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DEFROSTING EQUIPMENT FOR REFRIGERATOR SYSTEMS

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FIG. 1

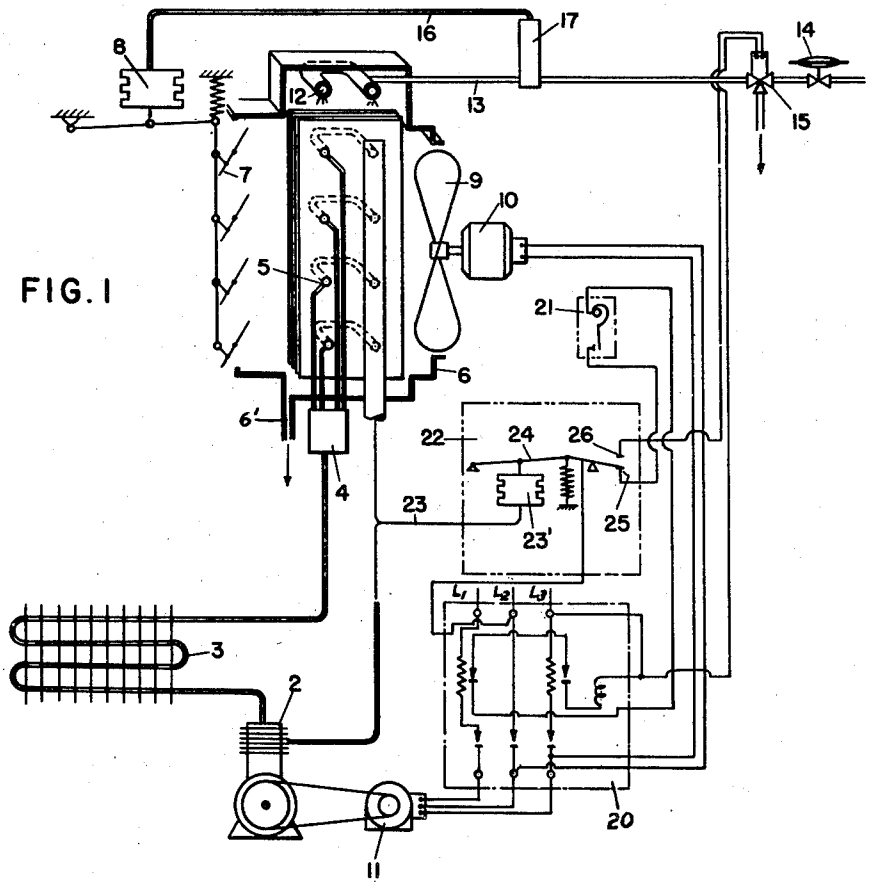
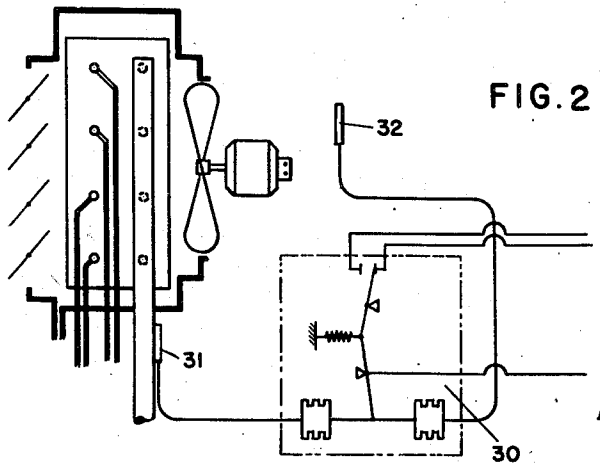


FIG. 2



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DEFROSTING EQUIPMENT FOR REFRIGERATOR SYSTEMS

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9 Claims. (Cl. 62—4)

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This invention relates to refrigeration systems and more particularly refrigeration systems including simple economical, automatic means for defrosting the evaporator or cooling coil of the system.

The chief object of the present invention is to provide automatic economical means for defrosting the evaporator or cooling coil of a refrigeration system when frost has collected thereon in an amount sufficient to interfere materially with the capacity of the system.

An object of the present invention is to provide a refrigerating system including automatic mechanism for defrosting the evaporator of the system in response to a decrease in suction pressure below the normal operating range of the system.

A further object is to provide automatic means for discontinuing operation of the compressor and evaporator fan and for spraying heating medium over the surfaces of the evaporator to defrost the same when frost has collected thereon in an amount sufficient to interfere materially with the efficiency of the refrigeration system. Other objects of my invention will be readily perceived from the following description.

