

Aug. 16, 1932.

L. S. CHADWICK
REFRIGERATION APPARATUS

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Filed May 9, 1929

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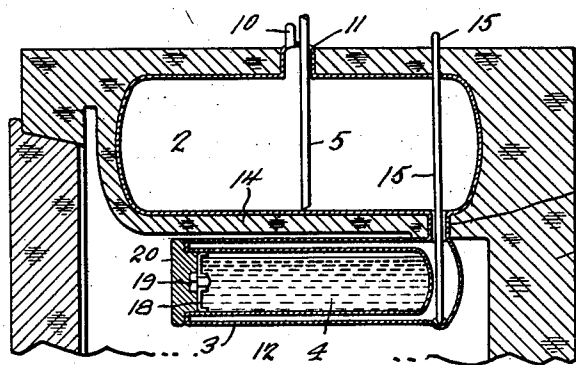
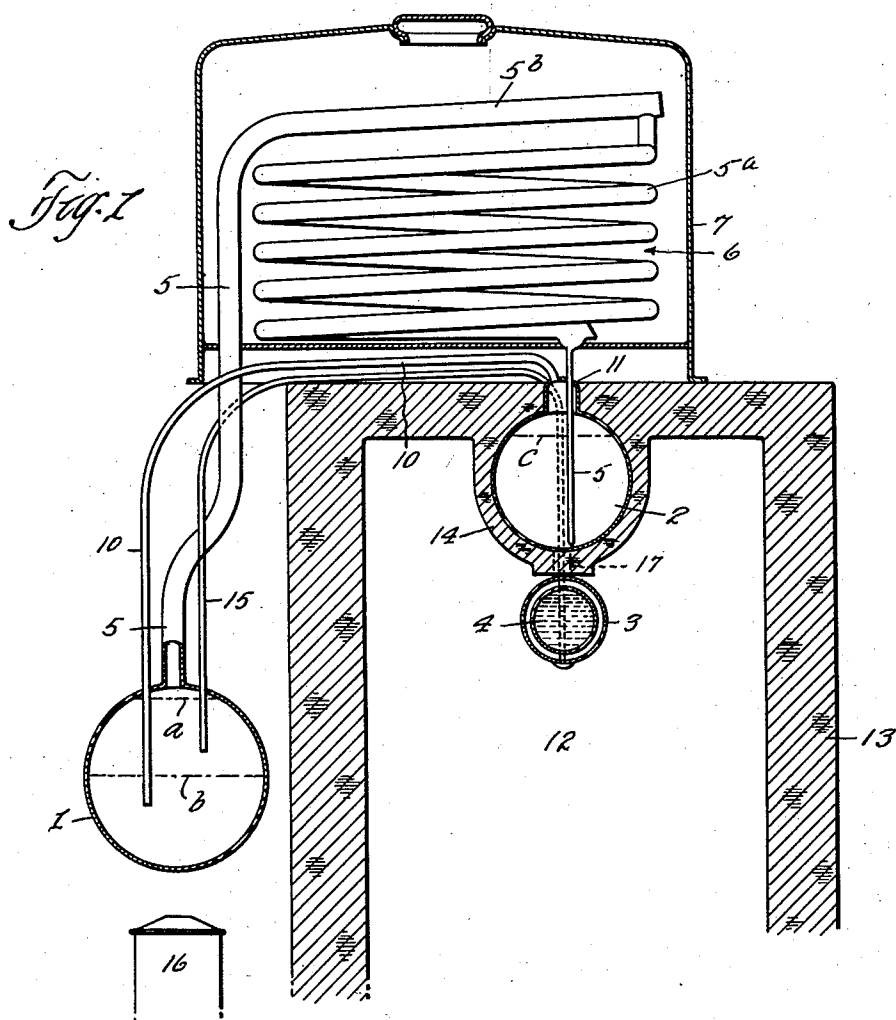


