Nov. 29, 1966 J. J. O'CONNELL ETAL 3,287,933

REFRIGERATING APPARATUS

Original Filed Feb. 10, 1964 4 Sheets-Sheet 1

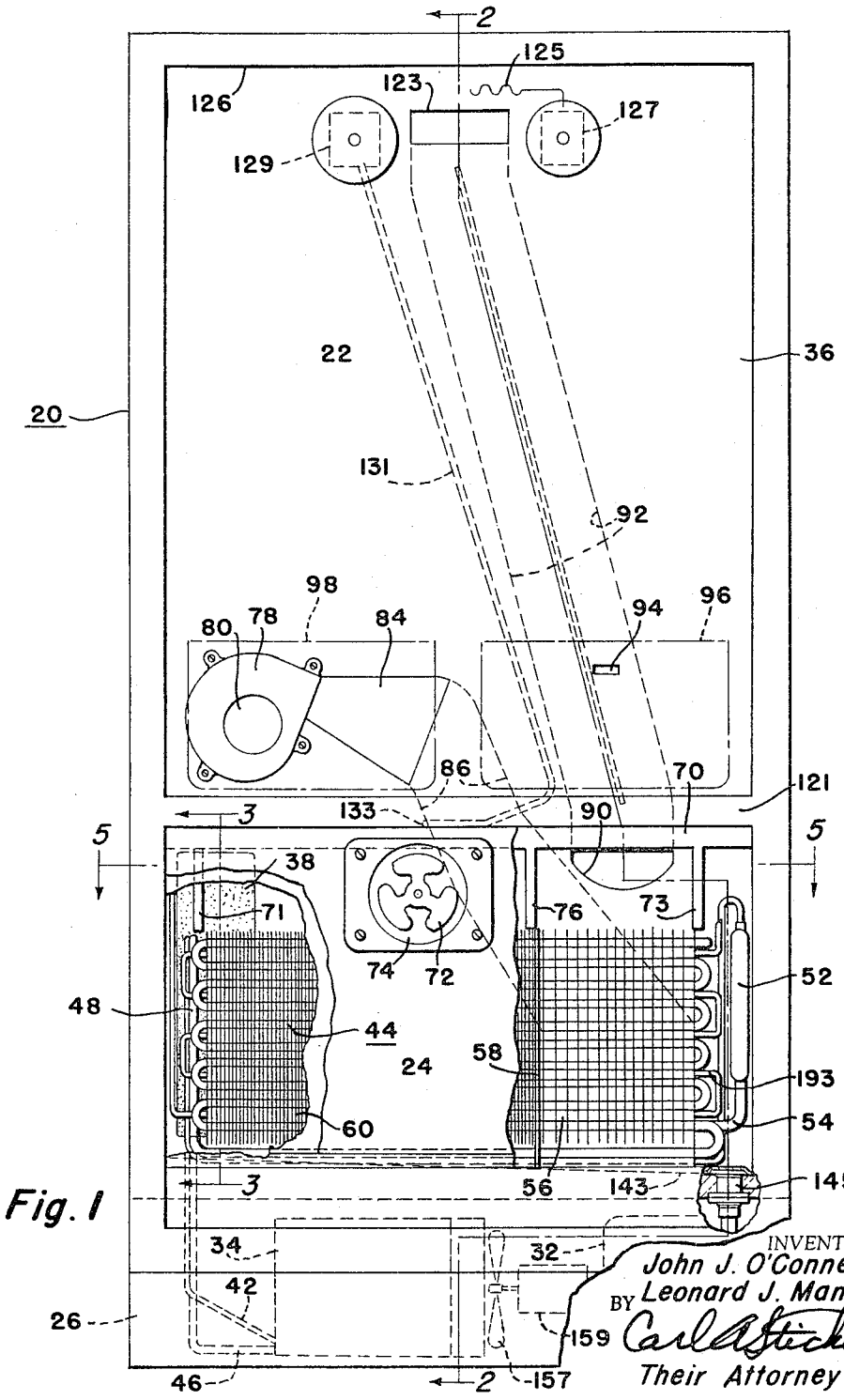


Fig. 1

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REFRIGERATING APPARATUS

Original Filed Feb. 10, 1964 4 Sheets-Sheet 2

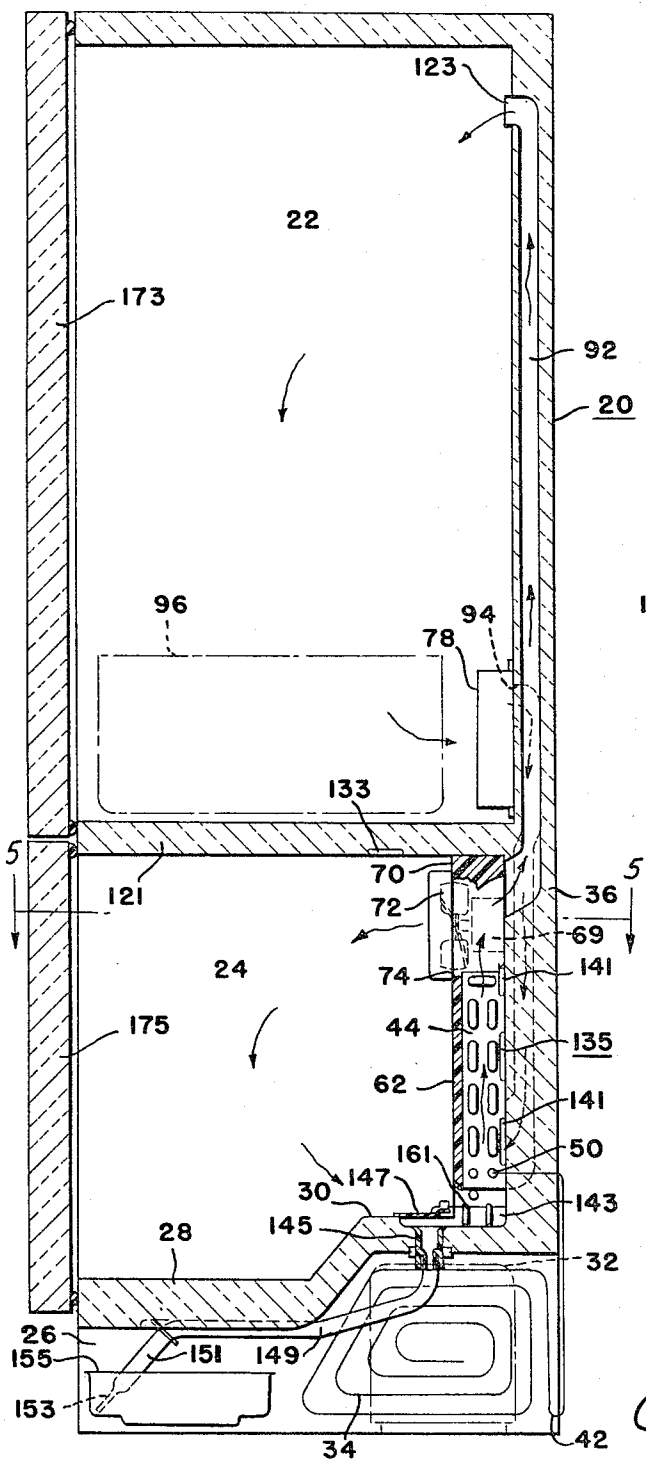


Fig. 2

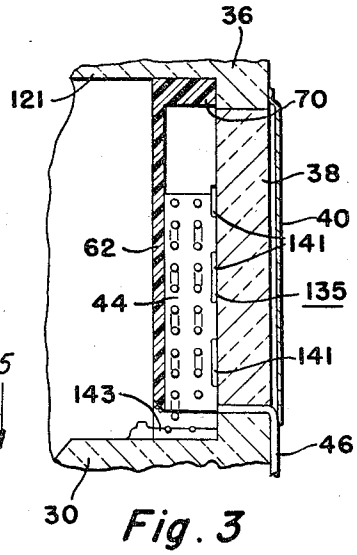


Fig. 3

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REFRIGERATING APPARATUS

Original Filed Feb. 10, 1964 4 Sheets-Sheet 3

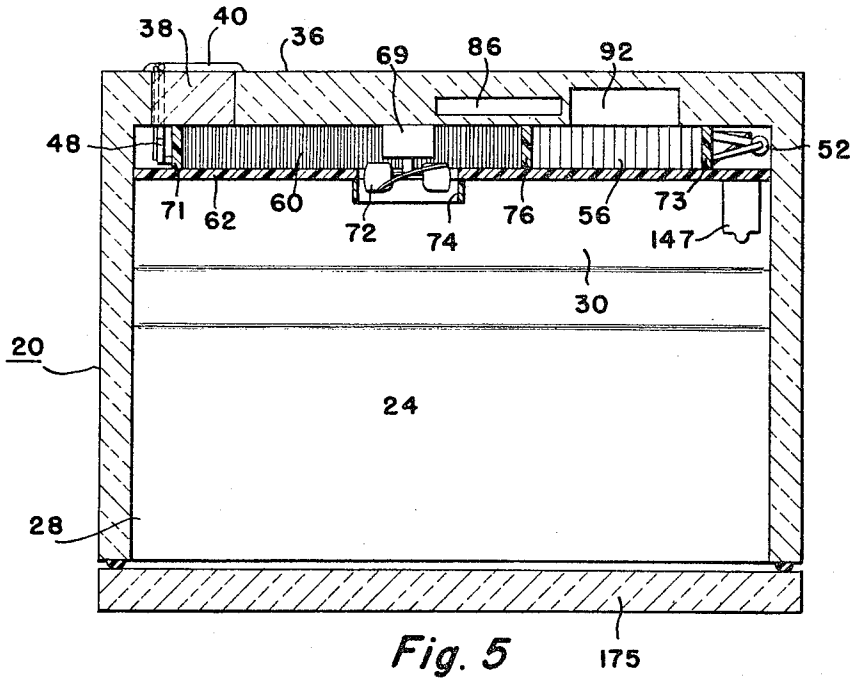


Fig. 5

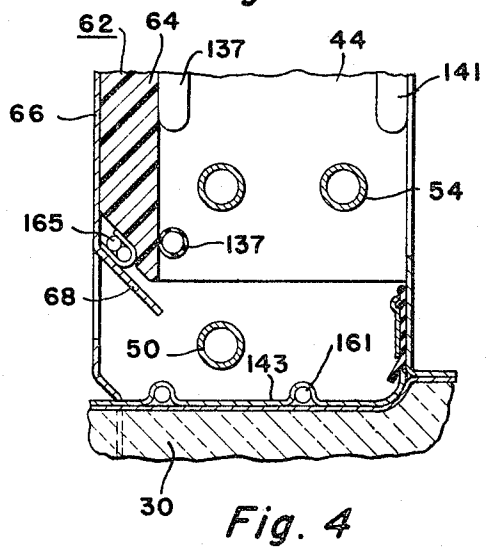


Fig. 4

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REFRIGERATING APPARATUS

Original Filed Feb. 10, 1964 4 Sheets-Sheet 4

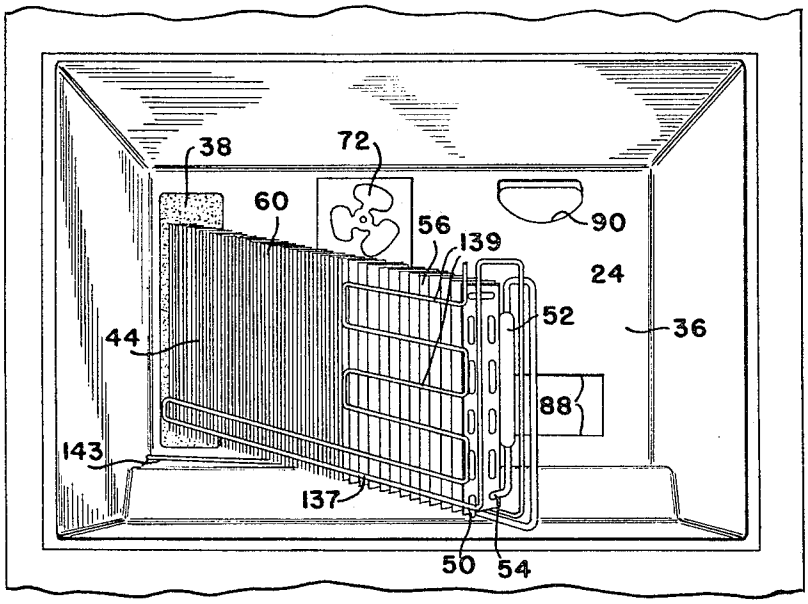


Fig. 6

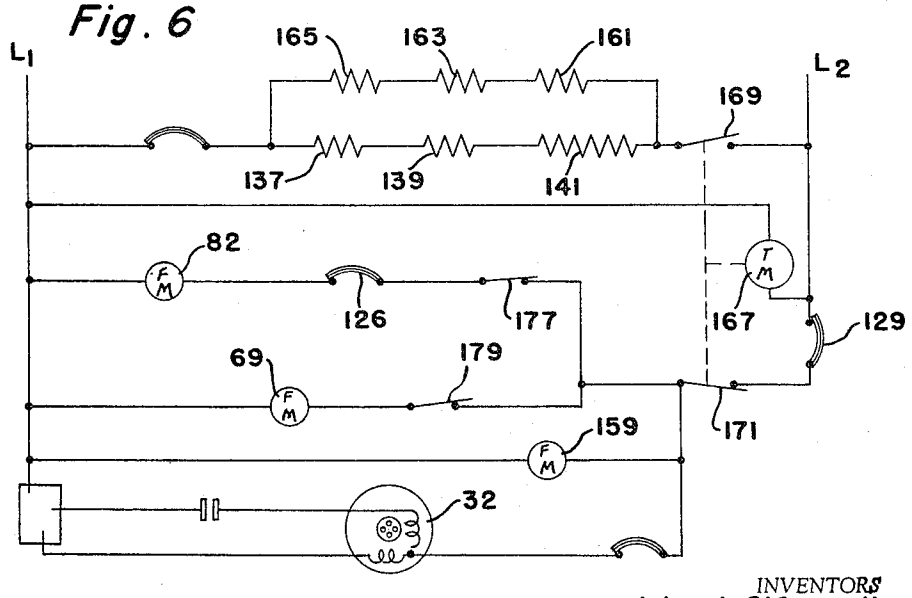


Fig. 7

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United States Patent Office 3,287,933 Patented Nov. 29, 1966

3,287,933

REFRIGERATING APPARATUS

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Original application Feb. 10, 1964, Ser. No. 343,736, now Patent No. 3,252,292 dated May 24, 1966. Divided and this application Sept. 13, 1965, Ser. No. 486,647

