

April 1, 1941.

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2,237,249

REFRIGERATION CONTROL SYSTEM

Filed Sept. 30, 1938

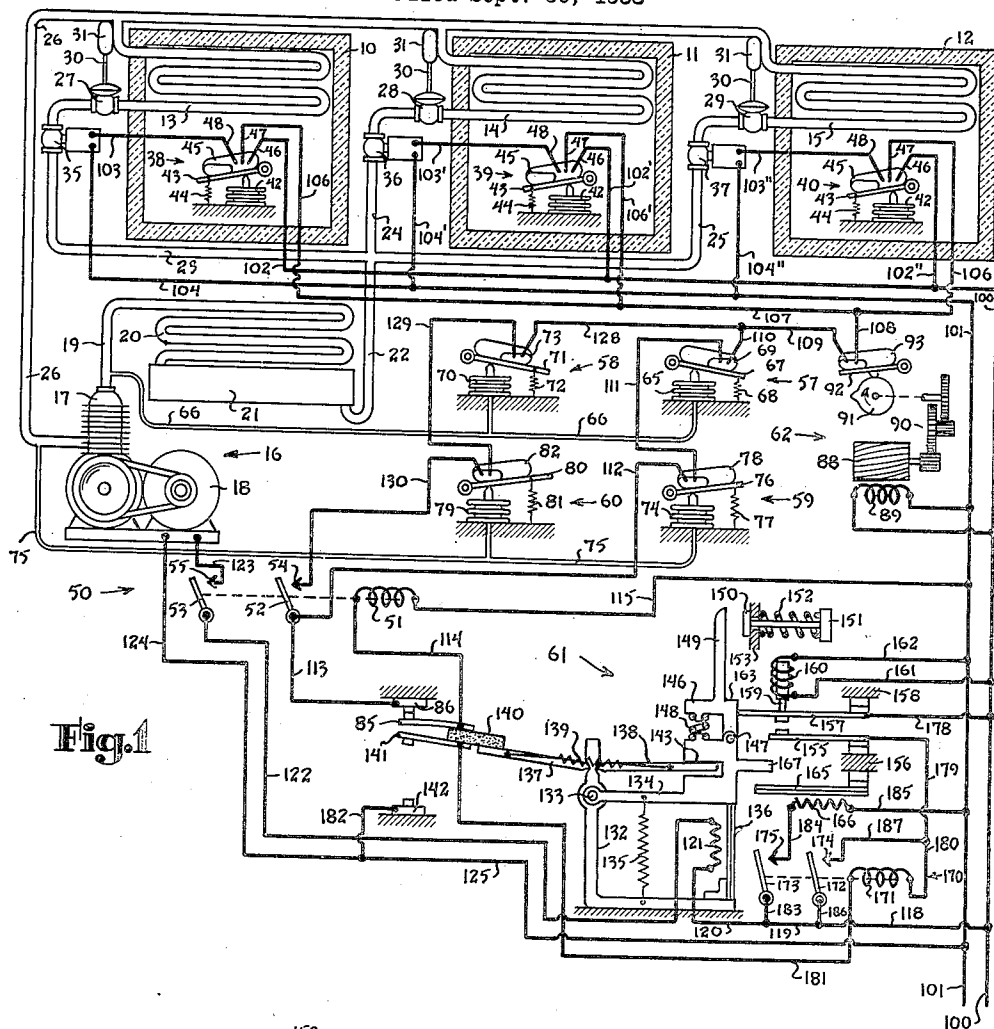


Fig. 1

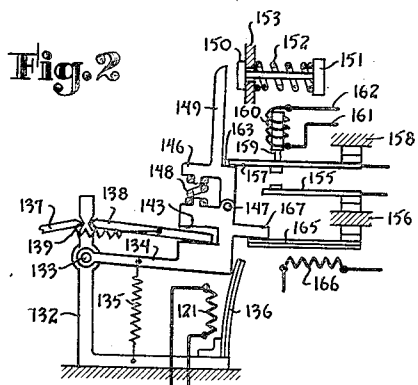


Fig. 2

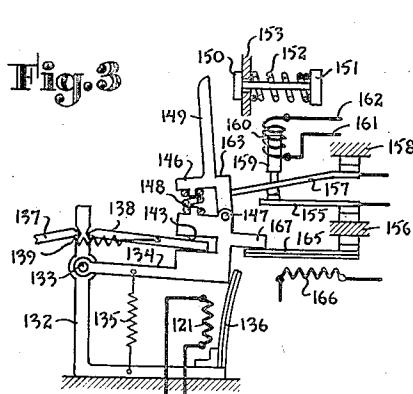


Fig. 3

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2,237,249

REFRIGERATION CONTROL SYSTEM

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Application September 30, 1938, Serial No. 232,606

15 Claims. (Cl. 62—4)

This invention relates to refrigeration control systems and to improvements in the component parts thereof.

The primary object of this invention is to provide an improved control arrangement for a refrigerating apparatus which cools a plurality of fixtures or zones wherein desired temperature conditions are at all times maintained in each fixture or zone, wherein the cooling coils of all of the fixtures or zones are defrosted at each cycle of operation of the refrigerating apparatus, wherein too great a reduction of pressure on the low pressure side of the refrigerating apparatus is prevented, wherein the building up of extremely high head pressures is prevented, wherein starting of the compressor against relatively high head pressures is prevented, wherein defrosting of the coils of all of the fixtures or zones is assured at least at predetermined intervals in case the cooling load in the various fixtures or zones tends to maintain the refrigerating apparatus in continuous operation, and wherein overheating of the compressor motor is prevented by opening the energizing circuit of the compressor motor regardless of whether the overheating is occasioned by overloading of the compressor motor or by the occurrence of a decrease in potential difference across the energizing circuit of the compressor motor, the arrangement being such that if the energizing circuit is opened by an overload condition manual reclosing is required but if it is opened by a decrease in potential difference it is reclosed automatically.

Further objects of the invention are to provide novel control arrangements forming parts of the improved complete control arrangement outlined above.

