

June 4, 1946.

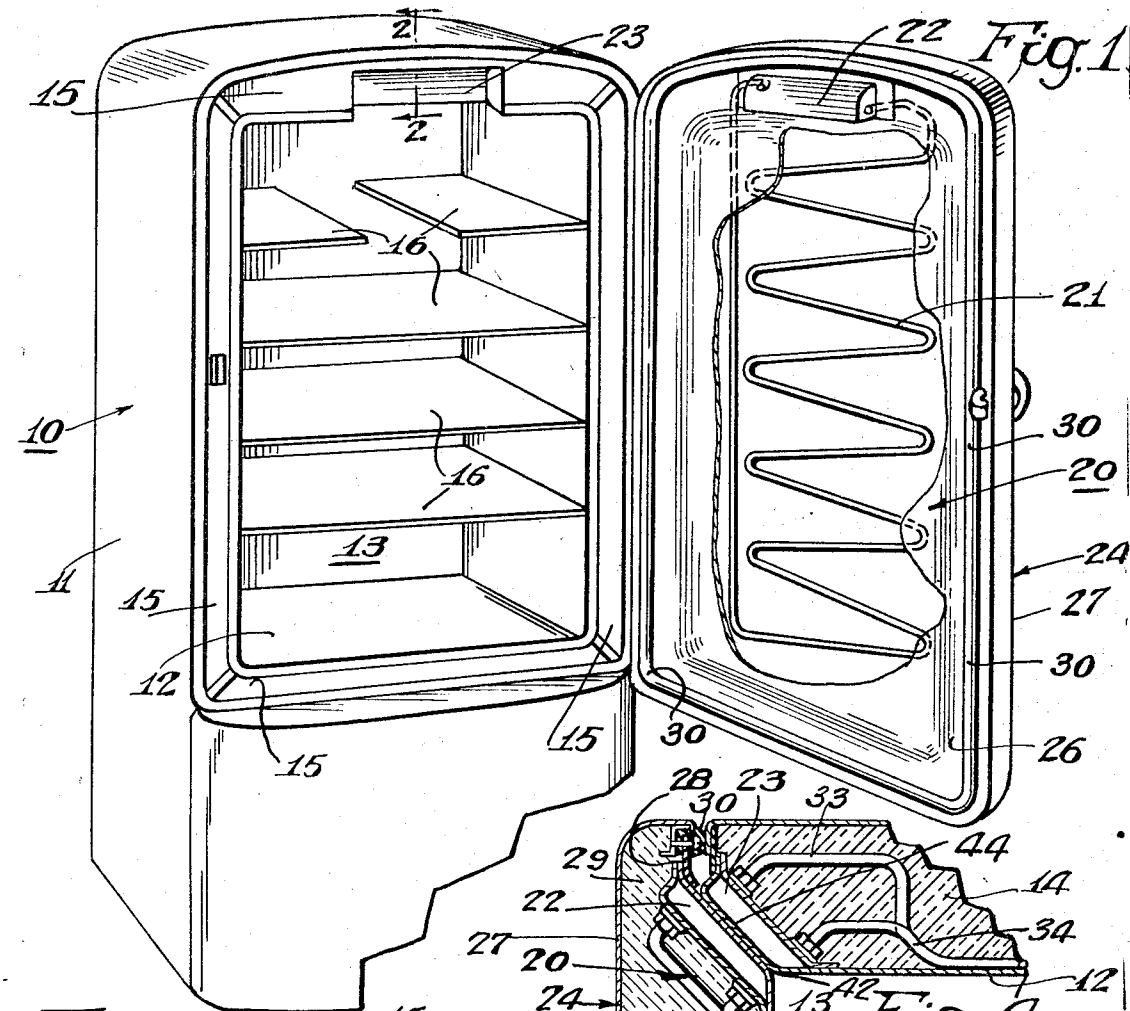
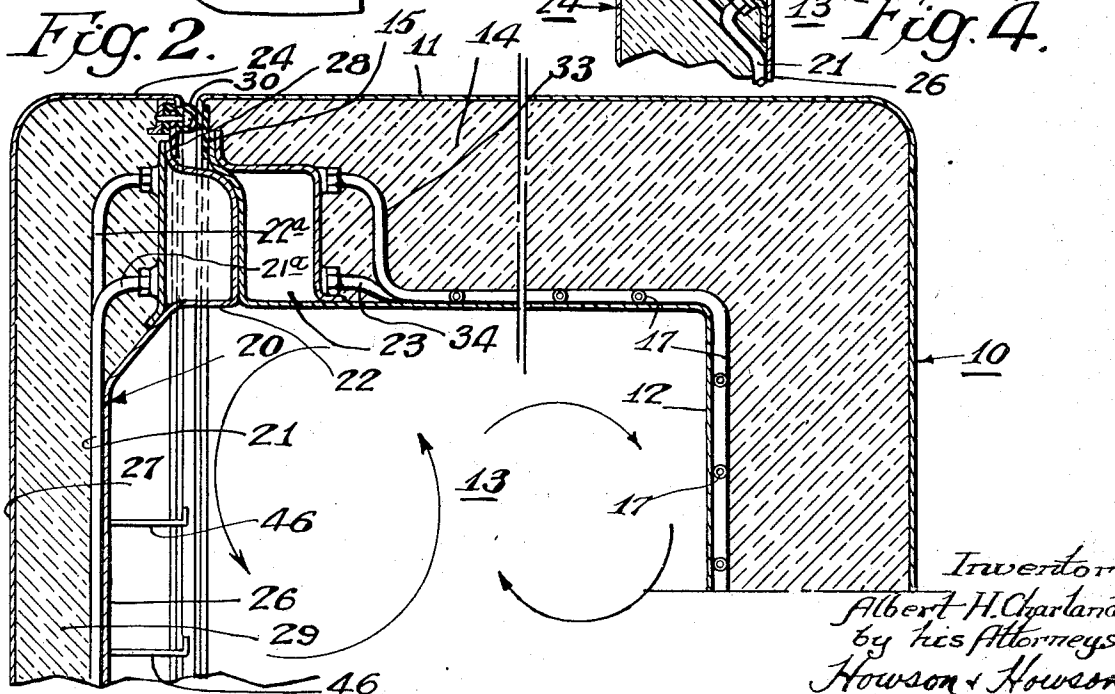
A. H. CHARLAND

