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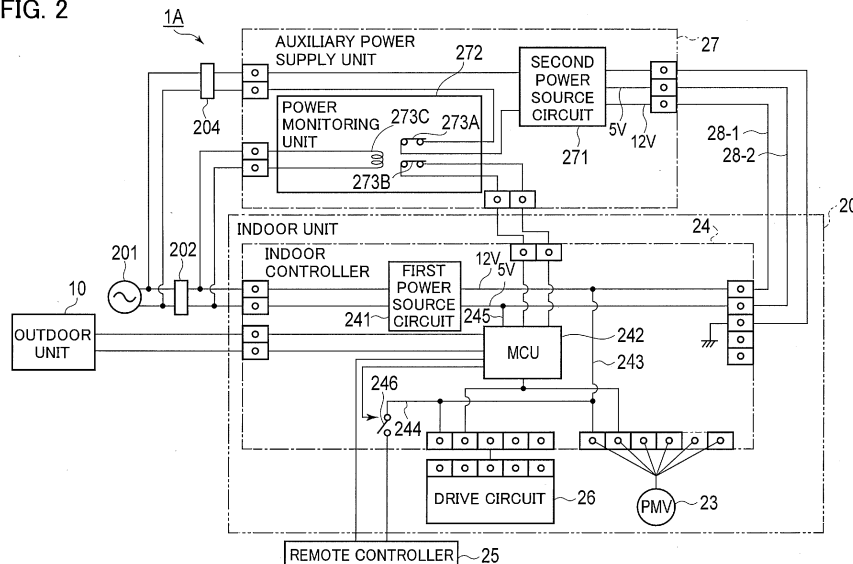
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(54) **AIR CONDITIONING SYSTEM AND INDOOR UNIT USED IN SAME**

(57) An air conditioning system (1A, 1B) includes: an outdoor unit (10); indoor units (20), an auxiliary power supply device (27) for supplying power from a second power source circuit (271) to the indoor units (20) when the first power source circuit (241) for supplying power to the indoor units (20) has assumed an off state, and a remote controller (25) for operating the actions of the indoor units (20). The air conditioning system (1A, 1B) does not display a display screen on the remote controller (25) when power is not supplied by the first power source

circuit (241). With the present invention, it is possible to prevent circumstances where the display screen such as a liquid crystal display of the remote controller is in display mode despite the power source having been turned off, and the user gets confused by not knowing whether the power source was operated normally; or circumstances where another user who did not turn off the power supply mistakenly assumes that the indoor units can be operated because the display screen of the remote controller is in display mode.

FIG. 2



Description

Technical Field

[0001] Embodiments of the present invention relates to an air conditioning system and an indoor unit used in the air conditioning system.

Background Art

[0002] Conventionally, an air conditioning system installed in a large-sized architecture, such as a building, is composed of an outdoor unit and a plurality of indoor units connected to the outdoor unit. In such an air conditioning system, a refrigerant pipe is arranged so that refrigerant circulates between the outdoor unit and the plurality of indoor units.

[0003] When the air conditioning system operates, the refrigerant generated in the outdoor unit is supplied to each of the indoor units via the refrigerant pipe to perform heat exchange, and the heat-exchanged refrigerant is returned to the outdoor unit via the refrigerant pipe and further used for the subsequent generation of the refrigerant.

[0004] When the refrigerant circulates in the air conditioning system in this way, lubricating oil accommodated in a compressor of the outdoor unit to lubricate sliding components in the compressor also circulates in the refrigerant pipe as well as the refrigerant, although the amount of such lubricating oil in circulation is slight. As the lubricating oil in circulation partly adheres to indoor heat exchangers and the inner surface of the refrigerant pipe and resides therein, the amount of lubricating oil in the compressor gradually decreases with the lapse of operating time. If the amount of lubricating oil is insufficient in the compressor, there arises a possibility that inconvenience such as seizure of sliding surfaces occurs.

[0005] Therefore, in order to avoid a lack of the lubricating oil in the compressor, it is necessary to carry out an oil recovery operation for recovering the lubricating oil residing in the indoor heat exchangers and the inner surface of the refrigerant pipe, periodically. The oil recovery operation is carried out under condition that the refrigeration cycle is set to the cooling mode in the outdoor unit, while electric expansion valves installed in the middle of the pipe in all the indoor units including an indoor unit during stop are opened to a predetermined opening degree.

Citation List

Patent Literature

[0006]

PTL 1: JP 4160884 B

PTL 2: JP H04-263733 A

Summary of Invention

[0007] The outdoor unit and each of the indoor units of the air conditioning system are supplied with power independently. Therefore, when there is an indoor unit whose operation will be stopped for a long period of time, an user may turn off a breaker to disconnect the relevant indoor unit from a power source (interrupt the power supply) in some cases. In the indoor unit whose operation is stopped, its electric expansion valve is closed so that no refrigerant flows in the indoor heat exchangers. If the power supply were not interrupted, during the oil recovery operation, an indoor controller could open the electric expansion valve also in the indoor unit whose operation has been stopped. However, in the indoor unit that is disconnected from the power supply and turned off, it is impossible to open electric expansion valve because there is no electric power to drive the indoor controller and the electric expansion valve. Thus, even if the oil recovery operation is performed, the lubricating oil could not be recovered from the indoor unit that is disconnected from the power source.

[0008] Meanwhile, under condition that the indoor units are turned off, there is a technique of connecting an auxiliary power supply unit, which supplies low-voltage power of about 12 V DC and about 5 V DC capable of operating the indoor controller, the electric expansion valve and the like, with the respective indoor units. With the relevant auxiliary power supply unit connected to each of the indoor units, even when the power supply of any one of the indoor units is in an off-state, it is possible to make the electric expansion valve open, thereby allowing the oil recovery operation to be carried out reliably.

[0009] In a conventional air conditioning system adopting this technology, an output terminal of 12 V DC power and an output terminal of 5 V DC power of the auxiliary power supply unit are connected to the existing power wirings for 12 V DC and 5 V DC in the indoor unit, respectively. This wiring for 12 V is connected to an electric expansion valve, a drain pump, a remote controller of the indoor unit, and the like which are driven with electric power supplied through the relevant wiring. On the other hand, the wiring for 5 V is connected to an indoor controller, and the communication with the outdoor controller is performed and the respective devices in the indoor unit are controlled with electric power supplied through the relevant wiring.

[0010] If the power supply to the indoor unit is turned off, all the devices connected to these wirings are supplied with electric power from the auxiliary power supply unit. Therefore, similarly to the situation where the power source is in the ON state, it is possible to control the respective devices into a state enabling them to perform the oil recovery operation.

[0011] However, when the power supply to the indoor unit is turned off in this air conditioning system, not only the electric expansion valve required to be driven but also the remote controller connected to the indoor unit is

supplied with electric power. While the remote controller is being supplied with electric power, the display screen is always brought into a display state to display time information, room-temperature information, and so on.

