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(54) **AIR CONDITIONING AND HOT-WATER SUPPLY SYSTEM**

(57) [Problem]

To provide an air conditioning and hot-water supply system that can perform operation of a hot-water supply cycle while using exhaust heat from the air conditioning cycle even when an air conditioning load is lower than a hot-water supply load.

[Solution]

The present invention is an air conditioning and hot-water supply system including: an air conditioning refrigerant circuit (5) that selectively performs cooling operation and heating operation; a hot-water supply refrigerant circuit (6) that performs hot-water supply operation; an intermediate heat exchanger (23) that performs heat exchange between an air conditioning refrigerant flowing through the air conditioning refrigerant circuit and a hot-water supply refrigerant flowing through the hot-water supply refrigerant circuit; and a control device (1a) that performs control of operation. The control device calculates a heat radiation amount required by the air conditioning refrigerant circuit in the cooling operation and a heat absorption amount required by the hot-water supply refrigerant circuit in the hot-water supply operation. The control device performs control such that when the heat radiation amount is larger than the heat absorption amount, the amount of heat equivalent to the difference therebetween is radiated from an air conditioning heat source side heat exchanger to outside air, and when the

heat absorption amount is larger than the heat radiation amount, the amount of heat equivalent to the difference therebetween is absorbed from outside air by a hot-water supply heat source side heat exchanger.

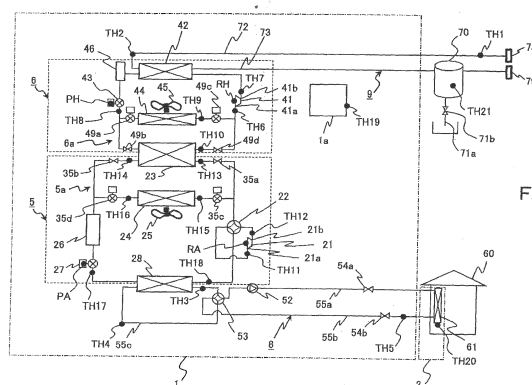


FIG. 1

Description

TECHNICAL FIELD

[0001] The present invention relates to an air conditioning and hot-water supply system, and particularly, is suitable for an air conditioning and hot-water supply system in which an air conditioning refrigerant circuit for selectively performing cooling operation and heating operation and a hot-water supply refrigerant circuit for performing hot-water supply operation are connected to each other in a heat exchangeable manner therebetween through an intermediate heat exchanger to form a dual refrigerating cycle of an air conditioning cycle and a hot-water supply cycle.

BACKGROUND ART

[0002] This type of air conditioning and hot-water supply system is disclosed in, for example, Patent Literature 1. Patent Literature 1 discloses a system that includes a high-temperature cycle that provides high-temperature output, and a medium-temperature cycle that provides medium-temperature output or low-temperature output, and is configured to allow heat exchange between an evaporator of the high-temperature cycle and a condenser of the medium-temperature cycle. With the technique disclosed in Patent Literature 1, exhaust heat of the medium-temperature cycle can be effectively used in the high-temperature cycle, thereby allowing economic operation.

CITATION LIST

PATENT LITERATURE

[0003] PATENT LITERATURE 1: JP-A No. H4-32669

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0004] However, in the technique disclosed in Patent Literature 1, exhaust heat of the medium-temperature cycle (air conditioning cycle) can be used as a heat source of the high-temperature cycle (hot-water supply cycle) only when the amount of exhaust heat of the medium-temperature cycle is more than the amount of heat absorption of the high-temperature cycle. In other words, the hot-water supply cycle using the exhaust heat of the air conditioning cycle can be operated only when the air conditioning load of the air conditioning cycle is high. For example, in the case of performing air conditioning of a space having high heat insulation performance or a space where internal heat generation is low due to few occupants or the like, or performing air conditioning under low outside air temperature at night, it is assumed that the air conditioning load becomes low. And, depending on the environmental conditions, the hot-water supply load can become higher than the air conditioning load. In such a case, in the technique disclosed in Patent Literature 1, a problem remains in that operation meeting the required capacity for the high-temperature cycle cannot be performed only with the exhaust heat from the medium-temperature cycle.

[0005] Accordingly, the present invention has been made to address the above-described problem, and an object of the present invention is to provide an air conditioning and hot-water supply system that can perform operation meeting the required capacity for a hot-water supply cycle while using exhaust heat from an air conditioning cycle even when an air conditioning load is lower than a hot-water supply load. Furthermore, another object of the present invention is to provide an air conditioning and hot-water supply system that, even if there is a difference between the amount of heat radiation of the air conditioning cycle and the amount of heat absorption of the hot-water supply cycle, can improve efficiency as the whole of the system by exchanging an amount of heat equivalent to the difference therebetween with outside air.

SOLUTION TO PROBLEM

[0006] In order to achieve the above-described objects, according to the present invention, an air conditioning and hot-water supply system includes: an air conditioning refrigerant circuit; a hot-water supply refrigerant circuit; an intermediate heat exchanger that performs heat exchange between an air conditioning refrigerant flowing through the air conditioning refrigerant circuit and a hot-water supply refrigerant flowing through the hot-water supply refrigerant circuit; and a control device that performs control of operation. The air conditioning refrigerant circuit is formed to be circular by connecting, sequentially with refrigerant piping, an air conditioning compressor, an air conditioning flow path switching valve, the intermediate heat exchanger, an air conditioning expanding valve, and an air conditioning use side heat

exchanger, and configured such that an air conditioning heat source side heat exchanger unit is connected between the air conditioning flow path switching valve and the air conditioning expanding valve in series or in parallel with the intermediate heat exchanger, the air conditioning heat source side heat exchanger unit including: an air conditioning heat source side heat exchanger for performing heat exchange between outside air and the air conditioning refrigerant; and an air conditioning outdoor fan that sends outside air to the air conditioning heat source side heat exchanger. The hot-water supply refrigerant circuit is formed to be circular by connecting, sequentially with refrigerant piping, a hot-water supply compressor, a hot-water supply use side heat exchanger that performs heat exchange with a heat transfer medium on a hot-water supply use side, a hot-water supply expanding valve, and the intermediate heat exchanger, and configured such that a hot-water supply heat source side heat exchanger unit is connected between the hot-water supply compressor and the hot-water supply expanding valve in series or in parallel with the intermediate heat exchanger, the hot-water supply heat source side heat exchanger unit including: a hot-water supply heat source side heat exchanger for performing heat exchange between outside air and the hot-water supply refrigerant; and a hot-water supply outdoor fan that sends outside air to the hot-water supply heat source side heat exchanger. In a first load condition in which a heat radiation amount is larger than a heat absorption amount, the control device controls the air conditioning heat source side heat exchanger unit so that a differential amount of heat equivalent to a difference between the heat radiation amount and the heat absorption amount is radiated from the air conditioning heat source side heat exchanger unit to outside air. In a second load condition in which the heat absorption amount is larger than the heat radiation amount, the control device controls the hot-water supply heat source side heat exchanger unit so that the differential amount of heat is absorbed from outside air by the hot-water supply heat source side heat exchanger unit.

[0007] According to the present invention, the air conditioning refrigerant circuit and the hot-water supply refrigerant circuit are connected via the intermediate heat exchanger in such a manner as to allow heat exchange therebetween. Also, the air conditioning heat source side heat exchanger is provided to the air conditioning refrigerant circuit, and the hot-water supply heat source side heat exchanger is provided to the hot-water supply refrigerant circuit. Thus, in both the first load condition and the second load condition, it is possible to perform operation meeting the required capacity for the hot-water supply cycle while using exhaust heat from the air conditioning cycle. Furthermore, in the present invention, the control device calculates the air conditioning-side heat radiation amount and the hot-water-supply-side heat absorption amount, and controls operation of the air conditioning heat source side heat exchanger unit and the hot-water supply heat source side heat exchanger unit so that the amount of heat equivalent to the difference therebetween is exchanged with outside air, thereby allowing improvement in efficiency as the whole of the air conditioning and hot-water supply system.

[0008] Here, in the present invention, "controlling the air conditioning heat source side heat exchanger unit" includes control of rotational speed of the air conditioning outdoor fan, control of opening of the first air conditioning refrigerant flow control valve and the second air conditioning refrigerant flow control valve, change of the number of paths of the air conditioning heat source side heat exchanger, control by a combination of the above, and all other control to adjust a heat exchange amount of the air conditioning heat source side heat exchanger. Also, in the same manner, "controlling the hot-water supply heat source side heat exchanger unit" includes control of rotational speed of the hot-water supply outdoor fan, control of opening of the first hot-water supply refrigerant flow control valve and the second hot-water supply refrigerant flow control valve, change of the number of paths of the hot-water supply heat source side heat exchanger, control by a combination of the above, and all other control to adjust a heat exchange amount of the hot-water supply heat source side heat exchanger.

[0009] Also, preferably, in the above-described configuration, the air conditioning and hot-water supply system is configured such that: the air conditioning heat source side heat exchanger unit is connected in parallel with the intermediate heat exchanger; the hot-water supply heat source side heat exchanger unit is connected in parallel with the intermediate heat exchanger; the air conditioning heat source side heat exchanger unit includes a first air conditioning refrigerant flow control valve and a second air conditioning refrigerant flow control valve that are provided at an inlet and an outlet of the air conditioning heat source side heat exchanger for controlling a flow rate of the air conditioning refrigerant; and the hot-water supply heat source side heat exchanger unit includes a first hot-water supply refrigerant flow control valve and a second hot-water supply refrigerant flow control valve that are provided at an inlet and an outlet of the hot-water supply heat source side heat exchanger for controlling a flow rate of the hot-water supply refrigerant. This is because control as the whole of the system is facilitated.

[0010] Also, preferably, in the above-described configuration, the arrangement is such that the control device controls rotational speed of the air conditioning outdoor fan in the first load condition, and controls rotational speed of the hot-water supply outdoor fan in the second load condition. This is because adjustment of the amount of heat exchange is facilitated.

[0011] Also, preferably, in the above-described configuration, the arrangement is such that: in the first load condition, when a difference between a heat exchange amount of the air conditioning heat source side heat exchanger unit and the differential amount of heat is beyond a predetermined range even after the rotational speed of the air conditioning outdoor fan has been controlled, the control device performs control to adjust opening of at least one of the first air conditioning refrigerant flow control valve and the second air conditioning refrigerant flow control valve so as to make

up the difference therebetween; and, in the second load condition, when a difference between a heat exchange amount of the hot-water supply heat source side heat exchanger unit and the differential amount of heat is beyond a predetermined range even after the rotational speed of the hot-water supply outdoor fan has been controlled, the control device performs control to adjust opening of at least one of the first hot-water supply refrigerant flow control valve and the second hot-water supply refrigerant flow control valve so as to make up the difference therebetween.

[0012] With this arrangement, in the first load condition, even when the air conditioning refrigerant cannot be distributed at a desired flow rate to the intermediate heat exchanger and the air conditioning heat source side heat exchanger unit simply by controlling rotational speed of the air conditioning outdoor fan, the air conditioning refrigerant can be distributed at a desired flow rate by adjusting (throttling) opening of at least one of the first air conditioning refrigerant flow control valve and the second air conditioning refrigerant flow control valve and facilitating the flow of the air conditioning refrigerant into the intermediate heat exchanger. Thus, air conditioning exhaust heat can be used for the hot-water supply cycle without wasting the exhaust heat. In the same manner, in the second load condition, the hot-water supply refrigerant can be distributed at a desired flow rate to the intermediate heat exchanger and the hot-water supply heat source side heat exchanger unit by adjusting (throttling) opening of at least one of the first hot-water supply refrigerant flow control valve and the second hot-water supply refrigerant flow control valve.

[0013] Also, preferably, in the above-described configuration, the arrangement is such that: in the first load condition, the control device controls opening of the hot-water supply expanding valve so that a predetermined condition required for hot-water supply operation is satisfied, and then controls at least one of rotational speed of the air conditioning outdoor fan and opening of the air conditioning expanding valve so that a predetermined condition required for cooling operation is satisfied; and, in the second load condition, the control device controls opening of the air conditioning expanding valve so that a predetermined condition required for the cooling operation is satisfied, and then controls at least one of rotational speed of the hot-water supply outdoor fan and opening of the hot-water supply expanding valve so that a predetermined condition required for the hot-water supply operation is satisfied. With this arrangement, a cycle, which is smaller in the amount of heat of the heat radiation amount of the air conditioning cycle and the heat absorption amount of the hot-water supply cycle, is firstly controlled, and then the other cycle, which is larger in the amount of heat, is controlled, thereby offering an advantage that a heat-amount balance is easily adjusted.

[0014] Also, preferably, in the above-described configuration, the arrangement is such that the control device calculates target condensation temperature of the cooling operation and target evaporation temperature of the hot-water supply operation on the basis of the heat radiation amount and heat absorption amount calculated and outdoor temperature, sets the target condensation temperature to the predetermined condition required for the cooling operation, and sets the target evaporation temperature to the predetermined condition required for the hot-water supply operation.

[0015] Also, preferably, in the above-described configuration, the arrangement is such that, in a third load condition in which a difference between the heat radiation amount and the heat absorption amount falls within a predetermined range, the control device cancels the heat exchange with outside air performed by the air conditioning heat source side heat exchanger unit and the hot-water supply heat source side heat exchanger unit, and performs control so that operation is performed by heat exchange via the intermediate heat exchanger between the air conditioning refrigerant circuit and the hot-water supply refrigerant circuit. With this arrangement, operation can be performed using only the intermediate heat exchanger, thereby eliminating the need to rotate the air conditioning outdoor fan and the hot-water supply outdoor fan. Thus, a reduction in power consumption can be expected.

[0016] Also, preferably, in the above-described configuration, the arrangement is such that: the air conditioning heat source side heat exchanger is composed of a plurality of paths through which the air conditioning refrigerant flows; the hot-water supply heat source side heat exchanger is composed of a plurality of paths through which the hot-water supply refrigerant flows; and the control device performs control to change the number of paths of the air conditioning heat source side heat exchanger in the first load condition, and performs control to change the number of paths of the hot-water supply heat source side heat exchanger in the second load condition. With this arrangement, it is possible to efficiently operate the cycle while reducing a heat transfer area. Also, the refrigerant flow rate into the heat exchanger can be reduced, thereby allowing prevention of a shortage of the refrigerant.

[0017] Also, preferably, in the above-described configuration, the arrangement is such that the air conditioning refrigerant circuit includes air conditioning refrigerant return piping for returning the air conditioning refrigerant from the air conditioning heat source side heat exchanger to a suction side of the air conditioning compressor, and an air conditioning gate valve provided to the air conditioning refrigerant return piping, and the hot-water supply refrigerant circuit includes hot-water supply refrigerant return piping for returning the hot-water supply refrigerant from the hot-water supply heat source side heat exchanger to a suction side of the hot-water supply compressor, and a hot-water supply gate valve provided to the hot-water supply refrigerant return piping. With this arrangement, it is possible to return the refrigerant to the suction side of the compressor, thereby allowing prevention of a shortage of the refrigerant.

[0018] Also, preferably, in the above-described configuration, the arrangement is such that the control device includes a high heating operation mode in which heating operation with the air conditioning heat source side heat exchanger and the intermediate heat exchanger used as evaporators is performed in the air conditioning refrigerant circuit and hot-water

supply operation with the hot-water supply heat source side heat exchanger used as an evaporator is performed in the hot-water supply refrigerant circuit, and in the high heating operation mode, the control device performs control to open the first air conditioning refrigerant flow control valve and the second air conditioning refrigerant flow control valve and cause the air conditioning refrigerant to flow into both the air conditioning heat source side heat exchanger and the intermediate heat exchanger, and performs control to open the first hot-water supply refrigerant flow control valve and the second hot-water supply refrigerant flow control valve and cause the hot-water supply refrigerant to flow into the hot-water supply heat source side heat exchanger without causing the hot-water supply refrigerant to flow into the intermediate heat exchanger.

[0019] Also, preferably, in the above-described configuration, the arrangement is such that the air conditioning and hot-water supply system further includes a hot-water supply flow path that is a flow path through which the heat transfer medium on the hot-water supply use side flows, the flow path being formed by connecting an inlet of the hot-water supply use side heat exchanger and a water supply port of the heat transfer medium on the hot-water supply use side with piping and connecting an outlet of the hot-water supply use side heat exchanger and a hot-water supply port of the heat transfer medium on the hot-water supply use side with piping, the flow path being provided with a hot water storage tank at a position between the hot-water supply use side heat exchanger and the hot-water supply port on the flow path, the hot water storage tank storing the heat transfer medium on the hot-water supply use side, wherein the control device includes a flash boiling operation mode in which cooling operation with the intermediate heat exchanger used as a condenser is performed in the air conditioning refrigerant circuit and hot-water supply operation with the hot-water supply heat source side heat exchanger and the intermediate heat exchanger used as evaporators is performed in the hot-water supply refrigerant circuit, and in the flash boiling operation mode, the control device closes the first air conditioning refrigerant flow control valve and the second air conditioning refrigerant flow control valve, controls rotational speed of the hot-water supply compressor so that the hot-water supply compressor is operated at a predetermined rotational speed, and controls the hot-water supply outdoor fan so that a differential amount of heat equivalent to a difference between the heat radiation amount of the air conditioning refrigerant circuit and the heat absorption amount of the hot-water supply refrigerant circuit is absorbed from outside air.

[0020] Also, preferably, in the above-described configuration, the arrangement is such that the control device includes a rapid cooling operation mode in which cooling operation with the air conditioning heat source side heat exchanger and the intermediate heat exchanger used as condensers is performed in the air conditioning refrigerant circuit and hot-water supply operation with the intermediate heat exchanger used as an evaporator is performed in the hot-water supply refrigerant circuit, and in the rapid cooling operation mode, the control device closes the first hot-water supply refrigerant flow control valve and the second hot-water supply refrigerant flow control valve, controls rotational speed of the air conditioning compressor so that the air conditioning compressor is operated at a predetermined rotational speed, and controls the air conditioning outdoor fan so that a difference between the heat radiation amount of the air conditioning refrigerant circuit and the heat absorption amount of the hot-water supply refrigerant circuit is radiated to outside air.

ADVANTAGEOUS EFFECT OF INVENTION

[0021] According to the present invention, it is possible to perform operation meeting the required capacity for a hot-water supply cycle while using exhaust heat from an air conditioning cycle not only in the case where an air conditioning load is higher than a hot-water supply load but also in the case where the air conditioning load is lower than the hot-water supply load. Furthermore, according to the present invention, even if there is a difference between the amount of heat radiation of the air conditioning cycle and the amount of heat absorption of the hot-water supply cycle, an amount of heat equivalent to the difference therebetween can be exchanged with outside air, thereby allowing an improvement in efficiency as the whole of the system. In addition, since the present invention includes various operation modes, it is possible to fulfill various operation requests while achieving a balance between the amount of heat radiation of the air conditioning cycle and the amount of heat absorption of the hot-water supply cycle.

BRIEF DESCRIPTION OF DRAWINGS

[0022]

Fig. 1 is a system diagram of an air conditioning and hot-water supply system according to a first embodiment of the present invention.

Fig. 2 is a diagram showing operation modes of the air conditioning and hot-water supply system shown in Fig. 1.

Fig. 3 is a diagram showing operation modes of the air conditioning and hot-water supply system shown in Fig. 1.

Fig. 4 is an action diagram showing flows of a refrigerant and a heat transfer medium in a cooling/hot-water supply individual operation mode shown in Fig. 2.

Fig. 5 is an action diagram showing flows of a refrigerant and a heat transfer medium in a heating/hot-water supply

individual operation mode shown in Fig. 2.

Fig. 6 is a flowchart showing a procedure of control process in a scheduled operation mode shown in Fig. 2.

Fig. 7 is a flowchart showing a procedure of control process in the scheduled operation mode shown in Fig. 2.

Fig. 8 is a flowchart showing a procedure of control process in the scheduled operation mode shown in Fig. 2.

Fig. 9 is an action diagram showing flows of a refrigerant and a heat transfer medium in a control-1 mode of the scheduled operation mode shown in Fig. 2.

Fig. 10 is an action diagram showing flows of a refrigerant and a heat transfer medium in a control-2 mode of the scheduled operation mode shown in Fig. 2.

Fig. 11 is an action diagram showing flows of a refrigerant and a heat transfer medium in a control-3 mode of the scheduled operation mode shown in Fig. 2.

Fig. 12 is an action diagram showing flows of a refrigerant and a heat transfer medium in a high heating operation mode shown in Fig. 3.

Fig. 13 is a flowchart showing a procedure of control process in a flash boiling operation mode shown in Fig. 3.

Fig. 14 is a flowchart showing a procedure of control process in a flash boiling operation mode shown in Fig. 3.

Fig. 15 is a flowchart showing a procedure of control process in a rapid cooling operation mode shown in Fig. 3.

Fig. 16 is a flowchart showing a procedure of control process in a zero exhaust hot-air operation mode shown in Fig. 3.

Fig. 17 is a flowchart showing a procedure of control process in the zero exhaust hot-air operation mode shown in Fig. 3.

Fig. 18 is a flowchart showing a procedure of control process in an energy-saving operation mode shown in Fig. 3.

Fig. 19 is a flowchart showing a procedure of control process in the energy-saving operation mode shown in Fig. 3.

Fig. 20 is a system diagram of an air conditioning and hot-water supply system according to a second embodiment of the present invention.

Fig. 21 is a system diagram of an air conditioning and hot-water supply system according to a third embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0023] As shown in Fig. 1, an air conditioning and hot-water supply system according to a first embodiment of the present invention includes: an air conditioning refrigerant circuit 5 that drives an air conditioning compressor 21 to selectively perform cooling operation and heating operation; a hot-water supply refrigerant circuit 6 that drives a hot-water supply compressor 41 to perform hot-water supply operation; an air conditioning cold/hot water circulation circuit 8 that exchanges heat with the air conditioning refrigerant circuit 5 to perform air conditioning of the inside of a house 60; a hot-water supply flow path 9 that exchanges heat with the hot-water supply refrigerant circuit 6 to perform hot-water supply; and a control device 1a that performs control of operation. The air conditioning and hot-water supply system is a system in which the air conditioning refrigerant circuit 5 and the hot-water supply refrigerant circuit 6 are thermally connected to each other through an intermediate heat exchanger 23 to form a dual refrigerating cycle of an air conditioning cycle and a hot-water supply cycle.

[0024] The air conditioning and hot-water supply system has a unit configuration including a heat pump unit 1 disposed outside and an indoor unit 2 disposed inside. The air conditioning refrigerant circuit 5, the hot-water supply refrigerant circuit 6, the air conditioning cold/hot water circulation circuit 8, the hot-water supply flow path 9 and the control device 1a are incorporated in the heat pump unit 1. Furthermore, an indoor heat exchanger 61 that exchanges heat with air in the house 60 is incorporated in the indoor unit 2.

[0025] The air conditioning refrigerant circuit 5 is a circuit through which an air conditioning refrigerant circulates to form a refrigerating cycle (air conditioning cycle), and has a configuration in which an air conditioning heat source side heat exchanger 24 that exchanges heat with outside air sent from an air conditioning outdoor fan 25 is connected to an air conditioning refrigerant main circuit 5a. The air conditioning refrigerant main circuit 5a is formed to be circular by connecting, with refrigerant piping, the air conditioning compressor 21 that compresses the air conditioning refrigerant, a four-way valve (air conditioning flow path switching valve) 22 that switches a flow path of the air conditioning refrigerant, the intermediate heat exchanger 23 that exchanges heat with a hot-water supply refrigerant circulating through the hot-water supply refrigerant circuit 6, an air conditioning refrigerant tank 26, an air conditioning expanding valve 27 that decompresses the air conditioning refrigerant, and an air conditioning use side heat exchanger 28 that exchanges heat with the air conditioning cold/hot water circulation circuit 8. Here, heat exchange with the air conditioning cold/hot water circulation circuit 8 is performed, however, direct heat exchange with air in the house 60, not via the air conditioning cold/hot water circulation circuit 8, may be performed.

[0026] More specifically, the air conditioning heat source side heat exchanger 24 is connected between the four-way valve 22 and the air conditioning expanding valve 27 of the air conditioning refrigerant main circuit 5a in parallel with the intermediate heat exchanger 23. A first expanding valve (first air conditioning refrigerant flow control valve) 35c and a second expanding valve (second air conditioning refrigerant flow control valve) 35d that each control a flow rate of the

air conditioning refrigerant are incorporated in an inlet and an outlet of the air conditioning heat source side heat exchanger 24. Here, the air conditioning heat source side heat exchanger 24, the air conditioning outdoor fan 25, the first expanding valve 35c, and the second expanding valve 35d correspond to an air conditioning heat source side heat exchanger unit of the present invention. It should be noted that a refrigerant suited for a use condition is used from among R410a, R134a, HFO1234yf, HFO1234ze and CO₂ as the air conditioning refrigerant that circulates through the air conditioning refrigerant circuit 5.

[0027] Next, a structure of each of the equipment incorporated in the above-described air conditioning refrigerant circuit 5 will be explained in detail. The air conditioning compressor 21 is a variable displacement compressor whose capacity can be controlled. A piston type, rotary type, scroll type, screw type or centrifugal type can be adopted as such a compressor. Specifically, the air conditioning compressor 21 is a scroll type compressor whose capacity can be controlled by inverter control, and whose rotational speed can be varied from a low speed to a high speed.

