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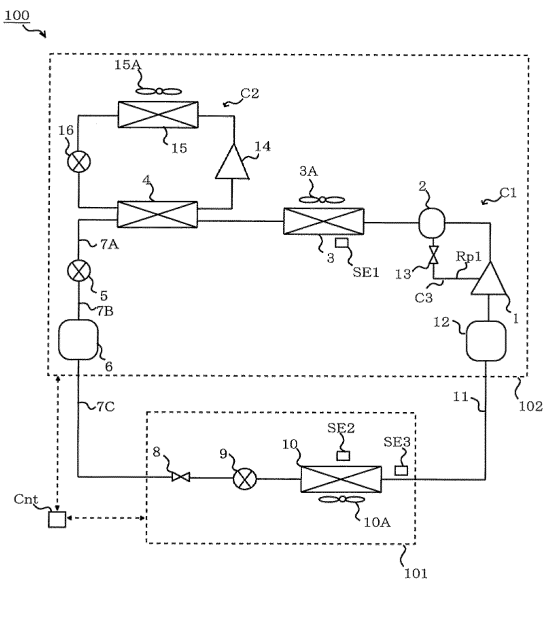
(54) REFRIGERATION CYCLE DEVICE

(57) A refrigeration cycle apparatus includes: a first refrigerant circuit including a first compressor, an oil separator, a first heat exchanger that functions as a condenser, a first refrigerant flow passage of a second heat exchanger, a first expansion device, and a third heat exchanger that functions as an evaporator, the first refrigerant circuit allowing first refrigerant to flow therein; a second refrigerant circuit including a second compressor, a fourth heat exchanger that functions as a condenser, a second expansion device, and a second refrigerant flow passage of the second heat exchanger, the second refrigerant circuit allowing second refrigerant to flow therein; an oil return circuit that includes a first opening and closing device, connects the oil separator and the first compressor, and returns, to the first compressor, refrigerating machine oil stored in the oil separator, and a controller configured to control the first compressor, the second compressor, the first expansion device, the second expansion device, and the first opening and closing device, wherein the controller implements first control of starting operation of the second compressor, and opening the first opening and closing device, in a case where the first compressor and the second compressor are stopped, and pressure in a low pressure part of the first refrigerant circuit is a reference value or more.

FIG. 1A



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Description

Technical Field

[0001] The present invention relates to a refrigeration cycle apparatus including a plurality of refrigerant circuits.

Background Art

[0002] Refrigeration cycle apparatuses have hitherto been proposed that include a low-stage circuit including a compressor, a cascade heat exchanger, a liquid receiving part, an expansion device, and an evaporator; and a high-stage circuit including a compressor, a condenser, an expansion device, a heat exchanger, and a cascade heat exchanger (for example, refer to Patent Literature 1). The evaporator of the low-stage circuit is used for, for example, cooling a target space for air-conditioning. In the cascade heat exchanger, refrigerant of the low-stage circuit is cooled by refrigerant of the high-stage circuit. Furthermore, a heat exchanger is provided in the liquid receiving part. Therefore, the refrigerant of the low-stage circuit is cooled by refrigerant of the liquid receiving part.

[0003] A compressor of the low temperature circuit is often stopped by, for example, power failure. When the compressor of the low-stage circuit is stopped, the refrigerant of the low-stage circuit does not circulate. Then, while gas refrigerant of the low-stage circuit is not cooled by the evaporator of the low-stage circuit, the gas refrigerant of the low-stage circuit is often heated by outdoor air. As a result, the pressure of the gas refrigerant of the low-stage circuit may increase. If high pressure refrigerant such as carbon dioxide refrigerant is used in a large amount, the pressure of the gas refrigerant increases more remarkably. If the outdoor air temperature is high, as in the summer, for example, the pressure of the gas refrigerant increases more remarkably. Examples of means to prepare for such increase of the pressure of the gas refrigerant include improving the withstand pressure in a pipe in which the gas refrigerant flows. However, improving the withstand pressure leads to an increase in pipe cost.

[0004] In the refrigeration cycle apparatus disclosed in Patent Literature 1, when the compressor of the low-stage circuit is stopped, operation of the compressor of the high-stage circuit is started. Consequently, in the cascade condenser and the liquid receiving part, the refrigerant of the high-stage circuit cools the refrigerant of the low-stage circuit. Thus, in the refrigeration cycle apparatus disclosed in Patent Literature 1, the refrigerant of the low-stage circuit is cooled, and the increase of the pressure of the low-stage circuit is suppressed.

Citation List

Patent Literature

[0005] Patent Literature 1: Japanese Patent No. 5575191

Summary of Invention

Technical Problem

[0006] In the refrigeration cycle apparatus of Patent Literature 1, even when the compressor of the low-stage circuit is stopped, the refrigerant of the low-stage circuit naturally circulates, and the refrigerant of the low-stage circuit is cooled by the refrigerant of the high-storage circuit. Herein, in a state where the compressor of the low-stage circuit is stopped, the refrigerant is often less likely to pass through the compressor of the low-storage circuit. In a case where the compressor is, for example, a scroll compressor, when refrigerant that reaches a refrigerant suction pipe of the compressor does not pass between a fixed scroll and an orbiting scroll, the refrigerant cannot reach a discharge pipe of the compressor. When the refrigerant is hard to pass through the compressor of the low-storage circuit, a flow rate of refrigerant that naturally circulates is reduced. In a case where this flow rate is reduced, when the rotation speed of the compressor of the high temperature circuit is not significantly increased, cooling of the refrigerant of the low-stage circuit is insufficient, and there is a possibility that the increase of the pressure of the low temperature circuit cannot be suppressed. That is, the refrigeration cycle apparatus of Patent Literature 1 has a problem that power consumption in the high-stage circuit is increased to suppress the increase of the pressure of the low-stage circuit.

[0007] The present invention has been made to solve the aforementioned problem in the conventional technology, and an object thereof is to provide a refrigeration cycle apparatus capable of suppressing increase of the pressure of refrigerant of a first refrigerant circuit (low-stage circuit) while suppressing power consumption. Solution to Problem

[0008] A refrigeration cycle apparatus according to one embodiment of the present invention includes: a first refrigerant circuit including a first compressor, an oil separator, a first heat exchanger that functions as a condenser, a first refrigerant flow passage of a second heat exchanger, a first expansion device, and a third heat exchanger that functions as an evaporator, the first refrigerant circuit allowing first refrigerant to flow therein; a second refrigerant circuit including a second compressor, a fourth heat exchanger that functions as a condenser, a second expansion device, and a second refrigerant flow passage of the second heat exchanger, the second refrigerant circuit allowing second refrigerant to flow therein; an oil return circuit that includes a first opening and closing device, connects the oil separator and the first compressor, and returns, to the first compressor, refrigerating machine oil stored in the oil separator, and a controller configured to control the first compressor, the second compressor, and the first opening and closing device, wherein the controller implements first control of starting operation of the second compressor, and opening the first opening and closing device, in a case where the first compressor and the second compressor are stopped, and pressure in a low pressure part of the first refrigerant circuit is a reference value or more.

Advantageous Effects of Invention

[0009] The refrigeration cycle apparatus according to one embodiment of the present invention includes the aforementioned configuration, and therefore it is possible to suppress increase of the pressure of refrigerant of the first refrigerant circuit (low-stage circuit) while suppressing power consumption.

Brief Description of Drawings

[0010]

[Fig. 1A] Fig. 1A illustrates a refrigerant circuit configuration and relevant components of a refrigeration cycle apparatus 100 according to Embodiment 1.
[Fig. 1B] Fig. 1B is a schematic diagram of a first compressor 1 included in the refrigeration cycle apparatus 100 according to Embodiment 1.
[Fig. 1C] Fig. 1C illustrates an installation example of the refrigeration cycle apparatus 100 according to Embodiment 1.
[Fig. 1D] Fig. 1D is a function block diagram of a controller Cnt of the refrigeration cycle apparatus 100 according to Embodiment 1.
[Fig. 1E] Fig. 1E is a diagram illustrating positional relation between a second heat exchanger 4 and a liquid receiver 6.
[Fig. 1F] Fig. 1F is a diagram illustrating an effect of the refrigeration cycle apparatus 100 according to Embodiment 1.
[Fig. 1G] Fig. 1G is a modification of the refrigeration cycle apparatus 100 according to Embodiment 1.
[Fig. 2A] Fig. 2A is a diagram illustrating a configuration of a refrigeration cycle apparatus 200 according to Embodiment 2.
[Fig. 2B] Fig. 2B is a function block diagram of a controller Cnt of the refrigeration cycle apparatus 200 according to Embodiment 2.
[Fig. 2C] Fig. 2C is Modification 1 of the refrigeration cycle apparatus 200 according to Embodiment 2.
[Fig. 2D] Fig. 2D is Modification 2 of the refrigeration cycle apparatus 200 according to Embodiment 2.

Description of Embodiments

[0011] Embodiments of a refrigeration cycle apparatus according to the present invention will be described with reference to the drawings. The present invention is not limited to the embodiments of the drawings illustrated in the following, but can be suitably changed and modified within the technical scope of the present invention.

Embodiment 1

[0012] Fig. 1A illustrates a refrigerant circuit configuration and relevant components of a refrigeration cycle apparatus 100 according to Embodiment 1.
[0013] Fig. 1B is a schematic diagram of a first compressor 1 included in the refrigeration cycle apparatus 100 according to Embodiment 1.
[0014] Fig. 1C illustrates an installation example of the refrigeration cycle apparatus 100 according to Embodiment 1.