For a more thorough understanding of this invention reference is made to the accompanying drawing in which:

Figure 1 is a diagrammatic illustration of the complete control system of this invention as applied to a multiple fixture or zone refrigerating apparatus.

Figures 2 and 3 are partial views showing the overload cut-out mechanism of Figure 1 in various operative positions.

Referring now to Figure 1 a plurality of fixtures or zones to be cooled are illustrated at 10, 11, and 12. These fixtures or zones may be rooms, walk-in boxes, show counters, or any other type of device which it be desired to cool. The fixtures or zones 10, 11, and 12 are provided with cooling coils 13, 14, and 15 preferably in the form of evaporators for cooling the same. Refrigerant

is supplied to and withdrawn from the evaporators 13, 14, and 15 by means of a refrigerating apparatus generally designated at 16. The refrigerating apparatus may comprise a compressor 17 operated by an electric motor 18. Compressed refrigerant leaves the compressor 17 through a high pressure line 19 and flows into a condenser 20 wherein it is condensed. Condensed refrigerant is collected in a receiver 21 and then flows through a liquid line 22 and branch liquid lines 23, 24, and 25 into the evaporators 13, 14, and 15, respectively. Expanded refrigerant is withdrawn from the evaporators 13, 14, and 15 through a low pressure or suction line 26 by the compressor 17. It is here noted that the evaporators 13, 14, and 15 are arranged in parallel relationship. Expansion valves 27, 28, and 29 control the supply of refrigerant flowing to the evaporators 13, 14, and 15, respectively, and these expansion valves may be of the thermostatic type provided with a bulb 31 located at the discharge of the evaporators and connected by a capillary tube 30 to the expansion valves. Since the construction outlined above is generally old in the art a further description of the above is not considered necessary.

Located in the branch liquid lines 23, 24, and 25 are solenoid valves 35, 36, and 37 for turning on or turning off the supply of refrigerant to the evaporators 13, 14, and 15, respectively. When the solenoid valves 35, 36, and 37 are energized, refrigerant is supplied to their associated evaporators and when the solenoid valves are deenergized, the supply of refrigerant to their associated evaporators is shut off. The zones or fixtures 10, 11, and 12 are provided with temperature responsive control means in the form of thermostats 38, 39, and 40, respectively. The thermostat 38 may comprise a bellows 42 charged with a volatile fluid for operating a lever 43 against the action of an adjustable tension spring 44. The lever 43 operates a mercury switch 45 provided with electrodes 46, 47, and 48. For purposes of illustration it is assumed that when the temperature within the fixture 10 rises to 42°, the switch 45 is tilted to a position to bridge the electrodes 46, 47, and 48 and when the temperature decreases to 40°, the switch 45 is tilted to the position shown to unbridge the electrodes. The construction and operation of the thermostats 39 and 40 are exactly the same as that of thermostat 38 and consequently like reference characters for like parts have been utilized.

A relay or starter for the compressor motor 18 is generally designated at 50 and may comprise

an operating coil 51 for operating switch arms 52 and 53 with respect to stationary contacts 54 and 55. The arrangement is such that when the operating coil 51 is energized the switch arms 52 and 53 move into engagement with their respective contacts 54 and 55 and when the operating coil 51 is deenergized the switch arms 52 and 53 are moved out of engagement with their respective contacts by means of springs, gravity or other means (not shown).

The thermostats 38, 39, and 40 in addition to controlling the energization of their associated solenoid valves 35, 36, and 37 also control the operation of the relay or starter 50 and hence the operation of the compressor 17. The relay or starter 50 is also controlled by control means 57 and 58 responsive to the pressure on the high pressure side of the refrigerating apparatus, by control means 59 and 60 responsive to the pressure on the low pressure side of the refrigerating apparatus, by an overload cut-out mechanism 61 responsive to the current flow in the energizing circuit of the compressor motor 18 and by a timer generally designated at 62.

The control means 57 responsive to pressure on the high pressure side of the refrigerating apparatus may comprise a bellows 65 connected by a pipe 66 to the high pressure line 19 for operating a lever 67 against the action of an adjustable tension spring 68. The lever 67 operates a mercury switch 69 the parts being so arranged that the switch 69 is moved to closed position when the pressure on the high pressure side of the refrigerating apparatus decreases to 140 pounds and moves to open position when the pressure increases to 145 pounds. The control means 57 operates to determine at what pressure on the high pressure side of the refrigerating apparatus the compressor motor 18 may be placed in operation.

The control means 58 may comprise a bellows 70 connected by the pipe 66 to the high pressure line 19 for operating a lever 71 against the action of an adjustable tension spring 72. The lever 71 operates a mercury switch 73, the parts being so arranged that the switch 73 is moved to open position when the pressure on the high pressure side of the refrigerating apparatus rises to 200 pounds and to closed position when the pressure decreases to 195 pounds. The control means 58 determines at what pressure on the high pressure side of the refrigerating apparatus that the compressor motor 18 is stopped.

The control means 59 may comprise a bellows 74 connected by a pipe 75 to the low pressure or suction line 26 for operating a lever 76 against the action of an adjustable tension spring 77. The lever 76 operates a mercury switch 78 to close the switch when the pressure on the low pressure side of the refrigerating apparatus rises to 38 lbs. and to open the switch when the pressure decreases to 33 lbs. For purposes of illustration it is assumed that the pressure on the low pressure side of the refrigerating apparatus rises to 38 pounds only after defrosting of all of the evaporators 13, 14, and 15 has occurred. The control means 59 operates to prevent operation of the compressor motor 18 until the pressure on the low pressure side of the refrigerating apparatus has risen to a value indicating that defrosting of all of the evaporators has occurred.

The control means 60 may comprise a bellows 79 connected by the pipe 75 to the low pressure or suction line for operating a lever 80 against the action of an adjustable tension spring 81. 75

The lever 80 operates a mercury switch 82, the parts being so arranged that the switch 82 is moved to open position when the pressure on the low pressure side of the refrigerating apparatus decreases to 10 lbs. and is moved to closed position when the pressure increases to 15 lbs. The control means 60 determines the pressure on the low pressure side of the refrigerating apparatus at which the compressor motor 18 is stopped.

