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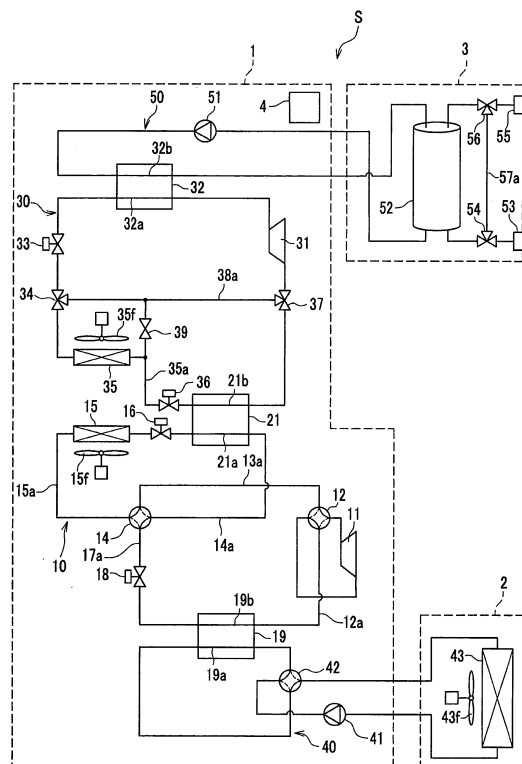
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(54) **AIR CONDITIONING/HOT WATER SUPPLY SYSTEM**

(57) An air conditioning and hot water supply system capable of improving the efficiency of the entire air conditioning and hot water supply system is provided. The air conditioning and hot water supply system includes an air conditioning compressor (11), an air conditioning heat source-side exchanger (15), an intermediate heat exchanger (21), air conditioning decompression devices (17, 18), an air conditioning usage-side exchanger (19), a first switching means (12), and a second switching means (14), and the first switching means (12) switches the direction of a first refrigerant passing through the air conditioning usage-side exchanger (19) in a cooling operation and a heating operation, and the second switching means (14) switches the direction of the first refrigerant passing through the air conditioning heat source-side exchanger (15) and the intermediate heat exchanger (21) in accordance with the operation mode, thus causing the intermediate heat exchanger (21) to function as a condenser for the first refrigerant.

FIG. 1



Description

Technical Field

[0001] The present invention relates to an air conditioning and hot water supply system for air conditioning and hot water supply.

Background Art

[0002] A technique as shown in PTL 1 is disclosed as an air conditioning and hot water supply system for air conditioning and hot water supply. PTL 1 describes an air conditioning apparatus (an air conditioning and hot water supply system) constituting a refrigerant circuit by coupling a main cycle and a sub-cycle with a cascade condenser (intermediate heat exchanger).

[0003] In this case, the main cycle is constituted by connecting a first compressor, a first four-way switch valve, an outdoor heat exchanger, a first electronic expansion valve, and an indoor heat exchanger, and the sub-cycle is constituted by connecting a second compressor, a second four-way switch valve, a third four-way switch valve, a hot water supply heat exchanger, an auxiliary heat exchanger, a second electronic expansion valve, and a third electronic expansion valve.

Citation List

Patent Literature

[0004] PTL 1: JP 2005-299935 A

Summary of Invention

Technical Problem

[0005] During cooling operation, the air conditioning apparatus (the air conditioning and hot water supply system) described in PTL 1 causes a primary-side (main cycle-side) of a cascade condenser (intermediate heat exchanger) to function as a condenser, and causes a secondary-side (sub-cycle-side) thereof to function as an evaporator, so that the exhaust heat from the main cycle can be used by the sub-cycle.

[0006] However, during heating operation, the air conditioning apparatus (the air conditioning and hot water supply system) described in PTL 1 causes the main cycle carrying out the air conditioning operation and the sub-cycle carrying out the hot water supply operation to function independently, and no heat exchange is done via the cascade condenser (the intermediate heat exchanger).

[0007] Therefore, for example, in a case where the indoor air which is the air conditioning target is at a temperature close to a setting temperature during the heating operation, the intermittent operation is performed with the main cycle, and there is a problem in that the efficiency of the entire system is deteriorated.

cy of the entire system is deteriorated.

[0008] Accordingly, it is an object of the present invention to provide an air conditioning and hot water supply system capable of improving the efficiency of the entire air conditioning and hot water supply system.

Solution to Problem

[0009] In order to solve the above-described problem, according to the present invention, there is provided an air conditioning and hot water supply system including an air conditioning refrigerant circuit in which a first refrigerant circulates and a hot water supply refrigerant circuit in which a second refrigerant circulates, wherein the air conditioning refrigerant circuit includes: an air conditioning compressor configured to compress the first refrigerant; an air conditioning heat source-side exchanger configured to exchange heat with an air conditioning heat source; an intermediate heat exchanger configured to exchange heat between the first refrigerant and the second refrigerant; an air conditioning decompression device configured to decompress the first refrigerant; an air conditioning usage-side exchanger that functions as an evaporator during cooling operation and that functions as a condenser during heating operation; first switching means configured to switch a direction of the first refrigerant passing through the air conditioning usage-side exchanger in the cooling operation and the heating operation; and second switching means connected to the first switching means, and wherein the second switching means causes the intermediate heat exchanger to function as a condenser for the first refrigerant by switching the direction of the first refrigerant passing through the air conditioning heat source-side exchanger and the intermediate heat exchanger in accordance with an operation mode.

Advantageous Effects of Invention

[0010] According to the present invention, an air conditioning and hot water supply system can be provided that can improve the efficiency of the entire air conditioning and hot water supply system.

[0011] Brief Description of Drawings

[0012]

[Fig. 1] Fig. 1 is a system diagram showing a hot water supply and air conditioning system according to the present embodiment.

[Fig. 2] Fig. 2 is a flowchart showing a procedure of determining processing for determining an operation mode of the air conditioning and hot water supply system according to the present embodiment.

[Fig. 3] Fig. 3 is a flowchart showing a procedure of determining processing for determining an operation mode of the air conditioning and hot water supply system according to the present embodiment.

[Fig. 4] Fig. 4 is a flowchart showing a procedure of

estimating processing for estimating an air conditioning exhaust heat amount and a hot water supply absorbed heat amount.

[Fig. 5] Fig. 5 is a flowchart showing a procedure of estimating processing for estimating a single total electric power consumption and a surplus total electric power consumption.

[Fig. 6] Fig. 6 is a system diagram showing a flow of refrigerant and heated liquid in a heat pump unit in a hot water supply operation mode.

[Fig. 7] Fig. 7 is a system diagram showing a flow of refrigerant and heat transfer media in the heat pump unit in a cooling operation (normal) mode.

[Fig. 8] Fig. 8 is a system diagram showing a flow of refrigerant and heat transfer media in the heat pump in a cooling operation (natural circulation) mode.

[Fig. 9] Fig. 9 is a system diagram showing a flow of refrigerant and heat transfer media in the heat pump in a heating operation mode.

[Fig. 10] Fig. 10 is a system diagram showing a flow of refrigerant, heat transfer media, and heated liquid in the heat pump unit in a cooling hot water supply operation (exhaust heat recovery A) mode.

[Fig. 11] Fig. 11 is a system diagram showing a flow of refrigerant, heat transfer media, and heated liquid in the heat pump unit in a cooling hot water supply operation (exhaust heat recovery B) mode.

[Fig. 12] Fig. 12 is a system diagram showing a flow of refrigerant, heat transfer media, and heated liquid in the heat pump unit in a cooling hot water supply operation (exhaust heat recovery C).

[Fig. 13] Fig. 13 is a system diagram showing a flow of refrigerant, heat transfer media, and heated liquid in the heat pump unit in a heating hot water supply operation (independent) mode.

[Fig. 14] Fig. 14 is a system diagram showing a flow of refrigerant, heat transfer media, and heated liquid in the heat pump unit in a heating hot water supply operation (air conditioning surplus heating) mode.

[Fig. 15] Fig. 15 is a graph showing change of the heating load, the amount of solar radiation, and the outdoor temperature on or around the coldest day in Tokyo.

Description of Embodiments

[0013] An embodiment of the present invention will be hereinafter explained in detail with reference to drawings as necessary. The same portions in the drawings are denoted with the same reference numerals, and redundant explanation thereabout is omitted.

«Air conditioning and hot water supply system»

[0014] Fig. 1 is a system diagram showing a hot water supply and air conditioning system according to the present embodiment. As shown in Fig. 1, an air conditioning and hot water supply system S includes a heat

pump unit 1 installed outdoors (outside of the air conditioned space), an indoor unit 2 installed indoors (inside of the air conditioned space), and a hot water supply tank unit 3, and a control device 4.

[0015] The air conditioning and hot water supply system S has the functions for performing "cooling operation" for cooling the indoor space where the indoor unit 2 is installed, "heating operation" for heating the indoor space where the indoor unit 2 is installed, "hot water supply operation" for providing high-temperature heated liquid to a tank 52 by heating the heated liquid (e.g., water), "cooling hot water supply operation" for cooling operation and hot water supply operation, and "heating hot water supply operation" for heating operation and hot water supply operation.

[0016] The air conditioning and hot water supply system S includes an air conditioning refrigerant circuit 10 where a first refrigerant circulates, a hot water supply refrigerant circuit 30 where a second refrigerant circulates, an air conditioning heat transfer media circulating circuit 40 where a heat transfer media circulates, and a hot water supply circuit 50 where a heated liquid passes.

<Air conditioning refrigerant circuit>

[0017] The air conditioning refrigerant circuit 10 provided in the heat pump unit 1 includes an air conditioning compressor 11, a first four-way switch valve 12, a second four-way switch valve 14, an air conditioning heat source-side exchanger 15, an air conditioning second expansion valve 16, a primary-side heat transfer pipe 21a of an intermediate heat exchanger 21, an air conditioning first expansion valve 18, a secondary-side heat transfer pipe 19b of an air conditioning usage-side exchanger 19, which are connected in a circular manner by pipes.

[0018] In the explanation below, four ports provided in each of the first four-way switch valve 12 and the second four-way switch valve 14 are denoted as follows: a port at the upper side in the drawing is an "upper port", a port at the right side in the drawing is a "right port", a port at the lower side in the drawing is a "lower port", and a port at the left side in the drawing is a "left port".

[0019] As shown in Fig. 1, the right port of the first four-way switch valve 12 is connected to the discharge-side of the compressor 11. The upper port of the first four-way switch valve 12 is connected to the upper port of the second four-way switch valve 14 via a pipe 13a. The left port of the first four-way switch valve 12 is connected to the suction-side of the compressor. The lower port of the first four-way switch valve 12 is connected to the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19 via a pipe 12a.

[0020] The right port of the second four-way switch valve 14 is connected to a primary-side heat transfer pipe 21a of the intermediate heat exchanger 21 via a pipe 14a. The lower port of the second four-way switch valve 14 is connected to the air conditioning first expansion valve 18 via a pipe 17a. The left port of the second four-

way switch valve 14 is connected to the air conditioning heat source-side exchanger 15 via a pipe 15a.

[0021] The air conditioning compressor 11 is a compressor for compressing a first refrigerant to make a high-temperature high-pressure refrigerant.

[0022] The first four-way switch valve 12 is a four-way switch valve for switching, according to the cooling operation or the heating operation, the direction of the first refrigerant passing through the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19. More specifically, by switching the first four-way switch valve 12, during the cooling operation, the low-temperature low-pressure first refrigerant expanded in the air conditioning first expansion valve 18 flows into the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19. During the heating operation, the high-temperature high-pressure first refrigerant compressed in the air conditioning compressor 11 flows into the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19.

[0023] The second four-way switch valve 14 is a four-way switch valve for switching the direction of the first refrigerant passing through the air conditioning heat source-side exchanger 15 and intermediate heat exchanger 21 in accordance with the operation mode. It should be noted that the details of the operation mode will be explained later.

[0024] The air conditioning heat source-side exchanger 15 is an exchanger for exchanging heat between the first refrigerant and the air (outdoor air) blown by the air conditioning fan 15f.

[0025] The air conditioning first expansion valve 18 and the air conditioning second expansion valve 16 function as decompression devices for reducing the pressure of the first refrigerant in accordance with the operation mode. By the way, during the air conditioning operation, any one of the air conditioning first expansion valve 18 and the air conditioning second expansion valve 16 functions as a decompression device for reducing the pressure of the first refrigerant.

[0026] The air conditioning usage-side exchanger 19 is an exchange for exchanging heat between the heat transfer media passing through the primary-side heat transfer pipe 19a and the first refrigerant passing through the secondary-side heat transfer pipe 19b.

[0027] The intermediate heat exchanger 21 is an exchange for exchanging heat between the first refrigerant passing through the primary-side heat transfer pipe 21a and the second refrigerant passing through the secondary-side heat transfer pipe 21b.

[0028] It should be noted that the first refrigerant may be HFC, HFO-1234yf, HFO-1234ze, natural refrigerant (e.g., CO₂ refrigerant), and the like.

<Hot water supply refrigerant circuit>

[0029] The hot water supply refrigerant circuit 30 provided in the heat pump unit 1 includes a hot water supply

compressor 31, a primary-side heat transfer pipe 32a of a hot water supply usage-side exchanger 32, a hot water supply first expansion valve 33, a hot water supply three-way switch valve 34, a hot water supply heat source-side exchanger 35, a hot water supply second expansion valve 36, a secondary-side heat transfer pipe 21b of the intermediate heat exchanger 21, and a hot water supply three-way switch valve 37, which are connected in a circular manner by pipes.

[0030] It should be noted that the hot water supply three-way switch valve 34 and the hot water supply three-way switch valve 37 are connected with each other via a pipe 38a. The hot water supply refrigerant circuit 30 includes a hot water supply refrigerant control valve 39. One end of the hot water supply refrigerant control valve 39 is connected to a pipe branching from a pipe 35a, and the other end of the hot water supply refrigerant control valve 39 is connected to a pipe branching from the pipe 38a.

[0031] The water supply compressor 11 is a compressor for compressing the second refrigerant to make a high-temperature high-pressure refrigerant.

[0032] The water supply usage-side exchanger 32 is an exchange for exchanging heat between the second refrigerant passing through the primary-side heat transfer pipe 32a and the heated liquid passing through the secondary-side heat transfer pipe 32b.

[0033] The hot water supply first expansion valve 33 and the hot water supply second expansion valve 36 function as decompression devices for reducing the pressure of the second refrigerant in accordance with the operation mode. It should be noted that, during the hot water supply operation, any one of the hot water supply first expansion valve 33 and the hot water supply second expansion valve 36 functions as a decompression device for reducing the pressure of the second refrigerant.

[0034] The water supply heat source-side exchanger 35 is an exchange for exchanging heat between the second refrigerant and the air (outdoor air) blown by a hot water supply fan 35f.

[0035] The hot water supply three-way switch valves 34, 37 are three-way switch valves configured to be able to adjust the ratio of the amount of flow of the second refrigerant passing therethrough. The hot water supply refrigerant control valve 39 is an on/off valve configured to be able to open and close.

[0036] It should be noted that the second refrigerant may be HFC, HFO-1234yf, HFO-1234ze, natural refrigerant (e.g., CO₂ refrigerant), and the like. It should be noted that the second refrigerant is desired to be a refrigerant having a critical point (temperature, pressure) higher than that of the first refrigerant.

<Air conditioning heat transfer media circulating circuit>

[0037] The air conditioning heat transfer media circulating circuit 40 provided from the heat pump unit 1 to the indoor unit 2 includes a first pump 41, a heat transfer

media four-way switch valve 42, a primary-side heat transfer pipe 19a of an air conditioning usage-side exchanger 19, and an indoor exchanger 43, which are connected in a circular manner by pipes.

[0038] The first pump 41 is a pump for pumping the heat transfer media flowing from the indoor exchanger 43 toward the heat transfer media four-way switch valve 42.

[0039] The heat transfer media four-way switch valve 42 is a four-way switch valve for switching, in the cooling operation and the heating operation, the direction of flow of the heat transfer media, so that the heat transfer media passing through the primary-side heat transfer pipe 19a of the air conditioning usage-side exchanger 19 and the first refrigerant passing through the secondary-side heat transfer pipe 19b are made into countercurrents.

[0040] The indoor exchanger 43 is an exchange for exchanging heat between the heat transfer media and the air (indoor air) blown by the indoor fan 43f.

[0041] It should be noted that the heat transfer media may be brine such as ethylene glycol (antifreezing fluid), water, and the like.

<Hot water supply circuit>

[0042] The hot water supply circuit 50 provided from the heat pump unit 1 to the hot water supply tank unit 3 includes a second pump 51, a secondary-side heat transfer pipe 32b of a hot water supply usage-side exchanger 32, and a tank 52, which are connected in a circular manner by pipes.

[0043] The second pump 51 is a pump for pumping up the heated liquid from the tank 52 and pumping the heated liquid toward the secondary-side heat transfer pipe 32b of the hot water supply usage-side exchanger 32.

[0044] The tank 52 accumulates the heated liquid, and is covered with an heating insulating material (not shown).

[0045] In the explanation below, the heated liquid is explained in such a matter that the heated liquid is water.

[0046] The hot water supply tank unit 3 includes a water feeding metal piece 53, a hot water supply metal piece 55, and three-way switch valves 54, 56.

[0047] One end of the water feeding metal piece 53 is connected to the three-way switch valve 54, and the other end of the water feeding metal piece 53 is connected to a water feeding terminal (not shown). When the user performs operation to open the hot water supply terminal (not shown), the heated liquid (water) flows into a lower portion of the tank 52 via the water feeding metal piece 53 due to the pressure given by the water feeding source.

[0048] The three-way switch valves 54, 56 are three-way switch valves configured to be able to adjust the ratio of the amount of flow of the heated liquid passing there-through, and are connected with each other via a pipe 57a. By causing the amount of heated liquid (water) to flow via the pipe 57a in accordance with the degree of opening of each of the three-way switch valves 54, 56,

the high-temperature heated liquid provided from the tank 52 is adjusted to attain an appropriate temperature.

[0049] One end of the hot water supply metal piece 55 is connected to the three-way switch valve 56, and the other of the hot water supply metal piece 55 is connected to a hot water supply terminal (not shown). When the user performs operation to open the hot water supply terminal, the heated liquid (hot water) of which temperature is adjusted is provided via the hot water supply metal piece 55 to the hot water supply terminal.

<Control device>

[0050] The air conditioning and hot water supply system S includes a control device 4.

[0051] The control device 4 has a function of controlling various kinds of operations of the air conditioning and hot water supply system S by determining the operation mode of the air conditioning and hot water supply system S and controlling, in accordance with the determined operation mode, the state (the degree of opening) of various kinds of valves (the first four-way switch valve 12, the second four-way switch valve 14, the air conditioning first expansion valve 18, the air conditioning second expansion valve 16, the hot water supply first expansion valve 33, the hot water supply three-way switch valves 34, 37, the hot water supply second expansion valve 36, the hot water supply refrigerant control valve 39, and the three-way switch valves 54, 56), and the rotation speed of the compressors (the air conditioning compressor 11 and the hot water supply compressor 31), the rotation speed of the fan of each exchanger (the air conditioning fan 15f, the hot water supply fan 35f, and the indoor fan 43f), and the rotation speeds of the pumps (the first pump 41 and the second pump 51).

