

**[Document Name]** Specification

**[Title of the Invention]** Electric circuit board and refrigeration apparatus equipped with the electric circuit board

**[Technical Field]**

5 To provide an electric circuit board connected to a control board of a refrigerating apparatus via a communication line, and a refrigerating apparatus equipped with the electric circuit board.

**[Background of the Invention]**

10 In the data transmission device of a refrigerating apparatus, if the positive electrode signal line and the negative electrode signal line are connected with the wrong polarity, communication becomes impossible. Therefore, there is a demand for a data transmission device without requiring the improvement work even if the wires are connected with the wrong polarity. For example, in the data transmission device disclosed in  
15 Patent Document 1 (Japanese Unexamined Patent Publication No. 5-347637), when the CPU determines whether the connection is correct or not, and when it is determined that the connection is incorrect, the transmission polarity switching circuit is used. The positive electrode signal is output to the positive electrode signal line, and the negative  
20 electrode signal is output to the negative electrode signal line.

**[Summary of the Invention]**

**[Problems to be Solved by the Invention]**

However, the above-mentioned data transmission device causes an increase in production cost since the CPU is used to determine the  
25 correctness of the connection. As a result, there is a demand to eliminate the need for the use of CPU to determine the correctness of the connection and without the additional improvement, even if the wiring is connected with the wrong polarity.

**[Means for Solving Problems]**

30 The electric circuit board according to the first aspect is an electric circuit board that is connected to a control board of a refrigerating apparatus comprising a heat source unit and a utilization unit via a communication line. The electric circuit board comprises a first input line, a second input line, a first output line, a second output line, and a relay.  
35 A positive electrode signal or a negative electrode signal is input to the first input line. A signal of a pole different from that of the first input line is input to the second input line. The first output line outputs a positive electrode signal. The second output line outputs a negative electrode signal. When the first input line is a positive electrode, the relay connects  
40 the first input line and the first output line, and connects the second input line and the second output line. Further, when the first input line is a negative electrode, the relay connects the first input line and the second output line, and connects the second input line and the first output line.

45 In this electric circuit board, even if the polarities of the signals input to the first input line and the second input line are reversed due to incorrect wiring, the signals with the correct polarities are output to the

first output line and the second output line by the relay operation, therefore the inoperability due to incorrect wiring can be avoided.

The electric circuit board related to the second aspect is the electric circuit board according to the first aspect. The electric circuit board further comprises a first circuit and a second circuit. The first circuit connects the first input line with the first output line, and connects the second input line with the second output line. A second circuit connects the first input line and the second output line, and connects the second input line with the first output line. The relay includes a switching contact. The switching contact turns on the first circuit and turns off the second circuit when the first input line is a positive electrode. Further, the switching contact turns off the first circuit and turns on the second circuit when the first input line is the negative electrode.

Since this electric circuit board is a simple configuration in which either one of the first circuit and the second circuit is continuity conductive by the switching contact of the relay, so a general-purpose inexpensive relay can be used.

The electric circuit board related to the third aspect is an electric circuit board according to the first aspect or the second aspect. The electric circuit board further comprises a first voltage divider circuit and a second voltage divider circuit. The first voltage divider circuit is connected between the first input line and the second input line, and when the first input line is a positive electrode that causes a voltage drop from the connection end with the first input line toward the connection end with the second input line. The second voltage divider circuit is connected between the first input line and the second input line, and when the first input line is the negative electrode causes a voltage drop from the connection end with the second input line toward the connection end with the first input line. When the first input line is a positive voltage, the second voltage, which is the potential difference between the connection point of the voltage dividing resistors of the second voltage divider circuit and the ground becomes larger than the first voltage which is the potential difference between the connection point of the voltage divider resistors of the first voltage divider circuit and the ground, and a predetermined operating voltage is output to the relay.

In this electric circuit, the relay is operated by the magnitude of the potential difference from the ground of the connection point of the voltage dividing resistance in the two voltage dividing circuits is reversed by utilizing the polarities of the first input line and the second input line. Therefore, it is not necessary to determine the polarity error by the CPU, and the circuit design is easy.

The electric circuit board related to the fourth aspect is the electric circuit board according to the third aspect. In the first voltage divider circuit, the first diode, a first diode with the first resistor and the second resistor are connected in series, in which a forward current flows from the connection end with the first input line toward the connection end with

the second input line in the first voltage divider circuit. In the second voltage dividing circuit, a second diode with the third resistor and the fourth resistor are connected in series in which a forward current flows from the connection end with the second input line toward the connection end with the first input line.

In this electric circuit board, the potential of the connection point of the voltage dividing resistor with respect to the ground can be made different due to the polarity error by making the forward directions of the diodes provided in each of the two voltage dividing circuits are opposite directions to each other.

The electric circuit board according to the fifth aspect is the electric circuit board according to the fourth aspect. The first voltage is the potential difference between the connection point between the first resistor and the second resistor and the ground. The second voltage is the potential difference between the connection point between the third resistor and the fourth resistor and the ground.

In this electric circuit board, by designing the resistance value so that the magnitude of each potential is reversed due to the polarity error, therefore, it is possible to address the polarity error without relying on the CPU.

The electric circuit board related to the sixth aspect is an electric circuit board according to any one of the third aspect to the fifth aspect. The electric circuit board further comprises a comparator. The comparator compares the first voltage with the second voltage, and when the second voltage is larger than the first voltage, then outputs the operating voltage to the relay. The voltage of the inverting input of the comparator is the first voltage, and the voltage of the non-inverting input of the comparator is the second voltage.

Since this electric circuit board can supply a stable operating voltage to the relay, the reliability is improved.

