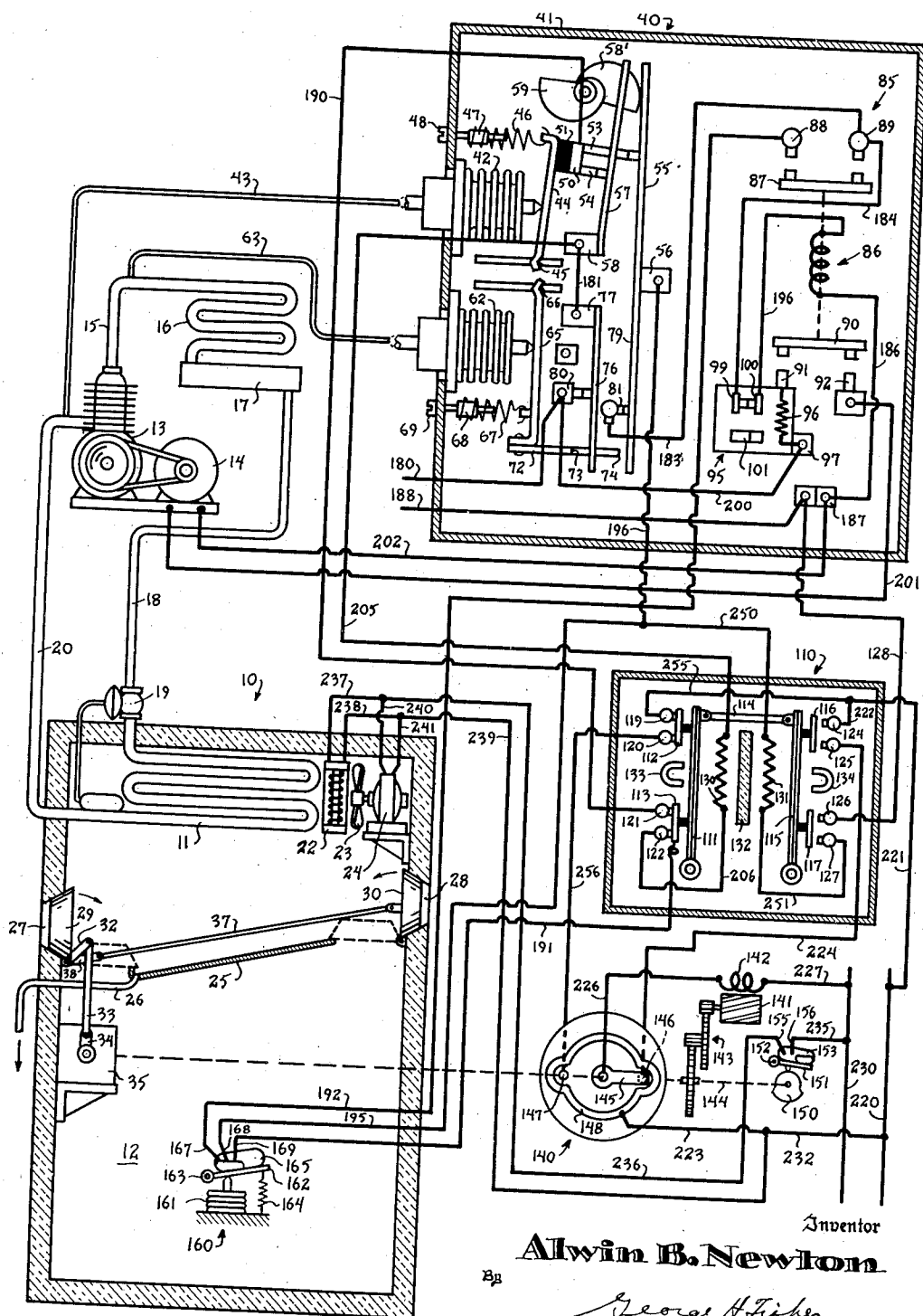


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REFRIGERATION CONTROL SYSTEM

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REFRIGERATION CONTROL SYSTEM

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This invention relates to refrigerating apparatus and more particularly to a control system for a refrigerating apparatus that automatically causes defrosting of the evaporator when conditions require it.

It has heretofore been proposed to initiate a defrosting cycle of the evaporator between each operation of the compressor by preventing restarting of the compressor until the suction pressure in the system rises to such a value that the evaporator is completely defrosted. Such a control system has been found to be very satisfactory in most cases. However, when the fixture being cooled is to be maintained at a very low temperature, such as 10° F., it may not be possible to initiate a defrosting cycle between each operation of the compressor and maintain this low temperature in the fixture, and it is to this type of a refrigerating apparatus that my invention is particularly directed.

In accordance with the teachings of my invention, a controller responsive to the temperature in the fixture normally controls operation of the compressor to maintain this temperature at desired values. Provision is made for interrupting operation of the compressor should the head pressure in the system become excessively high and to prevent restarting of the compressor until this head pressure drops to a predetermined value to reduce the starting load on the compressor motor. Provision is also made for interrupting operation of the compressor should the suction pressure drop to an excessively low value, and when the compressor is stopped by reason of the suction pressure becoming excessively low it cannot be restarted until the suction pressure rises to a sufficiently high value to cause defrosting of the evaporator. However, when the compressor is stopped by reason of the temperature in the fixture dropping to the required value, it is not necessary for the suction pressure to rise to the defrosting value so that defrosting of the evaporator occurs only when the compressor is stopped by reason of the suction pressure becoming excessively low without causing the fixture temperature to drop to the desired value.

