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MEANS FOR DEFROSTING COOLING COILS

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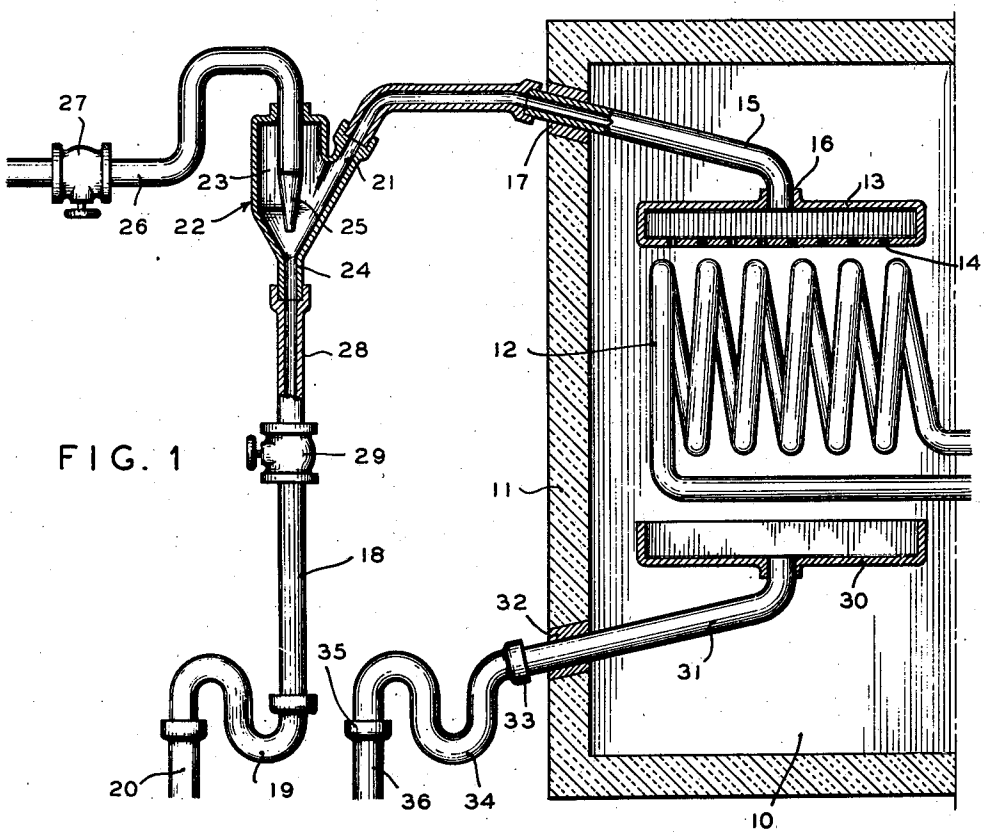


FIG. 1

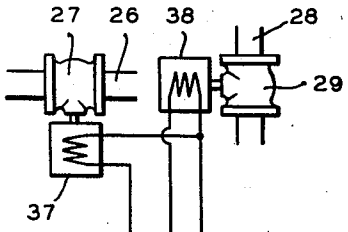
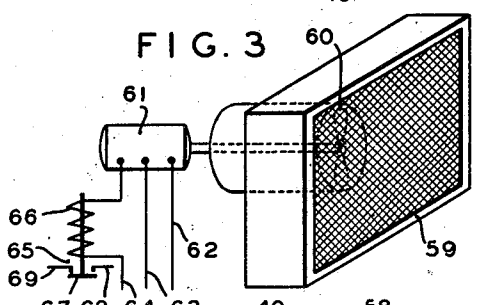


FIG. 3



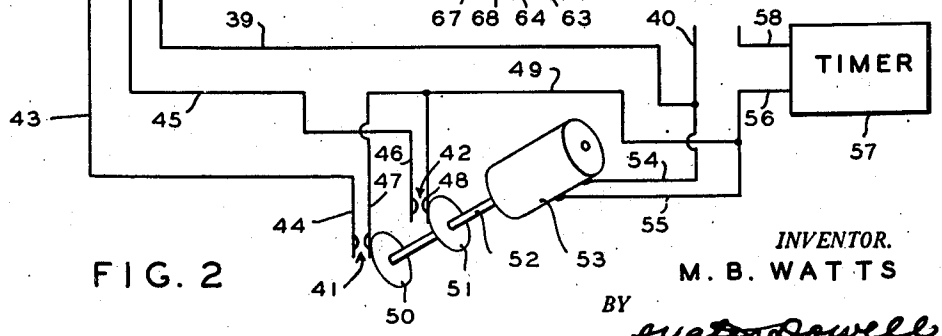


FIG. 2

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MEANS FOR DEFROSTING COOLING COILS

