Sept. 29, 1942. D. G. SMELLIE 2,296,879

REFRIGERATION

Filed July 20, 1938 3 Sheets-Sheet 1

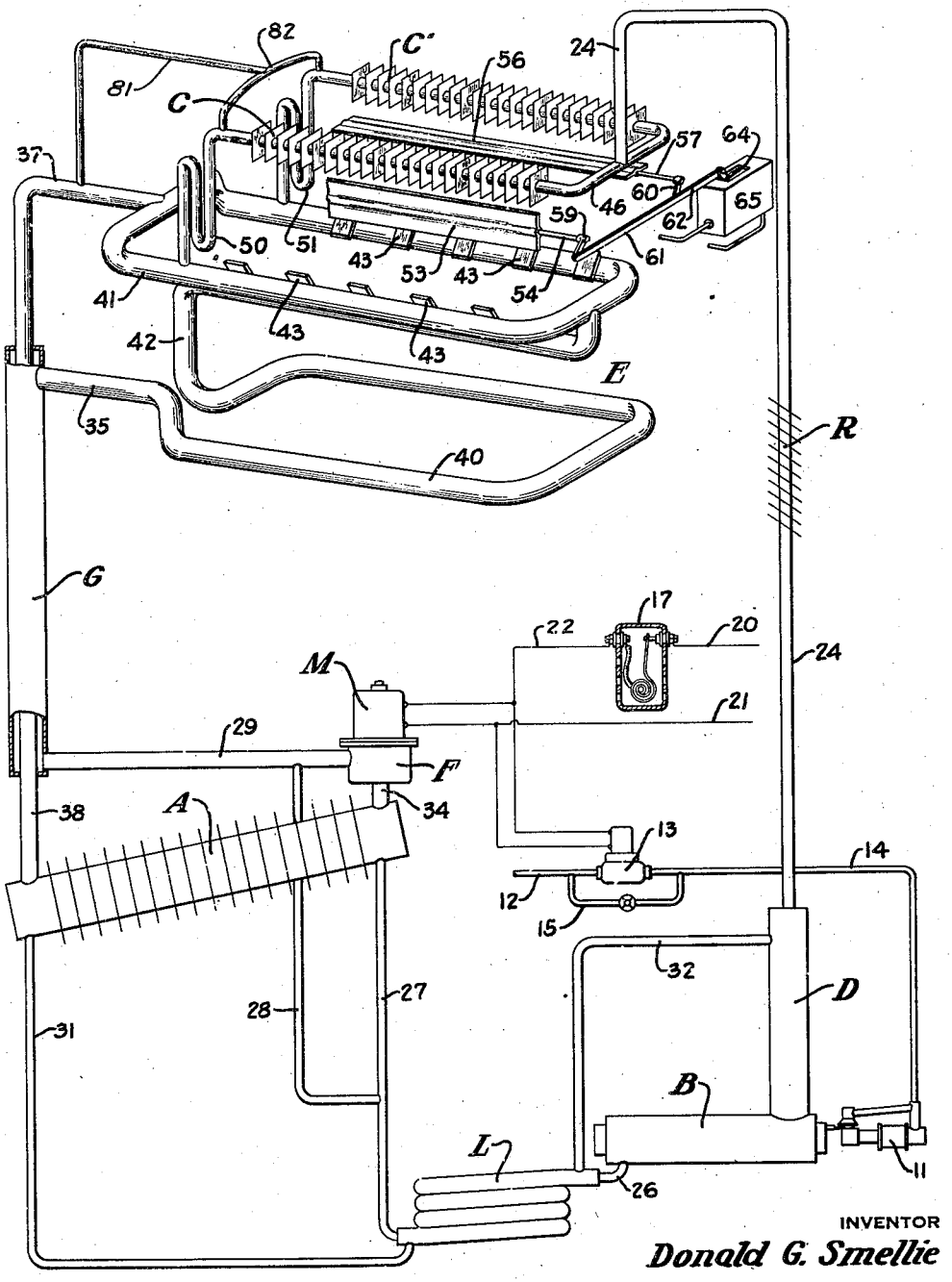


Fig. 1

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REFRIGERATION

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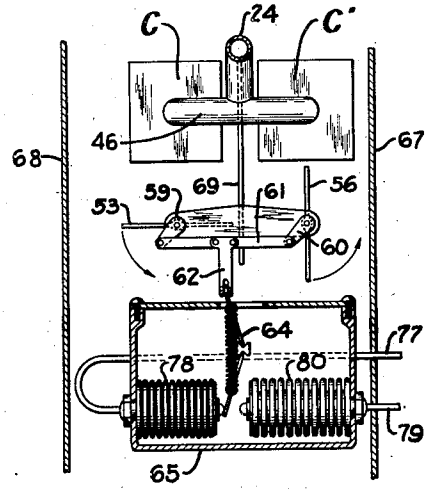


Fig. 2

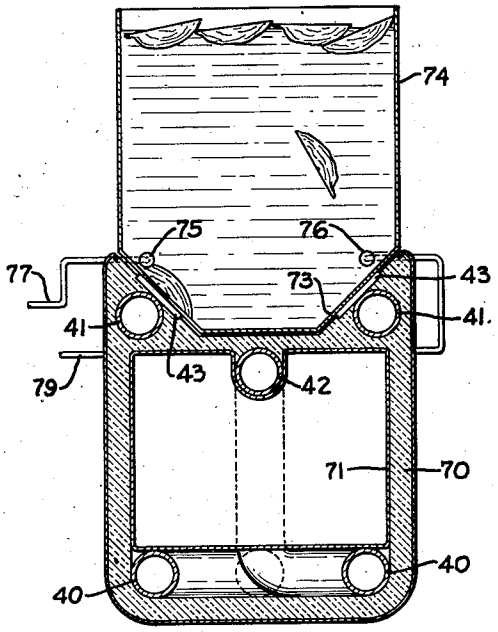


Fig. 3

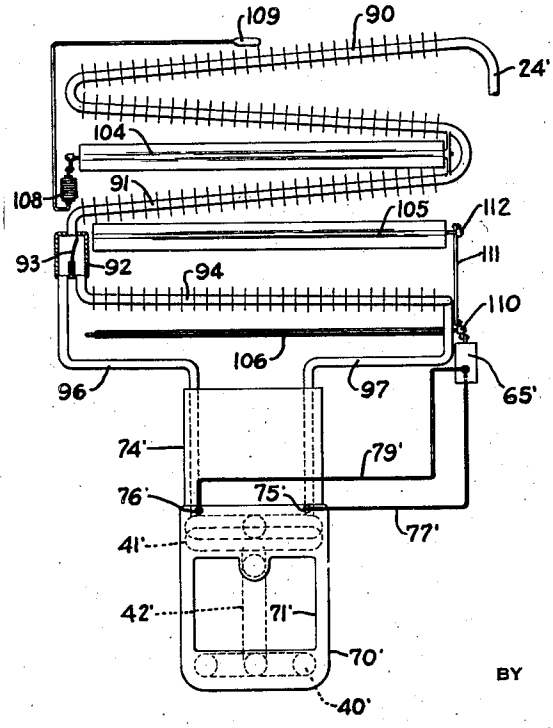


Fig. 4

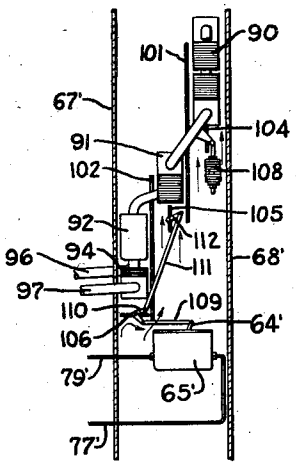


Fig. 5

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REFRIGERATION

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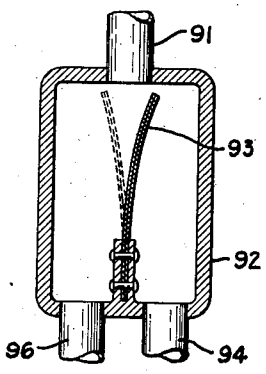


