March 16, 1954 S. M. SCHWELLER 2,672,025

TWO-TEMPERATURE REFRIGERATING APPARATUS

Filed April 28, 1951 5 Sheets-Sheet 1

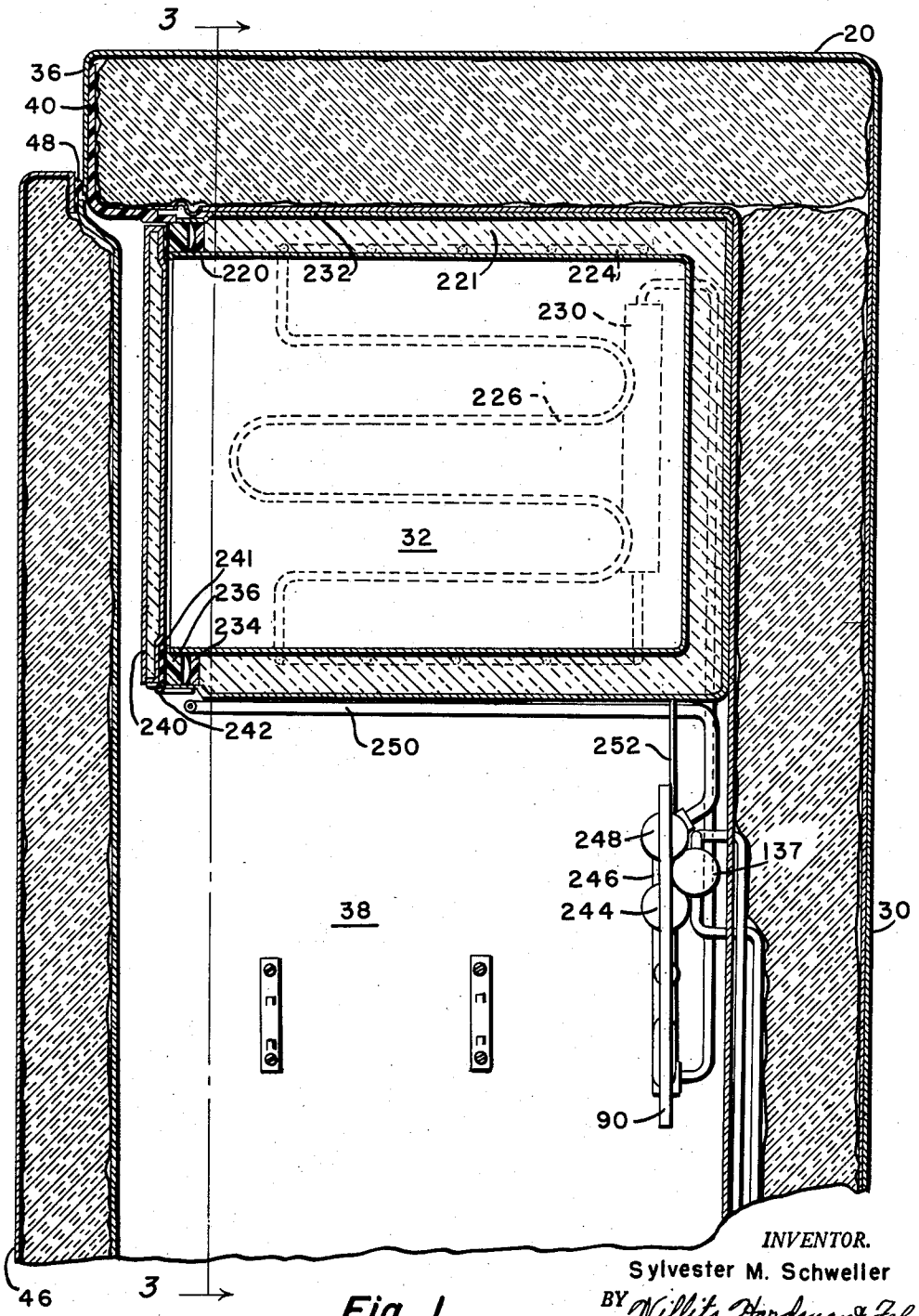


Fig. 1

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TWO-TEMPERATURE REFRIGERATING APPARATUS

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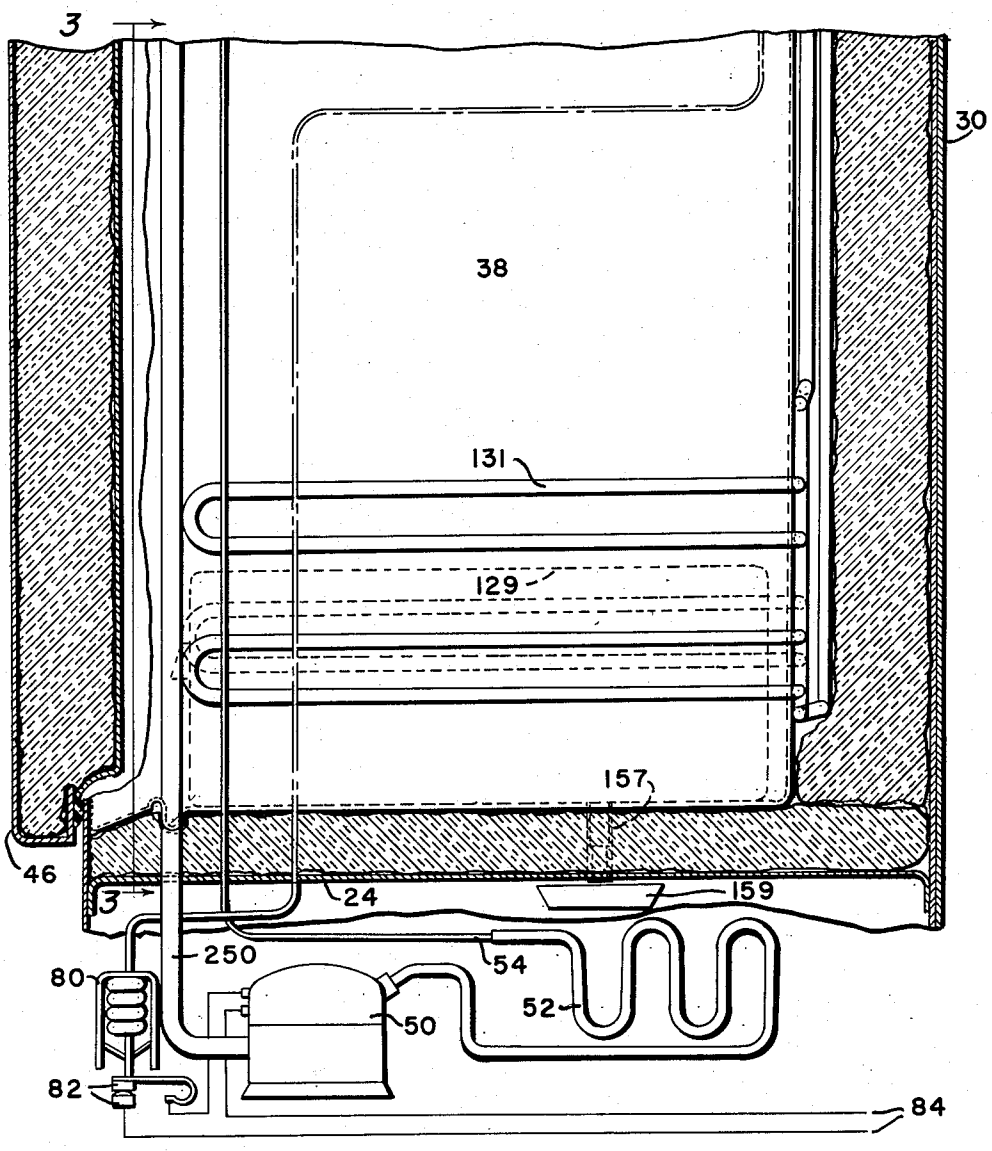


