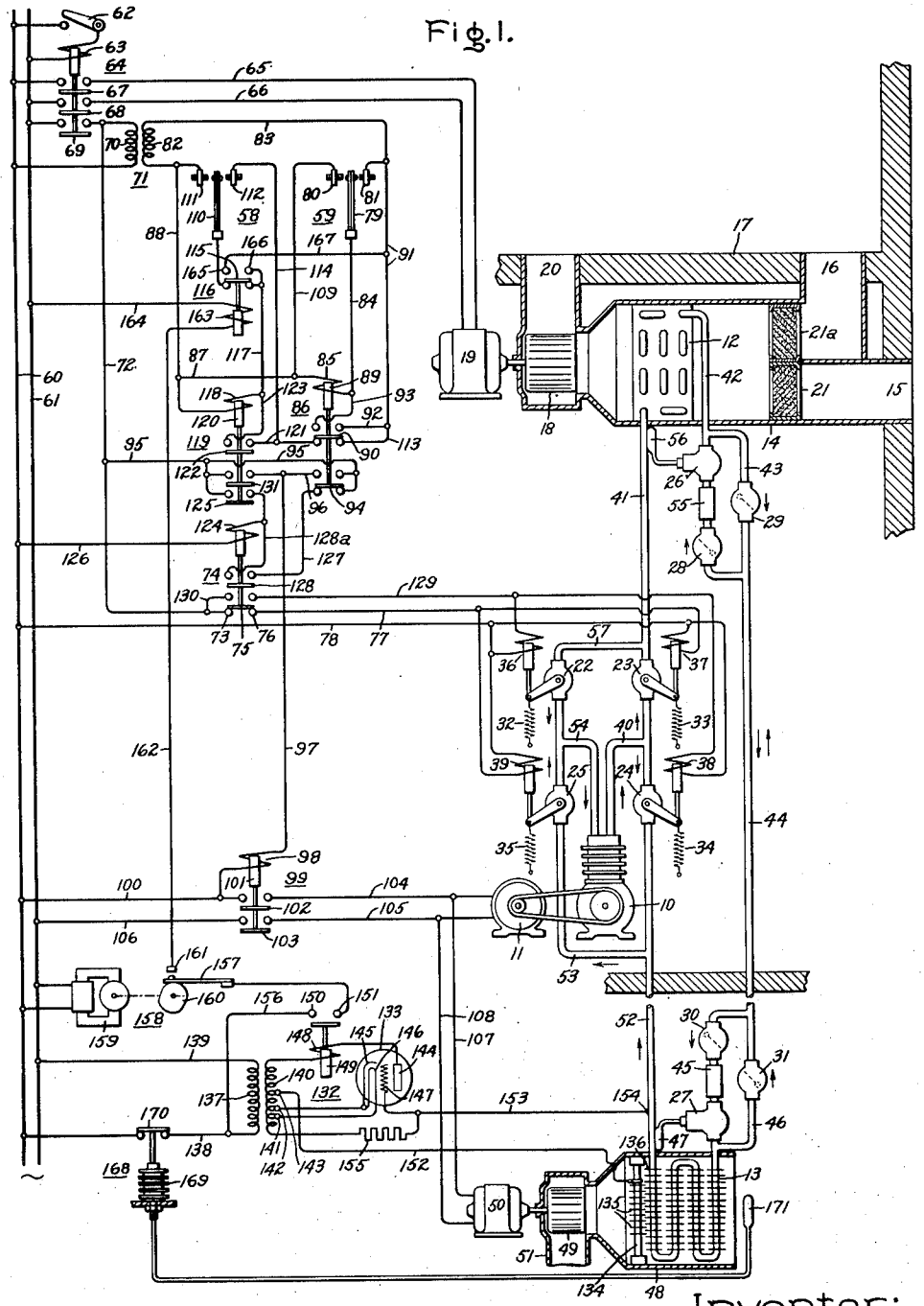
Jan. 10, 1939. H. R. CRAGO 2,143,687

DEFROSTING CONTROL FOR HEAT PUMPS

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Fig. 1.



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DEFROSTING CONTROL FOR HEAT PUMPS

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Fig. 2.