[Entire Configuration Description]

[0015] The refrigeration cycle apparatus 100 includes an indoor unit 101 and an outdoor unit 102. As illustrated in Fig. 1C, the indoor unit 101 is provided in a building Bd. The outdoor unit 102 is provided outside the building Bd. The indoor unit 101 and the outdoor unit 102 are connected through a refrigerant pipe 7C and a refrigerant pipe 11. Refrigerant of two-phase gas-liquid flows in the refrigerant pipe 7C. Gas refrigerant flows in the refrigerant pipe 11.
[0016] As illustrated in Fig. 1A, Fig. 1B and Fig. 1C, the refrigeration cycle apparatus 100 includes a first refrigerant circuit C1, and a second refrigerant circuit C2. That is, the refrigeration cycle apparatus 100 has a dual refrigeration cycle. The first refrigerant circuit C1 corresponds to a first refrigeration cycle (low-stage refrigeration cycle), and the second refrigerant circuit C2 corresponds to a second refrigeration cycle (high-stage refrigeration cycle). Cooling capability of the second refrigerant circuit C2 is lower than cooling capability of the first refrigerant circuit C1. The first refrigerant circuit C1 and the second refrigerant circuit C2 are independent refrigerant circuits. First refrigerant that circulates in the first refrigerant circuit C1, and second refrigerant that circulates in the second refrigerant circuit C2 may be the same kind of refrigerant, or may be different kinds of refrigerants. In Embodiment 1, the first refrigerant is carbon dioxide refrigerant. The carbon dioxide refrigerant is refrigerant having low global warming potential, and having small environmental load. On the other hand, the carbon dioxide refrigerant has high working pressure. The carbon dioxide refrigerant can be also used for the second refrigerant. The refrigeration cycle apparatus 100 is equivalent to, for example, a refrigeration device configured to store stored goods and other goods, an air-conditioning device for cooling an air-conditioned space, or other devices. In Embodiment 1, the refrigeration cycle apparatus 100 will be described as a refrigeration device.
[0017] The refrigeration cycle apparatus 100 includes

the controller Cnt. The refrigeration cycle apparatus 100 includes a first fan 3A, a second fan 10A, and a fan 15A. Additionally, the refrigeration cycle apparatus 100 includes a condenser temperature sensor SE1, an evaporator temperature sensor SE2, and a pressure sensor SE3.

[0018] The first refrigerant circuit C1 includes the first compressor 1, the oil separator 2, a first heat exchanger 3, a first refrigerant flow passage of a second heat exchanger 4, a first expansion device 5, the liquid receiver 6, a valve 8, an expansion device 9, a third heat exchanger 10, and an accumulator 12. Additionally, the first refrigerant circuit C1 includes an oil return circuit C3. The oil return circuit C3 includes a pipe Rp1 that connects the oil separator 2 and the first compressor 1, and an opening and closing device 13 provided in this pipe Rp1. Furthermore, the first refrigerant circuit C1 includes a refrigerant pipe 7A, a refrigerant pipe 7B, the refrigerant pipe 7C, and the refrigerant pipe 11. The first refrigerant flows in the first refrigerant circuit C1. The first refrigerant circuit C1 is configured such that the first refrigerant flows sequentially in the order of the first compressor 1, the oil separator 2, the first heat exchanger 3, the first refrigerant flow passage of the second heat exchanger 4, the first expansion device 5, the liquid receiver 6, the valve 8, the expansion device 9, the third heat exchanger 10, and the accumulator 12. The refrigerant pipe 7A connects the second heat exchanger 4 and the first expansion device 5. The refrigerant pipe 7B connects the first expansion device 5 and the liquid receiver 6. The refrigerant pipe 7C connects the liquid receiver 6 and the valve 8. The refrigerant pipe 11 connects the third heat exchanger 10 and the accumulator 12. The refrigerant pipe 7C and the refrigerant pipe 11 each are a pipe for connecting the indoor unit 101 and the outdoor unit 102. The first refrigerant circuit C1 has a function of cooling an object to be cooled by the refrigeration cycle apparatus 100. In Embodiment 1, the indoor unit 101 supplies cold air to a space SP provided with the indoor unit 101. Consequently, stored goods and the other goods in the space SP are cooled. Herein, the space SP is a space in, for example, the building Bd that refrigerates and preserves the stored goods.

[0019] The second refrigerant circuit C2 includes a second compressor 14, a fourth heat exchanger 15, a second expansion device 16, and a second refrigerant flow passage of the second heat exchanger 4. The second refrigerant flows in the second refrigerant circuit C2. The second refrigerant circuit C2 is configured such that the second refrigerant flows in the order of the second compressor 14, the fourth heat exchanger 15, the second expansion device 16, and the second refrigerant flow passage of the second heat exchanger 4. The second refrigerant circuit C2 has a function of super-cooling the first refrigerant circuit C1, and a function of cooling the first refrigerant in the first refrigerant circuit C1 when the first compressor 1 is stopped.

[0020] The first compressor 1 compresses the first refrigerant to increase the temperature and the pressure of the first refrigerant. A case where the first compressor 1 is a scroll compressor will be described as an example. The first compressor 1 includes an airtight vessel 1A, a compression mechanism 1B, a stator 1C, a rotor 1D, a shaft 1E, a suction pipe 1F, and a discharge pipe 1G. The compression mechanism 1B includes a fixed scroll and an orbiting scroll. A compression chamber that compresses the first refrigerant is formed between the fixed scroll and the orbiting scroll. The stator 1C is fixed in the airtight vessel 1A. Refrigerating machine oil is stored on a bottom of the airtight vessel 1A. The refrigerating machine oil in the airtight vessel 1A is drawn into a flow passage (not illustrated) in the shaft 1E by rotation of the shaft 1E. The refrigerating machine oil drawn into the flow passage in the shaft 1E is supplied to the compression mechanism 1B. The suction pipe 1F, the discharge pipe 1G, and the pipe Rp1 of the oil return circuit C3 are connected to the airtight vessel 1A. A suction part of the first compressor 1 corresponds to the suction pipe 1F, or a refrigerant pipe connected to the suction pipe 1 F. A discharge part of the first compressor 1 corresponds to the discharge pipe 1G, or a refrigerant pipe connected to the discharge pipe 1G. Refrigerating machine oil stored in the oil separator 2 is returned from the pipe Rp1 to the airtight vessel 1A. The second compressor 14 compresses the second refrigerant to increase the temperature and the pressure of the second refrigerant. The oil separator 2 stores the refrigerating machine oil discharged together with the refrigerant from the first compressor 1. The refrigerating machine oil stored in the oil separator 2 is returned to the first compressor 1 through the oil return circuit C3. The oil return circuit C3 has one end being connected to the oil separator 2, and the other end connected to the first compressor 1. The oil return circuit C3 connects the oil separator 2 and the first compressor 1, and the refrigerating machine oil stored in the oil separator 2 is returned to the first compressor 1.

[0021] The first heat exchanger 3 has one side being connected to the oil separator 2 through the refrigerant pipe, and the other side being connected to the second heat exchanger 4 through the refrigerant pipe. The first heat exchanger 3 is provided with the first fan 3A. In the first heat exchanger 3, air and the first refrigerant exchange heat.

[0022] The second heat exchanger 4 includes the first refrigerant flow passage and the second refrigerant flow passage. The second heat exchanger 4 is a cascade heat exchanger. The second heat exchanger 4 is configured such that the first refrigerant that flows in the first refrigerant flow passage, and the second refrigerant that flows in the second refrigerant flow passage can exchange heat. The first refrigerant flow passage of the second heat exchanger 4 has one side being connected to the first heat exchanger 3 through the refrigerant pipe, and the other side being connected to the first expansion device 5 through the refrigerant pipe 7A. The second refrigerant flow passage of the second heat exchanger

4 has one side being connected to the second expansion device 16 through the refrigerant pipe, and the other side being connected to a suction part for refrigerant of the second compressor 14 through the refrigerant pipe.

[0023] The first expansion device 5 and the expansion device 9 may be each composed of a solenoid valve that can control the opening degree. Additionally, a capillary tube can be used in each of the first expansion device 5 and the expansion device 9. The liquid receiver 6 has a function of storing liquid refrigerant. The liquid receiver 6 is provided on a downstream side relative to the condenser. That is, the liquid receiver 6 is provided on a downstream side relative to the first refrigerant flow passage of the second heat exchanger that functions as the condenser. The valve 8 may be composed of, for example, a solenoid valve that can control opening and closing. The valve 8 is provided in the indoor unit 101.

[0024] The third heat exchanger 10 has one side being connected to the expansion device 9 through the refrigerant pipe, and the other side being connected to the accumulator 12 through the refrigerant pipe. The third heat exchanger 10 is provided with the second fan 10A. In the third heat exchanger 10, air and the first refrigerant exchange heat. The air cooled in the third heat exchanger 10 is supplied to the space to be air-conditioned.

[0025] The fourth heat exchanger 15 has one side being connected to the second compressor 14 through the refrigerant pipe, and the other side being connected to the second expansion device 16 through the refrigerant pipe. The fourth heat exchanger 15 is provided with the fan 15A. In the fourth heat exchanger 15, air and the second refrigerant exchange heat. The second expansion device 16 can be composed of a solenoid valve that can control the opening degree. Additionally, a capillary tube can be used in the second expansion device 16.

[0026] An embodiment in which the refrigerant (the first refrigerant and the second refrigerant) and air exchange heat in the first heat exchanger 3 and the fourth heat exchanger 15 is described as an example. However, the first heat exchanger 3 and the fourth heat exchanger 15 are not limited to this embodiment. An embodiment in which refrigerant and heat medium other than air exchange heat may be used in the first heat exchanger 3 and the fourth heat exchanger 15. That is, a heat medium circuit independent of the first refrigerant circuit C1 and the second refrigerant circuit may be connected to the first heat exchanger 3 and the fourth heat exchanger 15. For example, water, brine, refrigerant, or other heat medium can be used as the heat medium. When the heat medium is water and brine, pumps that convey water and brine can be used in place of the first fan 3A and the fan 15A that supply air. When the heat medium is refrigerant, a compressor that compresses refrigerant can be used in place of the first fan 3A and the fan 15A that supply air.

