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(54) Refrigeration cycle apparatus as well as air conditioner and water heater having the same

(57) In a refrigeration cycle apparatus capable of protecting faulty wiring while saving a space and cost necessary for the protection of faulty wiring, a power supply circuit (2) for receiving an alternating voltage from an alternating current source (1) and a communication power supply circuit (3) are installed in a heat source side unit (51) of an outdoor unit, and a power supply circuit (11) and a zero cross circuit (12) for detecting a zero cross point of the alternating voltage supplied from the heat source side unit (51) are installed in a user side unit (52) of an indoor unit.

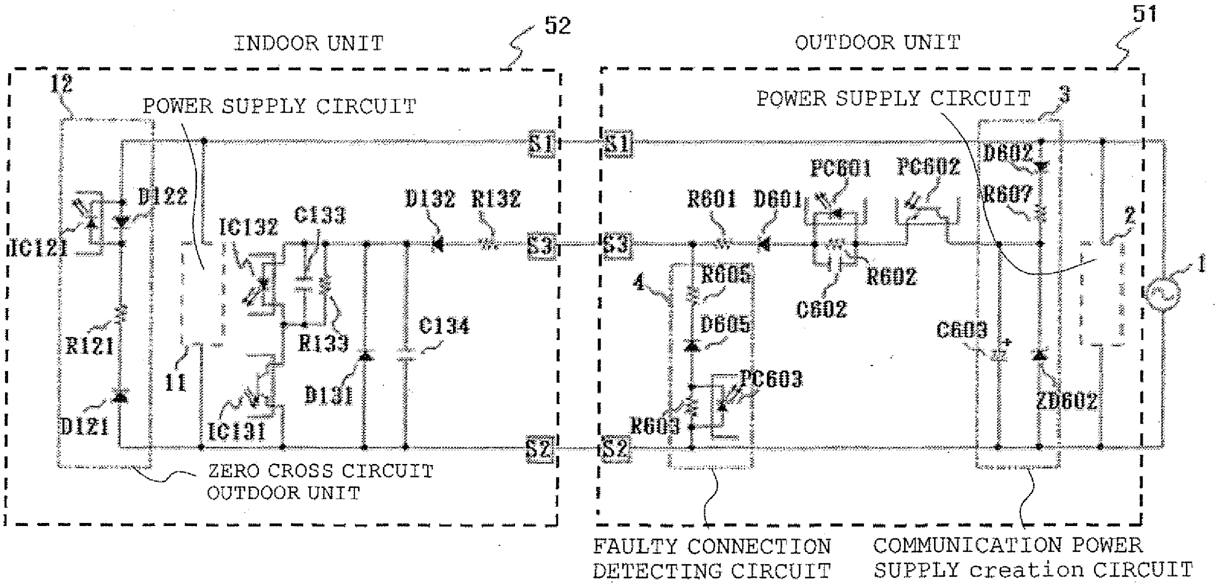

FIG. 1

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a refrigeration cycle apparatus as well as an air conditioner and a water heater having the same, and more particularly, to protection of an internal circuit against faulty wiring in two apparatuses connected by a power supply line and communication line.

2. Description of the Related Art

[0002] In some air conditioner, an excess voltage detector is disposed to a communication circuit terminal part, whose output, a relay contact, is connected in series to a communication circuit, and when an excess voltage is applied to the communication circuit, the circuit is electrically disconnected from the communication circuit terminal instantly. In such an air conditioner, a conventional refrigeration cycle apparatus is mounted which has a protective function for protecting a substrate and electronic parts and the like constituting an internal circuit when power supply cables and signal cables are faultily wired (refer to, for example, Japanese Unexamined Patent Application Publication No. 7-217972).
[0003] Patent Document 1: Japanese Unexamined Patent Application Publication No. 7-217972

Problems to be Solved by the Invention

[0004] However, since the above refrigeration cycle apparatus requires an excess voltage detector for protecting the faulty wiring, and further a relay for disconnecting the circuit is necessary, it is disadvantageous in that a large substrate space is necessary and cost of parts and cost for mounting parts are expensive.
[0005] The object of the present invention, which was made to solve the above problems, is to provide a refrigeration cycle apparatus capable of protecting faulty wiring while saving or not using an additional substrate space necessary to protect them and reducing a cost or without an additional cost.

Means to Solve the Problems

[0006] In a refrigeration cycle apparatus according to the present invention including a user side unit and a heat source side unit connected to each other by at least three cables through the connection ends thereof, the user side unit and the heat source side unit have communication circuits, respectively;
One unit of the user side unit and the heat source side unit receives an alternating voltage from an alternating current source, supplies electrical power to the other unit of the user side unit and the heat source side unit through the connection ends using two cables of the three cables as alternating current cables, a current loop is formed using a remaining cable and one of the alternating current cables as communication cables constituting the communication circuit a communication is executed through the connection ends, the other unit has a zero cross circuit for detecting a zero cross point of the alternating voltage received from the one unit and judges whether the three cables are faultily wired from an output from the zero cross circuit, and when the three cables are faultily wired, the other unit shuts down the communication circuit.

Effect of the Invention

[0007] Since the refrigeration cycle apparatus according to the present invention detects the faulty wiring by using a zero cross circuit originally used for a different object, it has an advantage in that no space is additionally required to detect the faulty wiring and a cost is not increased.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is a schematic view of a configuration circuit of a refrigeration cycle apparatus according to Embodiment 1;
Fig. 2A - 2C are diagrams showing combinations of faulty wiring of a heat source side unit in an outdoor unit and a user side unit in an indoor unit;
Fig. 3A - 3B are diagrams showing combinations of the faulty wiring of the heat source side unit of the outdoor unit and the user side unit of the indoor unit; Fig. 4 is a schematic view of a power supply circuit 11 of a user side unit 52 of the indoor unit of the refrigeration cycle apparatus according to Embodiment 2;

Fig. 5A - 5B show voltage waveforms of a secondary side in the case of faulty wiring;
Fig. 6A - 6B are voltage waveform diagrams on a secondary side when a delay is provided until a reset is released when cables are faultily wired in the refrigeration cycle apparatus according to Embodiment 4;
Fig. 7 shows a power supply circuit diagram for causing a load resistor to consume no power while the refrigeration cycle apparatus according to Embodiment 5 is operated in a state that cables are normally wired;
Fig. 8 is a view showing a communication start delay time set by a program of a microcomputer in the refrigeration cycle apparatus according to Embodiment 6;
Fig. 9 is a schematic view of a configuration circuit in the refrigeration cycle apparatus according to Embodiment 7;
Fig. 10 shows an example of a configuration view when the refrigeration cycle apparatuses according to Embodiments 1 to 7 is mounted on the air conditioner;
Fig. 11 shows an example of a configuration view when the refrigeration cycle apparatuses according to Embodiments 1 to 7 are mounted on a water heater.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiment 1

[0009] Fig. 1 is a schematic view of a configuration circuit of a refrigeration cycle apparatus according to Embodiment 1, Fig. 2A - 2C are diagrams showing combinations of faultily wired cables of a heat source side unit of an outdoor unit and a user side unit of an indoor unit, and
Fig. 3A - 3B are diagrams showing combinations of faultily wired cables of the heat source side unit of the outdoor unit and the user side unit of the indoor unit.
S1, S2, and S3 are terminal numbers of terminal boards of the heat source side unit 51 of the outdoor unit and the user side unit 52 of the indoor unit, and the cables are normally wired when they are wired so that the terminal numbers of the indoor unit agree with those of the outdoor unit.
[0010] First, a circuit configuration of the heat source side unit 51 of the outdoor unit will be explained.
An external alternating current source 1 of the heat source side unit 51 is connected to both the ends of a power supply circuit 2 disposed in the heat source side unit 51. A diode D602, a resistor R607, and a zener diode ZD602, which are connected in series, are connected in parallel to both the ends of the power supply circuit 2, a connection point, at which the power supply circuit 2 is connected to the diode D602, is connected to a terminal S1, and a connection point, at which the power supply circuit 2 is connected to the zener diode ZD602, is connected to a terminal S2. Then, a capacitor C603 is connected in parallel to both the ends of the zener diode ZD602, and a communication power supply creation circuit 3 is composed of the diode D602, resistor R607, zener diode ZD602, and capacitor C603.
[0011] A transmission photocoupler PC602, a reception photocoupler PC601, a diode D601, and a resistor R601 are connected in series in this order from the connection point of the resistor R607 and the zener diode ZD602, and the other end of the resistor R601 is connected to a terminal S3 of a terminal board. Further, a resistor R602 and a capacitor C602 are connected in parallel to both the ends of the reception photocoupler PC601, respectively. Then, a resistor R605, a diode D605, and a resistor R603, which are connected in series, are connected between the terminal S3 and the terminal S2. A photocoupler PC603 is connected in parallel to both the ends of the resistor R603, and a faulty connection detecting circuit 4 is composed of the resistor R605, diode D605, resistor R603, photocoupler PC603, and other parts which are not shown in Fig. 1.
[0012] Next, a circuit configuration of the user side unit 52 of the indoor unit will be explained.
A resistor R132, a diode D132, a reception photocoupler IC132, and a transmission photocoupler IC131 are connected in series in this order from the terminal S3 and finally connected to the terminal S2 to thereby constitute a communication circuit. Further, a diode D131 and a capacitor C134 are connected in parallel to both the ends of the reception photocoupler IC132 and the transmission photocoupler IC131 connected in series. Then, a resistor R133 and a capacitor C133 are connected in parallel to both the ends of the reception photocoupler IC132, respectively.
[0013] A power supply circuit 11 is connected to the terminals S1 and S2. Further, a diode D122, a resistor R121, and a diode D121, which are connected in series, are connected in parallel to both the ends of the power supply circuit 11. Then, a photocoupler IC121 is connected to both the ends of the diode D122, and a zero cross circuit 12 is composed of the diode D122, resistor R121, diode D121, photocoupler IC121, and parts composed of other parts which are not shown in Fig. 1.
[0014] Next, an operation of a circuit when the cables of the terminal boards of the heat source side unit 51 and the user side unit 52 are normally wired as shown in Fig. 1 will be explained.
The alternating current source 1 supplies an alternating voltage to the power supply circuit 2 which creates a direct voltage to be supplied to internal IC parts and the like. Further, the alternating voltage supplied by the alternating current source 1 is half-wave rectified by the diode D602 and the half-wave rectified current is restricted by the resistor R607. Then, a constant voltage is created by the zener diode ZD602 and further smoothed by the capacitor C603, thereby a

communication power supply of about 25V is created.

