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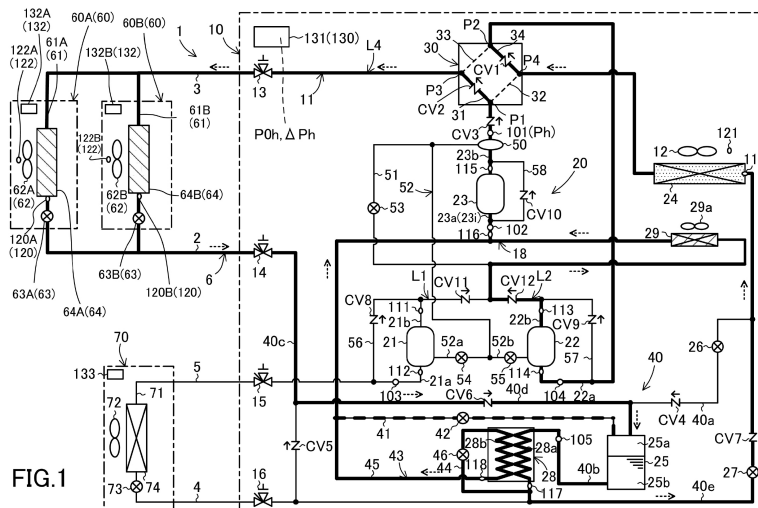
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(54) AIR-CONDITIONING DEVICE

(57) An air conditioner (1) includes a refrigerant circuit (6) and a control device (130). The refrigerant circuit (6) includes a compressor (23), a radiator (64), an expansion valve (63), and an evaporator (24), and performs a refrigeration cycle for executing a heating operation to heat an indoor space by compressing a refrigerant to a critical pressure (P_c) or more. The control device (130)

controls the refrigerant circuit (6). The control device (130) controls the expansion valve (63) to adjust a refrigerant temperature (TE) at an outlet (E) of the radiator (64), and controls a high pressure (Ph) of the refrigerant circuit (6) based on a temperature difference (ΔTR) between an indoor temperature (TR) and a target indoor temperature (TRO).



Description

TECHNICAL FIELD

[0001] The present disclosure relates to an air conditioner.

BACKGROUND ART

[0002] Various techniques related to air conditioners are disclosed as shown in Patent Literature 1, for example. The air conditioner disclosed in Patent Literature 1 includes a refrigerant circuit. The refrigerant circuit includes a compressor, a radiator, an expansion valve, and an evaporator, and performs a refrigeration cycle for executing a heating operation to heat an indoor space.

CITATION LIST

PATENT LITERATURE

[0003] Patent Literature 1: Japanese Unexamined Patent Publication No. 2021-055874

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0004] In a case where the heating operation is performed by using a refrigerant having a low critical pressure, the refrigerant is compressed to a critical pressure or more. When the refrigerant is compressed to the critical pressure or more, a condensation temperature of the refrigerant does not exist in an area of the critical pressure or more, and thus it is difficult to control the temperature of the refrigerant. Therefore, in a supercritical operation in which the refrigerant is compressed to the critical pressure or more, it is difficult to adjust an indoor temperature, and it is difficult to adjust a temperature difference between the indoor temperature and a target indoor temperature.

[0005] An object of the present disclosure is to adjust, in the air conditioner, a temperature difference between an indoor temperature and a target indoor temperature during a heating operation to heat an indoor space by compressing a refrigerant to a critical pressure or more.

SOLUTION TO THE PROBLEM

[0006] A first aspect of the present disclosure is directed to an air conditioner (1). The air conditioner (1) includes a refrigerant circuit (6) including a compressor (23), a radiator (64), an expansion valve (63), and an evaporator (24), and configured to perform a refrigeration cycle for executing a heating operation to heat an indoor space by compressing a refrigerant to a critical pressure (P_c) or more, and a control device (130) configured to control the refrigerant circuit (6), in which the control

device (130) controls the expansion valve (63) to adjust a refrigerant temperature (T_E) at an outlet (E) of the radiator (64), and controls a high pressure (P_h) of the refrigerant circuit (6) based on a temperature difference (ΔTR) between an indoor temperature (TR) and a target indoor temperature (TRO).

[0007] In the first aspect, in the air conditioner (1), the temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO) can be adjusted during the heating operation to heat the indoor space by compressing the refrigerant to the critical pressure (P_c) or more.

[0008] In a second aspect of the present disclosure, in the first aspect, the control device (130) controls the compressor (23) to increase the high pressure (P_h) of the refrigerant circuit (6) when the temperature difference (ΔTR) is larger than a first value.

[0009] In the second aspect, when the temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO) is larger than the first value, the indoor temperature (TR) can be increased by increasing the high pressure (P_h) of the refrigerant circuit (6). The temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO) can be decreased.

[0010] In a third aspect of the present disclosure, in the first or second aspect, the control device (130) controls the compressor (23) to decrease the high pressure (P_h) of the refrigerant circuit (6) when the temperature difference (ΔTR) is less than a second value.

[0011] In the third aspect, in a case where the temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO) is less than the second value, a load on the compressor (23) can be reduced by decreasing the high pressure (P_h) of the refrigerant circuit (6).

[0012] In a fourth aspect of the present disclosure, in any one of the first to third aspects, the control device (130) controls the compressor (23) to set the high pressure (P_h) of the refrigerant circuit (6) to a lower limit value (P_{h1}) of a control range when the temperature difference (ΔTR) is less than a third value.

[0013] In the fourth aspect, in a case where the temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO) is less than the third value, setting the high pressure (P_h) of the refrigerant circuit (6) to the lower limit value (P_{h1}) is advantageous in reducing the load on the compressor (23).

[0014] In a fifth aspect of the present disclosure, in any one of the first to fourth aspects, the refrigerant circuit (6) includes a gas-liquid separator (25) connected to a downstream side of the radiator (64) and configured to separate the refrigerant into a gas refrigerant and a liquid refrigerant, a venting passage (41) that connects a gas reservoir (25a) of the gas-liquid separator (25) with a suction side (23i) of the compressor (23), and an on-off valve (42) provided in the venting passage (41), and the

control device (130) opens the on-off valve (42) when the temperature difference (ΔTR) is larger than a fourth value.

[0015] In the fifth aspect, in a case where the temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO) is larger than the fourth value, the indoor temperature (TR) can be further increased by promoting the flow of the refrigerant from the gas reservoir (25a) of the gas-liquid separator (25) to the suction side (23i) of the compressor (23). This is advantageous in decreasing the temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO).

[0016] In a sixth aspect of the present disclosure, in any one of the first to fifth aspects, the refrigerant circuit (6) includes a gas-liquid separator (25) connected to a downstream side of the radiator (64) and configured to separate the refrigerant into a gas refrigerant and a liquid refrigerant, and a specific enthalpy (h_e) of the refrigerant at the outlet (E) of the radiator (64) is smaller than a specific enthalpy (h_c) of the refrigerant at a critical point (C).

[0017] In the sixth aspect, by increasing the amount of the liquid refrigerant flowing into the gas-liquid separator (25), a gas-liquid separation effect by the gas-liquid separator (25) can be increased.

[0018] In a seventh aspect of the present disclosure, in any one of the first to six aspects, the radiator (64) includes a first radiator (64A) and a second radiator (64B) that are connected in parallel to each other, and the expansion valve (63) includes a first expansion valve (63A) associated with the first radiator (64A) and a second expansion valve (63B) associated with the second radiator (64B), and the control device (130) controls the high pressure (P_h) of the refrigerant circuit (6) based on one or both of a first temperature difference (ΔTRA) that is a temperature difference between an indoor temperature (TRA) and a target indoor temperature (TROA) associated with the first radiator (64A) and a second temperature difference (ΔTRB) that is a temperature difference between an indoor temperature (TRB) and a target indoor temperature (TROB) associated with the second radiator (64B).

[0019] In the seventh aspect, even in a case where there are two or more radiators (64), the temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO) can be adjusted during the heating operation to heat the indoor space by compressing the refrigerant to the critical pressure (P_c) or more.

[0020] In an eighth aspect of the present disclosure, in the seventh aspect, the control device (130) controls the high pressure (P_h) of the refrigerant circuit (6) based on a larger one of the first temperature difference (ΔTRA) or the second temperature difference (ΔTRB).

[0021] In the eighth aspect, employment of either the first temperature difference (ΔTRA) or the second temperature difference (ΔTRB) having a worse condition (a

larger temperature difference) is advantageous in decreasing the temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO).

[0022] In a ninth aspect of the present disclosure, in any one of the first to eighth aspects, the refrigerant is carbon dioxide.

[0023] In the ninth aspect, employment of carbon dioxide as the refrigerant is advantageous in terms of protection of the environment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024]

FIG. 1 is a piping system diagram of an air conditioner (1) according to an embodiment.

FIG. 2 is a piping system diagram of the vicinity of an air conditioning unit (60).

FIG. 3 is a block diagram showing the connection relationship between a controller (130) and peripheral devices.

FIG. 4 is a graph showing the relationship between a specific enthalpy (h) and a pressure (P) of a refrigerant.

FIG. 5 is a control flowchart of the air conditioner (1) during a heating operation.

DESCRIPTION OF EMBODIMENTS

[0025] Embodiments of the present disclosure will be described in detail below with reference to the drawings. The present disclosure is not limited to the embodiments below, and various changes can be made within the scope without departing from the technical concept of the present disclosure. Since each of the drawings is intended to illustrate the present disclosure conceptually, dimensions, ratios, or numbers may be exaggerated or simplified as necessary for ease of understanding.

[0026] An air conditioner (1) according to the present embodiment performs a refrigeration cycle. The air conditioner (1) is also referred to as a refrigeration apparatus. The air conditioner (1) performs air conditioning of indoor space. The air conditioner (1) cools a target. The target referred to herein includes air present in facilities such as a refrigerator, a freezer, and a show case. Hereinafter, such facilities are each referred to as a refrigeration facility.

(1) General Configuration

[0027] FIG. 1 is a piping system diagram of the air conditioner (1). As shown in FIG. 1, the air conditioner (1) includes a heat source unit (10) placed outside, an air conditioning unit (60) that performs air conditioning of an indoor space, and a refrigeration facility unit (70) that cools inside air. The air conditioning unit (60) includes the first air conditioning unit (60A) and the second air con-

ditioning unit (60B) connected in parallel with each other.

[0028] The air conditioner (1) includes four connection pipes (2, 3, 4, 5) connecting the heat source unit (10), the air conditioning unit (60), and the refrigeration facility unit (70). In the air conditioner (1), the heat source unit (10), the air conditioning unit (60), and the refrigeration facility unit (70) are connected with each other by the connection pipes (2, 3, 4, 5) in order to form a refrigerant circuit (6). In other words, the air conditioner (1) has the refrigerant circuit (6).

[0029] The refrigerant circuit (6) is filled with a refrigerant. The refrigerant circuit (6) circulates the refrigerant to perform a refrigeration cycle. The refrigerant of this embodiment is carbon dioxide. The refrigerant circuit (6) performs a refrigeration cycle in which the refrigerant is compressed to a critical pressure or more.

(1-1) Connection Pipes

[0030] The four connection pipes (2, 3, 4, 5) consist of a first liquid connection pipe (2), a first gas connection pipe (3), a second liquid connection pipe (4), and a second gas connection pipe (5). The first liquid connection pipe (2) and the first gas connection pipe (3) are associated with the air conditioning unit (60). The second liquid connection pipe (4) and the second gas connection pipe (5) are associated with the refrigeration facility unit (70).

