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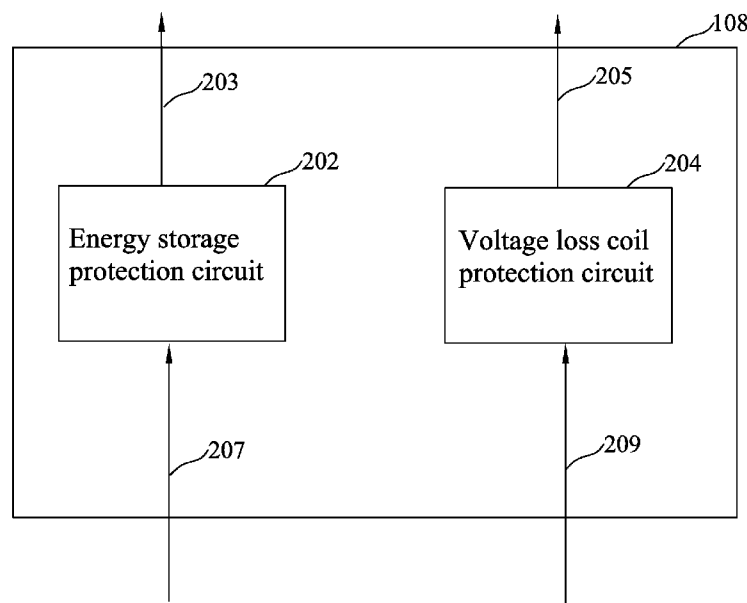


Fig. 2A

(57) **Abstract:** The present application provides an improved voltage loss protection circuit, which includes a voltage loss coil protection circuit and an energy storage protection circuit, and a starting cabinet with the improved voltage loss protection circuit. The voltage loss protection circuit can control a first power supply according to the operation state of a second power supply. The first power supply provides power to a compressor and the second power supply provides power to an oil pump for sending lubrication oil to the compressor. When the second power supply encounters voltage loss or excessive voltage reduction, the voltage loss coil protection circuit or the energy storage protection circuit operates independently in parallel to cut off the first power supply from the compressor to prevent the compressor from running without lubrication oil.



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VOLTAGE LOSS PROTECTION CIRCUIT AND STARTING CABINET

Field of the Application

- 5 This application relates to a voltage loss protection circuit for starting motors and a starting cabinet that includes the voltage loss circuit, and in particular to a voltage loss protection circuit and a starting cabinet for starting motors in an air conditioning unit.

Background of the Application

- 10 In the existing starting cabinet for starting motors in an air conditioning unit, the power supply for a lubricating oil pump and the main power supply for a compressor are from two separate power supplies. The two separate power supplies can ensure safe operation of the compressor through a voltage loss coil in the starting cabinet. More specifically, when the power supply for the lubricating oil pump is in voltage loss condition (that is, in failure condition or in excessive voltage reduction condition), the voltage loss coil in the voltage loss protection circuit cuts off the main power supply from the compressor to prevent the compressor from operating without lubricating oil.

- 20 In the existing starting cabinet for air conditioning unit, if the voltage loss coil is in a fault or failure condition, the main power supply for the compressor can be still running even if when the power supply for the lubricating oil pump has encountered power failure or voltage loss. Under such an operation condition, it may lead to failure of the compressor due to lacking lubricating oil.

- 25 Therefore, it is needed to provide an improved voltage loss protection circuit and a starting cabinet, in which even if when power failure or voltage loss has occurred to the oil pump power supply and the voltage loss coil is in fault or failure condition, the main power supply for the compressor can be stopped so as to provide a dual protection and to better avoid the problem of continuously running of the compressor without the

lubricating oil.

Summary of the Application

5 In a first aspect, the present application provides a voltage loss protection circuit that comprises:

a voltage loss coil protection circuit; and

an energy storage protection circuit;

wherein the voltage loss protection circuit is coupled to, or is coupled between, a

10 first power supply and a second power supply,

wherein when voltage loss of the second power supply occurs, the voltage loss coil protection circuit or the energy storage protection circuit works independently to cut off the first power supply,

wherein the voltage loss protection circuit controls a first power supply according
15 to the operation state of a second power supply.

In the voltage loss protection circuit above, the energy storage protection circuit further comprises:

an energy storage device;

20 a discharge control circuit; and

a discharge load, the energy storage device being connected to the discharge load through the discharge control circuit;

when the second power supply is in a normal state, the discharge control circuit disconnects the energy storage device from the discharge load; and

25 when the second power supply is in a faulty state, the discharge control circuit connects the energy storage device to the discharge load.

The voltage loss protection circuit above, wherein:

the first power supply providing power to a first equipment and the second power

supply providing power to a second equipment,

the discharge load is a circuit breaker tripping coil,

the energy storage device is a capacitor, the current from the capacitor is discharged to the circuit breaker tripping coil based on the fault state of the second

5 power supply to cut off the first power supply from the first equipment.

The voltage loss protection circuit above, wherein the voltage loss coil protection circuit comprises:

a circuit breaker being arranged in the power supply path of connecting the first
10 power supply to the first equipment,

wherein when the second power supply is in fault state, the voltage loss coil protection circuit or the energy storage protection circuit cause tripping of the circuit breaker.

15 The voltage loss protection circuit above, wherein:

the energy storage protection circuit is connected to the tripping coil.

The voltage loss protection circuit above, wherein:

the discharge load comprises a tripping coil;

20 the voltage loss coil protection circuit comprises a voltage loss trip coil.

The voltage loss protection circuit above, wherein:

the first power supply supplies power to a first equipment;

the second power supply supplies power to a second equipment.

25

In a second aspect, the present application provides a starting cabinet that comprises:

a first power supply, wherein the first power supply supplies power to a first equipment;

a second power supply, wherein the second power supply supplies power to a

second equipment;

a voltage loss protection circuit for controlling the first power supply according to the operation state of the second power supply, the voltage loss protection circuit comprising a voltage loss coil protection circuit and an energy storage protection circuit;

5 wherein the voltage loss protection circuit is coupled to, or is coupled between, the first power supply and the second power supply,

wherein when voltage loss of the second power supply occurs, the voltage loss coil protection circuit or the energy storage protection circuit works independently to cut off the first power supply.

10

In the starting cabinet above, the energy storage protection circuit further comprises:

an energy storage device;

a discharge control circuit; and

a discharge load, the energy storage device being connected to the discharge load

15 through the discharge control circuit;

when the second power supply is in a normal state, the discharge control circuit disconnects the energy storage device from the discharge load; and

when the second power supply is in a faulty state, the discharge control circuit connects the energy storage device to the discharge load.

20

The starting cabinet above, wherein:

the discharge load is a circuit breaker tripping coil,

the energy storage device is a capacitor,

the current from the capacitor is discharged to the circuit breaker tripping coil

25 based on the fault state of the second power supply to cut off the first power supply from the first equipment.

The starting cabinet above, wherein the voltage loss coil protection circuit comprises:

a circuit breaker being arranged in the power supply path of connecting the first

power supply to the first equipment,

wherein when the second power supply is in fault state, the voltage loss coil protection circuit or the energy storage protection circuit cause tripping of the circuit breaker.