[0012] From the viewpoint of a user, there is a case that the user gets confused by not knowing whether or not the power source was operated normally because the display screen such as a liquid crystal display of the remote controller is in a display mode despite that a user's manipulation to turn off the power source was performed. Additionally, another user who did not turn off the power supply mistakenly assumes that the indoor unit is operable because the display screen of the remote controller is in the display mode.

[0013] In the above-mentioned circumstances, the present invention provides an air conditioning system including: an outdoor unit; a plurality of indoor units connected to the outdoor unit through a refrigerant pipe; and an auxiliary power source unit connected to each indoor unit. The indoor unit includes a device operating with DC power, a first power source circuit, and a remote controller. The first power source circuit converts AC power supplied from the commercial power source into the DC power of a predetermined voltage and also supplies the DC power to the device. The auxiliary power supply device connected to the indoor unit includes a second power source circuit for converting the AC power supplied from the commercial power source into the DC power of the predetermined voltage and supplies the DC power from the second power source circuit to the device when supplying the AC power to the first power source circuit is interrupted. The remote controller includes a display screen and operates with the DC power to control the operation of the indoor unit. The air conditioning system includes means for bringing the display screen of the remote controller into a non-display state when supplying the AC power to the first power source circuit is interrupted.

Brief Description of the Drawings

[0014]

Fig. 1 is an explanatory diagram illustrating the flow of refrigerant in an air conditioning system according to first and second embodiments.

Fig. 2 is a circuit diagram of an indoor unit of the air conditioning system according to the first embodiment.

Fig. 3(a) is a front view illustrating a state where a display screen of a remote controller of the air conditioning system according to the first and second embodiments is turned on, and Fig. 3(b) is a front view illustrating a state where the display screen is turned off.

Fig. 4 is a flowchart illustrating the operation of an indoor controller and an auxiliary power supply of the air conditioning system according to the first em-

bodiment.

Fig. 5 is a circuit diagram of an indoor unit of the air conditioning system according to the second embodiment.

Description of Embodiments

(First Embodiment)

[0015] An air conditioning system according to a first embodiment will be described with reference to Figs. 1 and 2. Fig. 1 is an explanatory diagram illustrating the schematic configuration of the air conditioning system 1A according to the present embodiment and the flow of refrigerant in the air conditioning system 1A.

[0016] The air conditioning system 1A is composed of an outdoor unit 10 and a plurality of indoor units 20-1, 20-2 connected to the outdoor unit 10 through a refrigerant pipe 30. Although Fig. 1 illustrates an arrangement where two indoor units 20-1, 20-2 are connected to the outdoor unit 10 to simplify the explanation, more indoor units are connected to the outdoor unit actually.

[0017] In the air conditioning system 1A, the outdoor unit 10 is operated by electric power supplied from, for example, a 400 V three-phase AC commercial power source 101 through a breaker 102, and the indoor unit 20-1 is operated by electric power supplied from a 200 V single-phase AC commercial power source 201-1 through a breaker 202-1, while the indoor unit 20-2 is also operated by electric power supplied from the same commercial power source 201-1 as the indoor unit 20-1 through a breaker 202-2. The breaker 102 is arranged in a place, such as outdoors or an administrator's room, where a user cannot operate it.

[0018] When the air conditioning system 1A operates in the cooling mode, in the outdoor unit 10, the refrigerant is compressed to high temperature and high pressure by a compressor 11, subsequently sent to an outdoor heat exchanger 13 through a four-way valve 12 and then liquefied in the outdoor heat exchanger 13. Then, the liquefied refrigerant is suddenly expanded by an expansion valve 14 to low temperature and low pressure. The so-produced refrigerant is supplied to the indoor units 20-1, 20-2 through a refrigerant pipe 30.

[0019] Each of the indoor units 20-1, 20-2 includes an indoor heat exchanger 21-1, 21-2. The refrigerant passing through the refrigerant pipe 30 is taken in from connecting pipes 22-1, 22-2 and supplied to respective indoor heat exchangers 21-1, 21-2. In a middle of each of the connecting pipes 22-1, 22-2, there is installed an electric expansion valve 23-1, 23-2 that control the flow (flow rate) of the refrigerant flowing through the pipe. Each electric expansion valve 23-1, 23-2 is configured so that its opening degree can be changed by electric power. The amount of refrigerant to be supplied to each indoor heat exchanger 21-1, 21-2 is controlled by the opening degree of the corresponding electric expansion valve 23-1, 23-2. For each of the electric expansion valves

23-1, 23-2, there is employed, for example, a valve unit referred to as "a pulse motor valve" generally, which controls the protrusion and retraction of a needle valve by a pulse motor whose rotation angle is changeable with pulse electric power.

[0020] In the indoor heat exchanger 21-1, 21-2, cold air is generated due to heat exchange using the supplied refrigerant and blown into an objective area. Then, the heat-exchanged refrigerant is returned to the compressor 11 of the outdoor unit 10 through the refrigerant pipe 30 and thereafter, the subsequent circulation of refrigerant is repeated.

[0021] In the heating mode, the refrigerant flows in the opposite direction to the above-described direction by switching the connecting direction of the four-way valve 12, and the compressed high-temperature refrigerant flows into the indoor heat exchanger 21-1, 21-2 for indoor heating.

[0022] In the air conditioning system 1A, additionally, the outdoor controller 15 installed in the outdoor unit 15 and indoor controllers 24-1, 24-2 installed in the indoor units 20-1, 20-2 respectively are connected with each other through a communication line, and various kinds of information is transmitted and received therebetween. Further, remote controllers 25-1, 25-2 are connected to the indoor controllers 24-1, 24-2, respectively, thereby allowing the operations of the indoor units 20-1, 20-2 to be manipulated by the remote controllers 25-1, 25-2 respectively.

[0023] Devices such as the electric expansion valves 23-1, 23-2 built in these indoor units 20-1, 20-2 and the remote controllers 25-1, 25-2 connected to the indoor units 20-1, 20-2 operates with the DC power of low voltage.

[0024] Fig. 2 is a schematic circuit diagram relating to one indoor unit 20 (the indoor unit 20-1 or 20-2) connected to the outdoor unit 10 in the air conditioning system 1A. Besides, the plurality of indoor units 20-1 and 20-2 connected to the outdoor unit 10 have the same configuration.

[0025] In Fig. 2, the indoor unit 20 includes: the electric expansion valve 23; the indoor controller 24; a drive circuit 26 that drives a drain pump for discharging dew condensation water generated in the indoor heat exchanger 21 (see Fig. 1) to the outside of the unit, a motor for rotating wind-direction changing plates (louvers) for changing the direction of blowing from the indoor unit 20, and the like; and an indoor fan (not illustrated).

[0026] In the devices built in each of the indoor units 20-1, 20-2, the electric expansion valve 23, the indoor controller 24, the motors for rotating the drain pump and the wind-direction changing plates, and the like are operated by DC power of a predetermined low voltage. On the other hand, the indoor fan, though it is driven by DC power, is supplied with power from a separate power source circuit (not illustrated) because the indoor fan is configured to operate with high AC voltage obtained by full-wave rectifying the power source voltage.

