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COMPRESSOR MOTOR TIME DELAY CIRCUIT

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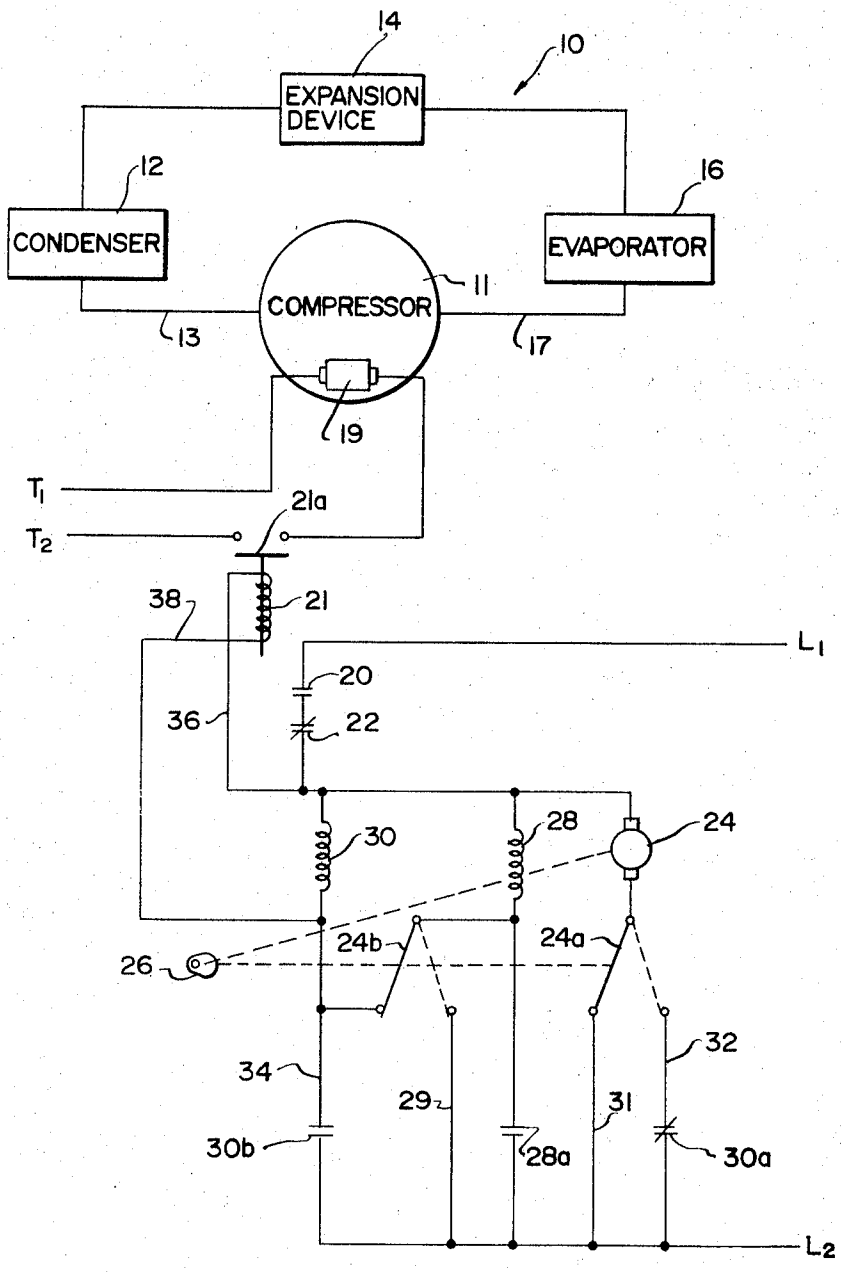

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COMPRESSOR MOTOR TIME DELAY CIRCUIT

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ABSTRACT OF THE DISCLOSURE

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.

It is recognized that there have been previous attempts to utilize timer means to prevent operation of the compressor in an on-off manner when switches in the control circuit are opened and closed rapidly. Thermal timers have heretofore been used and also mechanical switch timer means have been used. These systems, however, have not been altogether reliable and are generally more complex and expensive than the present construction.

An object of the present invention is to provide an improved compressor motor time delay arrangement.

Another object of this invention is to provide improved compressor motor time delay means for protecting a refrigerant compressor against rapid cycling that might be caused by chattering or rapid opening and closing of thermostat contacts, or by rapid voltage surges as a result of lightening. Other objects and advantages of the present invention will become apparent hereinafter.

The specific details of the invention and their mode of functioning will be made most manifest and particularly pointed out in clear and precise terms in conjunction with the accompanying drawing wherein:

The single figure illustrates schematically a refrigeration system and includes schematically a wiring diagram of a presently preferred form of compressor motor time delay circuit.