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15 Claims. (Cl. 62—2)

1

This invention relates to refrigeration and more particularly to the periodic removal of frost which accumulates on the cooling unit usually in the form of a coil located in a refrigerated compartment.

It is well known that when air in a refrigerated compartment is cooled below its dew point that the moisture of the air will be deposited on the cooling unit in the form of frost. This frost is a relatively good heat insulating medium and if allowed to accumulate and remain on the coils will materially impair the efficiency of the cooling unit.

It is also imperative in order to maintain the efficiency of the refrigeration system to remove the accumulated frost in as short a time as possible in order to maintain a relatively low temperature in the compartment and preclude the necessity of recooling the same after completion of the defrosting operation.

Numerous systems have been devised for accomplishing the defrosting operation, among which are the provision of a heated body adjacent the cooling unit, the passage of warm air or gas over the cooling unit, and the shutting down of the refrigeration system in order to allow the frost to melt. These attempts to solve the defrosting problem have all presented several disadvantages, the most serious of which is the relatively long defrosting cycle and the excessive raising of the temperature within the refrigerated compartment. Attempts have also been made to solve the defrosting problem by spraying a relatively warm fluid such as water over the cooling unit to melt the frost accumulated thereon. This system has the advantage of melting the frost in a relatively short time without materially raising the temperature in the refrigerated compartment but there are also very serious disadvantages connected with this system as it has been heretofore utilized.

In the first place, it is necessary to provide some sort of a spray head or distributing means for directing the water over all portions of the cooling unit and since this distributing means normally is provided with a plurality of relatively small openings, it is imperative that upon completion of the defrosting operation all liquid be removed therefrom to preclude freezing of the liquid therein and the consequent clogging of the openings or other impairment of the system. This problem has been partially solved by the provision of a self-draining liquid supply conduit. However, the provision of such a conduit immediately introduces another disadvantage in that the conduit must be left open to the atmosphere or sewer and consequently, due to a reverse chimney effect, a relatively large volume of cold air will pass from the refrigerated compartment through the open supply conduit to the exterior, thus materially impairing the efficiency of the system. There is also the further disadvantage that sewer gas or other contaminating substances will be introduced into the refrigerated compartment through the open supply conduit.

2

Another disadvantage arising from melting the frost by spraying water or other relatively warm fluid thereon is the fact that this operation immediately creates a considerable volume of water vapor in the form of fog surrounding the cooling unit. In prior devices no provision has been made for removing the fog thus produced and consequently upon completion of the defrosting operation such fog is redeposited on the cooling unit in the form of frost, thus materially increasing the load on the refrigeration system as well as insulating against heat transfer.

It is accordingly an object of this invention to provide a defrosting system utilizing a relatively warm fluid such as water and in which means is provided for positively removing all liquid remaining in the supply conduit and spray head after the completion of the defrosting operation, and also for positively removing the water vapor or fog from the vicinity of the cooling unit.

It is a further object of this invention to provide a defrosting system utilizing a relatively warm fluid such as water to remove the frost from a cooling unit and in which means is provided for effectively preventing the escape of cold air from the interior of the refrigerated compartment and for preventing the entrance thereto of contaminating substances.

It is a further object of this invention to provide an automatic defrosting system utilizing relatively warm fluid such as water to remove the frost from the cooling unit, the defrosting cycle being initiated and automatically controlled by electrical timing devices.

It is a further object of this invention to provide an automatic defrosting system utilizing a relatively warm fluid such as water for removing the frost from the cooling unit and in which the cooling unit is provided with electrical means for circulating air to be cooled therethrough wherein the defrosting cycle is controlled by the change in load upon the air circulating means occasioned by the accumulation of frost on the cooling unit.