Fig. 2

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TWO-TEMPERATURE REFRIGERATING APPARATUS

Filed April 28, 1951 5 Sheets-Sheet 3

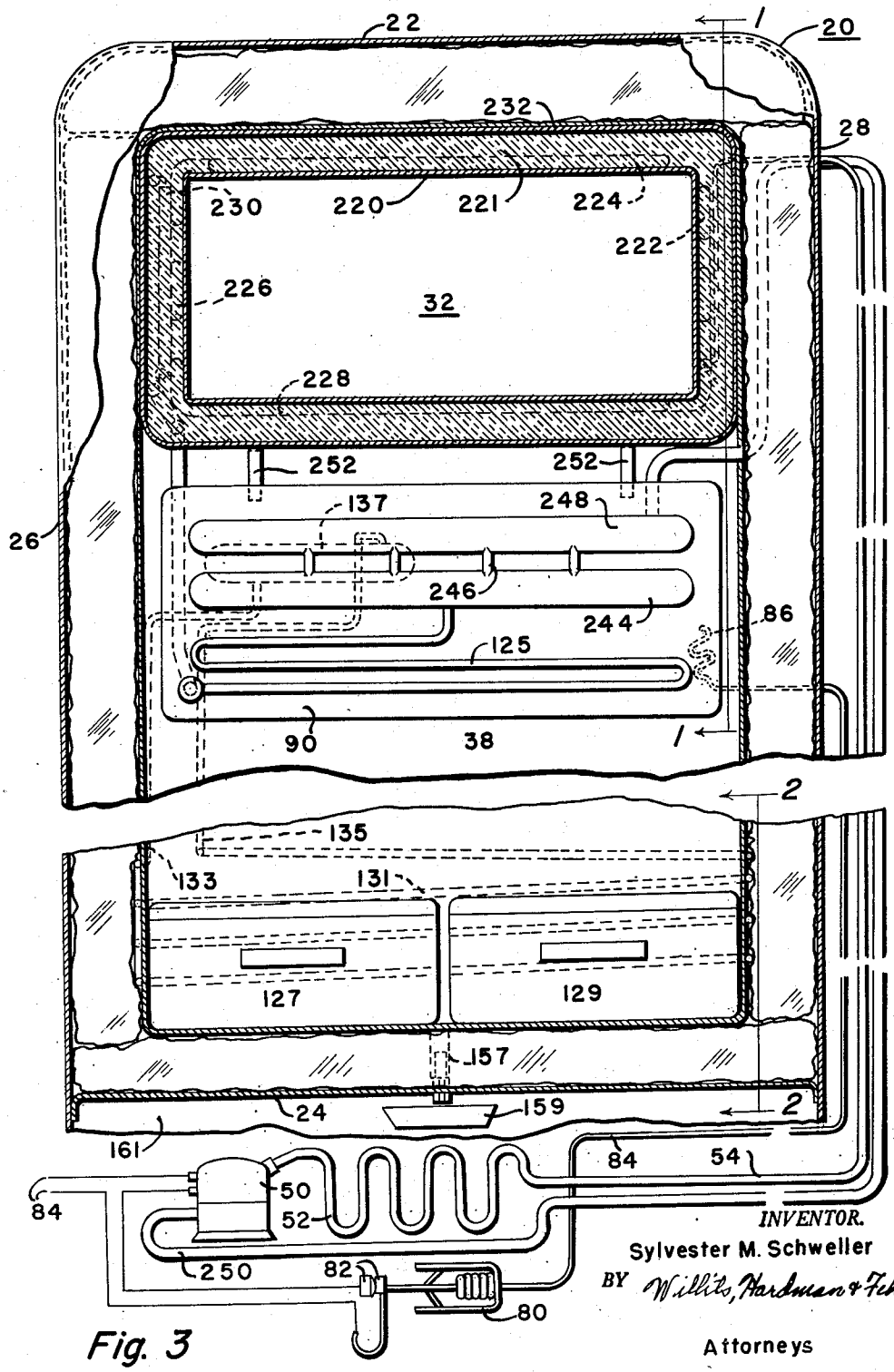


Fig. 3

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TWO-TEMPERATURE