Fig. 2

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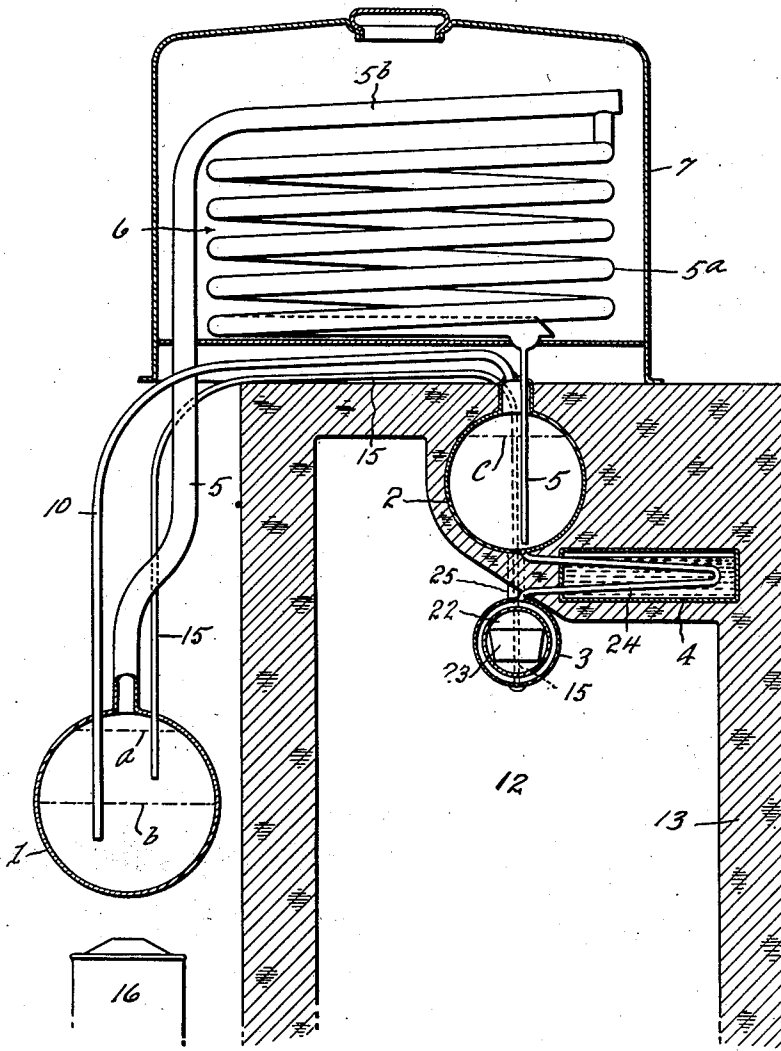


