CONTROL APPARATUS WITH TIMING MEANS FOR REFRIGERATION SYSTEMS

Filed July 1, 1965

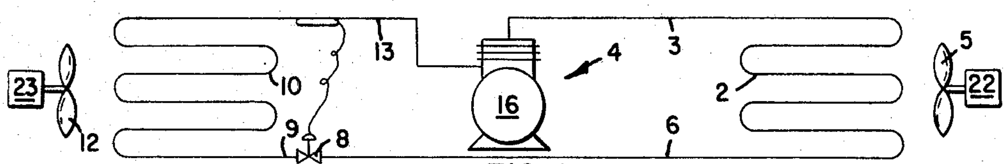

FIG. 1

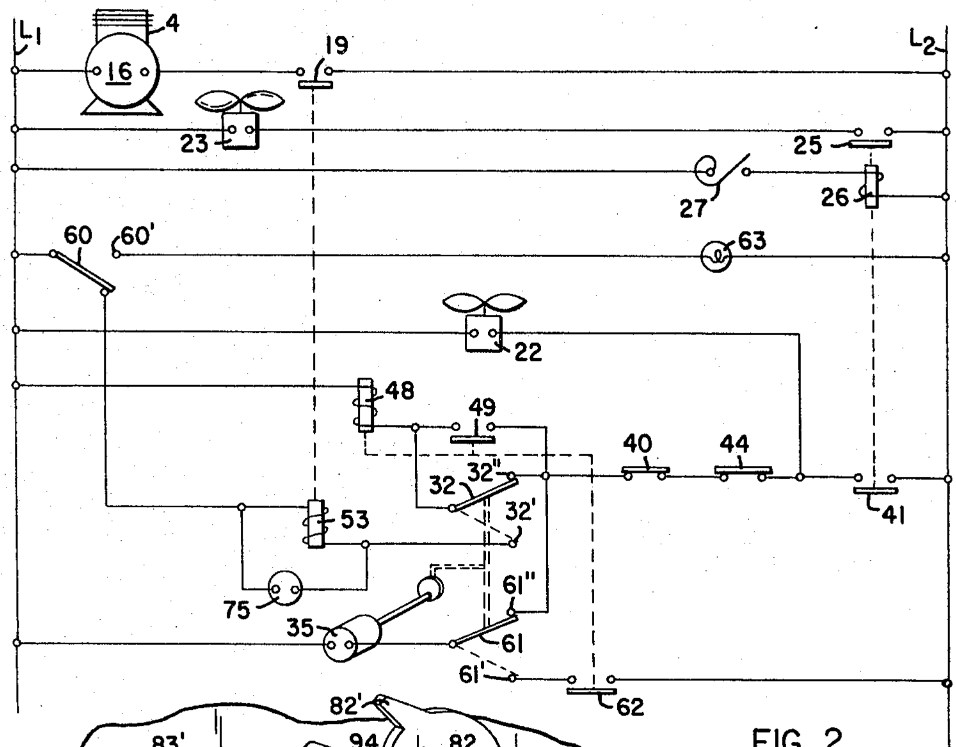

FIG. 2

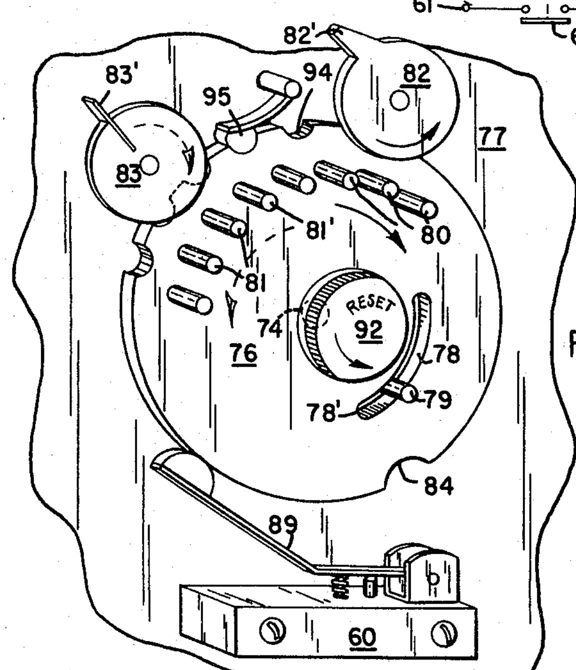

FIG. 3

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3,298,192

Patented Jan. 17, 1967

3,298,192

CONTROL APPARATUS WITH TIMING MEANS FOR REFRIGERATION SYSTEMS

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Filed July 1, 1965, Ser. No. 468,837
9 Claims. (Cl. 62—158)