Provision is made for isolating that portion of the fixture containing the evaporator from the storage compartment of the fixture during the defrosting operation so that the temperature of the storage compartment will not rise excessively during the defrosting period. At the same time, that portion of the fixture containing the evaporator is opened to the atmosphere

and provision is made for blowing heated air over the evaporator at this time to accelerate the defrosting thereof. As soon as the evaporator has been defrosted, the compressor will be restarted and communication reestablished between the two portions of the fixture so that the temperature in the storage compartment may be reduced to the desired value.

It is therefore an object of my invention to provide a refrigerating apparatus of the type above described wherein provision is made for automatically defrosting the evaporator when conditions require that this be done and at the same time for isolating the storage compartment of the fixture from the evaporator to prevent undue rise in temperature therein and at the same time to accelerate the defrosting of the evaporator by blowing heated air thereover, there also being provision for interrupting operation of the compressor when the head pressure becomes excessively high and for preventing restarting of the compressor at all times until the head pressure has dropped to a predetermined value.

Other objects and advantages will become apparent upon reference to the specification, claims and appended drawing wherein is illustrated a preferred form of my invention.

Referring more particularly to the drawing, a fixture 10 is provided with an evaporator 11 in the upper portion thereof, the lower portion of the fixture 10 having a storage compartment 12 within which meats or any other articles that are to be maintained at a relatively low temperature, below 32° F., such as 10° F., may be stored. The evaporator 11 forms a part of a mechanical refrigeration system of a conventional type which system also includes a compressor 13 driven by a motor 14, the compressor being connected by a pipe 15 to a condenser 16 leading to the receiver 17 whence condensed refrigerant flows through a pipe 18 to the evaporator 11 under the control of a conventional thermostatic type expansion valve 19. The evaporated refrigerant then flows back to the compressor by way of the pipe 20. The operation of such a refrigeration system is well understood in the art and further description thereof is believed to be unnecessary.

Suitably located within the fixture 10 is a heating element 22 and a fan or blower 23 driven by a motor 24, these elements being so arranged that when the heating element 22 and the motor 24 are energized the fan 23 will cause a circulation of heated air over the evaporator 11. Located below the evaporator is a drip pan 25 having an

outlet 26, this drip pan being arranged to catch the moisture which is melted from the evaporator 11 during the defrosting period, the moisture then passing from the drip pan by way of the drain 26. The upper portion of the fixture 10 is provided with openings 27, 28 which are normally closed by the doors 29 and 30, respectively, the door 29 being connected by links 32 and 33 to the arm 34 of a motor 35 and the door 30 being connected by the links 37, 38, 32, and 33 to the arm 34 of the motor 35. These linkages are so arranged that when the arm 34 of the motor 35 completes a half revolution, the doors will move from the full line positions to the dotted line positions wherein they close the spaces formed between the drip pan 25 and the side walls of the fixture 10 thus isolating the upper portion of the fixture containing the evaporator 11 from the lower portion or storage compartment 12. At the same time, the openings 27 and 28 permit communication between the upper portion of the fixture and the atmosphere to accelerate the defrosting of the evaporator.

The reference character 40 illustrates a control device for controlling the operation of the compressor motor, this control device being of the type illustrated in application Serial No. 196,447 of Albert L. Judson and Carl G. Kronmiller, filed on March 17, 1938. This control device generally comprises a base 41 on which is mounted a bellows 42 connected by means of a pipe 43 with the suction line 20 of the refrigeration system. This bellows acts on a lever 44 pivoted at 45 and having its opposite end connected by a spring 46 to a nut 47 mounted on an adjusting screw 48, this adjusting screw being provided for varying the tension of the spring 46 and the calibration of the bellows 42. The lever 44 carries a bridge member 50 by means of the insulating pad 51, this bridge member including contacts 53 and 54. The contact 53 cooperates with a contact arm 55 carried by the terminal 56 and the contact 54 cooperates with a contact arm 57 carried by the terminal 58. The positions of these contact arms 55 and 57 when disengaged by the contacts 53 and 54 may be varied by means of the concentrically arranged cams 58' and 59. With the parts in the positions illustrated, it may be assumed that the suction pressure is at 35 pounds and the evaporator has just been defrosted and at this pressure the contacts 53 and 54 are in engagement with the contact arms 55 and 57. As the suction pressure drops below 35 pounds, the contact 53 moves out of engagement with the contact arm 55 and upon a drop in the suction pressure below 5 pounds, for example, the arm 57 will be moved into engagement with the cam 59 and the contact 54 will then move out of engagement with the contact arm 57.

