United States Patent

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[54] **REFRIGERATION SYSTEM CONTROL**
8 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **307/126,** 317/22
[51] **Int. Cl.** **H01h 43/00**
[50] **Field of Search** ..... 307/141, 141.4, 141.8, 139, 126; 317/40, 22 X

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ABSTRACT: A control circuit for a refrigeration system to provide a delayed automatic system restart after the system is deenergized by one of the safety switches employed therein. Delayed energization of the system when the thermostat contacts close is also provided to prevent rapid cycling, to allow system pressure equalization, and to prevent compressor damage.

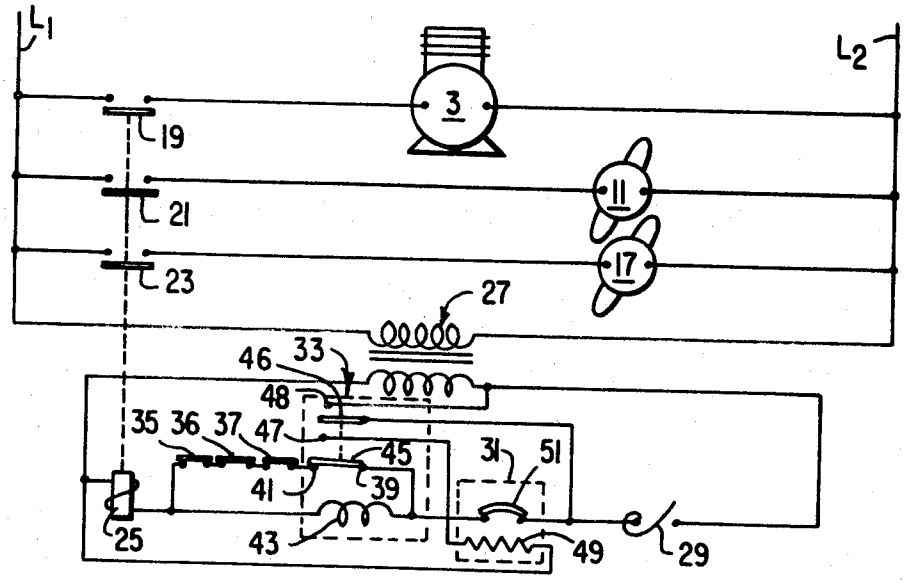


FIG. 1

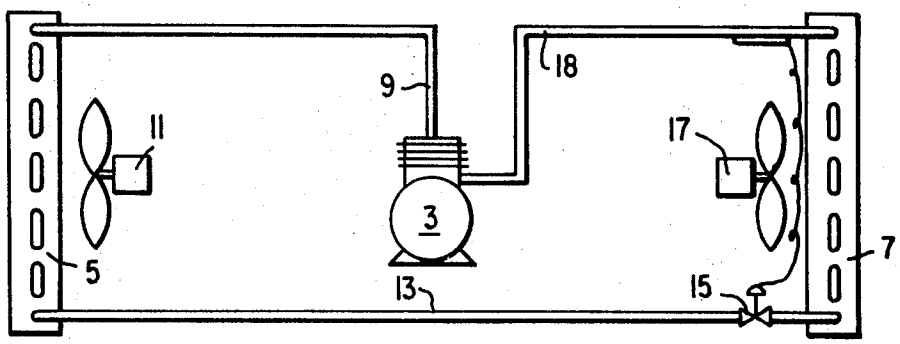


FIG. 2

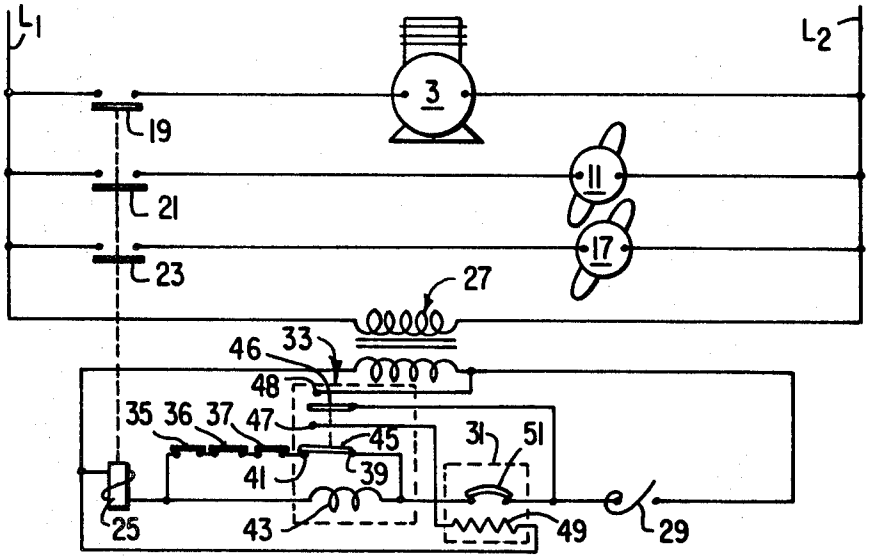
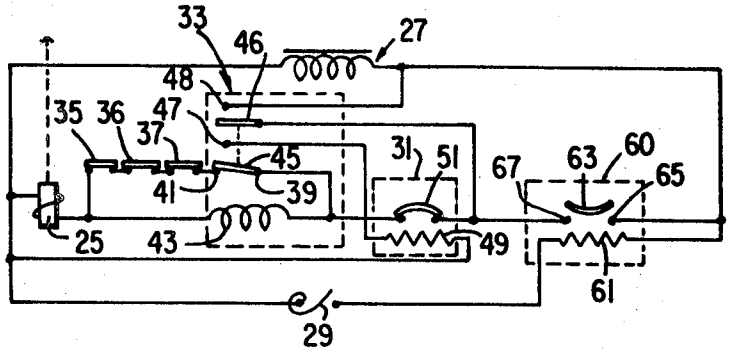


FIG. 3



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REFRIGERATION SYSTEM CONTROL

BACKGROUND OF THE INVENTION

Refrigeration systems ordinarily employ a number of safety devices to deenergize the system in the event of a system malfunction to prevent damage to the system components. A typical gas compression refrigeration system may employ a low-pressure switch to prevent compressor operation when compressor suction pressure drops below a preselected level, a high-pressure switch to prevent compressor operation when compressor discharge pressures exceed a preselected level, and a thermal overload switch to prevent compressor motor overloads. Once the system is deenergized by one of the safety switches, it is desirable to provide a time delay before attempting to restart the system. This delay may be necessary for a variety of reasons: to allow the compressor motor to cool down, to allow system pressures to equalize, etc. In order to provide this delay, many systems employ a circuit which requires manual reset after a safety switch opens. A serviceman may be required to reset the safety switch which results in unnecessary expense and delay in restarting the system, especially if the circuit was deenergized due to a temporary condition. One method presently in use to overcome the problems inherent in a manual reset type circuit is a circuit employing a timer to reenergize the circuit after a preselected time interval.