The overload cut-out mechanism 61 comprises a movable contact 85 and a stationary contact 86 which are in engagement during normal operation of the refrigerating apparatus. Upon the occurrence of an overload condition the contacts 85 and 86 are separated in a manner to be pointed out more fully hereafter.

The timer generally designated at 62 may comprise a rotor 88 operated by a field winding 89 connected across line wires 100 and 101 leading from some source of power (not shown). The rotor 88 operates a cam 91 through a reduction gear train 90, the cam 91 being provided with a high dwell for operating a lever 92 which in turn operates a mercury switch 93. For purposes of illustration it is assumed that the parts are so arranged that the mercury switch 93 is moved to open position for a short interval of time every six hours.

Assume now that the temperature within the fixture or zone 10 rises to 42° whereupon the switch 45 is tilted to a position to bridge the electrodes 46, 47, and 48; a circuit is thereupon completed from the line wire 100 through wire 102, electrodes 46 and 48, wire 103, solenoid valve 35 and wire 104 back to the other line wire 101. Completion of this circuit energizes the solenoid valve 35 to supply refrigerant to the evaporator 13 within the fixture or zone 10. When the temperature within the fixture or zone 10 decreases to 40° to open the switch 45 the solenoid valve 35 is deenergized to shut off the supply of refrigerant to the evaporator 13. In this manner the solenoid valve 35 is operated to maintain desired temperatures within the fixture or zone 10. The thermostat 39 and solenoid valve 36 are connected together and to the line wires 100 and 101 in exactly the same manner as the thermostat 38 and solenoid valve 35 and accordingly like reference characters "primed" have been utilized for like connections. Also the thermostat 40 and the solenoid valve 37 operate in the same manner and accordingly the wiring connections have been designated by like reference characters "double primed." Summing up, when any thermostat in any of the fixtures or zones calls for cooling, its associated solenoid valve is opened to supply refrigerant to its associated evaporator to maintain desired temperatures in all of the fixtures or zones.

Assume now that the high pressure decreases to 140 lbs. whereupon the switches 69 and 73 of the control means 57 and 58 are closed, that the pressure on the low pressure side of the refrigerating apparatus rises to a defrosting value of 38 lbs. whereupon the switches 78 and 82 of the control means 59 and 60 are closed, and that the temperature within the fixture or zone 10 rises to 42° to close the switch 45. A circuit is thereupon completed from the line wire 100 through wire 102, electrodes 46 and 47, wires 106, 107, and 108, mercury switch 93, wires 109 and 110, mercury switch 69, wire 111, mercury switch 78, wires 112 and 113, contacts 86 and 85 of the overload cut-out mechanism 61, wire 114, operating coil 51, and wire 115 back to the other line

wire 101. Completion of this starting circuit energizes the operating coil 51 to move the switch arms 52 and 53 into engagement with their respective contacts 54 and 55.

Movement of the switch arm 53 into engagement with the contact 55 completes an energizing circuit for the compressor motor 18 which may be traced from the line wire 100 through wires 118, 119, and 120, heater 121, wire 122, switch arm 53, contact 55, wire 123, compressor motor 18, and wires 124 and 125 back to the other line wire 101. Accordingly when the operating coil 51 is energized the compressor motor 18 and hence the refrigerating apparatus is in operation.

Movement of the switch arm 52 into engagement with the contact 54 completes a maintaining circuit for the operating coil 51 of the relay or starter 50 which is independent of the switches 69 and 78 of the control means 57 and 59, respectively. This maintaining circuit may be traced from the line wire 100 through wire 102, electrodes 46 and 47 of the thermostat 38, wires 106, 107, and 108, mercury switch 93, wires 109 and 128, mercury switch 73, wire 129, mercury switch 82, wire 130, contact 54, switch arm 52, wire 113, contacts 86 and 85, wire 114, operating coil 51, and wire 115 back to the other line wire 101. Completion of this circuit maintains the operating coil 51 energized until any of the switches 45, 73, 82, or 93 are opened, or until the contacts 85 and 86 of the overload cut-out mechanism 61 are separated. The electrodes 46 and 47 of the switches 45 of the thermostats 39 and 40 are connected in parallel with the electrodes 46 and 47 of the thermostat 38, these parallel connections being shown by 102' and 106' for the thermostat 39 and 102'' and 106'' for the thermostat 40.

Summing up two circuits are provided for controlling the energization of the operating coil 51, a starting circuit including the switches 45 of the thermostats 38, 39, and 40 connected in parallel, the switch 93 of the timer 62, the switches 69 and 78 of the control means 57 and 59 and the contacts 85 and 86 of the overload cut-out 61. The other circuit is a maintaining circuit which includes the switches 45 of the thermostats 38, 39, and 40 connected in parallel, switch 93 of the timer 62, the switches 73 and 82 of the control means 58 and 60, the maintaining switch formed by the switch arm 52 and contact 54 of the relay or starter 50, and the contacts 85 and 86 of the overload cut-out mechanism 61. The operating coil 51 of the relay may be energized and hence the relay pulled in only when the starting circuit is completed and it is maintained energized, after it has once been energized by the starting circuit, so long as the maintaining circuit is completed. Accordingly, the operating coil 51 of the relay or starter may be energized to operate the compressor 17 only when any of the thermostats 38, 39, and 40 are calling for cooling, the timer switch 93 is closed, the pressure on the high pressure side of the refrigerating apparatus has decreased to 140 pounds to close the switch 69, the pressure on the low pressure side of the refrigerating apparatus has risen to a defrosting value of 38 lbs. to close the switch 78, and the contacts 85 and 86 of the overload cut-out 61 are closed. Hence the refrigerating apparatus can only be started after defrosting of all of the evaporators has taken place and when the pressure on the high pressure side of the refrigerating apparatus has reduced to a predetermined

low value which greatly reduces the starting load on the compressor motor 18 and hence eliminates the majority of the starting overload conditions.

