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

(11) **EP 3 992 458 A1**

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

(43) Date of publication:
**04.05.2022 Bulletin 2022/18**

(21) Application number: **20902060.1**

(22) Date of filing: **24.02.2020**

(51) International Patent Classification (IPC):
***F04B 49/06*** *(2006.01)* ***F04B 49/02*** *(2006.01)*

(86) International application number:
**PCT/CN2020/076442**

(87) International publication number:
**WO 2021/120388 (24.06.2021 Gazette 2021/25)**

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

(30) Priority: **16.12.2019 CN 201911300233**

(71) Applicants:
- **GD Midea Heating & Ventilating Equipment Co., Ltd.**
  **Foshan, Guangdong 528311 (CN)**
- **Midea Group Co., Ltd.**
  **Foshan, Guangdong 528311 (CN)**

(72) Inventor: **ZHANG, Xiaodong**
**Foshan, Guangdong 528311 (CN)**

(74) Representative: **Whitlock, Holly Elizabeth Ann et al**
**Maucher Jenkins**
**Seventh Floor Offices**
**Artillery House**
**11-19 Artillery Row**
**London SW1P 1RT (GB)**

# (54) PRESSURE PROTECTION CIRCUIT, CONTROL METHOD, AND COMPUTER-READABLE STORAGE MEDIUM

(57) The present application provides a pressure protection circuit, a control method, and a computer-readable storage medium. The pressure protection circuit comprises: a driving module electrically connected to a compressor; a pressure switch module disposed between the driving module and a power supply loop of the compressor and used for outputting a switching signal, the switching signal being used for controlling the connection or disconnection of the power supply and the driving module; and a control module electrically connected to the driving module and the pressure switch module, and used for inputting a driving control signal to the driving module, so that the driving module controls the compressor to operate according to the driving control signal. The control module is further used for controlling, upon detecting that the switch signal does not match a bus signal of the driving module, the compressor to stop operating. By means of the technical solution of the present application, the compressor is prevented from operating under a working condition in which the pressure switch module fails, the probability of abnormal operation is reduced, and thus the operational safety and reliability of the compressor can be improved.

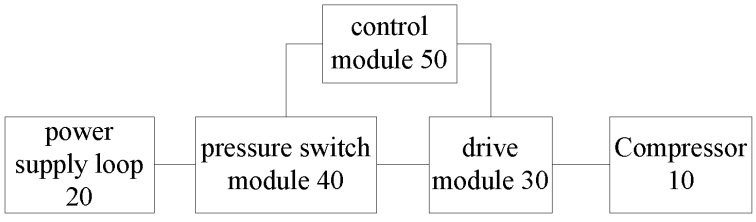



Figure 1

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## Description

### CROSS-REFERENCE TO RELATED APPLICATION

**[0001]** This application based on and claims priority to the Chinese Patent Application No. "201911300233.2" filed on December 16, 2019, the entire content of which is incorporated herein by reference.

### FIELD

**[0002]** The present disclosure relates to the field of compressor driving technology, specifically to a pressure protection circuit, a pressure protection control method and a computer-readable storage medium.

### BACKGROUND

**[0003]** A pressure protection circuit is a protection circuit commonly used in an air conditioning system. However, in current circuits, there is only protection against overpressure, while there is no effective detection method to determine whether the protection circuit is effective for protection when the circuit fails. Thus, when the circuit really fails, it cannot be detected, determined and handled, which will cause the system pressure to continue to rise and cause danger.

**[0004]** In addition, any discussion in the background of the entire specification does not mean that the background must be the related art known to those skilled in the art, and any discussion of the related art in the entire specification does not mean that the related art must be widely known or must constitute common knowledge in the art.

### SUMMARY

**[0005]** The present disclosure aims to solve at least one of the technical problems in the related art to a certain degree.

**[0006]** For this, an objective of the present disclosure is to provide a pressure protection circuit.

**[0007]** Another objective of the present disclosure is to provide a pressure protection control method.

**[0008]** Still another objective of the present disclosure is to provide a computer-readable storage medium.

**[0009]** For the above objectives, in a first aspect, the present disclosure provides in embodiments a pressure protection circuit, including: a drive module, electrically connected to a compressor; a pressure switch module, configured to be arranged between the drive module and a power supply loop of the compressor, and configured to output a switch signal, wherein the switch signal is used to control connection or disconnection between the power supply loop and the drive module; and a control module, electrically connected to the drive module and the pressure switch module, and configured to input a drive control signal to the drive module, such that the drive module controls the compressor to operate according to the drive control signal, wherein the control module is further configured to control the compressor to stop operating based detecting that the switch signal does not match a bus signal of the drive module.

**[0010]** In this technical solution, the pressure protection circuit includes the drive module, the pressure switch module and the control module. In the process of controlling operation of the compressor, the pressure switch module can detect a working state of the compressor, and control disconnection between the power supply loop and the drive module to stop providing power to the compressor, when it is detected that the compressor operates abnormally, such that the compressor stops operating.

**[0011]** For preventing the control of the pressure switch module from failing, a diagnostic function of the control module is added to detect whether a state of the switch signal matches the bus signal of the drive module. When it is detected that the above relationship matches, it indicates that the control of the pressure switch module remains in an effective state. When it is detected that the above relationship does not match, it indicates that the control of the pressure switch module fails. At this point, the compressor is controlled to stop operating, thus preventing the compressor from running when a working state of the pressure switch module is failed, thereby reducing a probability of abnormal operation and improving the security and reliability of the operation of the compressor.

**[0012]** In the above technical solution, the compressor includes a pressure vessel, and the pressure switch module includes: a pressure switch, configured to detect a pressure signal of the pressure vessel, and generate the switch signal correspondingly according to the pressure signal; and a power control switch, configured to be arranged between the drive module and the power supply loop, and electrically connected to the pressure switch, wherein the power control switch is connected according to the switch signal such that the power supply loop is connected to the drive module, or the power control switch is disconnected according to the switch signal such that the power supply loop is disconnected to the drive module.

**[0013]** In this technical solution, the pressure switch module includes the pressure switch and the power control switch, and the pressure switch is an electronic switch specifically, which can detect the working state of the compressor, in specific to detect whether the pressure signal of the pressure vessel is abnormal, to determine whether the compressor operates abnormally. If it is detected that the pressure signal is too high, there is a risk of explosion in the pipe of the compressor. At this point, the pressure switch transmits a turn-off signal to the power control switch to cut off the connection between the drive module and the power supply loop via the power control switch, so as to stop providing power to the compressor. For preventing the power control switch from failing, the above diagnostic function of the control mod-

ule is added to take remedial measures in time when the power control switch fails, thereby reducing the risk of operation in the event of failure.

**[0014]** Specifically, a pressure sensor may be arranged at an exit of the pressure vessel so as to detect the pressure signal by the pressure sensor.

**[0015]** In any one of the above technical solutions, the power control switch includes any one of a relay, a contactor and a semiconductor power switch.

**[0016]** Taking the relay as an example, because the relay has the risk of contact adhesion , if the relay is adhesive after closed, it will no longer respond to the switch signal of the pressure switch or a control signal of the control module. That is, the relay cannot be effectively disconnected after receiving the turn-off signal. At this point, the control module is needed to directly control the compressor to stop operating.