Further objects and advantages of the invention will be apparent from the following de-

scription taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a diagrammatic view illustrating the defrosting system of this invention applied to a conventional refrigerated compartment and with certain parts in section for greater clarity;

Fig. 2, a schematic diagram of an electrical control circuit for the defrosting system of Fig. 1; and

Fig. 3, a fragmentary diagrammatic view of control means for the defrosting system of Fig. 1 when utilized in conjunction with a cooling unit having means for circulating air therethrough.

With continued reference to the drawing, there is shown in Fig. 1 a refrigerated compartment 10 provided with conventional insulated walls 11, a cooling unit or evaporator 12 of any desired form being disposed within the compartment. The compartment 10 may be of any desired size and shape and cooling unit 12 would, of course, be proportioned and arranged in accordance with the requirements of the particular compartment to be refrigerated.

Immediately above the cooling unit 12 is located a spray head 13 having a plurality of relatively small apertures 14 in the lower surface thereof, there being a sufficient number of these apertures arranged in a manner to spray liquid such as water over the entire surface of the cooling unit or coil 12. A fluid supply conduit 15 is connected by a joint 16 to the spray head 13, this conduit extending through a wall of the compartment 10, there being provided a suitable sealing means 17 in the wall of the compartment to prevent the leakage of air around the conduit 15. In order to minimize the flow of cold air from the interior of the compartment to the exterior thereof through the conduit 15 due to a reverse chimney effect in the event of an open connection this conduit is preferably inclined upwardly from the spray head 13 to approximately where it extends through the wall of the compartment.

The conduit 15 is connected to the intake 21 of ejector 22 which is provided with an elongated chamber 23 at one end. The walls of the chamber 23 converge into a relatively small outlet 24. A nozzle 25 is disposed within the chamber 23 axially of the outlet 24 and is arranged to direct a relatively high velocity stream or jet of liquid into the outlet 24. The passage of this relatively high velocity stream or jet creates a partial vacuum in the chamber 23 and the intake 21 whereupon the ejector 22 becomes essentially a pump. It is to be noted that this ejector will draw either a liquid or gas through the intake 21 with equal facility.

The nozzle 25 is supplied with liquid under relatively high pressure through a liquid supply line 26 in which is connected a valve 27. Outlet 24 of the ejector 22 is connected to a discharge conduit 28 in which there is provided a valve 29.

In installations of the type under consideration, it is necessary that every precaution be taken against the entry of contaminating substances into the refrigerated space. Consequently whenever connections of any type are made to this space some provision must be made to automatically prevent the entry of such substances. In the proposed structure this problem is very simply solved by providing in the discharge conduit 28 a liquid trap 19 which may be connected to this valve 29 by a suitable pipe 18. Trap 19 may be connected to the usual sewer or discharge line 20. Since regardless of the manner of using this apparatus, that is, whether the valve 29 is left open or closed between defrosting periods, trap 19 will always be sufficiently filled with liquid to effectively seal pipe 18, discharge conduit 28 and supply conduit 15 against the entry of any contaminating substance and consequently no further precautions in this matter are necessary.

In order to remove the defrosting liquid and water resulting from the melting frost from the compartment 10, a drip pan 30 is located beneath the cooling unit 12. The drip pan 30 is provided with a drain 31 extending exteriorly of the compartment through a suitable sealing means 32 in one of the walls thereof. Connected to the outer end 33 of the drain 31 is a conventional U-shaped trap 34, the opposite end 35 of which may discharge to the atmosphere or be connected to a sewer pipe 36. Obviously, the trap 34 operating in a well-known manner will effectively seal the drain 31 against the passage of gas in either direction and also will effectively prevent the entry of other contaminating substances into the compartment 10. If desired, liquid supply conduit 15 and drain 31 may be formed of a relatively poor heat conducting material in order to prevent flow of heat therethrough and maintain the efficiency of the system.