6 Claims. (Cl. 62—441)

This application is a division of our copending application Serial No. 343,736, filed February 10, 1964 now Patent No. 3,252,292.

This invention pertains to refrigerating apparatus and more particularly to a refrigerator having below and above freezing compartments separately cooled by separate air circuits cooled by a single evaporator.

The growing popularity of frost free refrigerator compartments makes it desirable to market a greater variety of sizes of refrigerators having this and other desirable features. It is therefore an object of this invention to provide a large capacity, compact, economical, low cost refrigerator which is inexpensive to manufacture and maintain, having the desired below and above freezing temperatures in separate compartments which will not accumulate frost in any of the storage compartments.

It is another object of this invention to provide a compact, removable refrigerating system and a convenient inexpensive arrangement including a removable wall section of minimum size for readily installing and removing such a system in a foam insulated refrigerator cabinet.

It is another object of this invention to provide an improved compact, efficient air circulating system for a two-compartment refrigerator cabinet.

It is another object of this invention to provide a simple single compact evaporator in a two-compartment refrigerator which minimizes the obstruction to air flow due to frost accumulation on the evaporator surfaces.

It is another object of this invention to provide a well arrangement in a foam insulated refrigerator cabinet by which the thermosensitive element of the control system may be readily inserted and located in the desired place and readily removed whenever desired.

It is another object of this invention to provide an improved arrangement for defrosting an evaporator and environmental parts subject to frosting.

These and other objects are attained in the form shown in the drawings in which the lower below freezing compartment is provided with a raised rear portion over the compressor and condenser above which there is mounted a single vertically finned evaporator having widely spaced fins at one end and closely spaced fins for the remainder thereof. An insulated vertical partition wall separates the evaporator from the below freezing compartment immediately in front of it. The below freezing compartment is cooled by air which is drawn under the bottom of the partition wall and upwardly through the closely finned portion of the evaporator and discharged back into the compartment by a propeller type fan located in an aperture in the partition wall. The rear insulated wall of the below freezing compartment is provided with an opening normally closed by a narrow removable section which is slightly higher than the height of the evaporator and slightly wider than the thickness thereof. The compressor and condenser mounted beneath the raised portion are connected by supply and return conduits which extend through the opening in the rear wall and connect to the opposite end of the evaporator through two looped portions located at the opposite ends of the evaporator. This arrangement provides sufficient flexibility in the connections that the evaporator can be readily inserted through this opening and mounted at the back of the below freezing compartment. It may likewise be readily removed along with the removal of the compressor, and the condenser for examination and repair in the event of any failure.