[0015] A current loop is formed by the circuit configuration in the heat source side unit 51 and the user side unit 52 and the paths in which the terminals S3, S3 and the terminals S2, S2 are connected to each other. Further, the resistor R601 in the heat source side unit 51 and the resistor R132 in the user side unit 52 restrict a current flowing in the current loop to thereby suppress an excess current. Further, the diode D601 in the heat source side unit 51 and the diode D132 in the user side unit 52 restrict the direction of the current of the current loop. Then, the transmission photocoupler PC602 in the heat source side unit 51 and the transmission photocoupler IC131 in the user side unit 52 generates an ON and OFF state of the current flowing in the current loop, and the heat source side unit 51 and the user side unit 52 communicate with each other when the reception photocoupler PC601 in the heat source side unit 51 and the reception photocoupler IC132 in the user side unit 52 detect the ON/OFF of the current.

[0016] The faulty connection detecting circuit 4 detects faulty connection to the alternating current source and to the ground in the heat source side unit 51.

[0017] The zero cross circuit 12 detects a zero cross point of an alternating voltage that is input between the terminals S1 and S2 of the user side unit 52 from the heat source side unit 51. Then, the alternating voltage is supplied from the terminals S1 and S2 to the power supply circuit 11 to thereby create a direct voltage to be supplied to the internal IC parts and the like.

[0018] Next, an operation when the heat source side unit 51 and the user side unit 52 are faultily connected will be explained referring to Figs. 2A - 2C and 3A - 3B.

When the heat source side unit 51 receives an electric power from the alternating current source 1, an alternating voltage may be applied to a low voltage circuit portion, i.e., a communication circuit of the user side unit 52 due to faulty wiring among the terminals S1, S2, and S3 of the indoor unit and the outdoor unit (refer to Fig. 2B and Fig. 3A). Then, a high voltage withstanding photocoupler is used as the transmission photocoupler IC131 to protect the diode D131 and the diode D132 so that a current does not flow thereto. However, when the transmission photocoupler IC131 is turned ON in the state that the alternating voltage is applied, there is a possibility that parts used in the communication circuit are broken. Accordingly, it is necessary to prevent the transmission photocoupler IC131 from being turned ON at the time of faulty wiring.

[0019] As one of method of the prevention, it is possible to prevent the transmission photocoupler IC131 from being turned ON by detecting that faulty wiring among the terminals S1, S2, and S3 of the indoor unit and the outdoor unit by also using the zero cross circuit 12 used for a different object such as a cutoff of the alternating voltage input, a long time timer, and the like. In the faultily wired states shown in Fig. 2B and Fig. 2C and Fig. 3A and Fig. 3B, no alternating voltage is applied to the zero cross circuit 12 and its zero cross detection output is not input to a microcomputer (not shown). Since it can be judged by the above operation that it is faulty wiring, the communication circuit can be protected by preventing the transmission photocoupler IC131 from being turned ON. Further, in the case of the normal wiring in Fig. 1 and faulty wiring in Fig. 2A, it can be detected that the alternating voltage is input by that the alternating voltage is applied to the zero cross circuit 12 and a zero cross detection output therefrom is input to the microcomputer, and in the faulty wiring in Fig. 2A, since no alternating voltage, that is a high voltage, is applied to the communication circuit, the communication circuit is not broken.

[0020] With the above configuration and operation, the communication circuit can be protected by detecting faulty wiring among the terminals S1, S2, and S3 of the indoor unit and the outdoor unit by diverting the zero cross circuit 12 for a different object and preventing the transmission photocoupler IC131 from being turned ON. Further, since it is not necessary to add new parts only for the purpose of protecting the faulty wiring, faulty wiring can be protected without increasing a space at free of cost.

[0021] In the refrigeration cycle apparatus according to Embodiment 1, the heat source side unit 51 of the outdoor unit receives an alternating voltage from the alternating current source 1, the communication power supply is created by the communication power supply creation circuit 3 disposed therein, and the user side unit 52 of the indoor unit includes the zero cross circuit 12. However, it is not limited thereto, and the user side unit 52 of the indoor unit may receive an alternating voltage from the alternating current source 1, the communication power supply creation circuit 3 may be disposed therein, and the heat source side unit 51 of the outdoor unit may include the zero cross circuit 12.

Embodiment 2

[0022] Fig. 4 is a schematic view of a power supply circuit 11 of a user side unit 52 of an indoor unit of a refrigeration cycle apparatus according to Embodiment 2, showing only minimum parts. A configuration and an operation which are different from those of Embodiment 1 described above will be mainly explained below. In Embodiment 2, a method of protecting faulty wiring among terminals S1, S2, and S3 of an indoor unit and an outdoor unit when no zero cross circuit 12 is installed will be explained.

[0023] First, a circuit configuration of a power supply circuit 11 will be explained while referring to Fig. 4.

The terminals S1 and S2 of the user side unit 52 are connected to an input side of a diode bridge DB1. A smoothing capacitor C111 is connected in parallel to an output end of the diode bridge DB1. Then, a primary side of a transformer T111 and a switching element IC111, which are connected in series, are connected in parallel to both the ends of the smoothing capacitor C111.

[0024] A secondary side of the transformer T111, i.e., one end of the output end of the transformer T111 is connected to an input terminal of a three-terminal regulator IC112 through a diode P113. Further, a smoothing capacitor C113 is connected to the input terminal of the three-terminal regulator IC112 and to the other end of the output ends of the transformer T111, and the other end of the output ends of the transformer T111 is connected to a COM terminal of the three-terminal regulator IC112. Further, a load resistor R1 is connected in parallel to both the ends of the smoothing capacitor C113. Then, an output terminal of the three-terminal regulator IC112 is connected to one end of a smoothing capacitor C116, and the other end thereof is connected to the COM terminal of the three-terminal regulator IC112 and grounded. Further, the output terminal of the three-terminal regulator IC112 is connected to a microcomputer 21 and a reset IC 22, and an output terminal of the reset IC 22 is connected to the microcomputer 21.

[0025] Next, an operation of a power supply circuit when terminal boards of a heat source side unit 51 and the user side unit 52 are normally wired will be explained.

An alternating voltage is supplied between the terminals S1 and S2 of the user side unit 52 from the terminal S1 and S2 of the heat source side unit 51, input to the diode bridge DB1, and all-wave rectified therein. Then, the all-wave rectified voltage is smoothed by the smoothing capacitor C111. Further, when the voltage between both the ends of the smoothing capacitor C111 reaches a predetermined voltage, the switching element IC111 becomes a switching ON state so that electrical power energy is transferred to the secondary side through the transformer T111.

[0026] A voltage transmitted from the primary side through the transformer T111 is half-wave rectified by a diode D113. The half-wave rectified voltage is smoothed by the smoothing capacitor C113 and creates a VDD12V power supply at both the ends of the smoothing capacitor C113. Further, the voltage of the VDD12V power supply is dropped by the three-terminal regulator IC112 to create a VDD5V power supply, which is a microcomputer drive power supply. The VDD5V power supply is smoothed by the smoothing capacitor C116. Further, a reset IC 22 monitors the microcomputer drive power supply VDD5V, and when its voltage is lower than a predetermined voltage, the reset IC 22 outputs a reset signal to the microcomputer 21 so that it is not driven.

[0027] Next, an operation when the heat source side unit 51 and the user side unit 52 are faultily wired will be explained while referring to Figs. 1 to 3B.

In the faultily wired states shown in Fig. 2B and Fig. 2C and Fig. 3A and Fig. 3B, an alternating voltage is not directly input between terminals S1 and S2 of the user side unit 52. Specifically, a communication power supply is input to an alternating voltage terminal at the user side unit 52 side in Fig. 2B and Fig. 3B, and is input thereto through a faulty connection detecting circuit in Fig. 2C and Fig. 3B.

[0028] First, in the faultily wired states shown in Fig. 2B and Fig. 3B, since the communication power supply is only about 25V and its current is restricted by resistors R607, R601, and the like, a power supply capability to the user side unit 52 is very small. The voltage between both the ends of the smoothing capacitor C111 is increased by supplying the power and the switching element IC111 becomes an ON state. However, since an amount of discharge caused by that the switching element IC111 becomes the ON state is larger than an amount of charge to the smoothing capacitor C111, the voltage of the smoothing capacitor C111 is greatly dropped by the switching ON operation in a short time. Accordingly, the switching element IC111 is intermittently switched in such a manner that the turned-ON state of the switching element IC111 does not continue and a switching operation is resumed when the voltage between both the ends of the smoothing capacitor C111 is set to a predetermined voltage necessary to start the switching element IC111 again. As a result, as shown in Fig. 5, the voltage on the secondary side is not stabilized because it is periodically charged and discharged repeatedly. In Fig. 5, Ch1 is set to VDD12V, Ch2 is set to VDD5V, and Ch3 is set to an output of the reset IC 22 (Hi is in a reset release state). Then, when an appropriate load resistor R1 is connected to both the ends of the smoothing capacitor C113 that creates VDD12V, Vdd12V does not sufficiently rise in the state that the power supply capability is poor at the time of faulty wiring. Further, VDD5D created based thereon comes not to sufficiently rise as well, so that it is possible to make reset not to be released by suppressing VDD5V lower than a voltage for releasing the reset IC22 (hereinafter, a reset release voltage). In general, a difference in the input voltage and output voltage of a three-terminal regulator is about 2 V. Thus, for example, when the reset release voltage of the reset IC 22 is set to 4 V, the reset IC 22 can be prevented from executing a reset operation by connecting the load resistor R1 for setting the MAX value of VDD12V to 6 V or less when the power supply capability is very low in the case of the faulty wiring.

[0029] Next, in the faultily wired states shown in Fig. 2C and Fig. 3B, a voltage, which is divided by the faulty connection detecting circuit 4 and the impedance of the power supply circuit 11 in the user side unit 52, is applied to the terminals S1 and S2 of the user side unit 52. A resistor R605 has a large resistance value of 100 kΩ, the voltage applied to the terminals S1 and S2 of the user side unit 52 is suppressed to a low level, and a current is also greatly reduced in addition. Accordingly, since a power supply capability to the user side unit 52 is very low like the case of the faultily wired states of Fig. 2B and Fig. 3B, rising of VDD12V and VDD5V due to the supply of the power is suppressed by connecting the load resistor R1 so that it is possible to make the reset release by the reset IC22 not to be executed.