(Determining processing for determining operation mode)

[0052] Subsequently, the operation mode of the air conditioning and hot water supply system S executed by the control device 4 will be explained. Figs. 2 and 3 are flowcharts showing a procedure of the determining processing for determining the operation mode of the air conditioning and hot water supply system S according to the present embodiment.

[0053] First, explanation will be made with reference to Fig. 2.

[0054] In step S101, the control device 4 determines whether there is an air conditioning cycle operation request or not. In this case, the air conditioning cycle operation request is an operation request for air conditioning (cooling/heating) the indoor space (air conditioned space) where the indoor unit 2 is installed. The air conditioning cycle operation request may be input into the control device 4, for example, when the user operates a remote controller (not shown) installed indoors. A determination may be made on the basis of the indoor setting

temperature and the detection temperature (indoor temperature) of an indoor temperature detection device (not shown) for detecting the temperature indoors.

[0055] When the air conditioning cycle operation request is given (S101: Yes), the control device 4 proceeds to processing in step S105. When the air conditioning cycle operation request is not given (S101: No), the control device 4 proceeds to processing in step S102.

[0056] In step S102, the control device 4 determines whether there is a hot water supply cycle operation request or not. In this case, the hot water supply cycle operation request is a request for executing the hot water supply operation of the air conditioning and hot water supply system S. The hot water supply cycle operation request may be input into the control device 4, for example, when the user operates a remote controller (not shown) installed indoors. Alternatively, in a case where the amount of high-temperature heated liquid accumulated in the tank 52 of the hot water supply tank unit 3 is equal to or less than a predetermined amount, the "hot water supply cycle operation request" may be given, or in a case where it is in a predetermined time period, the "hot water supply cycle operation request" may be given.

[0057] When the hot water supply cycle operation request is given (S102: Yes), the control device 4 proceeds to processing in step S104. In a case where the hot water supply cycle operation request is not given (S102: No), the control device 4 proceeds to processing in step S103.

[0058] In step S103, the control device 4 determines that the operation mode of the air conditioning and hot water supply system S is "stand-by mode". It should be noted that the stand-by mode is a mode for waiting for an input of an operation command upon stopping the air conditioning operation (cooling operation/heating operation) and the hot water supply operation of the air conditioning and hot water supply system S.

[0059] In step S104, the control device 4 determines that the operation mode of the air conditioning and hot water supply system S is the "hot water supply operation mode". It should be noted that the hot water supply operation mode is a mode for executing the hot water supply operation of the air conditioning and hot water supply system S. The operation of the air conditioning and hot water supply system S (heat pump unit 1) in this operation mode will be explained later with reference to Fig. 6.

[0060] In step S105, the control device 4 determines whether there is a hot water supply cycle operation request. It should be noted that the hot water supply cycle operation request in step S105 is the same as the hot water supply cycle operation request in step S102, and explanation thereabout is omitted.

[0061] When the hot water supply cycle operation request is given (S105: Yes), the control device 4 proceeds to processing in step S111. When the hot water supply cycle operation request is not given (S105: No), the control device 4 proceeds to processing in step S106.

[0062] In step S106, the control device 4 determines whether the air conditioning cycle operation request is

"cooling operation" or not.

[0063] When the air conditioning cycle operation request is the "cooling operation" (S106: Yes), the control device 4 proceeds to processing in step S107. When the air conditioning cycle operation request is not the "cooling operation" (S106: No), the control device 4 proceeds to processing in step S110.

[0064] In step S107, the control device 4 determines whether the air conditioning load Q_{ac} is equal to or more than a predetermined threshold value $Q1$. It should be noted that the air conditioning load Q_{ac} is estimated on the basis of an outdoor temperature T_{ao} , an indoor temperature T_{ai} , an indoor setting temperature T_{ac_set} , and an indoor air flow amount V_{ac_set} . The threshold value $Q1$ is a threshold value used when the air conditioning load is too high or not, and is determined by experiment or simulation in advance and stored to the control device 4. In step S107, when the air conditioning load Q_{ac} is equal to or more than the threshold value $Q1$ (S107: Yes), the control device 4 proceeds to processing in step S108. When the air conditioning load Q_{ac} is less than the threshold value $Q1$ (S107: No), the control device 4 proceeds to processing in step S109.

[0065] In step S108, the control device 4 determines that the operation mode of the air conditioning and hot water supply system S is the "cooling operation (normal) mode". It should be noted that the cooling operation (normal) mode is a mode for executing the cooling operation of the air conditioning and hot water supply system S, and is a mode in which the natural circulation is not performed by the hot water supply refrigerant circuit 30. The operation of the air conditioning and hot water supply system S (heat pump unit 1) in this operation mode will be explained later with reference to Fig. 7.

[0066] In step S109, the control device 4 determines that the operation mode of the air conditioning and hot water supply system S is the "cooling operation (natural circulation) mode". It should be noted that the cooling operation (natural circulation) mode is a mode for executing the cooling operation of the air conditioning and hot water supply system S, and is a mode in which the natural circulation is performed in the hot water supply refrigerant circuit 30. The operation of the air conditioning and hot water supply system S (heat pump unit 1) in this operation mode will be explained with reference to Fig. 8.

[0067] In step S110, the control device 4 determines that the operation mode of the air conditioning and hot water supply system S is the "heating operation mode". It should be noted that the heating operation mode is a mode for executing the heating operation of the air conditioning and hot water supply system S. The operation of the air conditioning and hot water supply system S (heat pump unit 1) in this operation mode will be explained with reference to Fig. 9.

[0068] In step S111, the control device 4 determines whether the air conditioning cycle operation request is the "cooling operation" or not. When the air conditioning cycle operation request is the "cooling operation" (S111:

Yes), the control device 4 proceeds to processing in step S112. When the air conditioning cycle operation request is not the "cooling operation" (S111: No), the control device 4 proceeds to processing in step S201 of Fig. 3.

[0069] In step S112, the control device 4 estimates the air conditioning exhaust heat amount Q_{ac_ex} and the hot water supply absorbed heat amount Q_{ec_ex} . In this case, the air conditioning exhaust heat amount Q_{ac_ex} is an exhaust heat amount to the heat source required for the cooling operation when the air conditioning refrigerant circuit 10 and the hot water supply refrigerant circuit 30 are caused to operate independently. The hot water supply absorbed heat amount Q_{ec_ex} is an absorbed heat amount from the heat source required for the hot water supply operation when the air conditioning refrigerant circuit 10 and the hot water supply refrigerant circuit 30 are caused to operate independently.

[0070] It should be noted that the estimating processing of the air conditioning exhaust heat amount Q_{ac_ex} and the hot water supply absorbed heat amount Q_{ec_ex} will be explained with reference to Fig. 4.

[0071] In step S113, the control device 4 determines whether the air conditioning exhaust heat amount Q_{ac_ex} is more than the hot water supply absorbed heat amount Q_{ec_ex} .

[0072] When the air conditioning exhaust heat amount Q_{ac_ex} is more than the hot water supply absorbed heat amount Q_{ec_ex} (S113: Yes), the control device 4 proceeds to processing in step S114. When the air conditioning exhaust heat amount Q_{ac_ex} is equal to or less than the hot water supply absorbed heat amount Q_{ec_ex} (S113: No), the control device 4 proceeds to processing in step S115.

[0073] In step S114, the control device 4 determines that the operation mode of the air conditioning and hot water supply system S is the "cooling hot water supply operation (exhaust heat recovery A) mode". It should be noted that the cooling hot water supply operation (exhaust heat recovery A) mode is a type of a mode for executing the cooling operation of the air conditioning and hot water supply system S and hot water supply operation, and in which operation is performed while the exhaust heat of the air conditioning refrigerant circuit 10 is recovered by the hot water supply refrigerant circuit 30. The operation of the air conditioning and hot water supply system S (heat pump unit 1) in this operation mode will be explained with reference to Fig. 10.

[0074] In step S115, the control device 4 determines whether the air conditioning exhaust heat amount Q_{ac_ex} is equal to the hot water supply absorbed heat amount Q_{ec_ex} or not.

[0075] When the air conditioning exhaust heat amount Q_{ac_ex} is determined to be equal to the hot water supply absorbed heat amount Q_{ec_ex} (S115: Yes), the control device 4 proceeds to processing in step S116. When the air conditioning exhaust heat amount Q_{ac_ex} is determined not to be equal to the hot water supply absorbed heat amount Q_{ec_ex} (S115: No), the control device 4

proceeds to processing in step S117.

[0076] In step S116, the control device 4 determines that the operation mode of the air conditioning and hot water supply system S is the "cooling hot water supply operation (exhaust heat recovery B) mode". It should be noted that the cooling hot water supply operation (exhaust heat recovery B) mode is a type of a mode for executing the cooling operation of the air conditioning and hot water supply system S and hot water supply operation, and in which operation is performed while the exhaust heat of the air conditioning refrigerant circuit 10 is recovered by the hot water supply refrigerant circuit 30. The operation of the air conditioning and hot water supply system S (heat pump unit 1) in this operation mode will be explained with reference to Fig. 11.

[0077] In step S117, the control device 4 determines that the operation mode of the air conditioning and hot water supply system S is the "cooling hot water supply operation (exhaust heat recovery C) mode". It should be noted that the cooling hot water supply operation (exhaust heat recovery C) mode is a type of a mode for executing the cooling operation of the air conditioning and hot water supply system S and hot water supply operation, and in which operation is performed while the exhaust heat of the air conditioning refrigerant circuit 10 is recovered by the hot water supply refrigerant circuit 30. The operation of the air conditioning and hot water supply system S (heat pump unit 1) in this operation mode will be explained with reference to Fig. 12.

[0078] Subsequently, a case where the air conditioning cycle operation request is determined not to be the "cooling operation" in step S111 (S111: No) will be explained with reference to Fig. 3. More specifically, in a case where the hot water supply cycle operation request is given (see S105: Yes), and the air conditioning cycle operation request is determined to be the "heating operation" will be explained.

[0079] In step S201, the control device 4 estimates the single total electric power consumption W_{sys1} and the surplus heat operation electric power consumption W_{sys2} . In this case, the single total electric power consumption W_{sys1} is an estimated electric power consumption in a case where the air conditioning and hot water supply system S is operated in the heating hot water supply operation (independent) mode (see Fig. 13 explained later). The surplus heat operation electric power consumption W_{sys2} is an estimated electric power consumption in a case where the air conditioning and hot water supply system S is operated in the heating hot water supply operation (air conditioning surplus heating) mode (see Fig. 14 explained later).

[0080] It should be noted that the estimating processing of the single total electric power consumption W_{sys1} and the surplus heat operation electric power consumption W_{sys2} will be explained with reference to Fig. 5.

[0081] In step S202, the control device 4 determines whether the single total electric power consumption W_{sys1} is equal to or less than the surplus heat operation

electric power consumption Wsys2.

[0082] When the single total electric power consumption Wsys1 is determined to be equal to or less than the surplus heat operation electric power consumption Wsys2 (S202: Yes), the control device 4 proceeds to processing in step S203. When the single total electric power consumption Wsys1 is more than the surplus heat operation electric power consumption Wsys2 (S202: No), the control device 4 proceeds to processing in step S204.

[0083] In step S203, the control device 4 determines that the operation mode of the air conditioning and hot water supply system S is the "heating hot water supply operation (independent) mode". It should be noted that the heating hot water supply operation (independent) mode is a type of a mode for executing the heating operation of the air conditioning and hot water supply system S and hot water supply operation, and in which the air conditioning refrigerant circuit 10 and the hot water supply refrigerant circuit 30 are caused to operate independently, and the intermediate heat exchanger 21 is not used. The operation of the air conditioning and hot water supply system S (heat pump unit 1) in this operation mode will be explained with reference to Fig. 13.

[0084] In step S204, the control device 4 determines that the operation mode of the air conditioning and hot water supply system S is the "heating hot water supply operation (air conditioning surplus heating) mode". It should be noted that heating hot water supply operation (air conditioning surplus heating) mode is a mode for executing the heating operation of the air conditioning and hot water supply system S, and in which the surplus heat of the air conditioning refrigerant circuit 10 is recovered by the hot water supply refrigerant circuit 30, and the hot water supply operation is performed. The operation of the air conditioning and hot water supply system S (heat pump unit 1) in this operation mode will be explained with reference to Fig. 14.

[0085] (Estimating processing for estimating air conditioning exhaust heat amount Qac_ex and hot water supply absorbed heat amount Qec_ex)

[0086] Fig. 4 is a flowchart showing a procedure of estimating processing for estimating the air conditioning exhaust heat amount Qac_ex and the hot water supply absorbed heat amount Qec_ex in step S112 of Fig. 2.

[0087] In step S301, the control device 4 estimates the air conditioning load Qac. It should be noted that the air conditioning load Qac is estimated on the basis of the outdoor temperature Tao, the indoor temperature Tai, the indoor setting temperature Tac_set, and the indoor air flow amount Vac_set.

[0088] The outdoor temperature Tao is detected, for example, by a temperature sensor (not shown) provided at an external air inlet port of the air conditioning fan 15f or hot water supply fan 35f of the heat pump unit 1. The indoor temperature Tai is detected, for example, by a temperature sensor (not shown) provided at an indoor air inlet port of the indoor fan 43f of the indoor unit 2. The indoor air flow amount Vac_set is calculated by, for ex-

ample, detecting the rotation speed of the indoor fan 43f, thus calculating the air flow amount (the amount of flow of air). Alternatively, it is calculated from a setting air flow amount that is set by the user with a remote controller (not shown) installed indoors. The indoor setting temperature Tac_set is, for example, input into the control device 4 when the user operates a remote controller (not shown) installed indoors.

[0089] In step S302, the control device 4 estimates the air conditioning electric power consumption Wac. It should be noted that the air conditioning electric power consumption Wac is estimated on the basis of the air conditioning load Qac estimated in step S301, the outdoor temperature Tao, and the indoor setting temperature Tac_set.

[0090] In step S303, the control device 4 estimates the air conditioning exhaust heat amount Qac_ex. It should be noted that the air conditioning exhaust heat amount Qac_ex is estimated on the basis of the air conditioning load Qac estimated in step S301 and the air conditioning electric power consumption Wac estimated in step S302.

[0091] In step S304, the control device 4 estimates the hot water supply load Qec. It should be noted that the hot water supply load Qec is estimated on the basis of the outdoor temperature Tao, the water feeding temperature Twi, the hot water supply temperature Two, and the water feeding flow amount Vw.

[0092] The water feeding temperature Twi is detected by, for example, a temperature sensor (not shown) provided at an inlet side of the secondary-side heat transfer pipe 32b of the hot water supply usage-side exchanger 32 of the heat pump unit 1. The hot water supply temperature Two is the setting temperature of the hot water (heated liquid) boiled up by the heat pump unit 1 and is input into the control device 4 when, for example, the user operates a remote controller (not shown) installed indoors. The water feeding flow amount Vw is calculated by, for example, detecting the rotation speed of the second pump 51 of the heat pump unit 1.

[0093] In step S305, the control device 4 estimates the hot water supply electric power consumption Wec. It should be noted that the hot water supply electric power consumption Wec is estimated on the basis of the hot water supply load Qec estimated in step S304, the outdoor temperature Tao, and the hot water supply temperature Two.

[0094] In step S306, the control device 4 estimates the hot water supply absorbed heat amount Qec_ex. It should be noted that the hot water supply absorbed heat amount Qec_ex is estimated on the basis of the hot water supply load Qec estimated in step S304 and the hot water supply electric power consumption Wec estimated in step S305.

[0095] As described, the control device 4 estimates the air conditioning exhaust heat amount Qac_ex (see S303), and estimates the hot water supply absorbed heat amount Qec_ex (see S306), and terminates the processing in step S112 of Fig. 2, and proceeds to step S113.

[0096] (Estimating processing for estimating single total electric power consumption Wsys1 and surplus heat operation electric power consumption Wsys2)

[0097] Fig. 5 is a flowchart showing a procedure of estimating processing for estimating the single total electric power consumption Wsys1 and the surplus heat operation electric power consumption Wsys2 in step S201 of Fig. 3.

[0098] In step S401, the control device 4 estimates the air conditioning load Qac. It should be noted that the air conditioning load Qac is estimated on the basis of the outdoor temperature Tao, the indoor temperature Tai, the indoor setting temperature Tac_set, and the indoor air flow amount Vac_set.

[0099] In step S402, the control device 4 estimates the air conditioning compressor target rotation speed Ncp_ac. It should be noted that the air conditioning compressor target rotation speed Ncp_ac is estimated on the basis of the air conditioning load Qac estimated in step S401, the outdoor temperature Tao, the indoor setting temperature Tac_set, and the indoor air flow amount Vac_set.

[0100] In step S403, the control device 4 determines whether the air conditioning compressor target rotation speed Ncp_ac estimated in step S402 is equal to or more than the air conditioning compressor minimum rotation speed Ncp_acmin.

[0101] In this case, the air conditioning compressor minimum rotation speed Ncp_acmin is the lower limit of the rotation speed at which the air conditioning compressor 11 of the air conditioning refrigerant circuit 10 can control operation.

[0102] When the air conditioning compressor target rotation speed Ncp_ac is equal to or more than the air conditioning compressor minimum rotation speed Ncp_acmin (S403: Yes), the control device 4 proceeds to processing in step S404. When the air conditioning compressor target rotation speed Ncp_ac is less than the air conditioning compressor minimum rotation speed Ncp_acmin (S403: No), the control device 4 proceeds to processing in step S409.

[0103] In step S404, the control device 4 estimates the air conditioning electric power consumption Wac. It should be noted that the air conditioning electric power consumption Wac is estimated on the basis of the air conditioning load Qac estimated in step S401, the outdoor temperature Tao, and the indoor setting temperature Tac_set.

[0104] In step S405, the control device 4 estimates the hot water supply load Qec. It should be noted that the hot water supply load Qec is estimated on the basis of the outdoor temperature Tao, the water feeding temperature Twi, the hot water supply temperature Two, and the feeding flow amount Vw.

[0105] In step S406, the control device 4 estimates the hot water supply electric power consumption Wec. It should be noted that the hot water supply electric power consumption Wec is estimated on the basis of the hot

water supply load Qec estimated in step S405, the outdoor temperature Tao, and the hot water supply temperature Two.

[0106] In step S407, the control device 4 estimates the single total electric power consumption Wsys1. It should be noted that the single total electric power consumption Wsys1 is estimated by adding the air conditioning electric power consumption Wac estimated in step S404 and the hot water supply electric power consumption Wec estimated in step S406 (more specifically, $Wsys1 = Wac + Wec$).

[0107] In step S408, the control device 4 estimates the surplus heat operation electric power consumption Wsys2. It should be noted that, in the present embodiment, this is estimated as ($Wsys2 = Wsys1$).

[0108] As described above, the control device 4 estimates the single total electric power consumption Wsys1 (see S407), and estimates the surplus heat operation electric power consumption Wsys2 (see S408), and terminates the processing in step S201 of Fig. 3, and proceeds to step S202.

[0109] Subsequently, a case where the air conditioning compressor rotation speed Ncp_ac is less than the air conditioning compressor minimum rotation speed Ncp_acmin step S403 of Fig. 5 (S403: No) will be explained.