Fig. 3

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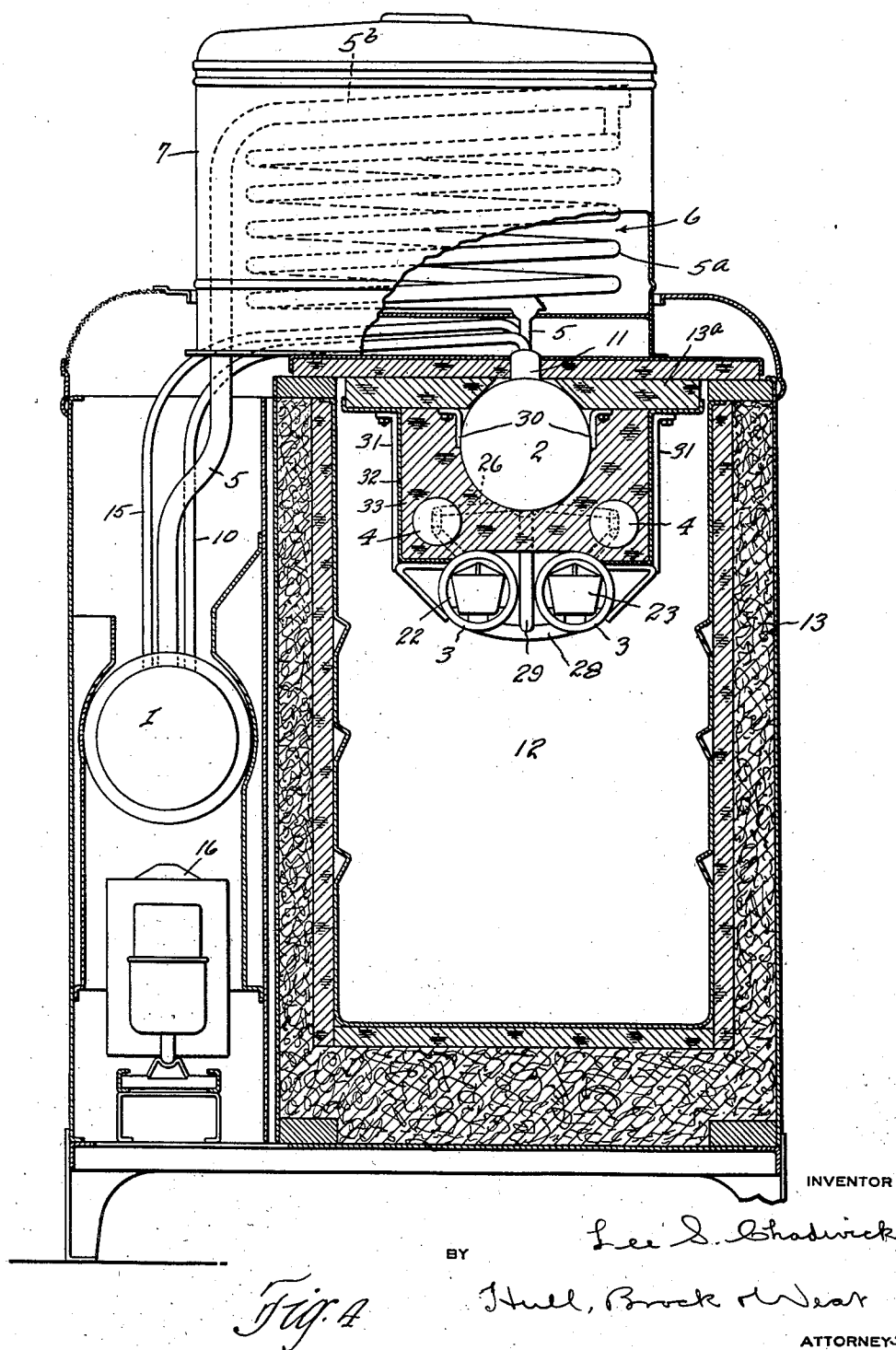
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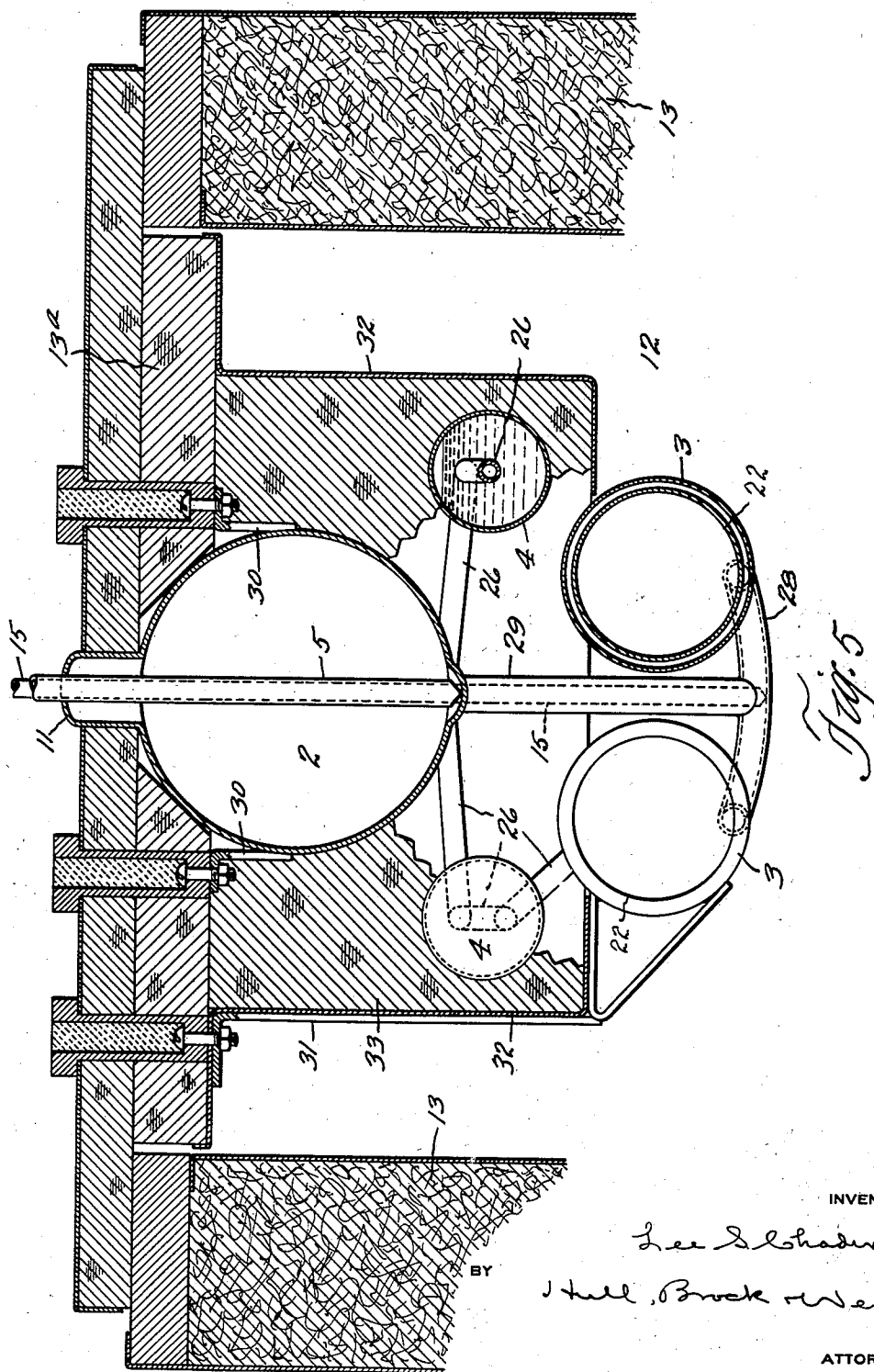