Referring now to the drawing, there is illustrated a refrigeration system **10** of conventional design that could

utilize the present invention. The refrigeration system **10** includes a refrigerant compressor **11** which might be of the hermetic type wherein the motor and compression mechanism are enclosed within a single hermetically sealed casing. The compressor in operation pumps high pressure vaporous refrigerant to the condenser **12** through discharge line **13**. In the condenser **12**, the vaporous refrigerant is converted to the liquid phase. The condenser may be air cooled or liquid cooled in a conventional manner. The liquid refrigerant then flows from the condenser through an expansion device indicated generally at **14**. Examples of suitable expansion devices are capillary tubes or thermal expansion valves. Refrigerant passes from the expansion device **14** to the evaporator **16**, where the refrigerant may evaporate and return to the vaporous phase. The refrigerant is returned to the compressor through a suction conduit **17** connecting the evaporator to the compressor.

In many applications the compressor motor is a low starting torque motor for purposes of economy. In the event that the high side and low side of the refrigeration system are not balanced after shut-off of the compressor. then the starting torque requirements will be excessive and the compressor motor may stall.

Consider now the electrical circuit of the present invention for preventing undesirable cycling of the compressor motor. The compressor motor **19** is supplied with power from a suitable source via lines T_1 and T_2. Contactor coil **21** controls energization of the compressor motor through opening and closing of contact **21***a*.

The contactor coil **21** is in a control circuit supplied with power through leads L_1 and L_2. The leads L_1 and L_2 may be at a higher or lower voltage than lines T_1 and T_2, for example, a transformer may be used to change the voltage at L_1 and L_2, although it may be taken directly from T_1 and T_2 if desired.

Provided in the circuit is a thermostat or control switch indicated generally at **20**. The thermostat **20** closes in response to cooling demand and opens when the cooling demand is satisfied. In practice, a control relay actuated by a room thermostat provides the control switch contacts.

Provided in series with the thermostat **20** is a protection switch **22**, which, for example, may be a high pressure cut-out switch suitably attached to the compressor or other part of the high pressure side of the refrigeration system which will open the electrical circuit if the compressor head pressure exceeds a predetermined maximum. It will be understood that other desirable safety switches may be used in addition to the illustrated protection switch **22**.

The compressor motor time delay circuit includes timing motor means comprising a timing motor **24**, a cam **26** rotated by the motor and a pair of timing motor switches or contacts **24***a* and **24***b* actuated by the cam **26**.

Connected in circuit with the timing motor **24** are a pair of relays. The first relay is a single pole single throw type and includes a relay coil **28** and a contact **28***a* in series therewith. The contact **28***a* is normally open, and when closed is adapted to connect the relay coil **28** between lines L_1 and L_2 so as to hold the relay coil energized.

The second relay is a single pole double throw type and includes relay coil **30** and first and second contacts **30***a* and **30***b*. The contact **30***a* in line **32** is normally closed and the contact **30***b* in line **34** is normally open.

The contactor coil **21** is connected across lines **36** and **38**. Contact **21***a* is adapted to open and close the circuit to the compressor motor **19**, which is in a circuit across the lines T_1 and T_2, which are connected to a suitable source of power.

Considering now the electrical circuit at start-up, the thermostat **20** is normally open until there is a demand for cooling. The contacts **24***a* and **24***b* 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 **24***b* and line **29** to line L_2. Upon energization of coil **28** normally open contact **28***a* 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 L_1 to L_2 through the thermostat **20**, the protection device **22**, timing motor **24**, contact **24***a* and normally closed contact **30***a* to L_2. The circuits to the contactor coil **21** and relay coil **30** are open since the switch **24***b* is in the dotted line position and the contact **30***b* 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 **24***a* and **24***b* have been moved to the solid line position indicated. Switch **24***a* switches to the solid line position first, with switch **24***b* following by a short interval of time, on the order of two seconds. The timing motor now runs through switch **24***a* and line **31**.

Relay coil **30** and the compressor contactor coil **21** now are energized through a circuit from lines L_1 to L_2 including contact **24***b* (which is in the solid line position) and contact **28***a*. The coils **21** and **30** are held energized through the contact **30***b* in line **34**, which was closed upon energization of coil **30**. Upon energization of the contactor coil **21**, contactor coil contact **21***a* will close, thereby closing the circuit between lines T_1 and T_2 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 **28***a* remains closed and contact **30***b* in line **34** remains closed. At the end of the predetermined time cycle, the timing motor **24** is stopped as the cam actuates switches **24***a* and **24***b* back to the dotted line position. The timing motor is stopped since the contact **30***a* 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 contact **21***a* opens the circuit across lines T_1 and T_2. 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 **24***a* 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 **24***a* and **24***b* 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 on-off cycle of less duration than the predetermined timing cycle, for example, a three minute on, three minute off cooling demand cycle, upon the first demand for cooling upon closure of thermostat **20**, the timing motor **24** would be energized as indicated above. The contactor coil **21** would be energized after a delay of twenty seconds to energize the compressor motor for a period of two minutes and forty seconds in the illustrated embodiment of the invention. When the thermostat **20** opens at the end of three 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 **24***a* and **24***b* 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 twenty 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. In 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, ontactor 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 timing motor 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 ineffectual to energize the contactor coil and thereby energize the compressor motor until the minimum predetermined time period has elapsed.

2. A time delay circuit as 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, the second normally open contact of the second relay means being parallel with the first relay coil and second

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 deenerized 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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