The electric circuit board related to the seventh aspect is an electric circuit board according to any one of the first aspect to the sixth aspect. The control board includes a first control board equipped with the heat source unit and a second control board equipped with the utilization unit. The electric circuit board includes a first electric circuit board connected to the first control board and a second electric circuit board connected to the second control board.

The refrigerating apparatus according to the eighth aspect is the refrigerating apparatus equipped with the electric circuit board according to any one of the first aspect to the seventh aspect.

#### **[Brief Description of the Drawings]**

FIG. 1 is a configuration diagram of an air conditioner which is a refrigerating apparatus on which an electric circuit board according to an embodiment of the present disclosure is equipped.

FIG. 2 is a diagram of an electric circuit of an air conditioner.

FIG. 3 is a circuit diagram of a polarity correction circuit.

FIG. 4 is a circuit diagram of a switching circuit.

FIG. 5 is a polarity correction circuit diagram showing a transmission path of a positive electrode signal and a negative electrode signal when a positive electrode signal is input to the first input line and a negative electrode signal is input to the second input line.

FIG. 6 is a polarity correction circuit diagram showing transmission paths of a positive electrode signal and a negative electrode signal when a positive electrode signal is input to the second input line and a negative electrode signal is input to the first input line.

FIG. 7 is an explanatory diagram showing a state of a switching circuit when the power supply from the first power supply is not cut off.

FIG. 8 is an explanatory diagram showing a state of a switching circuit when the power supply from the first power supply is cut off.

### **[Modes for Carrying Out the Invention]**

#### **(1) Outline of air conditioner 100**

FIG. 1 is a configuration diagram of an air conditioner 100, which is a refrigerating apparatus equipped with an electric circuit board according to an embodiment of the present disclosure. Further, FIG. 2 is a diagram of an electric circuit of the air conditioner 100.

First, in FIG. 1, the air conditioner 100 consists of an indoor unit 1 which is a user side unit and an outdoor unit 2 which is a heat source side unit.

The indoor unit 1 is installed in each room of the tenant, for example, and each indoor unit 1 is connected to the outdoor unit 2 by a refrigerant connecting pipe.

The air conditioner 100, includes a compressor 15, a four-way switching valve 16, an outdoor heat exchanger 17, an outdoor expansion valve 18 as a decompression mechanism, the refrigerant circuit 10 having an indoor expansion valve 20, and an indoor heat exchanger 13 are annularly connected in a ring shape by a refrigerant pipe.

#### **(1-1) Indoor unit 1**

The indoor expansion valve 20 and the indoor heat exchanger 13 of the refrigerant circuits 10 are components of the indoor unit 1. In addition, the indoor unit 1 is equipped with an indoor fan 14. The indoor fan 14 creates a flow of air to the indoor heat exchanger 13.

In FIG. 2, the indoor unit 1 includes an indoor control power supply 25, an indoor communication circuit 35, a polarity correction circuit 37, an indoor microcomputer 45, a switching circuit 75, and a second power supply 102. Both the indoor control power supply 25 and the indoor communication circuit 35 are connected to the indoor microcomputer 45.

The indoor control power supply 25 receives power from the first power supply 101, which is an AC power supply, via the power supply lines 801, 802, generates a control voltage from the first power supply 101, and supplies the control voltage to the indoor microcomputer 45. The first power supply 101 is a commercial power supply of AC220V.

The indoor communication circuit 35 is used when the indoor unit

1 communicates with the outdoor unit 2.

The polarity correction circuit 37 can switch the positive electrode signal is output to the positive electrode output line and the negative electrode signal is output to the negative electrode output line, even if the positive electrode signal line and the negative electrode signal line that transmit the signal from the outdoor unit 2 are connected with the wrong polarity.

The indoor microcomputer 45 controls the opening degree of the indoor expansion valve 20, the operating frequency of the indoor fan 14.

A circuit breaker 71 is interposed between the indoor control power supply 25 and the first power supply 101. For example, when the indoor unit 1 of the air conditioner 100 is installed in each of the plurality of tenants, when the any tenant decided not to use, the breaker 71 cuts off the power supply from the first power supply 101 to the indoor unit 1.

Furthermore, the indoor unit 1 includes a switching circuit 75 to detect if the power supply from the first power supply 101 is cut off, when the power from the first power supply 101 is cut off, and then switching to power supply from the second power supply 102, in which is a different power source from the first power supply 101.

The indoor unit 1 includes a first control board 81 and a first electric circuit board 91 that is different from the first control board 81.

The indoor control power supply 25, the indoor communication circuit 35, and the indoor microcomputer 45 are equipped with the first control board 81. Furthermore, the polarity correction circuit 37, the switching circuit 75, and the second power supply 102 are equipped with the first electric circuit board 91.

#### (1-2) Outdoor unit 2

The compressor 15, the four-way switching valve 16, the outdoor heat exchanger 17, and the outdoor expansion valve 18 of the refrigerant circuits 10 are components of the outdoor unit 2. In addition, the outdoor unit 2 is equipped with an outdoor fan 19. The outdoor fan 19 creates a flow of air to the outdoor heat exchanger 17.

Furthermore, the outdoor unit 2 includes an outdoor control power supply 26, an outdoor communication circuit 36, a polarity correction circuit 38, an outdoor microcomputer 46, and a DC power supply circuit 72 as shown in FIG. 2. Both the outdoor control power supply 26 and the outdoor communication circuit 36 are connected to the outdoor microcomputer 46.

The outdoor control power supply 26 receives electric power from the three-phase AC power supply 111 via the power supply lines 811, 812, and 813, generates a control voltage from the power line, and supplies the control voltage to the outdoor microcomputer 46. The AC power supply 111 is a commercial power supply of AC380V and the line 814 is a ground wire.