5

The starting cabinet above, wherein:

the energy storage protection circuit is connected to the tripping coil.

The starting cabinet above, wherein:

10 the discharge load comprises a tripping coil;

the voltage loss coil protection circuit comprises a voltage loss trip coil.

The starting cabinet above, wherein:

the first equipment is a compressor;

15 the second equipment is an oil pump.

In view of the technical problems in the existing voltage loss protection circuit and starting cabinet, the present application describes an improvement and optimal design of the voltage loss protection circuit and the starting cabinet by providing an energy
20 storage protection circuit and a discharging control circuit. With the energy storage protection circuit and discharging control circuit, when the second power supply is in a fault condition, on one hand, a voltage loss trip coil of the circuit breaker will act, and on the other hand, the energy storage device can also be discharged to the tripping coil in the circuit breaker to cause the tripping of the circuit breaker to cut off the first power
25 supply. The present application effectively utilizes the circuit breaker tripping coil, so the energy storage protection circuit can be added without changing or by slightly changing the existing voltage loss protection circuit. In the present application, when the first power supply is used to supply power to a compressor and the second power supply is used to supply power to an oil pump, the voltage loss protection circuit and

the starting cabinet in the present application provides dual protection to the compressor when the second power supply encounters failure or voltage loss. More specifically, when the second power supply encounters failure or voltage loss and the voltage loss trip coil cannot function, the energy storage protection circuit discharges current to the tripping coil to cause the tripping of the circuit breaker so as to cut off the first power supply to prevent the compressor from being operated without lubricating oil.

Brief Description of the Drawings

Features and advantages of the present application can be better understood by reading the following detailed description with reference to the accompanying drawings, in which identical reference numbers represent identical parts and components, wherein:

Fig. 1 is an illustrative structure diagram of an air conditioning unit 100 according to the present application;

Fig. 2A is an illustrative structure diagram of the voltage loss protection circuit 108 of the present application;

Fig. 2B is an illustrative structure diagram of the energy storage protection circuit 202 of the present application in greater details;

Fig. 2C is an illustrative structure diagram of the voltage loss coil protection circuit 204 of the present application in greater details ;

Fig. 3A-3C are illustrative views of relays 302, 304 and 306 in the voltage loss protection circuit 108 as shown in Fig. 1 of the present application; and

Fig. 4 is an illustrative structure diagram of a voltage loss protection circuit 400, which shows the structure of the voltage loss protection circuit 108 of Fig. 1 in greater details.

Detailed Description of the Embodiments

Although the present application allows various forms of embodiments, one or more embodiments are shown in the accompanying drawings and are described below according to the spirits of the present application. Therefore, it should be understood

that the contents disclosed by the present application are merely deemed as being illustrative rather than limiting the present disclosure to any specific embodiment disclosed in the present application. In the accompanying drawings below, identical parts and components use identical reference signs, and similar parts and components
5 use similar reference signs so as to avoid repeated description.

Fig. 1 is an illustrative structure diagram of an air conditioning unit 100 according to the present application. As shown in Fig. 1, the air conditioning unit 100 includes a starting cabinet 102, a compressor 112 and an oil pump 114. The air conditioning unit
10 100 has two outputs of separate power supplies 105, 107 for respectively supplying powers to the compressor 112 and the oil pump 114. During the operation of the air conditioning unit 100, after starting cabinet 102 starts the motors in the compressor 112 and the oil pump 114, the oil pump 114 continuously provides lubricating oil to the compressor 112.

15 Still as shown in Fig. 1, the starting cabinet 102 includes two separate power supplies, namely a first power supply 104 and a second power supply 106, and a voltage loss protection circuit 108. Specifically, the first power supply (or main power supply) 104 can use an alternating current power supply of 10000V to supply power to the
20 compressor 112 through the power supply output 105; the second power supply 106 can use an alternating current voltage of 110V or 220V to supply power to the oil pump 114 through the power supply output 107. A voltage loss protection circuit 108 is connected to or coupled between the first power supply 104 and the second power supply 106. Through a connection 117, the voltage loss protection circuit 108 receives
25 and detects the operation state of the second power supply 106 to determine whether the second power supply 106 is in a normal operation state or a fault operation state, such as power failure or voltage loss. When the second power supply 106 encounters power failure or a voltage loss, the second power supply 106 provides or feeds back such a fault operation state to the voltage loss protection circuit 108 through the

connection 117. After receiving the fault operation state of the second power supply 106, the voltage loss protection circuit 108 generates a control signal or an activation signal and transmits the control signal or activation signal to the first power supply 104 through a connection 115 so as to cut off the power supply path between the first power supply 104 and the compressor 112.

Fig. 2A is an illustrative structure diagram of the voltage loss protection circuit 108 of the present application. As shown in Fig. 2A, the voltage loss protection circuit 108 includes an energy storage protection circuit 202 and a voltage loss coil protection circuit 204. Through a connection 209, the voltage loss coil protection circuit 204 is connected with the second power supply 106 as shown in Fig. 1, so that the voltage loss coil protection circuit 204 can determine or detect whether the second power supply 106 is in a normal operation state or a fault operation state, such as the power failure or the voltage loss. The voltage loss coil protection circuit 204 includes a trip coil (242 or 406 as shown in Fig. 2C and Fig. 4). When the second power supply 106 operates normally, a predetermined current flows through the trip coil from the connection 209 so as to generate an electromagnetic force that is large enough to connect switch contacts of the circuit breaker (such as indicated by reference number 252 as shown in Fig. 2C) in the power supply path between the first power supply 104 and the compressor 112, so that the first power supply 104 is connected to the compressor 112. When power failure or voltage loss of the second power supply 106 occurs, the current in the trip coil disappears or reduces, which causes loss or decrease of the electromagnetic force by the trip coil, which in turn results in disconnecting the switch contacts of the circuit breaker in the power supply path between the first power supply 104 and the compressor 112, thus cutting off the first power supply 104 from the compressor 112.

Similarly, through a connection 207, the energy storage protection circuit 202 is connected with the second power supply 106 as shown in Fig. 1 so that when the second

power supply 106 operates in normal condition, the power supply 106 can charge the energy storage circuit 202. The energy storage protection circuit 202 includes an energy storage device (such as a capacitor 222 as shown in Figs. 2B and Fig. 4), and a charging path and a discharging path. When the second power supply 106 operates in a normal operation state, the charging path in the energy storage protection circuit 202 is connected to and the discharging path is disconnected from the energy storage device, so that the energy storage device can be charged but cannot be discharged. When the second power supply 106 is in fault operation state, the discharging path in the energy storage protection circuit 202 is connected to the energy storage device so that the energy storage device can be discharged. The discharging current of the energy storage device is used to disconnect the switch contacts of the circuit breaker in the power supply path between the first power supply 104 and the compressor 112. The energy storage protection circuit 202 can provide the discharging current through a connection 203 to disconnect the switch contacts of the circuit breaker in the power supply path between the first power supply 104 and the compressor 112.