After the compressor 17 has been placed in operation in the manner pointed out above, it will remain in operation until either all of the thermostats 38, 39, and 40 are satisfied, or the switch 93 of the timer 62 is opened, or the pressure on the high pressure side of the refrigerating apparatus rises to 200 lbs. to open the switch 73, or the pressure on the low pressure side of the refrigerating apparatus decreases to 10 lbs. to open the switch 82, or the contacts 85 and 86 separate upon the occurrence of an excess current flow in the energizing circuit of the compressor motor.

The system thus far described controls the operation of the refrigerating apparatus to maintain at all times desired temperature conditions in the various fixtures or zones 10, 11, and 12, to provide defrosting of all of the evaporators 13, 14, and 15 at each cycle of operation of the compressor 17, to prevent too great a reduction of pressure on the low pressure side of the refrigerating apparatus, to prevent the building up of extremely high pressures on the high pressure side of the refrigerating apparatus and to prevent starting of the compressor against relatively high head pressures. Ordinarily thermostats 38, 39, and 40 will tend to call for cooling at substantially the same times and will tend to be satisfied at substantially the same times so that intermittent defrosting of the evaporators 13, 14, and 15 will occur. However, it is quite possible under certain operating conditions that at least one of the thermostats 38, 39, and 40 will be calling for cooling at the same time and after the compressor is placed in operation it will remain in operation for a long period of time tending to build up frost on the evaporators 13, 14, and 15. The timer 62 operating the switch 93 is utilized for shutting down the refrigerating apparatus at predetermined times, say every six hours, and after the refrigerating apparatus has been shut down in this manner it is impossible to restart the same until the suction pressure has risen to the defrosting value of 38 lbs. Accordingly defrosting of the evaporators 13, 14, and 15 at least every six hours is provided. In other words, the timer 62 operates to insure that the evaporators 13, 14 and 15 will be defrosted at least at predetermined times although the evaporators are usually defrosted more often than this.

The overload cut-out mechanism 61 may comprise a support 132 carrying a pivot 133. A lever 134 is carried by the pivot 133 and is urged downwardly by a spring 135 into engagement with the end of a bimetallic element 136 also secured to the support 132. Levers 137 and 138 are fulcrumed on the support 132 and are connected together by an overcenter spring 139. The lever 137 carries an insulating pad 140 upon which are mounted the movable contact 85 and a movable contact 141 which is adapted to engage a stationary contact 142. The lever 134 is provided with a slot 143 for receiving the end of the lever 138. With the parts in the position shown in Figure 1, the lever 134 is engaging the bimetallic element 136 and the overcenter spring 139 holds the movable contact 85 in engagement with the stationary contact 86. If now the current flow in the energizing circuit for the compressor motor 18 should become ex-

cessive, the heater element 121 will heat the bimetallic element 136 and warp the same outwardly to the position shown in Figure 2. Outward movement of the bimetallic element 136 releases the lever 134 and the spring 135 moves the same downwardly. Downward movement of the lever 134 causes the lever 138 to move downwardly to move the spring 139 overcenter, which in turn causes the contacts 85 and 86 to separate with a snap action and causes contacts 141 and 142 to make with a snap action. Separation of the contacts 85 and 86 in this manner interrupts the above outlined starting and maintaining circuits for the operating coil 51 to drop out the relay or starter 50 and stop operation of the compressor motor 18.

An auxiliary lever 146 is secured to the main lever 134 by a pivot 147, the auxiliary lever being maintained normally in the position shown in Figures 1 and 2 by a compression spring 148. The lever 146 is provided with an extension 149 which is adapted to be engaged by an abutment 150 which is secured to a button 151. A compression spring 152 located between the button 151 and a stationary support 153 maintains the abutment 150 in the position shown in Figures 1, 2, and 3. After the overload cut-out mechanism 61 separates the contacts 85 and 86 in the manner outlined above, the overload cut-out mechanism may be restored to the position shown in Figure 1 by pressing inwardly on the button 151. This raises the lever 134 about its pivot 133 and allows the bimetallic element 136 to again move under the lever 134 to hold the parts in the position shown in Figure 1.

A stationary contact 155 is secured to a suitable support 156 and a movable contact 157 is secured to a support 158. An armature 159 is secured to the movable contact 157 and is influenced by a winding 160, connected by wires 161 and 162 across line wires 100 and 101. When the potential difference across the line wires 100 and 101 is at a predetermined value the winding 160 maintains the solenoid 159 and the movable contact 157 in the position shown in Figure 1. If the potential difference across the line wires 100 and 101 should decrease to a predetermined low value, then the armature 159 and the contact 157 move downwardly as shown in Figure 3 under the influence of springs, gravity or other means (not shown) to cause the movable contact 157 to engage the stationary contact 155. An abutment surface 163 formed on the lever 146 prevents downward movement of the movable contact 157 if the potential difference across the line wires 100 and 101 decreases after the overload cut-out mechanism has been operated to separate the contacts 85 and 86 as is clearly illustrated in Figure 2.

A bimetallic element 165 carried by the support 156 is adapted to engage a lug 167 carried by the lever 134, the bimetallic element 165 being heated by a heater 166. The energization of the heater 166 is controlled by a relay 170 which may comprise an operating coil 171 for moving switch arms 172 and 173 into engagement with contacts 174 and 175, respectively, when energized. When the operating coil 171 is deenergized the switch arms 172 and 173 are moved out of engagement with their respective contacts by means of springs, gravity or other means (not shown).

Assume now that the parts are in the position shown in Figure 1 and that the potential difference across the line wires 100 and 101 decreases to a predetermined value to cause the movable

contact 107 to engage the stationary contact 155. If this decrease in potential difference persists the current flow through the heater 121 will increase to cause outward flexing of the bimetallic element 136 to separate the contacts 85 and 86 and to close the contacts 141 and 142, this movement being permitted by the pivotal connection 147 between the levers 134 and 146 and the spring 148 as shown in Figure 3. Separating of the contacts 85 and 86 stops operation of the compressor motor 18 and movement of the contact 141 into engagement with the contact 142 completes a circuit from the line wire 100, through wire 170, contacts 157 and 155, wires 179 and 180, operating coil 171, wire 181, contacts 141 and 142, and wires 182 and 125 back to the other line wire 101. Completion of this circuit causes energization of the operating coil 171 to move the switch arms 172 and 173 into engagement with their respective contacts.