REFRIGERATING APPARATUS

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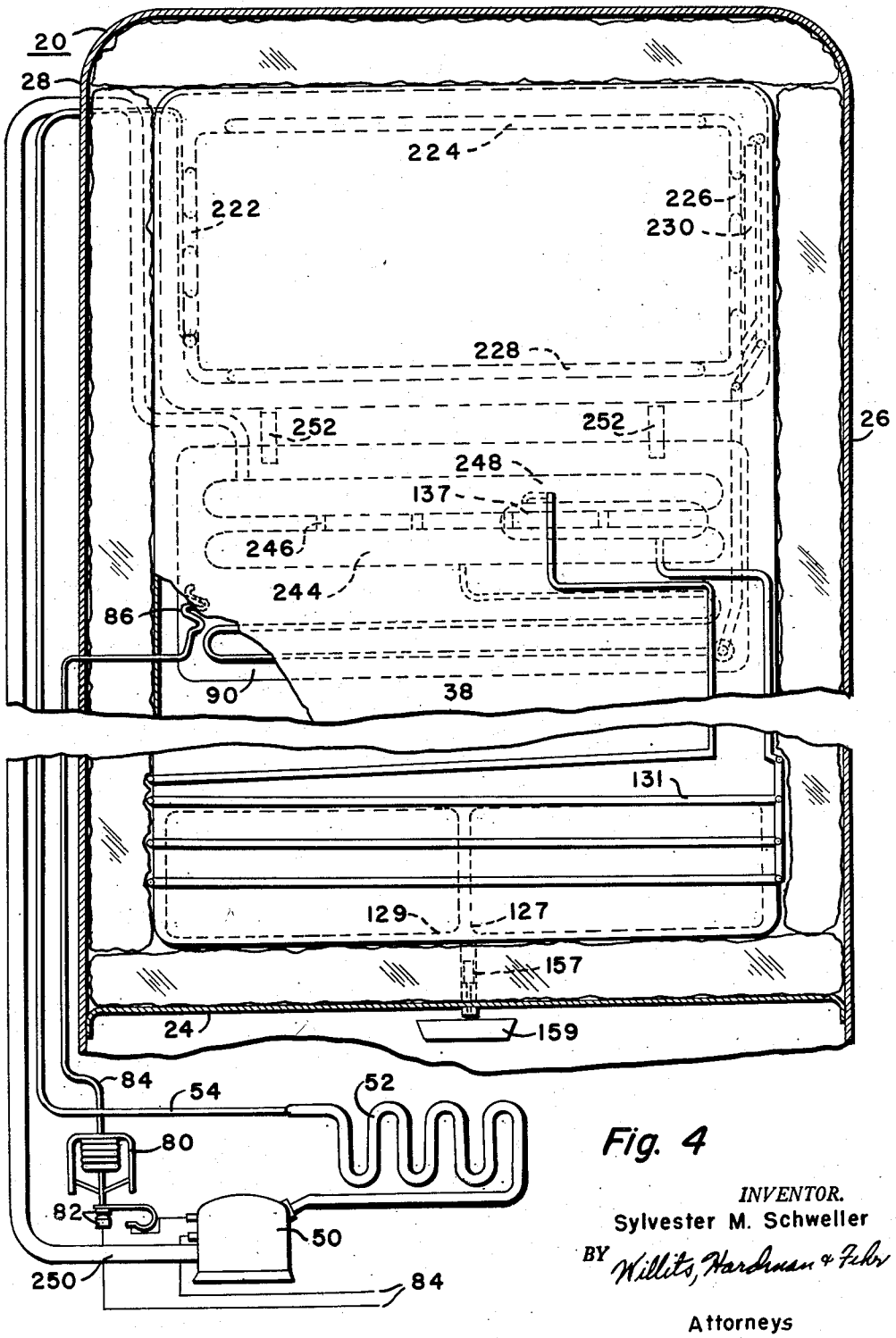


Fig. 4

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March 16, 1954 S. M. SCHWELLER 2,672,025

