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(54) **HOT WATER GENERATION DEVICE**

(57) To provide a hot water generator that can execute an efficient operation or an operation of maintaining user-friendly comfort by using a single pump conforming to the situation. A hot water generator (1) executes control of: an air-conditioning operation of switching the switching valve (45) to circulate water subjected to heat exchange in a water heat exchanger (11) in the air-conditioning water circuit (41); a hot-water heating operation of switching the switching valve (45) to circulate the water subjected to heat exchange in the water heat exchanger (11) in the hot-water heating circuit (42); and a combinatorial operation mode in which the air-conditioning operation continuing in first duration and the hot-water heating operation continuing in second duration are alternately repeated. Furthermore, the hot water generator (1) changes the second duration based on a load state of the air-conditioning water circuit (41) in the combinatorial operation mode.

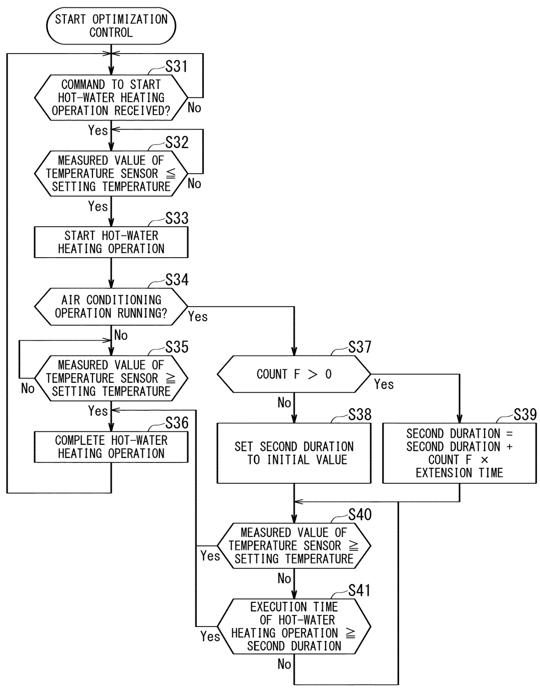

FIG. 4

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Description

TECHNICAL FIELD

[0001] Embodiments of the present invention relate to a hot water generator.

BACKGROUND

[0002] A known hot-water supply apparatus is a hot water generator that includes: a refrigeration cycle of heat pump type; an air-conditioning water circuit; and a hot-water heating circuit.

[0003] The hot water generator includes: a first circulation pump; a heat pump; a heat exchanger for a hot-water supply tank; a radiator for heating such as floor heating; a switching valve; and water piping for circulating water through these components. The switching valve switches the destination of the water discharged from the heat pump to any one of the radiator and the heat exchanger for a hot-water supply tank. The hot water generator further includes: a second circulation pump; a utilization side of the heat exchanger for a hot-water supply tank; a hot-water supply tank; and water piping for circulating water through these components.

[0004] A controller compares water temperature in the hot-water supply tank with reboil tank temperature. When the water temperature in the hot-water supply tank falls below the reboil tank temperature, the controller reboils the water in the hot-water supply tank to a target tank temperature. In addition, when change in water temperature per unit time in the hot-water supply tank is smaller than a reference value (for example, smaller than 10 degrees), the controller determines that the water temperature is decreasing due to heat loss from the hot-water supply tank, and causes the second circulation pump to operate at the maximum flow rate in such a manner that the water in the hot-water supply tank is subjected to forced convection and is uniformly boiled to the target tank temperature. Further, when the change in water temperature per unit time in the hot-water supply tank is equal to or larger than the reference value (for example, equal to or larger than 10 degrees), the controller determines that the water temperature is decreasing due to the use of the hot water in the hot-water supply tank, and causes the second circulation pump to operate at the minimum flow rate so as to maintain the temperature stratification of the water in the hot-water supply tank.

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0005] [Patent Document 1] JP 2015-224796 A

SUMMARY

PROBLEMS TO BE SOLVED BY INVENTION

[0006] In order to execute an efficient operation or an operation of maintaining user-friendly comfort conforming to the situation, the conventional hot-water supply apparatus requires a plurality of circulation pumps including the first circulation pump and the second circulation pump. The conventional hot-water supply apparatus with such a configuration hinders cost reduction and reduction in power consumption of the hot-water supply apparatus.

[0007] An object of the present invention is to provide a hot water generator that can execute an efficient operation or an operation of maintaining user-friendly comfort by using a single pump conforming to the situation.

MEANS FOR SOLVING PROBLEM

[0008] A hot water generator according to one aspect of the present invention includes a refrigeration circuit configured to circulate a refrigerant, and a hydro unit provided with a water heat exchanger configured to exchange heat between the refrigerant and first water that is a utilization-side heat medium. The hydro unit includes an air-conditioning water circuit configured to cause the first water being subjected to heat-exchange in the water heat exchanger to circulate in an external apparatus, a hot-water heating circuit configured to heat second water stored in a hot-water supply tank by causing the first water being subjected to heat-exchange in the water heat exchanger to circulate in the hot-water supply tank, a switching valve configured to switch a circulation passage of the first water to either the air-conditioning water circuit or the hot-water heating circuit, and a controller configured to control the switching valve. The controller is capable of executing an air-conditioning operation of switching the switching valve to circulate the first water in the air-conditioning water circuit, a hot-water heating operation of switching the switching valve to circulate the first water in the hot-water heating circuit, and a combinatorial operation mode in which the air-conditioning operation continuing in first duration and the hot-water heating operation continuing in second duration are alternately repeated, and changes the second duration of the hot-water heating operation based on a load state of the air-conditioning water circuit in the combinatorial operation mode.

[0009] Preferably, the controller of the hot water generator according to one aspect of the present invention extends the second duration when a load on the air-conditioning water circuit is smaller than minimum capacity of the refrigeration circuit.

[0010] Preferably, the controller of the hot water generator according to one aspect of the present invention determines that the load on the air-conditioning water circuit is smaller than the minimum capacity of the refrigeration circuit in a case of occurrence of thermo-off where a compressor of the refrigeration circuit stops in the air-conditioning operation.

[0011] Preferably, the controller of the hot water generator according to one aspect of the present invention changes the second duration in relation to whether the thermo-off occurs or not.

[0012] Preferably, the controller of the hot water generator according to one aspect of the present invention extends the second duration by a predetermined extension time when the thermo-off occurs during a predetermined first determination interval, and cancels extension of the second duration by the extension time when the thermo-off does not occur during a predetermined second determination interval.

[0013] Preferably, the controller of the hot water generator according to one aspect of the present invention extends the second duration when ambient air temperature is higher than a predetermined temperature.

EFFECTS OF INVENTION

[0014] The present invention provides a hot water generator that can execute an efficient operation or an operation of maintaining user-friendly comfort by using a single pump conforming to the situation.

BRIEF DESCRIPTION OF DRAWINGS

[0015]

Fig. 1 is a system configuration diagram of a hot water generator according to one embodiment of the present invention.

Fig. 2 is a diagram illustrating relationship between load on an air-conditioning water circuit and capacity of a refrigeration circuit according to the embodiment of the present invention.

Fig. 3 is a flowchart illustrating algorithm (i.e., calculation method) of thermo-off execution monitoring control of the hot water generator according to the embodiment of the present invention.

Fig. 4 is a flowchart illustrating algorithm (i.e., calculation method) of optimization control of the hot water generator according to the embodiment of the present invention.

Fig. 5 is a timing chart illustrating the optimization control of the hot water generator according to the embodiment of the present invention.

Fig. 6 illustrates a hydro unit of a second aspect of the hot water generator according to the embodiment of the present invention.

Fig. 7 illustrates the hydro unit of the second aspect of the hot water generator according to the embodiment of the present invention.

Fig. 8 illustrates the hydro unit of the second aspect of the hot water generator according to the embodiment of the present invention.

Fig. 9 illustrates the hydro unit of the second aspect of the hot water generator according to the embodiment of the present invention.

Fig. 10 illustrates the hydro unit of the second aspect of the hot water generator according to the embodiment of the present invention.

Fig. 11 illustrates the hydro unit of the second aspect of the hot water generator according to the embodiment of the present invention.

DETAILED DESCRIPTION

[0016] Embodiments of a hot water generator according to the present invention will be described by referring to Fig. 1 to Fig. 11. The same reference signs are given to identical or equivalent components in each figure.

[0017] Fig. 1 is a system configuration diagram of a hot water generator according to one embodiment of the present invention.

[0018] As shown in Fig. 1, the hot water generator 1 according to the present embodiment is a heat pump type. The hot water generator 1 includes: an outdoor unit 2 that is a heat source unit configured to exchange heat between outdoor air and a refrigerant; a hydro unit 3 (i.e., water heat exchanger) that exchanges heat between the refrigerant and water (i.e., first water) as a utilization-side heat medium; a remote controller 4 that is an input device configured to receive an operation by a user; and a controller 6 that controls the outdoor unit 2 and the hydro unit 3 on the basis of the operation inputted to the remote controller 4.

[0019] Main functions of the hot water generator 1 includes:

(1) a function of circulating the refrigerant between the outdoor unit 2 and the hydro unit 3 and thereby exchanging heat between the refrigerant and water as the utilization-side heat-medium in a water heat exchanger 11 in the hydro unit 3;

(2) a function of circulating hot water between the hydro unit 3 and an external apparatus 101 for air conditioning and thereby air-conditioning the room in which the external apparatus 101 is installed; and

(3) a function of circulating hot water between the hydro unit 3 and an in-tank heat exchanger 58 housed in a hot-water supply tank 13, thereby heating the water to be supplied from the external source to the hot-water supply tank 13 into hot water, and supplying it to the outside of the generator 1.

[0020] Hereinafter, the circulating water flowing through the closed circuit including the water heat exchanger 11 is referred to as the first water. The water to be stored in the hot-water supply tank 13 and finally supplied to the outside of the generator 1 is referred to as the second water.

[0021] The hot water generator 1 heats the first water, and supplies the obtained hot water at a first temperature to the external apparatus 101 for air conditioning, such as a radiator 102 of a floor heating system, i.e., floor heating panel and/or a radiator 102 of an air conditioning system, such as a fan coil unit. The first temperature is influenced by the type of the refrigerant and the capacity of the outdoor unit 2. In the case of circulating a R410A refrigerant, the first temperature reaches a maximum of about 60 degrees Celsius (°C). In the case of using a R32 refrigerant that can be at higher temperature, the first temperature can be raised to about 65 degrees Celsius (°C). The hot water at the first temperature (i.e., first water) flows through the external apparatus 101that lowers its temperature, and then is returned to the hydro unit 3.

[0022] In addition, the hot water generator 1 can also generate hot water (i.e., first water) at a second temperature (for example, around 70°C) higher than the first temperature by using heat exchange between the first water and the refrigerant through the water heat exchanger 11 as well as heating of the first water by the backup heater 12, and cause the generated hot water to pass through the inside of the hot-water supply tank 13.

[0023] The first water, which is hot water at the first temperature or the second temperature, is used for heating the second water in the hot-water supply tank 13. The second water is supplied to a destination (i.e., hot-water utilization place) such as a washroom, a kitchen, and a bathroom. City water is connected to the hot-water supply tank 13. The amount of the second water supplied to the utilization place is complemented by the city water in such a manner that the hot-water supply tank 13 is always kept full. Since the water pressure of the city water is applied to the second water in the hot-water supply tank 13, the second water comes out when a faucet at the utilization place is turned on.

[0024] In general, the outdoor unit 2 is installed outdoors and the hydro unit 3 is installed indoors. The outdoor unit 2 and the hydro unit 3 are connected to each other by using crossover pipes 17 and 18 of refrigerant piping 16 and a communication line (not shown). The hot water generator 1 does not have water pipes laid outdoors, and thus, can prevent the water in its water piping from freezing when the outdoor temperature is low in winter.

[0025] The hot water generator 1 includes a refrigeration circuit 21 of heat pump type. The heat source of the refrigeration circuit 21 is the outdoor air.