[0028] The air conditioning use side heat exchanger 28 is, although not illustrated, configured such that an air conditioning refrigerant heat transfer tube through which the air conditioning refrigerant flows and an air conditioning cold/hot water heat transfer tube through which water (heat transfer medium on an air conditioning use side) flows contact thermally. The air conditioning refrigerant tank 26 has a function as a buffer that controls an amount of the air conditioning refrigerant that changes due to switching of a flow path of the air conditioning refrigerant circuit 5. The air conditioning expanding valve 27 can decompress the air conditioning refrigerant to a predetermined pressure by adjusting opening thereof.

[0029] The air conditioning cold/hot water circulation circuit 8 is a circuit through which water flows as a heat transfer medium on an air conditioning use side for exchanging heat with the air conditioning refrigerant circuit 5, and is formed to be circular by connecting a four-way valve 53, an air conditioning cold/hot water circulation pump 52 and the indoor heat exchanger 61 installed in the house 60 with air conditioning cold/hot water piping 55a, connecting the indoor heat exchanger 61 and the four-way valve 22 with air conditioning cold/hot water piping 55b, and connecting the four-way valve 53 and the air conditioning use side heat exchanger 28 with air conditioning cold/hot water piping 55c. Water flowing in this air conditioning cold/hot water circulation circuit 8 (cold water or hot water) exchanges heat with air in the house 60 via the indoor heat exchanger 61 to cool or heat inside the house 60. Here, as the heat transfer medium on the air conditioning use side flowing in the air conditioning cold/hot water circulation circuit 8, brine such as ethylene glycol may be used instead of water. It is needless to say that use of brine allows application in a cold climate region.

[0030] It should be noted as additional remarks here that, in the following explanation, although terms "cold water" and "hot water" are sometimes used for water flowing through the air conditioning cold/hot water circulation circuit 8, "cold water" refers to water flowing through the air conditioning cold/hot water circulation circuit 8 at the time of cooling, and "hot water" refers to water flowing through the air conditioning cold/hot water circulation circuit 8 at the time of heating.

[0031] The hot-water supply refrigerant circuit 6 is a circuit through which a hot-water supply refrigerant circulates to form a refrigerating cycle (hot-water supply cycle), and has a configuration in which a hot-water supply heat source side heat exchanger 44 that exchanges heat with outside air sent from a hot-water supply outdoor fan 45 is connected to a hot-water supply refrigerant main circuit 6a. The hot-water supply refrigerant main circuit 6a is formed to be circular by connecting, with refrigerant piping, the hot-water supply compressor 41 that compresses the hot-water supply refrigerant, a hot-water supply use side heat exchanger 42 that exchanges heat with the hot-water supply flow path 9, a hot-water supply refrigerant tank 46 having a function as a buffer that controls an amount of the hot-water supply refrigerant, a hot-water supply expanding valve 43 that decompresses the hot-water supply refrigerant, and the intermediate heat exchanger 23 that exchanges heat with the air conditioning refrigerant circulating through the air conditioning refrigerant circuit 5.

[0032] More specifically, the hot-water supply heat source side heat exchanger 44 is connected between the hot-water supply compressor 41 and the hot-water supply expanding valve 43 of the hot-water supply refrigerant main circuit 6a in parallel with the intermediate heat exchanger 23. A third expanding valve (first hot-water supply refrigerant flow control valve) 49a and a fourth expanding valve (second hot-water supply refrigerant flow control valve) 49c that each control a flow rate of the hot-water supply refrigerant are incorporated in an inlet and an outlet of the hot-water supply heat source side heat exchanger 44. Here, the hot-water supply heat source side heat exchanger 44, the hot-water supply outdoor fan 45, the third expanding valve 49a, and the fourth expanding valve 49c correspond to a hot-water supply heat source side heat exchanger unit of the present invention. It should be noted that a refrigerant suited for a use condition is used from among R410a, R134a, HFO1234yf, HFO1234ze and CO₂ as the hot-water supply refrigerant that circulates through the hot-water supply refrigerant circuit 6.

[0033] Next, a structure of each of the equipment incorporated in the above-described hot-water supply refrigerant circuit 6 will be explained in detail. Capacity of the hot-water supply compressor 41 can be controlled by inverter control in the same manner as the air conditioning compressor 21, and a rotational speed thereof can be varied from a low speed to a high speed. The hot-water supply use side heat exchanger 42 is, although not illustrated, configured such that a hot-water supply water heat transfer tube through which water to be supplied to the hot-water supply flow path 9 flows and a hot-water supply refrigerant heat transfer tube through which the hot-water supply refrigerant flows contact

thermally. The hot-water supply expanding valve 43 can decompress the hot-water supply refrigerant to a predetermined pressure by adjusting opening thereof.

[0034] Here, in this embodiment, a plate heat exchanger is used as the intermediate heat exchanger 23. Also, two-way valves 35a, 35b are provided at an inlet and an outlet of the intermediate heat exchanger 23 of the air conditioning refrigerant circuit 5, and two-way valves 49b, 49d are provided at an inlet and an outlet of the intermediate heat exchanger 23 of the hot-water supply refrigerant circuit 6.

[0035] The hot-water supply flow path 9 is a flow path through which water as a heat transfer medium on a hot-water supply use side flows, and is formed by connecting an inlet of the hot-water supply use side heat exchanger 42 and a water supply port 78 with hot-water supply piping 72, and connecting an outlet of the hot-water supply use side heat exchanger 42 and a hot-water supply port 79 with hot-water supply piping 73. A hot water storage tank 70 is attached to the hot-water supply piping 73. The water supplied from the water supply port 78 undergoes heat exchange with the hot-water supply use side heat exchanger 42 and becomes hot water, and then the hot water is stored in the hot water storage tank 70. Then the hot water stored in the hot water storage tank 70 is supplied from the hot-water supply port 79 to a hot-water supply load side (bathtub, lavatory, kitchen and the like). Also, drain piping 71a and a drain valve 71b are provided at a bottom of the hot water storage tank 70. The drain valve 71b is normally closed. When receiving a command from the control device 1a, the drain valve 71b is opened to discharge the hot water stored in the hot water storage tank 70 to the outside through the drain piping 71a. It should be noted that, although not illustrated, a flow sensor that detects a flow rate of water is incorporated in the hot-water supply flow path 9.

[0036] This air conditioning and hot-water supply system includes plural temperature sensors TH1 to TH20. Specifically, for measuring the temperature of water flowing through the hot-water supply flow path 9, the temperature sensor TH2 is provided at an inlet of the hot-water supply use side heat exchanger 42, and the temperature sensor TH1 is provided at the water supply port 78. Also, for measuring the temperature of cold/hot water flowing through the air conditioning cold/hot water circulation circuit 8, the temperature sensor TH4 is provided at an inlet in heating operation of the air conditioning use side heat exchanger 28, the temperature sensor TH3 is provided at an outlet in heating operation of the air conditioning use side heat exchanger 28, and the temperature sensor TH5 is provided at an outlet of the indoor heat exchanger 61.

[0037] Also, for measuring the temperature of a hot-water supply refrigerant flowing through the hot-water supply refrigerant circuit 6, the temperature sensor TH6 is provided at a suction port 41a of the hot-water supply compressor 41, the temperature sensor TH7 is provided at a discharge port 41b of the hot-water supply compressor 41, the temperature sensor TH8 is provided at an outlet of the hot-water supply expanding valve 43, the temperature sensor TH9 is provided at an outlet of the hot-water supply heat source side heat exchanger 44, and the temperature sensor TH10 is provided at an outlet of the intermediate heat exchanger 23.

[0038] Also, for measuring the temperature of an air conditioning refrigerant flowing through the air conditioning refrigerant circuit 5, the temperature sensor TH11 is provided at a suction port 21a of the air conditioning compressor 21, the temperature sensor TH12 is provided at a discharge port 21b of the air conditioning compressor 21, the temperature sensors TH13 and TH14 are provided at an inlet and an outlet of the intermediate heat exchanger 23, the temperature sensors TH15 and TH16 are provided at an inlet and an outlet of the air conditioning heat source side heat exchanger 24, the temperature sensor TH17 is provided at an outlet in cooling operation of the air conditioning expanding valve 43, and the temperature sensor TH18 is provided at an outlet in cooling operation of the air conditioning use side heat exchanger 28.

[0039] Also, the air conditioning and hot-water supply system is provided with the temperature sensor TH19 for measuring outside air temperature, the temperature sensor TH20 for measuring the temperature of air in the house 60, and the temperature sensor TH21 for measuring the temperature of hot water stored in the hot water storage tank 70.

[0040] Furthermore, a rotational speed detecting sensor RA for detecting rotational speed is provided to the air conditioning compressor 21. A rotational speed detecting sensor RH is similarly provided to the hot-water supply compressor 41. Also, a valve opening detecting sensor PA that detects opening of a valve is provided to the air conditioning expanding valve 27, and a valve opening detecting sensor PH that detects opening of a valve is provided to the hot-water supply expanding valve 43.

[0041] The control device 1a receives inputs such as command signals from an unillustrated remote controller and detection signals from the temperature sensors TH1 to TH21, the rotational speed detecting sensors RA, RH and the valve opening detecting sensors PA, PH, and based on these input signals, performs: driving/stopping of the air conditioning compressor 21 and the hot-water supply compressor 41; switching of the four-way valves 22, 53; adjustment of opening of the air conditioning expanding valve 27 and the hot-water supply expanding valve 43; adjustment of opening of the expanding valves 35c, 35d, 49a, 49c; driving/stopping of the air conditioning cold/hot water circulation pump 52; opening and closing of the two-way valves 35a, 35b, 49a, 49d, 54a, 54b; and other control necessary for operation of the air conditioning and hot-water supply system.

[0042] Next, each operation mode performed in the air conditioning and hot-water supply system according to the first embodiment will be explained. Firstly, the outline of each operation mode will be explained using Figs. 2 and 3. The air

conditioning and hot-water supply system according to the first embodiment includes eight operation modes: "cooling/hot-water supply individual operation mode", "heating/hot-water supply individual operation mode", "scheduled operation mode", "high heating operation mode", "flash boiling operation mode", "rapid cooling operation mode", "zero exhaust hot-air operation mode", and "energy-saving operation mode".

[0043] The "cooling/hot-water supply individual operation mode" is an operation mode in which cooling operation by the air conditioning refrigerant circuit 5 and hot-water supply operation by the hot-water supply refrigerant circuit 6 are individually performed. In this operation mode, as shown in Fig. 2, during the hot-water supply cycle, the hot-water supply compressor 41 is operated; the hot-water supply use side heat exchanger 42 is used as a condenser; the hot-water supply heat source side heat exchanger 44 is used as an evaporator; and the intermediate heat exchanger 23 is not used. On the other hand, during the air conditioning cycle, the air conditioning compressor 21 is operated; the air conditioning use side heat exchanger 28 is used as an evaporator; the air conditioning heat source side heat exchanger 24 is used as a condenser; and the intermediate heat exchanger 23 is not used.

[0044] The "heating/hot-water supply individual operation mode" is an operation mode in which heating operation by the air conditioning refrigerant circuit 5 and hot-water supply operation by the hot-water supply refrigerant circuit 6 are individually performed. In this operation mode, as shown in Fig. 2, during the hot-water supply cycle, the hot-water supply compressor 41 is operated; the hot-water supply use side heat exchanger 42 is used as a condenser; the hot-water supply heat source side heat exchanger 44 is used as an evaporator; and the intermediate heat exchanger 23 is not used. On the other hand, during the air conditioning cycle, the air conditioning compressor 21 is operated; the air conditioning use side heat exchanger 28 is used as a condenser; the air conditioning heat source side heat exchanger 24 is used as an evaporator; and the intermediate heat exchanger 23 is not used.

[0045] The "scheduled operation mode" is an operation mode in which cooling operation by the air conditioning refrigerant circuit 5 and hot-water supply operation by the hot-water supply refrigerant circuit 6 are performed while exchanging heat between the air conditioning refrigerant flowing through the air conditioning refrigerant circuit 5 and the hot-water supply refrigerant flowing through the hot-water supply refrigerant circuit 6 via the intermediate heat exchanger 23. In this scheduled operation mode, three operation modes of control-1 to control-3 are set according to the relation between a hot-water supply heat absorption amount required by the hot-water supply refrigerant circuit 6 and an air conditioning heat radiation amount required by the air conditioning refrigerant circuit 5.

[0046] The "control-1 mode" is performed when the hot-water supply heat absorption amount and the air conditioning heat radiation amount are assumed to be equal from the fact that the difference therebetween falls within a predetermined range, that is, when the air conditioning and hot-water supply system is in a third load condition. In the control-1 mode, as shown in Fig. 2, during the hot-water supply cycle, the hot-water supply compressor 41 is operated; the hot-water supply use side heat exchanger 42 is used as a condenser; the hot-water supply heat source side heat exchanger 44 is not used; and the intermediate heat exchanger 23 is used as an evaporator. On the other hand, during the air conditioning cycle, the air conditioning compressor 21 is operated; the air conditioning use side heat exchanger 28 is used as an evaporator; the air conditioning heat source side heat exchanger 24 is not used; and the intermediate heat exchanger 23 is used as a condenser. In other words, in the control-1 mode, since there is a balance between the hot-water supply heat absorption amount and the air conditioning heat radiation amount, the operation is performed by using only the intermediate heat exchanger 23 without using the hot-water supply heat source side heat exchanger 44 and the air conditioning heat source side heat exchanger 24.

[0047] The "control-2 mode" is performed when the air conditioning heat radiation amount is larger than the hot-water supply heat absorption amount, that is, when the air conditioning and hot-water supply system is in a first load condition. In the control-2 mode, as shown in Fig. 2, during the hot-water supply cycle, the hot-water supply compressor 41 is operated; the hot-water supply use side heat exchanger 42 is used as a condenser; the hot-water supply heat source side heat exchanger 44 is not used; and the intermediate heat exchanger 23 is used as an evaporator. On the other hand, during the air conditioning cycle, the air conditioning compressor 21 is operated; the air conditioning use side heat exchanger 28 is used as an evaporator; the air conditioning heat source side heat exchanger 24 is used as a condenser; and the intermediate heat exchanger 23 is used as a condenser. In other words, in the control-2 mode, since the air conditioning heat radiation amount is larger than the hot-water supply heat absorption amount, a heat-amount balance cannot be achieved simply by radiating exhaust heat of the air conditioning cycle to the hot-water supply cycle via the intermediate heat exchanger 23. Therefore, cooling operation and hot-water supply operation are performed while radiating a differential amount of heat (surplus heat) equivalent to the difference between the air conditioning heat radiation amount and the hot-water supply heat absorption amount from the air conditioning heat source side heat exchanger 24 to outside air.

[0048] The "control-3 mode" is performed when the hot-water supply heat absorption amount is larger than the air conditioning heat radiation amount, that is, when the air conditioning and hot-water supply system is in a second load condition. In the control-3 mode, as shown in Fig. 2, during the hot-water supply cycle, the hot-water supply compressor 41 is operated; the hot-water supply use side heat exchanger 42 is used as a condenser; the hot-water supply heat source side heat exchanger 44 is used as an evaporator; and the intermediate heat exchanger 23 is used as an evaporator.

On the other hand, during the air conditioning cycle, the air conditioning compressor 21 is operated; the air conditioning use side heat exchanger 28 is used as an evaporator; the air conditioning heat source side heat exchanger 24 is not used; and the intermediate heat exchanger 23 is used as a condenser. In other words, in the control-3 mode, since the hot-water supply heat absorption amount is larger than the air conditioning heat radiation amount, a heat-amount balance cannot be achieved simply by radiating exhaust heat of the air conditioning cycle to the hot-water supply cycle via the intermediate heat exchanger 23. Therefore, cooling operation and hot-water supply operation are performed while absorbing a differential amount of heat (heat shortage) equivalent to the difference between the air conditioning heat radiation amount and the hot-water supply heat absorption amount from outside air via the hot-water supply heat source side heat exchanger 44.

[0049] The "high heating operation mode" is an operation mode in which heating operation by the air conditioning refrigerant circuit 5, with the intermediate heat exchanger 23 secondarily used, and hot-water supply operation by the hot-water supply refrigerant circuit 6 are performed. In this operation mode, as shown in Fig. 3, during the hot-water supply cycle, the hot-water supply compressor 41 is operated; the hot-water supply use side heat exchanger 42 is used as a condenser; the hot-water supply heat source side heat exchanger 44 is used as an evaporator; and the intermediate heat exchanger 23 is not used. On the other hand, during the air conditioning cycle, the air conditioning compressor 21 is operated; the air conditioning use side heat exchanger 28 is used as a condenser; the air conditioning heat source side heat exchanger 24 is used as an evaporator; and the intermediate heat exchanger 23 is used as a secondary evaporator. In this high heating operation mode, the evaporation temperature of the air conditioning cycle can be increased not only by using the air conditioning heat source side heat exchanger 24 as an evaporator but also by using the intermediate heat exchanger 23 as an evaporator as much as possible through the use of a heat-transfer surface of the plate of the intermediate heat exchanger 23. Therefore, this operation mode is suitable especially for the case where a room does not get warm enough in winter.

[0050] The "flash boiling operation mode" is an operation mode in which cooling operation by the air conditioning refrigerant circuit 5 and hot-water supply operation by the hot-water supply refrigerant circuit 6 are performed while exchanging heat between the air conditioning refrigerant flowing through the air conditioning refrigerant circuit 5 and the hot-water supply refrigerant flowing through the hot-water supply refrigerant circuit 6 via the intermediate heat exchanger 23. In this operation mode, as shown in Fig. 3, during the hot-water supply cycle, the hot-water supply compressor 41 is operated; the hot-water supply use side heat exchanger 42 is used as a condenser; the hot-water supply heat source side heat exchanger 44 is used as an evaporator; and the intermediate heat exchanger 23 is used as an evaporator. On the other hand, during the air conditioning cycle, the air conditioning compressor 21 is operated; the air conditioning use side heat exchanger 28 is used as an evaporator; the air conditioning heat source side heat exchanger 24 is not used; and the intermediate heat exchanger 23 is used as a condenser. This flash boiling operation mode is suitable for the case where a hot-water supply load increases temporarily, as for example when lots of hot water is temporarily needed.

[0051] The "rapid cooling operation mode" is an operation mode in which cooling operation by the air conditioning refrigerant circuit 5 and hot-water supply operation by the hot-water supply refrigerant circuit 6 are performed while exchanging heat between the air conditioning refrigerant flowing through the air conditioning refrigerant circuit 5 and the hot-water supply refrigerant flowing through the hot-water supply refrigerant circuit 6 via the intermediate heat exchanger 23. In this operation mode, as shown in Fig. 3, during the hot-water supply cycle, the hot-water supply compressor 41 is operated; the hot-water supply use side heat exchanger 42 is used as a condenser; the hot-water supply heat source side heat exchanger 44 is not used; and the intermediate heat exchanger 23 is used as an evaporator. On the other hand, during the air conditioning cycle, the air conditioning compressor 21 is operated at a predetermined operating rotational speed (maximum rotational speed); the air conditioning use side heat exchanger 28 is used as an evaporator; the air conditioning heat source side heat exchanger 24 is used as a condenser; and the intermediate heat exchanger 23 is used as a condenser. This rapid cooling operation mode is suitable for the case where there is a need to quickly cool the inside of a room in summer.

[0052] The "zero exhaust hot-air operation mode" is an operation mode in which cooling operation by the air conditioning refrigerant circuit 5 and hot-water supply operation by the hot-water supply refrigerant circuit 6 are performed while exchanging heat between the air conditioning refrigerant flowing through the air conditioning refrigerant circuit 5 and the hot-water supply refrigerant flowing through the hot-water supply refrigerant circuit 6 via the intermediate heat exchanger 23. In this operation mode, as shown in Fig. 3, during the hot-water supply cycle, the hot-water supply compressor 41 is operated; the hot-water supply use side heat exchanger 42 is used as a condenser; the hot-water supply heat source side heat exchanger 44 is not used; and the intermediate heat exchanger 23 is used as an evaporator. On the other hand, during the air conditioning cycle, the air conditioning compressor 21 is operated (and then stopped); the air conditioning use side heat exchanger 28 is used as an evaporator; the air conditioning heat source side heat exchanger 24 is not used; and the intermediate heat exchanger 23 is used as a condenser. This zero exhaust hot-air operation mode is suitable for the case where there is a need to prevent hot air from being released from the air conditioning heat source side heat exchanger 24.

[0053] The "energy-saving operation mode" is an operation mode in which cooling operation by the air conditioning

refrigerant circuit 5 and hot-water supply operation by the hot-water supply refrigerant circuit 6 are performed while exchanging heat between the air conditioning refrigerant flowing through the air conditioning refrigerant circuit 5 and the hot-water supply refrigerant flowing through the hot-water supply refrigerant circuit 6 via the intermediate heat exchanger 23. In this operation mode, as shown in Fig. 3, during the hot-water supply cycle, the hot-water supply compressor 41 is operated; the hot-water supply use side heat exchanger 42 is used as a condenser; the hot-water supply heat source side heat exchanger 44 is not used; and the intermediate heat exchanger 23 is used as an evaporator. On the other hand, during the air conditioning cycle, the air conditioning compressor 21 is operated (and then stopped); the air conditioning use side heat exchanger 28 is used as an evaporator; the air conditioning heat source side heat exchanger 24 is not used; and the intermediate heat exchanger 23 is used as a condenser. This energy-saving operation mode is suitable for the case where there is a need to perform hot-water supply operation and cooling operation while keeping electricity costs low anyway.

[0054] Next, details of each operation mode described above will be explained with reference to Figs. 4 to 19. It should be noted that, in Figs. 4, 5, 9 to 12, white thick arrows given to the heat exchangers show flows of heat, and arrows given to the circuits 5, 6, 8, 9 show directions of the refrigerant or fluid flowing through each circuit. Also, a white two-way valve shows that it is in an open state, and a black two-way valve shows that it is in a closed state. Also, as for the expanding valves 35c, 35d, 49a, 49c, a white expanding valve shows that it is in an open state, and a black expanding valve shows that it is in a closed state. Also, arc-shaped solid lines depicted in the four-way valves 22, 53 show flow paths of fluid flowing through the four-way valves. Also, as for the air conditioning outdoor fan 25 and the hot-water supply outdoor fan 45, a white fan shows that it is in operation, and a black fan shows that it is out of operation. Also, a heat exchanger shown with a dotted line shows a heat exchanger unused in each operation mode, that is, a heat exchanger with no refrigerant flowing.

[0055] Firstly, referring to Fig. 4, flows of a refrigerant and a heat transfer medium in the "cooling/hot-water supply individual operation mode" will be explained in detail.

[0056] In the air conditioning refrigerant circuit 5, a high-temperature and high-pressure gas refrigerant discharged from the discharge port 21b of the air conditioning compressor 21 passes through the four-way valve 22 and flows into the air conditioning heat source side heat exchanger 24. The high-temperature and high-pressure gas refrigerant flowing in the air conditioning heat source side heat exchanger 24 radiates heat to outside air sent from the air conditioning outdoor fan 25 to be condensed and liquefied. This high-pressure liquid refrigerant flows through the air conditioning refrigerant tank 26, and then is decompressed by the air conditioning expanding valve 27 adjusted to a predetermined opening and expands to become a low-temperature and low-pressure, vapor-liquid two-phase refrigerant and flow into the air conditioning use side heat exchanger 28. The vapor-liquid two-phase refrigerant flowing in the air conditioning use side heat exchanger 28 absorbs heat from high-temperature cold water flowing in the air conditioning cold/hot water circulation circuit 8 to evaporate and become a low-pressure gas refrigerant. This low-pressure gas refrigerant passes through the four-way valve 22, flows into the suction port 21a of the air conditioning compressor 21, and is compressed again by the air conditioning compressor 21 to become a high-temperature and high-pressure gas refrigerant.

[0057] In the air conditioning cold/hot water circulation circuit 8, the cold water having radiated heat to the air conditioning refrigerant flowing through the air conditioning use side heat exchanger 28 is caused to pass through the air conditioning cold/hot water piping 55a and flow into the indoor heat exchanger 61 by driving the air conditioning cold/hot water circulation pump 52. In the indoor heat exchanger 61, cold water in the air conditioning cold/hot water circulation circuit 8 and high-temperature air in the house 60 exchange heat, and the air in the house 60 is cooled. That is, the inside of the house 60 is cooled. At this time, the cold water flowing through the indoor heat exchanger 61 absorbs heat from the air in the house 60, and is raised in temperature. This cold water raised in temperature flows through the air conditioning cold/hot water piping 55b, 55c due to the air conditioning cold/hot water circulation pump 52, and while flowing through the air conditioning use side heat exchanger 28 again, exchanges heat with the air conditioning refrigerant flowing through the air conditioning refrigerant circuit 5 to be cooled.

[0058] On the other hand, in the hot-water supply refrigerant circuit 6, the gas refrigerant compressed to high temperature and pressure by the hot-water supply compressor 41 flows into the hot-water supply use side heat exchanger 42. The high-temperature and high-pressure gas refrigerant flowing in the hot-water supply use side heat exchanger 42 radiates heat to water flowing in the hot-water supply flow path 9 to be condensed and liquefied. Then the liquefied high-pressure refrigerant flows through the hot-water supply refrigerant tank 46, and then is decompressed by the hot-water supply expanding valve 43 adjusted to a predetermined opening, and expands to become a low-temperature and low-pressure, vapor-liquid two-phase refrigerant. This vapor-liquid two-phase refrigerant absorbs heat from outside air sent from the hot-water supply outdoor fan 45 and evaporates while flowing through the hot-water supply heat source side heat exchanger 44 to become a low-pressure gas refrigerant. This low-pressure gas refrigerant flows into the suction port 41a of the hot-water supply compressor 41, and is compressed again by the hot-water supply compressor 41 to become a high-temperature and high-pressure gas refrigerant.

