(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 680 566 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
15.07.2020 Bulletin 2020/29

(21) Application number: **17924638.4**

(22) Date of filing: **08.09.2017**

(51) Int Cl.:
F24F 11/30 *(2018.01)*

(86) International application number:
PCT/JP2017/032562

(87) International publication number:
WO 2019/049330 (14.03.2019 Gazette 2019/11)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

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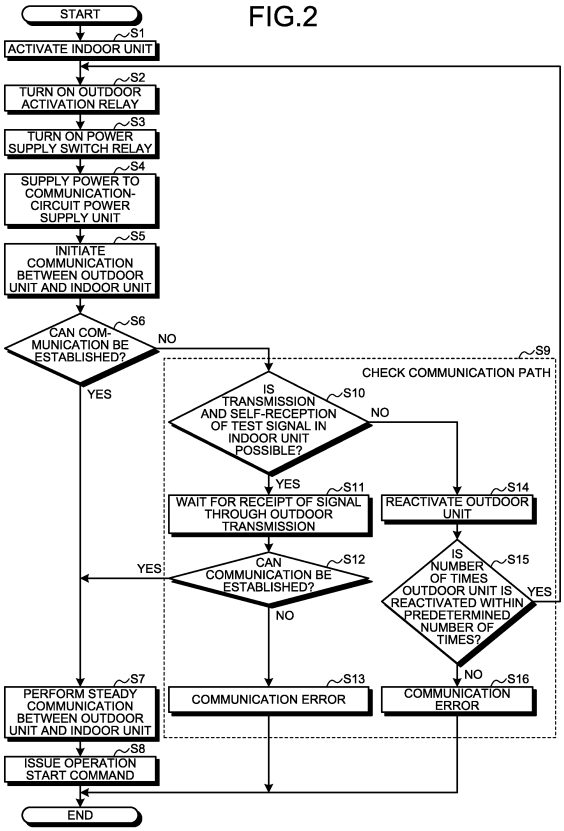
(54) **AIR CONDITIONER**

(57) An air conditioner (100) includes an indoor unit (2) and an outdoor unit (1). The indoor unit (2) activates the outdoor unit (1). Upon activating the outdoor unit (1), the indoor unit (2) determines whether communication can be established between the indoor unit (2) and the outdoor unit (1). When the communication cannot be established, the indoor unit (2) performs self-reception of receiving a first signal generated by the indoor unit (2). The indoor unit (2) determines whether to reactivate the outdoor unit (1) on the basis of the result of the self-reception.

FIG.2



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Description

Field

[0001] The present invention relates to an air conditioner that includes an indoor unit and an outdoor unit.

Background

[0002] In air conditioners, an indoor unit and an outdoor unit are generally configured to be connected together via three wires, i.e., a power line, a signal line, and a power/signal common line. Patent Literature 1 described below discloses an air conditioner having such a configuration.

[0003] In conventional air conditioners exemplified in Patent Literature 1 below, when the air conditioner is turned on or the air conditioner in the operation standby state is resumed, commercial power is applied from the indoor unit to the outdoor unit to activate the outdoor unit while an inrush-current prevention relay of the outdoor unit is operated. The outdoor unit activated initiates and establishes communication with the indoor unit. When communication could not be established between the indoor unit and the outdoor unit, the air conditioner performs again the control of applying commercial power from the indoor unit to the outdoor unit to attempt to establish communication.

Citation List

Patent Literature

[0004] Patent Literature 1: Japanese Patent Application Laid-open No. 2010-243051

Summary

Technical Problem

[0005] As described above, in conventional air conditioners, when communication could not be established between the indoor unit and the outdoor unit, the air conditioner performs again the control of applying commercial power from the indoor unit to the outdoor unit. However, if commercial power is re-applied to the outdoor unit in such a connection state that the outdoor unit can perform communication, there is a problem in that unintended overcurrent flows in the communication path and thus an outdoor-unit circuit may fail.

[0006] The present invention has been achieved in view of the above and an object of the present invention is to provide an air conditioner that can prevent a failure of an outdoor-unit circuit that may occur due to re-application of commercial power.

Solution to Problem

[0007] In order to solve the above problems and achieve the object, an air conditioner according to an aspect of the present invention includes an indoor unit and an outdoor unit. The indoor unit activates the outdoor unit. Upon activating the outdoor unit, the indoor unit determines whether communication is capable of being established between the indoor unit and the outdoor unit. When the communication is not capable of being established, the indoor unit performs self-reception of receiving a first signal generated by the indoor unit. The indoor unit determines whether to reactivate the outdoor unit on a basis of a result of the self-reception.

Advantageous Effects of Invention

[0008] The air conditioner according to the present invention provides an advantage in that a failure of an outdoor-unit circuit that may occur due to re-application of commercial power can be prevented.

Brief Description of Drawings

[0009]

FIG. 1 is a block diagram illustrating an electrical system of an air conditioner according to an embodiment.

FIG. 2 is a flowchart illustrating an operation of the main parts of the air conditioner according to the embodiment.

FIG. 3 is a block diagram illustrating an example configuration of an indoor communication circuit unit in the air conditioner according to the embodiment.

FIG. 4 is a block diagram illustrating an example configuration of an outdoor communication circuit unit in the air conditioner according to the embodiment.

FIG. 5 is a diagram for explaining an operation in the case of an instantaneous power failure.

FIG. 6 is a block diagram illustrating an example of a hardware configuration in an indoor control unit according to the embodiment.

FIG. 7 is a block diagram illustrating another example of a hardware configuration in the indoor control unit according to the embodiment.

Description of Embodiments

[0010] An air conditioner according to embodiments of the present invention will be explained below in detail with reference to the accompanying drawings. The present invention is not limited to the following embodiments. In the following descriptions, "physical connection" and "electrical connection" are not distinguished from each other and are simply referred to as "connection".

Embodiment.

[0011] FIG. 1 is a block diagram illustrating an electrical system of an air conditioner according to an embodiment. As illustrated in FIG. 1, an air conditioner 100 in the embodiment includes an outdoor unit 1 and an indoor unit 2 that activates the outdoor unit 1. FIG. 1 particularly illustrates a connection state before the outdoor unit 1 is activated.

[0012] A description will be first given of a schematic configuration of the air conditioner 100 according to the embodiment with reference to FIG. 1. The outdoor unit 1 and the indoor unit 2 are connected together via three lines, i.e., a power line 24, a power/signal common line 25, and a signal line 26. The outdoor unit 1 is connected to a three-phase alternating-current (AC) power supply 3. A three-phase AC voltage is applied to the outdoor unit 1 via power lines 65. A single-phase AC voltage is applied from two of the power lines 65 to the indoor unit 2 via the power line 24 and the power/signal common line 25. This means that the air conditioner 100 according to the embodiment is configured such that the outdoor unit 1 is supplied with three-phase AC power and the indoor unit 2 is supplied with single-phase AC power.

[0013] The indoor unit 2 includes an indoor control unit 4 and an outdoor activation relay 8. The outdoor activation relay 8 opens and closes a connection between the power line 24 and the signal line 26. The wording "open and close a connection" indicates switching between the unconnected state and the connected state. The indoor control unit 4 controls the outdoor activation relay 8 such that single-phase AC power is supplied between the signal line 26 and the power/signal common line 25.

[0014] The outdoor unit 1 includes an outdoor rectifier unit 9, a first inrush-current prevention relay 10, a power supply relay 12, a second inrush-current prevention relay 13, a smoothing capacitor 14, an inverter circuit unit 15, and an outdoor control unit 16. The outdoor unit 1 further includes a communication-circuit power supply unit 18, an outdoor communication circuit unit 19, a power supply switch relay 20, an inrush-current-prevention-relay drive unit 21, and a compressor 80. The compressor 80 is driven by the inverter circuit unit 15.

[0015] In the outdoor unit 1, the outdoor rectifier unit 9 is connected to the power supply relay 12. The power supply relay 12 opens and closes a connection between the three-phase AC power supply 3 and the outdoor rectifier unit 9. The outdoor rectifier unit 9 rectifies the output of the three-phase AC power supply 3. The smoothing capacitor 14 smooths the output of the outdoor rectifier unit 9. The outdoor communication circuit unit 19 communicates with the indoor unit 2 via the power/signal common line 25 and the signal line 26. The power supply switch relay 20 is connected between the power/signal common line 25 and the communication-circuit power supply unit 18. When a single-phase AC voltage applied between the power/signal common line 25 and the signal line 26 is supplied to the inrush-current-prevention-relay drive unit 21 via the outdoor activation relay 8 of the indoor unit 2 and the power supply switch relay 20, the inrush-current-prevention-relay drive unit 21 operates. The first inrush-current prevention relay 10 is connected in parallel to the power supply relay 12 and is controlled by the inrush-current-prevention-relay drive unit 21. The second inrush-current prevention relay 13 is connected in parallel to the first inrush-current prevention relay 10 and is controlled by the outdoor control unit 16.

