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

(11) EP 1 087 184 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
**04.05.2005 Bulletin 2005/18**

(51) Int Cl.[7]: **F24F 11/00**

(21) Application number: **00307919.1**

(22) Date of filing: **13.09.2000**

(54) **Air conditioner**

Klimaanlage

Dispositif de conditionnement d'air

(84) Designated Contracting States:
**ES GB**

(30) Priority: **24.09.1999 JP 27036299**

(43) Date of publication of application:
**28.03.2001 Bulletin 2001/13**

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- **PATENT ABSTRACTS OF JAPAN vol. 010, no. 257 (M-513), 3 September 1986 (1986-09-03) -& JP 61 083832 A (TAKASAGO THERMAL ENG CO LTS), 28 April 1986 (1986-04-28)**
- **PATENT ABSTRACTS OF JAPAN vol. 1997, no. 05, 30 May 1997 (1997-05-30) -& JP 09 014805 A (SANYO ELECTRIC CO LTD), 17 January 1997 (1997-01-17)**
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## Description

**[0001]** The present invention relates to an air conditioner comprising the features of the preamble of claim 1.

**[0002]** Such an air conditioner is known, for instance, from JP-A-9-14805. It comprises a control system as show in the diagram of Figure 8.

**[0003]** In Figure 8, a serial connection of a protection circuit 42, a relay contact 36, and a compressor magnet (an excitation coil in an electromagnetic contactor for a compressor) 38 is connected across two lines (i.e., R-S in Figure 8) among three-phase a.c. power source lines (R, S, T) for supplying power to an air conditioner.

**[0004]** The protection circuit 42 includes an internal thermo-switch (bimetal) 24 provided for a blower, an internal thermo-switch (bimetal) 26 provided for a compressor, and a high-pressure switch 28, which are connected in series.

**[0005]** A photo-coupler (such as a triac photo-coupler) 44, as an optical coupling device for transmitting signals, is connected in parallel to the relay contact 36 and the compressor magnet 38. An abnormality detection signal generated from the photo-coupler 44 is supplied to a microcomputer 46. The microcomputer 46 opens or closes the relay contact 36.

**[0006]** Figure 9 is a refrigerant circulation circuit for the air conditioner shown in JP-A-9-14805. In Figure 9, reference numeral 40 designates a compressor, numeral 18 an indoor side heat exchanger (in this case, a condenser), numeral 23 an outdoor side heat exchanger (in this case, an evaporator), numeral 25 a blower motor, numeral 29 a motor-driven expansion valve, numeral 30 a bypass valve, numeral 31 a motor-driven expansion valve, and numeral 32 a four-way valve. The high-pressure switch 28 and the thermo-switches 24 and 26 are those shown in Figure 8.

**[0007]** The protection circuit as described above is operated as follows. When the temperature of the blower motor shows an abnormal state, the thermo-switch 24 is opened. When the temperature of the compressor motor shows an abnormal state, the thermo-switch 26 is opened. When an abnormally high pressure condition is generated in the compressor, the high-pressure switch 28 is opened. These three abnormal states may take place separately or jointly. When any one of the thermo-switches 24, 26 and the high-pressure switch 28 is opened, the protection circuit 42 becomes an open state. Accordingly, electric current fed to the compressor magnet 38 is stopped, whereby the compressor ceases.

**[0008]** In the next, the operation to find a location where an abnormal state occurs, based on a difference of restoration time of each of the thermo-switches 24, 26 and the high-pressure switch 28 when abnormality takes place in the air conditioner, will be described.

**[0009]** The photo-coupler 44 becomes an off state in the following four cases:

(1) when the power source is instantaneously interrupted (the power source of lines R and S is interrupted);
(2) when the high-pressure switch 28 is opened;
(3) when the internal thermo-switch 24 for the blower is opened; and
(4) when the internal thermo-switch 26 for the compressor is opened.

**[0010]** As to the case (1), the period of instantaneous interruption is generally from several milliseconds to several hundred milliseconds at the longest. Accordingly, the photo-coupler 44 restores within 1 second after the instantaneous interruption.

**[0011]** In the case (2), a differential time such as "OFF at 30 kg/cm$^2$ and ON at 28.5 kg/cm$^2$" is generally determined for the high-pressure switch 28. Therefore, even in a case that pressure in the compressor exceeds 30 kg/cm$^2$ whereby the compressor is stopped by an opening action of the high-pressure switch 28, the high-pressure switch is not immediately restored to a closing state. The high-pressure switch 28 becomes a closing state when pressure in the compressor is decreased to 28.5 kg/cm$^2$ by operating the electromagnetic valve 30 (Figure 9) to bypass a refrigerant in the refrigeration circulation circuit between its high and low pressure sides. In this case, the time needed for the restoration is several seconds.

**[0012]** On the other hand, in the internal thermo-switch 24 or 26 installed in the blower or the compressor in the case (3) or (4), when it once becomes an off state, it takes at least several tens of minutes to restore. Accordingly, it was necessary for the microcomputer 46, based on an abnormality detection signal from the photo-coupler 44, to specify the thermo-switch by utilizing a difference of restoration time among the switches 24, 26, 28.

**[0013]** In the conventional air conditioner having the above-mentioned structure, the judgment as to which protection device operated was made on the basis of the restoration time determined for each thermo-switch. Therefore, there was a problem that it took much time to specify the switch.

**[0014]** Further, in the conventional air conditioner in which the microcomputer judged which switch had operated to stop the compressor, the air conditioner did not have means to display the switch operated to stop the compressor. Accordingly, efficiency in maintenance work was poor.

**[0015]** Further, there was another problem that a wire for connecting the switches might accidentally come off or was broken. In this case, the compressor could not be operated even though the main power source was turned on to actuate the air conditioner, because an electric current could not be supplied to the compressor magnet.

**[0016]** Itwould therefore be desirable to be ableto provide an air conditioner wherein the operation of a high-

pressure switch can quickly be detected.

**[0017]** It would also be desirable to be able to provide an air conditioner wherein maintenance work on the operation of the high-pressure switch can effectively be conducted.

**[0018]** It would also be desirable to be able to provide an air conditioner wherein maintenance work on the high-pressure switch being in an abnormal state can effectively be conducted.

**[0019]** It would also be desirable to be able to provide an air conditioner wherein maintenance work on the current detection means for detecting a current in the compressor, when it is in an abnormal state, can effectively be conducted.

**[0020]** In accordance with the present invention, there is provided an air conditioner which comprises:

a refrigerant circulation circuit for circulating a refrigerant discharged from a compressor through a condenser to an evaporator,
current detection means for detecting an operating current for the compressor,
a microcomputer for judging an operating condition of the compressor based on a result detected by the current detection means,
driving means adapted to receive an instruction from the microcomputer to drive the compressor, and
a high-pressure switch which is connected in series to the electric circuit of the driving means and is operable based on a discharge pressure of the compressor, wherein the microcomputer judges the absence or the presence of the operation of the high-pressure switch based on the result detected by the current detection means.

**[0021]** According to an embodiment there are provided display means for displaying an operating condition of the compressor according to an instruction from the microcomputer.

**[0022]** According to a further embodiment of the present invention, there are provided,

high-pressure refrigerant temperature detection means for detecting a temperature of the refrigerant flowing in a portion at a high pressure side in the refrigerant circulation circuit,

wherein the microcomputer judges an operating condition of the compressor based on a result detected by the current detection means and the high-pressure refrigerant temperature detection means, and

wherein the microcomputer judges that there is breakage or coming-off of a wire of the driving means for the compressor when a temperature detected by the high-pressure refrigerant temperature detection means does not change and a value detected by the current detection means is equal to or lower than a current value detected at the operation of the high-pressure switch.

