Oct. 25, 1938. E. L. SCHELLENS ET AL 2,134,149

REFRIGERATION

Filed Aug. 13, 1935 6 Sheets-Sheet 1

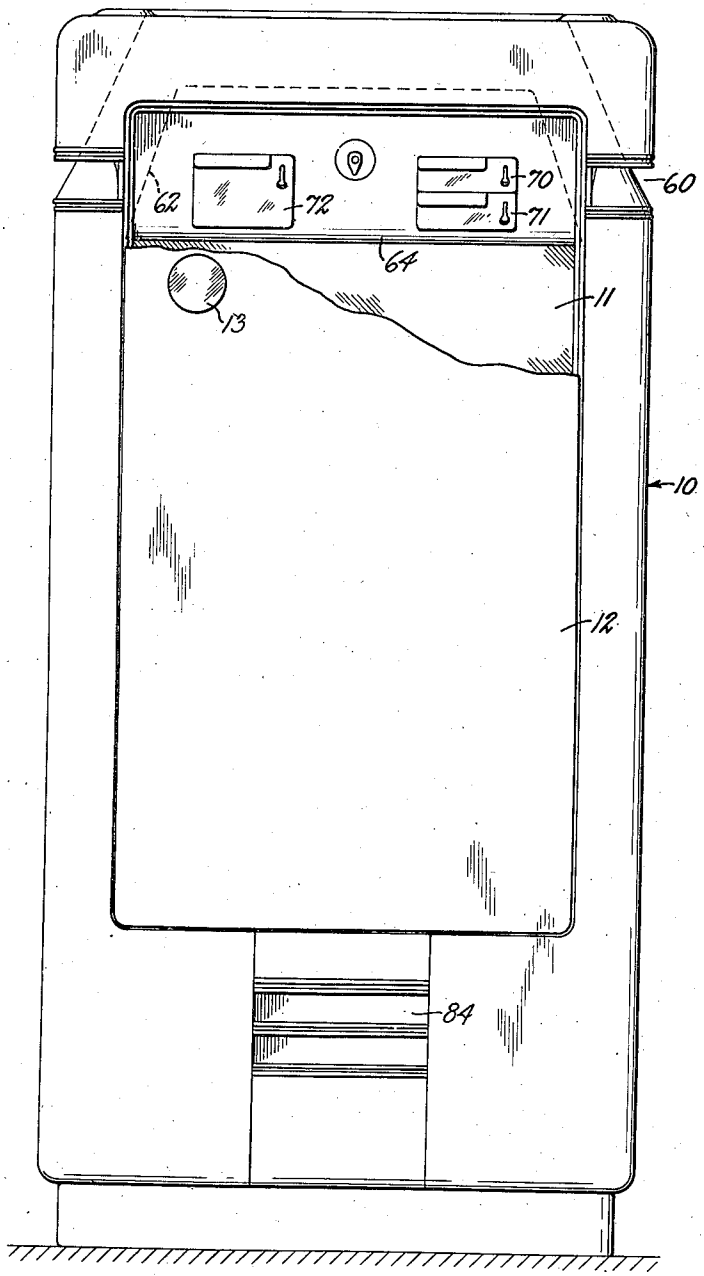


Fig. 1.

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Filed Aug. 13, 1935 6 Sheets-Sheet 2