2,401,460

REFRIGERATION

Filed Feb. 25, 1944

2 Sheets-Sheet 1



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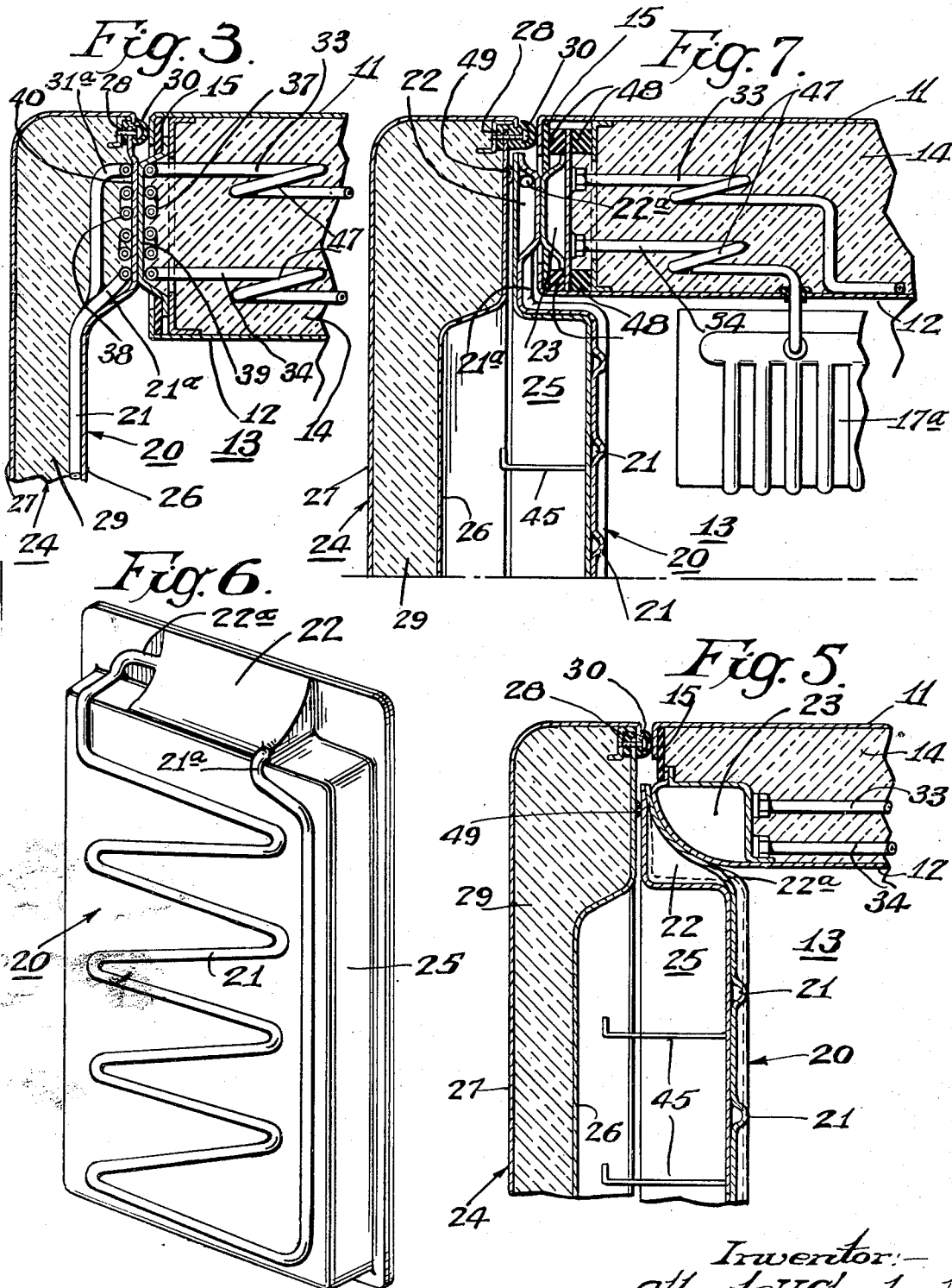
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Inventor:—
Albert H. Charland
by his Attorneys
Howson, Howson

