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2,561,305

SECONDARY HEAT EXCHANGER IN REFRIGERATION SYSTEM

Filed April 21, 1947

3 Sheets-Sheet 1

Fig. 1.

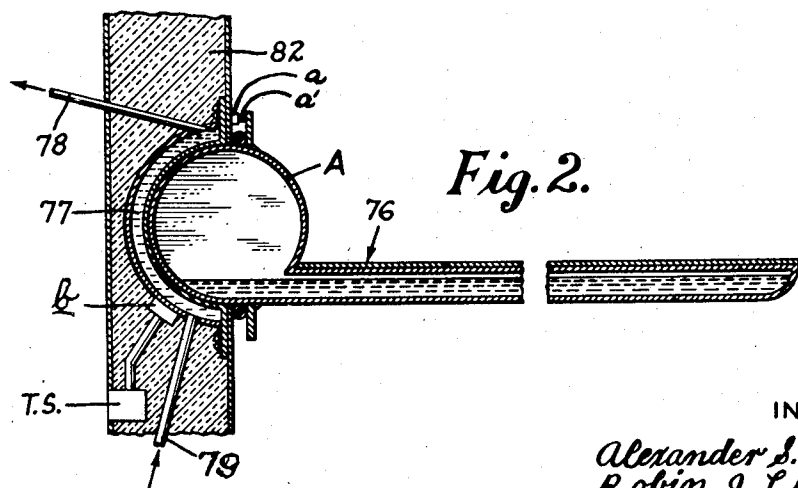
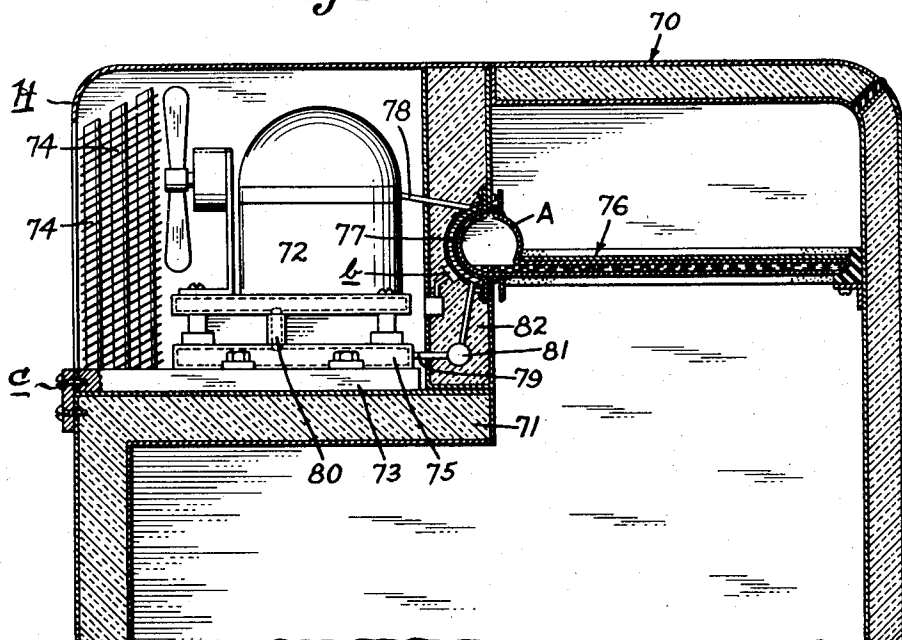


Fig. 2.

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Fig. 3.