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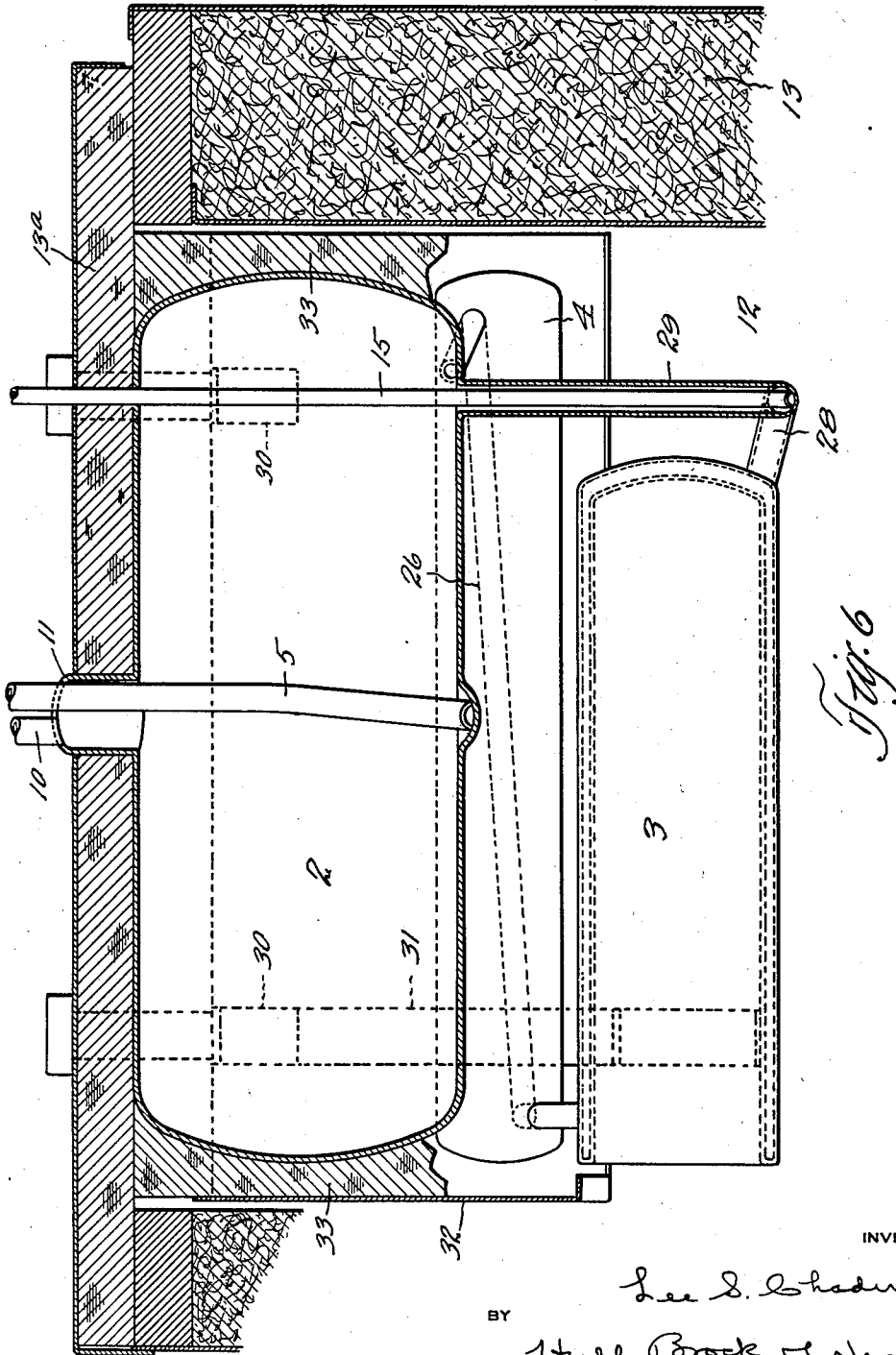
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REFRIGERATION APPARATUS