UNITED STATES PATENT OFFICE

2,401,460

REFRIGERATION

Albert H. Charland, Rosemont, Pa., assignor to
Philco Corporation, Philadelphia, Pa., a corpo-
ration of Pennsylvania

Application February 25, 1944, Serial No. 523,861

30 Claims. (Cl. 62—99)

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The present invention relates to refrigeration and is concerned particularly with that type of refrigeration utilizing a plurality of evaporator systems cooperating to produce the cooling effect within domestic refrigerating cabinets.

More specifically, the invention pertains to a novel arrangement of primary and secondary refrigerating systems correlated and co-functioning to induce circulatory convectional air currents throughout the entire space intended for the storage of food, so that the food stored in any part of said space will be subjected to proper refrigeration.

Refrigeration of food consists first in removing heat from the foods placed within the storage compartment of the refrigerator cabinet and subsequently keeping outside heat away from said foods so as to maintain them at the desired relatively low temperatures. The removal of heat from the foods in a refrigerated storage compartment is effected chiefly by convection flow of air within the confines of said compartment, so that proper circulation of the air is a primary factor for adequate refrigeration, and it is one of the primary objects of this invention to provide novel, effective and practical means for creating an improved circulation of the air within the food storage area.

Keeping warm outside air from the refrigerated space and from the foods stored therein is controlled to some extent by the choice of the insulating materials employed for that purpose. However, because there is no known perfect insulator, outside heat is constantly passing inwardly through the walls of the refrigerated compartment. Extended tests have proven that a relatively large percentage of heat leakage in the food compartment occurs at the front or door side of the refrigerator cabinet. It is another important object of this invention to provide means whereby the greater part of the heat tending to flow through the insulation of the refrigerator door into the refrigerated food storage compartment, may be absorbed before reaching said compartment. This permits operation of the main refrigerating unit at higher temperatures with resultant improvement in efficiency, since it is known that the efficiency of a refrigerating unit decreases when the unit is required to operate at low temperatures.

Still another important object of the invention resides in the provision of refrigerating means so associated with the food storage compartment that temperature distribution throughout the latter is improved materially, thereby assuring proper refrigeration for the preservation of various types of foods stored in different locations within said compartment.

The invention contemplates specifically the provision of a refrigerating system adapted to

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cool the closures or doors of refrigerator cabinets, said system being associated with and functioning in a positive manner to cool that surface of the closures or doors which seals the open side of refrigerator cabinets.

The invention also contemplates provision of a refrigerator closure or door incorporating means capable of refrigerating that portion of the closure or door disposed in confronting relation to the food storage compartment of the refrigerator.