The outdoor communication circuit 36 is used when the outdoor unit 2 communicates with the indoor unit 1.

The polarity correction circuit 38 can switch the outputs resulting in the positive electrode signal to the positive electrode output line and the negative electrode signal to the negative electrode output line even if the positive electrode signal line and the negative electrode signal line that transmit the signal from the outdoor communication circuit 36 are connected with the wrong polarity.

The outdoor microcomputer 46 controls the operating frequency of the compressor 15, the switching operation of the four-way switching valve 16, the opening degree of the outdoor expansion valve 18, the operating frequency of the outdoor fan 19.

The outdoor unit 2 includes a second control board 82 and a second electric circuit board 92, that is different from the second control board 82.

The outdoor control power supply 26, the outdoor communication circuit 36, and the outdoor microcomputer 46 are equipped with the second control board 82. In addition, the polarity correction circuit 38 and the DC power supply circuit 72 are equipped with the second electric circuit board 92.

#### (2) First electric circuit board 91

The polarity correction circuit 37 and the switching circuit 75 are equipped with the first electric circuit board 91.

In the present embodiment, the first electric circuit board 91 of the indoor unit 1 is a board separate from the first control board 81, but it can optionally be integrated into one board.

#### (2-1) Polarity correction circuit 37

FIG. 3 is a circuit diagram of the polarity correction circuit 37. The first terminal N1a of the first connector CN1 is connected to the first input line 11. In addition, the second terminal N1b of the first connector CN1 is connected to the second input line 12. The communication line of the positive electrode signal F1 is connected to the first terminal N1a, and the communication line of the negative electrode signal F2 is connected to the second terminal N2b.

The polarity correction circuit 37 comprises a switching relay 30, a first circuit 41, a second circuit 42, a first voltage divider circuit 51, a second voltage divider circuit 52, a relay driver circuit 53, and a comparator 55.

The function of the polarity correction circuit 37 is to use a switching relay 30 to connect the first input line 11 and the first output line 21 when the first input line 11 is a positive electrode, and to connect the second input line 12 and the second output line 22 is connected, and when the first input line 11 is a negative electrode, the first input line 11 and the second output line 22 are connected, and the second input line 12 and the first output line 21 are connected.

The purpose of installing the polarity correction circuit 37 is to ensure that the communication is performed correctly when connecting the indoor unit 1 and the outdoor unit 2 with a communication line, even in case of the service provider may make a mistake in wiring the

communication line, and resulting in a wiring error in the communication line but the communication is still performed correctly.

#### (2-1-1) Switching relay 30

5 The switching relay 30 comprises a relay coil 31 and a contact switching mechanism 32. The contact switching mechanism 32 can close the first contact C1a and the second contact C2a and at the same time, simultaneously open the third contact C1b and the fourth contact C2b while the relay coil 31 is energized.

10 Furthermore, the contact switching mechanism 32 can open the first contact C1a and the second contact C2a and at the same time, simultaneously close the third contact C1b and the fourth contact C2b, while the relay coil 31 is not energized.

#### (2-1-2) First circuit 41

15 The first circuit 41 connects the first input line 11 with the first output line 21, and connects the second input line 12 with the second output line 22.

20 The first circuit 41 is provided with the first contact C1a of the switching relay 30 in the middle of the wiring connecting the first input line 11 and the first output line 21. The first input line 11 and the first output line 21 are connected when the first contact C1a is closed, and the connection between the first input line 11 and the first output line 21 are released when the first contact C1a is open.

25 Furthermore, the first circuit 41 is provided with a second contact C2a of the switching relay 30 in the middle of the wiring connecting the second input line 12 and the second output line 22. The second input line 12 and the second output line 22 are connected when the second contact C2a is closed, and the connection between the second input line 12 and the second output line 22 is released when the second contact C2a is open.

#### (2-1-3) Second circuit 42

30 The second circuit 42 connects the first input line 11 with the second output line 22, and connects the second input line 12 with the first output line 21.

35 The second circuit 42 is provided with a third contact C1b of the switching relay 30 in the middle of the wiring connecting the first input line 11 with the second output line 22. The first input line 11 and the second output line 22 are connected when the third contact C1b is closed, and the connection between the first input line 11 and the second output line 22 are released when the third contact C1b is open.

40 Furthermore, the second circuit 42 is provided with a fourth contact C2b of the switching relay 30 in the middle of the wiring connecting the second input line 12 with the first output line 21. The second input line 12 and the first output line 21 are connected when the fourth contact C2b is closed, and the connection between the second input line 12 and the first output line 21 are released when the fourth contact C2b is open.

#### 45 (2-1-4) First voltage divider circuit 51

The first voltage divider circuit 51 is provided with the first diode

D11, the first resistor R11, and the second resistor R12, in which are connected in series from the connection point S11 facing the first input line 11 to the connection point S12 with the second input line 12.

5 Since the anode of the first diode D11 is connected to the connection point S11 and the cathode is connected to one end of the first resistor R11, therefore, the direction from the connection point S11 to the connection point S12 is the forward direction of the first diode D11.

10 Accordingly, when the first input line 11 is the positive electrode and the second input line 12 is the negative electrode, as a result the voltage is dropped in accordance with the resistance value ratio of the first resistor R11 and the second resistor R12 in which is located at both ends of the first resistor R11 and the second resistor R12 facing from the connection point S11 toward the connection point S12.

15 The connection point Q12 between the first resistor R11 and the second resistor R12 are connected to the inverting input terminal of the comparator 55, which will be described later.

(2-1-5) Second voltage divider circuit 52

20 The second voltage divider circuit 52 provided with the second diode D21, the third resistor R21, and the fourth resistor R22, in which are connected in series from the connection point S21 facing the second input line 12 toward the connection point S22 with the first input line 11.

25 Since the anode of the second diode D21 is connected to the connection point S21 and the cathode is connected to one end of the third resistor R21, therefore, the direction from the connection point S21 to the connection point S22 is the forward direction of the second diode D21.

30 Accordingly, when the second input line 12 is the positive electrode and the first input line 11 is the negative electrode, the third resistor R21 is located at both ends of the third resistor R21 and the fourth resistor R22 from the connection point S21 toward the connection point S22. And a voltage drop corresponding to the resistance value ratio of the fourth resistor R22 occurs.

The connection point Q22 between the third resistor R21 and the fourth resistor R22 is connected to the non-inverting input terminal of the comparator 55 described later.

35 (2-1-6) Relay driver circuit 53

The relay driver circuit 53 includes a transistor Tra while a predetermined positive voltage is applied to the base of the transistor Tra, a drive voltage E1 is applied to the relay coil 31, in which the collector and emitter of the transistor Tra are electrically connected to each other.

40 When the drive voltage E1 is applied to the relay coil 31, the relay coil 31 is energized, so that the first contact C1a and the second contact C2a provided in the first circuit 41 are closed, and at the same time, the third contact C1b and the fourth contact C2b provided in the second circuit 42 are open.

45 When the drive voltage E1 is not applied to the relay coil 31, the relay coil 31 is not energized, so that the first contact C1a and the second

contact C2a provided in the first circuit 41 are opened, and at the same time, the third contact C1b and the fourth contact C2b provided in the second circuit 42 are closed.

#### (2-1-7) Comparator 55

5       The comparator 55 compares the voltage input to the inverting input terminal (hereinafter referred to as the first voltage V1) with the voltage input to the non-inverting input terminal (hereinafter referred to as the second voltage V2). The predetermined output voltage  $V_{out} = E2$  is output from the output terminal when the second voltage  $V2 >$  the first voltage V1. On the other hand, the output voltage  $V_{out} = 0V$  is output from the output terminal when the second voltage  $V2 <$  the first voltage V1.

10       Accordingly, when a predetermined output voltage  $V_{out} = E2$  is output from the output terminal, the second voltage  $V2 >$  the first voltage V1, and while it is applied to the base of the transistor Tra, the collector and the emitter emitter are electrically connected to each other. The drive voltage E1 is applied to the relay coil 31.  $E1 = E2$  may be used.

15       In the present embodiment, the connection point Q12 is between the first resistor R11 and the second resistor R12 wherein is connected to the inverting input terminal of the comparator 55, and the inverting input terminal is connected to the ground GND via the fifth resistor R15. Therefore, the first voltage V1 is the potential difference between the connection point Q12 of the first resistor R11 and the second resistor R12 and the ground GND.

20       Furthermore, since the connection point Q22 is between the third resistor R21 and the fourth resistor R22 wherein is connected to the non-inverting input terminal of the comparator 55, and the non-inverting input terminal is connected to the ground GND via the sixth resistor R26. Therefore, the second voltage V2 is the potential difference between the connection point Q22 of the third resistor R21 and the fourth resistor R22 and the ground GND.

#### (2-2) Switching circuit 75

25       FIG. 4 is a circuit diagram of the switching circuit 75. The switching circuit 75 in FIG. 4 includes an on / off relay 76, a first switching circuit 77a, a second switching circuit 77b, a third switching circuit 77c, a photocoupler 78, and a relay driver circuit 79. The function of the switching circuit 75 is to detect the presence or absence of power supply from the first power supply 101 using the photocoupler 78, and to use the on / off relay 76 to supply electric power to the first control board 81 from the second power source 102 which is another power source when there is no power supply from the first power supply 101.

#### (2-2-1) On / off relay 76

30       In the present embodiment, the switching circuit 75 includes the two on / off relays 76. The number of on / off relays 76 can be set arbitrarily. The on / off relay 76 includes a relay coil 76a and a relay switch 76b.

35       The relay switch 76b can close the first contact S1a and the second

contact S2a, and at the same time open the third contact S1b and the fourth contact S2b while the relay coil 76a is energized.

Furthermore, the relay switch 76b can open the first contact S1a and the second contact S2a, and at the same time close the third contact S1b and the fourth contact S2b while the relay coil 76a is not energized.

#### (2-2-2) First switching circuit 77a

The first switching circuit 77a establishes conduction between the first DC power supply Ea and the first terminal N3a of the third connector CN3 only when the third contact S1b of the on / off relay 76 is closed, and the power is supplied from the first DC power source Ea that connects to the first control board 81.

#### (2-2-3) Second switching circuit 77b

The second switching circuit 77b establishes conduction between the second DC power supply Eb and the second terminal N3b of the third connector CN3 only when the fourth contact S2b of the on / off relay 76 is closed, and the power is supplied from the second DC power source Eb that connects to the first control board 81.

#### (2-2-4) Third switching circuit 77c

The third switching circuit 77c establishes conduction between the third DC power supply Ec and the third terminal N3c of the third connector CN3 only when the third contact S1b of the on / off relay 76 is closed, and the power is supplied from the third DC power source Ec that connects to the first control board 81.

#### (2-2-5) Photocoupler 78

As shown in FIG. 4, the photocoupler 78 is an insulating switch including a photodiode 78a and a phototransistor 78b. The first terminal N5a of the connector CN5 is connected to the anode of the photodiode 78a of the photocoupler 78. In addition, the second terminal N5b of the connector CN5 is connected to the cathode of the photodiode 78a of the photocoupler 78.