A duct extends diagonally upwardly from the zone immediately above the widely spaced fin portion and has a first discharge outlet behind the meat-keeping container in the lower right side, and a second discharge outlet in the top central portion of the above freezing compartment. On the lower left side of the above freezing compartment is a centrifugal fan which discharges through an expanding duct diagonally downward to a discharge outlet located behind the lower portion of the widely spaced finned evaporator portion. A switch mounted in the top portion of the above freezing compartment has a thermosensitive element extending downwardly through a well or tube in the foam insulation extending to the top of the below freezing compartment so as to make the switch responsive to the temperature of the air at the top of the below freezing compartment. The centrifugal fan located in the lower left part of the above freezing compartment is cycled in response to the temperature of the adjustable thermostatic switch mounted in the top portion of the above freezing compartment, and having a thermosensitive element located above the second discharge outlet so as to be responsive to the temperature of the above freezing compartment. A timer periodically defrosts both sections of the evaporator through a serpentine electric heater lodged in the fins of the evaporator having a proportionately greater portion in heat transfer relation with the widely spaced fin portion of the evaporator which accumulates the most frost. The drain surfaces as well as the partition wall are provided with heaters energized coincidentally with the energization of the defrost heater for melting any frost or ice accumulating on the drain surfaces or the partition wall. The drain is provided with a removable cover for easy cleaning and is provided with a simple removable trap in the machinery compartment.

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 embodiment of the present invention is clearly shown.

In the drawings:

FIGURE 1 is a front view, with the doors removed, of a 2-compartment household refrigerator embodying one form of my invention;

FIGURE 2 is an irregular vertical section taken substantially along the lines 2—2 of FIGURE 1;

FIGURE 3 is a fragmentary sectional view taken substantially along the lines 3—3 of FIGURE 1;

FIGURE 4 is an enlarged sectional view corresponding to the bottom of FIGURE 3 showing the heaters for the drain surface and the partition wall;

FIGURE 5 is a sectional view taken along the lines 5—5 of FIGURES 1 and 2;

FIGURE 6 is a front view of the below freezing compartment showing the cycle evaporator in position for removal through the opening provided in the rear wall; and

FIGURE 7 is a wiring diagram.

Referring now more articularly to FIGURES 1 and 2, there is shown a foam insulated household refrigerator cabinet **20**, having an upper above freezing compartment **22**, and a lower below freezing compartment **24**, beneath which is a machinery compartment **26** having separating the latter compartments a low front insulated wall portion **28** and a stepped up rear wall portion **30**, which is raised substantially above the front portion **28** to provide adequate space beneath for the sealed motor compressor unit **32** and the sheet-type condenser **34**. The rear insulated wall **36**, behind the below freezing compartment **24**, is provided with a narrow vertical removable portion **38** covered by a metal cover **40** beneath the lower edge

of which extends the capillary tube supply conduit **42** connecting the condenser **34** with the single evaporator **44** and a suction conduit **46** connecting the outlet of the evaporator with the suction inlet of the compressor **32**. On the left end of evaporator **44** the conduits **42** and **46** are provided with a vertical loop portion **48** providing flexibility of the conduits **46** and **42** to permit removal of the evaporator **44** through the opening provided when the removable portions **38** and **40** are removed.