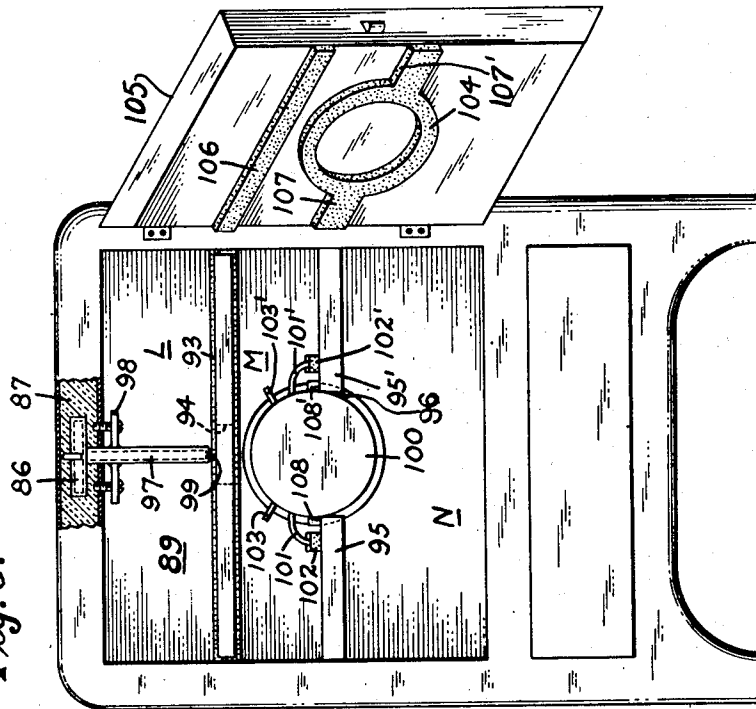
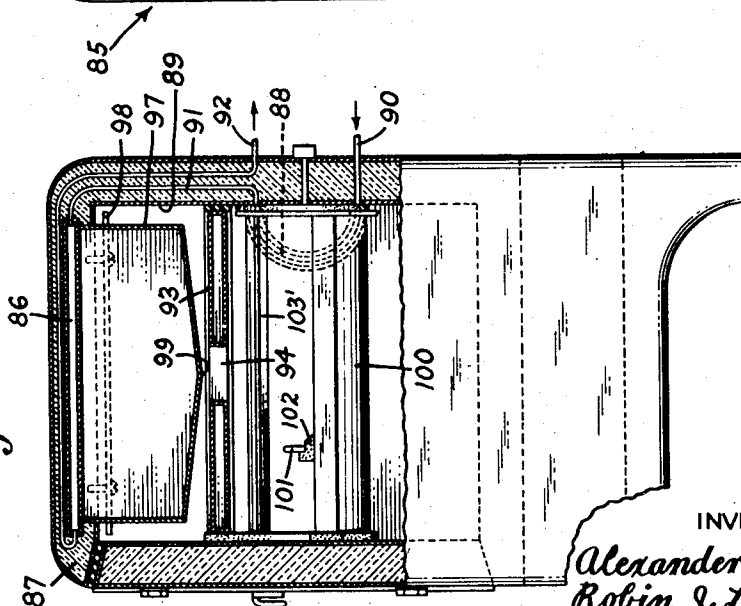


Fig. 4.



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Fig. 6.

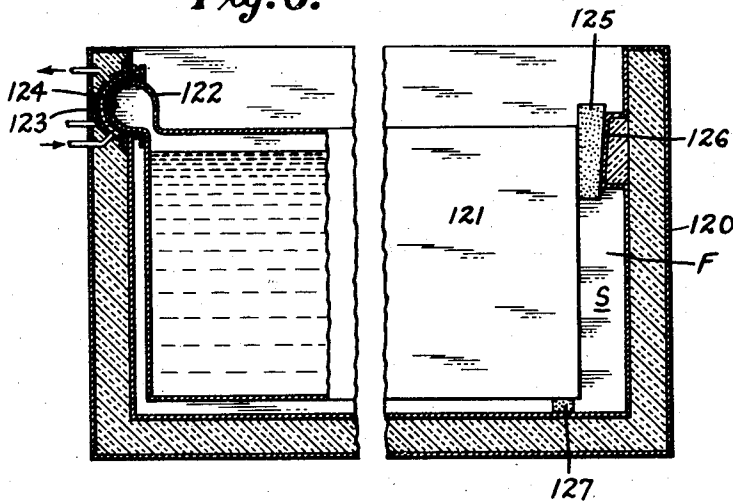
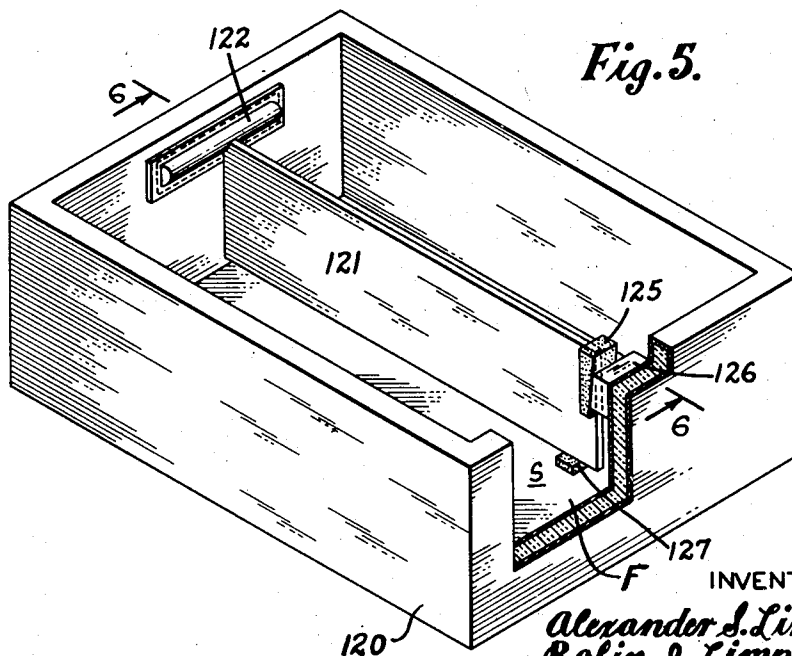


