

[54] **REFRIGERATOR FREEZER WITH FROST ELIMINATOR**

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[73] Assignee: General Motors Corporation,
Detroit, Mich.

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[21] Appl. No.: 466,684

[52] U.S. Cl. 62/150; 62/156; 62/186;
62/187; 62/419; 62/272; 62/441

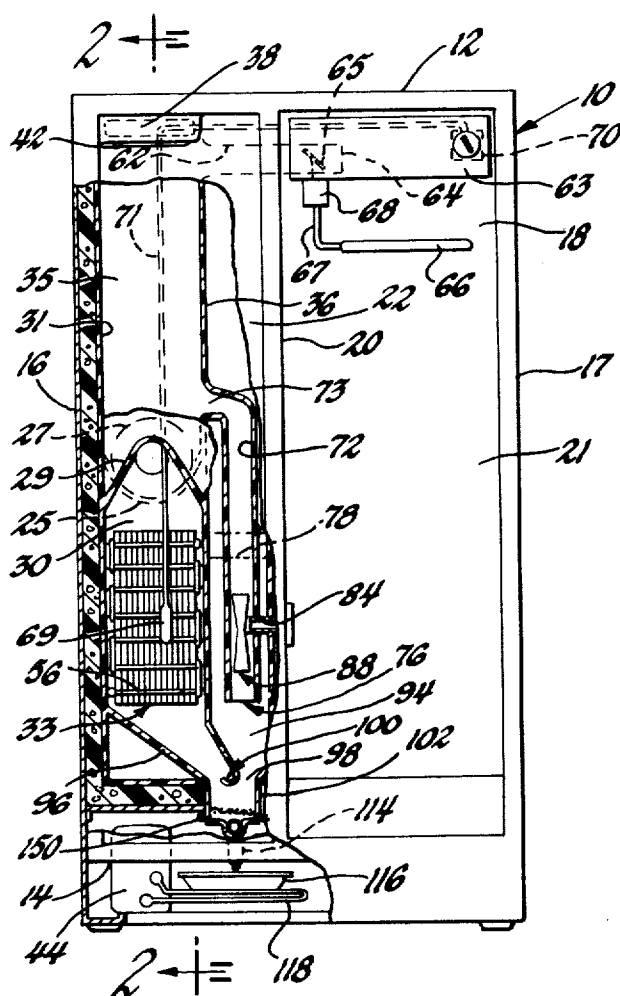
[51] Int. Cl. F25d 21/00

[58] Field of Search 62/150, 151, 156, 186,
62/187, 419[56] **References Cited**
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Primary Examiner—William J. Wye
Attorney, Agent, or Firm—Edward P. Barthel[57] **ABSTRACT**

A refrigerator-freezer having a forced air circulation system wherein the air is cooled by the evaporator and circulated by fan means to and from side-by-side refrigerator and freezer compartments. Control means maintain the air in the refrigerator compartment above 32° F. and the air in the freezer compartment below 32° F., and duct means, including a Venturi nozzle, are provided for combining the air flows in the freezer compartment such that moisture in the return air from the compartments is frozen into crystallized water while airborne by refrigerated air diverted from the evaporator chamber outlet. The crystallized water is separated therefrom while airborne prior to the combined air flows returning to the evaporator. Collecting means are provided for melting and evaporating the water outside of the freezer compartment.