[0030] Needless to say that the load resistor R1 must be set to a value that causes no problem when the power supply rises at the time of normal wiring as shown in Fig. 1, however, the value can be set without problem because the power supply capability has an apparent difference in the normally wired states shown in Fig. 1 and the faultily wired states shown in Fig 2B and Fig. 2C and Fig 3A and Fig. 3B. Further, in the faultily wired state of Fig. 2A, no alternating voltage as a high voltage is applied to the communication circuit, no destruction therein.

[0031] With the above configuration and operation, since a reset of a microcomputer 21 can be prevented from being released by the reset IC 22 in the faultily wired states shown in Fig. 2B and Fig. 2C and Fig. 3A and Fig. 3B by connecting the load resistor R1, a transmission photocoupler IC131 is not turned on and the communication circuit can be protected. Further, since the faultily wired cables can be protected only by adding the load resistor R1, space saving and cost reduction can be realized.

[0032] In the refrigeration cycle apparatus according to the embodiment 2, the heat source side unit 51 in the outdoor unit receives an alternating voltage from an alternating power supply 1 and supplies it to the user side unit 52 in the indoor unit, and the user side unit 52 in the indoor unit has the power supply circuit 11 for enabling the protection of the faultily wiring described above. However, it is not limited thereto, and the user side unit 52 in the indoor unit may receive an alternating voltage from the alternating power supply 1 and supply it to the heat source side unit 51 in the outdoor unit, and the power supply circuit 2 of the heat source side unit 51 in the outdoor unit can protect the faulty wiring mentioned above.

Embodiment 3

[0033] An configuration and an operation which are different from those of Embodiment 2 will be mainly explained in the following explanation of Embodiment 3.
Although the load resistor R1 is disposed to the secondary side of the transformer T111 in Embodiment 2, a load resistor R2 is connected in parallel to both the ends of a smoothing capacitor C111 on its primary side in Embodiment 3 as shown in Fig. 4.

[0034] Then, when a power supply capability is low in the faultily wired states shown in Fig. 2B and Fig. 2C and Fig. 3A and Fig. 3B, a voltage between both the ends of the smoothing capacitor C111 does not sufficiently rise by disposing an appropriate load resistor R2. Thus, VDD12V and VDD5V, which are created based on the voltage through the transformer T111, do not also sufficiently rise so that a reset is prevented from being released by a reset IC 22. However, it is necessary for the load resistor R2 to have a resistance value with no obstruction for a power supply operation in the normally wiring.

[0035] With the above configuration and operation, since it is possible to make the reset of a microcomputer 21 not to be executed by the reset IC 22 in the faultily wired states shown in Fig. 2B and Fig. 2C and Fig. 3A and Fig. 3B by connecting the load resistor R2, a transmission photocoupler IC131 is not turned on and a communication circuit can be protected.
Further, since the faulty wiring can be protected only by adding the load resistor R2, space saving and cost reduction can be realized.

[0036] Further, a switching element IC111 can be made to be a switching OFF state by providing an appropriate resistor as the load resistor R2 and sufficiently suppressing rising of a voltage between both the ends of the smoothing capacitor C111.
As a result, since a start of a microcomputer 21 can be stopped by shutting off a voltage supplied to the secondary side of the transformer T111, the transmission photocoupler IC131 is not turned ON and the communication circuit can be protected.
Further, it is also possible to protect the faulty wiring by combining Embodiments 2 and 3.

Embodiment 4

[0037] Fig. 6A - 6B are voltage waveform diagrams of a secondary side when a delay is provided until a reset is released at the time of faulty wiring in a refrigeration cycle apparatus according to Embodiment 4.
A configuration and an operation which are different from those of Embodiments 2 and 3 will be mainly explained in the following explanation of Embodiment 4.

[0038] In Embodiments 2 and 3, the load resistor R1 is provided in Embodiment 2 and the load resistor R2 is provided in Embodiment 3 so that a reset is not released by the reset IC22. However, in Embodiment 4, a delay is provided until the reset IC 22 releases a reset after VDD5V reaches a reset release voltage. With this operation, in a minute time during which VDD5V becomes equal to or higher than the reset release voltage, it is possible to prevent the reset IC 22 from releasing the reset. Although VDD5V is set equal to or higher than the reset release voltage as shown in Fig. 6A - 6B, it can be confirmed that the reset is not released by the provision of the delay. However, the delay of the reset release time must be suppressed within a time by which a control is not interfered at the time of normal wiring.

[0039] With the above configuration and operation, since a reset cannot be released in the faultily wired states shown in Fig. 2B and Fig. 2C and Fig.3A and Fig. 3B by providing a delay until the reset is released by the reset IC 22, a transmission photocoupler IC131 is not turned ON and a communication circuit can be protected.
Further, provision of the delay can prevent the reset IC22 from releasing the reset, the load resistor R1 or R2 can be set to a high resistance value, and power consumed by these load resistors can be suppressed at the time of normal wiring.
[0040] When the delay is not provided and the reset release time is very short, it is also possible to make it unnecessary to dispose the load resistors R1 and R2 by providing the delay.

Embodiment 5

[0041] Fig. 7 is a power supply circuit diagram when a load resistor is caused to consume no power while a refrigeration cycle apparatus according to Embodiment 5 is operated in the case of normal wiring.
A configuration and an operation which are different from those of Embodiments 2 to 4 described above will be mainly explained in the following explanation of Embodiment 5.
[0042] In Fig. 7, an output terminal of a 3-terminal regulator IC112 is connected to an emitter of a PNP transistor Q1. Further, a collector of the PNP transistor Q1 is connected to a base of an NPN transistor Q2. Further, the other end of a load resistor R1 having one end connected to an input terminal of the 3-terminal regulator IC112 is connected to a collector of the NPN transistor Q2. Then, an emitter of the NPN transistor Q2 is connected to one end of a smoothing capacitor C113 as well as to the ground. Further, an output terminal of the reset IC 22 and a microcomputer 21 are connected to a base of the PNP transistor Q1.
[0043] Next, an operation of a power supply circuit 11 shown in Fig. 7 will be explained while referring to a table 1 showing the outline of the operation.
When VDD5V is equal to or lower than a reset release voltage at the time of power-on, an output of the reset IC 22 is Lo and it is transmitted to the microcomputer 21 so that the device is in a reset state. When VDD5V is increased to a certain voltage, the voltage between the base and the emitter of the PNP transistor is increased and the PNP transistor becomes ON state. Then, the base of the NPN transistor Q2 becomes Hi, the voltage between the base and the emitter of the NPN transistor Q2 is increased, and the NPN transistor becomes ON state.
As a result, an electrical current flows into the load resistor R1.
[0044] Next, when the voltage of VDD5V becomes equal to or larger than the reset release voltage, the output of the rest IC22 becomes Hi, and the PNP transistor Q1 becomes OFF state. Then, the base of the NPN transistor Q2 is also becomes Lo, and the NPN transistor Q2 becomes OFF state. As a result, a current flowing in the load resistor R1 is shut off by the NPN transistor Q2 so that a current does not flow into the load resistor R1 is.
[0045]

Table 1

VDD5V	Output of reset IC	PNPTr Q1	NPNTr Q2	Load R1
Equal to or smaller than reset voltage	Lo	ON	ON	ON
Equalto or larger than reset voltage	Hi	OFF	OFF	OFF

[0046] With the configuration and operation described above, after a reset is released in the state of normal wiring, since no current flows in the load resistor R1, power consumption in the load resistor R1 can be made to zero.
Further, since a current flows in the load resistor R1 in the faultily wired states shown in Fig. 2B and Fig. 2C and Fig. 3A and Fig. 3B, a communication circuit can be protected.
The above circuit configuration can be realized only by adding two transistors and the load resistor R1, and space saving and cost reduction can be realized.
[0047] Further, it is also possible to protect the faulty wiring by combining Embodiments 2 to 4 and Embodiment 5.

Embodiment 6

[0048] Fig. 8 is a view showing a communication start delay time provided by a program of a microcomputer 21 in a refrigeration cycle apparatus according to Embodiment 6.
A configuration and an operation which are different from those of Embodiment 2 will be mainly explained in the following explanation of Embodiment 6.
[0049] In Embodiment 2, to prevent a reset from being released by the reset IC 22, a rising of VDD5V is suppressed by disposing the load resistor R1 so that the reset is not released by the reset IC 22. In Embodiment 6, however, the rising of VDD5V itself is not suppressed by hardware such as electronic parts and the like, but a predetermined delay

time, i.e., a communication start delay time t is provided before a communication star by the program of the microcomputer 21 after a reset is released by the reset IC 22 in response to the rising of the VDD5V. Since a power supply capability is low in the faultily wired states shown in Fig. 2B and Fig. 2C and Fig. 3A and Fig. 3B by providing the communication start delay time t, the VDD5V drops during the communication start delay time t so that the device becomes a reset state again.

[0050] With the configuration and operation described above, a transmission photocoupler IC131 does not turn ON and a communication circuit can be protected.

Further, since faulty wiring can be protected by software which is a program of the microcomputer 21 in place of hardware such as electronic parts and the like, additional space is not necessary and cost is not increased.

[0051] It is also possible to protect the faulty wiring by combining Embodiments 2 to 5 and Embodiment 6.

Embodiment 7

[0052] Fig. 9 is a schematic view of a configuration circuit of a refrigeration cycle apparatus according to Embodiment 7. A configuration and an operation which are different from those of Embodiment 2 described above will be mainly explained in the following explanation of Embodiment 7.

[0053] In a power supply circuit 11 of a user side unit 52, a low input voltage detection means 31, which detects a rectified and smoothed voltage, is connected in parallel to a capacitor C111, and wiring is executed so that a switching element IC111 can be turned on and off in response to a voltage detected thereby.

[0054] As explained in Embodiment 2, when a power supply capability is low in the faultily wired states shown in Fig. 2B and Fig. 2C and Fig. 3A and Fig. 3B, since a low voltage is applied between terminals S1 and S2 of the user side unit 52, a voltage applied to both the ends of the capacitor C111 is lowered. Then, a lowinput voltage detection is performed by the low input voltage detection means 31 to the power supply circuit 11 of the user side unit 52, and when the voltage is lower than a predetermined voltage, the switching element IC111 becomes OFF state.

[0055] With the above configuration and operation, since a start-up of the microcomputer 21 can be stopped by shutting off a voltage supply to a secondary side of the transformer T111, the transmission photocoupler IC131 does not turn on and the communication circuit can be protected.

[0056] An existing switching element may have a low input voltage detection function and becomes switching OFF state when detecting a low voltage, it is also possible to use it.

In this case, the function can be used without adding a sensing resistor or an additional part, space saving and cost reduction can be realized.