This invention relates to a refrigeration system, and more particularly, to a control arrangement for the compressor of the refrigeration system.

Refrigeration systems usually incorporate one or more protective devices, each effective at a certain malfunction in the system or the system compressor to render the compressor inoperative. Typical protective devices are, for example, an overtemperature sensor for the compressor motor windings, system pressure measuring devices, devices for sensing adequate compressor oil pressure, etc. On stoppage of the system compressor, whether as a result of a malfunction or, more commonly, the satisfaction of demand on the system, it is desirable that immediate restarting of the compressor be precluded.

In refrigeration systems which incorporate a control to prevent immediate restarting of the system compressor or compressors after stoppage thereof, where the compressor stoppage is due to a prevailing system or compressor malfunction, the compressor or compressors are nevertheless restarted, subject to the control imposed delay, indefinitely until the operator becomes cognizant of the system malfunction or the compressor becomes totally inoperative. This situation is of particular concern in commercial systems where the system is apt to be left unattended for prolonged periods of time.

It is a principal object of the present invention to provide a new and improved control arrangement for refrigeration system compressors.

It is a further object of the present invention to provide a control arrangement effective to limit the number of compressor restarts that may be made within a predetermined period of time.

It is an object of the present invention to provide, in conjunction with a control for delaying restart of a compressor for a timed interval subsequent to each deenergization thereof, an apparatus effective to render the restarting control inoperative following a predetermined number of compressor restarts within a given period of time.

It is an object of the present invention to provide an apparatus which counts each deenergization of a refrigeration system compressor, effective, following a preset number of compressor deenergizations in a given period of time, to prevent further operation of the compressor.

It is a further object of the present invention to provide, in an apparatus for limiting the number of compressor restarts in a given period of time to a predetermined number, means for automatically resetting the apparatus following the successful operation of the compressor.

The invention relates to a refrigeration system comprising in combination, a compressor, control means operable upon demand to energize the compressor; condition sensing means operable upon the occurrence of a predetermined malfunction to deenergize the compressor; timing means for preventing reenergization of the compressor by the control means for a timed interval following each deenergization thereof; and means responding to a predetermined number of compressor deenergizations in the timed interval to render the control means inoperative.

Other objects and advantages will be apparent from

the ensuing description and the accompanying drawings in which:

FIGURE 1 is a schematic representation of a refrigeration system incorporating the compressor control arrangement of the present invention;

FIGURE 2 is a wiring diagram of the compressor control arrangement of the present invention; and

FIGURE 3 is a perspective view illustrating the cycle counting mechanism embodied in the control arrangement shown in FIGURES 1 and 2.

Referring to FIGURE 1 of the drawings, there is shown a refrigeration system incorporating the control arrangement of the invention. The system includes an outdoor heat exchange coil or condenser **2** connected by means of line **3** with the discharge side of a suitable refrigerant compression mechanism, for example, a reciprocating type compressor **4**. The gaseous refrigerant from compressor **4** flowing through outdoor coil **2** is condensed by ambient air from outdoor fan **5**. Liquid refrigerant from coil **2** flows through line **6**, thermal expansion valve **8**, and line **9** to indoor coil or evaporator **10**. It is understood that other suitable expansion devices, as a capillary tube, may be employed in place of expansion valve **8**.

Liquid refrigerant in indoor coil **10** is vaporized by the stream of air from indoor fan **12**, the cooled air being thereafter passed to the area being conditioned by suitable means (not shown). Vaporous refrigerant from coil **10** flows through line **13** to compressor **4**.