Also carried by the base 41 is a bellows 62 connected by means of the pipe 63 with the high pressure line 15, this bellows acting upon a lever 65 pivoted at 66 and having its other end connected by means of the spring 67 to the nut 68 carried by the adjusting screw 69. Adjustment of this screw 69 adjusts the tension of the spring 67 and in this manner the calibration of the bellows 62 may be adjusted. Carried by the lever 65 is an adjustable abutment member 72 having abutments 73 and 74. The abutment 73 is adapted to engage a contact member 76 carried by a terminal 77 and the abutment member 74 is adapted to engage a contact member 79 carried by the terminal 56. The contact member 76 engages a contact member 80 and the contact mem-

ber 79 engages a contact member 81. Upon an increase in pressure in the line 15, the bellows 62 expands and the abutment member 74 moves into engagement with the contact arm 79 and causes movement of this arm out of engagement with the contact 81 at a pressure of 135 pounds, for example. Upon a further increase in pressure in the line 15, the abutment member 73 will engage the contact arm 76 at 185 pounds, for example, and cause movement of this contact member away from the contact 80. Upon a decrease in pressure below 185 pounds, the arm 76 will move back into engagement with the contact 80 and when the pressure drops below 135 pounds, the contact arm 79 will move into engagement with the contact 81.

The reference character 85 indicates a relay or starter for the compressor motor 14. This relay or starter comprises a relay coil 86 for operating a bridge member 87 with respect to the maintaining contacts 88 and 89 and a second bridge member 90 with respect to the load contacts 91 and 92. Upon energization of the relay coil 86, the bridge members will move into engagement with their respective contacts and upon deenergization of the coil 86, the bridge members move out of engagement with their respective contacts under the influence of gravity or any suitable biasing means (not shown).

The reference character 95 indicates an overload cut-out mechanism which includes a heater element 96 connected between a terminal 97 and the load contact 91 for heating a thermostatic element which trips open contacts 99 and 100 upon the occurrence of an overload condition. The contacts 99 and 100 may be manually reclosed by means of the reset arm 101. The operation of this control device 40 for the compressor motor 14 will be more fully explained as the description proceeds.

The reference character 110 indicates generally a thermally operated switching mechanism. This relay comprises a bimetallic element 111 carrying bridge members 112 and 113 suitably insulated from the bimetallic element 111, this bimetallic element being connected by means of link 114 to a second bimetallic element 115 carrying bridge elements 116 and 117 suitably insulated from this bimetallic element. When the bimetallic elements are in the positions shown, the bridge element 112 closes a circuit through the contacts 119 and 120 while the bridge element 113 closes a circuit through the contacts 121 and 122. In the other position which these elements are adapted to assume, the bridge elements 112 and 113 move out of engagement with their respective contacts and the bridge element 116 carried by the bimetallic element 115 closes a circuit through the contacts 124 and 125 while the bridge member 117 closes a circuit through contacts 126 and 127. Located adjacent the bimetallic element 111 is an electrical heating element 130 and a second heating element 131 is located adjacent the bimetallic element 115, there being an insulating wall 132 separating these heating elements so that one heating element will not affect the bimetallic element on the opposite side of the wall 132. When the heating element 130 is energized, the heat imparted thereby to the element 111 causes this element to move to the right to move the bridge members out of engagement with their respective contacts and by reason of the link 114 the element 115 is moved in the same direction. Conversely, when the heating element 131 is

energized, the bimetallic element 115 moves towards the left causing similar movement of the bimetallic element 111. In order to cause the elements to move with a snap action, magnets 133 and 134 are located adjacent the bimetallic elements 111 and 115, respectively. The magnet 133 prevents movement of the element 111 until sufficient stress has been set up in this element to cause rapid movement thereof whereupon the magnet 134 will attract the element 115 causing movement of the bridge members 116 and 117 into engagement with their respective contacts and movement of the bridge members 112 and 113 out of engagement with their respective contacts. As will be understood, the elements move in the opposite direction upon energization of heating element 131 in the same manner.

Referring more particularly now to the motor 35 for operating the doors 29 and 30 in the fixture 10, the internal parts of this motor have been illustrated generally by the reference character 140. This motor includes an armature 141 and a field winding 142, the armature 141 being connected by suitable reduction gearing 143 to the shaft 144 which carries the arm 34 for operating the doors 29 and 30. The shaft 144 also carries a contact arm 145 which cooperates with the contacts 146, 147 and the contact ring 148 in a manner to be hereinafter described. The shaft 144 may also carry a cam member 150 which engages a lever 151 pivoted at 152 and carrying the mercury switch 153. As the shaft 144 rotates through 180° to move the doors 28 and 29 from their full line positions to their dotted line positions, the cam 150 will likewise rotate through 180° whereupon the switch 153 will be tilted to a position wherein the terminals 155 and 156 are bridged by the mercury element of the switch 153, as will be understood from the drawing.

Located within the fixture 12 is the thermostat 160, this thermostat including a bellows 161 having a suitable volatile fill whereupon the bellows will expand or contract in accordance with variations in temperature within the fixture 12. The bellows 161 acts upon a lever 162 pivoted at 163 and biased into engagement with the upper portion of the bellows by means of the spring 164. A mercury switch 165 is carried by the lever 162. This switch includes three terminals 167, 168, and 169 which are adapted to be connected together by the mercury element of the switch when in the position illustrated. When the temperature within the fixture drops to a sufficiently low value, the switch 165 will be tilted in the opposite direction thus breaking the contact between the terminals of the switch.