[0027] The remote controller 25 is connected to the indoor controller 24. Further, the auxiliary power supply unit (auxiliary power supply device) 27 is connected to the indoor unit 20.

[0028] The remote controller 25 operates with electric power supplied from the indoor controller 24 and includes, as illustrated in Figs. 3(a) and 3(b), a liquid crystal display screen 25a and a group of buttons 25b for a user to manipulate the operation of the outdoor unit 20. When electric power is being supplied to the remote controller 25, the display screen 25a exhibits a display state (lighting state) where the controller is driven, and there are displayed information about the current time, information about the room temperature, and information about the manipulation on the button group 25b or the like, as illustrated in Fig. 3(a). Meanwhile, when no electric power is supplied to the remote controller 25 or when the remote controller 25 is in a sleep mode, it is brought into a non-display state (unlighted state) where nothing is displayed on the display screen 25a, as illustrated in Fig. 3 (b).

[0029] The indoor controller 24 includes a first power source circuit 241, an MCU (Micro Controller Unit) 242, and a switch 246 for switching on and off the supply of power to the remote controller 25. It is sufficient for the switch 246 to have a function of switching on and off (energization and shutoff) the supply of power to the remote controller 25, and the switch 246 may consist of a relay, a transistor, or an FET (Field Effect Transistor).

[0030] Using AC power supplied from the commercial power source 201 of single-phase 200V through a circuit breaker (breaker) 202, the first power source circuit 241 generates DC power having voltages in multiple levels, which is required for the operations of respective devices in the indoor unit 20. In the first embodiment, the first power source circuit 241 is a constant-voltage DC power source that rectifies AC power from the commercial power source 201 temporarily and subsequently generates two low-voltage DC powers of 12 V and 5 V by a DC/DC converter. Then, the 12 V electric power generated by the first power source circuit 241 and outputted from an output terminal is supplied to the electric expansion valve 23 and the drive circuit 26 through a first wiring 243 and further supplied to the remote controller 25 through a second wiring 244 branched from the first wiring 243. Further, the 5 V electric power generated by the first power source circuit 241 and outputted from the output terminal is supplied to the MCU 242 through a third wiring 245.

[0031] Based on instructions from the outdoor unit 10, the MCU 242 controls the operations of the devices in the indoor unit 20, for example, the electric expansion valve 23, the drive circuit 26, the fan (not illustrated), a switch 246, the remote controller 25, and so on.

[0032] The switch 246 is connected to the middle of the second wiring 244, which is supplied with the 12 V DC power generated by the first power source circuit 241, in series. The opening and closing control of the switch 246 by the MCU 242 will be described later.

[0033] The auxiliary power supply unit 27 in the form of a small box installed outside the indoor unit 20 is connected to the commercial power source 201 of the same AC 200V as the indoor unit 20 through a breaker 204. Besides, the commercial AC power source for connection with the auxiliary power supply unit 27 may consist of another AC power source different from the commercial power source 201 to which the indoor unit 20 is connected.

[0034] The auxiliary power supply unit 27 is provided with a second power source circuit 271 and a power monitoring unit 272. Using AC power supplied from the commercial power source 201 through the breaker 204, the second power source circuit 271 generates low-voltage DC power. The low-voltage DC power generated by the second power source circuit 271 is DC power required to operate a device, the operation of which is necessary even when the AC power supplied to the first power source circuit 241 is interrupted to cause its operation to be stopped, for example, the electric expansion valve 23 and so on. In the first embodiment, the second power source circuit 271 generates low-voltage DC powers of 12 V and 5 V substantially the same as the first power source circuit 241.

[0035] The auxiliary power supply unit 27 includes a step-down transformer, a rectifier and a DC/DC converter. The AC power from the commercial power source 201 is stepped down to a low-voltage AC of about 24 V by the step-down transformer and successively converted to direct current by the rectifier. Then, the DC/DC converter converts this direct current into DC 12 V and DC 5 V of desired constant voltages and outputs them. Besides, although the auxiliary power supply unit 27 is connected to the AC commercial power source of 200V, the auxiliary power supply unit 27 may be configured to receive low-voltage AC of about 24 V for the power source, provided that the step-down transformer is arranged outside the auxiliary power supply unit 27.

[0036] The breaker 202 interposed in the power supply path to the indoor controller 24 is provided on an upper wall surface etc. of a room containing the indoor unit 10 and is in a state where a user of the indoor unit can turn on/off the breaker. On the other hand, the breaker 204 interposed in the power supply path to the auxiliary power supply unit 27 is provided in an administrator's room or the like, and is in a place where a user of the indoor unit cannot turn on and off the breaker and also in a state where the breaker is always supplied with power from the commercial power source 201.

[0037] The 12 V DC power generated by the second power source circuit 271 and outputted from the output terminal is supplied to the indoor controller 24 through a fourth wiring 28-1, while the 5 V DC power is supplied to the indoor controller 24 through a fifth wiring 28-2. The fourth wiring 28-1 is connected to the first wiring 243 for 12 V of the indoor controller 24. The fifth wiring 28-2 is connected to the third wiring 245 for 5 V of the indoor controller 24.

[0038] The power monitoring unit 272 monitors presence or absence of AC power supply from the commercial power source 201 to the indoor controller 24 through the breaker 202, that is, the ON/OFF state of the breaker 202, and also switches the presence and absence of AC power supply to the second power source circuit 271 based on the monitoring result. As a simple specific example of the power monitoring unit 272, there is a two-contact-point relay including a first contact 273 as a normally-closed contact, a second contact 273B as a normally-closed contact, and a relay coil 273C that drives the contacts 273A, 273B to an open state when the AC power is energized.

[0039] Similarly to the first power source circuit 241, the relay coil 273C is connected to the commercial power source 201 through the breaker 202. When the breaker 202 is in the ON state, the relay coil 273C is energized by the AC power supplied from the commercial power source 201, and these two contacts 273A, 273B are opened. In addition, when the breaker 202 is operated to the OFF state, the relay coil 273C is deenergized, so that these two contacts 273A, 273B are closed.

[0040] One end of the first contact 273A is connected to the commercial power source 201 and the other end of the first contact 273A is connected to a power input terminal of the second power source circuit 271. Therefore, when the first contact 273A is opened, the supply of AC power from the commercial power source 201 to the second power source circuit 271 is interrupted, and when the first contact 273A is closed, the AC power is supplied from the commercial power source 201 to the second power source circuit 271.

[0041] Therefore, the MCU 242, the drive circuit 26, the electric expansion valve 23, and the like are operated by the DC powers of 12 V and 5 V supplied from the first power source circuit 241 in the indoor controller 24 when the breaker 202 is in the ON state, and operated by the DC powers of 12 V and 5 V supplied from the second power source circuit 271 when the breaker 202 is in the OFF state. Thus, even when the breaker 202 is in the OFF state, these devices installed in the main body of the indoor unit 20 such as the MCU 242, the drive circuit 26, and the electrically driven expansion valve 23 become operable. Further, since the MCU 242 is operable, it is also possible to communicate signals with the outdoor controller 15.