[0026] The refrigeration circuit 21 includes: a compressor 22 configured to compress and discharge the refrigerant; a four-way valve 26; an air heat exchanger 23 as an evaporator; an expansion valve 25; a water heat exchanger 11 as a condenser; a suction cup 27 provided on the suction side of the compressor 22; and the refrigerant piping 16 that connects these refrigeration cycle components in sequence to circulate the refrigerant. The refrigeration circuit 21 transfers heat from the air heat exchanger 23 to the water heat exchanger 11 by circulating the refrigerant. The refrigeration circuit 21 heats the first water into hot water by using the heat transferred to the water heat exchanger 11. Part of the refrigerant piping 16 and the water heat exchanger 11 are housed in the hydro unit 3. Excluding the part of the refrigerant piping 16 and the water heat exchanger 11, the remaining components of the refrigeration circuit 21 are housed in the outdoor unit 2.

[0027] When water is heated by the refrigeration circuit 21, the air heat exchanger 23 functions as an evaporator (also referred to as a heat absorber), and the water heat exchanger 11 functions as a condenser (also referred to as a radiator).

[0028] The compressor 22 is, for example, a rotary compressor. The compressor 22 compresses the refrigerant, pressurizes the refrigerant, and then discharges the refrigerant. The compressor 22 can change its operating frequency by known inverter control. The amount of heat to be transferred to the high temperature area increases by increasing the rotation speed of the compressor 22, and decreases by decreasing the rotation speed of the compressor 22. In this manner, the capacity of the outdoor unit 2, i.e., the heating capacity of the first water is controlled. The power consumption of the compressor 22 increases when the rotation speed of the compressor 22 is increased, and the power consumption of the compressor 22 decreases when the rotation speed of the compressor 22 is decreased.

[0029] The expansion valve 25 is, for example, an electronic expansion valve (PMV: Pulse Motor Valve) that can adjust its valve opening with fine resolution by being driven by a stepping motor.

[0030] The refrigerant piping 16 connects the compressor 22, the suction cup 27, the four-way valve 26, the air heat exchanger 23, the expansion valve 25, and the water heat exchanger 11. The refrigerant piping 16 includes: a first refrigerant pipe 16a that connects the discharge side of the compressor 22 and the four-way valve 26; a second refrigerant pipe 16b that connects the suction side of the compressor 22 and the four-way valve 26; a third refrigerant pipe 16c that connects the four-way valve 26 and the water heat exchanger 11; a fourth refrigerant pipe 16d that connects the air heat exchanger 23 and the water heat exchanger 11; and a fifth refrigerant pipe 16e that connects the air heat exchanger 23 and the four-way valve 26.

[0031] The suction cup 27 is provided in the second refrigerant pipe 16b. The expansion valve 25 is provided in the fourth refrigerant pipe 16d.

[0032] The crossover pipes 17 and 18 of the refrigerant piping 16 cause the refrigerant to flow back and forth between the outdoor unit 2 and the hydro unit 3. The crossover pipe 17 is part of the third refrigerant pipe 16c and is laid outside the outdoor unit 2 and outside the hydro unit 3. The crossover pipe 18 is part of the fourth refrigerant pipe 16d and is laid outside the outdoor unit 2 and outside the hydro unit 3. Out of the third refrigerant pipe 16c, the portion provided inside the hydro unit 3 is referred to as an intra-hydro-unit first refrigerant pipe 31. Out of the fourth refrigerant pipe 16d, the portion provided inside the hydro unit 3 is referred to as an intra-hydro-unit second refrigerant pipe 32.

[0033] The four-way valve 26 switches the flow of the refrigerant in the refrigerant piping 16. When the first water is heated in the refrigeration circuit 21, the four-way valve 26 circulates the refrigerant from the first refrigerant pipe 16a to the third refrigerant pipe 16c and circulates the refrigerant from the fifth refrigerant pipe 16e to the second refrigerant pipe 16b (i.e., refrigerant flow indicated by the solid line in Fig. 1).

[0034] The refrigeration circuit 21 discharges the compressed high-temperature and high-pressure refrigerant from the compressor 22 and sends this refrigerant to the water heat exchanger 11 via the four-way valve 26. The water heat exchanger 11 exchanges heat between the first water passing through the inside of the water heat exchanger 11 and the refrigerant passing through the inside of the water heat exchanger 11. Consequently, the first water is heated up and the refrigerant is cooled down to turn into a high-pressure liquid state. In other words, the water heat exchanger 11 functions as a radiator when heating water into hot water. The refrigerant having passed through the water heat exchanger 11 passes through the expansion valve 25, then is decompressed to become a low-pressure gas-liquid two-phase refrigerant, and then reaches the air heat exchanger 23. The air heat exchanger 23 exchanges heat between the outdoor air and the refrigerant passing through the inside of the air heat exchanger 23 so as to cool the outdoor air. At this time, the air heat exchanger 23 functions as a heat absorber that evaporates the refrigerant into a gaseous state. The refrigerant having passed through the air heat exchanger 23 is sucked into the compressor 22.

[0035] In winter, the refrigeration circuit 21 can switch the direction of the refrigerant flow in the refrigerant piping 16 by the four-way valve 26 so as to execute a defrosting operation. When executing the defrosting operation, the hot water generator 1 inverts the four-way valve 26 to generate a refrigerant flow in the refrigeration circuit 21 that is opposite to the direction of the refrigerant flow at the time of heating the water into hot water. In the case of the defrosting operation, the four-way valve 26 circulates the refrigerant from the first refrigerant pipe 16a to the fifth refrigerant pipe 16e, and circulates the refrigerant from the third refrigerant pipe 16c to the second refrigerant pipe 16b (i.e., refrigerant flow indicated by the dashed line in Fig. 1). In the case of the defrosting operation, the air heat exchanger 23 functions as a condenser and the water heat exchanger 11 functions as an evaporator. As a result, the temperature of the air heat exchanger 23 rises and the frost having adhered to its surface is melted.

[0036] In addition, the refrigeration circuit 21 for warm-temperature areas may be dedicated to heating of water without including the four-way valve 26. In this case, the discharge side of the compressor 22 is connected to the water heat exchanger 11 through the refrigerant piping 16 and the suction side of the compressor 22 is connected to the air heat exchanger 23 through the refrigerant piping 16.

[0037] In addition to the water heat exchanger 11, the hydro unit 3 further includes: an air-conditioning water circuit 41 configured to circulate the first water, which has been subjected to heat-exchange in the water heat exchanger 11, in the external apparatus 101; the hot-water supply tank 13 configured to store hot water; and a water circuit for hot-water supplying and heating, hereinafter referred to as a hot-water heating circuit, 42 configured to heat the second water in the hot-water supply tank 13 by circulating the first water, which has been subjected to heat-exchange in the water heat exchanger 11, in the hot-water supply tank 13.

[0038] The air-conditioning water circuit 41 and the hot-water heating circuit 42 share the utilization side of the water heat exchanger 11, the backup heater 12, a pump 43, and a switching valve 45. These components and water piping 46 that connects these components are referred to as a water-circuit shared-portion 48. In the water-circuit shared-portion 48, hot water circulates in one direction. The switching valve 45 is connected to the discharge side of the pump 43. The downstream side of the switching valve 45 branches into the air-conditioning water circuit 41 and the hot-water heating circuit 42. The switching valve 45 switches the circulation passage of the water, which has been subjected to heat-exchange in the water heat exchanger 11, to one of the air-conditioning water circuit 41 and the hot-water heating circuit 42. The air-conditioning water circuit 41 and the hot-water heating circuit 42 join together at the upstream side of the water heat exchanger 11. In other words, the water heat exchanger 11 is connected to the downstream side of the air-conditioning water circuit 41 and the downstream side of the hot-water heating circuit 42. The backup heater 12 is connected to the downstream side of the water heat exchanger 11, and the suction side of the pump 43 is connected to the downstream side of the backup heater 12. Note that the pump 43 may be connected the upstream side of the backup heater 12.

[0039] In the water-circuit shared-portion 48, the first water having been subjected to heat-exchange in the water heat exchanger 11 is supplied to either the air-conditioning water circuit 41 or the hot-water heating circuit 42 via the switching valve 45 by the operation of the pump 43. The first water, which has been used at the supply destination and lowered in temperature, is returned to the water heat exchanger 11 and heated again by the refrigerant that circulates through the refrigeration circuit 21. The first water having been subjected to heat-exchange in the water heat exchanger 11 is sucked into the pump 43 directly (i.e., without further heating) or after being further heated by the backup heater 12. When the backup heater 12 is driven (ON), the first water is heated to 70 degrees Celsius (°C) or higher. The backup heater 12 operates only in a hot-water heating operation when the first water is insufficiently heated in the water heat exchanger 11 by the heat pump, i.e., only when the water temperature of the first water is low.

[0040] In addition to the water-circuit shared-portion 48, the air-conditioning water circuit 41 further includes: a hot-water supply pipe 51 configured to send the first water, which has been subjected to heat-exchange in the water heat exchanger 11, to the external apparatus 101; and a hot-water return pipe 52 configured to return the first water, which has been used in the external apparatus 101 and lowered in temperature, from the external apparatus 101 to the water heat exchanger 11. The hot-water supply pipe 51 and the hot-water return pipe 52 are connected to the external apparatus 101 through external water piping 103. The air-conditioning water circuit 41, the water piping 103, and the external apparatus 101 circulate the first water that has been subjected to heat-exchange in the water heat exchanger 11.

[0041] The hot-water supply tank 13 stores the second water heated by the hot-water heating circuit 42, and discharges the second water by request from a user. The hot-water supply tank 13 is provided with a temperature sensor 55 that measures the water temperature inside the hot-water supply tank 13. The output of the temperature sensor 55 is inputted to the controller 6.

[0042] In addition to the water-circuit shared-portion 48, the hot-water heating circuit 42 further includes: a hot-water supply pipe 57 configured to send the first water, which has been subjected to heat-exchange in the water heat exchanger 11, to the hot-water supply tank 13; an in-tank heat exchanger 58 configured to exchange heat between the second water in the hot-water supply tank 13 and the water being subjected to heat-exchange in the water heat exchanger 11; and a hot-water return pipe 59 configured to return the first water, which has been used in the hot-water supply tank 13 and lowered in temperature, to the water heat exchanger 11.

[0043] To the hot-water supply tank 13, a water supply pipe 61 and a hot-water supply pipe 62 are connected. The water supply pipe 61 leads water, such as city water before heating, as the second water to the hot-water supply tank 13 from the external source. The hot-water supply pipe 62 sends the second water boiled in the hot-water supply tank 13 to the outside of the generator 1. The hot-water supply pipe 62 supplies hot water to a sink, a kitchen, and/or a bath. In the hot-water supply tank 13, the second water having flowed out through the hot-water supply pipe 62 is complemented by the city water through the water supply pipe 61. Thus, when a large amount of hot water is supplied through the hot-water supply pipe 62, the proportion of low-temperature city water increases in the hot-water supply tank 13, and the temperature of the second water decreases. Although the hot-water supply tank 13 is kept warm by a heat insulating material or the like, the temperature of the second water in the hot-water supply tank 13 decreases due to natural heat dissipation after a long period of time. Hence, the second water in the hot-water supply tank 13 is appropriately heated by the hot-water heating circuit 42.

[0044] The hot water generator 1 executes a plurality of operation modes including: an air-conditioning operation in which water being subjected to heat-exchange in the water heat exchanger 11 is circulated in the air-conditioning water circuit 41; a hot-water supplying and heating operation, hereinafter referred to as a hot-water heating operation, in which the water being subjected to heat-exchange in the water heat exchanger 11 is circulated in the hot-water heating circuit 42; and a combinational operation (hereinafter also referred to as the combinational operation mode) in which the air-conditioning operation and the hot-water heating operation are switched as appropriate. Switching of these operation modes is executed by selectively connecting the switching valve 45 on the downstream side to either the hot-water supply pipe 51 of the air-conditioning water circuit 41 or the hot-water supply pipe 57 of the hot-water heating circuit 42.

[0045] In the combinational operation mode, the air-conditioning operation continuing in first duration and the hot-water heating operation continuing in second duration are alternately repeated. The first duration of the air-conditioning operation is, for example, 20 minutes, and the initial value of the second duration of the hot-water heating operation is, for example, 30 minutes. Switching between the air-conditioning operation mode and the hot-water heating operation mode maintains the setting temperature required by the external apparatus 101, and at the same time, heats (boils) the water in the hot-water supply tank 13 up to the setting temperature and/or maintains the water in the hot-water supply tank 13 at the required setting temperature.

[0046] It is preferred that the remote controller 4 is composed of another remote controller installed on the wall surface of the room in addition to the remote controller installed in the hydro unit 3.

[0047] The remote controller 4 allows the user to command the air-conditioning operation or the hot-water heating operation. When both the air-conditioning operation and the hot-water heating operation are simultaneously commanded (simultaneous ON), the combinatorial operation mode is executed. In addition, the setting temperature of the room in which the external apparatus 101 is installed, and the setting temperature of the second water to be stored in the hot-water supply tank 13 can be inputted via the remote controller 4.

[0048] In the air-conditioning operation, the first water is supplied to the external apparatus 101 in such a manner that the temperature of the room in which the external apparatus 101 is installed reaches the setting temperature. Although illustration is omitted, the room in which the external apparatus 101 is installed is provided with a room temperature sensor for detecting the room temperature. In the hot-water heating operation, the first water is supplied to the in-tank heat exchanger 58 in such a manner that the temperature of the second water in the hot-water supply tank 13 maintains the setting temperature. In the combinational operation mode, the air-conditioning operation and the hot-water heating operation are executed simultaneously or in a time-sharing manner.

[0049] When both the air-conditioning operation and the hot-water heating operation (i.e., simultaneous ON) are set via the remote controller 4 and the temperature of the second water in the hot-water supply tank 13 falls below the setting temperature, the combinational operation mode is executed. When the temperature of the second water in the hot-water supply tank 13 is above the setting temperature, regardless of whether the simultaneous ON of the air-conditioning operation and the hot-water heating operation is set, execution of the hot-water heating operation is unnecessary and only the air-conditioning operation is executed. In the case where the air-conditioning operation is set to OFF, the hot-water heating operation is executed when the temperature of the second water in the hot-water supply tank 13 falls below the setting temperature. The operation of the compressor remains stopped as long as the temperature of the second water in the hot-water supply tank 13 is above the setting temperature.

[0050] The controller 6 includes a microprocessor (not shown) and a storage device (not shown) that stores various control programs to be executed by the microprocessor, parameters, and the like. The controller 6 executes the various control programs.

[0051] In addition, on the basis of a control signal received from the remote controller 4 and/or a sensor through a wired or wireless communication line, the controller 6 executes: operation control of each of the refrigeration circuit 21, the air-conditioning water circuit 41, and the hot-water heating circuit 42; and operation control of the hot water generator 1 including switching of the operation circuits between the air-conditioning water circuit 41 and the hot-water heating circuit 42.

[0052] Further, the controller 6 executes: control of the air-conditioning operation in which the air-conditioning operation is executed by switching the switching valve 45 to cause the water being subjected to heat-exchange in the water heat exchanger 11 to circulate in the air-conditioning water circuit 41; control of the hot-water heating operation in which the switching valve 45 is switched to cause the water being subjected to heat-exchange in the water heat exchanger 11 to circulate in the hot-water heating circuit 42 and thereby heat the water in the hot-water supply tank 13; and control of the combinatorial operation mode in which the air-conditioning operation continuing in the first duration and the hot-water heating operation continuing in the second duration are alternately repeated.

[0053] Hereinbelow, a description will be given of the relationship between the load on the air-conditioning water circuit 41 (hereinafter also referred to as "the air-conditioning load") and the capacity of the refrigeration circuit 21.

[0054] Fig. 2 is a diagram illustrating the relationship between the load on the air-conditioning water circuit 41 and the capacity of the refrigeration circuit 21 according to the embodiment of the present invention. The load on the air-conditioning water circuit 41 means the air-conditioning load for heating the room (i.e., raising the temperature of the room) by the external apparatus 101. In the case of the present embodiment, the load on the air-conditioning water circuit 41 is the air-conditioning load of the room in which the radiator 102 of the floor heating system and the radiator 102 of the air conditioning system are installed.

[0055] In Fig. 2, the broken line A indicates the relationship between the load on the air-conditioning water circuit 41 and the ambient air temperature, and the solid line B indicates the relationship between the capacity of the refrigeration circuit 21 and the ambient air temperature.

[0056] As shown by the broken line A in Fig. 2, the load on the air-conditioning water circuit 41 correlates with the ambient air temperature. The higher the ambient air temperature becomes, the smaller the heating capacity required for the room becomes, so the load on the air-conditioning water circuit 41 is reduced.

[0057] As shown by the solid line B in Fig. 2, the capacity of the refrigeration circuit 21 is balanced with the air-conditioning load when the ambient air temperature is in the range between a first ambient air temperature t1 and a second ambient air temperature t2 (line segment B2). Note that the first ambient air temperature t1 is lower than the second ambient air temperature t2. Within this range, the hot water generator 1 varies the capacity of the refrigeration circuit 21 by performing inverter control on the operating frequency of the compressor 22 so as to balance the air-conditioning load and the capacity of the refrigeration circuit 21. The operating frequency of the compressor 22 reaches its maximum value when the ambient air temperature is the first ambient air temperature t1, and this point is defined as the maximum capacity balance point Cmax. The operating frequency of compressor 22 reaches its minimum value when the ambient air temperature is the second ambient air temperature t2, and this point is defined as the minimum capacity balance point Cmin.

[0058] When the ambient air temperature is equal to or lower than the first ambient air temperature t1, i.e., on the lower temperature side (segment B1) than the maximum capacity balance point Cmax in Fig. 2, the capacity of the refrigeration circuit 21 is insufficient for the air-conditioning load and thus cannot reach the setting temperature required by the external apparatus 101. Thus, the compressor 22 runs continuously without stopping. However, normally, the capacity of the refrigeration circuit 21 is set to be larger than the air-conditioning load at the lowest ambient air temperature in the usage range. Hence, it is not operated on the side of the line segment Bl.

[0059] When the ambient air temperature is equal to or higher than the second ambient air temperature t2, i.e., on the higher temperature side (line segment B3) than the minimum capacity balance point Cmin in Fig. 2, the capacity of the refrigeration circuit 21 exceeds the air-conditioning load and thus may exceed the setting temperature required by the external apparatus 101. For this reason, when the temperature in the room where the external apparatus 101 is installed exceeds the setting temperature as a result of the air-conditioning operation, the compressor 22 is temporarily stopped such that the excess of the setting temperature required by the external apparatus 101 is prevented. Such a temporary suspension of the compressor 22 is referred to as thermo-off.

[0060] When the ambient air temperature is in the range from the first ambient air temperature t1 to the second ambient air temperature t2 and the combinatorial operation mode is executed, the controller 6 alternately repeats the air-conditioning operation and the hot-water heating operation while maintaining the respective setting values of the first duration and the second duration without changing, and thereby sends the required amount of heat to the external apparatus 101 so as to boil the water in the hot-water supply tank 13.

[0061] When the ambient air temperature is equal to or higher than the second ambient air temperature t2, the capacity of the refrigeration circuit 21 becomes redundant. Thus, when the ambient air temperature is equal to or higher than the second ambient air temperature t2 and the combinatorial operation mode is executed, the thermo-off occurs in the first duration of the air-conditioning operation, and the compressor 22 operates intermittently. In other words, under the condition where the ambient air temperature is equal to or higher than the second ambient air temperature t2, when the air-conditioning operation and the hot-water heating operation are alternately repeated without changing the first duration and the second duration, the time required for the hot water in the hot-water supply tank 13 to reach the setting temperature is unnecessarily delayed.

[0062] For this reason, the controller 6 of the hot water generator 1 according to the present embodiment changes the second duration of the hot-water heating operation on the basis of the state of the air-conditioning load in the combinational operation mode. This control is referred to as (hot-water supply capacity) optimization control.

[0063] In order to execute the optimization control, the controller 6 monitors whether the thermo-off occurs in the air-conditioning operation or not. This control is referred to as thermo-off execution monitoring control.

[0064] As shown in Fig. 3, in the thermo-off execution monitoring control of the hot water generator 1 according to the present embodiment, occurrence/non-occurrence of the thermo-off is monitored at a predetermined first determination interval (for example, every 20 minutes) during the air-conditioning operation. When the thermo-off occurs during the first determination interval, 1 is added (as so-called increment) to a value of count F for counting the number of thermo-off occurrence. Also in the thermo-off execution monitoring control, when the thermo-off does not occur during a predetermined second determination interval (for example, 30 minutes), 1 is subtracted (as so-called decrement) from the value of the count F. The thermo-off execution monitoring control is executed in the air-conditioning operation and in the combinational operation mode.

[0065] Specifically, the controller 6 monitors whether the remote controller 4 receives a command to start the air-conditioning operation or not (No in the step S1). Each step is executed by the controller 6. If the remote controller 4 receives the command to start the air-conditioning operation mode (Yes in the step S1), in the step S2, the controller 6 starts both: clocking of the first determination interval by the first timer; and clocking of the second determination interval by the second timer.

[0066] In the next step S3, the controller 6 monitors occurrence/non-occurrence of the thermo-off due to increase in room temperature up to or above the setting temperature attributable to the air-conditioning operation by the external apparatus 101. If the first determination interval elapsed based on the first timer (Yes in the step S4), in the next step S5, the controller 6 initializes the first timer to zero and restarts the clocking by the first time.

[0067] In the next step S6, the controller 6 checks whether the thermo-off has occurred during the previous (i.e., immediately preceding) clocking by the first timer or not.

[0068] If the thermo-off has occurred during the previous clocking by the first timer (Yes in the step S6), in the step S7, the controller 6 adds 1 to the value of the count F. It is preferred that an upper limit value is set for this count F. For example, the upper limit value of the count F is set to 8 in the steps S8 and S9. If a command to stop the air-conditioning operation mode is not received in the thermo-off execution monitoring control (Yes in the step S10), it returns to the step S3 and the processing is repeated.

[0069] If the thermo-off has not occurred during the previous clocking by the first timer, the controller 6 maintains the value of the count F (No in the step S6). If the controller 6 has not received the command to stop the air-conditioning operation (Yes in the step S10), it returns to the step S3 and the processing is repeated.

[0070] If the second timer reaches the second determination interval (No in the step S4, Yes in the step S11), in the step S12, the controller 6 initializes the second timer to zero and restarts the clocking by the second timer.

[0071] In the next step S13, the controller 6 checks whether the thermo-off has occurred during the previous clocking by the second timer or not.

[0072] If the thermo-off has occurred during the previous clocking by the first timer, the value of the count F is maintained (Yes in the step S13). If the command to stop the air-conditioning operation has not been received (Yes in the step S10), it returns to the step S3 and the processing is repeated.

[0073] If the thermo-off has not occurred during the previous clocking by the second timer (No in the step S13), in the next step S14, 1 is subtracted from the value of the count F. It is preferred that a lower limit value is set for the count F. For example, the lower limit value of the count F is set to 0 in the steps S15 and S16. If the command to stop the air-conditioning operation is not received in the thermo-off execution monitoring control (Yes in the step S10), it returns to the step S3 and the processing is repeated.

[0074] As shown in Fig. 4, the controller 6 of the hot water generator 1 according to the present embodiment extends the second duration when the air-conditioning load is smaller than the minimum capacity of the refrigeration circuit 21. In the case of occurrence of the thermo-off in which the compressor 22 of the refrigeration circuit 21 stops during the air-conditioning operation, the controller 6 determines the air-conditioning load to be smaller than the minimum capacity of the refrigeration circuit 21.

[0075] The controller 6 changes the second duration in correlation with occurrence/non-occurrence of the thermo-off. In other words, if the thermo-off occurs during the predetermined first determination interval, the controller 6 extends the second duration by a predetermined extension time. If the thermo-off does not occur during the predetermined second determination interval, the controller 6 cancels the extension of the second duration by the extension time.

[0076] Specifically, the controller 6 monitors whether the remote controller 4 has received a command to start the hot-water heating operation or not (No in the step S31). If the remote controller 4 has received the command to start the hot-water heating operation (Yes in the step S31), the controller 6 monitors whether the measured value of the temperature sensor 55 of the hot-water supply tank 13 is equal to or lower than the setting temperature or not (No in the step S32).

[0077] If the measured value of the temperature sensor 55 of the hot-water supply tank 13 is equal to or lower than the setting temperature (Yes in the step S32), in the next step S33, the controller 6 starts the hot-water heating operation. At this time, clocking of the execution time of the hot-water heating operation is started.

[0078] In the next step S34, the controller 6 determines whether the air-conditioning operation is being executed simultaneously with the hot-water heating operation or not.

[0079] If the air-conditioning operation is not being executed (No in the step S34), in the next step S35, the controller 6 monitors whether the measured value of the temperature sensor 55 has reached the setting temperature or not. If the measured value of the temperature sensor 55 reaches the setting temperature (Yes in the step S35), in the next step S36, the hot-water heating operation is completed, and the processing returns to the step S32.

[0080] If the air-conditioning operation is being executed (No in the step S34), in the next step S37, the controller 6 determines whether the count F as incremented/decremented in the thermo-off execution monitoring control is larger than 0 or not.

[0081] If the count F is 0 (No in the step S37), in the next step S38, the controller 6 sets the second duration to an initial value, for example, 30 minutes.

[0082] If the count F is larger than 0 (Yes in the step S37), the controller 6 extends the second duration for continuing the hot-water heating operation. In the step S39, the product of a predetermined extension time (for example, 5 minutes) and the value of the count F is added to the second duration. If the count F is 0, the extension of the second duration is canceled and the second duration returns to its initial value.

[0083] Next, in the step S40, the controller 6 monitors whether the measured value of the temperature sensor 55 has reached the setting temperature in the second duration set in the step S38 or extended in the step S39 (No in the step S41) .

[0084] If the second duration set in the step S38 or the second duration extended in the step S39 elapses (Yes in the step S41) or if the measured value of the temperature sensor 55 reaches the setting temperature (Yes in the step S40), the controller 6 completes the hot-water heating operation in the step S36, and the processing returns to the step S32.

[0085] In Fig. 5, in the combinatorial operation mode, the first duration for continuing the air-conditioning operation is 20 minutes, the initial value of the second duration for continuing the hot-water heating operation is 30 minutes, and the extension time is 5 minutes (C in Fig. 5).

[0086] In the interval A shown in Fig. 5, the air-conditioning load is small, the count F (x in Fig. 5) is 0, and the controller 6 alternately repeats the air-conditioning operation for 20 minutes (α in Fig. 5) and the hot-water heating operation for 30 minutes (β in Fig. 5).

[0087] In the interval B shown in Fig. 5, it is assumed that one or more thermo-off does not occur during the air-conditioning operation. Under this assumption, the count F is incremented by 1 every first determination interval, for example, every 20 minutes. The controller 6 extends the second duration each time the air-conditioning operation for 20 minutes is switched to the hot-water heating operation, and alternately repeats the air-conditioning operation and the hot-water heating operation.

[0088] In the interval C shown in Fig. 5, it is assumed that the thermo-off does not occur during the air-conditioning operation. Under this assumption, the count F is decremented by 1 every second determination interval, for example, every 30 minutes. The controller 6 shortens the second duration each time the air-conditioning operation for 20 minutes is switched to the hot-water heating operation, and alternately repeats the air-conditioning operation and the hot-water heating operation.

[0089] Since the thermo-off execution monitoring control and the optimization control are executed asynchronously, the second duration does not necessarily change by one unit of the extension time (5 minutes) and may change by a plurality of units, for example, 2 units of the extension time (i.e., total of 10 minutes).

[0090] Regardless of the count F, when the ambient air temperature is higher than a predetermined temperature at which the air-conditioning load is presumed to be smaller than the minimum capacity of the refrigeration circuit 21, the controller 6 may extend the second duration. In this case, it is preferred that the hot water generator 1 includes a temperature sensor configured to measure the ambient air temperature. The optimization control based on the ambient air temperature is suitable in the case of the hot water generator 1 provided with the compressor 22 that cannot change its operating frequency, for example.

[0091] As described above, the hot water generator 1 according to the present embodiment changes the second duration on the basis of the state of the air-conditioning load in the control of the combinational operation mode. Thus, the hot water generator 1 can allocate the surplus capacity of the refrigeration circuit 21 in the air-conditioning operation to the hot-water heating operation. For example, when the air-conditioning load is small, the hot water generator 1 can devote more time to the hot-water heating operation. Such operation control of the hot water generator 1 allows the hot water generator 1 to execute an efficient operation or an operation maintaining user-friendly comfort conforming to the situation, as compared with the operation control of the conventional hot-water supply apparatus provided with a plurality of pumps.

[0092] In addition, the hot water generator 1 according to the present embodiment extends the second duration when the air-conditioning load is smaller than the minimum capacity of the refrigeration circuit 21 in the combinational operation mode. Thus, the hot water generator 1 can reliably allocate the surplus capacity of the refrigeration circuit 21 in the air-conditioning operation to the hot-water heating operation. Consequently, the hot water generator 1 can bring the temperature of the second water in the hot-water supply tank 13 up to the setting temperature quickly.

[0093] Further, when the thermo-off occurs during the air-conditioning operation, the hot water generator 1 according to the present embodiment determines the air-conditioning load to be smaller than the minimum capacity of the refrigeration circuit 21. Hence, the hot water generator 1 can accurately determine whether the refrigeration circuit 21 has the surplus capacity in the air-conditioning operation or not.

[0094] Moreover, the hot water generator 1 according to the present embodiment changes the second duration in correlation with occurrence/non-occurrence of the thermo-off. Thus, the hot water generator 1 can reliably allocate the surplus capacity of the refrigeration circuit 21 in the air-conditioning operation to the hot-water heating operation.

[0095] Furthermore, the hot water generator 1 according to the present embodiment extends the second duration by the predetermined extension time when the thermo-off occurs during the predetermined first determination interval, and cancels the extension of the second duration by the predetermined extension time when the thermo-off does not occur during the predetermined second determination interval. Hence, the hot water generator 1 can timely reflect the surplus capacity of the refrigeration circuit 21 in the air-conditioning operation.

[0096] In addition, the hot water generator 1 according to the present embodiment may extend the second duration when the ambient air temperature is higher than a predetermined temperature. Such a hot water generator 1 executes an efficient operation or an operation maintaining user-friendly comfort conforming to the situation even in the case of being provided with a compressor 22 that cannot change its operating frequency.

[0097] Next, other aspects of the hot water generator 1 according to the present embodiment will be described. In a hot water generator 1A and a hot water generator 1B described in the respective aspects, the same components as those of the hot water generator 1 are denoted by the same reference signs, and duplicate description is omitted.

[0098] As shown in Fig. 6 to Fig. 8, the hot water generator 1A of the second aspect according to the present embodiment includes a hydro unit 3A.

[0099] The hydro unit 3A includes a second switching valve 65A that bypasses the air-conditioning water circuit 41 and the hot-water heating circuit 42.

[0100] The second switching valve 65A selectively connects the hot-water return pipe 52 of the air-conditioning water circuit 41 to either the water heat exchanger 11 or the hot-water supply pipe 57 of the hot-water heating circuit 42. The side of the water heat exchanger 11 in the second switching valve 65A merges with the hot-water return pipe 59 of the hot-water heating circuit 42.

[0101] As to the switching valve 45 and the second switching valve 65A, the routes allowing water flow are indicated in white, and the routes blocking water flow are indicated in black.

[0102] As shown in Fig. 6, when: the discharge side of the pump 43 is switched to the air-conditioning water circuit 41 by the switching valve 45; and the second switching valve 65A is connected on the downstream side to the hot-water supply pipe 57 of the hot-water heating circuit 42, the first water used in the air-conditioning water circuit 41 is reused for heating the second water in the hot-water supply tank 13 or keeping this second water warm. In other words, the hot water generator 1A can simultaneously execute both the air-conditioning operation and the hot-water heating operation while prioritizing the air-conditioning operation. The hot water generator 1A can prevent temperature drop of the external apparatus 101, which may occur in the hot-water heating operation.

[0103] In addition, as shown in Fig. 7, when: the discharge side of the pump 43 is switched to the air-conditioning water circuit 41 by the switching valve 45; and the second switching valve 65A is connected on the downstream side to the water heat exchanger 11, the air-conditioning water circuit 41 can circulate the first water independently. In other words, the hot water generator 1A can execute the air-conditioning operation mode alone.

[0104] Further, as shown in Fig. 8, when: the discharge side of the pump 43 is switched to the hot-water heating circuit 42 by the switching valve 45; and the second switching valve 65A is connected on the downstream side to the water heat exchanger 11, the hot-water heating circuit 42 can circulate the first water independently. In other words, the hot water generator 1A can execute the hot-water heating operation mode alone. Although the second switching valve 65A connects the hot-water return pipe 52 and the water heat exchanger 11, the side of the air-conditioning water circuit 41 of the switching valve 45 is closed, and thus, circulation of the first water in the air-conditioning water circuit 41 is prevented.

[0105] As shown in Fig. 9 to Fig. 11, the hot water generator 1B of the third aspect according to the present embodiment includes a hydro unit 3B.

[0106] The hydro unit 3B includes a second switching valve 65B that bypasses the air-conditioning water circuit 41 and the hot-water heating circuit 42.

[0107] The second switching valve 65B selectively connects the hot-water return pipe 59 of the hot-water heating circuit 42 to either the water heat exchanger 11 or the hot-water supply pipe 51 of the air-conditioning water circuit 41. The side of the water heat exchanger 11 of the second switching valve 65B merges with the hot-water return pipe 52 of the air-conditioning water circuit 41.

[0108] As to the switching valve 45 and the second switching valve 65B, the routes allowing water flow are indicated in white, and the routes blocking water flow are indicated in black.

[0109] As shown in Fig. 9, when: the discharge side of the pump 43 is switched to the hot-water heating circuit 42 by the switching valve 45; and the second switching valve 65B is connected on the downstream side to the hot-water supply pipe 51 of the air-conditioning water circuit 41, the water used in the hot-water heating circuit 42 is reused in the external apparatus 101. In other words, the hot water generator 1B can simultaneously execute the air-conditioning operation and the hot-water heating operation while prioritizing the hot-water heating operation. The hot water generator 1B can circulate water from the hot-water heating circuit 42 with a higher setting temperature in general to the air-conditioning water circuit 41 with a lower setting temperature, and can simultaneously execute the air-conditioning operation and the hot-water heating operation even when the setting temperature of the external apparatus 101 is lower than boiling setting temperature.

[0110] In addition, as shown in Fig. 10, when: the discharge side of the pump 43 is switched to the hot-water heating circuit 42 by the switching valve 45; and the second switching valve 65B is connected on the downstream side to the water heat exchanger 11, the hot-water heating circuit 42 can circulate the water independently. In other words, the hot water generator 1B can execute the hot-water heating operation alone.

[0111] Further, as shown in Fig. 11, when: the discharge side of the pump 43 is switched to the air-conditioning water circuit 41 by the switching valve 45; and the second switching valve 65B is connected on the downstream side to the hot-water supply pipe 51 of the air-conditioning water circuit 41, the air-conditioning water circuit 41 can circulate the water independently. In other words, the hot water generator 1B can execute the air-conditioning operation alone. Although the second switching valve 65B connects the hot-water return pipe 59 and the hot-water supply pipe 51, the side of the hot-water heating circuit 42 of the switching valve 45 is closed, and thus, water circulation in the hot-water heating circuit 42 is prevented.

[0112] As described above, according to the hot water generator 1 of the present embodiment, an efficient operation or an operation of maintaining user-friendly comfort can be executed conforming to the situation without using a plurality of pumps.

[0113] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

REFERENCE SIGNS LIST

[0114]

1, 1A, 1B	hot water generator
2	outdoor unit
3, 3A, 3B	hydro unit
4	remote controller
6	controller
11	water heat exchanger
12	backup heater
13	hot-water supply tank
21	refrigeration circuit
22	compressor
23	air heat exchanger
41	air-conditioning water circuit
42	hot-water heating circuit
43	pump
45	switching valve
48	water-circuit shared-portion
58	in-tank heat exchanger
65A, 65B	second switching valve
101	external apparatus

Claims

1. A hot water generator comprising:

    a refrigeration circuit configured to circulate a refrigerant; and
    a hydro unit provided with a water heat exchanger configured to exchange heat between the refrigerant and first water that is a utilization-side heat medium,
    wherein the hydro unit includes:

        an air-conditioning water circuit configured to cause the first water being subjected to heat-exchange in the water heat exchanger to circulate in an external apparatus;
        a hot-water heating circuit configured to heat second water stored in a hot-water supply tank by causing the first water being subjected to heat-exchange in the water heat exchanger to circulate in the hot-water supply tank;
        a switching valve configured to switch a circulation passage of the first water to either the air-conditioning water circuit or the hot-water heating circuit; and
        a controller configured to control the switching valve,

    wherein the controller is capable of executing:

        an air-conditioning operation of switching the switching valve to circulate the first water in the air-conditioning water circuit;
        a hot-water heating operation of switching the switching valve to circulate the first water in the hot-water heating circuit; and
        a combinatorial operation mode in which the air-conditioning operation continuing in first duration and the hot-water heating operation continuing in second duration are alternately repeated,

    wherein the controller is configured to change the second duration based on a load state of the air-conditioning water circuit in the combinatorial operation mode.

2. The hot water generator according to claim 1, wherein, in a case of occurrence of thermo-off where a compressor of the refrigeration circuit stops in the air-conditioning operation, the controller determines a load on the air-conditioning water circuit to be smaller than minimum capacity of the refrigeration circuit and extends the second duration.

3. The hot water generator according to claim 2, wherein the controller is configured to:

    extend the second duration by a predetermined extension time when the thermo-off occurs during a predetermined first determination interval; and
    cancel extension of the second duration by the extension time when the thermo-off does not occur during a predetermined second determination interval.

4. The hot water generator according to any one of claim 1 to claim 3, wherein the controller is configured to extend the second duration when ambient air temperature is higher than a predetermined temperature.

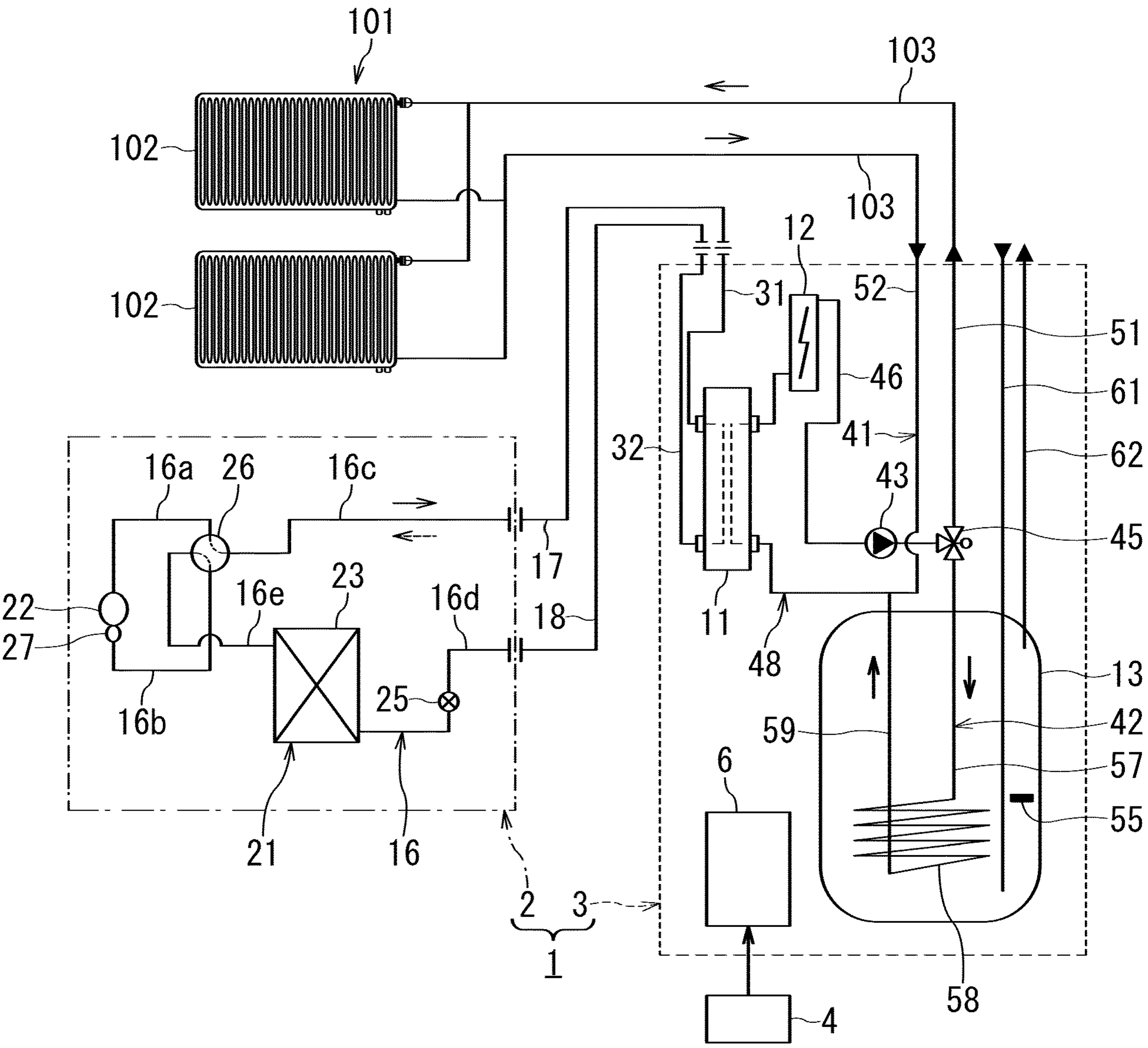
101
102
102
103
103
12
52
31
51
46
61
32
41
43
62
45
16a
26
16c
17
22
16e
23
16d
27
18
11
48
13
25
42
59
57
6
55
16b
21
16
2
3
1
58
4

FIG. 1

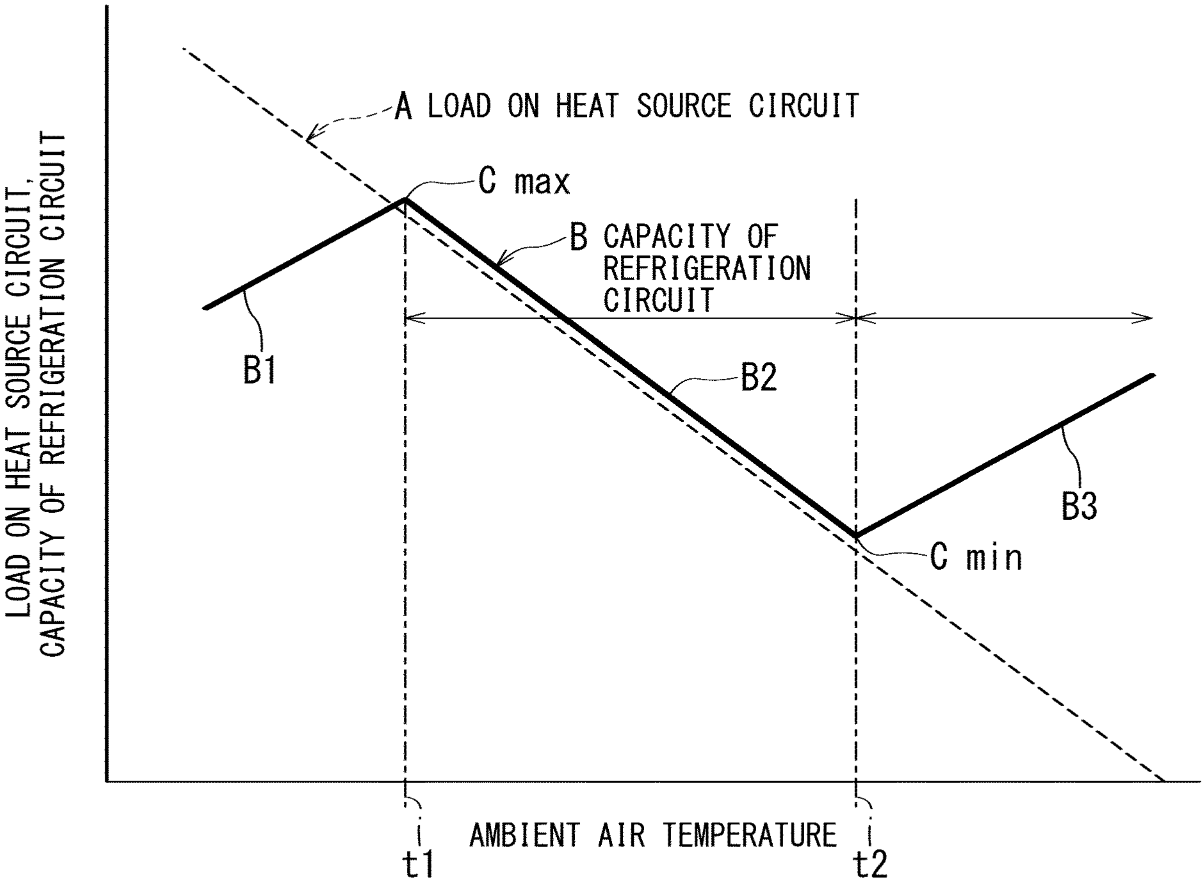
A LOAD ON HEAT SOURCE CIRCUIT
C max
B CAPACITY OF REFRIGERATION CIRCUIT
B1
B2
B3
C min
LOAD ON HEAT SOURCE CIRCUIT, CAPACITY OF REFRIGERATION CIRCUIT
AMBIENT AIR TEMPERATURE
t1
t2

FIG. 2

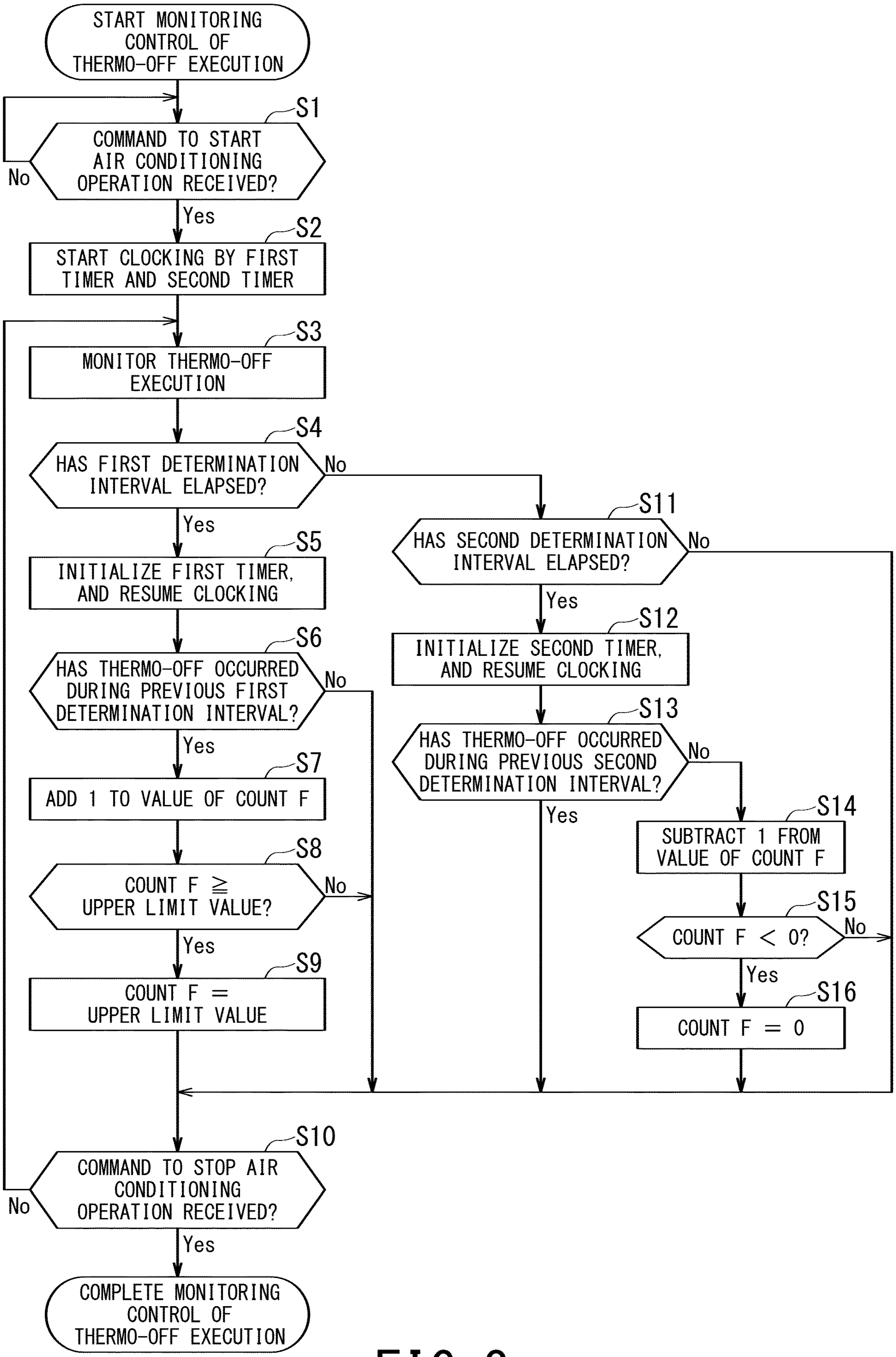
START MONITORING CONTROL OF THERMO-OFF EXECUTION
S1
COMMAND TO START AIR CONDITIONING OPERATION RECEIVED?
No
Yes
S2
START CLOCKING BY FIRST TIMER AND SECOND TIMER
S3
MONITOR THERMO-OFF EXECUTION
S4
HAS FIRST DETERMINATION INTERVAL ELAPSED?
No
Yes
S5
INITIALIZE FIRST TIMER, AND RESUME CLOCKING
S6
HAS THERMO-OFF OCCURRED DURING PREVIOUS FIRST DETERMINATION INTERVAL?
No
Yes
S7
ADD 1 TO VALUE OF COUNT F
S8
COUNT F ≧ UPPER LIMIT VALUE?
No
Yes
S9
COUNT F = UPPER LIMIT VALUE
S11
HAS SECOND DETERMINATION INTERVAL ELAPSED?
No
Yes
S12
INITIALIZE SECOND TIMER, AND RESUME CLOCKING
S13
HAS THERMO-OFF OCCURRED DURING PREVIOUS SECOND DETERMINATION INTERVAL?
No
Yes
S14
SUBTRACT 1 FROM VALUE OF COUNT F
S15
COUNT F < 0?
No
Yes
S16
COUNT F = 0
S10
COMMAND TO STOP AIR CONDITIONING OPERATION RECEIVED?
No
Yes
COMPLETE MONITORING CONTROL OF THERMO-OFF EXECUTION

FIG. 3

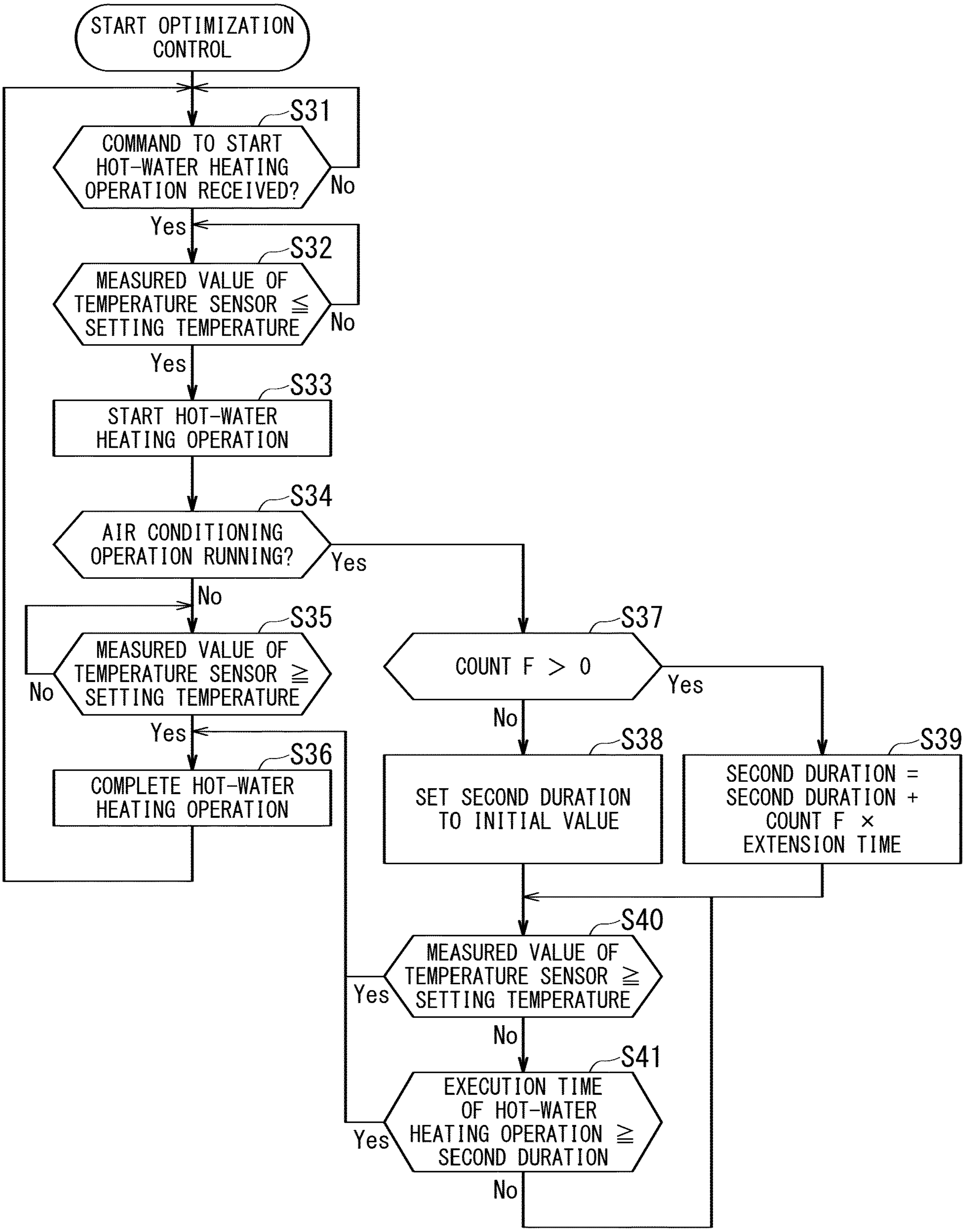
START OPTIMIZATION CONTROL
S31
COMMAND TO START HOT-WATER HEATING OPERATION RECEIVED?
No
Yes
S32
MEASURED VALUE OF TEMPERATURE SENSOR ≦ SETTING TEMPERATURE
No
Yes
S33
START HOT-WATER HEATING OPERATION
S34
AIR CONDITIONING OPERATION RUNNING?
Yes
No
S35
MEASURED VALUE OF TEMPERATURE SENSOR ≧ SETTING TEMPERATURE
No
Yes
S36
COMPLETE HOT-WATER HEATING OPERATION
S37
COUNT F > 0
Yes
No
S38
SET SECOND DURATION TO INITIAL VALUE
S39
SECOND DURATION = SECOND DURATION + COUNT F × EXTENSION TIME
S40
MEASURED VALUE OF TEMPERATURE SENSOR ≧ SETTING TEMPERATURE
Yes
No
S41
EXECUTION TIME OF HOT-WATER HEATING OPERATION ≧ SECOND DURATION
Yes
No

FIG. 4

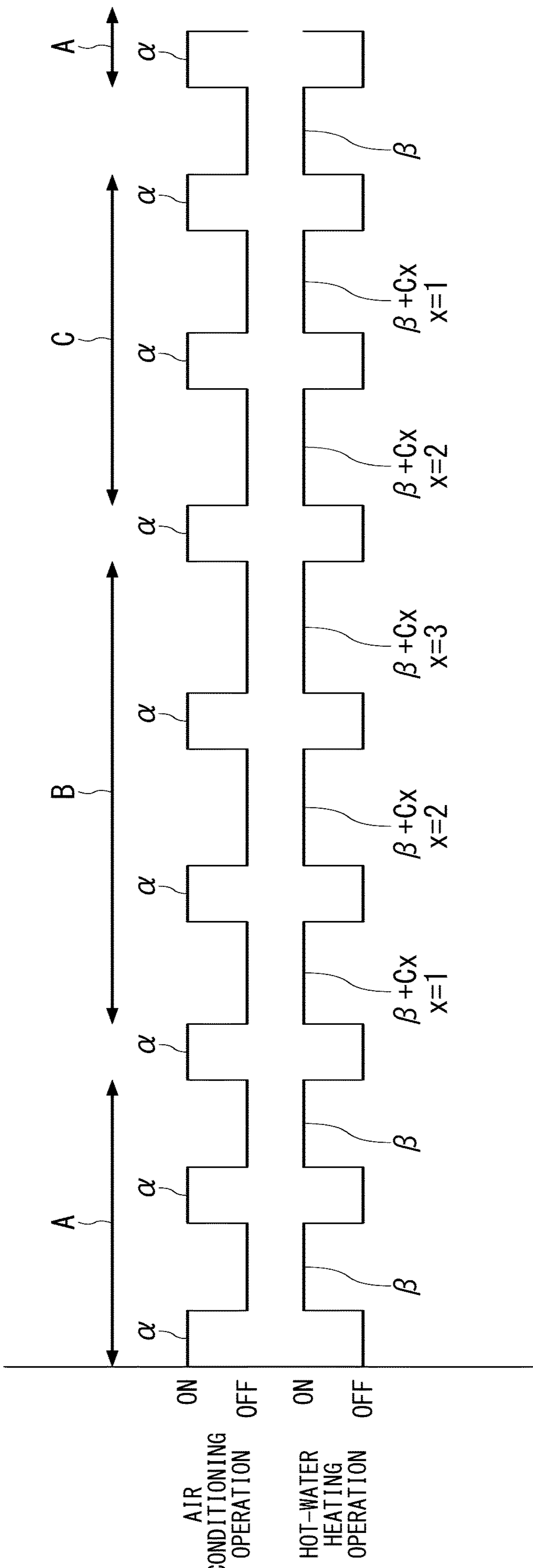
AIR CONDITIONING OPERATION
HOT-WATER HEATING OPERATION
ON
OFF
ON
OFF
A
B
C
A
α
β
β +Cx x=1
β +Cx x=2
β +Cx x=3
β +Cx x=2
β +Cx x=1
β