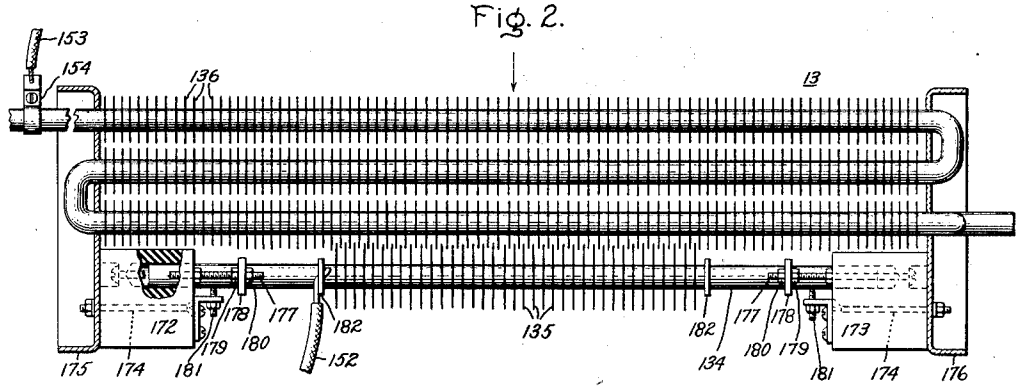
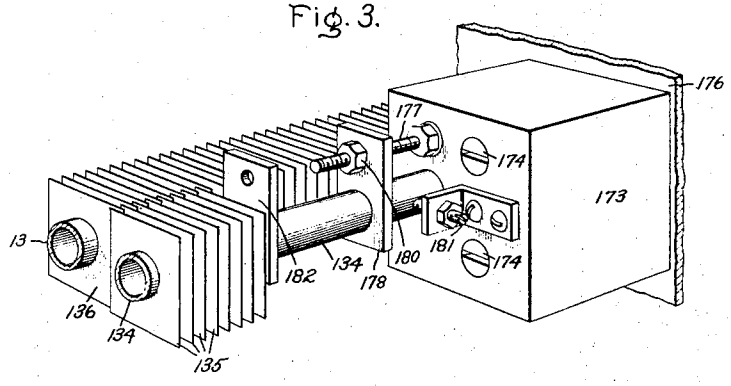


Fig. 3.



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UNITED STATES PATENT OFFICE

2,143,687

DEFROSTING CONTROL FOR HEAT PUMPS

Harry R. Crago, Verona, N. J., assignor to General Electric Company, a corporation of New York

Application May 20, 1937, Serial No. 143,752

19 Claims. (Cl. 62—6)

My invention relates to apparatus employing heat pumps or reversed cycle refrigerating machines for heating purposes and particularly to arrangements for detecting and removing frost which accumulates on the evaporators of such pumps or machines.

Heat pumps or reversed cycle refrigerating machines may be employed to heat the air within the rooms of dwelling houses or other buildings. A heat pump commonly comprises a compression refrigerating machine including two heat exchangers, a compressor, and an expansion valve. One of the heat exchangers is arranged to provide heat for the air in the enclosure and the other heat exchanger is arranged outside the enclosure to absorb heat. In some installations the refrigerating machine is made reversible and each of the exchangers may be operated either as a condenser or as an evaporator. The outside heat exchanger may be arranged so that it absorbs or gives up heat to a body of water such as deep well water which is of fairly constant temperature throughout the year. However, it is sometimes desirable to arrange the outside heat exchanger in an air duct and to pass outside air thereover. In the winter when the outside heat exchanger is being used as an evaporator frost may accumulate thereon due to the accumulation and freezing of moisture condensed from the air passing over the surface of the exchanger. Sufficient frost may accumulate to reduce materially the capacity of the heat exchanger. It is therefore desirable to provide some means for removing the frost before a large quantity has collected. The frost may be removed by reversing the refrigerating machine and thereby discharging hot compressed refrigerant from the compressor into the outside exchanger. However, it is usually not convenient for an attendant to watch continually the degree of frosting of the evaporator and then manually to reverse the refrigerating machine. Accordingly, it is an object of my invention to provide a fluid heating apparatus employing a reversed cycle refrigerating machine and having an improved arrangement for detecting and removing frost which has accumulated on the evaporator of the refrigerating machine.

Another object of my invention is to provide an air heating apparatus employing a reversed cycle refrigerating machine and having an improved arrangement for reversing the refrigerating machine when a predetermined amount of frost has accumulated on the evaporator thereof and to melt the frost and thereafter restore normal operation of the machine.

Another object of my invention is to provide in a refrigerating machine an improved arrangement utilizing an electrical circuit for detecting the accumulation of frost on the evaporator of the machine and for reversing the machine to melt the frost from the evaporator.

A further object of my invention is to provide in a refrigerating machine an arrangement including an electrical circuit for detecting the formation of a predetermined amount of frost on the evaporator of the machine and utilizing a portion of the evaporator as an electrode in the electrical circuit to initiate defrosting of the evaporator.

Further objects and advantages of my invention will become apparent as the following description proceeds and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention reference may be had to the accompanying drawings in which Fig. 1 shows diagrammatically a system embodying my invention and employed to heat the air within an enclosure; Fig. 2 is an enlarged detail view of the outside heat exchanger and frost detecting electrode shown in Fig 1; and Fig. 3 is an enlarged perspective view of a portion of the heat exchanger and electrode shown in Fig. 2.