TWO-TEMPERATURE REFRIGERATING APPARATUS

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FIG. 5

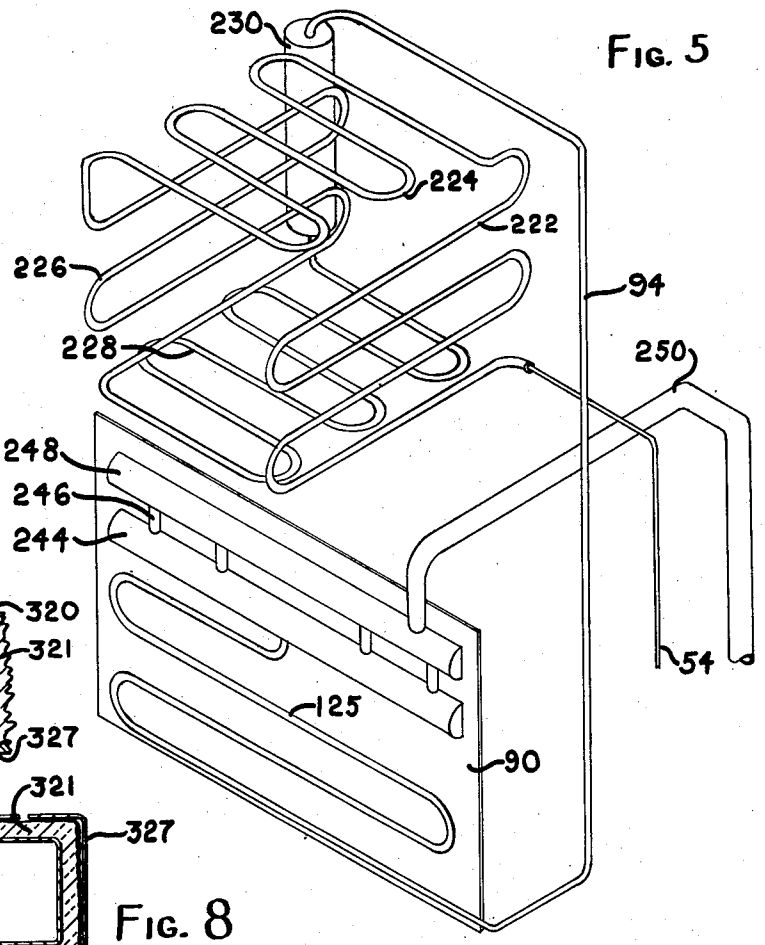
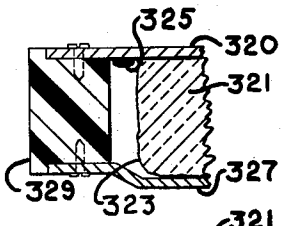


FIG. 9



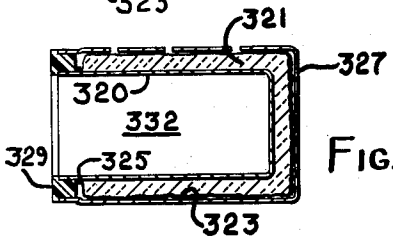


FIG. 8

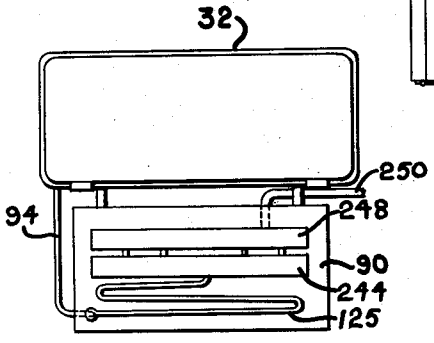


FIG. 7

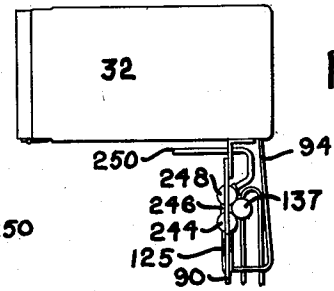


FIG. 6

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UNITED STATES PATENT OFFICE

2,672,025

TWO-TEMPERATURE REFRIGERATING APPARATUS

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Application April 28, 1951, Serial No. 223,590

5 Claims. (Cl. 62—6)

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This invention relates to refrigerating apparatus.

An object of this invention is to provide an improved mechanical refrigerator which is adapted to be manufactured in large quantities and be distributed and used throughout the United States. This refrigerator is refrigerated by a simple compressor, condenser, evaporator system having no controls other than the usual refrigerant expansion and compressor cycling controls.

The refrigerator has a cabinet with an outer wall substantially hermetically sealed against breathing action with the outside atmosphere. An inner liner is placed inside the outer casing and closely follows its contour, with the necessary insulating space between the casing and liner. The liner is so constructed or is provided with an access from the interior of the liner to the insulation space, so that breathing action can take place between the insulation space and the interior of the liner. Insulation is placed in the interior of the insulation space in the form of hermetically sealed bags containing insulation, which bags are made of some impervious material such as polyethylene.

A frozen food compartment is provided in the upper part of the refrigerator. It is maintained at very low temperature and is of rectangular cross section adapted to receive rectangular food packages, to be fully packed with them, and to prevent local warm spots among such frozen food packages. This frozen food compartment, with its surrounding insulation, is placed inside of the liner, so that its inner surface is at a very low temperature, and the outer surface of the insulation is above 32° F., so that no frost can gather on the outer surface of the insulation.

The refrigerator is also provided with an unfrozen food compartment to be maintained at a low temperature, above 32° F., which compartment is adapted to receive foods in large quantities which are to be maintained above 32° F. and which are not likely to be dehydrated. This unfrozen food compartment is also provided with one or more covered pans having a space in which relatively high humidities are maintained and in which foods may be preserved which are likely to be otherwise dehydrated.

Notwithstanding these advantages, the refrigerator is adapted to operate satisfactorily in varying atmospheric temperatures ranging from 50° to as high as 110°. It is also adapted to operate satisfactorily in varying degrees of atmospheric humidity, frequently reaching substantially the saturation point of 100% relative humidity, without danger of accumulating undesirable moisture within the compartments or within the insulation surrounding the compartments.

