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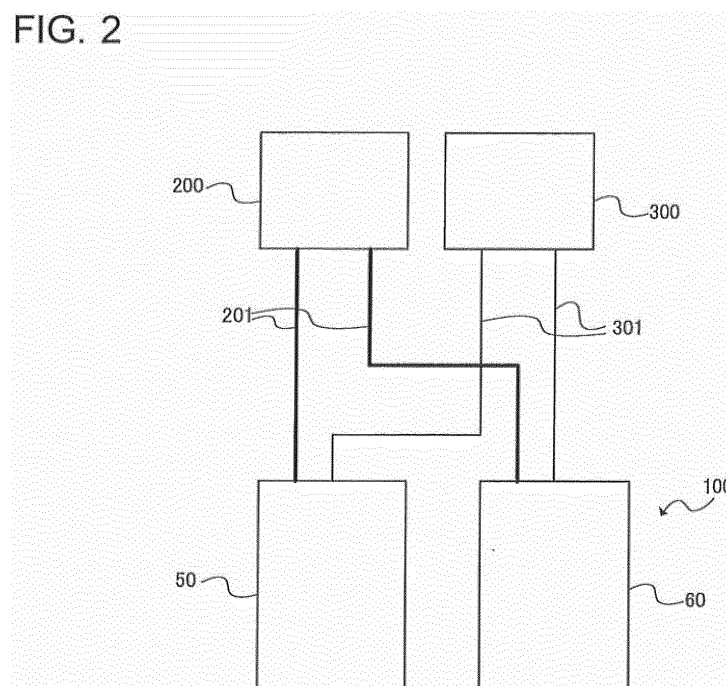
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(54) **REFRIGERATION CYCLE APPARATUS**

(57) A refrigeration cycle apparatus (100) is configured to be operatable with power supply of both of DC power supply and AC power supply.

FIG. 2



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Description

Technical Field

[0001] The present invention relates to a refrigeration cycle apparatus configured to operate with DC power supply.

Background Art

[0002] Refrigeration cycle apparatus such as air-conditioning apparatus have hitherto been configured to operate with three-phase AC power supply from commercial power sources, power generators, or other such devices (for example, see Patent Literature 1). Further, electric parts (for example, motors of compressors, motors of air-sending devices, or solenoid valves) of the refrigeration cycle apparatus generally operate with primary power supply of a three-phase AC of 200 V, a single-phase AC of 200 V, or a DC of 12 V, for example. Thus, in such refrigeration cycle apparatus, voltages having other values are generated from the primary power supply of the three-phase AC of 200 V.

[0003] Further, in refrigeration cycle apparatus such as the refrigeration cycle apparatus described in Patent Literature 1, large-capacity inverter devices are generally used to drive motors of components including compressors and air-sending devices (for example, see Patent Literature 2). Such inverter devices generally employ a method of generating DC bus voltage for driving inverters through rectification of three-phase or two-phase AC.

[0004] Meanwhile, in data centers including large-capacity information and communication technology (ICT) apparatus, there is an attempt to greatly increase the efficiency of systems through use of high voltage DC power supply systems instead of AC power supply systems (for example, see Non Patent Literature 1). With such a configuration, as DC for driving inverter devices used in refrigeration cycle apparatus, supplied DC voltage, which is high voltage, can be used as it is. As a result, simple configurations of refrigeration cycle apparatus and high efficiency of the refrigeration cycle apparatus may be achieved.

[0005] A representative electric circuit of an AC input refrigeration cycle apparatus (hereinafter referred to as "AC refrigeration cycle apparatus 1000") is described. Fig. 7 is a diagram for schematically illustrating the circuit configuration of the electric circuit of the AC refrigeration cycle apparatus 1000. The AC refrigeration cycle apparatus 1000 includes a compressor motor 1002, a DC/AC converter 1003, a smoothing capacitor 1004, a relay 1005, an inrush prevention resistor circuit 1006, a three-phase full-wave rectifier circuit 1007, and a zero crossing sensor 1014.

[0006] The compressor motor 1002 is configured to drive a compressor (not shown).

[0007] The DC/AC converter 1003 is configured to drive the compressor motor 1002.

[0008] The smoothing capacitor 1004 is configured to smooth current that is supplied to the DC/AC converter 1003.

[0009] The relay 1005 and the inrush prevention resistor circuit 1006 are configured to reduce inrush current that flows into the smoothing capacitor 1004.

[0010] The three-phase full-wave rectifier circuit 1007 is configured to rectify AC to DC.

[0011] The zero crossing sensor 1014 is configured to detect the presence of AC voltage.

[0012] The operation of the AC refrigeration cycle apparatus 1000 is described.

[0013] The AC refrigeration cycle apparatus 1000 takes in voltage supplied from an AC system 1009 through a system impedance 1011 and an AC circuit breaker 1008. The system voltage taken in by the AC refrigeration cycle apparatus 1000 is converted from AC into DC in the three-phase full-wave rectifier circuit 1007.

[0014] The voltage, which has been subjected to AC/DC conversion in the three-phase full-wave rectifier circuit 1007, is supplied to the smoothing capacitor 1004 through the relay 1005 and the inrush prevention resistor circuit 1006. Then, the DC bus voltage smoothed in the smoothing capacitor 1004 is input to the DC/AC converter 1003. In this way, the compressor motor 1002 is driven. Here, the relay 1005 and the inrush prevention resistor circuit 1006 are provided in order to reduce inrush current that flows from the AC system into the smoothing capacitor 1004 when power supply is input to the AC refrigeration cycle apparatus 1000 from the AC circuit breaker 1008.

[0015] When receiving power supply from the AC circuit breaker 1008, the AC refrigeration cycle apparatus 1000 opens the relay 1005, thereby slowly charging the smoothing capacitor 1004 with low current supplied from the system through the inrush prevention resistor. After that, the AC refrigeration cycle apparatus 1000 closes the relay 1005 after the smoothing capacitor 1004 is sufficiently charged with the DC voltage, and the DC/AC converter 1003 starts to drive the compressor motor 1002.

[0016] In the general AC refrigeration cycle apparatus 1000, some functions to determine whether the AC circuit breaker 1008 is opened are provided so that the inrush prevention relay 1005 may be opened in order to prevent excessive inrush current from flowing in subsequent input when the AC circuit breaker 1008 is opened due to some troubles during operation.

[0017] As one of the functions, there is given a function to determine the open AC circuit breaker 1008 when the voltage of the smoothing capacitor 1004 is a predetermined value or less. The predetermined value is set to a value smaller than the lower limit value of an allowable system voltage. For example, when DC voltage of 400 V AC systems, which are required to be continuously operated, is reduced by 10%, the voltage is about 509 V. With an open state determination level set to a value lower than that value, the open AC circuit breaker 1008

can be determined when the voltage of the smoothing capacitor 1004 drops after the AC circuit breaker 1008 is opened.

[0018] As another of the functions, there is given a function to determine the absence of AC, that is, the open AC circuit breaker 1008, when it is determined that AC voltage that is input to the AC refrigeration cycle apparatus 1000 does not have a point crossing zero, through detection of the presence of the AC voltage by the zero crossing sensor 1014.