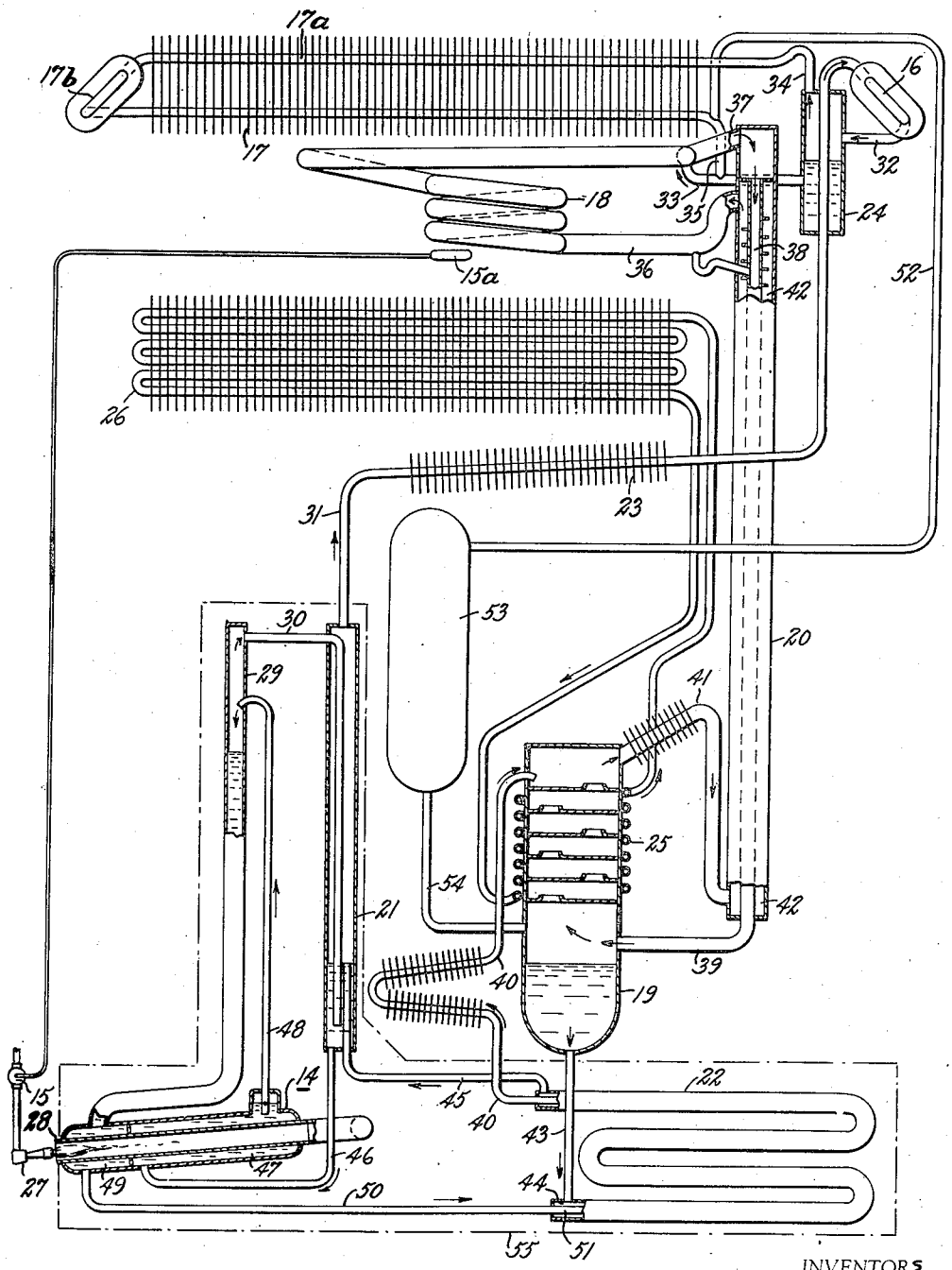


Fig. 2.

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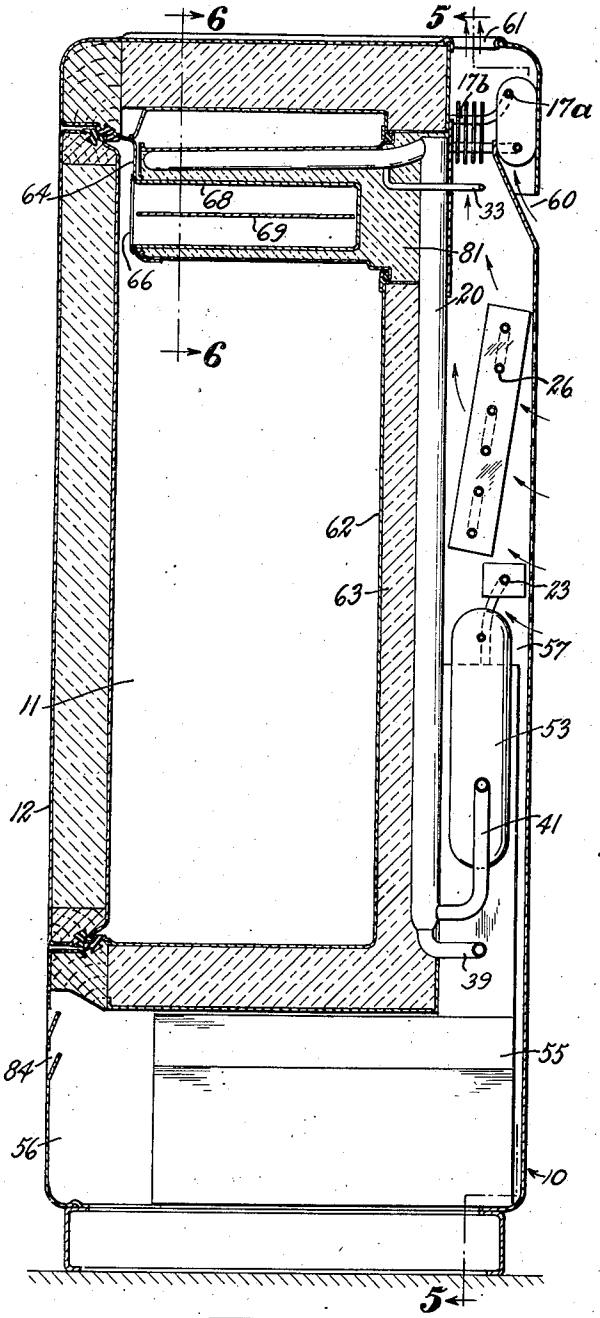


Fig. 4.

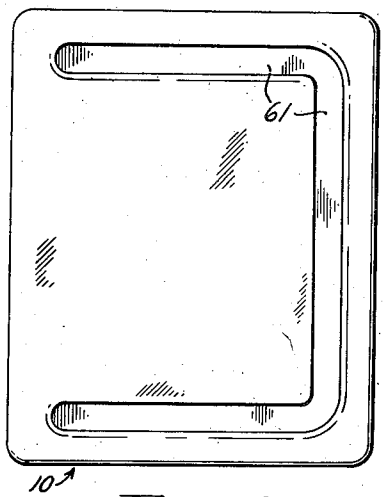


Fig. 3.