Referring to FIGURE 2 of the drawings, drive motor **16** of compressor **4** is connected through contactor **19** across leads L_1, L_2. Leads L_1, L_2 are connected to a suitable source of alternating current power (not shown). It is understood that a polyphase source of electrical power may be employed if the circuit is suitably modified.

Indoor fan motor **23** is connected by switch **25** across leads L_1, L_2. Outdoor fan motor **22** is connected by control relay switch **41** across leads L_1, L_2. Control relay **26** is series connected with temperature responsive switch **27** across leads L_1, L_2. Switch **27** responds to temperature conditions of the area being cooled.

Timer relay **48** is series connected by timer relay switch **49**, system low pressure switch **40**, system high pressure switch **44** and control relay switch **41** across leads L_1, L_2.

Timer switch **32**, when in the solid line position of the drawings, establishes a circuit bypassing timer relay switch **49**.

Switches **44**, **40** are arranged to sense refrigerant pressure conditions in discharge and suction lines **3**, **13**, respectively. Switch **44** deenergizes the compressor at a predetermined high refrigerant pressure in line **3** while switch **40** deenergizes the compressor at a predetermined low refrigerant pressure in line **13**. Other suitable protective devices, for example, a compressor motor winding temperature sensor, a compressor oil pressure sensor, etc., may be employed with or in substitution of system low and high pressure responsive switches **40**, **44**, respectively.

Compressor contactor coil **53** is connected in parallel with timer relay **48** through timer switch **32** and lockout switch **60**. Cycle timer **75** is connected in parallel with coil **53**. Timer **75** controls lockout switch **60**, as will be more apparent hereinafter. Lockout switch **60**, when moved to the dotted line position of the drawings, closes contact **60′** to complete an energizing circuit to signal light **63**.

Timer switch **61**, when in the solid line position of the drawings, connects timer **35** through system low and high pressure switches **40**, **44**, respectively, and control relay switch **41** across leads L_1, L_2. Timer switch **61**, when moved to the dotted line position, closes contact **61′** to place timer **35** in series with timer relay switch **62** across leads L_1, L_2. Timer relay switch **62** is opened by relay **48** upon energization thereof. Timer **35** controls the positions of timer switches **32**, **61**, as will be more apparent hereinafter.

Referring to FIGURE 3 of the drawings, shaft **74** of disc-like counter **76** is rotatably positioned for movement on a suitable support member **77**. Cooperating slot and pin means **78**, **79**, respectively, limit rotational displacement of counter **76**. Counter **76** is provided with a plurality of cylindrical protrusions **80**, **81** at spaced intervals circumjacent the circumference thereof. Disc-like drive members **82**, **83**, operatively arranged adjacent counter **76**, have suitable projections **82'**, **83'**, respectively, engageable with protrusions **80**, **81**, respectively, of counter **76** to drive counter **76** in either a clockwise or counterclockwise direction. Drive member **82**, driven in a counterclockwise direction by timer **35**, moves counter **76** in the direction of the solid line arrow of FIGURE 3 of the drawings. Drive member **83**, driven by timer **75** in a clockwise direction, moves counter **76** in the direction shown by the dotted line arrow of FIGURE 3.

Projection **83'** of drive member **83** is preferably resilient to prevent jamming or overloading of timer **75** when counter **76** is fully reset. Projection **83'** may, for example, be formed from spring steel. As will be more apparent hereinafter, timer **75** is energized concurrently with compressor drive motor **16**. During that period, drive member **83**, through the inter-engagement of projection **83'** with protrusions **81**, resets counter **76** to bring pin **79** into abutment with end **78'** of slot **78**. Since further counterclockwise movement of counter **76** is prevented by slot and pin means **78**, **79**, resilient projection **83'** bends or deforms upon engagement with protrusion **81'** and rotation of drive member **83** continues unabated without overload of timer **75**. Additionally, the resiliency of projection **83'** prevents jamming of the apparatus should drive member projections **82'**, **83'** both simultaneously engage counter **76**.