[0019] With the use of those circuit breaker open state determining functions, even when the AC circuit breaker 1008 is once opened and is then closed, inrush current in subsequent input can be prevented because the relay 1005 can be opened immediately after the circuit breaker 1008 is opened.

[0020] Further, in the AC refrigeration cycle apparatus 1000, larger charge current is caused to flow to the smoothing capacitor 1004 also when instantaneous voltage drop occurs and the voltage returns thereafter in the AC system 1009, but the current is reduced by some amount by the system impedance 1011. Thus, the influence of large charge current on the AC refrigeration cycle apparatus 1000 can be avoided through devising of the design of the smoothing capacitor 1004 or other components.

[0021] Next, a representative electric circuit of a DC input refrigeration cycle apparatus (hereinafter referred to as "DC refrigeration cycle apparatus 2000") is described. Fig. 8 is a diagram for schematically illustrating the circuit configuration of the electric circuit of the DC refrigeration cycle apparatus 2000. The DC refrigeration cycle apparatus 2000 includes a compressor motor 2002, a DC/AC converter 2003, a smoothing capacitor 2004, a relay 2005, and an inrush prevention resistor circuit 2006. Those components have functions similar to those of the compressor motor 1002, the DC/AC converter 1003, the smoothing capacitor 1004, the relay 1005, and the inrush prevention resistor circuit 1006, which are included in the AC refrigeration cycle apparatus 1000.

[0022] The DC refrigeration cycle apparatus 2000 is supplied with DC voltage through an AC/DC converter 2013 configured to convert the voltage of an AC system 2009 into DC, and a circuit breaker 2011 configured to open and close DC. A battery 2012 is installed on the output side of the AC/DC converter 2013. The battery 2012 is installed in order to stabilize high pressure DC.

[0023] The operation of the DC refrigeration cycle apparatus 2000 is described.

[0024] The DC refrigeration cycle apparatus 2000 takes in high pressure DC (a DC of about 380 V in the case of a 400 V AC system) through the DC circuit breaker 2011. The high pressure DC is obtained through conversion of voltage, which is supplied from the AC system 2009, in the AC/DC converter 2013. The DC voltage taken in by the DC refrigeration cycle apparatus 2000 is supplied to the smoothing capacitor 2004 through the relay 2005 and the inrush prevention resistor circuit 2006.

Then, the DC voltage smoothed in the smoothing capacitor 2004 is input to the DC/AC converter 2003. In this way, the compressor motor 2002 is driven.

[0025] Further, with this configuration, even in the case of application to air-conditioning systems for data centers, as disclosed in Non Patent Literature 1, the necessities of one of DC/AC converters provided on an uninterruptible power supply side and one of AC/DC converters provided on a load side are eliminated. As a result, power consumption can be reduced.

[0026] The battery 2012 functions as backup for a case where the AC system 2009 does not supply DC voltage due to, for example, interruption of power supply, in addition to stabilization of DC voltage. However, the output voltage of the battery 2012 changes depending on the state of charge (remaining life), and the minimum output voltage is generally reduced to about 70% of the maximum output voltage. Specifically, when the AC system 2009 is a 400 V AC system, a high pressure DC voltage is set to about 380 V, and the minimum output voltage of the battery 2012 in this case is about 270 V.

Citation List

25 Patent Literature

[0027]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2011-89737

Patent Literature 2: Japanese Unexamined Patent Application Publication No. 2009-232591

Non Patent Literature

[0028] Non Patent Literature 1: <http://www.ntt-f.co.jp/news/heisei23/h23-1110.html>

Summary of Invention

Technical Problem

[0029] However, refrigeration cycle apparatus such as the refrigeration cycle apparatus disclosed in Patent Literature 1 have apparatus configurations expected to be used with the primary power supply of three-phase AC power supply, and cannot use high voltage DC power supply represented by a DC of 380 V as the primary power supply, which is a problem.

[0030] Further, when a circuit configuration in which primary power supply is supplied to motors (for example, a motor of a compressor and a motor of an air-sending device) through contactors for use, there is a problem that motors configured to operate with high voltage DC are not versatile, for example. That is, refrigeration cycle apparatus configured to operate with power supply from AC power sources are popular, and it is difficult to obtain parts configured to operate with high voltage DC from

the market. Even when the parts configured to operate with high voltage DC can be obtained, there is another problem in that an increase in size of refrigeration cycle apparatus is necessary to perform drive with DC power supply, which leads to restriction on mounting to the refrigeration cycle apparatus. Further, there is still another problem of an increase in cost as compared to the existing refrigeration cycle apparatus.

[0031] The present invention has been made in order to solve at least one of the problems described above, and has an object to provide a refrigeration cycle apparatus configured to operate with not only AC power supply but also DC power supply.

Solution to Problem

[0032] According to one embodiment of the present invention, there is provided a refrigeration cycle apparatus including: a refrigerant circuit in which a compressor, a condenser, a pressure reducing device, and an evaporator are connected by refrigerant pipes; at least one auxiliary system device; and an air-sending device provided near at least one of the condenser and the evaporator, the refrigeration cycle apparatus being configured to be operatable with power supply of both of DC power supply and AC power supply.

Advantageous Effects of Invention

[0033] According to the refrigeration cycle apparatus of the one embodiment of the present invention, DC power supply can be used as primary power supply, and it is therefore possible to greatly improve the efficiency of the system. Brief Description of Drawings

[0034]

[Fig. 1] Fig. 1 is a schematic circuit diagram for schematically illustrating the configuration of a refrigeration cycle apparatus according to Embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is a system configuration diagram for schematically illustrating an example of the power supply configuration of the refrigeration cycle apparatus according to Embodiment 1 of the present invention.

[Fig. 3] Fig. 3 is a system configuration diagram for schematically illustrating another example of the power supply configuration of the refrigeration cycle apparatus according to Embodiment 1 of the present invention.

[Fig. 4] Fig. 4 is a system configuration diagram for schematically illustrating still another example of the power supply configuration of a refrigeration cycle apparatus according to Embodiment 2 of the present invention.

[Fig. 5] Fig. 5 is a system configuration diagram for schematically illustrating yet another example of the power supply configuration of the refrigeration cycle

apparatus according to Embodiment 2 of the present invention.

[Fig. 6] Fig. 6 is a system configuration diagram for schematically illustrating a further example of the power supply configuration of a refrigeration cycle apparatus according to Embodiment 3 of the present invention.

[Fig. 7] Fig. 7 is a diagram for schematically illustrating the circuit configuration of an electric circuit of an AC input refrigeration cycle apparatus.

[Fig. 8] Fig. 8 is a diagram for schematically illustrating the circuit configuration of an electric circuit of a DC input refrigeration cycle apparatus. Description of Embodiments

[0035] Now, Embodiments of the present invention are described with reference to the drawings. The relationships between the sizes of components in the following drawings including Fig. 1 may be different from the actual relationships. Further, in the following drawings including Fig. 1, components denoted by the same reference symbols correspond to the same or equivalent components. This is common throughout the description herein. In addition, the forms of the components described herein are merely examples, and the components are not limited to the description herein.