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REFRIGERATION

Filed Aug. 13, 1935 6 Sheets-Sheet 4

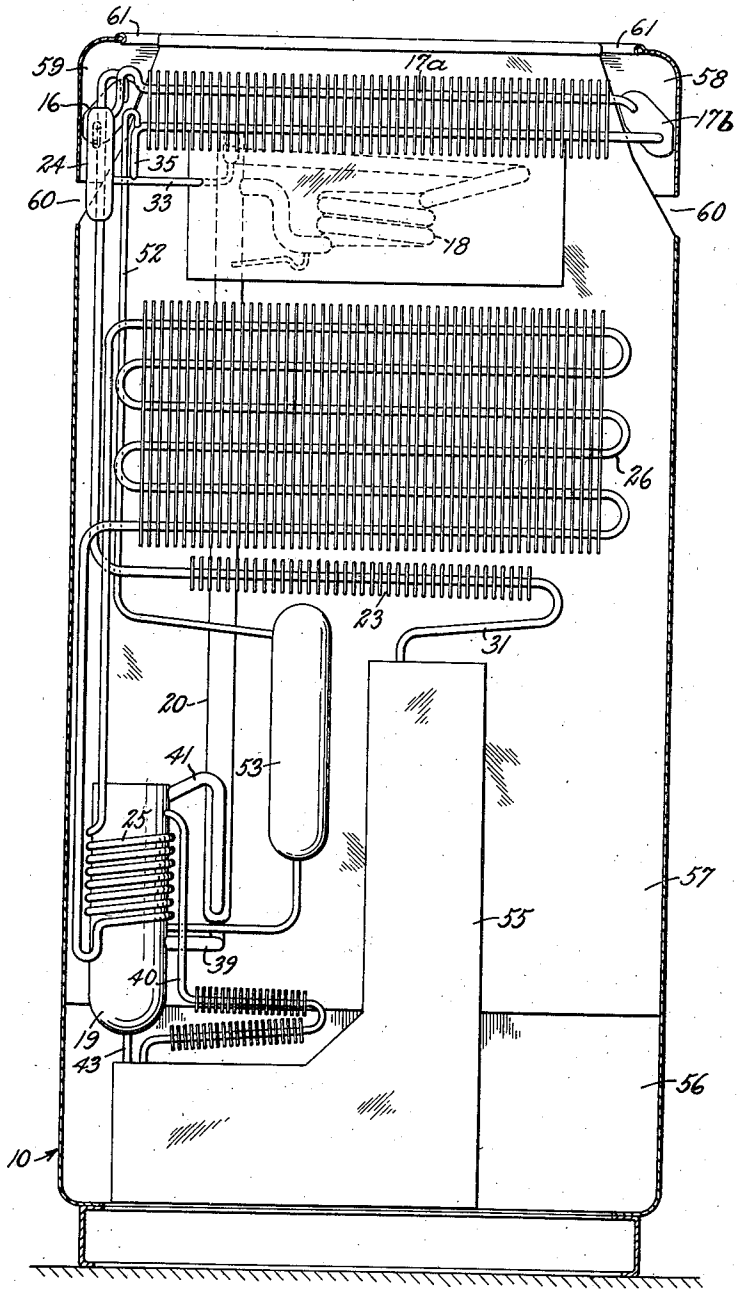


Fig. 5.

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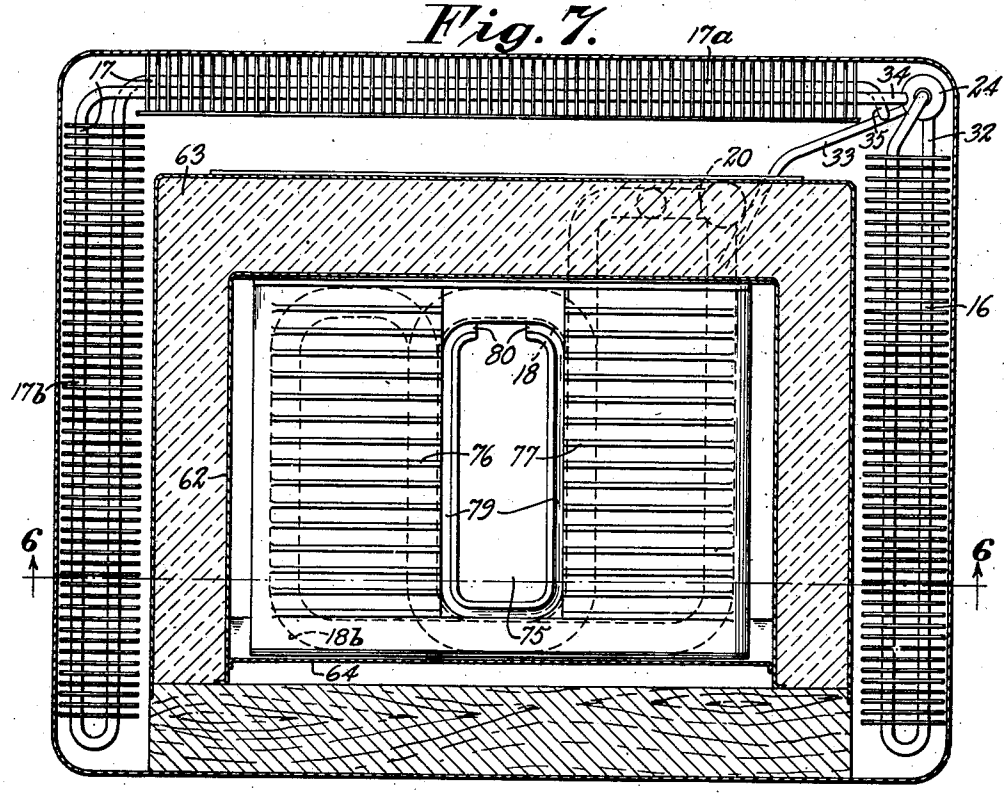
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Oct. 25, 1938. E. L. SCHELLENS ET AL. 2,134,149