The outer periphery of counter **76** is provided with a plurality of spaced recesses or notches **94** therein. Recesses **94** cooperate with resilient finger **95**, fixedly secured to support member **77**, to releasably retain counter **76** in each of the several positions defined by each of recesses **94** with finger **95**.

Arm **89** of normally closed locking switch **60** is held by suitable bias means (not shown) in contact with the periphery of counter **76**. Upon movement of switch arm **89** in recess **84** of counter **76**, switch **60** is opened to interrupt the power supply to contactor coil **53** and compressor drive motor **16**.

Switch **60** is preferably provided with a resetting control, such as knob **92**, necessitating that switch **60** and counter **76** be manually reset prior to any resumption of the compressor operation. Knob **92**, drivingly secured to mounting shaft **74**, permits manual resetting movement of counter **76** in a counterclockwise direction against the bias of resilient finger **95**. Signal light **63** gives visible indication when locking switch **60** is opened.

Timers **35**, **75** preferably operate at the same speed. Each revolution of timers **35**, **75** moves, by means of drive members **82**, **83** respectively, counter **76** a distance equaling the space between the axes of adjacent protrusions **80**. The direction of movement of counter **76** may be either clockwise or counterclockwise.

With the several switches of the control circuit diagram in the position shown in FIGURE 2 of the drawings, the refrigeration system is ready to start on a demand for cooling. On a predetermined demand for cooling of the area being conditioned, switch **27** closes to energize control relay **26**. Relay **26** closes control relay switches **25** and **41**. Switch **25** completes an energizing circuit to the indoor fan motor **23**. Switch **41** completes an energizing circuit to outdoor fan motor **22**.

Additionally, closure of switch **41** completes a circuit

from lead L_1 through system low and high pressure switches **40**, **44** respectively, and timer switch **32** to lead L_2 to energize timer relay **48**. Timer relay **48** closes timer relay switch **49** to complete the bypass circuit of timer switch **32**. A second circuit is completed through control relay switch **41**, switches **40**, **44** and timer switch **61** to energize timer **35**.

Timer **35**, after a short interval, moves timer switch **32** to close contact **32'** to complete energizing circuits to contactor coil **53** and timer **75**. Contactor coil **53** closes contact **19** to complete an energizing circuit to compressor motor **16**.

At the expiration of a predetermined timed interval timer **35** moves timer switch **61** to open contact **61''** and close contact **61'**. Since switch **62** is open, timer **35** is deenergized. Drive member **82** of timer **35** is in the position shown in FIGURE 3 of the drawings.

Assuming that energization of the compressor drive motor **16** is maintained for a relatively long period of time, drive member **83** of timer **75** moves, through the interengagement of projection **83'** with protrusion **81**, counter **76** in a counerclockwise direction shown by the dotted line arrow of FIGURE 3 to bring pin **79** into abutment with end **78'** of slot **78**. Further movement of counter **76** in a clockwise direction by member **83** is prevented by pin and slot means **78**, **79**.

Upon satisfaction of the cooling demand imposed upon the system, switch **27** opens to interrupt the energizing circuit to control relay **26** thereby opening switches **25** and **41**. Switches **25**, **41**, when opened, interrupt the energizing circuits to indoor and outdoor fan motors **23**, **22**, respectively. Switch **41** additionally interrupts the energizing circuit to contactor coil **53** and contact **19** opens to deenergize compressor drive motor **16**.

The circuit to timer relay **48** is interrupted. Timer relay **48** opens switch **49** and closes switch **62**. Switch **62** completes an energizing circuit through timer switch **61** to timer **35**. Following the expiration of a determined timed interval, for example, five minutes, timer **35** moves switch **32** to open contact **32'** and close contact **32''**. Timer **35** is then deenergized.

Drive member **82**, operably connected to timer **35**, moves, through the interaction of projection **82'** with an adjacent counter protrusion **80**, counter **76** through one position in a clockwise direction. Counter **76** is now in the solid line position shown in FIGURE 3 of the drawings. The system is now ready to restart upon closure of switch **27**.

