

Nov. 15, 1955

L. J. MANN

2,723,533

REFRIGERATING APPARATUS

Filed July 11, 1952

5 Sheets-Sheet 1

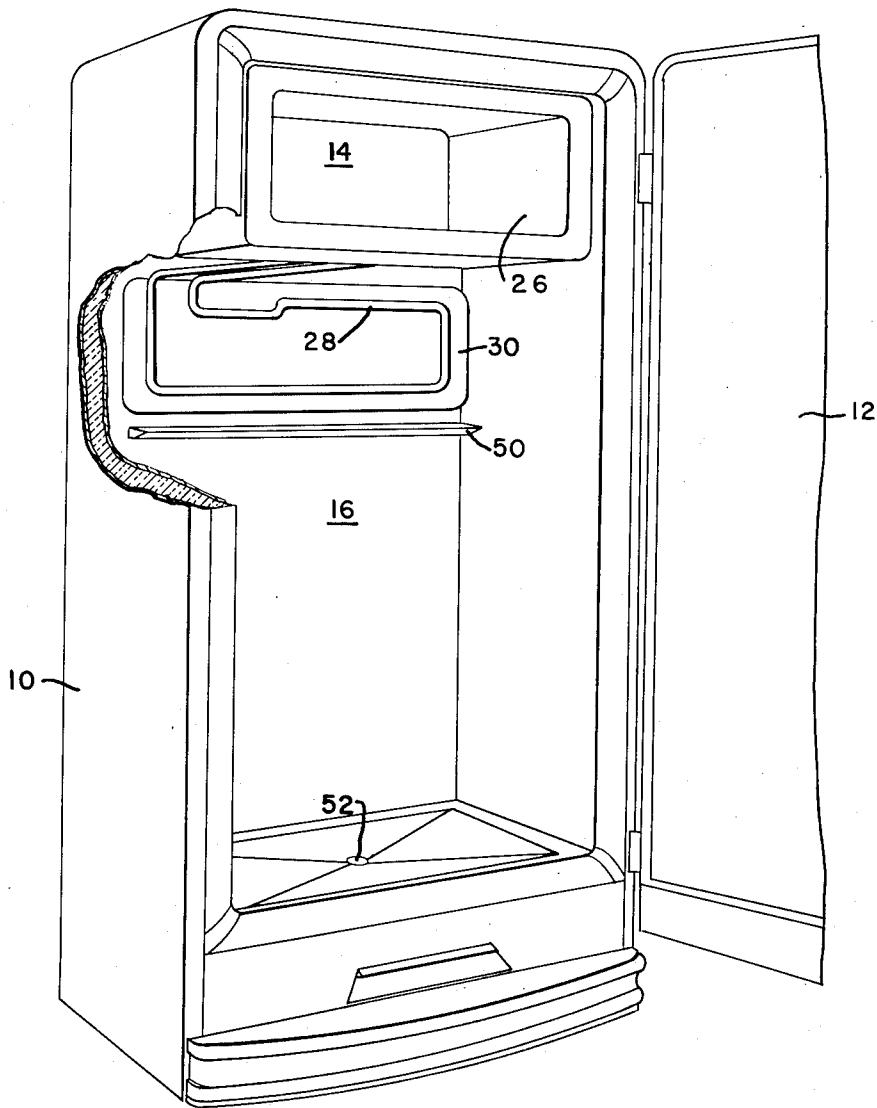


Fig. 1

