July 19, 1966 I. L. GOULD 3,261,173

REFRIGERATING APPARATUS

Filed July 29, 1964 6 Sheets-Sheet 1

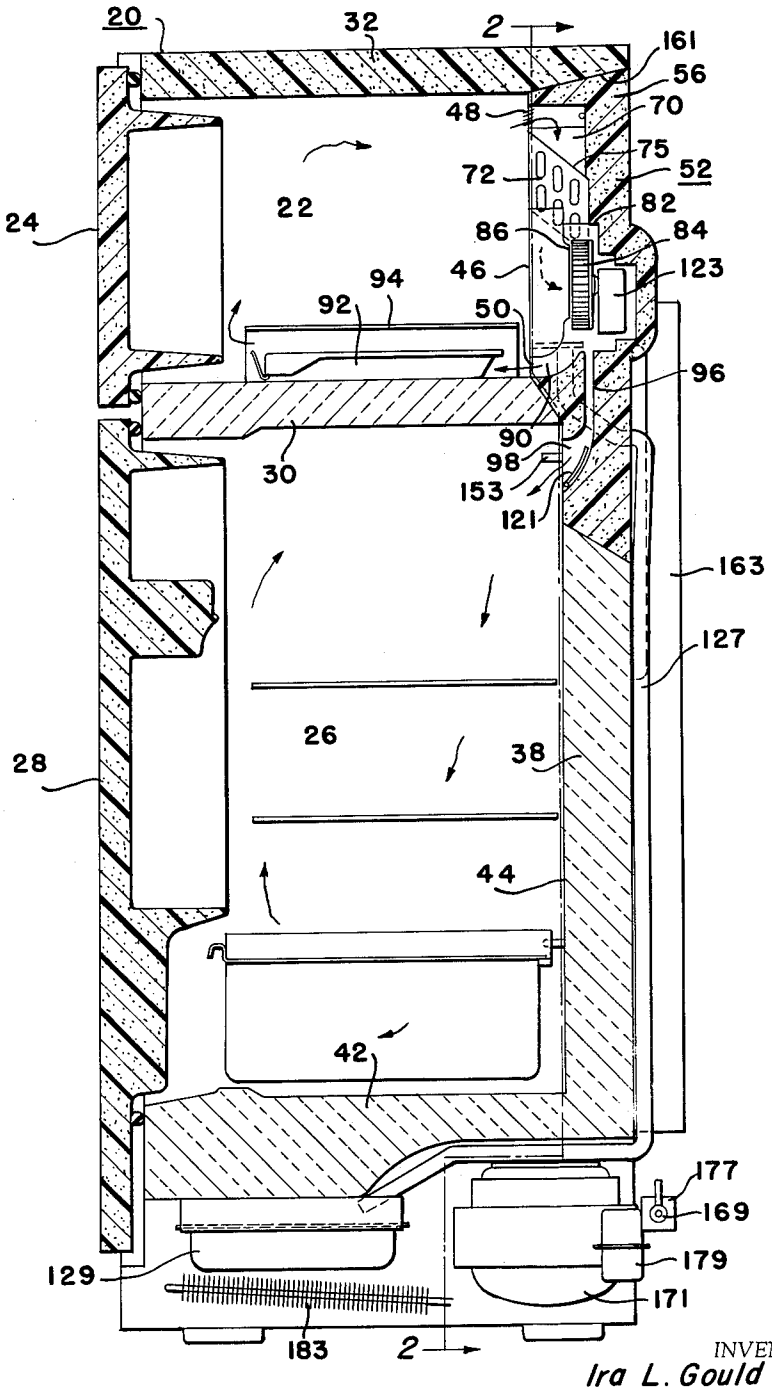


Fig. 1

INVENTOR.
Ira L. Gould

BY
Carl A. Stickel
His Attorney

July 19, 1966 I. L. GOULD 3,261,173

REFRIGERATING APPARATUS

Filed July 29, 1964 6 Sheets-Sheet 2

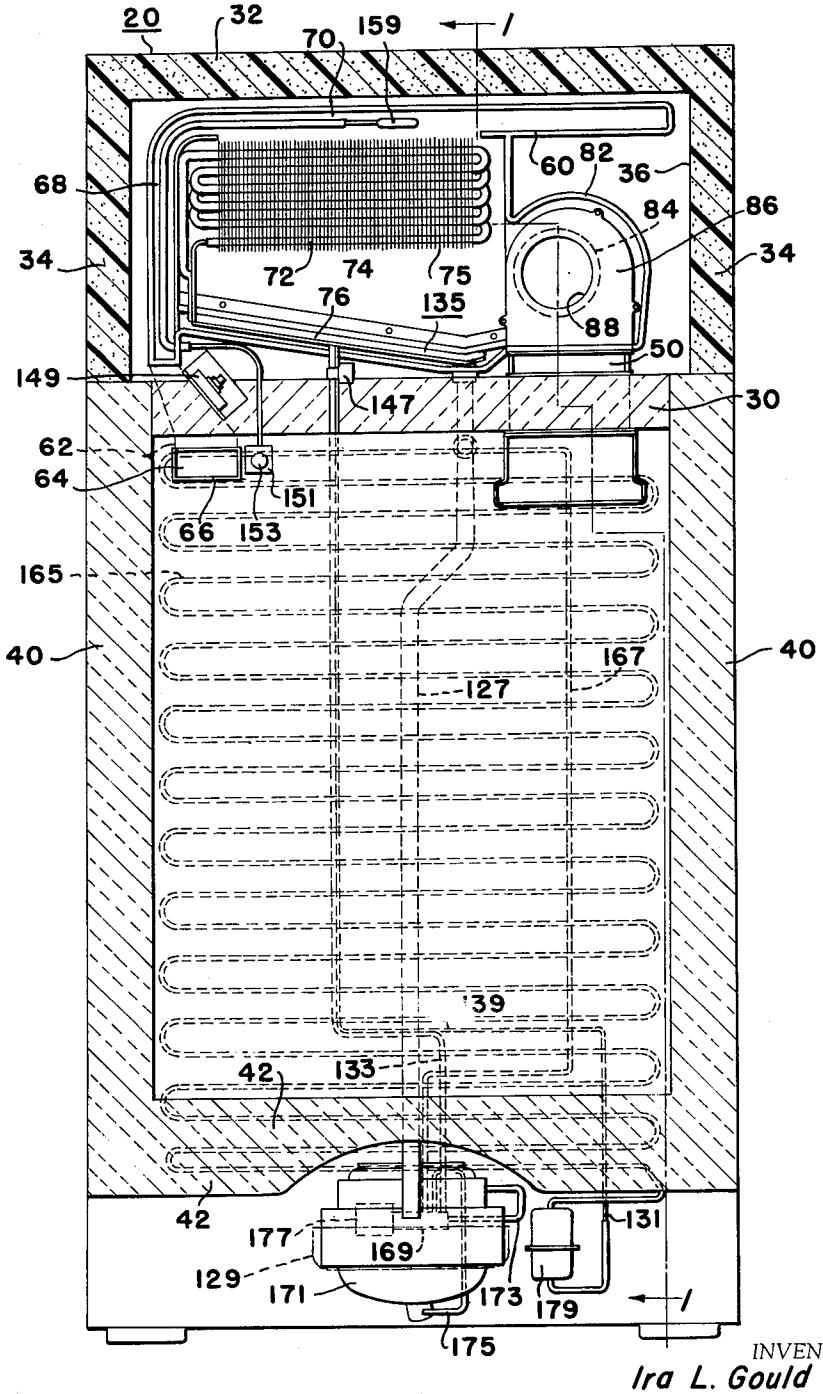


Fig. 2

INVENTOR.
Ira L. Gould
BY
Carl A. Sticker
His Attorney

July 19, 1966 I. L. GOULD 3,261,173

REFRIGERATING APPARATUS

Filed July 29, 1964 6 Sheets-Sheet 3

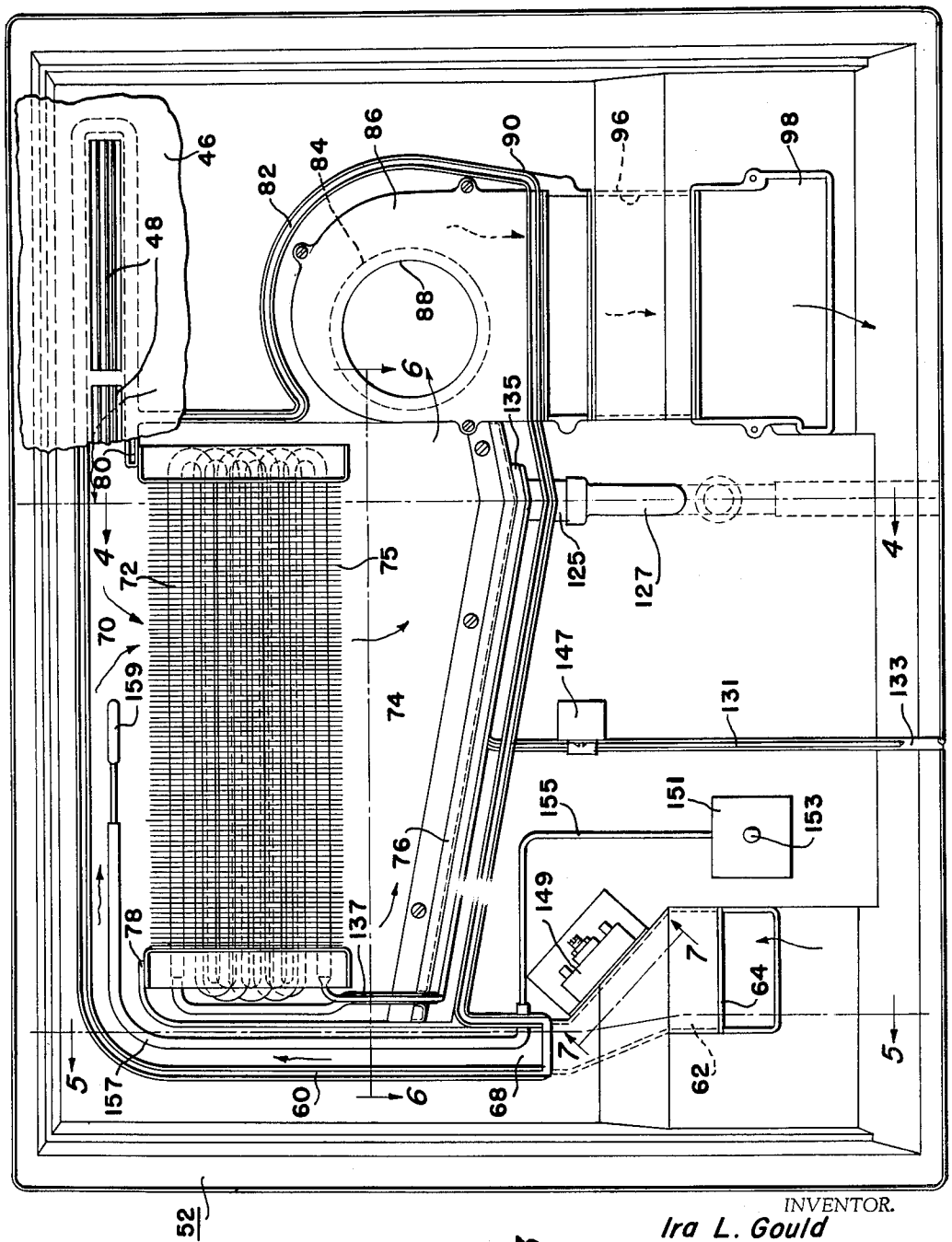


Fig. 3

INVENTOR.
Ira L. Gould
BY Carl A. Stickel
His Attorney

July 19, 1966 I. L. GOULD 3,261,173

REFRIGERATING APPARATUS

Filed July 29, 1964 6 Sheets-Sheet 4

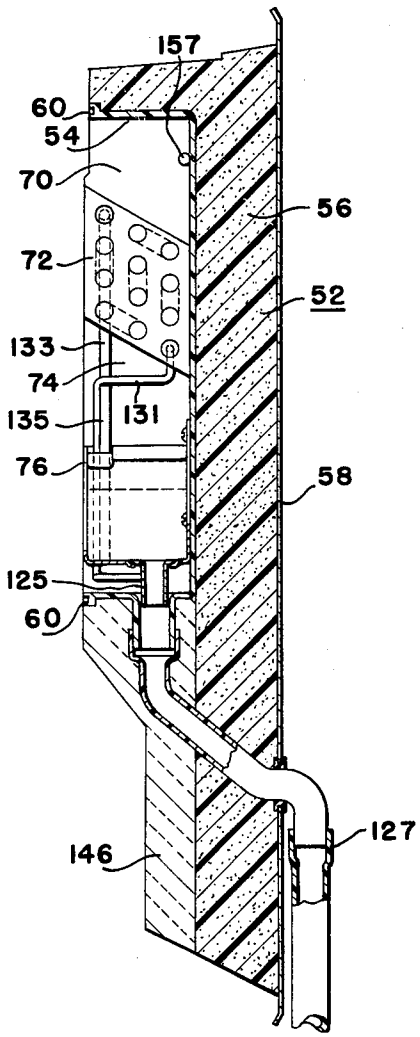


Fig. 4

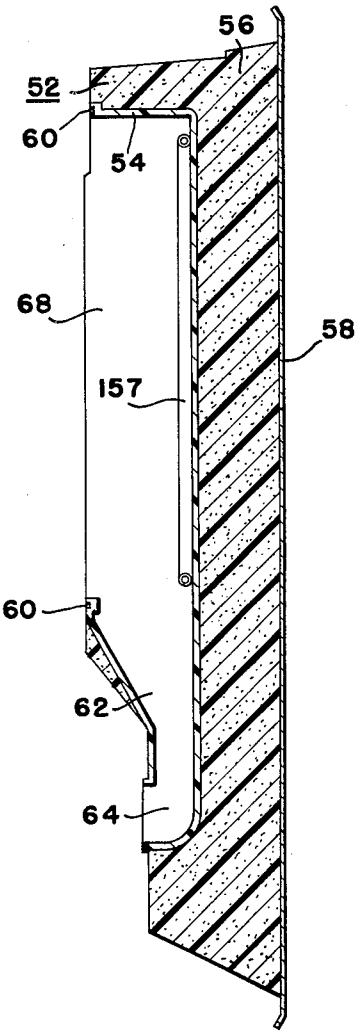


Fig. 5

INVENTOR.
Ira L. Gould
BY
Carl A. Stickel
His Attorney

July 19, 1966 I. L. GOULD 3,261,173

REFRIGERATING APPARATUS

Filed July 29, 1964 6 Sheets-Sheet 5

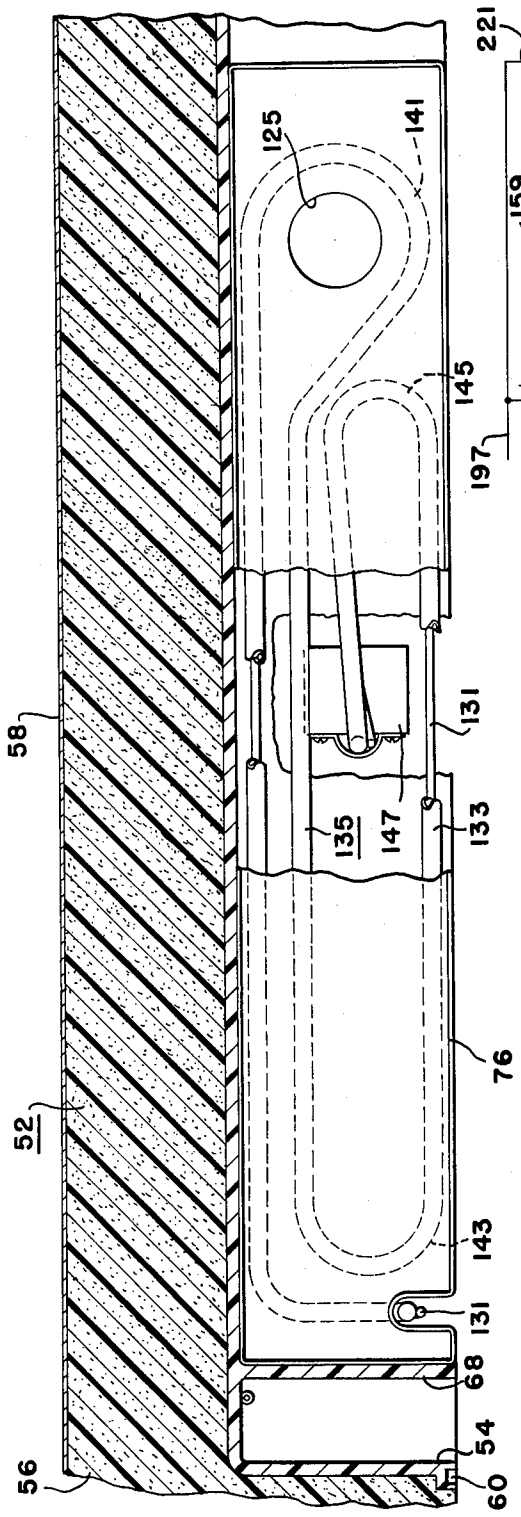


Fig. 6

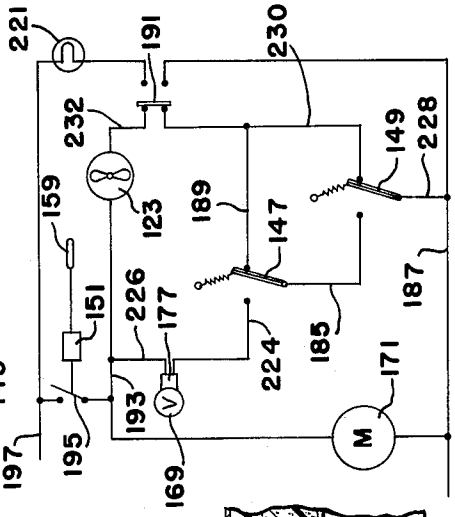


Fig. 8

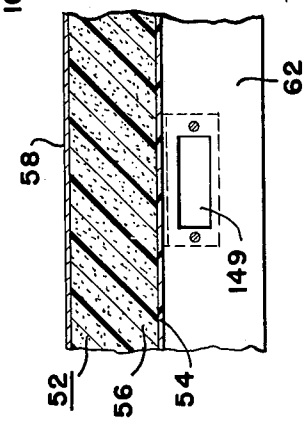


Fig. 7

INVENTOR.
Ira L. Gould
BY
Carl A. Stickel
His Attorney

July 19, 1966 I. L. GOULD 3,261,173

REFRIGERATING APPARATUS

Filed July 29, 1964 6 Sheets-Sheet 6

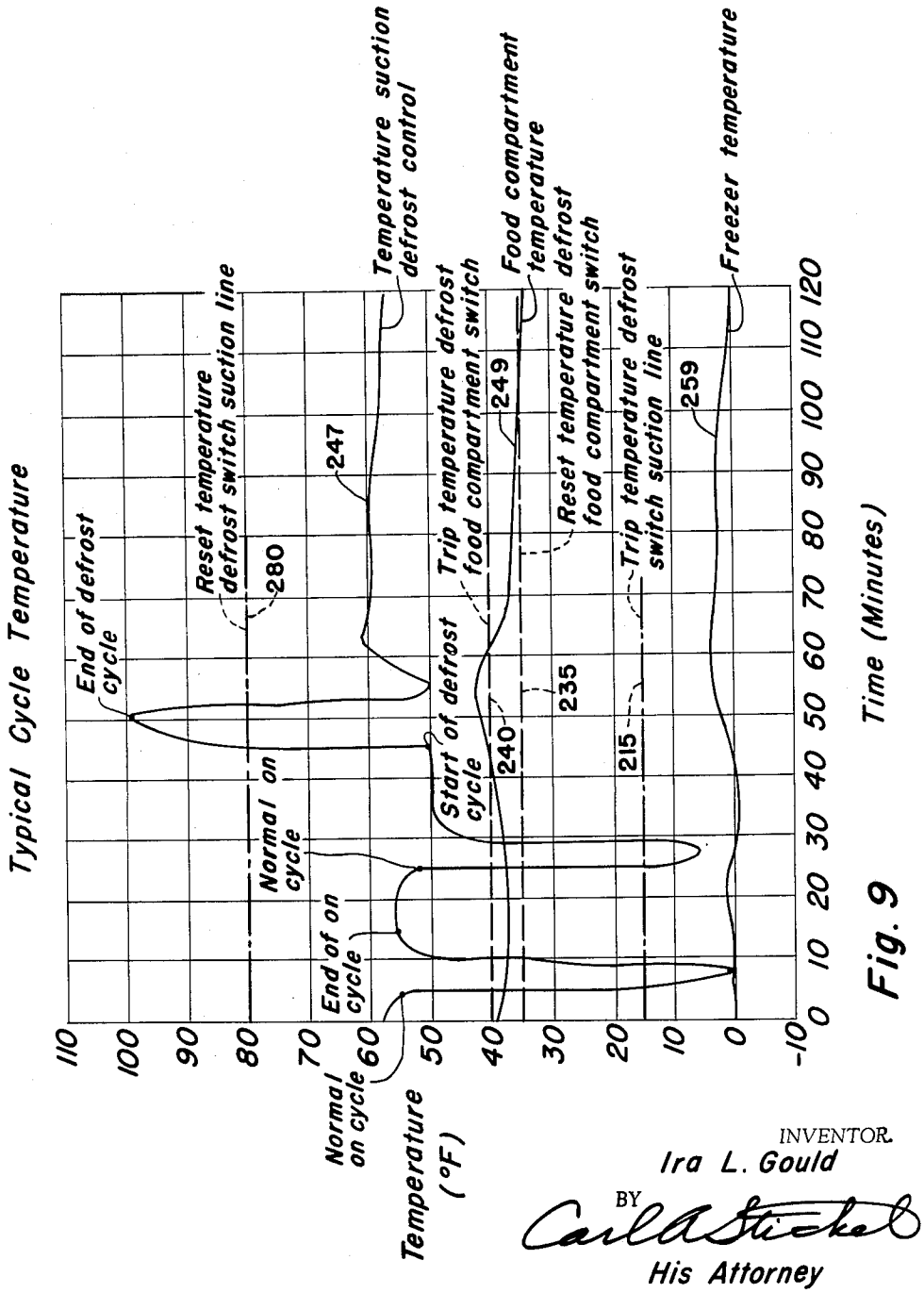