[Description of Controller Cnt]

[0027] Fig. 1D is a function block diagram of the controller Cnt of the refrigeration cycle apparatus 100 according to Embodiment 1. First control implemented by the refrigeration cycle apparatus 100, and a configuration of the controller Cnt, and the like will be described with reference to Fig. 1D.

[0028] The controller Cnt acquires information of the detected temperature of the condenser temperature sensor SE1, and information of the detected temperature of the evaporator temperature sensor SE2, and information of the detected pressure of the pressure sensor SE3. The condenser temperature sensor SE1 corresponds to a first temperature sensor of the present invention, and the evaporator temperature sensor SE2 corresponds to a second temperature sensor of the present invention.

[0029] The controller Cnt has a function of implementing the first control of starting operation of the second compressor 14 and opening the opening and closing device 13 in a case where the first compressor 1 and the second compressor 14 are stopped, and the pressure in a low pressure part of the first refrigerant circuit C1 is a reference value or more. Examples of the case in which the first compressor 1 and the second compressor 14 stop include a case in which a user turns off a power source of the refrigeration cycle apparatus 100. In a season in which the outdoor air temperature is high, such as summer, the temperature of the refrigerant pipe 11 in which the first refrigerant being in a gas state is sealed tends to increase. As a result, the pressure of the first refrigerant in the refrigerant pipe 11 increases to the reference value or more, and a possibility that the refrigerant pipe 11 is broken is increased. Additionally, even when the withstand pressure of the refrigerant pipe 11 is improved to prevent such breakage, pipe cost is increased. Therefore, in the case where the first compressor 1 and the second compressor 14 stop, and the pressure in the low pressure part of the first refrigerant circuit C1 is the reference value or more, even when the power source of the refrigeration cycle apparatus 100 is turned off, operation of the second compressor 14 is automatically started. The controller Cnt also operates the fan 15A, and the second expansion device 16 has a predetermined opening degree. Consequently, in the second heat exchanger, second refrigerant in the second refrigerant circuit C2 cools first refrigerant in the first refrigerant circuit C1, and increase of the pressure of the first refrigerant is suppressed. When the second refrigerant in the second refrigerant circuit C2 cools the first refrigerant in the first refrigerant circuit C1, the first refrigerant naturally circulates in the first refrigerant circuit C1. That is, the capability of conveying the first refrigerant at this time is smaller than the capability of conveying the first refrigerant during operation of the first compressor 1. Therefore, when the first refrigerant is hard to pass through the first compressor 1, a flow rate of the first refrigerant is reduced. In a case where the flow rate of the first refrigerant is reduced, when the rotation speed of the second compressor 14 of the second refrigerant circuit C2 is not increased, and the cooling capability is not increased, there is a possibility that the increase of the pressure in the first refrigerant circuit C1 cannot be suppressed. Therefore, in the refrigeration cycle apparatus 100, the opening and closing device 13 is opened in synchronization with start of operation of the second compressor 14. Consequently, the first refrigerant is likely to pass through the first compressor 1, and it is possible to suppress reduction of the flow rate of the first refrigerant even when the first refrigerant naturally circulates.

[0030] The implementation condition and the configuration of the first control may be as follows.

[0031] In a case where the detected temperature of the first heat exchanger 3 is not lower than the detected temperature of the third heat exchanger 10, the controller Cnt implements the first control in a state in which the first fan 3A and the second fan 10A are stopped. A condition that the detected temperature of the first heat exchanger 3 is not lower than the detected temperature of the third heat exchanger 10 is a condition that a likelihood that the first refrigerant can be liquefied even when the first refrigerant passes through the first heat exchanger 3 in a state in which the first fan 3A is operated is low. For example, when the outdoor air temperature is high like summer, the temperature of the first heat exchanger 3 provided in the outdoor unit 102 is increased. Accordingly, even when the first fan 3A is operated, and air is supplied to the first heat exchanger 3, the first refrigerant is not liquefied. Therefore, the refrigeration cycle apparatus 100 stops the first fan 3A to suppress power consumption. Additionally, the second fan 10A is brought into a stop state. This is because when the second fan 10A is operated, gasification of the first refrigerant is facilitated, and the pressure of the first refrigerant is increased.

[0032] Furthermore, the implementation condition and the configuration of the first control may be as follows.

[0033] In a case where the detected temperature of the first heat exchanger 3 is lower than the detected temperature of the third heat exchanger 10, the controller Cnt implements second control of operating the first fan 3A and the second fan in a state of stopping the second compressor 14, without conducting the first control. A condition that the detected temperature of the first heat exchanger 3 is lower than the detected temperature of the third heat exchanger 10 is a condition that there is a likelihood that the first refrigerant can be liquefied by making the first refrigerant pass through the first heat exchanger 3 in a state of operating the first fan 3A. For example, when the outdoor air temperature is low as in winter and night, the temperature of the first heat exchanger 3 provided in the outdoor unit 102 is reduced. Accordingly, when the first fan 3A is operated, and air is supplied to the first heat exchanger 3, the first refrigerant is liquefied, and it is possible to suppress increase of the pressure of the first refrigerant. The second fan 10A is brought into a stop state. This is because when the second fan 10A is operated, gasification of the first refrigerant is facilitated, and the pressure of the first refrigerant is increased.

[0034] In a case where the first compressor 1 and the second compressor 14 are stopped, a case of power failure is assumed. In the case of power failure, the refrigeration cycle apparatus 100 receives electric power supply from a different system, and performs various operations.

[0035] The controller Cnt includes a determination unit 90A, an operation control unit 90B, and a storage unit 90C.

[0036] The determination unit 90A has a function of determining whether or not the pressure in the low pressure part of the first refrigerant circuit C1 is the reference value or more. The low pressure part of the first refrigerant circuit C1 means, for example, a downstream side of the expansion device 9, and an upstream side of the suction part of the first compressor 1. That is, the low pressure part of the first refrigerant circuit C1 means a portion in which refrigerant decompressed by the expansion device flows. The determination unit 90A determines whether or not the pressure in the low pressure part of the first refrigerant circuit C1 is the reference value or more on the basis of the detected pressure in the pressure sensor SE3. This determination may be performed by using, for example, the outdoor air temperature in place of the pressure sensor SE3. This is because the outdoor air temperature is correlated with the first refrigerant circuit C1. Additionally, the determination unit 90A is configured to determine whether or not the detected temperature of the first heat exchanger 3 is not lower than the detected temperature of the third heat exchanger 10. Furthermore, the determination unit 90A is configured to determine whether or not the detected temperature of the first heat exchanger 3 is lower than the detected temperature of the third heat exchanger 10.

[0037] The operation control unit 90B controls the rotation speed of the first compressor 1 and the rotation speed of the second compressor 14. In a case where the first expansion device 5, the expansion device 9, and the second expansion device 16 each are a solenoid valve, the operation control unit 90B controls the opening degree of the first expansion device 5, the opening degree of the expansion device 9, and the opening degree of the second expansion device 16. The operation control unit 90B controls the fan rotation speed of the first fan 3A, the fan rotation speed of the second fan 10A, and the fan rotation speed of the fan 15A. Additionally, the operation control unit 90B controls opening and closing of the valve 8, and opening and closing of the opening and closing device 13. In a case where the determination unit 90A determines that the pressure in the low pressure part of the first refrigerant circuit C1 is the reference value or more, the operation control unit 90B performs the first control. In a case where the determination unit 90A determines that the detected temperature of the first heat exchanger 3 is not lower than the detected temperature of the third heat exchanger 10, the operation control unit 90B implements the first control in a state where the first fan 3A and the second fan 10A are stopped. In a case where the determination unit 90A determines that the detected temperature of the first heat exchanger 3 is lower than the detected temperature of the third heat exchanger 10, the operation control unit 90B implements the second control without implementing the first control.

[0038] Various data is stored in the storage unit 90C.

[0039] Each functional part included in the controller Cnt is composed of an MPU (Micro Processing Unit) that executes a program stored in dedicated hardware, or a memory. In a case where the controller Cnt is a dedicated hardware, the controller Cnt is equivalent to, for example, a single circuit, a combined circuit, an ASIC (application specific integrated circuit), an FPGA (field-programmable gate array), or combination thereof. Each functional part implemented by the controller Cnt may be implemented by an individual hardware, or each functional part may be implemented by a single hardware. In a case where the controller Cnt is an MPU, each function to be performed by the controller Cnt is implemented by software, firmware, or combination of software and firmware. The software or the firmware is described as a program, and stored in a memory. The MPU reads out and executes the program stored in the memory, so that each function of the controller Cnt is implemented. The memory is, for example, a nonvolatile or volatile semiconductor memory such as a RAM, a ROM, a flash memory, an EPROM, and an EEPROM.

[Positional Relation between Second Heat Exchanger 4 and Liquid Receiver 6]

[0040] Fig. 1E is a diagram for illustrating positional relation between the second heat exchanger 4 and the liquid receiver 6. The Z direction in Fig. 1E is the gravity direction. The liquid receiver 6 is disposed on a lower side relative to the second heat exchanger 4. Consequently, the first refrigerant liquefied by the second heat exchanger 4 promptly flows into the liquid receiver 6. In a case where the first control is implemented, the first refrigerant naturally circulates. Therefore, the capability of conveying the first refrigerant is smaller than the conveying capability of the first refrigerant during operation of the first compressor 1. Therefore, in the refrigeration cycle apparatus 100, the liquid receiver 6 is disposed on the lower side relative to the second heat exchanger 4 such that the first refrigerant liquefied promptly flows into the liquid receiver 6. Additionally, the refrigerant pipe 7A and the refrigerant pipe 7B are configured such that the first refrigerant liquefied by the second heat exchanger 4 tends to flow into the liquid receiver 6. That is, the refrigerant pipe 7A and the refrigerant pipe 7B are not configured such that, for example, the first refrigerant flows from the lower side to the upper side when the first refrigerant flows from the second heat exchanger 4 to the liquid receiver 6.