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The cabinet is provided with an outer door extending throughout the edge of the outer casing, and engages the outer casing with a sealed construction in a manner to reduce infiltration of outside air into the refrigerator.

The frozen food compartment preferably is made of a rectangular sided compartment virtually surrounded on all sides, except the door side, with a freezing evaporator placed on the outside of the frozen food compartment liner, which liner is made smooth on the inside to receive frozen food packages and to be easily scraped of a slight amount of frost which may gather after long periods of use. The compartment is adapted to be maintained cold without defrosting for relatively long periods of time (several months). Insulation is placed around the frozen food compartment, and is made sufficiently thick to cause the outer surface of the insulation to remain above 32° F., within the cabinet liner. The insulation is hermetically sealed against any breathing action which would permit any substantial accumulation of frost adjacent the freezing evaporator, on the outside of the frozen food compartment liner. This insulation may be made of hermetically sealed bags with surface so closely pressed against the outer surface of the frozen food compartment liner, that only a slight amount of frost can ever gather adjacent the freezing evaporator, or the insulation can be so hermetically sealed that no accumulation at all can occur within the insulation. The frozen food compartment, with the freezing evaporator and the insulation is adapted to be inserted into the upper part of the unfrozen food compartment liner.

The unfrozen food compartment is formed by that portion of the cabinet liner which extends below the frozen food compartment. The space between the cabinet liner and the outer casing is insulated by surrounding the liner with bags of insulation (hermetically sealed bags of polyethylene enclosing glass or mineral wool) pressed against the outer surface of the liner, so that no moisture whatever can gather inside the bags, and substantially no moisture can gather on the outer walls of the liner and nowhere inside the bags. In order to cool the major portion of the unfrozen food compartment, and in order to prevent accumulation of moisture either inside of

the unfrozen food compartment or in the insulation space, a frosting and defrosting evaporator is placed inside of the unfrozen food compartment and is preferably in the shape of a vertical rectangular plate, in the upper rear part of the unfrozen food compartment. This frosting and defrosting evaporator may be cooled by placing it in series refrigerant flow relationship with the freezing evaporator surrounding the frozen food compartment. The outer surface of the frosting and defrosting evaporator is colder than the outer surface of the insulation of the frozen food compartment, or of the cabinet liner, or of the insulation space between the cabinet liner and the outer casing, and hence continuously freezes moisture from these places and prevents any material accumulation of moisture within the cabinet.

A motor compressor unit and condenser are placed in the lower part of the refrigerator and are in refrigerant flow relationship with the freezing evaporator and the frosting and defrosting evaporator. The compressor is cycled frequently (several times a day) to maintain the desired temperature conditions in the refrigerator and this is accomplished by providing a thermostatic switch having its thermostatic bulb in substantial contact with the frosting and defrosting evaporator. The switch starts the compressor when the frosting and defrosting evaporator reaches a temperature above 32° F. such as 34° F. and after this evaporator has defrosted, and causes the compressor to run until this evaporator reaches a very low frosting temperature, lower than the temperature of the frozen food compartment, such as 0° F.

The construction and relationship of the freezing evaporator and the frosting and defrosting evaporator are such that a large portion of the liquid refrigerant in the frosting and defrosting evaporator is forced, in liquid form, into the freezing evaporator during the defrosting cycle, thus reducing the amount of heat and length of time required to defrost the frosting and defrosting evaporator.

This refrigerator is adapted to maintain the frozen food compartment uninterruptedly below 32° without the defrosting for long periods of time, such as several months, independently of the cycling of the motor compressor unit, which cycling occurs several times a day, since the temperature of the liquid refrigerant in the freezing evaporator does not rise above 32° F. even during the defrosting periods. The refrigerator is maintained in proper condition by the automatic defrosting the frosting and defrosting evaporator, which operation is performed during each compressor cycle and so quickly that no melting can take place in the frozen food compartment. The refrigerator can operate at very high efficiency in all sections of the country under varying conditions of atmospheric temperature and humidity without becoming frost or moisture bound either within its food preserving compartments or within its insulation space.

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:

Fig. 1 is a vertical sectional view taken substantially along the line 1—1 of Fig. 3 with the inner door omitted and with the side insulation removed, of the upper portion of a two temperature refrigerator embodying one form of my invention;

Fig. 2 is a vertical sectional view taken substantially along the line 2—2 of Fig. 3 with the side insulation removed of the bottom portion of the two temperature refrigerator, the upper portion of which is shown in Fig. 1;

Fig. 3 is a fragmentary front vertical sectional view taken substantially along the line 3—3 of Figs. 1 and 2;

Fig. 4 is a fragmentary rear vertical sectional view taken substantially along the line 4—4 of Figs. 1 and 2 with the back insulation removed;

Fig. 5 is a perspective view of the removable two unit primary refrigerant evaporating circuit alone;

Fig. 6 is a side view of the removable two unit refrigerant evaporating system;

Fig. 7 is a front view of the removable two unit refrigerant evaporating system with the door closed;

Fig. 8 is a vertical sectional view of a modified form of freezing compartment container; and

Fig. 9 is a fragmentary enlarged portion of the lower front edge of Fig. 8 showing the method of sealing.