Fig. 9

INVENTOR.
Ira L. Gould
BY
Carl A. Stickel
His Attorney

United States Patent Office 3,261,173 Patented July 19, 1966

3,261,173

REFRIGERATING APPARATUS

Ira L. Gould, Hamilton, Ohio, assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Filed July 29, 1964, Ser. No. 385,906
7 Claims. (Cl. 62—156)

This invention pertains to refrigerating apparatus and more particularly to refrigerators having separate compartments for the frost-free storage of frozen and unfrozen foods.

Refrigerators in which frost does not collect in the freezing compartments and which provide completely automatic defrosting have become popular despite the added first cost resulting from difficulties and complications in construction and assembly and increased operating cost resulting from increased thermal losses and more frequent automatic defrosting involving more heating than necessary.

It is an object of this invention to provide an inexpensive efficient refrigerator in which frost does not collect in the freezing compartment wherein the cooling and air circulating systems are compactly arranged in a removable wall section which cooperates with an inner finish wall to withdraw air from and return air to the compartments.

It is another object of this invention to provide an inexpensive efficient refrigerator in which frost does not collect in the freezing compartment wherein the evaporator is quickly defrosted with a minimum of heat applied only when it is unable to carry the refrigerating load and/or desired refrigerating temperatures in all compartments.

These and other objects are attained in the form shown in the drawings in which the refrigerator cabinet is provided with a removable upright rear wall section containing grooves which cooperate with a false rear wall in the upper below freezing compartment to provide ducts which conduct air from both compartments to the fan and back to the compartments. The motor driven fan as well as the evaporator are located in one of the grooves for circulating the air and cooling the air. The fan and the evaporator and the control system for the entire refrigerating system as well as the condenser and motor compressor unit are all made as a separate removable unit which is assembled separately from the cabinet and when completed is assembled to the cabinet so that the manufacture of the refrigerating unit and the cabinet may continue separately until the final assembly.