[Operation Description of Embodiment 1 (Normal Operation)]

[0041] The first refrigerant in the first refrigerant circuit C1 flows into the first heat exchanger 3 when the first refrigerant is discharged from the first compressor 1. The first refrigerant that flows into the first heat exchanger 3 transfers heat to air supplied from the first fan 3A. The first refrigerant that flows out from the first heat exchanger 3 flows into the second heat exchanger 4. The first refrigerant in the second heat exchanger 4 is cooled by the second refrigerant. The first refrigerant that flows out from the second heat exchanger 4 is decompressed by the first expansion device 5 to reduce the temperature and the pressure. The first refrigerant that flows out from the first expansion device 5 flows into the third heat exchanger 10. The first refrigerant that flows into the third heat exchanger 10 suctions heat from air supplied from the second fan 10A to cool the air. The first refrigerant that flows out from the third heat exchanger 10 flows into the accumulator 12. The first refrigerant that flows out from the accumulator 12 is suctioned into the first compressor 1.

[0042] When the second refrigerant in the second refrigerant circuit C2 is discharged from the second compressor 14, the second refrigerant flows into the fourth heat exchanger 15. The second refrigerant that flows into the fourth heat exchanger 15 transfers heat to air supplied from the fan 15A. The second refrigerant that flows out from the fourth heat exchanger 15 is decompressed by the second expansion device 16 to reduce the temperature and the pressure. The second refrigerant that flows out from the first expansion device 5 flows into the second heat exchanger 4 to cool the first refrigerant. Consequently, it is possible to give the degree of super-cooling to the first refrigerant. In a case where the first compressor 1 is stopped, it is possible to suppress increase in the pressure of the first refrigerant. The refrigerant that flows out from the second heat exchanger 4 is suctioned into the second compressor 14.

[Explanation on Operation of Embodiment 1 (First Control)]

[0043] In a case where the first compressor 1 and the second compressor 14 are stopped, and the pressure in the low pressure part of the first refrigerant circuit C1 is the reference value or more, the controller Cnt starts operation of the second compressor 14. The controller Cnt opens the opening and closing device 13. The first refrigerant in the low pressure part of the first refrigerant circuit C1 has high pressure, and therefore the first refrigerant in the first refrigerant circuit C1 naturally circulates. The first refrigerant flows into the airtight vessel 1A from the suction part of the first compressor 1. Then, the first refrigerant that flows into the airtight vessel 1A flows into the oil separator 2 through the pipe Rp1 and the opening and closing device 13. Then, the first refrigerant that flows into the oil separator 2 flows into the second heat exchanger 4 through the first heat exchanger 3. The first refrigerant that flows into the second heat exchanger 4 is cooled by the second refrigerant in the second refrigerant circuit to be brought into a two-phase gas-liquid state. The first refrigerant in the two-phase gas-liquid state flows into the liquid receiver 6 through the refrigerant pipe 7A and the first expansion device 5. Liquid refrigerant in the first refrigerant is stored in the liquid receiver 6, and gas refrigerant in the first refrigerant flows into the third heat exchanger 10 through the refrigerant pipe 7C, the valve 8, and the expansion device 9. The first refrigerant circulates in the first refrigerant circuit C1, so that the first refrigerant is cooled by second refrigerant in the second heat exchanger 4 to increase liquid refrigerant to be stored in the liquid receiver 6. Thus, increase of the pressure of the first refrigerant in the first refrigerant circuit is suppressed.

[Effects of Embodiment 1]

[0044] Fig. 1F is a diagram for illustrating an effect of the refrigeration cycle apparatus 100 according to Embodiment 1.

[0045] A horizontal axis of a graph illustrated in Fig. 1F denotes the cooling capability of the refrigeration cycle apparatus, and a vertical axis denotes the pressure of the first refrigerant circuit. A curved line L1 of the graph illustrated in Fig. 1F denotes the cooling capability of a conventional refrigeration cycle apparatus. A curved line L2 of the graph illustrated in Fig. 1F denotes the cooling capability of the refrigeration cycle apparatus 100. A curved line L3 of the graph illustrated in Fig. 1F denotes a reference value of the aforementioned pressure.

[0046] As illustrated in Fig. 1F, in the existing refrigeration cycle apparatus, even when the cooling capability is improved, that is, the rotation speed of the second compressor of the second refrigerant circuit is increased, the pressure in the first refrigerant circuit is not lower than a reference value of the low pressure part. However, in the refrigeration cycle apparatus 100, when the first control is implemented, the opening and closing device 13 is opened, and therefore the circulation amount (flow rate) of the first refrigerant in the first refrigerant circuit C1 is increased. Accordingly, the first refrigerant can be efficiently cooled by the second refrigerant, and it is possible to suppress increase of the rotation speed of the second compressor 14. That is, in the refrigeration cycle apparatus 100, it is possible to suppress increase of the pressure of the refrigerant in the first refrigerant circuit (low temperature circuit) while suppressing the power consumption.

[Modification of Embodiment 1]

[0047] Fig. 1G is a modification of the refrigeration cycle apparatus 100 according to Embodiment 1. In Embodiment 1, an embodiment in which the refrigeration cycle apparatus 100 receives electric power supply from a different system in a case where power failure occurs is described as an example. In the modification, electric power used in a refrigeration cycle apparatus 100 is received from an electric storage part Bt in place of a different system. The electric storage part Bt is a battery.

[0048] When power failure occurs, the refrigeration cycle apparatus 100 cannot be operated. For example, when a stop period of the refrigeration cycle apparatus 100 lasts for a long time in summer, a possibility is increased that the pressure in the low pressure part of the first refrigerant circuit C1 is increased. Therefore, in the modification of Embodiment 1, electric power supply from the electric storage part Bt can be received. That is, in the modification of Embodiment 1, the electric storage part Bt that supplies electric power to the second compressor 14 is provided. The electric storage part Bt supplies electric power to the outdoor unit 102, the indoor unit 101, and the controller Cnt.

Embodiment 2

[0049] Now, Embodiment 2 will be described with reference to the drawings. Description of portions common to the aforementioned Embodiment 1 will be omitted, and different portions will be mainly described.

[0050] Fig. 2A is a diagram illustrating a configuration of a refrigeration cycle apparatus 200 according to Embodiment 2.

[0051] Fig. 2B is a function block diagram of a controller Cnt of the refrigeration cycle apparatus 200 according to Embodiment 2.

[0052] The refrigeration cycle apparatus 200 according to Embodiment 2 includes a bypass C4 in addition to an oil return circuit C3. The bypass C4 includes a pipe Rp2 that connects a discharge part for first refrigerant of a first compressor 1, and a suction part for the first refrigerant of the first compressor 1, and an opening and closing device 13B provided in this pipe Rp2. The pipe Rp2 of the bypass C4 bypasses the first compressor 1. The pipe Rp2 of the bypass C4 includes one end being connected to the suction part for the first refrigerant of the first compressor 1, and the other end being connected to the discharge part for the first refrigerant of the first compressor 1. The controller Cnt controls opening and closing of the opening and closing device 13B. When the controller Cnt performs the first control, not only the opening and closing device 13 but also the opening and closing device 13B is opened. When the controller Cnt performs the first control, the opening and closing device 13 may not be opened, but the opening and closing device 13B may be opened. The opening and closing device 13 corresponds to a first opening and closing device of the present invention, and the opening and closing device 13B corresponds to a second opening and closing device of the present invention.

[Effects of Embodiment 2]

[0053] The refrigeration cycle apparatus 200 according to Embodiment 2 has the following effects in addition to effects similar to the effects of the refrigeration cycle apparatus 100 according to Embodiment 1.

[0054] The bypass C4 bypasses the first compressor 1. Therefore, the first refrigerant tends to pass through a flow passage of the bypass C4 than a flow passage from the suction part of the first compressor 1 to an inlet of the oil return circuit C3. That is, the refrigeration cycle apparatus 200 according to Embodiment 2 includes the bypass C4, and therefore the first refrigerant circuit C1 of the refrigeration cycle apparatus 200 according to Embodiment 2 is more likely to naturally circulate the first refrigerant.

[0055] In Embodiment 2, the bypass C4 is further provided, in addition to the oil return circuit C3. When the first control is performed, the controller Cnt opens not only the opening and closing device 13 but also the opening and closing device 13B. Consequently, it is possible to further increase the circulation amount (flow rate) of the first refrigerant in the first refrigerant circuit C1. Accordingly, the first refrigerant can be more efficiently cooled by the second refrigerant, and it is possible to suppress increase of the rotation speed of the second compressor 14. That is, in the refrigeration cycle apparatus 200, it is possible to suppress increase of the pressure of the refrigerant in the first refrigerant circuit (low temperature circuit) while further suppressing power consumption.

[Modification 1 of Embodiment 2]

[0056] Fig. 2C is Modification 1 of the refrigeration cycle apparatus 200 according to Embodiment 2.

[0057] A bypass C4 may include one end being connected to a suction part for first refrigerant of a first compressor 1, and the other end being connected between an oil separator 2 and a first heat exchanger 3. Even a refrigeration cycle apparatus 200 of Modification 1 can attain an effect similar to the effects of Embodiment 1 and Embodiment 2.

[Modification 2 of Embodiment 2]

[0058] Fig. 2D is Modification 2 of the refrigeration cycle apparatus 200 according to Embodiment 2.