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5 Sheets-Sheet 5



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REFRIGERATION APPARATUS

Application filed May 9, 1929. Serial No. 361,579.

This invention relates to improvements in refrigeration apparatus of the intermittent absorption class.

As is well known to those familiar with the art, an apparatus of the class referred to involves an evaporator that is arranged in heat exchanging relation to the refrigeration compartment wherein food stuffs are adapted to be placed for preservation, and usually there is a so-called freezing chamber in more intimate heat exchanging relation to the evaporator wherein water may be frozen to produce ice cubes or blocks, or wherein other substances, such as desserts, may be chilled or congealed. The temperature of the refrigeration compartment should be maintained at about 45° F. for the proper preservation of foods and for the protection of fruits and vegetables against injury from too low a temperature, while it is essential that the temperature of the freezing chamber be kept at or below the freezing point of water if ice is to be preserved, or below a point at which congealed substances in the freezing chamber would soften or melt. For the purpose of this specification, I will use the generic term "cold space" as a designation for either or both the refrigeration compartment and the freezing chamber.

In the operation of apparatus of the aforesaid class as usually constructed, there is a pronounced fluctuation in the temperature of the cold space between the alternate heating-condensing and cooling-absorption periods. One reason for this is that during the heating-condensing period the relatively warm refrigerant condensate collects in the evaporator and radiates heat to said space. Another reason is that early in the heating-condensing period, before the pressure in the system has risen sufficiently to cause condensation of the refrigerant vapors at the temperature of the condenser, condensation of said vapors occurs in the coolest part of

the system, and since the evaporator is the coolest part, because of its being exposed to the cooling influence of the cold space and of any cold objects or frozen or congealed substance therein, the initial condensation occurs in the evaporator and by reason of the heat exchange incident to such condensation the temperature of the cold space is unduly raised. This initial condensation of the refrigerant vapors in the evaporator is more likely to occur in that type of apparatus in which a still body of cooling fluid is employed in the condenser than in apparatus in which the condenser is cooled by flowing water, and naturally this condition is worse in warm weather or when the apparatus is located in a relatively warm room. In fact, anything that impairs the efficiency of the condenser will aggravate the condition. In either event—where the relatively warm condensate collects in the evaporator, or where the initial condensation occurs in the evaporator—there is a decided rise in the temperature of the cold space during the heating-condensing periods with the result that ice which has previously been frozen will be melted to a greater or less extent, or substances that have been congealed will be softened.

It is the main object of my invention to overcome the above mentioned difficulties by providing highly efficient means for stabilizing the temperature of the cold space, the same being thoroughly reliable, simple, immune from disorder, and requiring no attention.

To the attainment of the foregoing object, I provide an evaporator that is located in intimate heat exchanging relation to the cold space, a receiver for the refrigerant condensate that is insulated from said space and is placed in communication with, and at a higher elevation than, the evaporator so that the condensate will gravitate to the latter

vessel, and what I shall term an "auxiliary condenser" for condensing and cooling any vapors that leave the receiver for the evaporator, said auxiliary condenser being also
 5 insulated from the refrigeration space. According to the embodiments of the invention herein disclosed, the auxiliary condenser consists of a sealed receptacle, and it contains a
 10 suitable liquid whose freezing point is below a given temperature value above which it is desired the temperature of the cold space shall not go.

A further object of my invention is to provide a substantial and practical construction that is capable of being manufactured
 15 expeditiously and economically and which is highly efficient in the attainment of the purpose in view.

In the accompanying drawings, wherein
 20 various embodiments of the invention are illustrated, Fig. 1 is a diagrammatic view in the nature of a sectional front elevation of refrigeration apparatus incorporating a simple
 25 form of the invention with the auxiliary condenser enclosed by the evaporator; Fig. 2 is a central vertical section through the receiver and evaporator of the apparatus shown in Fig. 1, the adjacent portion of the cabinet
 30 being included in the view; Fig. 3 is a view similar to Fig. 1 showing a form of the invention in which the freezing chamber is surrounded by the evaporator and the auxiliary condenser is located in the line of communication
 35 between the receiver and evaporator and insulated from the refrigeration compartment; Fig. 4 is a sectional front elevation of refrigeration apparatus embodying the present preferred form of the invention; Fig. 5 is an enlarged detail showing in
 40 sectional front elevation the receiver, auxiliary condensers and evaporators of the structure disclosed in Fig. 4, and Fig. 6 is a sectional side elevation of the parts of Fig. 5.

Like reference characters designate corresponding parts throughout the several
 45 views of the drawings and after an introduction of the general elements I shall take up a detailed description of the different embodiments herein disclosed in the order in
 50 which they appear in the drawings.

In each instance, 1 designates the generator-absorber, 2 the receiver, 3 the evaporator, and 4 the auxiliary condenser. A delivery
 55 conduit 5 leads from the generator-absorber 1 to the receiver 2, terminating in the latter vessel adjacent the bottom wall thereof. A main condenser, designated generally by the reference numeral 6, consists of a suitable tank or enclosure 7 within which there is a
 coil 5^a formed by part of the delivery conduit 5, the portion of said conduit immediately above said coil; and which is inclined in
 a direction to drain toward the generator-absorber 1, constituting a dehydrator designated 5^b. The tank or enclosure 7 con-

tains a substantially still body of water or other cooling agent within which both the coil 5^a and dehydrator 5^b are submerged. A return conduit 10 leads from the receiver 2 to the generator-absorber 1, the same passing
 70 through the top wall of the latter vessel and terminating therein below the minimum liquid level in said vessel. The receiver 2 is shown as surmounted by a gas dome 11 through which the delivery conduit 5 enters
 75 said vessel and the return conduit 10 communicates with the interior thereof. The evaporator 3 is located below the plane of the receiver and within the refrigeration compartment 12 that is enclosed in a cabinet 13 whose
 80 walls are properly insulated in accordance with the usual practice. The receiver 2 is enclosed within a jacket 14 of insulating material so as to prevent heat transfer between said vessel and the refrigeration compartment. In each case a siphon tube 15 leads from a low point or sump in the evaporator to the generator-absorber, the purpose of which will presently appear. Situated in
 85 operative relation to the generator-absorber 1 is a heating device 16, and as herein disclosed, the same consists of an oil burner.