Referring now to the drawings there is provided an outer hermetically sealed sheet metal cabinet shell 20 enclosing the top 22, bottom 24, sides 26 and 28, and rear 30 of the cabinet. The joints of this shell are sealed by welding or other suitable metal seal and preferably are additionally sealed on the interior by the use of some form of non-metallic sealing material such as asphalt applied in molten form.

Within and substantially uniformly spaced from the outer shell 20 is a box-shaped inner metal liner 38 having its front side open. The front edges of this liner 38 are connected by a breaker strip or throat 40 of a thermoplastic or other suitable poor heat conducting material with the front wall 36 of the outer shell 20. The sealing of the outer shell 20 is completed by a hollow metal outer door 46 containing insulation. It is provided wtih a gasket type seal 48 extending entirely around the door which makes sealing engagement with the front 36 of the outer shell 20. This seals the interior of the cabinet from the outside air. Because of this completely hermetical sealing of the outside of the cabinet no air or moisture can enter the cabinet except by opening the door 46.

The cabinet is provided with a completely removable series type two unit primary evaporating system including an insulated, completely enclosed freezing compartment container 32 and a vertical refrigerant plate 90 fastened to the bottom of the container 32. Referring now more particularly to Figs. 1 to 4 inclusive, the freezing compartment container 32 is formed of an inner box-shaped metal can 220. Bonded to the outer surface of this can 220 is a tubular series type refrigerant evaporator including a serpentine portion 222 provided on the right side, a second serpentine portion 224 provided on the top, a third serpentine portion 226 provided on the left side, and a serpentine portion 228 provided upon the bottom. The configuration of this primary freezing evaporator, composed of the serpentine portions 222 to 228, is shown in Fig. 5. The bottom serpentine portion 228 connects onto the bottom of a cylindrical tank 230 which serves as a disengaging tank and accumulator.

Insulating means 221, such as glass or mineral wool, is provided upon all sides of the can 220 and

the freezing evaporator coils. The insulation 221 is then enclosed in an outer box-shaped metal can 232. The gap between the front edges of the inner and outer cans 220 and 232 is sealed by some suitable thermoplastic sealing material 234, such as hot asphalt. The front edges are structurally connected by a thermoplastic member 235 of polystyrene or phenol formaldehyde resin which provides a structural connection between the cans which also serves as a heat transfer barrier. By this arrangement, the space between the cans 220 and 232 is hermetically sealed. The interior of the can 220 is closed by an inner door 240 which is hinged by the hinge 242 to the front edge of the outer can 232. The door 240 is insulated and may be provided with a gasket seal 241 similar to the seal 49 so that no moisture can enter the interior of the freezing compartment 32. The interior of the metal can 220 is smooth so that any snow or frost forming therein may be readily scraped off. It provides a very convenient compartment for frozen foods which are normally packed in box-shaped containers. Because of the double can construction with the insulation and the serpentine evaporating portions directly in contact with the inner can, this unit has a relatively high mass and holdover capacity. This insulation between the inner can 220 and the outer can 232 is sufficient so that even though the inner can and its interior should be cooled below 0° F., the outer walls thereof will always remain above 32° F. The outer can 232 is so shaped that it exactly fits within the top part of the inner liner 38 and is removably fastened therein by any suitable means.

For cooling the remainder of the space within the liner 38 below the freezing compartment container 32, there is provided a vertical refrigerated plate 90 having a very small mass and holdover capacity relative to its surface area. This plate 90 is provided with a serpentine refrigerant passage 125, the lower end of which is connected by the tubing 94 which connects to the top of the tank 230 from which it is fed with refrigerant. The upper end of the serpentine passage 125 connects with a lower disengaging chamber 244 provided in the plate 90 which connects by four vertical passages 246 with a top disengaging chamber 248. The upper portion of the disengaging chamber 248 is connected by the suction conduit 250 with the inlet of the motor compressor unit 50 provided beneath the bottom wall 24. The motor compressor unit 50 withdraws evaporated refrigerant from the accumulator 248 and forwards compressed refrigerant to the condenser 52 from which liquid refrigerant is conducted through a capillary tube expansion device 54 to the lower inlet portion of the serpentine evaporator section 222 on the right side wall of the can 220. The refrigerated plate 90 is supported directly from the outer can 232 by a pair of metal strips 252. The liquid line 54 and the suction line 250 are placed within the insulation space directly beneath the breaker strip 40 so that by removing the strip 40, the entire primary refrigerating system can be readily removed from the cabinet.

The operation of the refrigerating system is controlled by a thermostatic control switch 80 which is disclosed in diagrammatic form. Preferably it is of the constant cut on type. It may be constructed in a manner similar to that shown in the Grooms Patent No. 2,351,038. It includes contacts 83 which are connected in series with one of the supply conductors 84 which conducts electrical energy to the motor compressor unit 50. It has a temperature sensitive element in the form of a capillary tube 84 which ends in a serpentine portion 86 clamped to the back side of the refrigerated plate 90 as shown in Figs. 3 and 4. This thermostat 80 is set so that its contacts close when the refrigerated plate 90 reaches a temperature of 34° to 36° F. It is set to open at about 0° F. The switch preferably is a fixed cut on type (i. e. fixed closing temperature) but the cut off may be made variable so that the cut off point may vary between about 0° F. and minus 10° F.