The branch wire of the power supply line 801 is connected to the first terminal N5a, and the branch wire of the power supply line 802 is connected to the second terminal N5b.

A rectifier circuit 73 is connected in parallel to both ends of the photodiode 78a. The rectifier circuit 73 rectifies the AC voltage of the first power supply 101 with the diode Da and the smoothing capacitor Ca, and generates a DC voltage suitable for the photodiode 78a to emit light by the voltage dividing resistors Ra and Rb.

#### (2-2-6) Relay driver circuit 79

As shown in FIG. 4, the relay driver circuit 79 includes a transistor Trb. In the transistor Trb, the voltage of the drive power supply Ed is applied to the relay coil 76a via the collector and the emitter conduct with each other, while a predetermined positive voltage is applied to the base.

While the voltage of the drive power supply Ed is applied to the relay coil 76a, the relay coil 76a is energized, so that the third contact S1b provided in the first switching circuit 77a and the third switching circuit

77c, with the fourth contact S2b provided in the switching second circuit 77b is opened. Therefore, the power of the first DC power supply Ea, the second DC power supply Eb, and the third DC power supply Ec is not supplied to the first control board 81.

5 On the other hand, when the voltage of the drive power supply Ed is not applied to the relay coil 76a, the relay coil 76a is not energized, so that the third contact S1b provided in the first switching circuit 77a and the third switching circuit 77c, with the fourth contact S2b provided in the switching circuit 77b is closed. Therefore, the power of the first DC  
10 power supply Ea, the second DC power supply Eb, and the third DC power supply Ec is supplied to the first control board 81.

#### (2-2-7) Second power supply 102

As shown in FIG. 2, the second power supply 102 introduces the DC voltage generated by the DC power supply circuit 72 of the outdoor unit 2  
15 via the communication lines L1 and L2, and introduces the voltage required for each of the first DC power supply Ea, the second DC power supply Eb and the third DC power supply Ec of the first control board 81.

When the power is supplied from the first power supply 101 to the first control board 81, the second power supply 102 and the first control  
20 board 81 are cut off by the switching circuit 75 and both are connected to the power is supplied from the first power supply 101 when the power is not supplied by the switching circuit 75.

The advantage is that, after the power supply from the first power supply 101 of the indoor unit 1 is cut off, the opening degree of the indoor expansion valve 20 which is an electric expansion valve is to be adjusted  
25 based on the operation mode before the power supply is cut off. For example, in the case of cooling operation, the opening degree of the indoor expansion valve is closed, and in the case of heating operation, it is slightly opened. These controls are properly operated by activating the indoor microcomputer 45.  
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#### (3) Second electric circuit board 92

As shown in FIG. 2, the polarity correction circuit 38 and the DC power supply circuit 72 are equipped with the second electric circuit board  
35 92.

In the present embodiment, the second electric circuit board 92 of the outdoor unit 2 is a circuit board separate from the second control board 82, but may be integrated into one board.

#### (3-1) Polarity correction circuit 38

The polarity correction circuit 38 can switch the outputs so the positive electrode signal to the positive electrode output line and the negative electrode signal to the negative electrode output line even if the positive electrode signal line and the negative electrode signal line that transmit the signal from the outdoor communication circuit 36 are connected with the wrong polarity  
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45 Since the circuit configuration of the polarity correction circuit 38 is the same as the circuit configuration of the polarity correction circuit

37 shown in FIG. 3, description thereof will be omitted the details here.

### (3-2) DC power supply circuit 72

The DC power supply circuit 72 is a circuit that generates a DC voltage to be supplied to the second power supply 102 equipped with the first electric circuit board 91 of the indoor unit 1.

The DC power supply circuit 72 introduces an AC voltage from one of the power supply lines 811, 812, 813 of the three-phase AC power supply 111, and generates a DC voltage via the filter circuit 72a, the rectifier circuit 72b, and the smoothing capacitor 72c.

As shown in FIG. 2, the DC voltage generated by the DC power supply circuit 72 is transmitted from the outdoor communication circuit 36 in a state of being superimposed on the positive electrode signal F1 and the negative electrode signal F2. The positive electrode signal F1 is transmitted to the indoor unit 1 via the communication line L1 and the negative electrode signal F2 is transmitted to the indoor unit 1 via the communication line L2.

### (4) Operation of polarity correction circuits 37 and 38

The operation of the polarity correction circuits 37 and 38 will be described herein by taking the polarity correction circuit 37 of the indoor unit 1 as an example.

(4-1) When the first input line 11 is a positive electrode and the second input line 12 is a negative electrode

When the signal line which the positive electrode signal F1 is transmitted and the communication line which the negative electrode signal F2 is transmitted, are correctly connected, the positive electrode signal F1 is input to the input line 11 via the communication line L1 and the first terminal N1a of the first connector CN1. In addition, the negative electrode signal F2 is input to the second input line 12 via the communication line L2 and the second terminal N1b of the first connector CN1.

FIG. 5 is a polarity correction circuit diagram showing the transmission paths of the positive electrode signal F1 and the negative electrode signal F2 when the positive electrode signal F1 is input to the first input line 11 and the negative electrode signal F2 is input to the second input line 12.

In FIG. 5, since a positive voltage is applied to the connection point S11 of the first voltage divider circuit 51, resulting the voltage drop occurs in accordance with the resistance value ratio of the first resistor R11 and the second resistor R12 that are located at both ends of the first resistor R11 and the second resistor R12 from the connection point S11 facing toward the connection point S12.

Furthermore, a positive voltage is also applied to the connection point S22 of the second voltage divider circuit 52, but since the direction is opposite to the forward direction of the second diode D21, resulting in the voltage drop occurs at both ends of each of the fourth resistor R22 and the sixth resistor R26 in accordance with the resistance value ratio of the

fourth resistor R22 and the sixth resistor R26, where no voltage drop occurs in the third resistor R21.

