April 20, 1943. L. A. PHILIPP 2,317,082

REFRIGERATING APPARATUS

Filed Dec. 6, 1940 2 Sheets-Sheet 1

Fig. 1.

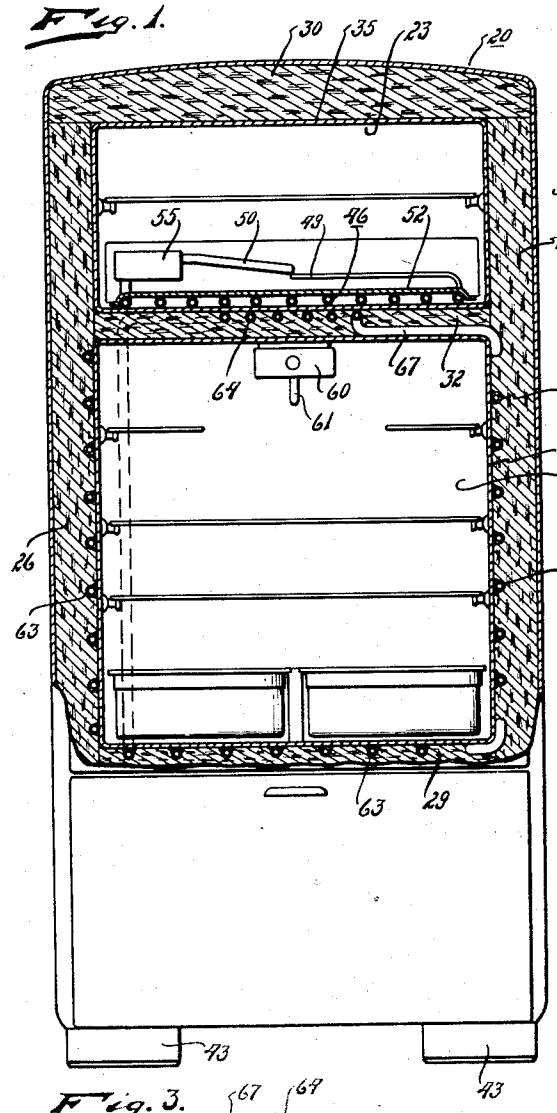


Fig. 2.

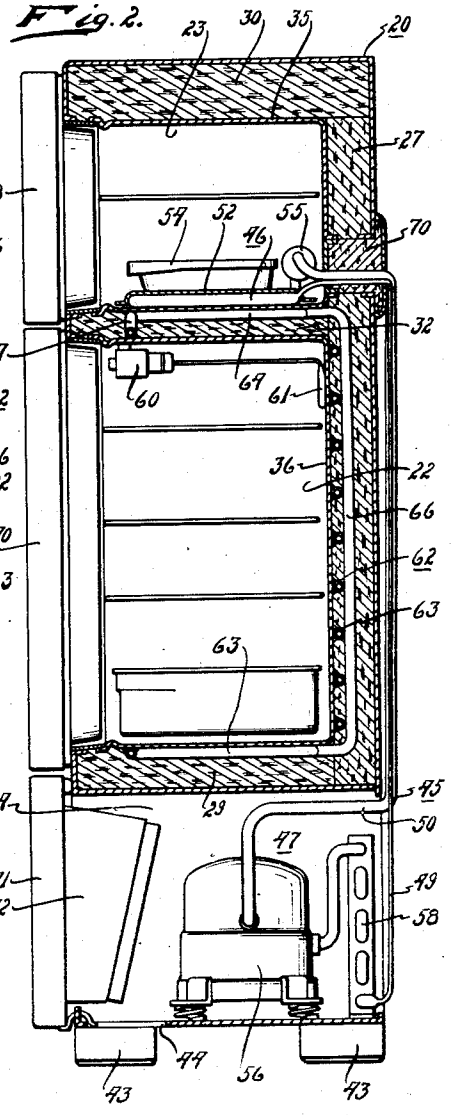
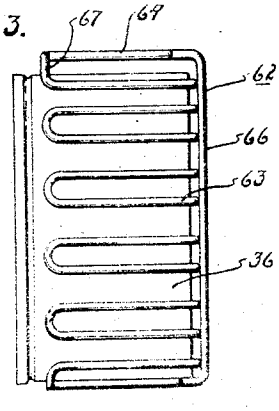


Fig. 3.



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Fig. 4.

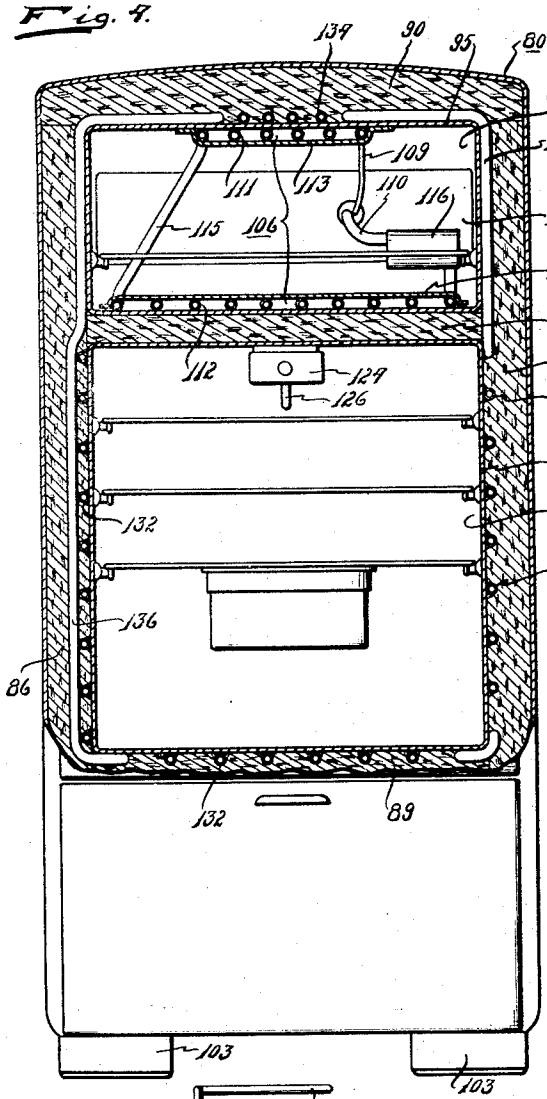


Fig. 5.

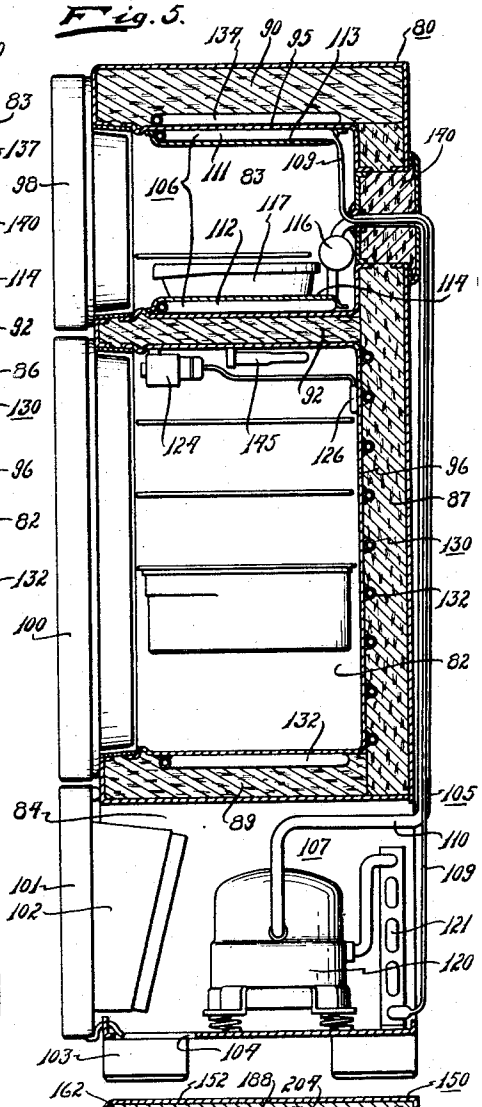


Fig. 6.

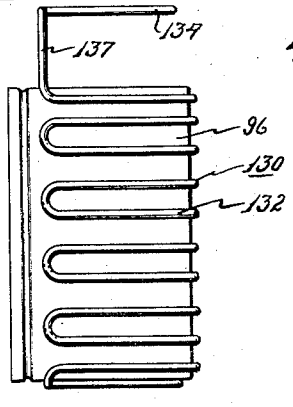
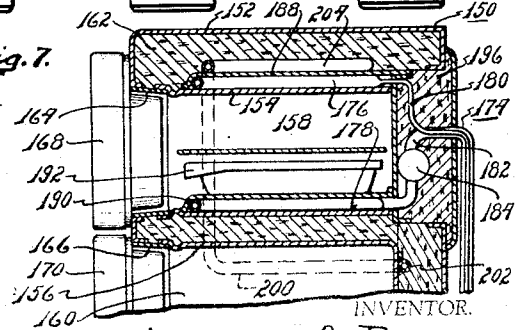


Fig. 7.



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REFRIGERATING APPARATUS

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Application December 6, 1940, Serial No. 368,845

1 Claim. (Cl. 62—116)

This invention relates to refrigerating apparatus, and, more particularly, to refrigerating apparatus of the multiple temperature type.

One of the objects of my invention is to provide an improved refrigerating apparatus which maintains a food storage compartment at a relatively high refrigerating temperature and a relatively high humidity and at the same time maintains a freezing compartment at a relatively low temperature.

A further object of my invention is to provide an improved refrigerating apparatus which includes an insulated cabinet having a freezing compartment and a food storage compartment which are formed by metallic inner linings, with a primary refrigerating system having one or more cooling elements thermally associated with the freezing compartment and having at least one arranged in direct contact with the metallic inner lining of that compartment, and a secondary refrigerating system having a cooling element arranged in direct contact with substantially all of the outside surface of the metallic inner lining of the food compartment, and also having a condensing element arranged in heat conducting relation with that cooling element of the primary system which is in direct contact with the inner lining of the freezing cimpartment.

It is also an object of the present invention to provide an improved refrigerating apparatus which includes an insulated cabinet whose interior is divided into two compartments separated by an insulating wall, each of which compartments is provided with a metallic inner lining, a primary refrigerant evaporator thermally associated with one of the compartments for maintaining sub-freezing temperatures throughout said compartment, a secondary refrigerant evaporator arranged in direct contact with substantially all of the outside surface of the inner lining of the other compartment for cooling circulating air therein, and a secondary condenser connected to said secondary evaporator and arranged in direct contact with the metallic lining of the first mentioned compartment.

Another object of my invention is to provide an improved arrangement for the ready removability of the aforesaid primary refrigerating system as a unitary structure without disturbing the secondary system.

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 front vertical view partly in elevation and partly in cross-section of a refrigerating apparatus embodying features of my invention;

Fig. 2 is a side vertical view partly in elevation and partly in cross-section of the apparatus shown in Fig. 1;

Fig. 3 is a side vertical view in elevation of a portion of the apparatus shown in Fig. 1;

Fig. 4 is a front vertical view partly in elevation and partly in cross-section of a modified form of refrigerating apparatus embodying features of my invention;

Fig. 5 is a side vertical view partly in elevation and partly in cross-section of the apparatus shown in Fig. 4;

Fig. 6 is a side vertical view in elevation of a portion of the apparatus shown in Fig. 4; and

Fig. 7 is a fragmentary view in cross-section of a modified form of refrigerating apparatus embodying features of my invention.

Referring to the drawings, the numeral **20** designates, in general, a cabinet having a compartment **22** for the storage of foods to be refrigerated, a freezing compartment **23** and a machine compartment **24**. The cabinet is provided with insulated walls for enclosing the food storage and freezing compartments, including side walls **26**, rear wall **27**, bottom wall **29** and top wall **30**. The food storage compartment and the freezing compartment are separated by a fixed, substantially horizontally disposed insulated wall **32**. An inner metallic lining member **35** forms the inner walls of the freezing compartment while an inner metallic lining member **36** forms the inner walls of the food storage compartment. Both of these lining members are preferably provided with a coating of vitreous enamel, such as porcelain, to provide neat appearing compartments and ones which may easily be cleaned. The freezing compartment **23** is provided with an opening at the front of the cabinet which is closed by a door **38** while the food storage compartment is similarly provided with an opening at the front of the cabinet which is closed by a door **40**. The machine compartment **24** is also provided at the front of the cabinet with an opening adapted to be closed by a movable door **41**. The inner side of this door is provided with a bin **42** for storing vegetables and the like. The entire cabinet is raised above the level of the floor by legs **43** to allow air from the room to circulate freely through an opening **44** in the bottom of the machine compartment into said compartment.

Numeral **45** designates, in general, a primary refrigerating system which includes a refrigerant cooling or evaporating element **46** disposed in the freezing compartment **23** and a refrigerant condensing or circulating element **47** disposed in the machine compartment **24**. These elements are operatively associated with one another by

a liquid supply conduit 49 and a vapor return conduit 50. The entire primary refrigerating system is adapted to be removed as a unit whenever desired as will be later described.

The evaporating element 46 comprises, in general, a serpentine conduit arranged in a single plane and removably secured to the inner lining member 35 at the bottom of freezing compartment 23 by means of a sheet metal plate 52. Supply conduit 49 is connected to one end of the conduit 46 while the other end of the conduit 46 is connected to an accumulator 55 which in turn opens into the return line 50. The cooling element is adapted to provide a surface upon which a receptacle 54 may be placed for quick freezing of its contents and also is adapted to maintain sub-freezing temperatures throughout the compartment.

The refrigerant condensing element 47 comprises, in general, a motor compressor unit 56 and a condenser 58. The motor compressor unit is of the type which includes a compressor and motor directly connected and enclosed within a hermetically sealed casing. Units of this type are well known in the art and further illustration thereof in the drawings is deemed unnecessary. The cooling of the condensing element may be accomplished either by forced or natural convection, the latter being the one illustrated. Air from the room circulates through the opening 44 and thence over the condensing unit. A flue (not shown) may be provided on the rear wall of the cabinet for enhancing the natural convection effect as is well understood in the art.

In operation, the compressor withdraws evaporated refrigerant from the evaporating element through the vapor conduit 50, compresses the gaseous refrigerant and delivers it to the condenser 58 wherein it is liquefied and from which it is delivered in liquid form to the evaporator 46 through the supply conduit 49, which, preferably, consists of a length of capillary tubing serving also as a restrictor. This tubing is of proper dimensions to meter the quantity of liquid refrigerant flowing from the condensing element to the evaporating element during entire operation of the system. It is preferably secured to the vapor return conduit 50 in intimate heat exchange relation therewith.

Preferably, the condensing element is intermittently operated. In order to control the operation of the condensing element, there is provided a thermostatically controlled switch 60 to which is connected a thermostat fluid containing bulb 61 which is disposed in direct contact with the inner lining member 36 of the food storage compartment which is cooled in a manner described below. The switch 60 is adapted to open and close the circuit to the motor of unit 56 in response to predetermined changes in temperature within the food storage compartment. Preferably, the thermostat is set so that the evaporating element 46 will be operated at temperatures which cause rapid freezing and so that the food storage compartment will be maintained at temperatures which are slightly above that which would be likely to cause the formation of frost in the food compartment.

Numeral 62 designates, in general, a secondary refrigerating system which is adapted to maintain the food compartment 22 at a relatively high and uniform refrigerating temperature and at a relatively high humidity so that little dehydration of the food stored therein is accomplished. This system includes a cooling or evaporating element designated in general by the number 63 and a condensing element designated in general by the number 64. These are operatively connected by a liquid supply conduit 66 and a vapor return conduit 67. The evaporating element 62 consists of a sinuous conduit which is secured in any suitable fashion as by soldering or by some cementing material such as "Hydrolene" in intimate heat conducting relationship to the outside of the inner lining member 36 of the food compartment. This conduit runs back and forth across the bottom of the liner, then progressively upwardly, embracing three sides of the liner as shown in Fig. 3 until it reaches the top of the lining member where it joins with the vapor return conduit 67. The condensing element 64 comprises a serpentine conduit arranged in a horizontal plane. This conduit is disposed in the insulated wall 32 and is secured in intimate heat exchange relation by any suitable means to lining member 35 immediately below the primary evaporator 46 in order to condense the refrigerant evaporated in the secondary system. The temperature of the refrigerant in the secondary system is determined by the effectiveness of the heat transfer from the secondary condenser to the primary evaporator. The extent or effectiveness of the heat transfer therebetween can be regulated by varying the area of surface of the condenser contacting the inner lining member to produce the desired temperature within the food compartment. The temperature differential between the two compartments may of course be varied in other ways as by introducing inert gas into the secondary system.

In operation, the refrigerant evaporated within the secondary system by the heat from the food compartment is conveyed by the return conduit 67 to the condenser 64 where it is condensed and delivered by gravity in liquid form through conduit 66 to the conduit at the bottom of the lining member 36. It then circulates upwardly through the sinuous conduit wrapped around the side walls of the lining member up to the top thereof. In this manner the entire food compartment is cooled to a substantially uniform refrigerating temperature throughout since no part of the compartment is unexposed to the heat absorbing effect of the secondary evaporator.

The primary refrigerating system is adapted to be removed as a unit from the cabinet without disturbing the secondary system. The primary refrigerant evaporator is removably secured to the lining member 35 of the freezing compartment by the plate 52 which is fastened to the lining member in any suitable releasable fashion as by screws, bolts or the like (not shown). The condensing unit is adapted to slide out the back of the machine compartment. A removable insulated plug 70 is provided in the rear wall of the freezing compartment. The vapor return and liquid supply conduits extend through the plug 70 into the freezing compartment to connect with the evaporator. The entire primary system may accordingly be removed as a unitary assembly from the cabinet for the purposes of repair, etc., while another primary may readily be inserted in its place, if desired.

Referring now to Figs. 4, 5 and 6, there is shown a cabinet 80, which is similar to cabinet 20, and includes a compartment 82 for the storage of foods to be refrigerated, a freezing compartment 83 and a machine compartment 84. The cabinet is provided with insulated walls for

enclosing the food storage and freezing compartments, including side walls 86, rear wall 87, bottom wall 89 and top wall 90. The food storage compartment and the freezing compartment are separated by a fixed, substantially horizontally disposed, insulated wall 92. An inner metallic lining member 95 forms the inner walls of the freezing compartment while an inner metallic lining member 96 forms the inner walls of the food storage compartment. Both of these lining members are preferably provided with a coating of vitreous enamel, such as porcelain to provide neat appearing compartments and ones which may easily be cleaned. The freezing compartment 83 is provided with an openeing at the front of the cabinet which is closed by a door 98 while the food storage compartment is similarly provided with an opening at the front of the cabinet which is closed by a door 100. The machine compartment 84 is also provided at the front of the cabinet with an opening adapted to be closed by a movable door 101. The inner side of this door is provided with a bin 102 for storing of vegetables. The entire cabinet is raised above the level of the floor by means of legs 103 to permit air from the room to circulate freely through an opening 104 in the bottom of the machine compartment into said compartment.

Numeral 105 designates, in general, a primary refrigerating system which includes a refrigerant cooling or evaporating element 106 disposed in the freezing compartment 83 and a refrigerant condensing or circulating element 107 disposed in the machine compartment 24. These elements are operatively associated with one another by a liquid supply conduit 109 and a vapor return conduit 110. The entire primary refrigerating system is adapted to be removed as a unit whenever desired as will later be described.

The evaporating element 106 comprises, in general, a sinuous conduit arranged in two horizontal planar sections 111 and 112, connected in series. Section 111 is removably secured to the top of the inner member 95 by means of a sheet metal plate 113 while section 112 is removably secured to the bottom of the inner lining member 95 by means of a sheet metal plate 114. Supply conduit 109 is connected to one end of evaporator section 111 which is in communication with evaporator section 112 through a conduit 115. Section 112 communicates with an accumulator 116 which opens into the vapor return line 110. The lower evaporator section is adapted to provide a surface upon which a receptacle 117 may be placed for quick freezing of its contents. The two evaporator sections combine to maintain a uniform sub-freezing temperature throughout the entire compartment 83.

The refrigerant condensing element 107 comprises, in general, a motor and compressor unit 120, and a condenser 121. The cooling of the condensing unit may be accomplished either by forced or natural convection the latter being the one illustrated. Air from the room circulates in the well-known manner through the opening 104 over the condenser and out the rear of the cabinet. A flue (not shown) is preferably provided at the rear of the cabinet to enhance the natural convection effect.

In operation, the compressor withdraws gaseous refrigerant from the evaporator 106 through the vapor return conduit 110, compresses the gaseous refrigerant and delivers it to the condenser 121 wherein it is liquefied and from which it is delivered in liqued form to the evaporator 106 through the liquid supply conduit 109. The flow of liquid refrigerant to the evaporator is controlled, preferably, by the supply conduit itself which comprises a capillary tube of proper dimensions to meter the quantity of liquid refrigerant flowing from the condensing element to the evaporating element during entire operation of the system. This capillary conduit is preferably secured to the return vapor conduit 110 in intimate heat exchange relation therewith.

Preferably, the condensing element is intermittently operated. In order to control the operation of the condensing element, I have provided a thermostatically controlled switch 124 to which is connected a thermostat fluid containing bulb 126 which is disposed in direct contact with the inner lining member 96 of the food storage compartment. The switch 124 is adapted to open and close the circuit to the motor of unit 120 in response to predetermined changes in temperature within the food storage compartment. Preferably, the thermostat is set so that the evaporating element 112 will be operated at temperatures which cause rapid freezing and the food storage compartment will be maintained at temperatures which are slightly above that which would be likely to cause the formation of frost in the food compartment.

Numeral 130 designates, in general, a secondary refrigerating system which is adapted to maintain the food compartment 82 at a relatively high and uniform refrigerating temperature and at a relatively high humidity so that little dehydration of the foods stored therein is produced. This system includes a cooling or evaporating element designated, in general, by the number 132 and a condensing element designated, in general, by the number 134. These are operatively connected by a liquid supply conduit 136 and a vapor return conduit 137. The evaporating element 132 comprises a sinuous conduit which is secured in intimate heat conducting relationship in any suitable fashion as by soldering or by some cementing material such as "Hydrolene" to the outside of the inner lining member 96 of the food compartment. This conduit runs back and forth across the bottom of the liner, then progressively upwardly, embracing three sides of the lining member as shown in Fig. 6 until it reaches the top of the lining member where it joins with the vapor return conduit 137. The condensing element 134 comprises a serpentine conduit arranged in a horizontal plane. This conduit is disposed in the insulated top wall 90 and is secured in intimate heat exchange relation by any suitable means such as solder or "Hydrolene" to lining member 95 immediately above the evaporator section 11 whereby the refrigerant evaporated in the secondary system is condensed. The temperature of the refrigerant in the secondary system is determined by the effectiveness of the transfer of heat from the secondary condenser to the primary evaporator. The extent or effectiveness of the heat transfer therebetween can be regulated by varying the area of the condenser contacting the inner lining member to produce the desired temperature within the food compartment. The temperature differential between the two compartments may of course be varied in other ways as by introducing inert gas into the secondary system. If desired, the secondary condenser 134 may be disposed in heat exchange relation with the evaporator section 112 instead of section 111.

In operation, the refrigerant evaporated within

the secondary by the heat from the food compartment is conveyed by the return conduit 137 to the condenser 134 where it is condensed and delivered by gravity in liquid form through conduit 136 to the conduit at the bottom of the lining member 96. It then circulates upwardly through the conduit wrapped around the side walls of the lining member up to the top thereof. In this manner the entire food compartment is cooled to a substantially uniform refrigerating temperature throughout since no part of the compartment is unexposed to the heat absorbing effect of the secondary evaporator. A sterilamp 145 may be provided within the food compartment to aid in the preservation of the foods.

The entire primary refrigerating system may be removed from the cabinet as a unitary structure. The structure includes the condensing element 107, evaporating element 106 and a removable insulated closure member 140 which is adapted to close an elongated opening at the rear of the freezing compartment 83. Preferably, the plates 113 and 114 which retain the evaporating sections in place are secured to the walls of the freezing compartment by means of screws (not shown) so that the sections 111 and 112 may be readily removed when desired. The vapor return conduit 110 and liquid supply conduit 109 extend through the insulated plug 140 and may be removed therewith. To remove the primary system, the evaporating sections 111 and 112 are pressed together and slipped through the opening at the rear of the freezing compartment while the condensing unit is slipped out the back of the machine compartment. Thus the entire structure may be readily removed for repairs and the like.

In Fig. 7, there is shown another modification of my invention. Numeral 150 designates in general a refrigerator cabinet having an outer metallic liner 152 and two inner metallic liners 154 and 156 respectively. The inner liner 154 forms a low temperature or freezing compartment 158 while the inner liner 156 forms a food storage compartment 160. Suitable insulation 162 is interposed between the inner liners and the outer liner 152. Access to the compartments 158 and 160 is obtained through openings 164 and 166 which are adapted to be closed by doors 168 and 170 respectively.

Numeral 174 designates in general a primary refrigerating system similar to that shown in Figs. 4 and 5. The primary evaporator comprises two horizontal planar conduit sections 176 and 178 respectively which are connected in series. Section 176 is connected to the condenser (not shown) of the primary system by means of a small diameter tube 180 while the section 178 is connected to the compressor (not shown) of the primary system by means of a suction conduit 182. An accumulating chamber 184 may be placed in the suction conduit 182 at the outlet of the evaporating section 178. The conduits 180 and 182 are preferably arranged in heat exchange relation with each other. The primary evaporating section 176 is preferably located outside the inner liner 154 of the freezing compartment 158 and is positioned in intimate heat exchange relation therewith across the top of said liner. A metallic plate 188 is secured to the top of the liner 154 and in conjunction therewith forms a pocket into which the section 176 is adapted to be inserted and held in close contact to the liner 154. The other evaporating section 178 is positioned within the liner 154 on the bottom wall thereof. A sheet metal plate 190 is secured to the bottom wall of the liner 154 and forms a pocket with the liner 154 into which this section 178 is adapted to be inserted and held in intimate heat exchange relation with the plate 190. Ice trays 192 may be placed for quick freezing of ice cubes and the like upon this plate 190. The two primary evaporating sections 176 and 178 are rendered readily removable from the cabinet by means of a removable closure member 196 at the rear of the compartment 158. This closure member carries the supply and suction conduits 180 and 182 as well as the accumulating element 184.

Numeral 200 designates in general a secondary refrigerating system which comprises a secondary evaporator 202 and a secondary condenser 204. The evaporator 202 like those shown in Figs. 1 and 4 consists of a serpentine conduit which substantially envelopes the food storage compartment 160 and is secured in intimate heat exchange relation to the outside of the liner 156. The secondary condenser 204 consists of a horizontal planar conduit section which is secured in intimate heat exchange relation to the top of the plate 188 above the primary evaporating section 176.

The operation of this modified system is substantially the same as that shown in Figs. 4, 5 and 6. In the primary system, liquid refrigerant is metered to the section 176 through the small diameter tube 180. From the section 176, the refrigerant circulates to the other evaporating section 178 whence it is returned in form of evaporated refrigerant to the condensing unit (not shown) to be reliquefied. The two sections 176 and 178 together serve to maintain a below freezing temperature in the compartment 158 whereby ice cubes and frozen desserts may be produced and also certain foods may be maintained in a frozen condition. The section 176 also serves to extract heat from the secondary condenser 204 whereby secondary refrigerant is condensed in the condenser 204. The liquefied secondary refrigerant as already described in the preceding embodiments of my invention circulates by gravity through the secondary evaporator and cools the food storage compartment to a proper refrigerating temperature.

Although only a preferred form of the invention has been illustrated, and that form described in detail, it will be apparent to those skilled in the art that various modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claim.

I claim:

Refrigerating apparatus comprising an insulated cabinet having two sheet metal liners arranged to provide two compartments for the storage of food, a secondary refrigerant coiled evaporator secured to the exterior of one of said liners, a secondary refrigerant coiled condenser arranged on a single plane and secured to the exterior of the second liner, a primary refrigerant coiled evaporator arranged on a single plane in contact with the interior of said second liner directly opposite said secondary condenser and a sheet metal plate arranged to provide a support for objects to be frozen and to removably secure said primary refrigerant evaporator to said second liner.

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