[0110] The air conditioning compressor 11 cannot operate at a rotation speed less than the air conditioning compressor minimum rotation speed Ncp_acmin, and therefore, when the air conditioning compressor target rotation speed Ncp_ac estimated from the air conditioning load Qac is less than the air conditioning compressor minimum rotation speed Ncp_acmin, the compressor rotates at the number of rotation equal to Ncp_acmin.

[0111] For this reason, the actually output air conditioning performance is more than the air conditioning load Qac by the amount equal to Ncp_acmin/Ncp_ac , and therefore the control device 4 performs intermittent operation to repeatedly goes back and forth between operating the air conditioning compressor 11 and stopping the air conditioning compressor 11. Therefore, in this case, the efficiency of the air conditioning and hot water supply system S is deteriorated.

[0112] In step S409, the control device 4 estimates the air conditioning electric power consumption deterioration rate ε during the intermittent operation. Then, the control device 4 estimates the air conditioning electric power consumption Wac1 in view of the intermittent operation. It should be noted that the air conditioning electric power consumption deterioration rate ε is estimated on the basis of the air conditioning compressor target rotation speed Ncp_ac and the air conditioning compressor minimum rotation speed Ncp_acmin. The air conditioning electric power consumption Wac1 estimated in view of the intermittent operation is estimated on the basis of the air conditioning load Qac estimated in step S401, outdoor temperature Tao, indoor setting temperature Tac_set, air conditioning electric power consumption deterioration

rate ε .

[0113] In step S410, the control device 4 estimates the hot water supply load Q_{ec} . It should be noted that the hot water supply load Q_{ec} is estimated on the basis of the outdoor temperature T_{ao} , the water feeding temperature T_{wi} , the hot water supply temperature T_{wo} , and the water feeding flow amount V_w .

[0114] In step S411, the control device 4 estimates the hot water supply electric power consumption W_{ec} . It should be noted that the hot water supply electric power consumption W_{ec} is estimated on the basis of the hot water supply load Q_{ec} estimated in step S304, the outdoor temperature T_{ao} , and the hot water supply temperature T_{wo} .

[0115] In step S412, the control device 4 estimates the single total electric power consumption W_{sys1} . It should be noted that the single total electric power consumption W_{sys1} is estimated by adding the air conditioning electric power consumption W_{ac1} in view of the intermittent operation estimated in step S409 and the hot water supply electric power consumption W_{ec} estimated in step S411 (more specifically, $W_{sys1} = W_{ac1} + W_{ec}$).

[0116] In step S413, the control device 4 estimates the air conditioning quasi-load Q_{ac_ec} . It should be noted that the air conditioning quasi-load Q_{ac_ec} is estimated on the basis of the outdoor temperature T_{ao} , the water feeding temperature T_{wi} , the hot water supply temperature T_{wo} , and the water feeding flow amount V_w .

[0117] In this case, in a case where the air conditioning and hot water supply system S is operated and controlled in the heating hot water supply operation (air conditioning surplus heating) mode (see Fig. 14), the air conditioning usage-side exchanger 19 of the air conditioning refrigerant circuit 10 is caused to function as a condenser, and the intermediate heat exchanger 21 of the air conditioning refrigerant circuit 10 is also caused to operate as a condenser.

[0118] Therefore, the air conditioning quasi-load Q_{ac_ec} is estimated where the hot water supply absorbed heat amount in the intermediate heat exchanger 21 of the hot water supply refrigerant circuit 30 is adopted as the air conditioning quasi-load of the intermediate heat exchanger 21 of the air conditioning refrigerant circuit 10.

[0119] In step S414, the control device 4 estimates the air conditioning load Q_{ac2} in view of the air conditioning quasi-load Q_{ac_ec} . It should be noted that the air conditioning load Q_{ac2} in view of the quasi-load is estimated by adding the air conditioning load Q_{ac} estimated in step S401 and the air conditioning quasi-load Q_{ac_ec} estimated in step S413 (more specifically, $Q_{ac2} = Q_{ac} + Q_{ac_ec}$).

[0120] In step S415, the control device 4 estimates the air conditioning electric power consumption W_{ac2} in view of the quasi-load. It should be noted that the air conditioning electric power consumption W_{ac2} is estimated on the basis of the air conditioning load Q_{ac2} estimated in step S414, the outdoor temperature T_{ao} , and the indoor setting temperature T_{ac_set} .

[0121] In step S416, the control device 4 estimates the hot water supply electric power consumption W_{ec2} in view of the air conditioning quasi-load Q_{ac_ec} . It should be noted that the hot water supply electric power consumption W_{ec2} is estimated on the basis of the air conditioning load Q_{ac2} estimated in step S414, the hot water supply load Q_{ec} estimated in step S410, the outdoor temperature T_{ao} , the hot water supply temperature T_{wo} , and the indoor setting temperature T_{ac_set} .

[0122] In step S417, the control device 4 estimates the surplus heat operation electric power consumption W_{sys2} . It should be noted that the surplus heat operation electric power consumption W_{sys2} is estimated by adding the air conditioning system electric power consumption W_{ac2} estimated in step S415 and the hot water supply system electric power consumption W_{ec2} estimated in step S416 (more specifically, $W_{sys2} = W_{ac2} + W_{ec2}$).

[0123] As described above, the control device 4 estimates the single total electric power consumption W_{sys1} (see S407 and S412), and estimates the surplus heat operation electric power consumption W_{sys2} (see S408, S417), and terminates the processing in step S201 of Fig. 3, and proceeds to step S202.

(Control processing in each operation mode)

[0124] Subsequently, each operation mode of the air conditioning and hot water supply system S executed by the control device 4 will be explained with reference to Figs. 6 to 14. The control device 4 determines that the operation mode of the air conditioning and hot water supply system S (see Figs. 2, 3), and performs various kinds of operations by controlling the air conditioning and hot water supply system S in accordance with the determined operation mode.

[0125] It should be noted that, in Figs. 6 to 14 explained below, the pipes where the first refrigerant, the second refrigerant, the heat transfer media, and the heated liquid are passed are denoted with thick lines, and the flow directions are indicated by arrows. In various kinds of valves (the hot water supply three-way switch valves 34, 37, the hot water supply second expansion valve 36, and the hot water supply refrigerant control valve 39), the side of each valve which is closed is indicated as being filled in black.

(Stand-by mode: step S103)

[0126] In this mode, the air conditioning refrigerant circuit 10, the hot water supply refrigerant circuit 30, the air conditioning heat transfer media circulating circuit 40, and the hot water supply circuit 50 are at a stop. The control device 4 waits for input of an operation command. When an operation command is input, the operation mode of the air conditioning and hot water supply system S is determined (see Figs. 2, 3).

(Hot water supply operation mode: step S104)

[0127] Fig. 6 is a system diagram showing a flow of refrigerant and heated liquid of the heat pump unit 1 in the hot water supply operation mode.

[0128] In this mode, the air conditioning refrigerant circuit 10 and the air conditioning heat transfer media circulating circuit 40 are at a stop. The passage of the flow of the refrigerant to the intermediate heat exchanger 21 is stopped in the hot water supply refrigerant circuit 30.

[0129] The hot water supply refrigerant circuit 30 will be explained. The control device 4 fully opens the hot water supply refrigerant control valve 39 and completely closes the hot water supply second expansion valve 36, and the control device 4 controls the hot water supply three-way switch valves 34, 37, so that the refrigerant in the hot water supply refrigerant circuit 30 passes the hot water supply heat source-side exchanger 35 and flows making a detour around the intermediate heat exchanger 21. The control device 4 also controls the degree of opening (diaphragm of the opening) of the hot water supply first expansion valve 33. The control device 4 controls the rotation speeds of the hot water supply compressor 31 and the hot water supply fan 35f.

[0130] The high-temperature high-pressure second refrigerant discharged from the hot water supply compressor 31 flows into the primary-side heat transfer pipe 32a of the hot water supply usage-side exchanger 32 that functions as a condenser. The second refrigerant passing through the primary-side heat transfer pipe 32a of the hot water supply usage-side exchanger 32 exchanged heat with the heated liquid passing through the secondary-side heat transfer pipe 32b of the hot water supply usage-side exchanger 32, so that the heat is radiated, and the second refrigerant is made into a medium-temperature high-pressure second refrigerant.

[0131] The medium-temperature high-pressure second refrigerant that has flown out of the primary-side heat transfer pipe 32a of the hot water supply usage-side exchanger 32 is depressurized by the hot water supply first expansion valve 33, so that it is made into a low-temperature low-pressure second refrigerant.

[0132] Then, the low-temperature low-pressure second refrigerant flows into the hot water supply heat source-side exchanger 35 functioning as an evaporator via the hot water supply three-way switch valve 34. The second refrigerant passing through the hot water supply heat source-side exchanger 35 exchanges heat with the air (outdoor air) blown by the hot water supply fan 35f, so that the heat is drawn from the air (heat is absorbed from the air). Then, the second refrigerant that has absorbed heat is passed to the hot water supply compressor 31 from the hot water supply heat source-side exchanger 35 via the hot water supply refrigerant control valve 39 and the hot water supply three-way switch valve 37, thus circulating in the hot water supply refrigerant circuit 30.

[0133] Subsequently, the hot water supply circuit 50 will be explained. The control device 4 controls the rota-

tion speed of the second pump 51.

[0134] By driving the second pump 51, the heated liquid flown out of the lower portion of the tank 52 flows into the secondary-side heat transfer pipe 32b of the hot water supply usage-side exchanger 32. The heated liquid passing through the secondary-side heat transfer pipe 32b of the hot water supply usage-side exchanger 32 exchanges heat with the second refrigerant passing through the primary-side heat transfer pipe 32a of the hot water supply usage-side exchanger 32, so that the heat is absorbed, and it is made into a high-temperature heated liquid. Then, the high-temperature heated liquid is returned back from the secondary-side heat transfer pipe 32b of the hot water supply usage-side exchanger 32 to the upper portion of the tank 52, and accumulated therein.

(Cooling operation (normal) mode: step S108)

[0135] Fig. 7 is a system diagram showing a flow of refrigerant and heat transfer media of the heat pump unit 1 in the cooling operation (normal) mode.

[0136] In this mode, the hot water supply refrigerant circuit 30 and the hot water supply circuit 50 are at a stop. The flow of the refrigerant to the intermediate heat exchanger 21 is stopped in the hot water supply refrigerant circuit 30.

[0137] The air conditioning refrigerant circuit 10 will be explained. The control device 4 performs control so that switching means (not shown) in the first four-way switch valve 12 and the second four-way switch valve 14 are at the positions of the cooling operation.

[0138] More specifically, the control device 4 controls the first four-way switch valve 12 so that the first refrigerant flown out from the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19 flows into the air conditioning compressor 11, and controls the second four-way switch valve 14 so that the first refrigerant discharged from the air conditioning compressor 11 flows into the air conditioning heat source-side exchanger 15.

[0139] The control device 4 performs control so to fully open the air conditioning second expansion valve 16, and controls the degree of opening (diaphragm of the opening) of the air conditioning first expansion valve 18. The control device 4 also controls the rotation speeds of the air conditioning compressor 11 and the air conditioning fan 15f. As shown in Fig. 7, when the second four-way switch valve 14 is controlled, the high-temperature high-pressure first refrigerant discharged from the air conditioning compressor 11 can be caused to flow into the air conditioning heat source-side exchanger 15 before the intermediate heat exchanger 21. More specifically, in the case opposite to the above case (in a case where the first refrigerant flows into the intermediate heat exchanger 21 before the air conditioning heat source-side exchanger 15), the high-temperature high-pressure first refrigerant discharged from the air conditioning compressor 11 radiates heat in the intermediate heat ex-

changer 21. As a result, the temperature of the first refrigerant reduces, and the amount of heat radiation to the outdoor air decreases in the air conditioning heat source-side exchanger 15. Therefore, it is necessary to compensate the amount of heat radiation by compressing the first refrigerant using the compressor 11, and accordingly, the load of the compressor 11 increases.

[0140] The high-temperature high-pressure first refrigerant discharged from the air conditioning compressor 11 flows into the air conditioning heat source-side exchanger 15, that functions as a condenser, via the first four-way switch valve 12 and the second air conditioning four-way switch valve 1.

[0141] The first refrigerant passing through the air conditioning heat source-side exchanger 15 radiates heat (exhaust heat) by exchanging heat with the air (outdoor air) blown by the air conditioning fan 15f, so that the first refrigerant is made into a medium-temperature high-pressure first refrigerant. The medium-temperature high-pressure first refrigerant flown out from the air conditioning heat source-side exchanger 15 flows into the air conditioning first expansion valve 18 via the air conditioning second expansion valve 16, the primary-side heat transfer pipe 21a of the intermediate heat exchanger 21, and the second four-way switch valve 14.

[0142] Then, the medium-temperature high-pressure first refrigerant is decompressed by the air conditioning first expansion valve 18, so that it is made into a low-temperature low-pressure first refrigerant, and the first refrigerant flows into the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19 functioning an evaporator. The first refrigerant passing through the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19 exchanged heat with the heat transfer media passing through the primary-side heat transfer pipe 19a of the air conditioning usage-side exchanger 19, so that the heat is drawn from the heat transfer media (the heat is absorbed). Then, the first refrigerant having absorbed heat is passed from the air conditioning usage-side exchanger 19 via the first four-way switch valve 12 to the air conditioning compressor 11, and circulates in the air conditioning refrigerant circuit 10.

[0143] Subsequently, the air conditioning heat transfer media circulating circuit 40 will be explained. The control device 4 controls the rotation speeds of the first pump 41 and the indoor fan 43f. The control device 4 controls the heat transfer media four-way switch valve 42 so that the heat transfer media passing through the primary-side heat transfer pipe 19a of the air conditioning usage-side exchanger 19 and the first refrigerant passing through the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19 are made into countercurrents.

[0144] By driving the first pump 41, the heat transfer media flows into the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19. The heat transfer media passing through the secondary-side

heat transfer pipe 19b of the air conditioning usage-side exchanger 19 exchanges heat (exhaust heat) with the first refrigerant passing through the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19, so that it is made into a low-temperature heat transfer media.

[0145] Then, the low-temperature heat transfer media flows into the indoor exchanger 43 of the indoor unit 2. The heat transfer media passing through the indoor exchanger 43 exchanges heat with the air (indoor air) blown by the indoor fan 43f, so that the heat is absorbed. Then, the heat transfer media having absorbed heat is passed from the indoor exchanger 43 to the first pump 42, and circulates in the air conditioning heat transfer media circulating circuit 40.

[0146] As described above, the heat transfer media absorbs heat in the indoor exchanger 43 of the indoor unit 2, so that the air (indoor air) is cooled, and the indoor (air conditioned space) is cooled.

(Cooling operation (natural circulation) mode: step S109)

[0147] Fig. 8 is a system diagram showing a flow of refrigerant and heat transfer media of the heat pump unit 1 in the cooling operation (natural circulation) mode.

[0148] The cooling operation (natural circulation) mode is an operation mode in a case where the air conditioning load is too high when the cooling operation is performed. In the operation mode, the heat of the first refrigerant passing through the primary-side heat transfer pipe 21a is radiated (exhaust heat) to the second refrigerant passing through the secondary-side heat transfer pipe 21b of the intermediate heat exchanger 21, so that the first refrigerant is further condensed.

[0149] More specifically, in the cooling operation (natural circulation) mode, the air conditioning load is too high, and therefore, the cooling operation (natural circulation) mode is different from the cooling operation (normal) mode (see Fig. 7) in that the insufficient amount of heat radiation of the first refrigerant in air conditioning heat source-side exchanger 15 is compensated such that the heat is radiated in the intermediate heat exchanger 21 that functions as a condenser.

[0150] It should be noted that in order to execute the cooling operation in the cooling operation (natural circulation) mode, it is necessary to provide a head difference between the hot water supply heat source-side exchanger 35 and the intermediate heat exchanger 21. More specifically, as shown in Fig. 8, the hot water supply heat source-side exchanger 35 installed at a position higher than the intermediate heat exchanger 21 by a predetermined height H. This is because, in the hot water supply refrigerant circuit 30, the second refrigerant that has radiated heat in the hot water supply heat source-side exchanger 35 functioning as a condenser and had made into liquid state is caused to flow into the intermediate heat exchanger 21 due to its own weight.

[0151] In this mode, the hot water supply circuit 50 is

stopped. The air conditioning heat transfer media circulating circuit 40 is the same as the cooling operation (normal) mode explained above, and therefore, explanation thereabout is omitted.

[0152] The air conditioning refrigerant circuit 10 is the same as the cooling operation (normal mode) explained above except the feature that not only the air conditioning heat source-side exchanger 15 but also the intermediate heat exchanger 21 function as condensers, and therefore, explanation thereabout is omitted.

[0153] The hot water supply refrigerant circuit 30 will be explained. The control device 4 completely closes the hot water supply refrigerant control valve 39, controls the hot water supply three-way switch valves 34, 37, and fully opens the hot water supply second expansion valve 36, so that a circular circuit is formed by the hot water supply heat source-side exchanger 35, the pipe 35a, the hot water supply second expansion valve 36, the secondary-side heat transfer pipe 21b of the intermediate heat exchanger 21, and the pipes 37a, 38a. The control device 4 controls the rotation speed of the hot water supply fan 35f.

[0154] The second refrigerant flows, in the low-temperature liquid state, into the secondary-side heat transfer pipe 21b of the intermediate heat exchanger 21 that functions as an evaporator. Then, the second refrigerant absorbs heat from the first refrigerant passing through the primary-side heat transfer pipe 21a of the intermediate heat exchanger 21. Accordingly, the second refrigerant is evaporated, and the second refrigerant is made into an upward stream to pass through the pipes 37a, 38a, and flows into the hot water supply heat source-side exchanger 35 that functions as a condenser.

[0155] When the medium-temperature second refrigerant in the gaseous state passes through the hot water supply heat source-side exchanger 35, the second refrigerant exchanges heat with the air (outdoor air) blown by the hot water supply fan 35f, and the second refrigerant radiates heat, so that it is made into a low-temperature liquid state. Then, the low-temperature second refrigerant in the liquid state descends in the pipe 35a due to its own weight, and flows into the secondary-side heat transfer pipe 21b of the intermediate heat exchanger 21 via the hot water supply second expansion valve 36, thus circulating in the hot water supply refrigerant circuit 30.

(Heating operation mode: step S110)

[0156] Fig. 9 is a system diagram showing a flow of refrigerant and heat transfer media in the heat pump unit 1 in the heating operation mode.

[0157] In this mode, the hot water supply refrigerant circuit 30 and the hot water supply circuit 50 are at a stop. The passage of the refrigerant to the intermediate heat exchanger 21 is stopped in the hot water supply refrigerant circuit 30.

[0158] The air conditioning refrigerant circuit 10 will be explained. The control device 4 performs control so that

switching means (not shown) in the first four-way switch valve 12 and the second four-way switch valve 14 are at the positions of the heating operation mode.

[0159] More specifically, the control device 4 controls the first four-way switch valve 12 so that the first refrigerant discharged from the air conditioning compressor 11 flows into the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19, and controls the second four-way switch valve 14 so that the first refrigerant flown from the intermediate heat exchanger 21 flows into the air conditioning compressor 11.