(2) Heat Source Unit

[0031] The heat source unit (10) includes a heat source circuit (11) and an outdoor fan (12). The heat source circuit (11) includes a compression element (20), an outdoor heat exchanger (24), and a gas-liquid separator (25). The heat source circuit (11) includes a first outdoor expansion valve (26) and a second outdoor expansion valve (27). The heat source circuit (11) further includes a subcooling heat exchanger (28) and an intercooler (29).

[0032] The heat source circuit (11) includes four shut-off valves (13, 14, 15, 16). The four shut-off valves (13, 14, 15, 16) consist of a first gas shut-off valve (13), a first liquid shut-off valve (14), a second gas shut-off valve (15), and a second liquid shut-off valve (16).

[0033] The first gas shut-off valve (13) is connected with the first gas connection pipe (3). The first liquid shut-off valve (14) is connected with the first liquid connection pipe (2). The second gas shut-off valve (15) is connected with the second gas connection pipe (5). The second liquid shut-off valve (16) is connected with the second liquid connection pipe (4).

[0034] The heat source unit (10) includes a flow path switching mechanism (30). The piping system diagram of the refrigerant circuit (6) in FIG. 1 and the other drawings omits the detail of the flow path switching mechanism (30). The flow path switching mechanism (30) switches the flow path of a refrigerant in the refrigerant circuit (6).

(2-1) Compression Element

[0035] The compression element (20) compresses the refrigerant. The compression element (20) includes a first compressor (21), a second compressor (22), and a third compressor (23). The compression element (20) performs an operation for compressing the refrigerant in a single stage, and an operation for compressing the refrigerant in two stages. The third compressor (23) is an example of the compressor of this example.

[0036] The first compressor (21) is a refrigeration facility compressor associated with the refrigeration facility unit (70). The second compressor (22) is an air conditioning compressor associated with the air conditioning unit (60). The first compressor (21) and the second compressor (22) are low-stage compression parts. The first compressor (21) and the second compressor (22) are connected in parallel.

[0037] The third compressor (23) is a high-stage compression part. The third compressor (23) is connected in series with the first compressor (21) or connected in series with the second compressor (22).

[0038] The first compressor (21), the second compressor (22), and the third compressor (23) are rotary compressors, each having a compression mechanism driven by a motor. The first compressor (21), the second compressor (22), and the third compressor (23) are variable displacement compressors. The number of rotations of each motor of the first compressor (21), the second compressor (22), and the third compressor (23) is adjusted by an inverter device. In other words, the operating capacities of the first compressor (21), the second compressor (22), and the third compressor (23) are adjustable.

[0039] The suction portion of the first compressor (21) is connected with a first suction pipe (21a). The discharge portion of the first compressor (21) is connected with a first discharge pipe (21b). The suction portion of the second compressor (22) is connected with a second suction pipe (22a). The discharge portion of the second compressor (22) is connected with a second discharge pipe (22b). The suction portion of the third compressor (23) is connected with a third suction pipe (23a). The discharge portion of the third compressor (23) is connected with a third discharge pipe (23b).

(2-2) Intermediate Flow Path

[0040] The heat source circuit (11) includes an intermediate flow path (18). The intermediate flow path (18) connects each discharge portion of the first compressor (21) and the second compressor (22) with the suction portion of the third compressor (23). The intermediate flow path (18) includes the first discharge pipe (21b), the second discharge pipe (22b), and the third suction pipe (23a).

(2-3) Outdoor Heat Exchanger and Outdoor Fan

[0041] The outdoor heat exchanger (24) is an example of an evaporator. The outdoor heat exchanger (24) is a fin-and-tube air heat exchanger. The outdoor fan (12) is disposed near the outdoor heat exchanger (24). The outdoor fan (12) transfers outdoor air. The outdoor heat exchanger exchanges heat between the refrigerant flowing therein and the outdoor air transferred by the outdoor fan (12).

(2-4) Liquid-Side Flow Path

[0042] The heat source circuit (11) includes a liquid-side flow path (40). The liquid-side flow path (40) is provided between the liquid end of the outdoor heat exchanger (24) and the two liquid shut-off valves (14, 16). The liquid-side flow path (40) includes first to fifth pipes (40a, 40b, 40c, 40d, 40e).

[0043] One end of the first pipe (40a) is connected to the liquid end of the outdoor heat exchanger (24). The other end of the first pipe (40a) is connected to the top portion of the gas-liquid separator (25). One end of the second pipe (40b) is connected to the bottom portion of the gas-liquid separator (25). The other end of the second pipe (40b) is connected to the second liquid shut-off valve (16). One end of the third pipe (40c) is connected to the intermediate portion of the second pipe (40b). The other end of the third pipe (40c) is connected to the first liquid shut-off valve (14). One end of the fourth pipe (40d) is connected to part of the first pipe (40a) between the first outdoor expansion valve (26) and the gas-liquid separator (25). The other end of the fourth pipe (40d) is connected to the intermediate portion of the third pipe (40c). One end of the fifth pipe (40e) is connected to part of the first pipe (40a) between the outdoor heat exchanger (24) and the first outdoor expansion valve (26). The other end of the fifth pipe (40e) is connected to part of the second pipe (40b) between the gas-liquid separator (25) and the junction with the third pipe (40c).

(2-5) Outdoor Expansion Valves

[0044] The first outdoor expansion valve (26) is provided in the first pipe (40a). The first outdoor expansion valve (26) is provided in part of the first pipe (40a) between the liquid end of the outdoor heat exchanger (24) and the junction with the fourth pipe (40d). The second outdoor expansion valve (27) is provided in the fifth pipe (40e). The opening degrees of the first outdoor expansion valve (26) and the second outdoor expansion valve (27) are adjustable. The first outdoor expansion valve (26) and the second outdoor expansion valve (27) are electronic expansion valves, the opening degrees of which are adjusted based on pulse signals.

(2-6) Gas-Liquid Separator

[0045] The gas-liquid separator (25) is a closed container that stores a refrigerant. The gas-liquid separator (25) separates the refrigerant into a gas refrigerant and a liquid refrigerant. A gas reservoir (25a) and a liquid reservoir (25b) are formed in the gas-liquid separator (25). The gas reservoir (25a) is formed near the top portion of the gas-liquid separator (25). The liquid reservoir (25b) is formed near the bottom portion of the gas-liquid separator (25).

(2-7) Venting Pipe

[0046] The heat source circuit (11) includes a venting pipe (41) as a venting passage. One end of the venting pipe (41) is connected to the gas reservoir (25a) in the top portion of the gas-liquid separator (25). The other end of the venting pipe (41) is connected to the intermediate flow path (18). The venting pipe (41) sends the gas refrigerant in the gas-liquid separator (25) to the intermediate flow path (18). The venting pipe (41) is an example of the venting passage that allows the gas reservoir (25a) of the gas-liquid separator (25) to communicate with a suction side (23i) of the third compressor (23) as the high-stage compression part.

[0047] The venting pipe (41) is provided with a venting valve (42) as an on-off valve. The venting valve (42) is an expansion valve of which the opening degree is adjustable. The venting valve (42) is an electronic expansion valve of which the opening degree is adjusted based on pulse signals. The venting valve (42) may be an electric valve, an electromagnetic on-off valve, or the like. The venting valve (42) is an example of the on-off valve provided in the venting pipe (41) as the venting passage.

(2-8) Subcooling Heat Exchanger

[0048] The subcooling heat exchanger (28) includes a first flow path (28a) as a high-pressure flow path and a second flow path (28b) as a low-pressure flow path. The subcooling heat exchanger (28) exchanges heat between the refrigerant in the first flow path (28a) and the refrigerant in the second flow path (28b). In other words, the subcooling heat exchanger (28) uses the refrigerant flowing in the second flow path (28b) in order to cool the refrigerant flowing in the first flow path (28a).

[0049] The second flow path (28b) forms part of an injection flow path (43). The injection flow path (43) includes an upstream flow path (44) and a downstream flow path (45).

[0050] One end of the upstream flow path (44) is connected to part of the third pipe (40c) that is upstream of the junction with the fourth pipe (40d). The other end of the upstream flow path (44) is connected to the inflow end of the second flow path (28b). The upstream flow path (44) is provided with an injection valve (46) as a subcooling decompression valve. The injection valve (46) is an ex-

pansion valve of which the opening degree is adjustable. The injection valve (46) is an electronic expansion valve of which the opening degree is adjusted based on pulse signals.

[0051] One end of the downstream flow path (45) is connected to the outflow end of the second flow path (28b). The other end of the downstream flow path (45) is connected to the intermediate flow path (18).

(2-9) Intercooler

[0052] The intercooler (29) is provided in the intermediate flow path (18). The intercooler (29) is a fin-and-tube air heat exchanger. A cooling fan (29a) is disposed near the intercooler (29). The intercooler (29) exchanges heat between the refrigerant flowing therein and the outdoor air transferred by the cooling fan (29a).

(2-10) Oil Separation Circuit

[0053] The heat source circuit (11) includes an oil separation circuit. The oil separation circuit includes an oil separator (50), a first oil return pipe (51), and a second oil return pipe (52).

[0054] The oil separator (50) is connected to the third discharge pipe (23b). The oil separator (50) separates oil from the refrigerant discharged from the compression element (20). The inflow ends of the first oil return pipe (51) and the second oil return pipe (52) communicate with the oil separator (50). The outflow end of the first oil return pipe (51) is connected to the intermediate flow path (18). The first oil return pipe (51) is provided with a first oil level control valve (53).

[0055] The outflow side of the second oil return pipe (52) is separated into a first branch pipe (52a) and a second branch pipe (52b). The first branch pipe (52a) is connected to an oil reservoir of the first compressor (21). The second branch pipe (52b) is connected to an oil reservoir of the second compressor (22). The first branch pipe (52a) is provided with a second oil level control valve (54). The second branch pipe (52b) is provided with a third oil level control valve (55).

(2-11) Bypass Pipes

[0056] The heat source circuit (11) includes a first bypass pipe (56), a second bypass pipe (57), and a third bypass pipe (58). The first bypass pipe (56) is associated with the first compressor (21). The second bypass pipe (57) is associated with the second compressor (22). The third bypass pipe (58) is associated with the third compressor (23).

[0057] Specifically, the first bypass pipe (56) connects the first suction pipe (21a) and the first discharge pipe (21b) directly. The second bypass pipe (57) connects the second suction pipe (22a) and the second discharge pipe (22b) directly. The third bypass pipe (58) connects the third suction pipe (23a) and the third discharge pipe (23b)

directly.

(2-12) Check Valves

[0058] The heat source circuit (11) includes a plurality of check valves. The plurality of check valves include first to twelfth check valves (CV1 to CV12). The check valves (CV1 to CV12) allow the flow of a refrigerant in the direction of the arrow in FIG. 1 and disallow the flow of a refrigerant in the reverse direction.

[0059] The first check valve (CV1) and the second check valve (CV2) are provided in the flow path switching mechanism (30).

[0060] The third check valve (CV3) is provided in the third discharge pipe (23b). The fourth check valve (CV4) is provided in the first pipe (40a). The fifth check valve (CV5) is provided in the third pipe (40c). The sixth check valve (CV6) is provided in the fourth pipe (40d). The seventh check valve (CV7) is provided in the fifth pipe (40e). The eighth check valve (CV8) is provided in the first bypass pipe (56). The ninth check valve (CV9) is provided in the second bypass pipe (57). The tenth check valve (CV10) is provided in the third bypass pipe (58). The eleventh check valve (CV11) is provided in the first discharge pipe (21b). The twelfth check valve (CV12) is provided in the second discharge pipe (22b).

