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(54) FREEZING APPARATUS

(57) A freezing apparatus according to the present disclosure cools a refrigerant by heat exchange between the refrigerant and water. In this freezing apparatus, a low-stage compression mechanism, an intercooler that cools the refrigerant discharged from the low-stage compression mechanism, a high-stage compression mechanism that sucks the refrigerant that has passed through the intercooler, and a gas cooler that cools the refrigerant discharged from the high-stage compression mechanism are connected by refrigerant piping, and a water supply means, the intercooler, the gas cooler, an external radiator, a hot-water supply means, and a water delivery mechanism are connected by water piping. This freezing apparatus is provided with a first flow adjustment mechanism that adjusts the flow rate of water flowing into the hot-water supply means and the external radiator after passing through the gas cooler.

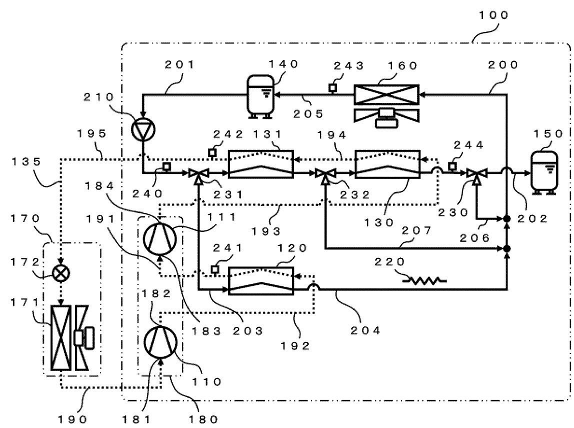

FIG. 1

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Description

Technical Field

[0001] The present disclosure relates to a refrigeration apparatus connected to a refrigerator, a refrigeration showcase, or the like, and more particularly, to a refrigeration apparatus capable of performing hot-water supply by exhaust heat of the refrigeration apparatus.

Background Art

[0002] Patent Literature (hereinafter, referred to as PTL) 1 discloses a refrigeration apparatus that uses water heated by exhaust heat of the refrigeration apparatus for hot-water supply. This refrigeration apparatus includes: an intercooler that cools a refrigerant discharged from a low-stage compression mechanism; and a gas cooler that cools a refrigerant discharged from a high-stage compression mechanism. In the refrigeration apparatus, the intercooler and the gas cooler are connected in parallel by water pipes, and the water heated by the intercooler and the gas cooler is used for hot-water supply.

Citation List

Patent Literature

[0003] PTL 1
Japanese Patent No. 4947197

Summary of Invention

Technical Problem

[0004] The present disclosure provides a refrigeration apparatus capable of switching operation between performing hot-water supply and not performing hot-water supply depending on a demand for hot-water supply while performing cooling operation of the refrigeration apparatus.

Solution to Problem

[0005] A refrigeration apparatus of the present disclosure is for cooling a refrigerant by heat exchange between the refrigerant and water, and includes a first flow-control mechanism for adjusting a flow rate of water that flows into a hot-water supply means and an external heat radiation device after passing through a gas cooler, in which a low-stage compression mechanism, an intercooler for cooling a refrigerant discharged from the low-stage compression mechanism, a high-stage compression mechani sm suctioning a refrigerant that has passed through the intercooler, and the gas cooler for cooling a refrigerant discharged from the high-stage compression mechanism are connected to one another by a refrigerant pipe, and the water supply means, the intercooler, the gas cooler, the external heat radiation device, the hot-water supply means, and a water conveyance mechanism are connected to one another by a water pipe.

Advantageous Effects of Invention

[0006] A refrigeration apparatus of the present disclosure can stream, by a first flow-control mechanism, water heated by a gas cooler to a hot-water supply means when hot-water supply is necessary and to an external heat radiation device when hot-water supply is unnecessary. Therefore, the refrigeration apparatus can switch operation between performing hot-water supply and not performing hot-water supply, and can continue cooling operation of the refrigeration apparatus regardless of a demand for hot-water supply.

Brief Description of Drawings

[0007]

FIG. 1 illustrates a schematic configuration of a refrigeration apparatus according to Embodiment 1;
FIG. 2 is a block diagram illustrating a control configuration according to Embodiment 1;
FIG. 3 is a flowchart of anti-freezing control according to Embodiment 1;
FIG. 4 is a flowchart of intercooler water flow control according to Embodiment 1;
FIG. 5 is a flowchart of auxiliary-gas-cooler water flow control according to Embodiment 1; and
FIG. 6 is a flowchart of hot-water temperature control according to Embodiment 1.

Description of Embodiments

(Knowledge on which Present Disclosure is Based)

[0008] Unlike general heat pump water heaters, a refrigeration apparatus that performs hot-water supply using exhaust heat of the refrigeration apparatus needs to continuously perform cooling operation of the refrigeration apparatus regardless of a demand for hot-water supply. Thus, the inventors have devised to provide an external heat radiation device to radiate the heat of the water heated by the exhaust heat of the refrigeration apparatus when hot-water supply is unnecessary, and to make the refrigeration apparatus to continue the cooling operation by circulating the water. However, the inventors found a problem in that water is collected in the external heat radiation device when hot-water supply is necessary, and then the water in the external heat radiation device is frozen when the ambient temperature falls below the freezing point. The subject matter of the present disclosure has been constructed to solve this problem.
[0009] The present disclosure provides a refrigeration apparatus capable of switching operation between per-

forming hot-water supply and not performing hot-water supply depending on a demand for hot-water supply while performing cooling operation of the refrigeration apparatus, and also capable of preventing water from freezing.

[0010] Hereinafter, embodiments will be described in detail with reference to the drawings. However, any unnecessarily detailed description may be omitted. For example, detailed descriptions of already well-known matters and repeated descriptions of substantially the same configuration may be omitted.

[0011] Note that the accompanying drawings and the following description are provided for a person skilled in the art to sufficiently understand the present disclosure, and are not intended to limit the subject matter described in the claims.

(Embodiment 1)

[0012] Hereinafter, Embodiment 1 is described with reference to FIGS. 1 to 6.

[1-1. Configuration]

[0013] In FIG. 1, refrigeration apparatus 100 includes: compressor 180 including low-stage compression mechanism 110 and high-stage compression mechanism 111; intercooler 120 for cooling a refrigerant discharged from low-stage compression mechanism 110; gas cooler 130 for cooling a refrigerant discharged from high-stage compression mechanism 111; and auxiliary gas cooler 131 for further cooling the refrigerant discharged from gas cooler 130.

[0014] Further, refrigeration apparatus 100 is connected to cooling equipment 170 that is cooled by the refrigerant sent out from refrigeration apparatus 100.

[0015] Cooling equipment 170 is constituted by evaporator 171 and expansion mechanism 172 connected with each other, and, for example, is a showcase or the like installed in a store such as a convenience store or a supermarket and displaying refrigerated or frozen products while cooling the products.

[0016] Further, low-stage compression mechanism 110 includes low-stage suction port 181 and low-stage discharge port 182.

[0017] Furthermore, high-stage compression mechanism 111 includes high-stage suction port 183 and high-stage discharge port 184.

[0018] A device constituting refrigeration apparatus 100 and a device constituting cooling equipment 170 are connected with each other through refrigerant pipe 135.

[0019] Refrigerant pipe 135 includes: low-pressure suction pipe 190 connecting evaporator 171 and low-stage suction port 181 together; intermediate-pressure discharge pipe 192 connecting low-stage discharge port 182 and intercooler 120 together; intermediate-pressure suction pipe 191 connecting intercooler 120 and high-stage suction port 183 together; high-pressure discharge pipe 193 connecting high-stage discharge port 184 and gas cooler 130 together; high-pressure connecting pipe 194 connecting gas cooler 130 and auxiliary gas cooler 131 together; and outlet pipe 195 connecting auxiliary gas cooler 131 and expansion mechanism 172 together.

[0020] Note that, for refrigeration apparatus 100 of the present embodiment, carbon dioxide, whose refrigerant pressure on the high-pressure side is equal to or higher than a critical pressure (supercritical), is used as a refrigerant. This carbon dioxide refrigerant is a natural refrigerant with low environmental load and without flammability and toxicity.

[0021] Next, refrigeration apparatus 100 of the present embodiment is of a water cooling type, and includes a water supply tank as water supply means 140, a hot-water storage tank as hot-water supply means 150, and an air-cooled hermetic cooling tower as external heat radiation device 160. These devices, intercooler 120 of refrigeration apparatus 100, gas cooler 130, and auxiliary gas cooler 131 are connected with one another through water pipe 200 through which water flows.

[0022] Water pipe 200 includes: first water pipe 201 connecting water supply means 140 and gas cooler 130 together through auxiliary gas cooler 131; second water pipe 202 connecting gas cooler 130 and hot-water supply means 150 together; third water supply pipe 203 branching off from first water pipe 201 and connected to intercooler 120; fourth water pipe 204 connecting intercooler 120 and external heat radiation device 160 together; fifth water pipe 205 connecting external heat radiation device 160 and water supply means 140 together; sixth water pipe 206 branching off from second water pipe 202 and joining with fourth water pipe 204; and seventh water pipe 207 branching off between auxiliary gas cooler 131 and gas cooler 130 and joining with fourth water pipe 204.