[0059] Furthermore, the bypass C4 may include one end connected to a suction part for first refrigerant of a first compressor 1, and the other end connected between a first heat exchanger 3 and a first refrigerant flow passage of a second heat exchanger 4. Even a refrigeration cycle apparatus 200 of Modification 2 can obtain an effect similar to the effects of Embodiment 1 and Embodiment 2.

[0060] The modification of Embodiment 1 is applicable to Embodiment 2, Modification 1 of Embodiment 2, and Modification 2 of Embodiment 2.

Reference Signs List

[0061] 1 first compressor 1A airtight vessel 1B compression mechanism 1C stator 1D rotor 1E shaft 1F suction pipe 1G discharge pipe 2 oil separator 3 first heat exchanger 3A first fan 4 second heat exchanger 5 first expansion device 6 liquid receiver 7A refrigerant pipe 7B refrigerant pipe 7C refrigerant pipe 8 valve 9 expansion device 10 third heat exchanger 10A second fan 11 refrigerant pipe 12 accumulator 13 opening and closing device 13B opening and closing device 14 second compressor 15 fourth heat exchanger 15A fan 16 second expansion device90A determination unit 90B operation control unit 90C storage unit 100 refrigeration cycle apparatus 101 indoor unit 102 outdoor unit 200 refrigeration cycle apparatus Bd building Bt electric storage part C first refrigerant circuit C1 first refrigerant circuit C2 second refrigerant circuit C3 oil return circuit C4 bypass Cnt controller SE1 condenser temperature sensor SE2 evaporator temperature sensor SE3 pressure sensor SP space Rp1 pipe Rp2 pipe.

Claims

1. A refrigeration cycle apparatus comprising:

a first refrigerant circuit including a first compressor, an oil separator, a first heat exchanger that functions as a condenser, a first refrigerant flow passage of a second heat exchanger, a first expansion device, and a third heat exchanger that functions as an evaporator, the first refrigerant circuit allowing first refrigerant to flow therein;

a second refrigerant circuit including a second compressor, a fourth heat exchanger that functions as a condenser, a second expansion device, and a second refrigerant flow passage of the second heat exchanger, the second refrigerant circuit allowing second refrigerant to flow therein;

an oil return circuit that includes a first opening and closing device, connects the oil separator and the first compressor, and returns, to the first compressor, refrigerating machine oil stored in the oil separator, and

a controller configured to control the first compressor, the second compressor, and the first opening and closing device, wherein

the controller implements first control of starting operation of the second compressor, and opening the first opening and closing device, in a case where the first compressor and the second compressor are stopped, and pressure in a low pressure part of the first refrigerant circuit is a reference value or more.

2. The refrigeration cycle apparatus of claim 1, further comprising:

a first fan that supplies air to the first heat exchanger;
a first temperature sensor provided in the first heat exchanger;
a second fan that supplies air to the third heat exchanger; and
a second temperature sensor provided in the third heat exchanger, wherein
in a case where a detected temperature of the first heat exchanger is not lower than a detected temperature of the third heat exchanger, the controller implements the first control in a state in which the first fan and the second fan are stopped.

3. The refrigeration cycle apparatus of claim 2, wherein the controller implements second control of operating the first fan in a state in which the second compressor and the second fan are stopped, without implementing the first control, in a case where the detected temperature of the first heat exchanger is lower than the detected temperature of the third heat exchanger.

4. The refrigeration cycle apparatus of any one of claims 1 to 3, wherein
the first refrigerant circuit further includes a liquid receiver that is provided on a downstream side in a flow direction of the first refrigerant relative to the first refrigerant flow passage of the second heat exchanger, and on an upstream side in the flow direction of the first refrigerant relative to the third heat exchanger, and
the liquid receiver is disposed on a lower side relative to the second heat exchanger.

5. The refrigeration cycle apparatus of any one of claims 1 to 4, further comprising
a bypass that includes a second opening and closing device, and bypasses the compressor, wherein
in the first control, the second opening and closing device is also opened.

6. The refrigeration cycle apparatus of any one of claims 1 to 5, further comprising
an electric storage part that supplies electric power to the second compressor.

7. The refrigeration cycle apparatus of any one of claims 1 to 6, further comprising
a pressure sensor that detects pressure in the low pressure part of the first refrigerant circuit, wherein
the controller implements the first control, in a case where the first compressor and the second compressor are stopped, and the detected pressure in the low pressure part of the first refrigerant circuit is the reference value or more.

8. The refrigeration cycle apparatus of any one of claims 1 to 7, wherein
the first refrigerant of the first refrigerant flow passage is cooled by the second refrigerant, when the second refrigerant flows in the second refrigerant flow passage.

9. A refrigeration cycle apparatus comprising:

a first refrigerant circuit including a first compressor, an oil separator, a first heat exchanger that functions as a condenser, a first refrigerant flow passage of a second heat exchanger, a first expansion device, and a third heat exchanger that functions as an evaporator, the first refrigerant circuit allowing first refrigerant to flow therein;
a second refrigerant circuit including a second compressor, a fourth heat exchanger that functions as a condenser, a second expansion device, and a second refrigerant flow passage of the second heat exchanger, the second refrigerant circuit allowing second refrigerant to flow therein;
a bypass that includes an opening and closing device, and bypasses the compressor; and
a controller that controls the first compressor, the second compressor, and the opening and closing device, wherein
the controller implements first control of starting operation of the second compressor, and opening the opening and closing device, in a case where the first compressor and the second compressor are stopped, and pressure in a low pressure part of the first refrigerant circuit becomes a reference value or more.

10. The refrigeration cycle apparatus of claim 9, wherein the bypass includes one end connected to a suction part for the first refrigerant of the first compressor, and an other end connected to a discharge part for the first refrigerant of the first compressor.

11. The refrigeration cycle apparatus of claim 9, wherein the bypass includes one end connected to a suction part for the first refrigerant of the first compressor, and an other end connected between the oil separator and the first heat exchanger.

12. The refrigeration cycle apparatus of any one of claims 9 to 11, wherein
the first refrigerant circuit further includes a liquid receiver that is provided on a downstream side in a flow direction of the first refrigerant relative to the first refrigerant flow passage of the second heat exchanger, and on an upstream side in the flow direction of the first refrigerant relative to the third heat

exchanger, and
the liquid receiver is disposed on a lower side relative to the second heat exchanger.