[0016] Next, a description will be given, in more detail, of the configuration of the air conditioner 100 according to the embodiment. The outdoor unit 1 includes an outdoor terminal block 23. The outdoor terminal block 23 includes an R terminal 27, an S terminal 28, a T terminal 29, an outdoor S1 terminal 30, an outdoor S2 terminal 31, and an outdoor S3 terminal 32. The R terminal 27, the S terminal 28, and the T terminal 29 are connected to the three-phase AC power supply 3. The power from the three-phase AC power supply 3 is supplied to the outdoor unit 1 via the R terminal 27, the S terminal 28, and the T terminal 29.

[0017] In the outdoor unit 1, the outdoor S1 terminal 30 is connected to the R terminal 27 and the outdoor S2 terminal 31 is connected to the S terminal 28. With these connections, single-phase AC power is supplied to the communication-circuit power supply unit 18 via the outdoor S1 terminal 30 and the outdoor S2 terminal 31. The power supplied to the outdoor S1 terminal 30 and the outdoor S2 terminal 31 is not limited to single-phase power between the R terminal 27 and the S terminal 28 and can be single-phase power between any two of the three phases of the three-phase AC power supply 3.

[0018] The indoor unit 2 includes an indoor terminal block 22. The indoor terminal block 22 includes an indoor S1 terminal 33, an indoor S2 terminal 34, and an indoor S3 terminal 35. The indoor S1 terminal 33 is connected to the outdoor S1 terminal 30 via the power line 24. The indoor S2 terminal 34 is connected to the outdoor S2 terminal 31 via the power/signal common line 25. The indoor S3 terminal 35 is connected to the outdoor S3 terminal 32 via the signal line 26.

[0019] In addition to the indoor control unit 4 and the outdoor activation relay 8 described above, the indoor unit 2 includes an indoor rectifier unit 5, an indoor communication circuit unit 6, an indoor operation switching unit 7, and a remote control receiving unit 36. The outdoor activation relay 8 includes a terminal a, a terminal b, and a terminal c. The terminal a is connected to the indoor S1 terminal 33. The terminal b is connected to the indoor communication circuit unit 6. The terminal c is a base of the outdoor activation relay 8 and is connected to the indoor S3 terminal 35. The contact of the outdoor activation relay 8 is connected to either the terminal a or the terminal b. In other words, the outdoor activation relay 8 switches whether to connect the indoor S3 terminal 35 to the indoor S1 terminal 33 or to the indoor communication circuit unit 6.

[0020] In the following descriptions, for the sake of con-

venience, the state where the contact of the outdoor activation relay 8 is connected to the terminal a is referred to as "ON" and the state where the contact of the outdoor activation relay 8 is connected to the terminal b is referred to as "OFF".

[0021] When the outdoor activation relay 8 is OFF, the contact of the outdoor activation relay 8 is connected to the terminal b and thus the indoor S3 terminal 35 is connected to the indoor communication circuit unit 6 via the outdoor activation relay 8. With this connection, a communication line is established between the outdoor unit 1 and the indoor unit 2 via the power/signal common line 25 and the signal line 26; therefore, the outdoor unit 1 and the indoor unit 2 exchange various operation signals.

[0022] When the outdoor activation relay 8 is ON, the contact of the outdoor activation relay 8 is connected to the terminal a and thus the indoor S3 terminal 35 is connected to the indoor S1 terminal 33. With this connection, single-phase AC power is supplied between the power/signal common line 25 and the signal line 26.

[0023] The indoor S1 terminal 33 is connected to the indoor rectifier unit 5. The indoor S2 terminal 34 is connected to the indoor rectifier unit 5 and the indoor communication circuit unit 6. A single-phase AC voltage applied between the power line 24 and the power/signal common line 25 is converted into a direct-current (DC) voltage by the indoor rectifier unit 5 and the power is supplied to the indoor control unit 4.

[0024] The indoor operation switching unit 7 connected to the indoor control unit 4 determines whether to reduce the standby power that is the power consumed by the outdoor unit 1 during operation standby. The example in FIG. 1 is a case where whether to reduce the standby power is determined depending on the connection state of jumper wires. In the indoor operation switching unit 7, when a jumper wire is connected between a terminal c1 and a terminal c2, the standby power is reduced, and when a jumper wire is connected between the terminal c2 and a terminal c3, the standby power is not reduced. Whether to reduce the standby power can be switched by a switch instead of using jumper wires.

[0025] The remote control receiving unit 36 is connected to a remote controller 37 and the indoor control unit 4. The remote control receiving unit 36 receives an operation command from the remote controller 37 and transmits the received command to the indoor control unit 4.

[0026] The outdoor unit 1 further includes an inrush-current prevention resistor 11 and an outdoor operation switching unit 17. The R terminal 27 in the outdoor unit 1 is connected to one end of each of the first inrush-current prevention relay 10 and the second inrush-current prevention relay 13 and to the terminal a that is one of the terminals on one side of the power supply relay 12. The other end of each of the first inrush-current prevention relay 10 and the second inrush-current prevention relay 13 is connected to one end of the inrush-current prevention resistor 11. The other end of the inrush-current prevention resistor 11 is connected to the outdoor rectifier unit 9 and to the terminal b that is one of the terminals on the other side of the power supply relay 12. Both ends of each of the first inrush-current prevention relay 10 and the second inrush-current prevention relay 13 are connected to the outdoor operation switching unit 17.

[0027] The S terminal 28 is connected to the terminal c that is another of the terminals on one side of the power supply relay 12. A terminal d that is another of the terminals on the other side of the power supply relay 12 is connected to the outdoor rectifier unit 9. The T terminal 29 is connected to the outdoor rectifier unit 9 without passing through the power supply relay 12.

[0028] In the example illustrated in FIG. 1, the terminal a and the terminal c that are terminals on one side of the power supply relay 12 are respectively connected to the R terminal 27 and the S terminal 28; however, there is no limitation thereto. It is sufficient if any two of the R terminal 27, the S terminal 28, and the T terminal 29 are connected to the terminal a and the terminal c of the power supply relay 12.

[0029] A circuit unit is configured from a parallel circuit of the first inrush-current prevention relay 10 and the second inrush-current prevention relay 13 and the inrush-current prevention resistor 11 connected in series with the parallel circuit. The circuit unit is connected at one end to the terminal a and connected at the other end to the terminal b in FIG. 1; however, there is no limitation thereto. The circuit unit may be connected at one end to the terminal c and connected at the other end to the terminal d. In other words, it is sufficient if one end and the other end of the circuit unit are connected to the input and output of any one of the contacts in the power supply relay 12.

[0030] In FIG. 1, the power supply relay 12 is illustrated as a two-contact relay; however, the power supply relay 12 may be configured from two single-contact relays.

[0031] The outdoor rectifier unit 9 rectifiers the AC voltage from the three-phase AC power supply 3 to convert it into a given DC voltage. The power supply relay 12 and the second inrush-current prevention relay 13 are operated under the control of the outdoor control unit 16. When the power supply relay 12 and the second inrush-current prevention relay 13 are not in operation, their contacts are open as illustrated in FIG. 1.

[0032] The outdoor operation switching unit 17 is connected to both ends of the first inrush-current prevention relay 10 and is also connected to the outdoor control unit 16. The outdoor operation switching unit 17 determines whether to reduce the standby power during operation standby. The example in FIG. 1 is a case where whether to reduce the standby power is determined depending on the connection state of jumper wires. In the outdoor operation switching unit 17, when a jumper wire is connected between a terminal a1 and a terminal a2, the standby power during operation standby is reduced. When a jumper wire is connected between a terminal b1

and a terminal b2, these terminals b1 and b2 form a current path bypassing the first inrush-current prevention relay 10. Thus, the standby power during operation standby is not reduced. Information indicating whether to reduce the standby power during operation standby is transmitted from the outdoor operation switching unit 17 to the outdoor control unit 16.

[0033] Both ends of the smoothing capacitor 14 are connected to the outdoor rectifier unit 9. The DC voltage smoothed by the smoothing capacitor 14 is applied to the inverter circuit unit 15 and the outdoor control unit 16.

