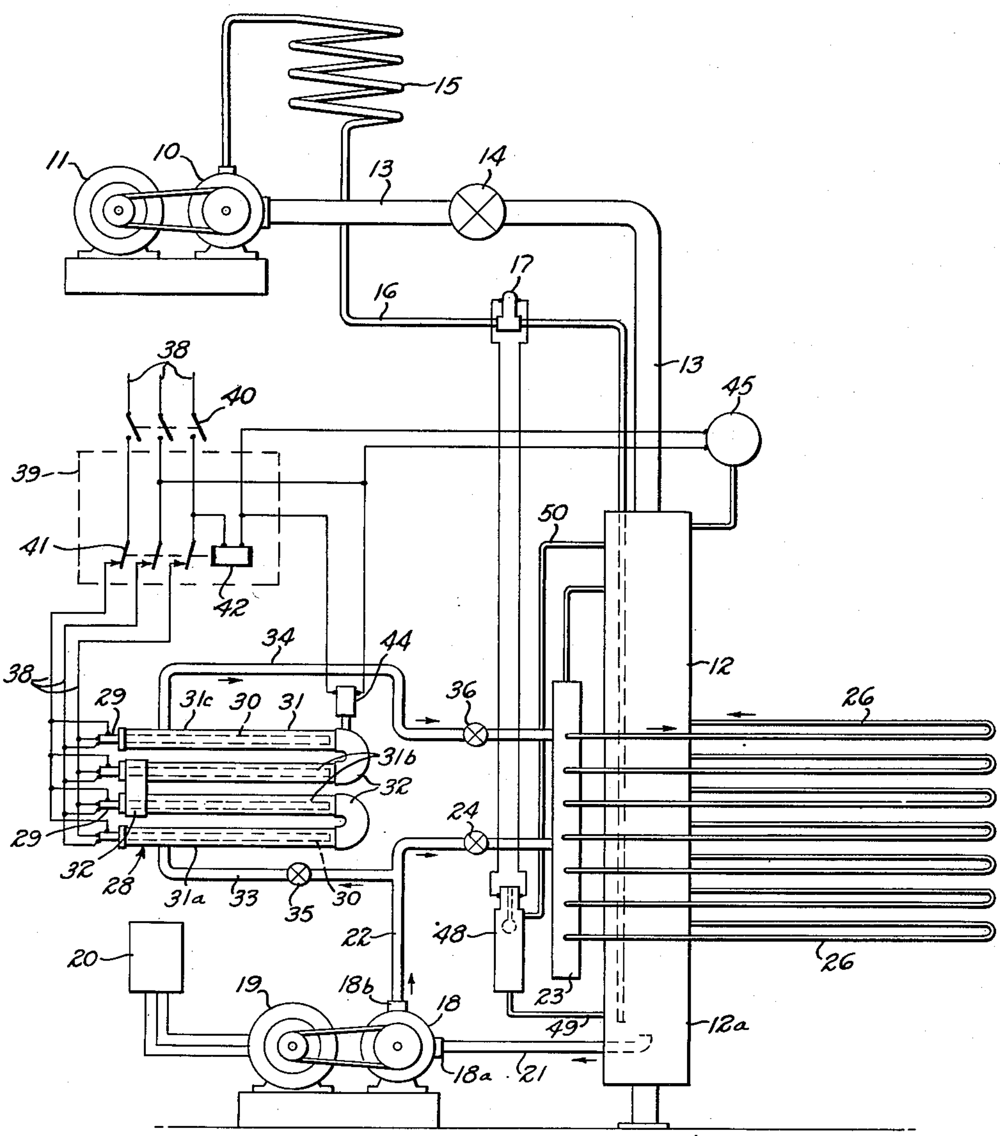
Feb. 17, 1953 F. W. POWERS ET AL 2,628,479

DEFROSTING SYSTEM

Filed Oct. 2, 1950



INVENTORS:
FELIX W. POWERS
ALBERT LUNDIN
BY THEIR ATTORNEYS
HARRIS, KIECH, FOSTER & HARRIS
By [signature]

Patented Feb. 17, 1953 2,628,479

UNITED STATES PATENT OFFICE

2,628,479

DEFROSTING SYSTEM

Felix W. Powers, Pasadena, and Albert Lundin, Huntington Park, Calif.