[0042] On the other hand, the second contact 273B has both ends connected to two input terminals of the MCU 242 of the indoor controller 24. By detecting presence or absence of conductivity between the two input terminals, the MCU 242 monitors opening or closing state of the second contact 273B, namely, presence or absence of the AC power supply from the commercial power source 201 (ON or OFF state of the breaker 202).

[0043] When detecting that the second contact 273B has become opened, the MCU 242 of the indoor controller 24 judges that the breaker 202 is in the ON state and then turns on the switch 246 to supply the power to the

remote controller 25. On the other hand, when detecting that the second contact 273B has becomes closed, the MCU 242 judges that the breaker 202 is in the OFF state and turns off the switch 246 to interrupt the power supply from the second wiring 244 to the remote controller 25. Note that the second wiring 244 is a wiring branched from the first wiring 243 which is connected to the fourth wiring 28-1. Therefore, regardless of ON or OFF of the breaker 202, the second wiring 244 is always supplied with the power of 12 V from either the first power source circuit 241 or the second power source circuit 271. The above monitoring and operation based thereon are executed by a program integrated in the MCU 24. Besides, since this monitoring and operation based thereon are simple in processing contents, they may be executed by an electric logic circuit, instead of the MCU 24 using such a program.

[0044] When the above-constructed air conditioning system 1A operates and the refrigerant circulates through the refrigerant pipe 30, the lubricating oil contained in the compressor 11 of the outdoor unit 10 to lubricate the sliding components circulates in the refrigerant pipe 30 although its amount is slight, similarly to the refrigerant. As part of the lubricating oil in circulation adheres to respective inner surfaces of the indoor heat exchangers 21-1, 21-2, the refrigerant pipe 30, and the connecting pipes 22-1, 22-2, and stays there, there is a possibility that the amount of lubricating oil in the compressor 11 decreases with the passage of the operation time, thereby causing a malfunction.

[0045] Therefore, in order to avoid a shortage of lubricating oil in the compressor, the oil recovery operation for recovering the lubricating oil staying on the inner surfaces of the indoor heat exchangers 21-1, 21-2, the refrigerant pipe 30, and the connecting pipes 22-1, 22-2 is executed in the air conditioning system 1A periodically. Specifically, the outdoor controller 15 in the outdoor unit 10 integrates the operation duration time of the compressor 11, and when this time reaches a predetermined time, the indoor controllers 24-1, 24-2 in the indoor units 20-1, 20-2 are informed of the start of the oil recovery operation through the communication line. In the oil recovery operation, it is performed to set the refrigeration cycle of the outdoor unit 10 to the cooling mode and further open the electric expansion valves 23-1, 23-2 installed in the middle of the connecting pipes 22-1, 22-2 in all the indoor units 20-1, 20-2 including the indoor unit during stop. Therefore, when acquiring the information about the start of the oil recovery operation, the indoor controllers 24-1, 24-2 causes the electric expansion valves 23-1, 23-2 to be opened, thereby making the system capable of performing the oil recovery operation.

[0046] In order to execute this oil recovery operation reliably, in the air conditioning system 1A according to the first embodiment described above, even in the indoor units 20-1, 20-2 where the breakers 202 of the indoor units are turned off by the user, it becomes possible to operate the electric expansion valves 23-1, 23-2 from the

closed state to the opened state of a predetermined opening degree.

[0047] The operation performed by the auxiliary power supply 27 and the indoor controller 24 in the air conditioning system 1A on the basis of the ON/OFF operation of the breaker 202 will be described below with reference to the flowchart of Fig. 4.

[0048] First, when the breaker 202 is in the ON state and the second contact 273B of the power monitoring unit 272 is opened by the AC power supplied from the commercial power source 201, the switch 246 is controlled to the ON state by the MCU 242 of the indoor controller 24 (S1), and the 12 V DC power generated by the first power source circuit 241 is supplied to the remote controller 25. On the other hand, in the auxiliary power supply unit 27, it is constantly executed to monitor whether the breaker 202 is turned on or off, that is, whether or not the electric power is supplied from the commercial power source 201 to the indoor controller 24 through the breaker 202 (S2).

[0049] Then, when a user manipulates the breaker 202 into the OFF state so that the power supply from the commercial power source 201 to the first power source circuit 241 is interrupted in the indoor unit 20 ("YES" at S2), the relay coil 273C in the power monitoring unit 272 is deenergized simultaneously, so that the first contact 273A and the second contact 273B are closed. With the first contact 273A closed, the electric power is supplied from the commercial power source 201 to the second power source circuit 271 through the breaker 204. Then, the output of 5 V DC power and 12 V DC power from the second power source circuit 271 to the indoor controller 24 is started (S3). As a result of starting the power supply from the second power source circuit 271, even if the breaker 202 is manipulated into the OFF state, it becomes possible to operate the devices such as the electric expansion valve 23 and the drive circuit 26. Therefore, even when the power supply to the indoor unit 20 is being stopped (the breaker 202 is turned off) and if only there is an instruction to start the oil recovery operation from the outdoor controller 15 through the communication line, the MCU 242 of the indoor controller 24 receives this signal and enables to perform the oil recovery operation normally by opening the electric expansion valve 23. Similarly, if there is an instruction to complete the oil recovery operation from the outdoor controller 15, the MCU 242 of the indoor controller 24 receives this signal and enables to finish the oil recovery operation by closing the electric expansion valve 23.

[0050] Further, when the MCU 242 of the indoor controller 24 detects that the second contact 273B has been closed ("YES" at S4), the switch 246 is switched to the OFF state (S5). When the switch 246 is switched to the OFF state, the power supply from the auxiliary power supply unit 27 to the remote controller 25 is stopped, so that the display screen 25a is turned off and brought into a non-display state. Therefore, it is possible to avoid such a situation that the display screen 25a of the remote con-

troller 25 becomes displayed (lighting) to cause the user to be confused, despite that a user manipulates to turn off the breaker 202.

[0051] Thereafter, when the breaker 202 is manipulated to the ON state by the user and the power supply from the commercial power source 201 to the first power source circuit 241 is restarted ("YES" at S6), the first contact 273A and the second contact 273B of the power monitoring unit 272 become opened. When the first contact 273A is opened, the power supply from the commercial power source 201 to the second power source circuit 271 is interrupted, and the power supply from the second power source circuit 271 to the indoor controller 24 is stopped (S7). Thereafter, the process proceeds to step S2 and returns to the monitoring of the ON or OFF state of the breaker 202.

[0052] When the MCU 242 of the indoor controller 24 detects that the second contact 273B has been opened ("YES" at S8), the process returns to step S1 where the switch 246 is switched to the ON state, and the power supply to the remote controller 25 is restarted to bring the display screen 25a into a display state (lighting).