Movement of the switch arm 172 into engagement with the contact 174 completes a maintaining circuit for the operating coil 171 which may be traced from the line wire 100 through wires 118 and 186, switch arm 172, contact 174, wires 187 and 190, operating coil 171, wire 181, contacts 141 and 142, and wires 182 and 125 back to the other line wire 101. This maintaining circuit maintains the operating coil 171 energized until such time as the contacts 141 and 142 are separated. Movement of the switch arm 173 into engagement with contact 175 completes a circuit from the line wire 100 through wires 118, 119, and 183, switch arm 173, contact 175, wire 194, heater 166, and wire 125 back to the other line wire 101. Completion of this circuit energizes the heater element 166 which flexes the bimetallic element 165 upwardly to move the lever 134 upwardly which in turn separates the contacts 141 and 142 and recloses the contacts 85 and 86.

From the above it is seen that the overload cut-out mechanism 61 operates to separate the contacts 85 and 86 to stop operation of the compressor when the current flow in the energizing circuit of the compressor motor becomes excessive. If the excessive current flow in the energizing circuit for the compressor motor is caused by a decrease in potential difference across the power lines, the contacts 85 and 86 will be reclosed automatically after they have once been opened, the length of time required for automatically reclosing the contacts 85 and 86 being determined by the length of time required for the bimetallic element 165 to move the lever 134 upwardly. If the excessive current flow in the energizing circuit of the compressor motor should be caused by something other than a decrease in potential difference, the contacts 85 and 86 are separated to stop operation of the compressor motor and they may be reclosed only by manual manipulation of the button 151. Automatic reclosing under these conditions is prevented by the abutment surface 163 on the lever 146.

Since most of the overload conditions in a refrigerating apparatus are caused by starting the compressor against relatively high head pressures or by continuing the compressor in operation when the head pressure becomes extremely high or the suction pressure becomes extremely low, the complete system outlined above obviates most of these conditions so that the compressor motor 18 will seldom if ever become overloaded. The other condition which causes excessive current flow through the compressor mo-

tor is usually a decrease in potential difference across the energizing circuit and since this is not a very serious condition it is desirable to automatically reclose the overload cut-out mechanism when the overload cut-out mechanism is opened by this condition. If an overload condition other than those outlined above should occur this would be an indication that something was radically wrong with the refrigerating system and when the overload cut-out mechanism stops operation of the compressor motor due to these other conditions, manual resetting of the overload cut-out mechanism is required. This will indicate that the system should be checked for faulty operation.

From the above it is seen that this invention contemplates a complete system for maintaining accurate temperature conditions in a plurality of fixtures or zones, for defrosting the evaporators at each cycle of operation of the refrigerating apparatus, for insuring that the evaporators will defrost at least once during a predetermined time interval and for providing safe operation of the system. In this latter respect the existence of extremely high pressures on the high pressure side of the refrigerating apparatus and extremely low pressures on the low pressure side of the apparatus are prevented as well as overheating of the compressor motor.

Although for purposes of illustration one form of this invention has been disclosed, other forms thereof may become apparent to those skilled in the art upon reference to this disclosure and therefore this invention is to be limited only by the scope of the appended claims and prior art.

I claim as my invention:

1. In a control system for a refrigerating apparatus having a compressor and evaporator means associated therewith for cooling a medium, the combination of, an electrically operated relay for operating the compressor when energized and including a maintaining switch closed upon energization of the relay, a first control device including a first switch and means responsive to pressure on the high pressure side of the refrigerating apparatus for closing and opening the first switch as the pressure respectively falls below or rises above a predetermined low pressure value, a second control device including a second switch and means responsive to pressure on the high pressure side of the refrigerating apparatus for closing and opening the second switch as the pressure respectively falls below or rises above a predetermined high pressure value, a third control device including a third switch and means responsive to the pressure on the low pressure side of the refrigerating apparatus for closing and opening the third switch as the pressure respectively rises above or falls below a predetermined high value, a fourth control device including a fourth switch and means responsive to the pressure on the low pressure of the refrigerating apparatus for closing and opening the fourth switch as the pressure respectively rises above or falls below a predetermined low value, a starting circuit for the electrically operated relay including only the first and third switches for energizing the relay when both the first and third switches are closed whereby the compressor is started when the pressure on the high pressure side of the refrigerating apparatus falls below the predetermined low value and the pressure on the low pressure side rises above the predetermined high value, and a maintaining circuit for the electrically operated relay including

only the maintaining switch and the second and fourth switches for maintaining the relay energized when the maintaining switch and the second and fourth switches are closed whereby the compressor is maintained in operation until the pressure on the high pressure side of the refrigerating apparatus rises above the predetermined high value or until the pressure on the low pressure side of the refrigerator apparatus falls below the predetermined low value.

2. In a control system for a refrigerating apparatus having a compressor and evaporator means associated therewith for cooling a medium, the combination of, an electrically operated relay for operating the compressor when energized and including a maintaining switch closed upon energization of the relay, a first control device including a first switch and means responsive to pressure on the high pressure side of the refrigerating apparatus for closing and opening the first switch as the pressure respectively falls below or rises above a predetermined low pressure value, a second control device including a second switch and means responsive to pressure on the high pressure side of the refrigerating apparatus for closing and opening the second switch as the pressure respectively falls below or rises above a predetermined high pressure value, a third control device including a third switch and means responsive to the pressure on the low pressure side of the refrigerating apparatus for closing and opening the third switch as the pressure respectively rises above or falls below a predetermined high value, a fourth control device including a fourth switch and means responsive to the pressure on the low pressure of the refrigerating apparatus for closing and opening the fourth switch as the pressure respectively rises above or falls below a predetermined low value, a fifth control device including a fifth switch and means responsive to the temperature of the medium being cooled for closing and opening the fifth switch as the temperature respectively rises above or falls below a predetermined value, a starting circuit for the electrically operated relay including only the first, third and fifth switches for energizing the relay only when the first, third and fifth switches are closed, and a maintaining circuit for the electrically operated relay including only the maintaining switch and the second, fourth and fifth switches for maintaining the relay energized until either the second, fourth or fifth switches are opened.