Application October 2, 1950, Serial No. 188,026

13 Claims. (Cl. 62—4)

1

This invention relates to mechanical refrigerating apparatus and more particularly to the provision in such apparatus of improved defrosting means to remove excessive accumulations of frost and ice from the evaporator or chilling unit thereof.

Such chilling units or evaporators, which are frequently in the form of pipe coils, may rapidly accumulate ice and frost on the exterior surfaces thereof when operated below freezing temperatures. As the thickness of such deposits increase, the cooling surfaces become insulated and unable to abstract heat from the surrounding medium, thus progressively reducing operating efficiency. Frequent removal of this ice and frost coating, which operation is commonly known in the art as defrosting, is therefore required in order to maintain the efficient functioning of the refrigerating apparatus.

When its becomes necessary to defrost such cooling surfaces as are contained in the ordinary household refrigerator, the refrigerator compressor is shut off, allowing the temperature of the refrigerant within the evaporator to rise above freezing, and the iced surfaces may be simultaneously exposed to the warmer outside air until the ice melts and runs off the coils. Obviously this method is not suitable for defrosting in commercial plants since it requires too much time as well as the intermittent exposure of the contents of the refrigerated area to undesirable high temperatures. In commercial type refrigeration systems various methods of defrosting by the use of water sprays have heretofore been suggested but they have involved the disadvantages of complicated equipment and expensive installations, particularly to provide for drainage and in the means employed for preventing freezing of water used for defrosting during nondefrosting periods.

Other means which have heretofore been employed in the defrosting of commercial size refrigeration units include the use of heated refrigerant gases circulated from the compressor directly through the evaporator, the heated gases eventually raising the temperature within the cooling coils until the exterior frost or ice is melted. This method is disadvantageously slow and time-consuming due to the relatively slow heat transfer between the heated gaseous medium and the cooling coils and usually results in considerable rise in temperature in the refrigerated area during the long defrosting period.

It is an object of our invention to provide an improved system for defrosting of low temperature chilling units which will serve to quickly and rapidly heat such chilling units to a temperature

2

just sufficient to cause the exterior frost and ice to melt or drop off, thereby defrosting the apparatus in a minimum period of time and without permitting a substantial rise in temperature of the refrigerated area during the defrosting period.

Our invention contemplates the use of heating means to elevate the temperature of a liquid, such as the liquid refrigerant, when defrosting is required, and the circulation of such heated liquid through the cooling coils, rapidly elevating the temperature of the latter from the inside out, until the excessive frost and ice are melted and drop therefrom.

A further object of our invention is the provision of a defrosting system in which a heated liquid may be intermittently circulated through the cooling element of a refrigerator while flow of cool refrigerant from the condenser unit is shut off.

A further object of our invention is to provide a valve-controlled conduit system, liquid pump and liquid heating means connected into a refrigeration system in such a manner that the refrigerating medium may be caused to circulate continuously between the liquid heating means and the cooling coils during the defrosting operation, by-passing the conventional condenser and compressor commonly employed in the refrigerating cycle.

A further object is to provide in a refrigeration apparatus of the aforementioned character, electrical heating elements disposed in heat transfer relationship with the liquid refrigerant in order to elevate the temperature of the latter for circulation through the cooling coils during a defrosting cycle.

A further object is to provide a refrigerating system in which the temperature to which the liquid refrigerant is heated in the defrosting cycle may be automatically controlled by deenergization of the electrical heating elements, in the event the temperature of the refrigerant liquid within the liquid heating means or the pressure within the refrigerant liquid tank reaches a predetermined level.

An additional object is the provision of a defrosting system which is efficient in operation, relatively inexpensive to install and simple to operate.

Still further objects and aspects of the invention will become apparent in the following discussion of the drawing, and in which:

Fig. 1 is a semidiagrammatic elevational view of a refrigerating system embodying the invention.