Although it is explained here to use the low input voltage detection function, a similar effect can be also obtained by using a switching element having a switching start activation voltage higher than a low voltage input in the faultily wired states in Fig. 2B and Fig. 2C and Fig. 3A and Fig. 3B.

Embodiment 8

[0057] Fig. 10 shows an example of a configuration view when a refrigeration cycle apparatus according to any of Embodiments 1 to 7 is mounted on an air conditioner.

A flow path of a refrigerant circulating in the refrigeration cycle of the air conditioner according to Embodiment 8 passes firstly from a compressor 61 of an outdoor unit 101 through a 4-way valve 62, a first heat exchanger 63, and an expansion valve 64 and flows out to the outside of the outdoor unit 101. The refrigerant flowed out to the outside of the outdoor unit 101 flows out to the outside of an indoor unit 102 through a second heat exchanger 65 in the indoor unit 102. Then, the refrigerant which is flowed out to the outside of the indoor unit 102 returns again to the compressor 61 through the 4-way valve 62 in the outdoor unit 101.

[0058] Heat exchange with an external air is performed in the first heat exchanger 63, and heat exchange with an indoor air is performed in the second heat exchanger 65.

[0059] A heat source side unit 51 is disposed in the outdoor unit 101, and an alternating voltage is supplied from an external alternating current source 1. Further, a user side unit 52 is installed in the indoor unit 102 and electrically connected to the heat source side unit 51 in the outdoor unit 101 according to the configurations explained in Embodiments 1 to 7.

[0060] With the above configuration, the air conditioner can be obtained which is provided with the refrigeration cycle apparatus in which faulty wiring is protected as explained in Embodiments 1 to 7.

[0061] The configuration of the air conditioner shown in Fig. 10 is only an example, and the refrigeration cycle apparatuses according to Embodiments 1 to 7 having a different configuration may be mounted thereon.

Embodiment 9

[0062] Fig. 11 shows an example of an configuration view when the refrigeration cycle apparatus according to any of Embodiments 1 to 7 is mounted on a water heater.
In a refrigeration cycle unit 111, a refrigeration cycle is composed of a compressor 61, a radiator 67, an expansion valve 64 and an evaporator 66. A refrigerant flow path circulating in the refrigeration cycle passes from the compressor 61 through the radiator 67, the expansion valve 64, and the evaporator 66, and returns to the compressor 61 again.
[0063] In a heat accumulation circuit unit 112, a water circulation cycle is composed of a pump 69, a radiator 67, and a tank 68. A water flow path circulating in the water circulation cycle passes from the pump 69 through the radiator 67 and the tank 68 and returns to the pump 69 again.
[0064] The water in the water circulation cycle is supplied with heat energy from the refrigerant in the refrigeration cycle through the radiator 76 and heated water is stored in the tank 68.
[0065] The heat source side unit 51 is installed in the refrigeration cycle unit 111 and supplied with an alternating voltage from the external alternating current source 1. Further, the user side unit 52 is installed in the heat accumulation circuit unit 112 and electrically connected to the heat source side unit 51 in the refrigeration cycle unit 111 according to the configurations explained in Embodiments 1 to 7.
[0066] With the above configuration, the water heater can be obtained which is provided with the refrigeration cycle apparatus in which faulty wiring is protected as explained in Embodiments 1 to 7.
[0067] The configuration of the water heater shown in Fig. 11 is only an example and the refrigeration cycle apparatuses according to Embodiments 1 to 7 having a different configuration may be mounted thereon.

Claims

1. A refrigeration cycle apparatus comprising a user side unit (52) and a heat source side unit (51) connected by at least three cables through each connection end, **characterized in that**:

the user side unit (52) and the heat source side unit (51) have a communication circuit, respectively;
either of the user side unit (52) and the heat source side unit (51) receives an alternating voltage from an alternating current source (1);
with the other unit of the user side unit (52) and the heat source side unit (51), an electrical power is supplied through the connection ends using two cables of the three cables as alternating current lines, and a current loop is formed and communication is executed through the connection ends using the other cable and one of the alternating current lines as communication lines constituting the communication circuit; and
the other unit has a zero cross circuit (12) for detecting a zero cross point of the alternating voltage received from the either of the unit and judges a faulty wiring of the three cables from an output of the zero cross circuit (12), and when the three cables are faultily wired, the other unit shuts off the communication circuit.

2. A refrigeration cycle apparatus comprising a user side unit (52) and a heat source side unit (51) connected by at least three cables through each connection end, wherein:

the user side unit (52) and the heat source side unit (51) have a communication circuit, respectively;
either of the user side unit (52) and the heat source side unit (51) receives an alternating voltage from an alternating current source (1);
with the other unit of the user side unit (52) and the heat source side unit (51), an electrical power is supplied through the connection ends using two cables of the three cables as alternating current lines, and a current loop is formed and communication is executed through the connection ends using the other cable and one of the alternating current lines as communication lines constituting the communication circuit,
wherein the other unit has; a power supply circuit (2, 11) for converting an alternating voltage supplied from the alternating current cables to a direct voltage;
a microcomputer (21) for controlling the communication circuit; and
reset means (22) for monitoring a microcomputer drive power supply voltage supplied to the microcomputer (21) and resets the microcomputer (21) when the microcomputer drive power supply voltage is lower than a predetermined voltage so that the microcomputer is not driven,
wherein the power supply circuit (2, 11) has reset release check means (R1, R2) for preventing the reset state of the microcomputer (21) from being released when the three cables are faultily wired; and
when the three cables are faultily wired, the reset release check means (R1, R2) keeps the microcomputer (21) in a reset state so that the communication circuit is made to be shut off.

3. The refrigeration cycle apparatus of claim 2, wherein the power supply circuit (2, 11) comprises:

   a primary circuit for rectifying and smoothing an alternating voltage supplied from the alternating current lines; and a secondary circuit having secondary rectifying means (D113) connected to the primary circuit through a transformer (T111) for rectifying a voltage converted by the transformer (T111) and a secondary smoothing capacitor (C113) for smoothing the rectified voltage,

   wherein the reset release check means (R1, R2) is composed of a secondary load resistor (R1) connected in parallel to the secondary smoothing capacitor (C113).

4. The refrigeration cycle apparatus of claim 2, wherein the power supply circuit (2, 11) comprises:

   a primary circuit having primary rectifying means (DB1) for rectifying an alternating voltage supplied from the alternating current lines and a primary smoothing capacitor (C111) for smoothing the rectified voltage; and a secondary circuit connected to the primary circuit through a transformer (T111) for rectifying and smoothing a voltage converted by the transformer (T111),

   wherein the reset release check means (R1, R2) is composed of a primary load resistor (R2) connected in parallel to the primary smoothing capacitor (C111).

5. The refrigeration cycle apparatus of any of claims 2 to 4, wherein the reset means (22) releases a reset after a predetermined delay time passes since the microcomputer drive power supply voltage exceeds the predetermined voltage.

6. A refrigeration cycle apparatus comprising a user side unit (52) and a heat source side unit (51) connected by at least three cables through each connection end, **characterized in that**:

   the user side unit (52) and the heat source side unit (51) have a communication circuit, respectively;
   either of the user side unit (52) and the heat source side unit (51) receives an alternating voltage from an alternating current source (1);
   with the other unit of the user side unit (52) and the heat source side unit (51), an electrical power is supplied through the connection ends using two cables of the three cables as alternating current lines, and a current loop is formed and communication is executed through the connection ends using the other cable and one of the alternating current lines as communication lines constituting the communication circuit,
   wherein the other unit has: a power supply circuit (2, 11) for converting an alternating voltage supplied from the alternating current cables to a direct voltage;
   a microcomputer for (21) controlling the communication circuit; and
   reset means (22) for monitoring a microcomputer drive power supply voltage supplied to the microcomputer (21) and resets the microcomputer (21) when the microcomputer drive power supply voltage is lower than a predetermined voltage so that the microcomputer (21) is not driven,
   wherein when the three cables are faultily wired, the reset means (22) shuts off the communication circuit by keeping the microcomputer (21) in a reset state so that the drive of the microcomputer (21) is checked by releasing a reset after a predetermined delay time passes since the microcomputer drive power supply voltage exceeds the predetermined voltage.

7. The refrigeration cycle apparatus of claim 3, wherein when the microcomputer (21) is in a reset released state, the power supply circuit (2, 11) shuts off a current flowing in the secondary load resistor (R1).

8. The refrigeration cycle apparatus of claim 7, wherein the power supply circuit (2, 11) has load current shut-off means (Q2) connected in series to the secondary load resistor (R1), and the load current shut-off means (Q2) shuts off a current flowing in the secondary load resistor (R1) by being shut off when the reset means (22) outputs a reset signal.

9. The refrigeration cycle apparatus of any of claims 2 to 8, wherein the microcomputer (21) causes the communication circuit to start a communication after a predetermined delay time passes since a reset is released by the reset means (22).

10. A refrigeration cycle apparatus comprising a user side unit (52) and a heat source side unit (51) connected by at least three cables through each connection end, **characterized in that**:

the user side unit (52) and the heat source side unit (51) have a communication circuit, respectively; either of the user side unit (52) and the heat source side unit (51) receives an alternating voltage from an alternating current source (1);
with the other unit of the user side unit (52) and the heat source side unit (51), an electrical power is supplied through the connection ends using two cables of the three cables as alternating current lines, and a current loop is formed and communication is executed through the connection ends using the other cable and one of the alternating current lines as communication lines constituting the communication circuit,

wherein the other unit has:

a power supply circuit (2, 11) for converting an alternating voltage supplied from the alternating current cables to a direct voltage;
a microcomputer (21) for controlling the communication circuit; and
reset means (22) for monitoring a microcomputer drive power supply voltage supplied to the microcomputer (21) and resets the microcomputer (21) when the microcomputer drive power supply voltage is lower than a predetermined voltage so that the microcomputer (21) is not driven,

wherein when the three cables are faultily wired, the reset means (22) shuts off the communication circuit by keeping the microcomputer (21) in a reset state so that the drive of the microcomputer is checked by that the microcomputer (21) causes the communication circuit to start a communication after a predetermined delay time passes since a reset is released by the reset means (22).