**[0017]** In any one of the above technical solutions, the control module includes: an integrated control chip arranged separately, or the control module includes a first control chip and a second control chip, wherein the first control chip is electrically connected to the drive module and configured to output the drive control signal to the drive module, the second control chip is electrically connected to the drive module to acquire the bus signal, the second control chip is further connected to a join point between the pressure switch and the power control switch to acquire the switch signal, the second control chip is further electrically connected to the first control chip to control the first control chip to stop outputting the drive control signal based detecting that the switch signal does not match the bus signal, such that the compressor stops operating.

**[0018]** In this technical solution, the control module may be achieved via an integrated control chip, or be achieved by setting the two control chips, i.e. the first control chip and the second control chip as mentioned above.

**[0019]** The use of one integrated control chip is conducive to a simplified configuration of the circuit, and since the pressure protection circuit in the related art has been provided with a control chip with the same function as the first control chip, the second control chip defined in embodiments of the present disclosure is added based on the pressure protection circuit in the related art, which is conducive to reducing the manufacturing cost while realizing abnormity diagnosing, detecting and controlling.

**[0020]** Further, by being provided with the second control chip, the compressor can still be effectively stopped when the first control chip is abnormal, thereby ensuring the security of the system.

**[0021]** In any one of the above technical solutions, the drive module includes a drive chip, wherein the drive chip is electrically connected to the first control chip and the second control chip individually, and the drive chip is configured to unlock the drive control signal; wherein the second control chip is further configured to control the drive chip to turn off.

**[0022]** In this technical solution, the second control chip may also directly control the drive chip of the drive module to turn off, thereby ensuring the reliability of the compressor to be controlled to stop operating.

**[0023]** In any one of the above technical solutions, the pressure switch is arranged at an exit of the pressure vessel and further includes: a pressure sensor, configured to detect the pressure signal; a microprocessor, electrically connected to the pressure sensor and configured to set the switch signal as a turn-off signal based on detecting that the pressure signal is higher than or equal to a pressure threshold, wherein the turn-off signal is used to control the power control switch to be disconnected, wherein the second control chip is further configured to determine that the switch signal does not match the bus signal, if the turn-off signal is detected and the bus signal does not enter an attenuating state.

**[0024]** In this technical solution, taking the relay as an example, if the pressure switch detects the pressure signal being higher than or equal to the pressure threshold, i.e., overpressure is detected, the turn-off signal is transmitted to the relay, and the second control chip receives a power-off signal simultaneously. At this point, the second control chip actively detects the change of a bus voltage of the drive module. If the bus voltage continues decreasing, it indicates that the relay is normally disconnected. If the bus voltage does not change, it indicates that the relay is not normally disconnected. At this point, the second control chip turns off the drive chip of the compressor, i.e. the first control chip, and thus the first control chip stops outputting the drive control signal to the drive module.

**[0025]** The pressure threshold may be a maximum pressure value ensuring normal operation of the compressor.

**[0026]** In any one of the above technical solutions, the second control chip is further configured to determine that the switch signal matches the bus signal, if the turn-off signal is detected and the bus signal enters the attenuating state, and the microprocessor is further configured to set the switch signal as a turn-on signal, wherein the turn-on signal is used to control the power control switch to be connected, wherein the second control chip is further configured to determine that the switch signal matches the bus signal, if the turn-on signal is detected and the bus signal enters an augmenting state.

**[0027]** In this technical solution, it is detected that whether the switch signal matches the bus signal of the drive module. It is defined that the compressor is controlled to stop operating under a mismatched condition, and a matched condition corresponds to a normal working state of the compressor, thereby ensuring the integrity of pressure protection control.

**[0028]** In any one of the above technical solutions, the pressure protection circuit further includes: a control power, configured to provide power to the control module, wherein the control power is further configured to provide

power to the pressure switch, such that the pressure switch generates the switch signal correspondingly according to a power supply signal of the control power and a detection result of the pressure signal, and to output the power supply signal to the power control switch or to stop outputting the power supply signal to the power control switch according to the switch signal.

**[0029]** In this technical solution, connection or disconnection of the power control switch is determined according to whether the power supply signal of the control power is received. In a normal working state, if stopping receiving the power supply signal, the power control switch will be disconnected automatically. In an abnormal working state such as the contact adhesion as mentioned above, after the contact is connected and adhesive, even if the power supply signal is stopped, the power control switch is still in a connected state. There is a risk that the operating pressure of the compressor continues increasing in this case, and the risk would be avoided as much as possible by controlling the compressor to stop operating.

**[0030]** In any one of the above technical solutions, the drive module includes an intelligent power module and/or an IGBT module, wherein the intelligent power module and/or the IGBT module are (is) provided with a transistor component, wherein the first control chip is further configured to set a pulse width modulated signal as the drive control signal, wherein the pulse width modulated signal is used to control the transistor component to be connected or disconnected.

**[0031]** In this technical solution, the drive module may include a rectifier, a PFC module and an intelligent power module (IPM), etc., or may only include an IPM module. By outputting the drive control signal to the drive module, the drive control of a compressor motor is realized along with connection of the power supply loop. Thus, the compressor motor can be controlled to stop operating by stopping outputting the drive control signal, thereby ensuring the controllability of the operation of the compressor.

**[0032]** In a second aspect, the present disclosure provides in embodiments a pressure protection control method, including: controlling the compressor to stop operating based on detecting that a bus signal of the drive module does not match an operation status of the pressure switch module.

**[0033]** In this technical solution, in the process of controlling operation of the compressor, the pressure switch module can detect a working state of the compressor, and control disconnection between a power supply loop and the drive module to stop providing power to the compressor, when it is detected that the compressor operates abnormally, such that the compressor stops operating.

**[0034]** For preventing the control of the pressure switch module from failing, a diagnostic function is added to detect whether a state of the switch signal matches the bus signal of the drive module. When it is detected that the above relationship matches, it indicates that the control of the pressure switch module remains in an effective state. When it is detected that the above relationship does not match, it indicates that the control of the pressure switch module fails. At this point, the compressor is controlled to stop operating, thus preventing the compressor from running when a working state of the pressure switch module is failed, thereby reducing a probability of abnormal operation and improving the security and reliability of the operation of the compressor.

**[0035]** In the above technical solution, the compressor includes a pressure vessel, wherein controlling the compressor to stop operating based on detecting that a bus signal of the drive module does not match an operation status of the pressure switch module specifically includes: detecting the bus signal in response to acquisition of a turn-off signal output by the pressure switch module, determining that the operation status does not match the bus signal and controlling the compressor to stop operating, if it is detected that the bus signal does not decrease to a voltage threshold within a specified period, wherein the turn-off signal is generated when a pressure signal of the pressure vessel detected by the pressure switch module is higher than or equal to a pressure threshold.