The refrigerating apparatus shown comprises a refrigerant compressor 10, driven by means of a motor 11, which evacuates refrigerant vapor such, for example, as ammonia vapor or Freon, from a refrigerant liquid tank 12 through a suction conduit 13 having a manually operated normally open shutoff valve 14. The compressed vapor from the compressor 10 is forced through a condenser 15, where it is cooled and condensed under relatively high pressure to the liquid phase, in accordance with conventional operation, and is led through a conduit 16, having a solenoid operated shutoff valve 17 disposed therein, to the refrigerant liquid tank 12. The conduit 16 extends within the tank to a lower portion 12*a* thereof where the refrigerant liquid is discharged into the tank under reduced pressure.

A liquid pump 18 driven by a motor 19 connected through a manually operated starting switch 20 to a source of power (not shown), pumps the refrigerant liquid from the lower portion 12*a* of the tank 12 through a conduit 21 to an inlet 18*a* of the pump and thence, from an outlet 18*b* thereof, through a conduit 22 to a liquid distributor header 23. Disposed in the conduit 22 between the liquid pump 18 and the liquid distributor header 23 is a normally open, manually operated shutoff valve 24. The liquid distributor header 23 receives the liquid under reduced pressure and discharges same into a plurality of cooling coils 26 on which ice and frost will accumulate in normal operation upon circulation of the liquid refrigerant therethrough during the cooling cycle.

The defrosting apparatus includes a liquid heating means, illustrated generally at 28, having a plurality of electrical heating elements 29 interposed in heat transfer relationship with the liquid refrigerant between the liquid pump 18 and the liquid distributor header 23. Each such heating element 29 is disposed within a relatively small diameter tube 30, which may be filled with a fluid, as, for example, oil, and secured within a larger diameter conduit section 31, the annular space between the tube 30 and the conduit section 31 providing a passageway for the flow of the liquid refrigerant. The conduit sections 31 include an inlet conduit section 31*a*, a plurality of intermediate conduit sections 31*b* and an outlet conduit section 31*c* which are joined in series by connecting conduit sections 32 in order to provide a continuous sinuous passage or coil for the flow of refrigerant liquid from an inlet conduit 33 leading from the outlet 18*b* of the fluid pump 18, to inlet conduit section 31*a* and thence to an outlet conduit 34, leading from the outlet conduit section 31*c* back to the liquid distributor header 23. Disposed in the inlet conduit 33 is a normally closed, manually operated shutoff valve 35 and a similar shut off valve 36 is located in the outlet conduit 34 between the conduit section 31*c* and the liquid distributor header 23.

The electrical heating elements 29 may be of any conventional type such as high resistance conductors arranged in a closed circuit and adapted to heat up when an electric current is passed through the circuit. As illustrated in the drawings, current is supplied to the heater elements through conductors 38 which are connected through the contacts of a normally closed relay 39 and a manually operated switch 40 to a three-phase source of electric power (not shown). The relay 39 comprises a relay switch 41 and a relay coil 42, the former serving to connect or interrupt the flow of electrical energy to the heater elements 29. The relay coil 42 is connected in series with a normally open thermostatic switch 44 and also a normally open pressure switch 45, the switches 44 and 45 being connected in parallel with each other to a source of power that may conveniently be obtained from any two of the conductors 38.

The flow of liquid refrigerant into the refrigerant liquid tank is controlled by means of the solenoid operated shut off valve 17 which is connected by conductors to a source of power (not shown) through a float regulator 48 in which the liquid is maintained at an equal height with the liquid level in the refrigerant liquid tank 12 by means of the bleeder conduits 49 and 50 which lead from the lower and upper portions respectively of the float regulator 48 to the refrigerant liquid tank 12.