Fig. 6

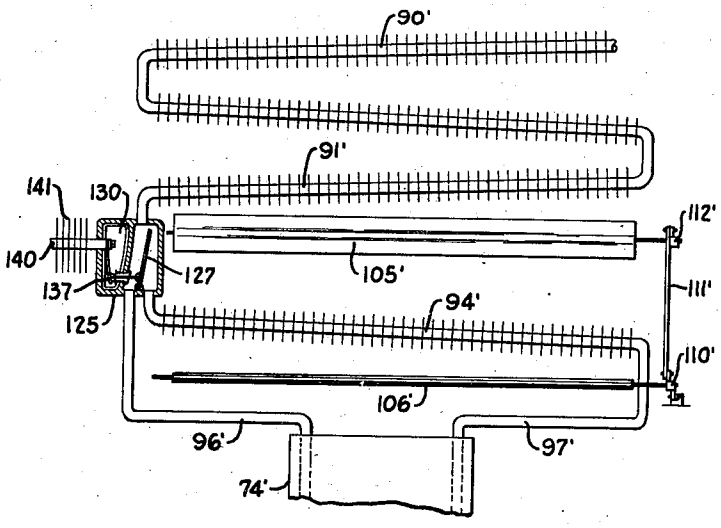


Fig. 7

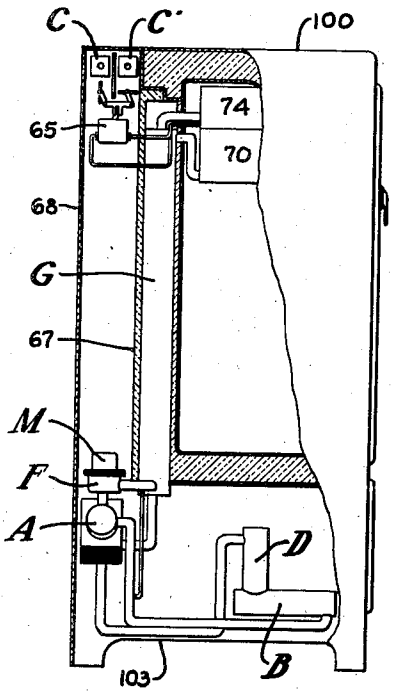


Fig. 9

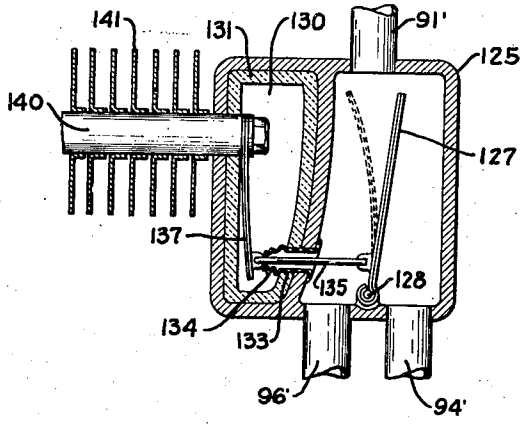


Fig. 8

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UNITED STATES PATENT OFFICE

2,296,879

REFRIGERATION

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Application July 20, 1938, Serial No. 220,201

30 Claims. (Cl. 62—5)

This invention relates to refrigerating systems and more particularly to a novel design for ice making evaporators for use with refrigerating systems.

Heretofore, refrigerating systems have been provided with metallic trays having internal grids whereby water placed in the tray was frozen into a plurality of small blocks or cubes. These systems have the disadvantage that the trays freeze solidly to their supporting shelves and require considerable force to be freed therefrom, and the individual blocks of ice can be removed from the grid only by melting a large portion of the same or through the application of large forces applied by complex and extensive link mechanisms. Previous refrigerators also are characterized in that the very low temperatures carried on the evaporating coil and the absence of an exposed body of water within the storage compartment causes extreme dehumidification of the air circulating within the storage compartment with resulting deterioration and damage to foodstuffs in the refrigerator. Also objectionable frost coated all surfaces of the evaporator. Furthermore, while previously refrigerating systems operate for a greater length of time in hot weather than in cold weather, the ice making capacity of the machine is fixed to the maximum number of cubes which the ice tray will hold regardless of the frequency of operation of the refrigerating mechanism. In order to provide a greater quantity of ice it is necessary continually to empty the ice trays and to store the previously frozen ice until it is desired to use the same.

According to this invention, there is provided a refrigerating system and evaporator structure in which individual blocks of ice are continually formed in a large body of water and float to the surface thereof when they reach a predetermined size. The production of ice is continuous whenever the machine is operating and the quantity of ice produced is directly proportional the time during which the refrigerating mechanism is operated. The ice produced is in the form of individual blocks which float freely in a large body of very cold water whereby any desired number of ice blocks may be removed from the refrigerating machine with a ladle, and the ice forming mechanism is itself a storage device for previously formed ice blocks. The large body of water which is maintained in the refrigerating compartment provides a means for maintaining the air within the compartment within reasonable limits of relative humidity; the water container also serves as a medium whereby the air circulating through the refrigerating compartment is maintained at temperatures low enough safely to preserve food stuffs but not sufficiently cold to cause frost formation, and the large body of water from which the ice is formed forms a convenient tank of cold drinking water.

In addition, the apparatus herein disclosed is provided with a heavily insulated low temperature freezing compartment within which desserts and the like may be frozen without interfering with or impeding the normal functions of the refrigerator apparatus.

According to the invention, refrigeration is produced in one or another section of an ice freezing evaporator by altering the heat rejecting area of certain parts of the refrigerating system. The alteration of the heat rejecting area of the system is under the control of the ice being frozen whereby refrigeration being produced in a given area of the evaporator is discontinued and produced in another area thereof whenever the ice blocks formed by the refrigeration produced in the first mentioned area of the evaporator reach a predetermined size. The refrigerating system as a whole is controlled in accordance with the temperature prevailing within the foodstuffs compartment; therefore, the rate at which ice is produced is a function of the ambient temperature; that is, a high ambient temperature causes the machine to cycle more frequently resulting in a greater production of ice during periods of such high temperature.