11. A refrigeration cycle apparatus comprising a user side unit (52) and a heat source side unit (51) connected by at least three cables through each connection end, **characterized in that**:

the user side unit (52) and the heat source side unit (51) have a communication circuit, respectively (1); either of the user side unit (52) and the heat source side unit (51) receives an alternating voltage from an alternating current source (1);
with the other unit of the user side unit (52) and the heat source side unit (51), an electrical power is supplied through the connection ends using two cables of the three cables as alternating current lines, and a current loop is formed and communication is executed through the connection ends using the other cable and one of the alternating current lines as communication lines constituting the communication circuit,

wherein the other unit has a power supply circuit (2, 11) for converting an alternating voltage supplied from the alternating current lines to a direct voltage,
wherein the power supply circuit (2, 11) has:

a primary circuit having primary rectifying means (DB1) for rectifying an alternating voltage supplied from the alternating current lines and a primary smoothing capacitor (C111) for smoothing the rectified voltage;
low input voltage detection means (31) for detecting a voltage of the alternating current lines for supplying an alternating voltage to the power supply circuit (2, 11) or a voltage applied to the primary smoothing capacitor (C111); and
switching means (IC111) for transferring a primary side energy to a secondary side,

wherein when the low input voltage detection means (31) detects a voltage lower than a predetermined voltage, the switching means (IC111) shuts off the communication circuit when the three cables are faultily wired by that the switching means (IC111) is not switched so that the microcomputer (21) is not started because no energy is transferred to the secondary side and a power supply on the secondary side is not started up.

12. An air conditioner on which the refrigeration cycle apparatus of any of claims 1 to 11 is mounted.

13. A water heater on which the refrigeration cycle apparatus of any of claims 1 to 11 is mounted.

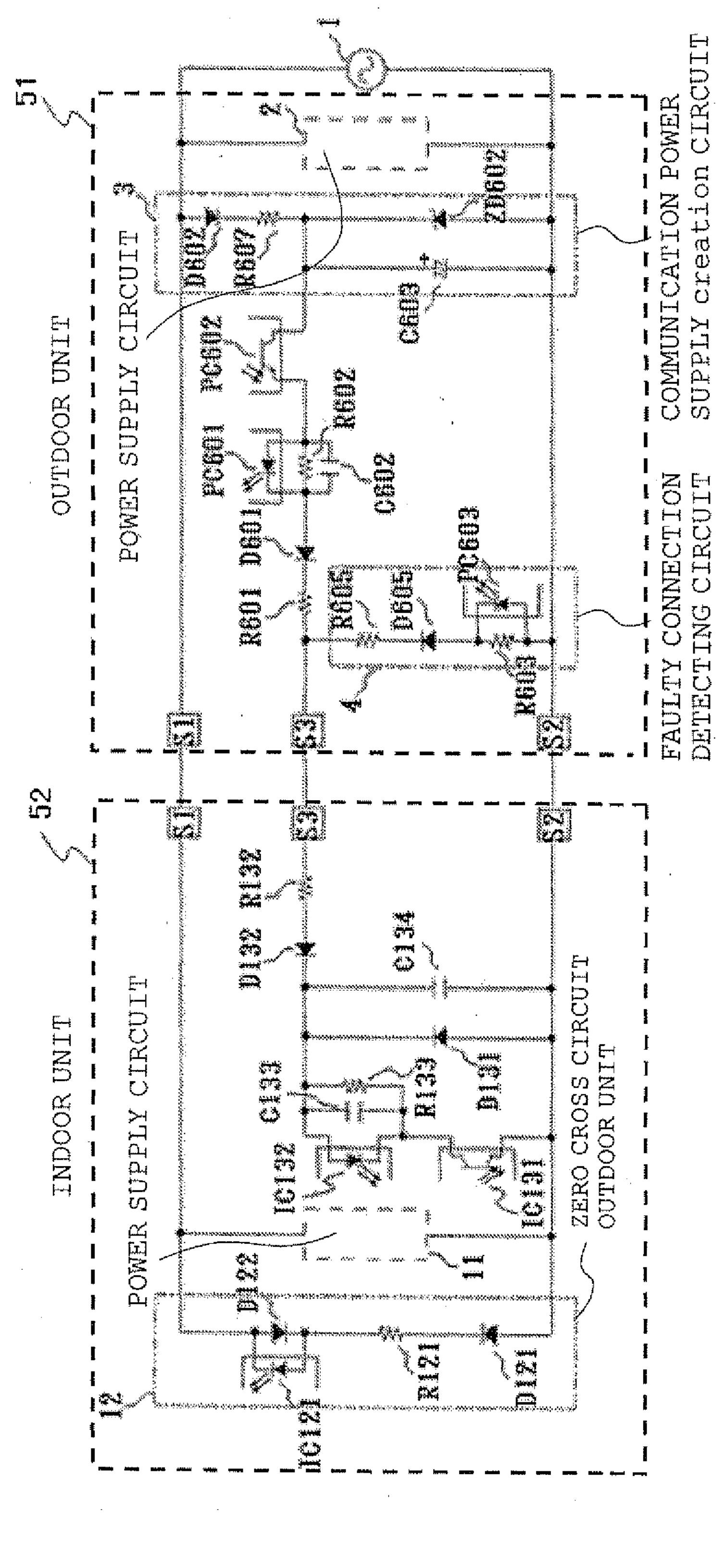
51
52
OUTDOOR UNIT
INDOOR UNIT
POWER SUPPLY CIRCUIT
POWER SUPPLY CIRCUIT
COMMUNICATION POWER SUPPLY creation CIRCUIT
FAULTY CONNECTION DETECTING CIRCUIT
ZERO CROSS CIRCUIT OUTDOOR UNIT
1
2
3
4
11
12
S1
S2
S3
D602
R607
ZD602
C603
PC602
PC601
R602
C602
D601
R601
R605
D605
PC603
R603
R132
D132
C134
C133
R133
D131
IC132
IC131
D122
R121
D121
IC121