Fig. 5.



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UNITED STATES PATENT OFFICE

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SECONDARY HEAT EXCHANGER IN
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7 Claims. (Cl. 62-117.25)

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This invention relates to heat transfer apparatus, more especially for use in refrigeration systems and has for its particular objects the provision of a unitary refrigerant circulatory equipment, either of the mechanical or so-called gas-absorption type, which can be readily removed when desired from the refrigerator cabinet, refrigerated display counters or the like with which it is associated and returned intact to the manufacturer thereof for servicing the same, all without necessitating the breaking of any joints in the refrigerant circulatory system or the inclusion with such unit to be returned of the main condenser element of the refrigerating system, especially where the condenser is of the static or atmospheric type which is usually of extended area.

Another object of the invention is the provision in such a refrigerated compartment of a so-called disjoined, unitary, secondary heat exchange element, such for example as a sharp freezing element or evaporator, and which element is preferably in the form of a hollow shelf or hollow slab that can be readily removed from the refrigerated compartment in which it is mounted and almost instantly de-frosted and cleaned, and then immediately returned to such compartment and "plugged" into the primary heat exchange element. As a consequence, it is possible to dispense with the usual prolonged and laborious de-frosting operation and thus to eliminate the otherwise inevitable thawing out of accumulated frost on the evaporator and of refrigerated foods and ice cubes and the drip of water from and upon the de-frosted surfaces and foods with the accompanying disagreeable odors arising therefrom. Other objects of the invention will hereinafter appear.

Heretofore it has been proposed, as disclosed in Patent No. 2,500,085 granted October 27, 1942, to associate water-spraying means with the evaporator element of a refrigerator to accomplish the quick de-frosting and cleansing thereof in situ. However, such an arrangement requires the introduction of a considerable quantity of water into and the removal of the same from the refrigerator as well as careful attention on the part of the attendant who is operating the sprays to insure against the flooding of the compartment containing the evaporator.

Our improved disjoined evaporator element dispenses with the necessity of directly introducing and controlling the supply of cleansing water into the refrigerator while possessing the advantages of quick de-frosting and effective cleansing of the evaporator which is the object sought to be ac-

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complished through the provision of such spraying means.

Our invention is fully set forth in the following detailed description and drawings forming a part thereof, in which

Figure 1 is a fragmentary vertical section of a refrigerator equipped with our removable secondary evaporator as well as otherwise embodying our invention;

Figure 2 is an enlarged fragmentary vertical section showing the primary and secondary evaporators isolated from the refrigerating compartment of the refrigerator of Fig. 2;

Figure 3 is a front elevation, partly in section, of a three-temperature refrigerator, embodying a modification of our invention;

Figure 4 is a side elevation of the refrigerator shown in Figure 3, partially broken away;

Figure 5 is an enlarged perspective view of a deep freezer, with its lid removed, embodying our invention; and

Figure 6 is a vertical section, partly in elevation, of the aforesaid deep freezer.