Referring now to the drawings, in Fig. 1 I have shown an air conditioning system utilizing a reversible refrigerating machine or heat pump for cooling the air within an enclosure during the summer and for heating the air in the winter. A thermostatic control is provided for reversing the refrigerant circuit and thereby to select either the heating or the cooling operation. The refrigerating machine comprises a compressor 10 driven by a motor 11 and connected in a refrigerant circuit including an indoor heat exchanger 12 and an outdoor heat exchanger 13. The heat exchanger 12 is arranged within a duct 14 provided with a fresh air inlet 15 and a recirculated air inlet 16 communicating with the enclosure to be conditioned and passing through a wall 17 of the enclosure. Air is circulated through the duct 14 by operation of a fan 18 driven by a motor 19 and is discharged into the enclosure through a duct 20 passing through the wall 17. Filters 21 and 21*a* are provided in the fresh and recirculated air paths to remove dust and other impurities from the air before it passes through the heat exchanger 12 and into the enclosure. Electrically operated valves 22, 23, 24 and 25 are pro-

vided for selecting the direction of flow of refrigerant through the refrigerant circuit of the heat pump. The heat exchangers 12 and 13 are provided with thermostatic expansion valves 26 and 27 respectively which control the admission of refrigerant to the exchangers when they operate as evaporators. The valve 26 is operable to control the admission of refrigerant to the heat exchanger 12 when that heat exchanger is being employed as an evaporator, check valves 28 and 29 being provided to prevent flow of refrigerant through the expansion valve 26 when the heat exchanger 12 is being employed as a condenser. Check valves 30 and 31 are provided to cooperate with the thermostatic valve 27 and automatically control the flow of refrigerant so that the valve 27 is effective only when the heat exchanger 13 is being utilized as an evaporator. The electrically operated valves 22, 23, 24 and 25 are biased to their closed positions by springs 32, 33, 34 and 35 respectively and are provided with solenoids 36, 37, 38 and 39 respectively for opening the valves in opposition to the springs. When it is desired to operate the heat exchanger 12 as a condenser to heat the air passing through the duct 14 the valves 23 and 25 are held open by operation of the solenoids 37 and 39, and when it is desired to operate the heat exchanger 12 as an evaporator or cooling element to cool the air passing through the duct 14 the valves 22 and 24 are held open by operation of the solenoids 36 and 38. Only one pair of valves may be held open at a time.

During the operation of the heat pump to heat the air passing through the duct 14, refrigerant is compressed by the compressor 10, discharged through a connection 40, passes through the valves 23 and a conduit 41 into the heat exchanger 12 where it is cooled by the air passing through the duct 14 and is liquefied. The liquid refrigerant flows through connections 42 and 43, the check valve 29 and a conduit 44 and thence through the check valve 30 and into a liquid receiver 45, the check valve 31 being held closed to prevent the passage of liquid refrigerant into the heat exchanger 13 through a connection 46. The liquid refrigerant is admitted to the exchanger 13 by operation of the expansion valve 27 having a thermostatic control bulb 47 secured to the evaporator 13 near the outlet thereof. The heat exchange element 13 is arranged within a duct 48 and air from outside the enclosure to be conditioned and preferably outdoor air is circulated over the heat exchanger 13 by operation of a fan 49 driven by a motor 50, it being discharged through a duct 51 outside the enclosure to be conditioned. The refrigerant within the exchanger 13 is vaporized by the absorption of heat from the air passing through the duct 48 and the vaporized refrigerant is returned to the compressor 10 through a conduit 52, a connection 53, the valve 25 and a suction connection 54 of the compressor.

During the operation of the heat pump to cool the air passing through the duct 14 the valves 22 and 24 are open and refrigerant compressed within the compressor 10 is discharged through connection 40 and valve 24 into the conduit 52 and thence flows into the heat exchanger 13 serving as a condenser. The compressed refrigerant within the exchanger 13 is cooled and liquefied by the air passing through the duct 48. The liquid refrigerant is discharged through connection 46 and check valve 31 into conduit 44 from which it flows through check valve 28 into a liquid receiver 55, the check valve 29 being closed to prevent the passage of refrigerant through the connection 43 and into the heat exchanger 12. Liquid refrigerant from the receiver 55 is admitted to heat exchanger 12 by operation of the thermostatic expansion valve 26, the valve being provided with a thermostatic control bulb 56 secured to the exchanger 12 near the discharge end thereof. The liquid refrigerant within the heat exchanger 12 absorbs heat from the air passing through the duct 14 and thereby cools the air, the refrigerant being vaporized and discharged from the heat exchanger through connection 41 from which it is returned to the compressor 10 through a connection 57, the valve 22 and suction connection 54.