The operation of the defrosting system disclosed in Fig. 1 and described above is as follows: Assuming an accumulation of frost on the cooling unit 12 sufficient to require removal thereof, valve 29 in the discharge conduit 28 is closed and valve 27 in the liquid supply line 26 opened to permit liquid to flow through nozzle 25 and into ejector 22. Since the valve 29 is in closed position, liquid cannot escape through the discharge conduit 28, and consequently this liquid will fill the ejector 22 and flow through intake 21, and liquid supply conduit 15 to the spray head 13. Upon reaching the spray head 13 the liquid will be discharged therefrom through apertures 14 in a relatively fine spray covering the outer surface of cooling unit 12 whereupon due to the relatively high temperature of the liquid, frost present on the surface of the cooling unit 12 will be melted. The defrosting liquid as well as the liquid resulting from the melted frost will be collected in the drip pan 30 and drained therefrom through drain 31 and trap 34 to the atmosphere or sewer pipe 36 as the case may be. Also, during this operation due to the relatively high temperature of the defrosting liquid a considerable volume of water vapor in the form of fog will be created in the vicinity of the cooling unit 12.

Upon completion of the removal of frost from the cooling unit 12 of the defrosting operation, valve 29 in discharge conduit 28 is opened permitting the flow of liquid therethrough whereupon ejector 22 becomes a pump and withdraws all liquid present in the spray head 13 and supply conduit 15. Withdrawal of this liquid effectively precludes the subsequent freezing thereof and consequent clogging of the relatively small apertures 14 of the spray head 13. After removal of all liquid from the spray head 13 and supply conduit 15 operation of the ejector 22 is continued to withdraw the fog surrounding the cooling unit 12, the ejector 22 during this operation acting as a vacuum pump. Upon completion of the fog removal operation valve 27 is closed thus shutting off the supply of liquid to the ejector 22 and immediately thereafter valve 29 is closed to effectively seal the supply conduit 15 and spray head 13 against the entry of undesired contaminating substances. If for any reason valve 29 is not

closed during the periods between defrosting operations, then trap 19 will effectively seal the discharge conduit 28 and supply conduit 15 against the entry of contaminating substances.

It will thus be seen that the above described system provides a relatively simple and efficient apparatus for defrosting a cooling unit in a refrigerated compartment by passing a relatively warm liquid thereover and for effectively and positively removing all liquid present during the defrosting operation and in addition for removing the fog created by this operation. This system also provides means for effectively preventing the flow of cold air from the refrigerated space to the exterior thereof and for preventing the inflow of undesirable contaminating substances.

In many installations it is highly desirable that operation of the defrosting system be entirely automatic and accordingly there is illustrated in Fig. 2 an electrical control circuit which may be utilized in conjunction with the apparatus shown in Fig. 1 and described above for performing the defrosting operation at predetermined intervals by merely presetting a timing device for any desired number of defrosting operations within a predetermined period of time.

In this control system valves 27 and 29 are provided with operating solenoids 37 and 38 respectively, these solenoids being connected by a common lead 39 to one side 40 of a source of electric power. The operation of solenoids 37 and 38 is controlled by switches 41 and 42 respectively, solenoid 37 being connected by lead 43 to one pole 44 of switch 41 and solenoid 38 being connected by lead 45 to one pole 46 of switch 42. The opposite pole 47 of switch 41 and pole 48 of switch 42 are connected to a common lead 49. Switches 41 and 42 are opened and closed in the proper sequence by cams 50 and 51 respectively, fixed on a rotary shaft 52 driven at a constant predetermined rate of speed by motor 53. Cams 50 and 51 are provided with the proper surface contour to close switches 41 and 42 in the proper sequence and to maintain these switches closed for a predetermined period of time, whereupon they are allowed to open in a predetermined sequence. Power for operation of the motor 53 is provided through a lead 54 connected to the power source 40 and through a lead 55 connected to the common lead 49 and in turn through a lead 56 to a timing device 57. The opposite side of timer 57 is connected through a lead 58 with the power source.