Embodiment 1

[0036] Fig. 1 is a schematic circuit diagram for schematically illustrating the configuration of a refrigeration cycle apparatus 100 according to Embodiment 1 of the present invention. With reference to Fig. 1, the apparatus configuration of the refrigeration cycle apparatus 100 is described. The refrigeration cycle apparatus 100 described herein is merely an example of an apparatus including a refrigeration cycle, and the present invention is applicable to apparatus other than the refrigeration cycle apparatus 100 described herein. For example, the number of outdoor units (heat source units) and the number of indoor units (load-side units) are not limited, and the number of components mounted on those units is not limited. Further, on which unit the components are mounted may be determined depending on the application of the refrigeration cycle apparatus 100.

[Apparatus Configuration]

[0037] As illustrated in Fig. 1, the refrigeration cycle apparatus 100 includes an indoor unit 60 and an outdoor unit 50. The indoor unit 60 and the outdoor unit 50 are connected to each other by refrigerant pipes 10 and 11.

<Indoor Unit 60>

[0038] The indoor unit 60 has mounted thereon an expansion valve 3, a use-side heat exchanger 4, and a compressor 1 each of which are connected in series, an in-

door solenoid valve 5 connected in parallel to the compressor 1, a pressure switch 9 mounted on the discharge side of the compressor 1, an indoor air-sending device 8 that is rotated by a fan motor 8a, and an indoor control device 40.

[0039] The expansion valve 3 functions as a pressure reducing device configured to decompress and expand refrigerant, and preferably includes an electronic expansion valve the opening degree of which is variably controllable.

[0040] The use-side heat exchanger 4 functions as an evaporator during cooling operation and as a condenser during heating. The indoor air-sending device 8 including, for example, a centrifugal fan or a multi-blade fan configured to supply air is provided near the use-side heat exchanger 4. The indoor air-sending device 8 includes, for example, a device of a type whose airflow rate is controlled by an inverter controlling the rotation speed of the device. That is, the use-side heat exchanger 4 is configured to exchange heat between air supplied from the indoor air-sending device 8 and refrigerant, thereby evaporating and gasifying or condensing and liquefying the refrigerant.

[0041] The compressor 1 is configured to suck refrigerant to compress the refrigerant so that the refrigerant enters a high-temperature and high-pressure state, and includes, for example, a compressor of a type the capacity of which is controlled by an inverter controlling the rotation speed of the compressor.

[0042] Further, on the compressor 1, a belt heater 1a for preventing refrigerant from stagnating is mounted.

[0043] The indoor solenoid valve 5 is configured to allow refrigerant discharged from the compressor 1 to partially pass therethrough through open/close control.

[0044] The pressure switch 9 functions as a protective device. The pressure switch 9 is enclosed in a refrigerant circuit 101 and is configured to detect that the pressure of refrigerant reaches a predetermined pressure.

[0045] The indoor control device 40 includes a computing device 41 including a versatile CPU, a data bus, an input/output port, a nonvolatile memory, and a timer, for example. The indoor control device 40 performs, based on operation information (indoor air temperature, set temperature, refrigerant pipe temperature, refrigerant pressure, and other types of information), predetermined control for the opening degree of the expansion valve 3, the rotation speed of the indoor air-sending device 8, the driving frequency of the compressor 1, and opening/closing of the indoor solenoid valve 5, for example. Further, the indoor control device 40 is connected to an outdoor control device 20, which is described later, by a transmission line (not shown), and is capable of transmitting and receiving information to and from the outdoor control device 20.

<Outdoor Unit 50>

[0046] The outdoor unit 50 has mounted thereon heat

source-side heat exchangers 2. In an example described here, the two heat source-side heat exchangers 2 are connected in parallel to each other. The outdoor unit 50 has mounted thereon an outdoor solenoid valve 6 connected in series to one heat source-side heat exchanger 2, an outdoor air-sending device 7 that is rotated by a fan motor 7a, and the outdoor control device 20.

[0047] The heat source-side heat exchanger 2 functions as a condenser during cooling operation and as an evaporator during heating operation. The outdoor air-sending device 7 including, for example, a centrifugal fan or a multi-blade fan configured to supply air is provided near the heat source-side heat exchangers 2. The outdoor air-sending device 7 includes, for example, a device of a type whose airflow rate is controlled by an inverter controlling the rotation speed of the device. That is, the heat source-side heat exchanger 2 is configured to exchange heat between air supplied from the outdoor air-sending device 7 and refrigerant, thereby evaporating and gasifying or condensing and liquefying the refrigerant.

[0048] The outdoor solenoid valve 6 is configured to allow refrigerant to partially flow to one heat source-side heat exchanger 2 through open/close control.

[0049] The outdoor control device 20 includes a computing device 21 including a versatile CPU, a data bus, an input/output port, a nonvolatile memory, and a timer, for example. The outdoor control device 20 performs, based on operation information (indoor air temperature, set temperature, refrigerant pipe temperature, refrigerant pressure, and other types of information) from the indoor unit 60, predetermined control for the rotation speed of the outdoor air-sending device 7, and opening/closing of the outdoor solenoid valve 6, for example. Further, the outdoor control device 20 is connected to the indoor control device 40 by a transmission line (not shown), and is capable of transmitting and receiving information to and from the indoor control device 40.

[0050] The compressor 1, the heat source-side heat exchangers 2, the expansion valve 3, and the use-side heat exchanger 4 are sequentially connected by the refrigerant pipes 10 and 11 to form a refrigeration cycle.

[0051] That is, the refrigeration cycle apparatus 100 includes the refrigerant circuit 101 including the refrigeration cycle formed by the compressor 1, the heat source-side heat exchangers 2, the expansion valve 3, and the use-side heat exchanger 4.

[Operation]

[0052] Next, the operation of the refrigeration cycle apparatus 100 is described.

[0053] Here, cooling operation performed by the refrigeration cycle apparatus 100 is mainly described. Refrigerant is enclosed in the refrigerant circuit 101 of the refrigeration cycle apparatus 100. In the refrigerant circuit 101, this refrigerant changes to high-temperature and high-pressure refrigerant in the compressor 1, and is dis-

charged from the compressor 1 to flow into the heat source-side heat exchangers 2. The refrigerant that flowed into the heat source-side heat exchangers 2 is condensed and liquefied through heat exchange with air supplied from the outdoor air-sending device 7. In short, the refrigerant rejects heat to enter a liquid state. The condensed and liquefied refrigerant flows into the expansion valve 3 through the refrigerant pipe 10.