**[0036]** In this technical solution, taking the relay as an example, if overpressure is detected, it will trigger the detection of the change in a bus voltage of the drive module. If the bus voltage continues decreasing, it indicates that the relay is normally disconnected. If the bus voltage does not change, it indicates that the relay is not normally disconnected. At this point, it is controlled to stop outputting the drive control signal. For preventing the relay from failing, the above diagnostic function of the control module is added to take remedial measures in time when the power control switch fails, thereby reducing the risk of operation in the event of failure.

**[0037]** In any one of the above technical solutions, controlling the compressor to stop operating based on detecting that a bus signal of the drive module does not match an operation status of the pressure switch module specifically includes: controlling the driver module to output a drive control signal before the pressure switch module starts operation in response to a power-on signal; determining that the operation status does not match the bus signal and controlling the compressor to stop operation, if it is detected that the bus signal is in an increasing state.

**[0038]** In this technical solution, it may also be detected whether the bus signal of the drive module matches the operation status of the pressure switch module in a process of controlling the compressor to start operating. For example, when the pressure switch has not output a turn-off signal to the relay yet after power on, if it is detected that the bus voltage of the drive module reaches a high voltage value, it may also be determined that the relay operates abnormally, thus controlling the compressor to stop operating, thereby ensuring the security of the operation of the compressor.

**[0039]** In any one of the above technical solutions, con-

trolling the compressor to stop operation specifically includes: controlling to stop outputting the drive control signal to the drive module, and/or controlling to turn off a drive chip of the drive module, wherein the drive module further includes an intelligent power module and/or an IGBT module, wherein the intelligent power module and/or the IGBT module are(is) provided with a transistor component, and a pulse width modulated signal is set as the drive control signal, wherein the pulse width modulated signal is used to control the transistor component to be connected or disconnected.

**[0040]** In this technical solution, the drive module may include a rectifier, a PFC module and an intelligent power module (IPM) module, etc., or may only include an IPM module. By outputting the drive control signal to the drive module, the drive control of a compressor motor is realized along with connection of the power supply loop. Thus, the compressor motor can be controlled to stop operating by stopping outputting the drive control signal, thereby ensuring the controllability of the operation of the compressor.

**[0041]** In any one of the above technical solutions, the pressure switch module includes a relay arranged between the driver module and the power supply loop, wherein the pressure protection control method further includes: determining that the relay is abnormal and generating an abnormal alarm message if it is detected that the bus signal does not match the operation status.

**[0042]** In this technical solution, if it is detected that the relay is abnormal, the abnormal alarm message is transmitted to a user, to guide the user to solve the abnormality in time.

**[0043]** In a third aspect, the present disclosure provides in embodiments a computer-readable storage medium, when a computer program executed by a processor, implements steps of a pressure protection control method as defined in any one of the above technical solutions, thus having technical effects as defined in any one of the above technical solutions, which are not repeated here.

**[0044]** The additional aspects and advantages of the present disclosure will become apparent in the following description, or would be understood through the practice of the present disclosure.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0045]** The above and/or additional aspects and advantages of the present disclosure will become obvious and understandable with the following description for embodiments by combining the drawings.

Figure 1 is a circuit block diagram showing a pressure protection circuit in an embodiment of the present disclosure;

Figure 2 is a circuit block diagram showing a pressure protection circuit in another embodiment of the present disclosure;

Figure 3 is a flow chart showing a pressure protection control method according to an embodiment of the present disclosure;

Figure 4 is a flow chart showing a pressure protection control method in another embodiment of the present disclosure;

Figure 5 is a block diagram showing a computer-readable storage medium in an embodiment of the present disclosure.

**[0046]** Correspondences between drawing references in Figures 1 and 2 and name of components are as follows.

**[0047]** 10: compressor, 20: power supply loop; 30: drive module; 302: drive chip; 40: pressure switch module; 402: pressure switch; 404: relay; 50: control module; 502: first control chip; 504: second control chip; 60: control power.

## DETAILED DESCRIPTION

**[0048]** For understanding the above objectives features, and advantages of the present disclosure clearer, the present disclosure is described below with reference to embodiments and the drawings. It should be noted that the embodiments and the features thereof in the present disclosure can be combined with each other without conflict.

**[0049]** Many specific details are set forth in order to fully understand this disclosure in the following description. However, this disclosure can also be implemented in other ways than those described here. Thus, the protected scope of the present disclosure is not limited by the definition of the specific embodiments below.

**[0050]** Embodiments of the present disclosure are described below with reference to Figures 1 to 5.

### Embodiment 1

**[0051]** As shown in Figure 1, a pressure protection circuit according to an embodiment of the present disclosure is used to protect the operation of a compressor 10. The compressor 10 includes a pressure vessel, and the pressure protection circuit includes: a power supply loop 20, a drive module 30, a pressure switch module 40 and a control module 50.

**[0052]** The drive module 30 is electrically connected to the compressor 10.

**[0053]** The pressure switch module 40 is configured to be arranged between the drive module 30 and the power supply loop 20 of the compressor 10, and is configured to output a switch signal, where the switch signal is used to control connection or disconnection between the power supply loop 20 and the drive module 30.

**[0054]** As shown in Figure 2, the pressure switch module 40 includes an electrically connected pressure switch 402 and a power control switch. The pressure switch 402 is configured to detect a pressure signal of the pressure

vessel, and generate the switch signal correspondingly according to the pressure signal. The power control switch is arranged between the drive module 30 and the power supply loop 20. The power control switch is connected according to the switch signal such that the power supply loop 20 is connected to the drive module 30, or the power control switch is disconnected according to the switch signal such that the power supply loop 20 is disconnected to the drive module 30.

**[0055]** The power control switch includes any one of a relay 404, a contactor and a semiconductor power switch.

**[0056]** The pressure switch 402 is an electronic switch specifically, which can detect the working state of the compressor 10, in specific to detect whether the pressure signal of the pressure vessel is abnormal, to determine whether the compressor 10 operates abnormally. If it is detected that the pressure signal is too high, there is a risk of explosion in the pipe of the compressor 10. At this point, the pressure switch 402 transmits a turn-off signal to the power control switch to cut off the connection between the drive module 30 and the power supply loop 20 via the power control switch, so as to stop providing power to the compressor 10. For preventing the power control switch from failing, the above diagnostic function of the control module 50 is added to take remedial measures in time when the power control switch fails, thereby reducing the risk of operation in the event of failure.

**[0057]** As an embodiment for detecting a working state of the compressor 10, the pressure switch 402 is arranged at an exit of the pressure vessel and further includes: a pressure sensor, configured to detect the pressure signal; a microprocessor, electrically connected to the pressure sensor and configured to set the switch signal as a turn-off signal based on detecting that the pressure signal is higher than or equal to a pressure threshold, where the turn-off signal is used to control an control switch of a power 60 to be disconnected, where a second control chip 504 is further configured to determine that the switch signal does not match the bus signal, if the turn-off signal is detected and the bus signal does not enter an attenuating state.