Referring to the construction illustrated in Fig. 1, wherein the refrigerating unit and the primary evaporator constitute a unit which is bodily removable from the refrigerator without breaking any joints in the refrigerant circuit, the reference numeral 70 designates a refrigerator wherein the refrigerating compartment has an offset top wall 71 which serves as a support for the hermetically sealed compressor 72, said support having a hollow slab-like secondary condenser 73 mounted thereon which is in permanent communication with finned vertical fan cooled condenser tubes 74. Said slab-like condenser is substantially but not entirely filled with a refrigerant and the vapors therefrom circulate through said bank of tubes 74.

A primary slab-like condenser 75 is clamped or otherwise removably secured in intimate metal-to-metal contact with said secondary condenser 73, and the same serves as a support for the said compressor 72. A removable secondary evaporator 76 has a cylindrical terminal reservoir A that is of a curvature concentric with that of the hemi-cylindrical shell of a complementary primary evaporator 77. The latter is in permanent communication with the intake conduit 78 of the refrigerant circuit of the compressor and with the outlet 79 of the primary slab-like condenser 75 and the high-pressure discharge outlet 80 of the compressor is in permanent communication with the primary condenser 75. An expansion valve or restrictor 81 is interposed be-

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tween the high and low pressure sides of the condenser refrigerant circuit.

Preferably, an electric switch *a*, having a push button *a'*, is mounted on the rear wall of the food compartment of the refrigerator in such a manner that such push-button is normally depressed and the circuit through the switch is closed when the secondary evaporator 76 is positioned within such compartment, as shown in Fig. 1 and such push button automatically protrudes with the resultant breaking of such circuit upon the removal of the secondary evaporator from such compartment when it is desired to defrost the same by flushing it externally of the refrigerator with water delivered from a sink faucet, for example. The cycling of the compressor is controlled by the thermostatic switch, designated as T. S., which is controlled by the cold bulb *b* that is in intimate metal-to-metal contact with the shell of the primary evaporator 77 and is, therefore, directly responsive to the temperatures prevailing therein.

To remove the compressor, the primary evaporator and the primary condenser for shipment to the manufacturer for repairs or replacement, it is merely necessary to unclamp the primary condenser 75, from the supporting secondary condenser, then remove the screw *c* from the condenser slab 73 so as to release the hood member *H*, carried by the partition wall 82, then remove the secondary evaporator from its socket in the primary evaporator 77, and then bodily lift the compressor, the associated primary condenser and the partition wall 82 and the hood *H* and return the same as a unit to the factory, all without necessitating the breaking of any joints in the refrigerant circulatory system.

In Figs. 3 and 4, a three-temperature refrigerator embodying our invention is illustrated, the same comprising a box 85, having a top hydration or medium-cold compartment *L*, a middle sharp freezing compartment *M* and a bottom food compartment *N*. A slab-like flooded primary evaporator 86 is embedded in the insulation of the top wall 87 of such refrigerator and a second hollow primary evaporator 88, of hemispherical shape, is mounted in said compartment *M* on the rear wall 89 thereof, said evaporators being connected in series into the refrigerant circulatory system of the refrigerator in such a manner that the compressed refrigerant enters from the intake refrigerant conduit 90, into the bottom of the primary evaporator and is discharged into the conduit 91, thence passing into the right hand end of the slab-like evaporator 86, and being discharged into the outlet conduit 92, by which it is returned to the compressor of the refrigerating unit of the refrigerator.

A hollow sheet metal partition 93, having a central circular aperture 94, formed therein, separates compartments *L* and *M* from each other and two alined shelves 95, 95', formed of insulation material and spaced from each other so as to form a central, longitudinally extending opening 96, extend from the front to the rear of the refrigerator and serve to support between them a secondary evaporator, presently to be described, and also to thermally separate the compartments *M* and *N* from each other.