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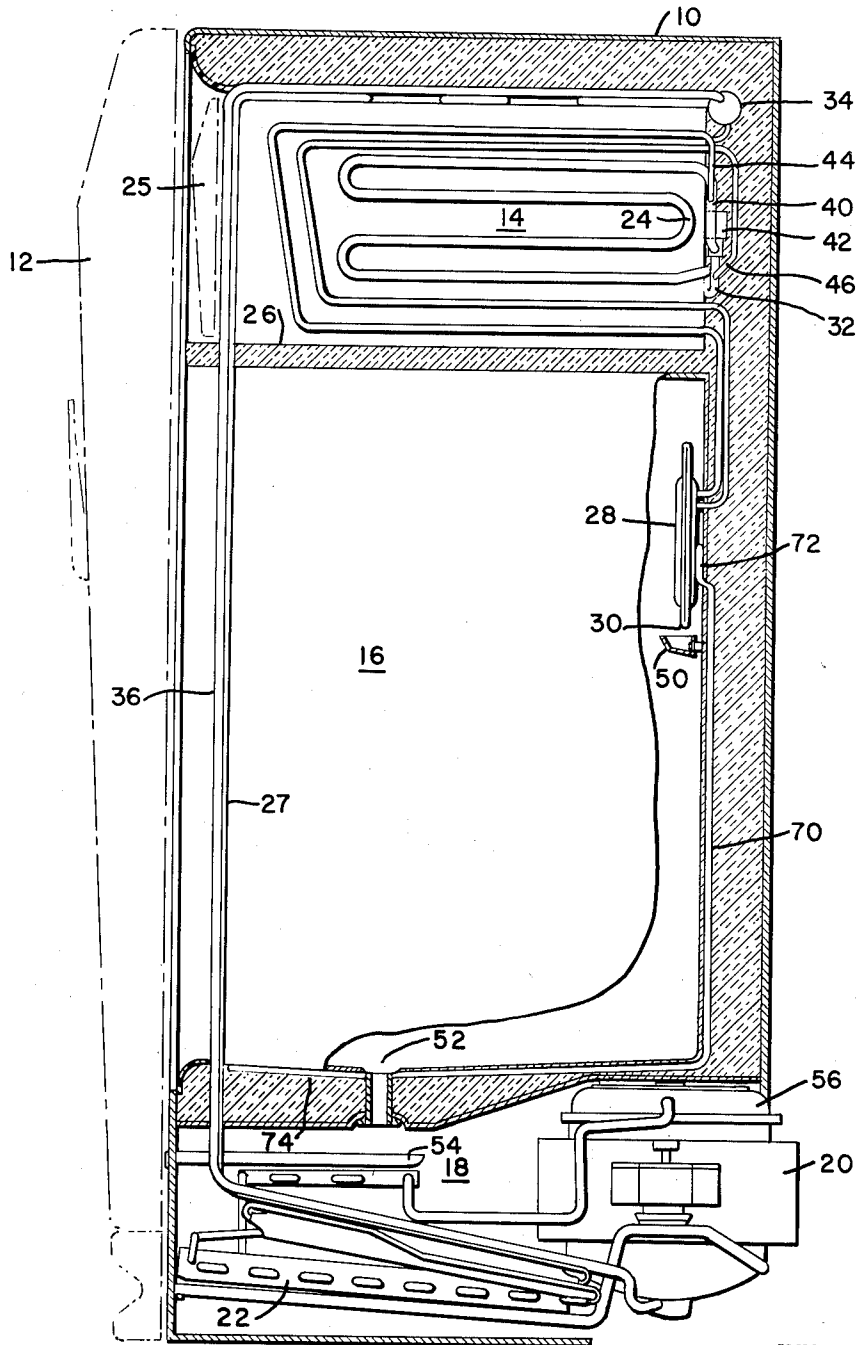
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5 Sheets-Sheet 2



