A compressor motor time-delay circuit for protecting a refrigerant compressor against rapid cycling which includes time-delay means for maintaining a specified predetermined minimum time period between starts of the compressor motor.

This invention relates to automatic control apparatus and more particularly, to a refrigerant compressor motor time delay circuit.

In operation of a refrigeration system utilizing a refrigerant compressor, it is desirable to prevent short cycling of the compressor motor upon intermittent opening and closing of the controls for the compressor. Many hermetic refrigerant compressors utilize a low starting torque compressor motor. If an attempt is made to restart the compressor shortly after the previous shut-off, system pressure will not be equalized and the motor will be inadequate to operate the compression mechanism. Without the time delay provided by the present invention, the compressor motor locked rotor protection means could be called upon to function too frequently. After several cycles, motor temperatures might increase to a level that prevents reset of the overload safety device for extended periods of time, limiting the ability of the system to operate as needed. Additionally, extremely rapid recycling of external control switches can occur, such as chattering of thermostat contacts caused by mounting on light walls subject to vibration. This type of operation can result in compressor motor and/or switching device failures because of extremely high transient currents. By preventing this, the present invention provides improved protection to the motor and switching devices.

ABSTRACT OF THE DISCLOSURE

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Considering now the electrical circuit at start-up, the thermostat 20 is normally open until there is a demand for cooling. The contacts 24a and 24b of the timing motor 24 are in the positions shown in dotted line. Upon closure of thermostat 20, a circuit is completed through thermostat 20, protection switch 22, relay coil 28, contact 24a and line 29 to line L2. Upon energization of coil 28 normally open contact 28a will be closed and a holding circuit will be provided to maintain the coil 28 energized.

The timing motor 24 is energized since a circuit is completed from L1 to L3 through the thermostat 20, the protection device 22, timing motor 24, contact 24a and normally closed contact 30a to L5. The circuits to the contactor coil 21 and relay coil 30 are open since the switch 24b is in the dotted line position and the contact 30b in line 34 is open.

After a short interval of operation of timing motor 24, on the order of 20 seconds, for example, cam 26 has rotated and switches 24a and 24b have been moved to the solid line position indicated. Switch 24a switches to the solid line position first, with switch 24b following by a short interval of time, on the order of two seconds. The timing motor now runs through switch 24a and line 31.

Relay coil 30 and the compressor contactor coil 21 now are energized through a circuit from lines L1 to L3 including contact 24b (which is in the solid line position) and contact 28a. The coils 21 and 30 are held energized through the contact 30b in line 34, which was closed upon energization of coil 30. Upon energization of the contactor coil 21, contactor coil contact 21a will close, thereby closing the circuit between lines T1 and T2 and permitting energization of the compressor motor 19.

Assuming that the demand for cooling has continued for a predetermined time period on the order of five minutes, thermostat 20 remains closed and the compressor motor 19 remains running. Relay contact 28a remains closed and contact 30b in line 34 remains closed. At the end of the predetermined time cycle, the timing motor 24 is stopped as the cam actuates switches 24a and 24b back to the dotted line position. The timing motor is stopped since the contact 30a in the line 32 has been opened. The circuit will remain in this condition until the cooling demand is satisfied and/or a protective device is opened.

Assume an operating condition wherein after two or three minutes of running time the thermostat 20 is opened. The relay coils 28 and 30 as well as the contactor coil 21 are deenergized. Accordingly the compressor motor 19 is stopped when the circuit across lines T1 and T2. Also timing motor 24 will be stopped. In the event that the thermostat 20 recloses, the timing motor 24 will commence to run through contact 24a and line 31. However, the relay coils 28 and 30 and contactor coil 21 will remain deenergized.

Should the thermostat 20 immediately reclose, the timer motor 24 will be energized as indicated. However, the relays 28 and 30 and the contactor coil 21 will remain deenergized. Thus the remainder of the time in the predetermined time cycle will run out before the switches 24a and 24b can be shifted back to the dotted line position illustrated.

In the event of an over-anticipated or misapplied thermostat that would produce a cooling demand off-cycle of less duration than the predetermined time cycle, for example, a three minute on, three minute off cooling demand cycle, upon the first demand for cooling the circuit across lines T1 and T2 for forty seconds in the illustrated embodiment of the invention.

For another time demand of thirty minutes, the compressor motor 19 would be deenergized and the timing motor 24 would be deenergized. Then when the thermostat 20 closed again calling for cooling, there would be two minutes and twenty seconds of demand time left before switches 24a and 24b would be returned to the dotted line position by cam 26 actuated by timing motor 24. The compressor motor 19 would remain off another twenty seconds before it could be restarted. The total time from start to restart then might be on the order of eight minutes and forty seconds in the given example.

The compressor motor time delay circuit of the present invention may be provided in a compact device that can be field wired to a refrigeration system with little difficulty. The relay 28 is a simple single pole double throw relay. The relay 30 is a simple single pole double throw relay.

The novel compressor motor time delay circuit of the present invention functions to provide a timed demand cycle. The circuit functions to prevent restart of the compressor motor for a minimum predetermined time, on the order of five minutes when the thermostat or safety protection switch is opened, so as to prevent undesirable rapid recycling of the compressor motor, and thus prevent damage to the compressor motor.

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

I claim:

1. A time-delay circuit for controlling operation of a refrigerant compressor motor to permit equalization of pressures in the refrigeration system after shutdown and for minimizing undesirable rapid cycling of the compressor motor in operation, said compressor motor being adapted to be supplied from a source of electric power and power supply means for the time-delay circuit, the improvement comprising control switch means for interrupting the power supply means, contactor coil means for controlling energization and deenergization of the compressor motor time-delay means operative in response to closure of the control switch means for initiating a minimum predetermined time period to prevent reenergization of the compressor motor for at least said minimum predetermined time, said time-delay means including a first relay means, second relay means and means including first and second cam-actuated switches, the contactor coil means including a contactor coil, the first relay means including first and second cam-actuated switches, the first relay means including a first relay coil and a normally open contact in series therewith, and the second relay means including a second relay coil and a first normally closed contact and a second normally open contact, the second normally open contact being in series with the second relay coil, the second normally open contact being in circuit with the contactor coil, whereby closure of the control switch means will energize the second relay coil, closing the second normally open contact and completing a circuit through the contactor coil to energize same and to energize the compressor motor and at the same time, the timing motor means will be actuated to initiate the minimum predetermined time period, with subsequent opening of the control switch means deenergizing the contactor coil to deenergize the compressor motor, as well as the timing motor means, and with subsequent closing of the control switch means being ineffective to energize the contactor coil and thereby energize the compressor motor until the minimum predetermined time period has elapsed.

2. A time delay upon closure of a thermostat, in claim 1, wherein the timing motor means includes a timing motor and a cam operated from the timing motor for actuating each of said timing motor switches between a first position and a second position, the first normally closed contact of the second relay means being in series with the timing motor when the first timing motor switch is in the first position and the second normally open contact of the second relay means being parallel with the first relay coil and second
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cam actuated switch when said second switch is in said first position.

3. A time delay circuit as in claim 2, wherein the timing motor is energized when the control switch means is closed and the first timing motor switch is in the first position and which timing motor is deenergized in the event that the control switch means is opened.

4. A time delay circuit as in claim 3 wherein the second cam actuated switch moves from the first position to the second position before the first cam-actuated switch and moves from the second position to the first position after the first cam-actuated switch.

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