[0059] In the hot-water supply flow path 9, the water having flowed into the water supply port 78 flows in the hot-water supply piping 72 to be guided to the hot-water supply use side heat exchanger 42. The water having flowed into the hot-

water supply use side heat exchanger 42 absorbs heat from the hot-water supply refrigerant flowing through the hot-water supply refrigerant circuit 6 in the hot-water supply use side heat exchanger 42, and turns into high-temperature hot water. This hot water flows in the hot-water supply piping 73 and is stored in the hot water storage tank 70. The stored hot water flows out of the hot-water supply port 79 to be guided to the hot-water supply load side upon request of a user.

[0060] It should be noted that, in this operation mode No. 1, the flow path through which the refrigerant flows to the intermediate heat exchanger 23 is blocked by the two-way valves 35a, 35b, 49b, 49d, so that heat exchange between the air conditioning refrigerant and the hot-water supply refrigerant is not performed.

[0061] Next, referring to Fig. 5, flows of a refrigerant and a heat transfer medium in the "heating/hot-water supply individual operation mode" will be explained in detail.

[0062] In the air conditioning refrigerant circuit 5, a high-temperature and high-pressure gas refrigerant discharged from the discharge port 21b of the air conditioning compressor 21 passes through the four-way valve 22, and flows into the air conditioning use side heat exchanger 28. The high-temperature and high-pressure gas refrigerant flowing in the air conditioning use side heat exchanger 28 radiates heat to hot water flowing in the air conditioning cold/hot water circuit 8 to be condensed and liquefied. This high-pressure liquid refrigerant is decompressed by the air conditioning expanding valve 27 adjusted to a predetermined opening, expands to become a low-temperature and low-pressure, vapor-liquid two-phase refrigerant, passes through the air conditioning refrigerant tank 26, and flows into the air conditioning heat source side heat exchanger 24. The vapor-liquid two-phase refrigerant flowing in the air conditioning heat source side heat exchanger 24 absorbs heat from outside air sent from the air conditioning outdoor fan 25 to evaporate and become a low-pressure gas refrigerant. This low-pressure gas refrigerant passes through the four-way valve 22, flows into the suction port 21a of the air conditioning compressor 21, and is compressed again by the air conditioning compressor 21 to become a high-temperature and high-pressure gas refrigerant.

[0063] In the air conditioning cold/hot water circulation circuit 8, the hot water raised in temperature by absorbing heat from the air conditioning refrigerant flowing through the air conditioning use side heat exchanger 28 is caused to pass through the air conditioning cold/hot water piping 55a and flow into the indoor heat exchanger 61 by driving the air conditioning cold/hot water circulation pump 52. In the indoor heat exchanger 61, hot water in the air conditioning cold/hot water circulation circuit 8 and low-temperature air in the house 60 exchange heat, and the air in the house 60 is heated. That is, the inside of the house 60 is heated. At this time, the hot water flowing through the indoor heat exchanger 61 radiates heat to the air in the house 60 to be cooled. This cooled hot water flows through the air conditioning cold/hot water piping 55b, 55c due to the air conditioning cold/hot water circulation pump 52, and while flowing through the air conditioning use side heat exchanger 28 again, exchanges heat with the air conditioning refrigerant flowing through the air conditioning refrigerant circuit 5, and consequently the temperature thereof is raised.

[0064] It should be noted that flows of a hot-water supply refrigerant in the hot-water supply refrigerant circuit 6 and water in the hot-water supply flow path 9 are the same as those of the "cooling/hot-water supply individual operation mode", and therefore the explanation thereof will not be repeated here. It should be also noted that, in this "heating/hot-water supply individual operation mode", the flow path through which the refrigerant flows to the intermediate heat exchanger 23 is blocked by the two-way valves 35a, 35b, 49b, 49d, so that heat exchange between the air conditioning refrigerant and the hot-water supply refrigerant is not performed.

[0065] Next, flows of a refrigerant and a heat transfer medium in the "scheduled operation mode" and control in this operation mode will be explained with reference to Figs. 6 to 11. In the scheduled operation mode, the control device 1a calculates and compares a heat radiation amount required by the air conditioning refrigerant circuit 5 and a heat absorption amount required by the hot-water supply refrigerant circuit 6, and determines one of the "control-1 mode", the "control-2 mode", and the "control-3 mode" on the basis of the comparison result, and controls operation of the air conditioning and hot-water supply system in accordance with the determination. Therefore, firstly, a procedure of control process executed by the control device 1a will be explained with reference to Figs. 6 to 8.

[0066] When a scheduled operation is started, firstly, at Step S1, the control device 1a executes a process of receiving various data. Specifically, the control device 1a receives data of target hot water temperature (boiling temperature), a target hot water amount (flow rate), and tap water temperature in the hot-water supply cycle, and also receives data of target temperature (preset temperature), target air volume, and indoor temperature in the air conditioning cycle. It should be noted that the target hot water temperature and target hot water amount of the hot-water supply cycle are data to be input to the control device 1a by remote control settings, and the tap water temperature is data to be input from the temperature sensor TH1. It should also be noted that, the target temperature and target air volume of the air conditioning cycle are data to be input to the control device 1a by remote control settings, and the indoor temperature is data to be input from the temperature sensor TH20.

[0067] Subsequently, the control device 1a proceeds to Step S2, and executes a process of calculation on the basis of the various data received at Step S1. Specifically, the control device 1a calculates target capacity (Qh), a target rotational speed of the hot-water supply compressor 41, target discharge temperature (Td) of the hot-water supply compressor 41, and an input (Whcomp) of the hot-water supply compressor 41 in the hot-water supply cycle, and also

calculates target capacity (Q_c), a target rotational speed of the air conditioning compressor 21, target evaporation temperature (T_e) of the air conditioning refrigerant, and an input (W_{comp}) of the air conditioning compressor 21 in the air conditioning cycle. Then the control device 1a proceeds to Step S3, and calculates a hot-water supply heat absorption amount from the difference between the target capacity (Q_h) and the compressor input (W_{hcomp}) of the hot-water supply cycle, and also calculates an air conditioning heat radiation amount from the sum of the target capacity (Q_c) and the compressor input (W_{comp}) of the air conditioning cycle.

[0068] Then the control device 1a proceeds to Step S4, and determines whether or not the hot-water supply heat absorption amount and air conditioning heat radiation amount calculated at Step S3 are equal, that is, whether or not the current load is in the third load condition. It should be noted that, at Step S4, if the difference between the hot-water supply heat absorption amount and the air conditioning heat radiation amount falls within a predetermined value range, the two amounts are determined to be equal. If Yes at Step S4, the control device 1a proceeds to Step S5, and executes process of the "control-1 mode". Specifically, the control device 1a opens the two-way valves 35a, 35b, 49b, 49d located at the inlet and outlet of the intermediate heat exchanger 23; closes the third expanding valve 49a and the fourth expanding valve 49c located at the inlet and outlet of the hot-water supply heat source side heat exchanger 44; and closes the first expanding valve 35c and the second expanding valve 35d located at the inlet and outlet of the air conditioning heat source side heat exchanger 24. That is, since the hot-water supply heat absorption amount and air conditioning heat radiation amount are equal, the control device 1a brings about a state that allows cooling operation and hot-water supply operation using only the intermediate heat exchanger 23.

[0069] Then the control device 1a proceeds to Step S6, and controls operation of the hot-water supply cycle and the air conditioning cycle according to the calculation results of Step S2. Specifically, the control device 1a, in the hot-water supply cycle, controls the hot-water supply compressor 41 so that it is operated at the target rotational speed; stops the hot-water supply outdoor fan 45; and controls opening of the hot-water supply expanding valve 43 so that the target discharge temperature (T_d) is reached. Also, the control device 1a, in the air conditioning cycle, controls the air conditioning compressor 21 so that it is operated at a predetermined rotational speed; stops the air conditioning outdoor fan 25; and controls opening of the air conditioning expanding valve 27 so that the target evaporation temperature (T_e) is reached. And then at next step, a return is executed, and the scheduled operation process exits.

[0070] On the other hand, if No at Step S4, the control device 1a proceeds to Step S7, and determines whether or not the hot-water supply heat absorption amount is smaller than the air conditioning heat radiation amount. If the hot-water supply heat absorption amount is determined to be smaller than the air conditioning heat radiation amount, that is, when the current load is in the first load condition, the control device 1a executes process of the "control-2 mode". If the hot-water supply heat absorption amount is determined to be larger than the air conditioning heat radiation amount, that is, when the current load is in the second load condition, the control device 1a executes process of the "control-3 mode".

[0071] Next, the process of the control-2 mode will be explained. In the process of the control-2 mode, as shown in Fig. 6, firstly, at Step S8, the control device 1a opens the two-way valves 35a, 35b, 49b, 49d located at the inlet and outlet of the intermediate heat exchanger 23; closes the third expanding valve 49a and the fourth expanding valve 49c located at the inlet and outlet of the hot-water supply heat source side heat exchanger 44; and opens the first expanding valve 35c and the second expanding valve 35d located at the inlet and outlet of the air conditioning heat source side heat exchanger 24. That is, since the air conditioning heat radiation amount is larger than the hot-water supply heat absorption amount, the control device 1a brings about a state that allows cooling operation and hot-water supply operation while radiating the differential amount of heat equivalent to the difference between the air conditioning heat radiation amount and the hot-water supply heat absorption amount from the air conditioning heat source side heat exchanger 24 to outside air.

[0072] Then the control device 1a proceeds to Step S9, and executes a process of receiving various data. Specifically, the control device 1a receives data of the hot-water supply heat absorption amount and the air conditioning heat radiation amount calculated at Step S3 and data of outside air temperature input from the temperature sensor TH19. And then the control device 1a proceeds to Step S10, and calculates target evaporation temperature (T_e) of the hot-water supply refrigerant in the hot-water supply cycle and target condensation temperature (T_c) of the air conditioning refrigerant in the air conditioning cycle on the basis of the various data received at Step S9.

[0073] Then the control device 1a proceeds to Step S11, and controls operation of the hot-water supply cycle and the air conditioning cycle according to the calculation results of Step S9. Specifically, the control device 1a, in the hot-water supply cycle, controls the hot-water supply compressor 41 so that it is operated at the target rotational speed; stops the hot-water supply outdoor fan 45; and controls opening of the hot-water supply expanding valve 43 so that the target evaporation temperature (T_e) is reached. Also, the control device 1a, in the air conditioning cycle, controls the air conditioning compressor 21 so that it is operated at the target rotational speed; controls rotational speed of the air conditioning outdoor fan 25 so that the target condensation temperature (T_c) is reached; and controls opening of the air conditioning expanding valve 27 so that the target condensation temperature (T_c) is reached.

[0074] Then the control device 1a proceeds to Step S12, and determines whether or not the target evaporation temperature (T_e) of the hot-water supply cycle is reached. If Yes at Step S12, the control device 1a proceeds to Step S13,

and determines whether or not the target condensation temperature (T_c) of the air conditioning cycle is reached. If Yes at Step S13, the control device 1a proceeds to Step S15, and confirms whether or not the hot-water supply cycle is operated at the target hot-water supply capacity (Q_h) and also whether or not the air conditioning cycle is operated at the target air conditioning capacity (Q_c). And then if Yes at Step S15, a return is executed at next step, and the scheduled operation process exits. It should be noted that, if No at Step S15, the control device 1a returns to Step S11.

[0075] On the other hand, if No at Step S12, the control device 1a returns to Step S11, and adjusts opening of the hot-water supply expanding valve 43 until the target evaporation temperature (T_e) of the hot-water supply cycle is reached. In this manner, in the process of the control-2 mode, since the hot-water supply heat absorption amount is smaller than the air conditioning heat radiation amount, the control device 1a firstly controls the hot-water supply cycle, which is smaller in the amount of heat, so that the target evaporation temperature (T_e) is reached. Also, if No at Step S13, the control device 1a adjusts (slightly closes) opening of the first expanding valve 35c and the second expanding valve 35d at Step S14. And then the control device 1a returns to Step S11, and adjusts opening of the first expanding valve 35c and the second expanding valve 35d until the target condensation temperature (T_c) of the air conditioning cycle is reached. In this manner, in the process of the control-2 mode, the control device 1a controls operation of the air conditioning cycle after the hot-water supply cycle has reached the target evaporation temperature (T_e).

[0076] Here, as for the sequence of control to cause the air conditioning cycle to reach the target condensation temperature (T_c), first, the rotational speed of the air conditioning outdoor fan 25 is adjusted (Step S11), and then if the air conditioning cycle does not reach the target condensation temperature (T_c) (No at Step S14), the opening of the first expanding valve 35c and the second expanding valve 35d located at the inlet and outlet of the air conditioning heat source side heat exchanger 24 is secondarily adjusted. That is, when the difference between the heat exchange amount of the air conditioning heat source side heat exchanger 24 and the differential amount of heat equivalent to the difference between the hot-water supply heat absorption amount and the air conditioning heat radiation amount as obtained at step S3 is beyond the predetermined range even after the rotational speed of the air conditioning outdoor fan 25 has been controlled, the control device 1a adjusts opening of the first expanding valve 35c and the second expanding valve 35d to make up the difference therebetween, and performs control so that the balance between the amounts of heat to be exchanged is maintained.

[0077] In the process of the control-3 mode, as shown in Fig. 7, firstly, at Step S16, the control device 1a opens the two-way valves 35a, 35b, 49b, 49d located at the inlet and outlet of the intermediate heat exchanger 23; opens the third expanding valve 49a and the fourth expanding valve 49c located at the inlet and outlet of the hot-water supply heat source side heat exchanger 44; and closes the first expanding valve 35c and the second expanding valve 35d located at the inlet and outlet of the air conditioning heat source side heat exchanger 24. That is, since the hot-water supply heat absorption amount is larger than the air conditioning heat radiation amount, the control device 1a brings about a state that allows cooling operation and hot-water supply operation while absorbing the differential amount of heat equivalent to the difference between the hot-water supply heat absorption amount and the air conditioning heat radiation amount from outside air in the hot-water supply heat source side heat exchanger 44.

[0078] Then the control device 1a proceeds to Step S17, and executes a process of receiving various data. Specifically, the control device 1a receives data of the hot-water supply heat absorption amount and the air conditioning heat radiation amount calculated at Step S3 and data of outside air temperature input from the temperature sensor TH19. And then the control device 1a proceeds to Step S18, and calculates target evaporation temperature (T_e) of the hot-water supply refrigerant in the hot-water supply cycle and target condensation temperature (T_c) of the air conditioning refrigerant in the air conditioning cycle on the basis of the various data received at Step S17.

[0079] Then the control device 1a proceeds to Step S19, and controls operation of the hot-water supply cycle and the air conditioning cycle according to the calculation results of Step S18. Specifically, the control device 1a, in the hot-water supply cycle, controls the hot-water supply compressor 41 so that it is operated at the target rotational speed; controls rotational speed of the hot-water supply outdoor fan 45 so that the target evaporation temperature (T_e) is reached; and controls opening of the hot-water supply expanding valve 43 so that the target evaporation temperature (T_e) is reached. Also, the control device 1a, in the air conditioning cycle, controls the air conditioning compressor 21 so that it is operated at the target rotational speed; stops the air conditioning outdoor fan 25; and controls opening of the air conditioning expanding valve 27 so that the target condensation temperature (T_c) is reached.

[0080] Then the control device 1a proceeds to Step S20, and determines whether or not the target condensation temperature (T_c) of the air conditioning cycle is reached. If Yes at Step S20, the control device 1a proceeds to Step S21, and determines whether or not the target evaporation temperature (T_e) of the hot-water supply cycle is reached. If Yes at Step S21, the control device 1a proceeds to Step S23, and confirms whether or not the hot-water supply cycle is operated at the target hot-water supply capacity (Q_h) and also whether or not the air conditioning cycle is operated at the target air conditioning capacity (Q_c). And then if Yes at Step S23, a return is executed at next step, and the scheduled operation process exits. It should be noted that, if No at Step S23, the control device 1a returns to Step S19.

[0081] On the other hand, if No at Step S20, the control device 1a returns to Step S19, and adjusts opening of the air conditioning expanding valve 27 until the target condensation temperature (T_c) of the air conditioning cycle is reached.

In this manner, in the process of the control-3 mode, since the air conditioning heat radiation amount is smaller than the hot-water supply heat absorption amount, the control device 1a firstly controls the air conditioning cycle, which is smaller in the amount of heat, so that the target condensation temperature (T_c) is reached. Also, if No at Step S21, the control device 1a adjusts (slightly closes) opening of the third expanding valve 49a and the fourth expanding valve 49c at Step S22. And then the control device 1a returns to Step S19, and adjusts opening of the third expanding valve 49a and the fourth expanding valve 49c until the target evaporation temperature (T_e) of the hot-water supply cycle is reached. In this manner, in the process of the control-3 mode, the control device 1a controls operation of the hot-water supply cycle after the air conditioning cycle has reached the target condensation temperature (T_c).

[0082] Here, as for the sequence of control to cause the hot-water supply cycle to reach the target evaporation temperature (T_e), first, the rotational speed of the hot-water supply outdoor fan 45 is adjusted (Step S19), and then if the hot-water supply cycle does not reach the target evaporation temperature (T_e) (No at Step S21), opening of the third expanding valve 49a and the fourth expanding valve 49c located at the inlet and outlet of the hot-water supply heat source side heat exchanger 44 is secondarily adjusted. That is, when the difference between the heat exchange amount of the hot-water supply heat source side heat exchanger 44 and the differential amount of heat equivalent to the difference between the hot-water supply heat absorption amount and the air conditioning heat radiation amount as obtained at step S3 is beyond the predetermined range even after the rotational speed of the hot-water supply outdoor fan 45 has been controlled, the control device 1a adjusts opening of the third expanding valve 49a and the fourth expanding valve 49c to make up the difference, and performs control so that the balance between the amounts of heat to be exchanged is maintained.

[0083] Next, flows of a refrigerant and a heat transfer medium in the scheduled operation mode will be explained with reference to Figs. 9 to 11. Firstly, the "control-1 mode" will be explained using Fig. 9. In the control-1 mode, the first expanding valve 35c, the second expanding valve 35d, the third expanding valve 49a, and the fourth expanding valve 49c are closed, and the air conditioning outdoor fan 25 and the hot-water supply outdoor fan 45 are stopped.

[0084] In the air conditioning refrigerant circuit 5, a high-temperature and high-pressure gas refrigerant discharged from the discharge port 21b of the air conditioning compressor 21 passes through the four-way valve 22, and flows into the intermediate heat exchanger 23. The high-temperature and high-pressure gas refrigerant flowing in the intermediate heat exchanger 23 radiates heat to a low-temperature hot-water supply refrigerant flowing through the intermediate heat exchanger 23 to be condensed and liquefied. This high-pressure liquid refrigerant flows through the air conditioning refrigerant tank 26, and then is decompressed by the air conditioning expanding valve 27 adjusted to a predetermined opening, expands to become a low-temperature and low-pressure, vapor-liquid two-phase refrigerant, and flows into the air conditioning use side heat exchanger 28. The vapor-liquid two-phase refrigerant flowing in the air conditioning use side heat exchanger 28 absorbs heat from high-temperature cold water flowing in the air conditioning cold/hot water circulation circuit 8 to evaporate and become a low-pressure gas refrigerant. This low-pressure gas refrigerant passes through the four-way valve 22, flows into the suction port 21a of the air conditioning compressor 21, and is compressed again by the air conditioning compressor 21 to become a high-temperature and high-pressure gas refrigerant.

[0085] In the air conditioning cold/hot water circulation circuit 8, the cold water having radiated heat to the air conditioning refrigerant flowing through the air conditioning use side heat exchanger 28 is caused to pass through the air conditioning cold/hot water piping 55a and flow into the indoor heat exchanger 61 by driving the air conditioning cold/hot water circulation pump 52. In the indoor heat exchanger 61, cold water in the air conditioning cold/hot water circulation circuit 8 and high-temperature air in the house 60 exchange heat, and the air in the house 60 is cooled. That is, the inside of the house 60 is cooled. At this time, the cold water flowing through the indoor heat exchanger 61 absorbs heat from the air in the house 60, and is raised in temperature. This cold water raised in temperature flows through the air conditioning cold/hot water piping 55b, 55c due to the air conditioning cold/hot water circulation pump 52, and while flowing through the air conditioning use side heat exchanger 28 again, exchanges heat with the air conditioning refrigerant flowing through the air conditioning refrigerant circuit 5 to be cooled.

[0086] On the other hand, in the hot-water supply refrigerant circuit 6, the gas refrigerant compressed to high temperature and pressure by the hot-water supply compressor 41 flows into the hot-water supply use side heat exchanger 42. The high-temperature and high-pressure gas refrigerant flowing in the hot-water supply use side heat exchanger 42 radiates heat to water flowing in the hot-water supply flow path 9 to be condensed and liquefied. Then the liquefied high-pressure refrigerant flows through the hot-water supply refrigerant tank 46, and then is decompressed by the hot-water supply expanding valve 43 adjusted to a predetermined opening, and expands to become a low-temperature and low-pressure, vapor-liquid two-phase refrigerant. This vapor-liquid two-phase refrigerant absorbs heat from the high-temperature air conditioning refrigerant flowing through the intermediate heat exchanger 23 and evaporates while flowing through the intermediate heat exchanger 23 to become a low-pressure gas refrigerant. This low-pressure gas refrigerant flows into the suction port 41a of the hot-water supply compressor 41, and is compressed again by the hot-water supply compressor 41 to become a high-temperature and high-pressure gas refrigerant.

[0087] In the hot-water supply flow path 9, the water having flowed into the water supply port 78 flows in the hot-water supply piping 72 to be guided to the hot-water supply use side heat exchanger 42. The water having flowed into the hot-

water supply use side heat exchanger 42 absorbs heat from the hot-water supply refrigerant flowing through the hot-water supply refrigerant circuit 6 in the hot-water supply use side heat exchanger 42, and turns into high-temperature hot water. This hot water flows in the hot-water supply piping 73 and is stored in the hot water storage tank 70. The stored hot water flows out of the hot-water supply port 79 to be guided to the hot-water supply load side upon request of a user.

[0088] In this manner, in the control-1 mode, since the hot-water supply heat absorption amount and the air conditioning heat radiation amount are equal, the operation of the air conditioning and hot-water supply system, in which exhaust heat of the air conditioning cycle is used for the hot-water supply cycle, can be performed by using only the intermediate heat exchanger 23 without using the air conditioning heat source side heat exchanger 24 and the hot-water supply heat source side heat exchanger 44. Thus, the control-1 mode allows an improvement in the efficiency as the whole of the system without wasting exhaust heat of the air conditioning cycle.

[0089] Next, the "control-2 mode" will be explained using Fig. 10. In the control-2 mode, while the first expanding valve 35c and the second expanding valve 35d are open, the third expanding valve 49a and the fourth expanding valve 49c are closed. Also, while the air conditioning outdoor fan 25 is rotated, the hot-water supply outdoor fan 45 is stopped.

[0090] In the air conditioning refrigerant circuit 5, a high-temperature and high-pressure gas refrigerant discharged from the discharge port 21b of the air conditioning compressor 21 passes through the four-way valve 22, and flows into the intermediate heat exchanger 23 and the air conditioning heat source side heat exchanger 24. The high-temperature and high-pressure gas refrigerant flowing in the intermediate heat exchanger 23 radiates heat to a low-temperature hot-water supply refrigerant flowing through the intermediate heat exchanger 23 to be condensed and liquefied. At the same time, the high-temperature and high-pressure gas refrigerant flowing in the air conditioning heat source side heat exchanger 24 radiates heat to outside air sent from the air conditioning outdoor fan 25 to be condensed and liquefied. This high-pressure liquid refrigerant flows through the air conditioning refrigerant tank 26, and then is decompressed by the air conditioning expanding valve 27 adjusted to a predetermined opening, expands to become a low-temperature and low-pressure, vapor-liquid two-phase refrigerant, and flows into the air conditioning use side heat exchanger 28. The vapor-liquid two-phase refrigerant flowing in the air conditioning use side heat exchanger 28 absorbs heat from high-temperature cold water flowing in the air conditioning cold/hot water circulation circuit 8 to evaporate and become a low-pressure gas refrigerant. This low-pressure gas refrigerant passes through the four-way valve 22, flows into the suction port 21a of the air conditioning compressor 21, and is compressed again by the air conditioning compressor 21 to become a high-temperature and high-pressure gas refrigerant.

[0091] On the other hand, in the hot-water supply refrigerant circuit 6, the gas refrigerant compressed to high temperature and pressure by the hot-water supply compressor 41 flows into the hot-water supply use side heat exchanger 42. The high-temperature and high-pressure gas refrigerant flowing in the hot-water supply use side heat exchanger 42 radiates heat to water flowing in the hot-water supply flow path 9 to be condensed and liquefied. Then the liquefied high-pressure refrigerant flows through the hot-water supply refrigerant tank 46, and then is decompressed by the hot-water supply expanding valve 43 adjusted to a predetermined opening, and expands to become a low-temperature and low-pressure, vapor-liquid two-phase refrigerant. This vapor-liquid two-phase refrigerant absorbs heat from the high-temperature air conditioning refrigerant flowing through the intermediate heat exchanger 23 and evaporates while flowing through the intermediate heat exchanger 23 to become a low-pressure gas refrigerant. This low-pressure gas refrigerant flows into the suction port 41a of the hot-water supply compressor 41, and is compressed again by the hot-water supply compressor 41 to become a high-temperature and high-pressure gas refrigerant.