(3) Air Conditioning Unit

[0061] FIG. 2 is a piping system diagram of the vicinity of the air conditioning unit (60). The air conditioning unit (60) is a utilization unit placed indoors. The air conditioning unit (60) includes an indoor circuit (61) and an indoor fan (62). The liquid end of the indoor circuit (61) is connected with the first liquid connection pipe (2). The gas end of the indoor circuit (61) is connected with the first gas connection pipe (3).

[0062] As shown in FIG. 2, the indoor circuit (61) includes an indoor expansion valve (63) and an indoor heat exchanger (64) arranged sequentially from the liquid end to the gas end. The indoor expansion valve (63) is an example of an expansion valve. The indoor expansion valve (63) is an expansion valve of which the opening degree is adjustable. The indoor expansion valve (63) is an electronic expansion valve of which the opening degree is adjusted based on pulse signals.

[0063] The indoor heat exchanger (64) is a fin-and-tube air heat exchanger. The indoor heat exchanger (64) is an example of a radiator. The indoor fan (62) is disposed near the indoor heat exchanger (64). The indoor fan (62) transfers indoor air. The indoor heat exchanger (64) exchanges heat between the refrigerant flowing therein and the indoor air transferred by the indoor fan (62).

[0064] The air conditioning unit (60) includes the first air conditioning unit (60A) and the second air conditioning unit (60B) connected in parallel with each other. The indoor circuits (61) include a first indoor circuit (61A)

and a second indoor circuit (61B) connected in parallel with each other. The first indoor circuit (61A) is associated with the first air conditioning unit (60A). The second indoor circuit (61B) is associated with the second air conditioning unit (60B).

[0065] The indoor heat exchanger (64) includes a first indoor heat exchanger (64A) and a second indoor heat exchanger (64B) connected in parallel with each other. The first indoor heat exchanger (64A) is an example of a first radiator. The second indoor heat exchanger (64B) is an example of a second radiator.

[0066] The indoor expansion valve (63) includes a first indoor expansion valve (63A) associated with the first indoor heat exchanger (64A) and a second indoor expansion valve (63B) associated with the second indoor heat exchanger (64B). The first indoor expansion valve (63A) is an example of a first expansion valve. The second indoor expansion valve (63B) is an example of a second expansion valve. The indoor fan (62) includes a first indoor fan (62A) associated with the first indoor heat exchanger (64A) and a second indoor fan (62B) associated with the second indoor heat exchanger (64B).

(4) Refrigeration Facility Unit

[0067] The refrigeration facility unit (70) is a utilization unit that cools the inside of the refrigeration facility. The refrigeration facility unit (70) includes a refrigeration facility circuit (71) and a refrigeration facility fan (72). The liquid end of the refrigeration facility circuit (71) is connected with the second liquid connection pipe (4). The gas end of the refrigeration facility circuit (71) is connected with the second gas connection pipe (5).

[0068] The refrigeration facility circuit (71) includes a refrigeration facility expansion valve (73) and a refrigeration facility heat exchanger (74) arranged sequentially from the liquid end to the gas end. The refrigeration facility expansion valve (73) is an expansion valve of which the opening degree is adjustable. The refrigeration facility expansion valve (73) is an electronic expansion valve of which the opening degree is adjusted based on pulse signals.

[0069] The refrigeration facility heat exchanger (74) is a fin-and-tube air heat exchanger. The refrigeration facility fan (72) is disposed near the refrigeration facility heat exchanger (74). The refrigeration facility fan (72) transfers inside air. The refrigeration facility heat exchanger (74) exchanges heat between the refrigerant flowing therein and the inside air transferred by the refrigeration facility fan (72).

(5) Flow Path Switching Mechanism

[0070] The flow path switching mechanism (30) is provided in the heat source circuit (11). The flow path switching mechanism (30) switches the flow path of the refrigerant circuit (6) in order to switch at least a first refrigeration cycle and a second refrigeration cycle. The first

refrigeration cycle is a refrigeration cycle in which the outdoor heat exchanger (24) functions as a radiator, and the indoor heat exchanger (64) and the refrigeration facility heat exchanger (74) function as evaporators.

5 The second refrigeration cycle is a refrigeration cycle in which the outdoor heat exchanger (24) functions as an evaporator, and the indoor heat exchanger (64) and the refrigeration facility heat exchanger (74) function as radiators.

10 **[0071]** The flow path switching mechanism (30) includes a first port (P1), a second port (P2), a third port (P3), a fourth port (P4), a first switching flow path (31), a second switching flow path (32), a third switching flow path (33), and a fourth switching flow path (34). Each of the switching flow paths (31 to 34) is provided with an on-off mechanism (not shown). Each on-off mechanism includes an on-off valve and an expansion valve.

15 **[0072]** The first port (P1) is connected with the discharge portion of the third compressor (23). The second port (P2) is connected with the suction portion of the second compressor (22). The third port (P3) is connected with the gas end portion of the indoor heat exchanger (64). The fourth port (P4) is connected with the gas end portion of the outdoor heat exchanger (24).

25 **[0073]** The first switching flow path (31), the second switching flow path (32), the third switching flow path (33), and the fourth switching flow path (34) are connected in a bridge shape. The first switching flow path (31) allows the first port (P1) and the third port (P3) to communicate with each other. The second switching flow path (32) allows the first port (P1) and the fourth port (P4) to communicate with each other. The third switching flow path (33) allows the second port (P2) and the third port (P3) to communicate with each other. The fourth switching flow path (34) allows the second port (P2) and the fourth port (P4) to communicate with each other.

30 **[0074]** The fourth switching flow path (34) is provided with the first check valve (CV1). The first switching flow path (31) is provided with the second check valve (CV2). The first check valve (CV1) in the fourth switching flow path (34) allows the flow of a refrigerant from the fourth port (P4) to the second port (P2) and disallows the flow of a refrigerant from the second port (P2) to the fourth port (P4). The second check valve (CV2) in the first switching flow path (31) allows the flow of a refrigerant from the first port (P1) to the third port (P3) and disallows the flow of a refrigerant from the third port (P3) to the first port (P1).

(6) Sensors

50 **[0075]** The air conditioner (1) includes a plurality of sensors. The plurality of sensors include a refrigerant pressure sensor that detects the pressure of the refrigerant, a refrigerant temperature sensor that detects the temperature of the refrigerant, and an air temperature sensor that detects the temperature of air.

[0076] The refrigerant pressure sensor includes a high-pressure sensor (101), an intermediate-pressure

sensor (102), a first suction pressure sensor (103), a second suction pressure sensor (104), and a liquid-side pressure sensor (105). The high-pressure sensor (101) is provided in the third discharge pipe (23b). The high-pressure sensor (101) detects the pressure of a refrigerant on the discharge side of the compression element (20), in other words, a high pressure of the refrigerant circuit (6).

[0077] The intermediate-pressure sensor (102) is provided in the third suction pipe (23a). The intermediate-pressure sensor (102) detects the pressure of a refrigerant between the low-stage compressor and the high-stage compressor, in other words, an intermediate pressure of the refrigerant circuit (6). The first suction pressure sensor (103) is provided in the first suction pipe (21a). The first suction pressure sensor (103) detects the pressure of a refrigerant on the suction side of the first compressor (21). The second suction pressure sensor (104) is provided in the second suction pipe (22a). The second suction pressure sensor (104) detects the pressure of a refrigerant on the suction side of the second compressor (22).

[0078] The liquid-side pressure sensor (105) is provided in the liquid-side flow path (40). Specifically, the liquid-side pressure sensor (105) is provided in the second pipe (40b). The liquid-side pressure sensor (105) detects a pressure corresponding to an internal pressure of the gas-liquid separator (25). The liquid-side pressure sensor (105) detects the pressure corresponding to the pressure of the refrigerant in the first flow path (28a).

[0079] The refrigerant temperature sensor includes a first discharge temperature sensor (111), a first suction temperature sensor (112), a second discharge temperature sensor (113), a second suction temperature sensor (114), a third discharge temperature sensor (115), a third suction temperature sensor (116), a liquid-side temperature sensor (117), an injection-side temperature sensor (118), an outdoor heat exchanger temperature sensor (119), and an indoor heat exchanger temperature sensor (120).

[0080] The first discharge temperature sensor (111) is provided in the first discharge pipe (21b) and detects the temperature of the refrigerant discharged from the first compressor (21). The first suction temperature sensor (112) is provided in the first suction pipe (21a), and detects the temperature of the refrigerant sucked into the first compressor (21). The second discharge temperature sensor (113) is provided in the second discharge pipe (22b) and detects the temperature of the refrigerant discharged from the second compressor (22). The second suction temperature sensor (114) is provided in the second suction pipe (22a) and detects the temperature of the refrigerant sucked into the second compressor (22). The third discharge temperature sensor (115) is provided in the third discharge pipe (23b) and detects the temperature of the refrigerant discharged from the third compressor (23). The third suction temperature sensor (116) is provided in the third suction pipe (23a) and

detects the temperature of the refrigerant sucked into the third compressor (23).

[0081] The liquid-side temperature sensor (117) is provided in the liquid-side flow path (40). Specifically, the liquid-side temperature sensor (117) is provided on the outflow side of the first flow path (28a) of the subcooling heat exchanger (28) in the liquid-side flow path (40). The liquid-side temperature sensor (117) detects the temperature of the refrigerant flowing out of the first flow path (28a).

[0082] The injection-side temperature sensor (118) is provided in the downstream flow path (45) of the injection flow path (43). In other words, the injection-side temperature sensor (118) is provided on the outflow side of the second flow path (28b) of the subcooling heat exchanger (28). The injection-side temperature sensor (118) detects the temperature of the refrigerant flowing out of the second flow path (28b).

[0083] The outdoor heat exchanger temperature sensor (119) is provided in a heat transfer tube of the outdoor heat exchanger (24). The outdoor heat exchanger temperature sensor (119) is provided on a liquid-side end portion of the outdoor heat exchanger (24). The outdoor heat exchanger temperature sensor (119) detects the temperature of the refrigerant on the liquid-side end portion of the outdoor heat exchanger (24).

[0084] The indoor heat exchanger temperature sensor (120) is provided in a heat transfer tube of the indoor heat exchanger (64). The indoor heat exchanger temperature sensor (120) is provided on a liquid-side end portion of the indoor heat exchanger (64). The indoor heat exchanger temperature sensor (120) detects the temperature of the refrigerant on the liquid-side end portion of the indoor heat exchanger (64). The indoor heat exchanger temperature sensor (120) includes a first indoor heat exchanger temperature sensor (120A) and a second indoor heat exchanger temperature sensor (120B).

[0085] The first indoor heat exchanger temperature sensor (120A) is associated with the first indoor heat exchanger (64A). The first indoor heat exchanger temperature sensor (120A) is provided in a heat transfer tube of the first indoor heat exchanger (64A). The first indoor heat exchanger temperature sensor (120A) is provided on a liquid-side end portion of the first indoor heat exchanger (64A). The first indoor heat exchanger temperature sensor (120A) detects the temperature of the refrigerant on the liquid-side end portion of the first indoor heat exchanger (64A).

[0086] The second indoor heat exchanger temperature sensor (120B) is associated with the second indoor heat exchanger (64B). The second indoor heat exchanger temperature sensor (120B) is provided in a heat transfer tube of the second indoor heat exchanger (64B). The second indoor heat exchanger temperature sensor (120B) is provided on a liquid-side end portion of the second indoor heat exchanger (64B). The second indoor heat exchanger temperature sensor (120B) detects the temperature of the refrigerant on the liquid-side

end portion of the second indoor heat exchanger (64B).

[0087] The air temperature sensor includes an outdoor air temperature sensor (121) and an indoor temperature sensor (122). The outdoor air temperature sensor (121) detects the temperature of outdoor air.

