March 4, 1941. E. F. HUBACKER 2,233,414

APPARATUS FOR HEAT TRANSFER

Filed June 5, 1939 3 Sheets-Sheet 1

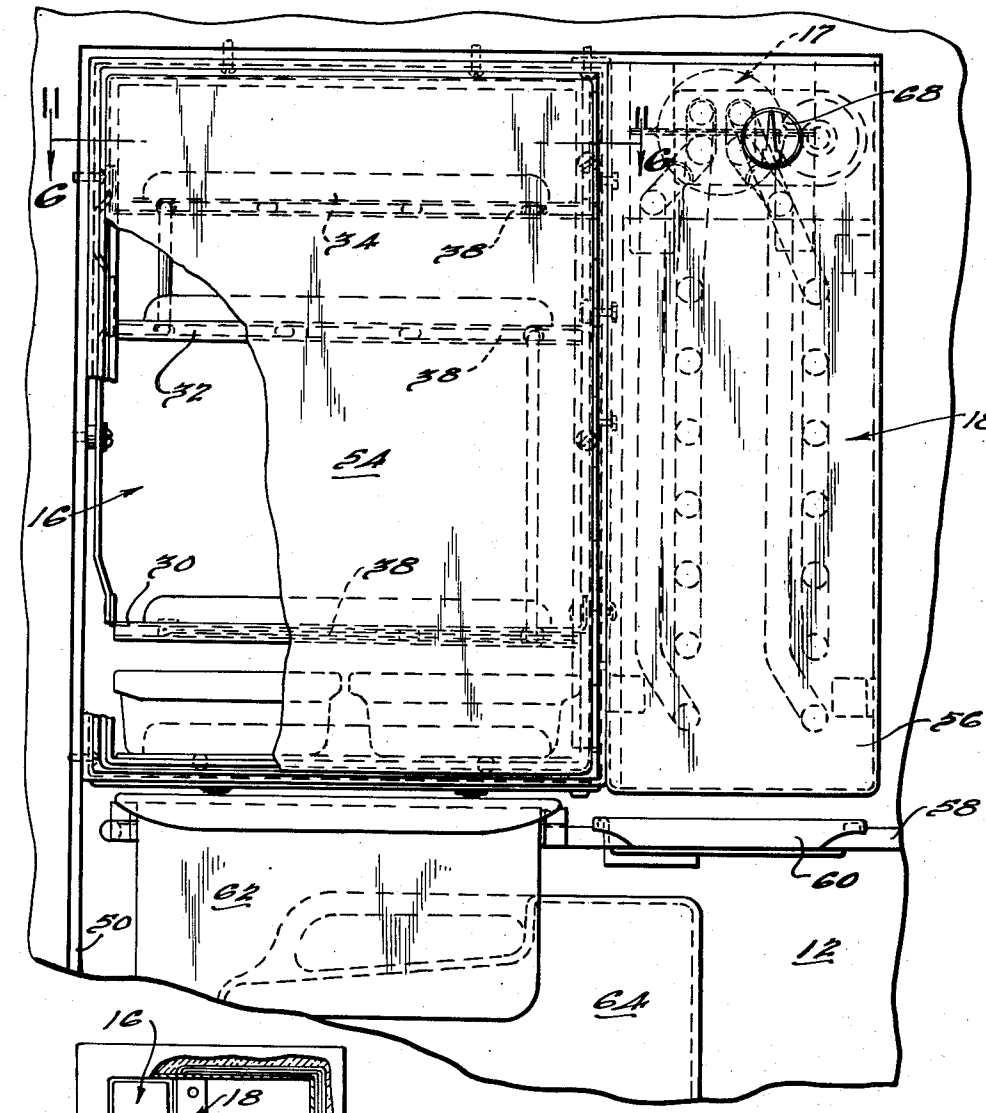


FIG. 2.

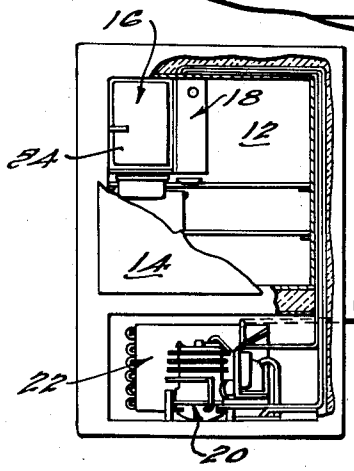


FIG. 1.

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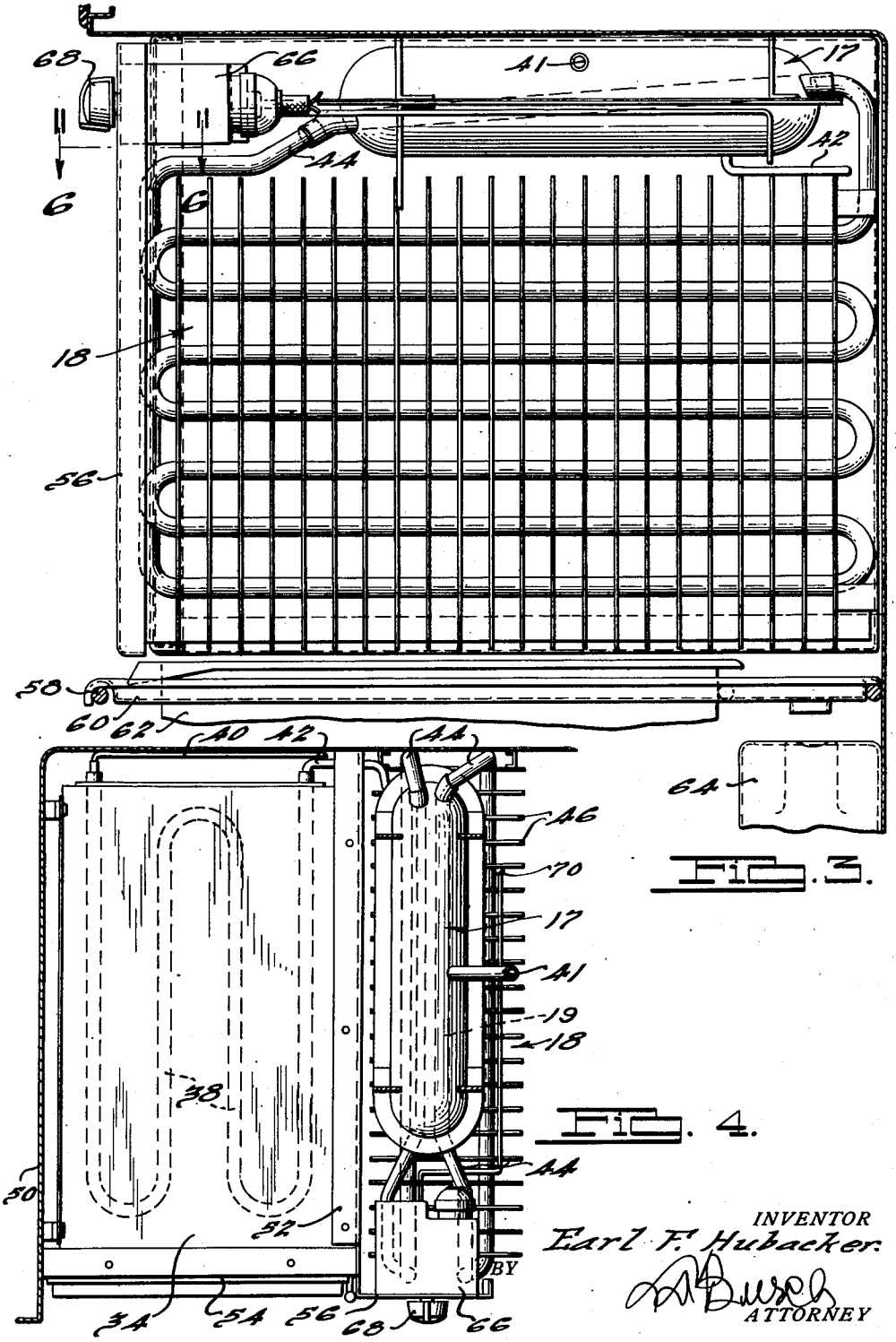


Fig. 3.

Fig. 4.

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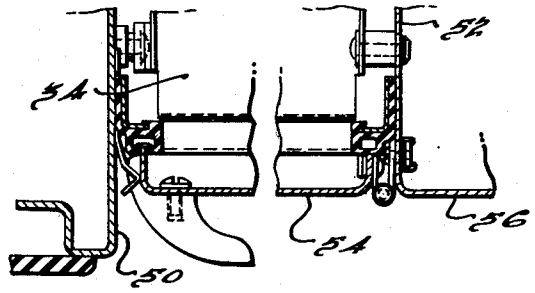


Fig. 6.

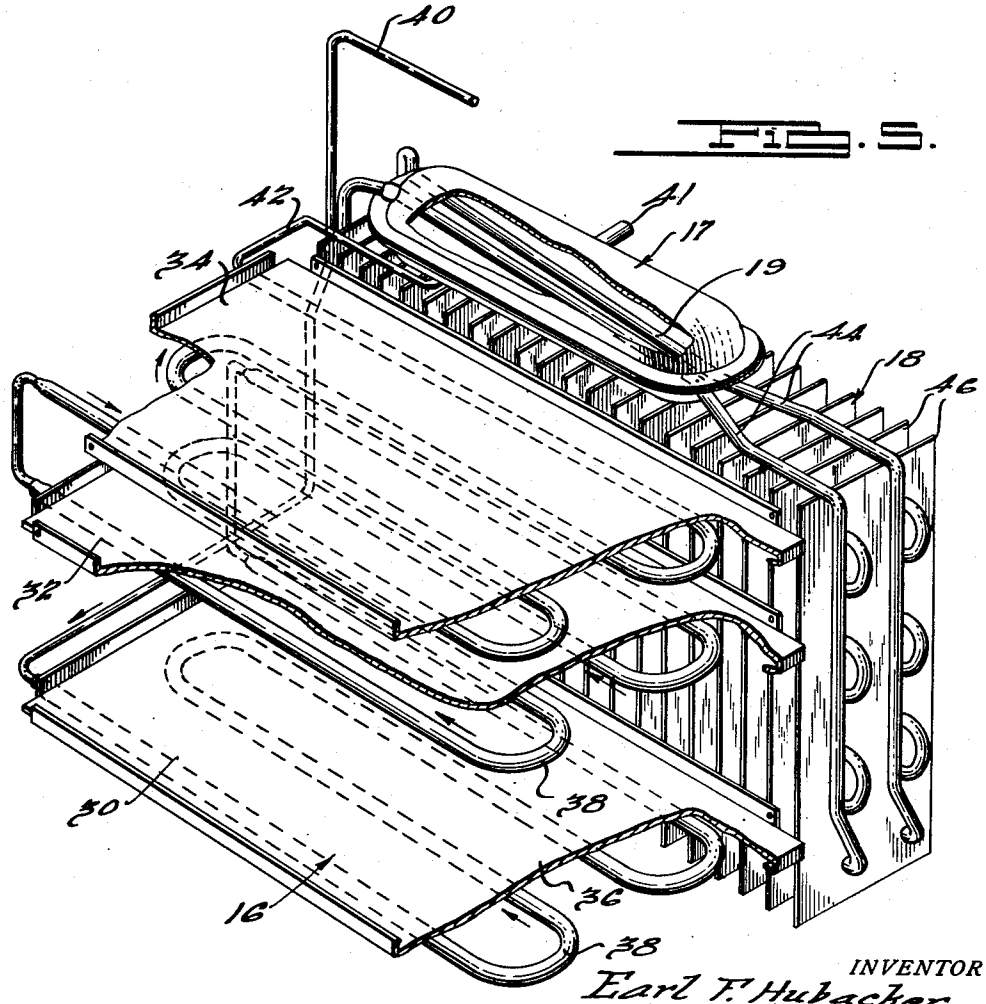


Fig. 5.

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2,233,414

APPARATUS FOR HEAT TRANSFER

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Application June 5, 1939, Serial No. 277,427

4 Claims. (Cl. 62—116)

This invention relates to the art of refrigeration and has particular reference to improved methods of and apparatus for heat transfer which are particularly useful for providing different temperature and humidity conditions within different compartments and at the same time.

As illustrated in the drawings, my invention is shown as being embodied in a refrigerating system and refrigerator of the "domestic type" and which comprises, in general, a heat insulated compartment; a primary refrigerating system which includes a pair of evaporators adapted to operate at different temperature levels and a secondary refrigerating system comprising a condenser arranged in heat exchange relationship with one of said evaporators, and a heat absorbing element or evaporator arranged to operate at a different temperature level than either of the evaporators of said primary refrigerating system. One of the evaporators of the primary refrigerating system may be arranged within the freezing compartment within the heat insulated compartment and is adapted to operate at a temperature level sufficiently low to congeal liquids and to store frozen foods, and the evaporator of the secondary refrigerating system may be exposed to the air within the heat insulated compartment for cooling the air therein and be provided with sufficient surface and be adapted to operate at such a temperature level as to maintain the air and media in the heat insulated compartment within a temperature range of from 35 to 40° F. The temperature level at which it is preferable to operate the evaporator of the secondary system is such as to produce a relative humidity within the heat insulated compartment of approximately 75%.

A principal object of the invention is to provide a new and improved form of refrigerating apparatus which will operate to produce refrigeration at a plurality of different temperatures simultaneously.

Another object of the invention is to produce a new and improved form of refrigerating system and refrigerant for use therein so that the system will operate to produce refrigeration at a plurality of different temperature levels at the same time.

Another object of the invention is to provide a new and improved form of evaporator construction which has one part particularly designed for fast ice freezing and for the low temperature storage of frozen foods and another part which is particularly designed for air cooling and is of such capacity and operated at such a temperature relative to the space to be cooled as to provide more favorable temperature and humidity conditions within such space for the storage of food stuffs.

Another object of the invention is to provide a new and useful method of and apparatus for absorbing heat at different temperature levels and which consists of a primary refrigerating system having two parts or evaporators operating at different temperature levels, and a secondary refrigerating system comprising a condenser thermally associated with one of the evaporators of the primary refrigerating system, and an evaporator which is arranged to operate at a temperature level different than that at which either of the evaporators of said primary refrigerating system operate.

Another object of the invention is to provide a new and useful method of and apparatus for heat transfer and which contemplates a system having two heat absorbing elements operating at different temperature levels and at the same pressure, due primarily to the use in the system of a heat absorbing system comprising a plurality of liquid refrigerant components of different volatility and which vaporize within the range of temperatures at which the heat absorbing elements operate.

Other objects and advantages of the invention will be apparent from a consideration of the following specification taken in conjunction with the accompanying drawings of which there are three (3) sheets and wherein:

Fig. 1 is a view illustrating a refrigerator of the household type which includes a refrigerating system embodying the invention herein contemplated;

Fig. 2 is an enlarged front elevational view of the heat absorbing portion of the refrigerating system;

Fig. 3 is a side elevational view of the apparatus illustrated in Fig. 2;

Fig. 4 is a plan view of the heat absorbing apparatus illustrated in Figs. 2 and 3;

Fig. 5 is a perspective view of the heat absorbing elements with parts thereof being broken away in order to illustrate the path of circulation of the refrigerant; and

Fig. 6 is a section taken in a plane along the line 6—6 of Figs. 2 and 3 looking in the direction of the arrows.

Referring now to Fig. 1, there is illustrated somewhat diagrammatically a refrigerator of the "household type" which consists, in general, of

a heat insulated provision compartment 12, the access to which is closed by door 14, said compartment having arranged therein evaporators, indicated generally at 16 and 18. The refrigerator also includes an apparatus compartment wherein may be arranged a condensing unit of the type which includes a motor-compressor unit 20, a condenser 22 and an expansion control (not shown) which regulates the supply of liquid refrigerant to the low side of the system. An electric cord 24, adapted for attachment to a suitable electric receptacle, also is provided for supplying current to the motor which operates the compressor of the refrigerating system. The condensing unit or part of the refrigerating system may be of conventional construction and the operation of it will be further discussed in connection with the operation of the system as a whole.

Reference may now be had to Fig. 5 wherein the "low side" of the system and the secondary system are more clearly illustrated. The "low side" of the primary refrigerating system consists of evaporators 16 and 17, and the secondary refrigerating system comprises a finned coil evaporator 18 and a condenser 19, the condenser 19 being arranged in heat exchange relationship with evaporator 17.

The evaporator 16 of the primary refrigerating system may comprise a series of refrigerated shelves 30, 32 and 34 arranged one above the other and adapted to support liquid holding trays, such as ice trays. Each of the shelves 30, 32 and 34 may comprise a metallic plate 36 having a refrigerant duct or coil 38 secured to the underside thereof in good thermal conductivity therewith. Liquid refrigerant under the control of the refrigerant expansion control previously referred to, is supplied through liquid line 40 to one end of the duct 38 associated with the bottom shelf 30 and refrigerant from the coil 38 of the bottom shelf 30 flows in series through the coils of the shelves 32 and 34, in the order named, and thence, in series, through conduit 42 to the evaporator 17. Evaporator 17 may comprise a liquid header and have suction line 41 connected thereto for returning vaporous refrigerant and lubricant entrained therein to the intake side of the compressor. The evaporator 17 may be operated at a temperature level different than that of the evaporator 16, preferably at a higher temperature level and in accordance with the system hereinafter disclosed. The evaporator 16 preferably is operated at a temperature level sufficiently low to produce fast ice freezing and to store frozen foods.

The secondary refrigerating system which includes the evaporator 18 and condenser 19 may comprise, as illustrated, one or more continuous coils 44, the ends of each coil being joined together, and each of the coils being charged with a suitable refrigerant, such as, (CCl_2F_2) dichlorodifluoromethane, commercially referred to as F-12; (NH_3) ammonia; (C_3H_8) propane; (CH_3Cl) methyl chloride or any other suitable heat exchange fluid. The condenser 19 of the secondary refrigerating system may consist, as illustrated, of a portion of each of the coils 44 immersed in the liquid refrigerant within the evaporator 17. Preferably, the refrigerant expansion control which regulates the flow of liquid refrigerant to the evaporators 16 and 17 through liquid line 40 operates in such a way as to maintain the level of liquid refrigerant within the evaporator 17 above the portions of the coils 44 which form the condenser 19 and below the top of the header. The suction line 41 communicates with the header forming evaporator 17 above the liquid level therein. The evaporator 18 of the secondary refrigerating system comprises a finned coil exposed to circulating air within the compartment 12 and which may be arranged immediately below evaporator 17. As previously stated, each of the coils 44 of the secondary refrigerating system is charged with a suitable refrigerant which, due to the absorption of heat, will vaporize in those portions of the coils 44 carrying the fins 46 and will be condensed into liquid in the condenser 19, due to the transfer of heat to the refrigerant within the evaporator 17.

The evaporator 16 may be arranged in a zone or compartment defined by the inside lining 50 of the compartment 12 and a partition 52, which cooperates with the tank lining 50 to define a space which preferably is closed by a door 54, and within which the evaporator 16 is arranged, the shelves 30, 32 and 34 may be supported therein in any suitable manner, but preferably in such a way as to retard the transfer of heat from the lining 50 and the partition 52 to the shelves.

The evaporator 18 may be arranged alongside the partition 52 and be exposed to the air within the compartment 12. A part of partition 52 may be formed to provide a shield 56 for covering the front of evaporator 18. A shelf 58 may extend across the compartment 12 immediately below the evaporators 16 and 18 and support a drip collecting tray 60 and a slidably mounted pan 62. The pan 62 may be supported in such close proximity to the horizontal part of the partition 52 that the same provides a cover for the pan 62, yet permits a limited circulation of air between the space within the pan and the space externally thereof. The tray 60 is arranged to underlie the evaporator 18 and to collect the drip therefrom and to conduct such drip into receptacle 64 which may be arranged between the pan 62 and the back wall of the provision compartment and immediately below the evaporator 16. The partition 56 may support a cold control 66 having a manually adjustable knob 68, the cold control 66 comprising a thermostatic switch arranged in the circuit which supplies current to the electric motor which drives the compressor and having a thermostatic element 70 associated with the evaporator 18, the cold control 66 operating in such a manner as to close the motor circuit when the temperature of the evaporator 18 rises above a predetermined degree and to open the motor circuit when the temperature of the evaporator 18 falls below a predetermined degree, thereby tending to maintain the temperature of the compartment 12 within certain predetermined limits.

Evaporators 16 and 17, it will be observed, are connected in series and preferably are operated at the same suction pressure. These evaporators comprise the "low side" of the primary refrigerating system which includes the motor compressor unit 20 and condenser 22, the refrigerant in the system being vaporized in the "low side" of the system and condensed into a liquid in the motor compressor unit 20 and condenser 22 which comprises the "high side" of the system. Preferably the primary refrigerating system is charged with a refrigerant which consists of a solution or mixture of two or more refrigerant components

of different volatility, such for example as, a refrigerant solution comprising a mixture of (CH_3Cl) methyl chloride or (C_2H_5Cl) ethyl chloride. Other examples of refrigerants comprising a mixture or solution of two or more refrigerant components are:

Sulphur dioxide (SO_2) and carbon tetrachloride (CCl_4)
Sulphur dioxide (SO_2) and ethyl chloride (C_2H_5Cl)
Sulphur dioxide (SO_2) and methyl chloride (CH_3Cl)
Sulphur dioxide (SO_2) and methylene chloride (CH_2Cl_2)
Sulphur dioxide (SO_2) and amyl chloride ($C_5H_{11}Cl$)
Methyl chloride (CH_3Cl) and methylene chloride (CH_2Cl_2)
Methyl chloride (CH_3Cl) and isopropyl acetate ($CH_3COOC_3H_7$)
Methyl chloride (CH_3Cl) and methyl isobutyl ketone ($CH_3COC_4H_9$)
Methyl chloride (CH_3Cl) and dimethyl ether ($(CH_3)_2O$)
Methyl chloride (CH_3Cl) and methyl alcohol (CH_3OH)
Methyl chloride (CH_3Cl) and carbon tetrachloride (CCl_4)
Methyl chloride (CH_3Cl) and tetrachloroethane ($C_2H_2Cl_4$)
Methyl chloride (CH_3Cl) and toluene ($C_6H_5CH_3$)
Methyl chloride (CH_3Cl) and tetrachloroethylene (C_2Cl_4)
Methyl chloride (CH_3Cl) and amyl chloride ($C_5H_{11}Cl$)
Methyl chloride (CH_3Cl) and monochlorobenzene (C_6H_5Cl)
Methyl chloride (CH_3Cl) and normal butane (C_4H_{10})
Methyl chloride (CH_3Cl) and (F–12) dichlorodifluoromethane (CCl_2F_2)
Methyl chloride (CH_3Cl) and (F–11) trichloromonofluoromethane (CCl_3F)
Methyl chloride (CH_3Cl) and (F–114) dichlorotetrafluoroethane ($C_2Cl_2F_4$)
Methyl chloride (CH_3Cl) and (F–21) dichloromonofluoromethane ($CHCl_2F$)

"F–11", "F–12", "F–21" and "F–114" are simply the commercial names of some of the refrigerants indicated, and are used principally for the purposes of convenience.

In addition to the foregoing mixtures or solutions, other mixtures or solutions of two or more components may be used.

Of the refrigerants in the foregoing list, normal butane (C_4H_{10}) is the only one classified as an aliphatic hydrocarbon compound;

Ethyl chloride (C_2H_5Cl), methyl chloride (CH_3Cl), methylene chloride (CH_2Cl_2), amyl chloride ($C_5H_{11}Cl$), carbon tetrachloride (CCl_4), tetrachloroethane ($C_2H_2Cl_4$) and tetrachloroethylene (C_2Cl_4) are classied as halogen derivatives of aliphatic hydrocarbon compounds; and

Dichlorodifluoromethane (CCl_2F_2), trichloromonofluoromethane (CCl_3F), dichlorotetrafluoroethane ($C_2Cl_2F_4$) and dichloromonofluoromethane ($CHCl_2F$) may be classified as halogen derivatives of aliphatic hydrocarbons or as fluorine derivatives of an aliphatic halogen compound.

In operation, the refrigerant comprising a plurality of liquid refrigerant components of different volatility, such as the examples pointed out, is fed to the low temperature evaporator **16** of the primary refrigerating system through the liquid supply line **40** and under the regulation of the refrigerant expansion control. In passing through the coils **38** of the shelves of the evaporator **16**, part of the refrigerant mixture will vaporize, principally the higher volatile portions thereof, thereby absorbing heat from the shelves **30**, **32** and **34** and whatever media may be arranged thereon. The refrigerant which does not vaporize in the coils **38** of the shelves, together with the vaporous refrigerant generated in the coils of the shelves, is conducted by conduit **42** to the evaporator **17** where, due to the absorption of heat in the condenser, such liquid refrigerant is vaporized and is thence returned along with the vaporous refrigerant from the shelves through the suction conduit **41** to the intake side of the compressor. In the compressor, the vaporous refrigerant is compressed and thence delivered to the condenser wherein such refrigerant is condensed into liquid form and is thence returned, under the control of the refrigerant expansion control, to the evaporator **16** through liquid line **40**. Due to the fact that the higher volatile portions of the refrigerant vaporize in the evaporator **16**, the liquid refrigerant delivered to the evaporator **17** will boil at a higher temperature than that at which refrigerant boils in the evaporator **16**.

The refrigerant in the coils **44** of the secondary system is condensed in the condenser **19** and thence flows, by gravity, down the front part of the coils **44** to the bottom of the evaporator **18**. Vapor generated, due to the absorption of heat in the coils **44**, causes an upward circulation of refrigerant in the looped portions thereof. The temperature at which the evaporator **18** operates preferably is higher than that at which the evaporator **17** operates, and this result may be obtained by using as a refrigerant in the coils **44** one which will vaporize at a higher temperature than the refrigerant in the evaporator **17**, and under the pressure to which the refrigerant in the coils **44** is subjected. Of course, it is possible by the use of different refrigerants and different pressures in the coils **44** to obtain a wide range of temperatures at which the evaporator **18** may be operated.

This application is a continuation, in part, of my prior copending applications Serial No. 56,625, filed December 30, 1935, for Method of and apparatus for heat transfer; Serial No. 179,249, filed December 11, 1937, for Method of and apparatus for heat transfer; and Serial No. 181,748, filed December 27, 1937, for Method of and apparatus for heat transfer.

While the invention has been described with some detail, it is to be understood that the description is for the purpose of illustration only and is not definitive of the limits of the inventive idea. The right is reserved to make such changes in the details of construction and arrangement of parts as will fall within the purview of the attached claims.

I claim:

1. Refrigerating apparatus comprising a heat insulated compartment, an evaporator comprising a plurality of refrigerated shelves arranged in said compartment and a liquid header arranged adjacent the top one of said shelves, means for supplying liquid refrigerant to said shelves and to said header, and a coil associated with said header and charged with refrigerant, the refrigerant in said coil vaporizing at a higher temperature level than the refrigerant in said

shelves, and said coil being exposed to the air in said compartment, and means for shielding said shelves from the air in said compartment.

2. In a refrigerating apparatus including a heat insulated cabinet, means defining a freezing compartment within said cabinet and separated from the circulating air within said cabinet, means defining a first closed refrigerating system comprising a first evaporator located within said freezing compartment, a refrigerant receiving header located outside of said freezing compartment, means connecting said evaporator and header in series, and means for delivering a first refrigerant medium to said first evaporator and withdrawing the same from said header including a compressor, a secondary closed refrigerating system comprising a condenser disposed in heat transfer relation with the refrigerant medium in said header, an evaporator in heat transfer relation to said circling air in said cabinet and a separate refrigerant having a lower volatility than that portion of said first refrigerant medium evaporating in said freezing evaporator whereby to effect heat transfer between the air in said cabinet and the refrigerant contained in said header at a temperature considerably above the temperature at which evaporation takes place within said first named evaporator.

3. In a refrigerating apparatus including an insulated cabinet, means in said cabinet defining a freezing compartment including means shielding said compartment from circulation of the air in said cabinet, a primary refrigerating system including a first evaporator located in said freezing compartment, a second evaporator outside of said freezing compartment, means connecting said evaporators in series in a closed system including means for compressing and condensing a first refrigerant medium and delivering the same to said first evaporator and removing the same from said second evaporator, said arrangement being particularly characterized by the provision of a secondary closed refrigerating system including a third evaporator in heat transfer relation to said circulating air in said cabinet and a condensing section in heat transfer relation to the refrigerant medium in said second evaporator of said primary system, said secondary system being charged with a second refrigerating medium evaporating at a higher temperature than the temperature of evaporation in said first named evaporator located within said freezing compartment, whereby to increase the spread between the temperature at which said freezing compartment is operated and the temperature at which heat transfer is effected between the circulating air in said cabinet and said evaporating coil of said secondary system.

4. In a refrigerating apparatus including means defining a food cooling chamber and a separated freezing compartment therein, the combination therewith of an arrangement for effecting an increased spread between the temperature at which the freezing compartment is operated and the temperature at which heat transfer is effected within said food cooling chamber, said means comprising a primary refrigerating system including a first evaporator located in said freezing compartment, a header located outside of said freezing compartment, means connecting said evaporator and header in series and means for supplying refrigerant medium to said freezing evaporator and withdrawing the same from said header, said refrigerant medium being made up by placing together a plurality of separate refrigerants having different volatility whereby the more volatile one of said refrigerants evaporates in said freezing compartment evaporator to produce freezing therein and the remainder is conveyed to said header where evaporation of the less volatile of said refrigerants takes place at a second higher temperature, said arrangement being further particularly characterized by the provision of a secondary closed refrigerating system charged with a second refrigerating medium evaporating at a temperature higher than the temperature of the evaporation of said more volatile one of said first named refrigerants making up said first refrigerating medium, said secondary system further including an evaporator in heat transfer relation with the circulating air in said cabinet and a condensing portion in heat transfer relation with the less volatile refrigerant in said header.

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