FIG. 1

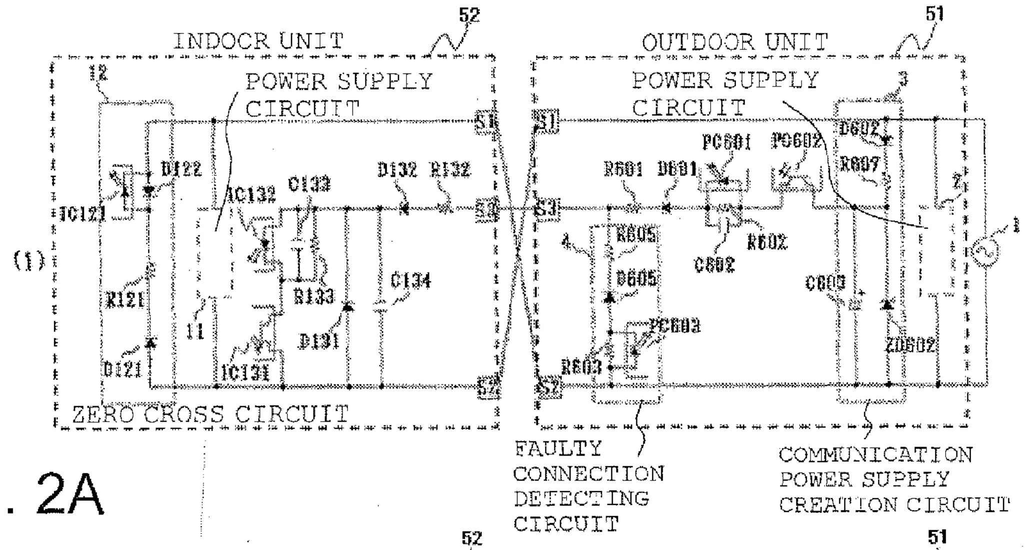

FIG. 2A

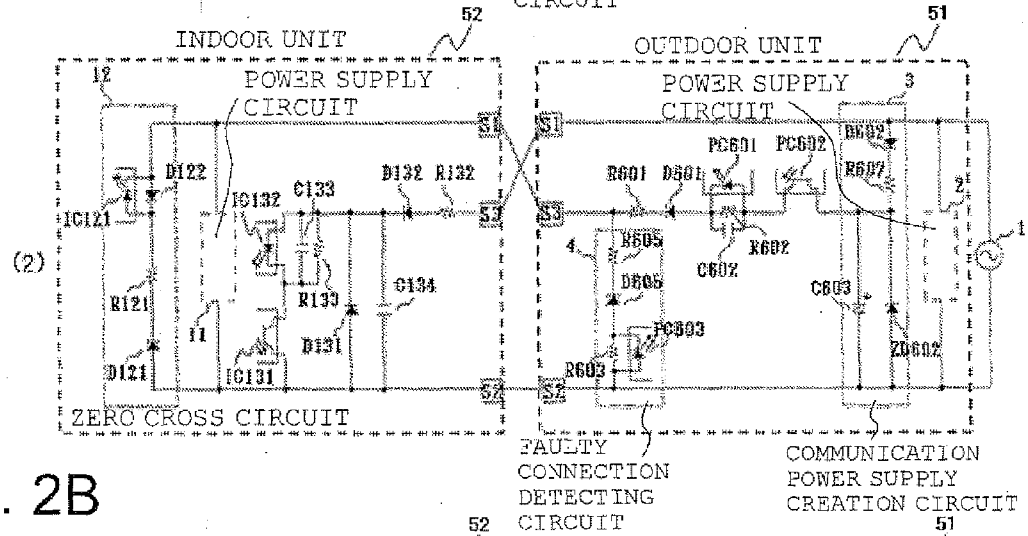

FIG. 2B

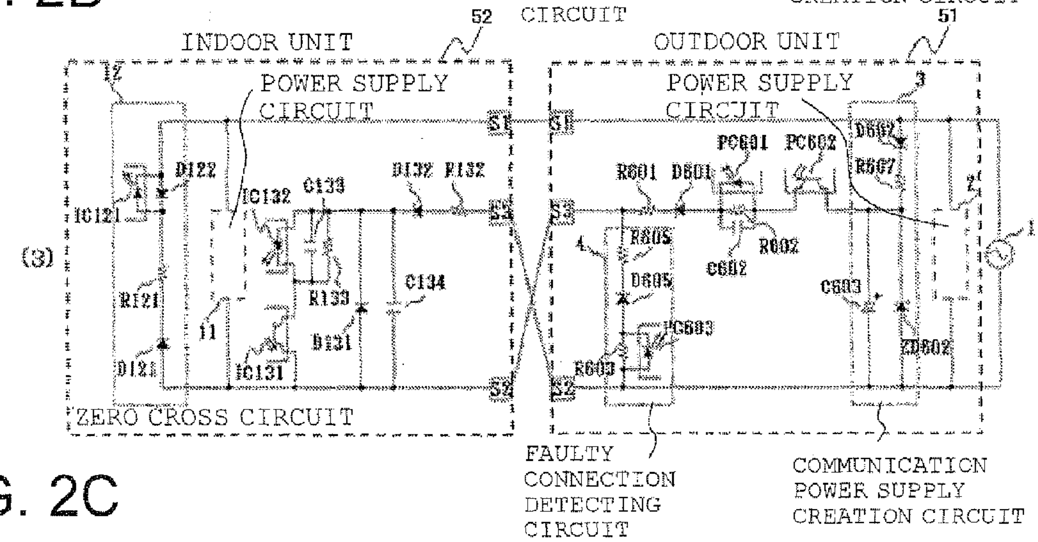

FIG. 2C

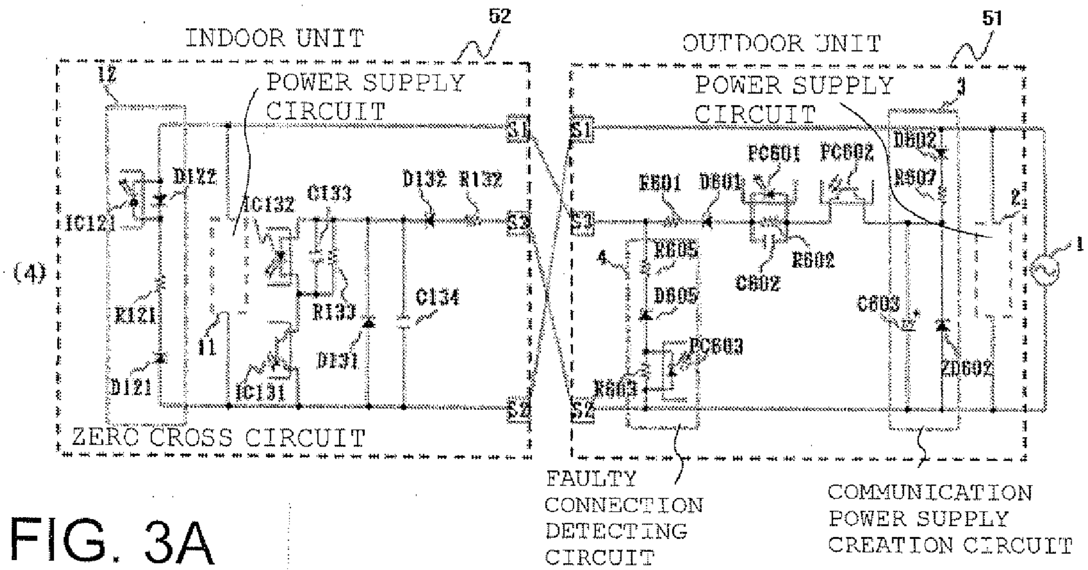
INDOOR UNIT
52
OUTDOOR UNIT
51
POWER SUPPLY CIRCUIT
POWER SUPPLY CIRCUIT
ZERO CROSS CIRCUIT
FAULTY CONNECTION DETECTING CIRCUIT
COMMUNICATION POWER SUPPLY CREATION CIRCUIT
(4)
S1
S2
S3
IC121
IC131
IC132
D121
D122
D131
D132
R121
R132
R133
C133
C134
R601
R602
R603
R605
R607
D601
D602
D605
PC601
PC602
PC603
C602
C603
ZD602
11
12
1
2
3
4

FIG. 3A

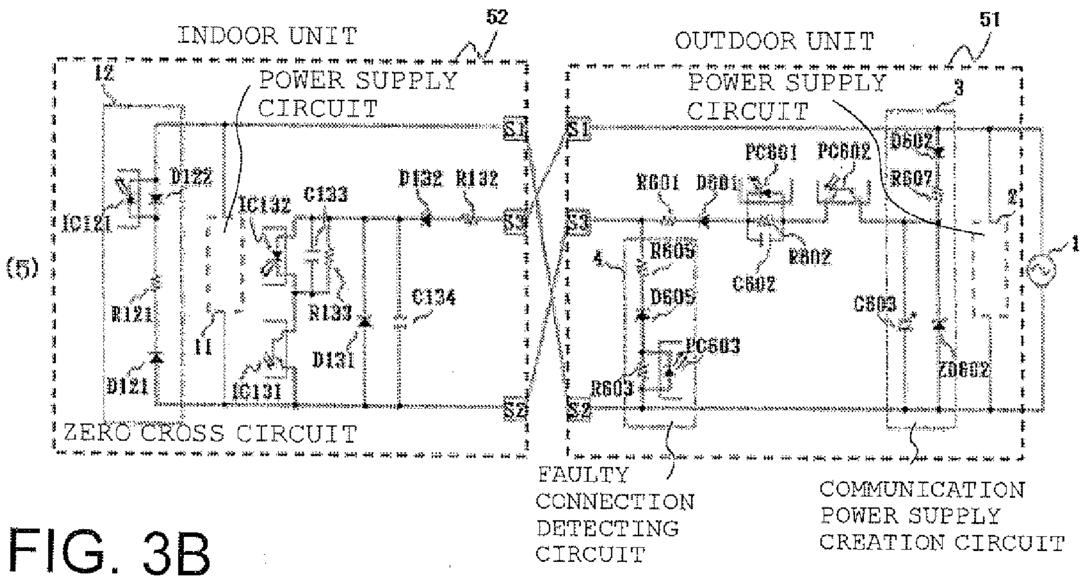
INDOOR UNIT
52
OUTDOOR UNIT
51
POWER SUPPLY CIRCUIT
POWER SUPPLY CIRCUIT
ZERO CROSS CIRCUIT
FAULTY CONNECTION DETECTING CIRCUIT
COMMUNICATION POWER SUPPLY CREATION CIRCUIT
(5)
S1
S2
S3
IC121
IC131
IC132
D121
D122
D131
D132
R121
R132
R133
C133
C134
R601
R602
R603
R605
R607
D601
D602
D605
PC601
PC602
PC603
C602
C603
ZD602
11
12
1
2
3
4

FIG. 3B

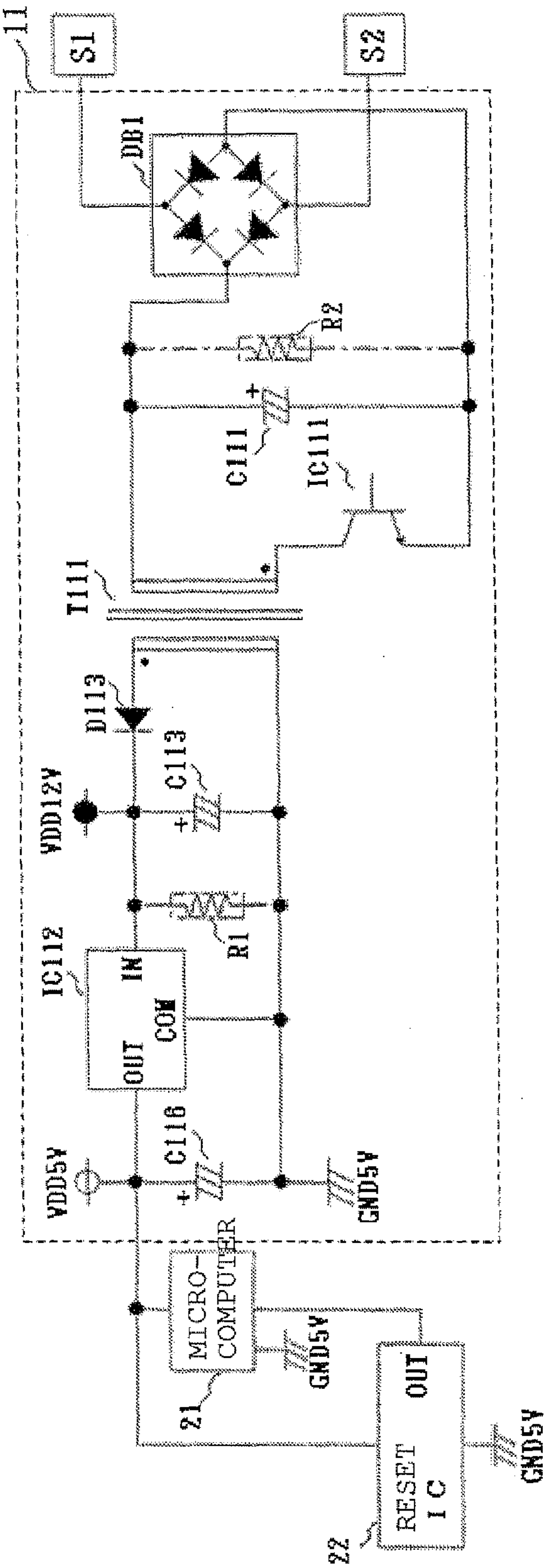
11
S1
S2
DB1
R2
C111
IC111
T111
D113
C113
VDD12V
R1
IC112
IN
COM
OUT
C116
VDD5V
GND5V
MICRO-COMPUTER
21
GND5V
RESET IC
OUT
GND5V
22

FIG. 4

(1)

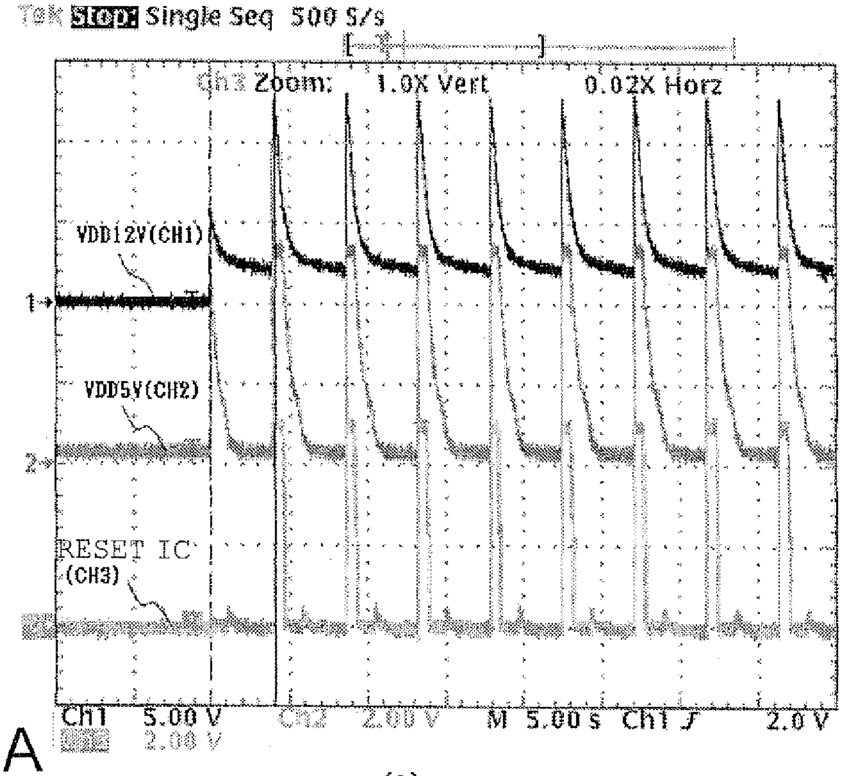

FIG. 5A

(2)