[0092] It should be noted that flows of cold water in the air conditioning cold/hot water circulation circuit 8 and water in the hot-water supply flow path 9 in the control-2 mode are the same as those in the control-1 mode, and therefore the explanation thereof will not be repeated here.

[0093] In this manner, in the control-2 mode, since the air conditioning heat radiation amount is larger than the hot-water supply heat absorption amount, the differential amount of heat equivalent to the difference between the air conditioning heat radiation amount and the hot-water supply heat absorption amount is radiated from the air conditioning heat source side heat exchanger 24 to outside air. At this time, the hot-water supply heat source side heat exchanger 44 is not used in the hot-water supply cycle. That is, in the hot-water supply cycle, operation of the air conditioning and hot-water supply system, in which exhaust heat of the air conditioning cycle is used for the hot-water supply cycle, can be performed by using only the intermediate heat exchanger 23. Thus, the control-2 mode allows an improvement in the efficiency as the whole of the system without wasting exhaust heat of the air conditioning cycle.

[0094] Next, the "control-3 mode" will be explained using Fig. 11. In the control-3 mode, while the first expanding valve 35c and the second expanding valve 35d are closed, the third expanding valve 49a and the fourth expanding valve 49c are open. Also, while the air conditioning outdoor fan 25 is stopped, the hot-water supply outdoor fan 45 is rotated.

[0095] In the air conditioning refrigerant circuit 5, a high-temperature and high-pressure gas refrigerant discharged from the discharge port 21b of the air conditioning compressor 21 passes through the four-way valve 22, and flows into the intermediate heat exchanger 23. The high-temperature and high-pressure gas refrigerant flowing in the intermediate heat exchanger 23 radiates heat to a low-temperature hot-water supply refrigerant flowing through the intermediate heat

exchanger 23 to be condensed and liquefied. This high-pressure liquid refrigerant flows through the air conditioning refrigerant tank 26, and then is decompressed by the air conditioning expanding valve 27 adjusted to a predetermined opening, expands to become a low-temperature and low-pressure, vapor-liquid two-phase refrigerant, and flows into the air conditioning use side heat exchanger 28. The vapor-liquid two-phase refrigerant flowing in the air conditioning use side heat exchanger 28 absorbs heat from high-temperature cold water flowing in the air conditioning cold/hot water circulation circuit 8 to evaporate and become a low-pressure gas refrigerant. This low-pressure gas refrigerant passes through the four-way valve 22, flows into the suction port 21a of the air conditioning compressor 21, and is compressed again by the air conditioning compressor 21 to become a high-temperature and high-pressure gas refrigerant.

[0096] On the other hand, in the hot-water supply refrigerant circuit 6, the gas refrigerant compressed to high temperature and pressure by the hot-water supply compressor 41 flows into the hot-water supply use side heat exchanger 42. The high-temperature and high-pressure gas refrigerant flowing in the hot-water supply use side heat exchanger 42 radiates heat to water flowing in the hot-water supply flow path 9 to be condensed and liquefied. Then the liquefied high-pressure refrigerant flows through the hot-water supply refrigerant tank 46, and then is decompressed by the hot-water supply expanding valve 43 adjusted to a predetermined opening, and expands to become a low-temperature and low-pressure, vapor-liquid two-phase refrigerant. This vapor-liquid two-phase refrigerant absorbs heat from the high-temperature air conditioning refrigerant flowing through the intermediate heat exchanger 23 and outside air sent from the hot-water supply outdoor fan 45 and evaporates while flowing through the intermediate heat exchanger 23 and the hot-water supply heat source side heat exchanger 44 to become a low-pressure gas refrigerant. This low-pressure gas refrigerant flows into the suction port 41a of the hot-water supply compressor 41, and is compressed again by the hot-water supply compressor 41 to become a high-temperature and high-pressure gas refrigerant.

[0097] It should be noted that flows of cold water in the air conditioning cold/hot water circulation circuit 8 and water in the hot-water supply flow path 9 in the control-3 mode are the same as those in the control-1 mode, and therefore the explanation thereof will not be repeated here.

[0098] In this manner, in the control-3 mode, since the hot-water supply heat absorption amount is larger than the air conditioning heat radiation amount, the differential amount of heat equivalent to the difference between the hot-water supply heat absorption amount and the air conditioning heat radiation amount is absorbed from outside air in the hot-water supply heat source side heat exchanger 44. At this time, the air conditioning heat source side heat exchanger 24 is not used in the air conditioning cycle. That is, exhaust heat of the air conditioning cycle is radiated to the hot-water supply cycle via only the intermediate heat exchanger 23. In other words, all exhaust heat of the air conditioning cycle is used in the hot-water supply cycle. Thus, the control-3 mode allows an improvement in the efficiency as the whole of the system without wasting exhaust heat of the air conditioning cycle.

[0099] Next, referring to Fig. 12, flows of a refrigerant and a heat transfer medium in the "high heating operation mode" will be explained in detail. In the high heating operation mode, the two-way valves 35a and 35b are open, the two-way valves 49b and 49d are closed, and the expanding valves 35c, 35d, 49a, 49c are open. Thus, the hot-water supply refrigerant does not flow into the intermediate heat exchanger 23 and flows into only the hot-water supply heat source side heat exchanger 44, and the air conditioning refrigerant flows into both the intermediate heat exchanger 23 and the air conditioning heat source side heat exchanger 24.

[0100] In the air conditioning refrigerant circuit 5, a high-temperature and high-pressure gas refrigerant discharged from the discharge port 21b of the air conditioning compressor 21 passes through the four-way valve 22, and flows into the air conditioning use side heat exchanger 28. The high-temperature and high-pressure gas refrigerant flowing in the air conditioning use side heat exchanger 28 radiates heat to hot water flowing in the air conditioning cold/hot water circuit 8 to be condensed and liquefied. This high-pressure liquid refrigerant is decompressed by the air conditioning expanding valve 27 adjusted to a predetermined opening, expands to become a low-temperature and low-pressure, vapor-liquid two-phase refrigerant, passes through the air conditioning refrigerant tank 26, and flows into the air conditioning heat source side heat exchanger 24 and the intermediate heat exchanger 23. The vapor-liquid two-phase refrigerant flowing in the air conditioning heat source side heat exchanger 24 absorbs heat from outside air sent from the air conditioning outdoor fan 25 to evaporate and become a low-pressure gas refrigerant. On the other hand, the vapor-liquid two-phase refrigerant flowing in the intermediate heat exchanger 23 absorbs some heat from the plate with no hot-water supply refrigerant flowing to evaporate and become a low-pressure gas refrigerant. This low-pressure gas refrigerant passes through the four-way valve 22, flows into the suction port 21a of the air conditioning compressor 21, and is compressed again by the air conditioning compressor 21 to become a high-temperature and high-pressure gas refrigerant.

[0101] On the other hand, in the hot-water supply refrigerant circuit 6, the gas refrigerant compressed to high temperature and pressure by the hot-water supply compressor 41 flows into the hot-water supply use side heat exchanger 42. The high-temperature and high-pressure gas refrigerant flowing in the hot-water supply use side heat exchanger 42 radiates heat to water flowing in the hot-water supply flow path 9 to be condensed and liquefied. Then the liquefied high-pressure refrigerant flows through the hot-water supply refrigerant tank 46, and then is decompressed by the hot-water supply expanding valve 43 adjusted to a predetermined opening, and expands to become a low-temperature and low-pressure, vapor-liquid two-phase refrigerant. This vapor-liquid two-phase refrigerant absorbs heat from outside air sent

from the hot-water supply outdoor fan 45 and evaporates while flowing through the hot-water supply heat source side heat exchanger 44 to become a low-pressure gas refrigerant. And then the low-pressure gas refrigerant having flowed out of the hot-water supply heat source side heat exchanger 44 flows into the suction port 41a of the hot-water supply compressor 41, and is compressed again by the hot-water supply compressor 41 to become a high-temperature and high-pressure gas refrigerant.

[0102] It should be noted that a flow of hot water in the air conditioning cold/hot water circulation circuit 8 is the same as that in the "heating/hot-water supply individual operation mode", and therefore the explanation thereof will not be repeated here. It should be also noted that a flow of water in the hot-water supply flow path 9 is the same as that in the "cooling/hot-water supply individual operation mode", and therefore the explanation thereof will not also be repeated here.

[0103] Here, a major feature of the high heating operation mode is that the intermediate heat exchanger 23 with no hot-water supply refrigerant flowing is used as an evaporator in the air conditioning cycle. That is, a feature of this mode is that the capacity of heating operation by the air conditioning refrigerant circuit 5 is increased as much as possible by also absorbing heat from the heat-transfer surface of the hollow plate. Therefore, performing operation in this high heating operation mode is effective in cases, as for example where it is difficult to sufficiently heat the inside of the house 60 in winter.

[0104] Next, flows of a refrigerant and a heat transfer medium in the "flash boiling operation mode" and control in this operation mode will be explained. However, flows of a refrigerant and a heat transfer medium are the same as those in the "control-3 mode" (see Fig. 11) of the scheduled operation mode. Therefore, the explanation thereof will not be repeated here, and only control of the flash boiling operation mode will be explained using Figs. 13 and 14.

[0105] When the flash boiling operation mode is started, firstly, at Step S101, the control device 1a determines whether or not tank temperature input from the temperature sensor TH21 is equal to or lower than temperature enabling the hot-water supply. If Yes at Step S101, the control device 1a determines at step S102 whether or not the hot-water supply heat absorption amount is larger than the air conditioning heat radiation amount. If the hot-water supply heat absorption amount is larger than the air conditioning heat radiation amount, the control device 1a proceeds to Step S103, and opens the two-way valves 35a, 35b, 49b, 49d located at the inlet and outlet of the intermediate heat exchanger 23; opens the third expanding valve 49a and the fourth expanding valve 49c located at the inlet and outlet of the hot-water supply heat source side heat exchanger 44; and closes the first expanding valve 35c and the second expanding valve 35d located at the inlet and outlet of the air conditioning heat source side heat exchanger 24. That is, since the hot-water supply heat absorption amount is larger than the air conditioning heat radiation amount, the control device 1a brings about a state that allows cooling operation and hot-water supply operation while absorbing the differential amount of heat equivalent to the difference between the hot-water supply heat absorption amount and the air conditioning heat radiation amount from outside air in the hot-water supply heat source side heat exchanger 44.

[0106] Then the control device 1a proceeds to Step S104, and executes a process of receiving various data. Specifically, the control device 1a receives a target hot water amount, target hot water temperature, tap water temperature (input from the temperature sensor TH1), and outdoor temperature (input from the temperature sensor TH19) in the hot-water supply cycle. Also, the control device 1a receives target temperature, target air volume, indoor temperature (input from the temperature sensor TH20), and outdoor temperature (input from the temperature sensor TH19) in the air conditioning cycle. Then the control device 1a proceeds to Step S105, and calculates, on the basis of the various data received at Step S104, target capacity, rotational speed of the air conditioning compressor 21, rotational speed of the air conditioning outdoor fan 25, discharge temperature of the air conditioning compressor 21, power consumption of the air conditioning compressor 21, and a heat radiation amount in the air conditioning cycle.

[0107] Then the control device 1a proceeds to Step S106, and receives data of the heat radiation amount of the air conditioning cycle as calculated at Step S105, and also receives data of a target hot water amount, target hot water temperature, tap water temperature, and outdoor temperature in the hot-water supply cycle. Then the control device 1a proceeds to Step S107, and calculates target capacity, rotational speed of the hot-water supply compressor 41, rotational speed of the hot-water supply outdoor fan 45, discharge temperature of the hot-water supply compressor 41, and power consumption of the hot-water supply compressor 21 in the hot-water supply cycle. And then the control device 1a proceeds to Step S108, and controls operation of the hot-water supply cycle and the air conditioning cycle according to the foregoing calculation results.

[0108] Specifically, the control device 1a, in the hot-water supply cycle, controls the hot-water supply compressor 41 so that it is operated at the target rotational speed; controls rotational speed of the hot-water supply outdoor fan 45 so that it is operated at the target rotational speed; and controls opening of the hot-water supply expanding valve 43 so that the target capacity is reached. Also, the control device 1a, in the air conditioning cycle, controls the air conditioning compressor 21 so that it is operated at the target rotational speed; stops the air conditioning outdoor fan 25; and controls opening of the air conditioning expanding valve 27 so that the target capacity is reached.

[0109] Then the control device 1a proceeds to Step S109, and determines whether or not the hot-water supply cycle and the air conditioning cycle have reached their respective target capacities. If Yes at Step S109, the control device 1a proceeds to Step S110, and determines whether or not to add water for hot-water supply.

If the addition of water is needed, the control device 1a proceeds to Step S111, and closes a tank return valve (not shown) and opens a water circuit valve (not shown) to perform the addition of water. On the other hand, if No at Step S110, the control device 1a proceeds to Step S112, and closes the tank return valve (not shown) and closes the water circuit valve (not shown). That is, the addition of water is not performed. Then at Step S113, hot water is supplied through a faucet of the hot-water supply load side (not shown) via the hot-water supply port 79. And then at next step, a return is executed, and the process of the flash boiling operation mode exits. It should be noted that, if No at Step S109, the control device 1a returns to Step S108. Also, if No at Step S101 and if No at Step S102, a return is executed, and the process of the flash boiling operation mode exits.

[0110] In this manner, it can be said that the flash boiling operation mode is an operation mode that can fulfill a high hot-water supply request, such as a request for lots of hot water, by performing operation using both the intermediate heat exchanger 23 and the hot-water supply heat source side heat exchanger 44 as evaporators in the hot-water supply cycle.

[0111] Next, flows of a refrigerant and a heat transfer medium in the "rapid cooling operation mode" and control in this operation mode will be explained. However, flows of a refrigerant and a heat transfer medium are the same as those in the "control-2 mode" (see Fig. 10) of the scheduled operation mode. Therefore, the explanation thereof will not be repeated here, and only control of the rapid cooling operation mode will be explained using Fig. 15.

[0112] When the rapid cooling operation mode is started, firstly, at Step S201, the control device 1a determines whether or not a cooling request is equal to or higher than a maximum capacity of individual cooling operation. If Yes at Step S201, the control device 1a determines at step S202 whether or not the air conditioning heat radiation amount is larger than the hot-water supply heat absorption amount. If the air conditioning heat radiation amount is larger than the hot-water supply heat absorption amount, the control device 1a proceeds to Step S203, and opens the two-way valves 35a, 35b, 49b, 49d located at the inlet and outlet of the intermediate heat exchanger 23; closes the third expanding valve 49a and the fourth expanding valve 49c located at the inlet and outlet of the hot-water supply heat source side heat exchanger 44; and opens the first expanding valve 35c and the second expanding valve 35d located at the inlet and outlet of the air conditioning heat source side heat exchanger 24. That is, since the air conditioning heat radiation amount is larger than the hot-water supply heat absorption amount, the control device 1a brings about a state that allows cooling operation and hot-water supply operation while radiating the differential amount of heat equivalent to the difference between the hot-water supply heat absorption amount and the air conditioning heat radiation amount from the air conditioning heat source side heat exchanger 24 to outside air.

[0113] Then the control device 1a proceeds to Step S204, and executes a process of receiving various data. Specifically, the control device 1a receives a target hot water amount, target hot water temperature, tap water temperature (input from the temperature sensor TH1), and outdoor temperature (input from the temperature sensor TH19) in the hot-water supply cycle. Also, the control device 1a receives data of target temperature, target air volume, indoor temperature (input from the temperature sensor TH20), and outdoor temperature (input from the temperature sensor TH19) in the air conditioning cycle. And then the control device 1a proceeds to Step S205, and calculates, on the basis of the various data received at Step S204, target capacity, discharge temperature of the air conditioning compressor 21, power consumption of the air conditioning compressor 21, and a heat radiation amount in the air conditioning cycle.

[0114] Then the control device 1a proceeds to Step S206, and receives data of the heat radiation amount of the air conditioning cycle as calculated at Step S205, and also receives data of a target hot water amount, target hot water temperature, tap water temperature, and outdoor temperature in the hot-water supply cycle. Then the control device 1a proceeds to Step S207, and calculates target capacity, rotational speed of the hot-water supply compressor 41, rotational speed of the hot-water supply outdoor fan 45, discharge temperature of the hot-water supply compressor 41, power consumption of the hot-water supply compressor 21 in the hot-water supply cycle. And then the control device 1a proceeds to Step S208, and controls operation of the hot-water supply cycle and the air conditioning cycle according to the foregoing calculation results.

[0115] Specifically, the control device 1a, in the hot-water supply cycle, controls the hot-water supply compressor 41 so that it is operated at the target rotational speed; controls the hot-water supply outdoor fan 45 to stop its operation; and controls opening of the hot-water supply expanding valve 43 so that the target capacity is reached. Also, the control device 1a, in the air conditioning cycle, controls the air conditioning compressor 21 so that it is operated at a predetermined rotational speed; controls rotation of the air conditioning outdoor fan 25 so that it is operated at a predetermined rotational speed; and controls opening of the air conditioning expanding valve 27 so that the target capacity is reached. Here, the predetermined rotational speed of the air conditioning compressor 21 is set to the maximum operating rotational speed, however, it is not limited thereto. Also, the predetermined rotational speed of the air conditioning outdoor fan 25 is set to the maximum operating rotational speed, however, it is not limited thereto.

[0116] Then the control device 1a proceeds to Step S209, and determines whether or not the hot-water supply cycle and the air conditioning cycle have reached their respective target capacities. If Yes at Step S209, a return is executed at next step, and the process of the rapid cooling operation mode exits. It should be noted that, if No at Step S209, the control device 1a returns to Step S208. Also, if No at Step S201 and if No at Step S202, a return is executed, and the

process of the rapid cooling operation mode exits.

[0117] In this manner, the rapid cooling operation mode can also fulfill a cooling request exceeding the maximum capacity of the individual cooling operation, such as a request to rapidly cool the inside of the house 60, by performing operation using both the intermediate heat exchanger 23 and the air conditioning heat source side heat exchanger 24 as condensers in the air conditioning cycle.

[0118] Next, flows of a refrigerant and a heat transfer medium in the "zero exhaust hot-air operation mode" and control in this operation mode will be explained. However, flows of a refrigerant and a heat transfer medium are the same as those in the "control-1 mode" (see Fig. 9) of the scheduled operation mode. Therefore, the explanation thereof will not be repeated here, and only control of the zero exhaust hot-air operation mode will be explained using Figs. 16 and 17. This zero exhaust hot-air operation mode has a major feature that control is performed in a manner so as to prevent generation of cooling exhaust heat by increasing the capacity (load) of the hot-water supply operation in accordance with the air conditioning heat radiation amount even when the air conditioning heat radiation amount is larger than the hot-water supply heat absorption amount. That is, in the zero exhaust hot-air operation mode, a heat-amount balance between the air conditioning heat radiation amount and the hot-water supply heat absorption amount is achieved by increasing the load of the hot-water supply operation rather than radiating the differential amount of heat equivalent to the difference between the air conditioning heat radiation amount and the hot-water supply heat absorption amount to outside air via the air conditioning heat source side heat exchanger 24, thereby allowing cooling operation and hot-water supply operation by heat exchange using only the intermediate heat exchanger 23 without using the air conditioning heat source side heat exchanger 24. Hereinafter, control of this operation mode will be explained.

[0119] When the zero exhaust hot-air operation mode is started, firstly, at Step S301, the control device 1a determines whether or not the air conditioning heat radiation amount is larger than the hot-water supply heat absorption amount. If the air conditioning heat radiation amount is larger than the hot-water supply heat absorption amount, the control device 1a proceeds to Step S302, and opens the two-way valves 35a, 35b, 49b, 49d located at the inlet and outlet of the intermediate heat exchanger 23; closes the third expanding valve 49a and the fourth expanding valve 49c located at the inlet and outlet of the hot-water supply heat source side heat exchanger 44; and closes the first expanding valve 35c and the second expanding valve 35d located at the inlet and outlet of the air conditioning heat source side heat exchanger 24.

[0120] Then the control device 1a proceeds to Step S303, and executes a process of receiving various data. Specifically, the control device 1a receives a target hot water amount, target hot water temperature, tap water temperature (input from the temperature sensor TH1), and outdoor temperature (input from the temperature sensor TH19) in the hot-water supply cycle. Also, the control device 1a receives data of target temperature, target air volume, indoor temperature (input from the temperature sensor TH20), and outdoor temperature (input from the temperature sensor TH19) in the air conditioning cycle. And then the control device 1a proceeds to Step S304, and calculates, on the basis of the various data received at Step S303, target capacity, rotational speed of the air conditioning compressor 21, rotational speed of the air conditioning outdoor fan 25, discharge temperature of the air conditioning compressor 21, power consumption of the air conditioning compressor 21, and a heat radiation amount in the air conditioning cycle.

[0121] Then the control device 1a proceeds to Step S305, and receives data of the heat radiation amount of the air conditioning cycle as calculated at Step S304, and also receives data of a target hot water amount, target hot water temperature, tap water temperature, and outdoor temperature in the hot-water supply cycle. Then the control device 1a proceeds to Step S306, and calculates target capacity, rotational speed of the hot-water supply compressor 41, rotational speed of the hot-water supply outdoor fan 45, and discharge temperature of the hot-water supply compressor 41 in the hot-water supply cycle. And then the control device 1a proceeds to Step S307, and controls operation of the hot-water supply cycle and the air conditioning cycle according to the foregoing calculation results.

[0122] Specifically, the control device 1a, in the hot-water supply cycle, controls the hot-water supply compressor 41 so that it is operated at the target rotational speed; controls the hot-water supply outdoor fan 45 to stop its operation; and controls opening of the hot-water supply expanding valve 43 so that the target capacity is reached. Also, the control device 1a, in the air conditioning cycle, controls the air conditioning compressor 21 so that it is operated at the target rotational speed; controls rotation of the air conditioning outdoor fan 25 so that it is operated at the target rotational speed; and controls opening of the air conditioning expanding valve 27 so that the target capacity is reached.

[0123] Then the control device 1a proceeds to Step S308, and determines whether or not the hot-water supply cycle and the air conditioning cycle have reached their respective target capacities. If Yes at Step S308, the control device 1a proceeds to Step S309, and determines whether or not hot water stored in the hot water storage tank 70 reaches a hot-water storage amount (the amount that can be stored in the hot water storage tank 70). If the hot-water storage amount is not reached (No at Step S309), the operation continues (Step 310), and the control device 1a returns to Step S309.

[0124] On the other hand, if Yes at Step S309, the control device 1a proceeds to Step S311, and opens the drain valve 71b to discharge the hot water stored in the hot water storage tank 70 to the outside through the drain piping 71a. Then the control device 1a proceeds to step S312, and stops operation of the air conditioning cycle. That is, the control device

1a stops operation of the air conditioning compressor 21 and the air conditioning outdoor fan 25. And then the control device 1a proceeds to Step S313, and opens the third expanding valve 49a and the fourth expanding valve 49c located at the inlet and outlet of the hot-water supply heat source side heat exchanger 44; and closes the two-way valves 49b, 49d located at the inlet and outlet of the intermediate heat exchanger 23.

5 **[0125]** Then the control device 1a proceeds to Step S314, and executes a process of receiving various data. Specifically, the control device 1a receives current time, target boiling-completion time, temperature in the hot water storage tank (input from the temperature sensor TH21), tap water temperature (input from the temperature sensor TH1), and outdoor temperature (input from the temperature sensor TH19) in the hot-water supply cycle. And then the control device 1a proceeds to Step S315, and calculates, on the basis of the various data received at Step S314, target capacity, rotational speed of the hot-water supply compressor 41, rotational speed of the hot-water supply outdoor fan 45, discharge temperature of the hot-water supply compressor 21, power consumption of the hot-water supply compressor 21, and opening of the hot-water supply expanding valve 43 in the hot-water supply cycle. Then the control device 1a proceeds to Step S316, and controls operation of the hot-water supply cycle according to the foregoing calculation results. Specifically, the control device 1a, in the hot-water supply cycle, controls the hot-water supply compressor 41 so that it is operated at the target rotational speed, and controls rotation of the hot-water supply outdoor fan 45 so that it is operated at the target rotational speed. And then a return is executed at next step, and the process of the zero exhaust hot-air operation mode exits. It should be noted that, if No at Step S308, the control device 1a returns to Step S307. Also, if No at Step S301, a return is executed, and the process of the zero exhaust hot-air operation mode exits.

10 **[0126]** In this manner, in the zero exhaust hot-air operation mode, with the intermediate heat exchanger 23 used as an evaporator in the hot-water supply cycle, hot-water supply operation is performed by increasing the capacity (load) of the hot-water supply operation in accordance with the air conditioning heat radiation amount even when the air conditioning heat radiation amount is larger than the hot-water supply heat absorption amount, and radiating air conditioning exhaust heat to the hot-water supply cycle. Also, in the zero exhaust hot-air operation mode, when the hot water storage tank 70 becomes full of hot water, the hot water is discharged to the outside through the drain piping 71a. That is, air conditioning exhaust heat is used for boiling water once, and then hot water no longer required is discharged to the outside, thereby allowing the release of air conditioning exhaust heat into outside air. Thus, the zero exhaust hot-air operation mode can fulfill, for example, a request to perform operation while minimizing the use of the air conditioning outdoor fan 25 because if the air conditioning outdoor fan 25 is turned on when a window of a nearby house is open, hot air can enter through the window.