The motor compressor unit 50 is of the so called high side type with the suction line 250 entering the inlet of the compressor substantially directly and with the compressor discharging into the interior of the shell of the motor compressor unit. The lubricant for the motor compressor unit is stored in the space into which the compressor discharges. The electric motor which drives the motor is likewise located in this space. A compressor of this type is shown in the Rataiczak Patent No. 2,377,965 issued June 12, 1945. With such a compressor properly charged with lubricant and refrigerant, the refrigerated plate 90 will completely defrost during every idle period of the motor compressor unit and will frost during each running cycle to keep the humidity within the unfrozen food compartment space below the freezing compartment container 32 at a desired figure. It will also keep the unfrozen food compartment at an almost constant temperature of about 36° F. regardless of the environment temperature. It will also keep the freezing compartment at a temperature below 10° F. despite the defrosting of the refrigerated plate 90. The high holdover capacity of the freezing compartment container prevents any large rise in its temperature during the defrosting of the plate 90.

To adjust the system to provide the proper relationship of the temperatures maintained in the freezing compartment and in the food compartment, the system is placed in a 110° room and after reaching uniform conditions, the thermostat cut off is adjusted to a point to obtain the desired temperature in the freezing compartment 32. In general, the cut off point may be adjusted between minus 5° and plus 5° F. to obtain a package temperature below 10° F. The refrigerator is then placed in a 70° room and operated until it reaches substantially uniform conditions. The refrigerant charge in the system is then reduced until the refrigerated plate 90 does not receive liquid refrigerant during the initial portion of the running cycle. If the food compartment 33 is still too cold, additional refrigerant is removed from the refrigerant circuit until the desired food compartment temperatures are obtained. This system provides satisfactory refrigerating temperatures in both the freezing compartment 32 and the food compartment 33 under temperatures varying from 70° to 110°.

The bottom of the liner 38 is provided with two covered pans 127 and 129 which are conveniently arranged to pull out as drawers. Since these pans are substantially closed, it is necessary to provide additional cooling in this area so that the food in these pans are kept at a suitable refrigerant temperature. For this purpose there is wrapped about the sides and back of this compartment, in serpentine fashion, the tubing 131 which constitutes the evaporator of

a secondary refrigerant circuit which includes the connecting conduit 133 and 135 which are connected to the bottom and the top respectively of the tubing 131 and the secondary condenser 137 which is clamped to the back side of the refrigerated plate 90 as shown in Figs. 1, 3 and 4. This secondary condenser 137 condenses refrigerant at a rate to provide sufficient evaporation of the refrigerant in the evaporator tubing 131 to keep the portion of the liner 38 adjacent the pans 127 and 129 at a temperature between about 34° and 36° F. The extent of the evaporator tubing provided can be increased or decreased to assist in providing the desired additional cooling of the unfrozen food compartment within the liner 38 beneath the container 32 necessary to keep this compartment at desired refrigerating temperatures. Because of this arrangement, high humidity is provided within the pans 127 and 129 making them ideal for the purpose of storing fresh fruits and vegetables without substantial dehydration.

The upper portion of the unfrozen food compartment above the pans 127 and 129 and beneath the container 32 is intended for foods in containers which are therefore not subject to dehydration. Therefore lower humidities are provided by the location of the frosting and defrosting plate 90 in this compartment so that the food containers will not become wet.

Moisture vapor tends to migrate to the coldest surface at which it has access. Because of the sealing of the frozen food container 32 by the hermetical sealing of its walls and by the door 240 and its gasket seal 241, the moisture vapor within the cabinet migrates to the next coldest surface which is the refrigerated plate 90. This causes moisture vapor within the insulation spaces between the liner 38 and the outer shell 20 to migrate to and be deposited as frost upon the refrigerated plate 90. From a practical standpoint, it is impossible to perfectly seal the inner walls of the insulation space. Therefore no attempt is made to seal such walls and thereby breathing openings or leakage accesses occur between the insulation spaces and the interior of the liner 38. Any excess humidity within the unfrozen food compartment also is deposited in the form of frost upon the refrigerated plate 90. When the refrigerated plate 90, because of its small mass and holdover capacity, rapidly rises to a temperature above 32°, such as 36°, upon the off cycle, all of this frost melts and is conducted to the bottom of the liner 38 from which it is drained by the drain 157 to the pan 159 in the machine compartment 161 provided beneath the bottom wall 24. Here the pan 159 will be heated sufficiently by its proximity to the motor compressor 50 and the condenser 52 that the moisture will be evaporated therefrom.

The insulation space between the liner 38 and the outer shell 20 is filled with some suitable form of heat insulation such as glass or mineral wool. As shown, the glass or mineral wool is enclosed in flexible hermetically sealed bags of polyethylene or polyvinylidene chloride. Such bags exclude moisture vapor from the glass or mineral wool.

A modified form of freezing compartment container 332 is shown in Fig. 8 as a modification of the disclosure of the freezing compartment container 32. This freezing compartment container 332 includes an inner box-shaped metal can 320 to the outer surface of which is attached the serpentine tubular refrigerant evaporator shown best in Fig. 5 and designated by the reference characters 222 to 228 inclusive. The evaporator tubing and the can 320 is surrounded by insulation 321, preferably in the form of glass or mineral wool. Instead of providing a metal wall of a seal for the insulation 321, there is provided a bag 323 of some suitable flexible plastic material such as polyethylene or polyvinylidene chloride. The front open edges of this bag 323 are sealed to the outer surface of the can 332 by some suitable sealing material 325 such as asphalt applied in a molten state. This bag 323 and the insulation therein is protected by an outer box-shaped metal container 327 which does not need to be sealed because of the seal provided by the bag 323. The inner and outer cans 320 and 327 are structurally connected together by a spacing frame 329 of a suitable solid thermoplastic material 329 such as polystyrene or phenol formaldehyde resin. This freezing compartment container 332 has fastened to its lower rear portion a refrigerated plate such as the refrigerated plate 90 so as to provide a unitary primary evaporating system which may be removed as a unit from the refrigerator.