In this case, the resistance values of the first resistor R11, the second resistor R12, the third resistor R21, the fourth resistor R22, and the sixth resistor R26 are set for the potential difference (V2) between the connection point Q22 of the second voltage divider circuit 52 and the ground GND becomes larger than the potential difference (V1) between the connection point Q12 of the first voltage divider circuit 51 and the ground GND.

Since V2 ( $V2 > V1$ ) is input to the non-inverting input terminal and V1 is input to the inverting input terminal of the comparator 55, a predetermined output voltage  $V_{out} = E2$  is output from the output terminal of the comparator 55.

This output voltage  $V_{out}$  is applied to the base of the transistor Tra of the relay driver circuit 53, and the collector and the emitter are established to conduct electricity to the relay coil 31, so that the first contact C1a and the first contact C1a and the second contact C2a in the first circuit 41 are closed, and at the same time, the third contacts C1b and the fourth contact C2b provided in the second circuit 42 are opened.

As a result, when the first input line 11 is a positive electrode, the first input line 11 and the first output line 21 are connected, and the second input line 12 and the second output line 22 are connected.

(4-2) When the first input line 11 is the negative electrode and the second input line 12 is the positive electrode

When the signal line which the positive electrode signal F1 is transmitted and the communication line which the negative electrode signal F2 is transmitted are erroneously connected, for example, this is the case where the positive electrode signal F1 is input to the second input line 12 that is transmitted via the communication line L1 and the second terminal N1b of the first connector CN1. At this moment, the negative electrode signal F2 is input to the first input line 11 via the communication line L2 and the first terminal N1a of the first connector CN1.

FIG. 6 is a polarity correction circuit diagram showing the transmission paths of the positive electrode signal F1 and the negative electrode signal F2 when the positive electrode signal F1 is input to the second input line 12 and the negative electrode signal F2 is input to the first input line 11.

In FIG. 6, since a positive voltage is applied to the connection point S21 of the second voltage divider circuit 52, resulting the voltage drop occurs in accordance with the resistance value ratio of the third resistor R21 and the fourth resistor R22 that are located at both ends of the third resistor R21 and the fourth resistor R22 from the connection point S21 facing toward the connection point S22.

Furthermore, a positive voltage is also applied to the connection point S12 of the first voltage divider circuit 51, but since the direction is opposite to the forward direction of the first diode D11, resulting in the

voltage drop occurs at both ends of each of the second resistor R12 and the fifth resistor R15 in accordance with the resistance value ratio of the second resistor R12 and the fifth resistor R15, where no voltage drop occurs in the first resistor R11.

5 In this case, the resistance values of the first resistor R11, the second resistor R12, the third resistor R21, the fourth resistor R22, and the fifth resistor R15 are set for the potential difference (V1) between the connection point Q12 of the first voltage divider circuit 51 and the ground GND becomes larger than the potential difference (V2) between the  
10 connection point Q22 of the second voltage divider circuit 52 and the ground GND.

Since V2 ( $V2 < V1$ ) is input to the non-inverting input terminal and V1 is input to the inverting input terminal of the comparator 55 so that the output voltage  $V_{out} = 0$  is then output from the output terminal of the  
15 comparator 55.

Since this output voltage  $V_{out} = 0$  becomes the base voltage of the transistor Tra of the relay driver circuit 53, there is no conduction between the collector and the emitter, and the relay coil 31 is not energized. Therefore, the first contact C1a and the second contact C2a provided in  
20 the first circuit 41 are opened, and at the same time, the third contact C1b and the fourth contact C2b provided in the second circuit 42 are closed.

As a result, when the first input line 11 is the negative electrode, the first input line 11 and the second output line 22 are connected, and the second input line 12 and the first output line 21 are connected.

25 As described above, the positive electrode signal F1 is always output from the first output line 21, and the negative electrode signal F2 is always output from the second output line 22 by the polarity correction circuit 37.

#### (5) Operation of switching circuit 75

30 The function of the switching circuit 75 detects that the power supply from the first power supply 101 is cut off when the power from the first power supply 101 is cut off, and can switch to the power from the second power supply 102 which is the different power source from the first power supply 101.

35 Hereinafter, the operation of the switching circuit 75 will be described separately for the case where the power supply from the first power supply 101 is not cut off and the case where the power supply from the first power supply 101 is cut off.

#### (5-1) When the power supply from the first power supply 101 is not cut off

40 FIG. 7 is an explanatory diagram showing a state of the switching circuit 75 when the power supply from the first power supply 101 is not cut off. In FIG. 7, the current flows are indicated by arrows.

In FIG. 7, a DC voltage obtained by rectifying the AC voltage of the first power supply 101 is applied to both ends of the photodiode 78a of the photocoupler 78 in the forward direction, and the photodiode 78a emits  
45 light when the If current flows.

The phototransistor 78b receives the  $I_{out}$  current through conduction between the collector and the emitter by the emitted light from the photodiode 78a.

5 As a result, this generates a potential difference between the emitter and the ground GND by the resistor  $R_c$  between the emitter and the ground GND, which is applied as the base voltage of the transistor  $Trb$  of the relay driver circuit 79, and the base current  $I_b$  flows.

10 When the base voltage is applied to the transistor  $Trb$ , the collector and the emitter conduct with each other, the voltage of the drive power supply  $E_d$  is applied to the relay coil 76a, and the  $I_{con}$  current is energized to the relay coil 76a.