Other objects and advantages of the invention will appear to those skilled in the art from the following detailed description and accompanying drawings, in which:

Fig. 1 is a perspective view of a domestic refrigerator embodying one form of the present invention;

Fig. 2 is an enlarged section taken substantially through line 2—2 of Fig. 1 but showing the door in closed position;

Fig. 3 is a view similar to Fig. 2 illustrating another form of the invention;

Fig. 4 is a view similar to Figs. 2 and 3 showing a possible adaptation of the invention to the so-called "plug-type" door;

Fig. 5 is a cross-sectional detailed view illustrating the invention in use with an inner closure or door adapted for the storage of food thereon;

Fig. 6 is a perspective view of the inner closure or door shown in Fig. 5; and

Fig. 7 illustrates a modification of the arrangement shown in Fig. 5.

Referring more particularly to the drawings, the domestic refrigerator therein illustrated comprises a cabinet 10 having an outer shell 11 and an inner liner 12, said liner defining a food storage compartment 13 within the cabinet. Suitable insulating material 14 is arranged between the outer shell 11 and the inner liner 12, and breaker strips 15 are interposed between said shell and liner in the usual manner at the open side of the cabinet. Shelves 16 may be mounted in conveniently spaced relationship within the compartment 13.

The food storage compartment 13 is cooled by a suitable evaporator which, as shown in Fig. 2, consists preferably of refrigerating coils 17 arranged in heat exchange relationship with the inner liner 12 and forming a part of a main refrigerating system of known primary or secondary type within the cabinet 10. It is to be understood however that, as represented in Fig. 7, a depending evaporator element 17a of any suitable type may be mounted in the food storage compartment 13 in the manner commonly practiced in the art.

In accordance with the present invention, a refrigerant evaporator is provided for movement into and out of confronting relation with the

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food storage compartment 13 at the open side thereof. The refrigerant evaporator may be and preferably is embodied in self-contained refrigerating means generally designated by the reference character 20 and basically comprising an evaporator portion 21 and a condenser portion 22. This condenser portion 22 is located preferably above the evaporator portion 21 and is adapted for snug contacting engagement with an evaporator portion 23 which, also in accordance with this invention, is included in the main refrigerating system associated with the said food storage compartment 13. The evaporator portion 21 and condenser portion 22 constitute elements of a self-contained circulatory system for refrigerant fluid.

The self-contained refrigerating means may be mounted on a panel or closure member arranged for movement in and out of the area facing the open side of the compartment 13 and, as a practical expedient, may conveniently be mounted on or incorporated in the usual refrigerator door 24, as represented in Figs. 1, 2, 3 and 4, or an inner door 25 of the so-called "Conservador" type as represented in Figs. 5, 6 and 7.

In the embodiment shown in Fig. 2, the door 24 preferably consists of relatively spaced inner and outer metallic panels 26 and 27 respectively, having thermo-break elements suitably arranged therebetween, as indicated at 28. Insulating material 29 is provided between said panels and a sealing gasket strip 30 is mounted on the inner marginal side edge portions of the door to effect an air-tight seal between the latter and adjacent portions of the cabinet.

In accordance with the present invention, the self-contained refrigerating means which is preferably a closed secondary refrigerating system, is associated with the refrigerator door 24 to provide a cooling surface thereon. As represented in Fig. 2, the evaporator portion 21 is in intimate heat exchange relation with that surface of the door 24 which when the door is closed immediately confronts the food storage compartment 13 of the refrigerator cabinet 10. In the form shown, the evaporator portion 21 adjoins the inside surface of the inner panel 26 and is preferably bonded to said panel or otherwise made to form an integral part thereof. The condenser portion 22, as shown in Fig. 2, consists of a header-like member located at the upper section of the door and protruding outwardly from the plane of the inner panel 26. Communication between the evaporator portion 21 and header member is established by means of tubular extensions 21a and 22a.

Still referring to Fig. 2, the supplemental evaporator portion 23 of the main refrigerating system within the cabinet also consists of a header-like member which, in this particular instance, is located at the upper front portion of the cabinet directly over the food storage compartment 13 and is recessed in from the outer face of the uppermost breakerstrip 15 to register with the header member of the secondary system on the door 24 so that when the latter is moved to closed position, said members are brought into mutual heat exchange relation. Connected to and communicating with the header-like supplemental evaporator portion 23 are tubes 33 and 34 which form parts of the circuit of the main refrigerating system intended to cool the food storage compartment 13.