Other objects and advantages of the invention will become apparent as the description proceeds when taken in connection with the accompanying drawings, in which:

Figure 1 is a diagrammatic representation of my invention applied to one form of refrigerating systems.

Figure 2 is a detailed view on an enlarged scale of the mechanism which controls the heat rejecting area of the refrigerating system;

Figure 3 is a detailed sectional view on an enlarged scale of the evaporator ice freezing system;

Figure 4 is a fragmentary view on an enlarged scale of a modified form of heat rejecting mechanism;

Figure 5 is an end view of the mechanism illustrated in Figure 4;

Figure 6 is a sectional view on an enlarged scale of a detail;

Figure 7 illustrates a modified form of heat rejecting mechanism;

Figure 8 is a detailed sectional view of a portion of the apparatus shown in Figure 7 on an enlarged scale.

Figure 9, which is drawn to a small scale, illustrates the manner in which various parts of the refrigerating system are arranged in a cabinet.

Referring now to the drawing and first to Figure 1 thereof, it will be seen that I have disclosed my invention as it is applied to a continuous absorption refrigerating system comprising a boiler B, an analyzer D, a rectifier R, a pair of condensers C and C', an evaporator E, a gas heat exchanger G, an absorber A, a liquid heat exchanger L, and a circulating fan F driven by a motor M, all of which are connected by various conduits to form a plurality of gas and liquid circuits constituting a complete refrigerating system.

The refrigerating system is charged with a suitable refrigerant such as ammonia, and an absorbent such as water, and an inert gas such as nitrogen or hydrogen.

The boiler B is heated by a burner 11 of any desired construction which is provided with a suitable flame failure cut off mechanism. The burner 11 is supplied with gas through a conduit 12, solenoid valve 13, and a conduit 14. A suitable by-pass 15 is provided around the valve 13 to permit a small amount of gas to by-pass the valve 13 when it is closed in order to maintain a pilot or igniting flame at the burner. The burner 11 and the motor M for the fan F are controlled by a thermostatic switch mechanism 17 which is preferably mounted in the food storage compartment. Electrical energy is supplied through the wires 20 and 21. The wire 21 connects directly to the motor M and to the solenoid valve 13. The line 20 connects to one terminal of the thermostatic switch mechanism 17, the other terminal of which is connected by the line 22 to the solenoid valve and the motor M. The arrangement is such that a rising temperature in the food storage compartment, evidencing a demand for refrigeration, causes the thermostatic switch 17 to close the circuits to the line 22 and 20, and thereby to energize the circulating motor M and the solenoid valve 13.

The boiler B normally contains the solution of a refrigerant in the absorbent which liberates refrigerant vapor when heated. The refrigerant vapor generated in the boiler B passes upwardly through the analyzer D in counterflow relationship to strong absorption solution flowing downwardly therethrough. Additional refrigerant vapor is generated in the analyzer from the strong solution by the heat of condensation of the vapor of the absorbent which passes into the analyzer. The refrigerant vapor is conveyed from the analyzer D through the condensers C and C' by a conduit 24 which includes the air cooled rectifier R. The rectifier R causes condensation of any vapor of absorption which may pass through the analyzer.

The weak solution formed in the boiler by the generation of refrigerant vapor is conveyed therefrom into the upper portion of the air cooled absorber A through a conduit 26, the liquid heat exchanger L, and a conduit 27. It is apparent that the absorber is at an elevation above the liquid surface level normally prevailing in the boiler analyzer system; therefore, it is necessary to provide some means to elevate weak solution from the boiler into the absorber. For this purpose, a conduit 28 is connected between the gas discharge conduit 29 and the conduit 27 below the liquid surface level therein, whereby the weak solution is elevated into the absorber by gas lift action. The weak solution flows downwardly through the absorber in counterflow relationship to a mixture of pressure equalizing medium and refrigerant vapor flowing upwardly therethrough. The refrigerant vapor is absorbed by the absorption solution and the heat of absorption is rejected to the medium surrounding the absorber which is preferably provided with a plurality of air cooling fins. The strong solution formed in the absorber is conveyed from the bottom portion thereof into the upper portion of the analyzer D through a conduit 31, the liquid heat exchanger L, and a conduit 32.

The lean pressure equalizing medium is conveyed from the upper end of the absorber into the suction inlet of the fan F by a conduit 34. The pressure equalizing medium is placed under pressure by the circulating fan and is conveyed therefrom into the lower portion of the evaporator E through the conduit 29, the outer part of the gas heat exchanger G, and a conduit 35. The evaporator-condenser structure will be described more fully hereinafter; for the present, it is sufficient to note that the lean pressure equalizing medium circulates upwardly through the evaporator in counterflow relation to refrigerant liquid flowing downwardly therethrough. The refrigerant evaporates into the inert gas to produce refrigeration and the resulting rich pressure equalizing medium refrigerant vapor mixture is conveyed from the upper portion of the evaporator to the lower portion of the absorber A through a conduit 37, the inner path of the gas heat exchanger G, and the conduit 38. The rich gas flows upwardly through the absorber in counterflow relationship to the absorption solution thereby to remove the refrigerant vapor contents therefrom in the manner previously described.

The evaporator E comprises the lower coil section 40 which connects to a superimposed rectangular evaporator conduit 41 through a riser conduit 42. The evaporator section 41 is provided with a plurality of spaced apart freezing pads 43 which are inclined to the horizontal for a purpose to be described hereinafter. The inert gas conduits 35 and 37 connect to the evaporator sections 40 and 41, respectively.

The condenser sections C and C' are identical and only one need be described. The condenser C comprises a finned conduit designed to be air-cooled and sloped slightly in one direction in order that liquid refrigerant may flow therethrough by gravity. Though the condensers are shown as being provided with a single conduit, each condenser may comprise a plurality of serially connected finned conduits if desired. The condensers C and C' are connected at one end by a conduit 46 to which the vapor supply conduit 24 is connected.

The condenser C is connected to the inert gas discharge end of the lefthand side of the evaporator coil section 41, as viewed in Figure 1, through a conduit 50 containing a U-shaped section. The condenser C' is similarly connected to the righthand side of the evaporator section through a conduit 51. The flow of cooling air over the condenser C is under the control of a plate valve 53 which is rigidly attached to a control shaft 54. The flow of cooling air over the condenser C' is under the control of a plate valve 56 which is rigidly mounted upon a control shaft

57. The control shafts 54 and 57 are provided with actuating cranks 59 and 60, respectively, which are pivotally connected to an actuating connecting rod 61. The connecting rod is provided with an extension 62 which is connected to an overcenter snap-acting mechanism 64 carried within a control box 65.

Referring now to Figure 2, the condenser and control arrangement will be described in detail.

The condensers extend longitudinally between the rear panel 67 of the refrigerator compartment and the rear wall 68 which define an air cooling flue for the condensers and the absorber of the refrigerating system. A dividing panel 69 is supported between the walls 67 and 68 and between the condensers C and C'. It will be seen from Figure 2 that the arrangement is such that the flap valves 53 and 56 are positioned to control the air flow across the condensers C and C'; furthermore, it will be seen that the flap valves 53 and 56 are mounted 90° apart, whereby one will be in full closed position while the other is in a full open position.