Operation

With the parts in the position illustrated, it may be assumed that a defrosting operation has just been completed, that the temperature within the compartment 12 of the fixture 10 is above the desired value which may be taken as 10° F., that the suction pressure within the refrigeration system is above 35 pounds so that the contacts 53 and 54 of the bridge member 50 are in engagement with the contact arms 55 and 57 and that the head pressure is below 135 pounds so that the contact arms 76 and 79 are in engagement with the contacts 80 and 81. With the parts in these positions, the relay coil 86 of the control device 40 will be energized through the following circuit: from the line wire 180 to

the terminal 80, contact member 76, terminal 77, wire 181, terminal 58, contact members 57 and 54 through the bridge member 50, contact members 53 and 55, 79 and 81, conductor 183 through the terminal 89, conductor 184, the overload cut-out contacts 99 and 100, relay coil 86, conductor 186 to the power terminal 187 and thence to the line 188, these line wires 180 and 188 being connected to a suitable source of power, not shown. The energization of the relay coil 86 causes the bridge members 87 and 90 to move into engagement with the maintaining contacts 88 and 89 and the load contacts 91 and 92, respectively.

Movement of the bridge member 90 into engagement with the contacts 91 and 92 closes a circuit to the compressor motor 14 as follows: from the line 180, the terminal 80, conductor 200, terminal 97, overload resistance member 96, contact 91, bridge member 90, contact 92, conductor 201, through the motor 14, conductor 202 to the power terminal 187 and line 188.

Movement of the bridge member 87 into engagement with the contacts 88 and 89 establishes the following holding circuit for the relay coil 86: from the line wire 180, contact members 80 and 76, terminal 77, conductor 181, terminal 58, contact members 57 and 54, bridge member 50, conductor 190, contact 121 of the switching mechanism 110, bridge member 113, conductor 191 to the terminal 169 of the switch 165, through the switch to terminal 167, conductor 192, the maintaining contact 88, bridge member 87, contact 89, conductor 184, overload contacts 99, 100, conductor 196, relay coil 86, conductor 186, power terminal 187, and line 188. This maintaining circuit, it should be noted, does not include the suction pressure contacts 53 and 55 or the high pressure contacts 79 and 81. In other words, as long as the suction pressure contacts 54 and 57 remain closed and the high pressure contacts 76 and 80 remain closed indicating that the suction pressure is above 5 lbs. and the head pressure is below 185 lbs., the compressor will remain in operation as long as the temperature in the fixture is above the desired value, once the compressor has been put into operation. Should the temperature in the fixture now drop to the desired value thus opening the circuit through the contacts 167 and 169, the maintaining circuit through the relay 86 will be interrupted. In order for the temperature in the storage compartment to drop to this desired value by operation of the evaporator 11, it is necessary that the suction pressure drop below 35 lbs. in order that the evaporator will have the desired cooling effect so that the original energizing circuit for the starting coil 86 will of necessity have been interrupted and the compressor will now stop, thus placing the refrigerating system out of operation.

The temperature in the storage compartment 12 will gradually rise above the desired value thus closing the contacts 167 and 169 of the switch 165 and the compressor 13 will again be placed in operation, but only after the head pressure has dropped below 135 lbs. so that contacts 79 and 81 are closed. It is not necessary at this time, however, for the suction pressure to rise to 35 lbs. so that it is possible to start the compressor even though the contact members 53 and 55 are not in engagement with one another. The circuit for energizing the relay coil 86 at this time is as follows: from the line wire 180 through the contacts 80 and 76, terminal 77,

conductor 181, contact members 57 and 54, bridge member 50, conductor 190, contact 121 of switching mechanism 110, bridge member 113, conductor 191, terminals 169 and 168 of the mercury switch 165, conductors 195, 196, terminal 56, contact members 79, 81, conductor 183, contact 89, conductor 184, contacts 99 and 100, conductor 196, relay coil 86, conductor 186, power terminal 167 to the line wire 188. It will thus be seen that the relay coil 186 will be energized upon a call for cooling by the thermostat 160, even if the suction pressure is below 35 lbs. so that the contact members 53 and 55 are not in engagement with one another, as long as the contact 121 of the switching mechanism 110 is in engagement with the bridge member 113. Accordingly, after each operation of the compressor by reason of the thermostat 160 becoming satisfied, the compressor will be restarted upon a further call for cooling after the head pressure drops to 135 lbs., this provision being made to reduce the starting load on the compressor motor 14.

After the compressor has been operated for a sufficient number of cycles, the frost on the evaporator 11 may become sufficiently thick so that the storage compartment 12 in the fixture 10 is not properly cooled. As the frost builds up on the evaporator 11, the suction pressure will gradually drop and if the suction pressure drops to 5 lbs., for example, without causing the temperature in the fixture to become low enough to satisfy the thermostat 160, the contraction of the bellows 42 will cause movement of contact member 54 out of engagement with contact member 57. The original maintaining circuit which was described above is now interrupted at these contacts and sufficient current now flows through the following circuit to cause the heating element 130 of the switching mechanism 110 to heat up, this circuit being as follows: from the line wire 180 through contact member 80, contact member 76, terminal 77, conductor 181, terminal 58, conductor 205, heating element 130, conductor 206, contact 122, bridge member 113, conductor 191, terminal 169 of the mercury switch 165, terminal 167, conductor 192, maintaining contact 88, bridge member 87, contact 89, conductor 184, contacts 99, 100, conductor 196, relay coil 86, conductor 186, power terminal 187, and line 188. This circuit was, of course, established upon energization of the relay coil 86 but sufficient current did not flow through this circuit while the original maintaining circuit for the starting coil which was described above was established since these circuits were in parallel and the heater was effectively shunted out by contacts 54 and 57. However, upon the opening of contacts 54 and 57, the only maintaining circuit for the relay coil 86 is through the heater 130 so this heater now begins to heat up and at the same time heat up the bimetallic element 111. After a short time, sufficient heat will be imparted to the bimetallic element 111 to cause this element to move to the right overcoming the attraction of the magnet 133 and at the same time the bimetallic element 115 moves to the right, this movement taking place with a snap action so that the bridge member 113 moves out of engagement with the contact 121 and the bridge members 116 and 117 carried by the bimetallic element 115 move into engagement with their respective contacts.

The maintaining circuits for the compressor motor 14 are now both interrupted as is the

original energizing circuit by reason of the drop in suction pressure so that the compressor now shuts down and the flow of refrigerant through the evaporator is thus interrupted. The circuit through the heater 130 is also interrupted at this time by the movement of bridge member 113 out of engagement with the contact 122. Movement of bridge member 116 into engagement with contacts 124 and 125 causes the field winding 142 of the motor 35 to be energized as follows: from the line wire 220 through conductors 221 and 222, contact 124, bridge member 116, contact 125, conductor 224 to the contact 146, arm 145 carried by the motor shaft 144, conductor 226, field winding 142 and conductor 227 to the line wire 230. Energization of the field winding 142 causes rotation of the armature 141 and through the reduction gearing 143 the shaft 144 is caused to rotate in a clockwise direction. As the shaft 144 rotates, the arm 145 moves out of engagement with the contact 146 thus interrupting this energizing circuit for the field winding 142 but as the arm 145 moves out of engagement with contact 146, it moves into engagement with the contact ring 148 thus establishing a maintaining circuit for the field winding 142 as follows: from the line wire 220 through conductors 232, 223, contact ring 148, arm 145, conductor 226, field winding 142, and conductor 227 to the line wire 230. It will thus be apparent that as long as the arm 145 remains in engagement with the contact ring 148, the field winding 142 will be energized. After the arm 145 has moved through 180°, however, it moves out of engagement with the ring 148 and into engagement with the contact 147. As the arm 145 moves out of engagement with the ring 148, it interrupts the circuit through the field winding 142 and the armature 141 accordingly stops rotating which in turn causes the shaft 144 to stop rotating.

The shaft 144 has now rotated through the 180 degrees, thus causing rotation of the arm 34 carried by the shaft through the 180 degrees and moving the doors 29 and 30 from their full line positions into the dotted line positions. These doors now cooperate with the drip pan 25 in separating the fixture 10 into two isolated compartments. At the same time, the upper compartment is placed in communication with the outside atmosphere by way of the openings 27 and 28. The cam 150 carried by the shaft 144 is also moved through the 180 degrees thus tilting the switch 153 to close the contacts 155 and 156. A circuit is now established through the heating element 22 as follows: from the line wire 230, conductor 235, switch 153, conductors 236, 237, heating element 22, conductors 238, 239, and 232 to the line wire 220. At the same time, the blower motor 24 is energized by way of the following circuit: from the line wire 230, conductor 235, switch 153, conductors 236, 240, motor 24, conductors 241, 239, and 232 to the line wire 220. The compressor has now been stopped, the doors 29 and 30 moved to their dotted line positions to isolate the storage compartment 12 from the evaporator 11, the upper compartment in the fixture 12 is now in communication with the atmosphere, the heating element 22 is energized, and the fan 23 is rotating and causing air to circulate over the heating element 22 and the evaporator 11 to cause rapid melting of the frost therefrom. Since the storage compartment 12 is separated or isolated from the evaporator 11, this defrosting opera-

tion does not cause an undue rise in temperature in the storage compartment 12. The temperature in the storage compartment will not rise noticeably faster during the defrosting operation than during any normal shutdown of the compressor and because of the heat being supplied to the evaporator at this time the length of the defrosting operation is reduced to a minimum.

After a short time, the frost will be melted from the evaporator 11, the water dripping into the pan 25 and running out the drain 26. The suction pressure will now rise rapidly to 35 lbs. whereupon the contacts 53 and 54 carried by the bridge member 50 move into engagement with the contact members 55 and 57. By this time the head pressure will also have fallen sufficiently so that the contact member 79 is in engagement with the contact 81. The original energizing circuit through the starting coil 86 which did not include the thermostat 160 will now be established since all of the contacts controlled by the bellows 42 and 62 will be closed. The following circuit will also be established through the heating element 131; from the line wire 180, through contacts 80, 76; terminal 77, conductor 181, terminal 58, contact members 57, 54, 53, 55, terminal 56, conductors 196, 250, heating element 131, conductor 251, contact 127, bridge member 117, contact 126, conductor 128, power terminal 187, and line wire 188. Sufficient current will now flow through the heating element 131 since this heating element is connected directly across the line wires 180 and 188, so that the bimetallic element 115 will become sufficiently heated to cause movement of this element and the bimetallic element 111 to the left thus moving the bridge members 116 and 117 out of engagement with their respective contacts and breaking the circuit through the heating element 131 while at the same time moving the bridge elements 112 and 113 into engagement with their respective contacts where they are held by the magnet 133. Since the thermostat 160 is now calling for cooling, it being recalled that the compressor stopped prior to the defrosting operation because the suction pressure dropped below 5 lbs. while there was a call for cooling in the storage compartment 12, the original maintaining circuit for the compressor will be reestablished. At the same time, a circuit is established through the field winding 142 of the motor 35 as follows: from the line wire 220 through conductors 221, 255, contact 119, bridge member 112, contact 120, conductor 256, contact 147, arm 145, which it will be recalled came to rest in engagement with this contact, conductor 226, field winding 142 and conductor 227 to the line wire 230. The armature 141 will again start rotating, moving the arm 145 out of engagement with the contact 147 but into engagement again with the contact ring 148, thus reestablishing the maintaining circuit for the field winding 142 and causing rotation of the motor until it returns to its original position as illustrated where the field winding will again be deenergized since the bridge member 116 has moved out of engagement with the contacts 124 and 125 back into the position illustrated. This 180 degree rotation of the shaft 144 causes the doors 29 and 30 to move back to their original positions closing the openings 27 and 28 and reestablishing communication between the upper and lower portion of the fixture 10. The cam 150 carried by the shaft 144 is also moved back to the position illustrated thus deenergizing the heater 22 and the fan

motor 24 so as to stop the circulation of heated air over the evaporator 11.

The defrosting operation is now completed and the compressor 13 will operate until the temperature in the compartment 12 drops to the desired value unless for some reason or other the head pressure became sufficiently high as to open the maintaining circuit at contacts 76 and 80 or unless the circuit to the compressor motor were opened at contacts 99 and 100 by reason of some overload condition. The compressor will now cycle on and off as before to maintain the temperature in the compartment 12 at the desired value until such time as the pressure within the system drops low enough to stop the compressor during one of its operations thus indicating the existence of sufficient frost on the evaporator as to warrant the necessity of another defrosting operation. It will be recalled, however, that the compressor can at no time start operating until the head pressure has dropped sufficiently to permit the closure of contacts 79 and 81, thus insuring that the compressor motor will not have to start operation under a heavy load condition.

It will thus be apparent that I have devised an arrangement wherein automatic defrosting of the evaporator is initiated whenever necessary, in a system wherein a fixture temperature is to be maintained at a relatively low value, the storage compartment of the fixture being isolated from the evaporator during each defrosting operation to prevent an undue temperature rise therein and at the same time a circulation of heated air over the evaporator is effected to accelerate the defrosting operation so that the evaporator will be available for cooling the storage compartment 12 to the desired temperature within a relatively short time and before the temperature therein has had an opportunity to increase to any appreciable degree. At the same time, assurance is had that the head pressure in the refrigeration system will drop to a predetermined value between each operation of the compressor to safeguard the compressor motor against a high starting load.

Having described a preferred form of my invention, many modifications may become apparent to those skilled in the art. For example, in place of the heater 22 and the fan 23 the heater might be placed below the evaporator and the fan 23 dispensed with. It should be understood that the fan may be used without the heater, or the heater without the fan. Furthermore, any other suitable arrangement for accelerating the defrosting of the evaporator might be employed, with or without the fan. If desired, when heating means for the evaporator is employed, the communication between the upper compartment and the outside of the refrigerator may be dispensed with and the doors used only to separate the two compartments from one another. The tray 25 may be provided with insulation on the bottom thereof or with radiating fins on the top thereof, if desired, to lessen the danger of moisture dripping from the evaporator from freezing thereon. Also, any suitable motor means might be provided for operating the doors 29 and 30. While the restarting of the compressor after a defrosting period is in response to the pressure in the evaporator, since this pressure is an indication of the evaporator temperature, it should be obvious that the response might be from a bulb mounted in engagement with the surface of the evaporator to indicate when the evaporator is defrosted. Many other modifications will also

become apparent to those skilled in the art, and I therefore wish it to be understood that my invention is limited only by the scope of the appended claims.

I claim as my invention:

1. In a refrigeration system having an evaporator, a condenser and a compressor for circulating refrigerant through the evaporator, a casing housing said evaporator, said casing including a storage compartment, means responsive to the temperature in said storage compartment for controlling operation of said compressor to maintain the temperature in said storage compartment at a desired value, means for interrupting operation of the compressor when the suction pressure therein drops to a predetermined value and preventing restarting of the compressor after it has been stopped by reason of this drop in suction pressure until the evaporator is defrosted, and means responsive to the stopping of the compressor by the drop in suction pressure for isolating the evaporator from the storage compartment to prevent undue rise in temperature in the storage compartment while the evaporator is being defrosted.

2. In a refrigeration system having an evaporator, a condenser and a compressor for circulating refrigerant through the evaporator, a casing housing said evaporator, said casing including a storage compartment, means responsive to the temperature in said storage compartment for controlling operation of said compressor to maintain the temperature in said storage compartment at a desired value, means for interrupting operation of the compressor when the suction pressure therein drops to a predetermined value and preventing restarting of the compressor after it has been stopped by reason of this drop in suction pressure until the evaporator is defrosted, means responsive to the stopping of the compressor by the drop in suction pressure for accelerating the defrosting of the evaporator, and automatic means for isolating portions of said compartment from said evaporator during defrosting.

3. In a refrigeration system, an evaporator for normally maintaining the temperature of a space below the freezing point of water, a compressor for circulating refrigerant through the evaporator, means responsive to the temperature of the space for normally controlling operation of the compressor, a second means in control of said compressor, means responsive to the stopping of said compressor by said second means for preventing restarting thereof until the evaporator has been defrosted, means responsive to the stopping of the compressor by said second means for accelerating the defrosting of said evaporator, and automatic means for isolating portions of said space from said evaporator during defrosting.