[0023] Intercooler 120 and auxiliary gas cooler 131 are connected in parallel by first water pipe 201 and third water pipe 203. Further, auxiliary gas cooler 131 and gas cooler 130 are connected in series by first water pipe 201.

[0024] First water pipe 201 is provided with a water supply pump as water conveyance mechanism 210.

[0025] Fourth water pipe 204 is provided with a plug heater as anti-freezing heater 220.

[0026] First flow-control mechanism 230 is provided at a branching section where second water pipe 202 branches off to sixth water pipe 206.

[0027] Second flow-control mechanism 231 is provided at a branching section where first water pipe 201 branches off to third water pipe 203.

[0028] Third flow-control mechanism 232 is provided at a branching section where first water pipe 201 branches off to seventh water pipe 207.

[0029] Note that, in the present embodiment, three-way flow control valves are used as first flow-control mechanism 230, second flow-control mechanism 231, and third flow-control mechanism 232.

[0030] On the pipe surface of first water pipe 201, inflow-water temperature sensor 240 is provided for detecting the temperature of water to be flowing into intercooler 120 and auxiliary gas cooler 131.

[0031] On the pipe surface of intermediate-pressure suction pipe 191, intercooler-outlet refrigerant temperature sensor 241 is provided for detecting the temperature of a refrigerant that has passed through intercooler 120.

[0032] On the pipe surface of outlet pipe 195, auxiliary-gas-cooler-outlet refrigerant temperature sensor 242 is provided for detecting the temperature of a refrigerant that has passed through auxiliary gas cooler 131.

[0033] On the pipe surface of fifth water pipe 205, external-heat-radiation-device-outlet water temperature sensor 243 is provided for detecting the temperature of water that has passed through external heat radiation device 160.

[0034] On the pipe surface of second water pipe 202, hot-water temperature sensor 244 is provided for detecting the temperature of hot-water to be supplied.

[0035] Further, refrigeration apparatus 100 includes controller 250 (not illustrated) that overseas and controls each component.

[0036] Controller 250 performs the following operations as illustrated in FIG. 2: driving control of compressor 180; operation switching of hot-water supply depending on a demand for hot-water supply; anti-freezing control based on a value detected by external-heat-radiation-device-outlet water temperature sensor 243; intercooler water flow control based on values detected by inflow-water temperature sensor 240 and intercooler-outlet refrigerant temperature sensor 241; auxiliary gas cooler water flow control based on a value detected by inflow-water temperature sensor 240 and auxiliary-gas-cooler-outlet refrigerant temperature sensor 242; and hot-water temperature control based on a value detected by hot-water temperature sensor 244.

[1-2. Operation]

[0037] Operation and action of refrigeration apparatus 100 configured as described above is described hereinafter.

[0038] First, operation of a refrigerant is described.

[0039] Operating compressor 180 causes a refrigerant returned from evaporator 171 to be suctioned into low-stage compression mechanism 110 through low-stage suction port 181.

[0040] The refrigerant suctioned into low-stage compression mechanism 110 is compressed to an intermediate pressure and discharged from low-stage discharge port 182.

[0041] The refrigerant discharged from low-stage discharge port 182 flows into intercooler 120 through intermediate-pressure discharge pipe 192.

[0042] The refrigerant that has flowed into intercooler 120 is cooled by being heat-exchanged with water, and is suctioned into high-stage compression mechanism 111 through intermediate-pressure suction pipe 191 and high-stage suction port 183.

[0043] The refrigerant suctioned into high-stage compression mechanism 111 is compressed to a high pressure and discharged from high-stage discharge port 184.

[0044] The refrigerant discharged from high-stage discharge port 184 flows into gas cooler 130 through high-pressure discharge pipe 193.

[0045] The refrigerant that has flowed into gas cooler 130 is heat-exchanged with water and is cooled. Then, the refrigerant flows into auxiliary gas cooler 131 through high-pressure connecting pipe 194. Subsequently, the refrigerant is further cooled by being heat-exchanged with water in auxiliary gas cooler 131.

[0046] The cooled refrigerant is sent to evaporator 171 through expansion mechanism 172, heated by being heat-exchanged with the air in a showcase, for example, and suctioned into low-stage compression mechanism 110 again. Then, these operations of the refrigerant are repeated while compressor 180 is operating.

[0047] Next, operation of water is described.

[0048] Operating water conveyance mechanism 210 causes water supply means 140 to supply water. The water successively passes through first water pipe 201 and water conveyance mechanism 210 and flows into second flow-control mechanism 231.

[0049] The water that has flowed into second flow-control mechanism 231 is distributed, by second flow-control mechanism 231, to a channel flowing into auxiliary gas cooler 131 through first water pipe 201 and a channel flowing into intercooler 120 through third water pipe 203, while the flow rate of the water is adjusted.

[0050] The water that has flowed into auxiliary gas cooler 131 is heated by being heat-exchanged with the refrigerant, and then flows into third flow-control mechanism 232. Then, the water that has flowed into third flow-control mechanism 232 is distributed, by third flow-control mechanism 232, to a channel flowing into gas cooler 130 through first water pipe 201 and a channel passing through seventh water pipe 207, while the flow rate of the water is further adjusted.

[0051] The water that has flowed into gas cooler 130 is further heated by being heat-exchanged with the refrigerant, and then flows into first flow-control mechanism 230 through second water pipe 202. Then, the water that has flowed into first flow-control mechanism 230 is distributed to a channel flowing into hot-water supply means 150 through second water pipe 202 and a channel passing through sixth water pipe 206, while the flow rate of the water is further adjusted.

[0052] The water that has flowed into intercooler 120 is heated by being heat-exchanged with the refrigerant, and then flows into fourth water pipe 204.

[0053] The water that has passed through seventh water pipe 207 and sixth water pipe 206 joins with the water that has passed through fourth water pipe 204, and then flows into external heat radiation device 160.

[0054] The water that has flowed into external heat radiation device 160 is cooled by being heat-exchanged with the outside air, for example, and then flows into water supply means 140. These operations of water are repeated while water conveyance mechanism 210 is operating.

[0055] Next, anti-freezing control is described with reference to FIG. 3.

[0056] Operation of anti-freezing control is started by a control signal inputted by turning on an activation switch (not illustrated) of refrigeration apparatus 100.

[0057] First, controller 250 sets freezing dangerous temperature T0 (ST1). Freezing dangerous temperature T0 is usually set at approximately 3 to 5°C with a margin for the freezing point.

[0058] Then, controller 250 acquires external-heat-radiation-device-outlet water temperature Tout by external-heat-radiation-device-outlet water temperature sensor 243 (ST2).

[0059] Subsequently, controller 250 determines whether external-heat-radiation-device-outlet water temperature Tout is lower than freezing dangerous temperature T0 (ST3).

[0060] When determining that external-heat-radiation-device-outlet water temperature Tout is lower than freezing dangerous temperature T0 (ST3: YES), controller 250 determines whether the output of water conveyance mechanism 210 is maximized (ST4).

[0061] When determining that the output of water conveyance mechanism 210 is maximized (ST4: YES), controller 250 determines whether first flow-control mechanism 230 on the side of hot-water supply means 150 is fully closed (ST5).

[0062] When determining that first flow-control mechanism 230 on the side of hot-water supply means 150 is fully closed (ST5: YES), controller 250 performs control to increase the output of anti-freezing heater 220 (ST6). Then, ST2 to ST7 are repeated while the control signal is inputted (ST7: YES).

[0063] When determining that first flow-control mechanism 230 on the side of hot-water supply means 150 is not fully closed (ST5: NO), controller 250 performs control to reduce the flow rate of first flow-control mechanism 230 on the side of hot-water supply means 150 (ST8). Then, ST2 to ST7 are repeated while the control signal is inputted (ST7: YES).

[0064] When determining that the output of water conveyance mechanism 210 is not maximized (ST4: NO), controller 250 controls water conveyance mechanism 210 to increase the water flow rate (ST9). Then, ST2 to ST7 are repeated while the control signal is inputted (ST7: YES).

[0065] When determining that external-heat-radiation-device-outlet water temperature Tout is higher than freezing dangerous temperature T0 (ST3: NO), controller 250 determines whether there is an output of anti-freezing heater 220 (ST10).

[0066] When determining that there is an output of anti-freezing heater 220 (ST10: YES), controller 250 performs control to reduce the output of anti-freezing heater 220 (ST11). Then, ST2 to ST7 are repeated while the control signal is inputted (ST7: YES).

[0067] When determining that there is no output of anti-freezing heater 220 (ST10: NO), ST2 to ST7 are repeated while the control signal is inputted (ST7: YES).

[0068] Then, the anti-freezing control is ended when the activation switch (not illustrated) of refrigeration apparatus 100 is turned off and no control signal is inputted (ST7: NO).

[0069] Next, intercooler water flow control will be described with reference to FIG. 4.

[0070] Operation of intercooler water flow control is started by a control signal inputted by activating compressor 180.

[0071] First, controller 250 sets upper limit value ΔTic_up and lower limit value ΔTic_low (ST12A).