**[0058]** In this embodiment, because the relay 404 has the risk of contact adhesion, if the relay 404 is adhesive after closed, it will no longer respond to the switch signal of the pressure switch 402 or a control signal of the control module 50. That is, the relay cannot be effectively disconnected after receiving the turn-off signal. At this point, the control module 50 is needed to directly control the compressor 10 to stop operating. If the pressure switch 402 detects the pressure signal being higher than or equal to the pressure threshold, i.e., overpressure is detected, the turn-off signal is transmitted to the relay 404, and the second control chip 504 receives a power-off signal simultaneously. At this point, the second control chip 504 actively detects the change of a bus voltage of the drive module 30. If the bus voltage continues decreasing, it indicates that the relay 404 is normally disconnected. If the bus voltage does not change, it indicates that the relay 404 is not normally disconnected. At this point, the second control chip 504 turns off a drive chip 302 of the compressor 10, i.e. the first control chip 502, and thus the first control chip 502 stops outputting the drive control signal to the drive module 30.

**[0059]** The pressure threshold may be a maximum pressure value ensuring normal operation of the compressor 10.

**[0060]** The control module 50 is electrically connected to the drive module 30 and the pressure switch module 40, and is configured to input the drive control signal to the drive module 30.

**[0061]** The drive module 30 is further configured to control the compressor 10 to operate according to the drive control signal.

**[0062]** The control module 50 is further configured to control the compressor 10 to stop operating based on detecting that the switch signal does not match the bus signal of the drive module 30.

**[0063]** In the process of controlling operation of the compressor 10, the pressure switch module 40 can detect a working state of the compressor 10, and control disconnection between the power supply loop 20 and the drive module 30 to stop providing power to the compressor 10, when it is detected that the compressor 10 operates abnormally, such that the compressor 10 stops operating.

**[0064]** For preventing the control of the pressure switch module 40 from failing, a diagnostic function of the control module 50 is added to detect whether a state of the switch signal matches the bus signal of the drive module 30. When it is detected that the above relationship matches, it indicates that the control of the pressure switch module 40 remains in an effective state. When it is detected that the above relationship does not match, it indicates that the control of the pressure switch module 40 fails. At this point, the compressor 10 is controlled to stop operating, thus preventing the compressor 10 from running when a working state of the pressure switch module 40 is failed, thereby reducing a probability of abnormal operation and improving the security and reliability of the operation of the compressor 10.

**Embodiment 2**

**[0065]** The control module 50 is further defined based on embodiment 1. The control module 50 includes an integrated control chip arranged separately. The use of one integrated control chip is conducive to a simplified configuration of the circuit

**[0066]** Specifically, there is no need to add a chip with a diagnostic function based on setting the integrated control chip, and the integrated control chip diagnoses the switch signal such as whether +12V voltages are input, and the bus voltage, to implement a detection.

**Embodiment 3**

**[0067]** As shown in Figure 2, the control module 50 is further defined based on embodiment 1, including: the first control chip 502, electrically connected to the drive module 30 and configured to output the drive control signal to the drive module 30; the second control chip 504, electrically connected to the drive module 30 to acquire the bus signal. The second control chip 504 is further connected to a join point between the pressure switch 402 and the power control switch to acquire the switch signal. The second control chip 504 is further electrically connected to the first control chip 502 to control the first control chip 502 to stop outputting the drive control signal based on detecting that the switch signal does not match the bus signal, such that the compressor 10 stops operating.

**[0068]** In this embodiment, since the pressure protection circuit in the related art has been provided with a control chip with the same function as the first control chip 502, the second control chip 504 defined in embodiments of the present disclosure is added based on the pressure protection circuit in the related art, which is conducive to reducing the manufacturing cost while realizing abnormity diagnosing, detecting and controlling.

**[0069]** Further, the second control chip 504 may also control the drive module 30 directly, and the pressure protection circuit specifically includes: the drive chip 302 included in the drive module 30, where the drive chip 302 is electrically connected to the first control chip 502 and the second control chip 504 individually, and the drive chip 302 is configured to unlock the drive control signal. The second control chip 504 is further configured to control the drive chip 302 to turn off.

**[0070]** In this embodiment, the second control chip 504 may also directly control the drive chip 302 of the drive module 30 to turn off, thereby ensuring the reliability of the compressor 10 to be controlled to stop operating. Further, by being provided with the second control chip 504, the compressor 10 can still be effectively stopped when the first control chip 502 is abnormal, thereby ensuring the security of the system.

**[0071]** The second control chip 504 is further configured to determine that the switch signal matches the bus signal, if the turn-off signal is detected and the bus signal enters the attenuating state, and the microprocessor is further configured to set the switch signal as a turn-on signal, where the turn-on signal is used to control the control switch of the power 60 to be connected, where the second control chip 504 is further configured to determine that the switch signal matches the bus signal, if the turn-on signal is detected and the bus signal enters an augmenting state.

**[0072]** In this embodiment, it is detected that whether the switch signal matches the bus signal of the drive module 30. It is defined that the compressor 10 is controlled to stop operating under a mismatched condition, and a matched condition corresponds to a normal working state of the compressor 10, thereby ensuring the integrity of pressure protection control.

**[0073]** Specifically, the second control chip 504 with the diagnostic function is added to detect the bus voltage of the drive module 30 when the pressure switch 402 moves, so as to determine whether the contact of the relay 404 is effectively disconnected. When it is detected that the contact of the relay 404 is adhesive, the second control chip 504 will turn off the first control chip 502 of the drive module 30, such that the first control chip 502 turns off a control signal of the relay 404 and the drive control signal of the compressor 10.

**[0074]** On the basis of above embodiments 1 and 2, the pressure protection circuit further includes: a control power 60, configured to provide power to the control module 50, and the control power 60 is further configured to provide power to the pressure switch 402, such that the pressure switch 402 generates the switch signal correspondingly according to a power supply signal of the control power 60 and a detection result of the pressure signal, and to output the power supply signal to the power control switch or to stop outputting the power supply signal to the power control switch according to the switch signal.

**[0075]** In this embodiment, connection or disconnection of the power control switch is determined according to whether the power supply signal of the control power 60 is received. In a normal working state, if stopping receiving the power supply signal, the power control switch will be disconnected automatically. In an abnormal working state such as the contact adhesion as mentioned above, after the contact is connected and adhesive, even if the power supply signal is stopped, the power control switch is still in a connected state. There is a risk that the operating pressure of the compressor 10 continues increasing in this case, and the risk would be avoided as much as possible by controlling the compressor 10 to stop operating.

**[0076]** In any one of the above embodiments, the drive module 30 includes an intelligent power module and/or an IGBT module, where the intelligent power module and/or the IGBT module are (is) provided with a transistor component, and the first control chip 502 is further configured to set a pulse width modulated signal as the drive control signal, where the pulse width modulated signal is used to control the transistor component to be connected or disconnected.

**[0077]** In this embodiment, the drive module 30 may include a rectifier, a PFC module and an IPM (intelligent power module) module, etc., or may only include an IPM module. By outputting the drive control signal to the drive module 30, the drive control of a motor of the compressor 10 is realized along with connection of the power supply loop 20. Thus, the motor of the compressor 10 can be controlled to stop operating by stopping outputting the drive control signal, thereby ensuring the controllability of the operation of the compressor 10.