This invention relates to a refrigeration system of the compressor-condenser-expander type in which defrosting means are provided to remove frost collecting on the exterior surfaces of the evaporator. The system includes a prime mover to actuate the compressor and a motor to actuate a fan which passes air to be cooled over the evaporator. Starting mechanism is provided to actuate the prime mover and the fan motor. A thermostat responsive to area temperature governs operation of the starting mechanism. Spray members are provided to spray water over the evaporator. A solenoid valve controls passage of water to the spray members. A switch responsive to suction pressure below the normal operating range of the system is connected to the thermostat and the solenoid valve. When the switch is actuated by such decrease in suction pressure, it opens an electrical circuit including the thermostat to discontinue operation of the compressor and the fan. Simultaneously, it actuates the solenoid valve through a second electrical circuit to permit passage of water to the spray members. Preferably, the evaporator is disposed in a casing provided with dampers to regulate passage of air through the casing. Simultaneously with passage of water to the spray members, the dampers are closed. When defrosting has been accomplished, the second electrical circuit is opened and the first electrical circuit closed to permit normal operation of the refrigeration system.

The attached drawing illustrates a preferred embodiment of my invention, in which

Figure 1 is a diagrammatic view illustrating a refrigerating system including the defrosting equipment of the present invention, and

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Figure 2 is a diagrammatic view of a portion of the refrigerating system shown in Figure 1 illustrating a modified switch.

Referring to the drawing, there is shown a refrigerating system including a compressor 2, a condenser 3, an expansion device 4, which may be a thermal expansion device or a capillary tube, and an evaporator 5 disposed in a closed circuit. Evaporator 5 is disposed in a casing 6 having a drain 6' provided with dampers 7 actuated by a suitable pneumatic damper motor 8 such as an expansible element as hereinafter described. A fan 9 actuated by motor 10 passes air to be cooled through evaporator 5. A suitable prime mover 11 such as a motor or turbine is provided to actuate compressor 2.

Spray members 12 are disposed in casing 6 above evaporator 5 and are adapted to spray water over the exterior surfaces of the evaporator to defrost the same. Members 12 are connected to a line 13 through which water from a suitable source of supply is forwarded to members 12. A pressure regulator 14 and a three way solenoid valve 15 are disposed in line 13. Solenoid valve 15 governs passage of water to the spray members.

Damper motor 8 is connected by line 16 to a standpipe 17 connected to supply line 16. A suitable fluid such as oil or air is entrapped in line 16. It will be understood, of course, if oil is used a suitable trap may be employed in place of the standpipe. Pressure of water in line 16 exerts pressure on the fluid to actuate damper motor 8 to close dampers 7. When solenoid valve 15 is closed, water in line 16 and standpipe 17 is drained through such valve to any suitable discharge thus permitting damper motor 8 to again open dampers 7.

Suitable starting mechanism 20 is connected to prime mover 11 and to fan motor 10. The starter 20 is governed by a thermostat 21 responsive to the temperature of air in the area being cooled. Thermostat 21 actuates starter 20 to operate the refrigeration system when temperature in the area being cooled reaches a predetermined high point by closing an electrical circuit connecting the thermostat and the starter. When temperature in the area being cooled reaches a predetermined low point, the thermostat contacts are broken, the connecting circuit is opened and operation of the fan motor and compressor prime mover is discontinued.

A pressure switch 22 is provided connected by line 23 to the suction line of the refrigeration system. Suction pressure through bellows 23' of switch 22 moves a lever 24 connected to the starter 20 between contacts 25 and 26. When lever 24 engages contact 25 the circuit between the thermostat 21 and starter 20 is complete,

thermostat 21 governing normal operation of the refrigeration system. When lever 24 engages contact 26 a second electrical circuit is completed to actuate solenoid valve 15. Thus upon a decrease in suction pressure below the normal operating range, contact 25 and lever 24 are separated breaking the first circuit thereby discontinuing operation of the compressor and fan motor and the second circuit is completed, actuating solenoid valve 15 to open supply line 16 to passage of water to spray members 12 thereby also actuating damper motor 8, as described above, to close dampers 7.

It will be understood that during normal operation the evaporator balances the suction pressure for a given area temperature and air quantity determined by the capacity of fan 9. When ice or frost builds up on the evaporator, heat transfer is reduced thereby reducing the capacity of the evaporator. The accumulation of frost also decreases the air flow through the evaporator further reducing its capacity. The reduction in capacity causes a drop in suction pressure below the normal operating range. Assume that desired area temperature is 0° F.; normal suction pressure may be 5 p. s. i. If frost collects on the evaporator, pressure may drop to 2 p. s. i. Suction pressure switch 22 may be set to cut out at 2 p. s. i. Switch 22 may be set to again cut in at suction pressure corresponding to a temperature above 32° F.