25 **[0127]** Next, flows of a refrigerant and a heat transfer medium in the "energy-saving operation mode" and control in this operation mode will be explained. However, flows of a refrigerant and a heat transfer medium are the same as those in the "control-1 mode" (see Fig. 9) of the scheduled operation mode. Therefore, the explanation thereof will not be repeated here, and only control of the energy-saving operation mode will be explained using Figs. 18 and 19. In this energy-saving operation mode, when the air conditioning and hot-water supply system is in the third load condition in which the hot-water supply heat absorption amount and the air conditioning heat radiation amount are equal, the control device 1a directly operates the system. On the other hand, when the air conditioning and hot-water supply system is in the first load condition in which the air conditioning heat radiation amount is larger than the hot-water supply heat absorption amount, or in the second load condition in which the hot-water supply heat absorption amount is larger than the air conditioning heat radiation amount, the control device 1a controls the hot-water supply operation so that the system becomes the third load condition. Also, the control device 1a performs the hot-water supply operation while considering current time, remaining time, and operation capacity so that a target hot water amount and target hot water temperature are reached, up to target time. If necessary, the control device 1a controls the system so that, even during cooling operation, the energy-saving operation mode is stopped and switched to a normal exhaust heat recovery operation (that is, the scheduled operation mode).

30 **[0128]** When the energy-saving operation mode is started, firstly, at Step S401, the control device 1a determines whether or not the air conditioning heat radiation amount and the hot-water supply heat absorption amount are equal (whether or not the difference therebetween falls within a predetermined range). If the air conditioning heat radiation amount and the hot-water supply heat absorption amount are equal, the control device 1a proceeds to Step S402, and opens the two-way valves 35a, 35b, 49b, 49d located at the inlet and outlet of the intermediate heat exchanger 23; closes the third expanding valve 49a and the fourth expanding valve 49c located at the inlet and outlet of the hot-water supply heat source side heat exchanger 44; and closes the first expanding valve 35c and the second expanding valve 35d located at the inlet and outlet of the air conditioning heat source side heat exchanger 24. That is, since the air conditioning heat radiation amount and the hot-water supply heat absorption amount are equal and in balance, the control device 1a brings about a state that allows cooling operation and hot-water supply operation using only the intermediate heat exchanger 23.

35 **[0129]** Then the control device 1a proceeds to Step S403, and executes a process of receiving various data. Specifically, the control device 1a receives data of target temperature, target air volume, target air volume, indoor temperature (input from the temperature sensor TH20), and outdoor temperature (input from the temperature sensor TH19) in the air

conditioning cycle. And then the control device 1a proceeds to Step S404, and calculates, on the basis of the various data received at Step S403, target capacity, rotational speed of the air conditioning compressor 21, rotational speed of the air conditioning outdoor fan 25, discharge temperature of the air conditioning compressor 21, power consumption of the air conditioning compressor 21, and a heat radiation amount in the air conditioning cycle.

[0130] Then the control device 1a proceeds to Step S405, and receives data of the heat radiation amount of the air conditioning cycle as calculated at Step S404, and also receives data of a target hot water amount, target hot water temperature, tap water temperature, and outdoor temperature in the hot-water supply cycle. Then the control device 1a proceeds to Step S406, and calculates target capacity, rotational speed of the hot-water supply compressor 41, rotational speed of the hot-water supply outdoor fan 45, and discharge temperature of the hot-water supply compressor 41, and power consumption of the hot-water supply compressor 41 in the hot-water supply cycle. And then the control device 1a proceeds to Step S407, and controls operation of the hot-water supply cycle and the air conditioning cycle according to the foregoing calculation results.

[0131] Specifically, the control device 1a, in the hot-water supply cycle, controls the hot-water supply compressor 41 so that it is operated at the target rotational speed; controls the hot-water supply outdoor fan 45 to stop its operation; and controls opening of the hot-water supply expanding valve 43 so that the target capacity is reached. Also, the control device 1a, in the air conditioning cycle, controls the air conditioning compressor 21 so that it is operated at the target rotational speed; controls the air conditioning outdoor fan 25 to stop its operation; and controls opening of the air conditioning expanding valve 27 so that the target capacity is reached.

[0132] Then the control device 1a proceeds to Step S408, and determines whether or not the hot-water supply cycle and the air conditioning cycle have reached their respective target capacities. If Yes at Step S408, the control device 1a proceeds to Step S409, and stops operation of the air conditioning cycle to start individual hot-water supply operation using only the hot-water supply cycle. That is, the control device 1a stops operation of the air conditioning compressor 21 and the air conditioning outdoor fan 25. And then the control device 1a proceeds to Step S410, and opens the third expanding valve 49a and the fourth expanding valve 49c located at the inlet and outlet of the hot-water supply heat source side heat exchanger 44; and closes the two-way valves 49b, 49d located at the inlet and outlet of the intermediate heat exchanger 23.

[0133] Then the control device 1a proceeds to Step S411, and executes a process of receiving various data. Specifically, the control device 1a receives current time, target boiling-completion time, temperature in the hot water storage tank (input from the temperature sensor TH21), tap water temperature (input from the temperature sensor TH1), and outdoor temperature (input from the temperature sensor TH19) in the hot-water supply cycle. And then the control device 1a proceeds to Step S412, and calculates, on the basis of the various data received at Step S411, target capacity, rotational speed of the hot-water supply compressor 41, rotational speed of the hot-water supply outdoor fan 45, discharge temperature of the hot-water supply compressor 21, power consumption of the hot-water supply compressor 21, and opening of the hot-water supply expanding valve 43 in the hot-water supply cycle.

[0134] Then the control device 1a proceeds to Step S413, and controls operation of the hot-water supply cycle according to the foregoing calculation results. Specifically, the control device 1a, in the hot-water supply cycle, controls the hot-water supply compressor 41 so that it is operated at the target rotational speed, and controls rotation of the hot-water supply outdoor fan 45 so that it is operated at the target rotational speed. And then a return is executed at next step, and the process of the energy-saving operation mode exits. It should be noted that, if No at Step S408, the control device 1a returns to Step S407. Also, if No at Step S401 a return is executed, and the process of the energy-saving operation mode exits. In this manner, it can be said that the energy-saving operation mode is an energy-efficient operation mode because operation is performed while using all air conditioning exhaust heat for the hot-water supply operation.

[0135] As explained above, with the air conditioning and hot-water supply system according to the first embodiment of the present invention, if the air conditioning heat radiation amount is larger than the hot-water supply heat absorption amount, in the air conditioning cycle, cooling operation can be performed while radiating heat in the intermediate heat exchanger 23 and the air conditioning heat source side heat exchanger 24, and, in the hot-water supply cycle, hot-water supply operation can be performed while absorbing heat from the intermediate heat exchanger 23.

Also, if the air conditioning heat radiation amount is smaller than the hot-water supply heat absorption amount, in the air conditioning cycle, cooling operation can be performed while radiating heat in the intermediate heat exchanger 23, and, in the hot-water supply cycle, hot-water supply operation can be performed while absorbing heat from the intermediate heat exchanger 23 and the hot-water supply heat source side heat exchanger 44. Also, if the air conditioning heat radiation amount and the hot-water supply heat absorption amount are equal, cooling operation and hot-water supply operation can be performed while performing the giving and receiving of heat between the air conditioning cycle and the hot-water supply cycle via the intermediate heat exchanger 23.

[0136] That is, the air conditioning and hot water system according to this embodiment allows cooling operation and hot-water supply operation according to the relation between the air conditioning heat radiation amount and the hot-water supply heat absorption amount.

[0137] Also, the air conditioning and hot water system according to this embodiment is a system controlled so that

heat exchange is performed via the air conditioning heat source side heat exchanger 24 or the hot-water supply heat source side heat exchanger 44 by only the differential amount of heat equivalent to the difference between the air conditioning heat radiation amount and the hot-water supply heat absorption amount. Thus, the efficiency as the whole of the system is improved.

[0138] Also, the air conditioning and hot water system according to this embodiment includes the eight operation modes: the "cooling/hot-water supply individual operation mode", the "heating/hot-water supply individual operation mode", the "scheduled operation mode", the "high heating operation mode", the "flash boiling operation mode", the "rapid cooling operation mode", the "zero exhaust hot-air operation mode", and the "energy-saving operation mode", and thus can fulfill requests for various operations, thereby enhancing the convenience.

[0139] Next, an air conditioning and hot-water supply system according to a second embodiment of the present invention will be explained. However, the same elements as those of the air conditioning and hot-water supply system according to the foregoing first embodiment are designated by the same reference signs, and the explanation thereof will not be repeated. As shown in Fig. 20, a feature of the air conditioning and hot-water supply system according to the second embodiment of the present invention is that the intermediate heat exchanger 23 and the hot-water supply heat source side heat exchanger 44 are connected in series, and the intermediate heat exchanger 23 and the air conditioning heat source side heat exchanger 24 are connected in series.

[0140] More specifically, in refrigerant piping between the four-way valve 22 and the air conditioning expanding valve 27 in the air conditioning refrigerant circuit 5, there are incorporated in series, in order from the side on which the four-way valve 22 is disposed, the two-way valve 35a, the intermediate heat exchanger 23, the two-way valve 35b, the first expanding valve 35c, the air conditioning heat source side heat exchanger 24, the second expanding valve 35d, and the air conditioning refrigerant tank 26. Also, air conditioning bypass piping 101 for bypassing the intermediate heat exchanger 23 is connected to the air conditioning refrigerant circuit 5. An air conditioning bypass valve 35e is attached to the air conditioning bypass piping 101.

[0141] In the same manner, in refrigerant piping between the hot-water supply compressor 41 and the hot-water supply expanding valve 43 in the hot-water supply refrigerant circuit 6, there are incorporated in series, in order from the side on which the hot-water supply compressor 41 is disposed, the two-way valve 49d, the intermediate heat exchanger 23, the two-way valve 49b, the fourth expanding valve 49c, the hot-water supply heat source side heat exchanger 44, and the third expanding valve 49a. Also, hot-water supply bypass piping 201 for bypassing the intermediate heat exchanger 23 is connected to the hot-water supply refrigerant circuit 6. A hot-water supply bypass valve 49e is attached to the hot-water supply bypass piping 201.

[0142] With the air conditioning and hot-water supply system according to the second embodiment, similar operation to that of the air conditioning and hot-water supply system according to the first embodiment can be performed by properly controlling the opening and closing of the two-way valves 35a, 35b, 49b, 49d, the expanding valves 35c, 35d, 49a, 49c, and the bypass valves 35e, 49e.

[0143] Next, an air conditioning and hot-water supply system according to a third embodiment of the present invention will be explained. However, the same elements as those of the air conditioning and hot-water supply system according to the foregoing first embodiment are designated by the same reference signs, and the explanation thereof will not be repeated. As shown in Fig. 21, a feature of the air conditioning and hot-water supply system according to the third embodiment of the present invention is that an air conditioning heat source side heat exchanger 324 and a hot-water supply heat source side heat exchanger 444 each include plural paths.

[0144] More specifically, the air conditioning heat source side heat exchanger 324 provided in the air conditioning refrigerant circuit 5 is formed with two flow paths and configured such that one of the paths is closed as needed to allow an air conditioning refrigerant to flow into only the other path. Also, the air conditioning heat source side heat exchanger 324 and a suction side of the air conditioning compressor 21 are connected by air conditioning refrigerant return piping 301 for returning an air conditioning refrigerant remaining in the closed path to the suction side of the air conditioning compressor 21. It should be noted that the air conditioning refrigerant return piping 301 is provided with an air conditioning gate valve 301a so that, when the air conditioning gate valve 301a is opened, the air conditioning refrigerant remaining in the air conditioning heat source side heat exchanger 324 flows through the air conditioning refrigerant return piping 301 and returns to the suction side of the air conditioning compressor 21.

[0145] In the same manner, the hot-water supply heat source side heat exchanger 444 provided in the hot-water supply refrigerant circuit 6 is formed with two flow paths and configured such that one of the paths is closed as needed to allow a hot-water supply refrigerant to flow into only the other path. Also, the hot-water supply heat source side heat exchanger 444 and a suction side of the hot-water supply compressor 41 are connected by hot-water supply refrigerant return piping 401 for returning a hot-water supply refrigerant remaining in the closed path to the suction side of the hot-water supply compressor 41. It should be noted that the hot-water supply refrigerant return piping 401 is provided with a hot-water supply gate valve 401a so that, when the hot-water supply gate valve 401a is opened, the hot-water supply refrigerant remaining in the hot-water supply heat source side heat exchanger 444 flows through the hot-water supply refrigerant return piping 401 and returns to the suction side of the hot-water supply compressor 41.

[0146] With the air conditioning and hot-water supply system according to the third embodiment, operation of the air conditioning and hot-water supply system according to the first embodiment can be performed. In addition, the control device 1a changes the number of paths of the air conditioning heat source side heat exchanger 324, thereby allowing adjustment of the heat exchange amount of the air conditioning heat source side heat exchanger 324. Also, the control device 1a changes the number of paths of the hot-water supply heat source side heat exchanger 444, thereby allowing adjustment of the heat exchange amount of the hot-water supply heat source side heat exchanger 444. It should be noted that the number of paths of each heat exchanger may be arbitrarily selected according to the specifications of the air conditioning and hot-water supply system.

REFERENCE SIGN LIST

[0147]

1a	control device
5	air conditioning refrigerant circuit
5a	air conditioning refrigerant main circuit
6	hot-water supply refrigerant circuit
6a	hot-water supply refrigerant main circuit
9	hot-water supply flow path
21	air conditioning compressor
22	four-way valve (air conditioning flow path switching valve)
24, 324	air conditioning heat source side heat exchanger
25	air conditioning outdoor fan
27	air conditioning expanding valve
28	air conditioning use side heat exchanger
35c	first expanding valve (first air conditioning refrigerant flow control valve)
35d	second expanding valve (second air conditioning refrigerant flow control valve)
41	hot-water supply compressor
42	hot-water supply use side heat exchanger
43	hot-water supply expanding valve
44, 444	hot-water supply heat source side heat exchanger
45	hot-water supply outdoor fan
49a	third expanding valve (first hot-water supply refrigerant flow control valve)
49c	fourth expanding valve (second hot-water supply refrigerant flow control valve)
70	hot water storage tank
71a	drain piping
71b	drain valve
78	water supply port
79	hot-water supply port
301	air conditioning refrigerant return piping
301a	air conditioning gate valve
401	hot-water supply refrigerant return piping
401a	hot-water supply gate valve

Claims

1. An air conditioning and hot-water supply system comprising: an air conditioning refrigerant circuit; a hot-water supply refrigerant circuit; an intermediate heat exchanger that performs heat exchange between an air conditioning refrigerant flowing through the air conditioning refrigerant circuit and a hot-water supply refrigerant flowing through the hot-water supply refrigerant circuit; and a control device that performs control of operation, wherein:

the air conditioning refrigerant circuit is formed to be circular by connecting, sequentially with refrigerant piping, an air conditioning compressor, an air conditioning flow path switching valve, the intermediate heat exchanger,

an air conditioning expanding valve, and an air conditioning use side heat exchanger, and configured such that an air conditioning heat source side heat exchanger unit is connected between the air conditioning flow path switching valve and the air conditioning expanding valve in series or in parallel with the intermediate heat exchanger, the air conditioning heat source side heat exchanger unit including: an air conditioning heat source side heat exchanger for performing heat exchange between outside air and the air conditioning refrigerant; and an air conditioning outdoor fan that sends outside air to the air conditioning heat source side heat exchanger; the hot-water supply refrigerant circuit is formed to be circular by connecting, sequentially with refrigerant piping, a hot-water supply compressor, a hot-water supply use side heat exchanger that performs heat exchange with a heat transfer medium on a hot-water supply use side, a hot-water supply expanding valve, and the intermediate heat exchanger, and configured such that a hot-water supply heat source side heat exchanger unit is connected between the hot-water supply compressor and the hot-water supply expanding valve in series or in parallel with the intermediate heat exchanger, the hot-water supply heat source side heat exchanger unit including: a hot-water supply heat source side heat exchanger for performing heat exchange between outside air and the hot-water supply refrigerant; and a hot-water supply outdoor fan that sends outside air to the hot-water supply heat source side heat exchanger; and in a first load condition in which a heat radiation amount is larger than a heat absorption amount, the control device controls the air conditioning heat source side heat exchanger unit so that a differential amount of heat equivalent to a difference between the heat radiation amount and the heat absorption amount is radiated from the air conditioning heat source side heat exchanger unit to outside air, and, in a second load condition in which the heat absorption amount is larger than the heat radiation amount, the control device controls the hot-water supply heat source side heat exchanger unit so that the differential amount of heat is absorbed from outside air by the hot-water supply heat source side heat exchanger unit.

2. The air conditioning and hot-water supply system according to Claim 1, wherein:

the air conditioning heat source side heat exchanger unit is connected in parallel with the intermediate heat exchanger;
the hot-water supply heat source side heat exchanger unit is connected in parallel with the intermediate heat exchanger;
the air conditioning heat source side heat exchanger unit includes a first air conditioning refrigerant flow control valve and a second air conditioning refrigerant flow control valve that are provided at an inlet and an outlet of the air conditioning heat source side heat exchanger for controlling a flow rate of the air conditioning refrigerant; and
the hot-water supply heat source side heat exchanger unit includes a first hot-water supply refrigerant flow control valve and a second hot-water supply refrigerant flow control valve that are provided at an inlet and an outlet of the hot-water supply heat source side heat exchanger for controlling a flow rate of the hot-water supply refrigerant.

3. The air conditioning and hot-water supply system according to Claim 1 or 2, wherein

the control device controls rotational speed of the air conditioning outdoor fan in the first load condition, and controls rotational speed of the hot-water supply outdoor fan in the second load condition.

4. The air conditioning and hot-water supply system according to Claim 3, wherein

in the first load condition, when a difference between a heat exchange amount of the air conditioning heat source side heat exchanger unit and the differential amount of heat is beyond a predetermined range even after the rotational speed of the air conditioning outdoor fan has been controlled, the control device performs control to adjust opening of at least one of the first air conditioning refrigerant flow control valve and the second air conditioning refrigerant flow control valve so as to make up the difference therebetween; and, in the second load condition, when a difference between a heat exchange amount of the hot-water supply heat source side heat exchanger unit and the differential amount of heat is beyond a predetermined range even after the rotational speed of the hot-water supply outdoor fan has been controlled, the control device performs control to adjust opening of at least one of the first hot-water supply refrigerant flow control valve and the second hot-water supply refrigerant flow control valve so as to make up the difference therebetween.

5. The air conditioning and hot-water supply system according to Claim 3, wherein

in the first load condition, the control device controls opening of the hot-water supply expanding valve so that a predetermined condition required for hot-water supply operation is satisfied, and then controls at least one of rotational speed of the air conditioning outdoor fan and opening of the air conditioning expanding valve so that a predetermined

condition required for cooling operation is satisfied; and, in the second load condition, the control device controls opening of the air conditioning expanding valve so that a predetermined condition required for the cooling operation is satisfied, and then controls at least one of rotational speed of the hot-water supply outdoor fan and opening of the hot-water supply expanding valve so that a predetermined condition required for the hot-water supply operation is satisfied.

6. The air conditioning and hot-water supply system according to Claim 5, wherein the control device calculates target condensation temperature of the cooling operation and target evaporation temperature of the hot-water supply operation on the basis of the heat radiation amount and heat absorption amount calculated and outdoor temperature, sets the target condensation temperature to the predetermined condition required for the cooling operation, and sets the target evaporation temperature to the predetermined condition required for the hot-water supply operation.

7. The air conditioning and hot-water supply system according to Claim 1 or 2, wherein in a third load condition in which a difference between the heat radiation amount and the heat absorption amount falls within a predetermined range, the control device cancels the heat exchange with outside air performed by the air conditioning heat source side heat exchanger unit and the hot-water supply heat source side heat exchanger unit, and performs control so that operation is performed by heat exchange via the intermediate heat exchanger between the air conditioning refrigerant circuit and the hot-water supply refrigerant circuit.

8. The air conditioning and hot-water supply system according to Claim 1 or 2, wherein:

the air conditioning heat source side heat exchanger is composed of a plurality of paths through which the air conditioning refrigerant flows;

the hot-water supply heat source side heat exchanger is composed of a plurality of paths through which the hot-water supply refrigerant flows; and

the control device performs control to change the number of paths of the air conditioning heat source side heat exchanger in the first load condition, and performs control to change the number of paths of the hot-water supply heat source side heat exchanger in the second load condition.

9. The air conditioning and hot-water supply system according to Claim 8, wherein:

the air conditioning refrigerant circuit includes air conditioning refrigerant return piping for returning the air conditioning refrigerant from the air conditioning heat source side heat exchanger to a suction side of the air conditioning compressor, and an air conditioning gate valve provided to the air conditioning refrigerant return piping, and

the hot-water supply refrigerant circuit includes hot-water supply refrigerant return piping for returning the hot-water supply refrigerant from the hot-water supply heat source side heat exchanger to a suction side of the hot-water supply compressor, and a hot-water supply gate valve provided to the hot-water supply refrigerant return piping.

10. The air conditioning and hot-water supply system according to Claim 1 or 2, wherein:

the control device includes a high heating operation mode in which heating operation with the air conditioning heat source side heat exchanger and the intermediate heat exchanger used as evaporators is performed in the air conditioning refrigerant circuit and hot-water supply operation with the hot-water supply heat source side heat exchanger used as an evaporator is performed in the hot-water supply refrigerant circuit, and

in the high heating operation mode, the control device performs control to open the first air conditioning refrigerant flow control valve and the second air conditioning refrigerant flow control valve and cause the air conditioning refrigerant to flow into both the air conditioning heat source side heat exchanger and the intermediate heat exchanger, and performs control to open the first hot-water supply refrigerant flow control valve and the second hot-water supply refrigerant flow control valve and cause the hot-water supply refrigerant to flow into the hot-water supply heat source side heat exchanger without causing the hot-water supply refrigerant to flow into the intermediate heat exchanger.

11. The air conditioning and hot-water supply system according to Claim 1 or 2, further comprising:

a hot-water supply flow path that is a flow path through which the heat transfer medium on the hot-water supply

use side flows, the flow path being formed by connecting an inlet of the hot-water supply use side heat exchanger and a water supply port of the heat transfer medium on the hot-water supply use side with piping and connecting an outlet of the hot-water supply use side heat exchanger and a hot-water supply port of the heat transfer medium on the hot-water supply use side with piping, the flow path being provided with a hot water storage tank at a position between the hot-water supply use side heat exchanger and the hot-water supply port on the flow path, the hot water storage tank storing the heat transfer medium on the hot-water supply use side, wherein: the control device includes a flash boiling operation mode in which cooling operation with the intermediate heat exchanger used as a condenser is performed in the air conditioning refrigerant circuit and hot-water supply operation with the hot-water supply heat source side heat exchanger and the intermediate heat exchanger used as evaporators is performed in the hot-water supply refrigerant circuit, and in the flash boiling operation mode, the control device closes the first air conditioning refrigerant flow control valve and the second air conditioning refrigerant flow control valve, controls rotational speed of the hot-water supply compressor so that the hot-water supply compressor is operated at a predetermined rotational speed, and controls the hot-water supply outdoor fan so that a differential amount of heat equivalent to a difference between the heat radiation amount of the air conditioning refrigerant circuit and the heat absorption amount of the hot-water supply refrigerant circuit is absorbed from outside air.

12. The air conditioning and hot-water supply system according to Claim 1 or 2, wherein:

the control device includes a rapid cooling operation mode in which cooling operation with the air conditioning heat source side heat exchanger and the intermediate heat exchanger used as condensers is performed in the air conditioning refrigerant circuit and hot-water supply operation with the intermediate heat exchanger used as an evaporator is performed in the hot-water supply refrigerant circuit, and in the rapid cooling operation mode, the control device closes the first hot-water supply refrigerant flow control valve and the second hot-water supply refrigerant flow control valve, controls rotational speed of the air conditioning compressor so that the air conditioning compressor is operated at a predetermined rotational speed, and controls the air conditioning outdoor fan so that a difference between the heat radiation amount of the air conditioning refrigerant circuit and the heat absorption amount of the hot-water supply refrigerant circuit is radiated to outside air.