FIG. 1A

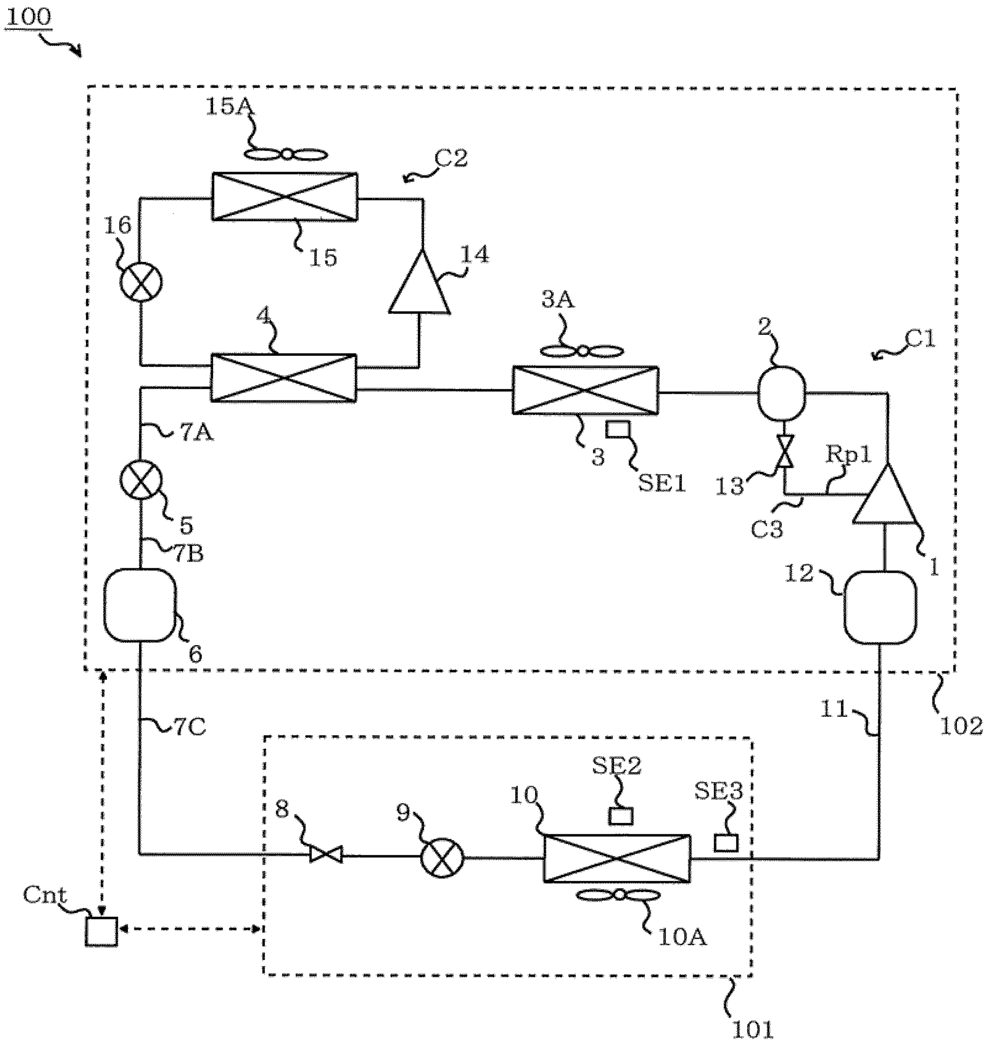

100
15A
C2
16
15
14
4
3A
2
C1
7A
3
SE1
13
Rp1
C3
5
7B
1
12
6
11
102
7C
SE2
SE3
8
9
10
Cnt
10A
101

FIG. 1B

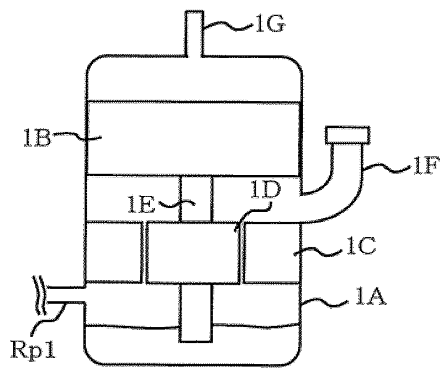

1G
1B
1F
1E
1D
1C
1A
Rp1

FIG. 1C

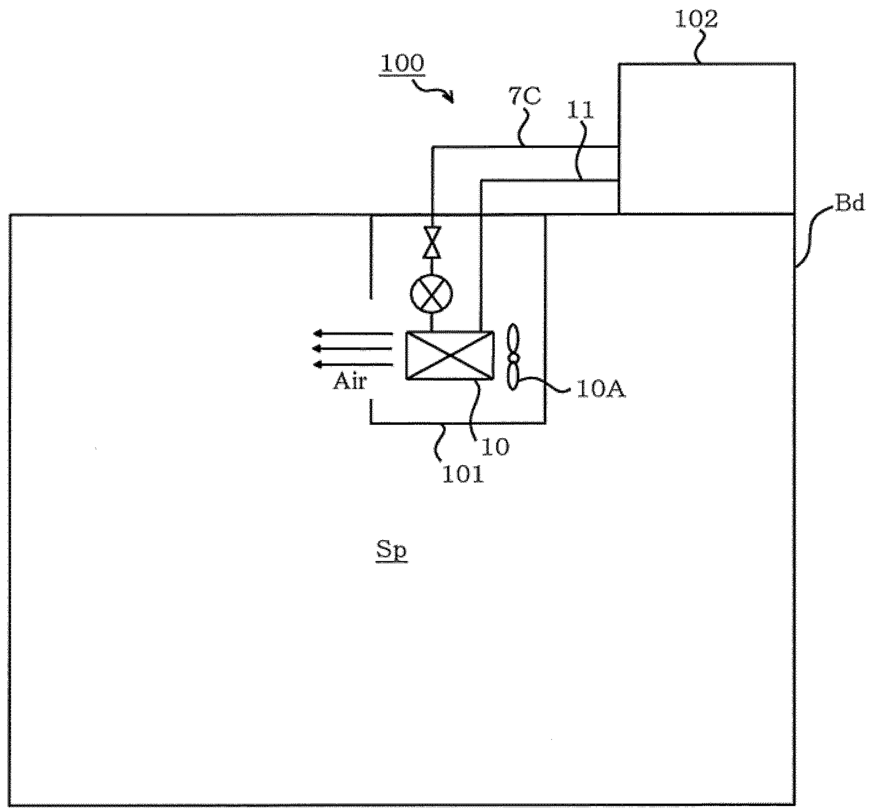

102
100
7C
11
Bd
Air
10A
10
101
Sp

FIG. 1D

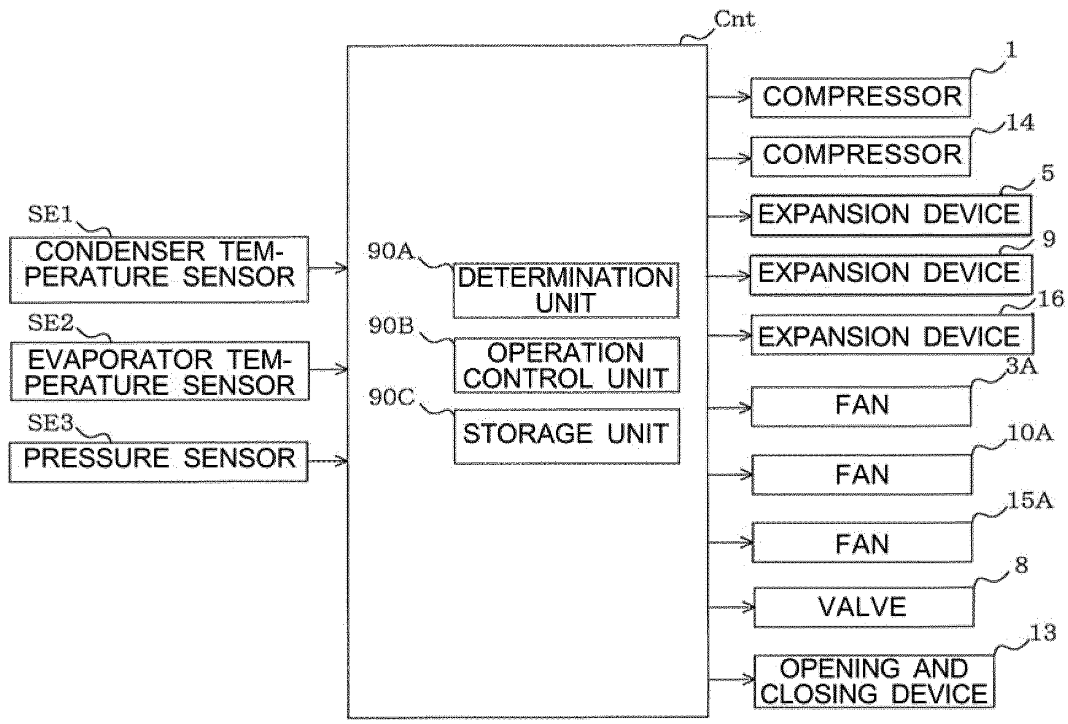

Cnt
1
COMPRESSOR
14
COMPRESSOR
5
EXPANSION DEVICE
9
EXPANSION DEVICE
16
EXPANSION DEVICE
3A
FAN
10A
FAN
15A
FAN
8
VALVE
13
OPENING AND CLOSING DEVICE
SE1
CONDENSER TEMPERATURE SENSOR
SE2
EVAPORATOR TEMPERATURE SENSOR
SE3
PRESSURE SENSOR
90A
DETERMINATION UNIT
90B
OPERATION CONTROL UNIT
90C
STORAGE UNIT