The operation of the defrosting system of our invention is initiated when the cooling coils 26 become coated with ice or frost, during the conventional cooling cycle, to an extent that the withdrawal of heat from the surrounding air in the refrigerated area is reduced to an inefficient operating level. The switch 40 is first closed in order to supply current through the conductors 38 to the heating elements 29 which in turn heat up the tubes 30. The liquid heating means 28 is thus prepared for the transfer of heat to the liquid refrigerant as it is by-passed therethrough. Prior to opening such by-pass liquid circuit, the valve 14 is closed in order that no refrigerant gases can be pulled back to the compressor through the suction conduit 13, thereby stopping the cooling cycle.

With the liquid pump 18 remaining in operation as in the cooling cycle, the valves 35 and 36 are opened and valve 24 is closed. This operation causes the liquid refrigerant from the refrigerant liquid tank 12 to travel through the conduits 21, 22 and 33 to the liquid heating means 28 via the inlet conduit section 31*a*, thence through the intermediate conduit sections 31*b*, via the connecting conduit sections 32, to the outlet conduit section 31*c*. From the latter the refrigerant liquid is led via outlet conduit 34 to the liquid distributor header 23, from which it is circulated through the cooling coils 26 back to refrigerant liquid tank 12.

During the passage of liquid refrigerant through the liquid heating means 28, the temperature of the former is rapidly elevated by transfer of heat from the tubes 30 to the refrigerant liquid flowing in the annular space between the tubes 30 and the conduit sections 31. Subsequently as the heated refrigerant is circulated through the expansion coils 26, heat is transferred to the coils from the refrigerant, elevating the temperature of the latter from the inside out until the excessive frost and ice are melted and drop from the coils. A portion only of the liquid refrigerant will vaporize to the gaseous phase at such elevated temperature during the passage thereof through the cooling coils 26 while the balance will be accumulated in the lower portion 12*a* of the tank 12 for reheating and recirculation through the coils 26. Such refrigerant as vaporizes will accumulate in the liquid refrigerant tank building up the pressure therein and in the coils 26, which increased pressure will in turn tend to reduce further vaporization and maintain the refrigerant in the liquid phase despite the elevated temperature thereof.

When the temperature of the liquid refrigerant, near its point of exit from the liquid heating means 28, reaches a predetermined value requisite to effect the melting of ice and frost on the cooling coils 26 as aforesaid, the thermostatic switch 44 automatically closes, completing the circuit from the relay coil 42 to the source of power (not shown) and energizing the former, thereby opening the relay switch 41 of the relay 39. The circuit to the heating elements 20 through conductors 38 being thus interrupted and the liquid heating means deactivated, the temperature of the refrigerant liquid is elevated no further until the temperature switch 44 reopens under the influence of the liquid refrigerant cooled to a lower temperature. In this manner the temperature of the liquid refrigerant in the cooling coils 26 is maintained within predetermined limits so that the cooling coils are heated only to a minimum temperature sufficient to cause melting of accumulated frost and ice, preventing unnecessary elevation of the temperature of the area refrigerated thereby.

The pressure switch 45 also serves to interrupt the current flow to the heating elements 29 by energization of the relay coil 42 and opening of the relay switch 41 when the pressure of refrigerant vapor within the refrigerant liquid tank reaches a certain predetermined safety limit. Thus the accumulation of excessive pressure within the tank 12 will terminate the heating of the liquid refrigerant and the further building up of such pressure due to the increased tendency of the refrigerant to vaporize in the cooling coils 26 when heated. Upon opening of the shutoff valve 14 and withdrawal of the excess refrigerant gases to the compressor 10, the pressure within the tank 12 may be reduced below the safety level, whereupon the pressure switch 45 will open to remake the circuit to the heating elements 29.

To maintain the proper supply of refrigerant liquid within the tank 12, the solenoid operated shutoff valve 17 is disposed within the conduit 16 and is automatically opened by means of the float regulator 48 when the liquid level within the tank 12 falls below a set level to permit the entry into the tank 12 of additional refrigerant from the compressor 10 or, conversely, it is closed thereby when such liquid level reaches a given height.