In Fig. 3, there is shown a modified form in which the use of the header members above

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referred to may be dispensed with. In this form, the supplemental evaporator portion 23 of the main refrigerating system in the cabinet 10 and the condenser portion 22 of the secondary system in the door 24 are obtained by concentrating a number of loops forming continuations of the tubes 33 and 34 of said main system and of the ducts 21a and 31a of said secondary system, as indicated at 37 and 38 respectively. In the particular arrangement shown in Fig. 3, the loops 37 included in the cabinet refrigerating system are in intimate contact with a plate 39 conveniently supported in position at the upper front of the cabinet for positive engagement with a surface 40 at the upper portion of the door in the panel 20 with which the loops 38 in the door secondary system are in intimate contact.

Fig. 4 illustrates a possible adaptation of the invention to a refrigerator door of the so-called "plug-type," that is, a door provided with slanting edge portions, such as shown at 42, and adapted to fit within correspondingly slanting edge portions, such as shown at 44, which outline the open front of the refrigerated food compartment 13. In the structure illustrated, header-like members form the condenser portion 22 of the secondary system associated with the door and the supplemental evaporator portion 23 of the main refrigerating system associated with the cabinet. It will be understood that these header-like members may be replaced by a looping arrangement as shown, for instance, in Fig. 3.

Figs. 5, 6 and 7 illustrate possible adaptations of the invention to the "Conservador" type of inner metal door 25 hinged to the open side of the food storage compartment and having shelves 45 on its outside for holding articles of food. As shown, the inner door 25 is provided with means forming the secondary refrigerating system 20 including the evaporator portion 21 and a condenser portion 22 connected with said evaporator portion by means of the tubular extensions 21a and 22a. The condenser portion 22 has its outer surface formed and arranged for direct contact with the outer surface of the supplemental evaporator portion 23 included in the main refrigerating system of the cabinet.

It is pointed out that, as represented in Fig. 2, suitable shelves 46 may be mounted on the inner panel 26 of the refrigerator door 24 to support small articles. Also, it is to be noted that, as illustrated in Figs. 3 and 7, the tubes 33 and 34 connected to the supplemental evaporator portion 23 may be formed with short coil sections as shown at 47 to absorb shocks which may result when the door is slammed closed. It is likewise possible to absorb such shocks and further assure proper interengagement of the supplemental evaporator and secondary condenser portions by resiliently mounting either or both of said portions, for instance by using rubber shock pads 48 as shown in Fig. 7. Also, a resilient member such as a rubber-faced element 49, as illustrated in Figs. 5 and 7, may be interposed between the adjacent surfaces of the main door 24 and condenser portion 22 of the inner door 25.

In operation, the main refrigerating system functions to cool the food storage compartment 13 in the usual manner, that is, the liquid refrigerant within the evaporator 17 or 17a absorbs heat from the air circulating within said compartment. The evaporator, of course, is connected to the usual circuit of the main refrigerating system of the cabinet and as shown is in series with the supplemental evaporator 23 since the latter

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is connected with the tubes 33 and 34 which, as stated above, form a part of said circuit. Consequently, the refrigerant fluid circulating through said circuit passes through the supplemental evaporator 23.

The self-contained refrigerating means or secondary system 20 is supplied preferably with a highly volatile refrigerant which evaporates in the evaporator portion 21 and the gas resulting therefrom rises in the tubular extension 22a and is discharged into the condenser portion 22. When this condenser portion is in heat exchange relation with the supplemental evaporator portion 23 of the main refrigerating system, the gas in said condenser portion is restored to liquid state by giving up heat which is absorbed by the refrigerating fluid passing through said evaporator portion 23 so that secondary liquid refrigerant flows through the tubular extension 21a into the secondary evaporator portion 21 to be re-evaporated therein.

Because of the particular relationship between the main evaporator portions of the primary and secondary systems, and because of the relatively large cooling surfaces of these evaporator portions, it will be appreciated that the convective circulation of the air within the food storage compartment is enhanced. As indicated by the arrows shown in Fig. 2, a circulatory convective air-flow is created in the forward portion of the refrigerator adjacent to the main door; which area has lacked proper cooling in prior constructions.

It is to be noted particularly that heat tending to leak into the food storage compartment through the insulated door 24 is taken up to a large extent by the secondary evaporator portion, thereby overcoming one of the chief contributory causes of detrimental rise of temperature within said compartment.

By properly spacing the number of coil turns in the secondary evaporator portion 20 and also in the main evaporator portion 17, it is possible to obtain adequate distribution of temperature throughout the entire food compartment.

Also by using shelves on the refrigerator door such as shown in Fig. 2, or by using an inner door provided with shelves in the manner illustrated in Fig. 5 or Fig. 7, it is possible to cool articles placed on said shelves by means of direct refrigeration through the secondary system associated with such door or doors.

Whereas, I prefer to employ a secondary refrigerating system associated with the closure member or door of the refrigerator cabinet, it will be recognized that, in the broader aspect, the invention is not limited thereto, since other known systems may be utilized to perform the functions hereinbefore set forth. Also, while the secondary evaporator portion has been shown and described as being located on the inside surface of inner door panel 26, it will be understood that said portion may be positioned on the outer or exposed surface of such panel if desired. The inner panel of the door may be formed by means of a double thickness of sheet material made to provide fluid circulating passages in the same manner as the "Conservador" type of inner door illustrated in Figs. 5 and 7 of the drawings. It is likewise to be understood that other modifications in the various structures herein set forth as possible embodiments of the invention may be made within the scope of the appended claims.

I claim:

1. In a refrigerator cabinet, a food storage

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compartment having an open side, self-contained refrigerating means movable into and out of confronting relation with said open side and including a condenser portion and an evaporator portion, and main refrigerating means in said cabinet including an evaporator portion disposed for heat exchange relation with said condenser portion of the self-contained refrigerating means when said means is moved into confronting relation with the open side of said compartment.

2. In a refrigerator cabinet, a food storage compartment having an open side, self-contained refrigerating means movable into and out of confronting relation with said open side and including a condenser portion and an evaporator portion, and refrigerating means in said cabinet including a main evaporator portion for cooling said compartment and a supplemental evaporator portion disposed for heat exchange relation with said condenser portion of the self-contained refrigerating means when said means is moved into confronting relation with the open side of said compartment.

3. In a refrigerator cabinet, a food storage compartment having an open side, self-contained refrigerating means hinged to the cabinet for swinging movement into and out of confronting relation with the open side of said compartment, said means including a condenser portion and an evaporator portion, and main refrigerating means in said cabinet including an evaporator portion disposed for heat exchange relation with said condenser portion of the self-contained refrigerating means when said means is moved into confronting relation with the open side of said compartment.

4. In a refrigerator cabinet, a food storage compartment having an open side, self-contained refrigerating means hinged to the cabinet for swinging movement into and out of confronting relation with the open side of said compartment and including a condenser portion and an evaporator portion, and refrigerating means in said cabinet including a main evaporator portion for cooling said compartment and a supplemental evaporator portion engageable with said condenser portion of the self-contained refrigerating means when said means is moved into confronting relation with the open side of said compartment.

5. In a refrigerator cabinet, a food storage compartment having an open side, a panel member movable into and out of confronting relation with said open side, a secondary refrigerating system on said panel member including a condenser portion, and a main refrigerating system in said cabinet including an evaporator portion disposed for heat exchange relation with said condenser portion of the secondary system when the panel member is moved into confronting relation with said compartment.

6. In a refrigerator cabinet, a food storage compartment having an open side, a closure member movable to close said open side, a secondary refrigerating system including a condenser portion and an evaporator portion arranged on said closure member to be carried thereby into confronting relation with said compartment when the closure member is moved to close the open side thereof, and a main refrigerating system mounted in the cabinet and having an evaporator portion disposed for heat exchange relation with said condenser portion of the secondary system when the closure member

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is moved to close the open side of said compartment.

7. In a refrigerator cabinet, a food storage compartment having an open side, a closure member movable to close said open side and provided with a surface disposed for confronting relation with said compartment, a secondary refrigerating system including a condenser portion and including an evaporator portion carried by said surface, and a main refrigerating system mounted in the cabinet and having an evaporator portion disposed for heat exchange relation with said condenser portion of the secondary system when the closure member is moved to close the open side of said compartment.

8. In a refrigerator cabinet having a food storage compartment and a door for closing the same, a main refrigerating system including an evaporator portion associated in heat exchange relation with said compartment, and a secondary refrigerating system associated in heat exchange relation with said door and including a condenser portion, said portions being relatively disposed and adapted for heat exchange therebetween.

