

Description

Summary of Invention

Technical Field

Technical Problem

[0001] Embodiments of the present invention relate to a refrigeration cycle device provided with an outdoor unit, an indoor unit, and a water heat exchange unit.

Background Art

[0002] A refrigeration cycle device (also referred to as a heat pump type heat source device) comprising a heat pump type refrigeration cycle in which a compressor and an outdoor heat exchanger of an outdoor unit, an indoor heat exchanger of an indoor unit, and a water heat exchanger of a water heat exchange unit, etc., are connected by piping, is known. In addition to cooling and heating operations, this refrigeration cycle device is capable of performing a cold water supply operation, in which cold water is supplied, and a hot water supply operation, in which hot water is supplied, from the water heat exchange unit to a load (a radiator or a hot water tank).

[0003] When the heating operation or the hot water supply operation is executed, frost gradually adheres to the surface of the outdoor heat exchanger that functions as an evaporator, and the heat exchange amount of the outdoor heat exchanger gradually decreases if no measures are taken. As a countermeasure, the above-mentioned refrigeration cycle device periodically or as necessary executes a defrosting operation, in which a discharge refrigerant (high temperature refrigerant) of the compressor is directly supplied to the outdoor heat exchanger during the heating operation and the hot water supply operation.

[0004] However, when the refrigerant after defrosting the outdoor heat exchanger flows into the water heat exchanger, such as in the case where the outside temperature is low, the temperature of the water heat exchanger may drop significantly and the water in the water heat exchanger may freeze. If the water in the water heat exchanger freezes, there is a possibility that the water heat exchanger may burst. To prevent the freezing and bursting from occurring, the above-mentioned refrigeration cycle device operates the pump of the water heat exchange unit to distribute water to the water heat exchanger in the case where the temperature of the water heat exchanger drops to or below a set value, thereby executing a freeze prevention operation to prevent the water heat exchanger from freezing.

Citation List

Patent Literature

[0005] Patent Literature 1: JP 2004-353903 A

[0006] The power supply of an unused water heat exchange unit may be cut off by a user. Even if the refrigerant after defrosting flows into the water heat exchanger of the unused water heat exchange unit and the temperature of the water heat exchanger drops, in a state where the power supply of the water heat exchange unit is cut off, the pump cannot execute the freeze prevention operation. There is a possibility that the water in the water heat exchanger may freeze without being able to execute the freeze prevention operation.

[0007] Embodiments described herein aim to provide a refrigeration cycle device with excellent safety that can prevent the water in the water heat exchanger from freezing.

Solution to Problem

[0008] A refrigeration cycle device of one embodiment comprising; an outdoor unit including a compressor, an outdoor heat exchanger, and an outdoor controller; an indoor unit including an indoor heat exchanger; and a water heat exchange unit including a water heat exchanger, a pump that circulates water between a water flow path of the water heat exchanger and a load, and a water heat controller, and operated by a power supply that is different from power supplies of the outdoor unit and the indoor unit. The water heat exchange controller operates the pump in a case where a temperature of the water heat exchanger is below a set value. The outdoor controller permits operation of the refrigeration cycle device in a case where the number of operable units of the water heat exchange unit reaches a specified number of units, and prohibits operation of the refrigeration cycle device in a case where the number of operable units of the water heat exchange unit does not reach the specified number of units.

Brief Description of Drawings

[0009]

FIG. 1 is a block diagram showing a configuration of an embodiment.

FIG. 2 is a flowchart showing the control of an indoor controller according to an embodiment.

FIG. 3 is a flowchart showing the control of a water heat controller according to an embodiment.

FIG. 4 is a flowchart showing the control of an outdoor controller according to an embodiment.

Mode for Carrying Out the Invention

[0010] An embodiment of a refrigeration cycle device is described below with reference to the drawings.

[0011] As shown in FIG. 1, one end of a plurality of indoor heat exchangers 11 and one end of a refrigerant flow path 21a in a plurality of water heat exchangers 21 are pipe-connected to a discharge port of a compressor 1 via a four-way valve 2, and the other end of each indoor heat exchanger 11 and the other end of the refrigerant flow path 21a in each water heat exchanger 21 are pipe-connected to one end of an expansion valve (pressure reducer) 3 via a flow control valve (first flow control valve) 12 and a flow control valve (second flow control valve) 22, respectively. Furthermore, one end of an outdoor heat exchanger 4 is pipe-connected to the other end of the expansion valve 3, and the other end of the outdoor heat exchanger 4 is pipe-connected to a suction port of the compressor 1 via the above four-way valve 2 and an accumulator 5. The heat pump type refrigeration cycle is configured by connecting these pipes.

[0012] Each flow control valve 12 is a pulse motor valve (PMV) whose opening degree varies continuously from fully closed to fully open in accordance with the number of drive pulse voltages supplied, and its opening degree variation adjusts the flow rate of refrigerant to the indoor heat exchanger 11. Each flow control valve 22 is also a pulse motor valve (PMV) whose opening degree varies continuously from fully closed to fully open in accordance with the number of drive pulse voltages supplied, and its opening degree variation adjusts the flow rate of refrigerant to the refrigerant flow path 21a of each water heat exchanger 21.

[0013] During the heating operation or the hot water supply operation, a small amount of refrigerant may leak and flow from the respective flow control valves 12 and 22 to the indoor heat exchanger 11 side and the water heat exchanger 21 side even when the respective flow control valves 12 and 22 are fully closed.

[0014] During the heating operation, as shown by the arrows, a gas refrigerant discharged from the compressor 1 flows through the four-way valve 2 to each indoor heat exchanger 11. The gas refrigerant flowing into each indoor heat exchanger 11 is condensed by losing heat to indoor air. The liquid refrigerant flowing out of each indoor heat exchanger 11 passes through each flow control valve 12, is further depressurized by the expansion valve 3, and flows into the outdoor heat exchanger 4. The liquid refrigerant flowing into the outdoor heat exchanger 4 draws heat from the outside air and vaporizes. The gas refrigerant flowing out of the outdoor heat exchanger 4 is sucked into the compressor 1 through the four-way valve 2 and the accumulator 5. That is, a refrigerant flow path (also referred to as a heating cycle) is formed in which each indoor heat exchanger 11 functions as a condenser and the outdoor heat exchanger 4 functions as an evaporator.