Fig. 2B is an illustrative structure diagram of the energy storage protection circuit 202 of the present application in greater details. As shown in Fig. 2B, the energy storage protection circuit 202 includes an energy storage capacitor 222, a charging path 223, a discharging path 225, a discharge control circuit 224 (which is used to control the discharging path 225), and a discharge load 226 connected in the discharging path 225. In the present application, the load 226 can be a tripping coil 405 in a circuit breaker as shown in Fig. 4. When the second power supply 106 operates in normal condition, the discharge control circuit 224 disconnects the discharging path 225 from the energy storage capacitor 222 so that the energy storage capacitor 222 is charged through input terminals 227, 229 by a DC power; when the second power supply 106 encounters power failure or a voltage loss, the discharge control circuit 224 connects the discharging path 225 to the energy storage capacitor 222, so that the discharging current from the energy storage capacitor 222 flows to the load 226; when the discharging

current from the energy storage capacitor 222 flows through the discharge load 226 (or through the tripping coil 405 in the circuit breaker as shown in Fig. 4), the discharge load 226 generates an activating magnetic force to disconnect the switch contacts of the circuit breaker in the power supplying path of the first power supply 104. In the present application, the discharge control circuit 224 can include a relay 306 (as shown in Figs. 3C and 4) to control the discharging path.

Fig. 2C is an illustrative structure diagram of the voltage loss coil protection circuit 204 of the present application in greater details. As shown in Fig. 2C, the voltage loss coil protection circuit 204 includes a trip coil 242, and in the present application, the trip coil 242 can be a voltage loss trip coil 406 as shown in Fig. 4. The trip coil 242 is arranged adjacent to a circuit breaker 252 that is located in the power supply path between the first power supply 104 and the compressor 112, so that the generation and disappearance of the magnetic force by the trip coil 242 can cause connection or disconnection of the contact points 254, 248 in the circuit breaker 252. As shown in Fig. 2C, the illustrative circuit breaker 252 includes a swinging rod 246 capable of swinging around a fixed point 253 and a movable plate 244 which is connected to and capable of swinging around the contact point 254. The movable plate 244 can connect the contact point 254 with the contact 248 or disconnect the contact point 254 from the contact point 248 when it is pivoted by the swinging rod 246.

A bias device, such as a bias spring component (not shown), applies a bias force to the swinging rod 246 so as to pull the swinging rod 246 in the absence of an external force, so that the movable piece 244 is separated from or moves away from the contact point 248. When the second power supply 106 operates in normal condition, alternating predetermined current flows into the trip coil 242 through input ends 245, 247, which generates an electromagnetic force large enough to push a driving mechanism (not shown). As an external force, the driving mechanism propels the swinging rod 246 to overcome the bias force applied to the swinging rod 246, thus moving the movable

plate 244 in contact with the contact point 248, resulting connecting the first power supply 104 to the compressor 112 through the contact point 254 and the contact points 248. When power failure or voltage loss occurs in the second power supply 106, the current flowing through the trip coil 242 disappears or reduces, which results in disappearance or reduction of the electromagnetic force in the trip coil 242 so that the bias force moves the movable piece plate 244 away from the contact point 248 because the electromagnetic force from the trip coil 242 is unable to overcome the bias force applied to the swinging rod 246, resulting in disconnecting the first supply power 104 from the compressor 112. In the present application, as one embodiment, the contact point 248 and the contact point 254 in the circuit breaker 252 can be installed in the power supply path between the first power supply 104 and the compressor 112.

It should be noted that the energy storage protection circuit 202 and the voltage loss coil protection circuit 204 in the present application can independently work in parallel to disconnect the switch contacts in the power supply path between the first power supply 104 and the compressor 112 when the second power supply 106 is in fault operation state.

Figs. 3A-C are illustrative views of relays 302, 304 and 306 in the voltage loss protection circuit 108 as shown in Fig. 1 of the present application.

As shown in Fig. 3A, the relay 302 (1KA) includes an actuating device 312, a normally closed switch 314 and a normally open switch 316. The actuating device 312 includes a coil 320. When no current flows through the coil 320, the actuating device 312 generates no electromagnetic force to set the normally closed switch 314 in a closed state and the normally open switch 316 in an open state. When there is current flowing through the coil 320, the actuating device 312 generates an electromagnetic force to set the normally closed switch 314 in an open state and the normally open switch 316 in a closed state.

As shown in Fig. 3B, the relay 304 (2KA) includes an actuating device 322, a normally closed switch 324 and a normally open switch 326. The actuating device 322 includes a coil 330. When no current flows through the coil 330, the actuating device 322 generates no electromagnetic force to set the normally closed switch 324 in a closed state and the normally open switch 326 in an open state. When there is current flowing through the coil 330, the actuating device 322 generates an electromagnetic force to set the normally closed switch 324 in an open state and the normally open switch 326 in a closed state.

As shown in Fig. 3C, the relay 306 (3KA) includes an actuating device 332, normally closed switches 334, 336 and a normally open switch 338. The actuating device 332 includes a coil 340. When no current flows through the coil 340, the actuating device 332 generates no electromagnetic force to set the normally closed switches 334, 336 in a closed state and the normally open switch 338 in an open state. When there is current flowing through the coil 340, the actuating device 322 generates electromagnetic force to set the normally closed switches 334, 336 in an open state and the normally open switch 338 in a closed state.

Fig. 4 is an illustrative structure diagram of a voltage loss protection circuit 400, which shows the structure of the voltage loss protection circuit 108 of Fig. 1 in greater details. As shown in Fig. 4, the voltage loss protection circuit 400 includes charging path and discharging path 451 (which is controlled by relay 306 (3KA)), an opening circuit path 452, an undervoltage trip path 453, a circuit breaker (or vacuum circuit breaker) closing circuit path 454, a circuit breaker (or vacuum circuit breaker) closing signal path 455, a fault output path 456, and an activating path 457. Because power supply 459 for voltage loss protection circuit 400 is connected to terminals 422 and 424 to supply power for all paths and control circuitries in the voltage loss protection circuit 400, the charging path and discharging path 451, the opening circuit path 452, the undervoltage

trip path 453, the circuit breaker (or vacuum circuit breaker) closing circuit path 454, the circuit breaker (or vacuum circuit breaker) closing signal path 455, the fault outputting path 456 and the activating path 457 are connected to the two input terminals 422, 424 of the power supply 459 in parallel. In one embodiment of the present application, the power supply 459 for voltage loss protection circuit 400 and the second power supply 106 share the same power supply inputs.

As an illustrative embodiment in Fig. 4, the energy storage protection circuit 202 as shown in Fig. 2A includes a full-wave filter 430, an indicator light 426, a test button 428, an energy storage capacitor 222 and a relay 306 (3KA). As shown in Fig. 4, the charging path and discharging path 451 are connected to the capacitor 222. The opening circuit path 452 includes a circuit breaker tripping coil 405 (or the load 226 as shown in Fig. 2B), a switch QF-BB2 and the normally open switch 326, three of which are connected in series; the undervoltage trip path 453 includes a voltage loss trip coil 406; the circuit breaker closing circuit path 454 includes a circuit breaker closing coil 407 and the normally open switch 316, which are connected in series; the circuit breaker closing signal path 455 includes the actuating device 312 in the relay 302 (1KA), the normally closed switch 324 and an activating signal unit 403, which are connected in series; the fault output path 456 includes the activating device 322 in the relay 304 (2KA) and a fault output unit 404, which are connected in series; and the activating path 457 includes the actuating device 322 in the relay 306 (3KA). In the embodiment in Fig. 4, the voltage loss trip coil 406 can perform the functions that are described in connection with the trip coil 242 as shown in Fig. 2C.