REFRIGERATION

Filed Aug. 13, 1935 6 Sheets-Sheet 5

Fig. 7.



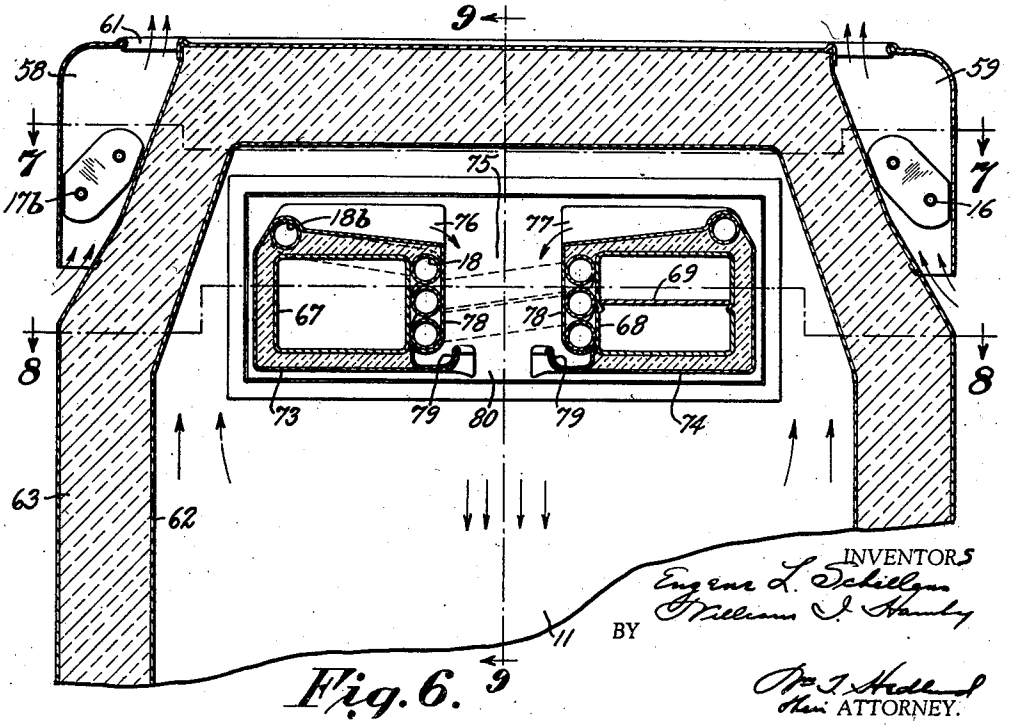


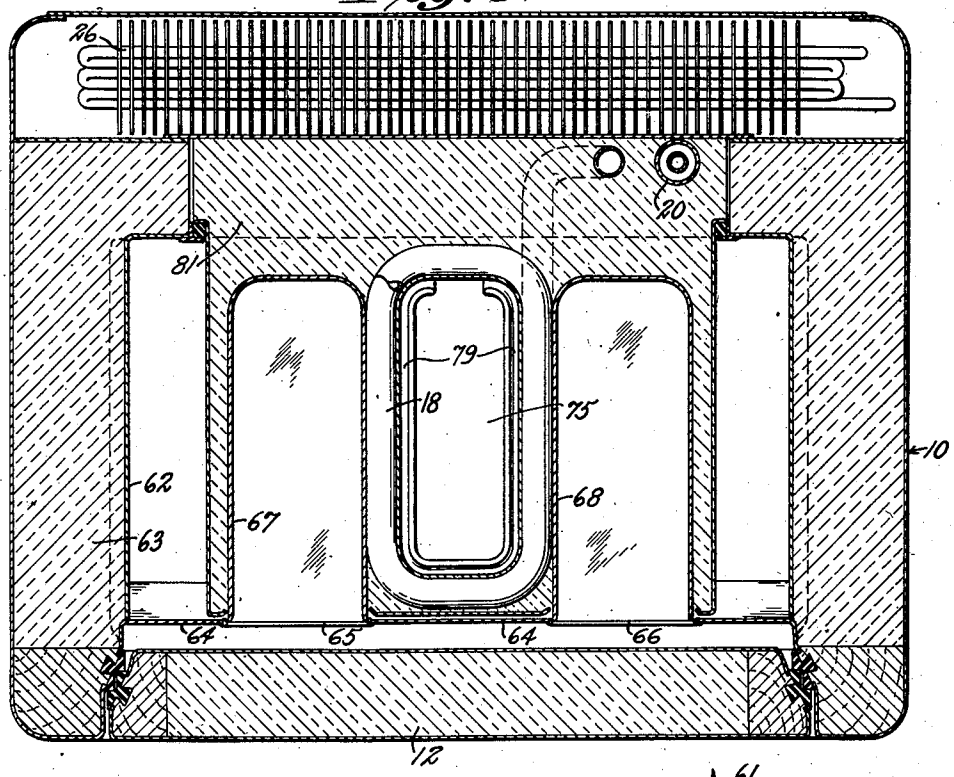
Fig. 6.