**[0023]** According to a further embodiment of the present invention, there are provided display means for displaying breakage or coming-off of a wire of the driving means for the compressor according to an instruction from the microcomputer.

**[0024]** According to a further embodiment of the present invention, there are provided,

high-pressure refrigerant temperature detection means for detecting a temperature of the refrigerant flowing in a portion at a high pressure side in the refrigerant circulation circuit,

wherein the microcomputer judges an operating condition of the compressor based on a result detected by the current detection means and the high-pressure refrigerant temperature detection means, and

wherein the microcomputer judges that the current detection means is abnormal when a temperature detected by the high-pressure refrigerant temperature detection means shows a change of rise and a value detected by the current detection means is equal to or lower than a current value detected at the operation of the high-pressure switch.

**[0025]** According to a further embodiment of the present invention, there are provided display means for displaying an abnormal condition of the current detection means according to an instruction from the microcomputer.

**[0026]** According to a further embodiment of the present invention, the current detection means has a structure that a wire for detecting an electric current in the compressor is inserted into an annular iron core to detect a magnitude of induced electric power, due to a mutual induction effect, depending on a magnitude of an electric current flowing in the wire.

**[0027]** According to a further embodiment of the present invention, the microcomputer judges that the current detection means is not correctly set to a power source line of the compressor when a temperature detected by the high-pressure refrigerant temperature detection means shows a change of rise and a value detected by the current detection means is equal to or lower than a current value detected at operation of the high-pressure switch.

**[0028]** According to a further embodiment of the present invention, the high-pressure refrigerant temperature detection means detects the temperature of the refrigerant discharged from the compressor.

**[0029]** According to a further embodiment of the present invention, the high-pressure refrigerant temperature detection means detects the temperature of the condenser.

**[0030]** According to a further embodiment of the present invention, the high-pressure refrigerant temperature detection means detects the temperature of an outlet port of the condenser.

**[0031]** In drawings:

Figure 1 is a diagram showing the general construction of an air conditioner according to Embodiments

1 to 3 of the present invention;

Figure 2 is a flow chart showing how to detect the operation of a high pressure switch in Embodiment 1;

Figure 3 is a flow chart showing operations of the air conditioner according to Embodiment 2 wherein an operating condition is displayed on the monitor screen when the operation of the high-pressure switch is detected;

Figure 4 is a diagram showing an example of a display on the monitor screen in Embodiment 2;

Figure 5 is a flow chart showing how to detect a wire coming off or being broken, or being not correctly set, on the basis of a change of temperature in an electric current sensor and a high-pressure refrigerant temperature detecting thermistor, according to Embodiment 3;

Figure 6 is a diagram showing an example of a display on the monitor screen according to Embodiment 3;

Figure 7 is a diagram showing an example of a display on the monitor screen according to Embodiment 3;

Figure 8 is a circuit diagram of a protection device of a conventional air conditioner; and

Figure 9 is a diagram showing a refrigeration cycle of the conventional air conditioner.

**[0032]** Preferred embodiments of the air conditioner according to the present invention will be described with reference to the attached drawings.

EMBODIMENT 1

**[0033]** Figure 1 is a diagram showing the general construction of the air conditioner according to Embodiment 1. In Figure 1, reference numeral 1 designates a compressor for compressing a refrigerant. A refrigerant circulation circuit is formed by connecting successively the compressor 1, a four-way valve 2, a condenser 3, a motor-driven expansion valve 4, and an evaporator 5 with refrigerant pipes in a loop form to thereby form a refrigeration cycle.

**[0034]** Reference numeral 6 designates a control board for controlling an outdoor unit and numeral 7 designates a microcomputer for controlling outdoor unit (hereinbelow, referred to as simply a microcomputer), mounted on the control board 6.

**[0035]** Numeral 8 designates a high-pressure switch, actuated depending on the magnitude of pressure of the refrigerant discharged from the compressor, and numeral 9 designates a low-pressure switch, actuated depending on the magnitude of pressure of the refrigerant sucked into the compressor. Data indicating operating conditions of the low-pressure switch 9 are taken into the microcomputer 7. Numeral 10 designates a thermo-switch, actuated depending on a temperature of the compressor 1. Data indicating operating conditions of the thermo-switch 10 are taken into the microcomputer 7.

**[0036]** The motor-driven expansion valve 4, which controls the flow rate of the refrigerant, is controlled in accordance with an instruction from the microcomputer 7.

**[0037]** As means for detecting the temperature of the refrigerant at a high pressure side in the refrigerant circulation circuit (hereinbelow referred to as high-pressure refrigerant temperature detection means), there are provided a thermistor 11 for detecting the temperature of the refrigerant discharged from the compressor 1, a thermistor 12 for detecting the temperature of the condenser 3, a thermistor 13 for detecting the temperature of an outlet port of the condenser. Data detected by the thermistors 11 to 13 are taken into the microcomputer 7.

**[0038]** Numeral 14 designates a monitor screen, as displaying means for displaying various kinds of data, provided on the control board 6, and numeral 15 designates a current sensor, as current detection means, which has a structure that a wire for detecting an electric current is inserted into an annular iron core, by which an operating current for the compressor 1 is detected based on a change of the magnitude of an electric current flowing in the wire, whereby the magnitude of an induced power is changed by a mutual induction effect. A current value detected by the current sensor 15 is taken into the microcomputer 7 through a transducing circuit 16.

**[0039]** Numeral 17a designates a contactor of compressor controlling relay. The contactor of compressor controlling relay 17a is connected to the compressor 1 with wires 18. Operations of the compressor 1 are controlled by opening and closing the contactor of compressor controlling relay 17a, whereby a commercial power source 21 is supplied or interrupted. Any one of the wires 18 connectable to the compressor 1 is inserted into the annular iron core of the current sensor 15.

**[0040]** Numeral 17b designates an excitation coil of compressor controlling relay, as driving means for driving the compressor 1. Numeral 19a designates a control relay for controlling the application and interruption of a voltage to the excitation coil of compressor controlling relay 17b. Numeral 19b designates an excitation coil of the control relay 19a. The excitation coil 19b is controlled according to an instruction from the microcomputer 7 via a driving circuit 20.

**[0041]** The contactor of the high pressure switch 8 is inserted in series between the excitation coil of compressor controlling relay 17b and the control relay 19a for the compressor controlling relay.

**[0042]** Operations of the air conditioner according to Embodiment 1 will be described with reference to the flow chart shown in Figure 2.

**[0043]** When the air conditioner is operated, the microcomputer 7 reads a temperature determined with a remote controller connected to the indoor unit and a

temperature detected by a thermistor for detecting room temperature at Step 201.

**[0044]** At Step 202, the temperature determined with the remote controller and the temperature detected by the thermistor, which are read in Step 201, are compared to judge whether or not the compressor 1 is under an operation condition.

**[0045]** When the compressor 1 is not under the operating condition at Step 202, the procedure returns to Step 201. Then, the microcomputer 7 reads the temperature determined with the remote controller for the indoor unit and a temperature detected by the thermistor for detecting room temperature.

**[0046]** When the compressor 1 is under the operating condition at Step 202, the compressor 1 is driven at Step 203.

**[0047]** Then, at Step 240, judgment is made whether an operating current for the compressor 1 detected by the current sensor 15 is equal to or lower than a current value detected when the high-pressure switch is operated.

**[0048]** When the operating current for the compressor 1 detected by the current sensor 15 is higher than the current value detected at the operation of the high-pressure switch at Step 204, the procedure returns to Step 203 to continue the operation of the compressor 1.