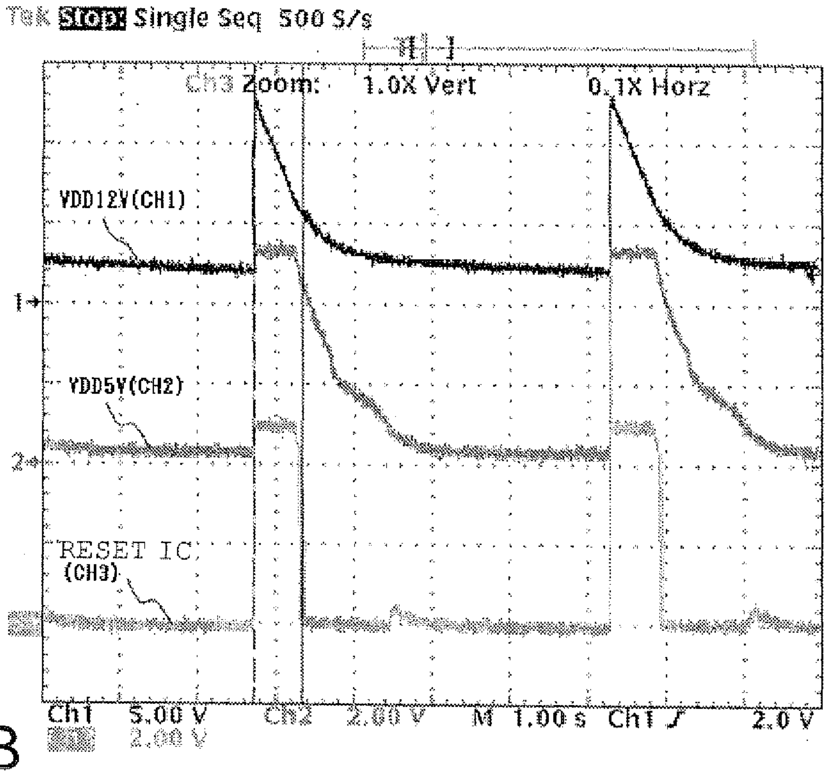

FIG. 5B

(1)

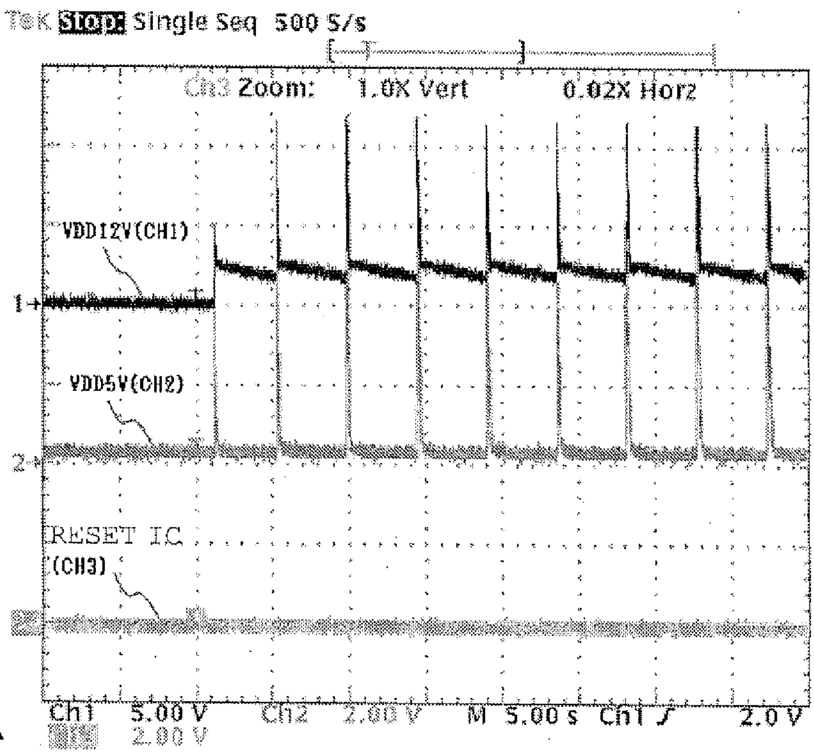

FIG. 6A

(2)

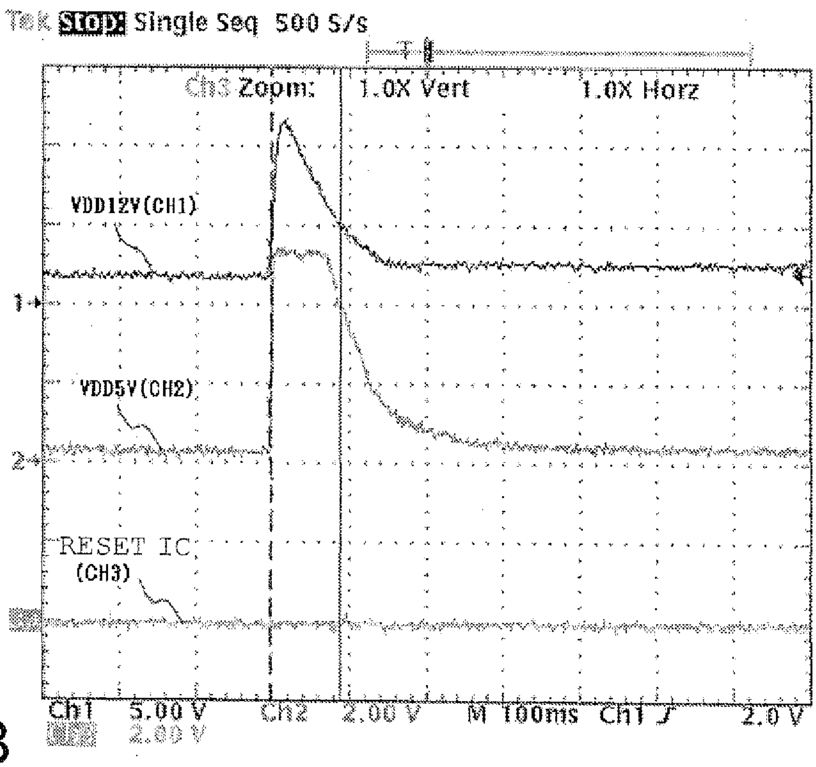

FIG. 6B

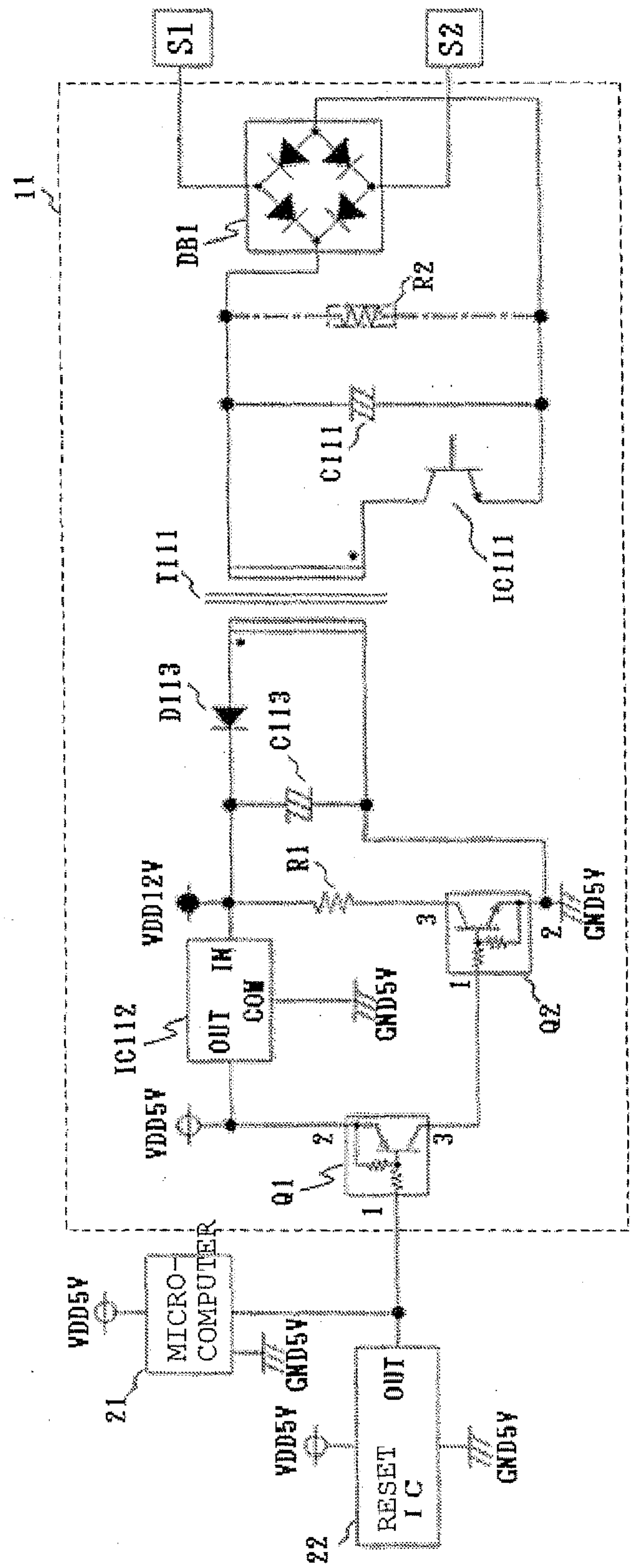
S1
S2
11
DB1
R2
C111
T111
IC111
D113
C113
R1
VDD12V
IN
OUT
COM
GND5V
IC112
VDD5V
Q1
Q2
MICRO-COMPUTER
21
RESET IC
OUT
22