SUMMARY OF THE INVENTION

This invention relates to a control circuit for a refrigeration system employing an impedance relay, actuated by the opening of one of the safety switches employed in the control circuit to open the circuit through the safety switches and energize a time delay relay, which, after a selected time interval, deactivates the impedance relay to complete the circuit through the safety switches and reactivate the system, assuming the safety switches have closed in the interim.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic view of a refrigeration system;

FIG. 2 is a schematic wiring diagram of the control circuit employed with the refrigeration system; and

FIG. 3 is a schematic wiring diagram illustrating a second embodiment of the low voltage portion of the control circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 there is illustrated a refrigeration system employing a compressor 3, a condenser coil 5, and an evaporator coil 7. Compressed refrigerant is provided to condenser coil 5 through line 9. A suitable heat exchange medium, such as ambient air, is passed through the coil by fan 11 in heat exchange relation with the refrigerant therein to condense the refrigerant gas.

The liquid flows from coil 5 through line 13 and expansion valve 15 to evaporator coil 7. Refrigerant is vaporized in heat exchange coil 7 as heat is extracted from the stream of air passed through the coil by fan 17. Refrigerant vapor from coil 7 returns to compressor 3 through line 18.

Referring to FIG. 2 of the drawings, a suitable source of alternating current (not shown) is adapted to supply current to a primary control circuit through leads L_1 and L_2. Switches 19, 21 and 23 are provided to energize compressor 3 and fans 11 and 17. The switches are closed by a contactor coil 25 in the secondary control circuit which will be hereinafter explained. While one contactor is illustrated, it should be understood that individual contactors could be utilized for each of the switches in the primary circuit.