[0015] During the hot water supply operation (hot water heating operation), as shown by the arrows, a gas refrigerant discharged from the compressor 1 flows through the four-way valve 2 into the refrigerant flow path 21a of each water heat exchanger 21. The gas refrigerant flow-

ing in each refrigerant flow path 21a is condensed by losing heat to water flowing in each water flow path 21b. The liquid refrigerant flowing out of each refrigerant flow path 21a passes through each flow control valve 22, is further depressurized by the expansion valve 3, and flows into the outdoor heat exchanger (evaporator) 4. The liquid refrigerant flowing into the outdoor heat exchanger 4 draws heat from the outside air and vaporizes. The gas refrigerant flowing out of the outdoor heat exchanger 4 is sucked into the compressor 1 through the four-way valve 2 and the accumulator 5. That is, a refrigerant flow path (also referred to as a hot water supply cycle) is formed in which the refrigerant flow path 21a of each water heat exchanger 21 functions as a condenser and the outdoor heat exchanger 4 functions as an evaporator.

[0016] During the cooling operation, the flow path of the four-way valve 2 is switched, and the gas refrigerant discharged from the compressor 1 flows through the four-way valve 2 into the outdoor heat exchanger 4.

[0017] The gas refrigerant flowing in the outdoor heat exchanger 4 is condensed by releasing heat to the outside air. The liquid refrigerant flowing out of the outdoor heat exchanger 4 is depressurized by the expansion valve 3 and further flows through each flow control valve 12 to each indoor heat exchanger 11. The liquid refrigerant flowing in each indoor heat exchanger 11 vaporizes by taking heat from the indoor air. The gas refrigerant flowing out of each indoor heat exchanger 11 is sucked into the compressor 1 through the four-way valve 2 and the accumulator 5. That is, a refrigerant flow path (also referred to as a cooling cycle) is formed in which the outdoor heat exchanger 4 functions as a condenser and each indoor heat exchanger 11 functions as an evaporator.

[0018] During the cold water supply operation, as in the cooling operation, the flow path of the four-way valve 2 is switched so that a gas refrigerant discharged from the compressor 1 flows through the four-way valve 2 to the outdoor heat exchanger 4. The gas refrigerant flowing in the outdoor heat exchanger 4 is condensed by releasing heat to the outside air. The liquid refrigerant flowing out of the outdoor heat exchanger 4 is depressurized by the expansion valve 3 and further flows through each flow control valve 22 to the refrigerant flow path 21a of each water heat exchanger 21. The liquid refrigerant flowing in each refrigerant flow path 21a vaporizes by taking heat from the water flowing in each water flow path 21b. The gas refrigerant flowing out of each refrigerant flow path 21a is sucked into the compressor 1 through the four-way valve 2 and the accumulator 5. That is, a refrigerant flow path (also referred to as a cold water supply cycle) is formed in which the outdoor heat exchanger 4 functions as a condenser and the refrigerant flow path 21a of each water heat exchanger 21 functions as an evaporator.

[0019] In the vicinity of the outdoor heat exchanger 4, an outdoor fan 6 is arranged to suck in outdoor air and pass it through the outdoor heat exchanger 4, and an

outdoor air temperature sensor 7 is arranged to detect a temperature T_o of the air (outdoor air) sucked in by the outdoor fan 6. A heat exchanger temperature sensor 8 to detect a temperature T_c of the outdoor heat exchanger 4 is attached to the outdoor heat exchanger 4.

[0020] An indoor fan 13 and an indoor temperature sensor 14 are respectively disposed in the vicinity of each indoor heat exchanger 11. Each indoor fan 13 sucks in indoor air and passes the sucked air through each indoor heat exchanger 11. Each indoor temperature sensor 14 detects a temperature (indoor temperature) T_a of the air sucked in by each indoor fan 13.

[0021] Each water heat exchanger 21 exchanges heat between refrigerant that passes through the refrigerant flow path 21a and water that passes through the water flow path 21b. The inlet of each water flow path 21b is connected to the water flow outlet of loads L_1 to L_n via a water pipe 23 and a pump 24 arranged in the water pipe 23, respectively. The loads L_1 to L_n are, for example, radiators and hot water tanks. The outlets of each water flow path 21b are connected to the water flow inlets of the loads L_1 to L_n via water pipes 25, respectively. With the operation of each pump 24, the water contained in the loads L_1 to L_n circulates through each water pipe 23, each water flow path 21b, and each water pipe 25. An electric heater 26 is disposed between where each pump 24 is disposed in each water pipe 23 and the inlet of each water flow path 21b, respectively, as an auxiliary heat source to heat the water. A water temperature sensor 27 to detect a temperature T_w of the water is respectively attached to the outlet of each water flow path 21b.

[0022] The above-mentioned outdoor unit 1, four-way valve 2, expansion valve 3, outdoor heat exchanger 4, accumulator 5, outdoor fan 6, outdoor air temperature sensor 7, and heat exchanger temperature sensor 8 are housed in an outdoor unit A together with an outdoor controller 10. The outdoor unit A is connected to an AC power supply (first power supply) 30 for the outdoor unit via a power line 31 and a power switch 32 inserted and connected to the power line 31. When the power switch 32 is turned on by a user, an AC voltage of the AC power supply 30 is supplied to the outdoor unit A. The supply of this power voltage enables the operation of the outdoor unit A, including the operation of the outdoor controller 10.