In order to control the operation of the air conditioning system, I provide a cooling control thermostat 58 and a heating control thermostat 59, both thermostats being located so that they are responsive to the temperature of the air within the enclosure to be conditioned. When there is a demand for cooling the thermostat 58 takes over control of the refrigerating machine and operates the valves for the cooling cycle. When there is a demand for heating the thermostat 59 takes over control of the refrigerating machine and the valves are set for the heating cycle. Power is supplied to the apparatus from alternating current supply lines 60 and 61. When it is desired to place the system in operation, a manual switch 62 is closed to energize an operating coil 63 of a main switch 64. Closing of the main switch 64 starts the fan motor 19, the motor leads 65 and 66 being connected to lines 60 and 61 respectively by arms 67 and 68 of the switch. A third arm 69 of the switch connects the primary winding 70 of a control transformer 71 across the supply lines. Closing of the arm 69 also establishes a circuit from the supply line 61 through a line 72 to a contact 73 of a relay 74. The relay 74 is normally in its drop-out position as shown, and an arm 75 thereof connects the contact 73 with a contact 76. This completes a circuit from the line 61 to a line 77 thence through the solenoids 37 and 39 in parallel and back to the line 60 through a connection 78. The operation of the system when there is a demand for cooling actuates the relay 74 to change the positions of the valves 22, 23, 24 and 25 in a manner described below.

The heating control thermostat 59 comprises a bi-metallic member 79 and fixed contacts 80 and 81. During the operation of the air conditioning system when there is a demand for heating, the bi-metallic strip 79 will bend to the right and engage the contact 81. A circuit is thereby closed from a secondary 82 of the transformer 71 through a connection 83, strip 79, a connection 84 to a coil 85 of a relay 86 and thence through a connection 87 and a lead 88 to the other side of the secondary 82. The coil 85 is thereby energized and raises an armature 89 of the relay 86. An arm 90 of the relay closes a holding circuit for the coil 85 comprising a lead 91, a connection 92, the arm 90 and a connection 93, thereby shunting the bi-metallic member 79 and maintaining the relay 86 in its raised position even though the member 79 should move out of engagement with the contact 81. A second arm 94 of the relay 86 closes a motor control circuit from the line 72 through a connection 95, the arm 94, a connection 96 and a line 97 to a solenoid 98 of a motor starting relay 99 and thence through a connection 100 to the other side of the supply line. The solenoid

98 is thereby energized and lifts an armature 101 to raise arms 102 and 103 of the switch 99 and connect motor leads 104 and 105 to supply lines 60 and 61 respectively through the connection 100 and a connection 106. The motor 11 is thus started and drives the compressor 10. The motor 50 is also started since it is connected to motor leads 104 and 105 by lines 107 and 108 respectively. Since the relay 74 is in its drop-out or normal position, solenoids 37 and 39 are excited and valves 23 and 25 are held open. The compressor therefore operates to supply hot compressed refrigerant through the valve 23 to the heat exchanger 12 and the air circulated through the duct 14 is heated.

When the air within the enclosure has been heated to a predetermined temperature, the bi-metallic member 79 of the thermostat 59 will engage the left-hand contact 80 and short-circuit the coil 85 through connection 84, member 79 and a connection 109. This deenergizes the coil 85 and the relay 86 falls to its drop-out position, thereby breaking the circuit of the coil 98 and opening the switch 99 to deenergize the motors 11 and 50 and stop the operation of the refrigerating machine.

Should there be a demand for cooling of the air within the enclosure, the thermostat 58 will operate to reverse the refrigerant connections and cool the air passing through the duct 14. The thermostat 58 comprises a bi-metallic member 110 and fixed contacts 111 and 112. Should there be a demand for cooling, the member 110 will bend to the right and engage the contact 112 thereby closing an electrical circuit to operate a relay 119. This circuit can be traced from the secondary 82 through connections 83 and 91, a connection 113, the arm 90 of the relay 86, a connection 114, the member 110 and an arm 115 of a relay 116 and a connection 117 to a coil 118 of the relay 119 and thence through line 88 to the other side of the secondary 82. The coil 118 is thereby energized and raises an armature 120 of the relay 119. The operation of the relay 119 closes a holding circuit for the coil 118 shunting the thermostatic member 110 through a connection 121, an arm 122 of the relay, and a connection 123. This maintains the relay 119 in its pick-up position even though contact is broken between the member 110 and the contact 112. The closing of the relay 119 also closes the circuit of an operating coil 124 of the relay 74. This circuit may be traced from the line 72 through connection 95, an arm 125 of the relay 119, the coil 124 of relay 74, and a connection 126 to the supply line 60. Operation of the relay 74 closes a holding circuit for the coil 124 which may be traced from the line 95, arm 94 of relay 86, a connection 127, an arm 128 of relay 74 and a connection 128a. This holding circuit will be maintained to keep the relay 74 in its pick-up position even though the relay 119 should drop out provided there is not a demand for heating, which would operate the relay 86 and break the holding circuit by raising the arm 94. The second arm 75 of the relay 74 breaks the circuit of the solenoids 37 and 39 thereby restoring the valves 23 and 25 to their closed positions. The arm 75 in its pick-up position, closes the circuits of the solenoids 36 and 38 which are connected in parallel between the line 78 and a line 129, the line 129 being connected to the line 72 through a connection 130 and the arm 75. The valves 22 and 20 are opened by operation of the solenoids 36 and 38 and the refrigerating machine is in condition for the cooling operation.