[0053] In the first embodiment described above, the switch 246 is provided in the indoor controller 24 to make the display screen 25a of the remote controller 25 in the non-display state. However, it is noted that the remote controller 25 and the indoor controller 24 are communicating with each other. Thus, without disposing the switch 246, the air conditioning system 1A may be configured so that when the power supply to the first power source circuit 241 is interrupted, the MCU 242 outputs an instruction to shift the remote controller 25 to a sleep mode where the display screen 25a is not displayed, and that when the power supply to the first power source circuit 201 is restarted, the MCU 242 outputs an instruction to cancel the sleep mode, thereby allowing the display screen 25a of the remote controller 25 to be non-displayed while the breaker 202 is in the OFF state.

<Second Embodiment>

[0054] An air conditioning system according to a second embodiment will be described with reference to Fig. 5. In the air conditioning system 1B according to the second embodiment, there is not provided a wiring for connecting the first wiring 243 in the indoor controller 24 and the remote controller 25 (the second wiring 244 in the air conditioning system 1A in the first embodiment) and instead, there is independently provided an sixth wire 247 for directly connecting the first power source circuit 241 and the remote controller 25. The sixth wiring 247 is not connected to the fourth wiring 28-1 connected to the auxiliary power supply unit 27. That is, the output terminal of the auxiliary power supply unit 27 is not connected to the remote controller 25. As the configuration of the air conditioning system of the second embodiment is similar to that of the air conditioning system 1A according to the first embodiment except for this part, the detailed descrip-

tion will be omitted.

[0055] In the so-constructed air conditioning system 1B according to the second embodiment, when a user manipulates the breaker 202 into the OFF state in any one of the indoor units 20 connected to the outdoor unit 10, the power supply from the commercial power source 201 to the indoor controller 24 through the breaker 202 is stopped, while the low-voltage power supply from the auxiliary power supply 27 to the indoor controller 24 is started, as similar to the first embodiment. At this time, the electric power of 12 V supplied from the auxiliary power supply unit 27 through the fourth wiring 28-1 is supplied to the electric expansion valve 23 and the drive circuit 26 through the first wiring 243. Thus, even after the power supply interruption operation by the breaker 202 has been performed, it becomes possible to operate the devices operating with low voltage power, such as the electric expansion valve 23 and the drive circuit 26. The electric power of 5 V supplied from the auxiliary power supply unit 27 through the fifth wiring 28-2 is supplied to the MCU 242 through the third wiring 245, so that the operation of the MCU 242 is continued.

[0056] On the other hand, when the breaker 202 is in the ON state, the remote controller 25 is supplied with power from the first power source circuit 241 through the sixth wiring 247. However, the sixth wiring 247 is not connected to the auxiliary power supply unit 27. Thus, if the breaker 202 is turned off, then the power supply for the remote controller 25 is stopped, so that the display screen 25a is brought into a non-display state, as illustrated in Fig. 3(b). Therefore, it is possible to avoid such a situation that the display screen 25a of the remote controller 25 becomes displayed to cause the user to be confused, despite that a user manipulates to turn off the breaker 202.

[0057] Besides, it is preferable to provide the auxiliary power supply units 27 in all of the plurality of indoor units constituting the air conditioning system. Nevertheless, since the breaker 202 of the indoor unit 20 is arranged in a place where a user cannot manipulate it easily, as for an indoor unit 20 that there is no possibility that a user manipulates the breaker 202 into the OFF state even when the same indoor unit 20 is not used, there is no need of connecting the auxiliary power supply unit 27 to the indoor unit 20.

[0058] Additionally, although the power monitoring unit 272 is constituted by a relay having two contacts in the above-mentioned embodiment, the power monitoring unit 272 may be configured by any other form so long as it has a function of allowing the MCU242 of the indoor controller 24 to detect presence or absence of the power supply from the commercial power source 201 to the indoor controller 24 and a function of controlling presence and absence of the power supply to the second power source circuit 271 on the basis of presence or absence of the power supply from the commercial power source 201 to the indoor controller 24. For this reason, without adopting a relay, the power monitoring unit 272 may con-

sist of a combination of a photo-coupler with an electric logic circuit, which can execute these two functions on the basis of presence or absence of the electric power inputted from the commercial power source 201 through the breaker 202.

[0059] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

Claims

1. An air conditioning system, comprising:

an outdoor unit;
a plurality of indoor units connected to the outdoor unit through a refrigerant pipe;
each of the indoor units comprising,

a device operating with DC power,
a first power source circuit configured to convert AC power supplied from a commercial power source into the DC power of a predetermined voltage and supply the DC power to the device, and
a remote controller having a display screen and operating with the DC power to control an operation of the indoor unit;

an auxiliary power supply unit comprising a second power source circuit for outputting the DC power of the predetermined voltage, the auxiliary power supply unit being configured to supply power from the second power source circuit to the device when supplying the AC power to the first power source circuit is interrupted; and
means for bringing the display screen of the remote controller into a non-display state when supplying the AC power to the first power source circuit is interrupted.

2. The air conditioning system of claim 1, wherein the auxiliary power supply unit is configured to stop supplying the DC power by the second power source circuit when the AC power is supplied to the first power source circuit.

3. The air conditioning system of claim 1, further comprising

a first wiring connected to a DC power output terminal of the first power source circuit and a DC power output terminal of the second power source circuit to supplying power from the first power source circuit or the second power source circuit to the device, wherein
the means for bringing the display screen of the remote controller into the non-display state comprises:

a second wiring for supplying electric power from the first wiring to the remote controller;
a switch interposed in the second wiring;
and
a controller configured so that:

when supplying the AC power to the first power source circuit is interrupted, the switch is opened to interrupt supplying the power to the remote controller, thereby bringing the display screen of the remote controller into the non-display state; and

when the AC power is supplied to the first power source circuit, the switch is closed for supplying the power to the remote controller.

4. The air conditioning system of claim 1, wherein the means for bringing the display screen of the remote controller into the non-display state is a controller that outputs an instruction to shift the operation of the remote controller to a sleep mode where the display screen is not displayed when supplying the AC power to the first power source circuit is interrupted.

5. The air conditioning system of claim 1, wherein the means for bringing the display screen of the remote controller into the non-display state is a wiring that is installed so as to supply the remote controller with electric power from only the first power source circuit.

6. An air conditioning system, comprising:

an outdoor unit;
a plurality of indoor units connected to the outdoor unit through a refrigerant pipe,
each of the indoor units comprising

a device operating with DC power,
a first power source circuit configured to convert AC power supplied from a commercial power source into the DC power of a predetermined voltage and supply the DC power to the device,

a remote controller having a display screen and operating with the DC power to control the operation of the indoor unit;
 an auxiliary power supply unit comprising a second power source circuit for converting the AC power supplied from the commercial power source into the DC power of the predetermined voltage, the auxiliary power supply unit being configured to supply the DC power from the second power source circuit to the device when supplying the AC power to the first power source circuit is interrupted; and
 means for bringing the display screen of the remote controller into a display state which is the same as a display state under a condition where the electric power is not supplied to the remote controller, when supplying the AC power to the first power source circuit is interrupted.

7. The air conditioning system of claim 1, wherein the device is an electric expansion valve that is installed in a middle of a connecting pipe connected to the refrigerant pipe to control flow of the refrigerant flowing in the connecting pipe.