3. In a control system for a refrigerating apparatus having a compressor and a plurality of evaporators for cooling medium in a plurality of zones, the combination of, thermostatic control means for each zone responsive to the temperature of the medium being cooled of that zone, control means responsive to the pressure on the low pressure side of the refrigerating apparatus, means controlled by the control means and the thermostatic control means for starting operation of the compressor only when any of the thermostatic control means calls for cooling and the pressure on the low pressure side of the refrigerating apparatus rises to a defrosting value and for continuing the compressor in operation until either all of the thermostatic control means are satisfied or the pressure on the low pressure side of the refrigerating apparatus decreases to a predetermined low value, and means operatively associated with said last mentioned means for stopping operation of the compressor at predetermined times whereby the pressure on the

low pressure side of the refrigerating apparatus will rise to a defrosting value at least at these predetermined times.

4. In a control system for a refrigerating apparatus having a compressor and a plurality of evaporators for cooling medium in a plurality of zones, the combination of, thermostatic control means for each zone responsive to the temperature of the medium being cooled of that zone, control means responsive to the pressure on the low pressure side of the refrigerating apparatus, means associated with each zone and controlled by the thermostatic control means of that zone to admit refrigerant to the evaporator of that zone upon a call for cooling by the thermostatic control means of that zone, means controlled by the control means and the thermostatic control means for starting operation of the compressor only when any of the thermostatic control means calls for cooling and the pressure on the low pressure side of the refrigerating apparatus rises to a defrosting value and for continuing the compressor in operation until either all of the thermostatic control means are satisfied or the pressure on the low pressure side of the refrigerating apparatus decreases to a predetermined low value, and means operatively associated with said last mentioned means for stopping operation of the compressor at predetermined times whereby the pressure on the low pressure side of the refrigerating apparatus will rise to a defrosting value at least at these predetermined times.

5. In a control system for a refrigerating apparatus having a compressor and a plurality of evaporators for cooling medium in a plurality of zones, the combination of, thermostatic control means for each zone responsive to the temperature of the medium being cooled of that zone, control means responsive to the pressure on the low pressure side of the refrigerating apparatus, control means responsive to the pressure on the high pressure side of the refrigerating apparatus, means controlled by both of the control means and the thermostatic control means for starting operation of the compressor only when any of the thermostatic control means call for cooling, the pressure on the low pressure side of the refrigerating apparatus rises to a defrosting value and the pressure on the high pressure side of the refrigerating apparatus decreases to a predetermined low value and for continuing the compressor in operation until either all of the thermostatic control means are satisfied or the pressure on the high pressure side of the refrigerating apparatus increases to a predetermined high value, and means associated with said last mentioned means for stopping operation of the compressor at predetermined times whereby the pressure on the low pressure side of the refrigerating apparatus will rise to a defrosting value at least at these predetermined times.

6. In a control system for a refrigerating apparatus having a compressor and a plurality of evaporators for cooling medium in a plurality of zones, the combination of, thermostatic control means for each zone responsive to the temperature of the medium being cooled of that zone, control means responsive to the pressure on the low pressure side of the refrigerating apparatus, control means responsive to the pressure on the high pressure side of the refrigerating apparatus, means controlled by both of the control means and the thermostatic control means for starting operation of the compressor only when any of the thermostatic control means call for cooling, the

pressure on the low pressure side of the refrigerating apparatus rises to a defrosting value and the pressure on the high pressure side of the refrigerating apparatus decreases to a predetermined low value and for continuing the compressor in operation until either all of the thermostatic control means are satisfied or the pressure on the low pressure side of the refrigerating apparatus decreases to a predetermined low value or the pressure on the high pressure side of the refrigerating apparatus increases to a predetermined high value, and means associated with said last mentioned means for stopping operation of the compressor at predetermined times whereby the pressure on the low pressure side of the refrigerating apparatus will rise to a defrosting value at least at these predetermined times.

7. In a control system for a refrigerating apparatus having a compressor and a plurality of evaporators for cooling medium in a plurality of zones, the combination of, thermostatic control means for each zone responsive to the temperature of the medium being cooled of that zone, means associated with each zone and controlled by the thermostatic control means of that zone to admit refrigerant to the evaporator of that zone upon a call for cooling by the thermostatic control means of that zone, control means responsive to the pressure on the low pressure side of the refrigerating apparatus, control means responsive to the pressure on the high pressure side of the refrigerating apparatus, means controlled by both of the control means and the thermostatic control means for starting operation of the compressor only when any of the thermostatic control means call for cooling, the pressure on the low pressure side of the refrigerating apparatus rises to a defrosting value and the pressure on the high pressure side of the refrigerating apparatus decreases to a predetermined low value and for continuing the compressor in operation until either all of the thermostatic control means are satisfied or the pressure on the high pressure side of the refrigerating apparatus increases to a predetermined high value, and means associated with said last mentioned means for stopping operation of the compressor at predetermined times whereby the pressure on the low pressure side of the refrigerating apparatus will rise to a defrosting value at least at these predetermined times.