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5 Sheets-Sheet 3

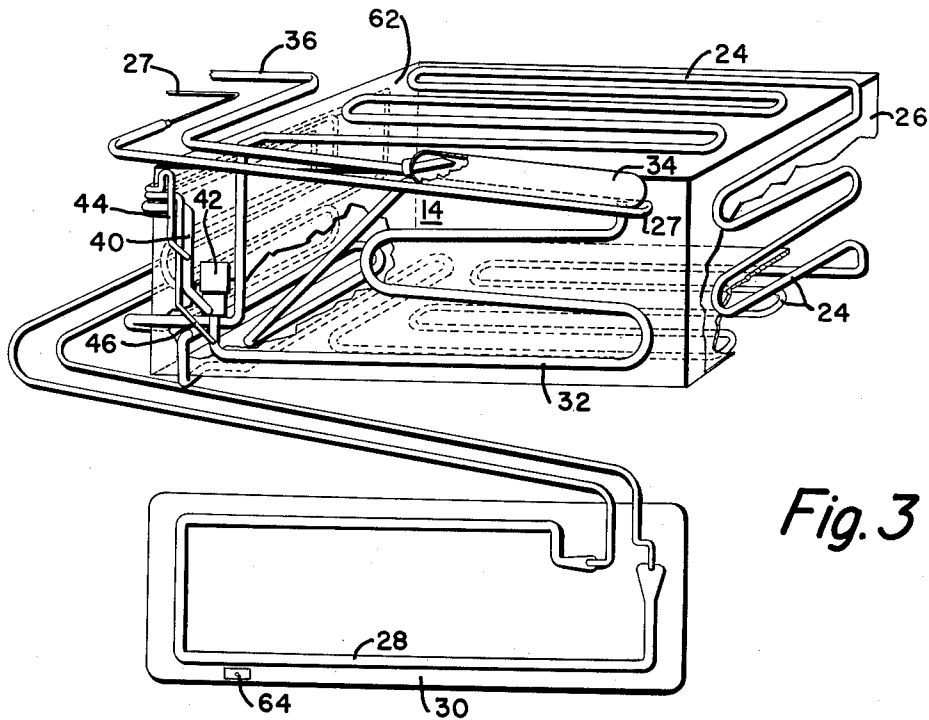


Fig. 3

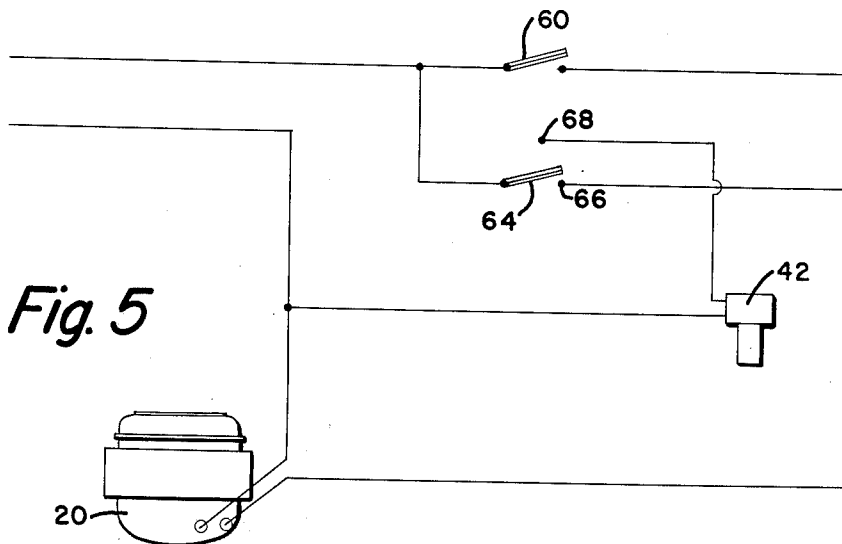


Fig. 5

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5 Sheets-Sheet 4

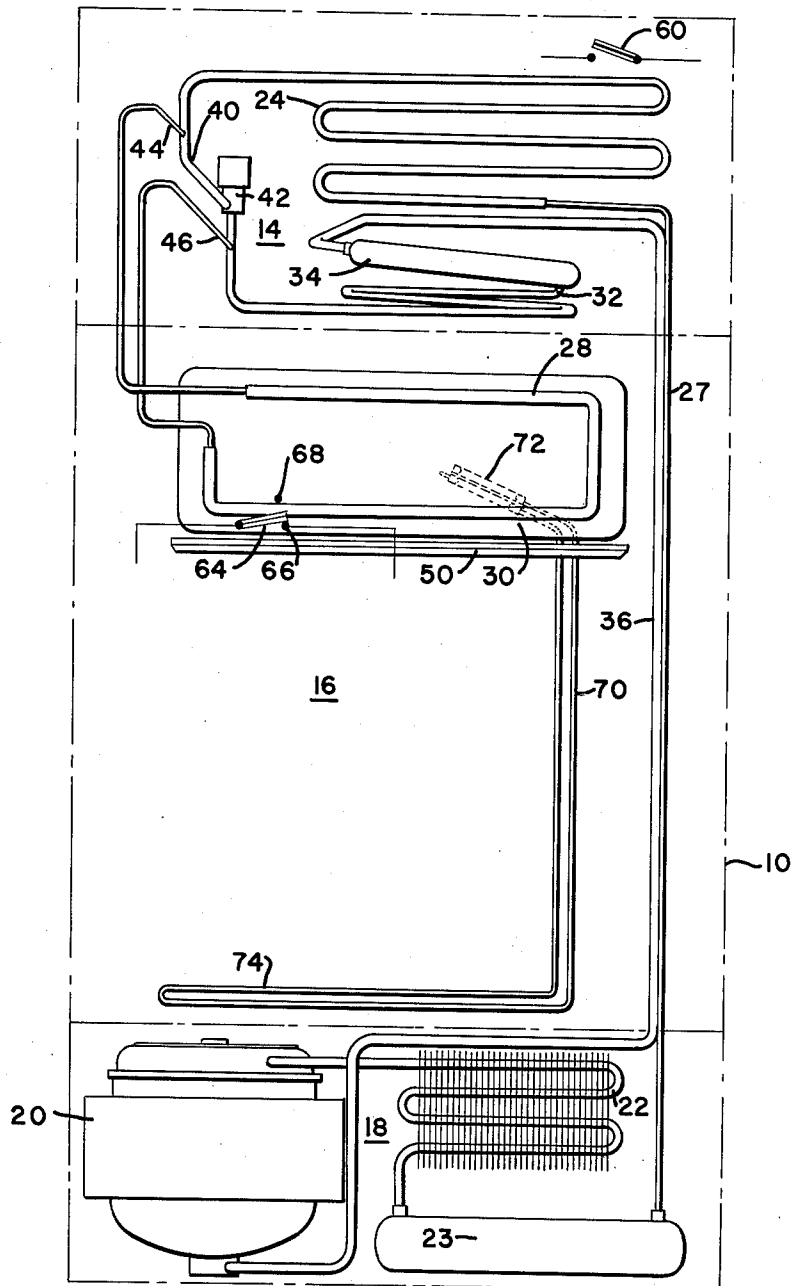


Fig. 4

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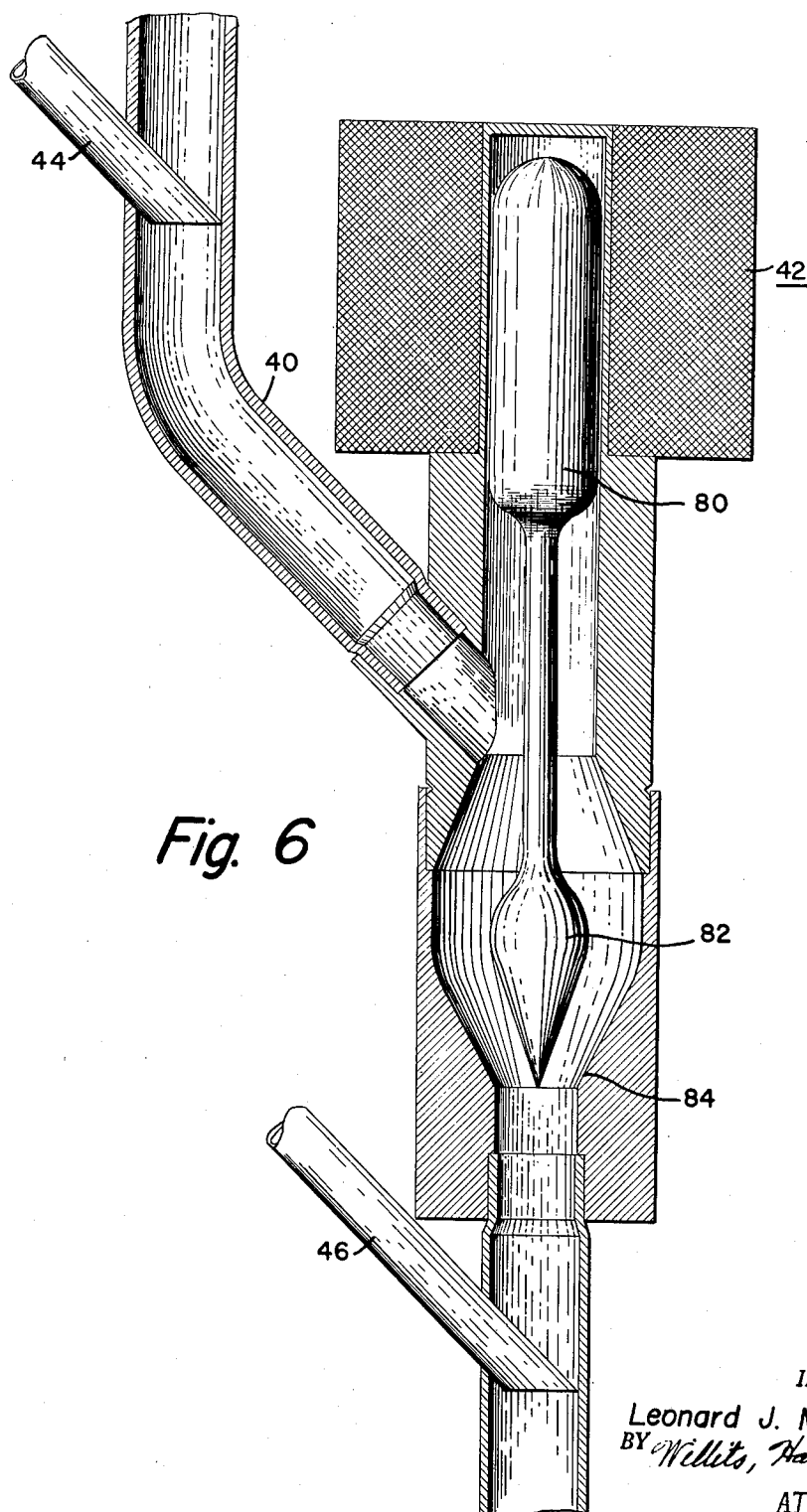
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5 Sheets-Sheet 5



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REFRIGERATING APPARATUS

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5 Claims. (Cl. 62-4)

This invention relates to refrigerating apparatus and more particularly to an improved refrigerator and frozen food storage unit in which the temperatures are closely controlled in each of the food storage compartments.

It is an object of this invention to provide inexpensive controls which are accurate and dependable.

Another object of this invention is to provide an improved refrigerator having one compartment which is at all times maintained at a temperature considerably below the freezing point of water and another compartment which is maintained at a temperature slightly above the freezing point by means of a cooling unit which allows the atmosphere in the last named compartment to be moist.