[0088] The indoor temperature sensor (122) detects the indoor temperature of an indoor space in which the air conditioning unit (60) (the indoor heat exchanger (64)) is placed. The indoor temperature sensor (122) includes a first indoor temperature sensor (122A) and a second indoor temperature sensor (122B).

[0089] The first indoor temperature sensor (122A) detects the indoor temperature of the indoor space in which the first air conditioning unit (60A) (the first indoor heat exchanger (64A)) is placed. The second indoor temperature sensor (122B) detects the indoor temperature of the indoor space in which the second air conditioning unit (60B) (the second indoor heat exchanger (64B)) is placed.

(7) Controller

[0090] FIG. 3 is a block diagram showing the connection relationship between a controller (130) as a control device and peripheral devices. The air conditioner (1) includes the controller (130). The controller (130) is an example of a control device. The controller (130) controls the refrigerant circuit (6). The controller (130) includes a microcomputer mounted on a control board and a memory device (specifically, a semiconductor memory) that stores software for operating the microcomputer.

[0091] As shown in FIG. 3, the controller (130) includes an outdoor controller (131), an indoor controller (132), and a refrigeration facility controller (133). As illustrated in FIG. 1, the outdoor controller (131) is provided in the heat source unit (10). The indoor controller (132) is provided in the air conditioning unit (60). The refrigeration facility controller (133) is provided in the refrigeration facility unit (70). The outdoor controller (131) can exchange communications with the indoor controller (132) and the refrigeration facility controller (133).

[0092] The indoor controller (132) includes a first indoor controller (132A) and a second indoor controller (132B) connected in parallel with each other. The first indoor controller (132A) is associated with the first air conditioning unit (60A). The second indoor controller (132B) is associated with the second air conditioning unit (60B).

[0093] The controller (130) receives control commands from the user and detection signals from the sensors. The controller (130) controls each device of the air conditioner (1). Specifically, the controller (130) controls ON/OFF of the first compressor (21), the second compressor (22), and the third compressor (23). The controller (130) adjusts the capacity (strictly, the number of rotations of each motor) of the first compressor (21), the second compressor (22), and the third compressor (23). The controller (130) controls ON/OFF of each fan.

The controller (130) adjusts the opening degree of each expansion valve. The controller (130) switches opening and closing of each valve.

5 (8) Heating Operation

(8-1) Operation of Air Conditioner for Heating

[0094] The operation of the air conditioner (1) will be described. The operation of the air conditioner (1) includes a refrigeration facility operation, a cooling operation, a cooling and refrigeration facility operation, a heating operation, a heating and refrigeration facility operation, and a defrosting operation. In this example, only the heating operation will be described. In the heating operation, the refrigeration facility unit (70) is stopped, and the air conditioning unit (60) heats the indoor space. The flow of the refrigerant in the heating operation is shown by the bold line in FIG. 1.

[0095] As shown in FIG. 1, in the heating operation, the controller (130) controls the on-off valves in the switching flow paths (31 to 34) in order to close the second switching flow path (32) and the third switching flow path (33) and to open the first switching flow path (31) and the fourth switching flow path (34).

[0096] The controller (130) stops the first compressor (21), and operates the second compressor (22) and the third compressor (23). The controller (130) opens the second outdoor expansion valve (27) and the injection valve (46) at predetermined opening degrees, and closes the first outdoor expansion valve (26). The controller (130) closes the refrigeration facility expansion valve (73) and opens the indoor expansion valve (63). The controller (130) operates the outdoor fan (12) and the indoor fan (62), and stops the refrigeration facility fan (72).

[0097] In the heating operation, the refrigeration cycle is performed in which the indoor heat exchanger (64) functions as a radiator, the outdoor heat exchanger (24) functions as an evaporator, and the function of the refrigeration facility heat exchanger (74) is substantially stopped.

[0098] Specifically, the refrigerant compressed by the second compressor (22) is cooled in the intercooler (29), and then is sucked into the third compressor (23). The refrigerant compressed by the third compressor (23) is sent to the air conditioning unit (60).

[0099] The refrigerant sent to the air conditioning unit (60) dissipates heat in the indoor heat exchanger (64). As a result, the indoor air is heated. The refrigerant having dissipated heat in the indoor heat exchanger (64) flows into the gas-liquid separator (25). In the gas-liquid separator (25), the refrigerant is separated into a gas refrigerant and a liquid refrigerant.

[0100] The liquid refrigerant separated in the gas-liquid separator (25) is cooled in the subcooling heat exchanger (28) by the refrigerant flowing through the injection flow path (43). The refrigerant in the injection flow path (43) is

sent to the intermediate flow path (18).

[0101] The refrigerant having been cooled by the sub-cooling heat exchanger (28) is decompressed by the second outdoor expansion valve (27) and then evaporates in the outdoor heat exchanger (24). The refrigerant having evaporated in the outdoor heat exchanger (24) is sucked into and compressed again in the second compressor (22).

(8-2) Components of Air Conditioner for Heating

[0102] In the heating operation, the refrigerant circuit (6) includes the second compressor (22) as a compressor, the third compressor (23) as a compressor, the indoor heat exchanger (64) as a radiator, the indoor expansion valve (63) as an expansion valve, and the outdoor heat exchanger (24) as an evaporator.

[0103] The air conditioning unit (60) includes the first air conditioning unit (60A) and the second air conditioning unit (60B) connected in parallel with each other.

[0104] The indoor heat exchanger (64) as a radiator includes the first indoor heat exchanger (64A) as the first radiator, and the second indoor heat exchanger (64B) as the second radiator. The first indoor heat exchanger (64A) and the second indoor heat exchanger (64B) are connected in parallel with each other.

[0105] The indoor expansion valve (63) as an expansion valve includes the first indoor expansion valve (63A) as the first expansion valve associated with the first indoor heat exchanger (64A), and the second indoor expansion valve (63B) as the second expansion valve associated with the second indoor heat exchanger (64B).

[0106] The indoor fan (62) includes the first indoor fan (62A) associated with the first indoor heat exchanger (64A) and the second indoor fan (62B) associated with the second indoor heat exchanger (64B).

[0107] The refrigerant circuit (6) includes the gas-liquid separator (25), the venting pipe (41) as a venting passage, and the venting valve (42) as an on-off valve.

[0108] In the heating operation, the gas-liquid separator (25) is connected with the downstream side of the indoor heat exchanger (64). The gas-liquid separator (25) separates the refrigerant into a gas refrigerant and a liquid refrigerant. The gas reservoir (25a) and the liquid reservoir (25b) are formed in the gas-liquid separator (25). The gas reservoir (25a) is disposed on the top portion of the gas-liquid separator (25), and stores the gas refrigerant. The liquid reservoir (25b) is disposed on the bottom portion of the gas-liquid separator (25), and stores the liquid refrigerant.

[0109] One end of the venting pipe (41) is connected to the gas reservoir (25a) of the gas-liquid separator (25). The other end of the venting pipe (41) is connected to the intermediate flow path (18). The intermediate flow path (18) is connected to the third suction pipe (23a) that is placed on the suction side (23i) of the third compressor (23).

[0110] The venting pipe (41) connects the gas reser-

voir (25a) of the gas-liquid separator (25) with the third suction pipe (23a) that is placed on the suction side (23i) of the third compressor (23) via the intermediate flow path (18).

[0111] The high-pressure sensor (101) detects the high pressure (Ph) as a high pressure in the refrigerant circuit (6). The high pressure (Ph) is an example of the high pressure in this example. The high pressure (Ph) of the refrigerant circuit (6) is also the pressure of the refrigerant on a discharge side of the third compressor (23).

[0112] The indoor heat exchanger temperature sensor (120) detects the temperature of the refrigerant on the liquid-side end portion of the indoor heat exchanger (64). In the heating operation, the indoor heat exchanger temperature sensor (120) detects the outlet refrigerant temperature (TE) as a refrigerant temperature at the outlet (E) of the indoor heat exchanger (64). The indoor heat exchanger temperature sensor (120) includes the first indoor heat exchanger temperature sensor (120A) and the second indoor heat exchanger temperature sensor (120B).

[0113] The first indoor heat exchanger temperature sensor (120A) detects the temperature of the refrigerant on the liquid-side end portion of the first indoor heat exchanger (64A). In the heating operation, the first indoor heat exchanger temperature sensor (120A) detects the first outlet refrigerant temperature (TEA) as the refrigerant temperature at the first outlet (EA) of the first indoor heat exchanger (64A). The first outlet refrigerant temperature (TEA) is associated with the first indoor heat exchanger (64A). The second indoor heat exchanger temperature sensor (120B) detects the temperature of the refrigerant on the liquid-side end portion of the second indoor heat exchanger (64B). In the heating operation, the second indoor heat exchanger temperature sensor (120B) detects the second outlet refrigerant temperature (TEB) as the refrigerant temperature at the second outlet (EB) of the second indoor heat exchanger (64B). The second outlet refrigerant temperature (TEB) is associated with the second indoor heat exchanger (64B).

[0114] The indoor temperature sensor (122) detects an indoor temperature (TR) in the indoor space in which the air conditioning unit (60) (the indoor heat exchanger (64)) is placed. The indoor temperature sensor (122) includes the first indoor temperature sensor (122A) and the second indoor temperature sensor (122B).

[0115] The first indoor temperature sensor (122A) detects the first indoor temperature (TRA) in the indoor space in which the first air conditioning unit (60A) (the first indoor heat exchanger (64A)) is placed. The first indoor temperature (TRA) is associated with the first indoor heat exchanger (64A). The second indoor temperature sensor (122B) detects a second indoor temperature (TRB) in the indoor space in which the second air conditioning unit (60B) (the second indoor heat exchanger (64B)) is placed. The second indoor temperature (TRB) is associated with the second indoor heat exchanger (64B).

(8-3) Function of Controller of Air Conditioner for Heating

[0116] The outdoor controller (131) of the controller (130) sets a target high pressure (Ph0) that is a target value of the high pressure (Ph) of the refrigerant circuit (6). The outdoor controller (131) of the controller (130) calculates a high pressure difference (ΔPh) which is a pressure difference between the high pressure (Ph) detected by the high-pressure sensor (101) and the target high pressure (Ph0).

[0117] The indoor controller (132) of the controller (130) sets a target outlet refrigerant temperature (TE0) that is a target value of the outlet refrigerant temperature (TE). The indoor controller (132) of the controller (130) calculates an outlet refrigerant temperature difference (ΔTE) that is a temperature difference between the outlet refrigerant temperature (TE) detected by the indoor heat exchanger temperature sensor (120) and the target outlet refrigerant temperature (TE0).

[0118] The first indoor controller (132A) of the controller (130) sets a first target outlet refrigerant temperature (TE0A) that is a target value of the first outlet refrigerant temperature (TEA). The first target outlet refrigerant temperature (TE0A) is associated with the first indoor heat exchanger (64A). The first indoor controller (132A) of a controller (130) calculates a first outlet refrigerant temperature difference (ΔTEA) that is a temperature difference between the first outlet refrigerant temperature (TEA) detected by the first indoor heat exchanger temperature sensor (120A) and the first target outlet refrigerant temperature (TE0A). The first outlet refrigerant temperature difference (ΔTEA) is associated with the first indoor heat exchanger (64A).

[0119] The second indoor controller (132B) of the controller (130) sets a second target outlet refrigerant temperature (TE0B) that is a target value of the second outlet refrigerant temperature (TEB). The second target outlet refrigerant temperature (TE0B) is associated with the second indoor heat exchanger (64B). The second indoor controller (132B) of the controller (130) calculates a second outlet refrigerant temperature difference (ΔTEB) that is a temperature difference between the second outlet refrigerant temperature (TEB) detected by the second indoor heat exchanger temperature sensor (120B) and the second target outlet refrigerant temperature (TE0B). The second outlet refrigerant temperature difference (ΔTEB) is associated with the second indoor heat exchanger (64B).

