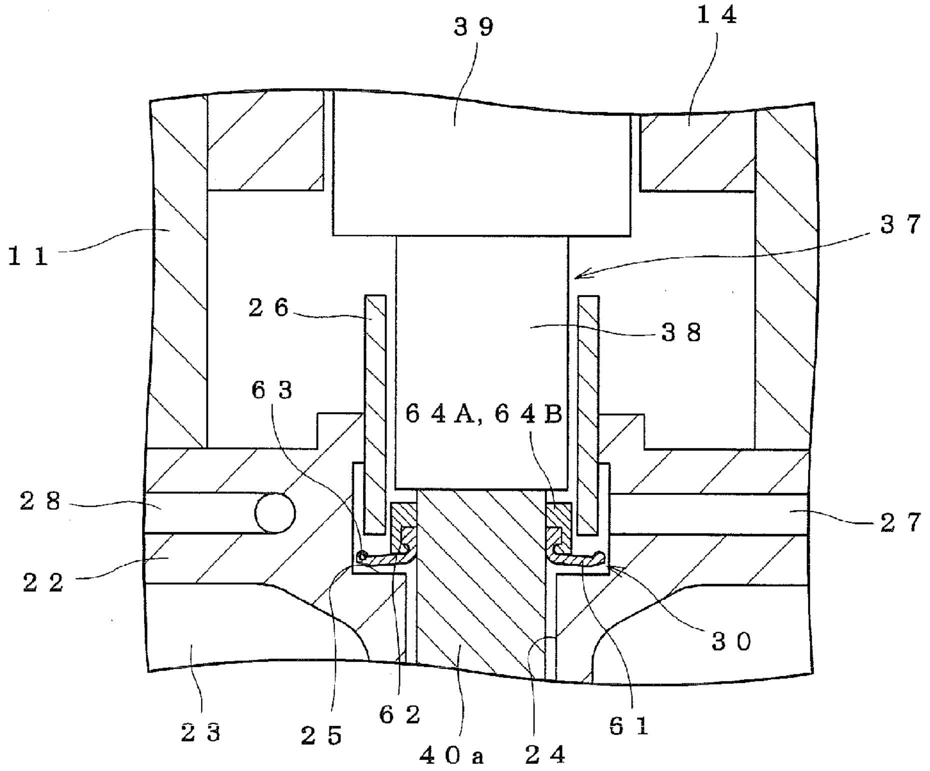
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Fig. 11