This removal is clearly illustrated in FIGURE 6. The entire refrigerating system may be removed by removing the compressor **32** and the condenser **34** through the opening in the back of the machinery compartment **26** along with the evaporator **34**, so that the refrigerating system is kept intact and may be removed for examination or sent away for repair. The refrigerating system is readily inserted by inserting the right end through the opening provided by the removal of the section **38**, and passing the entire evaporator through this opening and then placing it above the rear of the raised portion **30**. The refrigerant conduits **42** and **46** extend from the condenser **34** and the compressor **32** through the opening at the bottom of the section **38** to the looped portion **48** and connecting respectively to the inlet connection **50** and to the top of a vertically mounted accumulator **52** having its bottom portion connected to the evaporator outlet **54**. The evaporator **44** has horizontal serpentine tubing provided with widely spaced vertical fins **56** on the right side of the vertical partition wall **58** and a closely finned section **60** on the left side of the vertical partition wall **58**. An insulated partition wall **62** is provided in front of the evaporator **44** and substantially extends entirely across the rear of the below freezing compartment **24**. It includes an insulating sheet **64** which is faced with a metal sheet **66** having a bottom edge **68** turned rearwardly at an angle beneath the lower beveled bottom portion of the insulating sheet **64**. Behind the upper portion of the sheet portion **64** is provided with a horizontal insulated structure **70** spaced above the evaporator **44** having vertical partition wall portions **71** and **73** extending downwardly to the opposite ends of the evaporator **44** and an intermediate vertical wall portion **76** constituting a dividing means extending downwardly to the partition wall **58**. The insulating sheet **64** and the metal facing sheet **66** are terminated short of the step portion **40** in front of the closely spaced fin portion **60** to provide an air entrance **70** through which air from the compartment **24** enters the space beneath the closely finned part **60** of the evaporator **44**. A propeller-type fan **72** is rotatably mounted in an aperture **74** in the sheet **64** and the metal sheet **66** at a level higher than the evaporator **44** between the wall portion **71** and **76** for drawing the air from the compartment **24** beneath the bottom beveled edge **68** for drawing the air upwardly through the closely spaced fin portion **60** and discharging the air forwardly in the upper portion of the below freezing compartment **24**. It is driven by an electric motor **69**.

A fan scroll **78** located on the lower left-hand corner of the back wall of the above freezing compartment **22**, surrounds a centrifugal fan **80** driven by an electric motor **82** for drawing air from the above freezing compartment, and discharging the air through an expanding shroud **84** to a duct **86** extending through the rear wall **36** diagonally downwardly to a discharge outlet **88** in the rear wall **36**, behind the bottom of the widely spaced finned portion **56**, of the evaporator **44**. This air flows upwardly through the widely spaced fin portion **56** to the air entrance **90** above the evaporator **44**. The entrance **90** leads to a second air duct **92** in the rear wall **36** which extends diagonally upwardly and has a small first air discharge opening **94** discharging through the rear wall into the above freezing compartment directly behind the meat-keeping container **96**. This air discharge **94** keeps the meat-keeping container at a temperature of about 30° F. which is sufficiently cold to keep meats for a substantial period of time and in satisfactory condition without freezing.

The second air duct **92** extends diagonally upwardly within the backwall of the cabinet to the upper centrally located discharge outlet **123** located a few inches below the top wall of the refrigerator cabinet. The fan **80** is preferably located directly behind the high humidity container **98** on the left side of the above freezing compartment **22**, directly above the insulating wall **121** which separates the below freezing compartment **22** and around the container **98** to keep this container at a suitable temperature such as 35° F. for the moist storage of fruits and vegetables. On the rear wall of the compartment **22** between the outlet **123** and the top wall **126** there is a thermosensitive element or capillary tube **125** which is operably connected to the adjustable thermostatic switch **127** mounted on the right side of the discharge outlet **123**. This switch **127** is connected in series with the fan motor **82**, as indicated in FIGURE 7, for the purpose of maintaining the temperature in the compartment **22** at about 35° F., and the temperature in the meat-keeping container **96** at a temperature of about 30° F.

On the opposite side of the upper discharge opening **123** is a second adjustable thermostatic switch **129** which has a thermosensitive element extending down through a tube or well **131** in the insulation of the rear wall **36** to a terminal point **133** mounted on the top wall **121** of the below freezing compartment **24** as shown in FIGURES 1 and 2. This thermosensitive element is in the form of a capillary tube having a closed end in the portion **133** and connecting at its upper end to a fluid motor within the switch **129**. An illustration of such a switch is shown in Pat. No. 2,906,132 issued September 29, 1959.