[0054] The refrigerant that flowed into the expansion valve 3 is decompressed to be expanded, thereby changing to liquid and gas refrigerant in a low-temperature and low-pressure two-phase gas-liquid state. The two-phase gas-liquid refrigerant flows into the use-side heat exchanger 4. The two-phase gas-liquid refrigerant that flowed into the use-side heat exchanger 4 exchanges heat with air supplied from the indoor air-sending device 8 to be evaporated and gasified. In short, the refrigerant removes heat from the air (cools the air), thereby entering a gas state. The evaporated and gasified refrigerant flows out of the use-side heat exchanger 4, and is sucked by the compressor 1 again through the refrigerant pipe 11.

[0055] Air that is supplied to the use-side heat exchanger 4 is cooled by the heat of vaporization of the refrigerant that flowed into the use-side heat exchanger 4, and is supplied, by the indoor air-sending device 8, to a region to be cooled in which the indoor unit 60 is installed. The air cools the region to be cooled and heat generating devices installed in that region, for example, and the temperature of the air thus increases. Then, the air having the increased temperature is supplied to the use-side heat exchanger 4 again by the indoor air-sending device 8, and is cooled by the heat of vaporization of the refrigerant. In this way, air (for example, indoor air) circulates.

[0056] In the indoor control device 40, thermo-off control is performed. Through the thermo-off control, the necessity of air conditioning is determined based on a difference between a temperature in suction to the indoor unit 60 or a temperature in discharge from the indoor unit 60, and a set temperature being a target value of the temperature, and the operation of the compressor 1 is stopped.

[0057] After the thermostat is turned off once, thermo-on control is performed. Through the thermo-on control, the necessity of air conditioning is determined based on a difference between a temperature in suction to the indoor unit or a temperature in discharge from the indoor unit, and the set temperature being the target value of the temperature, and the operation of the compressor 1 is started.

[Example of Power Supply Configuration of Refrigeration Cycle Apparatus 100]

[0058] Fig. 2 is a system configuration diagram for schematically illustrating an example of the power supply configuration of the refrigeration cycle apparatus 100. With reference to Fig. 2, an example of the power supply

configuration of the refrigeration cycle apparatus 100 is described.

[0059] The refrigeration cycle apparatus 100 is configured to be operatable with power supply of both of DC power supply and AC power supply.

[0060] The electrical connections between the devices (compressor 1 and fan motors (fan motor 7a and fan motor 8a)) configured to operate with power supply of DC power supply are as illustrated in Fig. 8.

[0061] As illustrated in Fig. 2, to each of the outdoor unit 50 and the indoor unit 60, a DC power supply device 200 and an AC power supply device 300, which are provided outside the refrigeration cycle apparatus 100, are connected. That is, each of the outdoor unit 50 and the indoor unit 60 is supplied with DC power supply from the DC power supply device 200 and AC power supply from the AC power supply device 300.

[0062] In general, the power of a refrigeration cycle apparatus is largely consumed by a compressor (specifically, compressor motor) and an air-sending device (specifically, fan motor of air-sending device) among components mounted on the refrigeration cycle apparatus. Components including the compressor and the air-sending device are referred to as "power system device".

[0063] Meanwhile, among the components mounted on the refrigeration cycle apparatus, the power consumption of solenoid valves, a pressure switch, and a belt heater is relatively small as compared to the power consumption of the compressor or the air-sending device. Components including the solenoid valves (indoor solenoid valve 5 and outdoor solenoid valve 6), the pressure switch 9, and the belt heater 1a are collectively referred to as "auxiliary system device".

[0064] The refrigeration cycle apparatus 100 is accordingly configured so that the power system devices may operate with DC power supply directly supplied thereto from the DC power supply device 200.

[0065] Further, the refrigeration cycle apparatus 100 is configured so that the auxiliary system devices may operate using AC power supply supplied from the AC power supply device 300.

[0066] That is, the relationship of $W_{dc} > W_{ac}$ is satisfied, where W_{dc} represents consumed DC power supply, and W_{ac} represents consumed AC power supply.

[0067] The DC power supply device 200 and the refrigeration cycle apparatus 100 are connected to each other by communication cables 201. With this configuration, the refrigeration cycle apparatus 100 can obtain power supply information on DC voltage supplied from the DC power supply device 200, and the remaining life of the battery, for example. Then, the refrigeration cycle apparatus 100 controls the output of the compressor 1 and the fan motors (fan motor 7a and fan motor 8a) based on the obtained power supply information. DC power supply that is supplied from the DC power supply device 200 has a voltage of 200 V or more.

[0068] The AC power supply device 300 and the refrigeration cycle apparatus 100 are connected to each

other by communication cables 301.

[0069] Fig. 3 is a system configuration diagram for schematically illustrating another example of the power supply configuration of the refrigeration cycle apparatus 100. With reference to Fig. 3, another example of the power supply configuration of the refrigeration cycle apparatus 100 is described.

[0070] In the example illustrated in Fig. 2, the DC power supply device 200 and the AC power supply device 300 are connected to each of the outdoor unit 50 and the indoor unit 60, but in an example illustrated in Fig. 3, the DC power supply device 200 and the AC power supply device 300 are connected to the outdoor unit 50. Further, the indoor unit 60 is supplied with DC power supply from the DC power supply device 200 and AC power supply from the AC power supply device 300 through the outdoor unit 50.

[0071] In the example described here, the DC power supply device 200 and the AC power supply device 300 are connected to the outdoor unit 50, but the DC power supply device 200 and the AC power supply device 300 may be connected to the indoor unit 60. In such a case, the outdoor unit 50 is supplied with DC power supply from the DC power supply device 200 and AC power supply from the AC power supply device 300 through the indoor unit 60.

[0072] Further, in the example described here, both of the DC power supply device 200 and the AC power supply device 300 are connected to the outdoor unit 50, but one of the power supply devices may be connected to one of the units so that the other unit may be supplied with power supply through that unit.

[0073] Further, in the example described here, the fan motor 7a and the fan motor 8a are supplied with DC power supply from the DC power supply device 200. However, depending on the configuration of the heat source-side heat exchangers 2 and the use-side heat exchanger 4, there may be a case in which no air-sending device is provided. Thus, it is only necessary that at least one of the fan motor 7a and the fan motor 8a be supplied with DC power supply from the DC power supply device 200.

[0074] As described above, according to the refrigeration cycle apparatus 100, the high-voltage DC power source (DC power supply device 200) can be used as the primary power source. That is, as DC for driving the inverter device used in the refrigeration cycle apparatus 100, supplied DC voltage, which is high voltage, can be used as it is. In the refrigeration cycle apparatus 100, it is consequently possible to greatly increase the efficiency of the system. As a result, a simple configuration of the refrigeration cycle apparatus 100 and high efficiency of the refrigeration cycle apparatus 100 may be achieved.

[0075] The outdoor control device 20 and the indoor control device 40 may be supplied with power from any of the power supply devices, but are preferably supplied with power from a power supply device connected to an uninterruptible power supply (UPS), which is described in Embodiment 2 of the present invention.

Embodiment 2

[0076] Fig. 4 is a system configuration diagram for schematically illustrating still another example of the power supply configuration of a refrigeration cycle apparatus 100A according to Embodiment 2 of the present invention. With reference to Fig. 4, still another example of the power supply configuration of the refrigeration cycle apparatus 100A is described.