**[0049]** At Step 204, when the operating current for the compressor 1 detected by the current sensor 15 is equal to or lower than the temperature value detected at the operation of the high-pressure switch, the compressor 1 is stopped at Step 205.

**[0050]** Thus, the presence or the absence of the operation of the high-pressure switch 8 can be judged from a result of detection by the current sensor 15.

**[0051]** In Figure 1 showing Embodiment 1 of the present invention, a three-phase commercial power source 21 is used as means for applying a voltage to the compressor 1. However, the same effect is obtainable even in a case of using a single-phase commercial power source.

EMBODIMENT 2

**[0052]** The air conditioner according to Embodiment 2 of the present invention will be described with reference to Figures 3 and 4 wherein Figure 3 is a flow chart showing a method for displaying an operating condition of the air conditioner on the monitor screen when the operation of the high-pressure switch is detected, and Figure 4 is a diagram showing an example of a display on the monitor screen. The construction of the air conditioner according to Embodiment 2 is the same as that shown in Figure 1.

**[0053]** Operations of the air conditioner according to Embodiment 2 will be described with reference to the flow chart of Figure 3.

**[0054]** When the air conditioner is operated, the microcomputer 7 reads a temperature determined with the remote controller connected to the indoor unit and a temperature detected by a thermistor for detecting room temperature at Step 301.

**[0055]** At Step 302, the temperature determined with the remote controller and the temperature detected by the thermistor, which are read at Step 301, are compared to judge whether or not the compressor 1 is under an operating condition.

**[0056]** When the compressor 1 is not under the operating condition at Step 302, the procedure returns to Step 301. Then, the microcomputer 7 reads again the temperature determined with the remote controller for the indoor unit and a temperature detected by the thermistor.

**[0057]** When the compressor 1 is under the operating condition at Step 302, the compressor 1 is operated at Step 303. At the next Step 304, the fact that the compressor 1 is driven is displayed in a coded form.

**[0058]** At Step 305, judgment is made whether an operating current for the compressor 1 detected by the current sensor 15 is equal to or lower than a current value detected when the high-pressure switch is operated.

**[0059]** When the operating current for the compressor 1 detected by the current sensor 15 is higher than the current value detected at the operation of the high-pressure switch at Step 305, the procedure returns to Step 303 to continue the operation of the compressor 1.

**[0060]** At Step 305, when the operating current for the compressor 1 detected by the current sensor 15 is equal to or lower than the current value detected at the operation of the high-pressure switch, the compressor 1 is stopped at Step 306.

**[0061]** At Step 307, the fact that the high-pressure switch 8 is actuated to stop the compressor 1 is displayed in a coded form on the monitor screen 14 as shown in Figure 4.

**[0062]** Thus, the presence or the absence of the operation of the high-pressure switch 8 can be displayed on the monitor screen 14 from a result of detection by the current sensor 15. Accordingly, efficiency in maintenance work is increased.

EMBODIMENT 3

**[0063]** The air conditioner according to Embodiment 3 of the present invention will be described with reference to Figures 5, 6, and 7 wherein Figure 5 is a flow chart for detecting the fact that a wire comes off or is disconnected, or a wire is not correctly set, on the basis of a change of temperature detected by the current sensor and the thermistor for detecting the temperature of the refrigerant at a discharge side of the refrigerant circulation circuit, and Figures 6 and 7 are diagrams showing examples of a display on the monitor screen. The construction of the air conditioner according to Embodiment 3 is the same as that in Figure 1.

**[0064]** Operations of the air conditioner according to Embodiment 3 will be described with reference to the

flow chart of Figure 5.

**[0065]** When the air conditioner is operated, the microcomputer 7 reads a temperature determined with the remote controller connected to the indoor unit and a temperature detected by the thermistor for detecting room temperature.

**[0066]** At Step 502, the temperature determined with the remote controller and the temperature detected by the thermistor, which are read at Step 501, are compared to judge whether or not the compressor 1 is under an operating condition.

**[0067]** When it is confirmed that the compressor 1 is not under the operating condition at Step 502, the procedure returns to Step 501 at which the microcomputer 7 reads again the temperature determined with the remote controller for the indoor unit and a temperature detected by the thermistor for detecting room temperature.

**[0068]** When the compressor 1 is under the operating condition at Step 502, a temperature (T0) obtainable from a thermistor 11 for detecting the temperature of the refrigerant at a discharge side is taken at Step 503. Then, the compressor 1 is operated at Step 504. Further, the fact that the compressor 1 is operated is displayed in a coded form at Step 505.

**[0069]** At the next Step 506, a timer t1 which operates the compressor 1 for a predetermined time is set.

**[0070]** At Step 507, a decrement of count of the time t1 for operating the compressor 1 for a predetermined time, which is set at Step 506, is started.

**[0071]** Then, judgment is made as to whether or not the operation of a predetermined time (t1) of the compressor 1 is finished at Step 508. When the operation for a predetermined time of the compressor 1 is not finished, the operation of the compressor 1 is continued at Step 509, and the procedure returns to Step 507.

**[0072]** When it is found that the compressor 1 has operated for a predetermined time at Step 508, the microcomputer reads a temperature (T1) of the refrigerant detected by the thermistor 11 for detecting the temperature of the refrigerant discharged from the compressor 1 after it has been operated for a predetermined time (t1) at Step 510.

**[0073]** At Step 511, the temperature (T0) of the refrigerant detected by the thermistor 11, read at Step 503, and the temperature (T1) of the refrigerant detected by the thermistor 11, read at Step 510, are compared.

**[0074]** When T0<T1 at Step 511, judgment is made as to whether or not an operating current for the compressor 1 detected by the current sensor 15 is equal to or lower than a current value detected when the high-pressure switch is operated, at Step 512. When the operating current is not equal to or lower than the current value detected at the operation of the high-pressure switch, the operation of the compressor 1 is continued at Step 513.

**[0075]** On the other hand, when the operating current for the compressor 1 is equal to or lower than the current value detected at the operation of the high-pressure switch at Step 512, the compressor 1 is stopped at Step 514. Then, a signal of error indicating that a wire is not correctly set to the current sensor 15 is displayed on the monitor screen 14, as shown in Figure 7, at Step 515.

**[0076]** When T0<T1 is not established at Step 511, judgment is made as to whether or not an operating current for the compressor 1 detected by the current sensor 15 is equal to or lower than a current value detected at the operation of the high-pressure switch at Step 516. When the judgment is negative, the procedure returns to Step 503.

**[0077]** At Step 516, when the operating current for the compressor 1 is equal to or lower than the current value detected at the operation of the high-pressure switch, the compressor 1 is stopped at Step 517. Then, a signal of error indicating that there is a fault of coming-off or disconnection of a wire in the electric circuit to which the contact of the high-pressure switch 8 or the excitation coil 17b of the compressor controlling relay is connected, is displayed on the monitor screen 14 as shown in Figure 6, at Step 518.

**[0078]** Thus, the fact that a wire comes off or a wire is not correctly set to the current sensor, can be found, and a signal of error can be displayed on the monitor screen.

**[0079]** In the above-mentioned Embodiments, a change in the temperature of the refrigerant is detected based on a temperature detected by the thermistor 11 for detecting the temperature of the refrigerant discharged from the compressor. However, the same effect is obtainable even by judging based on a temperature detected by the thermistor 12 for detecting the temperature of the condenser or the thermistor 13 for detecting the temperature of an outlet port of the condenser.

**[0080]** In accordance with the air conditioner of the present invention, the presence or the absence of the operation of the high-pressure switch can be judged from a result of detection by the current detecting means. Accordingly, the operation of the high-pressure switch to stop the compressor can be judged in a very short time.

**[0081]** Further, the fact that the high-pressure switch is operated to stop the compressor is displayed on the displaying means. Accordingly, efficiency for maintenance work is increased.

**[0082]** Further, the microcomputer makes judgment of the coming-off or disconnection of a wire in the driving circuit for the compressor on the basis of a temperature detected by the high-pressure refrigerant temperature detection means and a current value detected by the current detection means.

**[0083]** Further, a signal indicating the disconnection or the coming-off of a wire in the driving circuit for the compressor can be displayed on the displaying means according to an instruction from the microcomputer. Accordingly, a problem that an electric current can not be supplied to the driving circuit for the compressor, so that the air conditioner is disabled, can be eliminated, and

efficiency in maintenance work is increased.

**[0084]** Further, the microcomputer judges abnormality in the current detection means based on a temperature detected by the high-pressure refrigerant temperature detection means and a current value detected by the current detection means.

**[0085]** Further, efficiency in maintenance work is increased by displaying an abnormal state of the current detection means on the display means according to an instruction from the microcomputer.

**[0086]** Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practised otherwise than as specifically described herein.

## Claims

**1.** An air conditioner comprising:

a refrigerant circulation circuit for circulating a refrigerant discharged from a compressor (1) through a condenser (3) to an evaporator (5);
current detection means (15) for detecting an operating current for the compressor (1);
a microcomputer (7) for judging an operating condition of the compressor (1) based on a result detected by the current detection means (15);
driving means adapted to receive an instruction from the microcomputer (7) to drive the compressor (1); and
a high-pressure switch (8) which is connected in series to the electric circuit of the driving means and is operable based on a discharge pressure of the compressor (1);

**characterised in that** the microcomputer (7) judges absence or presence of operation of the high-pressure switch (8) based on the result detected by the current detection means (15).

**2.** An air conditioner according to claim 1, including display means for displaying an operating condition of the compressor (1) according to an instruction from the microcomputer (7).

**3.** An air conditioner according to claim 1, further comprising:

high-pressure refrigerant temperature detection means (11; 12; 13) for detecting a temperature of the refrigerant flowing in a portion at a high pressure side in the refrigerant circulation circuit;
wherein the microcomputer (7) judges an operating condition of the compressor (1) based on a result detected by the current detection means (15) and the high-pressure refrigerant temperature detection means (11; 12; 13); and

wherein the microcomputer (7) judges that there is breakage or coming-off of a wire of the driving means for the compressor when a temperature detected by the high-pressure refrigerant temperature detection means (11; 12; 13) does not change and a value detected by the current detection means (15) is equal to or lower than a current value detected at the operation of the high-pressure switch (8).

**4.** An air conditioner according to claim 3, including display means for displaying breakage or coming-off of a wire of the driving means for the compressor (1) according to an instruction from the microcomputer (7).

**5.** An air conditioner according to claim 1, further comprising:

high-pressure refrigerant temperature detection means (11; 12; 13) for detecting a temperature of the refrigerant flowing in a portion at a high pressure side in the refrigerant circulation circuit;

wherein the microcomputer (7) judges an operating condition of the compressor (1) based on a result detected by the current detection means (15) and the high-pressure refrigerant temperature detection means (11; 12; 13); and

wherein the microcomputer (7) judges that the current detection means (15) is abnormal when a temperature detected by the high-pressure refrigerant temperature detection means (11; 12; 13) shows a change of rise and a value detected by the current detection means (15) is equal to or lower than a current value detected at the operation of the high-pressure switch (8).

**6.** An air conditioner according to claim 5, including display means for displaying an abnormal condition of the current detection means (15) according to an instruction from the microcomputer (7).

**7.** An air conditioner according to claim 1, wherein the current detection means (15) has a structure wherein a wire for detecting an operating current for the compressor (1) is inserted into an annular iron core to detect a magnitude of induced electric power, due to a mutual induction effect, depending on the magnitude of an electric current flowing in the wire.

**8.** An air conditioner according to claim 5, wherein the

microcomputer (7) judges that the current detection means (15) is not correctly set to a power source line of the compressor (1) when a temperature detected by the high-pressure refrigerant temperature detection means (11; 12; 13) shows a change of rise and a value detected by the current detection means (15) is equal to or lower than a current value detected at operation of the high-pressure switch (8).

**9.** An air conditioner according to claim 3 or 5, wherein the high-pressure refrigerant temperature detection means (11) detects the temperature of the refrigerant discharged from the compressor (1).

**10.** An air conditioner according to claim 3 or 5, wherein the high-pressure refrigerant temperature detection means (12) detects the temperature of the condenser (3).

**11.** An air conditioner according to claim 3 or 5, wherein the high-pressure refrigerant temperature detection means (13) detects the temperature of an outlet port of the condenser (3).

**Patentansprüche**

**1.** Klimaanlage bestehend aus:

einem Kühlmittelkreislauf für den Umlauf eines Kühlmittels, das aus einem Kompressor (1) über einen Kondensator (3) in einen Verdampfer (5) strömt;
einer Hilfseinrichtung (15) zur Stromerkennung, mit welcher ein Betriebsstrom für den Kompressor (1) ausgemacht wird;
einem Mikrocomputer (7) zur Bestimmung eines Betriebszustandes des Kompressors (1) aufgrund eines Ergebnisses, das mit der Hilfseinrichtung (15) zur Stromerkennung festgestellt wird;
einer Antriebseinrichtung, die zwecks Annahme einer Anweisung des Mikrocomputers (7) angepasst ist, um den Kompressor (1) anzutreiben; und
einem Hochdruckschalter (8), der mit dem elektrischen Schaltkreis der Antriebseinrichtung in Reihe geschaltet und aufgrund eines Enddruckes des Kompressors (1) betriebsbereit ist;

**dadurch gekennzeichnet, dass** der Mikrocomputer (7) das Vorliegen oder Ausbleiben der Betriebsfunktion des Hochdruckschalters (8) feststellt, dies aufgrund des Ergebnisses, das mit der Hilfseinrichtung (15) zur Stromerkennung ermittelt wird.

**2.** Klimaanlage gemäß Anspruch 1, einschließlich eines Anzeigegeräts zum Anzeigen eines Betriebszustandes des Kompressors (1) gemäß einer Anweisung des Mikrocomputers (7).

**3.** Klimaanlage gemäß Anspruch 1, die zusätzlich enthält:

Hilfseinrichtungen (11; 12; 13) zum Erfassen der Temperatur des Hochdruck-Kühlmittels zum Feststellen einer Temperatur des Kühlmittels, das in einem Teil der Hochdruckseite in dem Kühlmittelkreislauf umläuft;

wobei der Mikrocomputer (7) einen Betriebszustand des Kompressors (1) aufgrund eines Ergebnisses ermittelt, welches mit der Hilfseinrichtung (15) zur Stromerkennung und mit der Hilfseinrichtung zum Erfassen der Hochdruck-Kühlmitteltemperatur (11; 12; 13) festgestellt wird; und

wobei der Mikrocomputer (7) ermittelt, ob bei einer Antriebseinrichtung für den Kompressor ein Draht gebrochen ist oder sich gelöst hat, wenn eine mit der Hilfseinrichtung zum Erfassen der Temperatur der Hochdruckkühlflüssigkeit (11; 12; 13) ermittelte Temperatur sich nicht ändert und wenn ein von der Hilfseinrichtung (15) zur Stromerkennung ermittelter Wert gleich oder kleiner als ein Stromwert ist, der beim Betrieb des Hochdruckschalters (8) ermittelt wird.

**4.** Klimaanlage gemäß Anspruch 3, einschließlich eines Anzeigegeräts, das anzeigt, wenn ein Draht des Antriebsgeräts für den Kompressor (1) gemäß einer Anweisung des Mikrocomputers (7) gebrochen ist oder sich gelöst hat.