The operation of the control system illustrated in Fig. 2 is initiated by the timer 57 which may be present to close the circuit from power line 58 to motor 53 and poles 47 and 48 of switches 41 and 42 respectively at predetermined intervals. Energizing of the motor 53 will cause rotation of cams 50 and 51 and the configuration of the surface of these cams are such that switch 41 will be closed, thus energizing solenoid 37 and opening valve 27 to permit the flow of liquid to ejector 22 and spray head 13. During the defrosting operation initiated by opening of valve 27, switch 42 will remain open and consequently valve 29 will remain closed. Upon completion of the defrosting operation the time of which has been predetermined, cam 51 will close switch 42 thus energizing solenoid 38 and opening valve 29, whereupon ejector 22 will withdraw the liquid present in supply conduit 15 and spray head 13 together with the fog present around the cooling unit 12, thus completing the defrosting operation. After operation of the ejector for a predetermined time to remove the fog, switch 41 will be opened, thus closing the valve 27 and stopping the flow of liquid to ejector 22 and immediately thereafter switch 42 will be opened, thus closing valve 29 to prevent flow through the supply conduit 15 of contaminating or other undesirable substances into the compartment 10.

It will thus be seen that by the above described control circuit a relatively simple and efficient means has been provided whereby the refrigeration equipment may be defrosted at predetermined intervals, the defrosting cycle being predetermined in accordance with the normal time required for such operation.

In certain refrigeration installations means is provided usually in the form of an electrically driven fan for circulating air within the refrigerated compartment and over the cooling unit to more efficiently cool the compartment and in installations such as these the motor for driving the circulating fan and the power supply therefor may be conveniently utilized as a control means for a defrosting system such as that shown in Fig. 1 and described above.

Such a control system is illustrated in detail in Fig. 3 in which a cooling unit 59 is appropriately located in a compartment of the refrigerator and a fan or blower 60 driven by motor 61 is provided to circulate air through or over the cooling unit 59. Motor 61 may be of any desired type but for illustrative purposes only is supplied with 3-phase current through lines 62, 63, and 64. In order to take advantage of this particular arrangement for controlling a defrosting apparatus, a solenoid operated switch 65 is connected in the line 64 to the motor 61, the coil 66 of switch 65 being so proportioned as to operate the movable contact 67 upon a predetermined change in current flowing in line 64.

This particular control system is designed to take advantage of the fact that as frost accumulates on the cooling unit 59 the passage of air therethrough will be impeded, thus increasing the load on the fan 60 and the motor 61 so that the current flowing in line 64 will be increased. This increase in current results in movement of the contact 67, thus closing the circuit between contacts 68 and 69 to initiate operation of the defrosting apparatus. In adapting this control means to the circuit shown in Fig. 2 for controlling the defrosting system, switch 65 may be substituted for the timer 57, contact 68 being connected to a line 56 leading to motor 53 and contact 69 being connected to the power source 58.

The control system shown in Fig. 3 is fully disclosed and described in patents to Kitzmiller 2,001,027 and 2,001,028 and reference is made to these patents for any further detailed discussion thereof which may be deemed necessary.

It therefore appears apparent that by this invention there has been provided a relatively simple inexpensive and efficient defrosting system which readily lends itself to manual operation and control, to completely automatic control based on a predetermined cycle of operation, and a predetermined period of time between cycles of operation and also which may be conveniently controlled by the degree of accumulation of frost on the cooling unit. This defrosting system completely and rapidly removes the accumulated frost from the cooling unit while maintaining a relatively low temperature in the refrigerated compartment. Also by removing all liquid used to accomplish the defrosting operation there is precluded any possibility of clogging of the sys-

tem by formation of ice, and leakage of cold air into or from the compartment is prevented and removes any possibility of contamination of the interior of the compartment by the influx of gas or other substance.

It will be obvious to those skilled in the art that various changes may be made in the invention without departing from the spirit and scope thereof and therefore the invention is not limited by that which is shown in the drawings and described in the specification but only as indicated in the appended claims.