[0077] The configuration of the refrigeration cycle apparatus 100A other than the power supply configuration is as described in Embodiment 1.

[0078] In the example described in Embodiment 1, the DC power supply device 200 and the AC power supply device 300 are connected to each of the outdoor unit 50 and the indoor unit 60, but in an example described in Embodiment 2, only the DC power supply device 200 can be used as the power supply device.

[0079] As illustrated in Fig. 4, the DC power supply device 200 is connected to each of the outdoor unit 50 and the indoor unit 60. However, each of the outdoor unit 50 and the indoor unit 60 includes the devices (solenoid valves (indoor solenoid valve 5 and outdoor solenoid valve 6), pressure switch 9, belt heater 1a, for example) configured to operate with AC power supply. Thus, a DC/AC converter device 400 capable of converting DC power supply supplied from the DC power supply device 200 into AC power supply is connected between the DC power supply device 200, and the outdoor unit 50 and the indoor unit 60.

[0080] With this configuration, similarly to Embodiment 1, in the refrigeration cycle apparatus 100A, the solenoid valves (indoor solenoid valve 5 and outdoor solenoid valve 6), the pressure switch 9, and the belt heater 1a can operate by being supplied with AC power supply.

[0081] A UPS 500 is preferably connected downstream of the DC/AC converter device 400. UPSs are configured to enable continuous power supply to devices connected thereto for a certain period of time without interruption of power supply, even when power supply is not supplied.

[0082] In particular, the outdoor control device 20 and the indoor control device 40 each include a versatile CPU, a data bus, an input/output port, a nonvolatile memory, and a timer, for example, and have a function to control the components. Thus, it is desired that a situation in which power supply to those devices is interrupted be avoided as much as possible. Accordingly, the UPS 500 is preferably connected to a communication cable to which the outdoor control device 20 and the indoor control device 40 are connected, downstream of the DC/AC converter device 400, and upstream of the outdoor control device 20 and the indoor control device 40 so that power can be continuously supplied.

[0083] The outdoor control device 20 and the indoor control device 40 each correspond to a "controller" of the present invention.

[0084] Fig. 5 is a system configuration diagram for

schematically illustrating yet another example of the power supply configuration of the refrigeration cycle apparatus 100A. With reference to Fig. 5, yet another example of the power supply configuration of the refrigeration cycle apparatus 100A is described.

[0085] In the configuration example illustrated in Fig. 4, the DC/AC converter device 400 is supplied with power directly from the DC power supply device 200, but in an example illustrated in Fig. 5, the DC/AC converter device 400 is supplied with DC voltage that is reduced to a predetermined value in the DC power supply device 200. That is, the DC power supply device 200 includes a voltage drop circuit 202, and the voltage of DC power supply (for example, DC of 380 V) that is supplied to the outdoor unit 50 and the indoor unit 60, and the voltage of DC power supply (for example, DC of 48 V) that is supplied to the DC/AC converter device 400 have different voltage values.

[0086] As described above, according to the refrigeration cycle apparatus 100A, the high-voltage DC power source (DC power supply device 200) can be used as the primary power source. That is, as DC for driving the inverter device used in the refrigeration cycle apparatus 100A, supplied DC voltage, which is high voltage, can be used as it is. In the refrigeration cycle apparatus 100A, it is consequently possible to greatly increase the efficiency of the system. As a result, a simple configuration of the refrigeration cycle apparatus 100A and high efficiency of the refrigeration cycle apparatus 100A may be achieved. Further, according to the configuration of the refrigeration cycle apparatus 100A, the numbers of the outdoor unit 50 and the indoor unit 60 can be quickly and easily increased, which means that expandability is improved.

Embodiment 3

[0087] Fig. 6 is a system configuration diagram for schematically illustrating still another example of the power supply configuration of a refrigeration cycle apparatus 100B according to Embodiment 3 of the present invention. With reference to Fig. 6, still another example of the power supply configuration of the refrigeration cycle apparatus 100B is described.

[0088] The configuration of the refrigeration cycle apparatus 100B other than the power supply configuration is as described in Embodiment 1.

[0089] In the example described in Embodiment 2, only the DC power supply device 200 is used as the power supply device, and the DC/AC converter device 400 is connected between the DC power supply device 200, and the outdoor unit 50 and the indoor unit 60, but in an example described in Embodiment 3, the DC/AC converter device 400 is mounted on the outdoor unit 50.

[0090] As illustrated in Fig. 6, the DC power supply device 200 is connected to each of the outdoor unit 50 and the indoor unit 60. However, each of the outdoor unit 50 and the indoor unit 60 includes the devices (solenoid

valves (indoor solenoid valve 5 and outdoor solenoid valve 6), pressure switch 9, belt heater 1a, for example) configured to operate with AC power supply. Those devices do not operate with DC power supply supplied from the DC power supply device 200. Thus, the DC/AC converter device 400 capable of converting DC power supply supplied from the DC power supply device 200 into AC power supply is mounted on the outdoor unit 50. Further, AC power supply subjected to conversion in the DC/AC converter device 400 is supplied to the devices of the outdoor unit 50 so that the devices can be driven. In addition, the AC power supply is also supplied to the indoor unit 60 so that the devices of the indoor unit 60 can be driven by being supplied with power.

[0091] With this configuration, similarly to Embodiment 1, in the refrigeration cycle apparatus 100B, the solenoid valves (indoor solenoid valve 5 and outdoor solenoid valve 6), the pressure switch 9, and the belt heater 1a can operate by being supplied with AC power supply.

[0092] In the example described here, the DC/AC converter device 400 is mounted on the outdoor unit 50, but the present invention is not limited thereto. The DC/AC converter device 400 may be mounted on the indoor unit 60 so that AC power supply may be supplied to the outdoor unit 50 from the indoor unit 60. Further, the DC/AC converter device 400 may be supplied with DC voltage that is reduced to a predetermined value in the DC power supply device 200, as illustrated in Fig. 5.

[0093] As described above, according to the refrigeration cycle apparatus 100B, the high-voltage DC power source (DC power supply device 200) can be used as the primary power source. That is, as DC for driving the inverter device used in the refrigeration cycle apparatus 100B, supplied DC voltage, which is high voltage, can be used as it is. In the refrigeration cycle apparatus 100B, it is consequently possible to greatly increase the efficiency of the system. As a result, a simple configuration of the refrigeration cycle apparatus 100B and high efficiency of the refrigeration cycle apparatus 100B may be achieved.

[0094] The refrigeration cycle apparatus according to each of Embodiments 1 to 3 of the present invention is described so far. The present invention is widely applicable, and is applied to, for example, an air-conditioning apparatus that is installed in a facility, for example, a data center in which the DC power supply device 200 is already installed.