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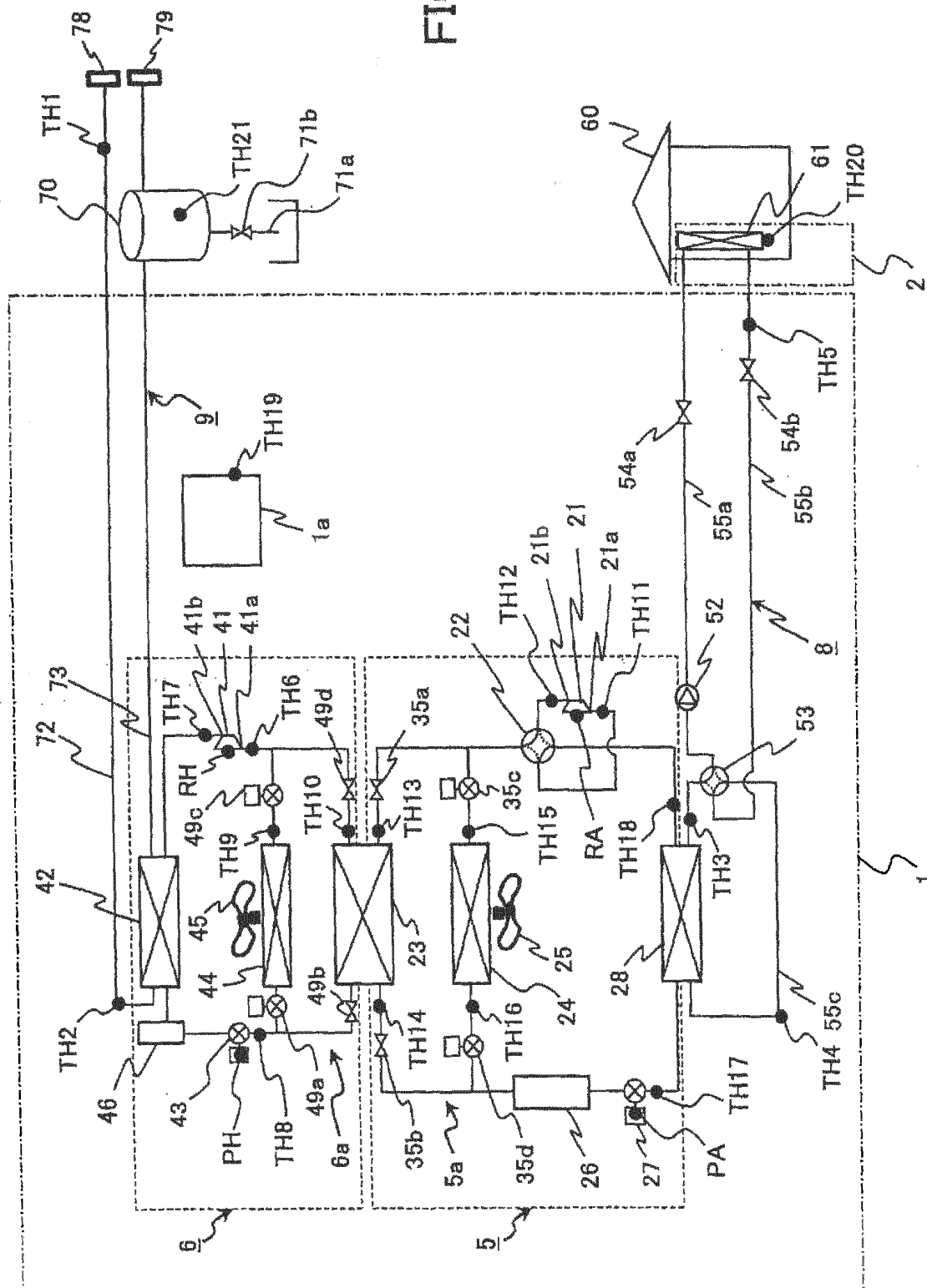


FIG. 2

OPERATION MODE NAME	COOLING/ HOT-WATER SUPPLY INDIVIDUAL OPERATION MODE	HEATING/ HOT-WATER SUPPLY INDIVIDUAL OPERATION MODE	SCHEDULED OPERATION MODE		
			CONTROL-1 (HOT-WATER SUPPLY HEAT ABSORPTION AMOUNT=AIR CONDITIONING HEAT RADIATION AMOUNT)	CONTROL-2 (HOT-WATER SUPPLY HEAT ABSORPTION AMOUNT<AIR CONDITIONING HEAT RADIATION AMOUNT)	CONTROL-3 (HOT-WATER SUPPLY HEAT ABSORPTION AMOUNT>AIR CONDITIONING HEAT RADIATION AMOUNT)
HOT-WATER SUPPLY CYCLE	HOT-WATER SUPPLY COMPRESSOR 41	OPERATED	OPERATED	OPERATED	OPERATED
	HOT-WATER SUPPLY USE SIDE HEAT EXCHANGER 42	CONDENSER	CONDENSER	CONDENSER	CONDENSER
	HOT-WATER SUPPLY HEAT SOURCE SIDE HEAT EXCHANGER 44	EVAPORATOR	NONUSE	NONUSE	EVAPORATOR
	INTERMEDIATE HEAT EXCHANGER 23	NONUSE	EVAPORATOR	EVAPORATOR	EVAPORATOR
AIR CONDITIONING CYCLE	AIR CONDITIONING COMPRESSOR 21	OPERATED	OPERATED	OPERATED	OPERATED
	AIR CONDITIONING USE SIDE HEAT EXCHANGER 28	EVAPORATOR	EVAPORATOR	EVAPORATOR	EVAPORATOR
	AIR CONDITIONING HEAT SOURCE SIDE HEAT EXCHANGER 24	CONDENSER	NONUSE	CONDENSER	NONUSE
	INTERMEDIATE HEAT EXCHANGER 23	NONUSE	CONDENSER	CONDENSER	CONDENSER

FIG. 3

OPERATION MODE NAME	HIGH HEATING OPERATION MODE	FLASH BOILING OPERATION MODE (HOT-WATER SUPPLY HEAT ABSORPTION AMOUNT > AIR CONDITIONING HEAT RADIATION AMOUNT)	RAPID COOLING OPERATION MODE (HOT-WATER SUPPLY HEAT ABSORPTION AMOUNT < AIR CONDITIONING HEAT RADIATION AMOUNT)	ZERO EXHAUST HOT-AIR OPERATION MODE (HOT-WATER SUPPLY HEAT ABSORPTION AMOUNT < AIR CONDITIONING HEAT RADIATION AMOUNT)	ENERGY-SAVING OPERATION MODE (HOT-WATER SUPPLY HEAT ABSORPTION AMOUNT = AIR CONDITIONING HEAT RADIATION AMOUNT)
HOT-WATER SUPPLY CYCLE	HOT-WATER SUPPLY COMPRESSOR 41	OPERATED	OPERATED	OPERATED	OPERATED
	HOT-WATER SUPPLY USE SIDE HEAT EXCHANGER 42	CONDENSER	CONDENSER	CONDENSER	CONDENSER
	HOT-WATER SUPPLY HEAT SOURCE SIDE HEAT EXCHANGER 44	EVAPORATOR	NONUSE	NONUSE	NONUSE
	INTERMEDIATE HEAT EXCHANGER 23	EVAPORATOR	EVAPORATOR	EVAPORATOR	EVAPORATOR
AIR CONDITIONING CYCLE	AIR CONDITIONING COMPRESSOR 21	OPERATED	OPERATED (MAXIMUM ROTATIONAL SPEED)	OPERATED (THEREAFTER STOPPED)	OPERATED (THEREAFTER STOPPED)
	AIR CONDITIONING USE SIDE HEAT EXCHANGER 28	CONDENSER	EVAPORATOR	EVAPORATOR	EVAPORATOR
	AIR CONDITIONING HEAT SOURCE SIDE HEAT EXCHANGER 24	EVAPORATOR	CONDENSER	NONUSE	NONUSE
	INTERMEDIATE HEAT EXCHANGER 23	EVAPORATOR	CONDENSER	CONDENSER	CONDENSER

FIG. 4

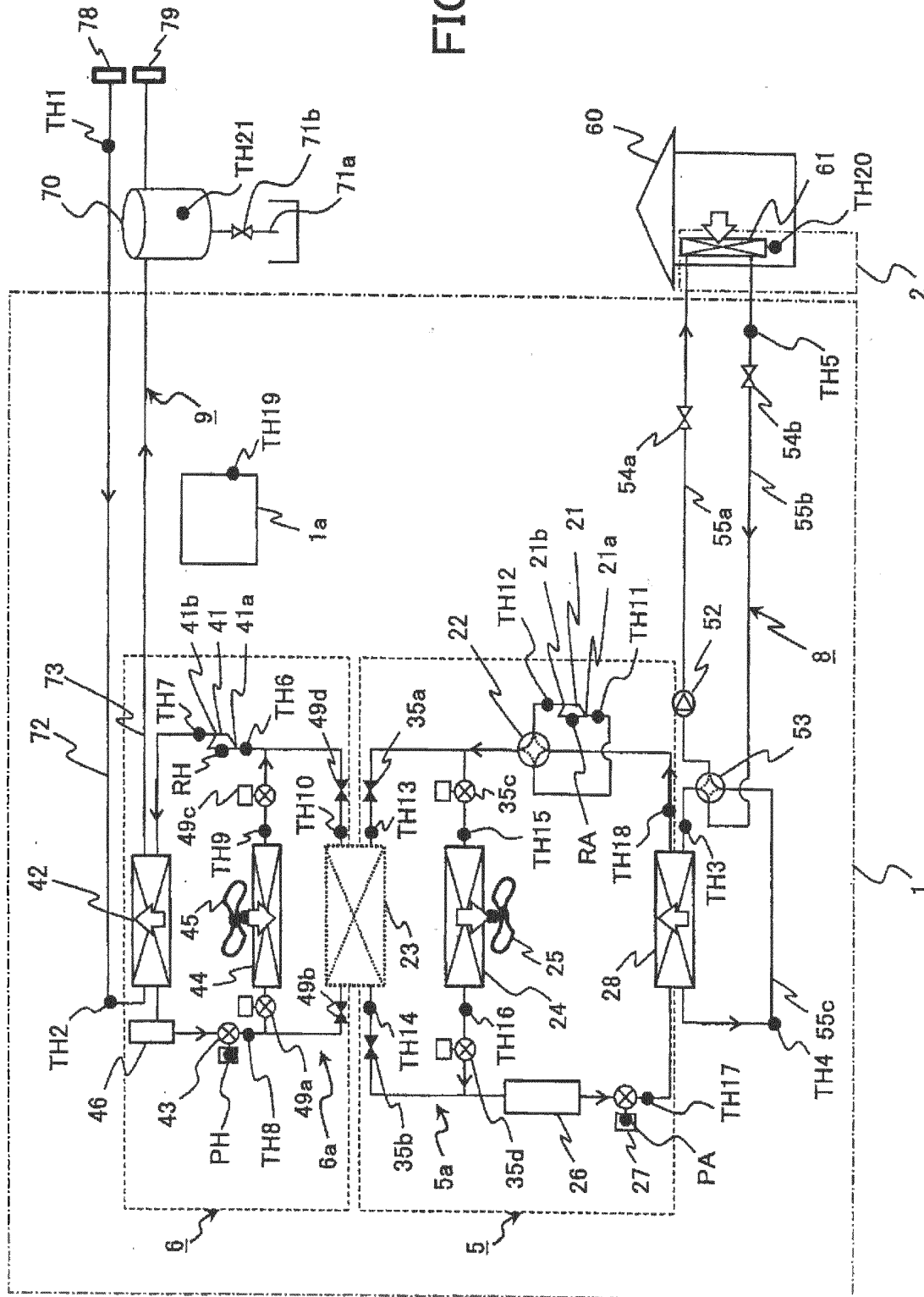


FIG. 5

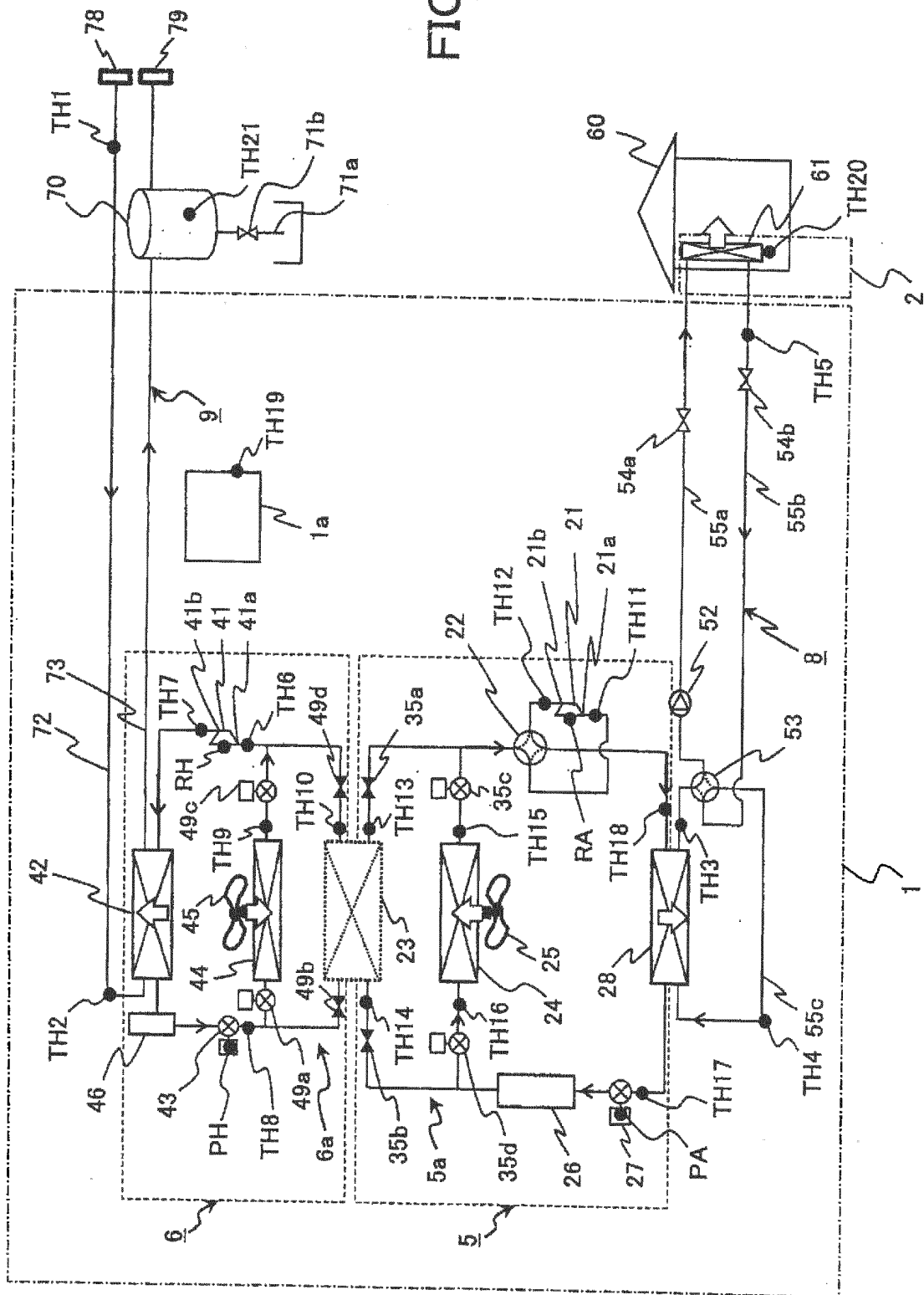


FIG. 6

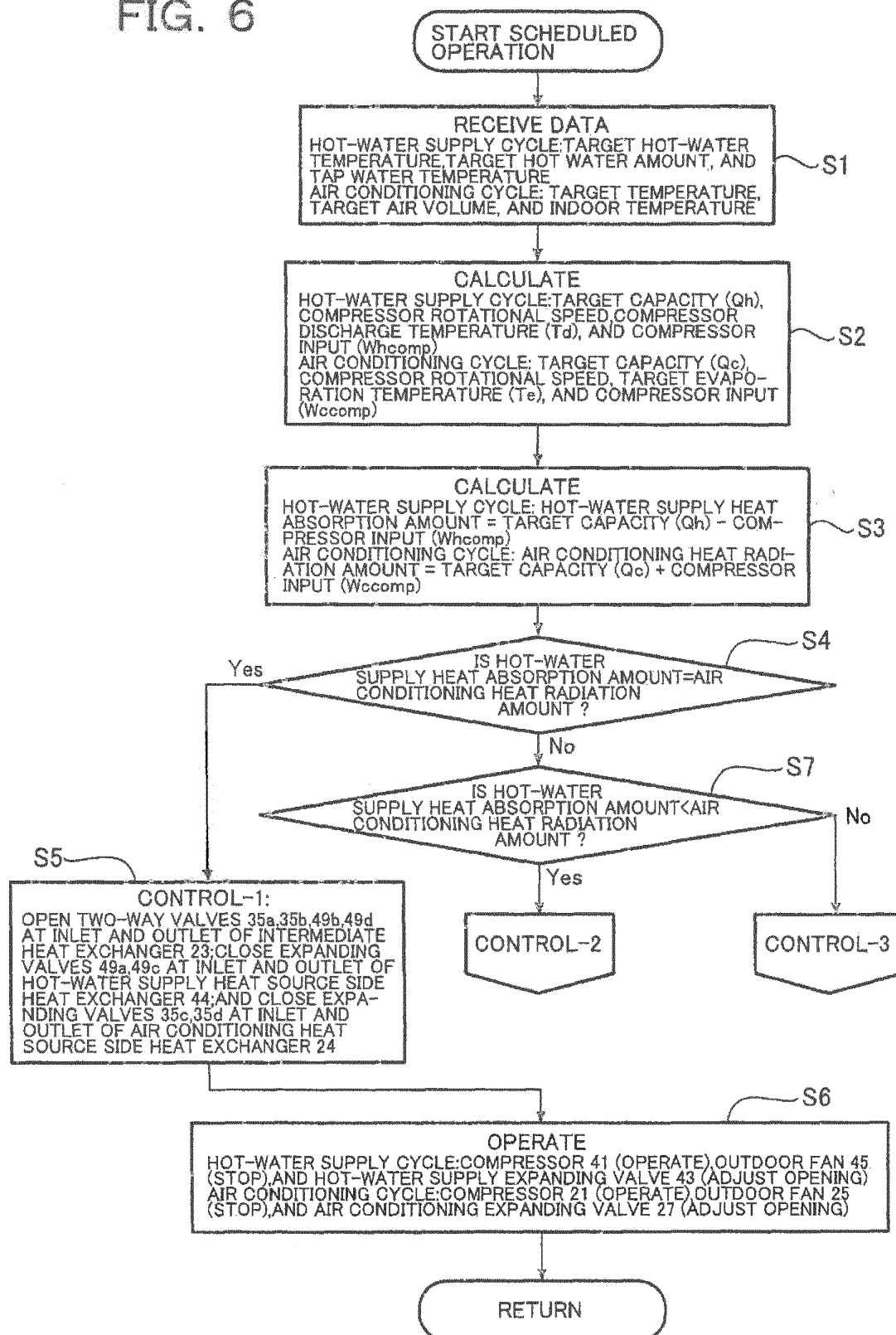


FIG. 7

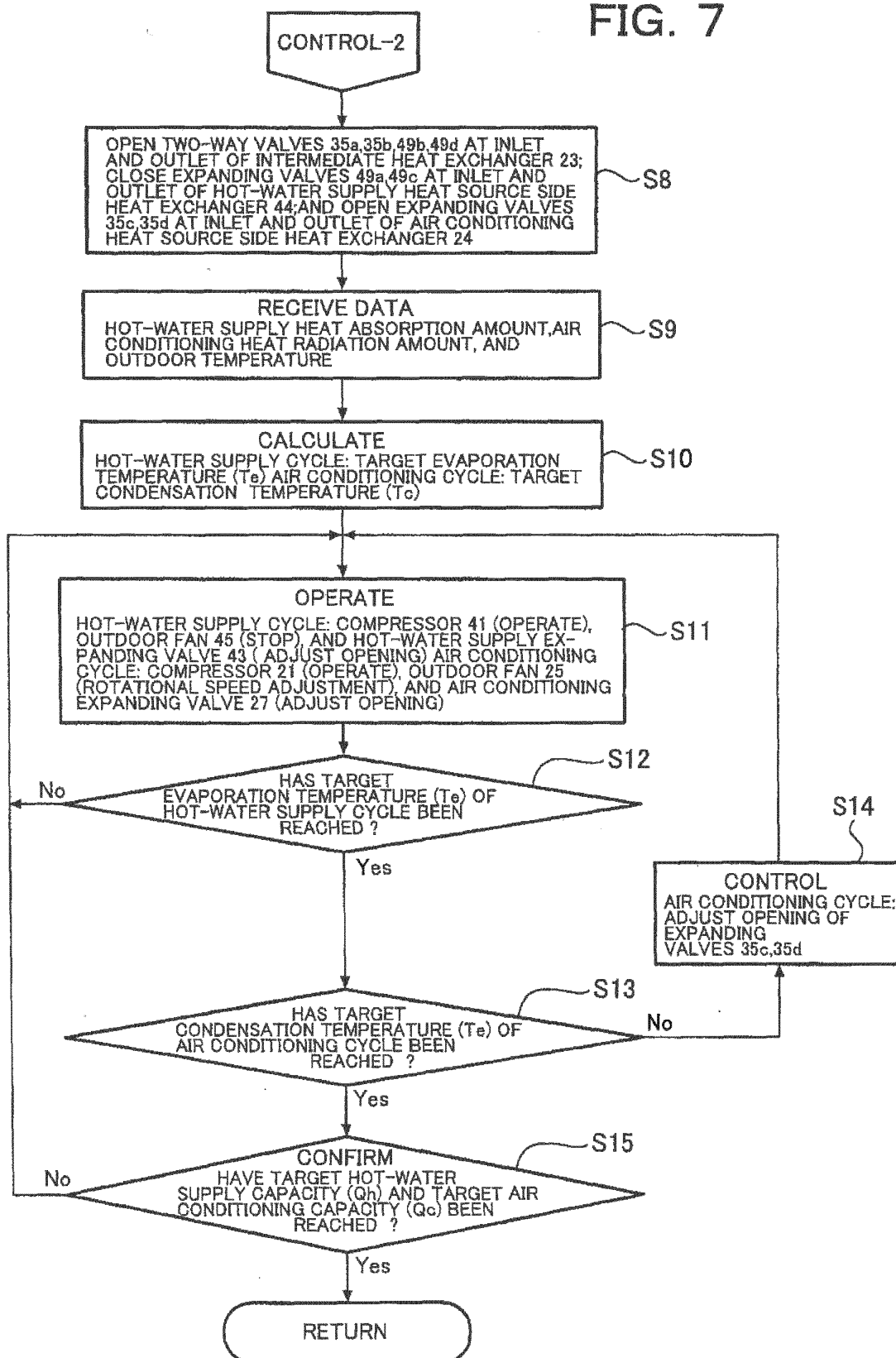
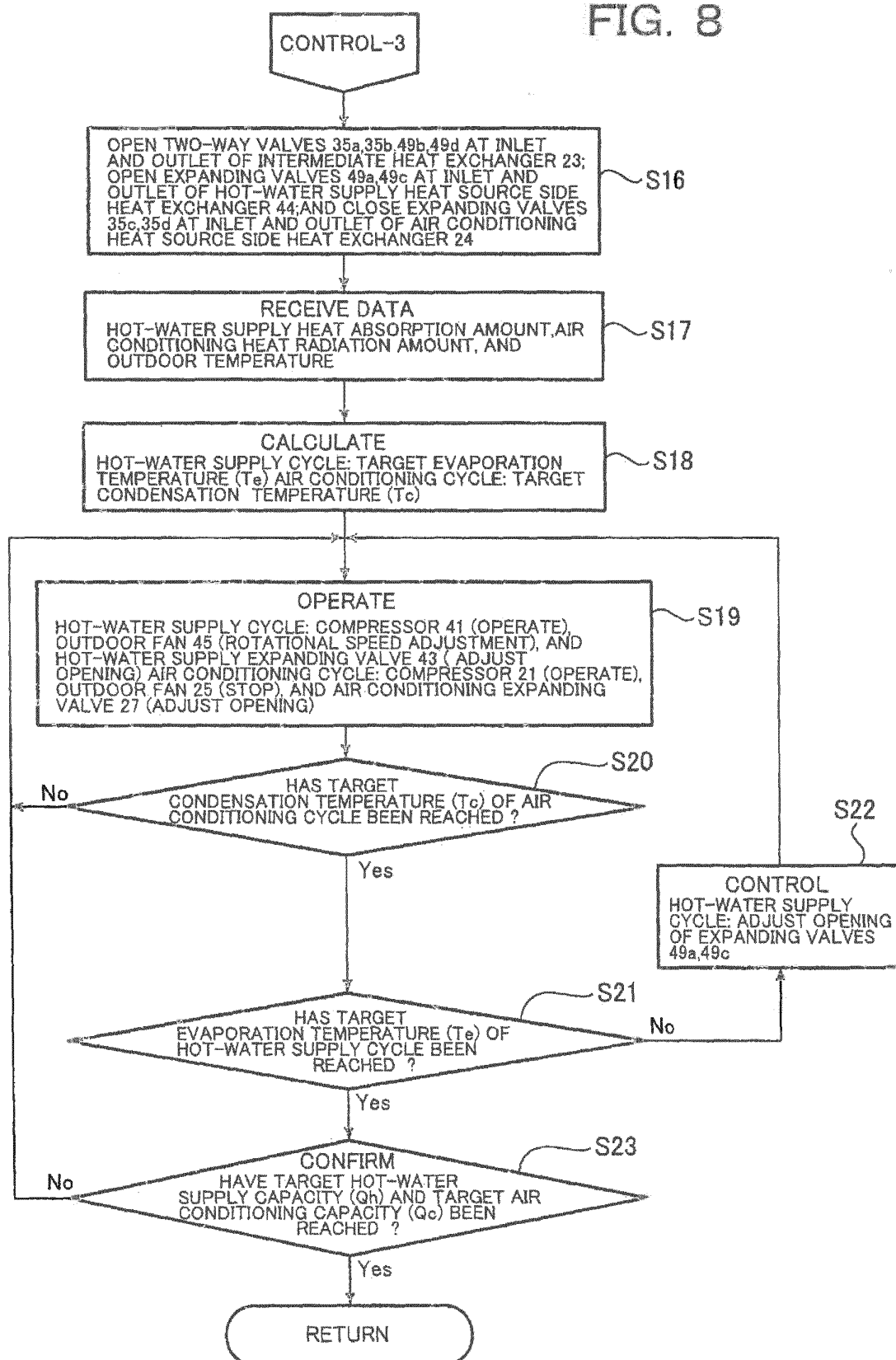