3 Claims, 6 Drawing Figures

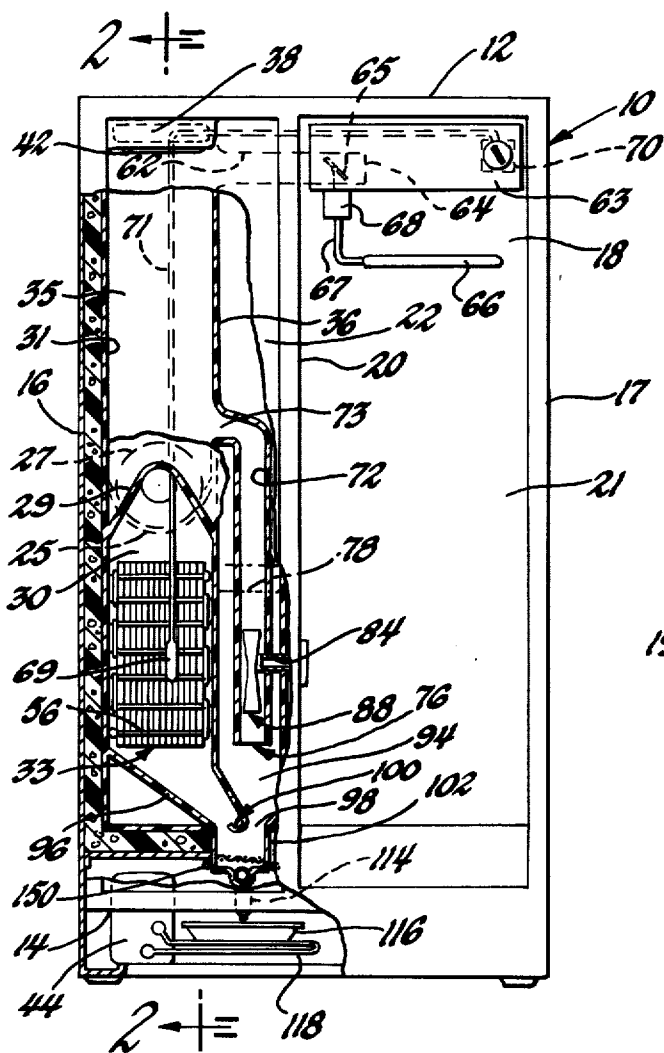


Fig. 1

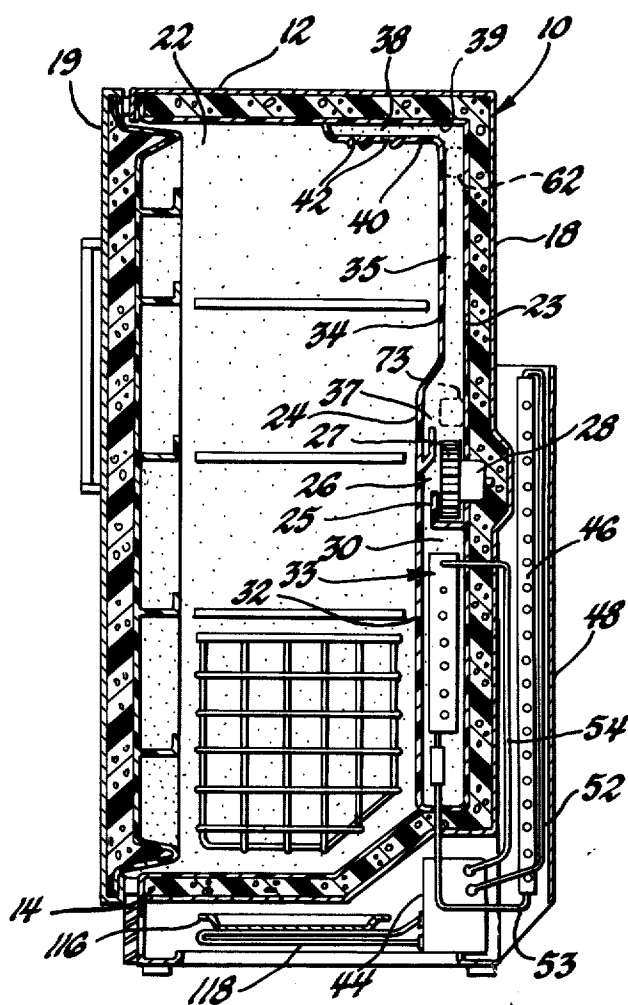


Fig. 2

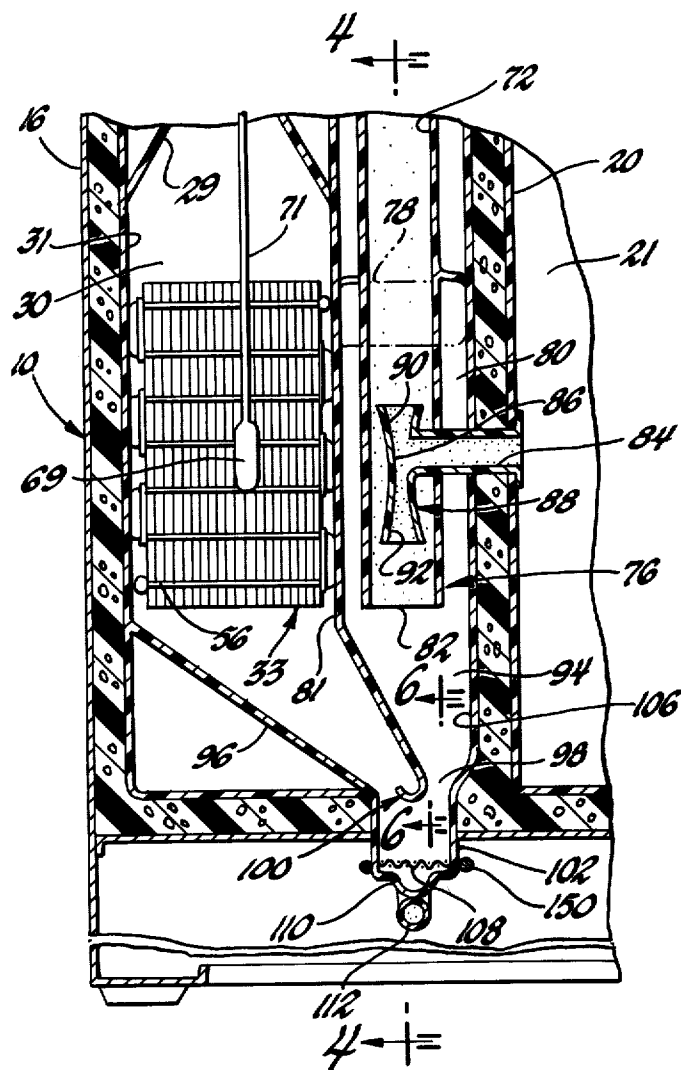


Fig. 3

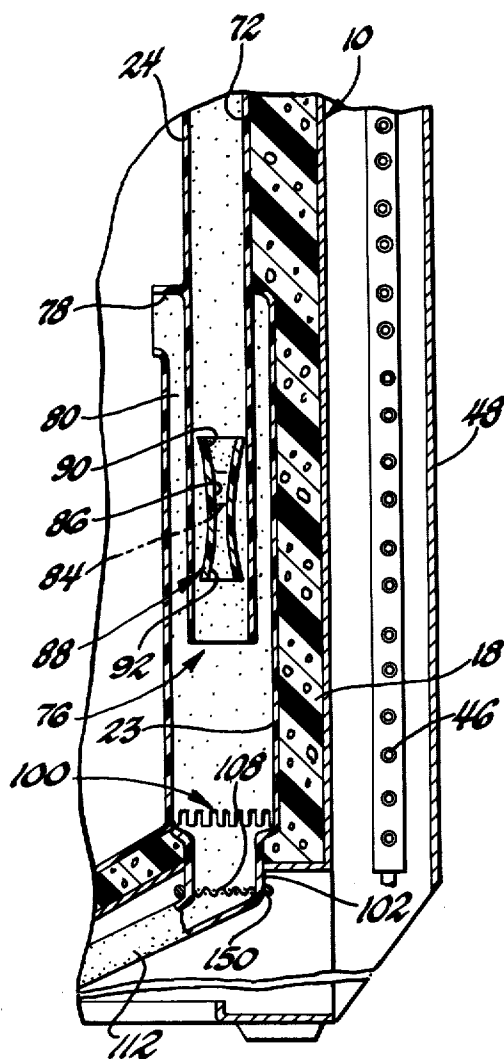


Fig. 4

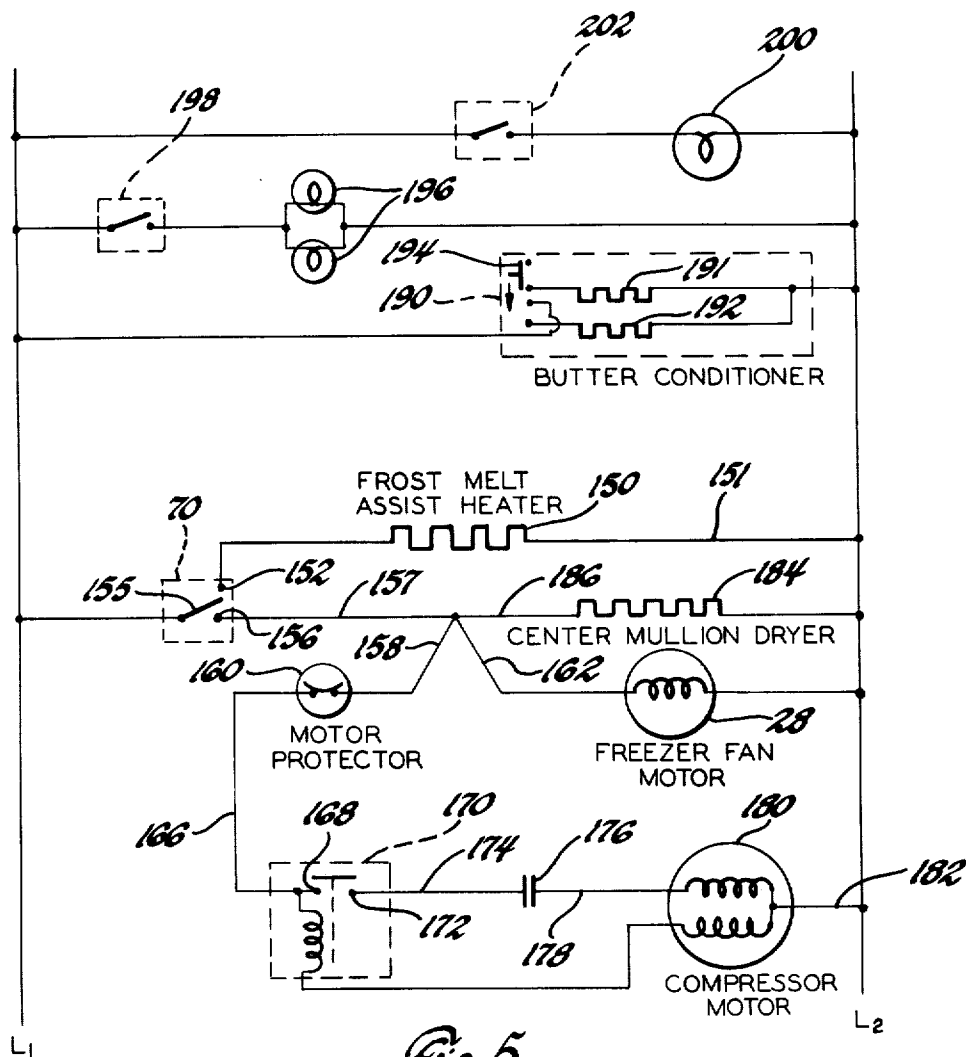


Fig. 5

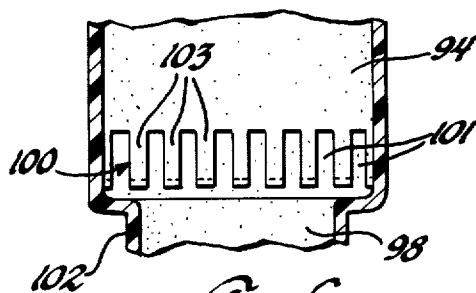


Fig. 6

REFRIGERATOR FREEZER WITH FROST ELIMINATOR

This invention relates to refrigeration apparatus and is directed to a domestic refrigerator having above and below freezing compartments whereby a large portion of the moisture from the air before it passes over the evaporator is removed, thereby substantially reducing the need to defrost the evaporator.

It is an object of this invention to provide improved refrigerating apparatus comprising side-by-side frozen food and fresh food chambers, a refrigeration system for cooling a quantity of air to below-freezing by passing it through an evaporator flow chamber, duct means dividing the quantity of cooled air into a first portion and lesser second portion, subsequently dividing the first portion into a third and lesser fourth portion, a blower system for circulating the third portion in the freezer chamber and the fourth portion in the fresh food chamber thereby raising the fourth portion to a temperature above-freezing, duct means including a Venturi nozzle for recombining the second and fourth portions in the freezer chamber to below-freezing temperature, whereby moisture is frozen or condensed in solid form while airborne; duct means for subsequently recombining the third portion with the recombined second and fourth portions to further reduce the temperature and solidify additional moisture therefrom; and collecting means for separating the solidified moisture from the air stream and returning the recombined quantity to the evaporator chamber for cooling.