FIG. 1E

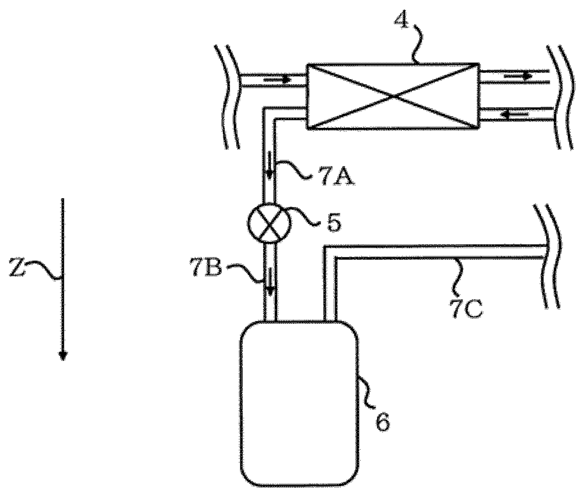

4
7A
5
7B
Z
7C
6

FIG. 1F

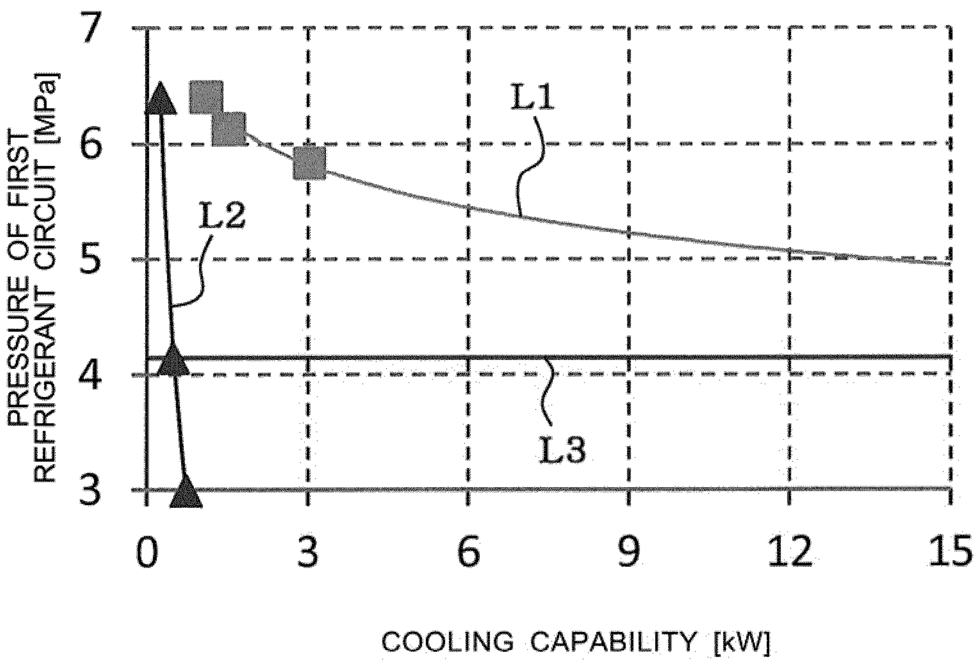
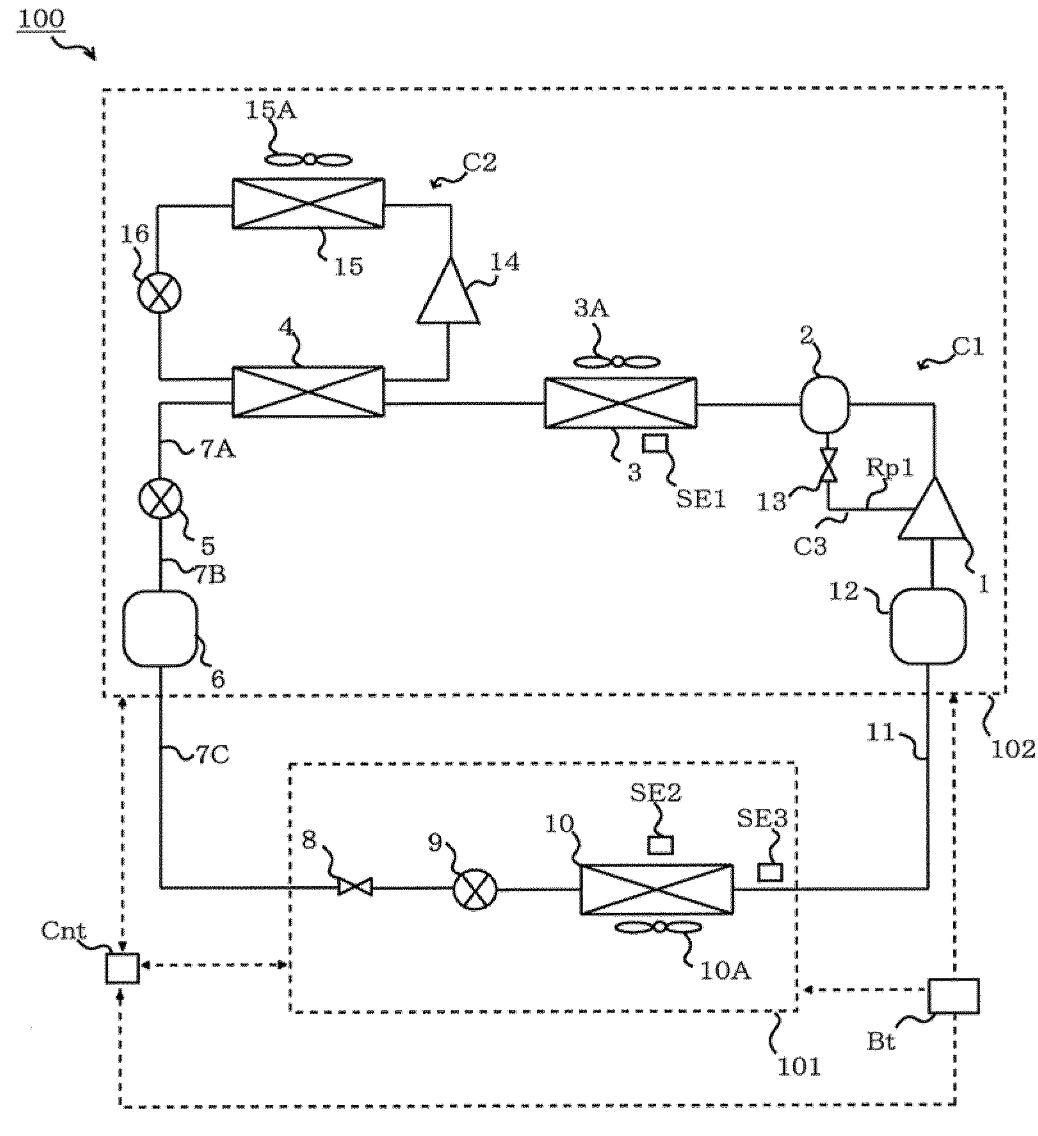

7
6
5
4
3
0
3
6
9
12
15
L1
L2
L3
PRESSURE OF FIRST REFRIGERANT CIRCUIT [MPa]
COOLING CAPABILITY [kW]

FIG. 1G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C2
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14
3A
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2
C1
7A
3
SE1
13
Rp1
5
C3
7B
1
12
6
7C
11
102
SE2
10
SE3
8
9
Cnt
10A
Bt
101