Referring to FIG. 2, the secondary control circuit is electrically connected to the primary control circuit by means of a transformer 27. The secondary control circuit includes the aforementioned contactor coil 25, a room thermostat 29, a normally closed time delay relay 31, an impedance relay 33, and safety switches 35, 36 and 37. The switches 35, 36 and 37 may be any desired safety switches such as a low-pressure switch, a high-pressure switch and a compressor motor thermal overload switch.

Considering the operation of the control circuit illustrated in FIG. 2, when the thermostat 29 closes in response to room temperature, the circuit through time delay relay 31, contacts 39 and 41 of impedance relay 33, safety switches 35, 36 and 37, and contactor coil 25 will be completed. The contactor coil will close switches 19, 21 and 23 to energize compressor 3 and fans 11 and 17 to provide cooling in the area served by thermostat 29. If a system malfunction occurs, as sensed by safety switches 35, 36 or 37 and one of the switches opens, the open circuit between impedance relay contact 41 and contactor coil 25 will cause a current flow through impedance coil 43 of impedance relay 33. However, due to the resistance of impedance coil 43, current flow through contactor coil 25 will be insufficient to maintain switches 19, 21 and 23 closed. The compressor and fans will therefore be deenergized.

Current flow through impedance coil 43 will cause switch lever 45 of impedance relay 33 to move from contact 41 to contact 47 which will energize heater 49 of time delay relay 31. After a preselected time interval, the relay 31 will reach a temperature sufficient to warp time delay relay switch arm 51 to open the switch. The interruption of current flow through impedance relay coil 43 will allow switch arm 45 to return to contact 41. This will deenergize heater 49. When the switch arm 51 of time delay relay 31 cools and completes the circuit through relay 31, current will again flow through impedance relay 33, safety switches 35, 36 and 37, and contactor coil 25, if the safety switch originally opened has closed during the compressor shutdown time interval.

It can be seen from the foregoing that an interruption of current flow through impedance coil 43 will allow switch lever 45 to return to its normal position. The time delay relay 31 provides a sufficient time interval for the open safety switch to close before current flow to impedance coil 43 is interrupted to restart the system. To prevent a premature system start by interruption of current flow through impedance coil 43 by manual manipulation of the thermostat to open and close the thermostat contacts, a second switch lever 46 is provided in relay 33. The current flow through coil 43 will move switch lever 46 to contact 48 as lever 45 moves from contact 41 to contact 47. This will complete a circuit in parallel with thermostat 29 so that manual operation of the thermostat will not interrupt the current flow through impedance coil 43 and cause a premature system startup.

If the problem has not corrected itself, the aforementioned sequence of events will continue indefinitely until the malfunction is corrected. A sufficient time delay is provided by relay 31 before an attempted restart to assure that minor, temporary malfunctions will have corrected themselves and, in the absence of a serious malfunction, the system will automatically be put back in operation. The relay 31, besides providing the desired time delay, also provides the current interruption necessary to reset the impedance relay.

Referring to FIG. 3, there is illustrated a second embodiment of the control circuit. With respect to relays 31, 33, safety switches 35, 36 and 37 and contactor coil 25, the circuit is identical to and functions the same as the secondary circuit illustrated in FIG. 2. The circuit of FIG. 3 differs from the circuit of FIG. 2 by the addition of the normally open time delay relay 60.

Considering the operation of the control circuit illustrated in FIG. 3, when the thermostat closes in response to room temperature conditions, a circuit will be completed through heater 61 of relay 60. After a predetermined time interval switch arm 63 will warp due to the heat generated by heater 61, thereby completing the circuit through contacts 65 and 67 of relay 60, through relays 31 and 33, safety switches 35, 36 and 37 and contactor coil 25 to energize compressor 3 and fans 11 and 17. The circuit will respond to a system malfunction in the same manner as the circuit illustrated in FIG. 2.

The switch arm **46** and contacts **48** of FIG. **3** are connected in parallel with relay **60** to prevent premature reset of the system by interruption of current through relay **60**.

When the thermostat contacts open in response to room temperature or by manual resetting of the thermostat, the system will remain in operation for a predetermined time interval until relay **60** cools down and the circuit through contacts **65** and **67** is broken.