[0034] The power supply switch relay 20 includes a terminal a, a terminal b, and a terminal c. The terminal a is connected to the communication-circuit power supply unit 18. The terminal b is connected to the inrush-current-prevention-relay drive unit 21. The terminal c is connected to the outdoor S2 terminal 31. The terminal c is a base of the power supply switch relay 20 and is connected to the outdoor S2 terminal 31. The contact of the power supply switch relay 20 is connected to either the terminal a or the terminal b. In other words, the power supply switch relay 20 switches whether to connect the outdoor S2 terminal 31 to the inrush-current-prevention-relay drive unit 21 or to the communication-circuit power supply unit 18.

[0035] In the following descriptions, for the sake of convenience, the state where the contact of the power supply switch relay 20 is connected to the terminal a is referred to as "ON" and the state where the contact of the power supply switch relay 20 is connected to the terminal b is referred to as "OFF".

[0036] The outdoor control unit 16 controls the power supply switch relay 20. When the power supply switch relay 20 is OFF, the contact of the power supply switch relay 20 is connected to the terminal b and thus the outdoor S2 terminal 31 is connected to the inrush-current-prevention-relay drive unit 21 via the power supply switch relay 20. With this connection, when a single-phase alternating current flows between the power/signal common line 25 and the signal line 26 by the indoor unit 2, the inrush-current-prevention-relay drive unit 21 is energized. Energization of the inrush-current-prevention-relay drive unit 21 causes the contact of the first inrush-current prevention relay 10 to close.

[0037] When the power supply switch relay 20 is ON, the contact of the power supply switch relay 20 is connected to the terminal a. In this case, the outdoor S2 terminal 31 is connected to the communication-circuit power supply unit 18 via the power supply switch relay 20. The communication-circuit power supply unit 18 generates a DC voltage from a single-phase AC voltage applied between the power line 24 and the power/signal common line 25 and applies this DC voltage to the outdoor communication circuit unit 19. The DC voltage can be generated by a half-wave rectifier circuit or a full-wave rectifier circuit; however, any circuit can be used to generate the DC voltage.

[0038] The inverter circuit unit 15, controlled by the outdoor control unit 16, converts the applied DC voltage into a given AC voltage at a given frequency. The inverter circuit unit 15 applies the AC voltage obtained by the conversion to the compressor 80 to drive the compressor 80.

[0039] Next, a description will be given of an operation of the air conditioner 100 during operation standby with reference to FIG. 1. First, power is supplied from the three-phase AC power supply 3 to the outdoor unit 1 via the R terminal 27, the S terminal 28, and the T terminal 29. During operation standby, the contacts of the first inrush-current prevention relay 10, the second inrush-current prevention relay 13, and the power supply relay 12 are open; therefore, no power is supplied to the inverter circuit unit 15, the outdoor operation switching unit 17, and the outdoor control unit 16 that are outdoor-unit loads.

[0040] Although one end of the communication-circuit power supply unit 18 is connected to the power line 24 via the outdoor S1 terminal 30, the other end of the communication-circuit power supply unit 18 is not connected to the outdoor S2 terminal 31 because of the power supply switch relay 20. Thus, power is not supplied to the communication-circuit power supply unit 18. Consequently, power is not supplied to the outdoor communication circuit unit 19, either. Although one end of the inrush-current-prevention-relay drive unit 21 is connected to the power/signal common line 25 via the outdoor S2 terminal 31, the other end of the inrush-current-prevention-relay drive unit 21 is connected to the signal line 26 via the outdoor S3 terminal 32. Thus, power is not supplied to the inrush-current-prevention-relay drive unit 21.

[0041] With the operation mode described above, power is not supplied to the inverter circuit unit 15, the outdoor control unit 16, the outdoor operation switching unit 17, the communication-circuit power supply unit 18, and the outdoor communication circuit unit 19 during operation standby; therefore, the operation standby power in the outdoor unit 1 is reduced.

[0042] Next, the operation before the air conditioner 100 starts its operation will be described. When power is supplied from the three-phase AC power supply 3 to the indoor unit 2 via the power line 24 and the power/signal common line 25, the power is supplied to the indoor control unit 4 and thus the indoor unit 2 is activated. After the indoor unit 2 is activated, the settings of the indoor operation switching unit 7 are identified. In the example in FIG. 1, a jumper wire is connected between the terminal c1 and the terminal c2; therefore, it is determined that the air conditioner reduces the standby power during operation standby. The indoor control unit 4 transitions to the state waiting for an input of an operation command from the remote controller 37 via the remote control receiving unit 36.

[0043] Upon receiving an operation command signal from the remote controller 37, the indoor control unit 4 turns on the outdoor activation relay 8 to activate the outdoor unit 1. At this point in time, switching is made

such that the indoor S3 terminal 35 is disconnected from the indoor communication circuit unit 6 but is connected to the indoor S1 terminal 33. With this control, a single-phase AC voltage is applied between the outdoor S2 terminal 31 and the outdoor S3 terminal 32.

[0044] The power supplied between the outdoor S2 terminal 31 and the outdoor S3 terminal 32 energizes the inrush-current-prevention-relay drive unit 21 via the power supply switch relay 20 and also causes the contact of the first inrush-current prevention relay 10 to close. When the contact of the first inrush-current prevention relay 10 is closed, the AC voltage from the three-phase AC power supply 3 is converted into a DC voltage by the outdoor rectifier unit 9. The DC voltage obtained by the conversion is applied to the smoothing capacitor 14 and the inverter circuit unit 15.

[0045] The inrush-current prevention resistor 11 is inserted in the power supply path through the first inrush-current prevention relay 10; therefore, inrush current can be prevented. The outdoor control unit 16 is activated by the application of the DC voltage. The outdoor control unit 16 activated closes the contact of the second inrush-current prevention relay 13. The outdoor control unit 16 monitors the voltage to which the smoothing capacitor 14 is charged. After the outdoor control unit 16 determines that the monitoring voltage becomes stable at a set voltage, the outdoor control unit 16 closes the contact of the power supply relay 12. Then, the outdoor control unit 16 opens the contact of the second inrush-current prevention relay 13. The second inrush-current prevention relay 13 is a relay used for increasing the likelihood of self-reset when an instantaneous power failure occurs and for improving user convenience. An instantaneous power failure is a phenomenon that external power supply is temporarily interrupted. The operation of the second inrush-current prevention relay 13 in the case of an instantaneous power failure will be described later.

[0046] After a given set time has elapsed since the outdoor activation relay 8 is turned on, the indoor control unit 4 turns off the outdoor activation relay 8. At this point in time, switching is made such that the indoor S3 terminal 35 is disconnected from the indoor S1 terminal 33 but is connected to the indoor communication circuit unit 6. With this control, a single-phase AC voltage applied between the outdoor S2 terminal 31 and the outdoor S3 terminal 32 is interrupted and thus the inrush-current-prevention-relay drive unit 21 is de-energized. Consequently, the contact of the first inrush-current prevention relay 10 is opened. With this operation, inrush current during an outdoor-unit activation operation can be prevented.

[0047] When the inrush-current-prevention-relay drive unit 21 is de-energized, the outdoor control unit 16 turns on the power supply switch relay 20 to switch the connection state of the outdoor S2 terminal 31 such that the outdoor S2 terminal 31 is disconnected from the inrush-current-prevention-relay drive unit 21 but is connected to the communication-circuit power supply unit 18. With this control, a single-phase AC voltage applied between the outdoor S1 terminal 30 and the outdoor S2 terminal 31 is applied to the communication-circuit power supply unit 18. The communication-circuit power supply unit 18 converts the single-phase AC voltage into a given DC voltage and applies the DC voltage to the outdoor communication circuit unit 19.

[0048] In the above descriptions, the first inrush-current prevention relay 10 is turned off after the outdoor activation relay 8 is turned off by the indoor control unit 4; however, this order may be reversed and the power supply switch relay 20 may be first turned on. When the power supply switch relay 20 is turned on, the inrush-current-prevention-relay drive unit 21 is de-energized and thus the first inrush-current prevention relay 10 is turned off. Thus, even if the order is reversed, the outdoor unit 1 can still be activated.