What is claimed is:

1. A refrigeration system comprising a refrigeration compartment, a cooling unit disposed in said compartment, a defrosting system for removing accumulated frost from said cooling unit, said defrosting system comprising a spray head disposed above said cooling unit, a drip pan disposed beneath said cooling unit, a drain connected to said drip pan and extending exteriorly of said compartment, a liquid trap in said drain, a liquid supply conduit connected to said spray head extending upwardly therefrom and exteriorly of said compartment, said liquid supply conduit being connected to the intake of an ejector, a liquid supply line having a valve therein connected to said ejector, a discharge conduit having a valve therein and a liquid trap connected to the outlet of said ejector whereby upon closing of the valve in said discharge conduit and opening of the valve in said supply line liquid will flow through said ejector and into said spray head and be sprayed over said cooling unit, thus melting the frost accumulated thereon, the liquid and melted frost being collected in said drip pan and removed from said compartment through said drain and whereby upon opening of the valve in said discharge conduit said ejector will operate to produce a partial vacuum in said liquid supply conduit and said spray head thereby removing all liquid present therein and upon continued operation of said ejector to thereby remove any water vapor present in the vicinity of said cooling unit, thus rapidly defrosting said cooling unit while maintaining a relatively low temperature in said compartment.

2. In a refrigeration system including a compartment and a cooling unit therein, a spray head above said cooling unit, a liquid supply conduit connected to said spray head and having a portion located exteriorly of said compartment, a drip pan in said compartment beneath said cooling unit, a drain connected to said drip pan including a liquid trap disposed externally of said compartment, an ejector having its intake connected to said liquid supply conduit, a liquid supply line having a valve therein connected to said ejector, a discharge conduit having a valve therein connected to the outlet of said ejector, whereby upon closing the valve in said discharge conduit and opening the valve in said supply line liquid will flow through said liquid supply conduit into said spray head and be sprayed over said cooling unit to melt frost accumulated thereon with the resultant liquid collected in said drip pan and drainable therefrom through said trap, and whereby upon opening of the valve in said discharge conduit said ejector will operate to produce a partial vacuum in said liquid supply conduit and all liquid removed therefrom and water vapor removed from the vicinity of said cooling unit whereby said cooling unit may be rapidly defrosted while maintaining a relatively low temperature in said compartment.

3. In a refrigeration system having a compartment and a cooling unit therein, a spray head disposed above said cooling unit, a liquid supply conduit connected to said spray head and extending externally of said compartment, a drip pan in said compartment disposed beneath said cooling unit, a drain connected to said drip pan and having a liquid trap disposed therein externally of said compartment, an ejector having its intake connected to said liquid supply conduit, a liquid supply line having a valve therein connected to said ejector, a discharge conduit having a valve therein connected to the outlet of said ejector whereby upon closing of the valve in said discharge conduit and opening of the valve in said supply line liquid will flow through said liquid supply conduit into said spray head and be sprayed over said cooling unit thus melting frost accumulated thereon, the resultant liquid being collected in said drip pan and draining therefrom through said trap and whereby upon opening of the valve in said discharge conduit said ejector will operate to produce a partial vacuum in said liquid supply conduit thus removing all liquid therefrom and serving to remove water vapor present in said compartment in the vicinity of said cooling unit whereby said cooling unit may be rapidly defrosted while maintaining a relatively low temperature in said compartment.

4. In a refrigeration system having a compartment and a cooling unit therein, a spray head disposed above said cooling unit, a liquid supply conduit connected to said spray head, a drip pan in said compartment disposed beneath said cooling unit, a drain connected to said drip pan, an ejector connected to said liquid supply conduit, a liquid supply line connected to said ejector, a discharge conduit having a valve therein connected to the outlet of said ejector whereby upon closing of the valve in said discharge line liquid will flow through said ejector and said liquid supply conduit into said spray head and be sprayed over said cooling unit thus melting frost accumulated thereon and whereby upon opening of the valve in said discharge conduit said ejector will operate to produce a partial vacuum in said liquid supply conduit thus removing all liquid therefrom, whereby said cooling unit will be rapidly defrosted while maintaining a relatively low temperature in said compartment.

5. In a refrigeration system having a compartment and a cooling unit therein, a spray head disposed above said cooling unit, a liquid supply conduit connected to said spray head, a drip pan in said compartment disposed beneath said cooling unit, a drain connected to said drip pan, an ejector connected to said liquid supply conduit, a liquid supply line connected to said ejector, a discharge conduit connected to said ejector, and means for controlling the supply of liquid to said ejector and the disharge of liquid therefrom whereby during one cycle of operation liquid will be supplied to said spray head thus melting frost accumulated on said cooling unit and during another cycle of operation said ejector will operate to produce a partial vacuum in said liquid supply conduit thus removing all liquid therefrom whereby said cooling unit may be rapidly defrosted while maintaining a relatively low temperature in said compartment.