4. In a refrigeration system, an evaporator for normally maintaining the temperature of a space below the freezing point of water, a compressor for circulating refrigerant through the evaporator, means responsive to the temperature of the space for normally controlling operation of the compressor, a second means in control of said compressor, means responsive to the stopping of said compressor by said second means for preventing restarting thereof until the evaporator has been defrosted, and means responsive to the stopping of the compressor by said second means for isolating the evaporator from the space being cooled.

5. In a refrigeration system having an evaporator, a condenser and a compressor for circulating refrigerant through the evaporator, a casing housing said evaporator, said casing including a storage compartment, means responsive to the temperature in said storage compartment for controlling operation of said compressor to maintain the temperature in said storage compartment at a desired value, means for interrupting operation of the compressor when the suction pressure therein drops to a predetermined value and preventing restarting of the compressor after it has been stopped by reason of this drop in suction pressure until the evaporator is defrosted, and means responsive to the stopping of the compressor by the drop in suction pressure for isolating the evaporator from the storage compartment and opening that portion of the casing housing the evaporator to the outside atmosphere.

6. In a refrigeration system having an evaporator, a condenser and a compressor for circulating refrigerant through the evaporator, a casing housing said evaporator, said casing including a storage compartment, means responsive to the temperature in said storage compartment for controlling operation of said compressor to maintain the temperature in said storage compartment at a desired value, means for interrupting operation of the compressor when the suction pressure therein drops to a predetermined value and preventing restarting of the compressor after it has been stopped by reason of this drop in suction pressure until the evaporator is defrosted, means responsive to the stopping of the compressor by the drop in suction pressure for isolating the evaporator from the storage compartment and opening that portion of the casing housing the evaporator to the outside atmosphere, and means for heating the evaporator during the defrosting period.

7. In a refrigeration system having an evaporator, a condenser and a compressor for circulating refrigerant through the evaporator, a casing housing said evaporator, said casing including a storage compartment, means responsive to the temperature in said storage compartment for controlling operation of said compressor to maintain the temperature in said storage compartment at a desired value, means for interrupting operation of the compressor when the suction pressure therein drops to a predetermined value and preventing restarting of the compressor after it has been stopped by reason of this drop in suction pressure until the evaporator is defrosted, and means responsive to the stopping of the compressor by the drop in suction pressure for isolating the evaporator from the storage compartment to prevent undue rise in temperature in the storage compartment while the evaporator is being defrosted, said last named means including a pair of doors movable between two positions, in one of which the interior of the casing is closed to the outside atmosphere and communication between the evaporator and the storage compartment is permitted, and in the other position of the doors, communication between the evaporator and the storage compartment is prevented and communication between that portion of the casing housing the evaporator, and the outside atmosphere is permitted.

8. In a refrigeration system having an evaporator, a condenser and a compressor for circulating refrigerant through the evaporator, a casing housing said evaporator, said casing includ-

ing a storage compartment, means responsive to the temperature in said storage compartment for controlling operation of said compressor to maintain the temperature in said storage compartment at a desired value, means for interrupting operation of the compressor when the suction pressure therein drops to a predetermined value and preventing restarting of the compressor after it has been stopped by reason of this drop in suction pressure until the evaporator is defrosted, heating means located adjacent the evaporator, and means operative simultaneously with the stopping of the compressor by the drop in suction pressure for energizing said heating means and for isolating the evaporator from the storage compartment to prevent undue rise in temperature in the storage compartment during the defrosting of the evaporator.

9. In a refrigeration system having an evaporator, a condenser and a compressor for circulating refrigerant through the evaporator, a casing housing said evaporator, said casing including a storage compartment, means for initiating operation of the compressor only when the suction pressure is above a low predetermined value and the head pressure is below a predetermined value, means responsive to the temperature in the storage compartment for continuing operation of the compressor as long as the temperature is above a predetermined value unless the suction pressure falls below said low predetermined value or the head pressure rises above a high predetermined value, means responsive to stopping of the compressor by reason of the suction pressure falling below said low predetermined value to prevent restarting of the compressor until the evaporator is defrosted, and means responsive to the stopping of the compressor by the drop in suction pressure below the low predetermined value for isolating the evaporator from the storage compartment.

10. In a refrigeration system having an evaporator, a condenser and a compressor for circulating refrigerant through the evaporator, a casing housing said evaporator, said casing including a storage compartment, means for initiating operation of the compressor only when the suction pressure is above a low predetermined value and the head pressure is below a predetermined value, means responsive to the temperature in the storage compartment for continuing operation of the compressor as long as the temperature is above a predetermined value unless the suction pressure falls below said low predetermined value or the head pressure rises above a high predetermined value, means responsive to stopping of the compressor by reason of the suction pressure falling below said low predetermined value to prevent restarting of the compressor until the evaporator is defrosted, means responsive to the stopping of the compressor by the drop in suction pressure below the low predetermined value for isolating the evaporator from the storage compartment, and means for circulating heated air over the evaporator while the evaporator is isolated from the storage compartment.