Another object of this invention is to provide a refrigerator which will maintain the desired temperature and humidity conditions under wide variations of load in each of the compartments.

Still another object of this invention is to provide a refrigeration system for use in a multi-temperature refrigerator wherein a minimum of time is required for defrosting the one evaporator.

More particularly it is an object of this invention to provide a refrigerator in which all of the liquid refrigerant is quickly removed from the evaporator which requires defrosting at the beginning of its off cycle.

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 perspective view showing a refrigerator embodying the invention

Figure 2 is a vertical sectional view showing a refrigerator embodying the invention;

Figure 3 is a pictorial view showing the physical arrangement of the primary evaporator coil therein;

Figure 4 is a schematic view showing the refrigerant circuit;

Figure 5 is a schematic view showing the electrical controls; and

Figure 6 is a vertical sectional view somewhat diagrammatic showing the construction of the solenoid valve.

A large number of different arrangements have been proposed from time to time for refrigerating both the frozen food compartment and the higher temperature compartment but all of these prior arrangements have either been incapable of closely controlling the temperatures in the two compartments or have required the use of complicated and expensive controls which have rendered the cost prohibitive. It is not only necessary to regulate the temperatures in the two compartments but it is also necessary to provide a system in which it is possible to defrost the evaporator in the main food compartment at frequent intervals without causing any undue warm-up of the frozen food compartment. I have discovered that it is possible to provide a system wherein the temperatures can be closely controlled and wherein

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the one evaporator can be automatically defrosted during each off cycle thereof without causing undue fluctuations in the temperatures maintained within the respective compartments.