15 While the relay coil 76a is energized, the third contact  $S1b$  provided in the first switching circuit 77a and the third switching circuit 77c and the fourth contact  $S2b$  provided in the second switching circuit 77b are open. Therefore, the power of the first DC power supply  $E_a$ , the second DC power supply  $E_b$ , and the third DC power supply  $E_c$  is not supplied to the first control board 81.

(5-2) When the power supply from the first power supply 101 is cut off

20 FIG. 8 is an explanatory diagram showing a state of the switching circuit 75 when the power supply from the first power supply 101 is cut off. In FIG. 8, the current flows are indicated by the arrows.

25 In FIG. 8, since no DC voltage is applied to both ends of the photodiode 78a of the photocoupler 78, so that no light is emitted. Therefore, the phototransistor 78b does not receive the light emission of the photodiode 78a, the collector and the emitter then do not conduct with each other. As a result, there is no potential difference between the emitter and the ground GND.

30 Since the base voltage is not applied to the transistor  $Trb$ , the collector and the emitter do not conduct with each other, and the relay coil 76a is not energized.

35 Since the relay coil 76a is not energized, so that the third contact  $S1b$  provided in the first switching circuit 77a and the third switching circuit 77c, with the fourth contact  $S2b$  provided in the second switching circuit 77b are closed, and the first direct current is connected. The power of the power source  $E_a$ , the second DC power source  $E_b$ , and the third DC power source  $E_c$  is supplied to the first control board 81.

(6) Characteristics of invention

(6-1)

40 In the first electric circuit board 91 and the second electric circuit board 92, when the first input line 11 is a positive electrode, the switching relay 30 connects the first input line 11 with the first output line 21, and connects the second input line 12 with the second output line 22. Furthermore, when the first input line 11 is the negative electrode, the switching relay 30 connects the first input line 11 and the second output  
45 line 22 and connects the second input line 12 and the first output line 21.

Therefore, even if the polarities of the signals input to the first

input line 11 and the second input line 12 are reversed due to incorrect wiring, the signals with the correct polarities are output to the first output line 21 and the second output line 22 by the operation of the switching relay 30, therefore the inoperability due to incorrect wiring can be avoided.

5 (6-2)

In the first electric circuit board 91 and the second electric circuit board 92, the first circuit 41 connects the first input line 11 with the first output line 21, and connects the second input line 12 with the second output line 22. The second circuit 42 connects the first input line 11 with the second output line 22, and connects the second input line 12 with the first output line 21. The switching contact of the switching relay 30 turns on the first circuit 41 and turns off the second circuit 42 when the first input line 11 is a positive electrode. Furthermore, the switching contact of the switching relay 30 turns off the first circuit 41 and turns on the second circuit 42 when the first input line 11 is the negative electrode.

Since the configuration is as simple as making either one of the first circuit 41 and the second circuit 42 conductive by the switching contact of the switching relay 30, a general-purpose inexpensive relay can be used.

20 (6-3)

In the first electric circuit board 91 and the second electric circuit board 92, the first voltage dividing circuit 51 is connected between the first input line 11 and the second input line 12, when the first input line 11 is a positive electrode, a voltage drop is caused from the connection point S11 with the first input line 11 toward the connection point S12 with the second input line 12. The second voltage dividing circuit 52 is connected between the first input line 11 and the second input line 12, and when the first input line 11 is the negative electrode, a voltage drop is caused from the connection point S21 with the second input line 12 toward the connection point S22 with the first input line 11, when the first input line 11 is a positive voltage, the second voltage V2, which is the potential difference between the connection point Q22 of the voltage dividing resistance of the second voltage dividing circuit 52 and the ground GND is higher than that of the first voltage V1, which is the potential difference between the connection point Q12 of the voltage dividing resistance of the first voltage dividing circuit 51 and the ground GND, and a predetermined operating voltage is output to the switching relay 30.

The relay 30 is switching is performed by utilizing the fact that the magnitude of the potential difference between the connection points Q12 and Q22 of the voltage dividing resistors in the two voltage dividing circuits 51 and 52 from the ground GND is reversed by the polarities of the first input line 11 and the second input line 12. Therefore, it is not necessary for the CPU to determine the polarity error, and the circuit design is simple and easy.

45 (6-4)

The first voltage divider circuit 51 includes the first diode D11, the

first resistor R11, and the second resistor R12 are connected in series, in which the forward current flows from the connection point S11 with the first input line 11 toward the connection point S12 with the second input line 12. The second voltage dividing circuit 52 includes the second diode D21, the third resistor R21, and the fourth resistor R22 is connected in series, in which the forward current flows from the connection point S21 with the second input line 12 toward the connection point S22 with the first input line 11.

The forward directions of the diodes D11 and D21 provides in the two voltage dividing circuits 51 and 52 opposite to each other, subsequently, the potentials of the voltage dividing resistors with respect to the ground of the connection points Q12 and Q22 can be made different due to the polarity error.

(6-5)

The first voltage V1 is the potential difference between the connection point Q12 between the first resistor R11 and the second resistor R12 and the ground GND. The second voltage V2 is the potential difference between the connection point Q22 between the third resistor R21 and the fourth resistor R22 and the ground GND.

By simply designing the resistance value so that the magnitude of each potential is reversed due to the polarity error, it is possible to deal with the polarity error without depending on the CPU.

(6-6)

The comparator 55 of the first electric circuit board 91 and the second electric circuit board 92 compares the first voltage V1 with respect to the second voltage V2 and when the second voltage V2 is larger than the first voltage V1, the operating voltage is output to the switching relay 30. The voltage of the inverting input of the comparator 55 is the first voltage V1, and the voltage of the non-inverting input of the comparator 55 is the second voltage V2. Since a stable operating voltage can be supplied to the switching relay 30, reliability is improved.