When the evaporator is no longer able to keep the above freezing compartment at satisfactory refrigerating temperatures and when the temperature of the interchange has at some preceding time fallen below a predetermined temperature which is assumed to indicate that the evaporator has become coated with frost, a defrost cycle is initiated. The defrost cycle is initiated by operating a reversing valve to make the evaporator become a condenser which provides internal heat for melting the frost from the evaporator with a minimum introduction of heat into the refrigerator. When the interchanger reaches a predetermined high temperature indicating completion of defrosting, the normal cycling is resumed.

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 vertical sectional view taken along the line 1—1 of FIGURE 2 of a refrigerator embodying one form of my invention;

FIGURE 2 is a vertical sectional view taken along the line 2—2 of FIGURE 1;

FIGURE 3 is an enlarged view of the removable rear wall section;

FIGURE 4 is a fragmentary vertical sectional view taken along line 4—4 of FIGURE 3;

FIGURE 5 is a fragmentary vertical sectional view taken along the line 5—5 of FIGURE 3;

FIGURE 6 is an enlarged fragmentary horizontal sectional view taken along the line 6—6 of FIGURE 3;

FIGURE 7 is a fragmentary inclined sectional view taken along the line 6—6 of FIGURE 3;

FIGURE 8 is a wiring diagram; and

FIGURE 9 is a temperature-time graph showing operating and defrost cycles.

Referring now to the drawings and more particularly to FIGURES 1 and 2, there is illustrated an insulated refrigerator cabinet 20 provided with an upper below freezing compartment 22 closed by an insulated door 24 and a lower above freezing food storage compartment 26 closed by the insulated door 28. These compartments are separated by a horizontal dividing wall 30 which may be insulated with glass fiber insulation. The top wall 32 and the upper side walls 34 may be insulated with efficient plastic foam insulation and lined with an inner finish wall 36 of either plastic or sheet metal. The above freezing food storage compartment 26 has its rear wall 38, its side walls 40, and its bottom wall 42 insulated with less expensive, less efficient glass fiber insulation. The doors 24 and 28 may be insulated with efficient plastic foam insulation. This arrangement insulates the refrigerator economically and efficiently since the more efficient plastic foam insulation containing an insulating gas substantially superior to air such as is disclosed in Patent 2,962,183 issued November 29, 1960, is used where the greatest temperature difference prevails while the less expensive glass fiber insulation is used where a lesser temperature differential prevails.

The above freezing food storage compartment is also lined with an inner finish wall surface 44 which may be of metal or a suitable plastic. The below freezing food storage compartment 22 is provided with a false finish rear wall 46 having a series of outlet louvers 48 extending across the top and an air entrance opening 50 at the bottom.

According to my invention, behind the false rear wall 46 and behind the upper portion of the rear finish wall 44 I provide a removable insulated upright rear wall section 52 formed of a one-piece formed plastic member 54 to the one side of which is cast polyurethane plastic foam insulation 56 containing an insulating gas such as trichloromonofluoromethane as disclosed in Patent 2,962,-183. The outer face of the foam insulation 56 may have adhered to it a metal sheet 58. The plastic piece 54 is provided with a continuous groove 60 which receives a sealing strip held after assembly tightly against the false rear wall 46.

As is better shown in FIGURES 3, 4, and 5, the plastic piece 54, the foam insulation 56 and the sheet metal back form a removable unit 52. This removable unit includes a duct 62 having an entrance 64 aligned with an opening 66 in the upper left portion of the rear inner finish wall 44 of the above freezing compartment 26. This duct 62 connects with a groove 68 provided in the plastic member 54 extending adjacent the left side and the top of the removable section or unit 52 where an entrance chamber 70 is provided forming a third compartment communicating through the entrance louvers 48 with the below freezing compartment. The entrance chamber 70 is located directly above the fin and tube type evaporator 72 having vertical fins 75 and horizontal

tubes. The increase the entrance surface and maintain a large face area, this evaporator has its fins **75** in the shape of the an acute rhomboid which reduces its depth and also brings all of the fin surface near the tubing so as to make it more efficient. This evaporator also fits very compactly into the space provided and provides a desirable form of entrance chamber **70** above it.

The plastic member **54** is also provided with a discharge chamber **74** below the evaporator which includes an inclined drip collector and drain trough **76** at the bottom thereof. The sides of the evaporator **72** are fitted at the top against the projections **78** and **80** of the plastic member **54**. The plastic member **54** also includes a scroll housing **82**. Fitting in this scroll housing **82** is a small centrifugal fan **84** covered by the removable cover **86** having a central entrance opening **88**. This cover **86** is spaced away from the false rear wall **46** to form a duct to provide direct communication between the central opening **88** and the discharge chamber **74**. The scroll **82** extends downwardly to provide a large outlet duct **90** terminating at the outlet **50** in the false rear wall **46**. The ice trays **92** are located directly in from of the opening **50** beneath the cover **94** so that they are quickly cooled by the cold air discharged from the outlet **50** beneath the cover **94** around the trays. After the air passes beneath the cover **94**, it is discharged from the front end thereof for distribution throughout the compartment **22**.

The scroll **82** is also provided with a second much more narrow duct **96** terminating in an outlet **98** directly behind a corresponding opening in the upper right corner of the rear finish wall **44** of the above freezing food storage compartment **26**. The fan outlet ducts **90** and **96** are proportioned to deliver about ¾ of the air to the below freezing compartment **22** and ¼ of the air to the above freezing compartment **26**. This outlet **98** is preferably provided with a curved adjustable damper **121** which may be adjusted either manually or thermostatically to maintain the desired above freezing food storage refrigerating temperature in the compartment **26**. The fan **84** is driven by an electric motor **123** fastened to the removable unit **52**. The removable unit **52** also supports the evaporator **72**.

The drip collector and drain trough **76** at its lowest point is provided with an integral drain fitting **125** to which is connected a drain tube **127** extending through the removable section **82** diagonally outwardly and thence downwardly along the back of the rear wall **38** and thence forwardly to a removable drain pan **129** removably supported beneath the bottom wall **42**. The capillary liquid supply tube **131** and the suction conduit **133** are soldered together to form a heat interchanger **135** extending from the point indicated by the reference character **137** adjacent the inlet of the evaporator **72** to a point designated by the reference character **139**. This heat interchanger includes several loops **141**, **143** and **145** directly beneath the drain trough **76**. This is the most active heat interchanging portion and serves to heat the drain trough **76** during the reverse cycle defrosting period so that ice will not clog the drain trough. The heat interchanger **135** extends downwardly from the central portion of the drain trough **76**. Directly below the drain trough **76** where is clamped by a U clamp into heat transfer with an intermediate part of the heat interchanger **135** a first double throw snap acting thermostatic defrost switch **147** which is set so as to operate when cooled by the interchanger to 15° F. from the normal (right) position to the defrost (left) position and from the defrost position to the normal position when warmed by the interchanger to 80° F. as illustrated in FIGURES 3, 6, 8 and 9. The tripping and resetting temperatures of 15° F. and 80° F. are represented by the lines **215** and **280** in FIGURE 9. This switch **147** is located in the glass fiber insulation **146** which is subject to the cold environment of the chamber **72** and the

compartment **22** to assure its responsiveness to the temperature of the interchanger **135** at all times.

The duct **62** is provided with a second double throw snap acting thermostatic defrost switch **149** as is best shown in FIGURES 3, 7 and 9 which is set to move from the normal (right) position to the defrost (left) position when the compartment **26** is not being maintained at satisfactory refrigerating temperatures such as below 40° F. As illustrated in FIGURE 9, this switch **149** which as indicated by the line **249**, is responsive to food compartment temperature and is set to trip from normal to defrost position upon a rise above 40° F. and reset from its defrost to normal position upon a fall below 35° F. as indicated by the lines **240** and **235** in FIGURE 9. The removable section or unit **52** is also provided with a thermostatic control **151** provided with an adjusting knob **153** extending forwardly through the finish wall **44** of the above freezing compartment **26**. This thermostatic control **151** is provided with a thermosensitive tube **155** extending through a plastic covering tube **157** in the duct **68** to the entrance chamber **70** where it may be provided with a bulb **159** above the center of the evaporator **72**. The bulb in this location is therefore responsive to both the temperatures of the above and below freezing compartments. It is responsive to the temperature of the above freezing compartment **26** through the air which flows therefrom through the entrance **64** and the ducts **62** and **66** to the entrance chamber **70**. It is also responsive to the air flowing through the louvers **48** directly into the entrance chamber **70** from the below freezing compartment **22**.

The removable section **52** is provided with beveled peripheral edges **161** fitting corresponding beveled edges in the rear wall structure of the cabinet **20** to provide an efficient seal. The zone beneath the drip collector **76** may be filled with removable glass fiber insulation **146**. The removable section **52** and particularly the rear sheet metal facing **58** is connected to the top of the flanged sheet metal condenser structure **163** supporting the serpentine condenser tubing **165** at the rear of the cabinet **20**. The upper entrance end of the condenser tubing is connected by the downwardly extending tube **167** to a 4-way reversing valve **169** located behind the sealed motor compressor unit **171**. This reversing valve may be similar in principle to that disclosed in Patent 2,976,701 issued March 28, 1961. This reversing valve is also connected to the discharge tube **173** of the sealed motor compressor unit **171**. The suction line **133** is also connected to the reversing valve **169**. The inlet tube **175** of the sealed motor compressor unit **171** constitutes the fourth connection for the reversing valve **169** which is operated to reversing position by a solenoid **177** connected directly to the valve body.

The bottom of the condenser tubing **165** connects to a filter **179** which connects to the entrance end of the capillary tube **131**. The sealed motor compressor unit **171** also has connected to it a superheat remover coil **183** located directly beneath the drain pan **129** so that the contents of the drain pan **129** may be heated and evaporated to make unnecessary the removal of the drain pan **129** to empty defrost water therefrom. Thus the entire operating and control system of the refrigerator is structurally connected in the assembly which includes the removable section **52**, the condenser structure **163**, the sealed unit **171**, the filter **179**, the superheat removal coil **183** and all the connecting tubing and wiring. Thus the cabinet may be manufactured and completed separate from the refrigerating system which can also be manufactured separately and tested. This makes possible economical manufacturing since neither part of the refrigerator interferes with the assembly of the other. The refrigerating system can be readly inserted into and removed from the rear of the cabinet.

The closing of the contacts **195** will cause the normal operation of the sealed motor compressor unit **171** and

when either of the defrost switches **147** or **149** is in the normal position will cause the operation of the fan motor **123** to draw about ¼ of the air from the above freezing compartment **26** through the entrance **66**, the duct **62**, and the groove **68** to the entrance chamber **70** while about ¾ of the air is drawn from the below freezing compartment **22** through the louvers **48** extending across the top of the rear false wall **46** into the entrance chamber **70**. The combined air is cooled by the fins and the tubes of the evaporator **72** as it is drawn downwardly into the discharge chamber **74** by the fan **84**. The cooling of the air by evaporator **72** will cause frost to form in greatest amount on the upper entrance edges of the fins **75** forming the upper inlet face of the evaporator. The thickness of the frost coating on the fins diminishes from the upper entrance edges to the lower exit edges. The rhomboid shape of the fins **75** provides a long entrance edge which distributes the frost across the entrance edges of the fins so that it takes a much longer time for the frost to clog this form of evaporator. Therefore defrosting is not required frequency. The refrigeration is stopped whenever the thermostatic control **151** reaches a temperature of 5° F. assuring the maintenance of cold below freezing temperatures in the compartment **22**. It is also stopped whenever either the doors are opened by the operation of the double throw switch **191** which in the opposite position illuminates the illuminating light **221** within the compartment **26**. This stops the operation of the fan **123** directly but this does not directly effect the operation of the motor compressor unit **171**.

When the fins **75** of the evaporator **72** become sufficiently frosted, the air flow through the evaporator **72** will be reduced considerably. Since ¾ of the cold air is circulated to the below freezing compartment **22** and only ¼ to the above freezing compartment **26**, the effect of this reduction is quicker and greater upon the compartment **26** as illustrated by the line **249** than in the below freezing compartment **22** as illustrated by the line **259** in FIGURE 9. This reduction in air flow together with the insulating effect of the frost also will cause the temperature of the evaporator **72** to be reduced during the operation of the motor compressor unit. The evaporator **72** will therefore have less cooling effect upon the air and particularly will receive less heat from the air so that its temperature will be lowered and less refrigerant will be evaporated in the evaporator. This will cause more and more liquid to flow out of the evaporator **72** into the suction conduit **133**. This amount of liquid refrigerant will gradually overcome the warming effect of the liquid flowing through the capillary supply tube **133** so that the interchanger **135** will become progressively colder with the cold point moving away from the evaporator **72** toward the reversing valve **169**.

The wiring diagram, FIGURE 8, illustrates the normal positions of the double throw snap acting thermostat defrost switches **147** on the suction line and **149** on the food compartment outlet duct **62**. The food compartment switch **149** as indicated by the line designated by reference character **240** on the temperature chart, FIGURE 9, is set to move from the normal position to the defrost position at 40° F. This is intended to indicate that the evaporator **72** is frosted sufficiently that it can no longer carry the refrigeration load. This thermostatic switch **149**, however, cannot be relied upon alone to indicate a need for defrosting the evaporator since a refrigerator on being newly installed and operated in a residence for the first time would be above this 40° F. temperature for a considerable period of time until the refrigerator was cooled to proper refrigerating temperatures. Therefore under such circumstances the switch **149** would repeatedly call for defrosting of the system which would prevent the refrigerator from properly refrigerating. The evaporator **72**, however, would be without frost under such conditions.

The suction line switch **147** as indicated by the reference character **215** in the temperature chart, FIGURE 9, is set to operate from the normal position to the defrost position when it is reduced to a temperature of 15° F. This switch cannot alone be used to indicate the need for defrosting because ordinarily for a very short time at the start of every running or refrigerating cycle an amount of liquid refrigerant is unavoidably drawn into the suction conduit sufficient to cool the switch **147** below the tripping temperature of 15° F. even though the evaporator **72** is not frosted. However, during conditions of an initial start up and also following a defrost cycle, as well as under abnormally high room temperature conditions, this initial surge or drawing of the liquid refrigerant into the suction line does not occur.

Therefore according to my invention I arrange so that it is necessary for both of the switches **147** and **149** to move to the defrost position before a defrosting cycle can occur. With this dual type of defrost control, the switch **147** remains in the normal position to prevent the occurrence of a defrost cycle while the switch **149** remains in the defrost position during abnormally high room temperature conditions and initial starting conditions when the evaporator **72** is not frosted. The operation of the refrigerating system when the refrigerator is initially started is illustrated beginning with the 50 minutes location on the temperature chart of FIGURE 9. The temperature of the suction line defrost switch **147** as indicated by the line **247** remains high for a long time. It is well above the switch tripping point indicated at 15° F. by the line **215**. The temperature of the switch **149** is responsive to the temperature of the above freezing food storage compartment **26** which as indicated at 50 minutes begins initially at room temperature and then is slowly reduced as the refrigerating system operates. This food storage compartment temperature is indicated on the temperature-time graph, FIGURE 9, by the line **246** which substantially indicates the temperature of the switch **149** also. As indicated in FIGURE 9, the switch **149** resets to the normal position when its temperature is lowered to 35° as indicated by the line **235** in FIGURE 9. The food compartment **26** is reduced to this reset temperature of 35° at the time of 105 minutes on FIGURE 9. After this, under normal operating conditions, the switch **149** is relied upon to prevent unnecessary defrosting cycles.

During and after the initial refrigeration or pull down cycle, the suction line temperature at the switch **147** will remain high because of the effect of the heat exchange with the liquid line carrying warm liquid from the condenser. This is indicated by the line **247** at the zero time on the temperature-time chart of FIGURE 9. However, on the next refrigeration cycle which may be similar to the cycle shown between 5 and 15 minutes on FIGURE 9 it is very likely that some liquid refrigerant will be initially drawn from the evaporator **72** unavoidably and enter the suction conduit **133** and cool the switch **147** below its tripping temperature of 15° F., thereby operating the switch **147** from the normal position to the defrost position. Defrosting, however, is prevented as long as the temperature of the switch **149** remains below 40° F. as indicated by the line **249** in FIGURE 9. As shown in the wiring diagram of FIGURE 8, the switch **147** is in the normal (right) position. This switch **147** however is ineffective in the defrost (left) position as long as the switch **149** is in the normal position. The switch **149** is not sensitive to door openings as long as 6 minutes because the door switch **191** stops the fan **84** and because of the lag effect of its location in the insulation alongside the duct **62**. Thus normal door openings will not cause unnecessary defrost cycles.

When the switch **149** is in the normal or right position as shown in FIGURE 8, it connects the supply conductor **187** through the conductor **228** and the conductor **230** with the normally closed door switch **191** which in

turn is connected through the conductor **232** with the fan motor **123** which connects through the conductor **193** and the thermostatic switch **195** with the second supply conductor **197**. As long as the food compartment switch **149** remains in the normal position, the suction line switch **147** is effectively disconnected even though this switch **147** should move from the right normal position to the left defrost position providing a connection between the conductor **185** and **224** which connects with the reversing valve solenoid **177**. Therefore this reversing valve circuit will not be effective until the switch **149** reaches a temperature of 40° F. and moves from its normal right position to its normal left position.

A normal cycle preceding a defrost cycle is indicated on FIGURE 9 beginning at the 20 minute vertical line. As indicated by the line **247**, the suction line temperature at the switch **147** will first fall below the 15° mark indicated by the line **215** and then rise to a temperature of about 50° F. Because of the accumulation of frost on the evaporator **72**, there is a gradual rise in food compartment temperature from about 38° to 40° F. This is reached at about 40 minutes or shortly thereafter. This is indicated by the intersection of the line **249** with the line **240** shortly after the 40 minute point in FIGURE 9. This rise in temperature to 40° F. is sufficient to cause the switch **149** to be moved from the normal position to the defrost position. This completes the defrost circuit from the supply conductor **189** through the conductor **228**, the switch **149** in its left or defrost position, the conductor **185**, the switch **147** in its left or defrost position, the conductor **224**, the solenoid **177** of the reversing valve **169** and the conductors **226** and **193**.

The warm condition of the compartments **22** and **26** will cause the thermostatic switch **151** to close its contacts **195** thereby energizing both the solenoid **177** and the sealed motor compressor unit **171**. The energization of the solenoid **177** will cause the reversing valve **169** to be moved into the reversing position thereby causing the output of the compressor unit **171** to be delivered direct to the evaporator **72** to apply thereto hot compressed gas which will liberate heat to the evaporator from the inside of the tubing thereof and condense. This will quickly melt the frost from the evaporator **72** without substantially raising the temperature of the air in the circulating ducts or in the compartments **22** and **26** since the fan motor **123** is deenergized as indicated on FIGURE 9, the freezing compartment temperature rises only from 0° F. to 4° F. and the food compartment temperature rises only from 40° F. to 43° F. The melting frost will be collected by the drip collector and trough **76** and will drain to the outlet **125** from which the defrost water will be conducted through the tube **127** to the drain **129**. The evaporator **72** will warm up as soon as the frost is melted therefrom and the switch **147** will be quickly heated to its tripping temperature of 80° as indicated by the intersection of the lines **247** and **280** at about 45 minutes on FIGURE 9 which will cause it to return to its normal position. This will terminate the defrost cycle and prevent the immediate recurrence of another defrost cycle. This also will reenergize the fan motor **123**. The continued operation of the motor compressor unit **127** will gradually reduce the temperature of the above freezing compartment below to 35° which will cause the switch **149** to return to its normal position. This will prevent the recurrence of another defrost cycle until this compartment **26** again rises above 40° F.

The switch **147** is most essential as a frost detector under abnormally high room temperature and high humidity conditions. Under such circumstances the refrigerating system often will operate continuously and with frequent door openings will not be able to keep the temperature of the compartment **26** below 40° F. This, therefore will cause the food compartment temperature defrost switch **149** to be continuously in the defrost position even though the evaporator **72** is relatively free of frost. However, as long as the evaporator is not heavily frosted there will be no cold liquid refrigerant drawn into the suction line far enough to cool the suction line switch **147** below its tripping temperature of 15° F. The reason for this is that sufficient warm liquid refrigerant flows through the capillary liquid supply tube **131** in heat transfer with the suction conduit **133** to keep the suction conduit **133** and the switch **147** at a temperature well above its tripping temperature of 15° F.