9. In a refrigerator cabinet having a food storage compartment and a door for closing the same, a main refrigerating system associated in heat exchange relation with said compartment and a secondary refrigerating system associated in heat exchange relation with said door, said systems respectively provided with refrigerant evaporator sections and refrigerant condensing sections, the refrigerant condensing section of the secondary refrigerating system and the refrigerant evaporating section of the main refrigerating system having portions cooperating to effect heat exchange therebetween.

10. In a refrigerator cabinet having a food storage compartment and a door for closing the same, a main refrigerating system associated in heat exchange relation with said compartment and a secondary refrigerating system associated in heat exchange relation with said door, said systems respectively provided with refrigerant evaporating sections and refrigerant condensing sections, the refrigerant condensing section of the secondary refrigerating system and the refrigerant evaporating section of the main refrigerating system having portions adapted for mutual engagement to effect heat exchange therebetween.

11. In a refrigerator cabinet having a food storage compartment and a door for closing the same, a main refrigerating system associated in heat exchange relation with said compartment and provided with an auxiliary evaporator portion, and a secondary refrigerating system associated in heat exchange relation with said door and provided with a condenser portion engageable with said evaporator portion of the main refrigerating system when the door is in closed position.

12. In combination, a refrigerator cabinet having a compartment and a refrigerating system including cold producing means for cooling said compartment, a closure member for said compartment, and a secondary refrigerating system including a condenser portion and an evaporator portion carried by the closure member, said condenser portion being disposed for heat exchange relation with the cold producing means of said cabinet compartment when said member is in closed position.

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13. In combination, a refrigerator cabinet having a compartment and a refrigerating system including cold producing means for cooling said compartment, a door for closing said compartment including an outer panel and an inner panel, a secondary refrigerating system including a condenser portion and including an evaporator portion arranged on said inner panel, said condenser portion being disposed for heat exchange engagement with the cold producing means of said cabinet compartment, when said door is closed.

14. In a refrigerator cabinet, a food storage compartment having an access opening, a main refrigerating system in said cabinet for cooling said compartment and including an evaporator portion, means movable into and out of confronting relation with said opening and including a refrigerant evaporator portion and condenser portion, said condenser portion being disposed to be brought into snug contact engagement with the evaporator portion of the main refrigerating system when said means is moved into confronting relation with said opening, and resilient means arranged to absorb possible shocks occasioned by such contact and to assure said snug engagement.

15. In a refrigerator cabinet, a food storage compartment having an access opening, a panel movable into and out of confronting relation with said opening, a secondary refrigerating system on said panel including an evaporator portion and a condenser portion for said system, and a main refrigerating system in said cabinet including a header-like member disposed for heat exchange relation with the condenser portion of said secondary system.

16. In a refrigerator cabinet, a food storage compartment having an access opening, a panel movable into and out of confronting relation with said opening, a secondary refrigerating system on said panel including an evaporator portion and a header-like member in communication with said evaporator portion to form a condenser for said system, and a main refrigerating system in said cabinet including an evaporator portion disposed for heat exchange relation with the header-like member forming the condenser portion of said secondary system.

17. In a refrigerator cabinet, a food storage compartment having an access opening, a panel movable into and out of confronting relation with said opening, a secondary refrigerating system on said panel including refrigerant conduit means forming an evaporator portion for said system and a header-like member in communication with said conduit means to form a condenser portion for said system, and a main refrigerating system in said cabinet including an evaporator portion in the form of a header-like member disposed for heat exchange relation with the header-like member forming the condenser portion of said secondary system.

18. In a refrigerator cabinet, a food storage compartment having an access opening, a panel movable into and out of confronting relation with said opening, a secondary refrigerating system on said panel including an evaporator portion and a condenser portion for said system, and a main refrigerating system for said cabinet including an evaporator portion in the form of a coil section disposed for heat exchange relation with the condenser portion of said secondary system.

19. In a refrigerator cabinet, a food storage compartment having an access opening, a panel

movable into and out of confronting relation with said opening, a secondary refrigerating system on said panel including an evaporator portion for said system and a coil section in communication with said evaporator portion to form a condenser portion for said system, and a main refrigerating system in said cabinet including an evaporator portion disposed for heat exchange relation with the coil section forming the condenser portion of said secondary system.