[0072] Upper limit value ΔTic_up and lower limit value ΔTic_low are herein values for setting the degree to which intercooler-outlet refrigerant temperature Tic is made close to inflow water temperature Tin. Usually, upper limit value ΔTic_up is set to approximately 2 to 6 K, and lower limit value ΔTic_low is set to approximately 0.5 to 4 K. Further, upper limit value ΔTic_up and lower limit value ΔTic_low may be changed depending on inflow water temperature Tin. For example, when inflow water temperature Tin is equal to or higher than 25°C, upper limit value ΔTic_up may be set to 2K, and lower limit value ΔTic_low may be set to 0.5K. When inflow water temperature Tin is equal to or higher than 20°C and lower than 25°C, upper limit value ΔTic_up may be set to 4K, and lower limit value ΔTic_low may be set to 2K. When inflow water temperature Tin is lower than 20°C, upper limit value ΔTic_up may be set to 6K, and lower limit value ΔTic_low may be set to 4K.

[0073] Then, controller 250 acquires inflow water temperature Tin by inflow-water temperature sensor 240 and intercooler-outlet refrigerant temperature Tic by intercooler-outlet refrigerant temperature sensor 241 (ST13).

[0074] Next, controller 250 determines whether intercooler-outlet refrigerant temperature Tic is lower than a value obtained by adding lower limit value ΔTic_low to inflow water temperature Tin (ST14).

[0075] When determining that intercooler-outlet refrigerant temperature Tic is lower than the value obtained by adding lower limit value ΔTic_low to water inflow temperature Tin (ST14: YES), controller 250 controls water conveyance mechanism 210 to reduce the water flow rate (ST15). Then, ST13 to ST16 are repeated while the control signal is inputted (ST16: YES).

[0076] When determining that intercooler-outlet refrigerant temperature Tic is higher than the value obtained by adding lower limit value ΔTlow to inflow water temperature Tin (ST14: NO), controller 250 determines whether intercooler-outlet refrigerant temperature Tic is higher than a value obtained by adding upper limit value ΔTup to inflow water temperature Tin (ST17).

[0077] When determining that intercooler-outlet refrigerant temperature Tic is higher than the value obtained by adding upper limit value ΔTup to inflow water temperature Tin (ST17: YES), controller 250 controls water conveyance mechanism 210 to increase the water flow rate (ST18). Then, ST13 to ST16 are repeated while the control signal is inputted (ST16: YES).

[0078] When determining that intercooler-outlet refrigerant temperature Tic is lower than the value obtained by adding upper limit value ΔTup to inflow water temperature Tin (ST17: NO), ST13 to ST16 are repeated while the control signal is inputted (ST16: YES).

[0079] Then, the intercooler water flow control is ended when compressor 180 is stopped and no control signal is inputted (ST16: NO).

[0080] Next, auxiliary gas cooler water flow control will be described with reference to FIG. 5.

[0081] Operation of auxiliary gas cooler water flow control is started by a control signal inputted by activating compressor 180.

[0082] First, controller 250 sets upper limit value ΔTgc_up and lower limit value ΔTgc low (ST12B).

[0083] Upper limit value ΔTgc_up and lower limit value ΔTgc_low are herein values for setting the degree to which auxiliary-gas-cooler-outlet refrigerant temperature Tgc is made close to inflow water temperature Tin. Note that upper limit value ΔTgc_up is set to the same value as upper limit value ΔTic_up, and lower limit value ΔTgc_low is set to the same value as lower limit value ΔTic_low in the present embodiment, but different values may be set.

[0084] Then, controller 250 acquires inflow water temperature Tin by inflow-water temperature sensor 240 and auxiliary-gas-cooler-outlet refrigerant temperature Tgc by auxiliary-gas-cooler-outlet refrigerant temperature sensor 242 (ST19).

[0085] Subsequently, controller 250 determines whether auxiliary-gas-cooler-outlet refrigerant temperature Tgc is lower than a value obtained by adding lower limit value ΔTgc_low to inflow water temperature Tin (ST20).

[0086] Then, when determining that auxiliary-gas-cooler-outlet refrigerant temperature Tgc is lower than the value obtained by adding lower limit value ΔTgc_low to inflow water temperature Tin (ST20: YES), controller 250 controls second flow-control mechanism 231 to reduce the flow rate on the side of auxiliary gas cooler 131 (ST21). Then, ST19 to ST22 are repeated while the control signal is inputted (ST22: YES).

[0087] When determining that auxiliary-gas-cooler-outlet refrigerant temperature Tgc is higher than the value obtained by adding lower limit value ΔTgc_low to inflow water temperature Tin (ST20: YES), controller 250 determines whether auxiliary-gas-cooler-outlet refrigerant temperature Tgc is higher than a value obtained by adding upper limit value ΔTgc_up to inflow water temperature Tin (ST23).

[0088] Then, when determining that auxiliary-gas-cooler-outlet refrigerant temperature Tgc is higher than the value obtained by adding upper limit value ΔTgc_up to inflow water temperature Tin (ST23: YES), controller 250 controls second flow-control mechanism 231 to increase the flow rate on the side of auxiliary gas cooler 131 (ST24). Then, ST19 to ST22 are repeated while the control signal is inputted (ST22: YES).

[0089] When determining that auxiliary-gas-cooler-outlet refrigerant temperature Tgc is lower than the value obtained by adding upper limit value ΔTgc_up to inflow water temperature Tin (ST23: NO), ST19 to ST22 are repeated while the control signal is inputted (ST22: YES).

[0090] Then, the auxiliary gas cooler water flow control is ended when compressor 180 is stopped and no control signal is inputted (ST22: NO).

[0091] Next, hot-water temperature control will be described with reference to FIG. 6.

[0092] Operation of hot-water temperature control is started by a control signal inputted by turning on a hot-water supply switch (not illustrated).

[0093] First, controller 250 sets hot-water set temperature Tset and difference ΔTdiff (ST25).

[0094] Here, hot-water set temperature Tset is usually set to approximately 40 to 90°C. Difference ΔTdiff is a value set to prevent hot-water supply temperature Tky from being unstable, and is usually set to approximately 1 to 5°C.

[0095] Then, controller 250 acquires hot-water temperature Tky by hot-water temperature sensor 244 (ST26).

[0096] Subsequently, controller 250 determines whether hot-water temperature Tky is lower than a value obtained by subtracting difference ΔTdiff from hot-water set temperature Tset (ST27).

[0097] When determining that hot-water temperature Tky is lower than the value obtained by subtracting difference ΔTdiff from hot-water set temperature Tset (ST27: YES), controller 250 controls third flow-control mechanism 232 to reduce the flow rate on the side of gas cooler 130 (ST28). Then, ST26 to ST29 are repeated while the control signal is inputted (ST29: YES).

[0098] When determining that hot-water temperature Tky is higher than the value obtained by subtracting difference ΔTdiff from hot-water set temperature Tset (ST27: YES), controller 250 determines whether hot-water temperature Tky is higher than a value obtained by adding difference ΔTdiff to hot-water set temperature Tset (ST30).

[0099] Then, when determining that hot-water temperature Tky is higher than the value obtained by adding difference ΔTdiff to hot-water set temperature Tset (ST30: YES), controller 250 controls third flow-control mechanism 232 to increase the flow rate on the side of gas cooler 130 (ST31). Then, ST26 to ST29 are repeated while the control signal is inputted (ST29: YES).

[0100] When determining that hot-water temperature Tky is lower than the value obtained by adding difference ΔTdiff to hot-water set temperature Tset (ST30: NO), ST26 to ST29 are repeated while the control signal is inputted (ST29: YES).

[0101] Then, the hot-water temperature control is ended when the hot-water supply switch (not illustrated) is turned off and no control signal is inputted (ST29: NO).

[1-3. Effects]

[0102] As described above, in the present embodiment, refrigeration apparatus 100 includes first flow-control mechanism 230 for adjusting the flow rate of water flows into hot-water supply means 150 and external heat radiation device 160 after passing through gas cooler 130. In refrigeration apparatus 100, low-stage compression mechanism 110, intercooler 120 for cooling a refrigerant discharged from low-stage compression mechanism 110, high-stage compression mechanism 111 for suctioning the refrigerant that has passed through intercooler 120, and gas cooler 130 for cooling a refrigerant discharged from high-stage compression mechanism 111 are connected to one another by refrigerant pipe 135, and water supply means 140, intercooler 120, gas cooler 130, external heat radiation device 160, hot-water supply means 150, and water conveyance mechanism 210 are connected to one another by water pipe 200.

[0103] This allows water heated by gas cooler 130 to flow into hot-water supply means 150 when hot-water supply is necessary and into external heat radiation device 160 when hot-water supply is unnecessary. Therefore, refrigeration apparatus 100 can switch operation between performing hot-water supply and not performing hot-water supply, and can continue cooling operation of refrigeration apparatus 100 regardless of a demand for hot-water supply.

[0104] As in the present embodiment, water pipe 200 may include: first water pipe 201 connecting water supply means 140 and gas cooler 130 together; second water pipe 202 connecting gas cooler 130 and hot-water supply means 150 together; third water pipe 203 branching off from first water pipe 201 and connected to intercooler 120; fourth water pipe 204 connecting intercooler 120 and external heat radiation device 160 together; fifth water pipe 205 connecting external heat radiation device 160 and water supply means 140 together; and sixth water pipe 206 branching off from second water pipe 202 and joining with fourth water pipe 204.

[0105] This allows the water heated by intercooler 120 to always flow into external heat radiation device 160. Therefore, sensible heat advection and critical velocity for avoiding freezing of external heat radiation device 160 can be ensured at an ambient temperature below the freezing point.