(6-7)

The first control board 81 is equipped with the indoor unit 1 which is a utilization unit. A second control board 82 is equipped with the outdoor unit 2 which is a heat source unit. The first electric circuit board 91 is connected to the first control board 81. The second electric circuit board 92 is connected to the second control board 82.

When connecting the indoor unit 1 and the outdoor unit 2 with a communication line, even in case of the service provider may make a mistake in wiring the communication line, even when connects the positive electrode signal line with the negative electrode input line (second input line 12) and connects the negative electrode signal line with the positive electrode input line (first input line 11), the polarity correction circuit 37 of the indoor unit 1 uses the switching relay 30 to output the positive electrode signal to the positive electrode output line (first output line 21) and the negative electrode signal to the negative electrode output

line (second output line 22). As a result, even if a wiring error occurs in the communication line, communication is still performed correctly.

Although the embodiments of the present disclosure have been described above, it will be understood that various modifications of the embodiments and details are possible without departing from the spirit and scope of the present disclosure described in the claims.

**[Explanation of Code]**

1 Indoor unit (utilization unit)

2 Outdoor unit (heat source unit)

10 11 First input line

12 Second input line

21 First output line

22 Second output line

30 Switching relay (relay)

15 33 Switching contact

41 First circuit

42 Second circuit

51 First voltage divider circuit

52 Second voltage divider circuit

20 D11 First diode

D21 Second diode

R11 First resistor

R12 Second resistor

R21 Third resistor

25 R22 Fourth resistor

**[Prior Art Document]**

**[Patent Document]**

[Patent Document 1] Japanese Unexamined Patent Publication No. 5-347637

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**[Document Name] Claims****[Claim 1]**

An electric circuit board wherein the electric circuit board is connected to a control board of a refrigerating apparatus comprising a heat source unit and a utilization unit via a communication line and

the electric circuit board comprising the first input line (11) is input into a positive electrode signal or a negative electrode signal,

the second input line (12) where the signal of the different pole from that of the first input line (11), is input into

the first output line (21) that outputs the positive electrode signal and

the second output line (22) that outputs the negative electrode signal and

a relay (30) connecting the first input line (11) with the first output line (21), and the second input line (12) with the second output line (22) and when the first input line (11) is the negative electrode, the first input line (11) is connected to the second output line (22), when the first input line (11) is a positive electrode, the second input line (12) is connected to the first output line (21).

**[Claim 2]**

The electric circuit board according to claim 1, wherein the electric circuit board further comprises a first circuit (41) connecting the first input line (11) with the first output line (21) and connecting the second input line (12) with the second output line (22) and

a second circuit (42) connecting the first input line (11) with the second output line (22) and connecting the second input line (12) with the first output line (21), and

the relay (30) including a switching contact (33) that is

when the first input line (11) is a positive electrode, the first circuit (41) is turned on and the second circuit (42) is turned off, and

when the first input line (11) is the negative electrode, the first circuit (41) is turned off and the second circuit (42) is turned on.

**[Claim 3]**

The electric circuit board according to claim 1 or 2, wherein the electric circuit board further comprises

the first voltage divider circuit (51) that causes a voltage drop from the connection end that is connected between the first input line (11) and the second input line (12), and the first input line (11) with the second input line (12), that is connected the connection end with each other and the first input line (11) is a positive electrode and

the second voltage divider circuit (52) that causes a voltage drop from the connection end that is connected between the first input line (11) and the second input line (12), and the first input line (11) with the second input line (12), that is connected the connection end with each other and

the first input line (11) is the negative electrode, and

when the first input line (11) is a positive voltage, the second voltage (V2), which is the potential difference between the connection point of the voltage dividing resistors (R21, R22) of the second voltage dividing circuit (52) and the ground is larger than the first voltage (V1) which is the potential difference between the connection point of the voltage dividing resistors (R11 and R12) of the first voltage dividing circuit (51) and the ground and the predetermined operating voltage (Vout) is output to the relay (30).

[Claim 4]

The electric circuit board according to claim 3, wherein a first diode (D11) with the first resistor (R11) and the second resistor (R12) are connected in series, in which a forward current flows from the connection end with the first input line (11) toward the connection end with the second input line (12) in the first voltage divider circuit (51), and

a second diode (D21) with the third resistor (R21) and the fourth resistor (R22) are connected in series in which a forward current flows from the connection end with the second input line (12) toward the connection end with the first input line (11) in the second voltage dividing circuit (52).

[Claim 5]

The electric circuit board according to claim 4, wherein the first voltage (V1) is a potential difference between the connection point between the first resistor (R11) and the second resistor (R12) and the ground, and

the second voltage (V2) is a potential difference between the connection point between the third resistor (R21) and the fourth resistor (R22) and the ground.

[Claim 6]

The electric circuit board according to any one of claims 3 to 5, wherein the electric circuit board further comprises a comparator (55) that outputs the operation output voltage (Vout) to the relay (30) when the second voltage (V2) is larger than the first voltage (V1), with respect to the first voltage (V1) and the second voltage (V2), and

the voltage of the inverting input of the comparator is the first voltage (V1), and

the voltage of the non-inverting input of the comparator is the second voltage (V2).

[Claim 7]

The electric circuit board according to any one of claims 1 to 6, wherein the control board comprises a first control board (81) equipped with the utilization unit and a second control board (82) equipped with

the heat source unit and

the electric circuit board comprises a first electric circuit board (91) connected to the first control board (81) and a second electric circuit board (92) connected to the second control board (82).

5

[Claim 8]

The refrigerating apparatus equipped with the electric circuit board according to any one of claims 1 to 7.