Other features and advantages of the invention will be apparent from the following description of one embodiment of the invention, considered in conjunction with the accompanying drawings wherein:

FIG. 1 is a semi-diametric front elevation of a refrigeration apparatus embodying the invention, with the doors to the different compartments omitted;

FIG. 2 is a vertical sectional view taken on the lines 2—2 of FIG. 1;

FIG. 3 is a fragmentary enlarged front elevational view with portions broken away to facilitate illustration of the invention;

FIG. 4 is a fragmentary vertical section view taken substantially on the line 4—4 of FIG. 3;

FIG. 5 is a schematic diagram of a portion of the control circuit illustrating the control of the optional frost melt assist heater of the refrigeration apparatus, and

FIG. 6 is an enlarged view taken on line 6—6 of FIG. 3 of the frozen moisture separating device.

Referring now to the drawings a refrigerator of the present invention comprises an insulated cabinet 10, the outer shell of which has top and bottom walls 12 and 14, sidewalls 16 and 17 and a rear wall 18. The interior of the cabinet 10 has an upright insulated center partition wall 20 which divides the interior into an above-freezing temperature fresh food chamber or compartment 21 on the right and below-freezing temperature frozen food or freezer compartment 22 on the left arranged in a side-by-side manner. The compartments are closed by separate insulated doors as door 19 shown in FIG. 2 closing compartment 22.

The refrigeration of the compartments is effected by the flow of the refrigerated air therethrough by a suitable air moving means such as a blower. As shown in FIGS. 1 and 2 of the drawings between the rear wall liner 23 and a forwardly spaced cover plate 24 there is provided a centrifugal fan housing 25 having in its front

wall an inlet opening 26. Within the housing 25 is a centrifugal fan 27 driven by an electric motor 28 which protrudes from the rear wall 18. Extending downwardly from the fan housing at the rear of the freezer compartment 22 is a first cold air evaporator flow chamber 30 defined in part by the liner rear wall 23 and evaporator cover plate 32. Within the evaporator flow chamber 30, whose upper walls 29 converge to form inlet opening 26, is located a vertically finned air-cooling refrigerant evaporator 33 of customary construction.

As seen in FIG. 2 at the rear of the freezer compartment 22 there is provided an inwardly offset spaced duct front wall 34, defining an upwardly extending flow chamber or cold air supply duct 35 transversely defined between the liner side wall 31 and supply duct side wall 36. The duct 35 communicates with an upwardly discharging fan housing outlet 37 and terminates in a forwardly extending right angle portion 38 of duct 35 defined between the liner top wall 39 and forwardly extending channel 40 having a plurality of exit louvers 42 in order to provide exits for the cold air in the horizontally disposed angle duct 38. The circulated air is refrigerated by being passed in heat exchange relationship with the fin and tube evaporator 33, which is suitably refrigerated by conventional means, including a sealed motor-compressor unit 44. A condenser 46 is located on the back wall of the refrigerator cabinet between the cabinet rear wall 18 and an outer condenser cover plate assembly 48. The motor-compressor 44 is connected via a compressor refrigerant discharge line 52 to the condenser 46 while supply restriction line 53 connects the outlet of the condenser to the evaporator and suction return line 54 connects the evaporator to the compressor inlet. The refrigeration apparatus functions in a conventional manner to provide refrigerant fluid to the serpentine tube portion 56 of the evaporator.

A portion of the air circulated by the centrifugal fan 27 is divided or split off from the vertical delivery duct 35 into a horizontally disposed cross-over duct assembly 62 comprising a rectangular plastic tube which extends through the center partition 20 into the above-freezing compartment 21 adjacent the top wall 12. The air exits the duct 62 and is diverted downwardly into the fresh food compartment 21 by a cover member 63 spaced outwardly from the liner rear wall 23 and suitably secured thereto. At the duct discharge end 64 damper means in the form of a butterfly damper 65 is located and is controlled thermostatically in accordance with the temperature of a thermostat bulb 66 located in compartment 21 so that the bulb is connected via tube 67 to bellows 68, which operates damper 65, is responsive to the temperature of the air therein. A conventional thermostat cold control is provided at 70 having bulb 69 adjacent evaporator 33 by tube 71 for regulating the operation of motor-compressor 44 on a cooling demand cycle. The discharge opening 64 may be louvered for directing the air from duct 62 to the chamber 21.