**5.** Klimaanlage gemäß Anspruch 1, die zusätzlich umfasst:

Hilfsmittel zum Erfassen der Temperatur eines Hochdruck-Kühlmittels (11; 12; 13), mit dem man eine Temperatur des Kühlmittels feststellt, das in einem Teil der Hochdruckseite im Kühlmittelkreislauf umläuft;

wobei der Mikrocomputer (7) einen Betriebszustand des Kompressors (1) aufgrund eines Ergebnisses bestimmt, welches mit der Hilfseinrichtung (15) zur Stromerkennung und mit der Hilfseinrichtung zum Feststellen der Temperatur des Hochdruck-Kühlmittels (11; 12; 13) ermittelt wird; und

wobei der Mikrocomputer (7) bestimmt, ob die Hilfseinrichtung (15) zur Stromerkennung nicht normal anzeigt, wenn eine Temperatur, die von der Hilfseinrichtung zum Erfassen der Temperatur des Hochdruck-Kühlmittels (11; 12; 13) eine Veränderung in Richtung Anstieg anzeigt und wenn ein von

der Hilfseinrichtung (15) zur Stromerkennung festgestellter Wert gleich oder kleiner als ein Stromwert ist, der beim Betrieb des Hochdruckschalters (8) ermittelt wird.

**6.** Klimaanlage gemäß Anspruch 5, einschließlich von Anzeige-Hilfseinrichtungen zum Anzeigen eines abnormalen Zustandes der Hilfseinrichtung (15) zur Stromerkennung gemäß einer Anweisung vom Mikrocomputer (7).

**7.** Klimaanlage gemäß Anspruch 1, wobei die Hilfseinrichtung (15) zur Stromerkennung eine Struktur besitzt, in die ein Draht zum Erfassen eines Betriebsstromes für den Kompressor (1) in einem ringförmigen Eisenkern eingesetzt ist, um die Größe der induzierten elektrischen Leistung aufgrund einer gegenseitigen Induktionswirkung je nach der Größe des durch den Draht fließenden elektrischen Stromes zu bestimmen.

**8.** Klimaanlage gemäß Anspruch 5, wobei der Mikrocomputer (7) bestimmt, ob die Hilfseinrichtung (15) zur Stromerkennung nicht richtig an eine Stromleitung bzw. -quelle des Kompressors (1) angeschlossen ist, wenn eine von der Hilfseinrichtung zum Erfassen der Temperatur des Hochdruck-Kühlmittels (11; 12; 13) festgestellte Temperatur eine Veränderung in Richtung Anstieg anzeigt, und wenn ein von der Hilfseinrichtung (15) zur Stromerkennung festgestellter Wert gleich oder kleiner ist als ein Stromwert, der beim Betrieb mit dem Hochdruckschalter (8) ermittelt wird.

**9.** Klimaanlage gemäß Anspruch 3 oder 5, wobei die Hilfseinrichtung (11) zum Erfassen der Temperatur des Hochdruck-Kühlmittels die Temperatur des aus dem Kompressor (1) ausströmenden Kühlmittels feststellt.

**10.** Klimaanlage gemäß Anspruch 3 oder 5, wobei die Hilfseinrichtung (12) zum Erfassen der Temperatur des Hochdruck-Kühlmittels die Temperatur des Kondensators (3) feststellt.

**11.** Klimaanlage gemäß Anspruch 3 oder 5, wobei die Hilfseinrichtung (13) zum Erfassen der Temperatur des Hochdruck-Kühlmittels die Temperatur einer Auslassöffnung des Kondensators (3) feststellt.

**Revendications**

**1.** Appareil de conditionnement d'air comprenant:

un circuit de circulation de fluide frigorigène pour faire circuler un fluide frigorigène déchargé d'un compresseur (1) vers un évaporateur (5) à travers un condenseur (3);
un moyen de détection de courant (15) pour détecter un courant de fonctionnement pour le compresseur (1);
un micro-ordinateur (7) pour estimer une condition de fonctionnement du compresseur (1) sur la base d'un résultat détecté par le moyen de détection de courant (15);
un moyen d'activation conçu pour recevoir une instruction en provenance du micro-ordinateur (7) pour activer le compresseur (1); et
un commutateur haute pression (8) qui est relié en série au circuit électrique du moyen d'activation et peut fonctionner sur la base d'une pression de refoulement du compresseur (1);

**caractérisé en ce que** le micro-ordinateur (7) estime l'absence ou la présence de fonctionnement du commutateur haute pression (8) sur la base du résultat détecté par le moyen de détection de courant ( 15).

**2.** Appareil de conditionnement d'air selon la revendication 1, comprenant un moyen d'affichage pour afficher une condition de fonctionnement du compresseur (1) conformément à une instruction en provenance du micro-ordinateur (7).

**3.** Appareil de conditionnement d'air selon la revendication 1, comprenant en outre:

des moyens de détection de température de fluide frigorigène à haute pression (11; 12; 13) pour détecter une température du fluide frigorigène circulant dans une partie d'un côté à haute pression dans le circuit de circulation de fluide frigorigène;
dans lequel le micro-ordinateur (7) estime une condition de fonctionnement du compresseur (1) sur la base d'un résultat détecté par le moyen de détection de courant (15) et les moyens de détection de température de fluide frigorigène à haute pression (11; 12; 13); et
dans lequel le micro-ordinateur (7) estime qu'il y a une rupture ou un détachement d'un fil du moyen d'activation pour le compresseur lorsqu'une température détectée par les moyens de détection de température de fluide frigorigène à haute pression (11; 12; 13) ne varie pas et qu'une valeur détectée par le moyen de détection de courant (15) est égale ou inférieure à une intensité de courant détectée lors du fonctionnement du commutateur haute pression (8).

**4.** Appareil de conditionnement d'air selon la revendication 3, comprenant un moyen d'affichage pour afficher la rupture ou le détachement d'un fil du moyen

d'activation pour le compresseur (1) conformément à une instruction en provenance du micro-ordinateur (7).

**5.** Appareil de conditionnement d'air selon la revendication 1, comprenant en outre:

des moyens de détection de température de fluide frigorigène à haute pression (11; 12; 13) pour détecter une température du fluide frigorigène circulant dans une partie du côté à haute pression dans le circuit de circulation de fluide frigorigène;
dans lequel le micro-ordinateur (7) estime une condition de fonctionnement du compresseur (1) sur la base d'un résultat détecté par le moyen de détection de courant (15) et les moyens de détection de température de fluide frigorigène à haute pression (11; 12; 13); et
dans lequel le micro-ordinateur (7) estime que le moyen de détection de courant (15) est anormal lorsqu'une température détectée par les moyens de détection de température de fluide frigorigène à haute pression (11; 12; 13) montre une variation ascendante et qu'une valeur détectée par le moyen de détection de courant (15) est égale ou inférieure à une intensité de courant détectée lors du fonctionnement du commutateur haute pression (8).

**6.** Appareil de conditionnement d'air selon la revendication 5, comprenant un moyen d'affichage pour afficher une condition anormale du moyen de détection de courant ( 15) conformément à une instruction du micro-ordinateur (7).

**7.** Appareil de conditionnement d'air selon la revendication 1, dans lequel le moyen de détection de courant (15) a une structure dans laquelle un fil destiné à détecter un courant de fonctionnement pour le compresseur (1) est inséré dans un noyau de fer annulaire pour détecter une grandeur de puissance électrique induite, en raison d'un effet d'induction mutuel, en fonction de l'intensité d'un courant électrique circulant dans le fil.