Reference Signs List

[0095] 1 compressor 1a belt heater 2 heat source-side heat exchanger 3 expansion valve 4 use-side heat exchanger 5 indoor solenoid valve 6 outdoor solenoid valve 7 outdoor air-sending device 7a fan motor 8 indoor air-sending device 8a fan motor 9 pressure switch 10 refrigerant pipe 11 refrigerant pipe 20 outdoor control device 21 computing device 40 indoor control device 41 computing device 50 outdoor unit 60 indoor unit 100 refrigeration cycle apparatus

eration cycle apparatus 100A refrigeration cycle apparatus 100B refrigeration cycle apparatus 101 refrigerant circuit 200 DC power supply device 201 communication cable 202 voltage drop circuit 300 AC power supply device 301 communication cable 400 DC/AC converter device

Claims

1. A refrigeration cycle apparatus, comprising:

a refrigerant circuit in which a compressor, a condenser, a pressure reducing device, and an evaporator are connected by refrigerant pipes; at least one auxiliary system device; and an air-sending device provided to at least one of the condenser and the evaporator, the refrigeration cycle apparatus being configured to be operatable with power supply of both of DC power supply and AC power supply.

2. The refrigeration cycle apparatus of claim 1, wherein the DC power supply is supplied from a DC power supply device provided outside the refrigeration cycle apparatus.

3. The refrigeration cycle apparatus of claim 1 or 2, wherein the AC power supply is supplied from an AC power supply device provided outside the refrigeration cycle apparatus or is obtained through conversion of the DC power supply.

4. The refrigeration cycle apparatus of any one of claims 1 to 3, wherein at least one of the compressor and the air-sending device is driven with the DC power supply, and wherein at least one of the at least one auxiliary system device is driven with the AC power supply.

5. The refrigeration cycle apparatus of claim 2, wherein the DC power supply that is supplied from the DC power supply device has a voltage of 200 V or more.

6. The refrigeration cycle apparatus of any one of claims 1 to 5, further comprising:

a controller configured to control operations of the compressor, the pressure reducing device, and the air-sending device, and be supplied with the AC power supply obtained through conversion of the DC power supply; and an uninterruptible power supply connected upstream of the controller.

7. The refrigeration cycle apparatus of any one of claims 1 to 6, further comprising:

an indoor unit having mounted thereon at least one device of the compressor, the condenser, the pressure reducing device, and the evaporator; and

an outdoor unit having mounted thereon at least one device of the compressor, the condenser, the pressure reducing device, and the evaporator other than the at least one device mounted on the indoor unit, wherein both of the DC power supply and the AC power supply are supplied to each of the indoor unit and the outdoor unit.

8. The refrigeration cycle apparatus of any one of claims 1 to 6, further comprising:

an indoor unit having mounted thereon at least one device of the compressor, the condenser, the pressure reducing device, and the evaporator; and

an outdoor unit having mounted thereon at least one device of the compressor, the condenser, the pressure reducing device, and the evaporator other than the at least one device mounted on the indoor unit, wherein both of the DC power supply and the AC power supply are supplied to at least one of the indoor unit and the outdoor unit, and an other one of the indoor unit and the outdoor unit is supplied with power through the at least one of the indoor unit and the outdoor unit.

9. The refrigeration cycle apparatus of claim 2, wherein the refrigeration cycle apparatus is installed in a facility in which the DC power supply device is already installed.