[0049] Next, a description will be given of an operation of the main parts of the air conditioner 100 according to the embodiment with reference to FIGS. 1 to 4. FIG. 2 is a flowchart illustrating an operation of the main parts of the air conditioner 100 according to the embodiment. FIG. 3 is a block diagram illustrating an example configuration of the indoor communication circuit unit 6 in the air conditioner 100 according to the embodiment. FIG. 4 is a block diagram illustrating an example configuration of the outdoor communication circuit unit 19 in the air conditioner 100 according to the embodiment.

[0050] As illustrated in FIG. 3, the indoor communication circuit unit 6 includes a transmitting unit 38, a receiving unit 39, a transmission control unit 50, and a reception control unit 51. The transmitting unit 38 and the receiving unit 39 connected in series are interposed between the power/signal common line 25 and the signal line 26.

[0051] As illustrated in FIG. 4, the outdoor communication circuit unit 19 includes a transmitting unit 40, a receiving unit 41, a transmission control unit 60, and a reception control unit 61. The transmitting unit 40 and the receiving unit 41 connected in series are interposed between the power/signal common line 25 and the signal line 26.

[0052] At step S1, the indoor unit 2 is activated. As described above, the indoor unit 2 is activated by supplying power from the three-phase AC power supply 3 to the indoor unit 2.

[0053] At step S2, the outdoor activation relay 8 is controlled to be in an on state. With this control, the indoor S3 terminal 35 is connected to the indoor S1 terminal 33 and a single-phase AC voltage is applied between the outdoor S2 terminal 31 and the outdoor S3 terminal 32. When a single-phase AC voltage is applied between the outdoor S2 terminal 31 and the outdoor S3 terminal 32, the outdoor unit 1 is activated.

[0054] The outdoor activation relay 8 that has been controlled to be in an on state is returned to an off state. Consequently, switching is made such that the indoor S3 terminal 35 is disconnected from the indoor S1 terminal 33 but is connected to the indoor communication circuit

unit 6.

[0055] At step S3, the power supply switch relay 20 is controlled to be in an on state. With this control, switching is made such that the outdoor S2 terminal 31 is disconnected from the inrush-current-prevention-relay drive unit 21 but is connected to the communication-circuit power supply unit 18. Consequently, a single-phase AC voltage is applied to the communication-circuit power supply unit 18.

[0056] At step S4, power is supplied to the communication-circuit power supply unit 18. The communication-circuit power supply unit 18 supplied with power converts the single-phase AC voltage into a given DC voltage and applies the DC voltage obtained by the conversion to the outdoor communication circuit unit 19.

[0057] At step S5, communication is initiated between the outdoor unit 1 and the indoor unit 2. The outdoor unit 1 takes the initiative to the communication at step S5. In other words, the outdoor unit 1 serves as a master and the indoor unit 2 serves as a slave. Details of the communication operation performed between the outdoor unit 1 and the indoor unit 2 will be described later.

[0058] At step S6, it is determined whether communication can be established between the outdoor unit 1 and the indoor unit 2. When communication can be established (Yes at step S6), the process proceeds to step S7. At step S7, steady communication is performed between the outdoor unit 1 and the indoor unit 2. In the steady communication, various pieces of information necessary for the control of the air conditioner 100 are exchanged.

[0059] At step S8, the outdoor control unit 16 in the outdoor unit 1 receives an operation start command from the indoor unit 2 and starts a heating operation or a cooling operation.

[0060] In contrast, when communication cannot be established (No at step S6), the process proceeds to step S9. At step S9, a process of checking the communication path is performed, which includes processes at steps S10 to S16. As described above, if commercial power is reapplied to the outdoor unit 1 in such a connection state that the outdoor unit 1 can perform communication, unintended overcurrent may flow in the communication path and thus the outdoor-unit circuit may fail. To counter this, the process at step S9 is added.

[0061] At step S10, in the indoor unit 2, a test signal is transmitted and it is determined whether self-reception is possible. The self-reception indicates a process of receiving a signal generated by the transmitting unit 38 of the indoor unit 2 by the receiving unit 39 of the aforementioned indoor unit 2. The reception process involved in the self-reception can be performed independently of, or asynchronously to, the process at step S5. Details of the reception process involved in the self-reception will be described later. A test signal can be in any form of a communication signal as long as it can check the function of the self-reception. The signal generated by the transmitting unit 38, i.e., a test signal, is in some cases referred to as a "first signal" for the sake of convenience.

[0062] When the self-reception of a test signal is successful (Yes at step S10), the process proceeds to step S11. Successful self-reception of a test signal means that the communication path is connected correctly between the indoor unit 2 and the outdoor unit 1 and that the respective functions of the transmitting unit 38 and the receiving unit 39 of the indoor unit 2 are normal. In other words, when the self-reception is successful, it is determined that a communication operation in the indoor unit 2 is normal. Thus, at step S11, the indoor unit 2 waits for receipt of a signal through outdoor transmission. The outdoor transmission indicates an operation of transmitting a signal from the outdoor unit 1 to the indoor unit 2. At step S11, the indoor unit 2 is in a standby state to determine whether the receiving unit 39 of the indoor unit 2 can receive a signal generated by the transmitting unit 40 of the outdoor unit 1. The signal generated when the outdoor transmission is performed is in some cases referred to as a "second signal" for the sake of convenience.

[0063] After step S11, the process proceeds to step S12. At step S12, it is determined again whether communication can be established between the outdoor unit 1 and the indoor unit 2. The determination of whether communication can be established is performed based on the result indicating whether the receiving unit 39 of the indoor unit 2 can receive the signal transmitted from the transmitting unit 40 of the outdoor unit 1.

[0064] When communication can be established (Yes at step S12), the process proceeds to step S7. The operations at step S7 and subsequent steps are performed as described above and thus a description thereof is omitted.

[0065] In contrast, when communication cannot be established (No at step S12), the process proceeds to step S13. At step S13, it is determined that a communication error has occurred and the process in the flowchart in FIG. 2 ends.

[0066] The description here refers back to the determination process at step S10. When the self-reception of a test signal in the indoor unit 2 is not successful (No at step S10), the process proceeds to step S14. When the self-reception of a test signal is not successful, there is a possibility that the functions of the transmitting unit 40 and the receiving unit 41 of the outdoor unit 1 may not be normal in addition to the possibility that the communication path may not be connected correctly between the outdoor unit 1 and the indoor unit 2 and the functions of the transmitting unit 38 and the receiving unit 39 of the indoor unit 2 are not normal. Thus, at step S14, the outdoor unit 1 is reactivated. The outdoor unit 1 is reactivated by turning on the outdoor activation relay 8.

[0067] After step S14, the process proceeds to step S15. At step S15, it is determined whether the number of times the outdoor unit 1 is reactivated is within a predetermined number of times. When the number of times the outdoor unit 1 is reactivated is within the predetermined number of times (Yes at step S15), the process returns to step S2 and the processes at step S2 and

subsequent steps are repeated.

[0068] In contrast, when the number of times the outdoor unit 1 is reactivated exceeds the predetermined number of times (No at step S15), the process proceeds to step S16. At step S16, it is determined that a communication error has occurred and the process in the flowchart in FIG. 2 ends.

[0069] As described above, in the flowchart in FIG. 2, the process at step S10 is added. With this process, in a connection state where the outdoor unit 1 can perform communication, commercial power can be prevented from being re-applied to the outdoor unit 1. Consequently, in a state where a communication circuit is formed, an unintended failure of an outdoor-unit circuit can be prevented.

[0070] In the flowchart in FIG. 2, the process at step S15 is added. This process can eliminate the situation where the outdoor unit 1 cannot be reactivated due to an accidental factor; therefore, it is possible to increase the accuracy in determination of an occurrence of a communication error.

[0071] Next, a description will be given of a communication operation performed between the outdoor unit 1 and the indoor unit 2. Hereinafter, communication between the outdoor unit 1 and the indoor unit 2 is referred to as "indoor-outdoor communication" as appropriate.

[0072] A communication current supplied from the communication-circuit power supply unit 18 flows between the power/signal common line 25 and the signal line 26. A communication current is current used for communication between the outdoor unit 1 and the indoor unit 2. The outdoor unit 1 and the indoor unit 2 perform communication by detecting a current flowing state and a no-current flowing state.

[0073] The transmitting unit 38 includes an element for switching a state of a path through which a communication current flows during indoor-outdoor communication to either a communication current flowing state or a no-communication-current flowing state. One example of the element is a photocoupler. Hereinafter, a path through which a communication current flows during indoor-outdoor communication is referred to as a "current loop". The current loop is formed by inserting the transmitting unit 38 and the receiving unit 39 of the indoor unit 2 and the transmitting unit 40 and the receiving unit 41 of the outdoor unit 1 in series between the power/signal common line 25 and the signal line 26. In the following descriptions, a state where a communication current flows in the current loop is referred to as an "ON state" or simply "ON" and a state where a communication current does not flow in the current loop is referred to as an "OFF state" or simply "OFF".

[0074] In the indoor unit 2, the transmitting unit 38 controls ON/OFF of the current loop in accordance with the control by the transmission control unit 50. The transmitting unit 38 transmits data to the outdoor unit 1 in accordance with ON/OFF control of the current loop.

[0075] In the indoor unit 2, the receiving unit 39 includes an element for receiving data transmitted from the outdoor unit 1. The receiving unit 39 detects whether the value of a communication current flowing in the current loop is larger than or smaller than a current threshold to receive data. One example of the element is a photocoupler. The receiving unit 39 outputs the reception result to the reception control unit 51.

[0076] The transmission control unit 50 controls ON/OFF of the transmitting unit 38 in accordance with whether the transmission data indicates "0" or "1". When the transmission data indicates "0", the transmitting unit 38 may be controlled to be ON or may be controlled to be OFF. When the transmission data indicates "1", the transmitting unit 38 may be controlled to be ON or may be controlled to be OFF.

[0077] The reception control unit 51 determines that the reception data indicates "0" or "1" in accordance with the output of the receiving unit 39.

[0078] In the outdoor unit 1, the transmitting unit 40 includes an element for switching a state of the current loop between a communication current flowing state and a no-communication-current flowing state. One example of the element is a photocoupler. The transmitting unit 40 controls ON/OFF of the current loop in accordance with the control by the transmission control unit 60. The transmitting unit 40 transmits data to the indoor unit 2 in accordance with ON/OFF control of the current loop.

[0079] In the outdoor unit 1, the receiving unit 41 includes an element for receiving data transmitted from the indoor unit 2. The receiving unit 41 detects whether the value of a communication current flowing in the current loop is larger than or smaller than a communication current threshold to receive data. One example of the element is a photocoupler. The receiving unit 41 outputs the output result to the reception control unit 61.

[0080] The transmission control unit 60 controls ON/OFF of the transmitting unit 40 in accordance with whether the transmission data indicates "0" or "1". When the transmission data indicates "0", the transmitting unit 40 may be controlled to be ON or may be controlled to be OFF. When the transmission data indicates "1", the transmitting unit 40 may be controlled to be ON or may be controlled to be OFF.

[0081] The reception control unit 61 determines that the reception data indicates "0" or "1" in accordance with the output of the receiving unit 41.

[0082] The operation flow when data is transmitted from the outdoor unit 1 to the indoor unit 2 will be described below. When the indoor unit 2 receives data transmitted from the outdoor unit 1, the transmission control unit 50 of the indoor unit 2 controls the transmitting unit 38 of the indoor unit 2 such that it is ON.

[0083] Step 1: The transmission control unit 60 of the outdoor unit 1 controls ON/OFF of the transmitting unit 40 of the outdoor unit 1 in accordance with whether the transmission data indicates "0" or "1".

[0084] Step 2: The receiving unit 39 of the indoor unit 2 outputs the reception result to the reception control unit

51 of the indoor unit 2.

[0085] Step 3: The reception control unit 51 of the indoor unit 2 determines whether the reception data indicates "0" or "1" in accordance with the input result.

[0086] The operation flow when data is transmitted from the indoor unit 2 to the outdoor unit 1 will be described below. When the outdoor unit 1 receives data transmitted from the indoor unit 2, the transmission control unit 60 of the outdoor unit 1 controls the transmitting unit 40 of the outdoor unit 1 such that it is ON.

[0087] Step 1: The transmission control unit 50 of the indoor unit 2 controls ON/OFF of the transmitting unit 38 of the indoor unit 2 in accordance with whether the transmission data indicates "0" or "1".

[0088] Step 2: The receiving unit 41 of the outdoor unit 1 outputs the reception result to the reception control unit 61 of the outdoor unit 1.

[0089] Step 3: The reception control unit 61 of the outdoor unit 1 determines whether the reception data indicates "0" or "1" in accordance with the input result.

[0090] The operation flow when the indoor unit 2 performs the self-reception of a test signal will be described below. The indoor unit 2 performs the self-reception of a test signal at the time when the transmission control unit 60 of the outdoor unit 1 controls the transmitting unit 40 of the outdoor unit 1 such that it is ON.

[0091] Step 1: The transmission control unit 50 of the indoor unit 2 controls ON/OFF of the transmitting unit 38 of the indoor unit 2 in accordance with whether the transmission data indicates "0" or "1".

[0092] Step 2: The receiving unit 39 of the indoor unit 2 outputs the reception result to the reception control unit 51 of the indoor unit 2.

[0093] Step 3 The reception control unit 51 of the indoor unit 2 determines whether the reception data indicates "0" or "1" in accordance with the input result.

[0094] Next, a description will be given of an operation of the second inrush-current prevention relay 13 in the case of an instantaneous power failure with reference to FIGS. 1 to 5. FIG. 5 is a diagram for explaining an operation in the case of an instantaneous power failure. As described above, the second inrush-current prevention relay 13 is a relay used for increasing the likelihood of self-reset when an instantaneous power failure occurs and for improving user convenience.

[0095] FIG. 5 illustrates, in association with the bus voltage, a sequence operation of the power supply relay 12 on the left side and a sequence operation of the second inrush-current prevention relay 13 on the right side. The "bus voltage" here indicates a voltage of a DC bus that connects the outdoor rectifier unit 9 and the inverter circuit unit 15, and it matches the voltage of the smoothing capacitor 14 in the example in FIG. 1. In the following descriptions, the "voltage of the smoothing capacitor 14" is referred to as the "bus voltage".

[0096] As described above, the bus voltage is monitored by the outdoor control unit 16. When power supply is interrupted, the bus voltage drops because some load is connected to the circuit. The larger the load is, the faster the bus voltage drops. The contact of the power supply relay 12 is closed while the outdoor unit 1 is energized; therefore, if power supply is immediately restored, the bus voltage instantaneously rises and returns to the voltage obtained by smoothing the power-supply voltage. However, if power supply is not restored, the bus voltage continues to drop.

[0097] When the bus voltage falls below a first voltage threshold Vth1, the contact of the power supply relay 12 is opened and then the contact of the second inrush-current prevention relay 13 is closed. Because these operations are performed in sequence, the bus voltage at the time when the contact of the second inrush-current prevention relay 13 is closed may be a voltage Vth1', which is lower than the first voltage threshold Vth1.

[0098] Even when the bus voltage falls below the first voltage threshold Vth1 and further continues to drop, the outdoor control unit 16 keeps the contact of the second inrush-current prevention relay 13 closed as long as the bus voltage can still cause the outdoor control unit 16 to operate. When the power supply is restored at a voltage at which the outdoor control unit 16 can operate, the voltage of the smoothing capacitor 14 can be restored by using the path through the second inrush-current prevention relay 13 and the inrush-current prevention resistor 11. Because the inrush-current prevention resistor 11 is present in the path, an inrush current value can be limited and thus a failure of a circuit in the subsequent stage, e.g., the outdoor rectifier unit 9, due to excessive inrush current can be prevented.

[0099] When the bus voltage is restored and the power-supply voltage is returned to a stable voltage V_{DD}, the outdoor control unit 16 determines that the power-supply voltage becomes stable at the stable voltage V_{DD}. Thereafter, the outdoor control unit 16 closes the contact of the power supply relay 12 and then opens the contact of the second inrush-current prevention relay 13. As long as the three-phase AC power supply 3 keeps supplying power, the current for charging the smoothing capacitor 14 is supplied to the smoothing capacitor 14 via the power supply relay 12 without passing through the second inrush-current prevention relay 13. The above control operations can reduce unnecessary power used in the air conditioner 100.

[0100] Finally, a description will be given of a hardware configuration for implementing the function of the indoor control unit 4 according to the embodiment with reference to FIGS. 6 and 7. FIG. 6 is a block diagram illustrating an example of a hardware configuration in the indoor control unit according to the embodiment. FIG. 7 is a block diagram illustrating another example of a hardware configuration in the indoor control unit according to the embodiment.

[0101] To implement the function of the indoor control unit 4 according to the embodiment, the indoor control unit 4 can be configured to include a processor 200 for executing computations, a memory 202 storing programs

read by the processor 200, and an interface 204 for inputting and outputting signals.

[0102] The processor 200 may be a computing unit such as an arithmetic unit, a microprocessor, a microcomputer, a central processing unit (CPU), or a digital signal processor (DSP). Examples of the memory 202 include a nonvolatile or volatile semiconductor memory such as a random access memory (RAM), a read only memory (ROM), a flash memory, an erasable programmable read only memory (EPROM), or an electrically erasable programmable read only memory (EEPROM), a magnetic disk, a flexible disk, an optical disk, a compact disk, a mini disk, and a digital versatile disk (DVD).

[0103] The memory 202 stores programs for implementing a function of the indoor control unit 4 and a table referred to by the processor 200. The processor 200 can perform the computation processes described above by exchanging necessary information via the interface 204, executing the programs stored in the memory 202, and referring to the table stored in the memory 202. The computation results by the processor 200 can be stored in the memory 202.

[0104] The processor 200 and the memory 202 illustrated in FIG. 6 may be replaced by a processing circuit 203 as illustrated in FIG. 7. The processing circuit 203 is, for example, a single circuit, a combined circuit, an application specific integrated circuit (ASIC), a field-programmable gate array (FPGA), or a combination of them.

[0105] The configurations described in the above embodiments illustrate examples of an aspect of the present invention, and can be combined with another known art, or can be partly omitted or changed without departing from the scope of the present invention.

Reference Signs List

[0106] 1 outdoor unit; 2 indoor unit; 3 three-phase AC power supply; 4 indoor control unit; 5 indoor rectifier unit; 6 indoor communication circuit unit; 7 indoor operation switching unit; 8 outdoor activation relay; 9 outdoor rectifier unit; 10 first inrush-current prevention relay; 11 inrush-current prevention resistor; 12 power supply relay; 13 second inrush-current prevention relay; 14 smoothing capacitor; 15 inverter circuit unit; 16 outdoor control unit; 17 outdoor operation switching unit; 18 communication-circuit power supply unit; 19 outdoor communication circuit unit; 20 power supply switch relay; 21 inrush-current-prevention-relay drive unit; 22 indoor terminal block; 23 outdoor terminal block; 24 power line; 25 power/signal common line; 26 signal line; 27 R terminal; 28 S terminal; 29 T terminal; 30 outdoor S1 terminal; 31 outdoor S2 terminal; 32 outdoor S3 terminal; 33 indoor S1 terminal; 34 indoor S2 terminal; 35 indoor S3 terminal; 36 remote control receiving unit; 37 remote controller; 38, 40 transmitting unit; 39, 41 receiving unit; 50, 60 transmission control unit; 51, 61 reception control unit; 65 power line; 80 compressor; 100 air conditioner; 200 processor; 202 memory; 203 processing circuit; 204 interface.

Claims

1. An air conditioner that comprises an indoor unit and an outdoor unit and in which the indoor unit activates the outdoor unit, wherein
upon activating the outdoor unit, the indoor unit determines whether communication is capable of being established between the indoor unit and the outdoor unit, and, when the communication is not capable of being established, the indoor unit performs self-reception of receiving a first signal generated by the indoor unit and determines whether to reactivate the outdoor unit on a basis of a result of the self-reception.

2. The air conditioner according to claim 1, wherein when the indoor unit is capable of receiving the first signal in the self-reception, the indoor unit determines that a communication operation in the indoor unit is normal.

3. The air conditioner according to claim 1, wherein when the indoor unit is capable of receiving the first signal in the self-reception, the indoor unit waits for a second signal generated by the outdoor unit to be input, and, when the indoor unit is not capable of receiving the second signal, the indoor unit determines that a communication error occurs.

4. The air conditioner according to any one of claims 1 to 3, wherein
the indoor unit and the outdoor unit are connected together via three lines including a power line, a power/signal common line, and a signal line,
the indoor unit and the outdoor unit each include a transmitting unit and a receiving unit,
the transmitting unit and the receiving unit of the indoor unit and the transmitting unit and the receiving unit of the outdoor unit are inserted in series between the power/signal common line and the signal line to form a current loop, and
the indoor unit and the outdoor unit communicate with each other by detecting a communication current flowing in the current loop.

FIG.1

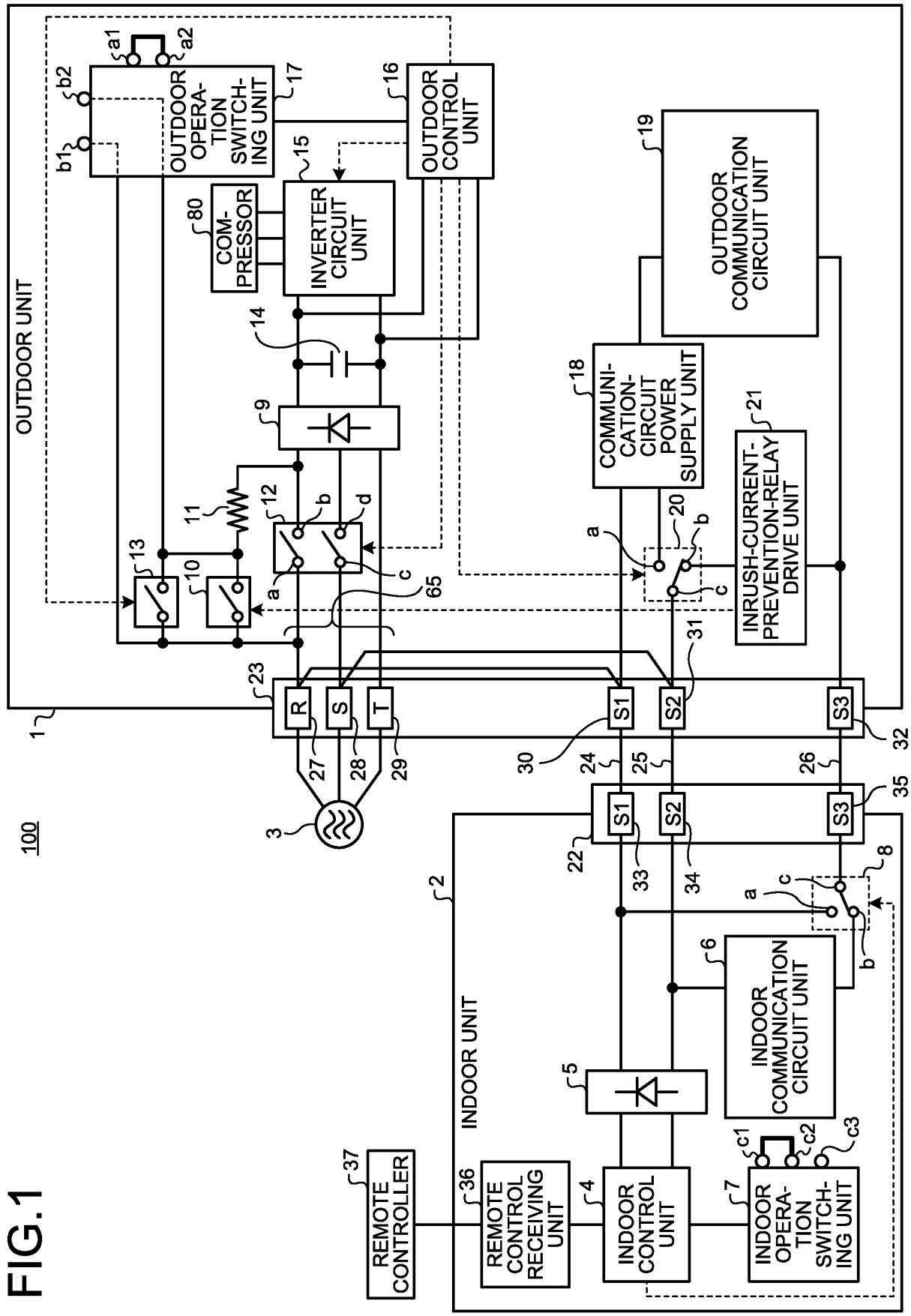

100
OUTDOOR UNIT
INDOOR UNIT
OUTDOOR OPERATION SWITCHING UNIT
OUTDOOR CONTROL UNIT
COMPRESSOR
INVERTER CIRCUIT UNIT
OUTDOOR COMMUNICATION CIRCUIT UNIT
COMMUNICATION-CIRCUIT POWER SUPPLY UNIT
INRUSH-CURRENT-PREVENTION-RELAY DRIVE UNIT
INDOOR COMMUNICATION CIRCUIT UNIT
INDOOR CONTROL UNIT
INDOOR OPERATION SWITCHING UNIT
REMOTE CONTROL RECEIVING UNIT
REMOTE CONTROLLER
R
S
T
S1
S2
S3