FIG. 8



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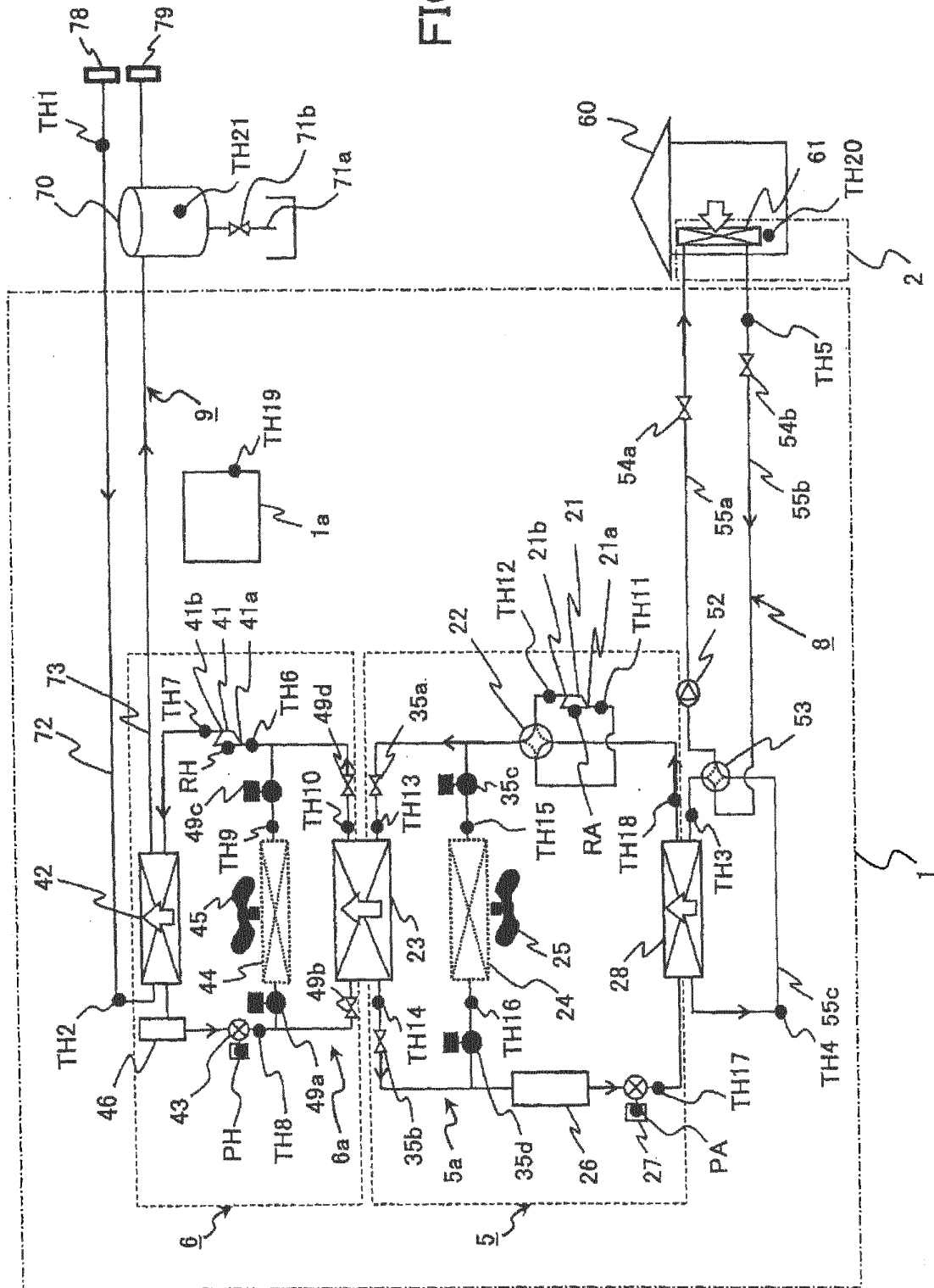