The cooling operation of the refrigerating machine is started simultaneously with the reversal of the refrigerant circuit since an arm 131 of relay 119 closes a circuit from line 100 to the coil 98 of switch 99 through the line 97 and the arm 131 to the line 95.

When the air within the enclosure has been cooled to a predetermined temperature, the thermostatic member 110 will engage the contact 111 thereby short-circuiting the solenoid 118 and causing the relay 119 to drop out and stop the motors 11 and 50 by opening the circuit of the coil 98. The valves 22 and 24, however, will remain in their open positions since the holding circuit for the coil 124 of the valve reversing relay 74 is maintained closed.

Should there be a subsequent demand for heating the relay 86 will be operated to raise the arm 94 and open the holding circuit of the coil 124, thereby causing the relay 74 to drop out and energize the solenoids 37 and 39 to open the valves 23 and 25, the valves 22 and 24 being closed by the opening of the circuits of the coils 36 and 38.

The control system described above is described and claimed in my copending application Serial No. 143,753, filed May 20, 1937, and assigned to the same assignee as my present invention.

During the heating operation in the winter, the heat exchanger 13 is operated as an evaporator at a low temperature and the circulation of outdoor air over the coils may result in the accumulation of substantial quantities of frost thereon. This accumulation of frost may be sufficient to impede seriously the circulation of air and substantially reduce the heat absorbing capacity of the heat exchanger. In order to prevent the undue accumulation of frost on the coils of the outdoor heat exchanger, I provide an arrangement for detecting the presence of a predetermined amount of frost on the coils and for then taking over control of the refrigerating machine to reverse the machine and circulate hot compressed refrigerant through the exchanger 13 in order to melt the accumulation of frost. When the frost has been melted, the system is restored to normal operation. A device is also provided to allow the defrosting operation to be performed only at times when the reversal of the refrigerating machine and the temporary cooling of the air passing through the duct 14 is not objectionable. Cold drafts are thereby prevented at all times when the enclosure is occupied. For example, if the air conditioning system is installed in an office, the defrosting mechanism may be prevented from operating during office hours.

The defrosting device comprises a relay 132 utilizing a vacuum tube or space discharge device 133 for detecting the presence of a predetermined accumulation of ice on the heat exchanger. An electrode 134 is mounted adjacent one turn of the coil of the heat exchanger and is provided with fins 135 corresponding to and spaced from fins 136 on the heat exchanger, the fins of the heat exchanger being used as a second electrode. Relay 132 is provided with a transformer having a primary 137 connected by leads 138 and 139 to the supply lines 60 and 61 respectively and a secondary 140 provided with a plurality of taps 141, 142 and 143. The space discharge device 133 has been illustrated as a three-electrode vacuum tube having a plate 144, a cathode 145 heated by a filament 146 and a grid 147 arranged between the plate and the cathode to control the electronic discharge therebetween. The filament 146 is connected across taps 141 and 142 of the sec-

ondary 140 and is maintained energized thereby to heat the cathode 145. A solenoid 148 is arranged in the plate circuit of the tube 133 between the plate 144 and one terminal of the secondary 140. The solenoid 148 is arranged to lift an armature 149 and to bridge contacts 150 and 151 of a defrosting control circuit. The electrode 134 is connected by a line 152 to the tap 143, and the grid 147 is connected by a line 153 to the heat exchanger 13 as indicated at 154 and to the lower terminal of the secondary 140 through a resistance 155 which gives the grid 147 a negative bias. When ice forms between the electrodes 135 and 136 the grid 147 is thereby connected to the tap 143 and the grid is thereby given a positive bias so that there is an electronic discharge between the cathode 145 and the plate 144 and current flows in the plate circuit to energize the solenoid 148. Operation of the solenoid bridges the contacts 150 and 151 and establishes a circuit from the line 60 through a connection 156 to a movable member 157 of a time switch 158. The time switch 158 is provided with an alternating current motor 159 connected across the supply lines 60 and 61 to drive a cam 160. The cam 160, in the embodiment illustrated, is arranged to rotate once in twenty-four hours and to maintain the switch 158 closed for a predetermined period and only at night. Should the defrosting mechanism operate during this predetermined period the movable member 157 will be held in its upper position against a contact 161 and the defrosting control circuit will be closed through a line 162, a solenoid 163 of relay 116 and a line 164. When the solenoid 163 is energized the arm 115 of the relay 116 connects contacts 165 and 166 and bridges a circuit from lines 83 and 91 through a connection 167 and the connection 117 to energize the solenoid 118 of the relay 119. The relay 119 as previously described is the cooling control relay, and upon operation of this relay the circuit of the refrigerating machine is reversed and the compressor is operated to pump hot compressed gas into the heat exchanger 13. The hot compressed gas will melt the accumulation of frost on the heat exchanger. When the frost between the electrodes 135 and 136 has been melted, the grid element 147 will again be given a negative bias and prevent the passage of current between the plate 144 and the cathode 145 thereby deenergizing the solenoid 148 and opening the defrosting control circuit. The relay 116 is deenergized and restores the system to the control of the heating thermostat 59 thereby reversing the refrigerant circuit so that the machine will heat the air passing through the duct 14.