FIG.2

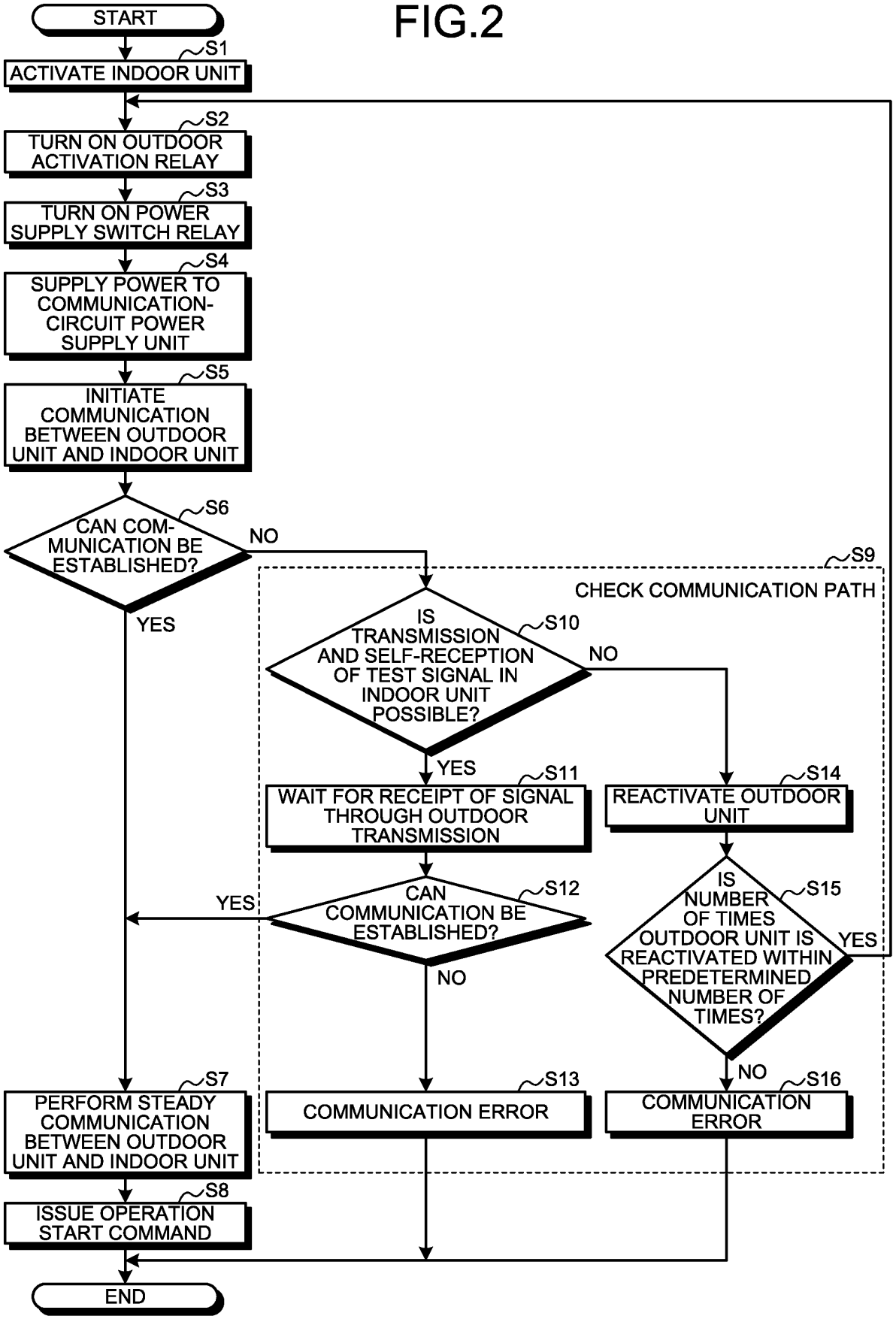

START
S1
ACTIVATE INDOOR UNIT
S2
TURN ON OUTDOOR ACTIVATION RELAY
S3
TURN ON POWER SUPPLY SWITCH RELAY
S4
SUPPLY POWER TO COMMUNICATION-CIRCUIT POWER SUPPLY UNIT
S5
INITIATE COMMUNICATION BETWEEN OUTDOOR UNIT AND INDOOR UNIT
S6
CAN COM-MUNICATION BE ESTABLISHED?
NO
YES
S9
CHECK COMMUNICATION PATH
S10
IS TRANSMISSION AND SELF-RECEPTION OF TEST SIGNAL IN INDOOR UNIT POSSIBLE?
NO
YES
S11
WAIT FOR RECEIPT OF SIGNAL THROUGH OUTDOOR TRANSMISSION
S14
REACTIVATE OUTDOOR UNIT
S12
CAN COMMUNICATION BE ESTABLISHED?
YES
NO
S15
IS NUMBER OF TIMES OUTDOOR UNIT IS REACTIVATED WITHIN PREDETERMINED NUMBER OF TIMES?
YES
NO
S7
PERFORM STEADY COMMUNICATION BETWEEN OUTDOOR UNIT AND INDOOR UNIT
S13
COMMUNICATION ERROR
S16
COMMUNICATION ERROR
S8
ISSUE OPERATION START COMMAND
END