The operation in the defrosting cycle is continued until all the frost and ice are melted from the evaporator coils 26 and until the water caused by melting has run off, whereupon the defrosting cycle is terminated and the cooling cycle is reestablished by opening the switch 40 to disconnect heating elements 29, opening the valve 14, closing the valves 35 and 36, and opening the valve 24. The refrigerant will then be led from the compressor 10 through the condenser 15, where it is cooled under pressure, to the refrigerant liquid tank 12, from which it is pumped to the liquid distributor header 23 and thence through the cooling coils 26 in the conventional refrigerating cycle.

Thus it is apparent that we have devised a defrosting system wherein the refrigerant in liquid form may be intermittently heated in a short period of time and circulated through the cooling coils, thus providing for rapid elimination of accumulated ice and frost in a minimum period of time during which the refrigerated area is exposed to elevated temperatures.

While we have disclosed an exemplary embodiment of our invention herein for purposes of illustration, it will be understood that various changes, modifications and substitutions may be incorporated therein without departing from the spirit of the invention.

We claim as our invention:

1. In a refrigerating system including a compressor normally forcing refrigerant vapor under pressure through a condenser where it is cooled and condensed to the liquid phase and then discharged into a refrigerant liquid tank under reduced pressure from which it is pumped by a liquid pump to a liquid distributor header from which it is circulated through cooling coils back to the refrigerant liquid tank, the combination of: liquid heating means interposed between the liquid pump and the liquid distributor header adapted to elevate the temperature of the liquid refrigerant circulated through the cooling coils to melt accumulated ice and frost thereon; an inlet conduit connecting said liquid heating means and the outlet of the liquid pump; an outlet conduit connecting said liquid heating means and the liquid distributor header; and valve means controlling the flow of refrigerant liquid from the liquid pump through said inlet conduit through said liquid heating means and said outlet conduit to the liquid distributor header.

2. In a refrigerating system including a compressor normally forcing refrigerant vapor under pressure through a condenser where it is cooled and condensed to the liquid phase and then discharged into a refrigerant liquid tank under reduced pressure from which it is pumped by a liquid pump to a liquid distributor header from which it is circulated through cooling coils back to the refrigerant liquid tank, the combination of: electrical heating means connected in heat transfer relationship between the outlet of said pump and said liquid distributor header adapted to elevate the temperature of the liquid refrigerant circulated through the cooling coils to melt accumulated ice and frost thereon; an inlet conduit connecting said liquid heating means and the outlet of the liquid pump; an outlet conduit connecting said liquid heating means and the liquid distributor header; and valve means controlling the flow of refrigerant liquid from the liquid pump through said inlet conduit through said liquid heating means and said outlet conduit to the liquid distributor header.

3. A refrigerating system as defined in claim 2 in which said electrical heating means has connected thereto a thermostatic switch adapted to inactivate said heating means when the temperature of the refrigerant liquid therein rises above a predetermined level.

4. A refrigerating system as defined in claim 2 in which the refrigerant liquid tank has a pressure switch connected thereto, said pressure switch being connected to said electrical heating means for deenergizing the latter when the pressure within the refrigerant liquid tank reaches a predetermined level.

5. A refrigerating system as defined in claim 2 in which said electrical heating means includes a sinuous fluid conduit in which is disposed a plurality of tubular electrical heating elements defining annular passageways between said sinuous fluid conduit and the exterior surfaces thereof.

6. In a refrigerating system including a compressor normally forcing refrigerant vapor under pressure through a condenser where it is cooled and condensed to the liquid phase and then discharged into a refrigerant liquid tank under reduced pressure from which it is pumped by a liquid pump to a liquid distributor header from

which it is circulated through cooling coils back to the refrigerant liquid tank, the combination of: electrical heating means interposed between the liquid pump and the liquid distributor header, said electrical heating means having associated therewith a normally closed relay switch adapted upon opening to interrupt the current to said heating means; a first conduit connecting said electrical heating means and the outlet of said liquid pump; a second conduit connecting said electrical heating means and the liquid distributor header; valve means for selectively controlling the flow of refrigerant liquid from the outlet of the liquid pump to the liquid distributor header or to said electrical heating means; a thermostatic switch disposed in said electrical heating means, said thermostatic switch being connected to said relay switch and adapted to open the latter when the temperature of the refrigerant liquid within said heating means reaches a predetermined level; and a pressure switch connected to the refrigerant liquid tank and said relay switch for opening the latter when the pressure within said tank reaches a predetermined level.