[0023] Each of the above-mentioned indoor heat exchangers 11, each of the above-mentioned flow control valves 12, each of the above-mentioned indoor fans 13, and each of the above-mentioned indoor temperature sensors 14, together with each indoor controller 15, are housed in a plurality of indoor units B_1 , B_2 , ... B_n , respectively. These indoor units B_1 to B_n are connected to an AC power supply (second power supply) 40 for indoor units via a power line 41 and power switches 42a to 42n inserted and connected to the power line 41, respectively. When the power switches 42a to 42n are tuned on by a user, an AC voltage of the AC power supply 40 is supplied to the indoor units B_1 to B_n , respectively. The supply of this power voltage enables the operation

of the indoor units B_1 to B_n , including the operation of the respective indoor controllers 15, respectively.

[0024] An operation indicator 15a is connected to each indoor controller 15, respectively. These operation indicators 15a include an operation button for designating the start and stop of operation, an operation button for an indoor set temperature T_s , and a display screen for displaying an operation status and the like by text or images.

[0025] Each of the above-mentioned water heat exchangers 21, each of the above-mentioned water pipes 23, each of the above-mentioned pumps 24, each of the above-mentioned water pipes 25, each of the above-mentioned heaters 26, and each of the above-mentioned water temperature sensors 27, together with each water heat controller 28, are housed in a plurality of water heat exchange units C_1 to C_n , respectively. The water heat exchange units C_1 to C_n are connected to an AC power supply (third power supply) 50 for water heat exchange units via a power line 51 and power switches 52a to 52n inserted and connected to the power line 51, respectively. When the power switches 52a to 52n are turned on by a user, the AC voltage of the AC power supply 50 is supplied to the water heat exchange units C_1 to C_n , respectively. The supply of this power voltage enables the operation of the water heat exchange units C_1 to C_n , including the operation of each water heat controller 28, respectively.

[0026] An operation indicator 28a is connected to each of the water heat controllers 28, respectively. These operation indicators 28a include an operation button for designating the start and stop of operation, an operation button for a water setting temperature T_{ws} for the water heat exchange units C_1 to C_n , and a display screen for displaying an operation status and the like by text or images.

[0027] Thus, a multi-type refrigeration cycle device (also referred to as a heat pump type heat source device) is configured in which indoor units B_1 to B_n and water heat exchange units C_1 to C_n are connected in parallel to the outdoor unit A.

[0028] The outdoor controller 10 of the outdoor unit A comprehensively controls the operation of the outdoor unit A, the operation of the indoor units B_1 to B_n , and the operation of the water heat exchange units C_1 to C_n in response to the user operation of each operation indicator 15a and each operation indicator 28a, and includes as its main functions a first control section 10a, a second control section 10b, a third control section 10c, a fourth control section 10d, and a fifth control section 10e.

[0029] The first control section 10a forms a refrigerant flow path (heating cycle) in which each indoor heat exchanger 11 functions as a condenser and the outdoor heat exchanger 4 functions as an evaporator during the heating operation of the indoor units B_1 to B_n . In addition, the first control section 10a forms a refrigerant flow path (hot water supply cycle) in which the refrigerant flow path 21a of each water heat exchanger 21 functions respec-

tively as a condenser and the outdoor heat exchanger 4 functions as an evaporator during the hot water supply operation in which hot water is supplied from the water heat exchange units C1 to Cn to the loads L1 to Ln.

[0030] The second control section 10b forms a refrigerant flow path (cooling cycle) in which the outdoor heat exchanger 4 functions as a condenser and each indoor heat exchanger 11 functions as an evaporator during the cooling operation of the indoor units B1 to Bn. In addition, the second control section 10b forms a (cold water supply cycle) in which the outdoor heat exchanger 4 functions as a condenser and the refrigerant flow path 21a of each water heat exchanger 21 functions respectively as an evaporator during the cold water supply operation in which cold water is supplied from the water heat exchange units C1 to Cn to the loads L1 to Ln.

[0031] The third control section 10c detects, during the above-mentioned heating operation and the above-mentioned hot water supply operation, the amount of frost on the outdoor heat exchanger 4 based on the temperature (evaporation temperature) Tc of the outdoor heat exchanger 4 detected by the heat exchanger temperature sensor 8. In the case where the amount of frost on the outdoor heat exchanger 4 is equal to or exceeds a specified amount, the refrigerant flow direction is switched to a defrosting cycle that is the same as the cooling cycle and the cold water supply cycle, which are opposite to the heating cycle and the hot water supply cycle, and the defrosting operation is executed in which a discharge refrigerant (high temperature refrigerant) of the compressor 1 flows directly into the outdoor heat exchanger 4 through the four-way valve 2 to remove the frost on the outdoor heat exchanger 4 by the heat of the refrigerant. This defrosting operation is continued until the amount of frost decreases to less than the specified amount or until a certain time elapses.

[0032] At the first trial operation after the installation of the refrigeration cycle device is completed, or at the first trial operation after the indoor units B1 to Bn or the water heat exchange units C1 to Cn are added or reduced, the fourth control section 10d communicates mutually with each indoor controller 15 of the indoor units B1 to Bn and each water heat controller 28 of the water heat exchange units C1 to Cn via a communication line 60 to detect a control address of each indoor controller 15, a control address of each water heat controller 28, the capacity (horsepower) of the indoor units B1 to Bn, the capacity (horsepower) of the water heat exchange units C1 to Cn, the number of water heat exchange units C1 to Cn (also referred to as the number of connected units) Ns, etc., and stores these detection results as control data in an internal memory of the outdoor controller 10.

[0033] During the trial operation, since the power switch 32 of the outdoor unit A, the power switches 42a to 42n of the indoor units B1 to Bn, and the power switches 52a to 52n of the water heat exchange units C1 to Cn are all turned on by a worker, the number of units Ns of all of the water heat exchange units C1 to Cn for which

installation has been completed is detected, and the detection result is stored in the internal memory of the outdoor controller 10 as the specified number of units Ns.