In the form of the invention illustrated in Figs. 1 and 2, communication is established between the receiver 2 and the evaporator 3
 95 through a pipe or conduit 17, and it will be noted that the syphon 15 rises from a sump in the bottom wall of the evaporator through said tube or conduit 17 and through the receiver 2, passing outwardly through the top
 100 wall of the latter vessel and through the top of the cabinet and thence over and downwardly to the generator-absorber. The evaporator 3 is a double wall vessel, the space between its inner and outer walls constituting the refrigerant space, while the cavity enclosed by the inner wall forms, in the present case, the auxiliary condenser 4. As shown in Fig. 2, a head 18 is fitted into the forward end of said cavity so as to make the same liquid tight, said head being provided with a filling opening that is closed by a screw plug 19. The auxiliary condenser contains a suitable brine having a
 105 freezing point below a given temperature value above which it is desired the temperature of the cold space shall not go. After the brine has been introduced into the auxiliary condenser and the filling opening thereof closed by the plug 19, a cap 20 of
 110 suitable material is placed over the end of the condenser to insulate it from the refrigeration compartment 12, the condenser being otherwise insulated from said compartment by the surrounding refrigerant space
 125 of the evaporator.

The system, involving the generator-absorber, receiver and evaporator, and the tubes or conduits through which they communicate, is hermetically sealed and per-

manently contains a proper quantity of a mixture consisting of a suitable refrigerant, such as ammonia, and an absorbent or solvent therefor, such as water. The apparatus operates in cycles that are divided into alternate heating-condensing and cooling-absorption periods, the length of time occupied by each complete cycle depending upon the size or capacity of the apparatus. For practical purposes and convenience of use the apparatus may be made of such size and capacity as will require 24 hours for the performance of a single cycle, approximately one hour of which is taken up by the heating-condensing period, while the remainder of the cycle is occupied by the cooling-absorption period.

At the conclusion of a cooling-absorption period all of the mixture is present in the generator-absorber, excepting possibly a relatively small quantity of absorbent condensate left in the evaporator. To start a cycle of operation, heat is applied to the generator-absorber as by lighting the oil burner that constitutes the heating device 16 and immediately the mixture starts to boil in the generator-absorber and the vapors rise through the conduit 5. At the same time the pressure throughout the system starts to build up, and by the action thereof the residue liquid in the evaporator 3 and a part of the mixture in the generator-absorber 1 is forced up the respective legs of the syphon 15, and inasmuch as the gas that is trapped between the rising columns of liquid in the legs of the syphon is rich in refrigerant, the same is quickly absorbed by the liquid and this tends to draw said columns toward each other thereby to effect a continuous, or almost continuous, body of liquid throughout the length of the syphon which overbalances toward and flows into the generator-absorber. This performance, which may repeat several times under certain conditions, empties the evaporator of the residue liquid at the beginning of the heating-condensing period.

As the vapors rise from the generator-absorber through the delivery conduit 5 and enter the portion 5^b thereof, which is submerged in the relatively cool liquid within the tank or enclosure 7, all or the greater percentage of the absorbent vapors condense and flow back into the generator-absorber, while the refrigerant vapors, and possibly a small quantity of the absorbent vapors, pass on to the coil 5^a. Before a sufficiently high pressure has been created within the system to cause the refrigerant vapors to condense within the coil 5^a of the main condenser at the temperature of the cooling fluid surrounding said coil, said vapors pass into the receiver and from there through the pipe or conduit 17 to the evaporator 3 where they will be immediately condensed and cooled by

intimate association with the auxiliary condenser 4. As soon as the pressure is sufficient to cause the refrigerant vapors to condense at the temperature of the main condenser, condensation will be confined to the main condenser and the resultant condensate will pass to the receiver 2 and accumulate therein after the evaporator has become filled.

During the heating-condensing period, the liquid in the generator-absorber falls from about the level indicated by the line *a* to about that indicated by the line *b*, and at the conclusion of said period the liquid in the receiver stands at about the level indicated by the line *c*.