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REFRIGERATION

Filed Aug. 13, 1935 6 Sheets-Sheet 6

Fig. 8.



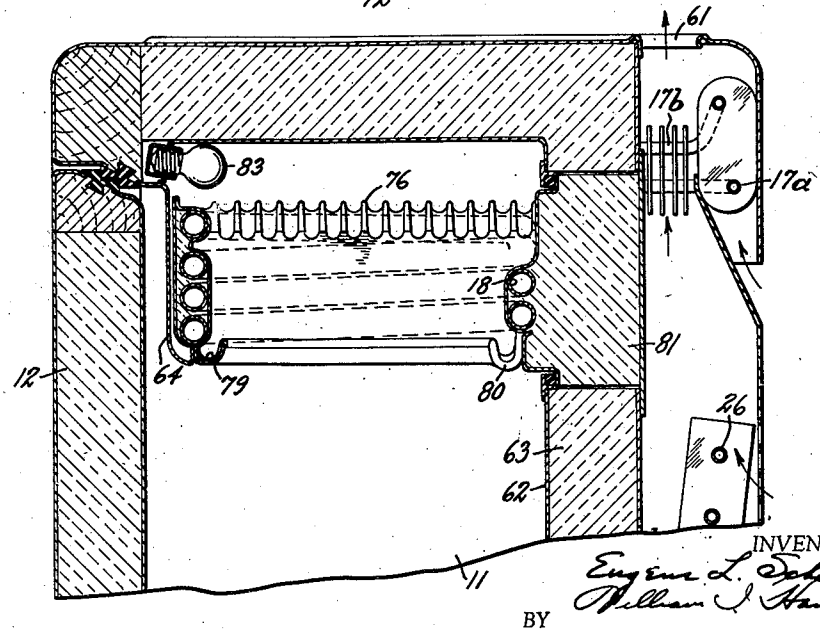


Fig. 9.

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UNITED STATES PATENT OFFICE

2,134,149

REFRIGERATION

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Application August 13, 1935, Serial No. 35,924

12 Claims. (Cl. 62—89)

This invention relates to refrigerators and it is an object of the invention to provide a refrigerator of improved appearance, operation, and utility as will appear upon consideration of the following description in conjunction with the accompanying drawings forming part of this specification and of which:

Fig. 1 is a front elevation, partly broken away, of a refrigerator embodying the invention;

Fig. 2 is a more or less diagrammatic view of an absorption refrigeration apparatus for the refrigerator;

Fig. 3 is a top view of the refrigerator shown in Fig. 1;

Fig. 4 is a vertical sectional view of the refrigerator;

Fig. 5 is a sectional view taken on line 5—5 in Fig. 4;

Fig. 6 is a detail section taken on line 6—6 in Figs. 4 and 7;

Fig. 7 is a section taken on line 7—7 in Fig. 6;

Fig. 8 is a section taken on line 8—8 in Fig. 6; and Fig. 9 is a detail section taken on line 9—9 in Fig. 6.

Referring to Fig. 1, a refrigerator 10 has a thermally insulated storage compartment 11 accessible by means of a door 12. The outer surface of the door 12 is flush with the outer surface of the front of the cabinet 10 and is hinged to the cabinet on one side by means of concealed hinges. The door 12 is provided with a concealed latch on the free side opposite the hinges. The latch is operated by means of mechanism concealed within the door and including a disc 13, or other suitable impact receiving member, which is reciprocable in a recess in the outer surface of the door. A fuller explanation of the door latch and operating mechanism may be had by reference to an application Serial No. 32,741 of Norman Bel Geddes.

In Fig. 2 is shown more or less diagrammatically an absorption refrigeration system generally of the type disclosed in Patent 1,609,334 to von Platen et al. The particular system shown in Fig. 2 comprises a generator 14, a first condenser section 16, a second condenser section 17, an evaporator 18, and an absorber 19. The evaporator 18 and the absorber 19 are interconnected for circulation of gas therebetween by means including a gas heat exchanger 20. The generator 14 and the absorber 19 are interconnected for circulation of liquid therebetween by means including an analyzer 21 and a liquid heat exchanger 22. The generator 14 is connected for flow of vapor therefrom to the condensing sections 16 and 17 by means including the analyzer 21, an air-cooled rectifier 23, and a liquid cooled rectifier 24. The condenser sections 16 and 17 are provided with heat transfer fins for cooling by air. The absorber 19 is cooled by heat transfer to air through a fluid heat transfer circuit including a coil 25 arranged in thermal conductive relation with the absorber 19 and connected to an air-cooled condenser 26. The circuit including the absorber cooling coil 25 and the condenser 26 contains a suitable heat transfer fluid such as methyl chloride which vaporizes in the coil 25 and liquefies in the condenser 26.