**Embodiment 4**

**[0078]** On the basis of the definition of the pressure protection circuit, a pressure protection control method for a compressor is further described. Figure 3 shows a pressure protection control method according to an embodiment of the present disclosure, which includes step 602.

**[0079]** At step 602, the compressor is controlled to stop operating based on detecting that the bus signal of the drive module does not match the operation status of the pressure switch module.

**[0080]** In this embodiment, in the process of controlling operation of the compressor, the pressure switch module can detect a working state of the compressor, and control disconnection between a power supply loop and the drive module to stop providing power to the compressor, when it is detected that the compressor operates abnormally, such that the compressor stops operating.

**[0081]** For preventing the control of the pressure switch module from failing, a diagnostic function is added to detect whether a state of the switch signal matches the bus signal of the drive module. When it is detected that the above relationship matches, it indicates that the control of the pressure switch module remains in an effective state. When it is detected that the above relationship does not match, it indicates that the control of the pressure switch module fails. At this point, the compressor is controlled to stop operating, thus preventing the compressor from running when a working state of the pressure switch module is failed, thereby reducing a probability of abnormal operation and improving the security and reliability of the operation of the compressor.

**[0082]** In any one of the above embodiments, controlling the compressor to stop operation specifically includes: controlling to stop outputting the drive control signal to the drive module, and/or controlling to turn off a drive chip of the drive module, where the drive module further includes an intelligent power module and/or an IGBT module, and the intelligent power module and/or the IGBT module are(is) provided with a transistor component, and a pulse width modulated signal is set as the drive control signal, where the pulse width modulated signal is used to control the transistor component to be connected or disconnected.

**[0083]** In this embodiment, the drive module may include a rectifier, a PFC module and an intelligent power module (IPM) module, etc., or may only include an IPM module. By outputting the drive control signal to the drive module, the drive control of a compressor motor is realized along with connection of the power supply loop. Thus, the compressor motor can be controlled to stop operating by stopping outputting the drive control signal, thereby ensuring the controllability of the operation of the compressor.

**Embodiment 5**

**[0084]** According to the detection to the pressure signal of the pressure vessel, controlling the compressor to stop operating based on determining that the bus signal of the drive module does not match the operation status of the pressure switch module specifically includes: detecting the bus signal in response to acquisition of a turn-off signal output by the pressure switch module, determining that the operation status does not match the bus signal and controlling the compressor to stop operating, if it is detected that the bus signal does not decrease to a voltage threshold within a specified period, where the turn-off signal is generated when a pressure signal of the pressure vessel detected by the pressure switch module is higher than or equal to a pressure threshold.

**[0085]** In this embodiment, taking the relay as an example, if overpressure is detected, it will trigger the detection of the change in a bus voltage of the drive module. If the bus voltage continues decreasing, it indicates that the relay is normally disconnected. If the bus voltage does not change, it indicates that the relay is not normally disconnected. At this point, it is controlled to stop outputting the drive control signal. For preventing the relay from failing, the above diagnostic function of the control module is added to take remedial measures in time when the power control switch fails, thereby reducing the risk of operation in the event of failure.

**Embodiment 6**

**[0086]** It may also be detected that whether the bus signal of the drive module matches the operation status of the pressure switch module by adjusting a control program at a power-on stage. The method specifically includes: controlling the driver module to output the drive control signal before the pressure switch module starts operation in response to a power-on signal; determining that the operation status does not match the bus signal and controlling the compressor to stop operation, if it is detected that the bus signal is in an increasing state.

**[0087]** In this embodiment, it may also be detected whether the bus signal of the drive module matches the operation status of the pressure switch module in a process of controlling the compressor to start operating. For example, when the pressure switch has not output a turn-off signal to the relay yet after power on, if it is detected that the bus voltage of the drive module reaches a high voltage value, it may also be determined that the relay operates abnormally, thus controlling the compressor to stop operating, thereby ensuring the security of the operation of the compressor.

**[0088]** On the basis of above embodiments 3 to 5, the pressure protection control method in embodiments of the present disclosure is further supplemented. The pressure switch module includes a relay arranged between the driver module and the power supply loop, where the pressure protection control method further includes: de-

termining that the relay is abnormal and generating an abnormal alarm message if it is detected that the bus signal does not match the operation status.

**[0089]** In this embodiment, if it is detected that the relay is abnormal, the abnormal alarm message is transmitted to a user, to guide the user to solve the abnormality in time.

**Embodiment 7**

**[0090]** On the basis of the pressure protection circuit in above embodiments 1 to 3, Figure 4 shows a pressure protection control method in another embodiment of the present disclosure, including steps S702, S704, S706, S708, S710 and S712.

**[0091]** At step S702, the second control chip operates normally.

**[0092]** At step S704, it is detected whether to output the power supply signal to the relay, if yes, step S712 is executed; if no, step S706 is executed.

**[0093]** At step S706, it is detected whether the bus signal decreases to a voltage threshold within a specified period, if yes, step S710 is executed; if no, step S708 is executed.

**[0094]** At step S708, it is determined that the contact of the relay is adhesive and the drive chip of the compressor is turned off, and the first control chip is controlled to stop outputting the control signal of the relay and the drive control signal.

**[0095]** At step S710, the compressor stops operating.

**[0096]** At step S712, the compressor operates normally.

**[0097]** Specifically, the air conditioning system is provided with the compressor, which includes the pressure vessel. The pressure in the pressure vessel will change when the compressor operates, and the power supply signal of the relay is turned off in the pressure protection circuit via disconnection of the pressure switch, making the contact of the relay to be disconnected, such that the power supply of the power part of the drive module in the compressor is disconnected, to stop the compressor.

**[0098]** The second control chip detects that the power supply signal of +12V is disconnected after the pressure switch moves, and detects the bus voltage Vdc in the drive module at this point. If the contact is disconnected normally, Vdc will continue to decrease. If the contact of the relay is adhesive, Vdc will remain in current state. When detecting that Vdc does not decrease to a preset voltage value within a preset period, the second control chip will turn off the drive chip of the compressor to stop the compressor.

**[0099]** When the second control chip detects that the relay is adhesive, the first control chip is informed simultaneously to turn off the drive control signal of the compressor and the control signal of the relay.

**[0100]** When it is detected that the overpressure protection circuit works normally, that is, Vdc decreases effectively, the second control chip operates normally without other actions.

**[0101]** When there is overpressure and the contact of the relay is adhesive, and the pressure protection circuit fails, contact adhesion is detected by the control module, and the drive chip is turned off and the compressor is stopped. In the meantime, the first control chip turns off the drive control signal of the compressor and the control signal of the relay, thus the system entering a safe status, thereby ensuring the security and reliability of the system.

**[0102]** As shown in Figure 5, the present disclosure further provided in embodiments a computer-readable storage medium 800, having stored therein a computer program 802 that, when executed by a processor, implements steps of a pressure protection control method as defined in any one of the above embodiments, thus having technical effects as defined in any one of the above embodiments, which are not repeated here.

**[0103]** In this embodiment, the computer program 802 when executed by a processor, implements the following step:

controlling the compressor to stop operating based on detecting that a bus signal of the drive module does not match an operation status of the pressure switch module.