For the purpose of defrosting the evaporator **44**, there is provided a serpentine sheathed electric heater **135** having, as shown in FIGURE 6, one lower loop **137** extending across both the widely spaced fins **56** and the closely spaced fins **60** and having two short upper loops **139** extending into heat transfer relation only with the widely spaced fins **56** so as to provide more heat for this portion of the evaporator since a greater amount of frost collects upon it. Upon the backside of the evaporator are provided several loops **141** of the heater **135** which extend across both the closely spaced fins **60** and the widely spaced fins **56**. For the purpose of collecting the water during defrosting, the raised portion **30** is provided with an inclined drain trough **143** extending downwardly from the left to the right to a point opposite the drain **145** in the rear right corner. This drain is provided with a removable cover **147** for access to the drain for cleaning purposes, and for shielding the drain from the circulating air. The drain is connected to tubing **149** extending through the machinery compartment **26** to a removable diagonal drain and seal member **151** having a normally closed end portion **153** which normally has a flat looped shape at the end so as to prevent flow of air therethrough. It will, however allow the flow of water into the collecting drain pan **155** located in the front part of the machinery compartment **26** where it is in the flow of air which is circulated by the condenser fan **157** driven by the fan motor **159**. The drain **143** is provided with a drain heater **161** in the form of a loop extending along the bottom having a second portion **163** (see FIGURE 7) extending to the drain **145**, and having a third portion **165** extending laterally between the bottom edge **68** of the sheet metal face **66** and the beveled bottom edge of the insulating sheet **64** of the dividing wall **62**.

As illustrated in FIGURE 7, a timer motor **167** is connected across the suply conductors L–1 and L–2 and at intervals of once or twice a day operates the dual switches **169** and **171** from the position shown in FIGURE 7 to a position in which the switch **171** is opened and the switch **169** is closed. When the switch **171** is opened, the fan motors **76**, **72**, and **159**, as well as the motor compressor unit **32**, are deenergized. The closing of the switch **169**

energizes the defrost heater **135** including the portions **137**, **139**, and **141**. Connected in parallel with the defrost heater are the two portions of the drain heater **134** and **163**, and the heater **165** upon the bottom of the member **66**. The drain heaters insure that any ice in the drainage system will be melted before the defrost water melted from the evaporator **44** reaches the different parts of the draining system. The heater **165** assures that any frost or ice collecting upon the partition wall **62** will be melted during the defrost period. The fan motors **78** and **82** may also be stopped whenever the doors **173** and **175** are opened through the opening of the switches **177** and **179** which are operated respectively by the doors **173** and **175**.

The motor compressor unit along with the fan **157** and its motor **159** and the condenser **34** may be removed through the rear opening of the machinery compartment **26**. The evaporator **44** may be removed by removing the section **38** of insulation and the cover **40** and withdrawing the evaporator through the opening provided by this removal as illustrated in FIGURE 6 by moving the left end of the evaporator **44** first through the opening and then withdrawing the remainder through the opening unitl it is free of the cabinets. The refrigerating system is capable of maintaining the compartment **24** at temperatures between —6° and 12° F. Normal operation is 0° F. While the above freezing compartment **22** is capable of maintaining a temperature of about 35° F. therein, with the execption of the meat-keeping container which is maintained at about 30° F. The timer motor **167** provides defrost periods once or twice a day automatically without any attention. The foam insulation is suffiicently efficient that only thin insulated walls are required. The use of a single finned evaporator to cool both compartments makes the cost of manufacture relatively low, while the arrangement of completely separate air circulating systems between the two compartments and the two sections of the evaporator provide desirable temperature and humidity conditions in both compartments at a relatively low cost. The use of the diagonal duct arrangements makes the arrangement compact and minimizes the thickness required for the rear wall.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. A refrigerator including insulating means enclosing a below freezing compartment and an above freezing compartment, said insulating means including insulated side walls and an insulated rear wall for said below freezing compartment, a refrigerant evaporating means in the form of a single elongated unit located within said below freezing compartment in front of and generally parallel to said rear wall and having its opposite ends adjacent said side walls, a partition wall located in said below freezing compartment in front of said evaporating means, upwardly extending dividing means behind and transverse to said partition wall cooperating with said evaporating means and the walls of said below freezing compartment to provide separate chambers on opposite sides thereof containing the opposite ends of said evaporating means, said partition wall on one side of said dividing means being provided with an opening at the bottom and the top and on the opposite side of said dividing means being imperforate, said insulating means being provided with supply and return air passages connecting said above freezing compartment with said separate chamber behind the imperforate portion of said partition wall on the opposite side of said dividing means.

2. A refrigerator including insulating means enclosing a below freezing compartment and an above freezing compartment, refrigerating apparatus for cooling said compartments, a well in the form of tubing extending from said above freezing compartment to said below freezing compartment, a thermostatic control connected in controlling relation with said refrigerating apparatus for controlling the operation of said apparatus, said thermostatic control being located in said above freezing compartment, said thermostatic control having a thermosensitive tubular means extending through said well from said above freezing compartment into heat transfer relation with said below freezing compartment.