8. An indoor unit connected to an outdoor unit in an air conditioning system, comprising:

a device operating with DC power;
 a first power source circuit configured to convert AC power supplied from a commercial power source into the DC power of a predetermined voltage and supply the DC power to the device; and
 a remote controller having a display screen and operating with DC power to control the operation of the air conditioning system;
 the indoor unit connected to an auxiliary power supply unit comprising a second power source circuit for outputting the DC power of the predetermined voltage and supply electric power from the second power source circuit to the device when supplying the AC power to the first power source circuit is interrupted; and
 means for bringing the display screen of the remote controller into a non-display state when supplying the AC power to the first power source circuit is interrupted.

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FIG. 1

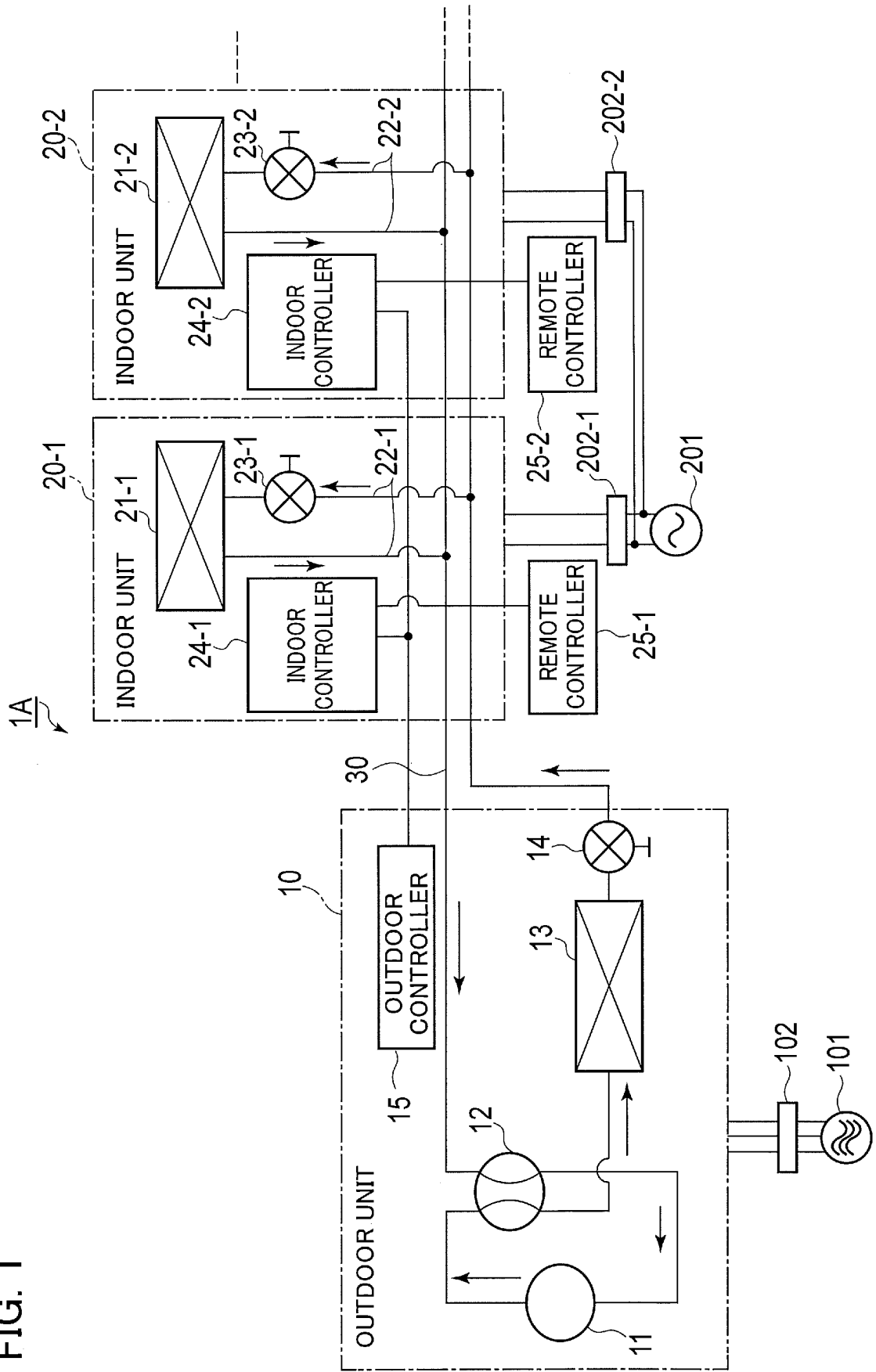


FIG. 2