**[0104]** In this embodiment, in the process of controlling operation of the compressor, the pressure switch module can detect a working state of the compressor, and control disconnection between a power supply loop and the drive module to stop providing power to the compressor, when it is detected that the compressor operates abnormally, such that the compressor stops operating.

**[0105]** For preventing the control of the pressure switch module from failing, a diagnostic function is added to detect whether a state of the switch signal matches the bus signal of the drive module. When it is detected that the above relationship matches, it indicates that the control of the pressure switch module remains in an effective state. When it is detected that the above relationship does not match, it indicates that the control of the pressure switch module fails. At this point, the compressor is controlled to stop operating, thus preventing the compressor from running when a working state of the pressure switch module is failed, thereby reducing a probability of abnormal operation and improving the security and reliability of the operation of the compressor.

**[0106]** In above embodiments, the compressor includes a pressure vessel, where controlling the compressor to stop operating based on detecting that a bus signal of the drive module does not match an operation status of the pressure switch module specifically includes: detecting the bus signal in response to acquisition of a turn-off signal output by the pressure switch module, determining that the operation status does not match the bus signal and controlling the compressor to stop operating, if it is detected that the bus signal does not decrease to a voltage threshold within a specified period, where the turn-off signal is generated when a pressure signal of the pressure vessel detected by the pressure switch module is higher than or equal to a pressure threshold.

**[0107]** In this embodiment, taking the relay as an example, if overpressure is detected, it will trigger the detection of the change in a bus voltage of the drive module. If the bus voltage continues decreasing, it indicates that the relay is normally disconnected. If the bus voltage does not change, it indicates that the relay is not normally disconnected. At this point, it is controlled to stop outputting the drive control signal. For preventing the relay from failing, the above diagnostic function of the control module is added to take remedial measures in time when the power control switch fails, thereby reducing the risk of operation in the event of failure.

**[0108]** In any one of the above embodiments, controlling the compressor to stop operating based on detecting that a bus signal of the drive module does not match an operation status of the pressure switch module specifically includes: controlling the driver module to output the drive control signal before the pressure switch module starts operation in response to a power-on signal; determining that the operation status does not match the bus signal and controlling the compressor to stop operation, if it is detected that the bus signal is in an increasing state.

**[0109]** In this embodiment, it may also be detected whether the bus signal of the drive module matches the operation status of the pressure switch module in a process of controlling the compressor to start operating. For example, when the pressure switch has not output a turn-off signal to the relay yet after power on, if it is detected that the bus voltage of the drive module reaches a high voltage value, it may also be determined that the relay operates abnormally, thus controlling the compressor to stop operating, thereby ensuring the security of the operation of the compressor.

**[0110]** In any one of the above embodiments, controlling the compressor to stop operation specifically includes: controlling to stop outputting the drive control signal to the drive module, and/or controlling to turn off a drive chip of the drive module, where the drive module further includes an intelligent power module and/or an IGBT module, where the intelligent power module and/or the IGBT module are(is) provided with a transistor component, and a pulse width modulated signal is set as the drive control signal, where the pulse width modulated signal is used to control the transistor component to be connected or disconnected.

**[0111]** In this embodiment, the drive module may include a rectifier, a PFC module and an intelligent power module (IPM) module, etc., or may only include an IPM module. By outputting the drive control signal to the drive module, the drive control of a compressor motor is realized along with connection of the power supply loop. Thus, the compressor motor can be controlled to stop operating by stopping outputting the drive control signal, thereby ensuring the controllability of the operation of the compressor.

**[0112]** In any one of the above embodiments, the pressure switch module includes a relay arranged between the driver module and the power supply loop, where the pressure protection control method further includes: determining that the relay is abnormal and generating an abnormal alarm message if it is detected that the bus signal does not match the operation status. If it is detected that the relay is abnormal, the abnormal alarm message is transmitted to a user, to guide the user to solve the abnormality in time.

**[0113]** In the present disclosure, terms such as "first", "second" and "third" are used herein for purposes of description and are not intended to indicate or imply relative importance or significance. Terms "a plurality of' means two or more than two this features, unless specified otherwise. Terms "mounted", "connected", "coupled", "fixed" and the like are used broadly, and may be, for example, fixed connections, detachable connections, or integrated connections; may also be direct connections or indirect connections via intervening structures, which can be understood by those skilled in the art according to specific situations.

**[0114]** In the specification, it should be understood that, the terms indicating orientation or position relationship such as "above", "below", "left", "right", "front", "rear", should be construed to refer to the orientation or position relationship as then described or as shown in the drawings. These terms are merely for convenience and concision of description and do not alone indicate or imply that the device or element referred to must have a particular orientation or must be configured or operated in a particular orientation. Thus, it cannot be understood to limit the present disclosure.

**[0115]** Reference throughout this specification to "an embodiment", "some embodiments" and "a specific example" means that a particular feature, structure, material, or characteristic described in connection with the embodiment or example is included in at least one embodiment or example of the present disclosure. Thus, the appearances of the above phrases, in various places throughout this specification are not necessarily referring to the same embodiment or example of the present disclosure. Furthermore, the particular features, structures, materials, or characteristics may be combined in any suitable manner in one or more embodiments or examples.

**[0116]** The above are only preferred embodiments of the present disclosure, which are not used to limit present disclosure. For those skilled in the art, the present disclosure may have various modifications and changes. Any modifications, alternatives, improvements, etc. made within the spirit and principles of this present disclosure shall be included in the protected scope of this disclosure.

## Claims

1. A pressure protection circuit suitable for a compressor, comprising:

   a drive module, electrically connected to the

compressor;
a pressure switch module, configured to be arranged between the drive module and a power supply loop of the compressor, and configured to output a switch signal, wherein the switch signal is used to control connection or disconnection between the power supply loop and the drive module; and
a control module, electrically connected to the drive module and the pressure switch module, and configured to input a drive control signal to the drive module, such that the drive module controls the compressor to operate according to the drive control signal,
wherein the control module is further configured to control the compressor to stop operating based on detecting that the switch signal does not match a bus signal of the drive module.

**2.** The pressure protection circuit according to claim 1, wherein the compressor comprises a pressure vessel, wherein the pressure switch module comprises:

a pressure switch, configured to detect a pressure signal of the pressure vessel, and generate the switch signal correspondingly according to the pressure signal; and
a power control switch, arranged between the drive module and the power supply loop, and electrically connected to the pressure switch, wherein the power control switch is connected according to the switch signal such that the power supply loop is connected to the drive module, or the power control switch is disconnected according to the switch signal such that the power supply loop is disconnected to the drive module.

**3.** The pressure protection circuit according to claim 2, wherein the power control switch comprises any one of a relay, a contactor and a semiconductor power switch.

**4.** The pressure protection circuit according to claim 2,

wherein the control module comprises an integrated control chip arranged separately; or
wherein the control module comprises a first control chip and a second control chip,
wherein
the first control chip is electrically connected to the drive module and configured to output the drive control signal to the drive module, the second control chip is electrically connected to the drive module to acquire the bus signal,
the second control chip is further connected to a join point between the pressure switch and the power control switch to acquire the switch signal,
the second control chip is further electrically connected to the first control chip to control the first control chip to stop outputting the drive control signal based on detecting that the switch signal does not match the bus signal, such that the compressor stops operating.