The delayed start feature and the delayed stop feature provided by the circuit of FIG. **3** is very advantageously employed in modern refrigeration systems using permanent split capacitor compressor motors. These motors have a very low starting torque and ordinarily cannot be started unless the high and low side pressures in the refrigeration system have equalized. An attempt to start the system immediately after shutdown, before system pressure equalization, can seriously damage the compressor motor.

Further, since the system thermostat is a very delicate instrument, vibration of the thermostat could cause the thermostat contacts to momentarily open while the system is in operation. The compressor would attempt to restart when the contacts closed before system pressures equalized. The relay **60** in the circuit of FIG. **3** prevents immediate restarting of the compressor and prevents compressor shutdown caused by momentarily opened thermostat contacts, thereby providing an added protection against burnout of the compressor motor.

It can be seen that both of the circuits described and illustrated provide compressor protection without the necessity of manually resetting the control circuit after a minor malfunction, and that deleterious rapid restarting of the system is prevented by the control circuit of FIG. **3**.

While I have described a preferred embodiment of my invention, it is to be understood the invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

I claim:

1. An automatic reset control circuit for use in a refrigeration system comprising:

an impedance relay having normally open switch means, normally closed switch means and an impedance coil,

safety switch means associated with the normally closed switch means of said impedance relay,

contactor means for energizing the air conditioning system, said safety switch means and the coil of said impedance relay being in parallel with each other and in series with the coil of said contactor,

a time delay relay having normally closed switch means and actuator means, said time delay relay switch means being in series with the impedance relay switch means, safety switch means, and contactor, the time delay relay actuator means being associated with the normally open switch means of said impedance relay; an open circuit across said safety switch means deenergizing said contactor and causing current flow through the impedance coil to open the normally closed switch means and close the normally open switch means of said impedance relay, closing of the normally open switch means energizing the time delay relay actuator means to open the time delay relay switch means after a predetermined time interval, opening of said time delay relay switch deenergizing the coil of said impedance relay to return the switch means thereof to the normal operating position thereof and deenergize the actuator means of said time delay relay.

2. A control circuit according to claim **1** wherein said time delay relay switch means includes a bimetallic element, said actuator means including a heater element, heat from said actuator means warping the bimetallic element to open the circuit through said time delay relay.

3. A control circuit according to claim **2** wherein said safety switch means includes a high-pressure switch, a low-pressure switch and a compressor motor overtemperature switch.

4. A control circuit according to claim **1** further including thermostatic control means connected in series with said time delay relay, the circuit through said thermostatic control means being completed in response to room temperature conditions to actuate the air conditioning system.

5. A control circuit according to claim **4** wherein said impedance relay includes second normally open switch means in parallel with said thermostatic control means, current flow through said impedance coil closing said second normally open switch to complete a circuit in parallel with said thermostat to prevent interruption of current through said impedance coil.

6. A control circuit according to claim **1** further including a second time delay relay in series with said first time delay relay, said second time delay relay having normally open switch means and actuator means,

thermostatic control means connected in series with the actuator means of said second time delay relay, the switch means of said second time delay relay being connected in series with the switch means of said first time delay relay, completion of the circuit through said thermostatic control means in response to room temperature conditions energizing the actuator means of said second time delay relay to close the switch means of said second time delay relay after a predetermined time interval to actuate the air conditioning system.

7. A control circuit according to claim **6** wherein said impedance relay includes second normally open switch means in parallel with said second time delay relay, current flow through said impedance coil closing said second normally open switch to complete a circuit in parallel with said second time delay relay to prevent interruption of current through said impedance coil.

8. The method of automatically resetting a control circuit for refrigeration apparatus which comprises the steps of:

a. supplying electrical energy to the components of the apparatus through a circuit including at least one safety switch and the normally closed contacts of an impedance relay and a normally closed time delay switch in series,

b. completing a circuit through the coil of the impedance relay upon opening the safety switch to cycle the impedance relay to open the normally closed contacts and close the normally open contacts thereby completing a circuit through a time delay switch actuator whereby said time delay switch is opened for a predetermined time interval and thereafter closed to reestablish the original supply of electrical energy should the safety switch have closed during the predetermined time interval.