8. In a control system for a refrigerating apparatus having a compressor and a plurality of evaporators for cooling medium in a plurality of zones, the combination of, an electrically operated relay for operating the compressor when energized and including a maintaining switch closed upon energization of the relay, thermostatically operated switch means for each zone responsive to the temperature of the medium being cooled of that zone and closed upon a call for cooling, a first switch, means responsive to the pressure on the low pressure side of the refrigerating apparatus for closing the first switch when the pressure rises above a defrosting value, a starting circuit for the electrically operated relay including the thermostatically operated switch means arranged in parallel with respect to each other and the first switch arranged in series with the thermostatically operated switch means for energizing the relay only when any of the thermostatically operated switch means are closed and the first switch is closed whereby the compressor is started only when at least one of the thermostatically operated switch means is calling for cooling and the pressure on the low pressure side of the refrigerating apparatus has risen to a defrosting

value, a maintaining circuit for the electrically operated relay including the thermostatically operated switch means arranged in parallel with respect to each other and the maintaining switch for maintaining the relay energized and the compressor in operation until all of the thermostatically operated switch means are satisfied, a normally closed time operated switch opened at predetermined times, said time operated switch being located in series with said thermostatically operated switch means for deenergizing the electrically operated relay and stopping operation of the compressor at predetermined times whereby the pressure on the low pressure side of the refrigerating apparatus will rise to the defrosting value at least at these predetermined times.

9. In a control system for a refrigerating apparatus having a compressor and a plurality of evaporators for cooling medium in a plurality of zones, the combination of, an electrically operated relay for operating the compressor when energized and including a maintaining switch closed upon energization of the relay, thermostatically operated switch means for each zone responsive to the temperature of the medium being cooled of that zone and closed upon a call for cooling, first and second switches, means responsive to pressure on the low pressure side of the refrigerating apparatus for closing the first switch when the pressure rises to a defrosting value and for opening the second switch when the pressure decreases to a predetermined low value, a starting circuit for the electrically operated relay including the thermostatically operated switch means arranged in parallel with respect to each other and the first switch arranged in series with the thermostatically operated switch means for energizing the relay only when any of the thermostatically operated switch means are closed and the first switch is closed whereby the compressor is started only when at least one of the thermostatically operated switch means is calling for cooling and the pressure on the low pressure side of the refrigerating apparatus has risen to a defrosting value, a maintaining circuit for the electrically operated relay including the maintaining switch, the thermostatically operated switch means arranged in parallel with respect to each other and the second switch for maintaining the relay energized and the compressor in operation until either all of the thermostatically operated switch means are satisfied or until the pressure on the low pressure side of the refrigerating apparatus decreases to the predetermined low value to open the second switch, a normally closed time operated switch opened at predetermined times, said time operated switch being located in series with the thermostatically operated switch means for deenergizing the electrically operated relay and stopping operation of the compressor at predetermined times whereby the pressure on the low pressure side of the refrigerating apparatus will rise to the defrosting value at least at these predetermined times.

10. In a control system for refrigerating apparatus having a compressor and a plurality of evaporators for cooling medium in a plurality of zones, the combination of, an electrically operated relay for operating the compressor when energized and including a maintaining switch closed upon energization of the relay, thermostatically operated switch means for each zone responsive to the temperature of the medium being cooled of that zone and closed upon a call for cooling, first and second switches, means responsive to pres-

sure on the low pressure side of the refrigerating apparatus for closing the first switch when the pressure rises to a defrosting value and for opening the second switch when the pressure decreases to a predetermined low value, third and fourth switches, means responsive to pressure on the high pressure side of the refrigerating apparatus for closing the third switch when the pressure decreases to a predetermined low value and for opening the fourth switch when the pressure increases to a predetermined high value, a starting circuit for the electrically operated relay including the thermostatically operated switch means arranged in parallel with respect to each other and the first and third switches for energizing the relay only when any of the thermostatically operated switch means are closed and the first and third switches are closed whereby the compressor is started only when at least one of the thermostatically operated switch means are calling for cooling, the pressure on the low pressure side of the refrigerating apparatus has risen to the defrosting value and the pressure on the high pressure side of the refrigerating apparatus has decreased to the predetermined low value, a maintaining circuit for the electrically operated relay including the thermostatically operated switch means arranged in parallel with respect to each other, the maintaining switch and the second and fourth switches for maintaining the relay energized and the compressor in operation until either all of the thermostatically operated switch means are satisfied or the pressure on the low pressure side of the refrigerating apparatus decreases to the predetermined low value to open the second switch or the pressure on the high pressure side of the refrigerating apparatus increases to the predetermined high value to open the fourth switch, a normally closed time operated switch opened at predetermined times, said time operated switch being located in series with said thermostatically operated switch means for deenergizing the electrically operated relay and stopping operation of the compressor at predetermined times whereby the pressure on the low pressure side of the refrigerating apparatus will rise to the defrosting value at least at these predetermined times.

11. In a control system for a refrigerating apparatus having a compressor and a plurality of evaporators for cooling medium in a plurality of zones, the combination of, an electrically operated relay for operating the compressor when energized and including a maintaining switch closed upon energization of the relay, thermostatically operated switch means for each zone responsive to the temperature of the medium being cooled of that zone and closed upon a call for cooling, means associated with each zone and controlled by the thermostatically operated switch means of that zone to admit refrigerant to the evaporator of that zone upon a call for cooling by the thermostatically operated switch means of that zone, a first switch, means responsive to the pressure on the low pressure side of the refrigerating apparatus for closing the first switch when the pressure rises above a defrosting value, a starting circuit for the electrically operated relay including the thermostatically operated switch means arranged in parallel with respect to each other and the first switch arranged in series with the thermostatically operated switch means for energizing the relay only when any of the thermostatically operated switch means are closed and the first switch is closed whereby the compressor is

started only when at least one of the thermostatically operated switch means is calling for cooling and the pressure on the low pressure side of the refrigerating apparatus has risen to a defrosting value, a maintaining circuit for the electrically operated relay including the thermostatically operated switch means arranged in parallel with respect to each other and the maintaining switch for maintaining the relay energized and the compressor in operation until all of the thermostatically operated switch means are satisfied, a normally closed time operated switch opened at predetermined times, said time operated switch being located in series with said thermostatically operated switch means for deenergizing the electrically operated relay and stopping operation of the compressor at predetermined times whereby the pressure on the low pressure side of the refrigerating apparatus will rise to the defrosting value at least at these predetermined times.