The refrigeration system contains a solution of refrigerant fluid such as ammonia in an absorption liquid such as water. The solution, for instance, a thirty per cent solution of ammonia in water, may be introduced into the system through a suitable charging plug (not shown) in the lower part of the absorber 19. A suitable inert pressure equalizing gas, such as hydrogen, is then introduced into the system at a pressure corresponding to that in which ammonia condenses at a fairly high room temperature as, for instance, 100° F. The generator 14 is suitably heated as, for instance, by a gas burner 27 arranged so that the burner flame is projected into a flue 28. Operation of the burner may be automatically controlled by a thermostatically operated valve 15 in the burner supply line. The valve operating thermostat shown in Fig. 2 is of an expansible fluid type and the sensitive bulb 15a is located adjacent the evaporator 18.

In operation of the refrigeration system, ammonia vapor expelled from solution by heat in the generator 14 flows from the upper end of the generator stand-pipe 29 through a conduit 30 into the analyzer 21, where the vapor bubbles upwardly through enriched absorption liquid. From the analyzer 21, ammonia vapor flows in conduit 31 through the air-cooled or high temperature rectifier 23 and the lower temperature or liquid cooled rectifier 24 to the first condenser section 16. Liquid ammonia formed by condensation in the condenser section 16 flows through a conduit 32 into the rectifier 24 and thence overflows through a conduit 33 into the upper end of the coil pipe evaporator 18. Ammonia vapor which may not have been condensed in the first condenser section 16 passes through conduit 32, the upper part of the rectifier 24, and a conduit 34 into the second condenser section 17. Liquid ammonia formed by condensation in the condenser section 17 flows through conduit 35 and conduit 33 into the evaporator 18.

In the evaporator 18, the liquid ammonia flows downwardly, evaporating and diffusing into hydrogen which enters the lower part of the evaporator through a conduit 36. The resulting gas mixture flows from the upper end of the evaporator 18 through a conduit 37, the inner passage 38 of the gas heat exchanger 20, and conduit 39 into the absorber 19. In the absorber, ammonia is absorbed out of the gas mixture into weakened absorption liquid which enters the upper part of the absorber through a conduit 40. The weak gas flows from the absorber through a conduit 41, the outer passage 42 of the gas heat exchanger 20, and conduit 36 to the evaporator 18.

Enriched absorption liquid flows from the lower part of the absorber 19 through a conduit 43, the outer passage 44 of the liquid heat exchanger 22, a conduit 45, the analyzer 21, and a conduit 46 to a chamber 47 in the generator 14. The enriched absorption liquid is raised by thermosyphon action from the chamber 47 through a conduit 48 into the upper part of the generator stand-pipe 29. The lower end of the generator stand-pipe 29 is connected to a chamber 49 of the generator from which weakened absorption liquid flows through a conduit 50, the inner passage 51 of the liquid heat exchanger 22, and the conduit 40 into the upper part of the absorber 19.

The lower end of the condenser section 17 is connected by means of a conduit 52 to a vessel 53, commonly referred to as a pressure vessel, which is connected by means of a conduit 54 to the absorber 19. By means of this path of flow from the condenser to the absorber, non-condensible hydrogen is conducted to the gas circuit instead of becoming trapped after passage through the condenser. The vessel 53 provides storage space for hydrogen which is displaced by uncondensed ammonia vapor and forced into the gas circuit, thus raising the total pressure in the system on increase in air temperature beyond that for which the system was initially charged.

The manner in which the above described refrigeration apparatus is arranged and located in the refrigerator may be seen in Figs. 4 and 5 and the succeeding detail figures. In these figures, the same parts of the apparatus are numbered the same as in Fig. 2. The generator 14, analyzer 21, and liquid heat exchanger 22 are encased in thermal insulation material 55, indicated in dotted outline in Fig. 2 and in solid outline in Figs. 4 and 5. The refrigerator 10, in addition to the thermally insulated storage compartment 11, is provided with an apparatus compartment having a horizontal portion 56 in the lower part of the refrigerator, and a communicating upright portion 57 in the rear of the refrigerator. Additionally, the upper part of the refrigerator is formed to provide two horizontal compartments 58 and 59 along the top side edges of the refrigerator and extending forwardly from the upper end of the rear compartment 57. The outer casing of the refrigerator is constructed to provide a linear opening 60 extending horizontally around the upper part of the refrigerator on the two sides and the rear, and at the bottom of the upper compartments 58 and 59.

As may be seen in Fig. 3, the top of the refrigerator is provided with a generally U-shaped or horseshoe shaped linear opening 61. The sides or legs of the opening 61 overlie the compartments 58 and 59, and the cross portion of the top opening 61 overlies the upper end of the rear apparatus compartment 57. It will now be understood that air may enter the side opening 60 and flow upwardly through compartments 58 and 59 and the upper part of compartment 57, leaving the top of these compartments through the opening 61. The first condenser section 16 is located generally horizontally in the top compartment 59 and arranged therein at an angle so that its heat transfer fins extend across the path of air flow upwardly through the compartment 59. The condenser section 17 is generally L-shaped, having two portions 17*a* and 17*b* generally perpendicular to each other. The portion 17*a* is located in the upper end of the rear apparatus compartment chamber 57, and the portion 17*b* is arranged similarly to the first condenser section 16, but in the top compartment 58 on the opposite side of the refrigerator from the condenser section 16 in the top compartment 59. It will now be understood that air entering the side opening 60 flows upwardly in thermal contact with the condenser sections 16 and 17 and then out through the top air outlet opening 61. It will be seen that the condenser, comprising sections 16 and 17, is generally U-shaped or horseshoe shaped.