Assume the suction pressure is normal, and the electrical circuit made through contact 25. Thermostat 21 is then in control of the operation of the refrigeration system. When the thermostat closes its contacts in response to an increase in area temperature, the circuit is completed to energize starter 20, actuating prime mover 11 to operate compressor 2. When prime mover 11 is actuated by starter 20, fan motor 10 is actuated to operate fan 9. Preferably, the fan starts and stops whenever the compressor starts and stops. Thermostat 21 maintains area temperature by starting and stopping the compressor and fan in response to such temperature. So long as operation is normal, switch 22 does not change its position.

Assume, however, that frost has collected on the evaporator 5 with a consequent reduction in capacity. Suction pressure decreases; when it reaches 2 p. s. i., suction pressure switch 22 is actuated, breaking contact 25 thereby stopping the compressor 2 and the fan motor 10. Simultaneously, contact 26 is made, completing the second electrical circuit to open solenoid valve 15 permitting city water to flow through line 13 to spray members 12 which discharge the water over the exterior surfaces of evaporator 5 to melt frost and ice collected thereon.

Admission of water through valve 15 to line 13 permits the level in standpoint 17 to rise, exerting pressure on the oil or air trapped therein and in line 1 to actuate the bellows 8. Motor 8 closes and dampers 7 in casing 6 preventing splash of water through the outlet of the casing and stopping gravity flow of air through casing 6 thus accelerating the defrosting operation.

So long as frost remains on the evaporator surface, pressure in the suction line is determined by the coldest point in the line. Thus, pressure in the suction line cannot rise above 32 p. s. i. (equivalent to about 34° F. with dichlorodifluoromethane). When the ice or frost has melted, the temperature of the water causes an immediate increase in suction pressure above 32 p. s. i., thus breaking contact 26 and making contact 25. Breaking contact 26 actuates 3-way solenoid valve 15 closing line 13 to passage of water from the source of supply to members 12 and opening a port in valve 15 to permit water to drain from the portion of line 13 connecting valve 15 and members 12. Draining of such water relieves pressure in line 16 and permits motor 8 to again open dampers 7 in casing 6. With the circuit including contact 25 completed, thermostat 21 is again in control of the refrigeration system.

In the system shown in Figure 1, upon a material change in the setting of thermostat 21, it is necessary to change the setting of switch 22 a corresponding amount if satisfactory defrosting is to be accomplished. In Figure 2, I have illustrated a modified defrosting control rendering it unnecessary to make such changes. In the system shown in Figure 2, switch 22 is replaced by a differential thermostat 30. A bulb 31 disposed adjacent the suction line measures the temperature of the suction line. A second bulb 32 measures air temperature of the area to be cooled; such bulb 32 preferably is so placed that air is passed thereover by the fan 9. Thermostat 30 may be set to operate when the difference in temperature between bulb 31 and bulb 32 exceeds a predetermined amount, say 15° F. Upon the accumulation of frost, suction pressure and hence suction temperature will drop below the normal balanced position and will cause actuation of thermostat 30 as described above. Such thermostat 30 will operate satisfactorily for all maintained area conditions and requires no readjustment if the setting of thermostat 21 be changed.

The present invention provides an economical and automatic defrosting system for low temperature cooling units. The system provided causes defrosting only when a sufficient thickness of frost or ice is formed on the evaporator which interferes materially with the capacity of the evaporator. The system need not operate on an arbitrary time cycle but operates at whatever intervals are required to keep the evaporator free of ice or frost which would affect materially the capacity of the evaporator.

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

I claim:

1. In defrosting equipment for an evaporator of a refrigeration system, the combination of a casing containing the evaporator, dampers in said casing to regulate passage of air through the casing, members for discharging heating medium over the exterior surfaces of the evaporator to remove frost therefrom, a line through which heating medium is supplied to the members, means for closing the dampers when heating medium is supplied to the discharge members, a control in the heating medium line to permit or to discontinue passage of heating medium to said members, and means responsive to a condition of frost on the coils for automatically actuating said control, said damper closing means being responsive to pressure in the heating medium line whereby the dampers are automatically closed when heating medium is supplied to the members.

2. In defrosting equipment for an evaporator of a refrigeration system, the combination of an evaporator coil, a casing enclosing said coil, a

damper to regulate passage of air through the casing, members for discharging heating medium over the exterior surfaces of the evaporator coil to remove frost therefrom, a line through which heating medium is supplied to the members, a control in said line to permit or to discontinue passage of heating medium to said members, means responsive to a condition of frost on the coil for automatically actuating said coil, an expansible element for actuating said damper, a second line connecting said element with the first line, fluid in said line, pressure of heating medium entering the second line compressing the fluid therein to actuate said element to close the damper.

3. In defrosting equipment for an evaporator of a refrigeration system, the combination of a casing containing the evaporator, dampers in said casing to regulate passage of air through the casing, means for actuating the dampers, spray members for discharging heating medium over the exterior surfaces of the evaporator to remove frost therefrom, a line through which heating medium is supplied to the spray members, means for actuating the dampers, said means being responsive to pressure in the heating medium line whereby the dampers are automatically closed when heating medium is supplied to the members, a control in the heating medium line to permit or to discontinue passage of heating medium to the spray members, a switch responsive to suction pressure of the refrigerating system, a thermostat for controlling normal operation of the refrigerating system, said thermostat being responsive to temperature in the area being cooled, an electrical circuit connecting the switch with the thermostat, a second electrical circuit connecting the switch with the control, a decrease in suction pressure below the normal operating range of the refrigerating system actuating the switch to open the first circuit and to close the second circuit to actuate the control.

4. In a refrigerating system, the combination of a compressor, a condenser, an expansion device, and an evaporator disposed in a closed circuit, a casing containing said evaporator, dampers in a wall of the casing, means for actuating the dampers, a prime mover for actuating the compressor, a fan for passing air through the evaporator, a motor for actuating the fan, a thermostat connected to the prime mover and the fan motor, said thermostat being responsive to temperature in an area being cooled to actuate the prime mover and the fan motor, members for discharging heating medium over the exterior surfaces of the evaporator to remove frost therefrom, a line through which heating medium is supplied to the members, said damper actuating means being responsive to pressure in the heating medium line whereby the dampers are automatically closed when heating medium is supplied to the spray members, a control in the heating medium line, a switch responsive to suction pressure of the refrigerating system, an electrical circuit connecting the switch with the thermostat, a second electrical circuit connecting the switch with the control, a decrease in suction pressure below the normal operating range of the system actuating the switch to open the first circuit and to close the second circuit thereby permitting passage of heating medium to the spray members and preventing operation of the prime mover and fan motor.

5. A refrigerating system according to claim 4 in which the control comprises a three-way solenoid valve adapted to drain heating medium from the supply line when passage of heating medium through said line is discontinued.

6. A refrigerating system according to claim 5 in which an expansible element actuates the dampers, said element being connected by a line to the supply line, fluid trapped in said line whereby pressure of heating medium in the supply line compresses the fluid to exert pressure on the element thereby automatically closing the damper when heating medium is supplied to the members.

7. In a refrigerating system, the combination of a compressor, a condenser, an expansion device and an evaporator disposed in a closed circuit, a prime mover for actuating the compressor, a fan for passing air through the evaporator, a motor for actuating the fan, a thermostat connected to the prime mover and the fan motor, said thermostat being responsive to temperature in an area being cooled to actuate the prime mover and the fan motor, members for discharging heating medium over the exterior surfaces of the evaporator to remove frost therefrom, a second differential thermostat responsive to a predetermined difference in temperatures of the suction line and the area being cooled, and a line for supplying heating medium to the members, a control in said line, an electrical circuit connecting the second thermostat to the first thermostat, a second electrical circuit connecting the second thermostat to the control, a predetermined difference in the temperatures of the suction line and the area being cooled actuating the second thermostat to open the first circuit and to close the second circuit to defrost the evaporator.

8. Refrigerating system according to claim 7 in which the second differential thermostat includes a lever adapted to engage either of two contacts, a fluid motor system connected to said lever to move the same in a predetermined direction, said system including a bulb disposed adjacent the suction line of the refrigeration system and a second fluid motor system adapted to move the lever in an opposite direction, said second fluid motor system including a bulb disposed in a position in which it reflects the temperature of the air in the area being cooled.

9. In a refrigerating system, the combination of a compressor, a condenser, an expansion device, and an evaporator disposed in a closed circuit, a casing containing the evaporator, dampers in the casing, a fan to pass air through the evaporator, spray members for discharging heating medium over the exterior surfaces of the evaporator, a control governing passage of heating medium to the spray members, and means for automatically discontinuing operation of the compressor, operation of the fan, automatically actuating the control to permit passage of heating medium to the spray members and for automatically closing the dampers to defrost the evaporator.

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