Referring now to the drawings wherein there is shown a preferred embodiment of the invention, reference numeral 10 generally designates a cabinet of a household refrigerator which is provided with an access door 12 in accordance with conventional practice. The interior of the cabinet is divided into a first storage compartment 14 which is designed to preserve frozen foods at temperatures considerably below freezing, a second compartment 16 which is designed to preserve unfrozen foods at temperatures several degrees above freezing, and a condensing compartment 18 wherein a conventional sealed motor-compressor unit 20, a condenser 22, and receiver 23 are mounted. An inner door 25 serves to normally close the opening into the frozen food compartment 14 when the door 12 is open so as to reduce the amount of moisture laden air which is allowed to enter the compartment 14.

Referring now to Figures 3 and 4 of the drawings wherein the refrigerant circuit has been schematically shown, reference numeral 24 designates the main primary evaporator section which serves to refrigerate the frozen food storage compartment 14. This evaporator section consists of a series of conduits which are arranged in thermal exchange with the outer surfaces of the frozen food compartment liner 26. Liquid refrigerant is supplied to the evaporator section 24, through a capillary tube type of restrictor 27. The amount of refrigerant supplied to the evaporator 24 is more than enough for the coil section 24, with the result that the overflow can be supplied to a second primary evaporator section 28 which is adapted to be located in the upper rear corner of the main food storage compartment 16. The evaporator section 28 is preferably in the form of a plate 30 having a single refrigerant passage provided therein adjacent the outer periphery of the plate as best shown in Figure 3.

The relative sizes of the evaporator sections and the food storage compartments is such that when the evaporator section 24 maintains freezing temperatures within the compartment 14, above freezing temperatures will be maintained in the compartment 16. Whenever more refrigerant is supplied to the evaporator sections 24 and 28 than can be evaporated therein, the excess refrigerant flows into a third evaporator section 32 which is arranged in thermal exchange relationship with the rear wall of the frozen food compartment liner 26. An accumulator 34 is provided at the outlet of the section 32 so as to accumulate any excess liquid refrigerant. The vaporized refrigerant is withdrawn from the accumulator 34 through the suction line 36 which leads to the compressor 20.

It is obvious from the above that there are in effect three primary evaporator sections which are normally connected in series refrigerant flow relationship when refrigerant is required in each of the compartments to be refrigerated. There will be times when the one compartment 14 will require refrigeration when further refrigeration in the compartment 16 would cause unwanted freezing. For this reason a by-pass 40 is provided around the one evaporator section 28 as shown and a solenoid operated valve 42 is located therein. When the valve 42 is in a closed position all of the refrigerant is required to flow through the evaporator sections 24, 28 and 32 in series. The valve is designed to have zero restriction when open whereby upon opening the valve all of the liquid refrigerant will by-pass the evaporator section 28. Furthermore the conduits 44 and 46 which connect the evaporator section 28 into the circuit are of smaller diameter than the by-pass 40 and are arranged to enter the

by-pass at an angle as shown so that the flow of refrigerant through the by-pass 40 serves to aspirate liquid refrigerant from the evaporator section 28 whenever the valve 42 is moved to the open position. This aspirator effect serves to reduce the pressure on the refrigerant in the section 28 and thereby causes violent boiling of any liquid refrigerant remaining in the evaporator section 28. This boiling effect serves to very rapidly cause evacuation of all of the refrigerant from the evaporator section 28.

The small diameter of the refrigerant passage in the plate 28 is such that the percolating action which takes place when suction is applied to both ends of the section 28 helps to push slugs of liquid refrigerant out of the evaporator section 28 with the result that the evaporator section 28 has no appreciable hold-over refrigeration capacity. Since this evaporator is located in a relatively large compartment in which the air temperature is several degrees above freezing and since the plate 30 is relatively small and light in weight it will warm up to a temperature above freezing very quickly in response to opening of the valve 42 so as to cause any frost which may be formed on the plate to melt.