In the compartment *L*, is a centrally positioned, slab-like, hollow secondary evaporator 97, which is supported by a plate 98 that is removably screwed or bolted to the top wall 87, of the refrigerator and is thereby held in limited, but intimate, metal-to-metal contact with the

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bottom face of the primary evaporator 86. Such secondary evaporator 97, is of angular configuration at the bottom thereof and the apex or extreme bottom thereof 99, is immediately adjacent the level of the said partition 93, and directly above the center of said aperture 94, therein.

In the compartment *M* is a centrally positioned cylindrical secondary removable evaporator 100 which as above explained is supported between the two shelves 95, 95', preferably by means of arcuate, metal arms 101, 101', which are brazed to the shell of said evaporator and normally rest upon blocks of insulation 102, 102' carried on the inner ends of said shelves immediately adjacent the said aperture 96. Oppositely disposed gutters 103, 103', which extend throughout substantially the entire length of the evaporator 100, serve to collect any surplus drip discharged thereon from the aforesaid secondary evaporator 97, and to retain the same until converted into frost or even ice by the chilling effect of the secondary evaporator 100. A circular rubber or the like sealing gasket 104, is mounted on the inner surface of the refrigerator door 105, in such a position that, when the door is closed, it exactly registers with the outer end of the evaporator 100 when the latter is in an operative position in the refrigerator and effectively prevents the passage of air circulating in the food compartment *N* around the front end of the evaporator 100. Other insulation stripes 106, and 107, 107', are so mounted on the door that, when the same is closed, the space between the front ends of the shelves 93, 95, and 95', and the door 105, will be likewise effectively sealed against air circulating in either of the compartments of the refrigerator. Still other insulation strips 108, 108', are mounted on the shelves 95, 95', the same projecting slightly into the opening 96 along the entire length of said shelves from the front to the rear of the sharp cooling compartment *M*. These gaskets and sealing strips serve to prevent the passage of air from one compartment to another around the front end of the evaporator 100, or around the edges of the shelves 95, 95', or 93, except for the relatively small amount of air that may pass downwardly from the dead air space in the compartment *L* into the compartment *M*. As shown, any moisture condensing on the medium cold secondary evaporator 97, which is maintained at a temperature of about 35° F. will drip through the opening 94, directly onto the top surface of the evaporator 100, between the gutters 103, 103' and thereon it will be converted into solid moisture in the form of frost or even ice all without there being any possibility of the collection of water in the compartment *L* which at the temperatures prevailing therein would become converted into an odoriferous unsanitary slime. The removable secondary evaporator can be quickly removed from the compartment *M* when it is desired to defrost the same merely by elevating the front end manually and then withdrawing the same from the refrigerator whereupon the accumulated frost and ice can be washed off under a faucet after which the evaporator can be returned to the refrigerator and resume its normal functions which are three-fold, namely, maintaining a sharp freezing temperature in the insulated compartment *M* and simultaneously by convection and radiation maintaining an optimum temperature, say between 40° F. and 45° F. in the food compartment *N* and at all times receiving the

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drip from the evaporator 97, in the medium cool compartment L, and converting the same to frost or ice, as above explained.

In Figs. 5 and 6, the reference numeral 120 designates a deep freezer cabinet, the well or storage chamber S of which is adapted to be maintained at a temperature of zero ° F., or even lower, if desired, by a removable, hollow, secondary slab-like evaporator 121 when the same is centrally mounted therein. The refrigerant reservoir 122 of the evaporator 121 is of cylindrical configuration and is adapted to be plugged into the socket 123 of the hemi-cylindrical, hollow primary evaporator 124. A wedge 125 serves to securely hold the evaporators in their assembled position while admitting of the ready separation, when desired, of the secondary evaporator from the well F for de-frosting purposes. A spacing block 127 serves to hold the evaporator 121 off the bottom of the well, when the reservoir thereof is plugged into said socket 123. The radius of curvature of the cylindrical surface of the reservoir 122 conforms to that of the concave face of the socket 123, thus insuring intimate heat transfer relation therebetween, when the reservoir is plugged into such socket. Where large capacity deep freezers are to be refrigerated, several such slab-like secondary evaporators can all be supported in spaced relation within the deep freezer either from a common primary evaporator or each of them from a separate primary evaporator hooked up either in parallel or in series into the refrigerant circuit of the deep freezer. It is of the utmost importance that shells of the primary evaporator elements be shielded from the moist air circulating in the refrigerated compartments in which their complementary secondary evaporators are removably mounted.