12. In a control system for a refrigerating apparatus having a compressor and a plurality of evaporators for cooling medium in a plurality of zones, the combination of, an electrically operated relay for operating the compressor when energized and including a maintaining switch closed upon energization of the relay, thermostatically operated switch means for each zone responsive to the temperature of the medium being cooled of that zone and closed upon a call for cooling, means associated with each zone and controlled by the thermostatically operated switch means of that zone to admit refrigerant to the evaporator of that zone upon a call for cooling by the thermostatically operated switch means of that zone, first and second switches, means responsive to pressure on the low pressure side of the refrigerating apparatus for closing the first switch when the pressure rises to a defrosting value and for opening the second switch when the pressure decreases to a predetermined low value, a starting circuit for the electrically operated relay including the thermostatically operated switch means arranged in parallel with respect to each other and the first switch arranged in series with the thermostatically operated switch means for energizing the relay only when any of the thermostatically operated switch means are closed and the first switch is closed whereby the compressor is started only when at least one of the thermostatically operated switch means is calling for cooling and the pressure on the low pressure side of the refrigerating apparatus has risen to a defrosting value, a maintaining circuit for the electrically operated relay including the maintaining switch, the thermostatically operated switch means arranged in parallel with respect to each other and the second switch for maintaining the relay energized and the compressor in operation until either all of the thermostatically operated switch means are satisfied or until the pressure on the low pressure side of the refrigerating apparatus decreases to the predetermined low value to open the second switch, a normally closed time operated switch opened at predetermined times, said time operated switch being located in series with the thermostatically operated switch means for deenergizing the electrically operated relay and stopping operation of the compressor at predetermined times whereby the pressure on the low pressure side of the refrigerating apparatus will rise to the defrosting value at least at these predetermined times.

13. In a control system for a refrigerating apparatus having a compressor and a plurality of evaporators for cooling medium in a plurality of zones, the combination of, an electrically operated relay for operating the compressor when energized and including a maintaining switch closed upon energization of the relay, thermostatically operated switch means for each zone responsive to the temperature of the medium being cooled of that zone and closed upon a call for cooling, means associated with each zone and controlled by the thermostatically operated switch means of that zone to admit refrigerant to the evaporator of that zone upon a call for cooling by the thermostatically operated switch means of that zone, first and second switches, means responsive to pressure on the low pressure side of the refrigerating apparatus for closing the first switch when the pressure rises to a defrosting value and for opening the second switch when the pressure decreases to a predetermined low value, third and fourth switches, means responsive to pressure on the high pressure side of the refrigerating apparatus for closing the third switch when the pressure decreases to a predetermined low value and for opening the fourth switch when the pressure increases to a predetermined high value, a starting circuit for the electrically operated relay including the thermostatically operated switch means arranged in parallel with respect to each other and the first and third switches for energizing the relay only when any of the thermostatically operated switch means are closed and the first and third switches are closed whereby the compressor is started only when at least one of the thermostatically operated switch means are calling for cooling, the pressure on the low pressure side of the refrigerating apparatus has risen to the defrosting value and the pressure on the high pressure side of the refrigerating apparatus has decreased to the predetermined low value, a maintaining circuit for the electrically operated relay including the thermostatically operated switch means arranged in parallel with respect to each other, the maintaining switch and the second and fourth switches for maintaining the relay energized and the compressor in operation until either all of the thermostatically operated switch means are satisfied or the pressure on the low pressure side of the refrigerating apparatus decreases to the predetermined low value to open the second switch or the pressure on the high pressure side of the refrigerating apparatus increases to the predetermined high value to open the fourth switch, a normally closed time operated switch opened at predetermined times, said time operated switch being located in series with said thermostatically operated switch means for deenergizing the electrically operated relay and stopping operation of the compressor at predetermined times whereby the pressure on the low pressure side of the refrigerating apparatus will rise to the defrosting value at least at these predetermined times.

14. In a control system for a refrigerating apparatus having an electrically operated compressor and a plurality of evaporator means for cooling medium in a plurality of zones, the combination of, an energizing circuit for the electrically operated compressor, thermostatic control means for each zone responsive to the temperature of the medium being cooled of that zone, control means responsive to the pressure on the high pressure side of the refrigerating apparatus, con-

trol means responsive to the pressure on the low pressure side of the refrigerating apparatus, switch means controlled by the control means and the thermostatic control means for controlling the energizing circuit to start the compressor only when any of the thermostatic control means calls for cooling, the pressure on the low pressure side of the refrigerating apparatus rises to a defrosting value and the pressure on the high pressure side of the refrigerating apparatus decreases to a predetermined low value and for continuing the compressor in operation until either all of the thermostatic control means are satisfied or the pressure on the low pressure side of the refrigerating apparatus decreases to a predetermined low value or the pressure on the high pressure side of the refrigerating apparatus increases to a predetermined high value, means associated with said switch means for opening the energizing circuit for stopping operation of the compressor at predetermined times whereby the pressure on the low pressure side of the refrigerating apparatus will rise to the defrosting value at least at these predetermined times, overload means associated with said switch means and responsive to current flow in the energizing circuit for opening the energizing circuit upon the occurrence of excessive current flow, means for manually operating the overload means for reclosing the energizing circuit, and means responsive to the potential difference across the ener-

gizing circuit and operative upon opening of the energizing circuit for automatically operating the overload means to reclose automatically the energizing circuit when the same has been opened by an excessive current flow in the energizing circuit caused by a decrease in potential difference across the energizing circuit.

15. In a control system for a refrigeration apparatus having a compressor and a plurality of evaporators for cooling medium in a plurality of zones, the combination of, thermostatic control means for each zone responsive to the temperature of the medium being cooled of that zone, control means responsive to the pressure on the low pressure side of the refrigerating apparatus, means controlled by the control means and the thermostatic control means for starting operation of the compressor only when any of the thermostatic control means calls for cooling and the pressure on the low pressure side of the refrigerating apparatus rises to a defrosting value and for continuing the compressor in operation until all of the thermostatic control means are satisfied, and means operatively associated with said last mentioned means for stopping operation of the compressor at predetermined times whereby the pressure on the low pressure side of the refrigerating apparatus will rise to a defrosting value at least at these predetermined times.

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