FIG. 10

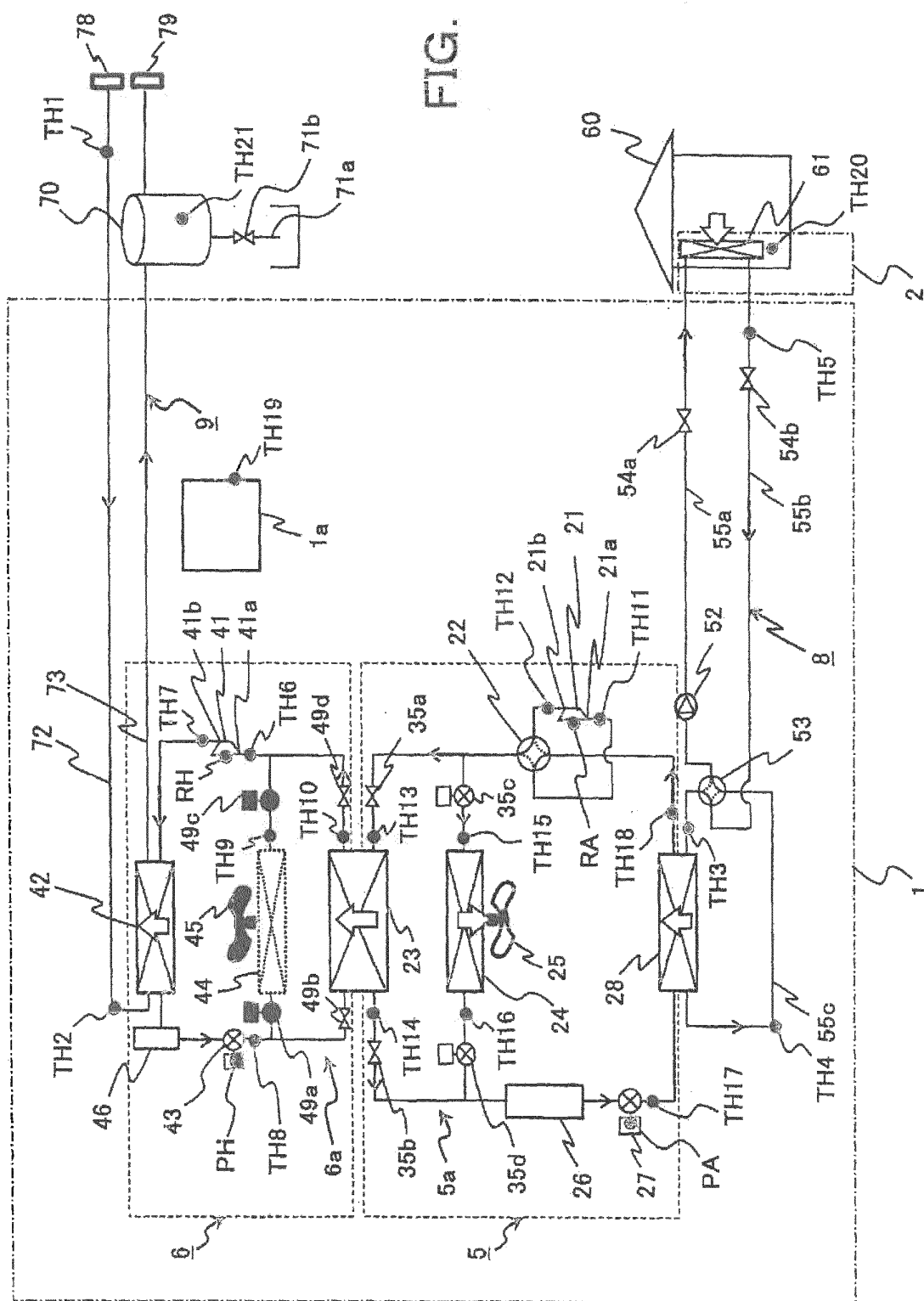


FIG. 11

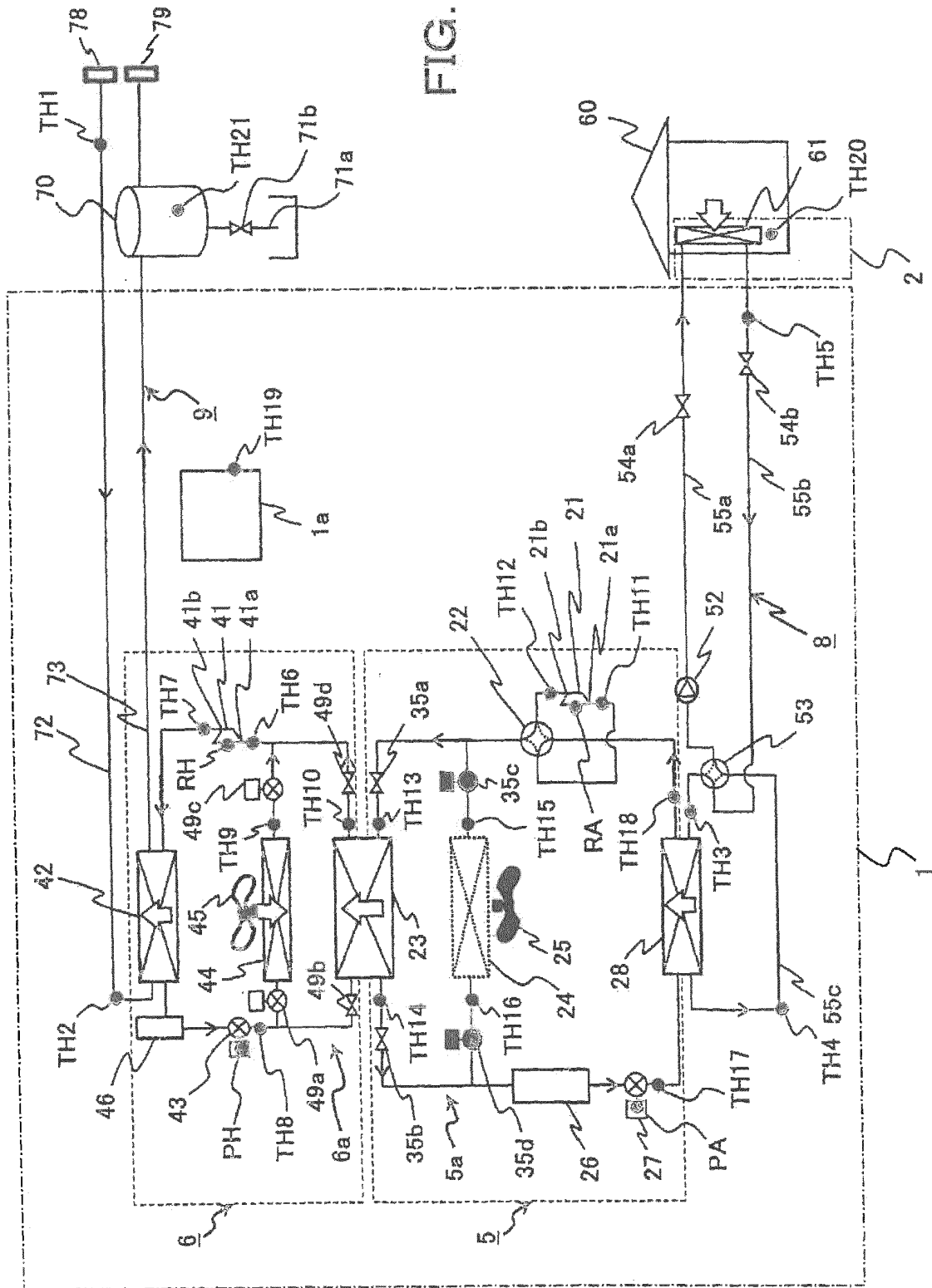


FIG. 12

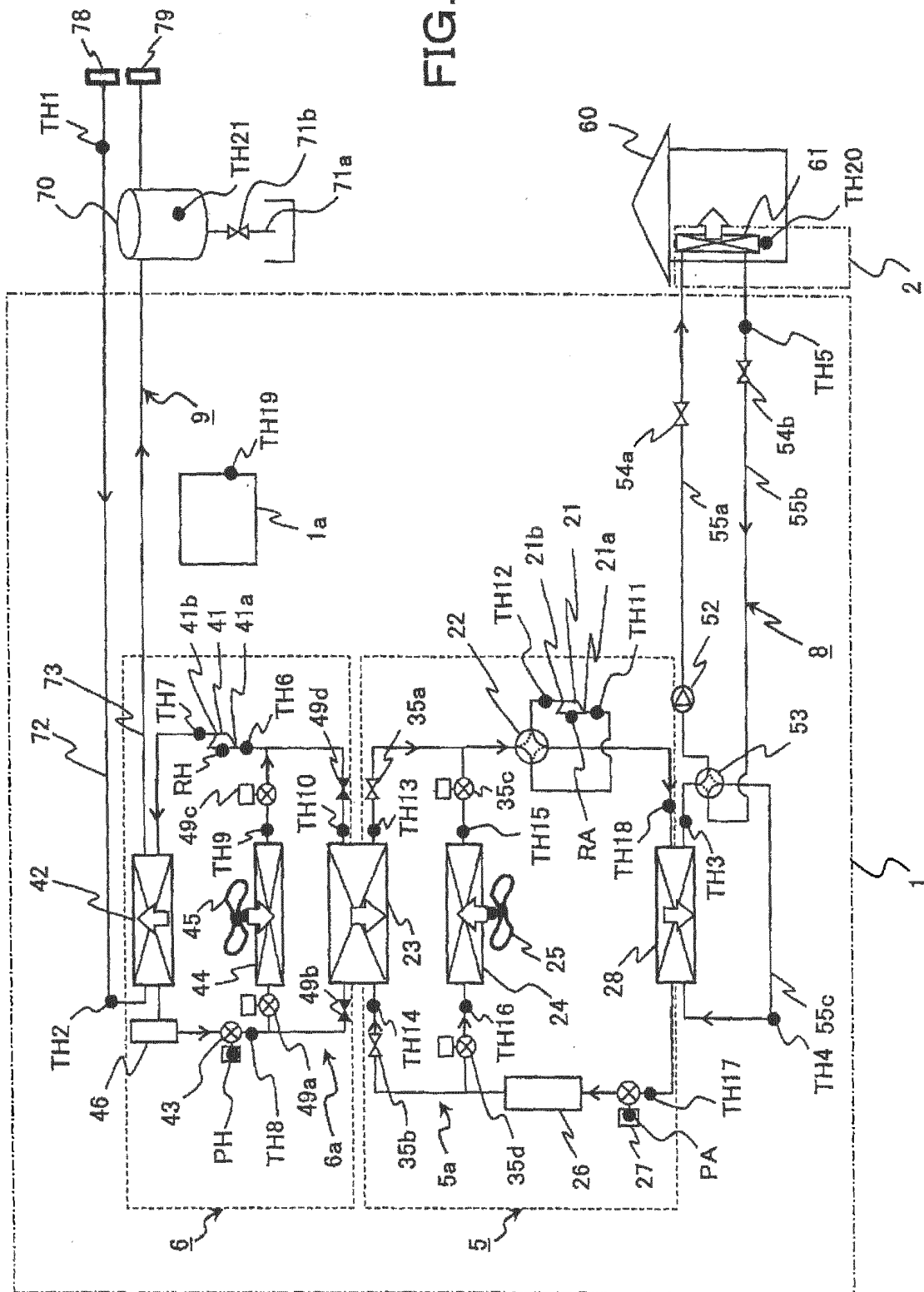


FIG. 13

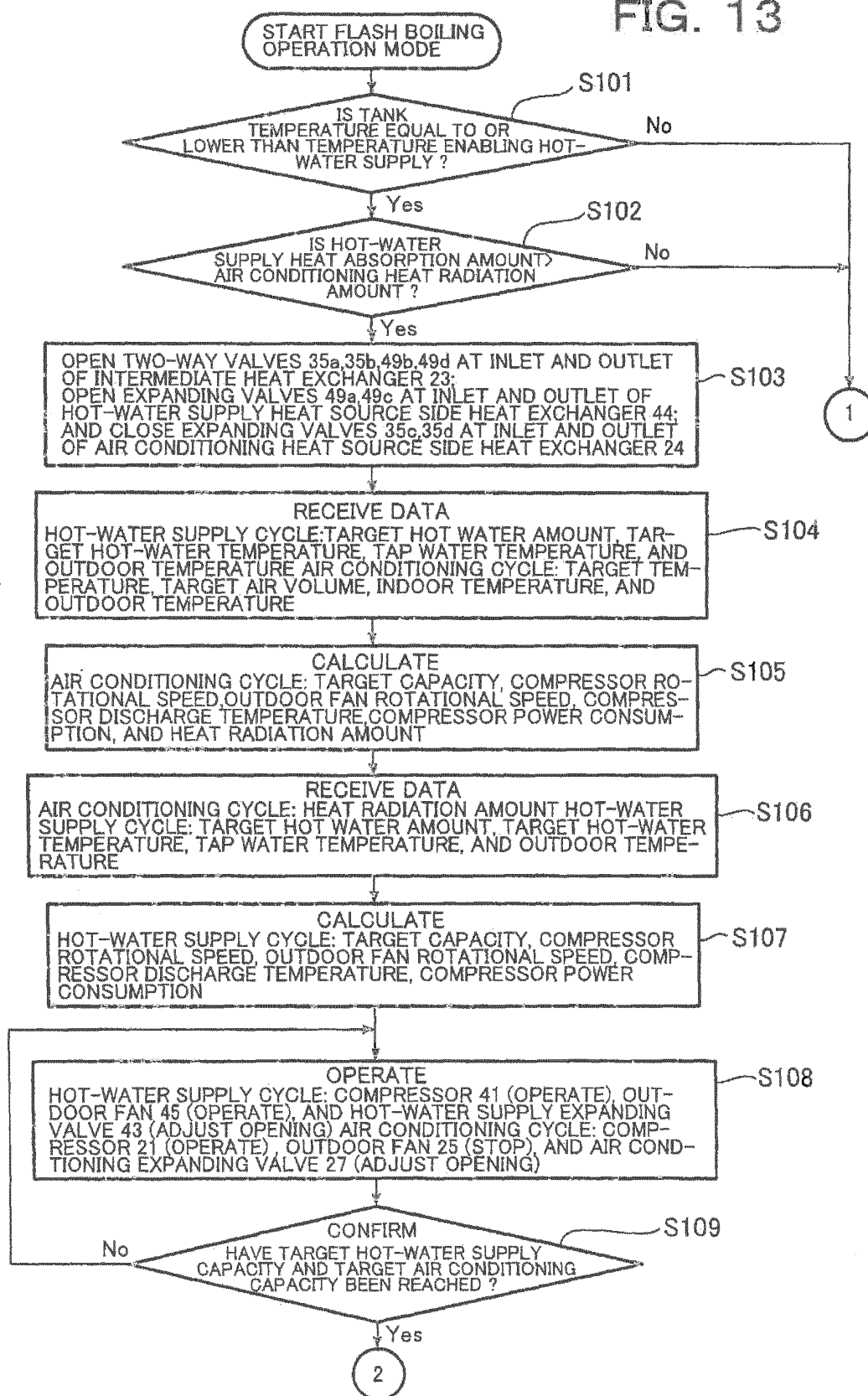


FIG. 14

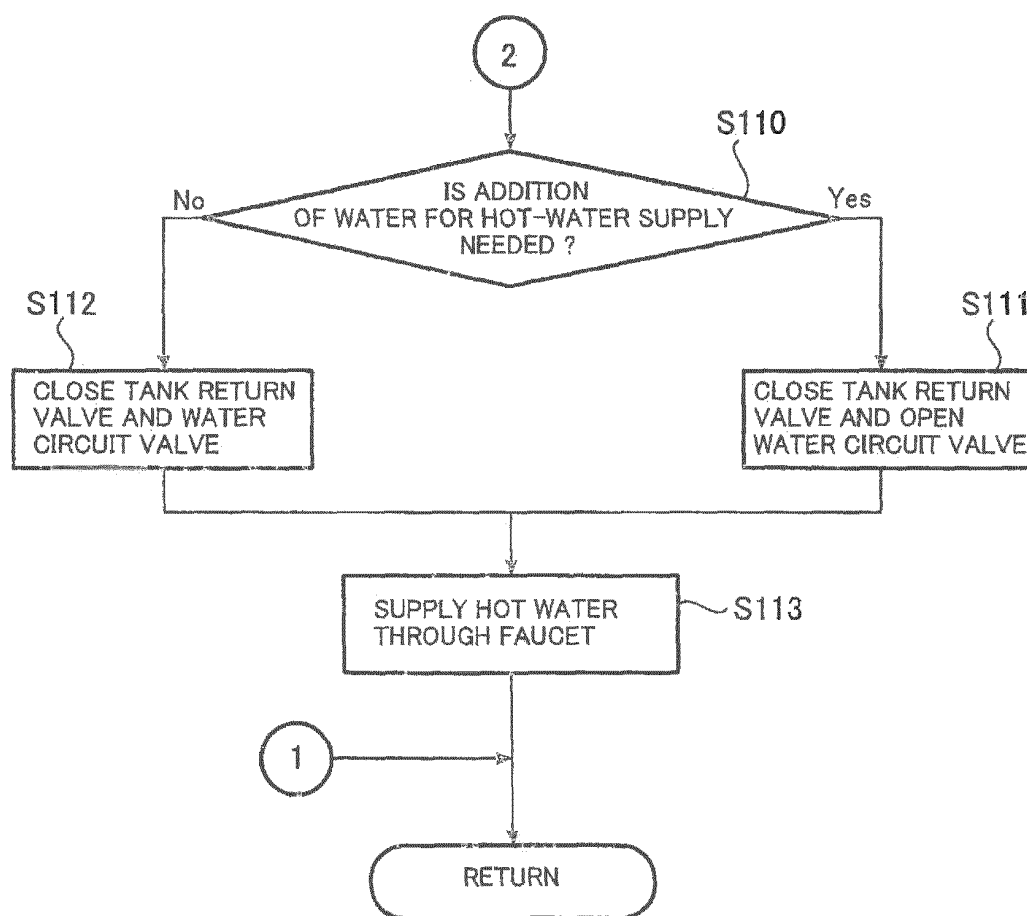


FIG. 15

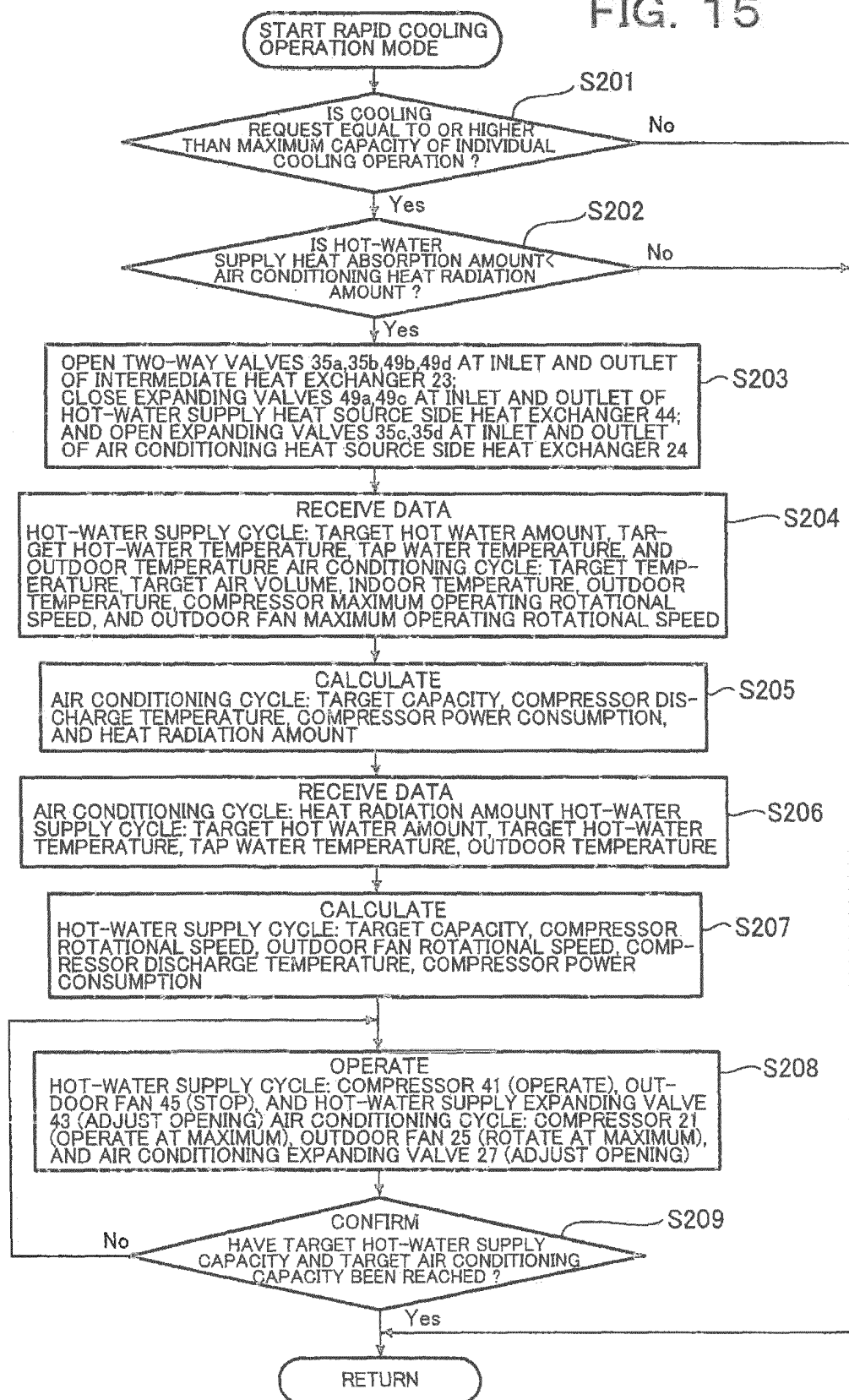


FIG. 16

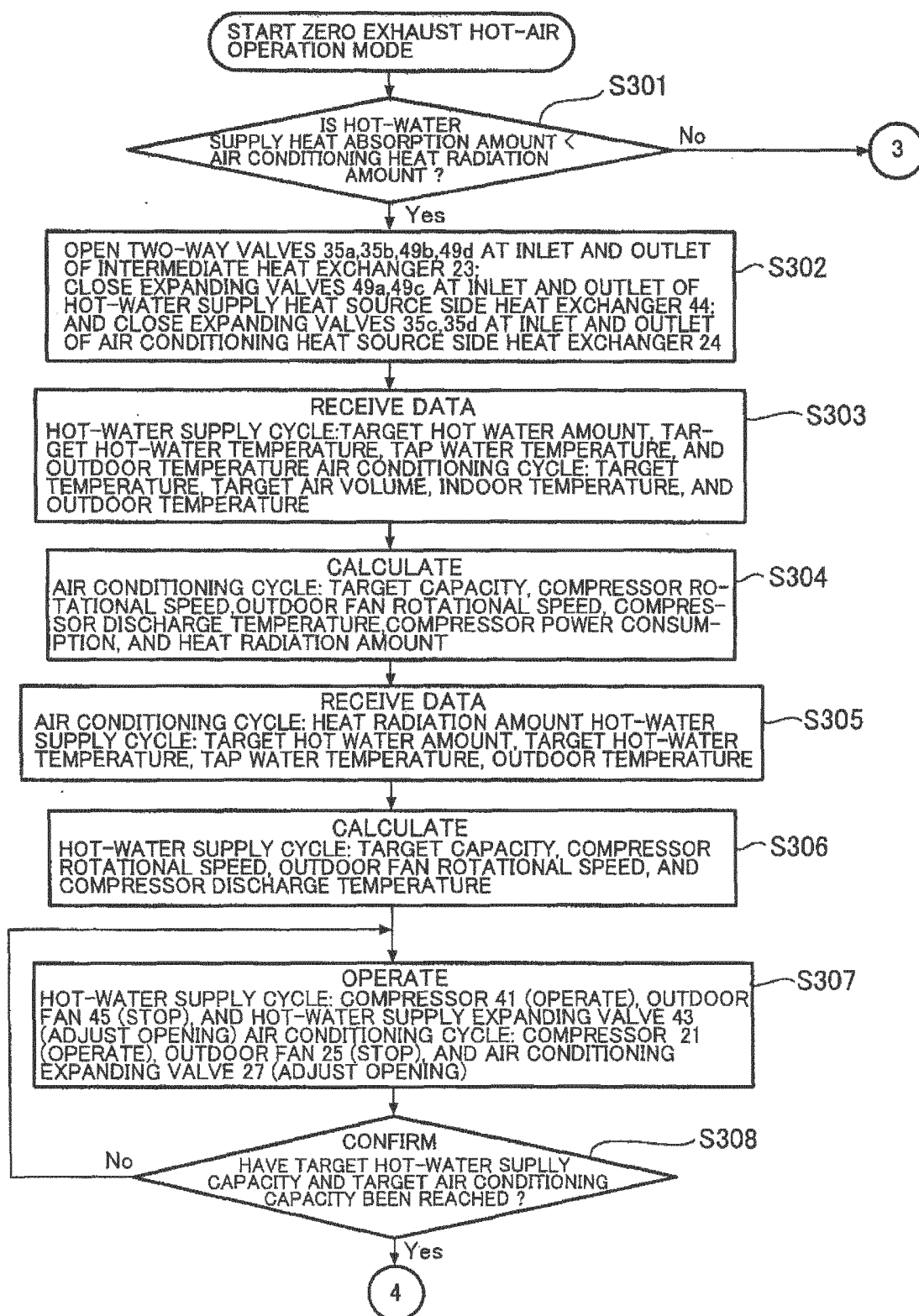


FIG. 17

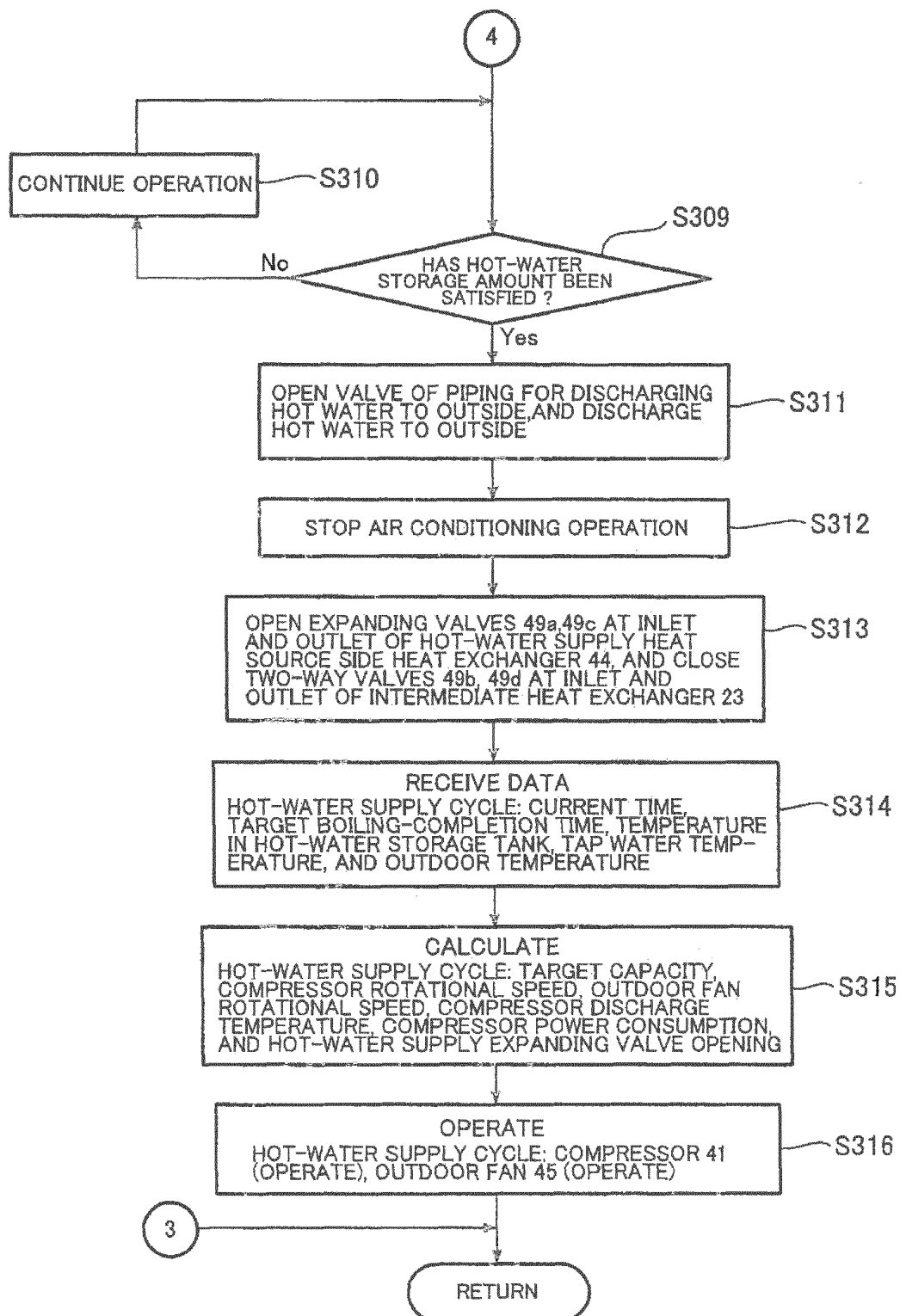


FIG. 18

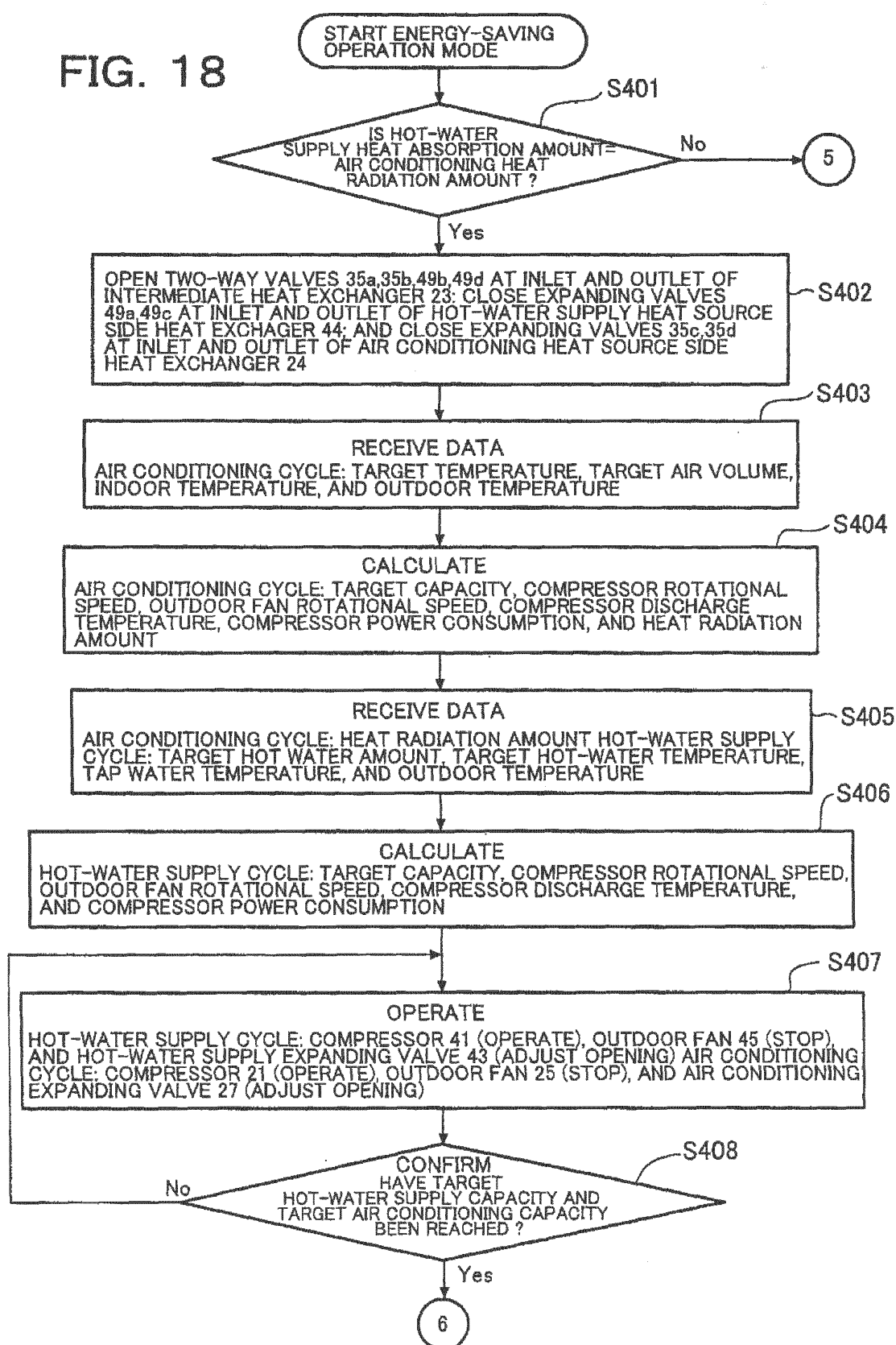


FIG. 19

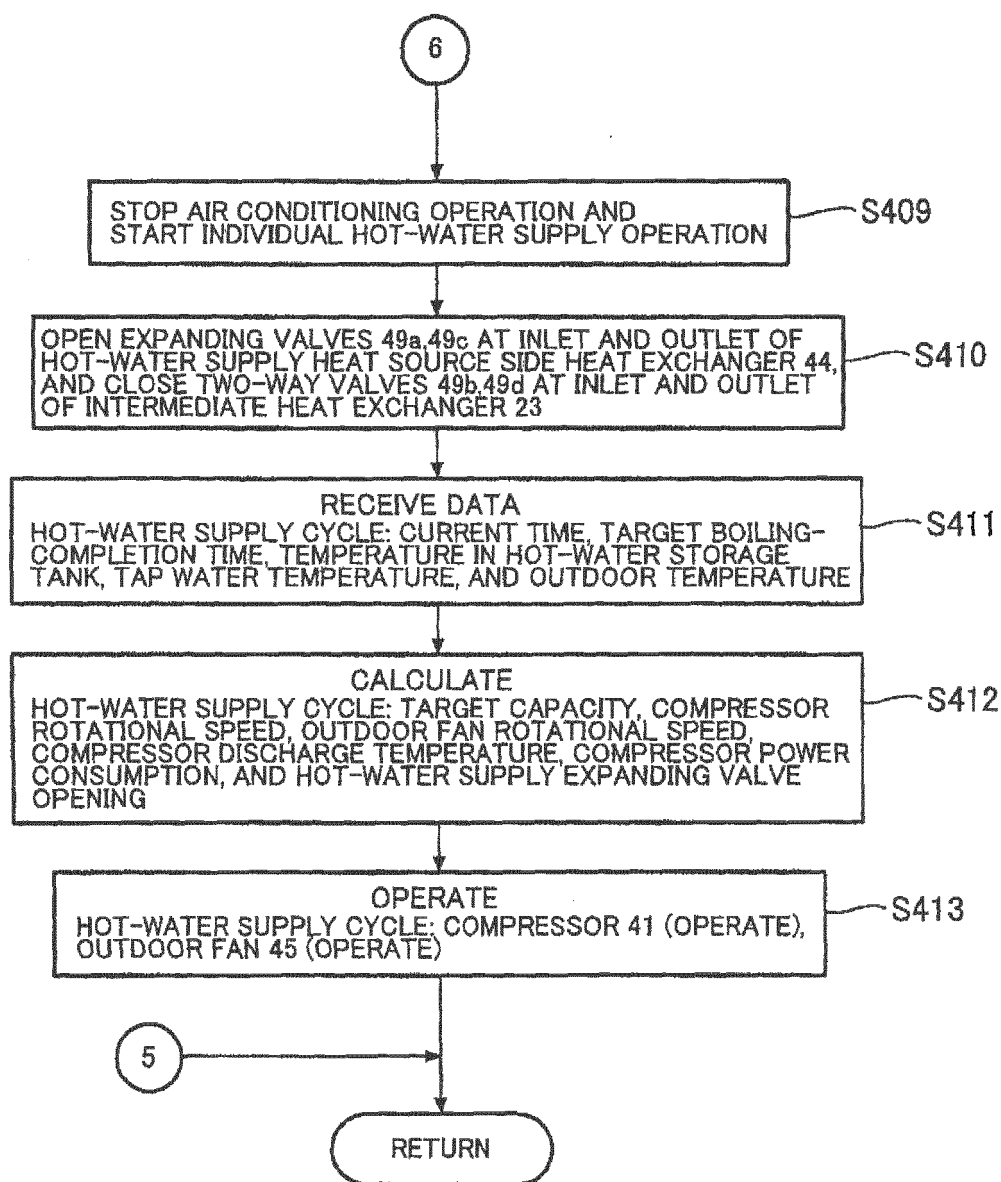


FIG. 20

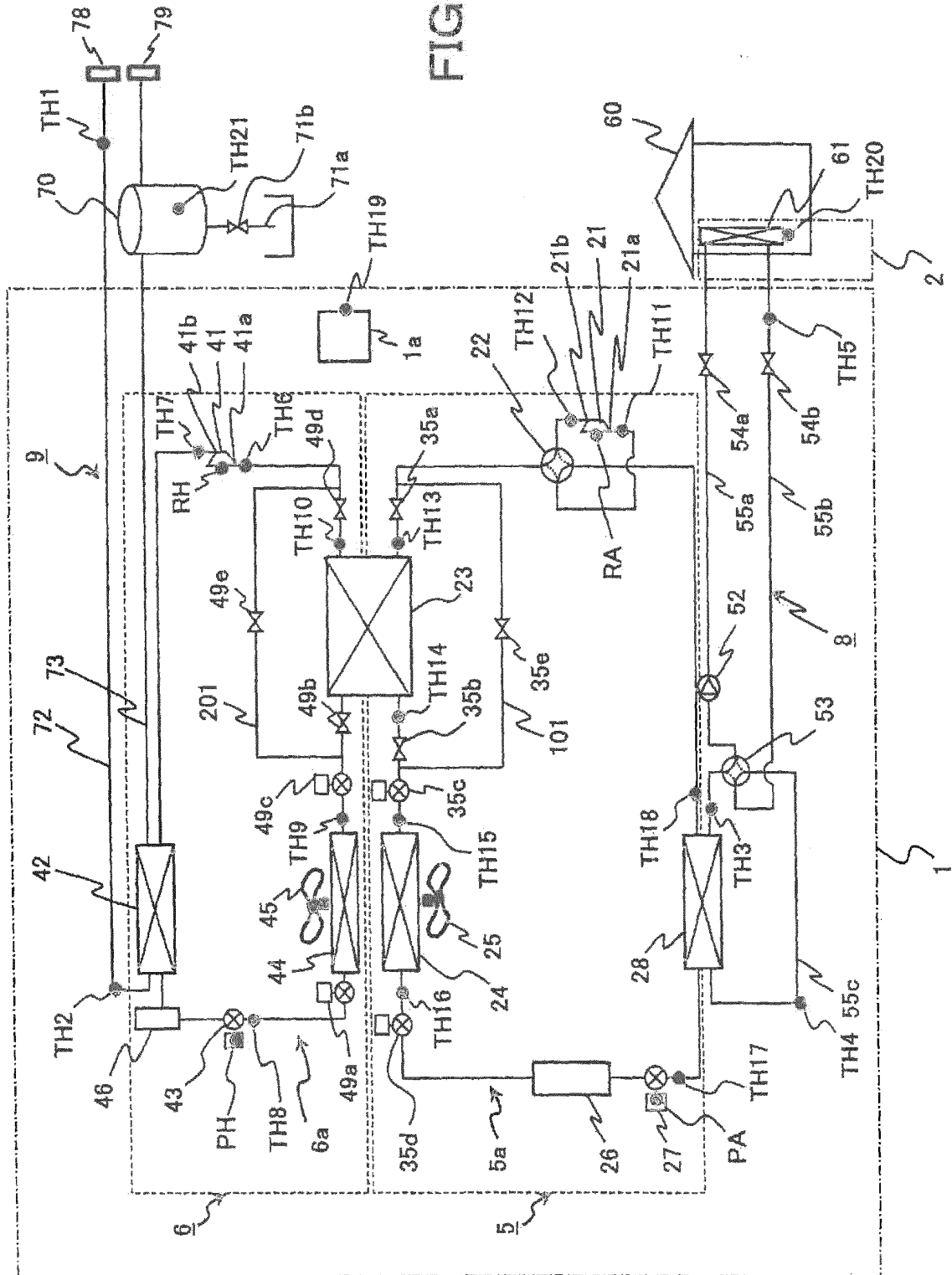
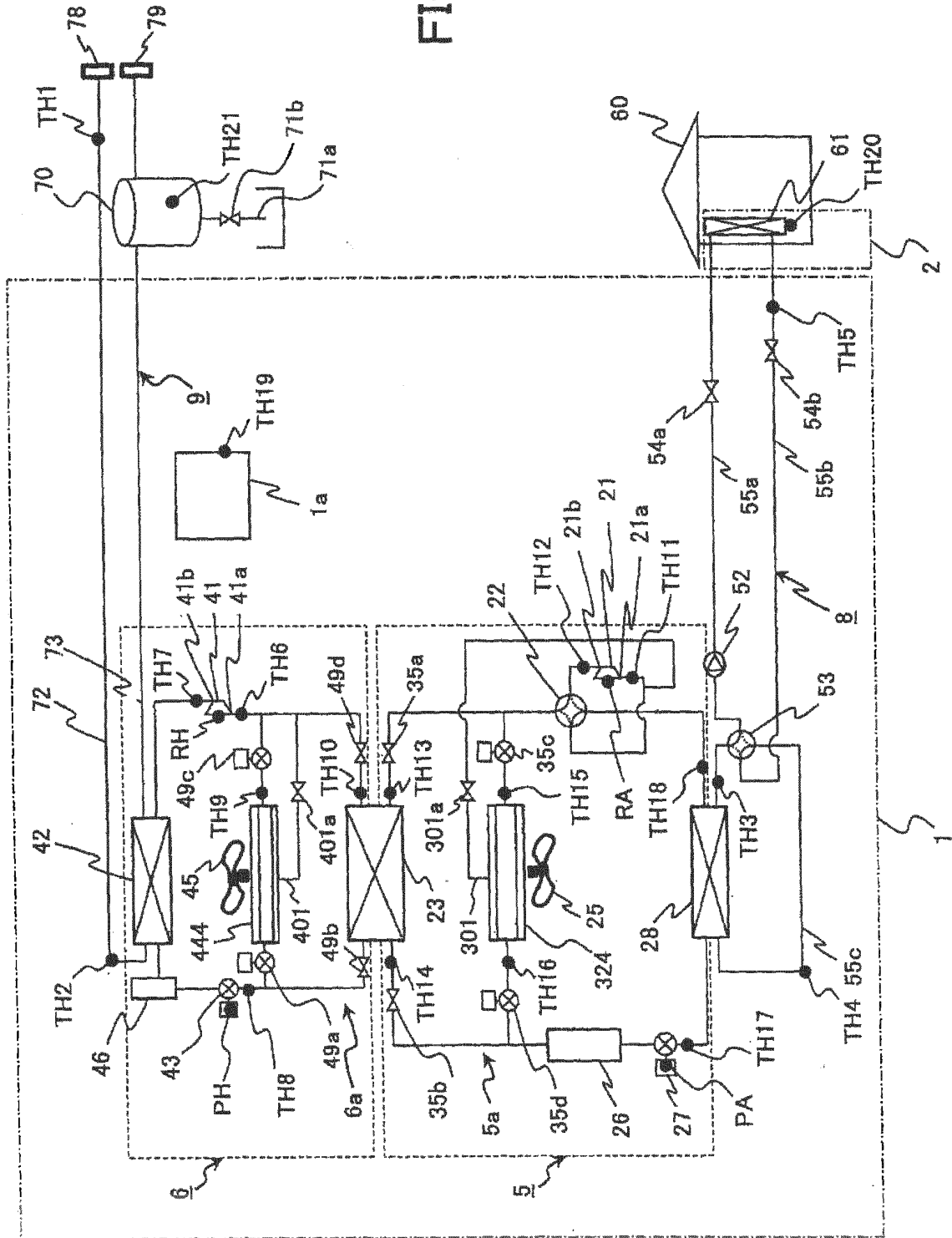


FIG. 21



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/062828

A. CLASSIFICATION OF SUBJECT MATTER

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)

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	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2005-299935 A (Fujitsu General Ltd.), 27 October 2005 (27.10.2005), claims; paragraphs [0001] to [0030]; fig. 1 to 10 (Family: none)	1-12
Y	JP 59-134469 A (Matsushita Electric Industrial Co., Ltd.), 02 August 1984 (02.08.1984), claims; page 1, lower right column, line 2 to page 3, lower right column, line 7; drawings (Family: none)	1-12

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

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search
18 October, 2010 (18.10.10)Date of mailing of the international search report
26 October, 2010 (26.10.10)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/062828

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 1-219454 A (Takenaka Corp.), 01 September 1989 (01.09.1989), page 4, upper left column, line 20 to page 4, upper right column, line 3; fig. 1 (Family: none)	2-12
Y	JP 2009-8381 A (Daikin Industries, Ltd.), 15 January 2009 (15.01.2009), claims; paragraphs [0001] to [0093]; fig. 1 to 10 & US 2010/0198415 A1 & EP 2163839 A1 & WO 2008/149715 A1 & KR 10-2010-0007953 A & CN 101680695 A & AU 2008259054 A	2-12
Y	JP 9-264614 A (Matsushita Electric Industrial Co., Ltd.), 07 October 1997 (07.10.1997), claims; paragraphs [0001] to [0044]; fig. 1 to 7 (Family: none)	2-12
A	JP 4-32669 A (Matsushita Electric Industrial Co., Ltd.), 04 February 1992 (04.02.1992), entire text; all drawings (Family: none)	1-12

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H432669 A [0003]