In the energy storage circuit 202 as shown in Fig. 4, the full-wave filter 430 converts AC power provided by the power supply 459 for circuit 400 into DC power for charging the capacitor 222.

When the test button 428 of energy storage protection circuit is pressed down, the

indicator light 426 is electrified and emits light to indicate that the energy storage protection circuit 202 is in operation; when the test button 428 is released, the indicator light 426 is disconnected from and the power supply 459 are disconnected so that the indicator light 426 does not emit light to indicate that the energy storage protection
5 circuit 202 is not in operation.

In the present application, the energy storage capacitor 222 is selectively connected to both ends of the circuit breaker tripping coil 405 through a control mechanism including the relay 306, so that: (1) when discharge current is needed, the energy storage capacitor
10 222 is connected to both ends of the circuit breaker tripping coil 405 so that the current from the capacitor 222 can be discharged to the circuit breaker tripping coil 405; and (2) when discharge current is not needed, the energy storage capacitor 222 is disconnected from the circuit breaker tripping coil 405 so that no current can be discharged into the circuit breaker tripping coil 405. Moreover, due to the connection
15 to the second power supply 106, the actuating device 332 in the relay 306 (3KA) can detect the voltage loss state of the second power supply 106.

The voltage loss protection circuit 400 can operate in 3 situations, namely, 1) the second power supply 106 works normally; 2) the second power supply 106 is in fault operation
20 state while the trip coil 406 works normally; 3) the second power supply 106 is in fault operation state while the trip coil 406 is in a fault condition.

To better understand the operation of the a voltage loss protection circuit 400, it is helpful to know the closed-or-open states of the three relays 302 (1KA), 304 (2KA) and
25 306 (3KA) when the first power supply 104 and the second power supply 106 both operate normally, as follows:

(1) The actuating device 312 in the relay 302 (1KA) is in a power-on state, because the activating signal 403 in the circuit breaker closing path 455 is in a valid state or a

connected state, thus at this time, the normally closed switch 314 is open and the normally open switch 316 is closed;

(2) The actuating device 322 in the relay 304 (2KA) is in a power-off state, because the fault output signal 404 is in an invalid state or a disconnected state, thus at this time,
5 the normally closed switch 324 is closed, and the normally open switch 326 is open (assuming that the air conditioning unit 100 has no fault); and

(3) The actuating device 332 in the relay 306 (3KA) is in the power-on state due to the connection to the second power supply 106, thus at this time, the normally closed switches 334, 336 are open, and the normally open switch 338 is closed.

10

Therefore, when the first power supply 104 and the second power supply 106 operate normally, the power supply 459 of the control circuit charges the energy storage capacitor 222 through the full-wave filter 430; however, as the normally closed switches 334, 336 are open, there is no discharging path for the energy storage capacitor 222.

15 Thus, without current flowing through the circuit breaker tripping coil 405 from the capacitor 222, the circuit breaker tripping coil 405 does not interfere with the operation of the voltage loss protection circuit 400. At this time, the power supply 459 of control circuit is applied to the voltage loss trip coil 406 by the power supply inputs 422, 424, a predetermined current flows through the voltage loss trip coil 406, so that the voltage
20 loss trip coil 406 generates an electromagnetic force large enough to drive the swinging rod 246 (see Fig. 2C) in the circuit breaker 252, which is located in the power supply path between the first power supply 104 and the compressor 112, to overcome the bias force on the swinging rod 246 and cause the closing of the circuit breaker 252, thus connecting the first power supply 104 to the compressor 112.

25

QF-BB2 is an auxiliary switch in the circuit breaker. When the first power supply 104 and the second power supply 106 operate normally, the electromagnetic force on the voltage loss trip coil 406 closes the auxiliary switch QF-BB2; but the opening circuit path 452 is not conductive because the normally open switch 326 of the relay 304 (2KA)

- is in the open state. Without current flowing through the circuit breaker tripping coil 405, the opening action of the circuit breaker will not be started. However, when the fault output unit 404 is started or connected in response to a faulty condition of the air conditioning unit 100, the air conditioning unit 100 is in a faulty condition (such as
- 5 when an over-current occurs in a circuit of the air conditioning unit 100), the actuating device 322 changes from the power-off state into the power-on state, which generates an electromagnetic force to convert the open state of the normally open switch 326 into the closed state.
- 10 With the normally open switch 326 being closed, current flows through the circuit breaker tripping coil 405, which in turn generates the electromagnetic force to drive the swinging rod 246 in the circuit breaker 252 to cause the tripping of the circuit breaker 252 so that the first power supply 104 is cut off from the compressor 112. However, when the first power supply 104 and the second power supply 106 operate normally, as
- 15 the normally closed switches 334, 336 are open, the energy storage capacitor 222 will not discharge current into the circuit breaker tripping coil 405 so that the energy storage capacitor 222 does not interfere with the operation of the voltage loss protection circuit 400.
- 20 It should be noted that the path 455 and path 456 operate interactively with each other. Specifically, when the air conditioning unit 100 operates in a normal condition, the fault output signal 404 is in an invalid state or a disconnected state and the actuating device 322 in the relay 304 (2KA) is in a power-off state, the normally-closed switch 324 is closed, thus the air conditioning unit 100 can be started by the activating signal 403.
- 25 However, when the air conditioning unit 100 operates in a fault condition, the fault output signal 404 is in a valid state or a connected state and the actuating device 322 in the relay 304 (2KA) is in a power-on state, the normally-closed switch 324 is open, thus the air conditioning unit 100 cannot be started by the activating signal 403.

Assuming that after the first power supply 104 and the second power supply 106 operate normally for a period of time, when the second power supply 106 encounters no voltage or excessive voltage reduction, but the trip coil 406 works normally, the voltage loss protection circuit 400 performs voltage loss protection operation process as follows:

5

(1) The second power supply 106 encounters no voltage or excessive voltage reduction and the oil pump 114 stops working;

(2) The current in the voltage loss trip coil 406 disappears or reduces so that the voltage loss trip coil 406 cannot generate electromagnetic force or cannot generate
10 electromagnetic force large enough to overcome the bias force on the swinging rod 246 in the circuit breaker. Without sufficient electromagnetic force, the bias force causes tripping of the circuit breaker to disconnect the first power supply 104 from the compressor 112; and

(3) The current in the actuating device 332 of the relay 306 (3KA) disappears or reduces
15 so that the normally closed switches 334, 336 change from the open state into the closed state to connect the energy storage capacitor 222 to the capacitor discharging path. As a result, the energy storage capacitor 222 discharges current through the circuit breaker tripping coil 405 to generate electromagnetic force in the circuit breaker tripping coil 405. The electromagnetic force in the circuit breaker tripping coil 405 drives the
20 swinging rod 246 in the circuit breaker so as to cause tripping of the circuit breaker, which disconnects the first power supply 104 from the compressor 112.

As being described above, in the present application, when the voltage loss trip coil 406 works normally and when the second power supply 106 encounters no voltage or
25 excessive voltage reduction, the voltage loss trip coil 406 and the energy storage capacitor 222 independently work in parallel to cause the tripping of the circuit breaker.