As seen in FIG. 1, in evaporator air bleeder or diverter duct 73 is branched or split off at exit duct 73 from the duct wall 36 for directing a portion of the cold air exiting from the evaporator 33 vertically downwardly to a frost eliminator section generally indicated at 76. Intermediate the duct exit 73 and the frost eliminator section 76 there is located an air return opening 78 in cover plate 23 for conveying the freezer compartment return air into vertical passage means 80, formed

by enlarged duct portion **81** which circumscribes or surrounds the lower portion of air return duct **72**, such that the return air is mixed or intermingled with the evaporator return air at the exit end **82** of the freezer air return duct **72**.

As seen in FIGS. 1 and 3, an above-freezing air return passage is provided at **84** extending through a lower portion of the center partition wall **20**. The passage **84** provides a fourth air return duct interconnecting the fresh food compartment **21** with the throat portion **86** of a vertically oriented Venturi mixing nozzle **88** located in the lower portion of the air return from the evaporator or second air return duct **72**. The Venturi nozzle **88** has its upper converging portion or cone air entrance **90** positioned to receive a portion of the freezer air therein for discharge from lower diverging portion or cone air exit **92** such that an aspirator effect or predetermined suction is created at the throat **86** to aid in drawing above-freezing spent air from compartment **21** for mixture in the Venturi axial passage with the below-freezing third evaporator air return entering third entrance **78** and exiting at **82** from the third frozen food compartment cold air return duct **81**.

As best seen in FIG. 3, an air combining or mixing chamber **94** is provided at the exit end **82** of enlarged return freezer air duct **81** disposed around the second bleeder air duct **72** in spaced relation from the outer walls thereof and whose left hand wall **96** is inwardly and downwardly sloped to exit **98** to provide a tapered cross-section toward the exit **98** and insure a streamlined flow of air through separator **100**. The sloped wall **96** terminates in a sharply and outwardly curved fluted edge to form crystallized water separator means. In the preferred embodiment a snow comb separator **100** is provided with slotted openings **101** separating curved teeth **103** which as seen in FIG. 4 and FIG. 6 provide the centrifugal air flow removal of crystallized frozen water formed from the mixing in chamber **94** of the relatively moist above-freezing temperature air returning from freezer compartment **22**.

Snow or crystallized water subjacent collector means is provided in the bottom wall **14** of the freezer compartment **22** and which in the disclosed form is a trough or receptacle **102** set flush with the bottom wall inner liner whose upper edge merges or blends with the sloped liner wall **93** and vertical liner **106** such that the snow or crystallized water comb separator is positioned in vertical alignment above trough **102**. It will be noted that a horizontally disposed screen **108** is positioned adjacent the collector bottom wall **110** and that melted snow in the collector will drain therefrom through the drain tube **112** and check valve **114** (FIG. 1) into the defrost water drain pan **116** positioned in an ambient environment above the desuperheat coil **118** of the refrigeration system, where it will be evaporated therefrom by the heat of the ambient air and the desuperheat coil **118**. The upright evaporator chamber **30** has a lower sloped wall **93** to define an air inlet **95** through which the air is drawn for passage over the upright evaporator **33**.

As shown the wiring diagram of FIG. 5 of the optional frost melt assist heater **150** is connected by conductor **151** from the supply conductors L_2 to a first fixed off-cycle or warm contact **152** of cold control thermostat **70**. The cold control includes a switch element **155** of the double throw type and normally connects through fixed contact **156** and conductors **157**,

158 to motor protector **160** and conductor **162** to freezer fan motor **28**. The conductor **166** connects motor protector **160** to contact **168** of relay **170**, while relay contact **172** is connected via conductor **174** to capacitor **176** which is in turn connected by conductor **178** to compressor motor **180** and thence by conductor **182** to supply line L_2 . It will be noted that center vertical mullion dryer **184** is connected via conductors **186** and **157** to cold control contact **156** such that it is energized only when the cold control element **155** contacts cold contact **156** during the cooling or run cycle of the refrigerator when the compressor motor **180** is running.