Referring now to Figures 2 and 3, it will be seen that the evaporator is completely encased in an insulated compartment 70 which is provided with an inner chamber 71. The insulated compartment 70 will be provided with a suitable insulated hingedly mounted door and seal. The evaporator sections 40 are mounted in heat exchange relationship with the bottom portion of the chamber 71 and the connecting conduit 42 is in heat exchange relationship with the rear and top portions of the compartment 71. The ice freezing evaporator sections 41 are housed in the installation forming the outer wall of the casing 70 with the freezing pads 43 lying slightly above the installation in the top portion of the compartment 70 which is formed to provide a U-shaped channel to receive the U-shaped bottom portion 73 of a water tank 74.

A pair of thermostatic bulb elements 75 and 76 are mounted in the bottom portion of the tank 74 and in position to be frozen into ice blocks formed within the tank 74 above certain of the freezing pads 43 and positioned at opposite sides of said tank. The bulb 75 is connected by a conduit 77 to a fixedly mounted thermostatic temperature responsive bellows element 78 which is mounted within the control housing 65. The free end of the bellows 78 is positioned to actuate the overcenter snap-acting mechanism 64. The bulb 76 is connected by conduit 79 to a bellows 80 also fixedly mounted within the control box 65 and having its free end positioned to actuate the mechanism 64.

The arrangement is such that the bellows 78 and 80 positively operate the over-center mechanism 64 to change the position of the plate valves 53 and 56 thereby to alter the condensing area of the refrigerating system. In the position shown in Figure 2, the condenser C' is being swept by cooling air, but no air can flow over the condenser C by reason of the horizontal position of the plate 53. Therefore, the refrigerant vapor is condensed by air cooling in the condenser C', and is discharged through the conduit 51 into the right hand portion of the coil 41, as viewed in Figure 1. The refrigerant vapor in the condenser section C does not condense therein because there is no air flow over the condenser section, and it does not flow therethrough because of liquid contained in the U-shaped portion of the conduit 50; therefore, the left hand evaporator section is inoperative, and ice blocks frozen within the interior of the tank 74 over the freezing pads 43 on the left hand section of the evaporator melt therefrom. As the ice blocks melt, the ice block in contact with the bulb 75 will eventually be freed therefrom whereupon the bellows 78 will begin to warm up and expand. If the bulb 76 has been frozen into an ice block sufficiently to collapse the bellows 80, the bellows 78 will move the mechanism 64 over-center and will cause the plate valves 53 and 56 to reverse position; that is, the condenser C' will no longer be swept by cooling air, and the condenser C will be swept by cooling air wherefore all condensation will occur in the condenser C. However, if the bulb 76 has not been frozen into an ice block, the bellows 78 will expand and be opposed by the bellows 80 without altering the position of the mechanism 64 until the bellows 80 collapses when the bulb 76 is frozen into an ice block.

The condensers C and C' are connected at their discharge ends by a slightly curved conduit 82 to which is connected a vent 81 at the high point thereof. The vent 81 opens into the inert gas discharge conduit 37 of the evaporator. This apparatus provides a means for purging the condensers of any non-condensible gases that might find their way thereinto. The refrigerant vapor does not discharge through these conduits for the reason that they are very restricted in cross-sectional area and any refrigerant vapor finding its way thereinto condenses and flows backwardly into one or the other of the condensers.

The apparatus just described causes the refrigerating effect to be shifted alternately to the right and the left hand side of the ice freezing coil, and this is accomplished by alternately allowing and preventing rejection of heat from various portions of the refrigerating system. Each side of the ice freezing coil is directly associated with one of the condenser elements wherefore refrigeration will be produced only in that side of the evaporator freezing coil which is associated with a condenser element which is permitted to perform its normal function; that is, when the respective valve plates 53 or 56 are in a position not to obstruct air flow over their associated condenser sections. The control mechanism is so arranged that it tends to operate to produce refrigeration in the evaporator section from which previously formed ice blocks have just melted free and floated to the surface of the water within the tank 74; however, the control mechanism will not so function unless ice is formed on the opposite side of the evaporator section to the depth desired or determined by the control mechanism.

The large exposed surface of the tank 74 in the storage compartment serves as an ideal box-cooling element by reason of the fact that the temperature of the walls of the water tank is not low enough to cause frost to deposit thereon, and the area of these walls is sufficiently large to permit efficient cooling of the box air without the use of a large temperature differential. By reason of this construction, the humidity within the refrigerating compartment is maintained at a very high value. The air striking the walls of the water tank will be cooled to a temperature approximating that of the water tank and its humidity will be lowered substantially to a hundred percent relative humidity. As the air warms up by absorbing heat from foodstuffs in the storage compartment, it will not have its humidity lowered to a very great degree for the reason that the temperature differential between the air leav-

ing the walls of the water tank and warm air flowing upwardly to be re-cooled by such walls is not great. If extremely dry air finds its way into the box when the door is open to remove foodstuffs, it will pick up moisture from the water contained in the freezing tank and will thereafter operate at a relatively high humidity. If desired, or necessary, a suitable trough may be secured to the lower portion of the walls of the water tank in order to catch any moisture which may condense thereon.

Referring now to Figures 4 to 6, there is disclosed a modified form of the invention. This form of the invention is designed to be utilized with a refrigerating system exactly as disclosed in connection with Figure 1; therefor a repeated disclosure of that system is deemed unnecessary. Certain portions of this apparatus are identical with portions of that disclosed in connection with Figure 1 and are therefore given the same reference characters primed.

The refrigerant vapor is discharged by a conduit 24' into a condenser 90 of the tubular air cooled type. The condenser 90 connects to a liquid pre-cooler 91 which discharges into a diversion chamber 92. The diversion chamber 92 is provided with an upstanding bi-metallic thermostatic diverter 93 which in its neutral or unflexed position would exactly divide the stream of liquid issuing from the pre-cooler 91. A pre-cooler 94 opens into the bottom of the chamber 92 on the right hand side of the diverter 93, as viewed in Figures 4 and 6. A conduit 96 is connected between the bottom of the chamber 92 on the left hand side of the diverter 93 and the left hand side of the evaporator freezing element 41'. The pre-cooler 94 is connected to the right hand side of the evaporator freezing elements 41' by means of a conduit 97.

The arrangement of the condenser 90 and the pre-cooler elements 91 and 94 is clearly depicted in Figure 5. The condenser 90 is at the top rear portion of the cooling air flue formed by the panel 68' and the rear panel 67' of the refrigerating cabinet. The pre-cooler 91 is placed centrally of the air flue, and the pre-cooler 94 and the diversion chamber 92 are placed adjacent the panel 67'. A pair of vertically positioned plates 101 and 102 divide the air flue into three separate passageways, each of which contains one of the elements 90, 91, and 94.

The cooling elements are arranged in the cooling air flue with the condenser 90, which is the warmest element, adjacent the rear panel 68', whereby the rear wall 67' of the refrigerating compartment is not heated thereby.

Plate valves 104, 105, and 106 are positioned within the flues beneath the elements 90, 91, and 94, respectively. The plate valve 104 is actuated by a thermostatic bellows 108 which responds to temperature conditions existing in the region of a bulb 109 which is positioned to respond to the temperature of the air leaving the condenser 90.

The plate valves 105 and 106 are actuated by a mechanism 64' housed in a control casing 65' which corresponds exactly to the elements 64 and 65 previously described. The bellows elements within the housing 65' are connected to both elements 75' and 76' by capillary conduits 77' and 79' which correspond exactly to the conduits 77 and 79. The over-center mechanism 64' is connected to an actuating connecting rod 109 which in turn is connected to a bell crank 110 rigidly attached to the plate valve 106. The arm of the bell crank 110 not connected to the connecting rod 109 is connected to an actuating lever 111 which connects to an actuating crank 112 rigidly carried by the plate valve 105. The arrangement is such that the valves 105 and 106 are always positioned 90° apart whereby one of the pre-coolers is always being swept by cooling air.

This form of the invention operates as follows: The thermostat 108—109 functions to maintain a constant discharge temperature of the air leaving the condenser 90 whereby the liquid refrigerant discharging into the pre-cooler 91 from the condenser 90 is always maintained at a constant temperature.

The position of the plate valves 105 and 106 will be determined by the demand for refrigeration in the evaporator; that is, one or the other of the bulbs 75' and 76' will not be frozen into an ice block and the associated bellows will be expanded to operate the over-center mechanism 64' to shift the plate valves into position to permit cooling air to circulate over the pre-cooler associated with the evaporator section which is demanding refrigeration. Assuming that the thermostatic bulb 76' has been freed of contact with the ice and that its associated bellows has expanded, the over-center mechanism 64' will be shifted to the position shown in Figure 5 and will move the plate valves 105 and 106 to the position shown in Figure 5. Cooling air will now circuate over the pre-cooler 91 but will not be permitted to circulate across the pre-cooler 94; due to this action, the liquid refrigerant discharging from the pre-cooler 91 will be at a relatively low temperature and will flex the bimetallic element 93 to the position shown in Figures 4 and 6 with the result that all the liquid refrigerant discharges through the conduit 96 into the left hand evaporator section 41' as shown in Figure 4. This action will continue until the bellows associated with the thermostatic bulb 76' is contracted by reason of said bulb being frozen into an ice block, and the bellows associated with the bulb 75' has expanded after being released from ice contact. When this condition has been reached, the position of the plate valves 105 and 106 will be reversed and the liquid refrigerant will discharge through the conduit 91 which will be warm because the plate valve 105 will prevent circulation thereover. The warm liquid refrigerant will flex the bi-metallic diverter element 93 into the position shown in dotted lines in Figure 6 with the result that the warm liquid will discharge into the pre-cooler 94 where its temperature will be substantially lowered by air cooling. This liquid refrigerant will then discharge through the conduit 97 into the right hand side of the evaporator sections 41', as viewed in Figure 4.

It is necessary to maintain the liquid discharged by the condenser 90 at a substantially constant temperature; otherwise, the temperature of the liquid ultimately discharging into the diversion chamber 92 might be so high or so low as to cause the thermostatic diverter 93 to operate improperly. For example, if the ambient temperature were to be very low, the liquid refrigerant discharged by the condenser might be at a temperature approaching that of liquid normally discharged from the first pre-cooling element 91 when that element was being swept by cooling air. Wherefore, the diverter element 93 would be flexed to discharge the liquid into the conduit 96 when the control mechanism had operated the plate valves to permit operation of the pre-cooler

94 in which event, liquid refrigerant should be diverted in the chamber 92 into the conduit 94. This difficulty is obviated by the condenser temperature control mechanism which cuts down the air flow over the condenser when the temperature of the cooling air is very low, whereby the temperature of the liquid discharged from the condenser is maintained substantially constant.

From the description above, it will be seen that this form of the invention operates by discharging the liquid refrigerant from the condenser at a constant relatively elevated temperature and that the temperature conditions of the liquid refrigerant leaving the first pre-cooler section determines its ultimate destination. The temperature at which the liquid is permitted to leave the first pre-cooler section is determined by the demand for refrigeration in the evaporator; therefore, refrigeration is produced alternately in opposite sides of the evaporator section 41'. The evaporator as a whole operates and is controlled in the manner explained in connection with Figures 1 to 3.

Referring now to Figures 7 and 8, there is disclosed a third modification of the invention. The condenser, the precooler, the plate valves, and the evaporator structures are identical with those disclosed in connection with Figures 4 and 5, and will not be described in detail herein. These elements are given the same reference characters primed as identical parts in Figures 4 and 5. The pre-cooler 91' discharges into a diversion chamber 125 which communicates with the conduit 96' and the pre-cooler 94'. A bi-metallic diversion element 127 is pivotally mounted at 128 at the bottom portion of the chamber 125 and between the conduits 96' and 94'. In the neutral position the bi-metallic element 127 would equally divide the stream of liquid refrigerant discharging into the diversion chamber from the pre-cooler 91'. In the form of the invention described in connection with Figures 4 and 5 variations in atmospheric temperature are compensated by the thermostatic mechanism 108 and 109 and the plate valve 104 in order that the diversion thermostat 93 may be actuated solely in response to a condition induced by adjustment of the various plate valves and not by conditions induced by an extreme variation in atmospheric temperature conditions. In the form of the invention disclosed in Figures 7 and 8, there is no plate valve governing the flow of air across the condenser 90' wherefore other means must be provided to compensate the changes in air temperature in order that the diversion thermostatic element 127 will operate correctly at all times. For this purpose, the diversion chamber 125 is provided on one side thereof with a thermostat chamber 130 which is lined with insulation 131 and communicates with the chamber containing the diversion element 127 by means of a hole 133. The hole 133 is closed by a flexible element 134 which is secured to an actuating link 135 whereby the link means may be shifted backwardly and forwardly in the opening 133 without permitting communication between the chamber 130 and the chamber containing the liquid refrigerant. The link 135 is pivotally connected to the diversion element 127 and to a thermostat 137. The thermostat 137 is carried by a rod 140 which is preferably constructed from material having a high heat conductivity. The heat conductor 140 is provided with a portion which extends through the wall of the chamber 130 and carries a plurality of heat conducting fins 141. The thermostat 137 responds quickly and accurately to temperature changes in the cooling air because of the large air contact area provided by the fins 141.

The operation of this form of the invention is identical with that disclosed in connection with Figures 4 and 5 except with respect to the air temperature compensating mechanism, the operation of which will now be described.