During the cycling of the compressor in our improved refrigerating apparatus illustrated in Fig. 1, compressed gaseous refrigerant, which will be relatively hot due to the heat developed in the compression thereof, will be delivered to the reservoir of the primary condenser 75 wherein, due to the effective heat transfer from its shell to the shell of the reservoir of the secondary condenser, which is of extended surface area and of ample capacity to accomplish the optimum amount of condensation desired, such refrigerant will be rapidly cooled and condensed to a liquid state. It then is forced by the pressure in the high side of the circulatory system to pass through the conduit 79 to the expansion valve 81 which serves to restrict the flow thereof as it passes into the low side of the system beyond said valve. Thereupon the cooled refrigerant expands and, as a consequence, such refrigerant effectively absorbs heat from the aforesaid shielded shell of the primary evaporator 77 and the refrigerant reservoir A, in intimate thermal contact therewith, and the secondary evaporator shelf in turn effectively absorbs heat from the air currents circulating in the cooling compartment of the refrigerator and any cube trays or food supported by said shelf.

Preferably the reservoirs of the secondary evaporators, before being charged with volatile liquid refrigerant, are first completely exhausted to remove the last trace of air and, as shown in Fig. 1, the amount of the charge of refrigerant which is sealed therein is desirably just sufficient to bring the level thereof, when the shelf of the secondary evaporator is in a horizontal position, slightly below the level of the bottom face

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of the upper surface of such shelf, so as to insure that at all times the hollow shelf will be almost but not completely filled with refrigerant, while at the same time affording ample space to admit of the free circulation of vapors, from the body of refrigerant in said reservoir, into the space above the surface thereof without any undue pressure being developed in such reservoir. The conduits or passages for conducting volatile refrigerant liquid and vapors thereof to and from the refrigerant reservoir of the secondary evaporator, renders it possible to obtain a sharp freezing and generally uniform temperature on the evaporator shelf even to the remotest margins thereof, since as the liquid refrigerant in the shelf conduits volatilizes by heat transfer from articles of food placed thereon, the resultant vapors migrate to the refrigerant reservoir, the zone of maximum cold, and there become condensed and then returned as liquid to said conduits.

The effective shielding of the primary evaporator 77 and its associated refrigerant conduits from contact with moist air generally present in the cooling compartment of all refrigerators is an essential feature of our novel evaporator construction, since thereby the possibility of the collection of frost or moisture upon the surfaces of such primary evaporator shell and its cooling coil is eliminated and, consequently, the defrosting or cleansing of such surfaces is wholly unnecessary. While it is desirable to dry the outside surface of the secondary evaporator reservoir before returning the same to the refrigerator, this is not absolutely necessary since any moisture remaining thereon when returned to the refrigerator would be quickly frozen and form an ice weld that would even serve to improve the thermal contact and, consequently, increase the heat exchange between the primary evaporator shell and the secondary evaporator reservoir. However, due to the effective leverage that can be obtained by elevating the front end of the shell of a secondary evaporator, such as evaporator 76, for example, it is possible to readily crack any ice weld that may form between such surfaces.

An especial advantage of the removable secondary evaporator resides in the fact that its removal can be almost instantly accomplished and it can be quickly defrosted of the moisture condensed in solid form thereon and cleaned under a faucet in a kitchen sink and then returned to the refrigerated food compartment before any objectionable or even appreciable thawing of ice cubes or of frozen foods occurs to an extent that it will permit any objectionable drip resulting within the refrigerator. Moreover, as previously stated, such quick defrosting eliminates any possibility of odors developing, such as inevitably occur during the prolonged defrosting operation now required in the ordinary mechanical refrigerator. As a matter of fact, in our improved refrigerator the defrosting pan can be utilized as a food container without there being any possibility of such food being contaminated by any drip from the evaporator such as aforesaid.

This application is a continuation in part of our co-pending application Ser. No. 468,330, filed December 9, 1942, for Heat Transfer Systems, now abandoned.