Additional heaters such as the butter conditioner **190** heater **191** and **192** are connected by slide switch **194** across the supply lines L_1 , L_2 . Refrigerator lamps **196** are energized by lamp switch **198** while freezer lamp **200** is energized by lamp switch **202**.

As one example of a typical air flow distribution cycle for the disclosed form of the invention wherein the fan **27** delivers about **55** cfm of cold air flows from the evaporator chamber **30**. Of the total about **45** cfm of air or approximately **80** percent of the flow enters duct **35** and about **10** cfm or approximately **20** percent of the air flow is diverted into the inlet **73** of the bleeder duct **72**. Of the **45** cfm in duct **35** about **40** cfm or approximately **70** percent of the air flow exits the freezer outlet **42** and about **5** cfm or approximately **10** percent of the air flow enters into the crossover duct **62** for exit from fresh food chamber outlet **64** with the damper **65** in its open position. It will be noted that the damper **65** can be operated by any suitable means such as by a rack and pinion arrangement (not shown) controlled by the fluid motor bellows **68** as shown in U.S. Pat. No. **3,070,973** to J. J. O'Connell and assigned to the assignee of the instant invention. In this way the **70** percent of the evaporator air exiting outlet **42** enters freezer compartment air return inlet **78** while the **5** cfm of the cold air cools the fresh food compartment **21** and exits through return passage **84** into the throat of nozzle **88** for combining with the **10** cfm of bleeder air. The combined **15** cfm of mixed bleeder air and above freezing air exits at **83** to mix with the **40** cfm of frozen food compartment freezer air in chamber **94** whereby frozen crystals of moisture formed by the air mixture is settled or separated out by gravity and comb separator **100** into collector trough **102** such that about **55** cfm of substantially moisture free predried air is drawn into the evaporator chamber **30** via its diverging entrance **95**.

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.

I claim:

1. A refrigerator comprising an insulated cabinet, an insulated vertical partition wall extending from top to bottom of said cabinet to provide separate vertical side-by-side fresh food and frozen food compartments, an upright evaporator chamber associated with the frozen food compartment rear wall containing an evaporator, a fan having an inlet connected to said evaporator chamber and having an outlet connected to both an upwardly extending cold air supply duct and a downwardly extending evaporator cold air diverter duct, a Venturi mixing nozzle located in said diverter duct, a frozen food compartment air return duct positioned in spaced relation around the lower portion of said di-

verter duct having its inlet disposed vertically below said fan, said air return duct defining a mixing chamber between the exit of said diverter duct and the bottom wall of said frozen food compartment, said cold air supply duct having an outlet for discharging part of the cold air therethrough, a crossover duct extending through the upper portion of said partition wall and having an air inlet communicating with said cold air supply duct and having an outlet for discharging a portion of the cold air into said fresh food compartment, thermostatically controlled damper means for controlling the flow of air from said crossover duct outlet to said fresh food compartment, passage means for returning air from the lower portion of said fresh food compartment to the throat portion of said Venturi nozzle, whereby below freezing diverter duct air flowing downwardly through said Venturi nozzle draws above freezing air from said fresh food compartment through said passage means into said throat for mixture with said air therewith, said air return duct having an outlet communicating with both subjacent crystallized water collecting means and the inlet of said evaporator chamber, whereby moisture in the combined return air is frozen by the diverter duct air flow while airborne, and means for separating the crystallized water from the combined return air during its flow from said mixing chamber for deposit into said collecting means prior to the combined return air flows being drawn upwardly into said evaporator chamber to minimize the formation of frost on said evaporator.