If, during system operation, one of the switches **40**, **44** opens in response to a malfunction as, for example, the opening of switch **44** at a predetermined high system pressure condition, the energizing circuits to contactor coil **53** and timer relay **48** are interrupted and the compressor drive motor **16** is deenergized. Switch **62** closes to energize timer **35**. Timer **75** is deenergized. Drive member **82** of timer **35** moves counter **76** in a clockwise direction through one position.

At the close of the determined timed interval, timer **35** moves switch **32** to open contact **32'** and close contact **32''**. The compressor drive motor **16** is restarted in the manner described heretofore.

If, on restarting of compressor drive motor **16**, switch **44** reopens, compressor drive motor **16** is again deenergized. Drive member **82** of timer **35** moves counter **76** an additional position in a clockwise direction. Following the occurrence of a preset number of compressor motor deenergizations, switch arm **89** drops into recess **84** of counter **76** to open locking switch **60**. Switch **60** opens contact **60'** to interrupt the power supply to the compressor contactor coil **53** and closes contact **60''** to complete a circuit to signal light **63**. To restart the system, the knob **92** must be manually operated to reset counter **76**.

It is understood that during each interval in which compressor drive motor **16** is energized, timer **75** is similarly energized. Depending upon the length of time compressor drive motor **16** is energized, drive member **83** of timer **75** may effect movement of counter **76** in a counterclockwise direction in opposition to the movement imparted to counter **76** by drive member **82** of timer **35**. Where, however, a sustained malfunction prevails, the period of energization of compressor drive motor **16** is so short that movement of counter **76** by timer **75** is without appreciable effect upon the time required to actuate locking switch **60** and totally deenergize the system.

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

I claim:

1. In a refrigeration system including a compressor, the combination of control means operable upon a demand to energize said compressor; condition sensing means operable upon the occurrence of a predetermined malfunction to deenergize said compressor; timing means for preventing reenergization of said compressor by said control means for a timed interval following each deenergization thereof; and means for counting the number of compressor deenergizations responding to a predetermined number of compressor deenergizations for said timed interval to render said control means inoperative.

2. The refrigeration system according to claim **1** in which said counting means includes a member movable in one direction through a preset distance at each deenergization of said compressor, and means adapted to reset said counting means following energization of said compressor, said reset means being arranged to move said counting means member in an opposite direction through said preset distance following energization of said compressor for said timed interval.

3. The refrigeration system according to claim **2** including drive means engageable with said counting means member to move said counting means member in said one direction, said drive means being drivingly secured to said timing means.

4. The refrigeration system according to claim **3** in which said reset means includes a second timing means, and one-way drive means between said counting means member and said second timing means effective upon operation of said second timing means to move said counting means member in said opposite direction.

5. The refrigeration system according to claim **3** in which said counting means includes a switch effective when actuated to prevent energization of said compressor,

said switch including an actuating arm operatively disposed adjacent said counting means member, predetermined movement of said counting means member moving said switch arm to actuate said switch.

6. The refrigeration system according to claim **4** including means for energizing said second timing means in response to energization of said compressor.

7. In a refrigeration system including a compressor the combination of, means controlling energization of said compressor in response to refrigeration system demand; condition sensing means operable upon the occurrence of a predetermined malfunction to deenergize said compressor; means responding to a predetermined number of compressor deenergizations to render said control means inoperative and prevent energization of said compressor including a lockout switch effective when actuated to render said control means inoperable and a switch operator movable in one direction through a predetermined incremental distance at each deenergization of said compressor, said switch operator being adapted to actuate said lockout switch upon movement through a preset number of said incremental distances; resetting means operable upon energization of said compressor for a timed interval to move said switch operator in an opposite direction through said incremental distance; and means adapted following predetermined movement of said switch operator in said opposite direction to render said resetting means inoperable.

8. The refrigeration system according to claim **7** including first timing means adapted to prevent reenergization of said compressor for a predetermined time following each deenergization thereof, said first timing means including a drive member engageable with said switch operator, said drive member being adapted upon operation of said first timing means to move said switch operator in said one direction through said predetermined incremental distance.

9. The refrigeration system according to claim **8** in which said resetting means includes second timing means having a drive member engageable with said switch operator adapted upon operation of said second timing means to move said switch operator in said opposite direction.

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