Assuming that after the first power supply 104 and the second power supply 106 operate normally for a period of time, when the second power supply 106 encounters no voltage

or excessive voltage reduction and when the voltage loss trip coil 406 is in a fault condition, the voltage loss protection circuit 400 performs the voltage loss protection operation process as follows:

- 5 (1) The second power supply 106 encounters no voltage or excessive voltage reduction and the oil pump 114 stops working;
- (2) The voltage loss trip coil 406 loses its function and does not respond to the voltage disappearance or excessive voltage reduction of the second power supply 106, thus being unable to disconnect the first power supply 104 from the compressor 112; and
- 10 (3) Because the current in the actuating device 332 of the relay 306 (3KA) disappears or reduces, the normally closed switches 334, 336 of the relay 306 (3KA) change from the open state into closed state. At the same time, the normal open switch 326 of the relay 304 (2KA) becomes open state; the normal open switch 326 in the relay 304 (2KA) is in open state; and the QF-BB2 is in closed state. As a result, the energy storage
- 15 capacitor 222 is connected to the circuit breaker tripping coil 405 so that current from the energy storage capacitor 222 is discharged to the circuit breaker tripping coil 405. The electromagnetic force is generated in the circuit breaker tripping coil 405 by the discharging current to drive the swinging rod 246 in the circuit breaker to cause the tripping of the circuit breaker, thus disconnecting the first power supply 104 from the
- 20 compressor 112.

The inventor of the present application observes that when the operation of a second equipment driven by a second power supply affects the operation of the first equipment driven by a first power supply, the existing voltage loss protection circuit or system may

25 have the technical problem of unreliable operation protection of the first equipment when the second power supply encounters a fault condition. By means of the improvement and optimal design of the voltage loss protection circuit, in the present application, the energy storage device and discharge control circuit are innovatively added so that it is possible for the tripping coil of the circuit breaker in an existing

system (such as a starting cabinet) to disconnect the first power supply from the first equipment when the second power supply encounters a fault condition.

Because the present application can effectively utilize the tripping coil of the existing
5 circuit breaker, the energy storage device can be added without changing (or with slightly changing) the existing structure of the voltage loss protection circuit in the system.

Although only certain features of the present application have been illustrated and
10 described herein, various improvements and variations can be made by those skilled in the art. Therefore, it should be understood that the appended claims are intended to cover all variations that fall within the scope of the present application.

Claims

1. A voltage loss protection circuit (108), comprising:

a voltage loss coil protection circuit (204); and

5 an energy storage protection circuit (202);

wherein the voltage loss protection circuit (108) is coupled to, or is coupled between, a first power supply (104) and a second power supply (106),

wherein when voltage loss of the second power supply (106) occurs, the voltage loss coil protection circuit (204) or the energy storage protection circuit (202) works

10 independently to cut off the first power supply (104),

wherein the voltage loss protection circuit (108) controls the first power supply (104) according to the operation state of the second power supply (106).

2. The voltage loss protection circuit (108) of claim 1, wherein the energy storage protection circuit (202) comprises:

15 an energy storage device (222);

a discharge control circuit (224, 306); and

a discharge load (226), the energy storage device (222) being connected to the discharge load (226) through the discharge control circuit (224);

20 when the second power supply (106) is in a normal state, the discharge control circuit (224, 306) disconnects the energy storage device (222) from the discharge load (226); and

when the second power supply (106) is in a faulty state, the discharge control circuit (224, 306) connects the energy storage device (222) to the discharge load (226).

25

3. The voltage loss protection circuit (108) of claim 2, wherein:

the first power supply (104) providing power to a first equipment (112) and the second power supply (104) providing power to a second equipment (114),

the discharge load (226) is a circuit breaker tripping coil (405),

the energy storage device (222) is a capacitor (222), the current from the capacitor (222) is discharged to the circuit breaker tripping coil (405) based on the fault state of the second power supply (106) to cut off the first power supply (104) from the first equipment (112).

5

4. The voltage loss protection circuit (108) of claim 3, wherein the voltage loss coil protection circuit (204) comprises:

a circuit breaker (252) being arranged in the power supply path of connecting the first power supply (104) to the first equipment (112),

10

wherein when the second power supply (106) is in fault state, the voltage loss coil protection circuit (204) or the energy storage protection circuit (202) cause tripping of the circuit breaker (252).

5. The voltage loss protection circuit (108) of claim 4, wherein:

15

the energy storage protection circuit (202) is connected to the tripping coil (405).

6. The voltage loss protection circuit (108) of claim 2, wherein:

the discharge load (226) comprises a tripping coil (405);

the voltage loss coil protection circuit (204) comprises a voltage loss trip coil (406).

20

7. The voltage loss protection circuit (108) of any one of claims 1-6, wherein:

the first power supply (104) supplies power to a first equipment (112);

the second power supply (106) supplies power to a second equipment (114).

25 8. A starting cabinet (102), comprising:

a first power supply (104), wherein the first power supply (104) supplies power to a first equipment (112);

a second power supply (106), wherein the second power supply (106) supplies power to a second equipment (114);

a voltage loss protection circuit (108) for controlling the first power supply (104) according to the operation state of the second power supply (106), the voltage loss protection circuit (108) comprising a voltage loss coil protection circuit (204) and an energy storage protection circuit (202);

5 wherein the voltage loss protection circuit (108) is coupled to, or is coupled between, the first power supply (104) and the second power supply (106),

 wherein when voltage loss of the second power supply (106) occurs, the voltage loss coil protection circuit (204) or the energy storage protection circuit (202) works independently to cut off the first power supply (104).

10

9. The starting cabinet (102) of claim 8, wherein the energy storage protection circuit (202) comprises:

 an energy storage device (222);

 a discharge control circuit (224, 306); and

15 a discharge load (226), the energy storage device (222) being connected to the discharge load (226) through the discharge control circuit (224);

 when the second power supply (106) is in a normal state, the discharge control circuit (224, 306) disconnects the energy storage device (222) from the discharge load (226); and

20 when the second power supply (106) is in a faulty state, the discharge control circuit (224, 306) connects the energy storage device (222) to the discharge load (226).

10. The starting cabinet (102) of claim 9, wherein:

 the discharge load (226) is a circuit breaker tripping coil (405),

25 the energy storage device (222) is a capacitor (222),

 the current from the capacitor (222) is discharged to the circuit breaker tripping coil (405) based on the fault state of the second power supply (106) to cut off the first power supply (104) from the first equipment (112).

11. The starting cabinet (102) of claim 9, wherein the voltage loss coil protection circuit (204) comprises:

a circuit breaker (252) being arranged in the power supply path of connecting the first power supply (104) to the first equipment (112),

5 wherein when the second power supply (106) is in fault state, the voltage loss coil protection circuit (204) or the energy storage protection circuit (202) cause tripping of the circuit breaker (252).

12. The starting cabinet (102) of claim 11, wherein:

10 the energy storage protection circuit (202) is connected to the tripping coil (405).

13. The starting cabinet (102) of claim 10, wherein:

the discharge load (226) comprises a tripping coil (405);

the voltage loss coil protection circuit (204) comprises a voltage loss trip coil (406).