20. In a refrigerator cabinet, a food storage compartment having an access opening, a panel movable into and out of confronting relation with said opening, a secondary refrigerating system on said panel including refrigerant conduit means forming an evaporator portion for said system and a coil section in communication with said conduit means to form a condenser portion for said system, and a main refrigerating system in said cabinet including an evaporator portion in the form of a coil section disposed for heat exchange relation with the coil section forming the condenser portion of said secondary system.

21. In combination with a refrigerator cabinet having cold-producing means situated therein, a food storage compartment provided with an access opening, a door mounted on said cabinet to extend across said opening, a shelf-carrying structure mounted in said opening between said compartment and door, and a refrigerant evaporator portion and condenser portion carried by said structure, said condenser portion being disposed for heat exchange relation with said cold-producing means situated in the cabinet.

22. In combination with a refrigerator cabinet having cold-producing means situated therein, a main food storage compartment provided with an access opening, a door mounted on said cabinet to extend across said opening, an auxiliary food compartment associated with said door, and a refrigerant evaporator portion and condenser portion carried by said auxiliary food compartment, said condenser portion being disposed for heat exchange relation with said cold-producing means situated in the cabinet.

23. In a refrigerator cabinet structure, a compartment having an access opening, cold producing means in the cabinet structure for cooling said compartment, means including a refrigerant evaporator movable into and out of confronting relation with said access opening, and a refrigerant condenser in communication with said evaporator and disposed for heat exchange relation with said cold producing means.

24. In a refrigerator, a cabinet structure defining a compartment having an open side, a retractable closure member for said open side, a refrigerant circulating system arranged on said closure member to be carried thereby into confronting relation with said compartment, said system including a refrigerant evaporating portion and a refrigerant condensing portion, said refrigerant evaporating portion being arranged in heat exchange relation with said closure member and connected with said refrigerant condensing portion, and cold producing means disposed in the cabinet structure for heat exchange relation with said refrigerant condensing portion when said member is moved to its closed position.

25. In a refrigerator cabinet structure having a compartment provided with an open side and a door for closing same, a refrigerant evaporator

arranged in the cabinet structure at the open side of said compartment, a refrigerant evaporator associated in heat exchange relation with said door, and a refrigerant condenser in circuit with the refrigerant evaporator last-named and disposed for heat exchange relation with the refrigerant evaporator at said open side of the compartment.

26. In a refrigerator cabinet structure having a compartment provided with an open side and a door for closing the same, a refrigerant evaporator mounted within the cabinet structure to provide a cold portion facing the open side of said compartment, a refrigerant evaporator associated in heat exchange relation with said door, said second-mentioned evaporator comprising refrigerant conduit means carried by the door in the general plane of the latter, and a refrigerant condenser carried by the door and adapted for communication with said conduit means and for heat exchange relation with said cold portion provided by the first-mentioned evaporator.

27. A closure member for an open side of a refrigerator cabinet structure of the type provided with cold producing means, said member comprising a panel positionable in confronting relation with the open side of such cabinet structure, a closed secondary refrigerating system carried by said panel, and including an evaporator portion in heat exchange relation with said panel and a condenser portion in communication with said evaporator portion and disposed on the panel for heat exchange relation with the cold producing means provided in the refrigerator cabinet structure.

28. A closure member for an open side of a refrigerator cabinet structure of the type provided with cold producing means, said member comprising a panel positionable in confronting relation with the open side of such cabinet structure, a closed secondary refrigerating system carried by said panel, and including an evaporator portion in heat exchange relation with said panel and a condenser portion in communication with said evaporator portion and disposed on the panel for heat exchange relation with the cold producing means provided in the refrigerator cabinet structure, and shelves supported on said panel.

29. A refrigerator door comprising a panel, a secondary refrigerating system including an evaporator portion and a condenser portion, said evaporator portion consisting of conduit means arranged on the panel in heat exchange relation therewith and providing for the circulation of refrigerant in a circuitous path along the body and in the plane of the panel, and said condenser portion being mounted on the panel and interposed in the conduit means of said evaporator portion for communication therewith.

30. A refrigerator door comprising relatively spaced panels insulated from each other, a secondary refrigerating system including an evaporator portion and a condenser portion, said evaporator portion consisting of conduit means arranged on one of said panels in heat exchange relation therewith and providing for the circulation of refrigerant in a circuit along the body and in the plane of said one panel, and said condenser portion being mounted on said one panel and interposed in the conduit means of the evaporator portion for communication therewith.

ALBERT H. CHARLAND.