**8.** Appareil de conditionnement d'air selon la revendication 5, dans lequel le micro-ordinateur (7) estime que le moyen de détection de courant (15) n'est pas correctement mis en place sur une ligne de source d'énergie du compresseur (1) lorsqu'une température détectée par les moyens de détection de température de fluide frigorigène à haute pression (11; 12; 13) montre une variation ascendante et qu'une valeur détectée par le moyen de détection de courant (15) est égale ou inférieure à une intensité de courant détectée lors du fonctionnement du commutateur haute pression (8).

**9.** Appareil de conditionnement d'air selon la revendication 3 ou 5, dans lequel le moyen de détection de température de fluide frigorigène à haute pression (11) détecte la température du fluide frigorigène déchargé du compresseur (1).

**10.** Appareil de conditionnement d'air selon la revendication 3 ou 5, dans lequel le moyen de détection de température de fluide frigorigène à haute pression (12) détecte la température du condenseur (3).

**11.** Appareil de conditionnement d'air selon la revendication 3 ou 5, dans lequel le moyen de détection de température de fluide frigorigène à haute pression (13) détecte la température d'un orifice de sortie du condenseur (3).

FIG.1

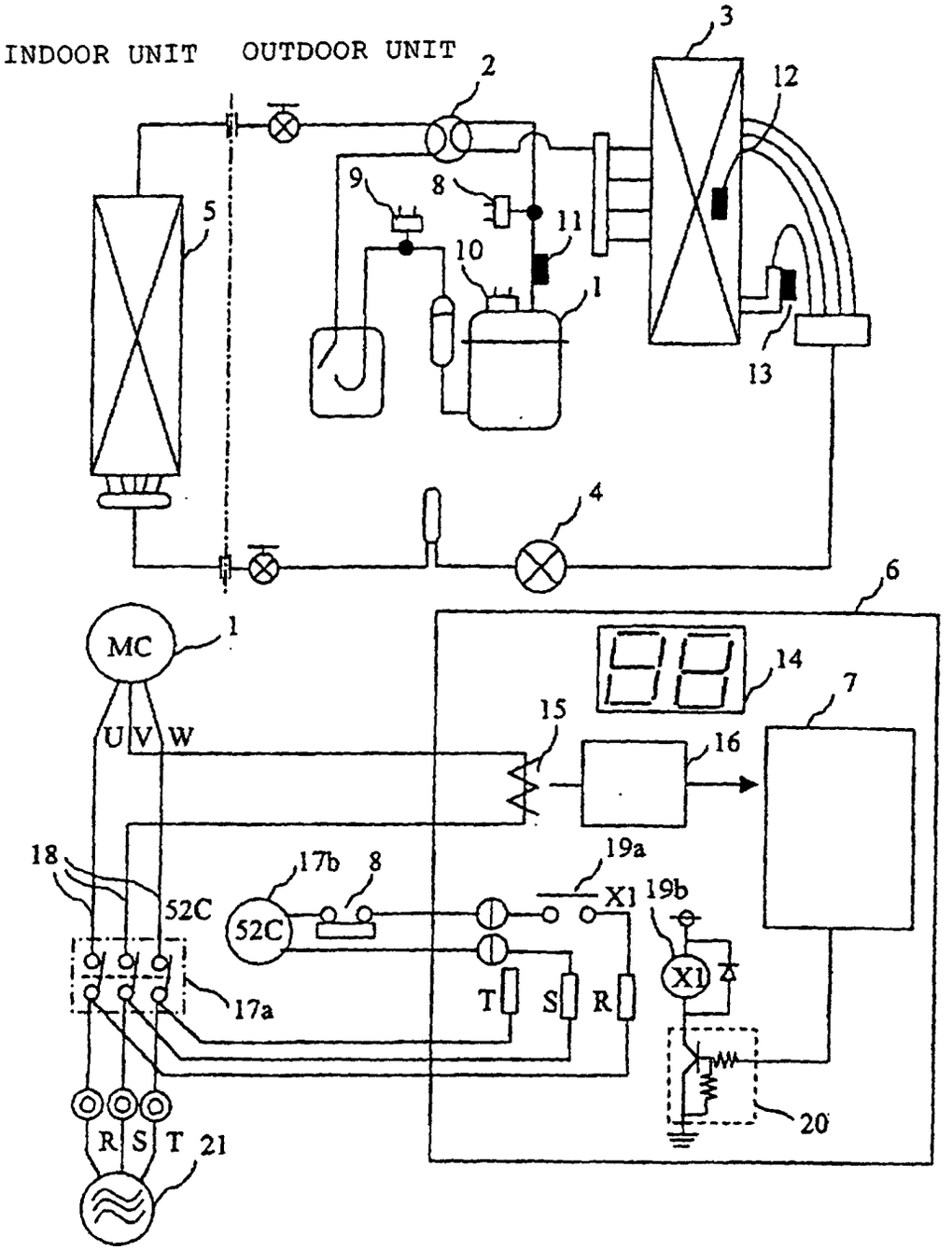

INDOOR UNIT
OUTDOOR UNIT
MC
U V W
R S T
52C
17a
17b
18
19a
19b
X1
T S R
20
21

FIG.2

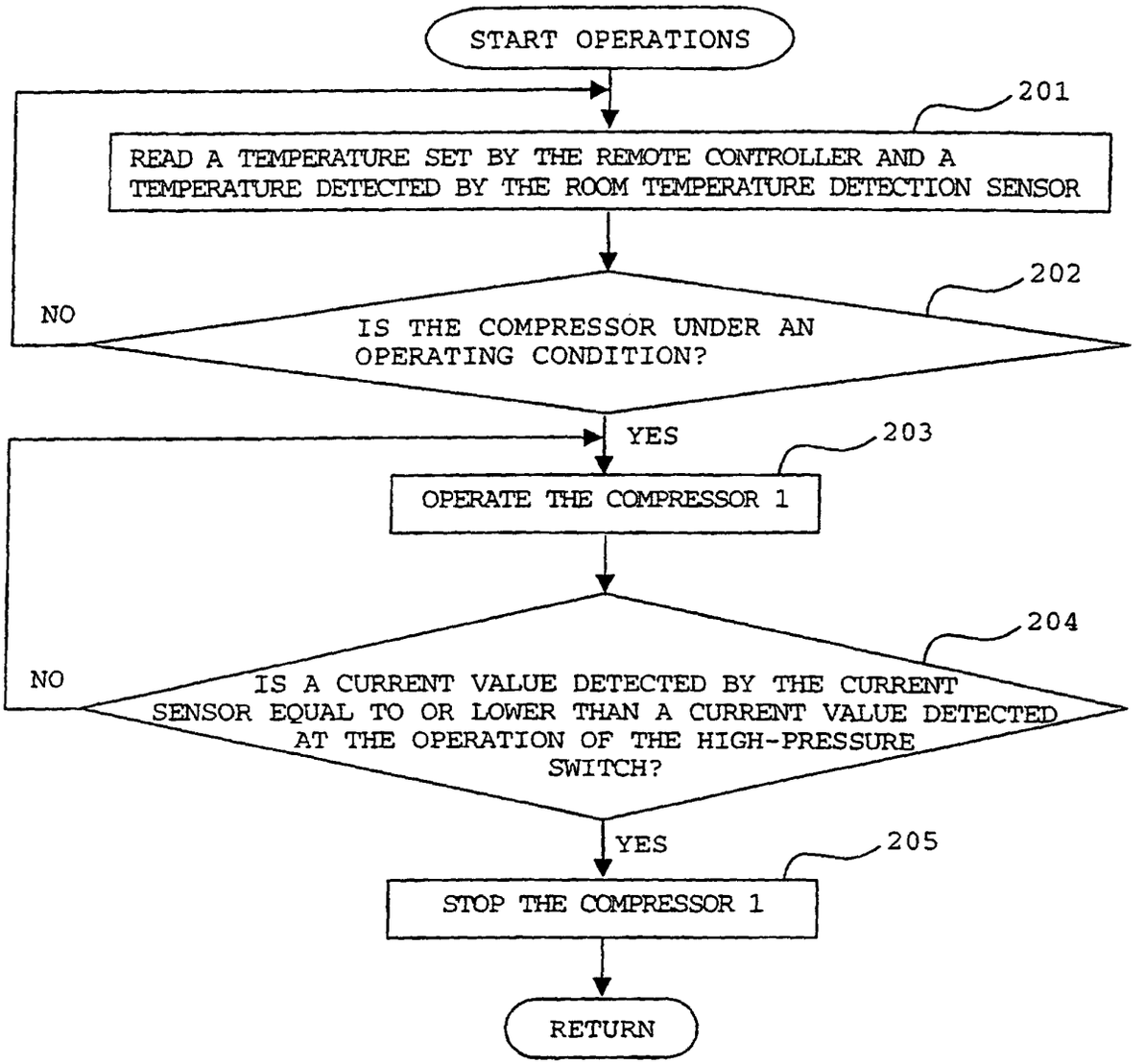

START OPERATIONS
201
READ A TEMPERATURE SET BY THE REMOTE CONTROLLER AND A TEMPERATURE DETECTED BY THE ROOM TEMPERATURE DETECTION SENSOR
202
NO
IS THE COMPRESSOR UNDER AN OPERATING CONDITION?
YES
203
OPERATE THE COMPRESSOR 1
204
NO
IS A CURRENT VALUE DETECTED BY THE CURRENT SENSOR EQUAL TO OR LOWER THAN A CURRENT VALUE DETECTED AT THE OPERATION OF THE HIGH-PRESSURE SWITCH?
YES
205
STOP THE COMPRESSOR 1
RETURN

FIG.3

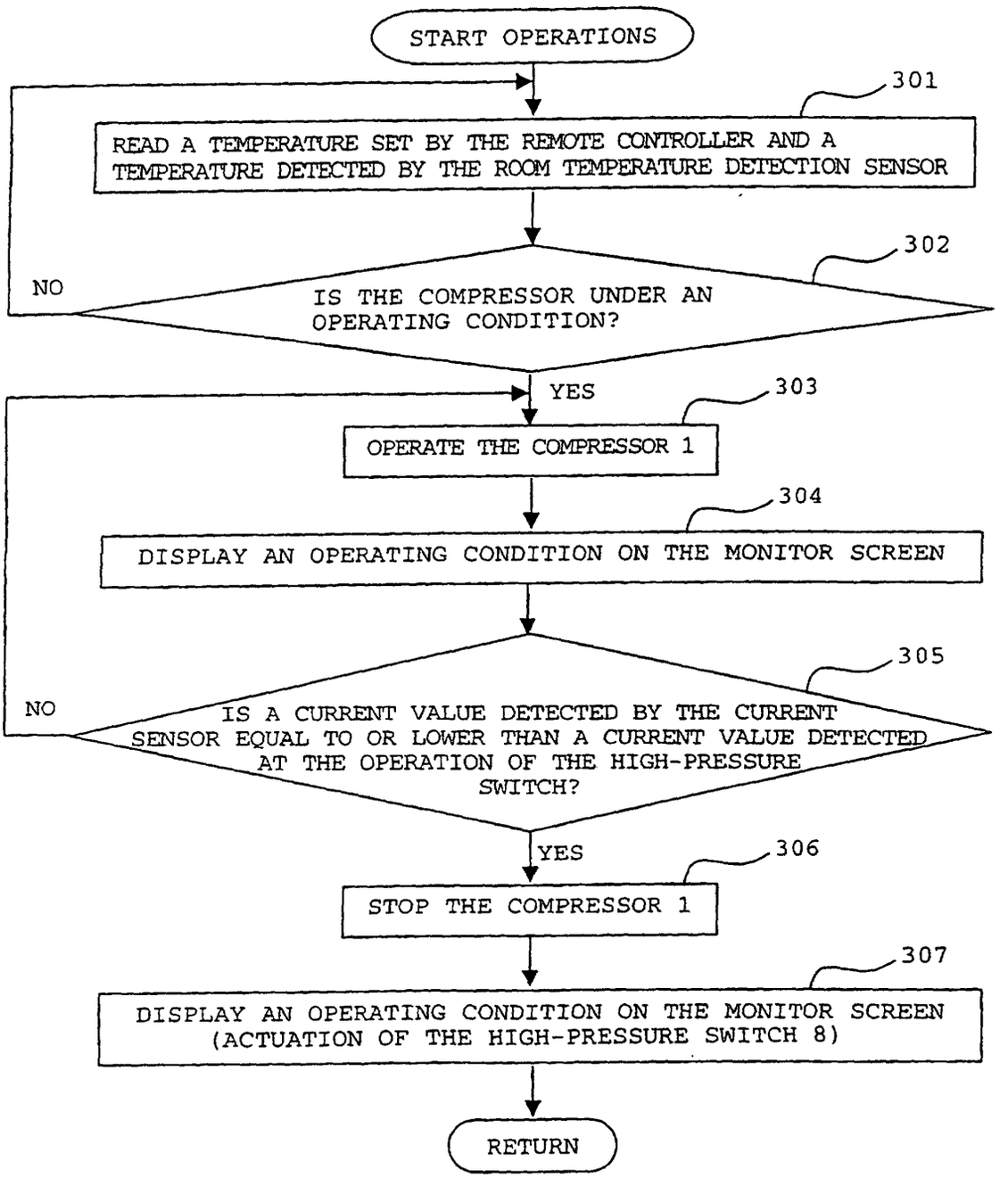

START OPERATIONS
301
READ A TEMPERATURE SET BY THE REMOTE CONTROLLER AND A TEMPERATURE DETECTED BY THE ROOM TEMPERATURE DETECTION SENSOR
302
NO
IS THE COMPRESSOR UNDER AN OPERATING CONDITION?
YES
303
OPERATE THE COMPRESSOR 1
304
DISPLAY AN OPERATING CONDITION ON THE MONITOR SCREEN
305
NO
IS A CURRENT VALUE DETECTED BY THE CURRENT SENSOR EQUAL TO OR LOWER THAN A CURRENT VALUE DETECTED AT THE OPERATION OF THE HIGH-PRESSURE SWITCH?
YES
306
STOP THE COMPRESSOR 1
307
DISPLAY AN OPERATING CONDITION ON THE MONITOR SCREEN (ACTUATION OF THE HIGH-PRESSURE SWITCH 8)
RETURN