15

14. The starting cabinet (102) of claims 9, wherein:

the first equipment (112) is a compressor (112);

the second equipment (114) is an oil pump (114).

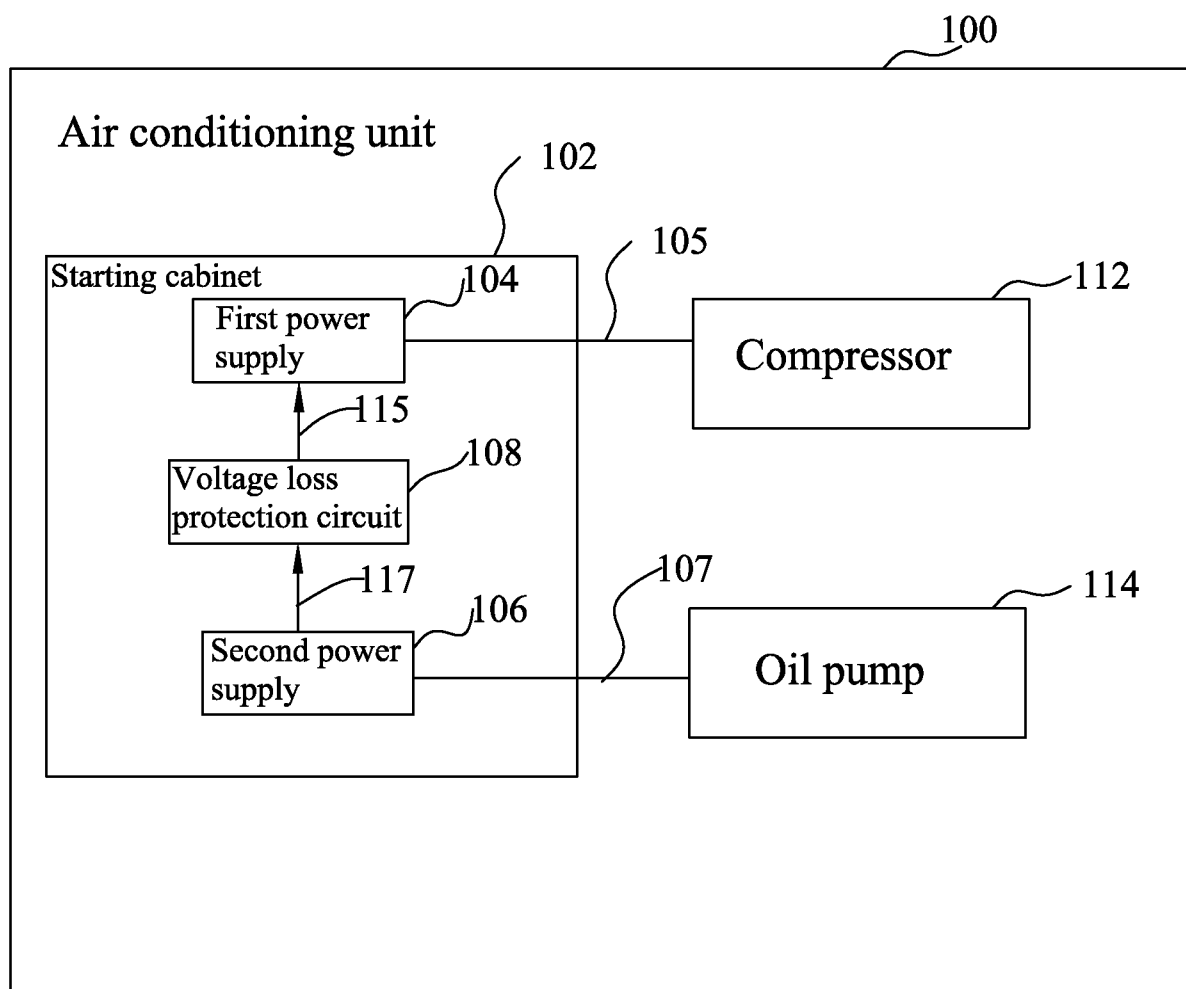


Fig. 1