The standard highly volatile refrigerants such as are commonly used in the refrigeration industry including the various Freon refrigerants, of which F₁₂ is typical, are adapted for use in

our improved refrigerators, but it is desirable that in the refrigerant circuit of the secondary evaporators low pressure, highly volatile refrigerants should be employed rather than high pressure refrigerants such as are frequently employed in the main refrigerant circuit of the compressor.

Various modifications and changes in and from the apparatus and method herein described which are within the scope of the appended claims may be made without departing from the spirit of our invention.

Having thus described our invention, what we claim is:

1. In a refrigerator, the combination comprising a thermally insulated cabinet having a compartment to be cooled, a main refrigerating circuit including a primary evaporator mounted in said cabinet, means, including a secondary evaporator that is mounted in said compartment and is disjoined from said refrigerating circuit, which completely shields said primary evaporator against air currents circulating in said cabinet and prevents any substantial thermal contact between the said evaporators and the wall of said compartment, said secondary evaporator and said primary evaporator having their respective rear and front surfaces complementary to each other and one of such surfaces constituting a socket for the reception of the other surface, said secondary evaporator also being of a length sufficient to constitute it an effective lever arm for effecting the rocking of the said rear surface of the secondary evaporator on the said front surface of the primary evaporator, acting as a fulcrum therefor, when it is desired to effect the breaking of any ice seal formed therebetween and the removal of the secondary evaporator from the compartment.

2. In a refrigerator, the combination comprising a thermally insulated cabinet having a compartment to be cooled, a main refrigerating circuit including a primary evaporator mounted in said cabinet, means including a secondary evaporator having an individual refrigerating circuit disjoined from said main refrigerating circuit for completely shielding the primary evaporator against air currents circulating in said cabinet, heat-insulating means, disposed adjacent the rear end of the secondary evaporator, for preventing direct thermal contact between the adjacent wall of said compartment and such secondary evaporator, said latter evaporator and said primary evaporator having their respective rear and front surfaces complementary to each other and one of such surfaces constituting a socket for the reception of the other surface; and said secondary evaporator being of a length sufficient to constitute it an effective lever arm for effecting the rocking of the said rear surface of the secondary evaporator on the front surface of the primary evaporator, acting as a fulcrum therefor, when it is desired to effect the breaking of any ice-seal formed therebetween and the removal of the secondary evaporator from the compartment.

3. A refrigerator as claimed in claim 1, wherein the complementary surfaces are curvilinear

and of the same curvature, whereby the surfaces can be concentrically associated in intimate thermal contact with each other.

4. A refrigerator as claimed in claim 1, wherein the complementary surfaces are arcuate surfaces, one of which constitutes a segment of a sphere and the other a socket having the same curvature whereby such surfaces can be quickly concentrically associated in intimate heat exchange relation and yet can be instantly separated, when desired, for de-frosting of the secondary evaporator.

5. In a refrigerator as claimed in claim 1, wherein elastic means are provided for maintaining the respective evaporators in intimate thermal contact, irrespective of any slight expansion or contraction thereof during a refrigerating cycle.

6. In a refrigerator, the combination comprising a thermally insulated cabinet having a cooling compartment, a main refrigerating circuit, including a primary evaporator and a primary condenser, means for circulating refrigerant through said circuit, a secondary condenser of high heat-radiating capacity which comprises two portions, one of which is spaced from the primary condenser and externally mounted on and directly attached to said cabinet and exposed to air currents external of the cabinet, and the other portion being in intimate thermal contact with said primary condenser, said secondary condenser having a refrigerating circuit entirely distinct from the primary refrigerating circuit, a secondary evaporator being disposed in good heat exchange relation to the primary evaporator and having an individual refrigerant circuit entirely distinct from the primary circuit, said primary evaporator, primary condenser, primary refrigerating circuit and means for circulating refrigerant therein being removable as a unit from said refrigerator without the breaking of any joints in the circulatory system thereof and without in any way disturbing the secondary condenser that is attached to said cabinet.

7. A refrigerator as claimed in claim 1 which is provided with a second compartment to be cooled that is disposed above the other compartment and which has a bottom aperture that is disposed above said disjoined secondary evaporator, and an evaporator mounted in the second compartment above the said aperture in the second compartment and connected into the main refrigerating circuit.

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