[0106] Further, streaming water into intercooler 120 and gas cooler 130 in parallel can lower the temperatures of the refrigerant that has passed through intercooler 120 and the refrigerant that has passed through gas cooler 130 nearly to the temperature of the water that flows into intercooler 120 and gas cooler 130.

[0107] Further, as in the present embodiment, refrigeration apparatus 100 may include controller 250 controlling refrigeration apparatus 100, and external-heat-radiation-device-outlet water temperature sensor 243 disposed on fifth water pipe 205 and detecting the temperature of water that has passed through external heat radiation device 160. Controller 250 may control water conveyance mechanism 210 based on a value detected by external-heat-radiation-device-outlet water temperature sensor 243.

[0108] This makes it possible, when there is a risk of freezing, to increase the water flow rate so that the temperature of the water that has passed through external heat radiation device 160 does not fall below a predetermined value. Therefore, even when the ambient temperature of external heat radiation device 160 is extremely low, critical velocity for avoiding freezing can be ensured.

[0109] Further, as in the present embodiment, controller 250 may control first flow-control mechanism 230 based on the value detected by external-heat-radiation-device-outlet water temperature sensor 243.

[0110] This makes it possible, when there is a risk of freezing, to stream some or all of the water heated by gas cooler 130 to external heat radiation device 160 so that the temperature of the water that has passed through external heat radiation device 160 does not fall below a predetermined value. Thus, even in a case where freezing is unavoidable only by a forced circulation by water conveyance mechanism 210, sensible heat advection can be obtained to avoid freezing of external heat radiation device 160.

[0111] Further, as in the present embodiment, refrigeration apparatus 100 may include anti-freezing heater 220 provided to fourth water pipe 204, and controller 250 may control anti-freezing heater 220 based on the value detected by external-heat-radiation-device-outlet water temperature sensor 243.

[0112] This makes it possible, when there is a risk of freezing, to heat the water flowing into external heat radiation device 160 so that the temperature of the water that has passed through external heat radiation device 160 does not fall below a predetermined value. Thus, even in a case where heat is not exhausted because the cooling operation of refrigeration apparatus 100 is stopped or a case where the amount of exhaust heat is small even though refrigeration apparatus 100 operates, sensible heat advection for avoiding freezing can be obtained.

[0113] Further, as in the present embodiment, refrigeration apparatus 100 includes: inflow-water temperature sensor 240 disposed on first water pipe 201 and detecting the temperature of the water flowing into intercooler 120 and gas cooler 130; and intercooler-outlet refrigerant temperature sensor 241 detecting the temperature of the refrigerant that has passed through intercooler 120. Controller 250 may control water conveyance mechanism 210 based on values detected by inflow-water temperature sensor 240 and intercooler-outlet refrigerant temperature sensor 241.

[0114] This makes it possible to adjust the difference between temperatures of the water flowing into intercooler 120 and the refrigerant that has passed through intercooler 120. Thus, it is possible to suppress an increase in input energy of water conveyance mechanism 210 caused by unnecessarily increasing the water flow rate, while maintaining a minimum water flow rate that does not cause an increase in the discharge refrigerant temperature of high-stage compressor mechanism 111 due to insufficient cooling of the refrigerant in intercooler 120.

[0115] Further, as in the present embodiment, refrigeration apparatus 100 may include second flow-control mechanism 231 for adjusting the flow rate of water that flows into gas cooler 130 and intercooler 120 after passing through first water pipe 201, and may also include: auxiliary gas cooler 131 disposed between second flow-control mechanism 231 and gas cooler 130 and cooling the refrigerant that has passed through gas cooler 130; and auxiliary-gas-cooler-outlet refrigerant temperature sensor 242 detecting the temperature of the refrigerant that has passed through auxiliary gas cooler 131. Controller 250 may control second flow-control mechanism 231 based on values detected by inflow-water temperature sensor 240 and auxiliary-gas-cooler-outlet refrigerant temperature sensor 242.

[0116] This makes it possible to adjust the difference between temperatures of the water flowing into auxiliary gas cooler 131 and the refrigerant that has passed through auxiliary gas cooler 131. Thus, it is possible to suppress an unnecessary increase in water flow rate and a decrease in the temperature of the water that has passed through auxiliary gas cooler 131, while maintaining a minimum water flow rate that does not cause a decrease in the refrigeration capacity due to insufficient cooling of the refrigerant in auxiliary gas cooler 131. Increasing the temperature of the water that has passed through auxiliary gas cooler 131 can increase the temperature of hot-water.

[0117] Further, as in the present embodiment, refrigeration apparatus 100 includes: seventh water pipe 207 branching off between auxiliary gas cooler 131 and gas cooler 130 and joining with fourth water pipe 204; third flow-control mechanism 232 for adjusting the flow rate of water that flows into gas cooler 130 and seventh water pipe 207 after passing through auxiliary gas cooler 131; and hot-water temperature sensor 244 disposed on second water pipe and detecting the temperature of the hot water to be supplied. Controller 250 may control third flow-control mechanism 232 based on a value detected by hot-water temperature sensor 244.

[0118] This makes it possible to adjust the flow rate of the water flowing into gas cooler 130. Accordingly, the temperature of the water leaving gas cooler 130, that is, the temperature of hot-water can be appropriately adjusted. Further, reducing the flow rate of the water flowing into gas cooler 130 can increase the temperature of the hot-water to be supplied up to the discharge refrigerant temperature of high-stage compression mechanism 111.

[0119] Further, as in the present embodiment, refrigeration apparatus 100 may use carbon dioxide as a refrigerant.

[0120] Thus, the temperature glide increases during the heat radiation process on the high-pressure side, so that the efficiency of heat exchange by the counter flow can be enhanced. Therefore, high-temperature hot-water can be generated more efficiently.

(Other Embodiments)

[0121] As described above, Embodiment 1 has been described as an example of the technique disclosed in the present application. However, the technique in the present disclosure is not limited thereto, and can be applied to the embodiment in which changes, substitutions, additions, omissions, and the like are made. Further, it is also possible to form a new embodiment by combining the components described in Embodiment 1.

[0122] Then, other embodiments are exemplified below.

[0123] In Embodiment 1, a single compressor of compressor 180 having a two-stage compression mechanism of low-stage compression mechanism 110 and high-stage compression mechanism 111 is used, but the same function can be obtained with the configuration in which two compressions are used as a low-stage compression mechanism and a high-stage compression mechanism.

[0124] Further, although a water supply tank has been described as an example of water supply means 140, water supply means 140 may be any means as long as it supplies water to first water pipe 201, and may directly supply water from tap water or a well. Therefore, water supply means 140 is not limited to a water supply tank.

[0125] Further, although a hot-water storage tank has been described as an example of hot-water supply means 150, hot-water supply means 150 may be any means as long as it discharges water from second water pipe 202. Therefore, hot-water supply means 150 is not limited to a hot-water storage tank.

[0126] Further, although an air-cooled hermetic cooling tower has been described as an example of external heat radiation device 160, external heat radiation device 160 may be any means as long as it can cool water heated by the exhaust heat of refrigeration apparatus 100. Therefore, the external heat radiation device 160 is not limited to an air-cooled hermetic cooling tower.

[0127] Further, although a plug heater has been described as an example of anti-freezing heater 220, anti-freezing heater 220 may be any means as long as it heats the water flowing into external heat radiation device 160. Therefore, anti-freezing heater 220 is not limited to a plug heater.

[0128] Further, although three-way flow control valves have been described as examples of first flow-control mechanism 230, second flow-control mechanism 231, and third flow-control mechanism 232, first flow-control mechanism 230, second flow-control mechanism 231, and third flow-control mechanism 232 may be any means as long as they can divert water flowing from a single water pipe into two different directions and can adjust the flow rate. Therefore, first flow-control mechanism 230, second flow-control mechanism 231, and third flow-control mechanism 232 are not limited to three-way flow control valves.

[0129] Furthermore, although carbon dioxide has been described as an example of a refrigerant to be used, the refrigerant to be used may be any medium for transferring heat in a refrigeration cycle. Therefore, the refrigerant to be used is not limited to carbon dioxide.

[0130] Note that, since the above-described embodiments are intended to exemplify the technique in the present disclosure, various changes, substitutions, additions, omissions, and the like can be made within the scope of the claims or their equivalents.

[0131] The disclosures of Japanese Patent Applications No. 2021-163802, filed on October 5, 2021, including the specifications, drawings and abstracts, are incorporated herein by reference in their entireties.

Industrial Applicability

[0132] The present disclosure is applicable to an apparatus that utilizes water heated by exhaust heat of a refrigeration apparatus. Specifically, the present disclosure is applicable to hot-water supply, floor heating, hot-water room heaters, heating dryers, and the like utilizing exhaust heat of a refrigeration apparatus.