FIG. 7

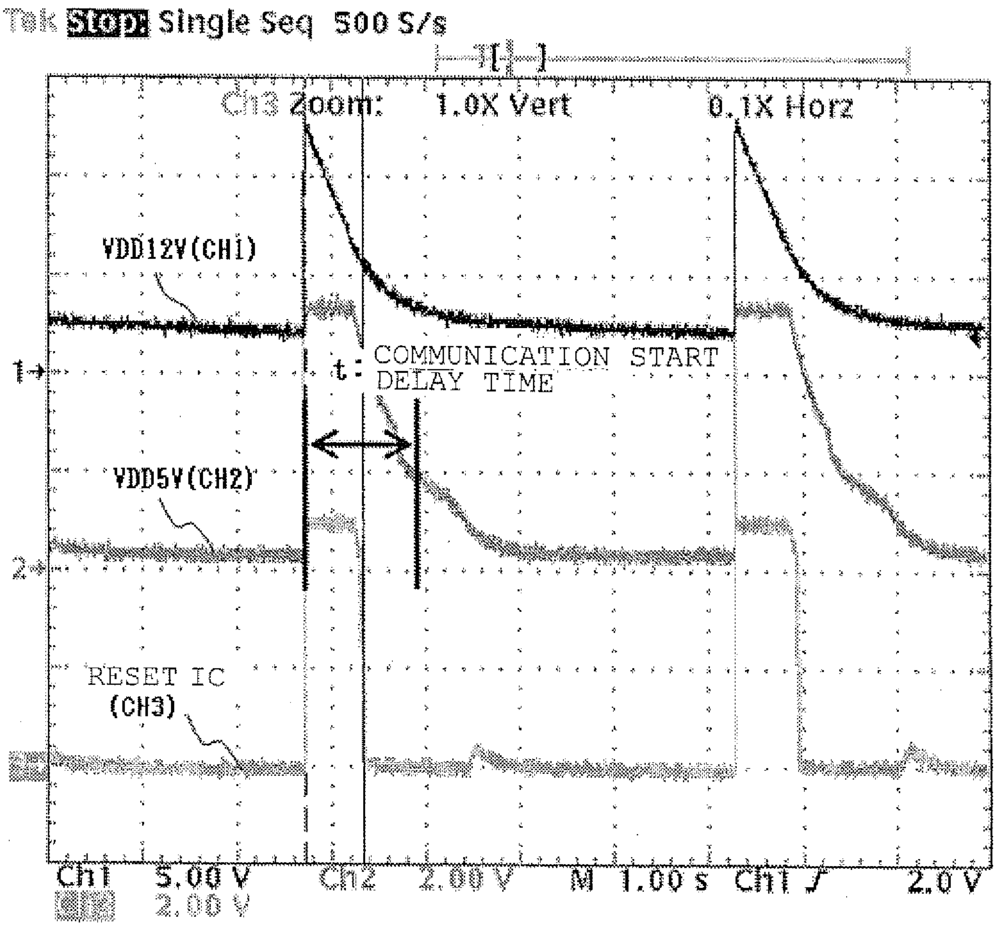
Tek Stop: Single Seq 500 S/s
Ch3 Zoom: 1.0X Vert 0.1X Horz
VDD12V(CH1)
t: COMMUNICATION START DELAY TIME
VDD5V(CH2)
RESET IC (CH3)
Ch1 5.00 V Ch2 2.00 V M 1.00 s Ch1 ∫ 2.0 V
Ch3 2.00 V

FIG. 8

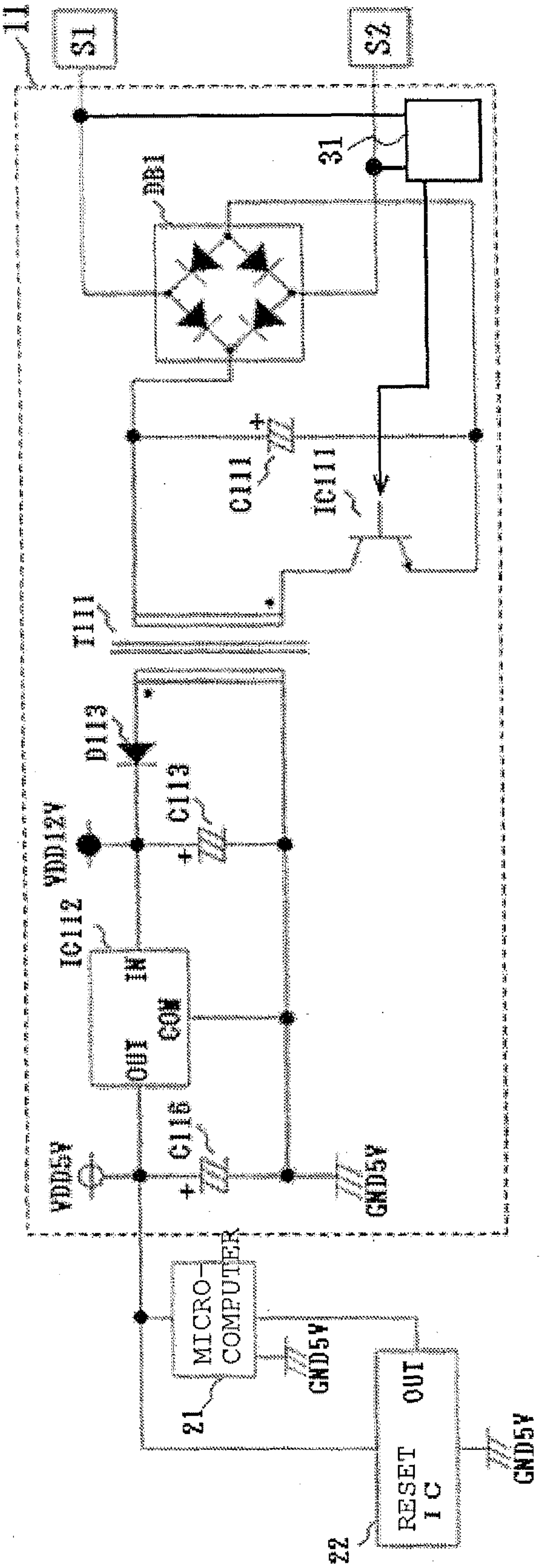
11
S1
S2
31
DB1
C111
IC111
T111
D113
C113
VDD12V
IC112
OUT
COM
IN
C115
VDD5V
GND5V
MICRO-
COMPUTER
21
GND5V
OUT
RESET
I C
22
GND5V

FIG. 9

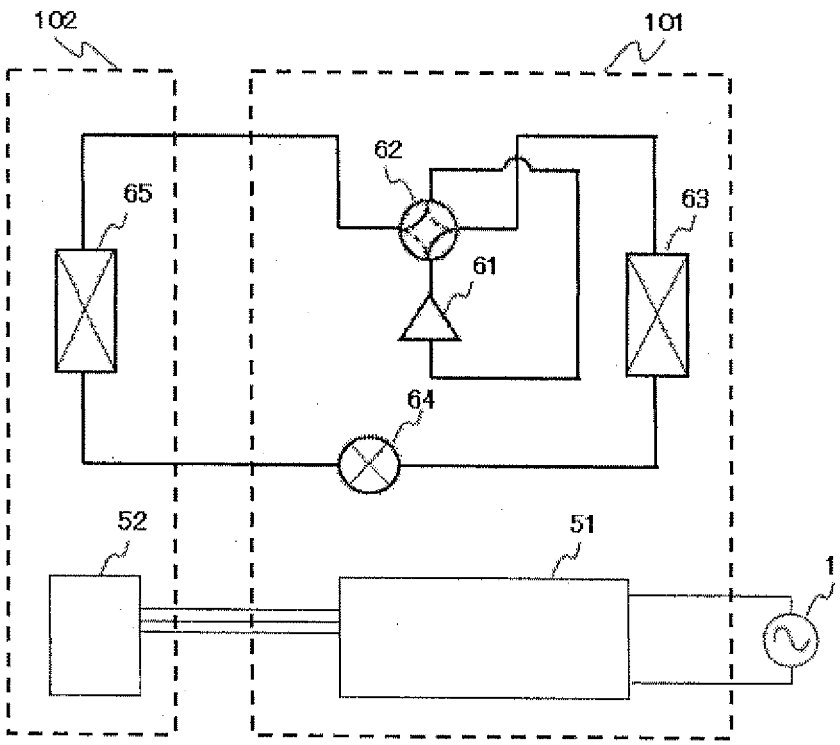

FIG. 10

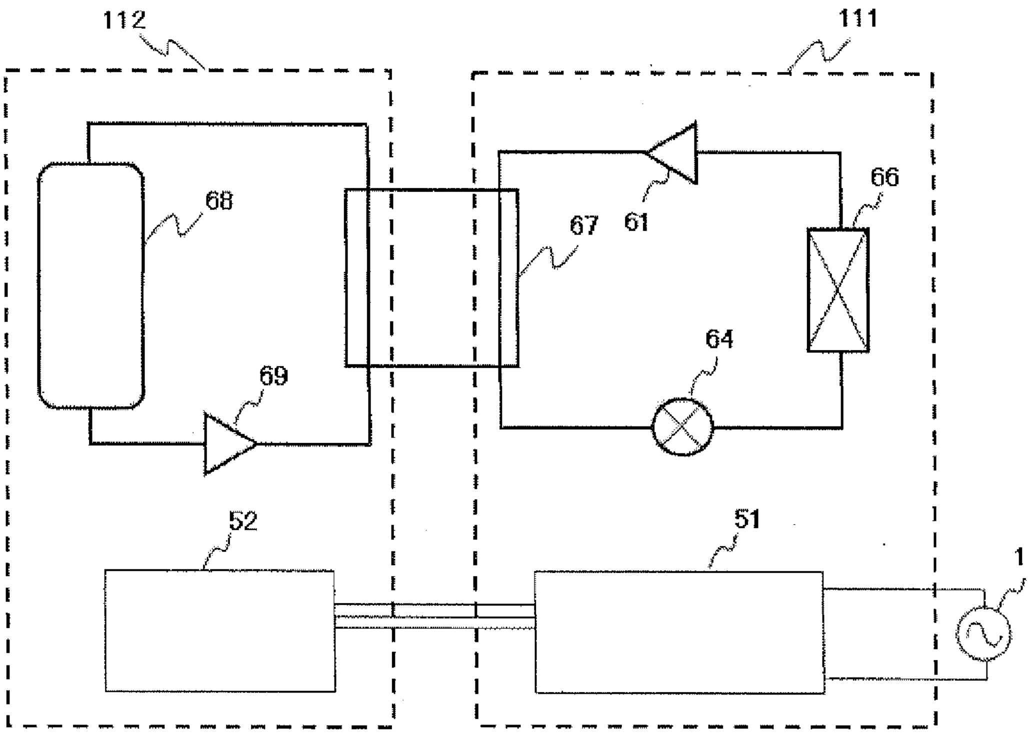

FIG. 11

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 7217972 A **[0002] [0003]**