Under certain conditions of operation, the temperature of the heat exchanger 13 may be such that there will be an accumulation of water instead of ice on the surface thereof. Should water bridge the electrodes 135 and 136 the refrigerating machine would be operated for defrosting although no frost was in fact present on the surface of the evaporator. When the operating characteristics and capacity of the heat pump are known the temperature of the air may be determined above which frost will not be formed on the evaporator. A temperature responsive device, such as a switch 168, may therefore be used to prevent defrosting operation if the air temperature is above the predetermined value. In order to prevent the operation of the defrosting mechanism by the presence of water between the electrodes I provide the temperature responsive switch 168 for opening the connection between the line 138 and the supply line 60 thereby deenergizing the defrosting control and preventing operation thereof. The switch 168 comprises an expansible bellows 169 for operating a switch arm 170 and a thermostatic bulb 171 arranged in the duct 48 so that it is responsive to the temperature of the air flowing therethrough. The thermostatically controlled switch 168 prevents reversal of the refrigerant circuit except when there is an accumulation of frost on the heat exchanger.

In. Figs. 2 and 3 I have shown enlarged detail views of the defrosting electrodes. The electrode 134 comprises a tube or rod mounted between insulating blocks 172 and 173 arranged at either end thereof and secured by screws 174 to end plates 175 and 176 of the heat exchanger 13. The electrode 134 is slidably mounted in the blocks 172 and 173 so that it may be moved axially, that is, longitudinally with respect to the coil of the heat exchanger 13.

The fins 135 of electrode 134 are arranged so that they project part way into the spaces between the fins 136 of the heat exchanger 13. By adjusting the position of the fins 135 the spacing between the fins 135 and 136 may be varied in order to select the thickness of frost necessary to initiate operation of the defrosting mechanism. Adjusting screws 177 are secured to the insulating blocks 172 and 173. These screws engage lugs 178 on the electrode 134, and the position of the electrode may be adjusted by varying the positions of nuts 179 and 180 threaded on the screws 177. Set screws 181 are provided to hold the electrode securely in the selected position. The longitudinal spacing of the fins 135 is the same as that of the fins 136, and since the fins 135 are interleaved with the fins 136, it is evident that the thickness of frost which will initiate operation of the defrosting mechanism may be varied up to one-half the distance between fins. Lugs 182 are provided on the electrode 134 for the connection thereto of the lead 152 of the defrosting circuit, the lead being shown connected to the left-hand lug in Fig. 2.

During the operation of the heat exchanger 13 as an evaporator, should the frost thereon accumulate to a thickness sufficient to bridge the gap between any of the fins 135 and 136 a connection will thereby be established between the leads 152 and 153 and the defrosting relay 132 will be operated to reverse the refrigerating machine and defrost the evaporator provided that the timing switch 158 is closed. When the frost has been melted, the gap between the fins 135 and 136 will again be opened and the relay 132 will drop out and restore the refrigerating machine to the control of the heating thermostat 59.

From the foregoing, it is apparent that I have provided an air conditioning system utilizing a reversed cycle refrigerating machine or heat pump for heating the air within an enclosure and provided with an improved defrosting mechanism which is of simple construction and reliable in operation for defrosting the evaporator of the refrigerating machine when a predetermined thickness of frost has accumulated thereon.

While I have described my invention in connection with a refrigerating machine for conditioning the air within an enclosure, other uses will readily be apparent to those skilled in the art. I do not, therefore, desire my invention to be limited to the particular construction shown

and described, and I intend in the appended claims to cover all modifications within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. Apparatus for heating fluid within an enclosure including a reversed cycle refrigerating machine having a condenser and an evaporator, means for circulating over said condenser fluid from said enclosure to warm said fluid, means for circulating over said evaporator fluid from outside said enclosure to supply heat to said refrigerating machine, and means dependent upon the formation of frost on a portion of said evaporator for reversing said refrigerating machine to supply hot compressed refrigerant to said evaporator for defrosting said evaporator.

2. Apparatus for heating fluid within an enclosure including a reversed cycle refrigerating machine having a condenser and an evaporator, means for circulating over said condenser fluid from said enclosure to warm said fluid, means for circulating over said evaporator fluid from outside said enclosure to supply heat to said refrigerating machine, and means dependent upon the formation of frost on a portion of said evaporator for reversing said refrigerating machine to supply hot compressed refrigerant to said evaporator for defrosting said evaporator and for restoring operation of said refrigerating machine to heat said fluid when said evaporator has been defrosted.