[0160] The control device 4 fully opens the air conditioning second expansion valve 16, and controls the degree of opening (diaphragm of the opening) of the air conditioning first expansion valve 18. The control device 4 controls the rotation speed of the air conditioning compressor 11 and air conditioning fan 15f.

[0161] As shown in Fig. 9, by controlling the second four-way switch valve 14, the low-temperature low-pressure first refrigerant flown out from the air conditioning first expansion valve 18 can be caused to flow into the air conditioning heat source-side exchanger 15 before the intermediate heat exchanger 21. In this case, the temperature of the first refrigerant that has exchanged heat with the air (outdoor air) blown by the air conditioning fan 15f does not become higher than the temperature of the air, and therefore, the first refrigerant does not radiate heat in the primary-side heat transfer pipe 21a of the intermediate heat exchanger 21.

[0162] By the case, in the case opposite to the above case (in a case where the first refrigerant flows into the intermediate heat exchanger 21 before the air conditioning heat source-side exchanger 15), the low-temperature low-pressure first refrigerant discharged from the air conditioning first expansion valve 18 absorbs heat in the intermediate heat exchanger 21, so that the dryness of the first refrigerant is increased. Therefore, in the upstream portion of the air conditioning heat source-side exchanger 15, the temperature difference between the temperature of the first refrigerant and the outdoor air temperature cannot be maintained, and thus the amount of heat absorbed by the first refrigerant decreases. Therefore, it is necessary to use the compressor 11 to compensate the absorbed heat amount, and therefore the load of the compressor 11 increases.

[0163] The high-temperature high-pressure first refrigerant discharged from the air conditioning compressor 11 flows into the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19 that functions as a condenser. The first refrigerant passing through the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19 exchanged heat with the heat transfer media passing through the primary-side heat transfer pipe 19a of the air conditioning usage-side exchanger 19, so that the heat is radiated, and the first refrigerant is made into a medium-temperature high-pressure first refrigerant. The medium-temperature high-pressure first refrigerant flown out from the

air conditioning usage-side exchanger 19 is depressurized by the air conditioning first expansion valve 18, and the first refrigerant is made into a low-temperature low-pressure first refrigerant.

[0164] Then, the low-temperature low-pressure first refrigerant flows into the air conditioning heat source-side exchanger 15 that functions as an evaporator. The first refrigerant passing through the air conditioning heat source-side exchanger 15 exchanges heat with the air (outdoor air) blown by the air conditioning fan 15f, so that the heat is drawn from the air (the heat is absorbed). Then, the first refrigerant having absorbed heat is passed from the air conditioning heat source-side exchanger 15 via the air conditioning second expansion valve 16, the intermediate heat exchanger 21, the second four-way switch valve 14, and the first four-way switch valve 12 to the air conditioning compressor 11, thus circulating in the air conditioning refrigerant circuit 10.

[0165] Subsequently, the air conditioning heat transfer media circulating circuit 40 will be explained. The control device 4 controls the rotation speeds of the first pump 41 and the indoor fan 43f.

[0166] By driving the first pump 41, the heat transfer media flows into the primary-side heat transfer pipe 19a of the air conditioning usage-side exchanger 19. The heat transfer media passing through the primary-side heat transfer pipe 19a of the air conditioning usage-side exchanger 19 exchanges heat with the first refrigerant passing through the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19, so that the heat is absorbed, and heat transfer media is made into a high-temperature heat transfer media.

[0167] Then, the high-temperature heat transfer media flows into the indoor exchanger 43 of the indoor unit 2. The heat transfer media passing through the indoor exchanger 43 exchanged heat with the air (indoor air) blown by the indoor fan 43f, so that the heat is radiated. Then, the heat transfer media having radiated the heat is passed from the indoor exchanger 43 to the first pump 41, thus circulating in the air conditioning heat transfer media circulating circuit 40.

[0168] As described above, the heat transfer media radiates heat in the indoor exchanger 43 of the indoor unit 2, so that the air (indoor air) is heated, and the indoor space (air conditioned space) is heated.

(Cooling hot water supply operation (exhaust heat recovery A) mode: step S114)

[0169] Fig. 10 is a system diagram showing a flow of refrigerant, heat transfer media and heated liquid in the heat pump unit 1 in the cooling hot water supply operation (exhaust heat recovery A) mode.

[0170] In this case, the exhaust heat recovery A satisfies "the air conditioning exhaust heat > the hot water supply absorbed heat", and the exhaust heat of the air conditioning refrigerant circuit 10 is recovered via the intermediate heat exchanger 21 by the hot water supply

refrigerant circuit 30, and the excessive air conditioning exhaust heat is discharged to the outdoor air.

[0171] The operation of the hot water supply circuit 50 is the same as that of the hot water supply operation mode as shown in Fig. 6, and explanation thereabout is omitted. The operation of the air conditioning heat transfer media circulating circuit 40 is the same as the cooling operation (normal) mode as shown in Fig. 7, and explanation thereabout is omitted.

[0172] The air conditioning refrigerant circuit 10 will be explained. The difference between the air conditioning refrigerant circuit 10 in the cooling operation (normal) mode (see Fig. 7) and the air conditioning refrigerant circuit 10 in the cooling hot water supply operation (exhaust heat recovery A) mode (see Fig. 10) is that, in the cooling operation (normal) mode, only the air conditioning heat source-side exchanger 15 functions as a condenser, and in the cooling hot water supply operation (exhaust heat recovery A) mode, not only the air conditioning heat source-side exchanger 15 but also the intermediate heat exchanger 21 function as condensers.

[0173] The difference is that, in the cooling operation (normal) mode, the second four-way switch valve 14 is controlled so that the first refrigerant discharged from the air conditioning compressor 11 flows into the air conditioning heat source-side exchanger 15, and in the cooling hot water supply operation (exhaust heat recovery A) mode, the second four-way switch valve 14 is controlled so that the first refrigerant discharged from the air conditioning compressor 11 flows into the intermediate heat exchanger 21.

[0174] The high-temperature high-pressure first refrigerant discharged from the air conditioning compressor 11 flows via the first four-way switch valve 12 and the second four-way switch valve 14 into the primary-side heat transfer pipe 21a of the intermediate heat exchanger 21 that functions as a condenser. The high-temperature high-pressure first refrigerant passing through the primary-side heat transfer pipe 21a of the intermediate heat exchanger 21 exchanges heat with the low-temperature low-pressure second refrigerant passing through the secondary-side heat transfer pipe 21b of the intermediate heat exchanger 21, so that the heat is radiated (exhaust heat).

[0175] Then, the first refrigerant flows via the air conditioning second expansion valve 16 into the air conditioning heat source-side exchanger 15 that functions as a condenser. The first refrigerant passing through the air conditioning heat source-side exchanger 15 exchanges heat with the air (outdoor air) blown by the air conditioning fan 15f, so that the heat is further radiated (exhaust heat), and the first refrigerant is made into a medium-temperature high-pressure first refrigerant.

[0176] The medium-temperature high-pressure first refrigerant flown out from the air conditioning heat source-side exchanger 15 flows via the second four-way switch valve 14 into the air conditioning first expansion valve 18, and the first refrigerant is decompressed by the

air conditioning first expansion valve 18, so that it is made into a low-temperature low-pressure first refrigerant.

[0177] Then, the low-temperature low-pressure first refrigerant flows into the primary-side heat transfer pipe 19a of the air conditioning usage-side exchanger 19 that functions as an evaporator. The first refrigerant passing through the primary-side heat transfer pipe 19a of the air conditioning usage-side exchanger 19 exchanged heat with the heat transfer media passing through the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19, so that the heat is drawn from the heat transfer media (the heat is absorbed). Then, the first refrigerant having absorbed heat is passed from the air conditioning usage-side exchanger 19 to the air conditioning compressor 11, thus circulating in the air conditioning refrigerant circuit 10.

[0178] As shown in Fig. 10, the second four-way switch valve 14 is controlled, so that the high-temperature high-pressure first refrigerant discharged from the compressor 11 can be caused to flow into the intermediate heat exchanger 21 before the air conditioning heat source-side exchanger 15. The first refrigerant passing through the primary-side heat transfer pipe 21a of the intermediate heat exchanger 21 and the second refrigerant passing through the secondary-side heat transfer pipe 21b of the intermediate heat exchanger 21 can be made into countercurrents. Therefore, the amount of heat radiated from the first refrigerant to the second refrigerant in the intermediate heat exchanger 21 can be increased.

[0179] Subsequently, the hot water supply refrigerant circuit 30 will be explained. The difference between the hot water supply refrigerant circuit 30 in the hot water supply operation mode (see Fig. 6) and the hot water supply refrigerant circuit 30 in the cooling hot water supply operation (exhaust heat recovery A) mode (see Fig. 10) is that, in the hot water supply operation mode, the second refrigerant passes through the hot water supply heat source-side exchanger 35, and in the cooling hot water supply operation (exhaust heat recovery A) mode, the second refrigerant passes through the hot water supply heat source-side exchanger 35.

[0180] The difference is that, in the hot water supply operation mode, the second refrigerant does not pass through the intermediate heat exchanger 21, and in the cooling hot water supply operation (exhaust heat recovery A) mode, the second refrigerant passes through the intermediate heat exchanger 21.

[0181] The control device 4 fully opens the hot water supply refrigerant control valve 39 and the hot water supply second expansion valve 36, and controls the hot water supply three-way switch valves 34, 37, so that a circle-like circuit is formed by the hot water supply compressor 31, the hot water supply usage-side exchanger 32, the hot water supply first expansion valve 33, the pipe 35a, the hot water supply second expansion valve 36, the intermediate heat exchanger 21, and the pipe 37a. The control device 4 controls the degree of opening (diaphragm of the opening) of the hot water supply first ex-

pansion valve 33, and stops the hot water supply fan 35f.

[0182] The high-temperature high-pressure second refrigerant discharged from the hot water supply compressor 31 flows into the primary-side heat transfer pipe 32a of the hot water supply usage-side exchanger 32 that functions as a condense. The second refrigerant passing through the primary-side heat transfer pipe 32a of the hot water supply usage-side exchanger 32 exchanges heat with the heated liquid passing through the secondary-side heat transfer pipe 32b of the hot water supply usage-side exchanger 32, so that the heat is radiated, and the second refrigerant is made into a medium-temperature high-pressure second refrigerant. The medium-temperature high-pressure second refrigerant flown out from the primary-side heat transfer pipe 32a of the hot water supply usage-side exchanger 32 is decompressed by the hot water supply first expansion valve 33, so that the second refrigerant is made into a low-temperature low-pressure second refrigerant.

[0183] Then, the low-temperature low-pressure second refrigerant flows via the three-way switch valve 34, the hot water supply refrigerant control valve 39, the pipe 35a, and the hot water supply second expansion valve 36 into the secondary-side heat transfer pipe 21b of the intermediate heat exchanger 21 that functions as an evaporator. The second refrigerant passing through the secondary-side heat transfer pipe 21b of the intermediate heat exchanger 21 exchanges heat with the first refrigerant passing through the primary-side heat transfer pipe 21a of the intermediate heat exchanger 21, so that the heat is drawn from the first refrigerant (the heat is absorbed). Then, the second refrigerant having absorbed the heat is passed from the secondary-side heat transfer pipe 21b of the intermediate heat exchanger 21 to the hot water supply compressor 31, thus circulating the hot water supply refrigerant circuit 30.

(Cooling hot water supply operation (exhaust heat recovery B) mode: step S116)

[0184] Fig. 11 is a system diagram showing a flow of refrigerant, heat transfer media and heated liquid in the heat pump unit 1 in the cooling hot water supply operation (exhaust heat recovery B) mode.

[0185] In this case, the exhaust heat recovery B satisfies "the air conditioning exhaust heat = the hot water supply absorbed heat", and the exhaust heat of the air conditioning refrigerant circuit 10 is recovered via the intermediate heat exchanger 21 by the hot water supply refrigerant circuit 30.

[0186] The operation of the hot water supply circuit 50 is the same as that of the hot water supply operation mode (see Fig. 6), the operation of the air conditioning heat transfer media circulating circuit 40 is the same as that of the cooling operation (normal) mode (see Fig. 7), and the operation of the hot water supply refrigerant circuit 30 is the same as that of the cooling hot water supply operation (exhaust heat recovery A) mode (see Fig. 10),

and therefore, explanation thereabout is omitted.

[0187] The air conditioning refrigerant circuit 10 will be explained. The difference between the air conditioning refrigerant circuit 10 in the cooling hot water supply operation (exhaust heat recovery A) mode (see Fig. 10) and the air conditioning refrigerant circuit 10 in the cooling hot water supply operation (exhaust heat recovery B) mode (see Fig. 11) is that, in the cooling hot water supply operation (exhaust heat recovery A) mode, the control device 4 rotates the air conditioning fan 15f, and in the cooling hot water supply operation (exhaust heat recovery B) mode, the control device 4 stops the rotation of the air conditioning fan 15f.

[0188] The other controls are the same as those of the air conditioning refrigerant circuit 10 in the cooling hot water supply operation (exhaust heat recovery A) mode, and therefore explanation thereabout is omitted.

[0189] As explained above, in the cooling hot water supply operation (exhaust heat recovery B) mode, "the air conditioning exhaust heat = the hot water supply absorbed heat" is satisfied. Therefore, the first refrigerant passing through the air conditioning refrigerant circuit 10 and the second refrigerant passing through the hot water supply refrigerant circuit 30 exchange heat in the intermediate heat exchanger 21, so that the exhaust heat from the air conditioning-side can be provided to the hot water supply-side (the heat can be absorbed) as it is.

(Cooling hot water supply operation (exhaust heat recovery C) mode: step S117)

[0190] Fig. 12 is a system diagram showing a flow of refrigerant, heat transfer media and heated liquid in the heat pump unit 1 in the cooling hot water supply operation (exhaust heat recovery C) mode.

[0191] In this case, the exhaust heat recovery C satisfies "the air conditioning exhaust heat < the hot water supply absorbed heat", and the exhaust heat of the air conditioning refrigerant circuit 10 is recovered via the intermediate heat exchanger 21 by the hot water supply refrigerant circuit 30, and the insufficient amount of heat required for the hot water supply is absorbed from the outdoor air.

[0192] The operation of the hot water supply circuit 50 is the same as that of the hot water supply operation mode (see Fig. 6), the operation of the air conditioning heat transfer media circulating circuit 40 is the same as that of the cooling operation (normal) mode (see Fig. 7), and the operation of the air conditioning refrigerant circuit 10 is the same as that of the cooling hot water supply operation (exhaust heat recovery B) mode (see Fig. 11), and therefore explanation thereabout is omitted.

[0193] The hot water supply refrigerant circuit 30 will be explained. The difference between the hot water supply refrigerant circuit 30 in the cooling hot water supply operation (exhaust heat recovery B) mode as shown in Fig. 11 and the hot water supply refrigerant circuit 30 in the cooling hot water supply operation (exhaust heat re-

covery C) mode as shown in Fig. 12 is that, in the exhaust heat recovery B mode, the second refrigerant makes a detour around the hot water supply heat source-side exchanger 35, and in the exhaust heat recovery C mode, the second refrigerant passes through the hot water supply heat source-side exchanger 35 and the secondary-side heat transfer pipe 21b of the intermediate heat exchanger 21 without making a detour around the hot water supply heat source-side exchanger 35.

[0194] More specifically, the control device 4 controls the hot water supply three-way switch valves 34, 37, and closes the hot water supply refrigerant control valve 39, so that the second refrigerant can pass through the hot water supply heat source-side exchanger 19 and the intermediate heat exchanger 21.

[0195] The control device 4 controls the degree of opening (diaphragm of the opening) of the hot water supply first expansion valve 33, and fully opens the hot water supply second expansion valve 36. The control device 4 controls the rotation speeds of the hot water supply compressor 31 and the hot water supply fan 35f.

[0196] The high-temperature high-pressure second refrigerant discharged from the hot water supply compressor 31 flows into the primary-side heat transfer pipe 32a of the hot water supply usage-side exchanger 32 that functions as a condenser. The second refrigerant passing through the primary-side heat transfer pipe 32a of the hot water supply usage-side exchanger 32 exchanged heat with the heated liquid passing through the secondary-side heat transfer pipe 32b of the hot water supply usage-side exchanger 32, so that the heat is radiated (exhaust heat), and the second refrigerant is made into a medium-temperature high-pressure second refrigerant. The medium-temperature high-pressure second refrigerant flown out from the primary-side heat transfer pipe 32a of the hot water supply usage-side exchanger 32 is decompressed by the hot water supply first expansion valve 33, so that the second refrigerant is made into a low-temperature low-pressure second refrigerant.

[0197] Then, the low-temperature low-pressure second refrigerant flows via the hot water supply three-way switch valve 34 into the hot water supply heat source-side exchanger 35 that functions as an evaporator. Then, the second refrigerant passing through the hot water supply heat source-side exchanger 35 exchanges heat with the air (outdoor air) blown by the hot water supply fan 35f, so that the heat is drawn from the air (the heat is absorbed).

[0198] Further, the second refrigerant flown out from the hot water supply heat source-side exchanger 35 flows into the secondary-side heat transfer pipe 21b of the intermediate heat exchanger 12 that functions as an evaporator. The second refrigerant passing through the secondary-side heat transfer pipe 21b of the intermediate heat exchanger 21 exchanges heat with the first refrigerant passing through the primary-side heat transfer pipe 21a of the intermediate heat exchanger 21, and the heat is drawn from the first refrigerant (the heat is absorbed).

[0199] The second refrigerant flown out from the secondary-side heat transfer pipe 21b of the intermediate heat exchanger 21 is passed to the hot water supply compressor 31 via the hot water supply three-way switch valve 37, thus circulating in the hot water supply refrigerant circuit 30.

(Heating hot water supply operation (independent) mode: step S203)

[0200] Fig. 13 is a system diagram showing a flow of refrigerant, heat transfer media and heated liquid in the heat pump unit 1 in the heating hot water supply operation (independent) mode.

[0201] In this mode, the passage of the refrigerant to the intermediate heat exchanger 21 is stopped in the hot water supply refrigerant circuit 30.

[0202] The operations of the hot water supply refrigerant circuit 30 and the hot water supply circuit 50 are the same as that of the hot water supply operation mode (see Fig. 6), and the operations of the air conditioning refrigerant circuit 10 and the air conditioning heat transfer media circulating circuit 40 are the same as that of the heating operation mode (see Fig. 9), and explanation thereabout is omitted.

(Heating hot water supply operation (air conditioning surplus heating) mode: step S204)

[0203] Fig. 14 is a system diagram showing a flow of refrigerant, heat transfer media and heated liquid of the heat pump unit 1 in the heating hot water supply operation (air conditioning surplus heating) mode.

[0204] This mode is executed in a case where the air conditioning load (heating load) is small, and the surplus heat of the air conditioning refrigerant circuit 10 is recovered via the intermediate heat exchanger 21 by the hot water supply refrigerant circuit 30.