[0034] When turning on the AC power supply 30 by turning on the power switch 32 after the trial operation is completed, the fifth control section 10e communicates mutually with each water heat controller 28 of the water heat exchange units C1 to Cn via the communication line 60 to detect the number of operable water heat exchange units C1 to Cn (that is, the number of water heat controllers 28 that can be operated) N, and compares the detected number of operable units N with the specified number of units Ns stored at the trial operation. In the case where the number of operable units N reaches the specified number of units Ns, the operation of the refrigeration cycle device including the outdoor unit A is permitted, and in the case where the number of operable units N is less than the specified number of units Ns, the operation of the refrigeration cycle device including the outdoor unit A is prohibited.

[Control of each indoor controller 15]

[0035] Each indoor controller 15 of the indoor units B1 to Bn executes the control shown in the flowchart of FIG. 2. S1, S2... in the flowchart indicate the steps of the process.

[0036] That is, during the heating operation and the cooling operation (YES in S1), each indoor controller 15 notifies the outdoor controller 10 via the communication line 60 of the required capacity of the indoor units B1 to Bn corresponding to the difference between a detected temperature Ta of each indoor temperature sensor 14 and the indoor set temperature Ts (S2). Then, each indoor controller 15 controls the refrigerant flow rate to each indoor heat exchanger 11, that is, the opening degree of each flow control valve 12, so that the detected temperature Ta of each indoor temperature sensor 14 becomes the indoor set temperature Ts (S3).

[Control of each water heat controller 28]

[0037] Each water heat controller 28 of water heat exchange units C1 to Cn executes the control shown in the flowchart of FIG. 3.

[0038] That is, during the hot water supply operation and cold water supply operation (YES in S11), each water heat controller 28 opens each flow control valve 12 to form a refrigerant flow path to each water heat exchanger 21 (S12), and operates each pump 24 to circulate water between the water flow path 21b of each water heat exchanger 21 and the load (S13). Furthermore, each water heat controller 28 detects a temperature Tw of the water flowing out of the water flow path 21b of each water heat exchanger 21 with each water temperature sensor 27, and controls the water delivery rate of each pump 24 so that the detected temperature Tw becomes the water setting temperature TwS (S14). Then, each water heat con-

troller 28 monitors the presence or absence of the defrosting operation by communicating with the outdoor controller (S15). The defrosting operation is performed periodically or as needed during the hot water supply operation, but not during the cold water supply operation. When the defrosting operation is executed during the hot water supply operation, the refrigerant after defrosting the outdoor heat exchanger 4 flows into each water heat exchanger 11 through each flow control valve 12 in the open state, thus lowering the temperature T_w of each water heat exchanger 11.

[0039] In the case where the defrosting operation is not in progress (NO in S15), each water heat controller 28 returns to the determination in S11 above. In the case where the defrosting operation is in progress (YES in S15), each water heat controller 28 compares the detected temperature T_w of each water temperature sensor 27 with a set value T_{ws} for freeze prevention (S16).

[0040] In the case where the detected temperature T_w of each water temperature sensor 27 is at or above the set value T_{ws} (YES in S16), each water heat controller 28 stops each pump 24 (S17). By stopping each pump 24, unnecessary cold water will not be supplied from each water heat exchanger 21 to the loads L1 to Ln. Subsequently, each water heat controller 28 returns to the determination in S11 above.

[0041] In the case where the detected temperature T_w of each water temperature sensor 27 is below the set value T_{ws} (NO in S16), each water heat controller 28 operates each pump 24 at a predetermined water delivery rate to prevent each water heat exchanger 21 from freezing (S18). The water delivery rate of each pump 24 at this time is only to prevent freezing; therefore, a small amount that would not cause cold water to be supplied to the loads L1 to Ln is sufficient. This freeze prevention operation prevents the water heat exchanger 21 from freezing. Subsequently, each water heat controller 28 returns to the determination in S11 above.

[0042] In the determination in S11 above, during, for example, the heating operation (NO in S11), which is neither the hot water supply operation nor the cold water supply operation, each water heat controller 28 fully closes each flow control valve 12 to prevent a refrigerant from flowing into each water heat exchanger 21 (S19). Then, each water heat controller 28 moves on to S16 above and compares the detected temperature T_w of each water temperature sensor 27 with the set value T_{ws} for freeze prevention (S16).

[0043] Even when each flow control valve 12 is fully closed, a small amount of refrigerant may leak and flow from each flow control valve 12 to each water heat exchanger 21 side, causing the temperature T_w of each water heat exchanger 21 to drop.

[0044] If the detected temperature T_w of each water temperature sensor 27 is at or above the set value T_{ws} (YES in S16), each water heat controller 28 stops each pump 24 (S17). By stopping each pump 24, unnecessary cold water will not be supplied from each water heat ex-

changer 21 to the loads L1 to Ln. Subsequently, each water heat controller 28 returns to the determination in S11 above.

[0045] In the case where the detected temperature T_w of each water temperature sensor 27 drops below the set value T_{ws} (NO in S16), each water heat controller 28 operates each pump 24 at a predetermined water delivery rate to prevent each water heat exchanger 21 from freezing (S18). The water delivery rate of each pump 24 at this time is only to prevent freezing; therefore, a small amount that would not cause cold water to be supplied to the loads L1 to Ln is sufficient. This freeze prevention operation prevents the water heat exchanger 21 from freezing. Subsequently, each water heat controller 28 returns to the decision of S11 above.

[Control of outdoor controller 10]

[0046] As shown in the flowchart of FIG. 4, when the AC power supply 30 is turned on by the on operation of the power switch 32 (S21), the outdoor controller 10 of the outdoor unit A determines whether the operation mode is a trial operation after the installation is completed (S22).

[0047] In the case of the trial operation (YES in S22), the outdoor controller 10 executes mutual communication with each water heat controller 28 of the water heat exchange units C1 to Cn via the communication line 60 (S23), detects the number of units N_s of all water heat exchange units C1 to Cn whose installation has been completed (also referred to as the number of connected units) through this mutual communication (S24), and stores the detection result as the specified number of units N_s in the internal memory (S25). The outdoor controller 10 then returns to the determination in S22 above if the AC power supply 30 is not shut off by the off operation of the power switch 32 (NO in S26).