It was explained with reference to the mechanism disclosed in Figures 4 and 5 that liquid refrigerant would discharge through the conduit 96' when the plate valves 105' and 106' are in position to permit the pre-cooling section 91' to be swept by cooling air; that is, the relatively cool liquid refrigerant discharging through the conduit 91' should deflect the bi-metallic element 127 to such position that the liquid will be discharged into the conduit 96' in the diversion chamber 125. Now, if the temperature of the air is very low, the temperature at which the liquid will be discharged from the pre-cooler 91' is relatively low and no difficulty will be encountered; however, if the temperature of the cooling air is very high, the temperature of the liquid discharged through the pre-cooler 91' may not be sufficiently low to deflect the bi-metallic element 127 sufficiently far to the right, as viewed in Figure 8, in order to direct all the liquid into the conduit 96'; however, under these conditions, the thermostat 137 has responded to the high ambient temperature and has shifted the thermostat 127 to the right as viewed in Figure 8 about the pivot 128. In the event that the pre-cooler 91' is not operating and the temperature of the cooling air is very low, it will be evident that the liquid refrigerant discharged through the pre-cooler 91' will be at a low temperature even though not cooled in the pre-cooler, and that this low temperature might cause part of the liquid refrigerant to be diverted into the conduit 96' when it should not flow thereinto; however, under these conditions, the thermostat 137 has shifted thermostat 127 to the left, as shown in dotted lines in Figure 8, about the pivot 128 whereby the thermostat 127 need not deflect to a very great degree in order to divert the liquid refrigerant into the pre-cooler 94'. Therefore it will be seen that I have provided in this form of the invention a diversion element which automatically compensates itself for ambient temperature changes in order that it may properly divert the liquid refrigerant into or away from the pre-cooler 94'.

Figure 9 illustrates the arrangement of the apparatus in a cabinet. The cooling air which enters the bottom portion 103 of the refrigerator cabinet 100 containing the absorber, liquid heat exchanger, boiler, and analyzer passes upwardly over the absorber and then in contact with the various condenser sections. This cooling air passes upwardly through a flue formed by the rear wall 67 of the refrigerating compartment and a panel 68 spaced from such rear wall. The air which passes over the condensers C and C' was previously passed over the absorber A but its temperature is still low enough to cause condensation of the refrigerant at all air temperatures normally encountered. Therefore, it is apparent that the cooling air passes first across one heat rejecting element, the absorber, and then across either of two or more heat rejecting elements, namely, the condensers. In the modi-

fications disclosed in Figures 4 to 8, the cooling air also traverses a pre-cooler element.

Each of the three forms of the invention disclosed herein is provided with an evaporator having a constantly operating insulated low temperature freezing or low temperature storage compartment and a plurality of ice-freezing evaporator sections which are alternately operated. The control of the alternately operated ice-freezing evaporator sections is achieved simply by altering the effective heat rejecting area of certain portions of the refrigerating system. The control mechanism is arranged in such fashion that refrigeration cannot be diverted from one section of the evaporator to another until ice has formed to a predetermined depth in those portions of the water tank in heat exchange relationship with the operative evaporator section. Furthermore, the production of refrigeration is ultimately controlled by temperature conditions prevailing within the storage compartment of the refrigerator with the result that the production of ice is a direct function of the ambient temperature. This follows from the fact that a high ambient temperature will increase heat loss through the walls of the refrigerator compartment thereby causing the apparatus to cycle more frequently, but more frequent cycling of the apparatus produces a greater quantity of ice whereby the production of ice will normally be at its maximum during the hot months of the year when the demand for ice is also at a maximum value.

If desired, the water tank may be provided with a spigot to permit cold water to be drawn therefrom for drinking purposes at any desired time. Normally, the water contained within the tank will be at a temperature close to the freezing point of water and will contain a number of blocks of ice floating freely on the surface of the water. Any number of ice blocks desired may be removed simply by ladling the desired number out of the water tank.

The control mechanism disclosed in connection with the form of the invention illustrated in Figures 1 to 3 is simpler than that disclosed in connection with the other modifications disclosed. However, the modifications disclosed in Figures 4 to 8 possess the advantage that it is not necessary to duplicate the condenser as a whole but only to duplicate the last or pre-cooling section thereof.

The very large exposed walls of the water tank are continually swept by the air within the food storage compartment and provide the box-cooling means for that compartment. Due to the fact that these walls of the water tank are at a temperature higher than the freezing temperature of water, there will be no frost formation thereon although there may be a slight amount of condensation. This feature will maintain the humidity in the refrigerating compartment at relatively high values and will promote proper preservation of foodstuffs. Humidity control is further aided by the large surface at the water contained in the ice-freezing tank which may be exposed directly to the air circulating in the storage compartment or which may be covered by a substantially non-sealing cover which will prevent accidental deposit of impurities into the water tank.

While I have illustrated and described several forms of my invention it is not limited thereto but may be embodied in other variations and conventional forms without departing from the spirit thereof of the scope of the appended claims.

I claim:

1. That improvement in the art of refrigeration which includes the steps of expelling refrigerant vapor from solution, selectively condensing the vapor in a plurality of condensing zones, selectively evaporating the liquid in a plurality of evaporating zones, freezing ice by heat absorbed in said evaporating zones, discontinuing condensation and evaporation in associated condensing and evaporating zones after a predetermined quantity of heat has been absorbed, and absorbing the vapor in solution.

2. Refrigerating apparatus comprising an evaporator having a plurality of freezing sections, a cooling medium heat rejecting element connected to each section, means for supplying cooling medium to said elements, and means for controlling heat rejection from said elements selectively to produce refrigeration in individual sections of said evaporator.

3. A cooling unit comprising an insulated compartment, an evaporating conduit having a plurality of sections mounted in the insulation of said compartment, some of said sections being in heat exchange relationship with the interior of said compartment and others of said sections being insulated from said compartment and having a plurality of freezing elements projecting from said insulation, a water container mounted in heat exchange relationship with such projecting elements, and means constructed and arranged to cause refrigeration to be produced substantially continuously in those sections of said evaporator in heat exchange relationship with said compartment, and sequentially in those sections of said evaporator in heat exchange relationship with said container.

4. Refrigerating apparatus comprising a cabinet, an evaporator mounted in said cabinet having a low temperature compartment insulated from the air in said cabinet, a water container having certain walls thereof exposed to the air within said cabinet, and a heat abstracting element insulated from the air in said cabinet having means to refrigerate said compartment and to freeze ice in said container, the exposed portions of said container serving to refrigerate the air within said compartment.

5. Refrigerating apparatus comprising a cabinet, a water tank mounted within said cabinet and having a portion thereof exposed to the air within said cabinet, an evaporator having a plurality of heat exchange contacts with said tank to freeze ice blocks therein, and means preventing said evaporator from contacting air in said cabinet, the arrangement being such that the exposed portion of said tank is maintained at temperatures above the freezing temperature of water and serves to cool the air in said cabinet.

6. An air cooled absorption refrigerating apparatus including a cabinet, a cooling air passage formed adjacent one wall of said cabinet, a plurality of evaporator elements mounted within said cabinet, a plurality of refrigerant heat rejecting elements mounted in said passage, each of said evaporator elements being connected to one of said heat rejecting elements, an air cooled absorber mounted to be cooled by air passing through said passage, and means governing the flow of air across said heat rejecting elements in response to refrigeration demands.

