

Feb. 5, 1957

D. C. BREEDING
REFRIGERATING APPARATUS

2,780,442

Filed June 24, 1952

3 Sheets-Sheet 1

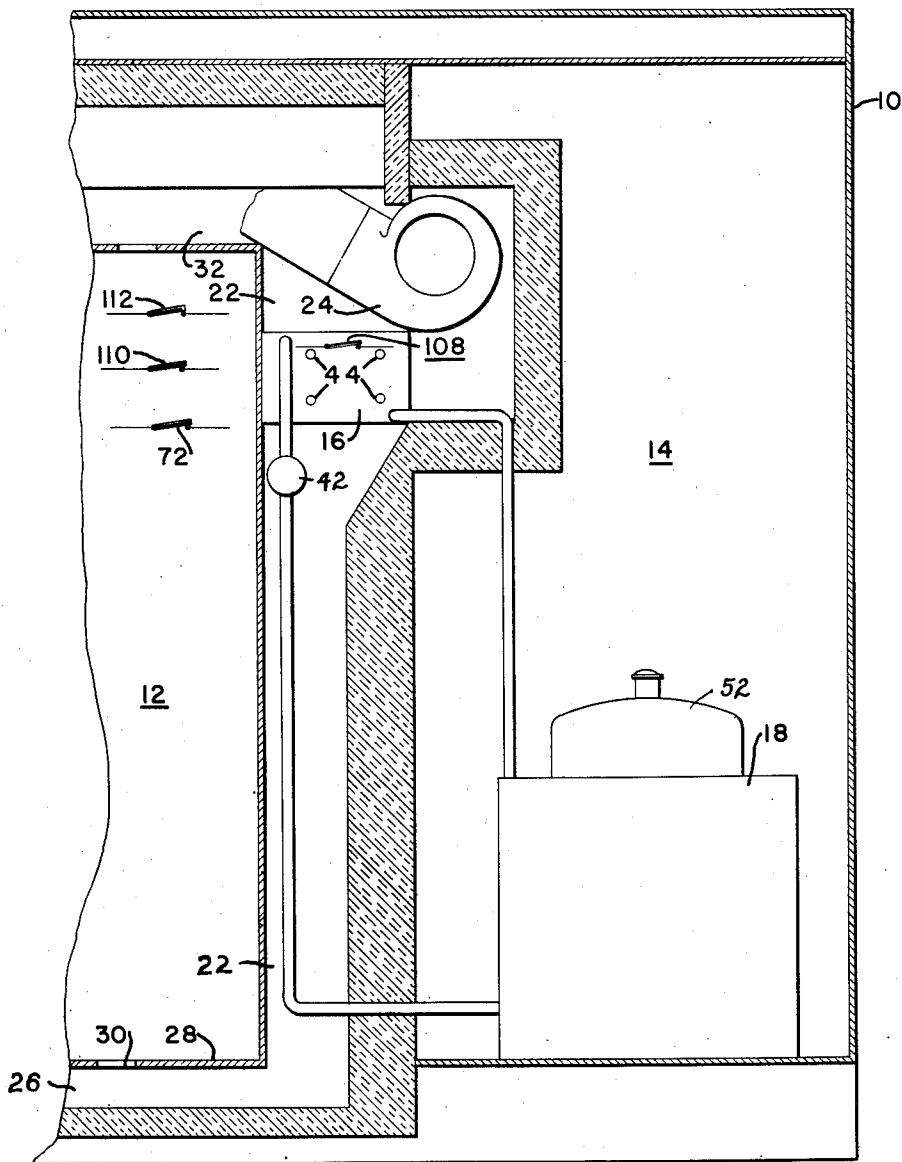


Fig. 1

INVENTOR.
David C. Breeding
BY *Willetts, Hardman & Felt*
ATTORNEYS

Feb. 5, 1957

D. C. BREEDING
REFRIGERATING APPARATUS

2,780,442

Filed June 24, 1952

3 Sheets-Sheet 2

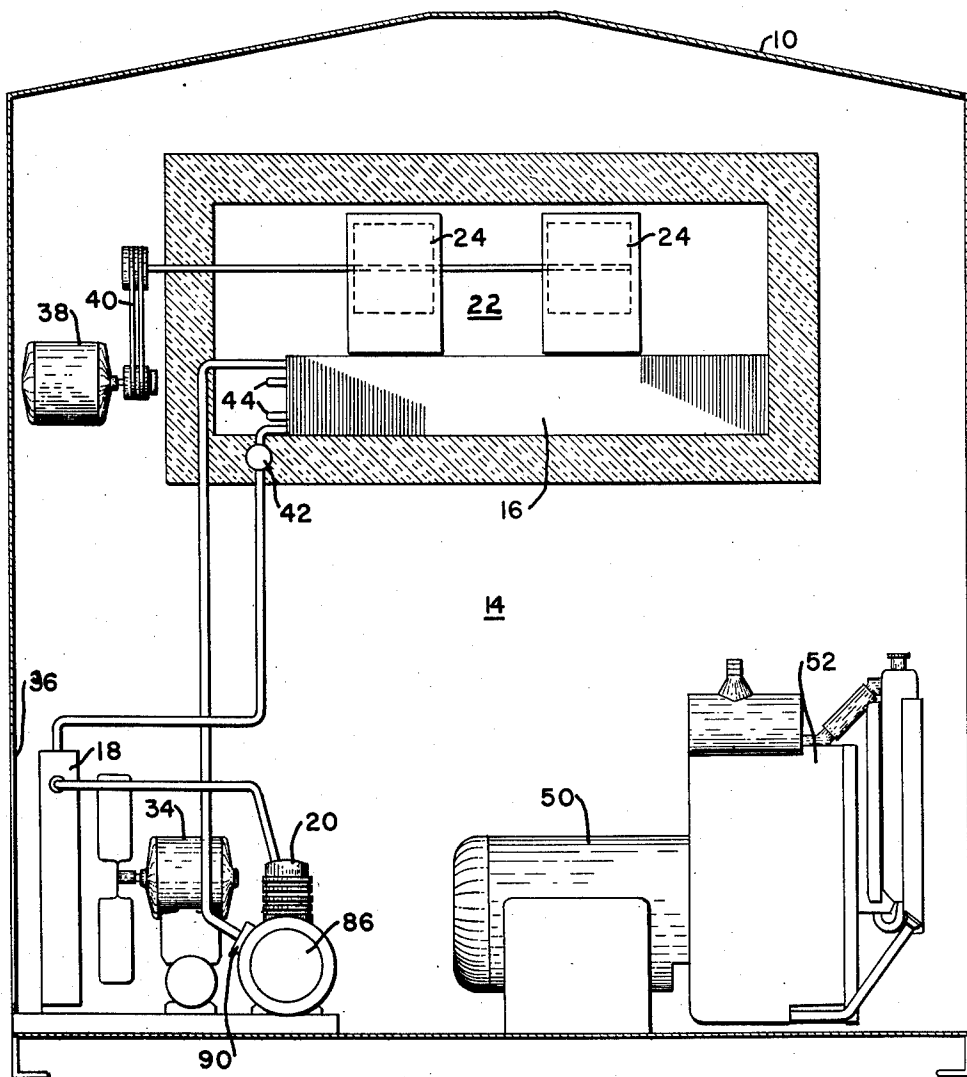


Fig. 2

INVENTOR.
David C. Breeding
BY *Willits, Hardman & Felt*
ATTORNEYS

Feb. 5, 1957

D. C. BREEDING

2,780,442

REFRIGERATING APPARATUS

Filed June 24, 1952

3 Sheets-Sheet 3

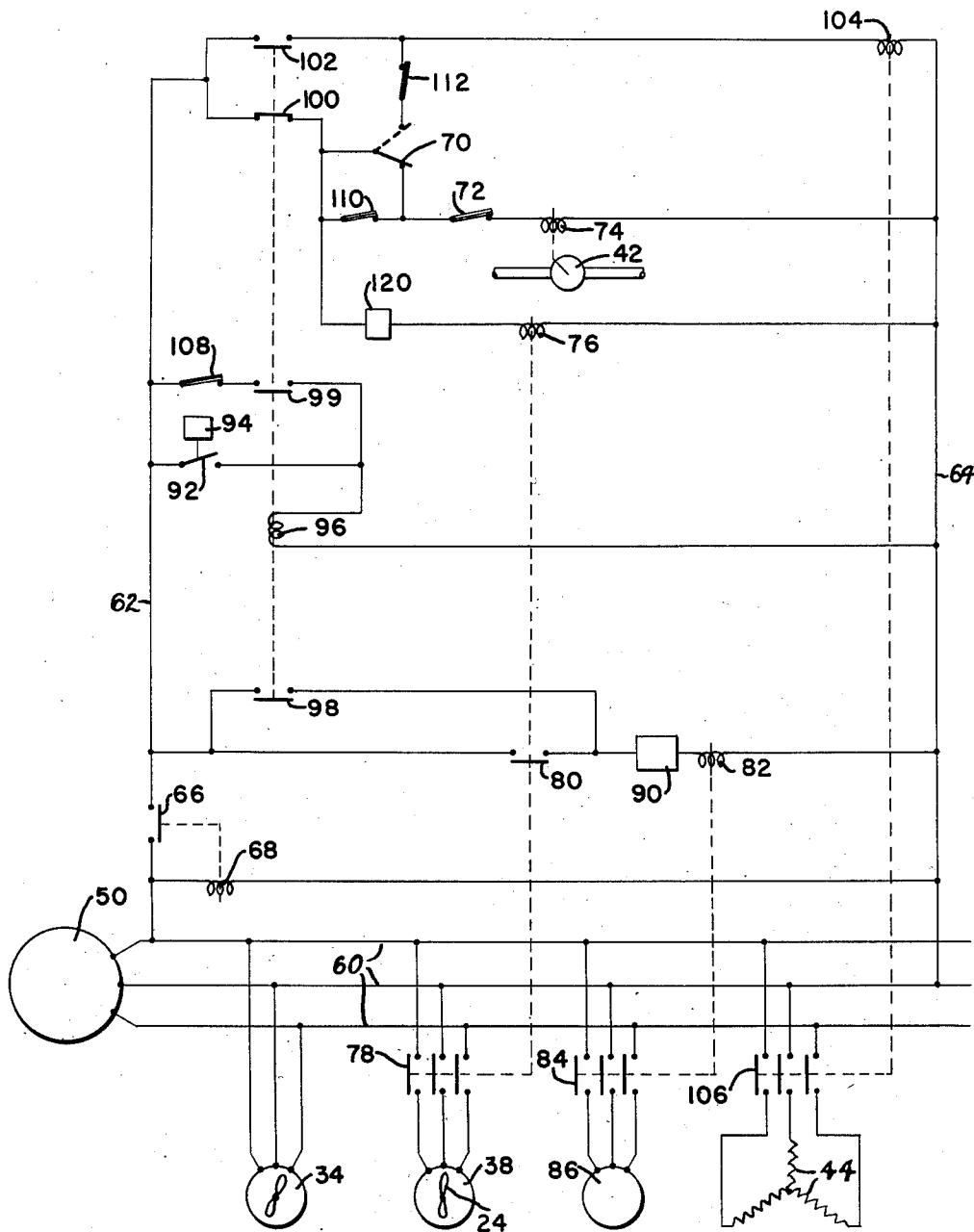


Fig. 3

INVENTOR.

David C. Breeding

BY *Willits, Hardman & Fisher*

ATTORNEYS

2,780,442

REFRIGERATING APPARATUS

David C. Breeding, Oakwood, Ohio, assignor to General Motors Corporation, Dayton, Ohio, a corporation of Delaware

Application June 24, 1952, Serial No. 295,185

9 Claims. (Cl. 257—3)

This invention relates to refrigerating apparatus and more particularly to apparatus of the type used for refrigerating railway cars and the like.

It is an object of this invention to provide a simplified control which may be set to maintain below freezing temperatures when transporting frozen foods and set to maintain above freezing temperatures when transporting fresh fruits, vegetables and the like.

Another object of this invention is to provide an improved control system whereby the evaporator is automatically defrosted from time to time. More particularly it is an object of this invention to provide a defrost control system which responds to a predetermined accumulation of ice on the surfaces of the evaporators.

Still another object of this invention is to provide a control which promptly terminates the defrost portion of the cycle just as soon as the evaporator is fully defrosted.

It is recognized that a large number of arrangements have been proposed from time to time for automatically controlling the defrosting of evaporators in refrigerated cars and the like. One of the most common of such systems employs a timing device for periodically initiating the operation of the defrost equipment at regular intervals irrespective of the amount of frost which may have accumulated on the evaporator, but such systems are impractical in that the rate of frost formation varies materially with different types of loads and different climatic conditions and consequently if the control is set to defrost frequently enough for the worst frosting conditions it will defrost much too frequently under more favorable conditions. Furthermore the length of time required for defrosting would likewise vary with the amount of frost on the evaporator and consequently the defrosting cycle would be objectionable and unnecessarily long in some circumstances. It is an object of this invention to provide a simple defrost control which overcomes these objections.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Figure 1 is a vertical sectional view, largely diagrammatic, showing the system applied to a railway car;

Figure 2 is a vertical sectional view, largely diagrammatic, taken substantially at right angles to the view in Figure 1 and showing the arrangement of the parts within the machinery compartment of the car; and

Figure 3 is a schematic wiring diagram showing the various electrical controls.

For purposes of illustrating the invention the system has been shown installed in a refrigerated railway car whereas certain aspects of the invention are equally applicable to other types of installations.

Referring now to the drawings, reference numeral 10 designates a conventional refrigerated railway car having an insulated food storage compartment 12 and a ma-

chinery compartment 14. The refrigerating system comprises an evaporator 16, a condenser 18 and a compressor 20. The evaporator 16 is mounted in an enlarged part of a vertically disposed air duct 22 as best shown in Figure 1. A pair of blowers 24 serves to circulate the air to be refrigerated in thermal exchange relationship with the evaporator 16. The lower end of the vertical duct 22 communicates with a horizontally disposed air duct 26 which is preferably arranged beneath the floor 28 of the food storage compartment 12. The floor is provided with openings such as the opening 30 for admitting air from the compartment 12 into the duct 26. The pair of blowers 24 discharges the conditioned air into an air distributing duct 32.

The blowers 24 are adapted to be driven by means of a motor 38 which is arranged directly within the machinery compartment as shown in Figure 2 and drives the blowers 24 through the belt 40. By placing the blower motor 38 in the machinery compartment 14, it is obvious that any overheating of the motor 38 will not cause any smoke or obnoxious odors to enter the conditioned air stream or the food storage compartment 12. A condenser cooling fan 34 is arranged as shown in Figure 2 and serves to cause air to flow in through the air inlet 36 and over the condenser 18. The flow of condensed refrigerant to the evaporator 16 is controlled by means of a solenoid operated valve 42 in a manner to be explained more fully hereinafter.

Since the evaporator will have frost accumulated thereon, strip heaters 44 have been built into the evaporator for defrosting the same and for supplying heat to the air stream whenever heating is required. Upon closing the refrigerant valve 42 and energizing the strip heaters any accumulated frost on the evaporator will be caused to melt. The power for operating the strip heaters 44 and all other electrical equipment forming a part of the system is supplied by an alternator 50 which is adapted to be driven by a direct connected diesel engine 52.

Referring now to Figure 3 of the drawings wherein there is schematically shown the control circuit for the above described equipment, reference numeral 60 designates the main power lines leading from the alternator 50 and reference numerals 62 and 64 designate the branch lines which supply power to the various controls. In order to initiate operation of the refrigeration system it is first necessary to start the diesel engine so as to cause the alternator 50 to supply power to the main power line 60 and then the rest of the control is fully automatic.

The flow of current through the auxiliary lines 62 and 64 is controlled by a switch 66 which in turn is controlled by a solenoid 68 which is a voltage responsive coil connected across the lines 62 and 64. The solenoid 68 is designed so as not to close the switch 66 until the voltage output of the alternator 50 reaches a predetermined satisfactory value adequate for supplying the necessary power to the various power consuming units on the car. Upon closing of the switch 66 the various circuits are placed in operation.

The system shown herein is designed to selectively maintain either below freezing temperatures or above freezing temperatures depending upon the type of products being transported. A selector switch 70 is provided for selecting the temperature to be maintained and when in the solid line position, as shown in Figure 3, it sets up the circuits which will automatically maintain temperatures in the neighborhood of 0° or below. Assuming now that the temperature in the car is above 5° and that the selector switch is set as shown, the thermostatic switch 72 which is located so as to respond to car temperature will be closed whereby the solenoid coil 74 will be energized so as to hold the refrigerant valve 42 in the open position. The solenoid 76 also will be ener-

3

gized with the result that the evaporator fan motor control switch 78 will be closed so as to cause the evaporator blowers 24 to operate.

Energization of the solenoid 76 also causes closing of the compressor motor controlled switch 80 which is arranged in series with the solenoid 82. Energization of the solenoid 82 automatically closes the switch 84 which leads to the compressor motor 86. Under normal conditions the refrigerating system will continue to operate until the refrigeration demand has been satisfied at which time the thermostatic switch 72 will open. The switch 72 is preferably set to open the circuit at minus 1° F. and to close the circuit at plus 5° F. Upon opening the circuit to the solenoid 74 the refrigerant valve 42 moves to the closed position and cuts off the supply of liquid refrigerant to the evaporator. The compressor, however, will continue to operate until the high-low pressure cut out 90 interrupts the circuit to the compressor controlled solenoid 82. This allows the refrigeration system to pump down before the compressor stops operating and thereby prevent excessive pressure to build up in the evaporator during defrosting.

In the event that an excessive amount of frost has accumulated on the fins of the evaporator so as to restrict the flow of air through the evaporator, the switch 92 will be closed by means of an air pressure differential responsive device 94 which responds to a predetermined difference in air pressure on opposing sides of the evaporator. Pressure differential responsive devices of this type are well known to those skilled in the art and for that reason the construction and arrangement of the same has not been described in detail. (See Goddard Patent 2,476,184 for a more complete description of a pressure differential responsive device which could be used.) When the flow of air through the coil becomes restricted because of the accumulation of frost on the evaporator, the switch 92 is closed by the device 94 and the control of the defrost operation is then shifted to the thermostat 108 which is located directly on the evaporator 16.

Closing of the switch 92 energizes the solenoid 96 which operates switches 98, 99, 100 and 102. It will be noted that the switch 98 is arranged in parallel with the switch 80 so as to permit operation of the compressor for pumping down the system during the defrost operation even though the solenoid 76 is de-energized. The switch 99 serves to maintain the solenoid 96 energized even after the pressure differential switch 92 opens. Opening of the switch 100 de-energizes the solenoids 74 and 76 so as to close the refrigerant valve 42 and stop the evaporator fan. Closing of the switch 102 causes energization of the solenoid 104 which operates the heater control switch 106 so as to close the circuit to the strip heaters 44. The heaters 44 will be energized only until the thermostatically operated switch 108, located directly on the evaporator, opens in response to the evaporator reaching a temperature of somewhere between 65° and 75°. When the temperature of the evaporator reaches this value it is obvious that all of the ice will have been melted off from the evaporator whereby the refrigeration system should start up again.

Again referring to Figure 3 of the drawings, it will be observed that opening of the switch 108 will also cause de-energization of the solenoid 96 since the pressure operated switch 92 will also be in the open position. The circuits are then re-established for normal operation of the refrigerating apparatus in a manner to maintain the temperatures between minus 1° and plus 5° F.

Since there are times when refrigerated cars of this type will be used for transporting fruit, vegetables, and other perishables which must be maintained at temperatures above freezing, the system has been designed so as to make it possible to maintain the temperatures within the refrigerated space between 32° and 34° F. In order to cause the system to maintain this higher range of

4

temperatures, the selector 70 must be moved from its full line position to its dotted line position. When the selector 70 is thus moved into the dotted line position, the operation of the refrigerating system will be placed under control of the thermostat 110 which is designed to close at 36° and above and to open at 33° and lower.

It is to be understood that the various temperature values given throughout this application have been given for purposes of illustration and that the system may be set to operate at other temperatures than those mentioned.

When frozen foods are being transported in the refrigerated car there is no particular need for ever supplying heat to the refrigerated space even though the car may be operated in cold regions where both the outdoor and the indoor temperatures may drop below 0°. However when fresh fruits and vegetables or other perishables which cannot be frozen are being transported in the car it sometimes becomes necessary to apply heat rather than refrigerating the car and for that reason the heater control solenoid 104 is placed under control of the thermostatically operated switch 112 which is designed to turn on the heat at car temperatures below 32° F. and to turn off the heat at car temperatures above 35° F.

In the event of an excessive accumulation of ice on the evaporator the pressure differential switch 92 will be closed so as to close the circuit to the defrost control solenoid 96 whereby the heaters will be turned on irrespective of the temperatures surrounding the thermostatically operated switch 112. The defrost cycle will operate the same as described hereinabove and will be terminated when all of the frost has been melted from the evaporator.

A blower motor overload protector 120 has been shown in series with the solenoid 76 so as to open the circuit to the solenoid in the event of a blower motor overload.

In order to simplify this disclosure, the various fuses and other safety devices which are conventionally used have been omitted whereas it is to be understood that such protective devices would be provided as usual. The thermostats 72, 110 and 112 have been shown as located in the space 12 whereas they could be located in the return air duct or any other place where they would measure temperatures within the conditioned space.

While the form of embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, as may come within the scope of the claims which follow.

What is claimed is as follows:

1. In a refrigerating system, an evaporator, a condenser, a compressor, refrigerant flow connections between said evaporator, condenser and compressor, a valve in said connections for controlling the flow of refrigerant to said evaporator, a heater arranged in thermal exchange with said evaporator for defrosting the same, means responsive to a predetermined accumulation of ice on said evaporator for closing said valve and for energizing said heater while said compressor is still operating, means responsive to a predetermined low pressure at the inlet of said compressor for thereafter stopping said compressor, and means responsive to a predetermined increase in the temperature of said evaporator for re-opening said valve and de-energizing said heater.

2. In a refrigerating system, an evaporator, a condenser, a compressor, refrigerant flow connections between said evaporator, condenser and compressor, blower means for circulating air in thermal exchange with said evaporator, a power supply, a valve in said connections for controlling the flow of refrigerant to said evaporator, a heater arranged in thermal exchange with said evaporator, control means responsive to a predetermined accumulation of ice on said evaporator for closing said valve and energizing said heater while said compressor is still operating, means responsive to a predetermined low pressure at the inlet of said compressor for thereafter stop-

5

ping said compressor, means responsive to a predetermined increase in the temperature of said evaporator for re-opening said valve, and means for selectively connecting either said valve or said heater in circuit with said power supply.

3. In a refrigerating system, an evaporator, a condenser, a compressor, refrigerant flow connections between said evaporator, condenser and compressor, blower means for circulating air in thermal exchange with said evaporator, a power supply, a valve in said connections for controlling the flow of refrigerant to said evaporator, a heater arranged in thermal exchange with said evaporator, control means responsive to a predetermined accumulation of ice on said evaporator for closing said valve and energizing said heater while said compressor is still operating, means responsive to a predetermined low pressure at the inlet of said compressor for thereafter stopping said compressor, means responsive to a predetermined increase in the temperature of said evaporator for re-opening said valve, and means for selectively connecting either said valve or said heater in circuit with said power supply, said control means including means for stopping said blower during defrosting.

4. In a refrigerating system, an evaporator, a condenser, a compressor, refrigerant flow connections between said evaporator, condenser and compressor, a power supply, a valve in said refrigerant flow connections for controlling the flow of refrigerant to said evaporator, means responsive to a predetermined accumulation of ice on said evaporator for closing said valve while said compressor is still operating, means responsive to a predetermined low pressure in the inlet of said compressor for thereafter stopping said compressor, and means responsive to a predetermined increase in the temperature of said evaporator for re-opening said valve, a heater arranged in thermal exchange with said evaporator, and control means for selectively connecting either said valve or said heater in circuit with said power supply, said control means comprising a first thermostatically operated switch in circuit with said heater, and a second thermostatically operated switch in circuit with said valve.

5. In a refrigerating system, an evaporator, a condenser, a compressor, refrigerant flow connections between said evaporator, condenser and compressor, a power supply, a valve in said refrigerant flow connections for controlling the flow of refrigerant to said evaporator, means responsive to a predetermined accumulation of ice on said evaporator for closing said valve while said compressor is still operating, means responsive to a predetermined low pressure in the inlet of said compressor for thereafter stopping said compressor, and means responsive to a predetermined increase in the temperature of said evaporator for re-opening said valve, a heater arranged in thermal exchange with said evaporator and control means for selectively connecting either said valve or said heater in circuit with said power supply, said control means comprising a first thermostatically operated switch in circuit with said heater, and a second thermostatically operated switch in circuit with said valve, and means responsive to the voltage of said power supply for controlling the energization of said control means.

6. A refrigerating system comprising an evaporator, a condenser, a compressor, refrigerant flow connections between said evaporator, condenser and compressor, blower means for circulating air in thermal exchange with said evaporator, a heater arranged in thermal exchange relationship with said evaporator for defrosting the same, control means responsive to a predetermined accumulation of ice on said evaporator for stopping the flow of refrigerant to said evaporator and for energizing said heater, means responsive to the temperature of said evaporator for deenergizing said heater, and means whereby the compressor serves to remove refrigerant from said evaporator after said control means has stopped the flow of refrigerant to said evaporator so as to prevent exces-

6

sive pressures in said evaporator during energization of said heaters.

7. In a refrigerating system for refrigerating the contents of a food storage compartment, said system comprising an evaporator, a condenser, a compressor, refrigerant flow connections between said evaporator, condenser and compressor, a valve in said connections at the inlet to said evaporator, blower means for circulating air in thermal exchange with said evaporator, means responsive to the air temperature in said compartment for closing said valve, a heater arranged in thermal exchange relationship with said evaporator for defrosting the same, control means responsive to a predetermined accumulation of ice on said evaporator for closing said valve and thereby stopping the flow of refrigerant to said evaporator and for energizing said heater while said compressor is still operating, means responsive to the temperature of said evaporator for de-energizing said heater, said control means including a pressure differential switch responsive to a predetermined drop in air pressure through said evaporator, and means responsive to a predetermined low pressure in said evaporator for stopping said compressor.

8. In a refrigerating system for refrigerating the contents of a storage compartment, said system comprising an evaporator, a condenser, a compressor, refrigerant flow connections between said evaporator, condenser and compressor, blower means for circulating air in thermal exchange with said evaporator, a heater arranged in thermal exchange relationship with said evaporator for defrosting the same, control means responsive to a predetermined accumulation of ice on said evaporator for stopping the flow of refrigerant to said evaporator and for energizing said heater while said compressor is still operating, means responsive to the temperature of said evaporator for de-energizing said heater, said control means including means for stopping said blower means during defrosting, and means responsive to a predetermined decrease in the temperature of the air in said compartment for energizing said heater for heating air for said compartment.

9. In a refrigerating system for refrigerating the contents of a storage space, said system comprising an evaporator, a condenser, a compressor, refrigerant flow connections between said evaporator, condenser and compressor, blower means for circulating air in thermal exchange with said evaporator, a heater arranged in thermal exchange relationship with said evaporator for defrosting the same, control means responsive to a predetermined accumulation of ice on said evaporator for stopping the flow of refrigerant to said evaporator and for energizing said heater while said compressor is still operating, means responsive to the temperature of said evaporator for de-energizing said heater, selector means for selecting the temperature to be maintained in said space, and means responsive to the temperature in said space for controlling said heater in one position of said selector means so as to provide for operation of said heater whenever the temperature in said space decreases beyond a predetermined value.

References Cited in the file of this patent

UNITED STATES PATENTS

65	1,984,054	Carraway	Dec. 11, 1934
	2,008,628	Ruff	July 16, 1935
	2,081,479	Fink	May 25, 1937
	2,104,383	Candor	Jan. 4, 1938
	2,143,687	Crago	Jan. 10, 1939
70	2,178,445	Warneke	Oct. 31, 1939
	2,181,053	Hamilton	Nov. 21, 1939
	2,244,892	Newton	June 10, 1941
	2,251,376	Ross	Aug. 5, 1941

(Other references on following page)

2,780,442

7

UNITED STATES PATENTS

2,303,857	Numero -----	Dec. 1, 1942
2,313,390	Newton -----	Mar. 9, 1943
2,323,511	Baker -----	July 6, 1943
2,341,781	Hornaday -----	Feb. 15, 1944
2,476,184	Goddard -----	July 12, 1949

5

2,523,957
2,524,568
2,534,272
2,541,904
2,580,627
2,624,180
2,694,553

8

Kleist -----	Sept. 26, 1950
Kritzer -----	Oct. 3, 1950
Kleist -----	Dec. 19, 1950
Alexander -----	Feb. 13, 1951
Watkins -----	Jan. 1, 1952
Grimshaw -----	Jan. 6, 1953
Hicke et al. -----	Nov. 16, 1954