3. Apparatus for conditioning the air within an enclosure including a refrigerating machine having two heat exchange elements, means for circulating air over one of said elements and into said enclosure, means for circulating air over the other of said elements outside said enclosure, means responsive to a predetermined demand for heating of the air within said enclosure for operating said refrigerating machine to heat said one of said elements, means responsive to a predetermined demand for cooling of the air within said enclosure for reversing said refrigerating machine and for operating said machine to cool said one of said elements, and means dependent upon the formation of frost on a portion of said other of said elements during operation of said refrigerating machine to heat the air within said enclosure for reversing said refrigerating machine to supply hot refrigerant to said other of said elements to melt the frost thereon.

4. Apparatus for conditioning the air within an enclosure including a refrigerating machine having two heat exchange elements, means for circulating air over one of said elements and into said enclosure, means for circulating air over the other of said elements outside said enclosure, means responsive to a predetermined demand for heating of the air within said enclosure for operating said refrigerating machine to heat said one of said elements, means responsive to a predetermined demand for cooling of the air within said enclosure for reversing said refrigerating machine and for cooling said one of said elements, and means dependent upon the formation of frost on a portion of said other of said elements and cooperating with a portion of said cooling demand responsive means for operating said refrigerating machine to supply hot compressed refrigerant to said other of said elements to melt the frost thereon.

5. Apparatus for heating the air within an enclosure including a reversed cycle refrigerating machine having a condenser and an evaporator, means for circulating over said condenser air from said enclosure to warm said air, means for circulating over said evaporator air from outside said enclosure to supply heat to said refrigerating machine, means dependent upon the formation of frost on a portion of said evaporator for reversing said refrigerating machine to supply hot compressed refrigerant to said evaporator for defrosting said evaporator and for restoring operation of said refrigerating machine to heat said air when said evaporator has been defrosted, and means for preventing the actuation of said last-mentioned means by the condensation of water on said evaporator.

6. Apparatus for heating the air within an enclosure including a reversed cycle refrigerating machine having a condenser and an evaporator, means for circulating over said condenser air from said enclosure to warm said air, means for circulating over said evaporator air from outside said enclosure to supply heat to said refrigerating machine, and means dependent upon the formation of frost on a portion of said evaporator for reversing said refrigerating machine to supply hot compressed refrigerant to said evaporator for defrosting said evaporator, said last-mentioned means including an electrical circuit having an electrode near to but spaced from said evaporator and utilizing said evaporator as a second electrode.

7. Apparatus for heating the air within an enclosure including a reversed cycle refrigerating machine having a condenser, an evaporator having heat radiating fins thereon, means for circulating over said condenser air from said enclosure to warm said air, means for circulating over said evaporator air from outside said enclosure to supply heat to said refrigerating machine, and means dependent upon the formation of a predetermined thickness of frost on a portion of said evaporator for reversing said refrigerating machine to supply hot compressed refrigerant to said evaporator for defrosting said evaporator, said last mentioned means comprising an electrical circuit including an electrode having a plurality of fins thereon arranged near to but spaced from a plurality of the fins of said evaporator and utilizing said plurality of fins of said evaporator as a second electrode.

8. Apparatus for heating the air within an enclosure including a reversed cycle refrigerating machine having a condenser, an evaporator having heat radiating fins thereon, means for circulating over said condenser air from said enclosure to warm said air, means for circulating over said evaporator air from outside said enclosure to supply heat to said refrigerating machine, means dependent upon the formation of a predetermined thickness of frost on a portion of said evaporator for reversing said refrigerating machine to supply hot compressed refrigerant to said evaporator for defrosting said evaporator, said last mentioned means comprising an electrical circuit including an electrode having a plurality of fins thereon arranged near to but spaced from a plurality of the fins of said evaporator and utilizing said plurality of fins of said evaporator as a second electrode, and means for adjusting the position of said electrode fins with respect to said evaporator fins for establishing said predetermined thickness of frost.

9. In a refrigerating machine having a cooling element, means dependent upon the formation of a predetermined thickness of frost on a portion of said cooling element for initiating defrosting of said cooling element, said means in-

cluding an electrical circuit having a pair of spaced electrodes and utilizing a portion of said cooling element as one of said electrodes for detecting the presence of said predetermined thickness of frost.

10. In a refrigerating machine having a cooling element, means dependent upon the formation of a predetermined thickness of frost on a portion of said cooling element for reversing said refrigerating machine to defrost said cooling element, said means including an electrical circuit having a pair of spaced electrodes and utilizing a portion of said cooling element as one of said electrodes for detecting the presence of said predetermined thickness of frost.

11. In a refrigerating machine having a cooling element, means dependent upon the formation of a predetermined thickness of frost on a portion of said cooling element for initiating defrosting of said cooling element, said means including an electrical circuit having a pair of spaced electrodes and utilizing a portion of said cooling element as one of said electrodes for detecting the presence of said predetermined thickness of frost, and means for adjusting the spacing of said electrodes to select said predetermined thickness of frost.