During the cooling-absorption period, which is inaugurated by the removal of the heat from the generator-absorber, resulting from the turning off or going out of the burner, the refrigerant in the receiver 2 and in the evaporator 3 vaporizes and passes back through the return conduit 10 to the generator-absorber and is re-absorbed by the liquor therein. By the process of evaporation, heat is abstracted from the refrigeration compartment 12 thereby maintaining said compartment at a relatively low temperature, and even during the heating-condensing period there is no appreciable elevation of the temperature of said compartment due to the fact that the warm refrigerant vapors that pass into the evaporator early in said period are immediately condensed and cooled by the auxiliary condenser and said compartment is protected from the relatively warm refrigerant condensate that thereafter collects within the receiver 2 because of the fact that said compartment is protected from the warmth of the receiver by the jacket 14 of insulating material. The frozen brine within the auxiliary condenser is melted more or less during the heating-condensing period, but it freezes again during the subsequent cooling-absorption period.

In the form of the invention illustrated in Fig. 3, the auxiliary condenser is removed from the interior of the evaporator 3, and the cavity enclosed by the inner wall of the evaporator, and which in this case is left open at the front, constitutes a freezing chamber 22 in which may be placed a tray 23 for water to be frozen into ice cubes or blocks, in accordance with common practice. The receiver 2 communicates with the evaporator 3 through a tube or conduit 24, a portion of which is enclosed by a tank or receptacle containing a suitable brine. This tank or receptacle constitutes the auxiliary condenser and is accordingly designated 4. The brine used in this case, if ice is to be preserved in the freezing chamber 22, has a freezing point below that of water, and I find that a 10% sodium hydroxide solution, that freezes at about 20° F., is suitable for the purpose. The

auxiliary condenser and the receiver 2 are insulated from the refrigeration compartment 12.

In this case, when the relatively warm refrigerant vapors reach the auxiliary condenser 4, early in a heating-condensing period, they condense and become chilled within that portion of the tube or conduit 24 that is surrounded by the frozen brine in the auxiliary condenser and the cool condensate gravitates to the evaporator 3. A pipe of conduit 25 also connects the receiver and evaporator for the passage of the siphon 15.

In Figs. 4, 5 and 6 is illustrated the present preferred form of the invention. Two evaporators, designated 3, are employed in this construction and they communicate with the receiver 2 through tubes or conduits 26, portions of which are disposed in brine-filled receptacles that constitute the auxiliary condensers 4. As shown in Fig. 6, the tubes or conduits 26 extend from the lower rear portion of the receiver laterally into the rear ends of the brine receptacles and thence forwardly and downwardly therethrough to a point near the front ends of the receptacles where they extend toward each other and downwardly and join the adjacent ends of the evaporators 3. The lowermost portions of the two evaporators 3 are joined at their rear ends through a tube or conduit 28 from the low point of which a conduit 29 rises and joins the receiver 2, and the adjacent end of the siphon 15 extends downwardly through the receiver and through the conduit 29 and has its receiving end disposed within the lowest part of the conduit 28, such part constituting a sump wherein the liquid left in the evaporator end of the system after a cooling-absorption period collects.

Structural details of the apparatus are illustrated in connection with the present embodiment and it will be noted that the receiver 2 and the evaporators 3 are supported from the top 13^a of the cabinet 13 through brackets 30 and 31, respectively, and a casing 32 surrounds the receiver and the auxiliary condensers and is adapted to contain insulating material designated 33.

The manner in which the present embodiment of the invention operates will be readily understood from what has been said with respect to the form last described.

Having thus described my invention, what I claim is:

1. In refrigeration apparatus of the intermittent absorption class, the combination of a cabinet enclosing the cold space, a generator-absorber, heating means therefor, a receiver insulated from the cold space, conduits through which the generator-absorber and receiver communicate, a main condenser for producing refrigerant condensate for delivery to the receiver, an evaporator communicating with the receiver and arranged

in heat exchanging relation to the cold space, and an auxiliary condenser insulated from the cold space for acting upon any refrigerant that passes from the receiver to the evaporator, the auxiliary condenser containing a liquid whose freezing point is above the temperature of the evaporating refrigerant and below a temperature value above which it is desired the temperature of the cold space shall not go.

2. In refrigeration apparatus of the intermittent absorption class, the combination of a generator-absorber, heating means therefor, a receiver, fluid conveying means through which the generator-absorber and receiver communicate, a main condenser for producing refrigerant condensate for delivery to the receiver, an evaporator communicating with the receiver, an auxiliary condenser for acting upon any refrigerant that passes from the receiver to the evaporator, and a siphon whose short leg terminates in the bottom portion of the evaporator and whose long leg terminates in the generator-absorber.

3. In refrigeration apparatus of the intermittent absorption class, in combination with a cabinet enclosing the cold space of the apparatus, a generator-absorber, heating means therefor, a receiver insulated from said cold space, conduits through which the generator-absorber and receiver communicate, a main condenser for producing refrigerant condensate for delivery to the receiver, an evaporator in heat exchanging relation to the cold space and communicating with the receiver, and an auxiliary condenser housed within the evaporator and containing a liquid whose freezing point is above the temperature of the evaporating refrigerant and below a temperature value above which is desired the temperature of the cold space shall not go.