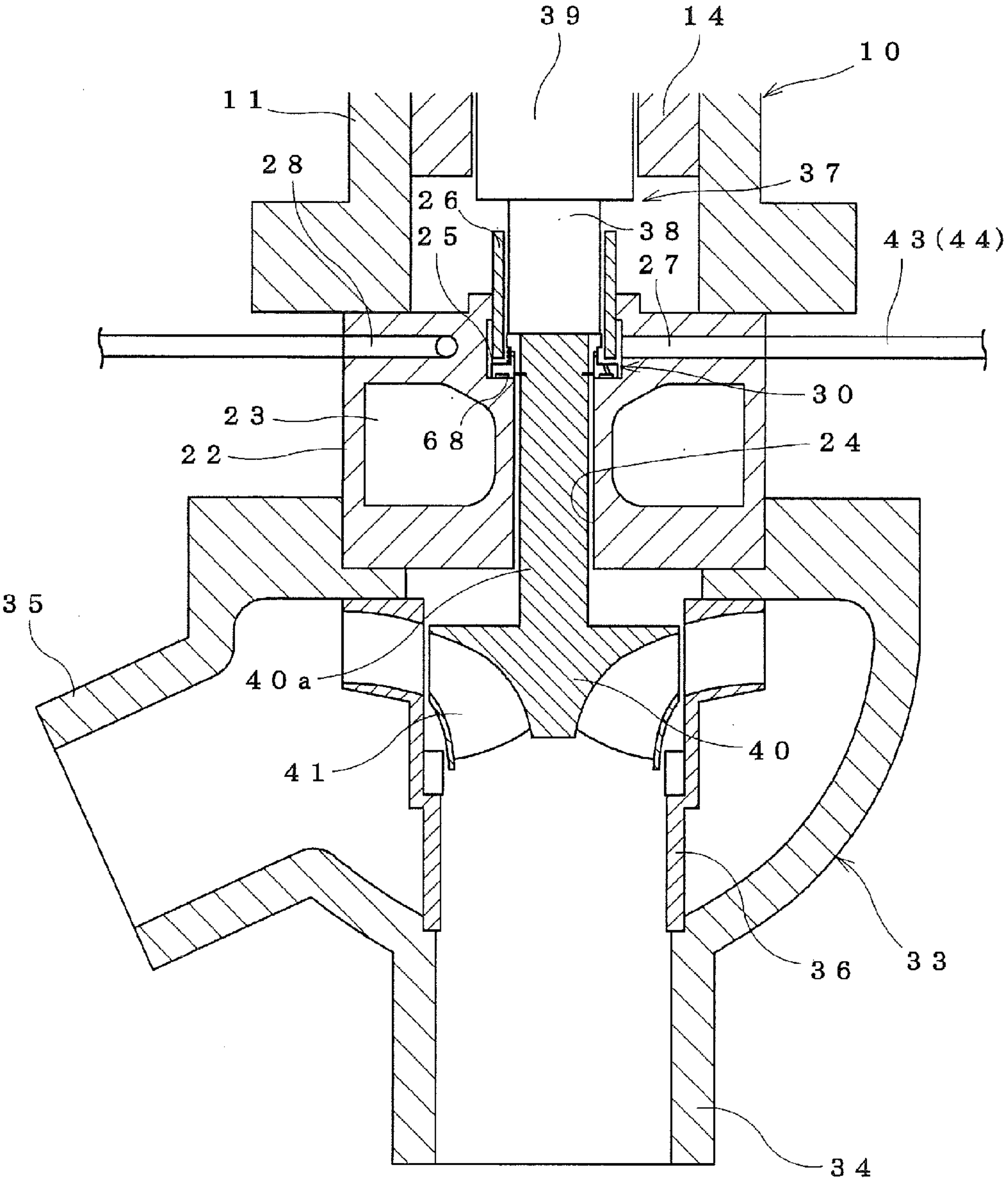
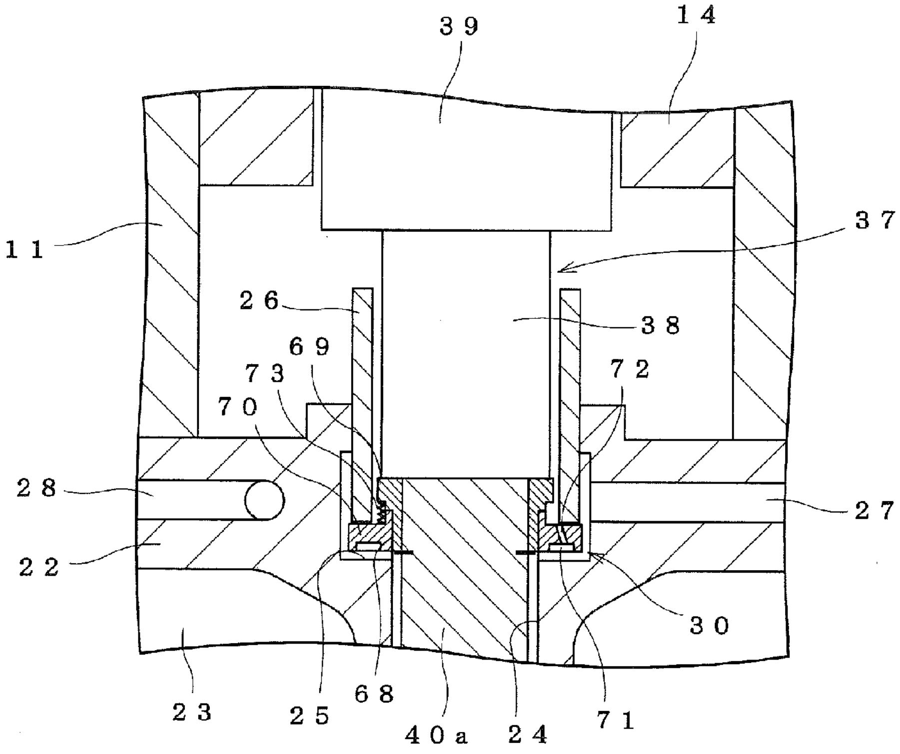


Fig. 12



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