[0048] In the case where it is not a trial operation (NO in S22), the outdoor controller 10 executes mutual communication with each water heat controller 28 of the water heat exchange units C1 to Cn via the communication line 60 (S27), detects the number of operable units N of the water heat exchange units C1 to Cn (that is, the number of operable water heat controllers 28) through this mutual communication (S28), and compares the detected number of operable units N with the above-mentioned specified number of units N_s stored at the time of the trial operation (S29).

[0049] In the case where the number of operable units N reaches the specified number of units N_s (NO in S29; $N=N_s$), the outdoor controller 10 permits the operation of the outdoor unit A (S30). Due to this permission, the execution of all the operations such as heating operation, hot water supply operation, cooling operation, and cold water supply operation becomes possible in response to the operation of the operation indicator 15a or the operation indicator 28a. The outdoor controller 10 then returns to the determination in S22 above if the AC power supply

30 is not shut off by the off operation of the power switch 32 (NO in S26) .

[0050] In the case where the number of operable units N does not reach the specified number of units N_s (YES in S29; $N < N_s$), the outdoor controller 10 prohibits the operation of the refrigeration cycle device including the outdoor unit A and informs the user of the prohibition and the cause thereof by the displays of the respective operation indicators 15a and 28a (S31). This prohibition of the operation makes it impossible to execute all the operations such as the heating operation, the hot water supply operation, the cooling operation, and the cold water supply operation. The outdoor controller 10 then returns to the determination of S22 above if the AC power supply 30 is not shut off by the off operation of the power switch 32 (NO in S26) .

[0051] For example, during the cold water supply operation, such as during the cooling season, the operation of one or more units among the water heat exchange units C1 to Cn may be unnecessary and stopped. In this case, to save electricity, the power switch 52a of the water heat exchange unit to be stopped, for example, the water heat exchange unit C1, may be turned off by the user, and the supply of power voltage to the water heat exchange unit C1 may be cut off. Subsequently, even if the season shifts from the cooling season to the heating season, the heating operation of the indoor units B1 to Bn and the hot water supply operation of the other water heat exchange units C2 to Cn may be started while the power switch 52a of the water heat exchange unit C1 remains turned off.

[0052] In this case, the operation of the flow control valve 22, the operation of the pump 24, the operation of the electric heater 26, and the operation of the water heat controller 28 are stopped in the water heat exchange unit C1 where the supply of the power voltage is cut off. When the heating operation of the indoor units B1 to Bn and the hot water supply operation of the other water heat exchange units C2 to Cn proceed as is, and the outdoor heat exchanger 4 becomes frosted and the defrosting operation for the outdoor heat exchanger 4 is executed, even if the flow control valve 22 of the water heat exchange unit C1 is fully closed, the refrigerant after defrosting may flow from the flow control valve 22 to the refrigerant flow path 21a side of the water heat exchanger 21. In this case, even if the detected temperature T_w of the water temperature sensor 27 drops below the set value T_{ws} for freeze prevention, the pump 24 cannot be operated in the water heat exchange unit C1 where the supply of the power voltage is cut off. If this happens, the water in the water heat exchanger 21 in the water heat exchange unit C1 will freeze. If the freezing progresses, there is a possibility that the water heat exchanger 21 may burst.

[0053] However, in the water heat exchange unit C1 where the supply of power voltage is cut off, the operation of the water heat controller 28 is stopped, and the number of operable units N of the water heat exchange units C1

to Cn becomes less than the specified number of units N_s . Therefore, the operation of the refrigeration cycle device including the outdoor unit A is prohibited. That is, not only the heating operation and the hot water supply operation, but also the defrosting operation is prohibited. Therefore, the water in the water heat exchanger 21 in the water heat exchange unit C1 can be prevented from freezing. As a result, the water heat exchanger 21 can be prevented from bursting due to the progress of freezing.

[0054] The user can recognize that the operation of the refrigeration cycle device including the outdoor unit A has been prohibited and the cause thereof by the displays of the respective operation indicators 15a and 28a. Based on this recognition, the user can turn on the power switch 52a of the water heat exchange unit C1 and also turn off the power switch 32 of the outdoor unit A and then turn it on again. From this point onward, the number of operable units N of the water heat exchange units C1 to Cn becomes equal to the specified number of units N_s , and all of the refrigeration cycle units including the outdoor unit A are permitted to operate.

[0055] In the above embodiment, the configuration is such that the specified number of units N_s is detected and stored by the communication of the outdoor controller 10 during the trial operation. However, the number of installed units C1 to Cn can be checked by a worker, and the number can be entered and stored in the outdoor controller 10 as the specified number of units N_s by operating the operation indicator 15a or 28a.

[0056] In the above embodiment, the number of operable units N of the water heat exchange units C1 to Cn is detected when the power switch 32 of the outdoor unit A is turned on; however, a configuration may also be adopted in which the number of operable units N of the water heat exchange units C1 to Cn is detected at each start of the operation of the outdoor unit A.