7. An air cooled absorption refrigerating apparatus including a cabinet, a cooling air pas-

sage formed adjacent one wall of said cabinet, a plurality of evaporator elements mounted within said cabinet, a plurality of refrigerant heat rejecting elements mounted in said passage, each of said evaporator elements being connected to one of said heat rejecting elements, an air cooled absorber mounted to be cooled by air passing through said passage, and means governing the flow of air across said heat rejecting elements in response to refrigeration demands, said last mentioned means operating alternately to allow and prevent flow of cooling air over each of said heat rejecting elements without altering the flow of cooling air over said absorber.

8. An air cooled absorption refrigerating apparatus including a cabinet, a cooling air passage formed adjacent one wall of said cabinet, a plurality of evaporator elements mounted within said cabinet, a plurality of refrigerant heat rejecting elements mounted in said passage, each of said evaporator elements being connected to one of said heat rejecting elements, an air cooled absorber mounted to be cooled by air passing through said passage, and means governing the flow of air across said heat rejecting elements in response to refrigeration demands, a condenser in said passage, and means preventing cooling air which has passed over one of said elements from flowing over another of said elements or said condenser, said condenser being positioned adjacent the wall of said passage remote from said cabinet.

9. Refrigerating apparatus comprising a low temperature freezing compartment having insulating walls, a water tank mounted on said compartment, an evaporator embedded in the insulated walls of said compartment having portions thereof positioned to refrigerate the interior of said compartment and portions thereof positioned to refrigerate said tank.

10. Refrigerating apparatus comprising a condenser, a first pre-cooling element connected to receive liquid from said condenser, a diversion chamber connected to receive liquid from said first precooling element, a second pre-cooling element connected to receive liquid from said diversion chamber, a container for water, a pair of evaporating elements in heat transfer relationship with said container, means connecting one of said evaporator elements to said diversion chamber, means connecting the other evaporating element to said second pre-cooling element, control means for permitting cooling air to flow over only one of said pre-cooling elements at a time, means responsive to the formation of a predetermined quantity of ice in said container for operating said control means to change the flow of cooling air from one of said precooling elements to the other, and means in said diversion chamber for diverting liquid supplied thereto into said second precooling element or into the evaporator section connected to said diversion chamber in accordance with the operation of said control means.

11. Refrigerating apparatus comprising a condenser, a first precooling element connected to receive liquid from said condenser, a diversion chamber connected to receive liquid from said first precooling element, a second precooling element connected to receive liquid from said diversion chamber, a container for water, a pair of evaporating elements in heat transfer relationship with said container, means connecting one of said evaporator elements to said diversion chamber, means connecting the other evaporating element to said second precooling element, control means for permitting cooling air to flow over only one of said precooling elements at a time, means responsive to the formation of a predetermined quantity of ice in said container for operating said control means to change the flow of cooling air from one of said precooling elements to the other, and means in said diversion chamber for diverting liquid supplied thereto into said second precooling element or into the evaporator section connected to said diversion chamber in accordance with the operation of said control means, said diversion element including a thermostat which is responsive to the temperature of the liquid supplied to said diversion chamber, and means for compensating said diversion thermostat for variations in cooling air temperature.

12. Refrigerating apparatus comprising a condenser, a first precooling element connected to receive liquid from said condenser, a diversion chamber connected to receive liquid from said first precooling element, a second precooling element connected to receive liquid from said diversion chamber, a container for water, a pair of evaporating elements in heat transfer relationship with said container, means connecting one of said evaporator elements to said diversion chamber, means connecting the other evaporating element to said second precooling element, control means for permitting cooling air to flow over only one of said precooling elements at a time, means responsive to the formation of a predetermined quantity of ice in said container for operating said control means to change the flow of cooling air from one of said precooling elements to the other, and means in said diversion chamber for diverting liquid supplied thereto into said second precooling element or into the evaporator section connected to said diversion chamber in accordance with the operation of said control means, said diversion element including a thermostat which is responsive to the temperature of the liquid supplied to said diversion chamber, and means for compensating said diversion thermostat for variations in cooling air temperature, said compensating means including means for regulating the flow of cooling air over said condenser and means responsive to air temperature for actuating said last mentioned air flow control means.

13. Refrigerating apparatus comprising a condenser, a first precooling element connected to receive liquid from said condenser, a diversion chamber connected to receive liquid from said first precooling element, a second precooling element connected to receive liquid from said diversion chamber, a container for water, a pair of evaporating elements in heat transfer relationship with said container, means connecting one of said evaporator elements to said diversion chamber, means connecting the other evaporating element to said second precooling element, control means for permitting cooling air to flow over only one of said precooling elements at a time, means responsive to the formation of a predetermined quantity of ice in said container for operating said control means to change the flow of cooling air from one of said precooling elements to the other, and means in said diversion chamber for diverting liquid supplied thereto into said second precooling element or into the evaporator section connected to said diversion chamber in accordance with the operation of said control means, said diversion element including a

thermostat which is responsive to the temperature of the liquid supplied to said diversion chamber, and means for compensating said diversion thermostat for variations in cooling air temperature, said compensating mechanism comprising a thermostatic element connected to alter the position of said diverting thermostat in accordance with the temperature of the cooling air.

14. Refrigerating apparatus comprising a pair of air cooled heat rejecting elements, means for supplying refrigerant to said elements, an evaporator having a pair of sections, means connecting each of said heat rejecting elements to an evaporator section, a water container mounted in heat exchange relationship with each of said sections, means controlling the flow of cooling air over said elements, temperature responsive means for actuating said air flow control means, said temperature responsive means including temperature reponsive elements positioned to be frozen into ice formed in said container adjacent each of said evaporator sections, the arrangement being such that said temperature responsive means operates said air flow control means to allow flow of cooling air over the heat rejecting element connected to the evaporator section adjacent that portion of the tank from which an ice block has just melted away from one of said temperature responsive elements and to prevent flow of cooling air over the other heat rejecting element.

15. Refrigerating apparatus comprising a plurality of condensers, an evaporator having sections connected to receive refrigerant liquid discharged by each of said condensers, an ice freezing chamber in heat transfer relation with each of said sections, means for governing the flow of cooling medium over said condensers, and means for rendering said governing means operative to allow air flow over said condensers alternately whereby refrigeration is produced in said evaporator sections alternately.

16. Refrigerating apparatus comprising a cooling unit having a plurality of branches encased in insulating material, heat conducting elements extending from said branches to the surface of said insulating material, a water tank mounted on said elements, a source of supply of cooling medium, and control means for directing cooling medium from said source of supply to a selected one of said branches.

17. Refrigerating apparatus comprising a cabinet, an insulated low temperature storage chamber mounted within said cabinet, a cooling unit mounted in the insulation of said chamber and arranged to refrigerate the interior of said chamber, a water container mounted adjacent said chamber, a second cooling unit having a pair of sections mounted in the insulation of said chamber and arranged to refrigerate said container, a source of supply of cooling medium, control means arranged to direct the cooling medium from said source of supply into a selected one of said sections of said second mentioned cooling unit, and means for draining cooling medium from each of said sections into said first mentioned cooling unit.