Referring now more particularly to Figs. 4 and 6 to 9, the refrigerator storage compartment 11 is outlined by what is usually referred to as a liner 62, enclosed by thermal insulation material 63. The liner 62 is generally rectangular, and may be formed of sheet metal which is porcelained on the interior to provide sanitary walls for the storage compartment. The upper parts of the side walls formed by the liner 62 are inclined slightly inwardly. This angular structure of the storage compartment at the top of the refrigerator permits of the previously described condenser compartments 58 and 59 in the outer side edges at the top of the refrigerator and within the generally rectangular contour of the refrigerator. The top of the storage compartment 11 is closed at the front by what may be termed a shield plate 64, which is provided with two rectangular openings 65 and 66. The shield plate 64 is preferably porcelained on its outer surface and presents the same appearance and cleanliness as the interior of the storage compartment formed by the liner 62.

The cooling element or evaporator coil 18 is located in the upper part of the refrigerator storage compartment 11 and behind the shield plate 64, which conceals the cooling element from view. The lower part of the evaporator coil 18 is located horizontally between, and in contact with, two generally similar receptacles 67 and 68. The receptacle 68 may be provided with a partition or shelf 69. The receptacles 67 and 68 are open at their forward ends and in alignment with the openings 65 and 66 in the shield plate 64. It will now be understood that the receptacles 67 and 68 form freezing compartments and are for the purpose of receiving ice freezing trays or the like. The front ends of these trays may be seen in Fig. 1. Two ordinary size trays 70 and 71 may be placed in the receptacle 68 which is provided with the intermediate partition or shelf 69 and a double size tray 72 for frozen desserts or the like may be placed in the left hand receptacle 67.

Around the outside of each of the receptacles 67 and 68 and in spaced relation thereto are placed metal casings 73 and 74. A larger upper loop 18*b* of the evaporator coil is located within the casings 73 and 74 and in thermal contact therewith. The top surfaces of the casings 73 and 74 are sloped downwardly toward the opening 75 in the middle of the lower part of the evaporator coil 18. These sloping surfaces are

corrugated to form finned heat transfer surfaces 76 and 77. An annular casing or sleeve 78 is placed inside of the coil 18. An annular member 79 provides a trough directly beneath the evaporator coil 18 and has a drain opening or spout 80 in the rear of the storage compartment 11. The spaces between the receptacles 67 and 68 on one hand and the casings 73 and 74 and the sleeve 78 on the other hand are filled with suitable insulation material. It will be understood that the lower part of the cooling coil 18 is in thermal contact with the receptacles 67 and 68 forming the freezing compartments and also with the annular casing or sleeve 78 on the inside of the coil 18. The outer casings 73 and 74, provided with the heat transfer fins 76 and 77, are in thermal contact with the upper turn 18b of the cooling coil, which is at a higher temperature than the lower part. The reason for this is that hydrogen flows upwardly through the cooling coil 18, and the partial pressure of ammonia is greater in the upper part of the coil than in the lower part of the coil, wherefore the ammonia evaporates at a higher temperature in the upper part of the coil.

It will be understood that the cooling element structure just described may be mounted on a removable insulated wall section or closure member 81 which fits into a window or opening in the rear wall of the thermally insulated storage compartment 11, as may be seen in Figs. 4 and 9. Thus, the cooling element may be removably assembled and disassembled as a unit with the refrigeration apparatus, the cooling element being inserted and withdrawn through the wall opening into which the closure member 81 fits when the apparatus is assembled in the refrigerator.

Referring now to Fig. 6, the direction of air flow in the storage compartment 11 is indicated by arrows. Air flows upwardly at each side of the refrigerator compartment, up behind the shield plate 64, across the upper part of the casings 73 and 74 in contact with the fins 76 and 77, and thence downwardly through the opening 75 in the center of the lower part of the cooling coil 18. Air is caused to flow in this direction for the reason that the sleeve 78 on the inside of the cooling coil 18 is at a lower temperature than the other cooling surfaces of the cooling element contacted by the air, wherefore air moves downwardly within the sleeve 78.

When frost is melted from the cooling element, the drip is collected in the trough 79 and discharged in the rear of the storage compartment 11 by way of the spout 80, into any suitable vessel placed beneath the spout.

Referring to Fig. 9, a suitable lamp 83, such as an electric light bulb connected, as known, to be lighted when the door 12 is open, is located in the top of the storage compartment 11, behind the shield plate 64, and above the central opening 75 in the center of the cooling coil 18. The light is directed downwardly through the central opening 75 into the refrigerator storage compartment therebelow, whereby light is available while its source is concealed.