FIG.4

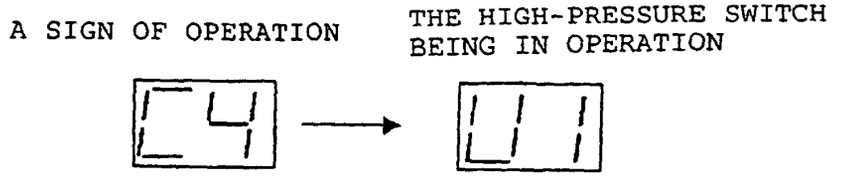

A SIGN OF OPERATION
THE HIGH-PRESSURE SWITCH BEING IN OPERATION
C4
U1

FIG. 5

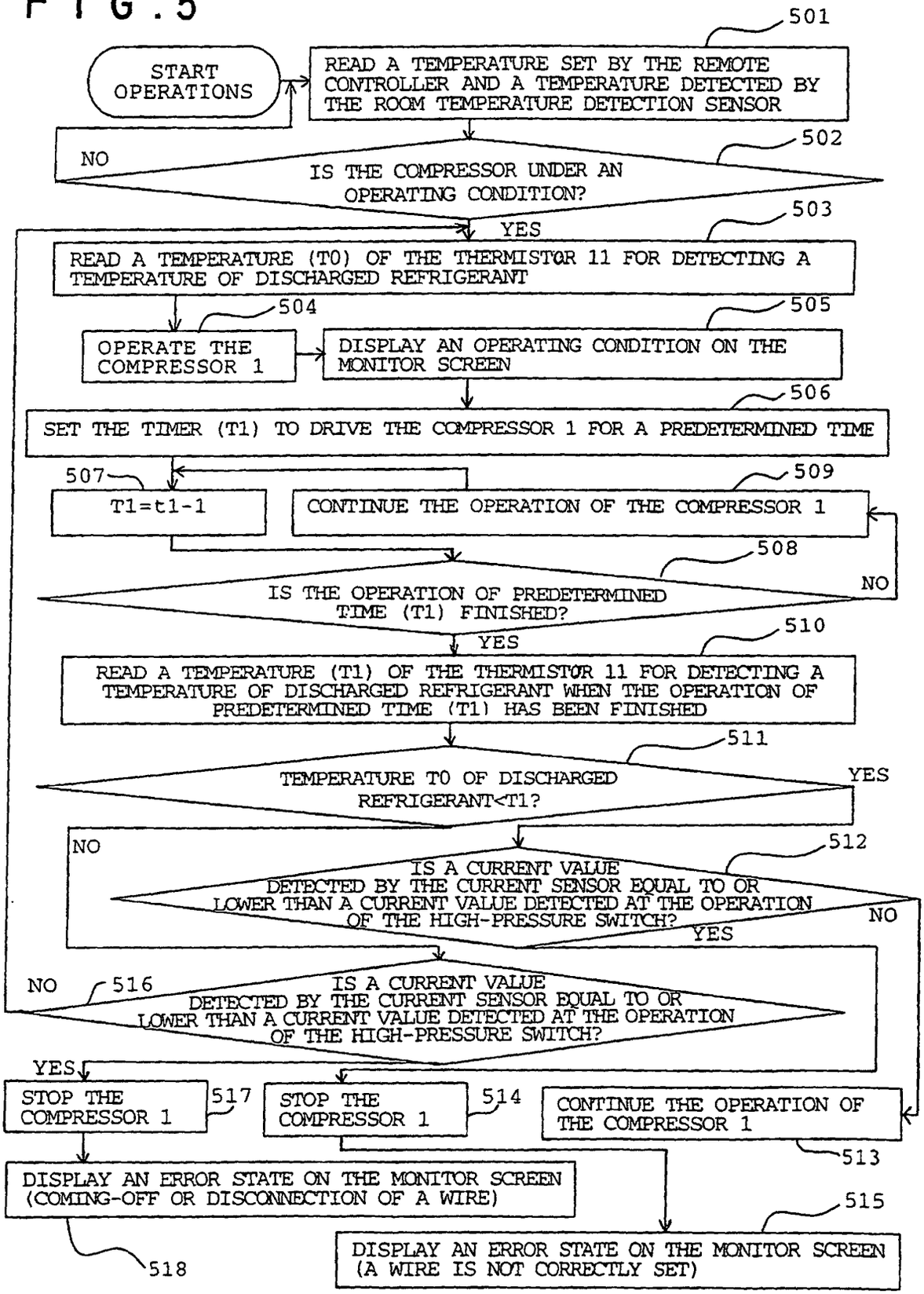

START OPERATIONS
501
READ A TEMPERATURE SET BY THE REMOTE CONTROLLER AND A TEMPERATURE DETECTED BY THE ROOM TEMPERATURE DETECTION SENSOR
502
NO
IS THE COMPRESSOR UNDER AN OPERATING CONDITION?
YES
503
READ A TEMPERATURE (T0) OF THE THERMISTOR 11 FOR DETECTING A TEMPERATURE OF DISCHARGED REFRIGERANT
504
OPERATE THE COMPRESSOR 1
505
DISPLAY AN OPERATING CONDITION ON THE MONITOR SCREEN
506
SET THE TIMER (T1) TO DRIVE THE COMPRESSOR 1 FOR A PREDETERMINED TIME
507
T1=t1-1
509
CONTINUE THE OPERATION OF THE COMPRESSOR 1
508
IS THE OPERATION OF PREDETERMINED TIME (T1) FINISHED?
NO
YES
510
READ A TEMPERATURE (T1) OF THE THERMISTOR 11 FOR DETECTING A TEMPERATURE OF DISCHARGED REFRIGERANT WHEN THE OPERATION OF PREDETERMINED TIME (T1) HAS BEEN FINISHED
511
TEMPERATURE T0 OF DISCHARGED REFRIGERANT<T1?
YES
NO
512
IS A CURRENT VALUE DETECTED BY THE CURRENT SENSOR EQUAL TO OR LOWER THAN A CURRENT VALUE DETECTED AT THE OPERATION OF THE HIGH-PRESSURE SWITCH?
NO
YES
NO
516
IS A CURRENT VALUE DETECTED BY THE CURRENT SENSOR EQUAL TO OR LOWER THAN A CURRENT VALUE DETECTED AT THE OPERATION OF THE HIGH-PRESSURE SWITCH?
YES
STOP THE COMPRESSOR 1
517
STOP THE COMPRESSOR 1
514
CONTINUE THE OPERATION OF THE COMPRESSOR 1
513
DISPLAY AN ERROR STATE ON THE MONITOR SCREEN (COMING-OFF OR DISCONNECTION OF A WIRE)
518
515
DISPLAY AN ERROR STATE ON THE MONITOR SCREEN (A WIRE IS NOT CORRECTLY SET)

FIG.6

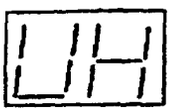
WIRE IN A STATE OF COMING-OFF OR DISCONNECTION




FLASHING

FIG.7

WIRE BEING SET IN AN ABNORMAL STATE




FLASHING

FIG.8

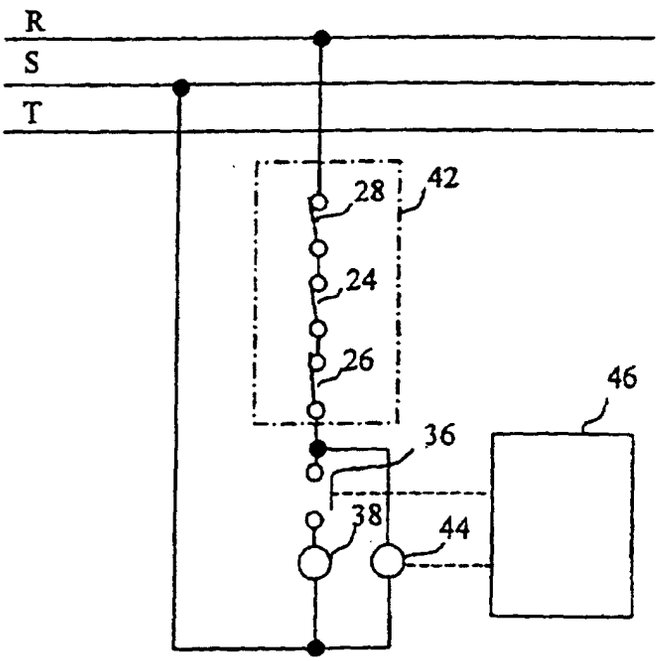


FIG.9