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. Refrigerating apparatus including an above freezing food compartment and a below freezing compartment to be maintained below a predetermined sub-freezing temperature, a thermal heat transfer barrier between said compartments, a refrigerant liquefying means, a freezing evaporating means in heat exchange relation with said below freezing compartment and having its inlet connected to said liquefying means and having its outlet extending above a major portion of the evaporating space to prevent the gravity drainage of liquid refrigerant therefrom, a food compartment evaporating means in heat exchange relation with said food compartment, a liner surrounding the food compartment, said food compartment evaporating means being located inside of said liner within the food compartment, a secondary refrigerant circuit having an evaporating portion located outside of and in contact with the outer wall surface of said liner and having a condensing portion inside said liner in direct contact with said food compartment evaporating means with a refrigerant connection between said evaporating and condensing portions, an open substantially unrestricted connection connecting the outlet of said freezing evaporating means and the inlet of said food compartment evaporating means.

2. Refrigerating apparatus including an above freezing food compartment and a below freezing compartment to be maintained below a predetermined sub-freezing temperature, a thermal heat transfer barrier between said compartments, a refrigerant liquefying means, a freezing evaporating means in heat exchange relation with said below freezing compartment and having its inlet connected to said liquefying means and having its outlet extending above a major portion of the evaporating space to prevent the gravity drainage of liquid refrigerant therefrom, a food compartment evaporating means in heat exchange relation with said food compartment, a liner surrounding the food compartment, said

food compartment evaporating means being located inside of said liner within the food compartment, a secondary refrigerant circuit having an evaporating portion located outside of and in contact with the outer wall surface of said liner and having a condensing portion inside said liner in direct contact with said food compartment evaporating means with a refrigerant connection between said evaporating and condensing portions, an open substantially unrestricted connection connecting the outlet of said freezing evaporating means and the inlet of said food compartment evaporating means, and a thermostatic cycling control means having a thermally sensitive element in direct contact with said food compartment evaporating means having means for preventing the starting of said liquefying means until the food compartment evaporating means reaches a temperature above 32° F. for defrosting said food compartment evaporating means and having means for preventing the stopping of said liquefying means until said food compartment evaporating means is cooled below said predetermined sub-freezing temperature.

3. Refrigerating apparatus including a hermetically sealed outer shell, a liner within and spaced from said outer shell a distance sufficient to provide adequate insulation space, said liner containing a unitary evaporator structure including an insulated box shaped freezing evaporator and an exposed refrigerated plate connected to and extending from said freezing evaporator, said freezing evaporator including box shaped metal refrigerated walls enclosing a frozen storage compartment and insulating means surrounding said metal walls and a moisture impervious enclosure immediately surrounding said insulating means and sealed to the open portion of said freezing evaporator, said enclosure being of such size and shape to fit within said liner, a refrigerant liquefying means having its liquid supply line connected to the inlet of said freezing evaporator and having its suction line connected to the outlet of said refrigerated plate, the outlet of said freezing evaporator being connected to the inlet of said plate and a secondary refrigerant circuit having an evaporating portion located in said insulation space in contact with the outer surface of said liner and having a condensing portion within the space enclosed by the liner in contact with said plate.

4. Refrigerating apparatus including a hermetically sealed outer shell, a liner within and spaced from said outer shell a distance sufficient to provide adequate insulation space, said liner containing a unitary evaporator structure including an insulated box shaped freezing evaporator and an exposed refrigerated plate connected to and extending from said freezing evaporator, said freezing evaporator including box shaped metal refrigerated walls enclosing a frozen storage compartment and insulating means surrounding said metal walls and a moisture impervious enclosure immediately surrounding said insulating means and sealed to the open portion of said freezing evaporator, said enclosure being of such size and shape to fit within said liner, a refrigerant liquefying means having its liquid supply line connected to the inlet of said freezing evaporator and having its suction line connected to the outlet of said refrigerated plate, the outlet of said freezing evaporator being connected to the inlet of said plate and a secondary refrigerant circuit having an evaporating portion located in said insulation space in contact with the outer surface of said liner and having a condensing portion within the space enclosed by the liner in contact with said plate, and a thermostatic switch controlling the cycling of said liquefying means and having a thermosensitive element in contact with said plate having means for preventing the starting of said liquefying means until said thermosensitive element rises above 32° F. and having means for preventing the stopping of said liquefying means until said thermosensitive element reaches a temperature below the temperature of said freezing evaporator.

5. Refrigerating apparatus including an above freezing food compartment and a below freezing compartment to be maintained below a predetermined sub-freezing temperature, a thermal heat transfer barrier between said compartments, a common access door for said compartments, a refrigerant liquefying means, a primary freezing evaporating means in heat exchange relation with said below freezing compartment and having its inlet connected to said liquefying means and having its outlet extending above a major portion of the evaporating space to prevent the gravity drainage of liquid refrigerant therefrom, a food compartment primary evaporating means in heat exchange relation with said food compartment, a liner surrounding the food compartment, said food compartment evaporating means being located inside of said liner within the food compartment, a secondary refrigerant circuit having an evaporating portion located outside of and in contact with the outer wall surface of said liner and having a condensing portion in thermal exchange relationship with one of said primary evaporating means with a refrigerant connection between said evaporating and condensing portions, and an open substantially unrestricted connection connecting the outlet of said freezing evaporating means and the inlet of said food compartment evaporating means.

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