6. In a refrigeration system having a compartment and a cooling unit therein, a spray head disposed adjacent said cooling unit, a liquid supply conduit connected to said spray head, an ejector connected to said liquid supply conduit,

a liquid supply line connected to said ejector, a discharge conduit connected to said ejector, means for controlling the supply of liquid to said ejector and the discharge of liquid therefrom whereby during one cycle of operation liquid will be supplied to said spray head and during another cycle of operation said ejector will operate to produce a partial vacuum in said liquid supply conduit thus removing all liquid therefrom whereby said cooling unit may be rapidly defrosted while maintaining a relatively low temperature in said compartment.

7. In a refrigeration system having a compartment and a cooling unit therein, a spray head disposed adjacent to said cooling unit, means for supplying liquid to said spray head whereby frost accumulated on said cooling unit is melted therefrom and pump means for positively removing all liquid present in said spray head upon completion of the defrosting operation and for removing water vapor present in said compartment in the vicinity of said cooling unit whereby said cooling unit may be rapidly defrosted while maintaining a relatively low temperature in said compartment.

8. In a refrigeration system including a compartment and a cooling unit therein, that improvement which consists in providing a defrosting system having means for spraying a fluid of relatively high temperature over said cooling unit to melt frost accumulated thereon, means for collecting said fluid and the melted frost and draining the same from said compartment, means for sealing said spray means and said drain means against the flow of cold air from said compartment and against the entry of foreign substances thereto, and means operatively connected to said spray means for creating a partial vacuum whereby fluid therein is positively removed.

9. In a refrigeration system including a compartment and a cooling unit therein, that improvement which consists in providing a defrosting system including means for directing fluid over said cooling unit to melt frost accumulated thereon, means for collecting said fluid and the melted frost and draining the same from said compartment, and means operatively connected to said spray means for creating a partial vacuum whereby fluid therein is positively removed.

10. In a refrigeration system including a compartment and a cooling unit therein, that improvement which consists in providing a defrosting system having means for spraying fluid over said cooling unit to melt frost accumulated thereon, and means operatively connected to said spray means for creating a partial vacuum whereby fluid therein is positively removed.

11. In a refrigeration system including a compartment and a cooling unit therein, that improvement which consists in providing an automatic defrosting system having means for spraying fluid of relatively high temperature over said cooling unit to melt frost accumulated thereon, means for collecting said fluid and melted frost and draining the same from said compartment, means operatively connected to said spray means for creating a partial vacuum whereby fluid therein is positively removed, electrical control means operatively associated with said spray means and said vacuum creating means whereby the same is operated through a predetermined cycle, and means associated with said control means for initiating operation thereof at predetermined intervals.

12. In a refrigeration system including a compartment and a cooling unit therein, that improvement which consists in providing an automatic defrosting system having means for spraying fluid over said cooling unit to melt frost accumulated thereon, means for collecting said fluid and the melted frost and draining the same from said compartment, means operatively connected to said spray means for creating a partial vacuum whereby fluid collected therein is positively removed, electrical control means for said defrosting system comprising electrically operated valve means associated with said spray means and said vacuum creating means, means for actuating said valve means in accordance with a predetermined cycle and means automatically responsive to the accumulation of frost on said cooling unit for initiating operation of said valve actuating means.

13. An apparatus as defined in claim 12 in which said valves are each operated by a solenoid, each solenoid being controlled by a switch actuated by a motor driven cam timing device controlling the period of operation of said motor and capable of being preset for a predetermined cycle of operation.

14. An apparatus as defined in claim 12 in which a motor driven fan is provided for circulating air through said cooling unit and in which electrical control means is provided in the power circuit for said motor, said control means initiating the actuation of said valves in response to a change in load on said motor due to an accumulation of frost on said cooling unit.

15. An apparatus as defined in claim 12 in which said valves are each operated by a solenoid, each solenoid being controlled by a switch actuated by a motor driven cam and means responsive to the accumulation of frost on said cooling unit for controlling the operation of said motor.

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