However, as the frost upon the evaporator **72** increases, the air circulated by the fan **84** will have less heating effect on the evaporator and therefore the rate of the evaporation of refrigerant in the evaporator **72** will be reduced so that the fluid entering the suction line will become more and more liquid. This will have an increased cooling effect in the suction conduit **133** sufficient to counteract more of the heating effect of the warm liquid refrigerant in the capillary supply tube **131**. This increased cooling will extend more and more toward the motor compressor unit **171** until it cools the switch **147** down to its tripping temperature of 15° F. Thus under these conditions the switch **147** acts as a primary detector of the time to begin a defrost cycle. The tripping of the switch **147** from the normal position to the defrost position under such circumstances will initiate a defrost cycle which will have a similar effect upon temperatures as the defrost cycle beginning at the 50 minute line in FIGURE 9.

Through the arrangement for internally heating the evaporator, defrosting is accomplished very rapidly and substantially all the heat generated is applied inside the frost coating surrounding the evaporator and not to the remainder of the refrigerator. Because of this, little heat is introduced into the refrigerator and little refrigeration time is lost. Defrosting takes place only when necessary since both defrost controls are required to be in defrost position before a defrost cycle can be initiated. The defrost control elements and wiring are also a part of the removable unit so that the removable unit can be tested in its entirety before assembly into the cabinet.

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 an insulated cabinet having first and second compartments insulated from each other, an evaporator, means for circulating air from said first and second compartments into heat transfer with said evaporator and returning the air in proportions to maintain said first compartment at below freezing temperatures and to maintain said second compartment at above freezing refrigerating temperatures, a refrigerant liquefying means, supply and return conduit means having portions in heat interchanging relation operatively connecting said evaporator and said liquefying means, means for defrosting said evaporator, temperature responsive means responsive to a predetermined high temperature of said second compartment and a concurrent predetermined low temperature of a part of said portions in heat interchanging relation for initiating the functioning of said defrosting means, said portions in heat interchanging relation comprising a substantial portion between said temperature responsive means and said evaporator.

2. A refrigerator including an insulated cabinet having first and second compartments insulated from each other, an evaporator, means for circulating air from said first and second compartments into heat transfer with said evaporator and returning the air in proportions to maintain said first compartment at below freezing temperatures and to maintain said second compartment at above freezing refrigerating temperatures, a refrigerant liquefying means, a drip collector located beneath said evaporator, supply and return conduit means operatively connecting said evaporator and said liquefying means having portions near said evaporator located in heat transfer

relation with said drip collector, first temperature responsive means in heat transfer with said return conduit means between the portions located in heat transfer with said drip collector and said liquefying means, said supply and return conduit means being located in heat transfer with each other throughout the heat transfer relation with the drip collector, second temperature responsive means responsive to the temperature of said second compartment, and means responsive to the concurrence of the operation of both said first and second temperature responsive means for initiating the defrosting of said evaporator.

3. A refrigerator including an insulated cabinet having first and second compartments insulated from each other, an evaporator having an inlet face, means forming a third compartment adjacent said inlet face provided with inlet means connecting with said first and second compartments, means for circulating air from said first and second compartments through said inlet means and said third compartment into heat transfer with said evaporator and returning the air in proportions to maintain said first compartment at below freezing temperatures and to maintain said second compartment at above freezing refrigerating temperatures, a refrigerant liquefying means operatively connected to said evaporator, and temperature responsive control means out of contact of said evaporator responsive to a temperature in said third compartment for controlling said liquefying means.

4. A refrigerator as set forth in claim 3, in which the control means is located in the second compartment and has a thermosensitive tube extending therefrom through the duct means to the third compartment.

5. A refrigerator including an insulated cabinet having adjoining first and second compartments located one entirely above the other and provided with an insulated separating wall between the compartments, said cabinet being provided with an upright removable insulated wall section having insulated overlapping portions overlapping at least a portion of said first and second compartments, said removable insulated wall section being provided with fan means and duct means extending in the insulated overlapping portions for conducting air from said first and second compartments to said fan means and back to said compartments, and cooling means located in and supported by said removable insulated wall section for cooling air in said duct means.

6. A refrigerator including an insulated cabinet having an upper below freezing compartment and a lower above freezing compartment with all parts of said upper compartment located entirely above all parts of said lower compartment and an insulated separating wall separating said compartments, said below freezing compartment being provided with an upright outer insulated wall containing and supporting an evaporator and containing an entrance chamber above the evaporator having an entrance adjacent the top of and communicating with the below freezing compartment, said upright outer insulated wall having within it a passage extending out from the interior of said above freezing compartment to and discharging into said entrance chamber and having in it a discharge chamber adjacent said evaporator and fan means having an inlet connected to said discharge chamber, said fan means being provided with a first outlet discharging into said below freezing compartment and a second outlet discharging into the above freezing compartment.

7. A refrigerator including an insulated cabinet having adjoining first and second compartments provided with an insulated separating wall between the compartments, said cabinet being provided with interior finish walls for said first compartment, said cabinet being provided with an upright removable insulated wall section alongside said first compartment, said removable insulated wall section having insulation provided with deep connecting grooves cooperating with said interior finish walls to form duct means, said interior finish walls, having openings providing communication with said grooves, said removable wall section being provided with fan means and air cooling means in one of said grooves for drawing air from said compartments through said grooves and cooling the air and delivering the cooled air back to said first and second compartments.

References Cited by the Examiner

UNITED STATES PATENTS

1,793,244	2/1931	Phelps	165—151 X
1,946,227	2/1934	McGrail	165—181 X
2,136,222	11/1938	Starr	165—151 X
2,285,945	6/1942	Rundell	62—449 X
2,392,727	1/1946	Dailey	62—449
2,423,175	7/1947	Churchill et al.	165—134 X
2,798,367	7/1957	Earle	62—449 X
3,071,935	1/1963	Kapeker	62—156 X
3,097,502	7/1963	Krueger	62—156
3,107,500	10/1963	Coad	62—156
3,119,240	1/1964	Devery	62—419 X

LLOYD L. KING, *Primary Examiner.*

ROBERT A. O'LEARY, *Examiner.*