[0205] The operation of the hot water supply circuit 50 is the same as that of the hot water supply operation mode (see Fig. 6), the operation of the air conditioning heat transfer media circulating circuit 40 is the same as that of the heating operation mode (see Fig. 9), and the operation of the hot water supply refrigerant circuit 30 is the same as that of the cooling hot water supply operation (exhaust heat recovery A) mode (see Fig. 10), and explanation thereabout is omitted.

[0206] The air conditioning refrigerant circuit 10 will be explained. The difference between the air conditioning refrigerant circuit 10 in the heating operation (mode (see Fig. 9) and the air conditioning refrigerant circuit 10 in the heating hot water supply operation (air conditioning surplus heating) mode (see Fig. 14) is that, in the heating operation mode, the intermediate heat exchanger 21 does not function as a condenser, and in the heating hot water supply operation (air conditioning surplus heating) mode, the intermediate heat exchanger 21 functions as a condenser.

[0207] The control device 4 performs control so that switching means (not shown) in the first four-way switch valve 12 and the second four-way switch valve 14 are at the positions of the heating hot water supply operation (air conditioning surplus heating) mode.

[0208] More specifically, the control device 4 controls the first four-way switch valve 12 so that the first refrigerant discharged from the air conditioning compressor 11 flows into the air conditioning usage-side exchanger 19. The control device 4 controls the second four-way switch valve 14 so that the first refrigerant flown out from the air conditioning heat source-side exchanger 15 flows into the air conditioning compressor 11.

[0209] Further, the control device 4 performs control so as to fully open the air conditioning first expansion valve 18, and controls the degree of opening (diaphragm of the opening) of the air conditioning second expansion valve 16. The control device 4 controls the rotation speeds of the air conditioning compressor 11 and the air conditioning fan 15f.

[0210] The high-temperature high-pressure first refrigerant discharged from the air conditioning compressor 11 flows via the first four-way switch valve 12 into the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19 that functions as a condenser. The first refrigerant passing through the secondary-side heat transfer pipe 19b of the air conditioning usage-side exchanger 19 exchanges heat with the heat transfer media passing through the primary-side heat transfer pipe 19a of the air conditioning usage-side exchanger 19, so that the heat is radiated (exhaust heat).

[0211] Then, the first refrigerant flows via the air conditioning first expansion valve 18 and the second four-way switch valve 14 into the primary-side heat transfer pipe 21a of the intermediate heat exchanger 21 that functions as a condenser. The first refrigerant passing through the primary-side heat transfer pipe 21a of the intermediate heat exchanger exchanges heat with the second refrigerant passing through the secondary-side heat transfer pipe 21b of the intermediate heat exchanger 21, and the heat is radiated to the second refrigerant (exhaust heat), so that the first refrigerant is made into a medium-temperature high-pressure first refrigerant.

[0212] Then, the medium-temperature high-pressure first refrigerant is decompressed by the air conditioning second expansion valve 16, and the first refrigerant is made into a low-temperature low-pressure first refrigerant. Further, the low-temperature low-pressure first refrigerant flows into the air conditioning heat source-side exchanger 15 that functions as an evaporator. The first refrigerant passing through the air conditioning heat source-side exchanger 15 exchanges heat with the air (outdoor air) blown by the air conditioning fan 15f, and the heat is drawn from the air (the heat is absorbed). Then, the first refrigerant having absorbed the heat is passed from the air conditioning heat source-side exchanger 15 via the second four-way switch valve 14 and the first four-way switch valve 12 to the air conditioning

compressor 11, thus circulating in the air conditioning refrigerant circuit 10.

<<Actions and effects of air conditioning and hot water supply system according to the present embodiment>>

[0213] According to the air conditioning and hot water supply system S according to the present embodiment, the air conditioning and hot water supply system S can be made that can operate the "hot water supply operation", the "cooling operation", the "cooling hot water supply operation", the "heating operation", and the "heating hot water supply operation" in accordance with user's request.

[0214] During the "cooling hot water supply operation", the cooling hot water supply operation (exhaust heat recovery A) mode, the cooling hot water supply operation (exhaust heat recovery B) mode, or the cooling hot water supply operation (exhaust heat recovery C) mode is executed in accordance with the relationship in the magnitude between the air conditioning exhaust heat and the hot water supply absorbed heat (see Fig. 2), so that the exhaust heat of the air conditioning refrigerant circuit 10 can be efficiently used for hot water supply and heating.

[0215] Therefore, the efficiency of the entire air conditioning and hot water supply system S can be improved.

[0216] In this case, explanation will be made while comparing the air conditioning apparatus (air conditioning and hot water supply system) described in PTL 1 and the air conditioning and hot water supply system S according to the present embodiment.

[0217] When the heating load is low during the heating operation (heating hot water supply operation), the air conditioning apparatus (the air conditioning and hot water supply system) described in PTL 1 is configured such that the first compressor (corresponding to air conditioning compressor 11 of the air conditioning and hot water supply system S according to the present embodiment) of the air conditioning cycle (air conditioning refrigerant circuit 10) performs the intermittent operation repeating the operation state and the stopped state, and therefore, there is a problem in that the operation efficiency of the air conditioning apparatus (air conditioning and hot water supply system) is reduced.

[0218] Therefore, the air conditioning and hot water supply system S according to the present embodiment is configured such that the second four-way switch valve 14 switches the direction of the first refrigerant passing through the air conditioning heat source-side exchanger 15 and the intermediate heat exchanger 21 in accordance with the operation mode, and even in the heating hot water supply operation, the primary-side heat transfer pipe 21a of the intermediate heat exchanger 21 (air conditioning refrigerant circuit 10) can be caused to function as a condenser (see Fig. 14).

[0219] Therefore, the air conditioning and hot water supply system S according to the present embodiment is configured such that, even when the heating load is

low during the heating hot water supply operation, a desired amount of heat (a portion of the high-temperature high-pressure first refrigerant discharged from the air conditioning compressor 11) is provided to the air conditioning usage-side exchanger 19 while the air conditioning compressor 11 maintains the continuous operation state, and thereafter, it is passed to the primary-side heat transfer pipe 21a of the intermediate heat exchanger 21 (see Fig. 14).

[0220] Therefore, after the required amount of heat is delivered to the air conditioning heat transfer media circulating circuit 40, the surplus amount of heat (the remaining portion of the high-temperature high-pressure first refrigerant discharged from the air conditioning compressor 11) can be passed to the primary-side heat transfer pipe 21a of the intermediate heat exchanger 21. As a result, without complicated control, the amount of heat required for the air conditioning can be ensured, and the air conditioning surplus heat can be given via the intermediate heat exchanger 21 to the hot water supply refrigerant circuit 30.

[0221] Accordingly, the air conditioning compressor 11 can be prevented from doing the intermittent operation, and the surplus heat can also be accumulated as the high-temperature heated liquid, and therefore, the operation efficiency can be improved in the entire air conditioning and hot water supply system S.

[0222] More specifically, in the air conditioning and hot water supply system S according to the present embodiment, the intermediate heat exchanger 21 can be caused to function as a condenser regardless of the cooling operation or the heating operation. Therefore, the heat (the exhaust heat and the surplus heat) can be passed from the air conditioning refrigerant circuit 10 to the hot water supply refrigerant circuit 30, and therefore, the air conditioning and hot water supply system can be established that can improve the operation efficiency throughout the year.

[0223] The effects of the air conditioning and hot water supply system S according to the present embodiment will be further explained. Fig. 15 is a graph showing change of heating load on or around the coldest day in Tokyo.

[0224] In Fig. 15, the vertical axis denotes a heating load [kW] (indicated by a solid line in the graph of Fig. 15), an outdoor air temperature [degrees Celsius] (indicated by a broken line in the graph of Fig. 15), and an amount of solar radiation [MJ] (indicated by alternate long and short dashed lines in the graph of Fig. 15), and the horizontal axis denotes a time [day], wherein Fig. 15 shows the day (time 0.0 to 1.0 [day]) before the coldest day (time 1.0 to 2.0 [day]) to the day (time 2.0 to 3.0 [day]) after the coldest day. It should be noted that the heating load is derived with regard to a highly insulated house where the Q value (heat loss coefficient) indicating the heat insulating performance is 1.6 [KW/m²·K].

[0225] To answer the recent demand for energy saving, it is tried to make a house (air conditioned space)

highly insulated and reduce the heating load during the winter. In the highly insulated house, the heating load is small, and therefore, the effect of energy saving can be obtained in the indoor air conditioning. However, when the heating load is reduced, the air conditioning compressor 11 of the air conditioning refrigerant circuit 10 may be in the intermittent operation state.

[0226] As shown in Fig. 15, the heating load rapidly drops during the day even in the coldest day (about 4.0 kW to about 0.6 kW in Fig. 15). In this case, when the heating load becomes equal to or less than a predetermined value (e.g., 1.0 kW), the air conditioning compressor 11 of the air conditioning refrigerant circuit 10 enters into the intermittent operation. Such intermittent operation is not preferable in terms of the operation efficiency.

[0227] As described above, in contrast to the energy saving effect expected by making a house highly insulated and reducing the heating load, the energy saving effect that can be obtained when the air conditioning system (air conditioning and hot water supply system) is actually operated is smaller because the air conditioning compressor 11 performs the intermittent operation.

[0228] Accordingly, the air conditioning and hot water supply system S according to the present embodiment is configured such that, even when the heating load is low during the heating operation, the air conditioning compressor 11 of the air conditioning refrigerant circuit 10 can be prevented from performing the intermittent operation. In the air conditioning and hot water supply system S according to the present embodiment, the primary-side heat transfer pipe 21a of the intermediate heat exchanger 21 can be caused to function as a condenser even during the heating operation, and therefore, the surplus heat of the air conditioning refrigerant circuit 10 can be used for the hot water supply, and the efficiency of the entire air conditioning and hot water supply system S can be improved.

[0229] The air conditioning and hot water supply system S determines the operation mode in accordance with the environment condition, the setting condition which is input from a remote controller (not shown), and the like. When the exhaust heat of the first refrigerant of the air conditioning refrigerant circuit 10 is required to be provided to the second refrigerant of the hot water supply refrigerant circuit 30, the air conditioning and hot water supply system S causes the intermediate heat exchanger to function as a condenser in the air conditioning refrigerant circuit 10.

[0230] Therefore, by making maximum use of the exhaust heat from the first refrigerant of the air conditioning refrigerant circuit 10, the efficiency of the entire air conditioning and hot water supply system S can be improved.

[0231] The air conditioning and hot water supply system S is configured such that, in a case where the air conditioning load is too high when the cooling operation is performed, natural circulation is performed in the hot water supply refrigerant circuit 30 even when the hot water supply operation is not performed, so that the inter-

mediate heat exchanger 10 can be caused to function as a condenser of the air conditioning refrigerant circuit 10 (see Fig. 8).

[0232] More specifically, without rotating the hot water supply compressor 31, the heat of the first refrigerant of the air conditioning refrigerant circuit 10 is absorbed by the second refrigerant of the hot water supply refrigerant circuit 30, so that an insufficient amount of air conditioning load can be compensated. Therefore, the efficiency of the entire air conditioning and hot water supply system S can be improved.

[0233] The air conditioning and hot water supply system S is configured such that the air conditioning heat source-side exchanger 15, the air conditioning usage-side exchanger 19, and the intermediate heat exchanger 21 are connected in series via various kinds of valves in the air conditioning refrigerant circuit 10. In the hot water supply refrigerant circuit 30, the hot water supply usage-side exchanger 32, the hot water supply heat source-side exchanger 35, and the intermediate heat exchanger 21 are connected in series via various kinds of valves.

[0234] If the exchangers are connected in parallel in the air conditioning refrigerant circuit 10 or the hot water supply refrigerant circuit 30, and control is performed to open and close various kinds of valves in accordance with the operation mode, surplus refrigerant may occur depending on the distribution of the refrigerant in the pipes. In such case, before starting the operation, first, it is necessary to adjust the distribution state of the refrigerant in the circuit.

[0235] Accordingly, in the air conditioning and hot water supply system S according to the present embodiment, the exchangers are connected in series in each circuit as explained above, and therefore, it is not necessary to adjust the distribution of the refrigerant in the circuit. This is because, in the air conditioning refrigerant circuit 10 and the hot water supply refrigerant circuit 30, the refrigerant is not diverted, and the refrigerant circulates in the circuit. Therefore, in the air conditioning and hot water supply system S according to the present embodiment, the operation can be smoothly started when the operation mode is switched, and the processing load of the control device 4 can be alleviated.

«Modification»

[0236] It should be noted that the air conditioning and hot water supply system S according to the present embodiment is not limited to the above embodiment, and can be changed in various manners without deviating from the gist of the invention.

[0237] For example, in the above embodiment, the first refrigerant is passed by fully open the air conditioning first expansion valve 18 in the air conditioning refrigerant circuit 10, but the embodiment is not limited thereto. More specifically, a bypass pipe is provided, one end of which is connected to the lower port of the second four-way switch valve 14, and the other end of which is connected

to the air conditioning first expansion valve 18, and the bypass pipe may be configured to have a two-way switch valve. Then when the air conditioning first expansion valve 18 is used as a decompression device, the control device 4 closes the two-way switch valve, and controls the degree of opening (diaphragm of the opening) of the air conditioning first expansion valve 18. When the air conditioning first expansion valve is not used as a decompression device, the control device 4 performs control so as to open the two-way switch valve, and close the air conditioning first expansion valve 18.

[0238] It should be noted that the above is also applicable to the air conditioning second expansion valve 16.

[0239] As compared with the two-way switch valve, the expansion valves (the first expansion valve 18 and the second expansion valve 16) have higher pressure losses when fully open, and therefore, when the refrigerant passes through the intermediate heat exchanger without decompression, the amount of heat exchange is reduced due to the pressure loss when the refrigerant passes through the expansion valve.

[0240] As described above, a bypass pipe and an on/off valve are installed in the air conditioning first expansion valve 18 and/or the air conditioning second expansion valve 16, and therefore, the pressure loss can be reduced in a case where each expansion valve is not used as a decompression device. Therefore, the efficiency of the entire air conditioning and hot water supply system S can be further improved.

[0241] In the above embodiment, the first expansion valve 18 and the second expansion valve 16 have been explained as variable diaphragms capable of continuously increasing and decreasing the amount of diaphragm (the degree of opening), but the embodiment is not limited thereto. More specifically, a fixed diaphragm valves for switching two patterns (larger/small) as the amount of diaphragm and having low pressure loss may be employed as the first expansion valve 18 and the second expansion valve 16.

[0242] In this case, as described above, the pressure loss in each expansion valve can be reduced without installing a bypass pipe and an on/off valve in the air conditioning first expansion valve 18 and/or the air conditioning second expansion valve 16. Therefore, the efficiency of the entire air conditioning and hot water supply system S can be improved, and the manufacturing cost can be reduced.

[0243] In the heating operation mode (see Fig. 9) and the heating hot water supply operation (independent) mode (see Fig. 13) in the embodiment explained above, the air conditioning first expansion valve 18 is used as a decompression device, but the embodiment is not limited thereto. More specifically, in each of the operation modes, the air conditioning second expansion valve 16 may be used as a decompression device.

[0244] In this case, the control device 14 controls switching means (not shown) of the second four-way switch valve 14 so that the first refrigerant flown out from

the second heat transfer pipe 19b of the air conditioning usage-side exchanger 19 flows via the air conditioning first expansion valve 18 into the intermediate heat exchanger 21, and the first refrigerant flown out from the air conditioning heat source-side exchanger 15 flows via the second four-way switch valve 14 and the first four-way switch valve 12 into the air conditioning compressor 11.

[0245] The control device 4 fully opens the air conditioning first expansion valve 18, and controls the degree of opening (diaphragm of the opening) of the air conditioning second expansion valve 16.

[0246] When the control device 4 performs control explained above, the valves function as follows: in the cooling operation (step S108, S109, S114, S116, S117 of Fig. 2), the air conditioning first expansion valve 18 functions as a decompression device, and in the heating operation (step S110 of Fig. 2, steps S203, S204 of Fig. 3), the air conditioning second expansion valve 16 functions as a decompression device.

[0247] In the above explanation about the embodiment, the heat transfer media is heated (cooled) in the air conditioning usage-side exchanger 19 in the heat pump unit 1 and is provided to the indoor unit 2, and the heat transfer media heated (or cooled) by the indoor exchanger 43 of the indoor unit 2 exchanged heat with the indoor air, so that the indoor space is heated (or cooled). But the embodiment is not limited thereto. More specifically, the air conditioning heat transfer media circulating circuit 40 may be omitted, and the air conditioning usage-side exchanger 19 may be installed in the indoor unit 2, and the first refrigerant passing through the air conditioning usage-side exchanger 19 may exchange heat with the indoor air, so that the indoor space is heated (or cooled).

[0248] In the above explanation about the embodiment, the heated liquid is water, and the high-temperature heated liquid (hot water) is accumulated in the tank 52, and the high-temperature heated liquid (hot water) accumulated in the tank 52 is provided to the hot water supply terminal (not shown). But the embodiment is not limited thereto. More specifically, an exchanger (not shown) may be further provided that can exchange heat between the high-temperature heated liquid accumulated in the tank 52 and the water provided to a hot water supply terminal (not shown), and the water may be heated by the high-temperature heated liquid accumulated in the tank 52, and the hot water may be provided to a hot water supply terminal (not shown). As described above, the heated liquid is not limited to water.

[0249] In the above embodiment, the hot water supply three-way switch valve 34 is used to pass the first refrigerant flown from the hot water supply first expansion valve 33 to the hot water supply heat source-side exchanger 35 or the hot water supply refrigerant control valve 39. But the embodiment is not limited thereto. More specifically, two flow amount control valves may be provided to pass the first refrigerant flown from the hot water

supply first expansion valve 33 to the hot water supply first expansion valve 33 or the hot water supply heat source-side exchanger 35.

[0250] It should be noted that the above can also be applied to the hot water supply three-way switch valve 37. 5

Reference Signs List

[0251]

S air conditioning and hot water supply system 10
 10 air conditioning refrigerant circuit
 11 air conditioning compressor
 12 first four-way switch valve (first switching means)
 14 second four-way switch valve (second switching means) 15
 15 air conditioning heat source-side exchanger
 16 air conditioning second expansion valve (air conditioning decompression device, air conditioning second decompression device) 20
 18 air conditioning first expansion valve (air conditioning decompression device, air conditioning first decompression device)
 19 air conditioning usage-side exchanger
 21 intermediate heat exchanger 25
 30 hot water supply refrigerant circuit
 31 hot water supply compressor
 32 hot water supply usage-side exchanger
 33 hot water supply first expansion valve (hot water supply decompression device) 30
 34, 37 hot water supply three-way switch valve (switching means)
 35 hot water supply heat source-side exchanger
 36 hot water supply second expansion valve (hot water supply decompression device) 35
 39 hot water supply refrigerant control valve (switching means)

Claims

1. An air conditioning and hot water supply system comprising an air conditioning refrigerant circuit in which a first refrigerant circulates and a hot water supply refrigerant circuit in which a second refrigerant circulates, 45
 wherein the air conditioning refrigerant circuit includes:
 an air conditioning compressor configured to compress the first refrigerant; 50
 an air conditioning heat source-side exchanger configured to exchange heat with an air conditioning heat source;
 an intermediate heat exchanger configured to exchange heat between the first refrigerant and the second refrigerant; 55
 an air conditioning decompression device con-

figured to decompress the first refrigerant;
 an air conditioning usage-side exchanger that functions as an evaporator during cooling operation and that functions as a condenser during heating operation;
 first switching means configured to switch a direction of the first refrigerant passing through the air conditioning usage-side exchanger in the cooling operation and the heating operation; and
 second switching means connected to the first switching means, and
 wherein the second switching means causes the intermediate heat exchanger to function as a condenser for the first refrigerant by switching the direction of the first refrigerant passing through the air conditioning heat source-side exchanger and the intermediate heat exchanger in accordance with an operation mode.

2. The air conditioning and hot water supply system according to claim 1, wherein the air conditioning decompression device includes:

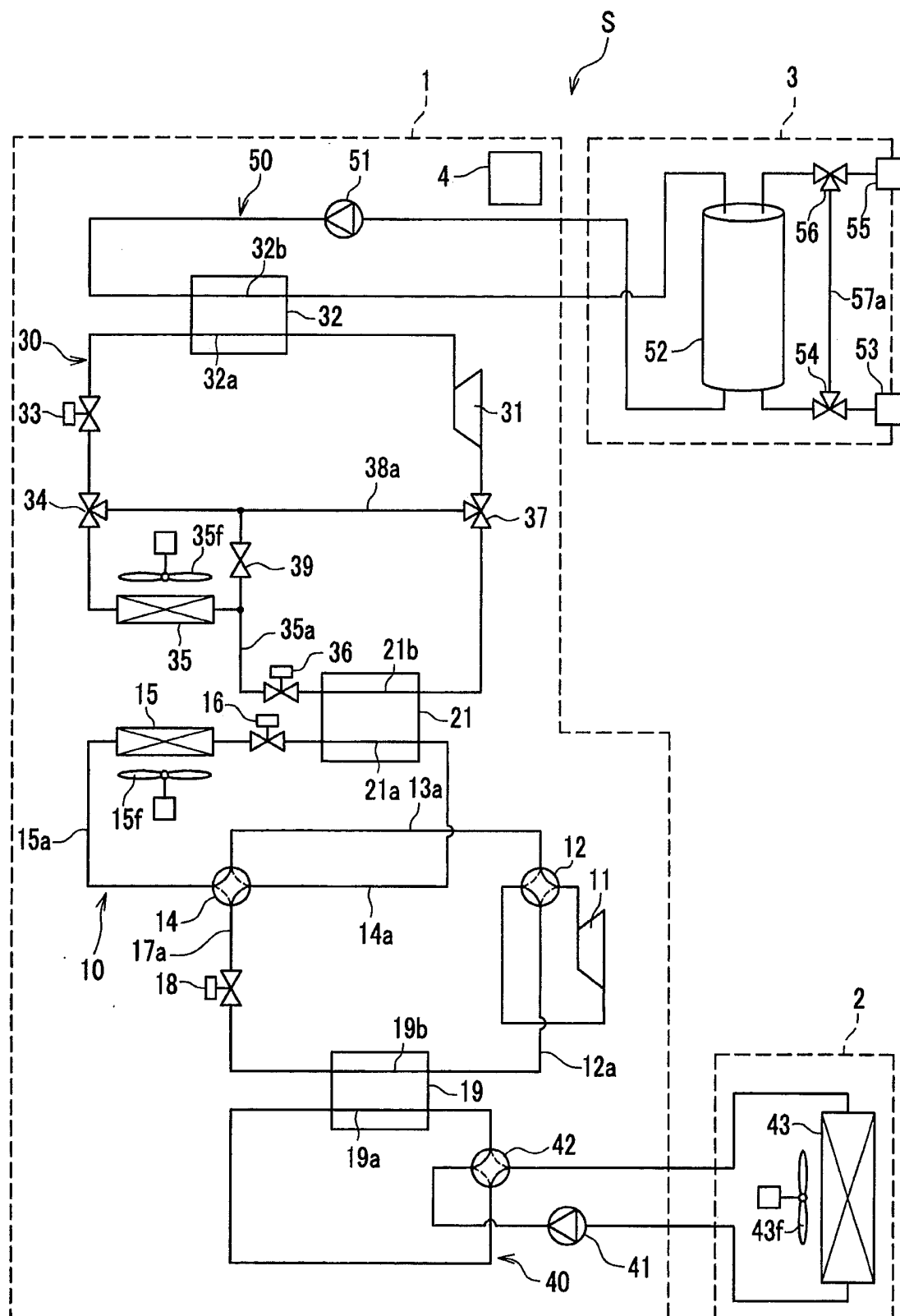
an air conditioning first decompression device configured to decompress a first refrigerant during the cooling operation; and
 an air conditioning second decompression device configured to decompress the first refrigerant during the heating operation.

3. The air conditioning and hot water supply system according to claim 1 or 2, wherein the hot water supply refrigerant circuit includes:

a hot water supply compressor configured to compress the second refrigerant;
 a hot water supply usage-side exchanger that functions as a condenser during hot water supply operation;
 a hot water supply decompression device configured to decompress the second refrigerant;
 a hot water supply heat source-side exchanger configured to be able to exchange heat with a hot water supply heat source;
 the intermediate heat exchanger that functions as a condenser for the first refrigerant and that functions as an evaporator for the second refrigerant; and
 switching means configured to pass the second refrigerant to the hot water supply heat source-side exchanger and/or the intermediate heat exchanger in accordance with an operation mode.

4. The air conditioning and hot water supply system according to claim 3, wherein the hot water supply heat source-side exchanger is arranged at a position higher than the intermediate heat exchanger.

FIG. 1



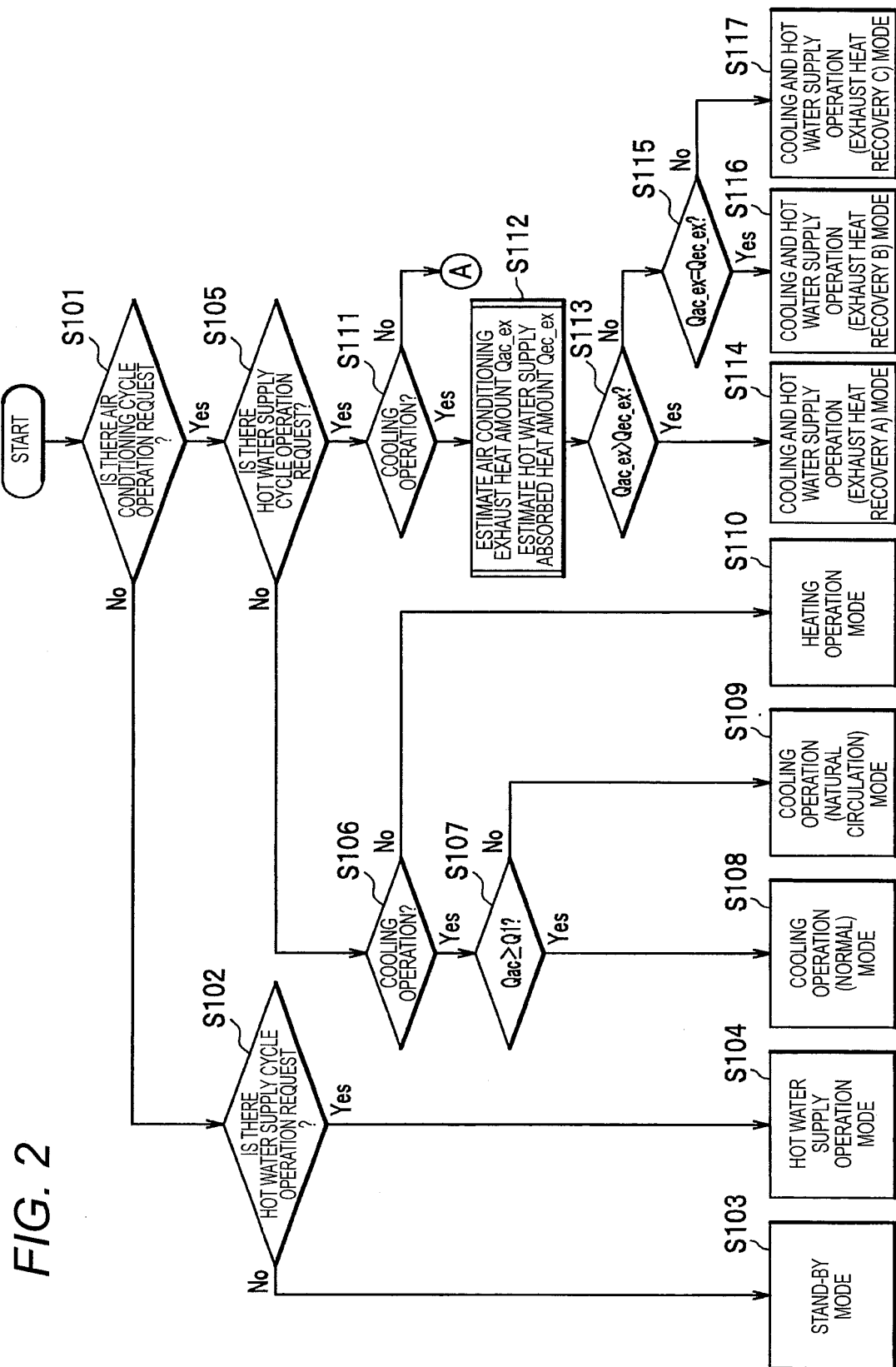


FIG. 3

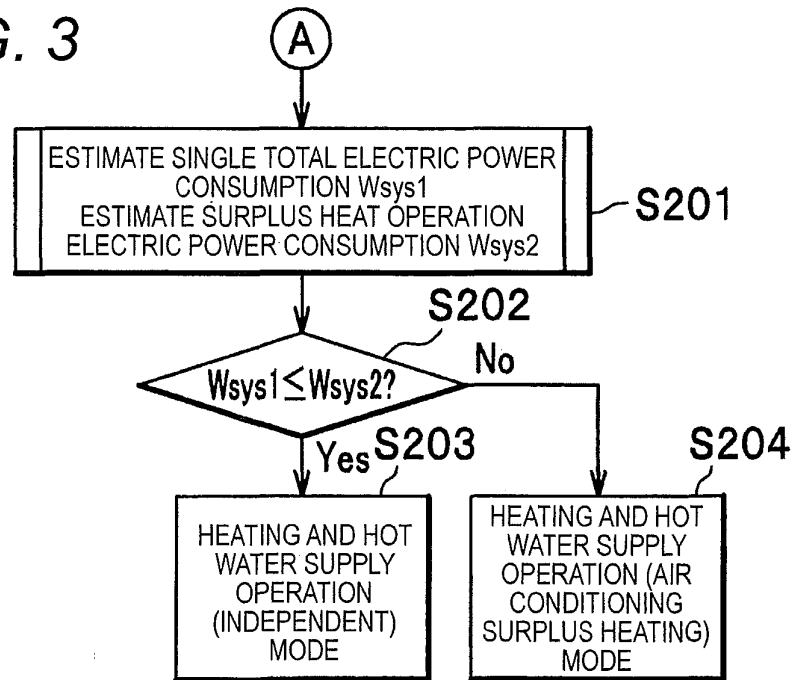


FIG. 4

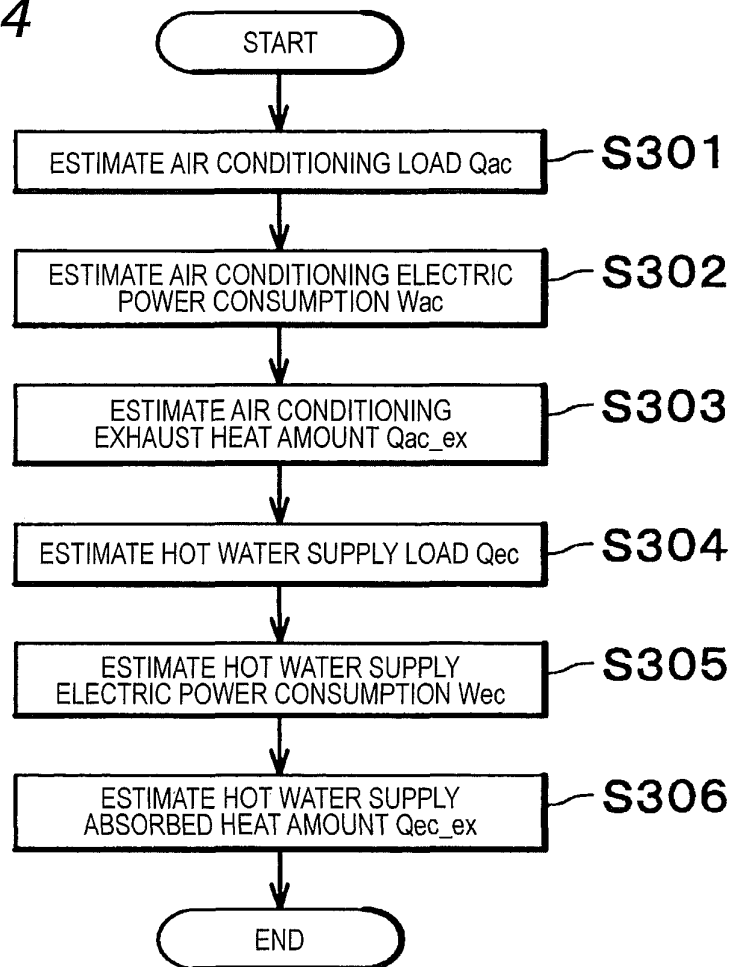


FIG. 5

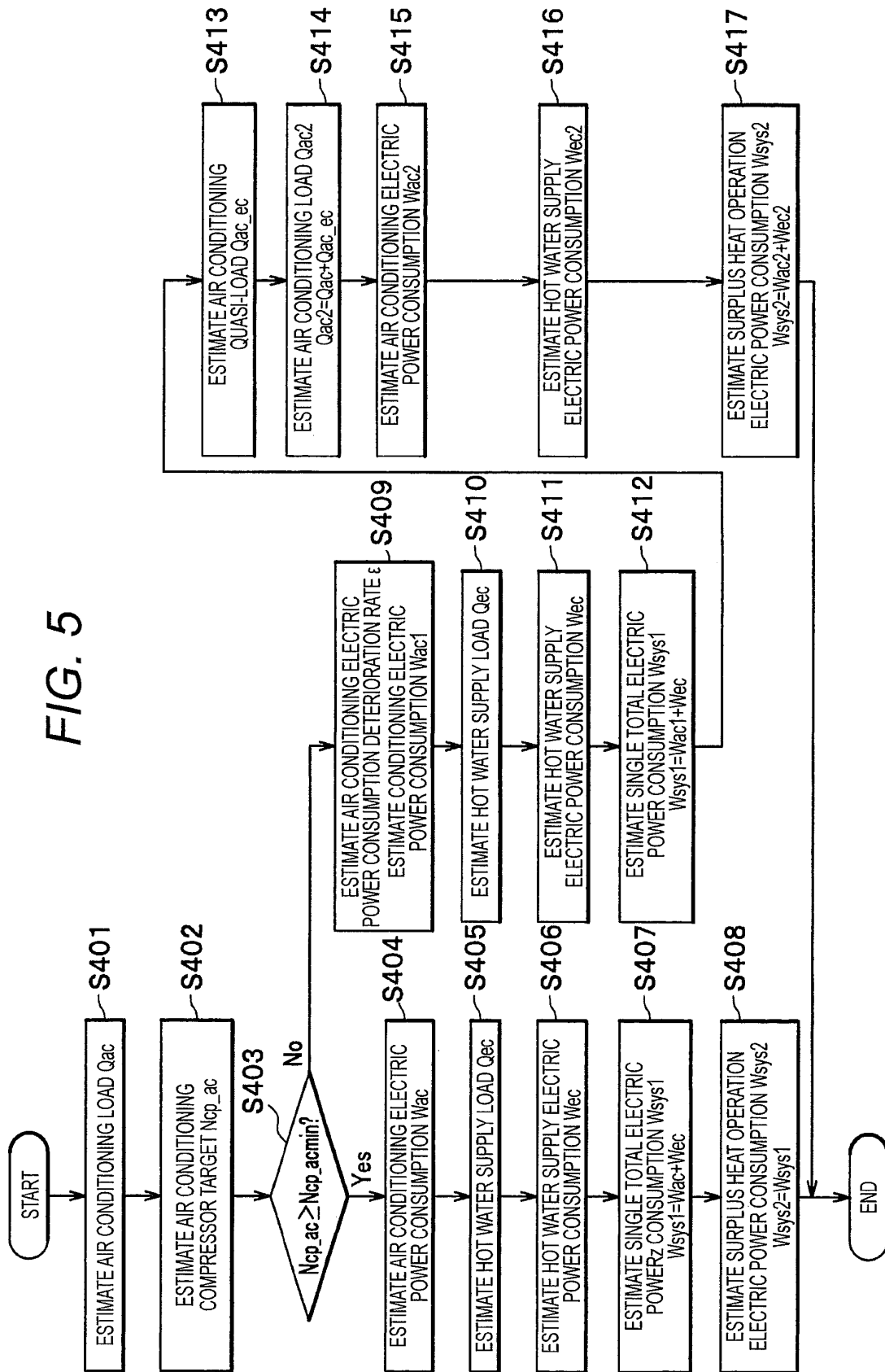


FIG. 6

HOT WATER SUPPLY OPERATION MODE

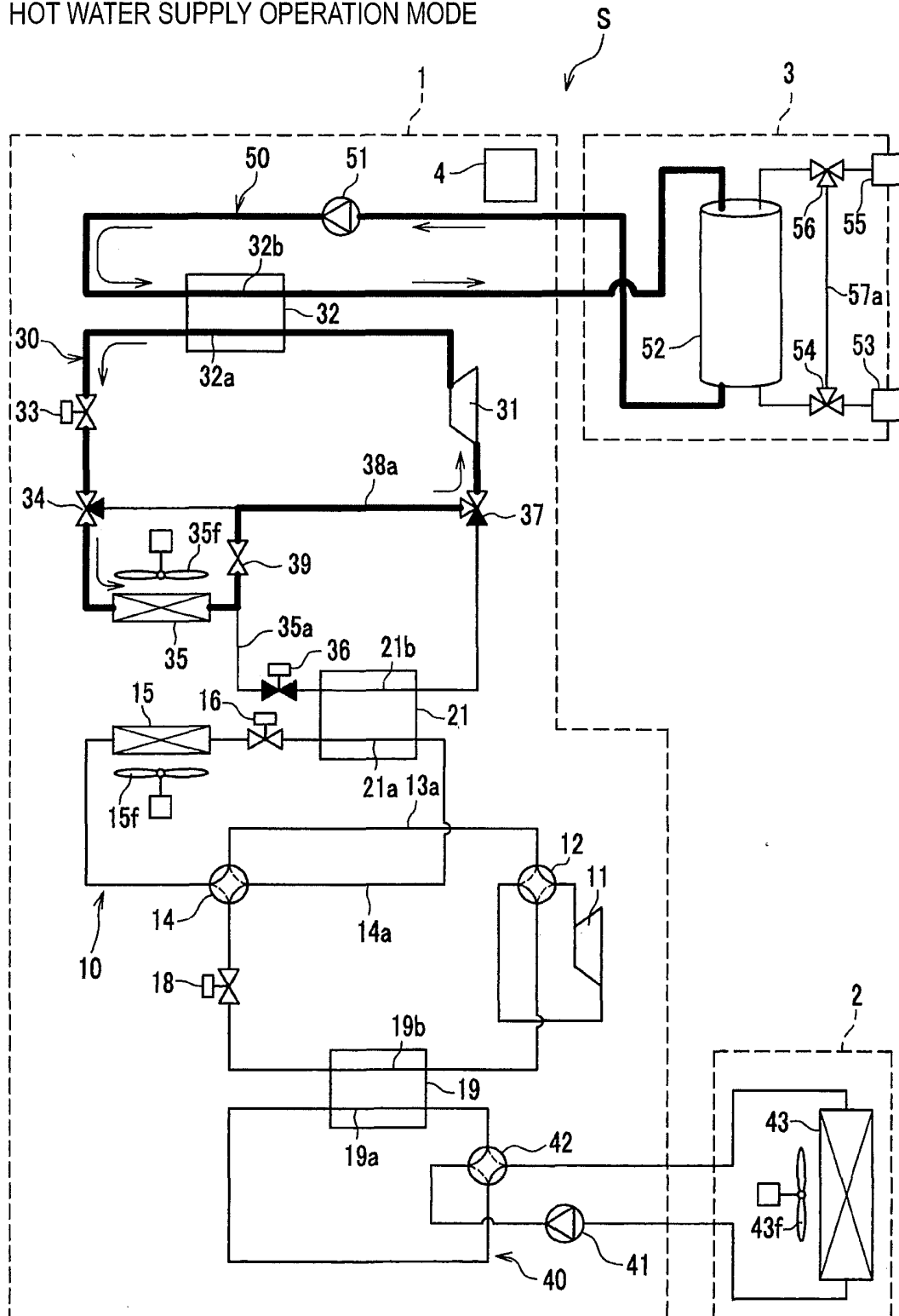


FIG. 7

COOLING OPERATION (NORMAL) MODE

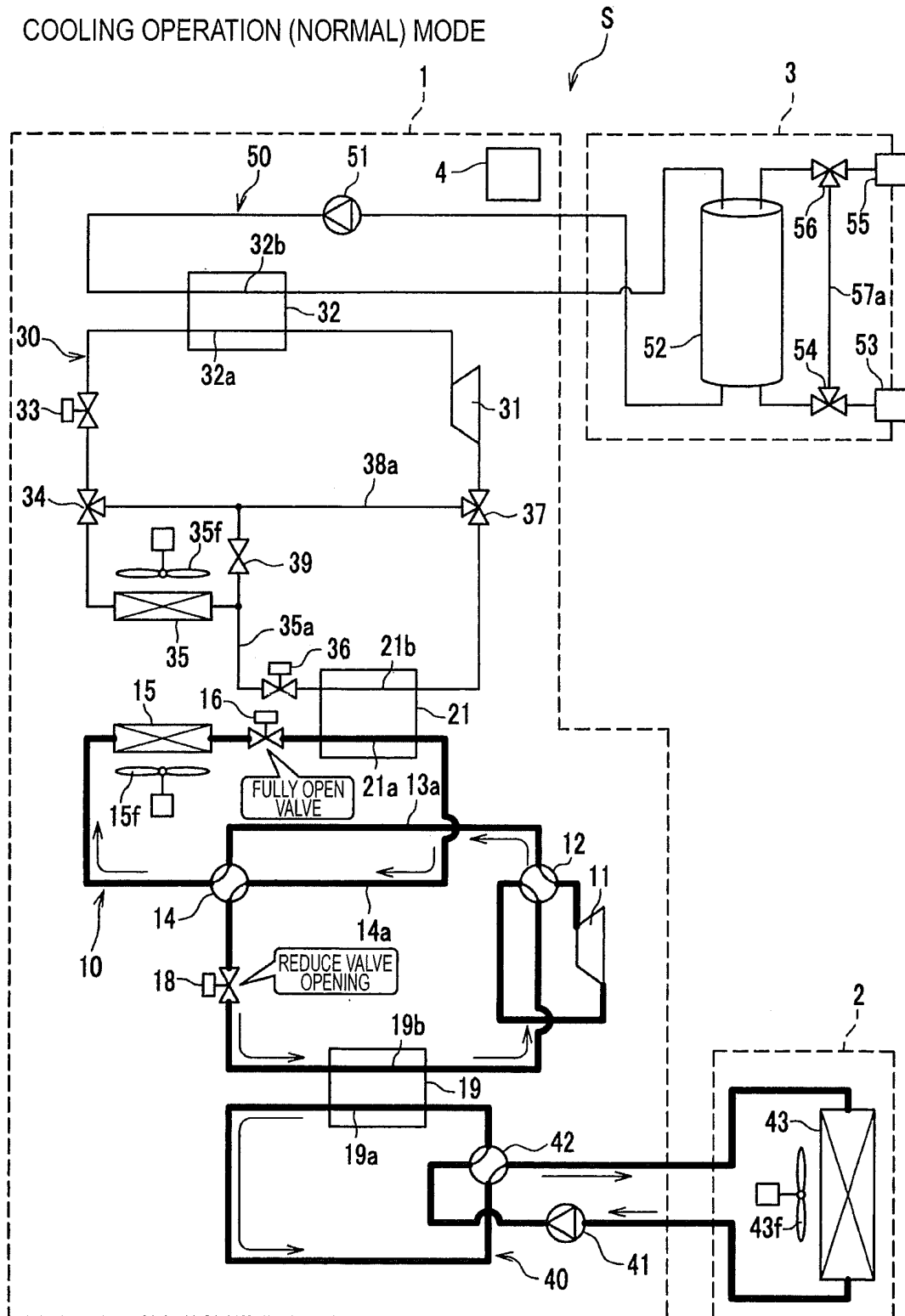


FIG. 8

COOLING OPERATION (NATURAL
CIRCULATION) MODE

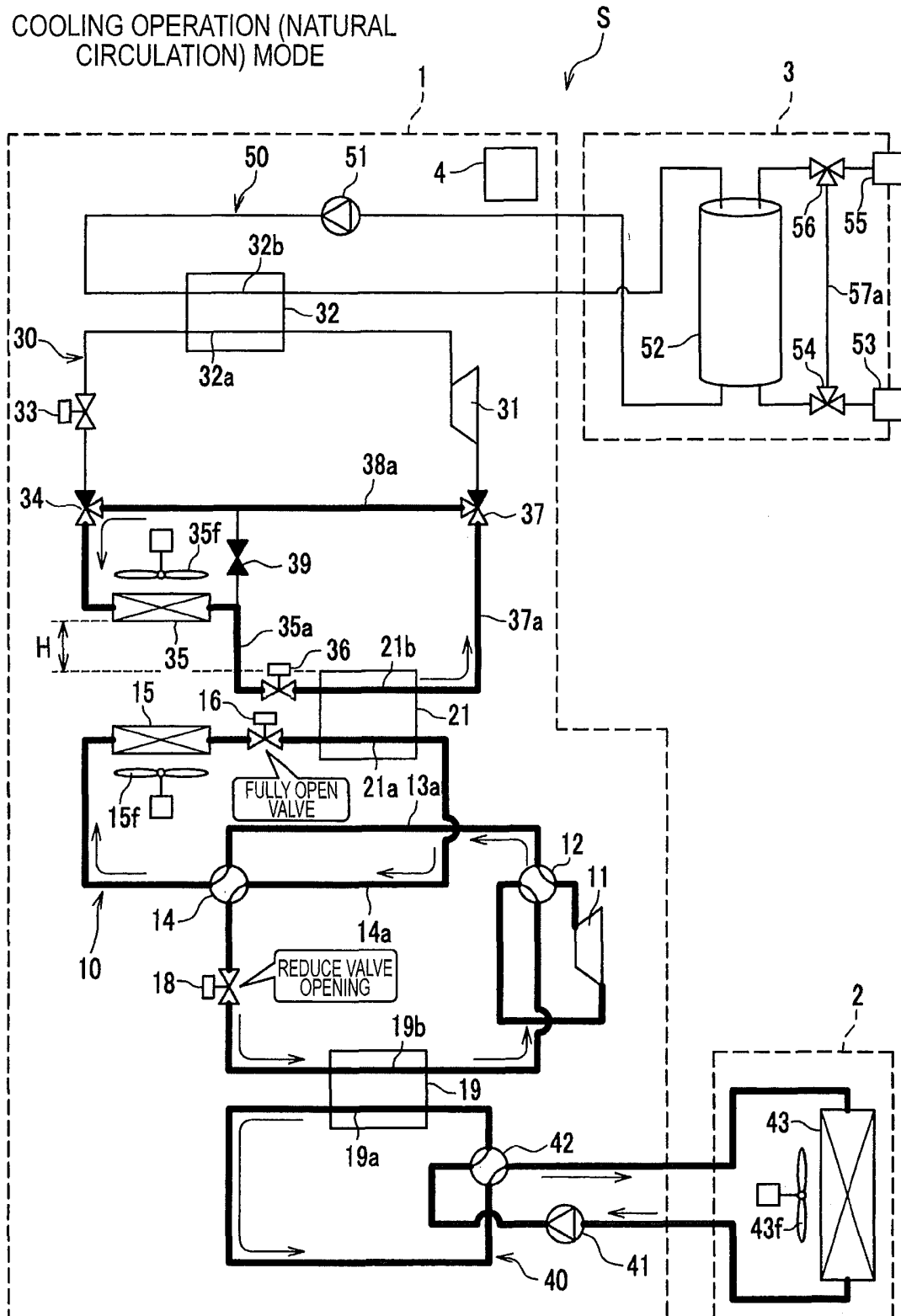


FIG. 9

HEATING OPERATION MODE

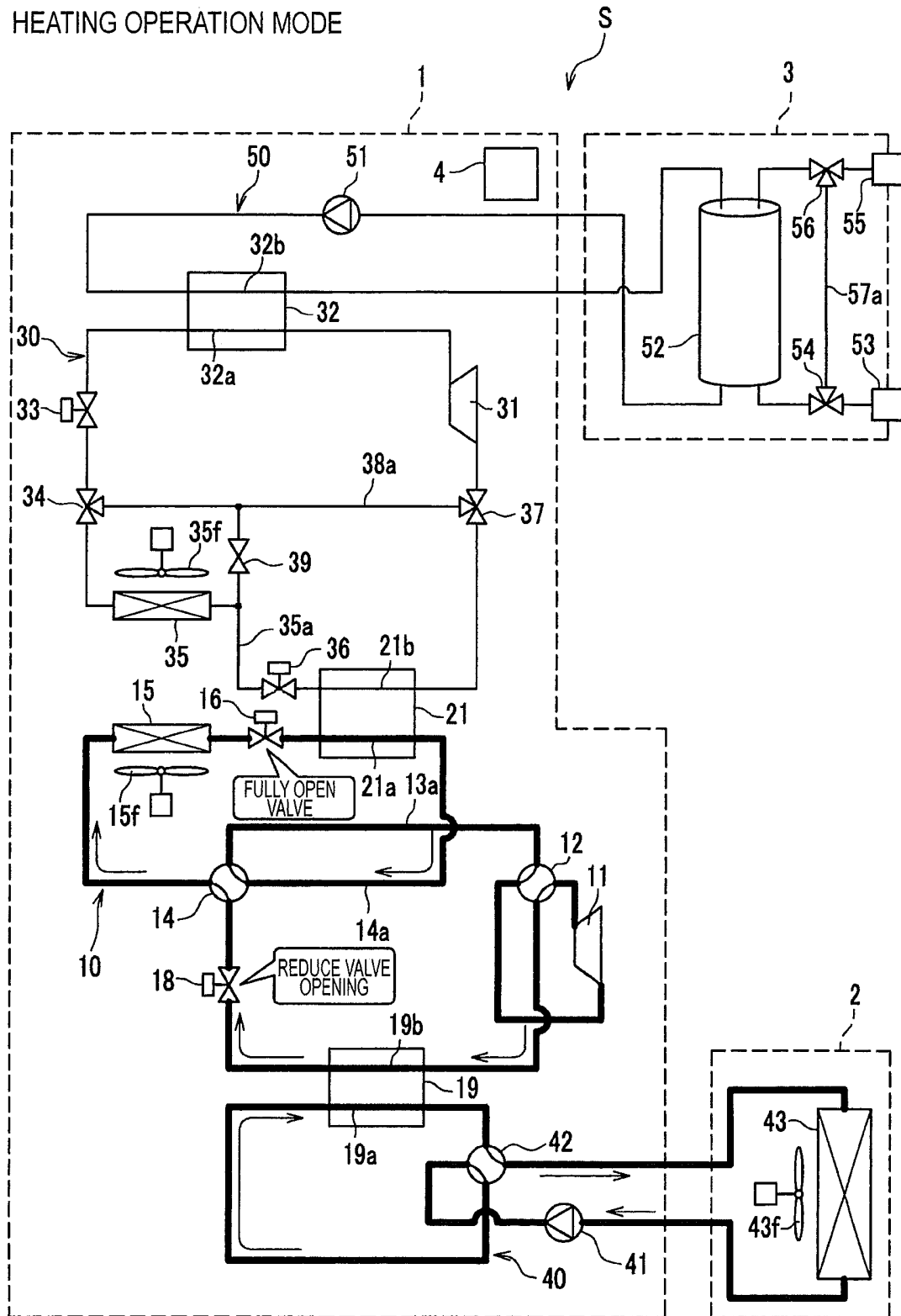


FIG. 10

COOLING AND HOT WATER SUPPLY OPERATION
(EXHAUST HEAT RECOVERY A) MODE

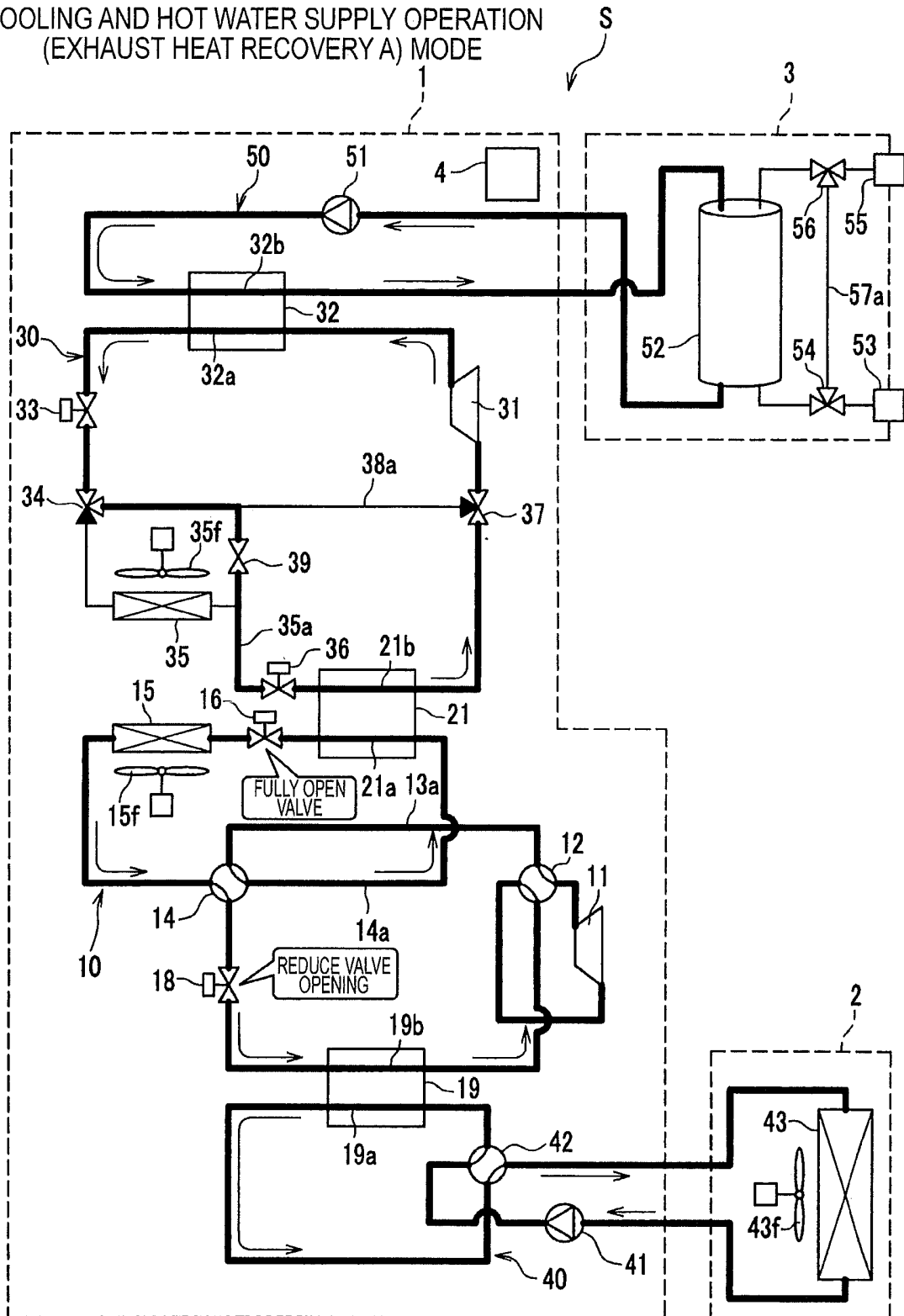


FIG. 11

COOLING AND HOT WATER SUPPLY OPERATION
(EXHAUST HEAT RECOVERY B) MODE

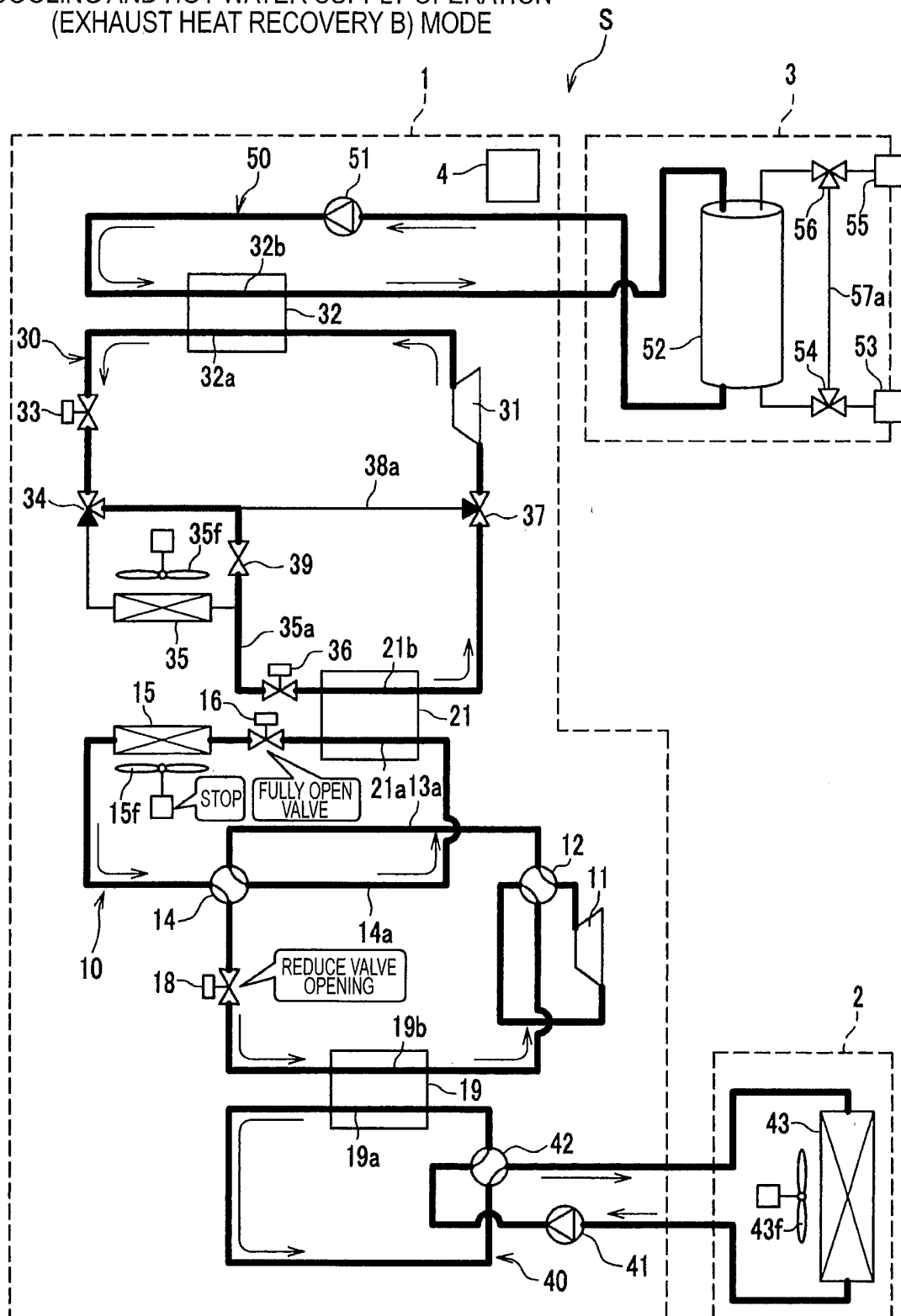


FIG. 12

COOLING AND HOT WATER SUPPLY OPERATION
(EXHAUST HEAT RECOVERY C) MODE

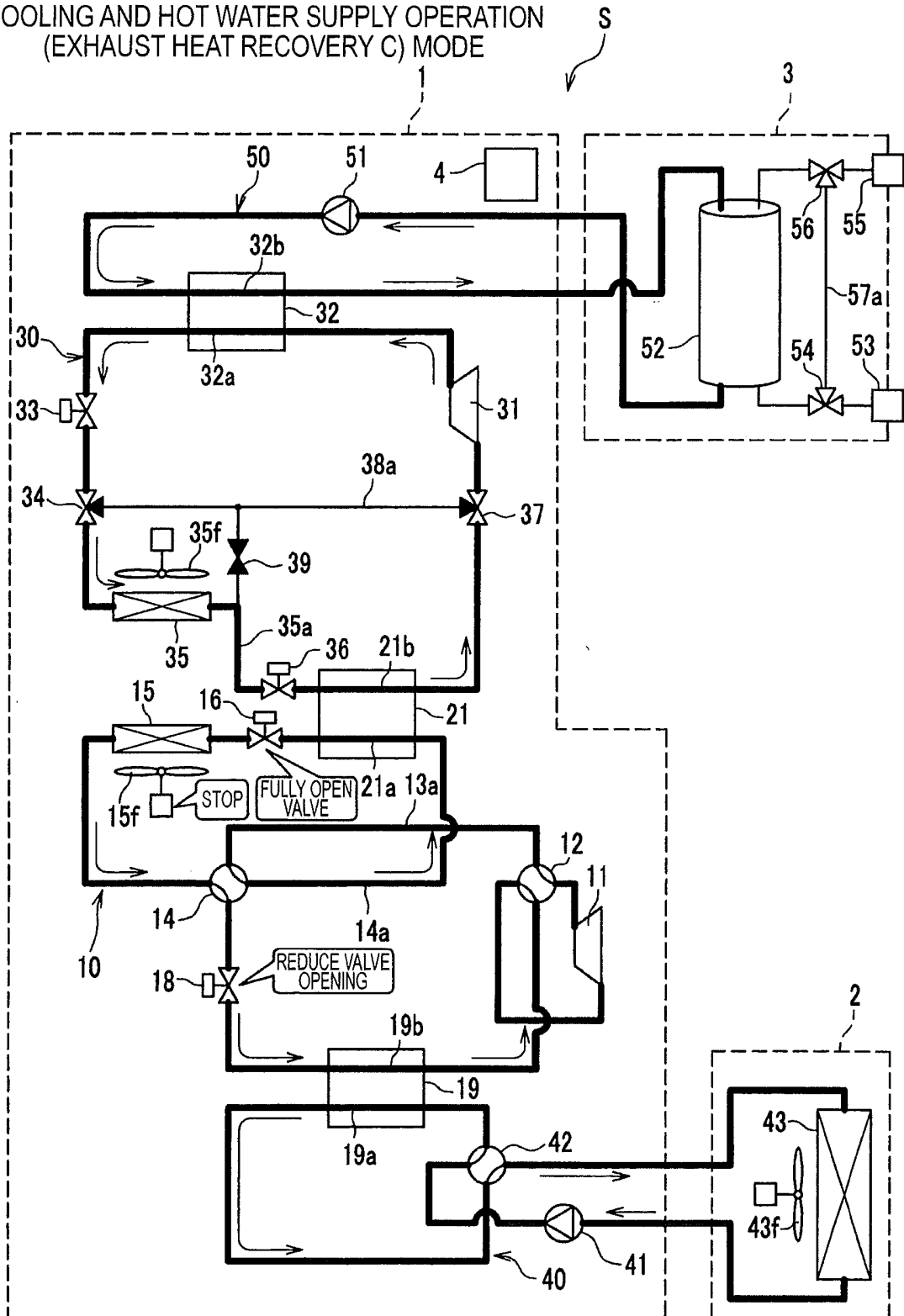


FIG. 13

HEATING AND HOT WATER SUPPLY OPERATION (INDEPENDENT) MODE

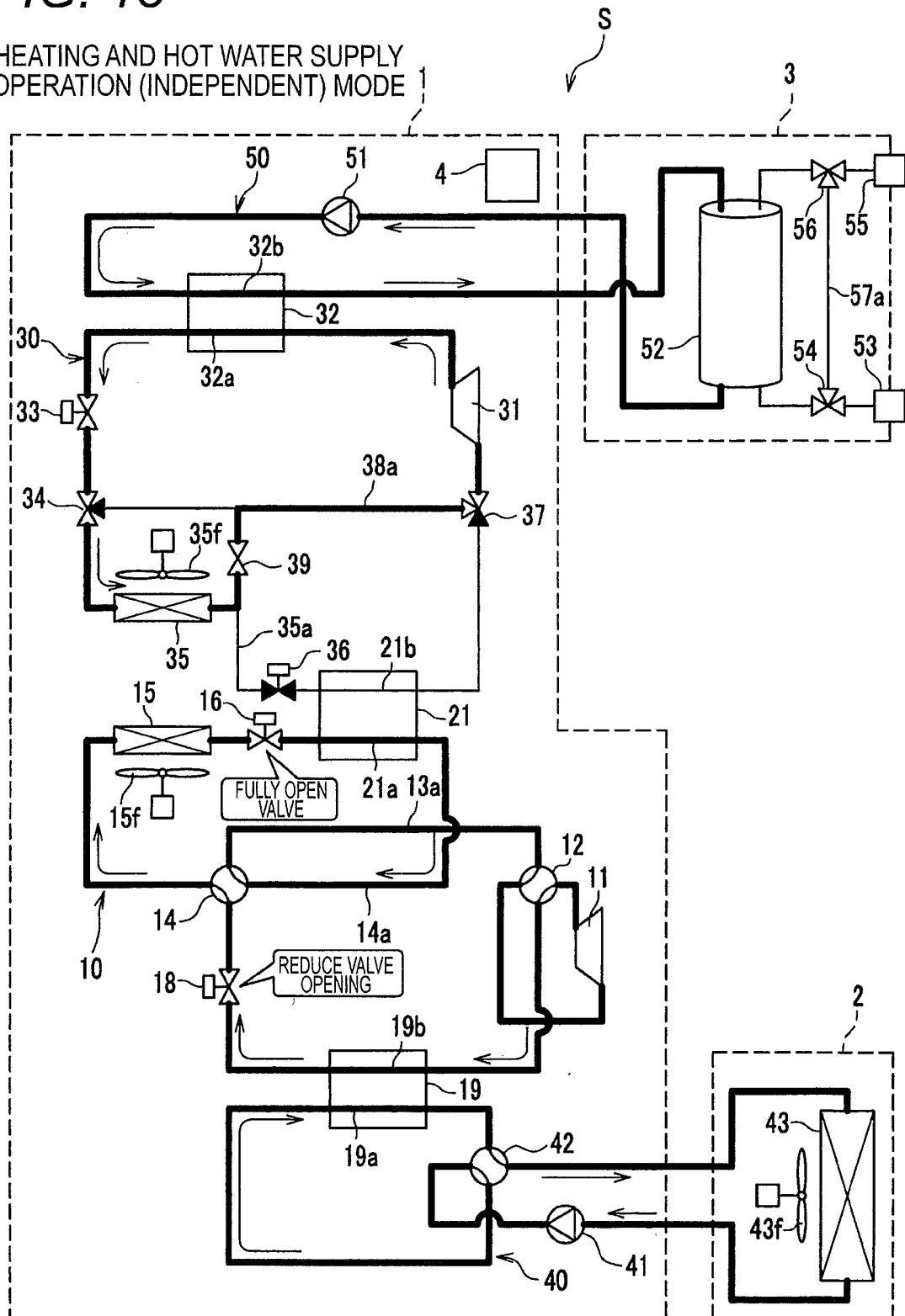
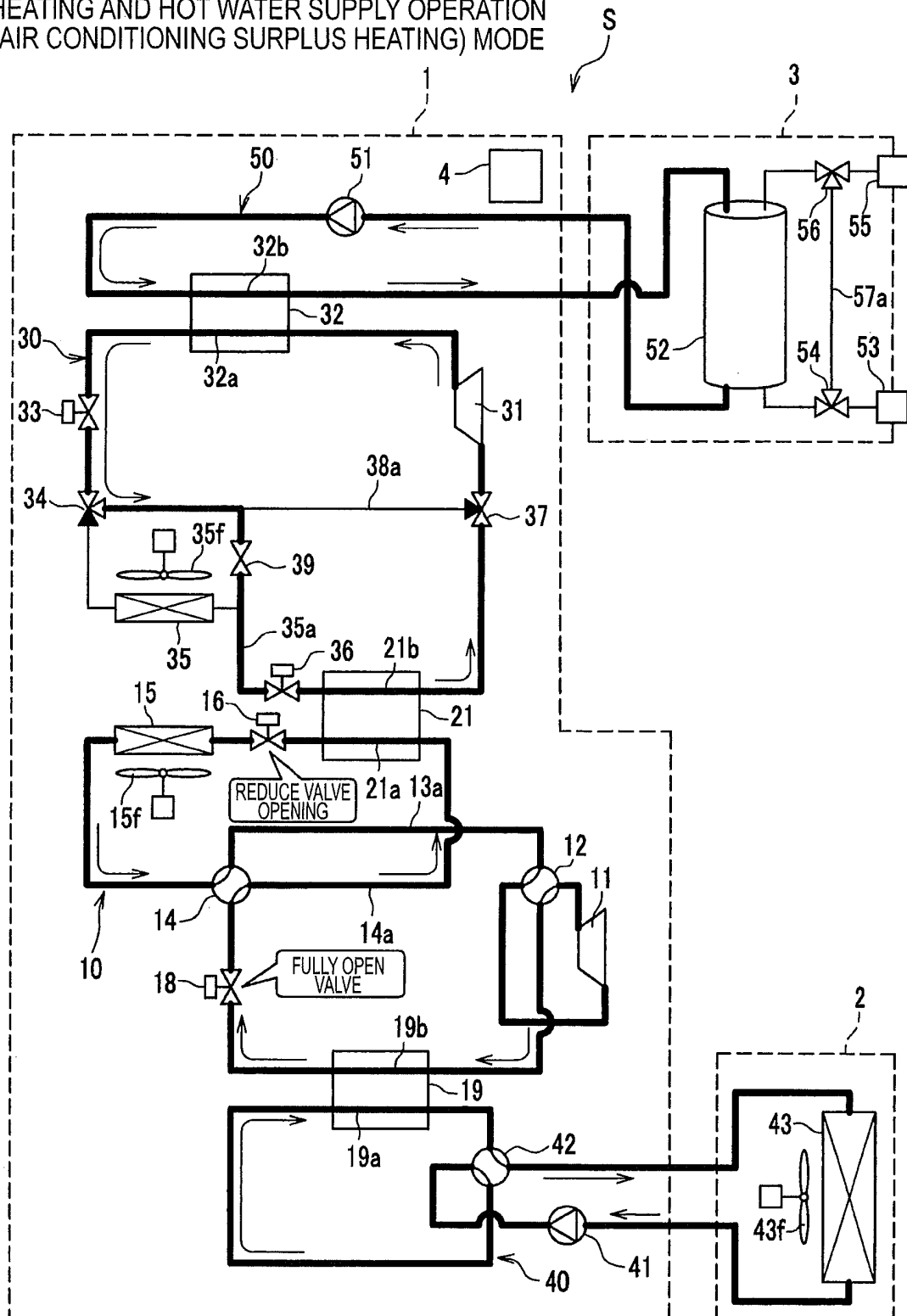
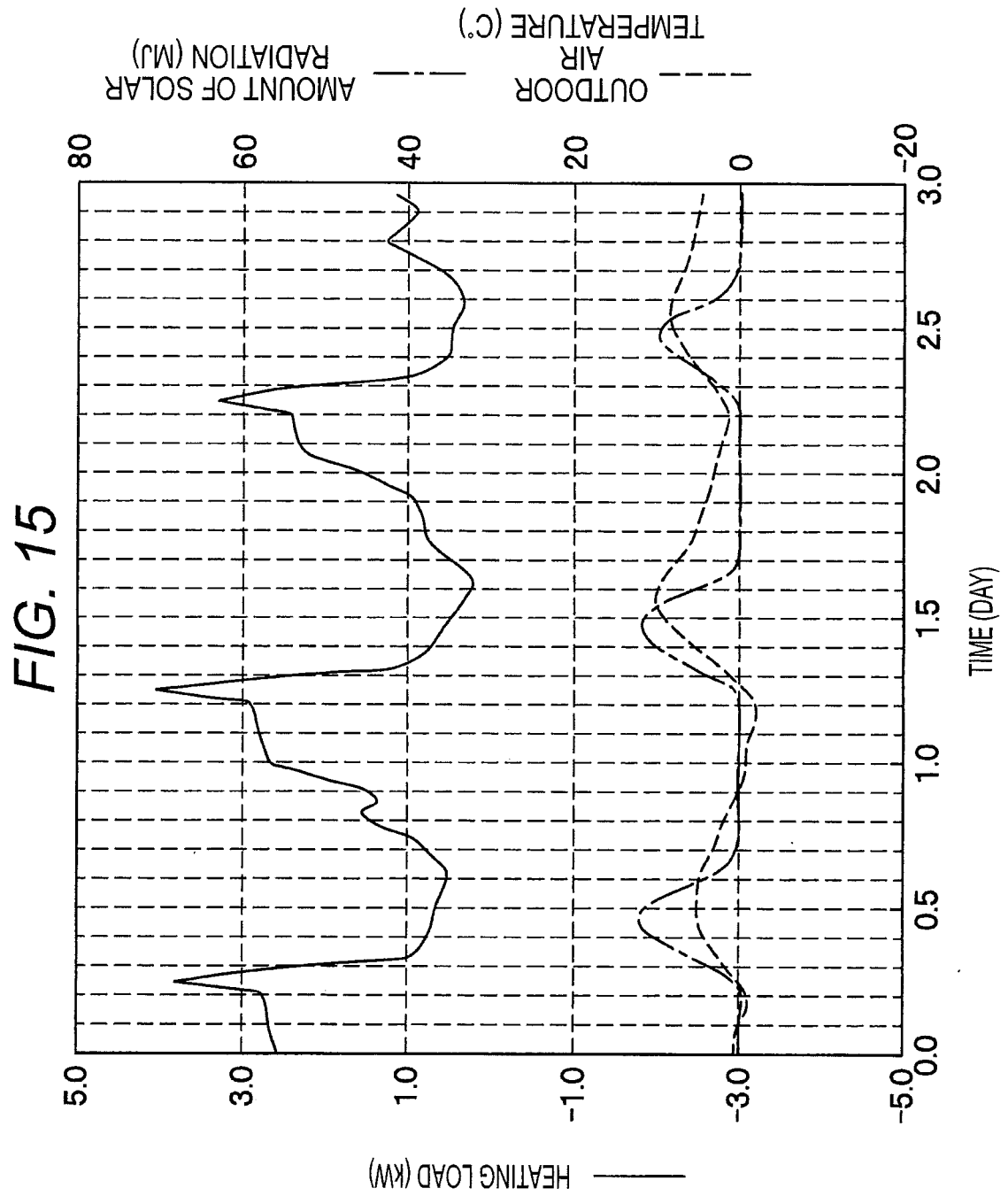


FIG. 14

HEATING AND HOT WATER SUPPLY OPERATION
(AIR CONDITIONING SURPLUS HEATING) MODE





INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/077531

A. CLASSIFICATION OF SUBJECT MATTER

F25B7/00 (2006.01) i, F25B6/04 (2006.01) i, F25B29/00 (2006.01) i

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)

F25B7/00, F25B6/04, F25B29/00

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

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.
A	JP 59-21959 A (Misawa Homes Co., Ltd.), 04 February 1984 (04.02.1984), page 4, lower left column, line 11 to page 5, lower left column, line 8; fig. 3 to 5 (Family: none)	1-4
A	JP 2005-257231 A (Fujitsu General Ltd.), 22 September 2005 (22.09.2005), paragraphs [0016] to [0039]; fig. 1 to 7 (Family: none)	1-4
A	JP 58-136959 A (Mitsubishi Electric Corp.), 15 August 1983 (15.08.1983), page 3, lower left column, line 20 to page 4, lower right column, line 3; fig. 3 to 5 (Family: none)	1-4

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

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Date of the actual completion of the international search
10 February, 2012 (10.02.12)Date of mailing of the international search report
21 February, 2012 (21.02.12)Name and mailing address of the ISA/
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/077531

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 4-143559 A (Matsushita Electric Industrial Co., Ltd.), 18 May 1992 (18.05.1992), page 2, lower left column, line 3 to page 4, left column, line 10; fig. 1 (Family: none)	3
A	WO 2011/104834 A1 (Hitachi, Ltd.), 01 September 2011 (01.09.2011), paragraphs [0050] to [0051]; fig. 6 to 7 (Family: none)	4

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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