[0120] The indoor controller (132) of the controller (130) sets a target indoor temperature (TRO) that is a target value of the indoor temperature (TR). The indoor controller (132) of the controller (130) calculates an indoor temperature difference (ΔTR) that is a temperature difference between the indoor temperature (TR) detected by the indoor temperature sensor (122) and the target indoor temperature (TRO).

[0121] The first indoor controller (132A) of the control-

ler (130) sets a first target indoor temperature (TROA) that is a target value of the first indoor temperature (TRA). The first target indoor temperature (TROA) is associated with the first indoor heat exchanger (64A). The first indoor controller (132A) of the controller (130) calculates a first indoor temperature difference (ΔTRA) as a first temperature difference between the first indoor temperature (TRA) detected by the first indoor temperature sensor (122A) and the first target indoor temperature (TROA). The first indoor temperature difference (ΔTRA) is associated with the first indoor heat exchanger (64A).

[0122] The second indoor controller (132B) of the controller (130) sets a second target indoor temperature (TROB) that is a target value of the second indoor temperature (TRB). The second target indoor temperature (TROB) is associated with the second indoor heat exchanger (64B). The second indoor controller (132B) of the controller (130) calculates a second indoor temperature difference (ΔTRB) as a second temperature difference that is a temperature difference between the second indoor temperature (TRB) detected by the second indoor temperature sensor (122B) and the second target indoor temperature (TROB). The second indoor temperature difference (ΔTRB) is associated with the second indoor heat exchanger (64B).

(9) Supercritical Operation

[0123] FIG. 4 is a graph showing the relationship between the specific enthalpy (h) and the pressure (P) of a refrigerant. FIG. 4 is also referred to as a P-h diagram. The refrigerant circulating in the refrigerant circuit (6) is carbon dioxide. The critical pressure (Pc) of carbon dioxide as a refrigerant at the critical point (C) is lower than those of other natural refrigerants, and specifically, is 7.38 [MPa] in absolute pressure. The critical temperature of carbon dioxide as a refrigerant at the critical point (C) is 31.1 [°C]. The critical specific enthalpy (hc) of carbon dioxide as a refrigerant at the critical point (C) is about 330 [kJ/kg]. The critical pressure (Pc), the critical temperature, and the critical specific enthalpy (hc) are associated with each other.

[0124] The refrigerant circuit (6) performs the refrigeration cycle for executing the heating operation to heat the indoor space by compressing the refrigerant to the critical pressure (Pc) or more. The refrigerant circuit (6) performs supercritical operation. The high pressure (Ph) of the refrigerant circuit (6) becomes the critical pressure (Pc) or more.

[0125] If the refrigerant is compressed to the critical pressure (Pc) or more, in other words, if the high pressure (Ph) of the refrigerant circuit (6) becomes the critical pressure (Pc) or more, the condensing temperature of the refrigerant does not exist in the area of the critical pressure (Pc) or more, and thus it is difficult to control the temperature of the refrigerant.

[0126] Therefore, in the supercritical operation in which the refrigerant is compressed to the critical pres-

sure (P_c) or more, it is difficult to adjust the indoor temperature (TR), and it is difficult to adjust the indoor temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO).

[0127] If the specific enthalpy (h) of the refrigerant is smaller, the ratio of liquid in the refrigerant is higher and the ratio of gas in the refrigerant is lower. If the specific enthalpy (h) of the refrigerant is larger, the ratio of liquid in the refrigerant is lower and the ratio of gas in the refrigerant is higher.

[0128] As shown in FIG. 4, the outlet specific enthalpy (h_e) of the refrigerant at the outlet (E) of the indoor heat exchanger (64) is smaller than the critical specific enthalpy (h_c) of the refrigerant at the critical point (C). At the outlet (E) of the indoor heat exchanger (64), the ratio of liquid in the refrigerant is larger and the ratio of gas in the refrigerant is smaller than at the critical point (C).

(10) Control Flow of Air Conditioner during Heating Operation

[0129] FIG. 5 is a control flowchart of the air conditioner (1) during the heating operation. In the following description, functions of the outdoor controller (131) and the indoor controller (132) will be simply described as functions of the controller (130) in a simplified manner.

[0130] The process begins from the start, and in a first step ($S1$), the heating operation is started in response to a heating operation start command from the user to the controller (130). In the heating operation, the controller (130) stops the first compressor (21), and operates the second compressor (22) and the third compressor (23).

[0131] In the heating operation, the controller (130) opens the second outdoor expansion valve (27) and the injection valve (46) at predetermined opening degrees, and closes the first outdoor expansion valve (26). In the heating operation, the controller (130) closes the refrigeration facility expansion valve (73). In the heating operation, the controller (130) opens the indoor expansion valve (63). In the heating operation, the controller (130) operates the outdoor fan (12) and the indoor fan (62), and stops the refrigeration facility fan (72). In the heating operation, the controller (130) causes the indoor heat exchanger (64) to function as a radiator, and causes the outdoor heat exchanger (24) to function as an evaporator.

[0132] The venting pipe (41) connects the gas reservoir (25a) of the gas-liquid separator (25) with the third suction pipe (23a) that is placed on the suction side (23i) of the third compressor (23) via the intermediate flow path (18). The venting valve (42) of the venting pipe (41) is closed initially.

[0133] In a second step ($S2$), the controller (130) sets the target high pressure ($Ph0$) of the refrigerant circuit (6) to the critical pressure (P_c) or more. In this example, the controller (130) first sets the target high pressure ($Ph0$) to 9 [MPa] as an initial value. In this example, a control range of the target high pressure ($Ph0$) is from 8 [MPa] to 11

[MPa].

[0134] The controller (130) calculates the high pressure difference (ΔPh) between the high pressure (Ph) detected by the high-pressure sensor (101) and the target high pressure ($Ph0$). When there is a difference between the high pressure (Ph) and the target high pressure ($Ph0$), the controller (130) adjusts a number of rotations of the second compressor (22) and a number of rotations of the third compressor (23) to bring the high pressure (Ph) closer to the target high pressure ($Ph0$) (bring the high pressure difference (ΔPh) closer to zero). For example, in a case where the high pressure (Ph) is lower than the target high pressure ($Ph0$), the number of rotations of the second compressor (22) and the number of rotations of the third compressor (23) are increased. In a case where the high pressure (Ph) is higher than the target high pressure ($Ph0$), the number of rotations of the second compressor (22) and the number of rotations of the third compressor (23) are decreased.

[0135] In the following description, it is assumed that the high pressure (Ph) and the target high pressure ($Ph0$) are equal to each other. That is, the controller (130) sets the high pressure (Ph) of the refrigerant circuit (6) to the critical pressure (P_c) or more.

[0136] In a third step ($S3$), the controller (130) controls the indoor expansion valve (63) to adjust the outlet refrigerant temperature (TE) at the outlet (E) of the indoor heat exchanger (64). Specifically, the controller (130) sets the target outlet refrigerant temperature ($TE0$). In this example, the controller (130) sets the target outlet refrigerant temperature ($TE0$) to 37[°], which is close to a human body temperature. The controller (130) calculates an outlet refrigerant temperature difference (ΔTE) between the outlet refrigerant temperature (TE) detected by the indoor heat exchanger temperature sensor (120) and the target outlet refrigerant temperature ($TE0$). The controller (130) controls the indoor expansion valve (63) to bring the outlet refrigerant temperature (TE) closer to the target outlet refrigerant temperature ($TE0$) (bring the outlet refrigerant temperature difference (ΔTE) closer to zero).

[0137] The opening degree of the indoor expansion valve (63) can be adjusted, for example, between 10[%] and 100[%]. Decreasing the opening degree of the indoor expansion valve (63) decreases the outlet refrigerant temperature (TE). Increasing the opening degree of the indoor expansion valve (63) increases the outlet refrigerant temperature (TE). By controlling the opening degree of the indoor expansion valve (63) to adjust the outlet refrigerant temperature (TE), the indoor temperature (TR) to be described later can be adjusted to some extent.

[0138] The above-described control is performed for each of the first indoor heat exchanger (64A) and the second indoor heat exchanger (64B). The controller (130) controls the first indoor expansion valve (63A) to bring the first outlet refrigerant temperature (TEA) closer to the first target outlet refrigerant temperature ($TE0A$)

(bring the first outlet refrigerant temperature difference (ΔTEA) closer to zero). The controller (130) controls the second indoor expansion valve (63B) to bring the second outlet refrigerant temperature (TEB) closer to the second target outlet refrigerant temperature (TEOB) (bring the second outlet refrigerant temperature difference (ΔTEB) closer to zero).

[0139] In a fourth step (S4), the controller (130) sets the target indoor temperature (TRO) in response to a command from the user. As an example, the target indoor temperature (TRO) is 28[°C].

[0140] In a fifth step (S5), the controller (130) calculates the indoor temperature difference (ΔTR) between the indoor temperature (TR) detected by the indoor temperature sensor (122) and the target indoor temperature (TRO). The controller (130) calculates the first indoor temperature difference (ΔTRA) between the first indoor temperature (TRA) detected by the first indoor temperature sensor (122A) and the first target indoor temperature (TROA). The controller (130) calculates the second indoor temperature difference (ΔTRB) between the second indoor temperature (TRB) detected by the second indoor temperature sensor (122B) and the second target indoor temperature (TROB).

[0141] In sixth to twelfth steps (S6 to S12), the controller (130) controls the high pressure (Ph) (target high pressure (Ph0)) of the refrigerant circuit (6) based on the indoor temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO).

[0142] Specifically, the controller (130) controls the high pressure (Ph) (target high pressure (Ph0)) of the refrigerant circuit (6) based on one or both of the first indoor temperature difference (ΔTRA) between the first indoor temperature (TRA) and the first target indoor temperature (TROA) and the second indoor temperature difference (ΔTRB) between the second indoor temperature (TRB) and the second target indoor temperature (TROB).

[0143] More specifically, the controller (130) controls the high pressure (Ph) (target high pressure (Ph0)) of the refrigerant circuit (6) based on the larger one of the first indoor temperature difference (ΔTRA) or the second indoor temperature difference (ΔTRB).

[0144] In the sixth step (S6), it is determined whether the indoor temperature difference (ΔTR) is smaller than a lower threshold (ΔTX) as a third value ($\Delta TR < \Delta TX$). The lower threshold (ΔTX) is an example of the third value. In this example, the lower threshold (ΔTX) is 1[°C]. When it is determined that the indoor temperature difference (ΔTR) is smaller than the lower threshold (ΔTX) ($\Delta TR < \Delta TX$), the processing proceeds to the seventh step (S7). When it is determined that the indoor temperature difference (ΔTR) is larger than the lower threshold (ΔTX) ($\Delta TR > \Delta TX$), the processing proceeds to the eighth step (S8). When the indoor temperature difference (ΔTR) is equal to the lower threshold (ΔTX) ($\Delta TR = \Delta TX$), the processing may proceed to the eighth step (S8).

[0145] In the seventh step (S7), the controller (130) controls the second compressor (22) and the third compressor (23) to set the high pressure (Ph) (target high pressure (Ph0)) of the refrigerant circuit (6) to a lower limit value (Ph1) of the control range. Specifically, the controller (130) decreases the high pressure (Ph) (target high pressure (Ph0)) of the refrigerant circuit (6) to be maintained at 8 [MPa], which is the lower limit value (Ph1) of the control range. Specifically, the controller (130) maintains the number of rotations of the second compressor (22) and the number of rotations of the third compressor (23) at lower limit values.