3. A refrigerator including insulating means enclosing a lower below freezing compartment and an upper above freezing compartment, refrigerant evaporating means located adjacent the rear wall of said below freezing compartment, a meat keeper container located adjacent one lower corner of said above freezing compartment, first air duct means enclosing an end of said evaporating means beneath said meat keeper container and extending upwardly therefrom behind the meat keeper container and behind said above freezing compartment to an upper central zone of said above freezing compartment, said first air duct means having a first discharge outlet opening into said above freezing compartment behind said meat keeper container and having a second discharge outlet opening into the upper central zone of said above freezing compartment, a second air duct means having an inlet adjacent the lower corner of said above freezing compartment opposite said meat keeper container and extending diagonally therefrom behind said below freezing compartment to said end of said evaporating means beneath said meat keeper container, the opposite end of said evaporating means being located in heat transfer relation with said below freezing compartment, and means for circulating air from said above freezing compartment through said second air duct means into heat transfer relation with said end of said evaporating means below said meat keeper container and thence through said second air duct means for discharge through said first and second discharge outlets.

4. A refrigerator including insulating means enclosing a below freezing compartment and an above freezing compartment, said insulating means comprising an insulated rear wall for said below freezing compartment, refrigerant evaporating means in the form of a single unit having ends located adjacent the rear wall of said below freezing compartment, means associated with said insulating means forming an enclosure for said evaporating means adjacent and cooperating with said rear wall, upwardly extending dividing means extending transversely to said rear wall within said enclosure and cooperating with said evaporating means to divide the interior of said enclosure into first and second sub-compartments with the first subcompartment containing one end of said evaporating means and with the second subcompartment containing the opposite end of said evaporating means, first air duct means extending from said second subcompartment to the upper portion of said above freezing compartment, said above freezing compartment at its lower portion having an inlet, second air duct means connecting said inlet with only said second subcompartment, fan means in one of said air duct means for circulating air through said duct means between said above freezing compartment and said second subcompartment in heat transfer with only said opposite end of said evaporating means, and means providing air flow between said below freezing subcompartment and said first subcompartment and including circulating means for circulating air from said below freezing compartment into heat transfer with only said one end of said evaporating means.

5. A refrigerator including insulating means enclosing a below freezing compartment and an above freezing compartment, said insulating means comprising an insulated rear wall for said below freezing compartment, refrigerant evaporating means in the form of a single unit having ends located adjacent the rear wall of said below freezing compartment, one end of said evaporating means being provided with a plurality of widely spaced heat transfer fins, the opposite end of said evaporating means being provided with a plurality of closely spaced heat transfer fins,

means associated with said insulating means forming an enclosure for said evaporating means adjacent and cooperating with said rear wall, upwardly extending dividing means extending transversely to said rear wall within said enclosure and cooperating with said evaporating means at a location substantially between said widely spaced and closely spaced heat transfer fins to divide the interior of said enclosure into first and second subcompartments with the first subcompartment containing the end of the evaporating means with the closely spaced fins and with the second sumcompartment containing the end of the evaporating means with the widely spaced fins, first means for circulating air from said below freezing compartment through and exclusively with said first subcompartment and in heat transfer relation exclusively with the one end of the evaporating means having the closely spaced fins and returning the air to said below freezing compartment, and second means for circulating air from the above freezing compartment exclusively with the second subcompartment and in heat transfer relation exclusively with the other end of the evaporating means having widely spaced fins and for returning said air to said above freezing compartment.

6. A refrigerator including insulating means enclosing a below freezing compartment and an above freezing compartment, said insulating means including insulated side walls and an insulated rear wall for said below freezing compartment, a refrigerant evaporating means located

within said below freezing compartment in front of said rear wall, a partition wall located in said below freezing compartment in front of said evaporating means, insulating material spaced above and extending over said evaporating means having downwardly extending dividing means substantially parallel to said side walls behind said partition wall cooperating with and extending down to the top of said evaporating means to provide separate chambers on opposite sides thereof, said partition wall on one side of said dividing means being provided with an opening at the bottom and the top and on the opposite side of said dividing means being imperforate, said insulating means being provided with supply and return air passages connecting said above freezing compartment with said separate chamber behind the imperforate portion of said partition wall on the opposite side of said dividing means.

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