Reference Signs List

[0133]

100 Refrigeration apparatus
110 Low-stage compression mechanism
111 High-stage compression mechanism
120 Intercooler
130 Gas cooler
131 Auxiliary gas cooler
135 Refrigerant pipe
140 Water supply means
150 Hot-water supply means
160 External heat radiation device
170 Cooling equipment
171 Evaporator
172 Expansion mechanism
180 Compressor
181 Low-stage suction port
182 Low-stage discharge port
183 High-stage suction port
184 High-stage discharge port
190 Low-pressure suction pipe
191 Intermediate-pressure suction pipe
192 Intermediate-pressure discharge pipe
193 High-pressure discharge pipe
194 High-pressure connecting pipe
195 Outlet pipe
200 Water pipe
201 First water pipe
202 Second water pipe
203 Third water pipe
204 Fourth water pipe
205 Fifth water pipe
206 Sixth water pipe
207 Seventh water pipe
210 Water conveyance mechanism
220 Anti-freezing heater
230 First flow-control mechanism
231 Second flow-control mechanism
232 Third flow-control mechanism
240 Inflow-water temperature sensor
241 Intercooler-outlet refrigerant temperature sensor
242 Auxiliary-gas-cooler-outlet refrigerant temperature sensor
243 External-heat-radiation-device-outlet water temperature sensor
244 Hot-water temperature sensor
250 Controller

Claims

1. A refrigeration apparatus for cooling a refrigerant by heat exchange between the refrigerant and water, the refrigeration apparatus comprising:

a first flow-control mechanism for adjusting a flow rate of water that flows into a hot-water supply means and an external heat radiation device after passing through a gas cooler, wherein
a low-stage compression mechanism, an intercooler for cooling a refrigerant discharged from the low-stage compression mechanism, a high-stage compression mechanism suctioning a refrigerant that has passed through the intercooler, and the gas cooler for cooling a refrigerant discharged from the high-stage compression mechanism are connected to one another by a refrigerant pipe, and
the water supply means, the intercooler, the gas cooler, the external heat radiation device, the hot-water supply means, and a water conveyance mechanism are connected to one another by a water pipe.

2. The refrigeration apparatus according to claim 1, wherein
the water pipe includes:

a first water pipe connecting the water supply means and the gas cooler together;
a second water pipe connecting the gas cooler and the hot-water supply means together;
a third water pipe branching off from the first water pipe and connected to the intercooler;
a fourth water pipe connecting the intercooler and the external heat radiation device together;

a fifth water pipe connecting the external heat radiation device and the water supply means together; and
a sixth water pipe branching off from the second water pipe and joining with the fourth water pipe.

3. The refrigeration apparatus according to claim 2, further comprising:

a controller controlling the refrigeration apparatus; and
an external-heat-radiation-device-outlet water temperature sensor provided to the fifth water pipe and detecting a temperature of water that has passed through the external heat radiation device, wherein
the controller controls the water conveyance mechanism based on a value detected by the external-heat-radiation-device-outlet water temperature sensor.

4. The refrigeration apparatus according to claim 3, wherein
the controller controls the first flow-control mechanism based on the value detected by the external-heat-radiation-device-outlet water temperature sensor.

5. The refrigeration apparatus according to claim 3 or 4, further comprising an anti-freezing heater on or at the fourth water pipe, wherein
the controller controls the anti-freezing heater based on the value detected by the external-heat-radiation-device-outlet water temperature sensor.

6. The refrigeration apparatus according to any one of claims 3 to 5, further comprising:

an inflow-water temperature sensor provided to the first water pipe and detecting a temperature of water flowing into the intercooler and the gas cooler; and
an intercooler-outlet refrigerant temperature sensor detecting a temperature of a refrigerant that has passed through the intercooler, wherein
the controller controls the water conveyance mechanism based on values detected by the inflow-water temperature sensor and the intercooler-outlet refrigerant temperature sensor.

7. The refrigeration apparatus according to any one of claims 3 to 6, further comprising:

a second flow-control mechanism for adjusting a flow rate of water that flows into the gas cooler and the intercooler after passing through the first water pipe;
an auxiliary gas cooler disposed between the second flow-control mechanism and the gas cooler and cooling a refrigerant that has passed through the gas cooler; and
an auxiliary-gas-cooler-outlet refrigerant temperature sensor detecting a temperature of a refrigerant that has passed through the auxiliary gas cooler, wherein
the controller controls the second flow-control mechanism based on values detected by the inflow-water temperature sensor and the auxiliary-gas-cooler-outlet refrigerant temperature sensor.

8. The refrigeration apparatus according to any one of claims 3 to 7, further comprising:

a seventh water pipe branching off between the auxiliary gas cooler and the gas cooler and joining with the fourth water pipe;
a third flow-control mechanism for adjusting a flow rate of water that flows into the gas cooler and the seventh water pipe after passing through the auxiliary gas cooler; and
a hot-water temperature sensor provided to the second water pipe and detecting a temperature of hot water to be supplied, wherein
the controller controls the third flow-control mechanism based on a value detected by the hot-water temperature sensor.

9. The refrigeration apparatus according to any one of claims 1 to 8, wherein
carbon dioxide is used as the refrigerant.

Amended claims under Art. 19.1 PCT

1. (Amended) A refrigeration apparatus for cooling a refrigerant by heat exchange between the refrigerant and water, the refrigeration apparatus comprising:

a first flow-control mechanism for adjusting a flow rate of water that flows into a hot-water supply means and an external heat radiation device after passing through a gas cooler, wherein
a low-stage compression mechanism, an intercooler for cooling a refrigerant discharged from the low-stage compression mechanism, a high-stage compression mechanism suctioning a refrigerant that has passed through the intercooler, and the gas cooler for cooling a refrigerant discharged from the high-stage compression mechanism are connected to one another by a refrigerant pipe, and
the water supply means, the intercooler, the gas cooler, the external heat radiation device, the hot-water supply means, and a water conveyance mechanism are connected to one another

by a water pipe,
the water pipe includes:

a first water pipe connecting the water supply means and the gas cooler together;
a second water pipe connecting the gas cooler and the hot-water supply means together;
a third water pipe branching off from the first water pipe and connected to the intercooler;
a fourth water pipe connecting the intercooler and the external heat radiation device together;
a fifth water pipe connecting the external heat radiation device and the water supply means together; and
a sixth water pipe branching off from the second water pipe and joining with the fourth water pipe.

2. (Cancelled)

3. (Amended) The refrigeration apparatus according to claim 1, further comprising:

a controller controlling the refrigeration apparatus; and
an external-heat-radiation-device-outlet water temperature sensor provided to the fifth water pipe and detecting a temperature of water that has passed through the external heat radiation device, wherein
the controller controls the water conveyance mechanism based on a value detected by the external-heat-radiation-device-outlet water temperature sensor.

4. The refrigeration apparatus according to claim 3, wherein
the controller controls the first flow-control mechanism based on the value detected by the external-heat-radiation-device-outlet water temperature sensor.

5. The refrigeration apparatus according to claim 3 or 4, further comprising an anti-freezing heater on or at the fourth water pipe, wherein
the controller controls the anti-freezing heater based on the value detected by the external-heat-radiation-device-outlet water temperature sensor.

6. The refrigeration apparatus according to any one of claims 3 to 5, further comprising:

an inflow-water temperature sensor provided the first water pipe and detecting a temperature of water flowing into the intercooler and the gas cooler; and
an intercooler-outlet refrigerant temperature sensor detecting a temperature of a refrigerant that has passed through the intercooler, wherein
the controller controls the water conveyance mechanism based on values detected by the inflow-water temperature sensor and the intercooler-outlet refrigerant temperature sensor.

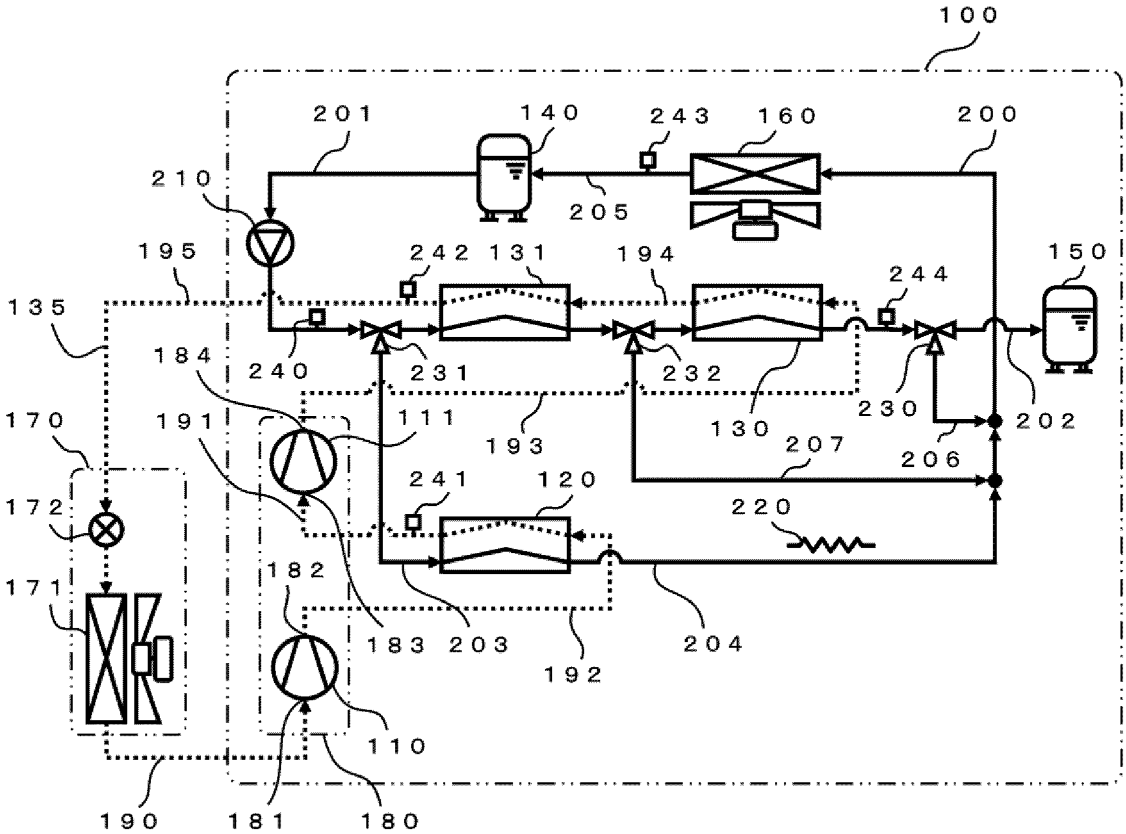
7. The refrigeration apparatus according to any one of claims 3 to 6, further comprising:

a second flow-control mechanism for adjusting a flow rate of water that flows into the gas cooler and the intercooler after passing through the first water pipe;
an auxiliary gas cooler disposed between the second flow-control mechanism and the gas cooler and cooling a refrigerant that has passed through the gas cooler; and
an auxiliary-gas-cooler-outlet refrigerant temperature sensor detecting a temperature of a refrigerant that has passed through the auxiliary gas cooler, wherein
the controller controls the second flow-control mechanism based on values detected by the inflow-water temperature sensor and the auxiliary-gas-cooler-outlet refrigerant temperature sensor.

8. The refrigeration apparatus according to any one of claims 3 to 7, further comprising:

a seventh water pipe branching off between the auxiliary gas cooler and the gas cooler and joining with the fourth water pipe;
a third flow-control mechanism for adjusting a flow rate of water that flows into the gas cooler and the seventh water pipe after passing through the auxiliary gas cooler; and
a hot-water temperature sensor provided to the second water pipe and detecting a temperature of hot water to be supplied, wherein
the controller controls the third flow-control mechanism based on a value detected by the hot-water temperature sensor.

9. (Amended) The refrigeration apparatus according to any one of claims 1 and 3 to 8, wherein
carbon dioxide is used as the refrigerant.


100
201
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242 131
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FIG. 1

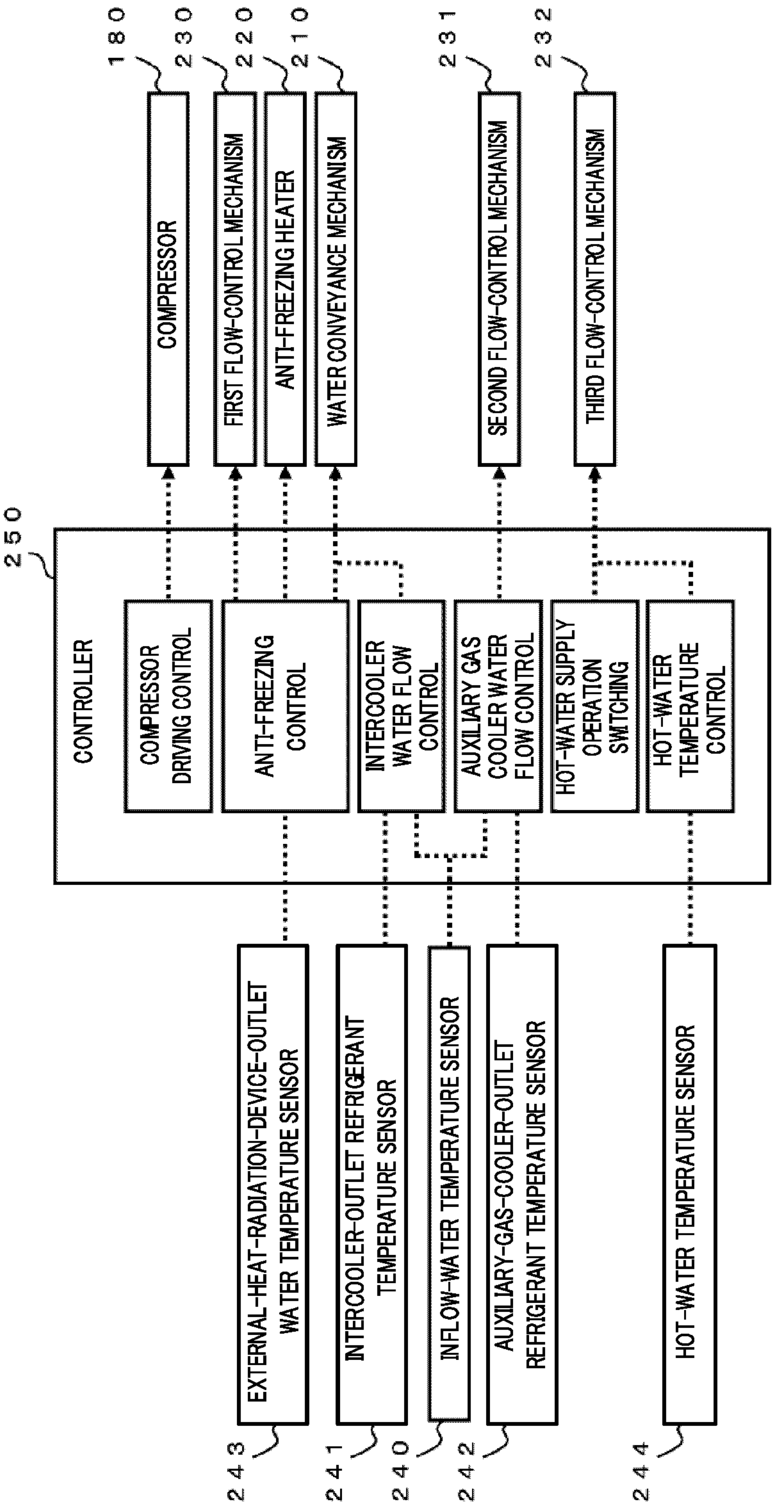
180
230
220
210
231
232
250
CONTROLLER
COMPRESSOR DRIVING CONTROL
ANTI-FREEZING CONTROL
INTERCOOLER WATER FLOW CONTROL
AUXILIARY GAS COOLER WATER FLOW CONTROL
HOT-WATER SUPPLY OPERATION SWITCHING
HOT-WATER TEMPERATURE CONTROL
COMPRESSOR
FIRST FLOW-CONTROL MECHANISM
ANTI-FREEZING HEATER
WATER CONVEYANCE MECHANISM
SECOND FLOW-CONTROL MECHANISM
THIRD FLOW-CONTROL MECHANISM
EXTERNAL-HEAT-RADIATION-DEVICE-OUTLET WATER TEMPERATURE SENSOR
INTERCOOLER-OUTLET REFRIGERANT TEMPERATURE SENSOR
INFLOW-WATER TEMPERATURE SENSOR
AUXILIARY-GAS-COOLER-OUTLET REFRIGERANT TEMPERATURE SENSOR
HOT-WATER TEMPERATURE SENSOR
243
241
240
242
244

FIG. 2

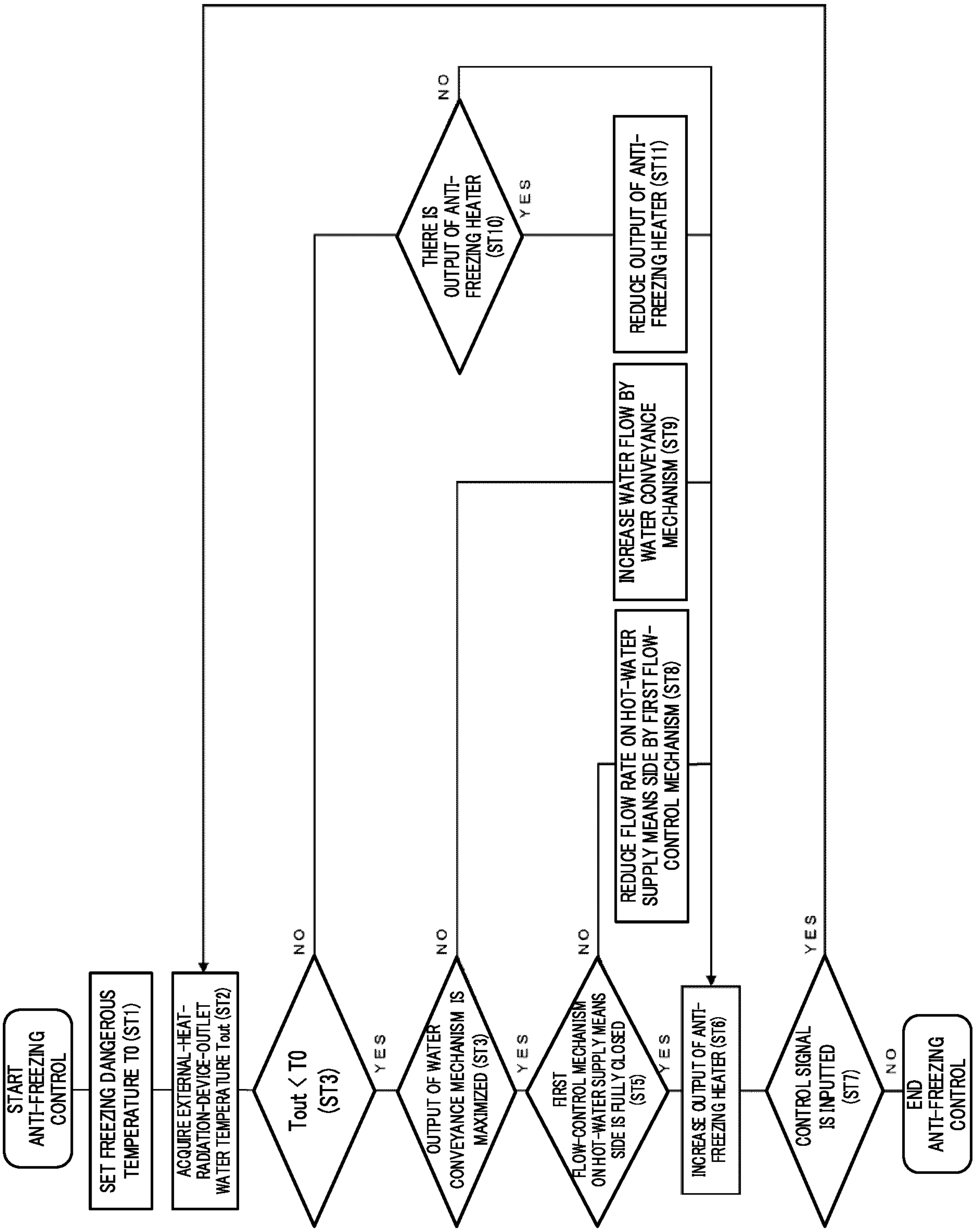
START ANTI-FREEZING CONTROL
SET FREEZING DANGEROUS TEMPERATURE T0 (ST1)
ACQUIRE EXTERNAL-HEAT-RADIATION-DEVICE-OUTLET WATER TEMPERATURE Tout (ST2)
Tout < T0 (ST3)
YES
NO
OUTPUT OF WATER CONVEYANCE MECHANISM IS MAXIMIZED (ST3)
YES
NO
FIRST FLOW-CONTROL MECHANISM ON HOT-WATER SUPPLY MEANS SIDE IS FULLY CLOSED (ST5)
YES
NO
INCREASE OUTPUT OF ANTI-FREEZING HEATER (ST6)
CONTROL SIGNAL IS INPUTTED (ST7)
YES
NO
END ANTI-FREEZING CONTROL
REDUCE FLOW RATE ON HOT-WATER SUPPLY MEANS SIDE BY FIRST FLOW-CONTROL MECHANISM (ST8)
INCREASE WATER FLOW BY WATER CONVEYANCE MECHANISM (ST9)
THERE IS OUTPUT OF ANTI-FREEZING HEATER (ST10)
YES
NO
REDUCE OUTPUT OF ANTI-FREEZING HEATER (ST11)

FIG. 3

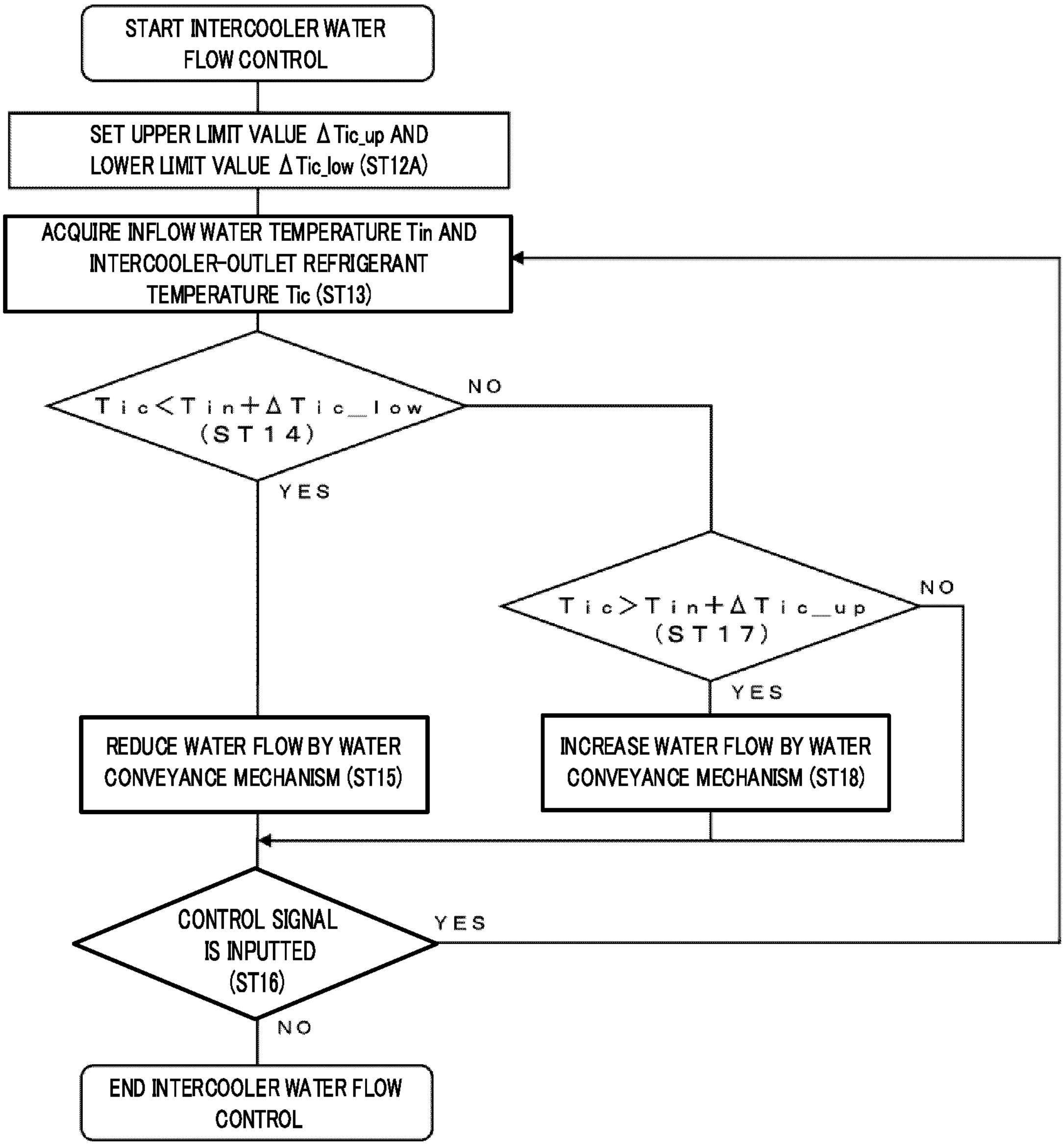
START INTERCOOLER WATER FLOW CONTROL
SET UPPER LIMIT VALUE ΔTic_up AND LOWER LIMIT VALUE ΔTic_low (ST12A)
ACQUIRE INFLOW WATER TEMPERATURE Tin AND INTERCOOLER-OUTLET REFRIGERANT TEMPERATURE Tic (ST13)
Tic<Tin+ΔTic_low (ST14)
NO
YES
Tic>Tin+ΔTic_up (ST17)
NO
YES
REDUCE WATER FLOW BY WATER CONVEYANCE MECHANISM (ST15)
INCREASE WATER FLOW BY WATER CONVEYANCE MECHANISM (ST18)
CONTROL SIGNAL IS INPUTTED (ST16)
YES
NO
END INTERCOOLER WATER FLOW CONTROL

FIG. 4

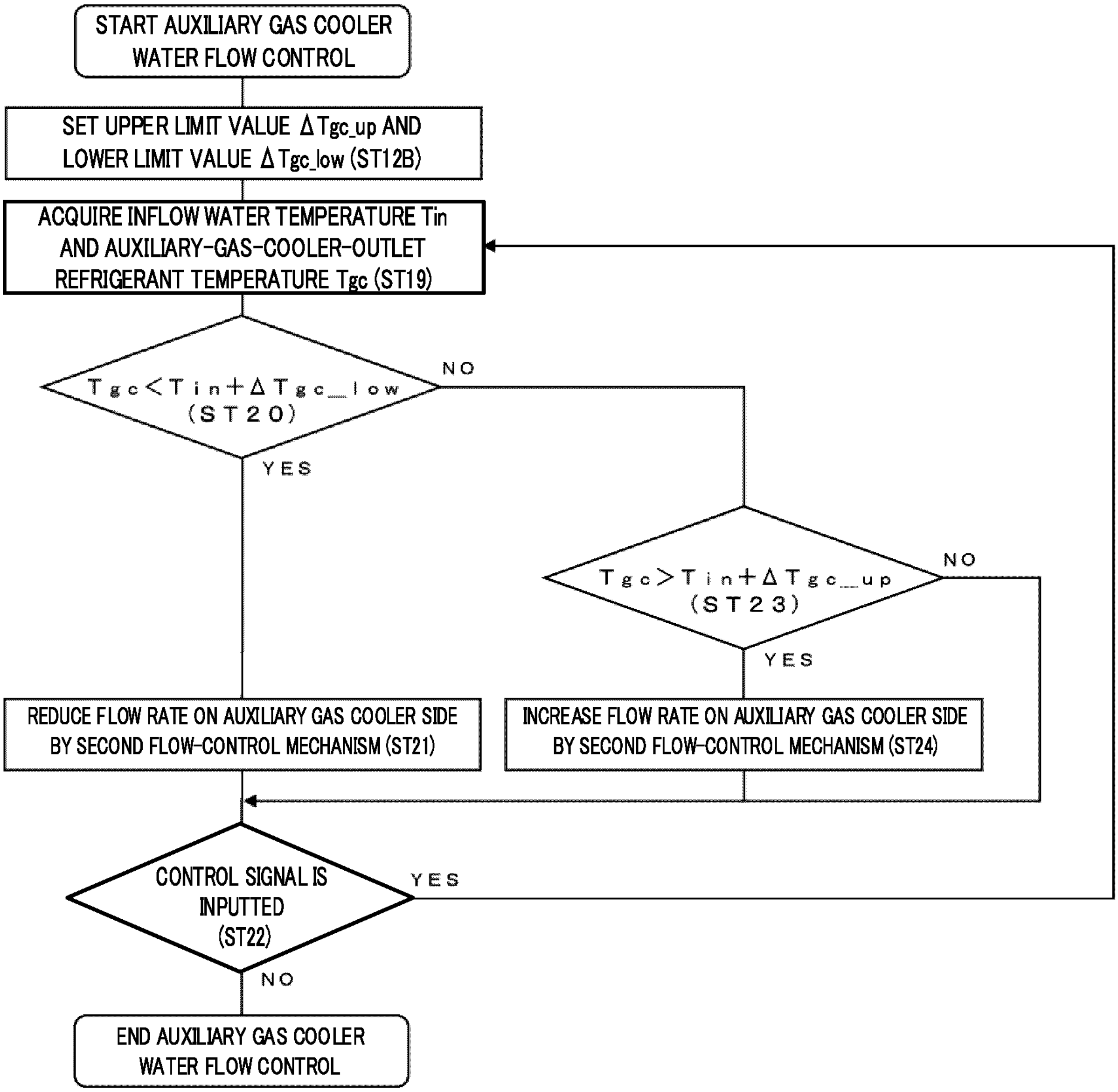
START AUXILIARY GAS COOLER WATER FLOW CONTROL
SET UPPER LIMIT VALUE ΔTgc_up AND LOWER LIMIT VALUE ΔTgc_low (ST12B)
ACQUIRE INFLOW WATER TEMPERATURE Tin AND AUXILIARY-GAS-COOLER-OUTLET REFRIGERANT TEMPERATURE Tgc (ST19)
Tgc<Tin+ΔTgc_low (ST20)
NO
YES
Tgc>Tin+ΔTgc_up (ST23)
NO
YES
REDUCE FLOW RATE ON AUXILIARY GAS COOLER SIDE BY SECOND FLOW-CONTROL MECHANISM (ST21)
INCREASE FLOW RATE ON AUXILIARY GAS COOLER SIDE BY SECOND FLOW-CONTROL MECHANISM (ST24)
CONTROL SIGNAL IS INPUTTED (ST22)
YES
NO
END AUXILIARY GAS COOLER WATER FLOW CONTROL

FIG. 5

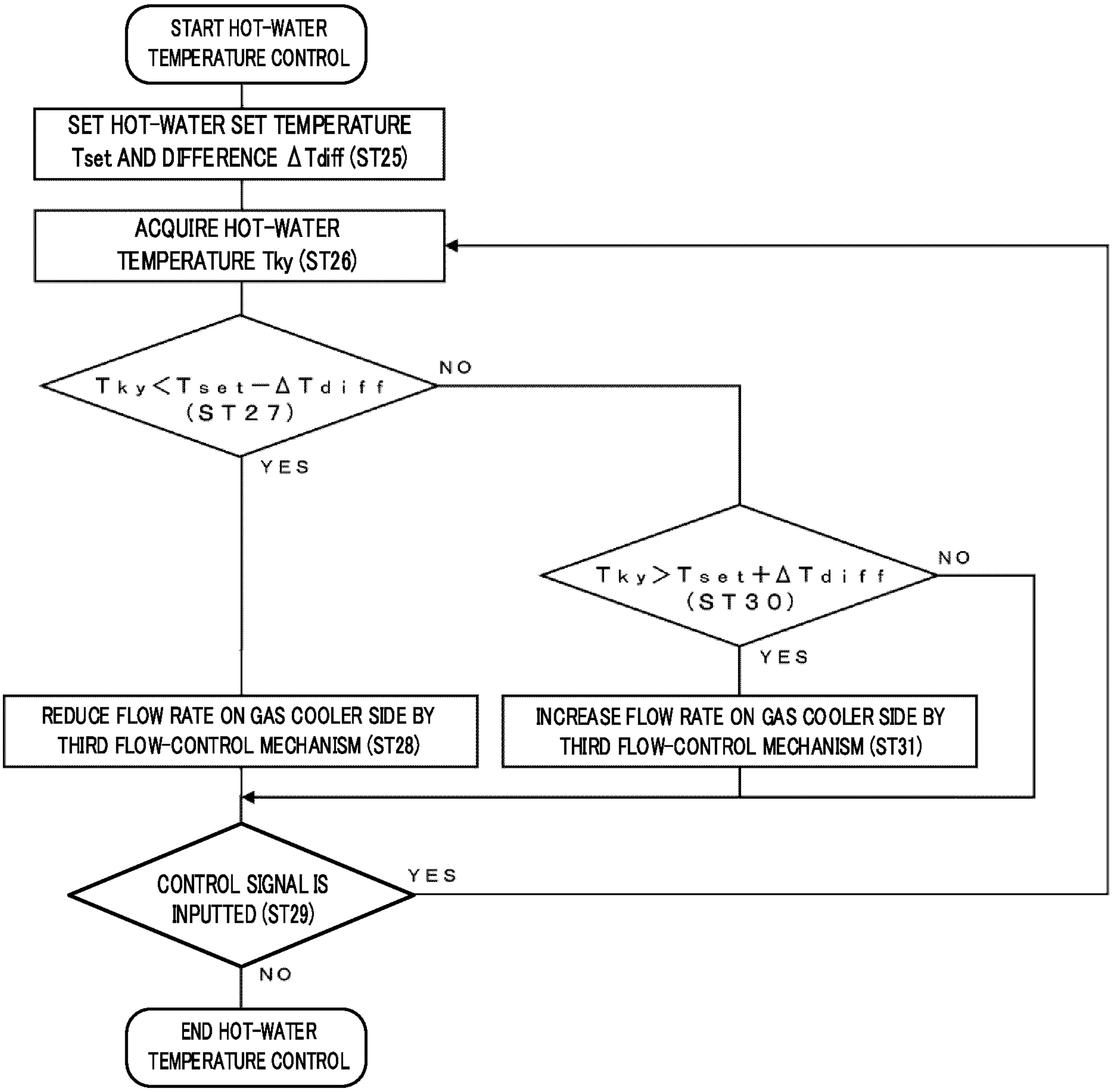
START HOT-WATER TEMPERATURE CONTROL
SET HOT-WATER SET TEMPERATURE Tset AND DIFFERENCE ΔTdiff (ST25)
ACQUIRE HOT-WATER TEMPERATURE Tky (ST26)
Tky<Tset−ΔTdiff (ST27)
NO
YES
Tky>Tset+ΔTdiff (ST30)
NO
YES
REDUCE FLOW RATE ON GAS COOLER SIDE BY THIRD FLOW-CONTROL MECHANISM (ST28)
INCREASE FLOW RATE ON GAS COOLER SIDE BY THIRD FLOW-CONTROL MECHANISM (ST31)
CONTROL SIGNAL IS INPUTTED (ST29)
YES
NO
END HOT-WATER TEMPERATURE CONTROL

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/033074

A. CLASSIFICATION OF SUBJECT MATTER

F25B 29/00(2006.01)i; ***F25B 1/00***(2006.01)i; ***F25B 1/10***(2006.01)i
FI: F25B29/00 371Z; F25B1/00 399Y; F25B1/00 396D; F25B1/10 Z; F25B1/00 101J

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; F25B1/00

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 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

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.
X	JP 2021-134954 A (PANASONIC IP MANAGEMENT CORP.) 13 September 2021 (2021-09-13) paragraphs [0015], [0038]-[0039], fig. 1	1-2, 9
Y	paragraphs [0015], [0038]-[0039], fig. 1	3-5
Y	WO 2017/221383 A1 (MITSUBISHI ELECTRIC CORP.) 28 December 2017 (2017-12-28) paragraphs [0021], [0023]	3-5
Y	WO 2011/089637 A1 (MITSUBISHI ELECTRIC CORP.) 28 July 2011 (2011-07-28) paragraph [0070]	5
A	US 2011/0289950 A1 (KIM, Byungsoon) 01 December 2011 (2011-12-01) entire text, all drawings	1-9

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 October 2022	**08 November 2022**

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

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/033074

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2021-134954 A	13 September 2021	EP 3872413 A1 paragraphs [0021], [0077]-[0080], fig. 1	
WO 2017/221383 A1	28 December 2017	EP 3477221 A1 paragraphs [0035], [0037]	
WO 2011/089637 A1	28 July 2011	EP 2527751 A1 paragraph [0071]	
US 2011/0289950 A1	01 December 2011	EP 2390588 A2 entire text, all drawings KR 10-2011-0130813 A CN 102261766 A	

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 4947197 B **[0003]**
- JP 2021163802 A **[0131]**