**5.** The pressure protection circuit according to claim 4, wherein the drive module comprises a drive chip, wherein the drive chip is electrically connected to the first control chip and the second control chip individually, and the drive chip is configured to unlock the drive control signal;
wherein the second control chip is further configured to control the drive chip to turn off.

**6.** The pressure protection circuit according to claim 4, wherein the pressure switch is arranged at an exit of the pressure vessel and further comprises:

a pressure sensor, configured to detect the pressure signal;
a microprocessor, electrically connected to the pressure sensor and configured to set the switch signal as a turn-off signal based on detecting that the pressure signal is higher than or equal to a pressure threshold, wherein the turn-off signal is used to control the power control switch to be disconnected,
wherein the second control chip is further configured to determine that the switch signal does not match the bus signal, if the turn-off signal is detected and the bus signal does not enter an attenuating state.

**7.** The pressure protection circuit according to claim 6,

wherein the second control chip is further configured to determine that the switch signal matches the bus signal, if the turn-off signal is detected and the bus signal enters the attenuating state, and
wherein the microprocessor is further configured to set the switch signal as a turn-on signal, wherein the turn-on signal is used to control the power control switch to be connected,
wherein the second control chip is further configured to determine that the switch signal matches the bus signal, if the turn-on signal is detected and the bus signal enters an augmenting state.

**8.** The pressure protection circuit according to any one of claims 2 to 7, further comprising:

a control power, configured to provide power to the control module,
wherein the control power is further configured to provide power to the pressure switch, such

that the pressure switch generates the switch signal correspondingly according to a power supply signal of the control power and a detection result of the pressure signal, and to output the power supply signal to the power control switch or to stop outputting the power supply signal to the power control switch according to the switch signal.

**9.** The pressure protection circuit according to claim 4, wherein the drive module comprises an intelligent power module and/or an IGBT module, wherein the intelligent power module and/or the IGBT module are (is) provided with a transistor component,
wherein the first control chip is further configured to set a pulse width modulated signal as the drive control signal, wherein the pulse width modulated signal is used to control the transistor component to be connected or disconnected.

**10.** A pressure protection control method applied to a pressure protection circuit for a compressor, wherein the pressure protection circuit comprises a pressure switch module and a drive module, and the pressure switch module is configured to control connection or disconnection between a power supply loop of the compressor and the drive module, wherein the pressure protection control method comprises:
controlling the compressor to stop operating based on detecting that a bus signal of the drive module does not match an operation status of the pressure switch module.

**11.** The pressure protection control method according to claim 10, wherein the compressor comprises a pressure vessel, wherein controlling the compressor to stop operating based on detecting that a bus signal of the drive module does not match an operation status of the pressure switch module specifically comprises:

detecting the bus signal in response to acquisition of a turn-off signal output by the pressure switch module,
determining that the operation status does not match the bus signal and controlling the compressor to stop operating, if it is detected that the bus signal does not decrease to a voltage threshold within a specified period,
wherein the turn-off signal is generated when a pressure signal of the pressure vessel detected by the pressure switch module is higher than or equal to a pressure threshold.

**12.** The pressure protection control method according to claim 10, wherein controlling the compressor to stop operating based on detecting that a bus signal of the drive module does not match an operation status of the pressure switch module specifically comprises:

controlling the driver module to output a drive control signal before the pressure switch module starts operation in response to a power-on signal;
determining that the operation status does not match the bus signal and controlling the compressor to stop operation, if it is detected that the bus signal is in an increasing state.

**13.** The pressure protection control method according to claim 10 or 11, wherein controlling the compressor to stop operation specifically comprises:

controlling to stop outputting the drive control signal to the drive module, and/or
controlling to turn off a drive chip of the drive module,
wherein the drive module further comprises an intelligent power module and/or an IGBT module, wherein the intelligent power module and/or the IGBT module are(is) provided with a transistor component, and a pulse width modulated signal is set as the drive control signal, wherein the pulse width modulated signal is used to control the transistor component to be connected or disconnected.

**14.** The pressure protection control method according to any one of claims 10 to 12, wherein the pressure switch module comprises a relay arranged between the driver module and the power supply loop, wherein the pressure protection control method further comprises:
determining that the relay is abnormal and generating an abnormal alarm message if it is detected that the bus signal does not match the operation status.

**15.** A computer-readable storage medium having stored therein an operating validation program that, when executed by a processor, implements a pressure protection control method according to any one of claims 10 to 14.