12. In a refrigerating machine having a cooling element, means dependent upon the formation of a predetermined thickness of frost on a portion of said cooling element for initiating defrosting of said cooling element, said means including a space discharge device having a control element and an electrical circuit including a pair of spaced electrodes for detecting the presence of said predetermined thickness of frost on said cooling element, said electrodes being connected in circuit with said control element.

13. In a refrigerating machine having a cooling element provided with heat absorbing fins, means dependent upon the formation of a predetermined thickness of frost on said cooling element for initiating defrosting of said cooling element, said means including an electrical circuit having one electrode comprising a plurality of fins corresponding to and spaced from a plurality of said fins on said cooling element and utilizing said fins on said cooling element as a second electrode for detecting the presence of said predetermined thickness of frost.

14. In a refrigerating machine having a cooling element provided with heat absorbing fins, means dependent upon the formation of a predetermined thickness of frost on said cooling element for initiating defrosting of said cooling element, said means including an electrical circuit having one electrode comprising a plurality of fins corresponding to and spaced from a plurality of said fins on said cooling element and utilizing said fins on said cooling element as a second electrode for detecting the presence of said predetermined thickness of frost, and means for adjusting the spacing of said electrodes to select said predetermined thickness of frost.

15. In a refrigerating machine having a cooling element provided with heat absorbing fins, means dependent upon the formation of a predetermined thickness of frost on said cooling element for initiating defrosting of said cooling element, said means including an electrical circuit having one electrode comprising a conductor having a plurality of fins thereon corresponding to and spaced from a plurality of said fins on said cooling element and utilizing said fins on said cooling element as a second electrode for detecting the presence of said predetermined thickness of frost, means including an electrical insulator for supporting said conductor, and means affording sliding movement of said conductor in said insulator for adjusting the spacing of said electrodes to select said predetermined thickness of frost.

16. In a refrigerating machine having a cooling element provided with heat absorbing fins, means dependent upon the formation of a predetermined thickness of frost on said cooling element for initiating defrosting of said cooling element, said means including an electrical circuit having one electrode comprising a conductor having a plurality of fins thereon corresponding to and spaced from a plurality of said fins on said cooling element and utilizing said fins on said cooling element as a second electrode for detecting the presence of said predetermined thickness of frost, means including electrical insulators for supporting the ends of said conductor and for affording sliding adjustment of said conductor to select said predetermined thickness of frost, and means for locking said conductor in position.

17. In a refrigerating machine having a cooling element, means dependent upon the formation of a predetermined thickness of frost on a portion of said cooling element for initiating defrosting of said cooling element, said means including an electrical circuit having a pair of spaced electrodes and utilizing a portion of said cooling element as one of said electrodes for detecting the presence of said predetermined thickness of frost, said circuit including an electrical terminal secured to said cooling element.

18. Apparatus for conditioning the air within an enclosure including a refrigerating machine having two heat exchange elements, one of said heat exchange elements comprising a tube having a plurality of fins thereon, means for circulating air over the other of said elements and into said enclosure, means for circulating air over said one of said elements outside said enclosure, means responsive to a predetermined demand for heating of the air within said enclosure for operating said refrigerating machine to heat said other of said elements, means responsive to a predetermined demand for cooling of the air within said enclosure for reversing said refrigerating machine and for operating said machine to cool said other of said elements, and means dependent upon the formation of a predetermined thickness of frost on a portion of said one of said elements during operation of said refrigerating machine to heat the air within said enclosure for reversing said refrigerating machine to supply hot refrigerant to said one of said elements to melt the frost thereon, said last-mentioned means including an electrode comprising a conductor provided with a plurality of fins corresponding to and spaced from a plurality of said fins on said one element and an electrical circuit including said fins on said evaporator and on said conductor and utilizing a space discharge device for detecting said predetermined thickness of frost between said fins on said evaporator and said fins on said conductor.

19. Apparatus for conditioning the air within an enclosure including a refrigerating machine having two heat exchange elements, means for circulating air over one of said elements and into said enclosure, means for circulating air over the other of said elements outside said en-

closure, means responsive to a predetermined demand for heating of the air within said enclosure for operating said refrigerating machine to heat said one of said elements, means responsive to a predetermined demand for cooling of the air within said enclosure for reversing said refrigerating machine and for operating said machine to cool said one of said elements, and means dependent upon the formation of a predetermined thickness of frost on a portion of said other of said elements during operation of said refrigerating machine to heat the air within said enclosure for reversing said refrigerating machine to supply hot refrigerant to said other of said elements to melt the frost thereon, said last-mentioned means including a pair of spaced electrodes arranged adjacent said evaporator and an electrical circuit including a space discharge device for detecting said predetermined thickness of frost, means for opening said electrical circuit for a predetermined period to prevent defrosting of said evaporator during said period, and means responsive to the temperature of the air circulating over said other element for preventing operation of said defrosting means when the temperature of said air is above a predetermined value.

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