7. In a refrigerating system the combination of: a compressor having an inlet and an outlet; means for driving said compressor; a condenser connected to the outlet of said compressor; a refrigerant liquid tank connected to said condenser; a liquid distributor header; a pump having an inlet connected to said refrigerant liquid tank and having an outlet connected to said header; a plurality of cooling coils connected to said header and said refrigerant liquid tank; a suction line connecting said refrigerant liquid tank to the inlet of said compressor; liquid heating means having an inlet conduit connected to the outlet of said pump and having an outlet conduit connected to said header; and selector valve means for selectively connecting the outlet of said pump to said header or to said liquid heating means.

8. In a refrigerating system the combination of: a compressor having an inlet and an outlet; means for driving said compressor; a condenser connected to the outlet of said compressor; a refrigerant liquid tank connected to said condenser; a liquid distributor header; a pump having an inlet connected to said refrigerant liquid tank and having an outlet connected to said header; a plurality of cooling coils connected to said header and said refrigerant liquid tank; a suction line connecting said refrigerant liquid tank to the inlet of said compressor; electrical heating means connected in heat transfer relationship between said pump and said liquid distributor header and having an inlet conduit connected to the outlet of said pump and having an outlet conduit connected to said header; and selector valve means for selectively connecting the outlet of said pump to said header or to said liquid heating means.

9. A refrigerating system as defined in claim 8 in which said electrical heating means has connected thereto a thermostatic switch adapted to inactivate said heating means when the temperature of the refrigerant liquid therein rises above a predetermined level.

10. A refrigerating system as defined in claim 8 in which the refrigerant liquid tank has a pressure switch connected thereto, said pressure switch being connected to said electrical heating means for deenergizing the latter when the pressure within the refrigerant liquid tank reaches a predetermined level.

11. In a dual cycle refrigerating system having a cooling cycle during which frost and ice progressively accumulate on the exterior surface of a plurality of cooling coils through which liquid refrigerant is circulated and a defrosting cycle during which said frost and ice are melted from said cooling coils, the combination of: a refrigerating apparatus including a compressor having an inlet and an outlet, means for driving said compressor, a condensor connected to the outlet of said compressor, a refrigerant liquid tank connected to said condenser, a liquid distributor header, a pump having an inlet connected to said refrigerant liquid tank and having a normally open outlet line connected to said header, a plurality of cooling coils connected to said header and said refrigerant liquid tank, a normally open suction conduit connecting the inlet of said compressor and said refrigerant liquid tank; and a defrosting apparatus including liquid heating means having a first normally closed conduit connected to said outlet line of said pump, and a second normally closed conduit connected to said header, the closing of said suction conduit and said line and the opening of said first and second conduits causing a shift from the cooling to the defrosting cycle.

12. A refrigerating system as defined in claim 11 in which said liquid heating means has connected thereto a thermostatic switch adapted to inactivate said heating means when the temperature of the refrigerant liquid therein rises above a predetermined level.

13. A refrigerating system as defined in claim 2 in which the refrigerant liquid tank has a pressure switch connected thereto, said pressure switch being connected to said liquid heating means for deenergizing the latter when the pressure within the refrigerant liquid tank reaches a predetermined level.

FELIX W. POWERS.
ALBERT LUNDIN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,819,510	Hebeler	Aug. 18, 1931
1,970,340	Ruff	Aug. 14, 1934
2,167,036	Baker	July 25, 1939
2,313,390	Newton	Mar. 9, 1943
2,451,385	Groat	Oct. 12, 1948
2,452,102	Cocanour	Oct. 26, 1948
2,459,173	McCloy	Jan. 18, 1949
2,551,163	Rickert	May 1, 1951
2,554,848	Warren	May 29, 1951