FIG. 5

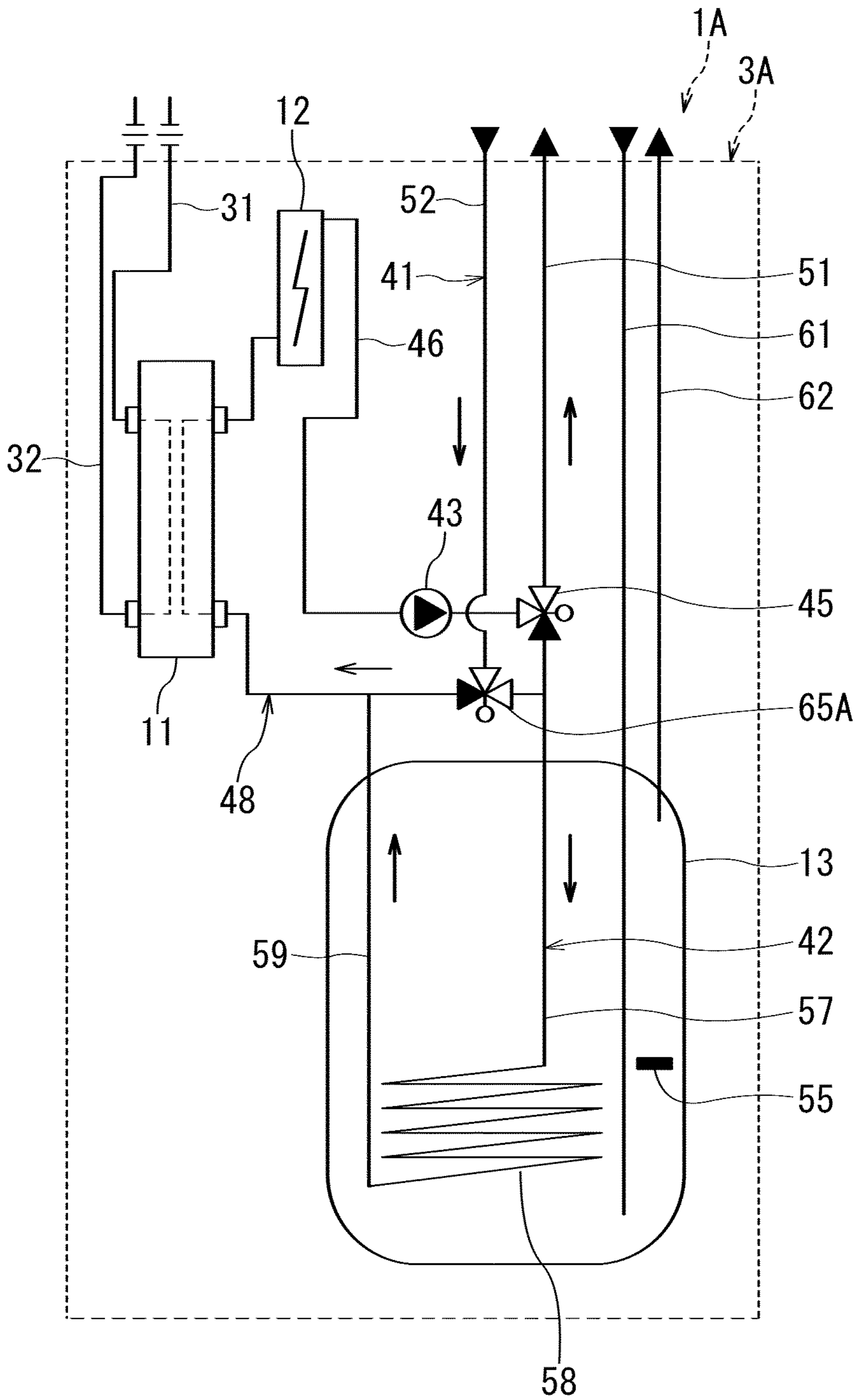

FIG. 6

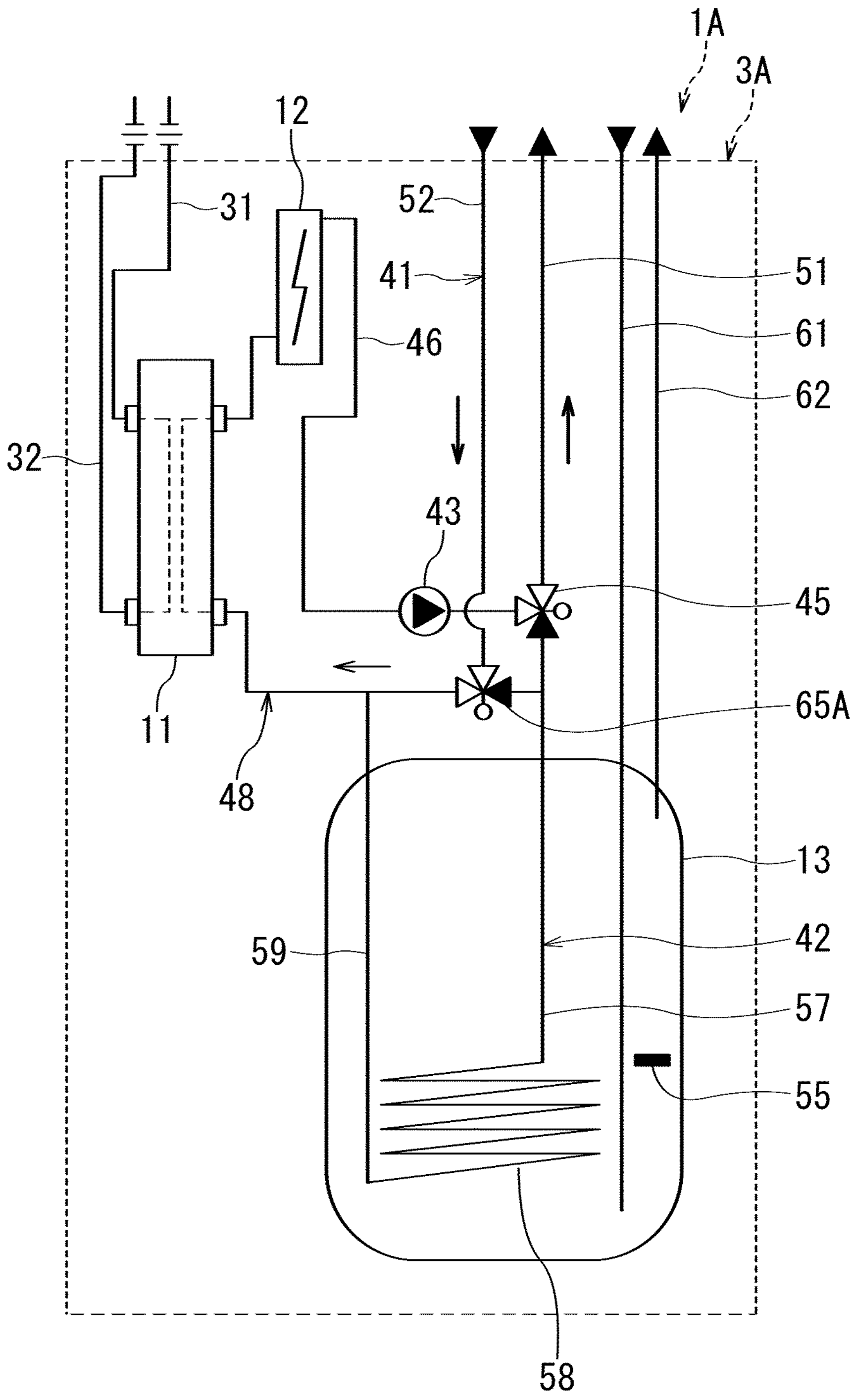

FIG. 7

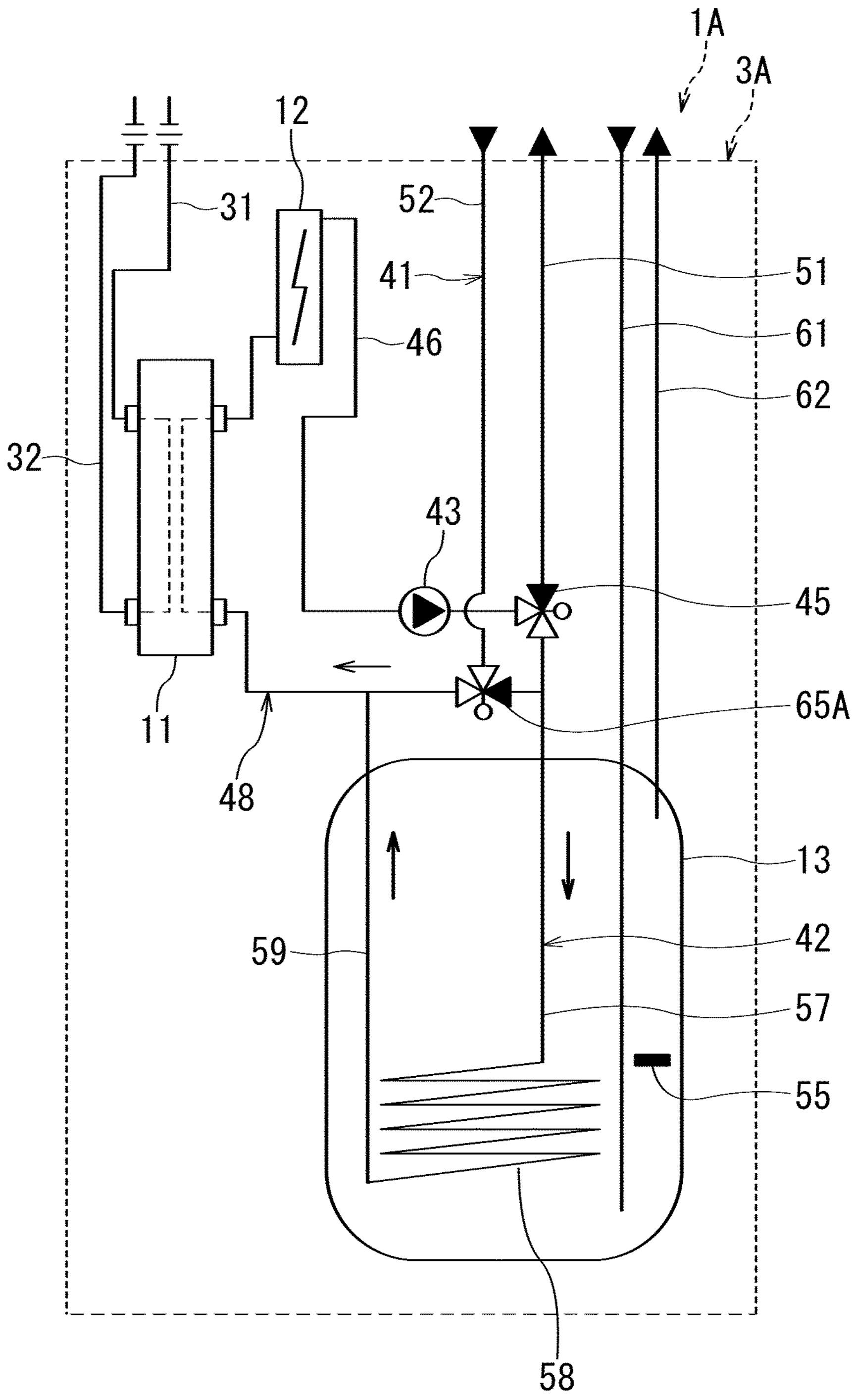

FIG. 8

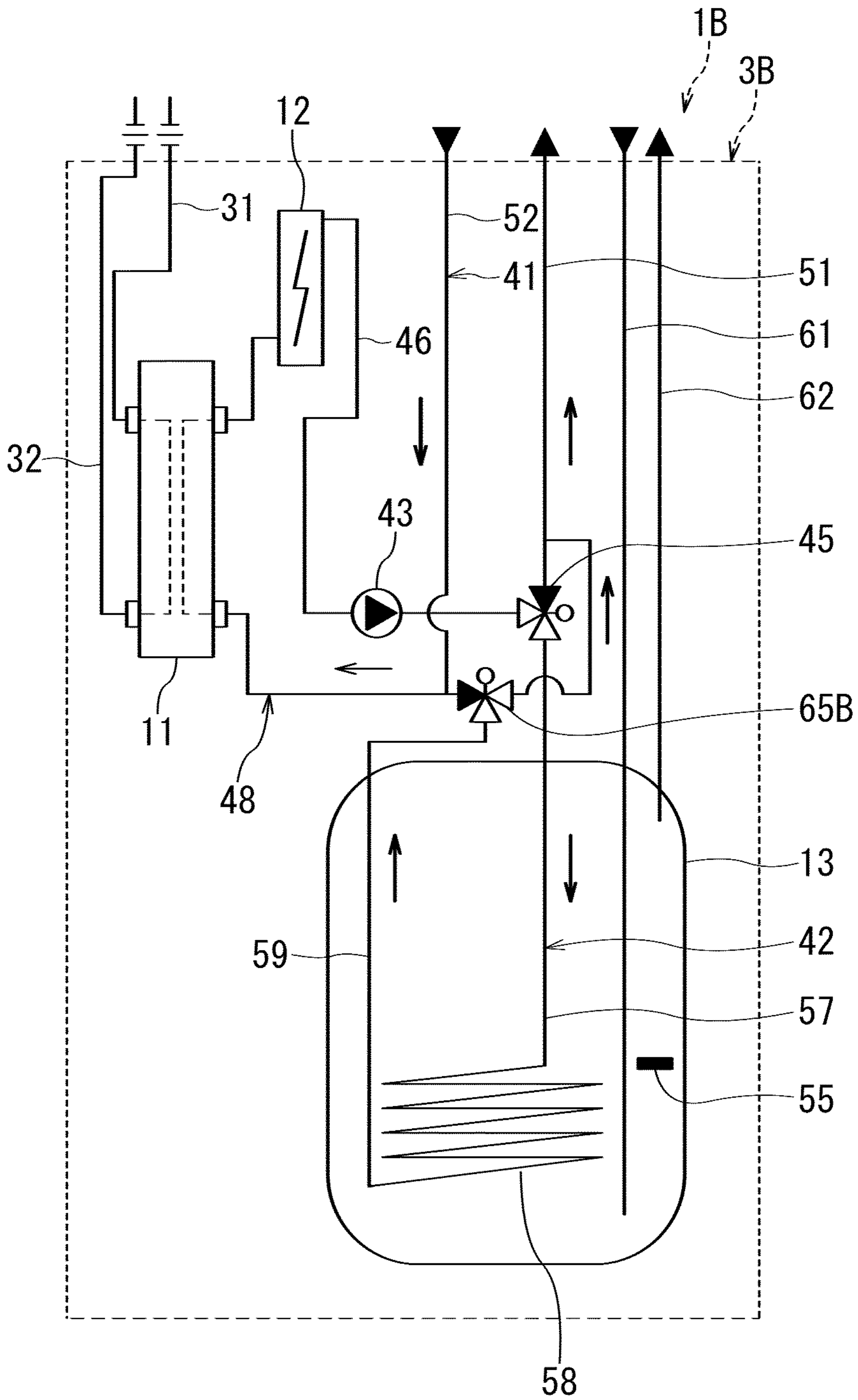

FIG. 9

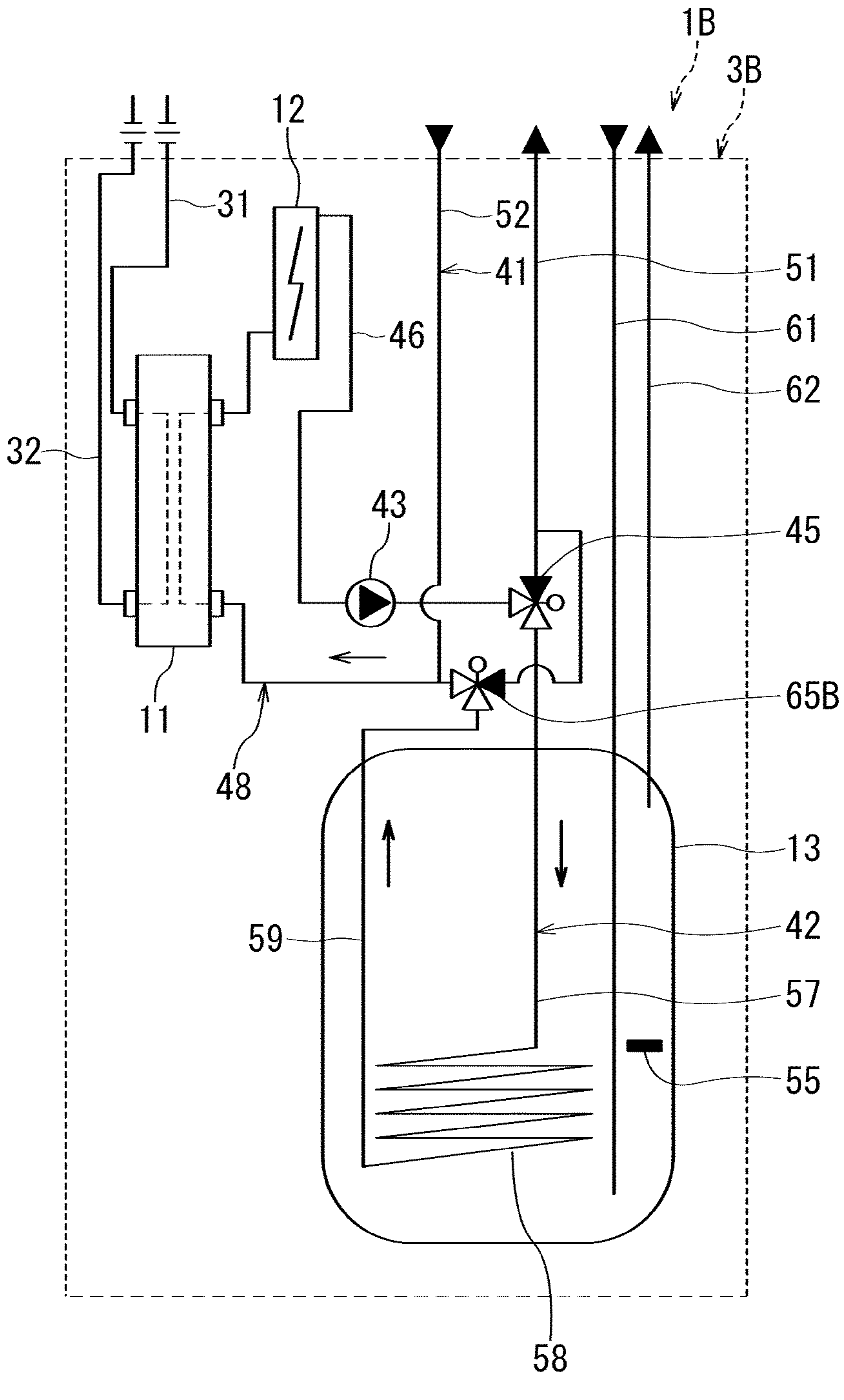

FIG. 10

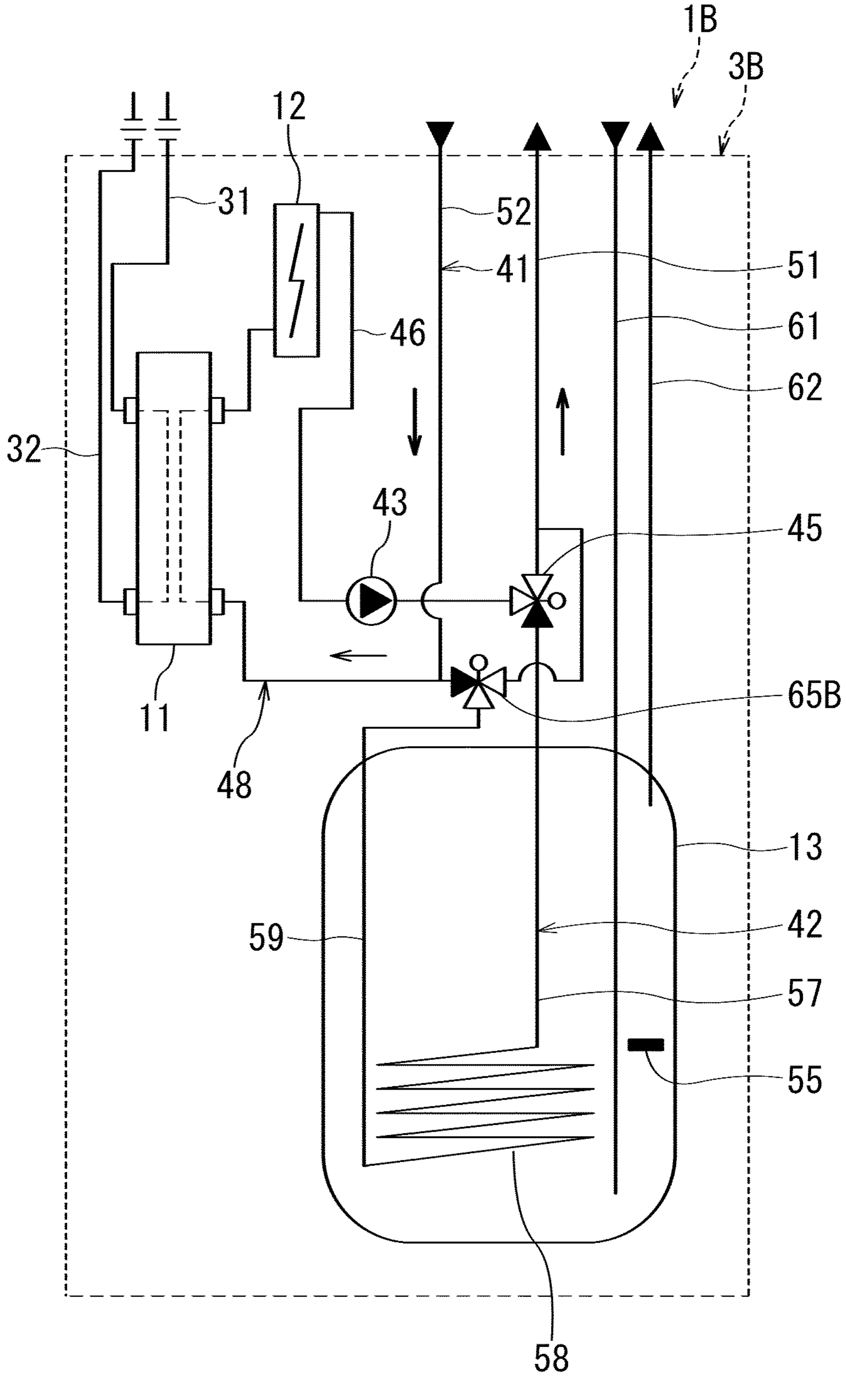

FIG. 11

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2020/032859

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F24H4/02(2006.01)i, F24D3/08(2006.01)i, F24D3/18(2006.01)i
FI: F24H4/02J, F24D3/08K, F24D3/08E, F24D3/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. F24H1/00-4/06, F24D3/00-3/18, F25B30/00-30/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2020
Registered utility model specifications of Japan	1996-2020
Published registered utility model applications of Japan	1994-2020

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2014-214978 A (PANASONIC CORPORATION) 17 November 2014 (2014-11-17), particularly, paragraphs [0208]-[0257], fig. 5	1-2, 4 3
Y A	JP 2015-203509 A (PANASONIC INTELLECTUAL PROPERTY MANAGEMENT CO., LTD.) 16 November 2015 (2015-11-16), particularly, fig. 1	1-2, 4 3
Y A	JP 2014-43958 A (MITSUBISHI ELECTRIC CORPORATION) 13 March 2014 (2014-03-13), particularly, fig. 1	1-2, 4 3
Y A	JP 2012-159217 A (MITSUBISHI ELECTRIC CORPORATION) 23 August 2012 (2012-08-23), particularly, fig. 4	1-2, 4 3
A	WO 2016/181501 A1 (MITSUBISHI ELECTRIC CORPORATION) 17 November 2016 (2016-11-17), particularly, paragraphs [0025]-[0027], fig. 1, 5, 7	1-4

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

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

Date of the actual completion of the international search	Date of mailing of the international search report
16 October 2020	02 November 2020

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

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/032859

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2004-28414 A (CORONA CORPORATION) 29 January 2004 (2004-01-29), particularly, paragraph [0028]	1-4
A	JP 2009-287872 A (DAIKIN INDUSTRIES, LTD.) 10 December 2009 (2009-12-10), particularly, paragraphs [0068], [0097]	1-4

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/032859

JP 2014-214978 A	17 November 2014	EP 2799784 A2 particularly, paragraphs [0210]-[0259], fig. 5
JP 2015-203509 A	16 November 2015	EP 2933580 A1 particularly, fig. 1 CN 104976764 A
JP 2014-43958 A	13 March 2014	CN 203478613 U particularly, fig. 1
JP 2012-159217 A	23 August 2012	(Family: none)
WO 2016/181501 A1	17 November 2016	US 2018/0051894 A1 particularly, paragraphs [0057]-[0060], fig. 1, 5, 7 EP 3115711 A1 CN 106152506 A
JP 2004-28414 A	29 January 2004	(Family: none)
JP 2009-287872 A	10 December 2009	(Family: none)

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

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2015224796 A **[0005]**