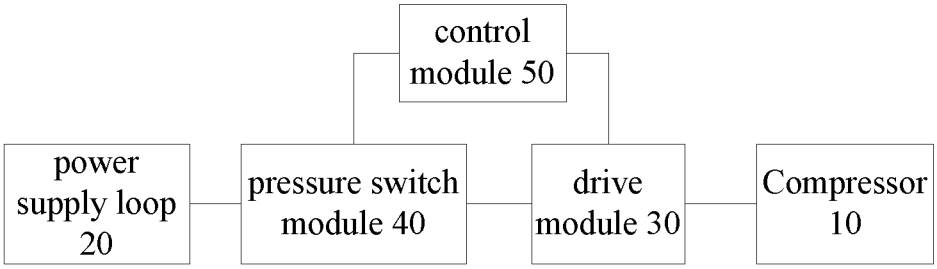



Figure 1

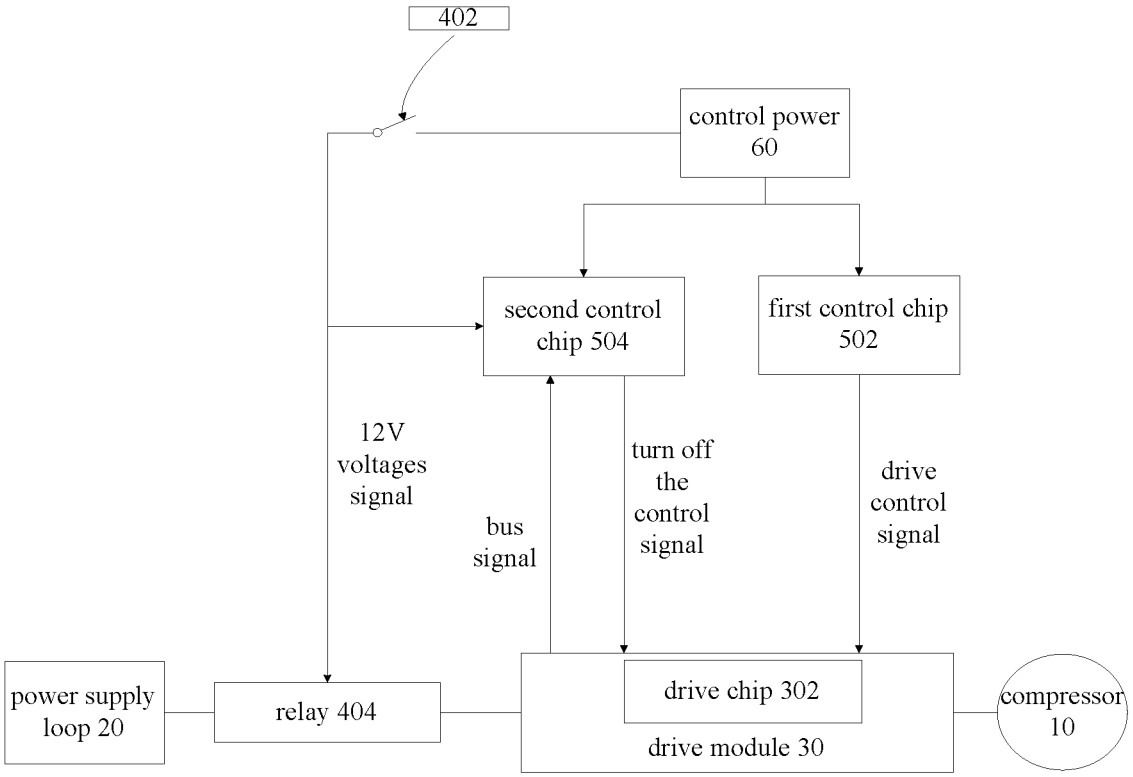



Figure 2

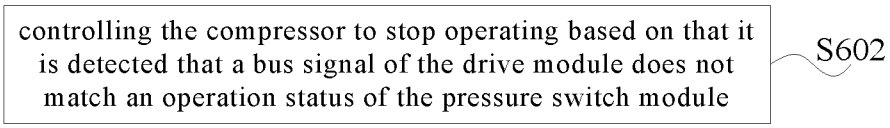



Figure 3

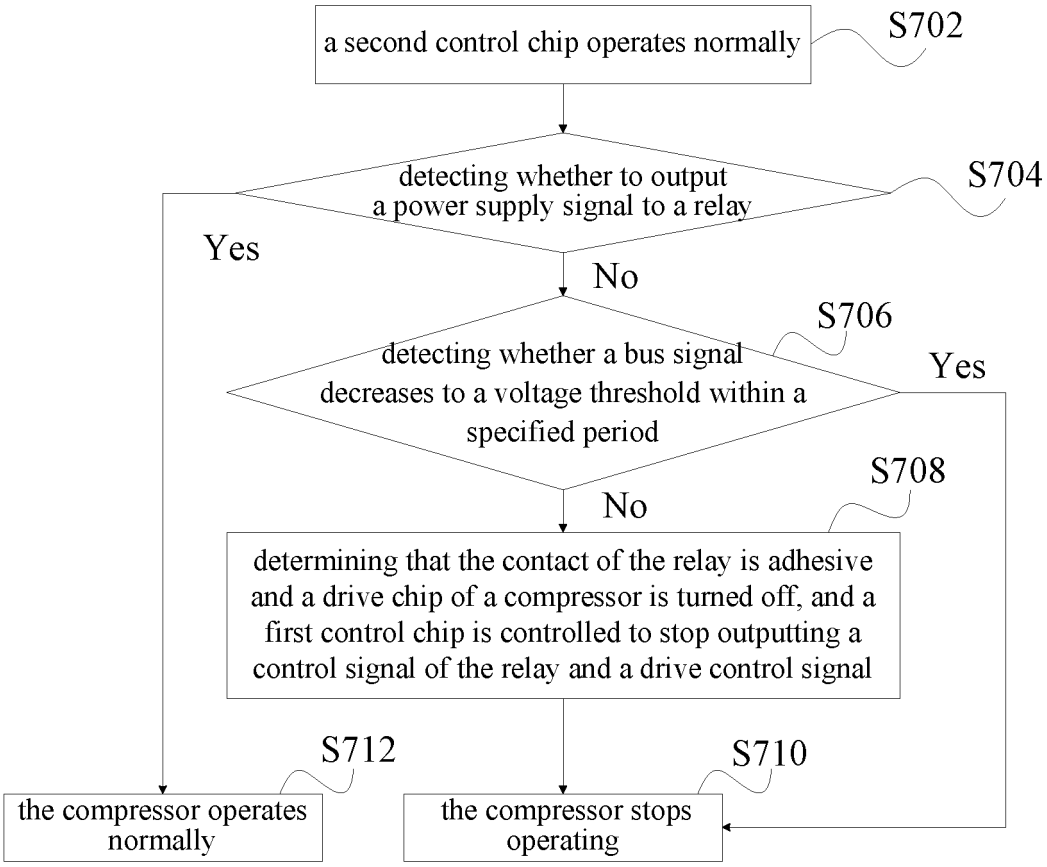



Figure 4




Figure 5

# INTERNATIONAL SEARCH REPORT

International application No.
**PCT/CN2020/076442**

**A. CLASSIFICATION OF SUBJECT MATTER**

F04B 49/06(2006.01)i; F04B 49/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

F04B,F24F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

CNABS, CNKI, DWPI, SIPOABS: 空调, 压缩机, 逆变器, 继电器, 硬件, 软件, 驱动, 关闭, 停止, 检测, 电压, 压力, 过压, 失效, 开关, 保护, 冗余, 双重, air conditioner, compressor, converter, relay, hardware, software, drive, close, stop, detect, voltage, pressure, overvoltage, overpressure, failure, switch, protect, redundant, double

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | CN 107580750 A (DAIKIN INDUSTRIES, LTD.) 12 January 2018 (2018-01-12)<br>description, paragraphs 57-94, and figures 1-15 | 1-15 |
| A | CN 1955596 A (LG ELECTRONICS (TIANJIN) ELECTRICAL APPLIANCES CO., LTD.) 02 May 2007 (2007-05-02)<br>entire document | 1-15 |
| A | JP 2004324966 A (AISIN SEIKI K. K.) 18 November 2004 (2004-11-18)<br>entire document | 1-15 |
| A | CN 107084514 A (GUANDONG MIDEA HVAC EQUIPMENT CO., LTD. et al.) 22 August 2017 (2017-08-22)<br>entire document | 1-15 |
| A | CN 107143985 A (GUANDONG MIDEA HVAC EQUIPMENT CO., LTD. et al.) 08 September 2017 (2017-09-08)<br>entire document | 1-15 |

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

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

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| **07 September 2020** | **21 September 2020** |
| Name and mailing address of the ISA/CN<br>**China National Intellectual Property Administration (ISA/CN)**<br>**No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088**<br>**China** | Authorized officer |
| Facsimile No. **(86-10)62019451** | Telephone No. |

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

**INTERNATIONAL SEARCH REPORT**
**Information on patent family members**

International application No.
**PCT/CN2020/076442**

| Patent document cited in search report | | | Publication date (day/month/year) | Patent family member(s) | | | Publication date (day/month/year) |
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| | | | | WO | 2016167111 | A1 | 20 October 2016 |
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| | | | | EP | 3285387 | A4 | 16 January 2019 |
| | | | | IN | 201717039444 | A | 22 December 2017 |
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| JP | 2004324966 | A | 18 November 2004 | None | | | |
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Form PCT/ISA/210 (patent family annex) (January 2015)

## REFERENCES CITED IN THE DESCRIPTION

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