2. A refrigerator comprising an insulated cabinet, an insulated vertical partition wall extending from top to bottom of said cabinet to provide separate vertical side-by-side fresh food and frozen food compartments, an upright evaporator chamber associated with the frozen food compartment rear wall containing an upright evaporator, a single fan positioned about midway between the upper and lower walls of said frozen food compartment and having an inlet connected to said evaporator chamber and having an outlet connected to both an upwardly extending cold air supply duct and a downwardly extending evaporator cold air diverter duct, a Venturi mixing nozzle located in the lower portion of said diverter duct, a frozen food compartment air return duct positioned in spaced heat transfer relation surrounding the lower portion of said diverter duct having its inlet disposed vertically below said fan and vertically above said nozzle, said air return duct defining a mixing chamber between the exit of said diverter duct and the bottom wall of said frozen food compartment, said cold air supply duct having an outlet adjacent the frozen food compartment top wall for discharging part of the cold air therethrough, a crossover duct extending through the upper portion of said partition wall and having an air inlet communicating with said cold air supply duct and having an outlet for discharging a portion of the cold air into said fresh food compartment, a thermostatically controlled damper for controlling the flow of air from said crossover duct outlet to said fresh food compartment to maintain the air in said fresh food compartment above 32°F. and the air in said frozen food compartment below 32°F., a passage for returning air from the lower portion of said fresh food compartment to the throat portion of said Venturi nozzle, whereby below freezing diverter duct air flowing downwardly through said Venturi nozzle draws above freezing air from said fresh food compart-

ment through said passage means into said throat for mixture therewith, said air return duct having an outlet communicating with both a subjacent crystallized water receptacle in the frozen food compartment bottom wall and the inlet of said evaporator chamber, whereby moisture in the combined return air of both the fresh food and freezer food compartments is frozen into crystallized water by the diverter duct air while airborne, and snow comb means for separating the crystallized water from the combined return air during its flow from said mixing chamber for deposit into said receptacle prior to the combined return air flow being drawn upwardly into said evaporator chamber so as to reduce the formation of frost on said evaporator, and means for melting and evaporating the water in an ambient environment outside said frozen food compartment.

3. A refrigerator comprising an insulated cabinet, an insulated vertical partition wall extending from top to bottom of said cabinet to provide separate vertical side-by-side fresh food and frozen food compartments, an upright evaporator chamber formed by a divider plate spaced from the rear wall of said frozen food compartment containing an evaporator with the plate extending substantially from the midpoint of the bottom of said frozen food compartment, said evaporator chamber defined in part by a vertical evaporator chamber side wall located intermediate the frozen food compartment liner side walls, the lower portion of said evaporator chamber side wall below said evaporator sloped toward said partition wall such that its free end terminates above a water collecting trough formed in the bottom wall of said frozen food compartment, said side wall free end terminating in a curled edge having a plurality of comb-like teeth, fan housing and duct means located in said evaporator chamber above said evaporator having an inlet communicating therewith and having an outlet connected to both an upwardly extending cold air supply duct and a downwardly extending evaporator air diverter duct, said cold air supply duct receiving approximately 80 percent and said diverter duct receiving approximately 20 percent of the total flow from said evaporator chamber, a Venturi mixing nozzle located in the lower portion of said diverter duct, said diverter duct having its outlet spaced a defined distance above said water collecting trough, an enlarged frozen food compartment air return duct surrounding in spaced relation the lower portion of said diverter duct, said sloped portion of said evaporator side wall together with said partition wall forming in part an air mixing chamber having a tapered cross section to provide a streamlined flow of air through said teeth, said cold air supply duct having an outlet adjacent the frozen food compartment top wall for discharging the majority of the cold air therethrough, a horizontal crossover duct extending through the upper portion of said partition wall and having an air inlet communicating with said supply duct and having an outlet for discharging a minority of the cold air into said fresh food compartment, thermostatically controlled damper means for controlling the flow of air from said crossover duct outlet to said fresh food compartment, passage means for returning air from the lower portion of said fresh food compartment to the throat portion of said Venturi nozzle, the diverter air flowing through said Venturi nozzle drawing the fresh food compartment air through said passage means into said throat for mixture therewith,

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said frozen food compartment return air duct having its outlet defined in part by said curled edge whereby the flow of return air is redirected vertically upwardly to said evaporator while allowing gravitational flow of crystallized water into said subjacent trough, whereby 5

the combined return air is predried prior to entering said evaporator chamber to minimize the formation of frost on said evaporator.

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UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,893,307
DATED : July 8, 1975
INVENTOR(S) : James W. Jacobs

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, -----,
line 57, after "and" insert -- a --;
line 60, after "doors" insert -- such --.

Column 2, line 60, "73" (first occurrence) should be
-- 72 --;
line 66, "23" should be -- 32 --.

Column 4, line 2, after "connects" insert -- the --.

Signed and Sealed this

thirteenth Day of *April* 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks