Nov. 4, 1941. W. A. KUENZLI 2,261,683

REFRIGERATION

Filed Aug. 12, 1937 4 Sheets-Sheet 1

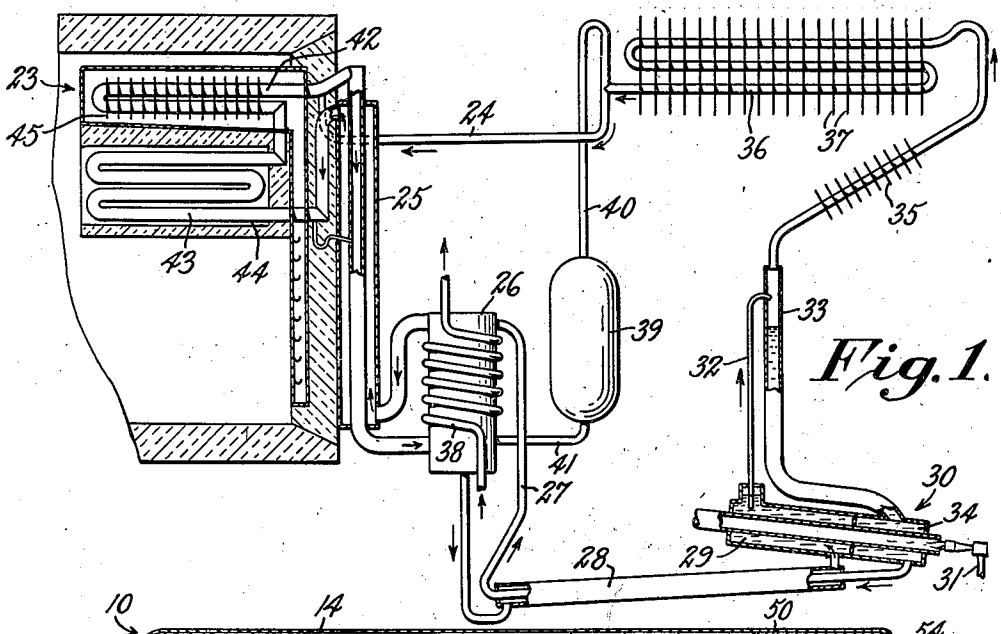


Fig. 1.

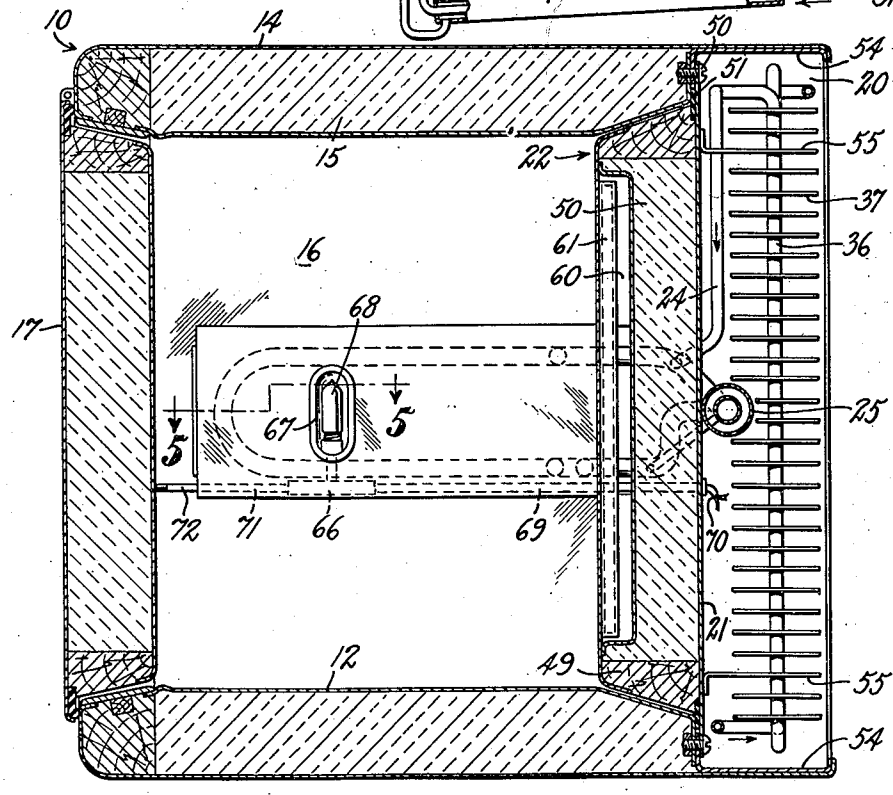


Fig. 4.

INVENTOR.
Walter A. Kuenzli
BY
Ed Fenander his ATTORNEY.

Nov. 4, 1941. W. A. KUENZLI 2,261,683

REFRIGERATION

Filed Aug. 12, 1937 4 Sheets-Sheet 2

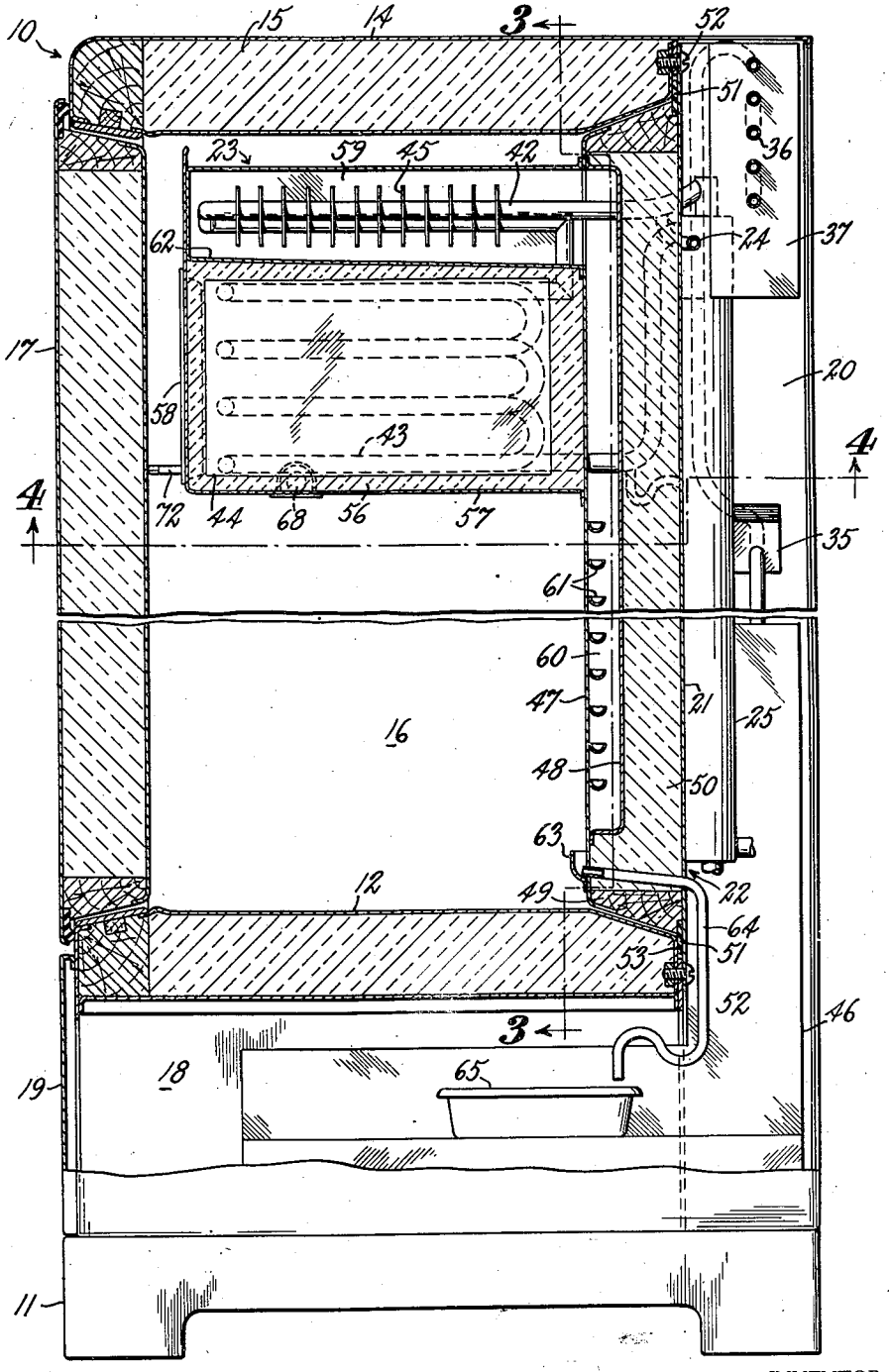


Fig. 2.

BY

INVENTOR.
Walter A. Kuenzli
Ed Fernander his ATTORNEY.

Nov. 4, 1941. W. A. KUENZLI 2,261,683

REFRIGERATION

Filed Aug. 12, 1937 4 Sheets-Sheet 3

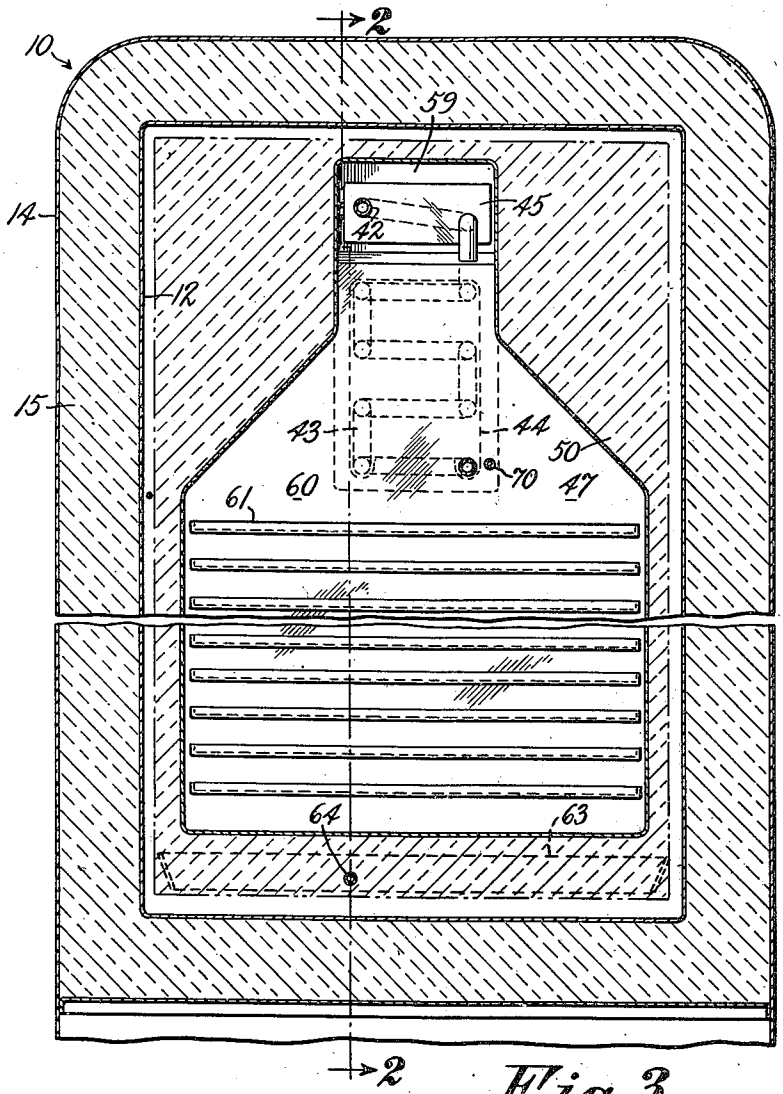


Fig. 3.

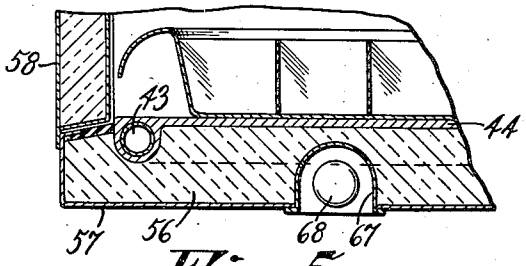


Fig. 5.

INVENTOR.
Walter A. Kuenzli

BY

E. A. Fenander his ATTORNEY.

Nov. 4, 1941. W. A. KUENZLI 2,261,683

REFRIGERATION

Filed Aug. 12, 1937 4 Sheets-Sheet 4

Fig. 6.

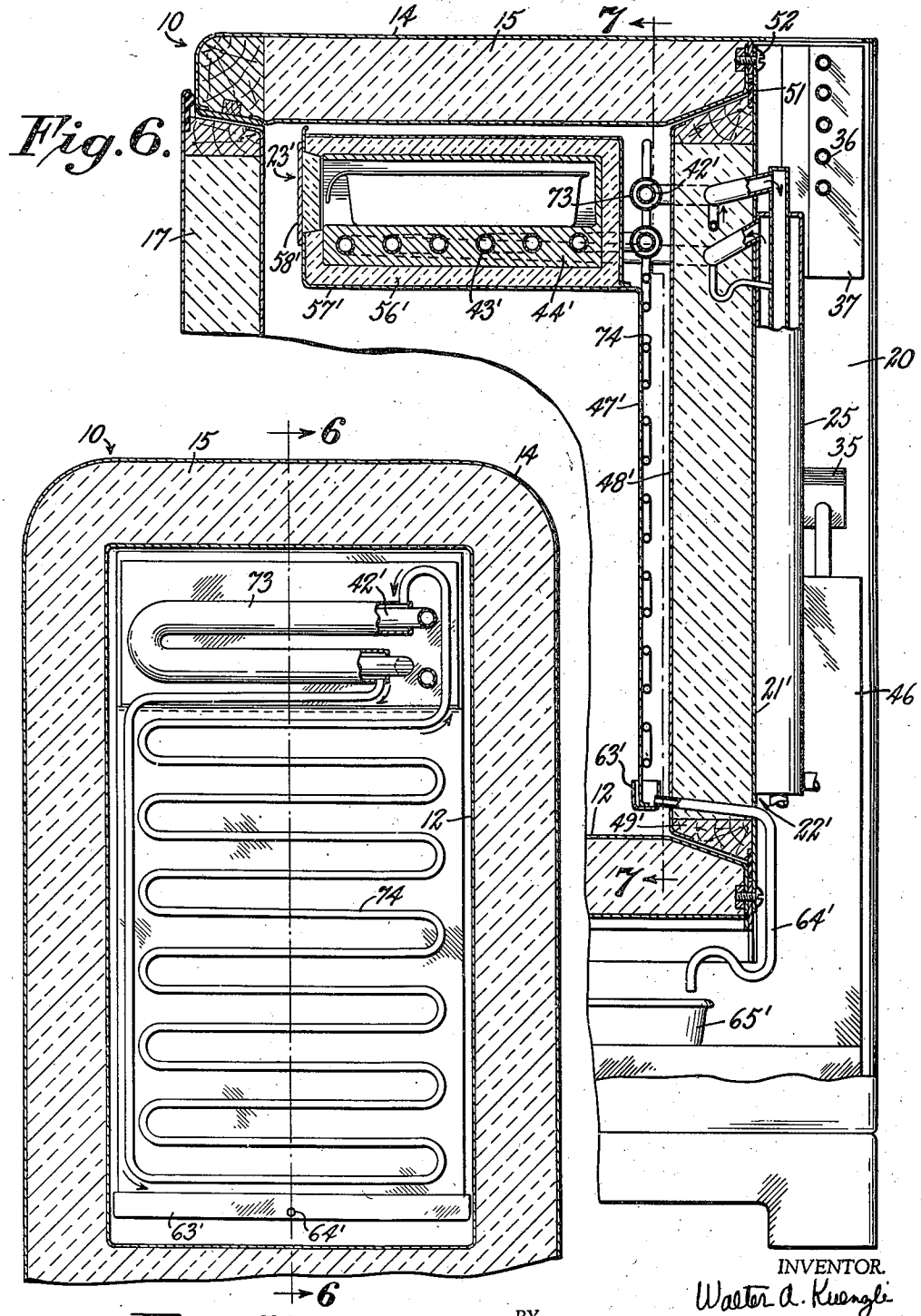


Fig. 7.

INVENTOR.
Walter A. Kuenzli
BY
Ed Fenander his ATTORNEY.

Patented Nov. 4, 1941 2,261,683

UNITED STATES PATENT OFFICE

2,261,683

REFRIGERATION

Walter A. Kuenzli, Evansville, Ind., assignor to Servel, Inc., New York, N. Y., a corporation of Delaware

Application August 12, 1937, Serial No. 158,646

16 Claims. (Cl. 62—95)

My invention relates to refrigeration, and more particularly to refrigerator cabinet structures and to cooling of storage compartments provided by such structures.

It has already been proposed to employ a wall of a storage compartment of a refrigerator as a cooling surface to cool and maintain the compartment at a low temperature. In such case the cooling surface is maintained above rather than below the freezing temperature of water to reduce the amount of water vapor removed from air flowing in contact therewith. With less water vapor removed from air in the storage compartment, the latter is maintained at a higher humidity and foods are preserved with less dehydration. In a refrigerator of this type condensation of water vapor occurs on the cooling surface.

It is an object of my invention to provide an improvement for collecting and draining condensate from a storage compartment of a refrigerator in which a wall of the compartment serves as a cooling surface.

Another object of my invention is to provide an improvement in a refrigerator cabinet by making the wall serving as a cooling surface as a separate removable member.

A further object of my invention is to provide an improvement in a refrigerator cabinet wherein the refrigeration apparatus and removable wall serving as a cooling surface form a unitary structure.

The invention, together with the above and other objects and advantages thereof, will be more fully understood from the following description taken in conjunction with the accompanying drawings forming a part of this specification, and of which:

Fig. 1 diagrammatically illustrates a refrigeration system and a fragmentary side vertical sectional view of a refrigerator embodying the invention;

Fig. 2 is an enlarged side vertical sectional view of the refrigerator diagrammatically shown in Fig. 1 and taken on line 2—2 of Fig. 3 to illustrate the invention more clearly;

Fig. 3 is a vertical sectional view taken on line 3—3 of Fig. 2;

Fig. 4 is a horizontal sectional view taken on line 4—4 of Fig. 2;

Fig. 5 is a fragmentary vertical sectional view taken on line 5—5 of Fig. 4;

Fig. 6 is a fragmentary side vertical sectional view of a refrigerator taken on line 6—6 of Fig. 7 and illustrating a modification of the invention; and

Fig. 7 is a vertical sectional view taken on line 7—7 of Fig. 6.

In accordance with my invention I utilize a removable rear wall of a refrigerator storage compartment as a cooling surface with the aid of a secondary heat transfer system. The secondary heat transfer system comprises a closed fluid circuit containing a volatile fluid and having a portion in thermal exchange relation with a cooling element of refrigeration apparatus. The wall serving as the cooling surface may form a part of the closed fluid circuit over which liquid flows, or the wall may be in thermal transfer relation with one or more members of the closed fluid circuit in which the volatile fluid flows.

I provide low and higher temperature cooling elements which may be operated below and above the freezing temperature of water. The low temperature cooling element is employed as a freezing unit and is insulated to prevent removal of water vapor from air in the storage compartment. The higher temperature cooling element is associated with the secondary heat transfer system and wall of the storage compartment for cooling the latter.

Referring to Figs. 2 and 4, I have shown my invention embodied in a refrigerator comprising a cabinet 10 having a base 11. The cabinet 10 is provided with an inner metal shell or liner 12 arranged within an outer metal shell 14 and insulated therefrom with any suitable insulating material 15. The inner shell 12 defines the lateral side walls, top, and bottom of a thermally insulated storage space 16 into which access may be had by a door 17 hinged at the front of the cabinet.

Below the storage space 16 is a compartment 18 into which access may be had by a door 19 hinged at the front of the cabinet. The compartment 18 extends to the rear of the cabinet and communicates with an upward extending compartment 20 which is substantially the same height as the cabinet 10. The lateral side walls of the outer shell 14 extend or project beyond an outer metal plate 21 of the rear insulated wall 22 of the storage space 16 to provide the compartment 20.

A cooling unit 23 of refrigeration apparatus is disposed in the storage space 16. Although I do not wish to be limited thereto, the cooling unit 23 may form part of refrigeration apparatus of a uniform pressure absorption type containing an inert gas or auxiliary agent. In apparatus of

this type, as shown in Fig. 1, refrigerant is introduced into the cooling unit 23 through a conduit 24. In cooling unit 23 the refrigerant, such as ammonia, evaporates and diffuses into an inert gas, such as hydrogen, to produce a refrigerating effect. The resulting gas mixture of refrigerant and inert gas flows from the upper part of cooling unit 23 through the inner passage of a gas heat exchanger 25 into the lower part of an absorber 26.

In absorber 26 refrigerant gas is absorbed by a suitable liquid absorbent, such as water, which enters through a conduit 27. The inert gas, which is practically insoluble and weak in refrigerant, is returned to the lower part of cooling unit 23 through the outer passage of the gas heat exchanger 25; and the enriched absorption liquid is conducted from absorber 26 through the outer passage of a liquid heat exchanger 28 into a rear chamber 29 of a generator 30.

By heating the generator 30, as by a gas burner 31, liquid is raised by vapor-lift action through conduit 32 from chamber 29 into the upper part of a stand-pipe 33. Liberated refrigerant vapor entering stand-pipe 33 through conduit 32, and also the refrigerant vapor expelled out of solution in stand-pipe 33 and a forward chamber 34, flows upward through an air-cooled rectifier 35 and into an air-cooled condenser 36 having a plurality of cooling fins 37. Refrigerant vapor is liquefied in condenser 36 and returned to the upper part of cooling unit 23 through conduit 24 to complete the refrigerating cycle.

The weakened absorption liquid from which refrigerant has been expelled flows from chamber 34 through the inner passage of liquid heat exchanger 28 and conduit 27 into the upper part of absorber 26. The heat liberated with absorption of refrigerant vapor in absorber 26 is transferred to a cooling medium which flows through a coil 38. The coil 38 is disposed about and in thermal relation with the absorber 26.

A vessel 39 is connected by a conduit 40 to the lower part of condenser 36 and by a conduit 41 to the gas circuit, as at absorber 26, for example, so that any inert gas which may pass into the condenser can flow into the gas circuit. Refrigerant vapor not liquefied in condenser 36 flows through conduit 40 to displace inert gas in vessel 39 and force such gas through conduit 41 into the gas circuit, thereby increasing the total pressure in the system. With such increase in pressure in the system an adequate condensing pressure is obtained to insure condensation of refrigerant vapor in condenser 36.

The cooling unit 23 includes an upper coil or cooling element 42 and a lower coil or cooling element 43. The coil 43 may be embedded in or otherwise suitably arranged in heat exchange relation with a shell 44 provided with a plurality of compartments to receive trays for freezing water and the like. The upper coil 42 is provided with a plurality of cooling fins 45 to increase the heat transfer surface of this cooling element.

Liquid refrigerant entering the upper coil 42 through conduit 24 flows downward in counterflow to inert gas which flows upward and enters the lower coil 43 from the outer passage of the gas heat exchanger 25. Circulation of gas is caused by difference in weights of columns of gas in the evaporator-absorber circuit. In the absorber ammonia vapor is removed from the gas so that the gas in the path of flow through the absorber and to the evaporator is lighter than the gas containing evaporating ammonia in the path of flow from the evaporator to the absorber. Circulation takes place upward in the absorber and thence toward the lower end of the evaporator because the columns of gas in this path are outweighed by the columns of gas in the return path. Since the inert gas flows first through the lower coil 43 of the cooling unit and then through the upper coil 42, the gas in the upper coil contains a greater amount of refrigerant vapor than the gas in the lower coil. The partial pressure of refrigerant vapor is therefore higher in coil 42 than in coil 43, and evaporation of liquid refrigerant takes place at a higher temperature in the upper coil than in the lower coil.

The different elements or parts of the refrigeration apparatus just described are made of metal and permanently secured together, as by welding, to provide a hermetically closed system. The gas heat exchanger 25, air-cooled rectifier 35, condenser 36, and other parts may be arranged in the vertically extending flue 20, as shown in Figs. 2 and 4. The liquid heat exchanger 28, generator 30 and stand-pipe 33 are embedded in a body of insulating material contained in a shell 46. The lower part of shell 46 is disposed in the lower apparatus compartment 18 with the burner 31 (not shown in Fig. 2) located so as to project its flame into the generator 30.

In accordance with my invention I utilize an inner metal plate 47 of the rear wall 22 of the storage space 16 as a cooling surface. The rear wall 22 and refrigeration apparatus form a unitary structure whereby the rear wall and apparatus may be mounted on the cabinet and removed therefrom as a unit. As shown in Figs. 2 and 4, the rear wall 22 comprises the outer metal plate 21 and spaced inner plates 47 and 48 which are held in spaced relation by a frame 49. The space defined by the plates 21 and 48 and frame 49 contains a suitable insulating material 50. The frame 49 is recessed to receive a gasket 51 of rubber or other suitable material which bears against the inner surface of outer plate 21. The rear wall 22 is secured in position in any suitable manner, as indicated at 52, with the gasket 51 interposed between the outer plate 21 and rear flange 53 of the inner liner 12, whereby the storage space 16 is effectively sealed at the rear wall to prevent the escape of cold air.

As shown in Fig. 4, the outer metal plate 21 of the removable wall 22 and brackets 54 secured thereto constitute a frame upon which the refrigeration apparatus is mounted. The gas heat exchanger 25, shell 46, and other parts are supported on the rear wall 22 to form a unitary structure. The condenser 36 is provided with cooling fins 55 which are wider than the fins 37 and secured at their inner edges to the outer metal plate 21. The conduits connecting the cooling unit 23 and other parts of the refrigeration apparatus extend through the rear wall 22.

The upper and lower cooling coils 42 and 43 are operated above and below the freezing temperature of water. Under these conditions water vapor would be condensed out of air if air were permitted to contact shell 44 in which the lower coil 43 is embedded. To reduce the amount of water vapor removed from air I insulate shell 44 and utilize the upper coil 43 to

cool the space 16 with the aid of a secondary heat transfer system to be described hereinafter.

As shown most clearly in Fig. 2, the shell 44 is insulated with any suitable insulating material 56 contained in a casing 57. A door 58 is provided at the front of casing 57 to provide access into the freezing compartments of shell 44. The casing 57 is formed to provide an upper chamber 59 which is not insulated and in which the upper coil 42 is located.

As shown in Figs. 2 and 3, the rear part of chamber 59 is in communication with the vertical chamber 60 defined by the spaced plates 47 and 48 of the rear wall 22. The chambers 59 and 60 form a closed fluid circuit which constitutes a secondary heat transfer system and is partly filled with a volatile liquid, such as ethyl chloride. To the inner surface of plate 47 are secured a plurality of troughs 61 whereby liquid will flow from each trough to the trough located beneath it.

In operation, with volatile fluid flowing over the edges of troughs 61 and over the inner surface of plate 47, the volatile fluid evaporates and takes up heat, thereby effecting cooling of the storage space 16. The vapor flows upward into the chamber 59 where it is cooled and condensed by the upper cooling element or coil 42 and fins 45. The condensate flows down on the lower inclined surface 62 of chamber 59 and over the troughs 61 and inner surface of plate 47 where it is again evaporated. In the secondary heat transfer system that has been provided, therefore, the volatile fluid circulates naturally in a closed circuit in which the liquid evaporates on the evaporation portion or plate 47 and condenses in the condensation portion or chamber 59.

In order to remove water vapor which condenses on the rear wall or plate 47, I provide a trough 63 which extends across the bottom of storage space 16 and is secured to the plate 47. The water vapor condensing on plate 47 accumulates and collects in the trough 63. A small conduit 64 which extends through the removable wall 22 is provided to drain the condensate from the trough 63. The conduit 64 is arranged to conduct the condensate to a receptacle or vessel 65 which may be mounted on the portion of shell 46 which is disposed in the lower apparatus compartment 18. If desired, the condensate may be conducted to a heat rejecting part of the apparatus, such as absorber 26, for example, where it is heated and evaporated.

A light fixture and switch therefor are mounted on the cooling unit 23. I accomplish this by mounting a combined light switch and fixture 66 in the insulation 56 of the casing 57, as shown most clearly in Figs. 4 and 5. The light fixture may be of any well-known type having a suitable reflector 67 to receive a lamp 68 for illuminating the interior of the storage space 16.

A hollow tube 69 formed of insulating material and adapted to receive an electrical conductor 70 extends from the switch 66 through the rear wall 22. A similar tube 71 extends from the switch 66 to the front of casing 57 and is adapted to receive a rod 72 which actuates the switch 66. The rod 72 bears against the inside of door 17 and is arranged to move outward when the door is opened, whereby the switch 66 is automatically closed to complete the electrical circuit for the lamp 68. When the door 17 is closed, rod 72 is moved rearward to open the switch 66 and disconnect the lamp 68 from the source of electrical supply.

In Figs. 6 and 7 I have shown a modification of my invention which differs from the embodiment just described in that a member of the secondary heat transfer system is arranged in thermal exchange relation with a wall of the storage space which serves as a cooling surface. The parts shown in Figs. 6 and 7 which are similar to those illustrated in Figs. 1 to 4 inclusive are indicated by the same reference numerals. In Fig. 6 the removable rear wall 22' comprises an outer plate 21' and an inner plate 48' which are maintained in spaced relation by a frame 49'.

The rear wall or plate 47' of the storage space 16 is spaced from the removable wall 22' and supported by a casing 57' of a cooling unit 23'. The cooling unit 23 includes coils 42' and 43' which correspond to the coils 42 and 43, respectively, in the embodiment described above. The low temperature coil 43' is embedded in a shell 44' which is insulated at 56' and provided with an outer casing 57'. A door 58' is located at the front of casing 57' to provide access into one or more compartments formed by the shell 44'.

The higher temperature coil 42' is located at the rear of casing 57' and is associated with a secondary heat transfer system to effect cooling of the storage space 16. The secondary heat transfer system includes a jacket 73 disposed about the coil 42'. The ends of the jacket or outer conduit 73 are connected to a zigzag coil 74 which is of substantially the same height as the plate 47'. The coil 74 includes straight portions and bends and is secured to and in thermal exchange relation with the inner surface of plate 47'.

The jacket 73 and coil 74 form a secondary heat transfer system which is partly filled with a volatile liquid, such as ethyl chloride. In operation, with the circuit one-half or two-thirds filled with volatile liquid, the volatile liquid evaporates in coil 74 and takes up heat, thereby effecting cooling of the storage space 16. The vapor flows upward into jacket 73 where it is cooled and condensed by the cooling element 42'. The condensate flows downward by gravity from the jacket 73 into coil 74 where it is again evaporated. The internal diameter of coil 74 is of such size that vapor bubbles formed in the coil will freely pass liquid in the system. In other words, the vapor bubbles will not be effective to lift liquid in the coil 74. In this modification the jacket 73 constitutes the condensation portion and the plate 47' and coil 74 constitute the evaporation portion of the secondary heat transfer system.

The bottom edge of plate 47' extends into a trough 63' and is secured thereto, as by welding, so that condensate formed on plate 47' and coil 74 will collect and accumulate in the trough. A conduit 64' extending through the lower part of rear wall 22' is provided to conduct condensate from the trough 63' to a vessel 65', in a manner similar to that shown in Fig. 2.

By making the cooling surface a part of the removable rear wall of the storage space, the assembly and construction of the cabinet is simplified considerably. Since the secondary heat transfer system is associated with a cooling element of the refrigeration apparatus, it is particularly advantageous to make the rear wall of the cabinet, secondary cooling system, and refrigeration apparatus as a unitary structure. The provision of a drain conduit through the removable rear wall eliminates the necessity of providing

additional openings in the bottom of the cabinet to remove condensate formed on the cooling surface.

Although I have shown and described particular embodiments of my invention, it will be apparent to those skilled in the art that modifications and changes may be made without departing from the spirit and scope of the invention. I therefore aim to cover all modifications and changes which come within the spirit and scope of the invention, as pointed out in the following claims.

What is claimed is:

1. A refrigerator comprising a cabinet having thermally insulated walls defining a storage space having an opening, a closure for the opening normally affording access into said space, one of said walls being removable, refrigeration apparatus including a cooling element, a secondary heat transfer system containing a volatile fluid and having a condensation portion and an evaporation portion, said condensation portion being in thermal exchange relation with said cooling element and said evaporation portion including a part of said removable wall.

2. A refrigerator comprising a cabinet having thermally insulated walls defining a storage space having an opening, a closure for said opening normally affording access into said space, refrigeration apparatus including a cooling element, one of said walls being removable and including spaced inner wall members to provide a chamber separated from said space by one of said wall members, a vaporization-condensation circuit containing a volatile fluid and including said chamber, said circuit including a vaporization portion comprising said chamber and a condensation portion in thermal exchange relation with said cooling element.

3. In a refrigerator comprising a cabinet having thermally insulated walls defining a storage space, refrigeration apparatus including a cooling element, structure providing a chamber and including an inner member of one of said walls, said chamber constituting a vaporization-condensation circuit partly filled with a volatile liquid, and said cooling element being disposed within the upper part of said chamber.

4. In a refrigerator comprising a cabinet having thermally insulated walls defining a storage space, refrigeration apparatus including a low temperature cooling element and a higher temperature cooling element, a vaporization-condensation circuit containing a volatile fluid, said circuit comprising a vaporization portion including a vertically extending sheet metal plate forming a wall part of said storage space for transferring cooling effect to the latter and a condensation portion in thermal exchange relation with said higher temperature cooling element whereby said higher temperature cooling element transmits cooling effect to said condensation portion, and said low temperature cooling element being located and arranged so that transfer of cooling effect therefrom to said storage space is impeded.

5. A refrigerator as defined in claim 4, in which one of said thermally insulated walls is removable, and said vertically extending sheet metal plate forms a part of said removable wall.

6. A refrigerator as defined in claim 4, in which one of said thermally insulated walls is removable and includes said vertically extending sheet metal plate, and structure carried by said removable wall to conduct from said storage space condensate formed on said plate.

7. In a refrigerator having thermally insulated walls defining a storage space having an opening, a door for closing the opening, one of said walls being removable, refrigeration apparatus including a cooling element disposed in said space and removable from said space with removal of said removable wall, a light fixture and switch mounted on said cooling element and insulated therefrom, and an electrical conductor connected to said fixture and said switch and extending through said removable wall.

8. In a refrigerator having thermally insulated walls defining a storage space having an opening, a door for closing the opening, one of said walls being removable, refrigeration apparatus including a cooling element disposed in said space and removable from said space with removal of said removable wall, a light fixture and switch mounted on said cooling element and insulated therefrom, an operating member for said switch arranged to open and close said switch when said door is closed and opened, respectively, and an electrical conductor connected to said fixture and said switch and extending through said removable wall.

9. In a refrigerator including a cabinet having thermally insulated walls defining a storage compartment, a low temperature cooling element and a higher temperature cooling element, one of said walls at least in part including two metal sheets having a passage therebetween separated from said compartment by one of said sheets, a vaporization-condensation circuit partly filled with a volatile liquid, said circuit having a vaporization portion including said passage for transferring cooling effect to said compartment and a condensation portion in thermal exchange relation with said higher temperature cooling element, and said low tempearture cooling element being located and arranged so that transfer of cooling effect therefrom to said storage compartment is impeded.

10. In a refrigerator including a cabinet having thermally insulated walls defining a storage compartment and having an opening, refrigeration apparatus including a cooling element in said compartment, a thermally insulated closure for the opening including two metal sheets having a passage therebetween separated from said compartment by one of said sheets, a vaporization-condensation circuit partly filled with a volatile liquid, said circuit having a vaporization portion including said passage and a condensation portion in thermal exchange relation with said cooling element, and said refrigeration apparatus and said closure constituting a unitary removable structure.

11. In a refrigerator including a cabinet having thermally insulated walls defining a storage compartment and having an opening, refrigeration apparatus including a cooling element in thermal transfer relation with said compartment, a thermally insulated closure for the opening including two metal sheets having a passage therebetween separated from said compartment by one of said sheets, a vaporization-condensation circuit partly filled with a volatile liquid, said circuit having a vaporization portion including said passage and a condensation portion in thermal exchange relation with said cooling element, and said refrigeration apparatus and said closure constituting a unitary removable structure.

12. A refrigerator including a cabinet having thermally insulated top, bottom and vertical walls forming a storage compartment, refrigeration

apparatus including a cooling element located within said compartment, and a drain conduit for collecting drip flowing downwardly from said cooling element by gravity and extending through one of said vertical walls, said one vertical wall, refrigeration apparatus, and drain being removable as a unit from said cabinet.

13. A refrigerator comprising in combination a cabinet including a shell bounding the walls of a compartment for the storage of food to be refrigerated, said shell having a part independently removable from said cabinet, said removable shell part being formed and arranged to provide a chamber for holding a secondary refrigerant in good thermal contact therewith, means providing a condensing chamber for said secondary refrigerant, and a primary refrigeration apparatus associated with said condensing chamber for condensing said secondary refrigerant, said primary refrigeration apparatus and said shell part being readily removable as a unit from said cabinet.

14. A refrigerator as set forth in claim 13 in which said refrigeration apparatus includes both high and low temperature cooling elements constituting parts of the same refrigerating unit, and the high temperature cooling element is associated with said condensing chamber.

15. A refrigerator comprising a cabinet having thermally insulated walls defining a storage space, one of said walls being removable and having an inner metal liner, and means including a heat transfer circuit containing a volatile fluid and having a condensation portion to which a cooling effect is transmitted and a vaporization portion with which said inner liner is associated whereby cooling effect is transferred to said space through said liner, whereby the inner liner of said removable wall serves as a cooling surface to effect cooling of said space.

16. A refrigerator comprising a cabinet having thermally insulated walls serving as the top, bottom, rear and lateral side walls of a storage space, said rear wall being removable and having a vertically extending inner metal liner bounding said space, and refrigerating means contacting said inner liner, whereby said inner liner serves as an extended cooling surface to effect cooling of said space.

WALTER A. KUENZLI.