11. In a refrigeration system having an evaporator, a condenser and a compressor for circulating refrigerant through the evaporator, a casing housing said evaporator, said casing including a storage compartment, means for initiating operation of the compressor only when the suction pressure is above a low predetermined value and the head pressure is below a predetermined value,

means responsive to the temperature in the storage compartment for continuing operation of the compressor as long as the temperature is above a predetermined value unless the suction pressure falls below said low predetermined value or the head pressure rises above a high predetermined value, a thermal switching mechanism including a pair of heating elements, means responsive to the heating of one of said heating elements for stopping operation of the compressor, means responsive to a drop in suction pressure below a predetermined value for energizing said one of said heating elements, means responsive to energization of the other of said heating elements for reenergizing said compressor, and means responsive to a rise in the suction pressure to a value which is a measure of the defrosting of the evaporator for energizing said other heating element.

12. In a refrigeration system having an evaporator, a condenser and a compressor for circulating refrigerant through the evaporator, a casing housing said evaporator, said casing including a storage compartment, means for initiating operation of the compressor only when the suction pressure is above a low predetermined value and the head pressure is below a predetermined value, means responsive to the temperature in the storage compartment for continuing operation of the compressor as long as the temperature is above a predetermined value unless the suction pressure falls below said low predetermined value or the head pressure rises above a high predetermined value, a thermal switching mechanism including a pair of heating elements, means responsive to the heating of one of said heating elements for stopping operation of the compressor, means responsive to a drop in suction pressure below a predetermined value for energizing said one of said heating elements, means responsive to energization of the other of said heating elements for reenergizing said compressor, means responsive to a rise in the suction pressure to a value which is a measure of the defrosting of the evaporator for energizing said other heating element, and means responsive to the energization of the first of said heating elements for isolating the evaporator from the storage compartment to prevent undue rise in temperature in the storage compartment while the evaporator is being defrosted.

13. In a refrigeration system, an evaporator, means for circulating a refrigerant through said evaporator, a casing housing said evaporator, said casing including a storage compartment, means responsive to the temperature of said storage compartment for causing refrigerant to be circulated through said evaporator when the temperature in said compartment rises to a predetermined value and for interrupting the flow of refrigerant through said evaporator when the temperature in said compartment drops to a predetermined value, means for interrupting the flow of refrigerant through said evaporator when the pressure therein drops to a predetermined value and preventing flow of refrigerant therethrough until the pressure therein rises to a value which is a measure of the evaporator becoming defrosted, and means operative in response to the pressure in the evaporator dropping to said predetermined value for isolating the evaporator from the storage compartment to prevent undue rise in temperature in the storage compartment while the evaporator is being defrosted.

14. In a refrigeration system, an evaporator,

means for circulating a refrigerant through said evaporator, a casing housing said evaporator, said casing including a storage compartment, means responsive to the temperature of said storage compartment for causing refrigerant to be circulated through said evaporator when the temperature in said compartment rises to a predetermined value and for interrupting the flow of refrigerant through said evaporator when the temperature in said compartment drops to a predetermined value, means for interrupting the flow of refrigerant through said evaporator when the pressure therein drops to a predetermined value and preventing flow of refrigerant there-through until the pressure therein rises to a value which is a measure of the evaporator becoming defrosted, and means operative in response to interruption in the flow of refrigerant by reason of the pressure in the evaporator dropping to said predetermined value for isolating the evaporator from the storage compartment and for providing communication between that portion of the casing housing the evaporator and the outside atmosphere.

15. In a refrigeration system, an evaporator, means for circulating a refrigerant through said evaporator, a casing housing said evaporator, said casing including a storage compartment, means responsive to the temperature of said storage compartment for causing refrigerant to be circulated through said evaporator when the temperature in said compartment rises to a predetermined value and for interrupting the flow of refrigerant through said evaporator when the temperature in said compartment drops to a predetermined value, means for interrupting the flow of refrigerant through said evaporator when the pressure therein drops to a predetermined value and preventing flow of refrigerant there-through until the pressure therein rises to a value which is a measure of the evaporator becoming defrosted, means operative in response to interruption in the flow of refrigerant by reason of the pressure in the evaporator dropping to said predetermined value for isolating the evaporator from the storage compartment and for

providing communication between that portion of the casing housing the evaporator and the outside atmosphere; and means for simultaneously causing a flow of heated air over the evaporator to accelerate the defrosting thereof.

16. In a refrigeration system having an evaporator, a condenser and a compressor for circulating refrigerant through the evaporator, a casing housing said evaporator, said casing including a storage compartment, means for causing operation of the compressor to maintain the temperature of the storage compartment at a predetermined value, means for interrupting operation of the compressor whenever the suction pressure in the system drops to a sufficiently low value regardless of the temperature in the storage compartment and preventing restarting thereof until the suction pressure rises to a high predetermined value, and means for isolating the evaporator from the storage compartment in response to the stopping of the compressor from suction pressure until the compressor is restarted.

17. In a refrigeration system having an evaporator, a condenser and a compressor for circulating refrigerant through the evaporator, a casing housing said evaporator, said casing including a storage compartment, means for causing operation of the compressor to maintain the temperature of the storage compartment at a predetermined value, means for interrupting operation of the compressor whenever the suction pressure in the system drops to a sufficiently low value regardless of the temperature in the storage compartment and preventing restarting thereof until the suction pressure rises to a high predetermined value, means for interrupting operation of the compressor whenever the head pressure rises to a predetermined value and preventing restarting of the compressor until the head pressure drops to a predetermined value, and means for isolating the evaporator from the storage compartment in response to the stopping of the compressor from suction pressure until the compressor is restarted.

ALWIN B. NEWTON.