[0146] In summary, in the sixth step (S6) and the seventh step (S7), when the indoor temperature difference (ΔTR) is less than the lower threshold (ΔTX) ($\Delta TR < \Delta TX$), the controller (130) controls the second compressor (22) and the third compressor (23) to set the high pressure (Ph) (target high pressure (Ph0)) of the refrigerant circuit (6) to the lower limit value (Ph1) (8 [MPa]) of the control range. When the seventh step (S7) ends, the processing proceeds to a thirteenth step (S13).

[0147] In the eighth step (S8), it is determined whether the indoor temperature difference (ΔTR) is smaller than an intermediate threshold (ΔTY) as a first value and a second value ($\Delta TR < \Delta TY$). The intermediate threshold (ΔTY) is an example of the first value and the second value. In this example, the intermediate threshold (ΔTY) is 5[°C]. When it is determined that the indoor temperature difference (ΔTR) is smaller than the intermediate threshold (ΔTY) ($\Delta TR < \Delta TY$), the processing proceeds to the ninth step (S9). When it is determined that the indoor temperature difference (ΔTR) is larger than the intermediate threshold (ΔTY) ($\Delta TR > \Delta TY$), the processing proceeds to the tenth step (S10). When the indoor temperature difference (ΔTR) is equal to the intermediate threshold (ΔTY) ($\Delta TR = \Delta TY$), the processing may proceed to the tenth step (S10).

[0148] In the ninth step (S9), the controller (130) controls the second compressor (22) and the third compressor (23) to decrease the high pressure (Ph) (target high pressure (Ph0)) of the refrigerant circuit (6). Specifically, the controller (130) decreases the number of rotations of the second compressor (22) and the number of rotations of the third compressor (23). As an example, the controller (130) decreases the high pressure (Ph) (target high pressure (Ph0)) of the refrigerant circuit (6) by 0.1 [MPa].

[0149] In the tenth step (S10), the controller (130) controls the second compressor (22) and the third compressor (23) to increase the high pressure (Ph) (target high pressure (Ph0)) of the refrigerant circuit (6). Specifically, the controller (130) increases the number of rotations of the second compressor (22) and the number of rotations of the third compressor (23). As an example, the controller (130) increases the high pressure (Ph) (target high pressure (Ph0)) of the refrigerant circuit (6) by 0.3 [MPa].

[0150] In summary, in the eighth step (S8) and the ninth

step (S9), when the indoor temperature difference (ΔTR) is less than the intermediate threshold (ΔTY) ($\Delta TR < \Delta TY$), the controller (130) controls the second compressor (22) and the third compressor (23) to decrease the high pressure (Ph) (target high pressure (Ph0)) of the refrigerant circuit (6). When the ninth step (S9) ends, the processing proceeds to a thirteenth step (S13).

[0151] In summary, in the eighth step (S8) and the tenth step (S10), when the indoor temperature difference (ΔTR) is larger than the intermediate threshold (ΔTY) ($\Delta TR > \Delta TY$), the controller (130) controls the second compressor (22) and the third compressor (23) to increase the high pressure (Ph) (target high pressure (Ph0)) of the refrigerant circuit (6). When the tenth step (S10) ends, the processing proceeds to the eleventh step (S11).

[0152] In the eleventh step (S11), it is determined whether the indoor temperature difference (ΔTR) is smaller than an upper threshold (ΔTZ) as a fourth value ($\Delta TR < \Delta TZ$). The upper threshold (ΔTZ) is an example of the fourth value. In this example, the upper threshold (ΔTZ) is 8[°C]. When it is determined that the indoor temperature difference (ΔTR) is smaller than the upper threshold (ΔTZ) ($\Delta TR < \Delta TZ$), the processing proceeds to the thirteenth step (S13). When it is determined that the indoor temperature difference (ΔTR) is larger than the upper threshold (ΔTZ) ($\Delta TR > \Delta TZ$), the processing proceeds to the twelfth step (S12). When the indoor temperature difference (ΔTR) is equal to the upper threshold (ΔTZ) ($\Delta TR = \Delta TZ$), the processing may proceed to the twelfth step (S12).

[0153] In the twelfth step (S12), the controller (130) opens the venting valve (42) of the venting pipe (41) (see the thick broken line in FIG. 1). As an example, the controller (130) increases the opening degree of the venting valve (42) of the venting pipe (41) by 10[%]. "Opening the venting valve (42)" includes not only newly opening the venting valve (42) of which the opening degree is zero but also further increasing the opening degree of the venting valve (42) that has been opened.

[0154] In summary, in the eleventh step (S11) and the twelfth step (S12), when the indoor temperature difference (ΔTR) is larger than the upper threshold (ΔTZ) ($\Delta TR > \Delta TZ$), the controller (130) opens the venting valve (42) of the venting pipe (41). When the twelfth step (S12) ends, the processing proceeds to the thirteenth step (S13).

[0155] In thirteenth step (S13), it is determined whether a heating operation stop command is issued from the user to the controller (130). When the heating operation stop command is issued from the user to the controller (130), the controller (130) stops the heating operation and processing reaches to the end. When a heating operation stop command is not issued from the user to the controller (130), the processing returns to the fifth step (S5).

(11) Functional Effects

[0156] In the air conditioner (1) according to the present embodiment, the refrigerant is compressed to the critical pressure (Pc) or more (the high pressure (Ph) of the refrigerant circuit (6) becomes the critical pressure (Pc) or more). Since the condensation temperature of the refrigerant does not exist in the area of the critical pressure (Pc) or more, it is difficult to control the temperature of the refrigerant, and thus it is difficult to adjust the indoor temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO).

[0157] By controlling the indoor expansion valve (63) to adjust the outlet refrigerant temperature (TE) at the outlet (E) of the indoor heat exchanger (64), the indoor temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO) can be adjusted to some extent.

[0158] However, the indoor temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO) may not be sufficiently adjusted only by controlling the indoor expansion valve (63). In this case, by controlling the high pressure (Ph) of the refrigerant circuit (6) based on the indoor temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO), the indoor temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO) can be further adjusted.

[0159] As described above, in the air conditioner (1), the indoor temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO) can be adjusted during the heating operation to heat the indoor space by compressing the refrigerant to the critical pressure (Pc) or more.

[0160] When the indoor temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO) is larger than the intermediate threshold (ΔTY) as the first value, the indoor temperature (TR) can be increased by increasing the high pressure (Ph) of the refrigerant circuit (6). The indoor temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO) can be decreased.

[0161] In a case where the indoor temperature difference (ΔTR) is smaller than the intermediate threshold (ΔTY) as the second value, loads on the second compressor (22) and the third compressor (23) can be reduced by decreasing the high pressure (Ph) of the refrigerant circuit (6).

[0162] In a case where the indoor temperature difference (ΔTR) is smaller than the lower threshold (ΔTX) as the third value, setting the high pressure (Ph) of the refrigerant circuit (6) to the lower limit value (Ph1) is advantageous in reducing the loads on the second compressor (22) and the third compressor (23).

[0163] In a case where the indoor temperature difference (ΔTR) is larger than the upper threshold (ΔTZ) as

the fourth value, the flow of the refrigerant from the gas reservoir (25a) of the gas-liquid separator (25) to the suction side (23i) of the third compressor (23) is promoted by opening the venting valve (42) of the venting pipe (41). Further increasing the indoor temperature (TR) is advantageous in reducing the indoor temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO). This is advantageous in rapidly increasing the indoor temperature (TR) immediately after the start of the heating operation.

[0164] Since the outlet specific enthalpy (h_e) of the refrigerant at the outlet (E) of the indoor heat exchanger (64) is smaller than the critical specific enthalpy (h_c) of the refrigerant at the critical point (C), the ratio of liquid in the refrigerant can be increased. By increasing the amount of the liquid refrigerant flowing into the gas-liquid separator (25), a gas-liquid separation effect by the gas-liquid separator (25) can be increased.

[0165] Even in the case of a multi-type with two or more indoor heat exchangers (64), the indoor temperature difference (ΔTR) between the indoor temperature (TR) and the target indoor temperature (TRO) can be adjusted during the heating operation to heat the indoor space by compressing the refrigerant to the critical pressure (P_c) or more.

[0166] The indoor expansion valve (63) (the first indoor expansion valve (63A) and the second indoor expansion valve (63B)) adjusts the outlet refrigerant temperature (TE) (the first outlet refrigerant temperature (TEA) and the second outlet refrigerant temperature (TEB)) for each air conditioning unit (60) (the first air conditioning unit (60A) and the second air conditioning unit (60B)). The indoor temperature difference (ΔTR) (the first indoor temperature difference (ΔTRA) and the second indoor temperature difference (ΔTRB)) can be individually controlled for each air conditioning unit (60) (the first air conditioning unit (60A) and the second air conditioning unit (60B)).

[0167] Employment of either the first indoor temperature difference (ΔTRA) or the second indoor temperature difference (ΔTRB) having a worse condition (a larger temperature difference) is advantageous in decreasing the indoor temperature difference (ΔTR).

[0168] Employment of carbon dioxide as a refrigerant is advantageous in terms of protection of the environment.

(12) Other Embodiments

[0169] In the above embodiment, the larger one of the first indoor temperature difference (ΔTRA) or the second indoor temperature difference (ΔTRB) is adopted, but the present disclosure is not limited thereto. For example, an average value of the two may be adopted, or the smaller one of the two may be adopted.

[0170] In the above embodiment, the first value and the second value are the same value, but the present disclosure is not limited thereto, and the first value and the

second value may be different from each other. For example, the first value and the third value may be the same value, or the second value and the third value may be the same value. The same applies to the fourth value.

[0171] The compressor may be a single (a single-stage) compressor.

[0172] The number of the indoor heat exchanger (64) as a radiator may be one or three or more.

[0173] The refrigerant circuit (6) is not required to include the gas-liquid separator (25).

[0174] The air conditioner (1) may be configured without the refrigeration facility unit (70).

[0175] The refrigerant is not necessarily carbon dioxide.

[0176] While the embodiments and variations thereof have been described above, it will be understood that various changes in form and details may be made without departing from the spirit and scope of the claims. The elements according to the embodiments, the variations thereof, and the other embodiments may be combined and replaced with each other.

[0177] The expressions of "first", "second", "third", ... described above are used to distinguish the terms to which these expressions are given, and do not limit the number and order of the terms.