The water resulting from the defrosting operation is collected in a trough 50 which is preferably attached to the rear wall of the food storage compartment 16. The trough 50 merely directs the water dripping from the plate 30 over against the rear wall of the cabinet so as to help maintain a moist atmosphere within the food storage compartment 16. The excess water will eventually reach the drain 52 which is provided in the bottom wall of a compressor compartment and which causes the water to drip into a pan 54 located directly above the condenser 22 so as to be heated by the condenser 22. In this manner the excess water is re-evaporated into the outside atmosphere and escapes through the opening 56 at the back of the compressor compartment 18.

Referring now to Figure 5 of the drawings wherein the controls have been diagrammatically shown, reference numeral 60 designates a thermostatically operated switch which is adapted to respond to the temperatures within the frozen food compartment 14. For purposes of simplification a bimetallic thermostat has been illustrated in Figure 5 whereas any form of temperature responsive element may be used. The temperature responsive element may be located directly in the frozen food compartment 14 or it may be attached to the outside wall of the liner 26 such as at the point designated by the reference numeral 62 in Figure 3 of the drawings. A second temperature responsive switch 64 is provided as shown for controlling the solenoid valve 42 and the motor-compressor unit 20. The temperature responsive element of the switch is preferably located on the plate 30 of the evaporator section 28 so as to respond to the temperature of the plate itself, rather than to the temperature of the air in the compartment 16. The air temperature is usually much higher than the temperature of the plate 30.

As best shown in Figure 5, the thermostat 64 is arranged to close a circuit to a contact 66 which serves to close a circuit to the compressor motor whenever the temperature of the plate 30 exceeds a predetermined value such as 36°. When the temperatures of plate 30 drop below a predetermined value such as minus 2° a circuit will be made to the contact 68 thereby energizing the solenoid valve 42. Energization of the valve 42 opens the by-pass 40 as explained hereinabove so as to promptly cause evacuation of the evaporator section 28. If the thermostat 64 moves away from the contact 66 at a time when the thermostatic switch 60 is open it is obvious that the compressor motor will be caused to be deenergized whereas if the switch 60 is closed, such as whenever the frozen food compartment evaporator calls for refrigerant, the motor-compressor unit will continue to operate so as to supply liquid refrigerant to the frozen

food compartment evaporator as long as any refrigeration is required.

Since there is no danger of damaging any frozen food by operating the evaporator sections 24 and 32 at lower than necessary temperatures, it is obvious that it is possible to insure safe temperatures in both of the food storage compartments at all times and at the same time it is impossible to cool the food storage compartment 16 to a dangerously low temperature as the thermostat 64 will stop the supply of refrigerant to the evaporator section 28 whenever the temperature of the plate 30 becomes too low.

For purposes of illustrating the invention I have shown a unit in which a secondary system 70 has been provided for refrigerating the bottom wall of the food storage compartment 16. This secondary system includes a secondary condenser portion 72 which is secured to the rear face of the plate evaporator 30 and a secondary evaporator 74 which is arranged in thermal exchange with the bottom wall of the food storage compartment as best shown in Figure 2. By providing a secondary system as shown, it is obvious that any heat which may tend to leak into the food storage compartment 16 from the machinery compartment 18 will be intercepted before entering the compartment 16 and will be transferred directly to the plate evaporator 30. This not only helps to better preserve the food stored in the compartment 16, but it also serves the helpful purpose of applying a certain amount of heat directly to the plate evaporator 30 so as to facilitate defrosting during the off cycle. When liquid refrigerant is supplied to the evaporator section 28 in the plate 30 this secondary condenser heat will be directly absorbed but when the supply of refrigerant to the plate evaporator 30 is cut off, this heat will hasten the defrosting of the plate before the main contents of the compartment 16 have a chance to warm up.

By virtue of the above described system it is obvious that the time required for defrosting the plate 30 has been materially reduced and that it is possible to starve the plate evaporator 30 when supplying refrigerant to the evaporator sections 24 and 32.