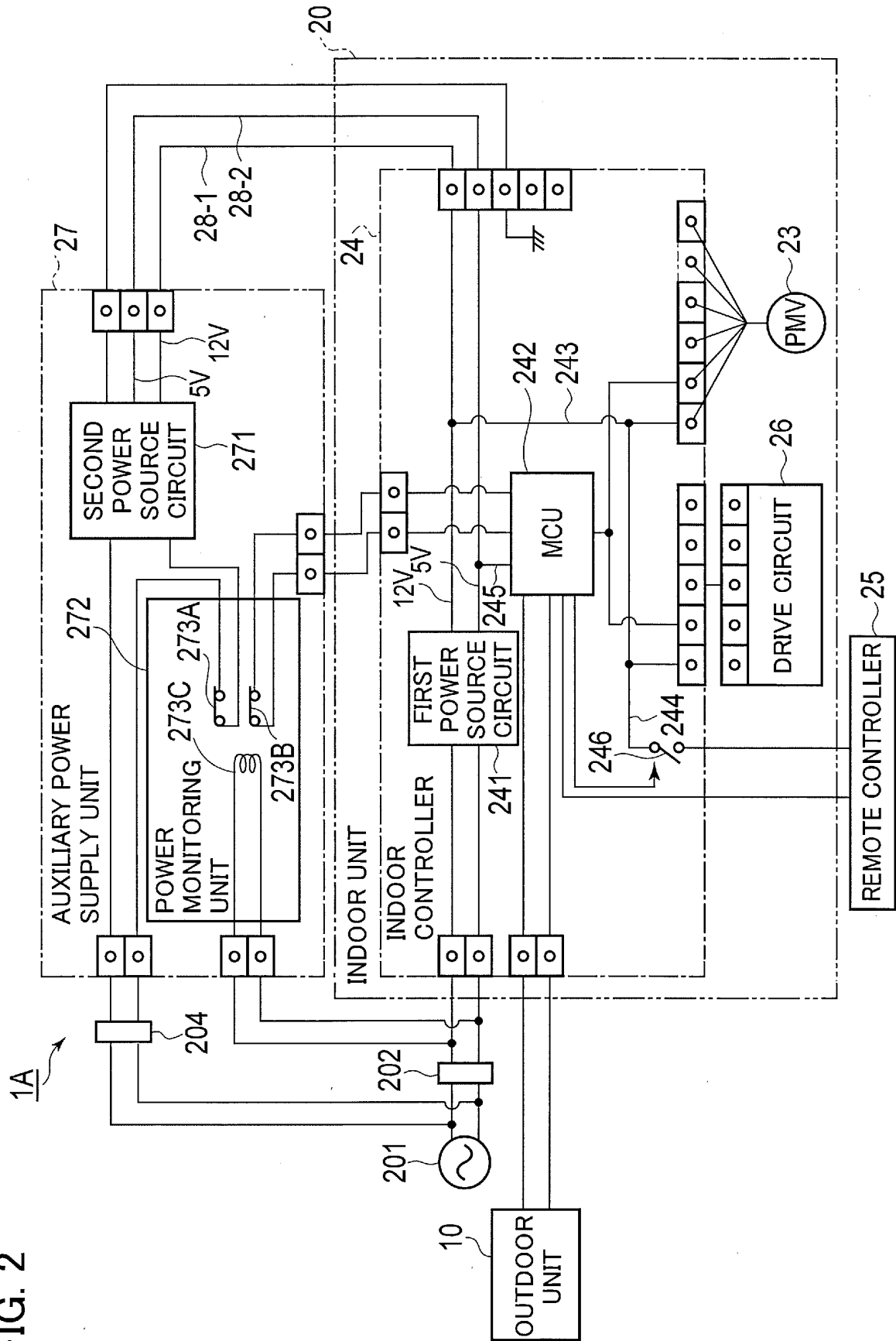


FIG. 3

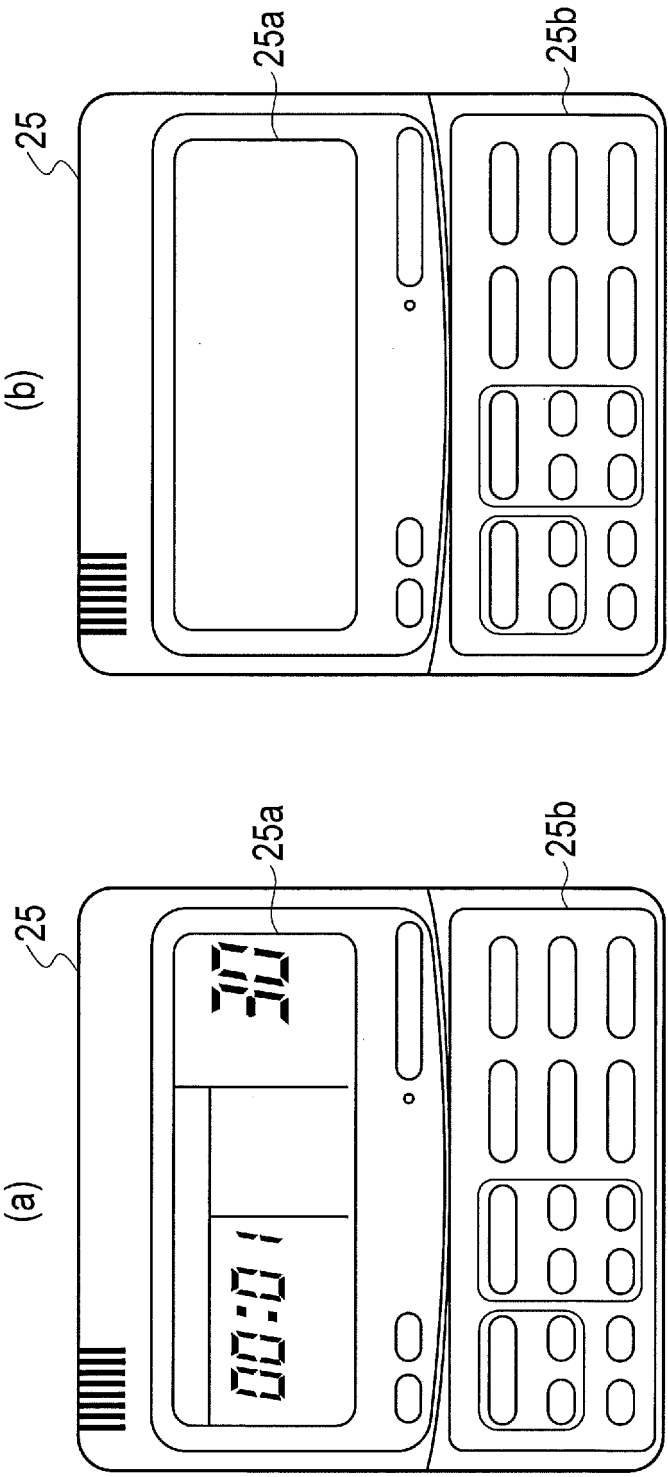


FIG. 4

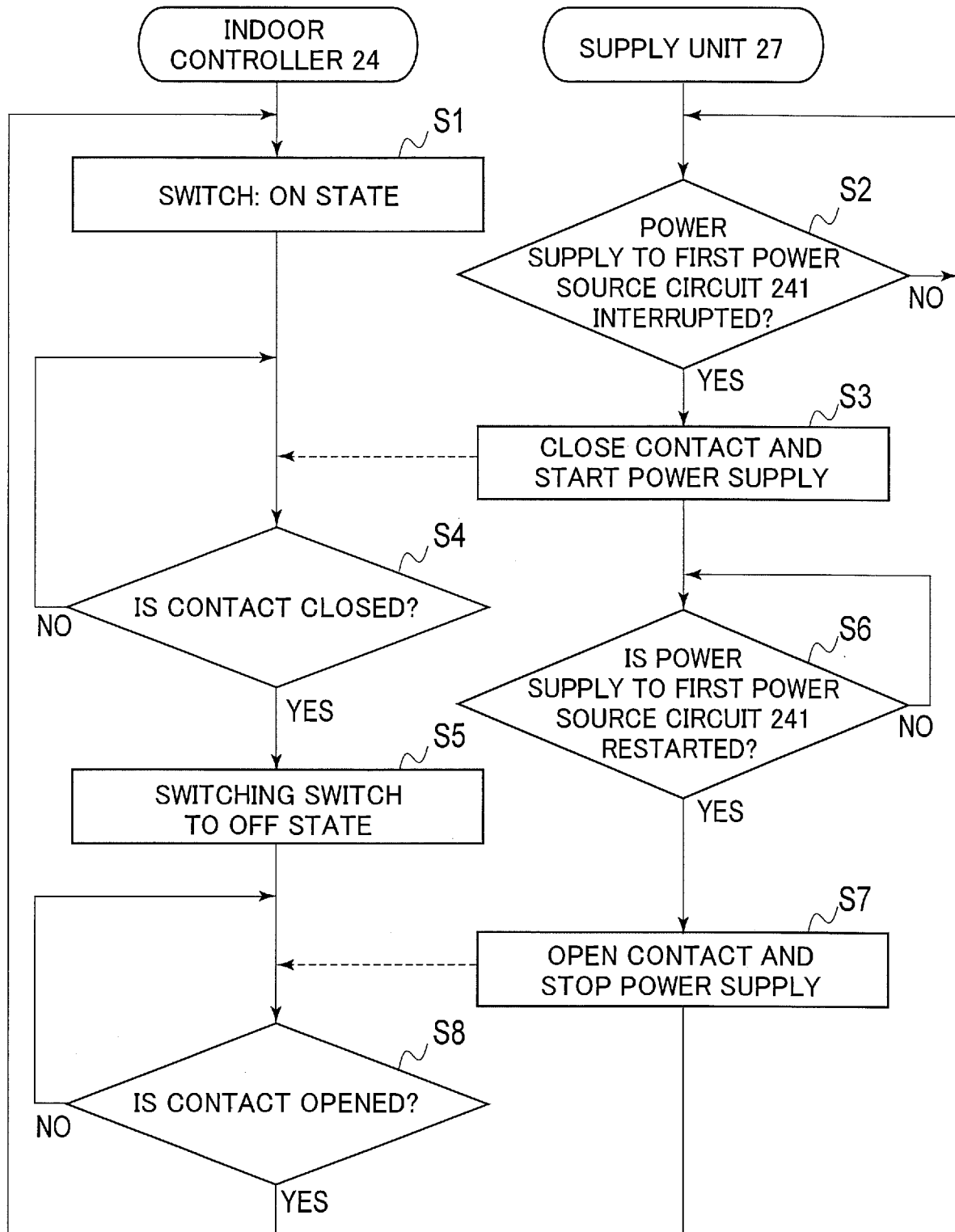
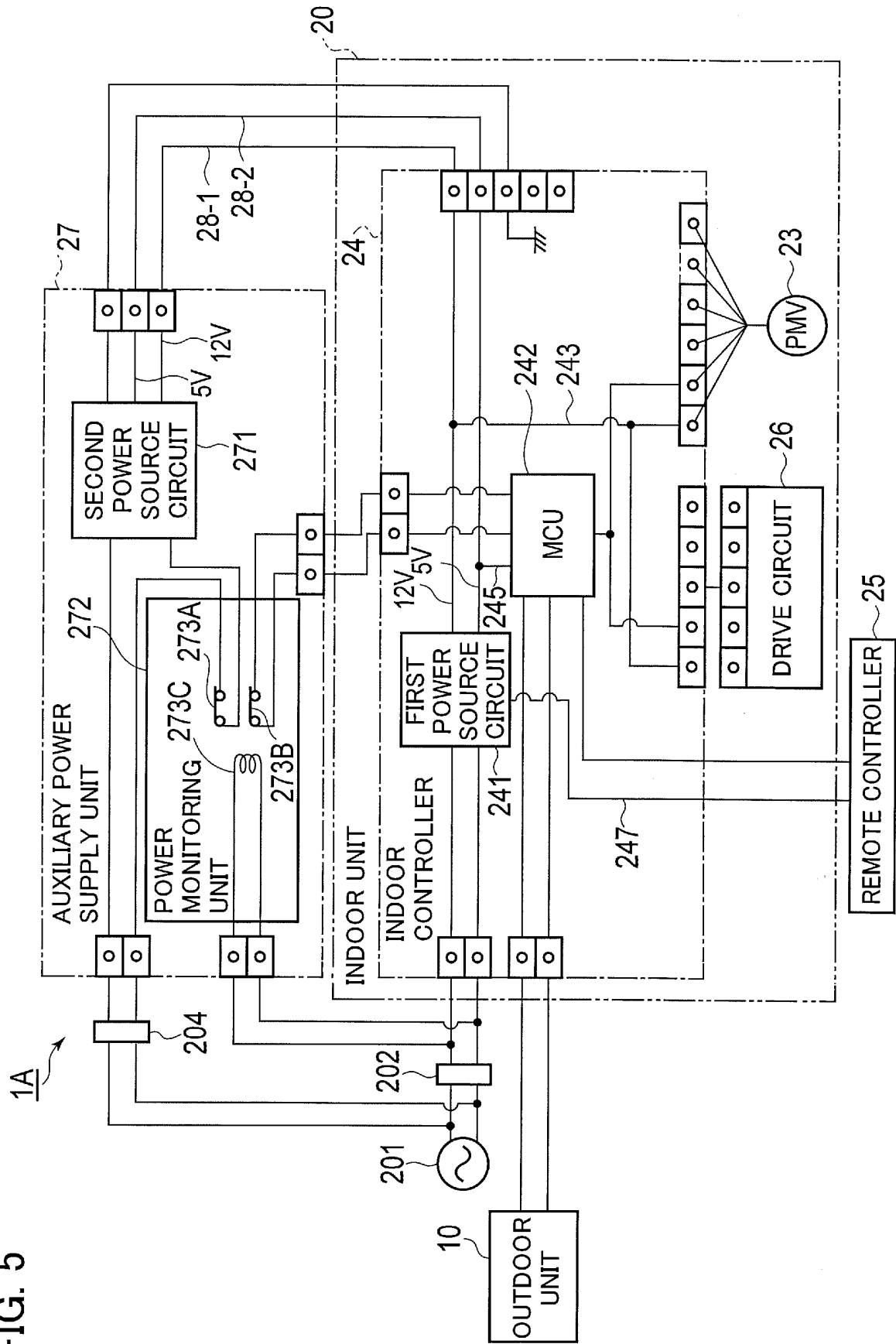


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/083403

A. CLASSIFICATION OF SUBJECT MATTER

F24F11/02(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)

F24F11/02

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 1996-2016

Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 4-110557 A (Mitsubishi Electric Corp.), 13 April 1992 (13.04.1992), page 3, lower left column, line 3 to page 4, lower left column, line 17; fig. 1 to 3 (Family: none)	1-8
Y	JP 2000-247133 A (Zexel Corp.), 12 September 2000 (12.09.2000), paragraphs [0056] to [0059]; fig. 6 (Family: none)	1-8
Y	JP 2008-57868 A (Daikin Industries, Ltd.), 13 March 2008 (13.03.2008), paragraphs [0013] to [0024]; fig. 1 to 3 & WO 2008/029621 A1	2

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

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"&" document member of the same patent family

Date of the actual completion of the international search

12 February 2016 (12.02.16)

Date of mailing of the international search report

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3-4-3, Kasumigaseki, Chiyoda-ku,

Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/083403

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 2013-137114 A (Daikin Industries, Ltd.), 11 July 2013 (11.07.2013), paragraphs [0042] to [0057]; fig. 1 to 2 & WO 2013/099275 A1	3
A	JP 2005-121333 A (Hitachi, Ltd.), 12 May 2005 (12.05.2005), paragraphs [0020] to [0045]; fig. 1 to 4 (Family: none)	1-8
A	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 32120/1991 (Laid-open No. 24390/1994) (Samsung Electronics Co., Ltd.), 29 March 1994 (29.03.1994), specification, paragraphs [0012] to [0015]; fig. 1 & US 5140511 A & GB 2243963 A & FR 2662031 A	1-8

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REFERENCES CITED IN THE DESCRIPTION

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- JP H04263733 A [0006]