REFERENCE SIGNS LIST

[0178]

1: air conditioner
 6: refrigerant circuit
 23: third compressor (compressor)
 23i: suction side
 24: outdoor heat exchanger (evaporator)
 25: gas-liquid separator
 25a: gas reservoir
 41: venting pipe (venting passage)
 42: venting valve (on-off valve)
 63: indoor expansion valve (expansion valve)
 63A: first indoor expansion valve (first expansion valve)
 63B: second indoor expansion valve (second expansion valve)
 64: indoor heat exchanger (radiator)
 64A: first indoor heat exchanger (first radiator)
 64B: second indoor heat exchanger (second radiator)
 130: controller (control device)
 E: outlet
 TE: outlet refrigerant temperature (refrigerant temperature)
 TR: indoor temperature
 TRA: first indoor temperature (indoor temperature)
 TRB: second indoor temperature (indoor temperature)
 TRO: target indoor temperature
 TROA: first target indoor temperature (target indoor

temperature)

TR0B: second target indoor temperature (target indoor temperature)

ΔTR : indoor temperature difference (temperature difference) 5

ΔTRA : first indoor temperature difference (first temperature difference)

ΔTRB : second indoor temperature difference (second temperature difference)

Ph: high pressure (high pressure) 10

Ph1: lower limit value

C: critical Point

Pc: critical Pressure

he: outlet specific enthalpy (specific enthalpy)

hc: critical specific enthalpy (specific enthalpy) 15

ΔTX : lower threshold (third value)

ΔTY : intermediate threshold (first value, second value)

ΔTZ : upper threshold (fourth value) 20

Claims

1. An air conditioner comprising:

a refrigerant circuit (6) including a compressor (23), a radiator (64), an expansion valve (63), and an evaporator (24), and configured to perform a refrigeration cycle for executing a heating operation to heat an indoor space by compressing a refrigerant to a critical pressure (Pc) or more; and

a control device (130) configured to control the refrigerant circuit (6), wherein the control device (130) 25

controls the expansion valve (63) to adjust a refrigerant temperature (TE) at an outlet (E) of the radiator (64), and

controls a high pressure (Ph) of the refrigerant circuit (6) based on a temperature difference (ΔTR) between an indoor temperature (TR) and a target indoor temperature (TRO). 30

2. The air conditioner according to claim 1, wherein the control device (130) controls the compressor (23) to increase the high pressure (Ph) of the refrigerant circuit (6) when the temperature difference (ΔTR) is larger than a first value. 35

3. The air conditioner according to claim 1 or 2, wherein the control device (130) controls the compressor (23) to decrease the high pressure (Ph) of the refrigerant circuit (6) when the temperature difference (ΔTR) is less than a second value. 40

4. The air conditioner according to any one of claims 1

to 3, wherein the control device (130) controls the compressor (23) to set the high pressure (Ph) of the refrigerant circuit (6) to a lower limit value (Ph1) of a control range when the temperature difference (ΔTR) is less than a third value.

5. The air conditioner according to any one of claims 1 to 4, wherein

the refrigerant circuit (6) includes

a gas-liquid separator (25) connected to a downstream side of the radiator (64) and configured to separate the refrigerant into a gas refrigerant and a liquid refrigerant, a venting passage (41) that connects a gas reservoir (25a) of the gas-liquid separator (25) with a suction side (23i) of the compressor (23), and an on-off valve (42) provided in the venting passage (41), and

the control device (130) opens the on-off valve (42) when the temperature difference (ΔTR) is larger than a fourth value. 45

6. The air conditioner according to any one of claims 1 to 5, wherein

the refrigerant circuit (6) includes a gas-liquid separator (25) connected to a downstream side of the radiator (64) and configured to separate the refrigerant into a gas refrigerant and a liquid refrigerant, and a specific enthalpy (he) of the refrigerant at the outlet (E) of the radiator (64) is smaller than a specific enthalpy (hc) of the refrigerant at a critical point (C). 50

7. The air conditioner according to any one of claims 1 to 6, wherein

the radiator (64) includes a first radiator (64A) and a second radiator (64B) that are connected in parallel to each other, the expansion valve (63) includes a first expansion valve (63A) associated with the first radiator (64A) and a second expansion valve (63B) associated with the second radiator (64B), and the control device (130) controls the high pressure (Ph) of the refrigerant circuit (6) based on one or both of a first temperature difference (ΔTRA) that is a temperature difference between an indoor temperature (TRA) and a target indoor temperature (TROA) associated with the first radiator (64A) and a second temperature difference (ΔTRB) that is a temperature difference between an indoor temperature (TRB) and a 55

target indoor temperature (TROB) associated with the second radiator (64B) .

8. The air conditioner according to claim 7, wherein the control device (130) controls the high pressure (Ph) of the refrigerant circuit (6) based on a larger one of the first temperature difference (ΔTRA) or the second temperature difference (ΔTRB). 5
9. The air conditioner according to any one of claims 1 to 8, wherein the refrigerant is carbon dioxide. 10

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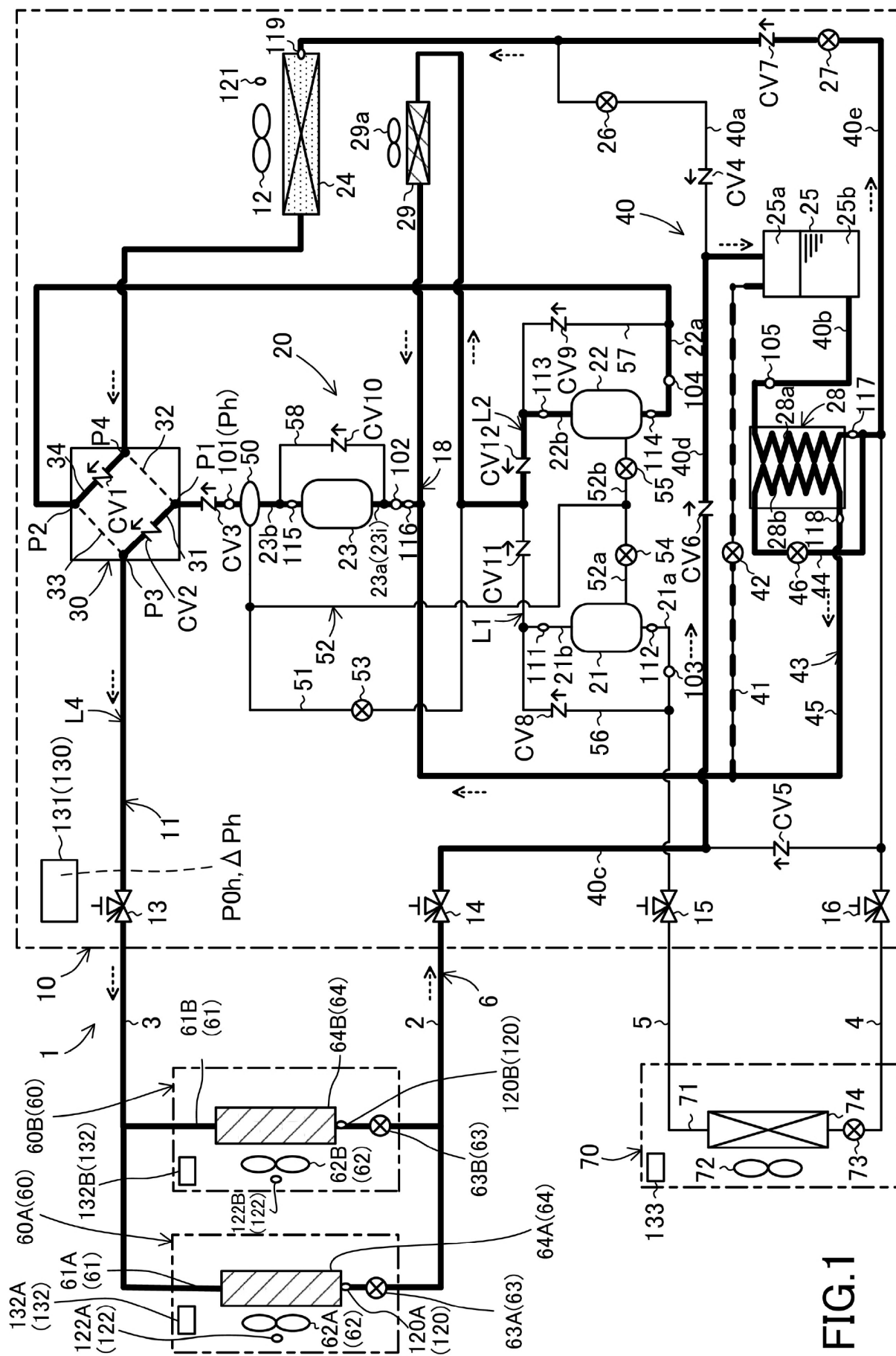


FIG.1

FIG.2

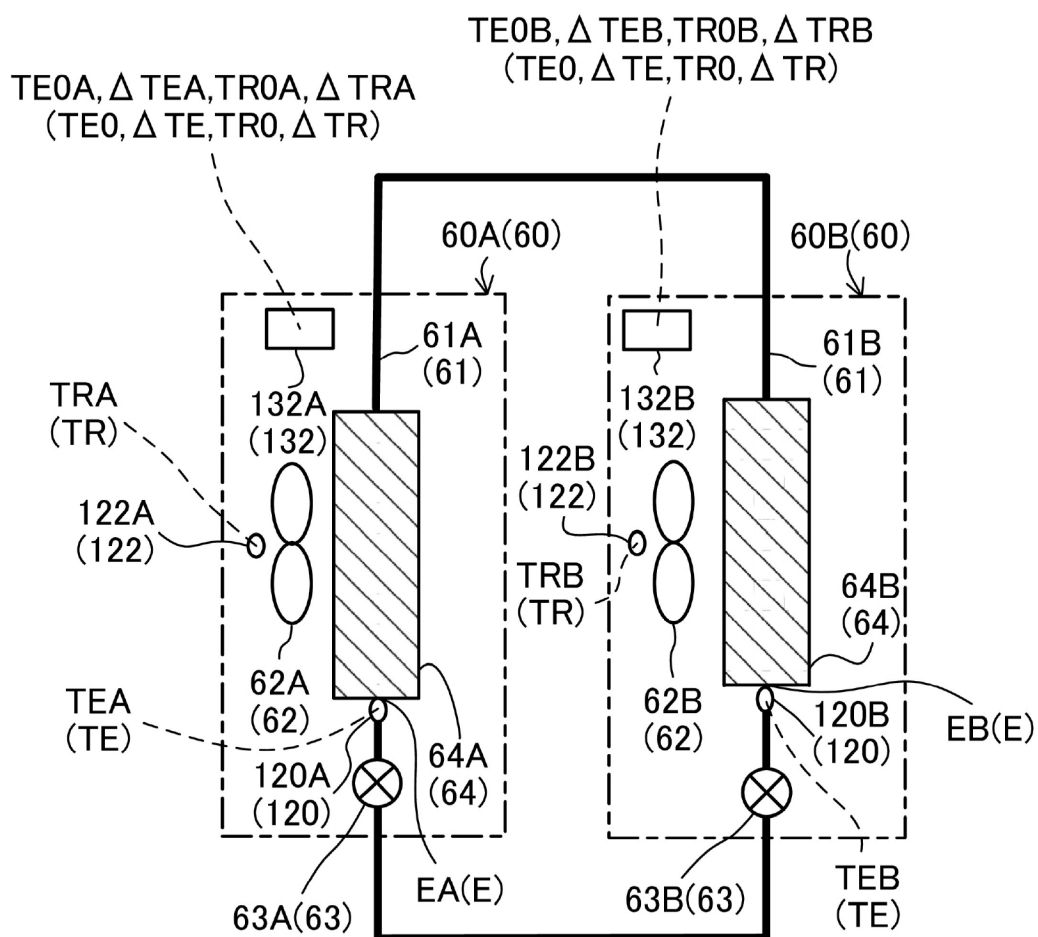


FIG.3

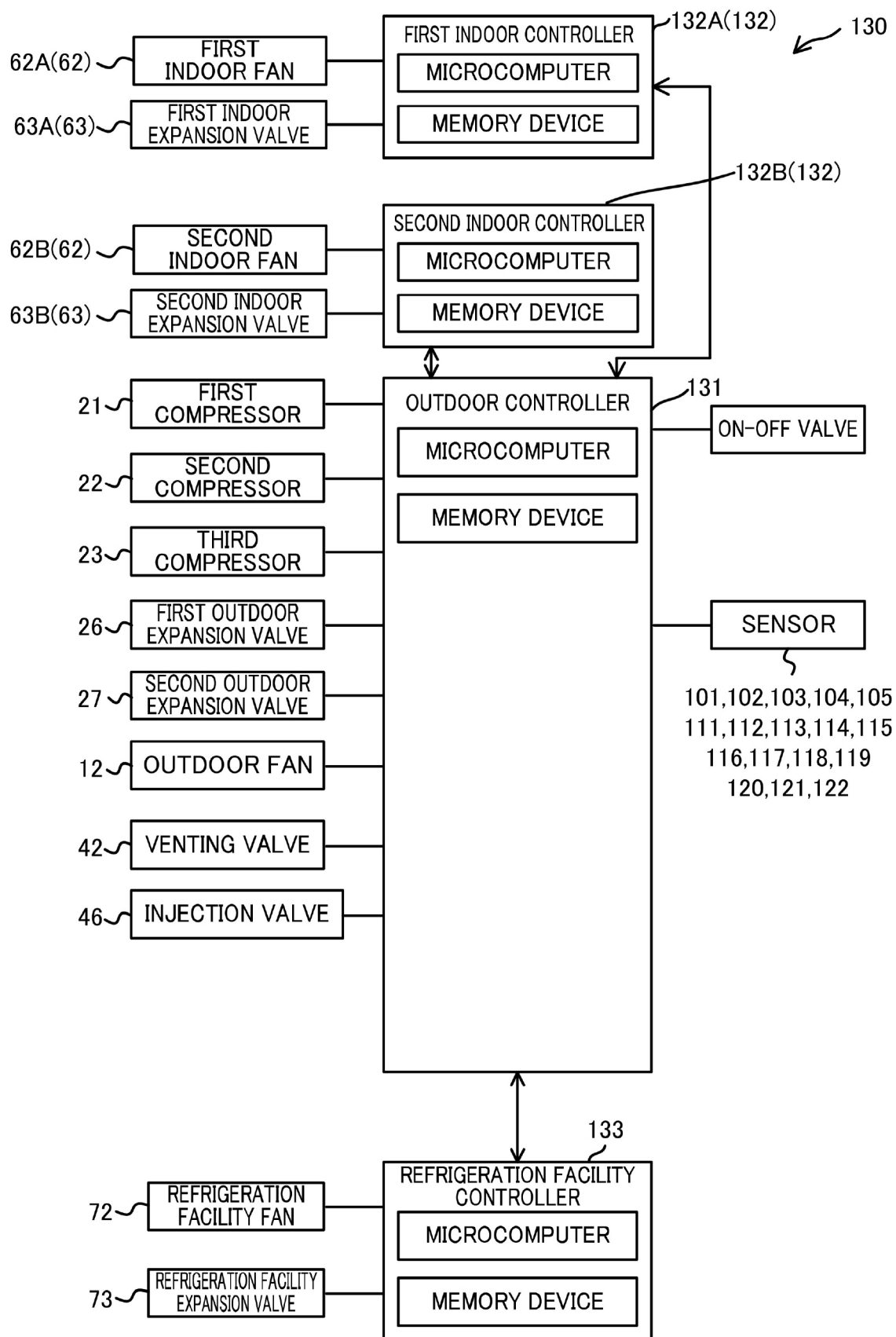


FIG.4

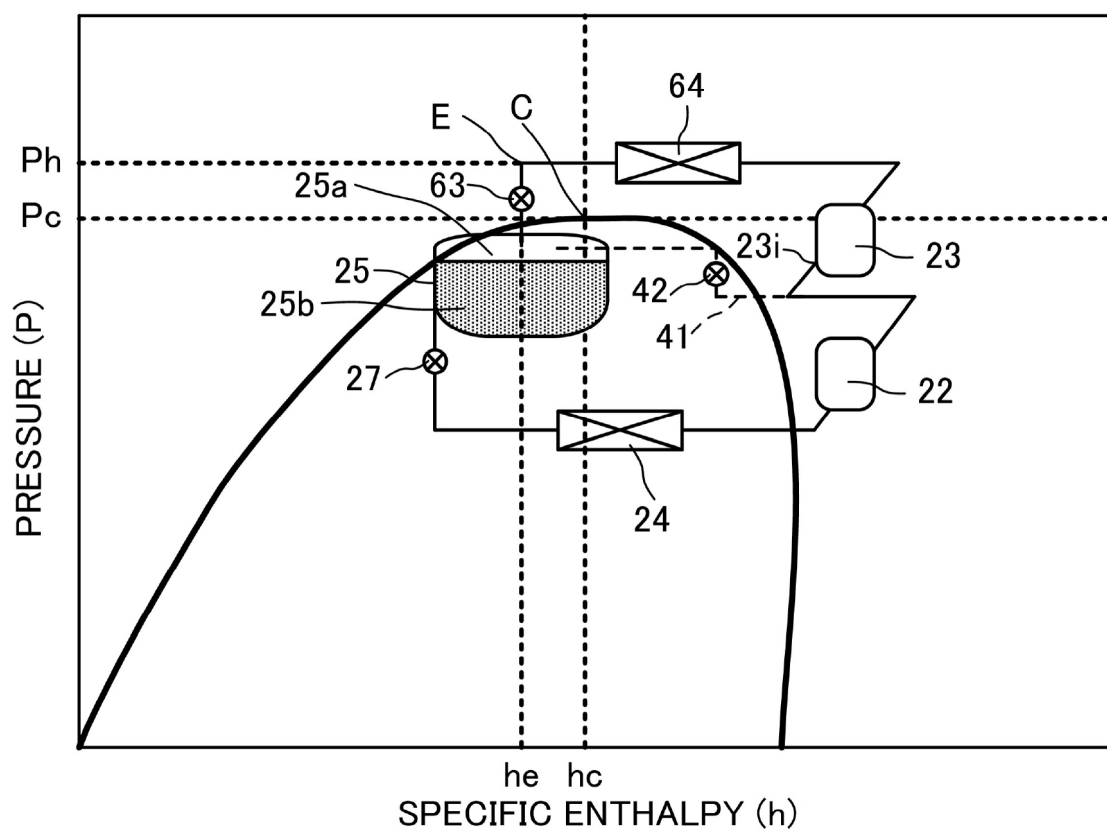
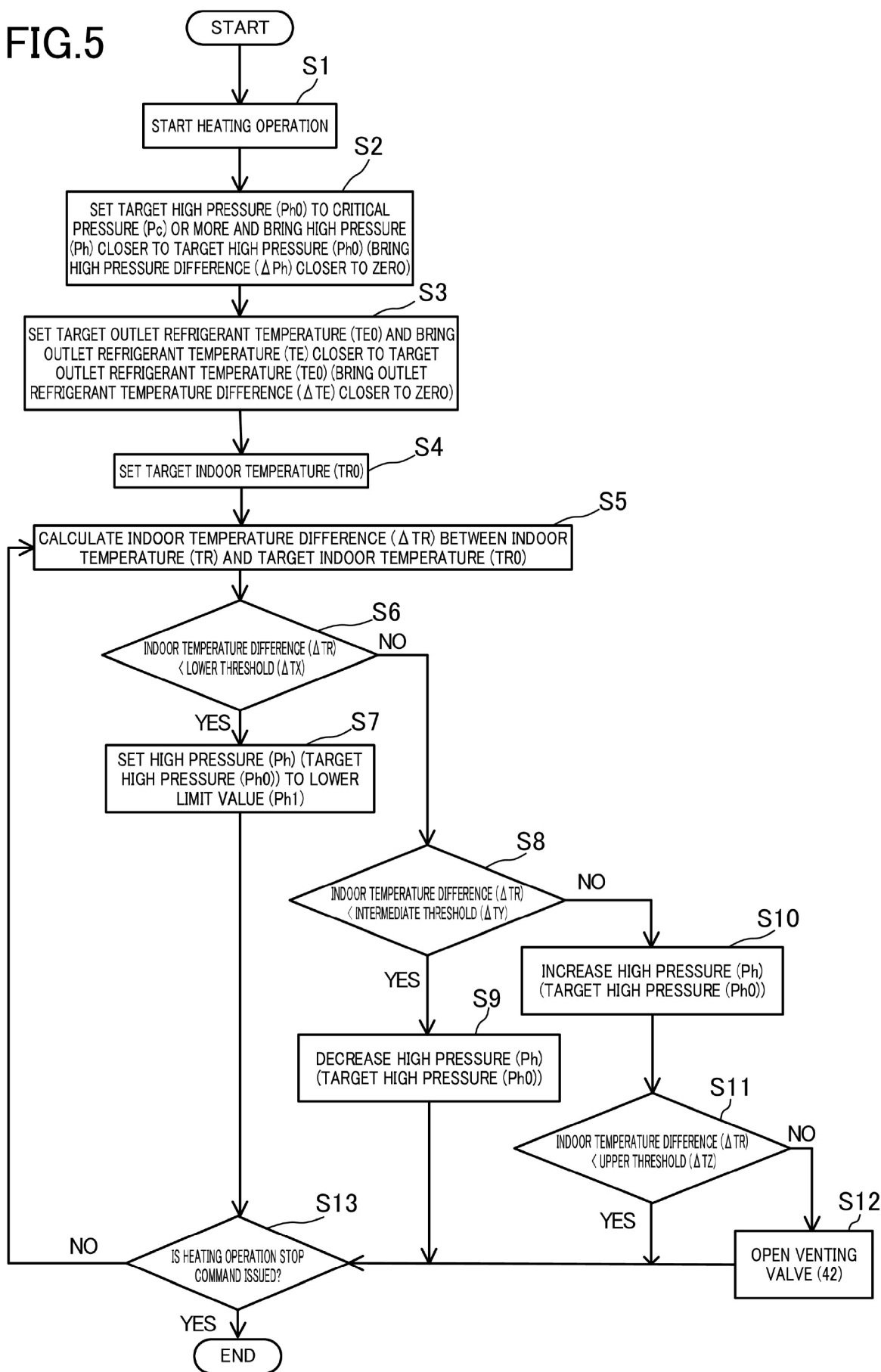


FIG.5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2024/017118

A. CLASSIFICATION OF SUBJECT MATTER

F25B 1/00(2006.01)i; **F25B 6/02**(2006.01)i; **F25B 41/20**(2021.01)i; **F25B 43/00**(2006.01)i
 FI: F25B1/00 371F; F25B1/00 396D; F25B1/00 304P; F25B41/20 Z; F25B43/00 L; F25B6/02 J

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)

F25B1/00; F25B43/00; F24F11/00-11/89

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 1971-2024
 Registered utility model specifications of Japan 1996-2024
 Published registered utility model applications of Japan 1994-2024

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	WO 2009/011197 A1 (MITSUBISHI ELECTRIC CORPORATION) 22 January 2009 (2009-01-22) paragraphs [0011]-[0015], [0021]-[0025], [0061]-[0082], fig. 1-2	1-4
Y		6-9
A		5
Y	JP 2021-55874 A (DAIKIN INDUSTRIES, LTD.) 08 April 2021 (2021-04-08) paragraphs [0030], [0040], [0042], fig. 1	6-9
Y	WO 2012/111063 A1 (MITSUBISHI ELECTRIC CORPORATION) 23 August 2012 (2012-08-23) paragraphs [0062]-[0067], fig. 1	7-9
A	WO 2017/208438 A1 (MITSUBISHI ELECTRIC CORPORATION) 07 December 2017 (2017-12-07) paragraphs [0030], [0089]-[0094], fig. 2	1, 9

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

☒ See patent family annex.

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“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

19 July 2024

Date of mailing of the international search report

30 July 2024

Name and mailing address of the ISA/JP

**Japan Patent Office (ISA/JP)
 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2024/017118

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				EP 2182304 A1	
				CN 101688701 A	
JP	2021-55874	A	08 April 2021	WO 2021/059635 A1 paragraphs [0030], [0040], [0042], fig. 1	
WO	2012/111063	A1	23 August 2012	US 2013/0312443 A1 paragraphs [0120]-[0125], fig. 1	
				EP 2677251 A1	
				CN 103370584 A	
WO	2017/208438	A1	07 December 2017	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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