FIG. 2A

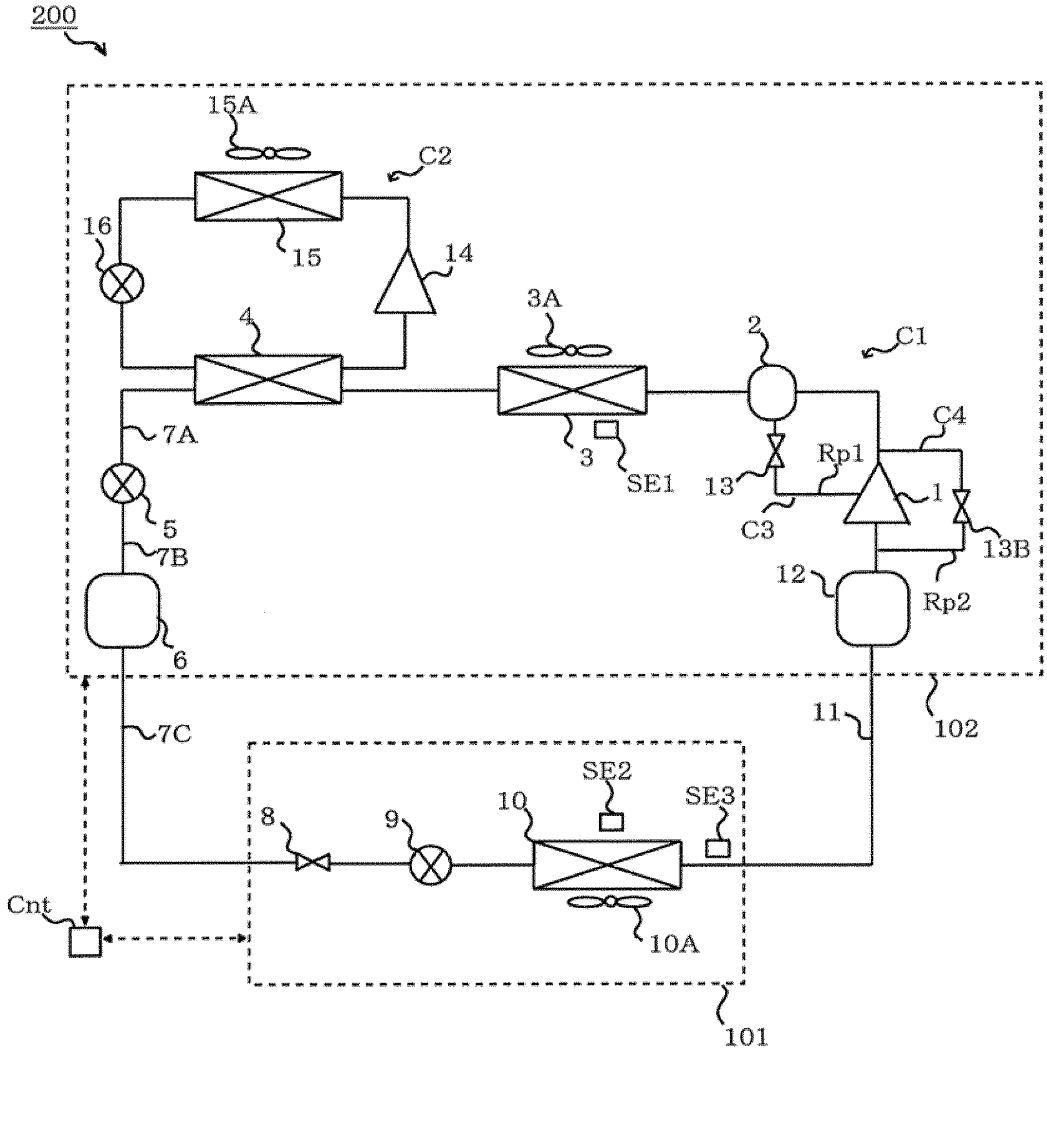

200
15A
C2
16
15
14
3A
4
2
C1
C4
7A
3
SE1
13
Rp1
1
5
C3
13B
7B
12
Rp2
6
11
102
7C
SE2
SE3
8
9
10
Cnt
10A
101

FIG. 2B

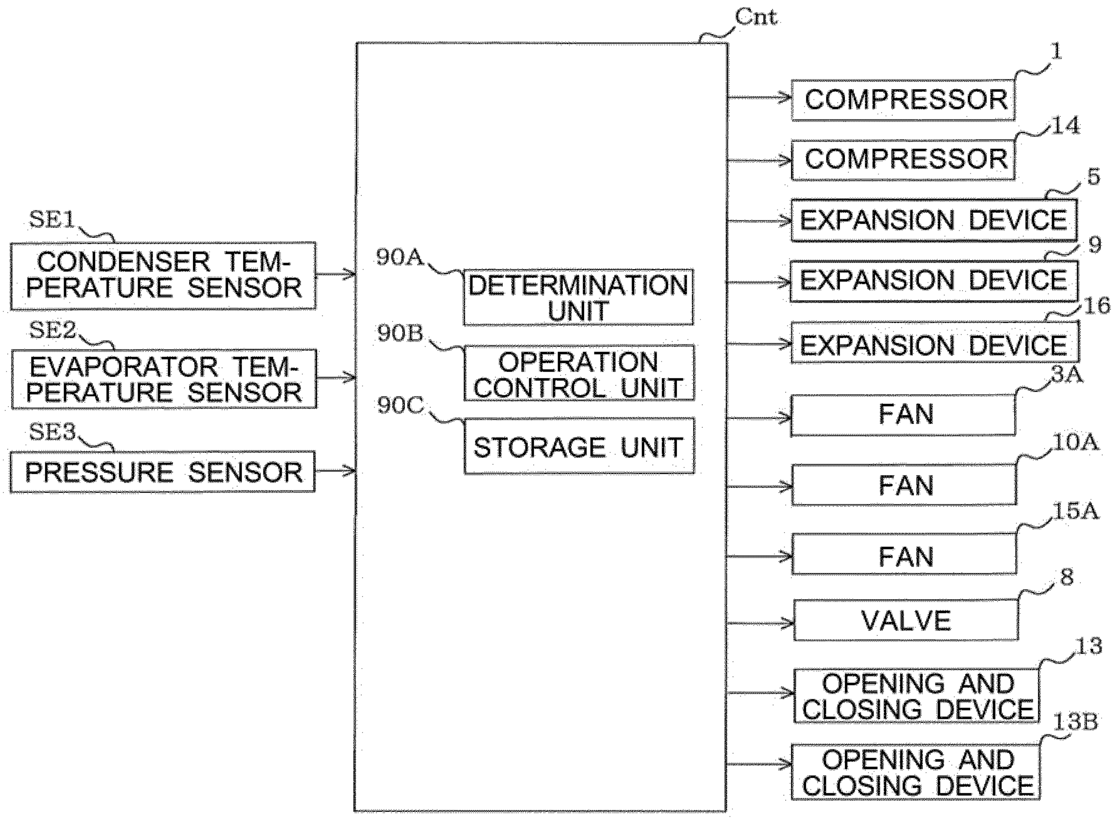

Cnt
1
COMPRESSOR
14
COMPRESSOR
5
EXPANSION DEVICE
9
EXPANSION DEVICE
16
EXPANSION DEVICE
3A
FAN
10A
FAN
15A
FAN
8
VALVE
13
OPENING AND CLOSING DEVICE
13B
OPENING AND CLOSING DEVICE
SE1
CONDENSER TEMPERATURE SENSOR
SE2
EVAPORATOR TEMPERATURE SENSOR
SE3
PRESSURE SENSOR
90A
DETERMINATION UNIT
90B
OPERATION CONTROL UNIT
90C
STORAGE UNIT

FIG. 2C

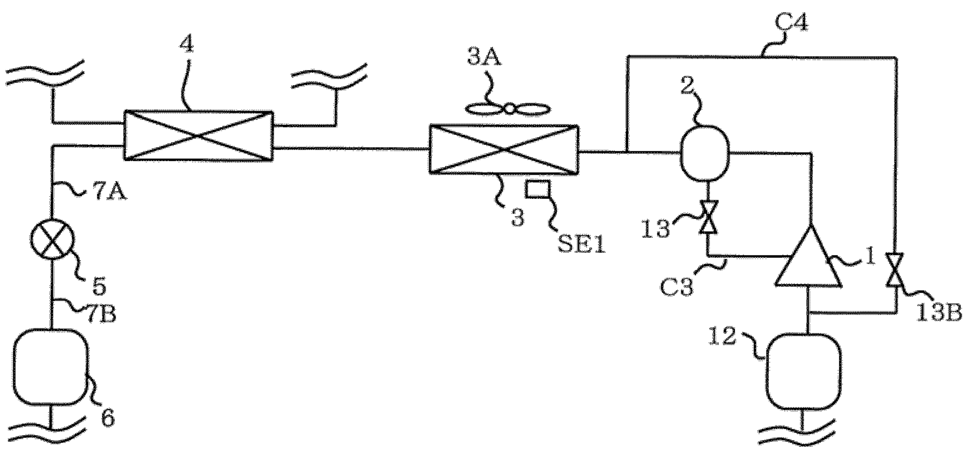
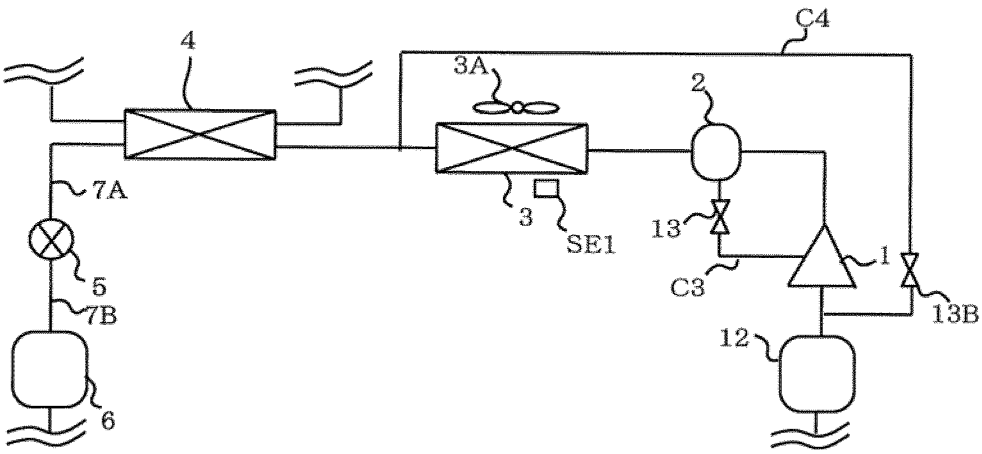

4
3A
C4
2
7A
5
7B
6
3
SE1
13
C3
1
13B
12

FIG. 2D



INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/015474

A. CLASSIFICATION OF SUBJECT MATTER
F25B7/00(2006.01)i, *F25B1/00*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25B7/00, F25B1/00

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2014-31982 A (Mitsubishi Electric Corp.), 20 February 2014 (20.02.2014), paragraphs [0001] to [0091]; fig. 1 to 7 & US 2015/0176866 A1 paragraphs [0001] to [0146]; fig. 1 to 7 & GB 2518559 A & WO 2014/024838 A1 & CN 104520657 A	1-12
A	WO 2016/121184 A1 (Mitsubishi Electric Corp.), 04 August 2016 (04.08.2016), paragraphs [0001] to [0086]; fig. 1A1 to 2H (Family: none)	1-12
A	JP 2009-243767 A (Sanden Corp.), 22 October 2009 (22.10.2009), paragraphs [0001] to [0062]; fig. 1 to 5 (Family: none)	1-12

☒ 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
26 June 2017 (26.06.17)	04 July 2017 (04.07.17)

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

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/015474

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 6-82107 A (Daikin Industries, Ltd.), 22 March 1994 (22.03.1994), paragraphs [0001] to [0044]; fig. 1 to 7 (Family: none)	1-12
A	WO 2014/045394 A1 (Mitsubishi Electric Corp.), 27 March 2014 (27.03.2014), paragraphs [0001] to [0050]; fig. 1 to 7 & EP 2910871 A1 paragraphs [0001] to [0066]; fig. 1 to 7	1-12
A	JP 4-203760 A (Daikin Industries, Ltd.), 24 July 1992 (24.07.1992), specification, page 1, lower right column, line 1 to page 6, upper left column, line 17; fig. 1 to 4 (Family: none)	1-12

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

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/015474

(1) Specified in claim 1 are "a first refrigerant circuit through which a first refrigerant flows, and a second refrigerant circuit through which a second refrigerant flows, the first refrigerant circuit including a first compressor, an oil separator, a first heat exchanger acting as a condenser, a first refrigerant flow path of a second heat exchanger, a first throttle device, and a third heat exchanger acting as an evaporator, the second refrigerant circuit including a second compressor, a fourth heat exchanger acting as a condenser, a second throttle device, and a second refrigerant flow path of the second heat exchanger."

Here, from the statement in the description (paragraph [0014]) and the illustration in a drawing (fig. 1A), it is considered that the aforementioned "first refrigerant circuit" refers to "a low-source circuit," while the aforementioned "second refrigerant circuit" refers to "a high-source circuit."

However, it is not clear in the aforementioned description of claim 1 which of the low-source circuit and the high-source circuit is referred to by "the first refrigerant circuit" and "the second refrigerant circuit."

The above-said opinion may be also applied to claim 9.

Therefore, the inventions of claims 1, 9 and claims 2-8, 10-12 referring to claims 1, 9 are unclear.

(2) Described in claim 9 is "a bypass circuit which includes an open/close device and bypasses the compressor."

Here, from the description in paragraph [0043] and the illustration of fig. 2A, it is assumed that the aforementioned "compressor" refers to "the first compressor."

However, it is not clear which compressor of "the first compressor" and "the second compressor" is referred to by the aforementioned description of claim 9.

Therefore, the inventions of claim 9 and claims 10-20 referring to claim 9 are unclear.

(3) Described in claim 9 is "a bypass circuit which includes a first refrigerant circuit..., a second refrigerant circuit..., and an open/close device, the bypass circuit bypassing the compressor..."

On the other hand, stated in paragraph [0043] of the description is that "the refrigeration cycle system 200 according to the second embodiment includes a bypass circuit C4 in addition to an oil return circuit C3."

From this statement, it is recognized that "the refrigeration cycle system 200 also requires a constituent feature of the oil return circuit C3 as in addition to the bypass circuit."

As said above, the invention-definition-matter specified in claim 9 is not consistent with the content of the invention explained in paragraph [0043] in the description.

Consequently, the inventions of claim 9 and claims 10-12 referring to claim 9 are not supported by the description, and further, these inventions are unclear.

(4) Described in claim 9 is "that..., the controller starts to operate the second compressor and performs first control to open the open/close device when the first compressor and the second compressor are at standstill and the pressure of the low-pressure unit of the first refrigerant circuit is at a reference value or greater..."

On the other hand, described in claim 1 is "that the controller starts to operate the second compressor and performs first control to open the first open/close device when the first compressor and the second compressor are at standstill and the pressure of the low-pressure unit of the first refrigerant circuit is at a reference value or greater."

(Continued to next extra sheet)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/015474

"The first control" of claim 9 is to open/close the bypass circuit C4 by the open/close device, whereas "the first control" of claim 1 is to open/close the oil return circuit C3 by the first open/close device. It can be thus said that "the first control" of claim 9 and "the first control" of claim 1 are to provide control to open or close different circuits.

As described above, "the first control" of claim 9 is not consistent with "the first control" of claim 1.

Therefore, the inventions of claim 9 and claims 10-12 referring to claim 9 are unclear.

(5) Meanwhile, the search on claims 1-12 has been carried out on the assumption that the above-said matter is specified in each claim and is clear.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 5575191 B **[0005]**