FIG.3

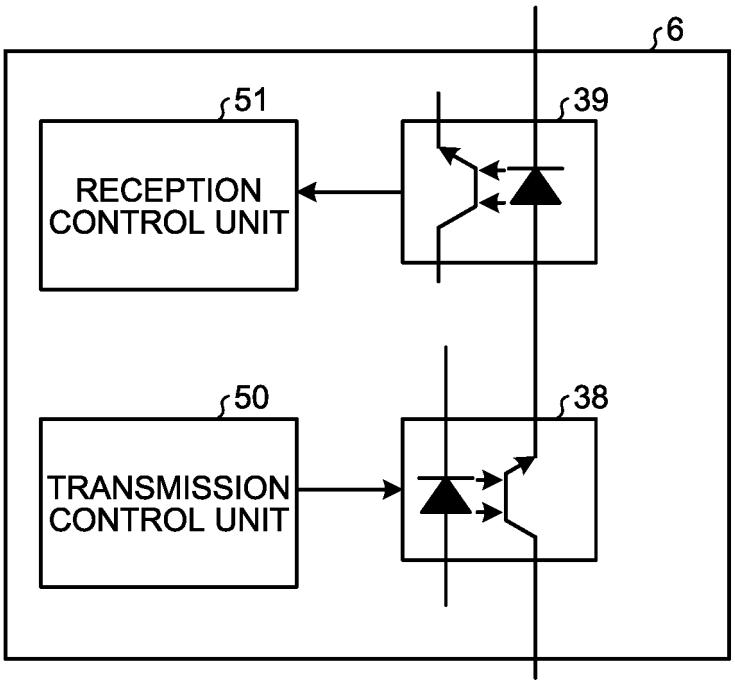

6
51
RECEPTION CONTROL UNIT
39
50
TRANSMISSION CONTROL UNIT
38

FIG.4

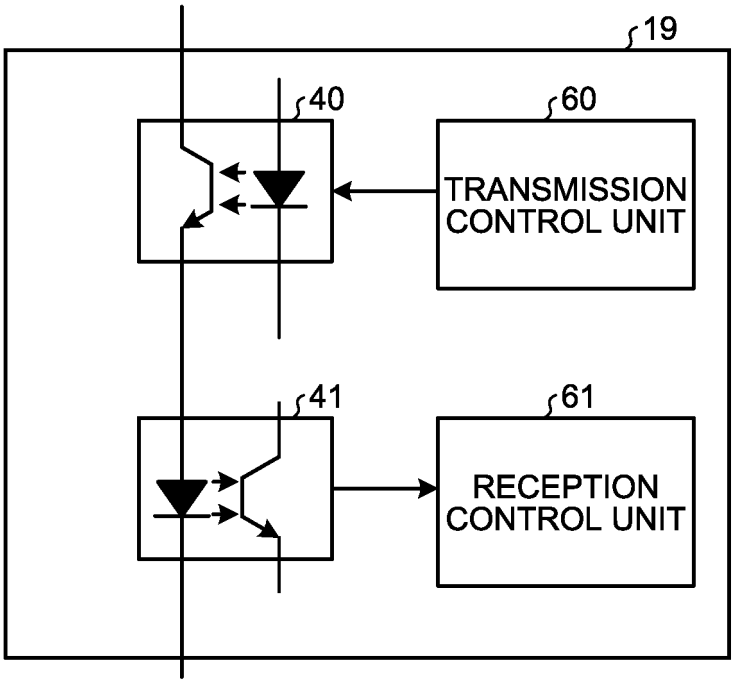

19
40
60
TRANSMISSION CONTROL UNIT
41
61
RECEPTION CONTROL UNIT

FIG.5

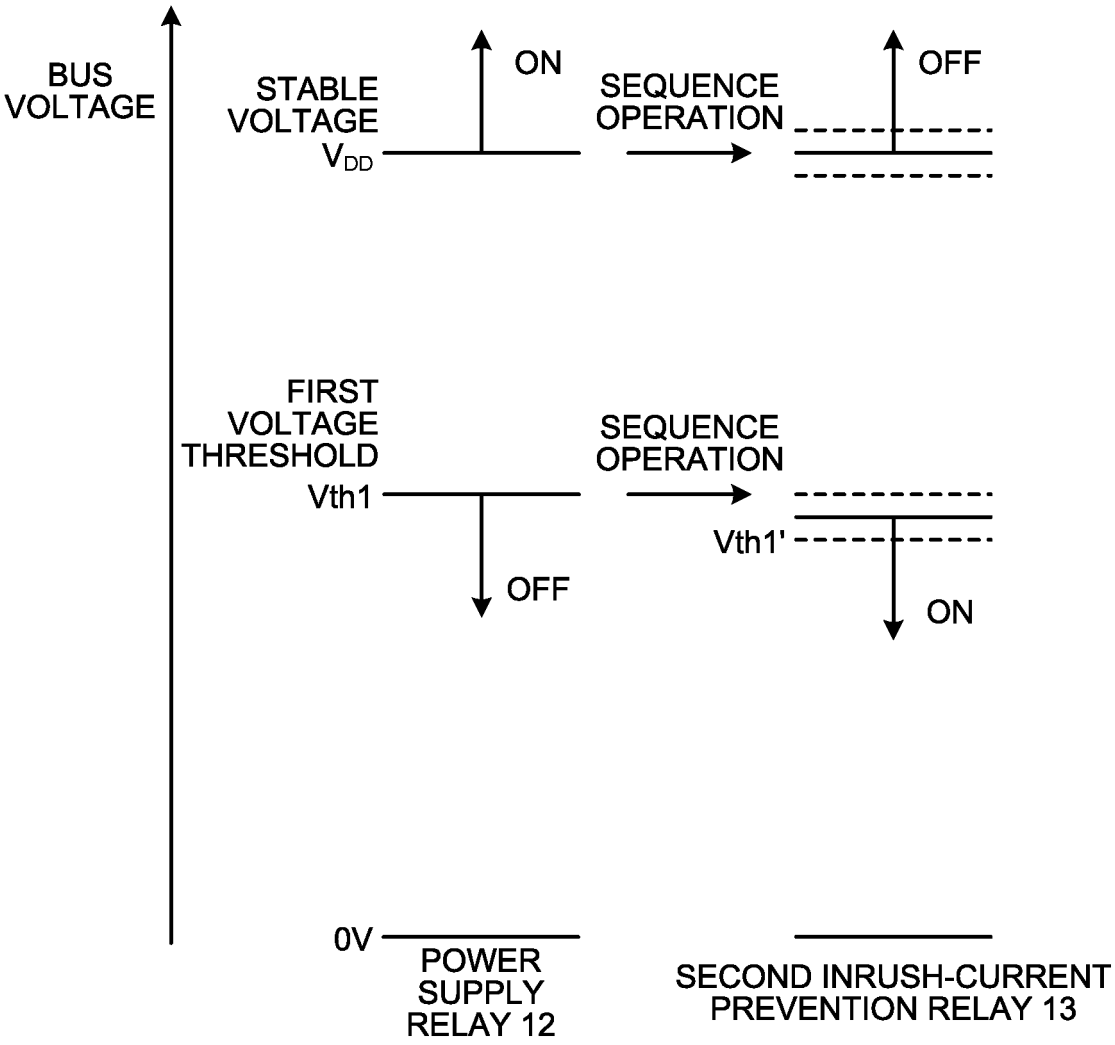

BUS VOLTAGE
STABLE VOLTAGE
V_{DD}
ON
SEQUENCE OPERATION
OFF
FIRST VOLTAGE THRESHOLD
Vth1
OFF
SEQUENCE OPERATION
Vth1'
ON
0V
POWER SUPPLY RELAY 12
SECOND INRUSH-CURRENT PREVENTION RELAY 13

FIG.6

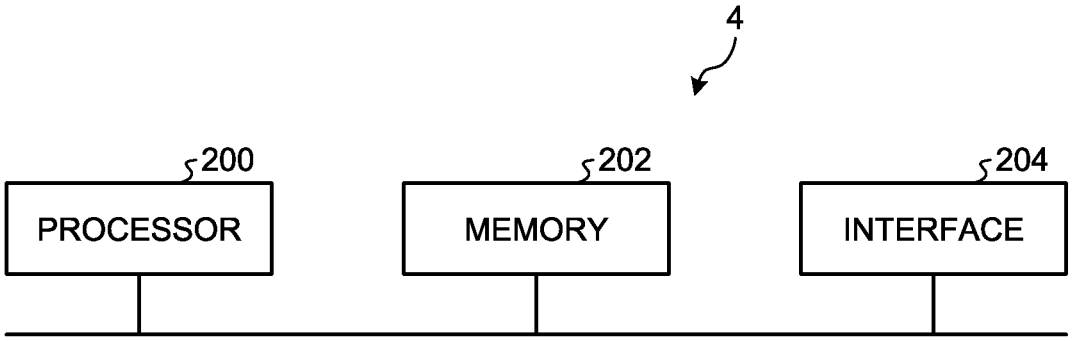
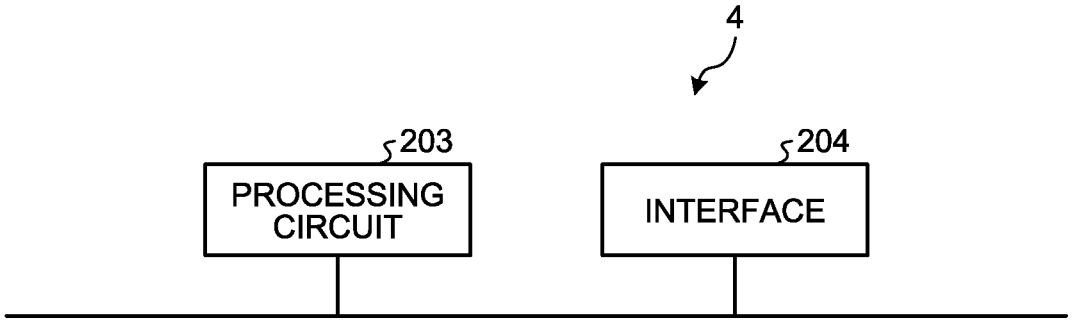

4
200
PROCESSOR
202
MEMORY
204
INTERFACE

FIG.7


4
203
PROCESSING CIRCUIT
204
INTERFACE

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/032562

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2014-202459 A (Mitsubishi Electric Corp.), 27 October 2014 (27.10.2014), paragraphs [0011], [0020], [0053] to [0057]; fig. 1 to 2, 4 & CN 203785123 U & CN 104101033 A	1-4
Y	JP 2003-56891 A (Chofu Seisakusho Co., Ltd.), 26 February 2003 (26.02.2003), paragraphs [0017] to [0021]; fig. 1 to 3 (Family: none)	1-4
Y	WO 2016/157472 A1 (Mitsubishi Electric Corp.), 06 October 2016 (06.10.2016), claim 6; paragraph [0006] (Family: none)	4

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
21 September 2017 (21.09.17)	03 October 2017 (03.10.17)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/032562

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 2017-38233 A (Mitsubishi Electric Corp.), 16 February 2017 (16.02.2017), claim 1; paragraphs [0011] to [0014] (Family: none)	4
A	JP 2016-90183 A (Mitsubishi Electric Corp.), 23 May 2016 (23.05.2016), paragraph [0043]; fig. 1 & US 2016/0131387 A1 paragraph [0047]; fig. 1 & EP 3021052 A1 & CN 105588218 A	1-4

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2010243051 A **[0004]**