18. Absorption refrigerating apparatus comprising a solution circuit including a boiler and an absorber, an inert gas circuit including an evaporator and said absorber, means for supplying refrigerant liberated from solution in said boiler to said evaporator in liquid phase, a water container having exposed walls positioned in heat transfer relationship with said evaporator at a plurality of points, a compartment housing said evaporator and water container whereby the air in said compartment is refrigerated by the exposed walls of said container.

19. Absorption refrigerating apparatus comprising a solution circuit including a boiler and an absorber, an inert gas circuit including an evaporator and said absorber, means for supplying refrigerant liberated from solution in said boiler to said evaporator in liquid phase, a water container having exposed walls positioned in heat transfer relationship with said evaporator at a plurality of points, a compartment housing said evaporator and water container whereby the air in said compartment is refrigerated by the exposed walls of said container, and means responsive to the temperature of the air in said compartment for governing the production of refrigeration in said evaporator.

20. Absorption refrigerating apparatus comprising a solution circuit including a boiler and an absorber, an inert gas circuit including an evaporator and said absorber, means for supplying refrigerant liberated from solution in said boiler to said evaporator in liquid phase, a cabinet housing said evaporator, means shielding said evaporator from contact with the air in said cabinet, and a water container having certain of the walls thereof exposed to the air in said cabinet mounted in heat transfer relationship with said evaporator at a plurality of points.

21. Absorption refrigerating apparatus comprising a solution circuit including a boiler and an absorber, an inert gas circuit including an evaporator and said absorber, means for supplying refrigerant liberated from solution in said boiler to said evaporator in liquid phase, a water container having exposed walls positioned in heat transfer relationship with said evaporator at a plurality of points, a compartment housing said evaporator and water container whereby the air in said compartment is refrigerated by the exposed walls of said container, and means responsive to the production of ice in said container for confining the production of refrigeration to selected portions of said evaporator.

22. That improvement in the art of refrigeration which includes the steps of flowing an inert gas between an absorbing zone and a plurality of evaporating zones each of which is associated with one of a plurality of heat rejecting zones arranged to supply refrigerant liquid thereto, applying heat to a solution of a refrigerant in an absorbent to expel refrigerant therefrom, conducting the refrigerant to said heat rejecting zones, and governing the production of refrigeration in said evaporating zones by regulating the rejection of heat from said heat rejecting zones.

23. That improvement in the art of refrigeration which includes the steps of flowing an inert gas between an absorbing zone and a plurality of evaporating zones each of which is associated with one of a plurality of heat rejecting zones arranged to supply refrigerant liquid thereto, applying heat to a solution of a refrigerant in an absorbent to expel refrigerant therefrom, conducting the refrigerant to said heat rejecting zones, supplying liquid refrigerant to one of said evaporating zones from its associated heat rejecting zone by preventing rejection of heat from all of said heat rejecting zones except that heat rejecting zone associated with said one evaporating zone, and selecting said one evaporating zone by a differential in refrigeration demand existing between said evaporating zones.

24. That improvement in the art of refrigeration which includes the steps of flowing an inert pressure equalizing medium between a place of absorption and a place of evaporation, applying heat to a solution of a refrigerant in an absorbent to expel refrigerant vapor therefrom, conducting the vapor expelled from solution to a place of condensation which is in heat exchange relationship with a flowing cooling medium, conducting refrigerant liquid from said place of condensation to said place of evaporation where the refrigerant liquid evaporates into the pressure equalizing medium to produce a refrigerating effect, maintaining a body of water in heat exchange relationship with said place of evaporation at a plurality of separated points beneath the surface of said body of water, discontinuing the production of refrigerant in said place of evaporation when a predetermined quantity of ice has been formed in said body of water by preventing the flow of cooling medium in heat exchange relationship with said place of condensation, and resuming production of refrigerant in said place of evaporation when said predetermined quantity of ice has floated to the surface of said body of water by restoring the flow of cooling medium in heat exchange relationship with said place of condensation.

25. In a refrigerating apparatus, a plurality of heat absorbing elements, means for circulating a cooling medium through said heat absorbing elements including a plurality of heat rejecting elements each of which is associated with one of said heat absorbing elements, and means for governing the production of refrigeration in each of said heat absorbing elements including means arranged to govern the rejection of heat by said heat rejecting elements.

26. In a refrigerating apparatus, a source of refrigerant vapor, a liquefying means connected to receive refrigerant vapor from said source, a plurality of evaporators, a plurality of serially connected air cooled elements, each of said air cooled elements being connected to one of said evaporators, means arranged to conduct liquid refrigerant from said liquefying means to one of said air cooled elements, and means for selectively directing refrigerant liquid from said one air cooled element into its associated evaporator or into another of said air cooled elements in accordance with refrigeration demand.

27. Absorption refrigerating apparatus including a plurality of evaporators, a generator, means arranged to supply liquid refrigerant to said evaporators, to remove refrigerant vapor from said evaporators, to absorb the vapor removed from said evaporators in solution and to return the solution to said generator, said means including a plurality of air cooled heat rejecting devices so constructed and arranged that the operation of said evaporators is directly dependent upon the rejection of heat from said heat rejecting devices, each of said heat rejecting devices being associated with one of said evaporators, and means arranged to control the flow of cooling air in heat transfer relationship with said heat rejecting devices to regulate the production of refrigerant in said evaporators.

28. In a refrigerating apparatus, a source of refrigerant vapor, a liquefying means connected to receive refrigerant vapor from said source, a plurality of evaporators, a plurality of serially connected air cooled elements, each of said air-cooled elements being connected to one of said evaporators, means arranged to conduct liquid refrigerant from said liquefying means to one of said air cooled elements, means for selectively directing refrigerant liquid from said one air cooled element into its associated evaporator or into another of said air cooled elements in accordance with refrigeration demand, and means for compensating said last mentioned means for variations in the temperature of the cooling air.

29. In a device of the character described, a cabinet having an insulated refrigerating chamber and a machinery chamber arranged for flow of cooling air therethrough, refrigerating mechanism associated with said cabinet comprising a cooling unit positioned within said refrigerating chamber, a water container positioned in said refrigerating chamber and in heat exchange relationship with said cooling unit at a plurality of points, means positioned in said machinery chamber arranged to supply a cooling medium to said cooling unit, said means including an air cooled heat rejecting element positioned to be cooled by air flowing through said machinery chamber and so related to said cooling unit that the operation of said cooling unit is dependent upon the rejection of heat by said heat rejecting element, and means for controlling the production of refrigeration by said cooling unit including a device for governing the flow of cooling air in heat exchange relationship with said heat rejecting element whereby alternately to freeze ice in said container and to allow previously frozen ice to float to the surface of the water in said container.

30. In a refrigerating apparatus, a source of refrigerant vapor, a liquefying means connected to receive refrigerant vapor from said source, a plurality of evaporators, a plurality of serially connected air cooled elements, each of said air cooled elements being connected to one of said evaporators, means arranged to conduct liquid refrigerant from said liquefying means to one of said air cooled elements, means for selectively directing refrigerant liquid from said one air cooled element into its associated evaporator or into another of said air cooled elements in accordance with refrigeration demand, and means for compensating said last mentioned means for variations in the temperature of the cooling air, including means for regulating the temperature of said liquefying means.

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