10. The refrigeration cycle apparatus of claim 9, wherein the facility comprises a data center.

FIG. 1

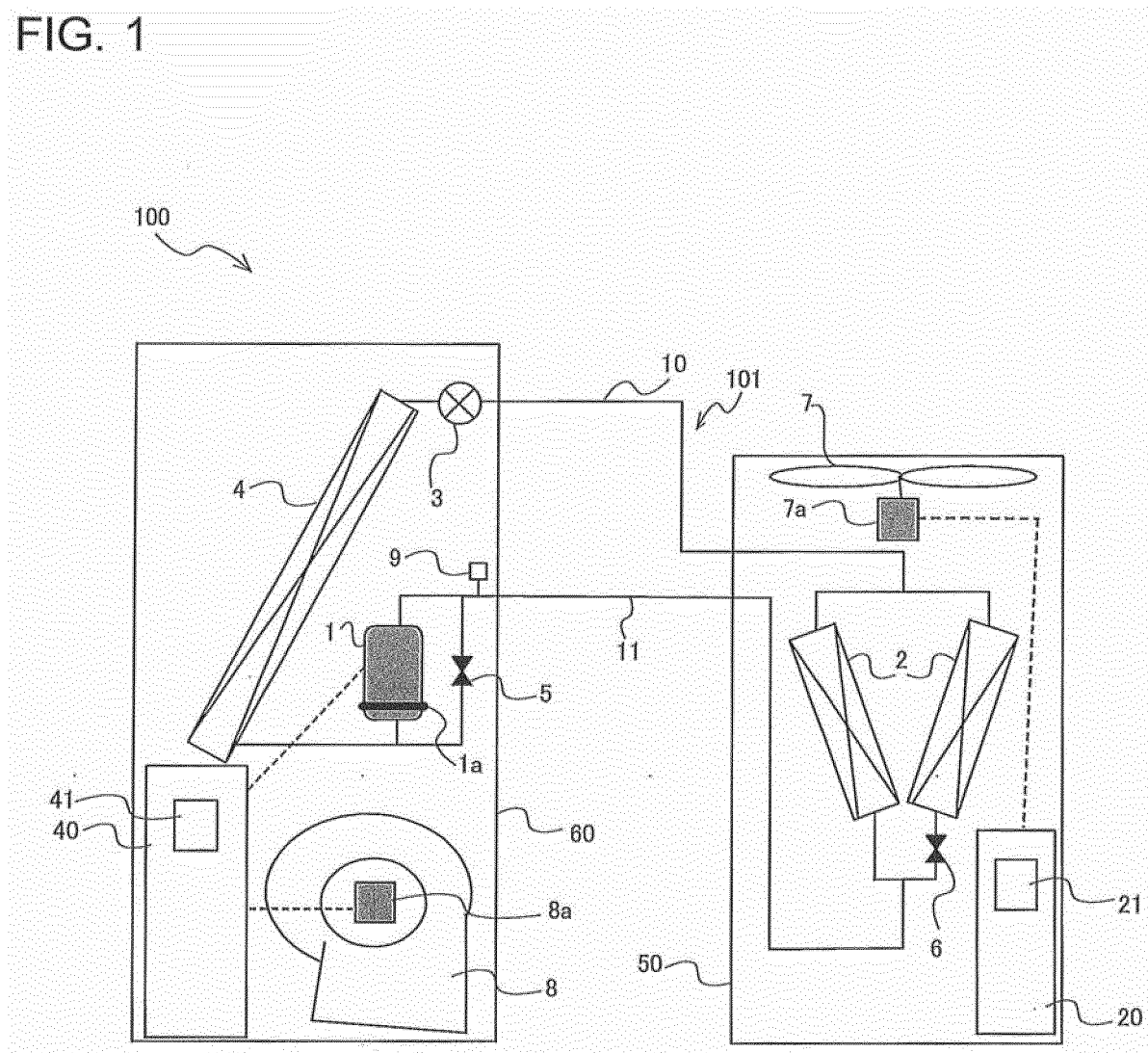


FIG. 2

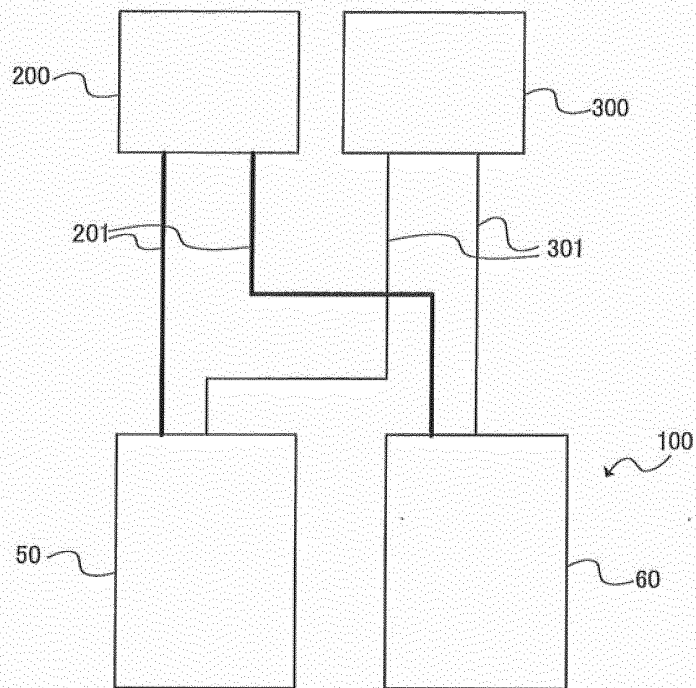


FIG. 3

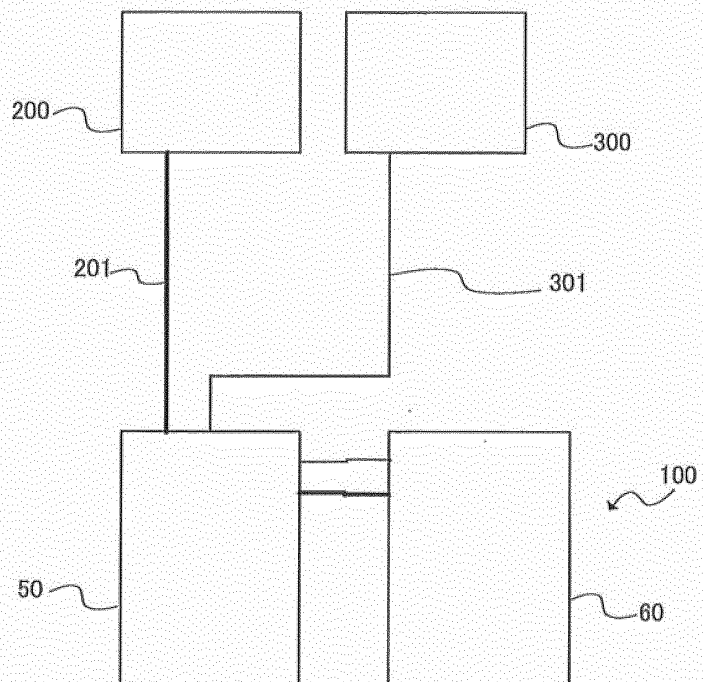


FIG. 4

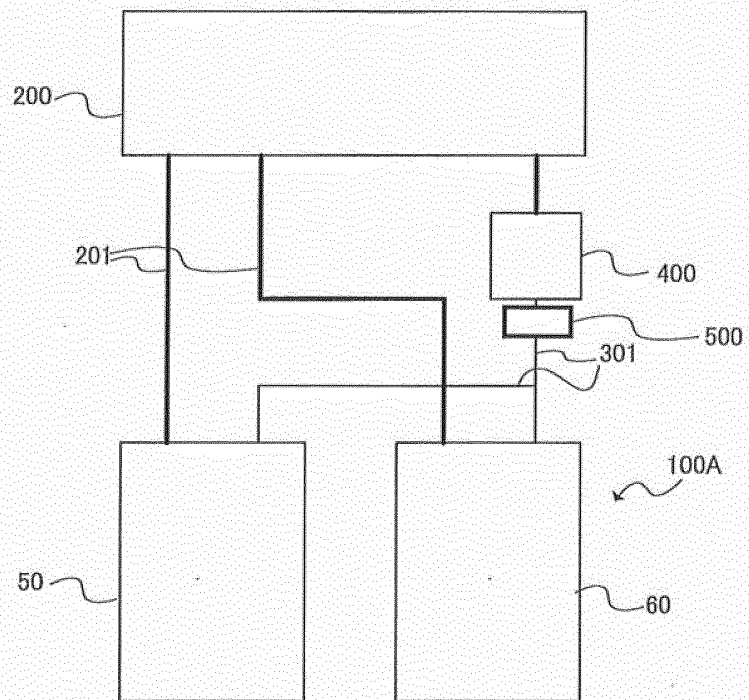


FIG. 5

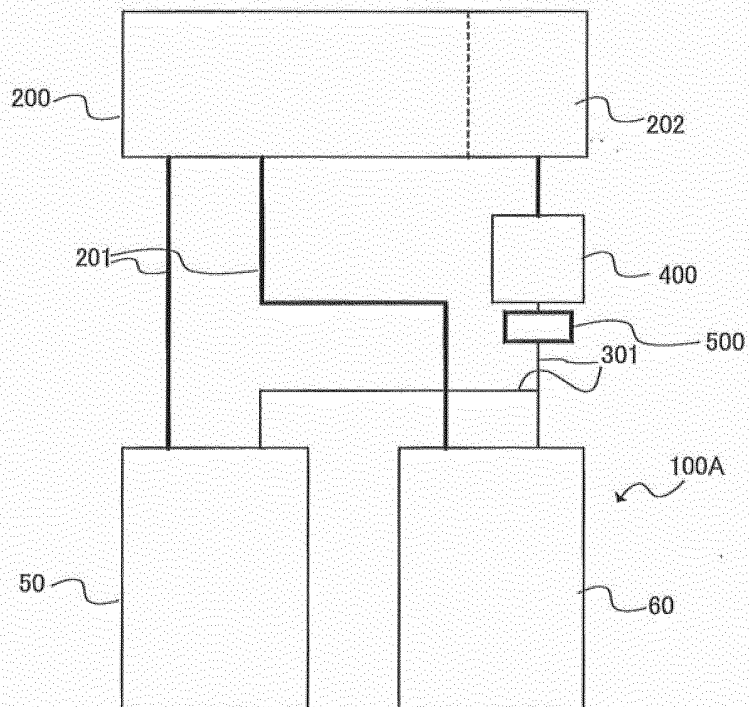


FIG. 6

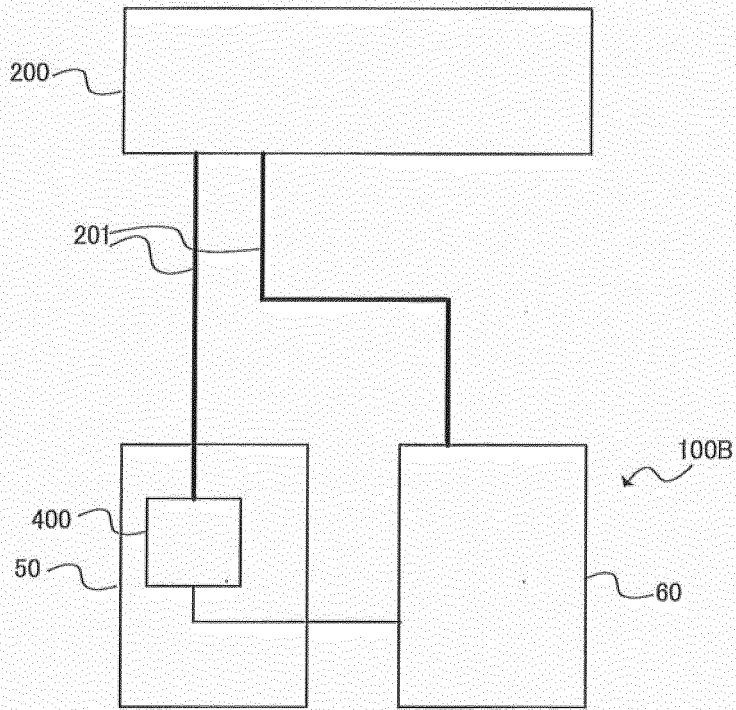


FIG. 7

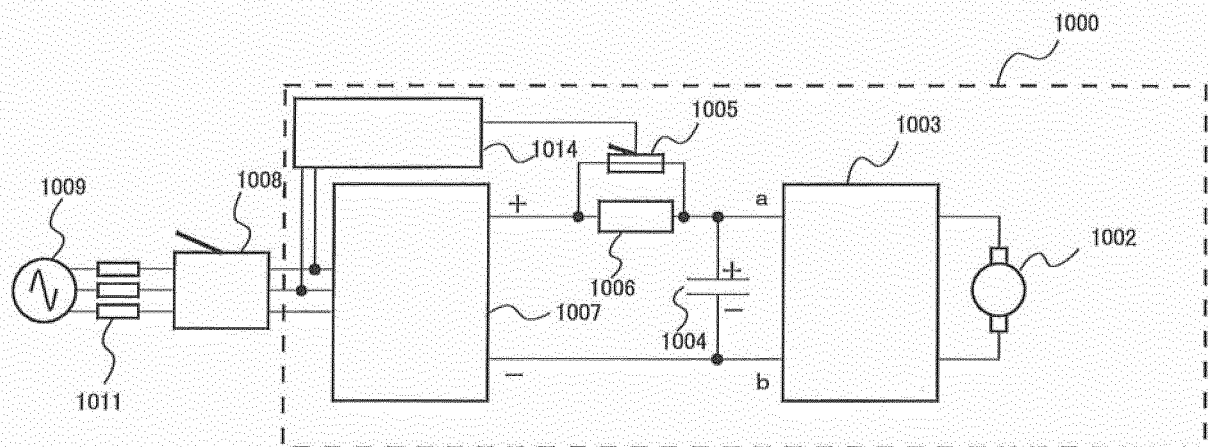
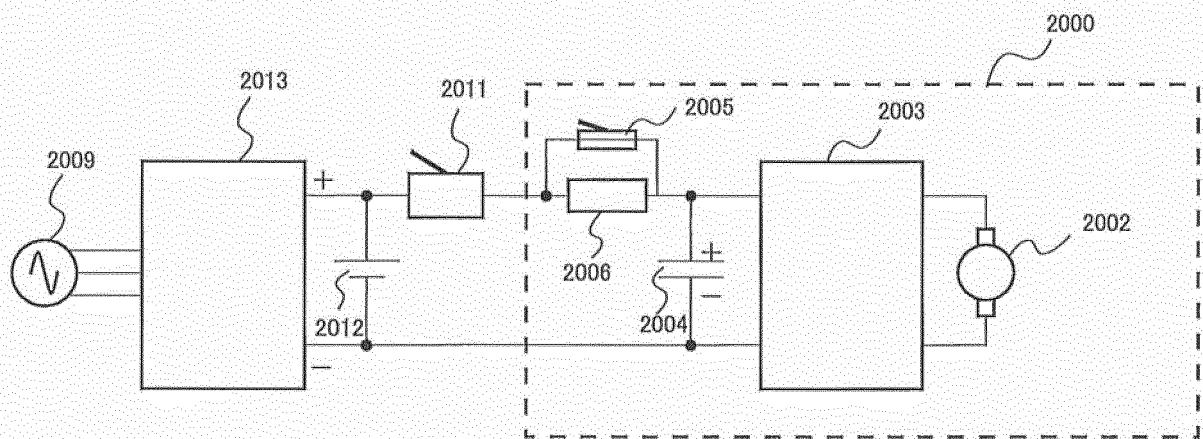


FIG. 8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/055637

A. CLASSIFICATION OF SUBJECT MATTER

F25B49/02(2006.01)i, F24F1/20(2011.01)i, F24F11/02(2006.01)i, F24F13/20(2006.01)i, F25B49/00(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)

F25B49/02, F24F1/20, F24F11/02, F24F13/20, F25B49/00

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

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Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

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 Y	JP 2009-41857 A (Sharp Corp.), 26 February 2009 (26.02.2009), paragraphs [0025] to [0050]; fig. 1 (Family: none)	1, 3 2-10
X Y	JP 2010-43764 A (Daikin Industries, Ltd.), 25 February 2010 (25.02.2010), paragraphs [0034], [0042] (Family: none)	1, 3 2-10
X Y	JP 2009-174789 A (Sanden Corp.), 06 August 2009 (06.08.2009), paragraph [0015] & WO 2009/093350 A1 & EP 2251618 A1	1, 3 2-10



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search
11 May 2015 (11.05.15)

Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

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PCT/JP2015/055637

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2013-194969 A (Corona Corp.), 30 September 2013 (30.09.2013), paragraph [0061]; fig. 1, 5 (Family: none)	2-10
Y	WO 2012/120600 A1 (Mitsubishi Electric Corp.), 13 September 2012 (13.09.2012), paragraph [0029] & EP 2683065 A1 & CN 103404011 A	2-10
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Y	JP 11-316041 A (Hitachi, Ltd.), 16 November 1999 (16.11.1999), paragraphs [0062], [0100] (Family: none)	5-10
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A	JP 2013-219857 A (Sharp Corp.), 24 October 2013 (24.10.2013), paragraph [0001] (Family: none)	1-10

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INTERNATIONAL SEARCH REPORT

International application No.

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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 2009-515495 A (Carling Technologies, Inc.), 09 April 2009 (09.04.2009), paragraph [0045] & US 2007/0103835 A1 & WO 2007/047615 A2 & KR 10-2008-0074863 A & CN 101341566 A	1-10

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REFERENCES CITED IN THE DESCRIPTION

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