[0057] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

Reference Signs List

[0058] A...Outdoor unit, B1 to Bn...Indoor unit, C1 to Cn...Water heat exchange unit, 1...Compressor, 2...Four-way valve, 3...Expansion valve (pressure reducer), 4 ...Outdoor heat exchanger, 8...Heat exchanger temperature sensor, 10...Outdoor controller, 11...Indoor heat exchanger, 12...Flow control valve, 15...Indoor controller, 21...Water heat exchanger, 21a...Refrigerant flow

path, 21b...Water flow path, 22...Flow control valve, 24...Pump, 26...Electric heater, 27...Water temperature sensor, 28...Water heat controller, 30, 40, 50...AC power supply, 32, 42a to 42n, 52a to 52n...Power switch, 60...Communication line

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Claims

1. A refrigeration cycle device comprising:

an outdoor unit including a compressor, an outdoor heat exchanger, and an outdoor controller; an indoor unit including an indoor heat exchanger; and

a water heat exchange unit including a water heat exchanger, a pump that circulates water between a water flow path of the water heat exchanger and a load, and a water heat controller, and operated by a power supply that is different from power supplies of the outdoor unit and the indoor unit, **characterized in that**

the water heat exchange controller operates the pump in a case where a temperature of the water heat exchanger is below a set value, and the outdoor controller permits operation of the refrigeration cycle device in a case where the number of operable units of the water heat exchange unit reaches a specified number of units, and prohibits operation of the refrigeration cycle device in a case where the number of operable units of the water heat exchange unit does not reach the specified number of units.

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2. The refrigeration cycle device of claim 1, **characterized in that** the outdoor controller, upon turning on power of the outdoor unit, detects the number of operable units of the water heat exchange unit by communicating with the water heat exchange unit.

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3. The refrigeration cycle device of claim 1 comprising:

a first flow control valve which adjusts a flow rate of a refrigerant to the indoor heat exchanger; and a second flow control valve which adjusts a flow rate of a refrigerant to the water heat exchanger, **characterized in that**

the outdoor controller

during a heating operation, forms a refrigerant flow path in which a discharge refrigerant of the compressor returns to the compressor through the indoor heat exchanger, the first flow control valve, and the outdoor heat exchanger,

during a hot water supply operation which supplies hot water to the load, forms a refrigerant flow path in which a discharge refrigerant of the compressor returns to the compressor through the water heat exchanger, the second flow con-

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trol valve, and the outdoor heat exchanger, and operates the pump of the water heat exchange unit, and

upon defrosting the outdoor heat exchanger during the heating operation and the hot water supply operation, forms a refrigerant flow path in which a discharge refrigerant of the compressor flows directly into the outdoor heat exchanger.

4. The refrigerant cycle device of claim 3, **characterized in that**

the first and second flow control valves are pulse motor valves whose opening degree continuously varies from fully closed to fully open according to the number of supplied drive pulse voltages, and a flow rate of a refrigerant is adjusted by the variation of the opening degree.