The other parts of the refrigeration apparatus are located in the apparatus compartments 56 and 57, as illustrated in Figs. 4 and 5. The horizontal portion of the generator 14 and the liquid heat exchanger 22 in the lower part of the insulation casing 55 are located in the lower apparatus compartment 56, so that the burner 27 is at the front of the refrigerator cabinet 10 and receives air for combustion through louvres 84. The other parts of the apparatus are arranged in the rear upright apparatus compartment 57. The gas heat exchanger 20 is preferably recessed in the insulation 63 of the storage compartment wall. The rear wall of the refrigerator 10 is provided with an opening or latticework 85 directly opposite the absorber cooling condenser 26. Air flows through the latticework 85, upwardly over the condenser 26, upwardly through the upper part of the apparatus compartment 57, and out through the opening 61 in the top of the refrigerator. This upward flow of air in the upper part of the apparatus compartment 57 aids in cooling the section 17a of the condenser by inducing a greater flow of air through the opening 60 and upwardly over the condenser section 17a.

It will be understood that other changes may be made within the scope of the invention which is not limited except as indicated in the following claims.

What is claimed is:

1. A refrigerator including a cabinet having thermally insulated top, bottom, and side walls forming a food storage compartment and a door affording access to said compartment, upper parts of said side walls being sloped inward on several sides of the cabinet forming a reduced upper portion of the food compartment, and refrigeration apparatus including a cooling element in said compartment and condenser parts located laterally on several sides with respect to said cooling element and in the spaces outside of said inward sloping wall parts substantially within the upward projected areas of the lower parts of said side walls.

2. A refrigerator including a cabinet having thermally insulated top, bottom and side walls forming a food storage compartment which is substantially rectangular in horizontal section and a door affording access to said compartment, the upper parts of said side walls adjoining the wall which includes said door being sloped inward to form a narrowed upper portion of the food compartment, and a refrigeration apparatus including a cooling element in said compartment and condenser parts located laterally with respect to said cooling element and in the spaces outside of said inward sloping wall parts substantially within the upward projected area of the lower parts of said side walls.

3. A refrigerator including a cabinet having thermally insulated top, bottom and side walls forming a food storage compartment which is substantially rectangular in horizontal section and open on one side and a door for closing said open side, the upper parts of said side walls adjoining the open side of said compartment being sloped inward to provide a reduced upper portion of the food compartment, said door being substantially rectangular and overlapping said reduced upper portion of the food compartment, and refrigeration apparatus including a cooling element in the reduced portion of said compartment and condenser parts located laterally with respect to said cooling element and in the spaces outside of said inward sloping wall parts substantially within the upward projected area of the lower parts of said side walls.

4. A refrigerator as set forth in claim 3 in which a plate of substantially the same width as the lower part of said storage compartment conceals the reduced upper portion of said com-

partment when viewed horizontally through said open side.

5. A refrigerator as set forth in claim 1 in which a casing encloses and fits around said insulated walls, said casing having substantially vertical sides and having openings therein located at the bottom and top of said condenser spaces.

6. A refrigerator including a cabinet having insulated walls enclosing a food compartment, an evaporator in the upper part of said food compartment, said cabinet including vertical wall parts below said evaporator, a cabinet wall part above said evaporator being horizontal, and cabinet wall parts laterally of said evaporator being oblique to and connecting the vertical and horizontal wall parts providing lateral spaces, casing parts bounding said lateral spaces and providing elongated apertures at the bottoms and tops of the lateral spaces, members completing with said evaporator a freezing system of the type employing inert gas, said freezing system including condenser parts in said lateral spaces arranged to be cooled by air passing through said apertures, and said freezing system including means to flow refrigerant from the condenser parts to the evaporator by gravity, the upper part of the evaporator and the lower part of the condenser being at substantially the same elevation.

7. Apparatus as set forth in claim 6 in which the casing parts bounding the lateral spaces have horizontal and vertical outer surfaces in alignment respectively with vertical and horizontal surfaces of the insulated cabinet walls.

8. A refrigerator as set forth in claim 6 having a substantially rectangular door in part overlapping the oblique insulated wall parts.

9. A refrigerator as set forth in claim 6 having a substantially rectangular cover plate at the front of the evaporator in part overlapping the oblique insulated wall parts and a door also in part overlapping the oblique insulated wall parts.

10. A refrigerator as set forth in claim 6 having the lateral spaces at both sides and having casing members at both sides and rear providing U-shaped elongated lower and upper apertures.

11. A refrigerator including a food storage compartment formed by thermally insulated top, bottom and side walls, upper parts of said side walls being sloped inward so that there is in the upper part of said compartment a space having reduced cross sectional area and spaces outside of the insulated walls on several sides of the refrigerator to receive condenser parts, and a cooling element in said food storage compartment, said cooling element being formed and arranged to occupy substantially the entire space of reduced area in the upper part of the food compartment so that there is no unuseable storage space in the food compartment and no storage space affected in area by the inward sloped parts of the side walls.

12. A refrigerator as set forth in claim 11 in which the food storage compartment is substantially rectangular in horizontal section and is provided with a substantially rectangular door opening in one side which is not sloped in at the top, a substantially rectangular door for closing said opening, said door overlapping the reduced upper part of said compartment, and a substantially rectangular plate adjacent the door opening and concealing said cooling element and the reduced upper part of the storage compartment.

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