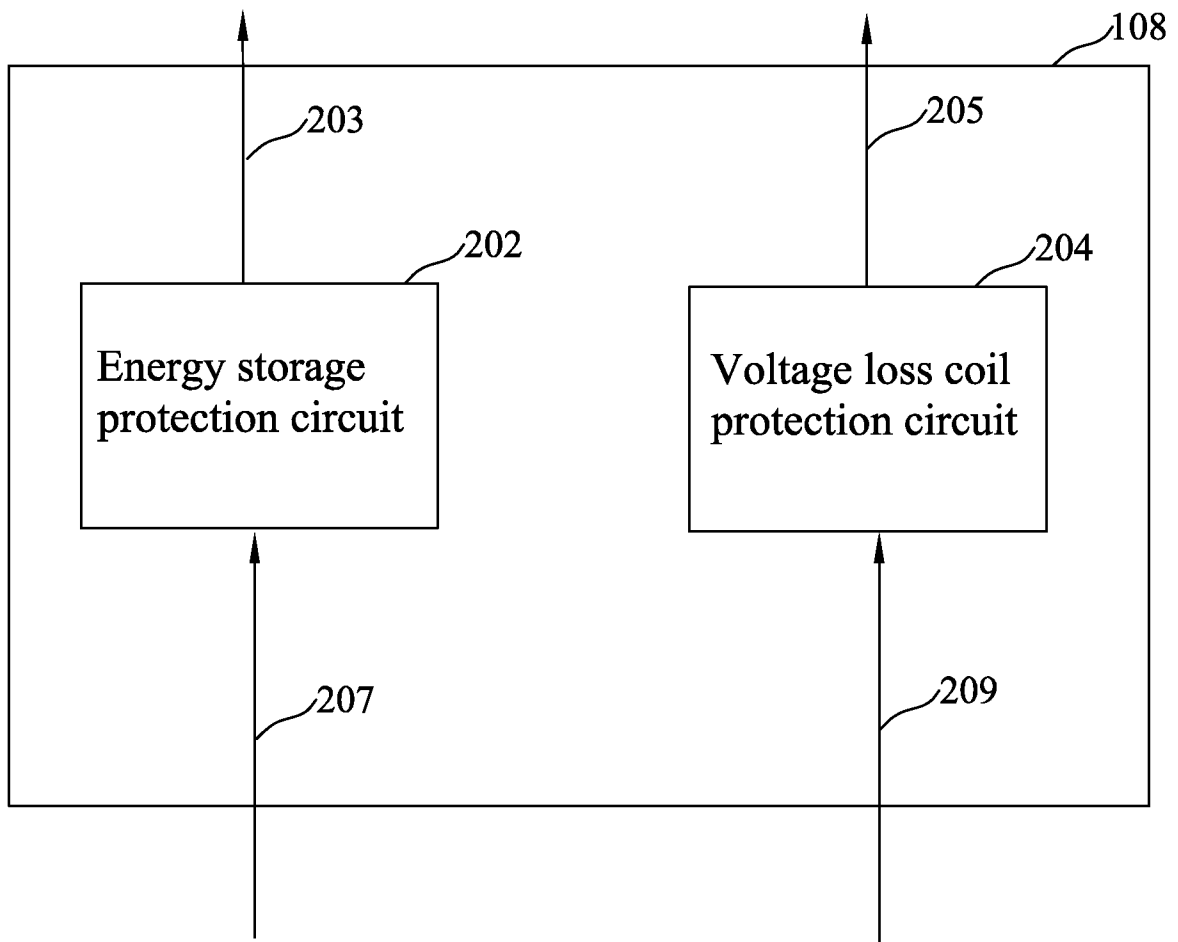


Fig. 2A

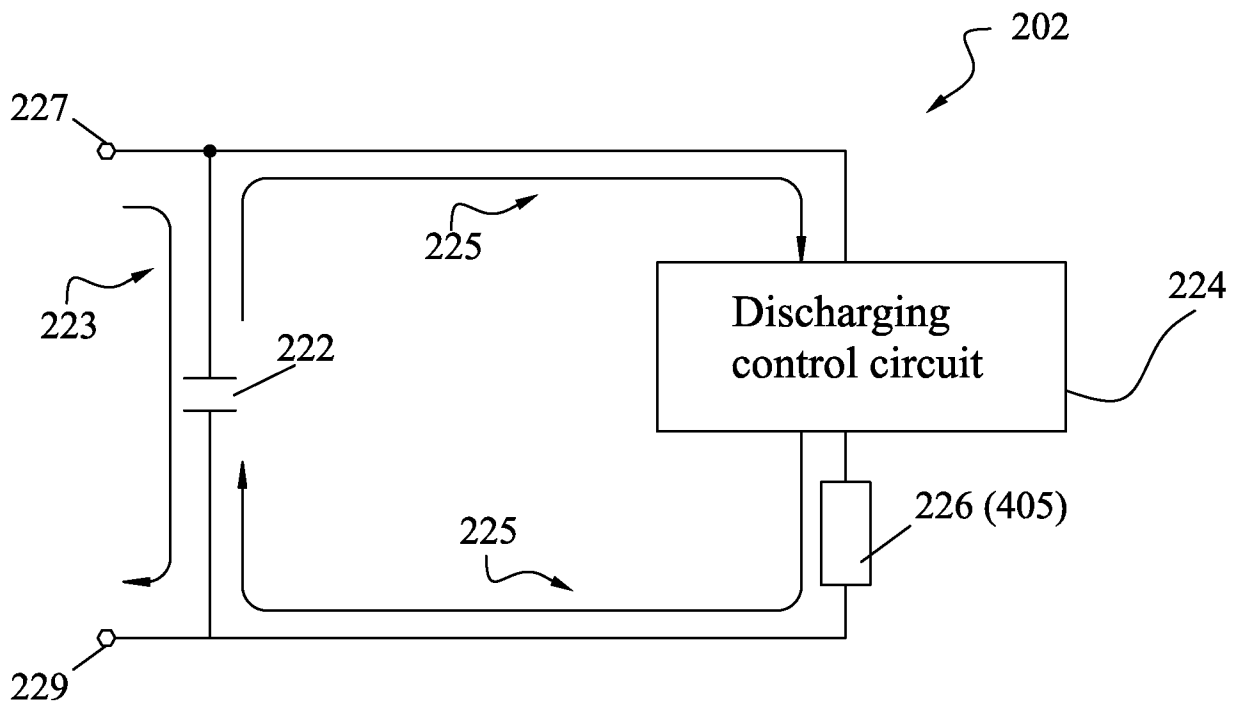


Fig. 2B

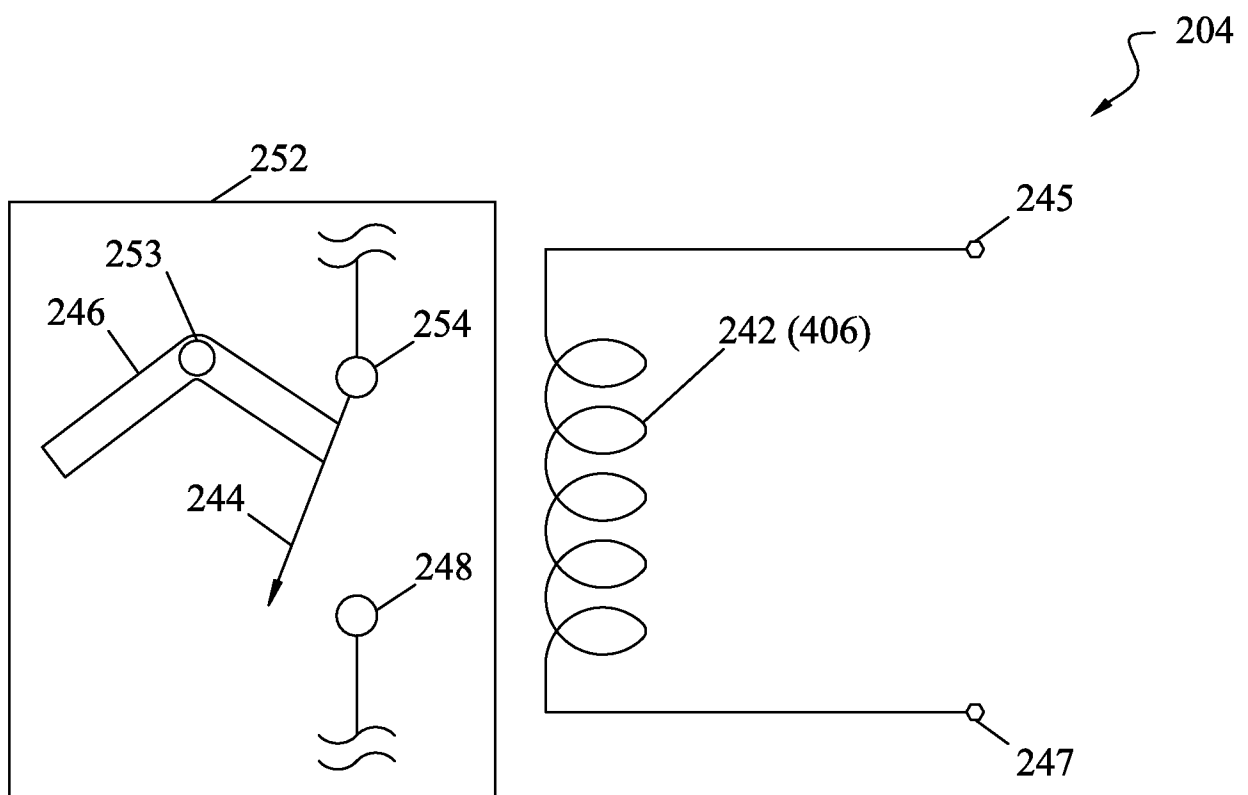


Fig. 2C

302
(1KA)

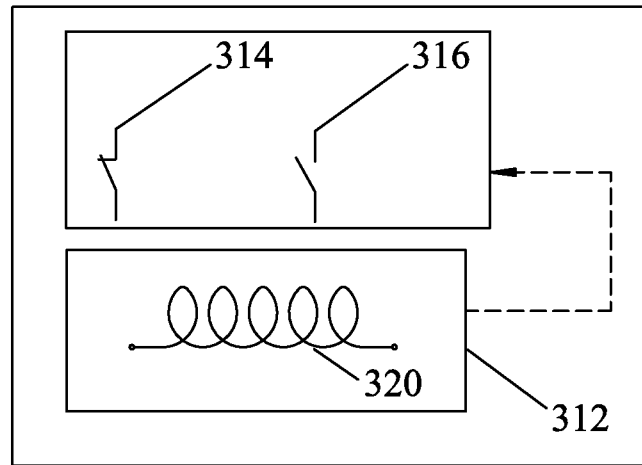


Fig. 3A

304
(2KA)