As best shown in Figure 6 of the drawing, the solenoid operated valve 42 is especially designed to provide no appreciable restriction to the flow of refrigerant when the valve is in the open position. When no current flows to the solenoid valve 42, the armature 80 and the associated valve element 82 carried thereby drop down until the element 82 contacts the valve seat 84 and closes off the flow of refrigerant through the valve. All refrigerant flowing through the evaporator 24 is then required to flow through the passage 28 in the plate type evaporator 30.

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. A household refrigerator including a cabinet having separated food compartments a first of which is for storing foods in a frozen state and a second of which is for storing foods in an unfrozen state, refrigerating means for cooling said compartments, said refrigerating means comprising a first evaporator section arranged in thermal exchange relationship with walls of said first compartment, a second evaporator section arranged in thermal exchange relationship with the air of said second compartment, and a third evaporator section arranged in thermal exchange relationship with one wall of said first compartment, refrigerant liquefying means, refrigerant flow connections for supplying liquid refrigerant from said refrigerant liquefying means to said evaporator sections in unrestricted series flow relationship, and means for by-passing said second evaporator section.

2. A household refrigerator including a cabinet having separated food compartments a first of which is for stor-

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ing foods in a frozen state and a second of which is for storing foods in an unfrozen state, refrigerating means for cooling said compartments, said refrigerating means comprising a first evaporator section arranged in thermal exchange relationship with walls of said first compartment, a second evaporator section arranged in thermal exchange relationship with the air of said second compartment, and a third evaporator section arranged in thermal exchange relationship with one wall of said first compartment, refrigerant liquefying means, refrigerant flow connections for supplying liquid refrigerant from said refrigerant liquefying means to said evaporator sections in unrestricted series flow relationship, means for by-passing said second evaporator section and means responsive to refrigeration requirements in either of said compartments for controlling the operation of said refrigerant liquefying means.

3. A household refrigerator including a cabinet having a plurality of food compartments a first of which is for storing foods in a frozen state and a second of which is for storing foods in an unfrozen state, refrigerating means for cooling said compartments, said refrigerating means comprising a first evaporator section arranged in thermal exchange relationship with walls of said first compartment, a second evaporator section arranged in thermal exchange relationship with the air of said second compartment, and a third evaporator section arranged in thermal exchange relationship with one wall of said first compartment, refrigerant liquefying means, refrigerant flow connections for supplying liquid refrigerant from said refrigerant liquefying means to said evaporator sections in series flow relationship, means for by-passing said second evaporator section, and means for starting and stopping said refrigerant liquefying means including means responsive to refrigeration requirements in said first named food storage compartment.

4. A household refrigerator including a cabinet having food compartments a first of which is for storing foods in a frozen state and a second of which is for storing foods in an unfrozen state, refrigerating means for cooling said compartments, said refrigerating means comprising a first evaporator section arranged in thermal exchange relationship with the walls of said first compartment, a second evaporator section arranged in thermal exchange rela-

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tionship with the air of said second compartment, and a third evaporator section arranged in thermal exchange relationship with one wall of said first compartment, refrigerant liquefying means, refrigerant flow connections for supplying liquid refrigerant from said refrigerant liquefying means to said evaporator sections in series flow relationship, means for by-passing said second evaporator section, and means for initiating operation of said refrigerant liquefying means in response to a demand for refrigeration in either one of said compartments.

5. A household refrigerator including a cabinet having food compartments a first of which is for storing foods in a frozen state and a second of which is for storing foods in an unfrozen state, refrigerating means for cooling said compartments, said refrigerating means comprising a first evaporator section arranged in thermal exchange relationship with the walls of said first compartment, a second evaporator section arranged in thermal exchange relationship with the air of said second compartment, and a third evaporator section arranged in thermal exchange relationship with one wall of said first compartment, refrigerant liquefying means, refrigerant flow connections for supplying liquid refrigerant from said refrigerant liquefying means to said evaporator sections in series flow relationship, means for by-passing said second evaporator, means for initiating operation of said refrigerant liquefying means in response to a demand for refrigeration in either one of said compartments, and means for removing liquid refrigerant from said second named evaporator in response to a predetermined decrease in refrigeration requirements in said second compartment.

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