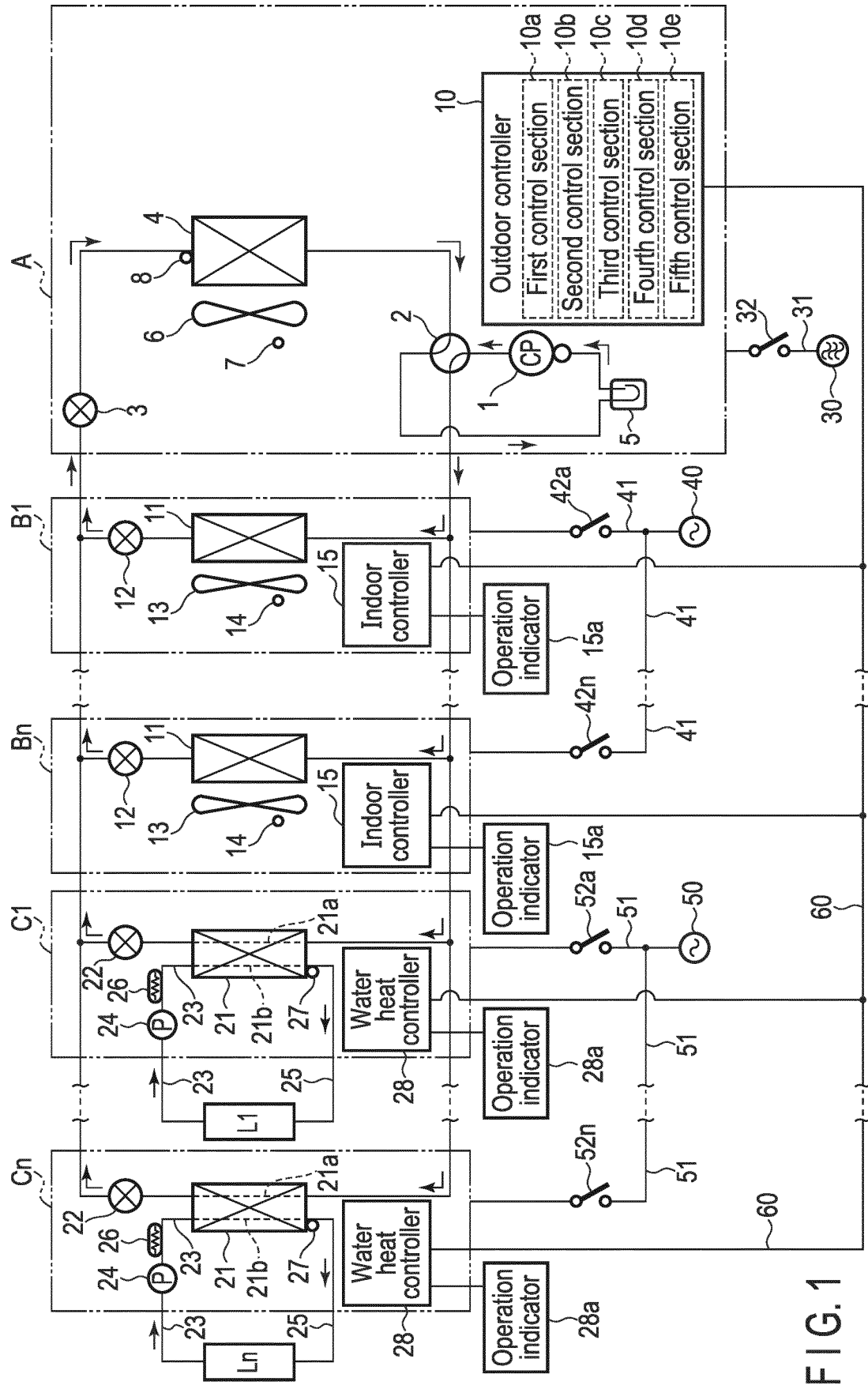


FIG. 1

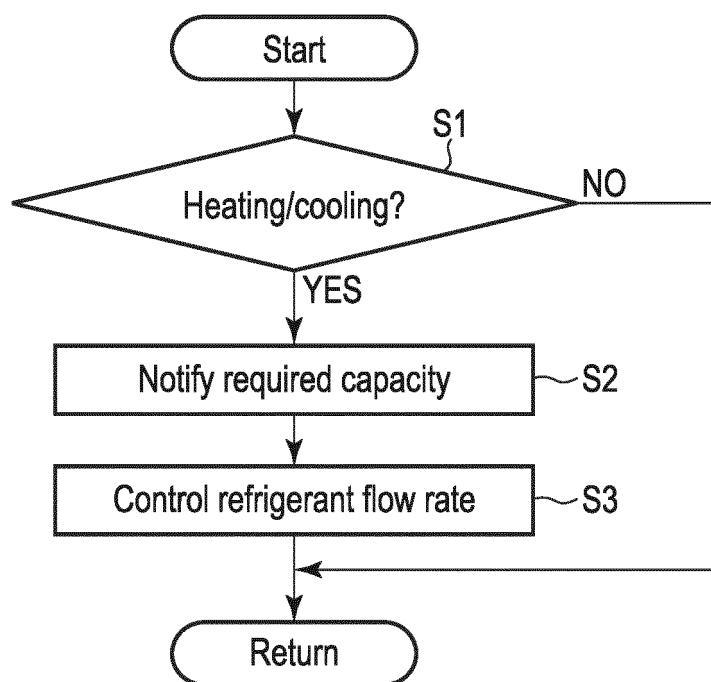


FIG. 2

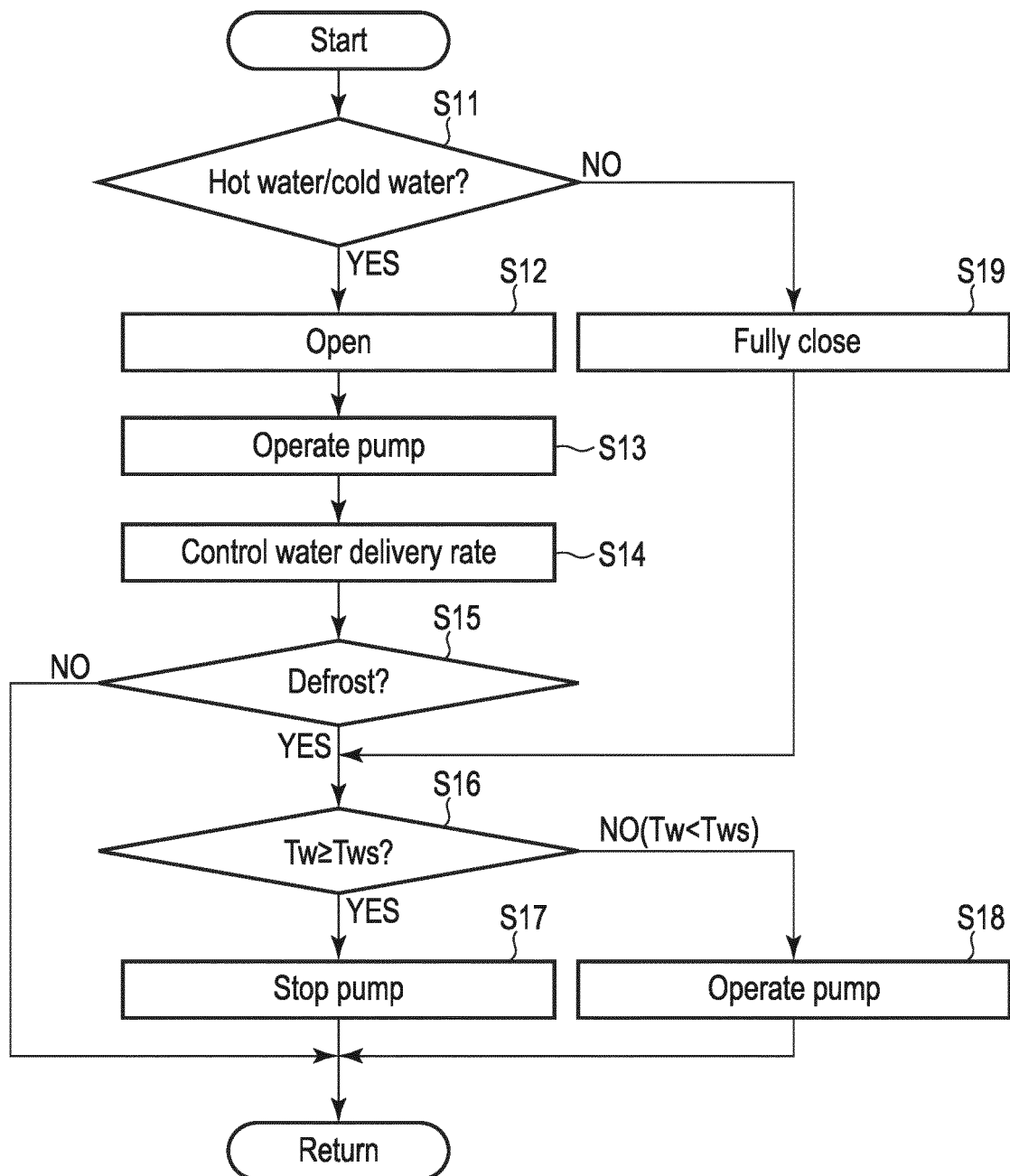


FIG. 3

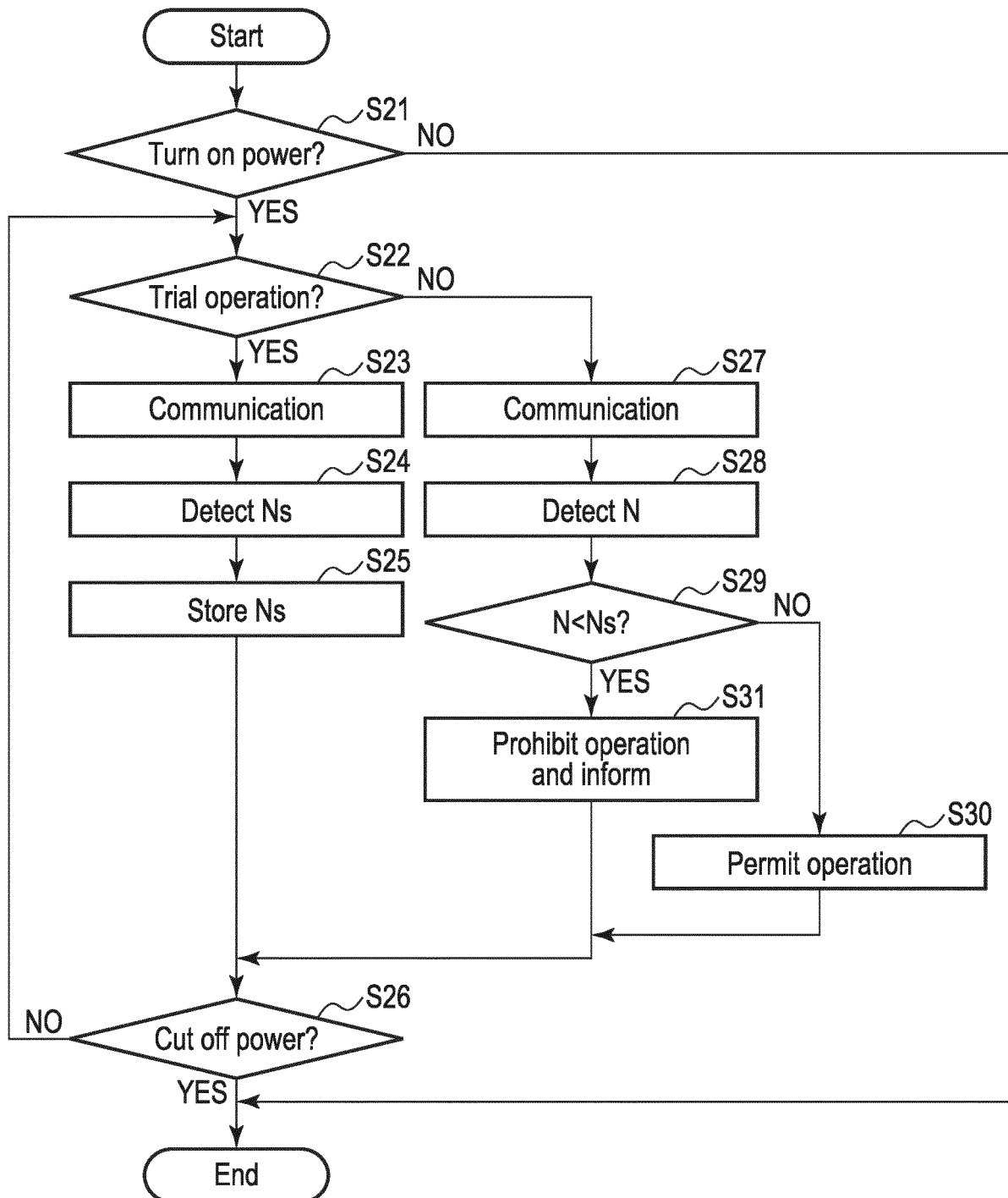


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/031827

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. F25B13/00 (2006.01)i, F25B1/00 (2006.01)i, F24F5/00 (2006.01)i,
F24F11/41 (2018.01)i, F24F11/46 (2018.01)i, F24F11/70 (2018.01)i,
F24F140/00 (2018.01)n

FI: F24F11/46, F25B13/00J, F25B13/00104, F25B1/00399Y, F24F5/00101,
F24F11/70, F24F11/41250, F24F140/00

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. F25B13/00, F25B1/00, F24F5/00, F24F11/41, F24F11/46, F24F11/70,
F24F140/00

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

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2017-142038 A (MITSUBISHI HEAVY INDUSTRIES THERMAL SYSTEMS LTD.) 17.08.2017 (2017-08-17), paragraphs [0015]-[0045], fig. 1, 2	1-4
Y	JP 2004-353903 A (SANYO ELECTRIC CO., LTD.) 16.12.2004 (2004-12-16), paragraphs [0010]-[0036], fig. 1, 2	1-4
Y	JP 2014-158311 A (MITSUBISHI ELECTRIC CORPORATION) 28.08.2014 (2014-08-28), paragraphs [0013]-[0056], fig. 1-8	1-4
Y	JP 2014-77560 A (FUJITSU GENERAL LIMITED) 01.05.2014 (2014-05-01), paragraph [0022], fig. 1	4

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search
09.09.2020

Date of mailing of the international search report
24.09.2020

Name and mailing address of the ISA/
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Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/031827

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 9-14731 A (TOSHIBA AVE CORP.) 17.01.1997 (1997-01-17), paragraph [0023], fig. 1	4
A	JP 2002-349940 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 04.12.2002 (2002-12-04), entire text, all drawings	1-4

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/JP2020/031827

JP 2017-142038 A 17.08.2017 EP 3205954 A1
paragraphs [0015]-[0045], fig. 1, 2

JP 2004-353903 A 16.12.2004 (Family: none)

JP 2014-158311 A 28.08.2014 (Family: none)

JP 2014-77560 A 01.05.2014 (Family: none)

JP 9-14731 A 17.01.1997 (Family: none)

JP 2002-349940 A 04.12.2002 (Family: none)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2004353903 A [0005]