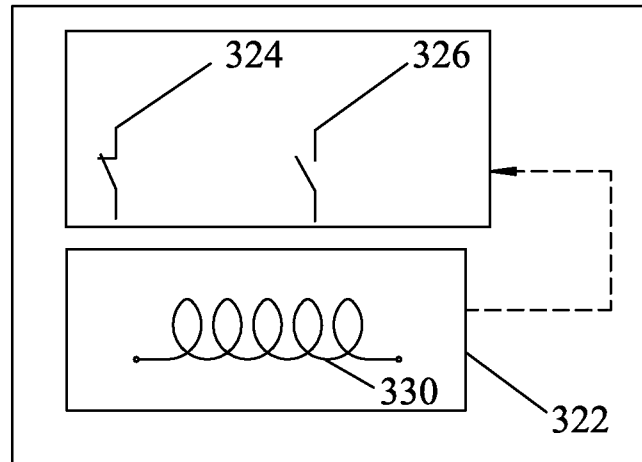


Fig. 3B

306
(3KA)

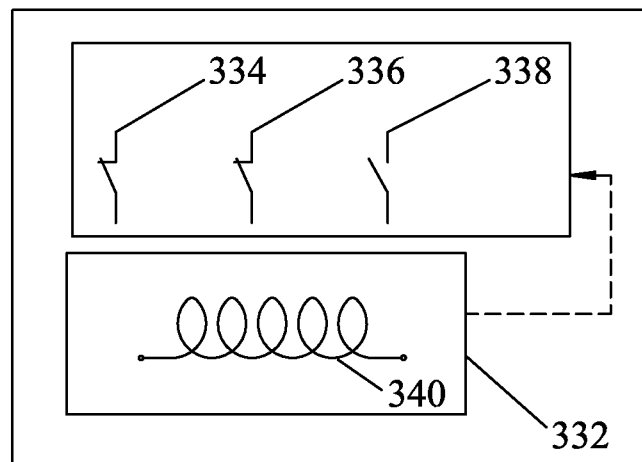


Fig. 3C

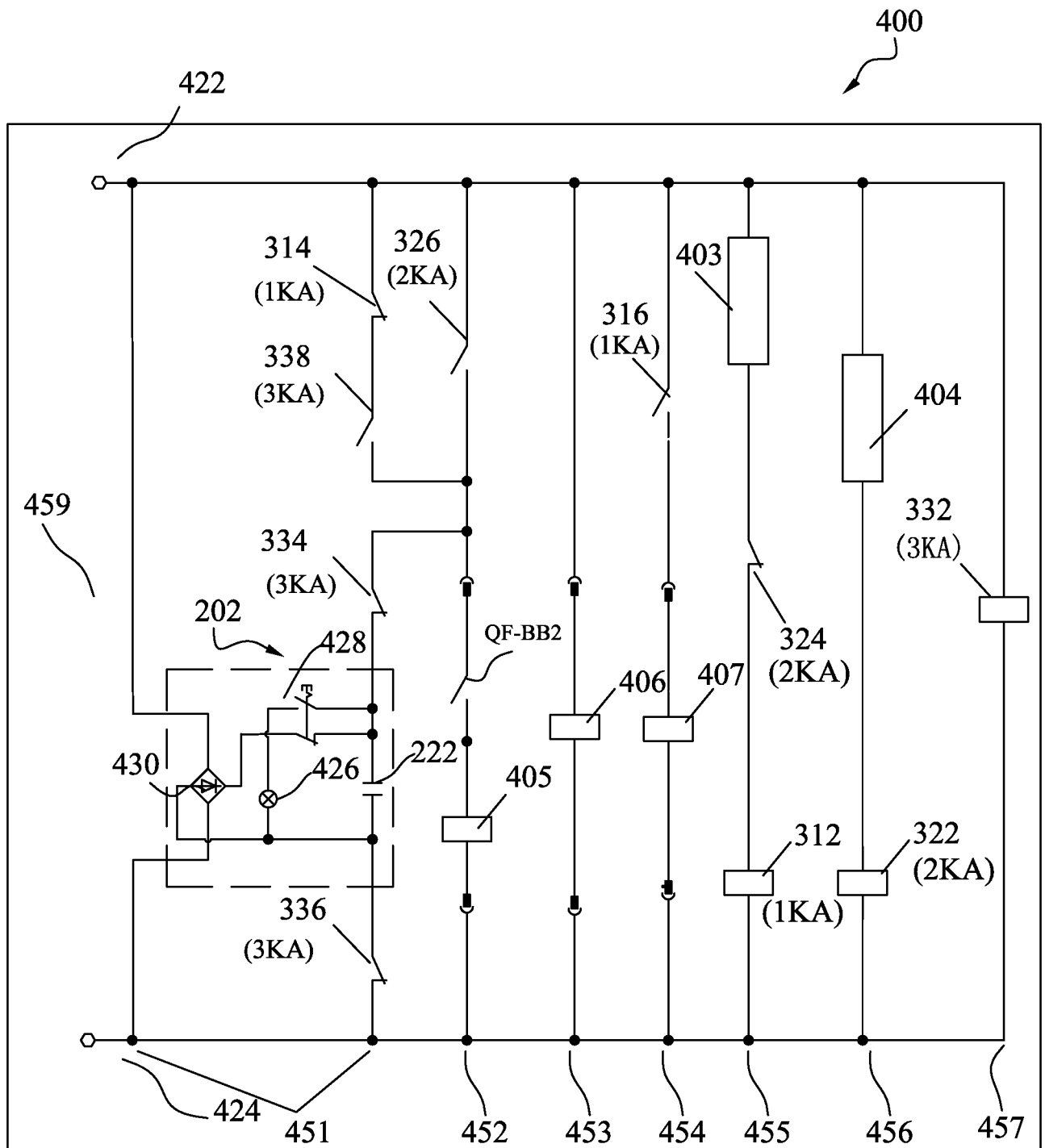


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2017/054385

A. CLASSIFICATION OF SUBJECT MATTER

INV. H02P29/024 F25B49/02 H01H83/12
ADD. H02P4/00 F04B39/02 G05B9/02 H02H3/24

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)

H02P F04B F25B G05B H01H H02H

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 579 291 A1 (ABB TECHNOLOGY AG [CH]) 10 April 2013 (2013-04-10)	1,2,6
Y	the whole document	3-5,7-14
A	US 2015/326004 A1 (CURTIS DALE [US]) 12 November 2015 (2015-11-12)	1-14
Y	the whole document	
Y	WO 2014/035745 A1 (JOHNSON CONTROLS TECH CO [US]) 6 March 2014 (2014-03-06)	3-5,7-14
	the whole document	



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

31 October 2017

Date of mailing of the international search report

10/11/2017

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2017/054385

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