4. In refrigeration apparatus of the intermittent absorption class, the combination of a generator-absorber, heating means therefor, a receiver, fluid conveying means through which the generator-absorber and receiver communicate, a main condenser for producing refrigerant condensate for delivery to the receiver, an evaporator below the plane of the receiver, a conduit extending between the receiver and the evaporator, a siphon whose short leg descends through the receiver and through said conduit and terminates adjacent the bottom of the evaporator while its long leg terminates in the generator-absorber, and an auxiliary condenser for condensing and cooling any refrigerant that passes from the receiver to the evaporator.

5. In refrigeration apparatus of the class set forth, a cabinet enclosing the refrigeration compartment, an evaporator in the nature of a closed vessel situated within said

compartment and in intimate heat exchanging relation to the interior thereof, a receiver at a higher elevation than the evaporator, a conduit through which communication is established between the receiver and the evaporator and which is arranged to drain toward the latter, and a condenser insulated from the refrigeration compartment for acting upon any refrigerant that passes from the receiver to the evaporator.

6. In refrigeration apparatus of the intermittent absorption class, in combination with a cabinet enclosing the cold space, a receiver insulated from said space and to which the refrigerant condensate is adapted to be delivered from the condenser of the apparatus, an evaporator in heat exchanging relation to the cold space, a receptacle insulated from the cold space and containing a liquid whose freezing point is above the temperature of the evaporating refrigerant and below a temperature value above which it is desired the temperature of the cold space shall not go, and fluid conducting means leading from the receiver to the evaporator and arranged in intimate heat exchanging relation to said receptacle.

7. In refrigeration apparatus of the intermittent absorption class, in combination with a cabinet enclosing the cold space, a receiver insulated from said space and to which the refrigerant condensate is adapted to be delivered from the condenser of the apparatus, an evaporator in heat exchanging relation to the cold space, a receptacle insulated from the cold space and containing a liquid whose freezing point is above the temperature of the evaporating refrigerant and below a temperature value above which it is desired the temperature of the cold space shall not go, and a conduit leading from the receiver to the evaporator and a part of which passes through said receptacle.

8. In refrigeration apparatus of the intermittent absorption class, in combination with a cabinet enclosing the cold space, a receiver insulated from said space and to which the refrigerant condensate is adapted to be delivered from the condenser of the apparatus, an evaporator in heat exchanging relation to the cold space and consisting of a double wall vessel surrounding a freezing chamber and the space between whose walls constitutes the refrigerant space, fluid conducting means leading from the receiver to the refrigerant space of the evaporator, and a receptacle insulated from the cold space and arranged in intimate heat exchanging relation to said means and containing a liquid whose freezing point is above the temperature of the evaporating refrigerant and below a temperature value above which it is desired the temperature of the freezing chamber shall not go.

9. In refrigeration apparatus of the inter-

mittent absorption class, in combination with a cabinet enclosing the cold space, a receiver insulated from said space and to which the refrigerant condensate is adapted to be delivered from the condenser of the apparatus, an evaporator in heat exchanging relation to the cold space and consisting of a double wall vessel surrounding a freezing chamber and the space between whose walls constitutes the refrigerant space, a conduit leading from the receiver to the refrigerant space of the evaporator, and a receptacle through which said conduit passes and which contains a liquid whose freezing point is above the temperature of the evaporating refrigerant and below a temperature value above which it is desired the temperature of the freezing chamber shall not go.

10. In refrigeration apparatus of the intermittent absorption class, the combination of a generator-absorber, heating means therefor, a receiver, fluid conveying means through which the generator-absorber and receiver communicate, a main condenser for producing refrigerant condensate for delivery to the receiver, an evaporator below the plane of the receiver, a conduit through which the receiver drains into the evaporator, an auxiliary condenser associated with said conduit, a second conduit extending between the receiver and the evaporator, and a siphon whose short leg descends through the receiver and through the last mentioned conduit and terminates adjacent the bottom of the evaporator while its long leg terminates in the generator-absorber.

11. In refrigeration apparatus of the intermittent absorption class, in combination with a cabinet enclosing the cold space, a plurality of evaporators in heat exchanging relation to said space, a receiver insulated from said space and to which refrigerant condensate is delivered from the condenser of the apparatus, fluid conveying means through which the receiver drains into the evaporators, and holding means for a liquid whose freezing point is above the temperature of the evaporating refrigerant and below a temperature value above which it is desired the temperature of the cold shall not go, said fluid conveying means being arranged in intimate heat exchanging relation to said liquid holding means.

12. In refrigeration apparatus of the intermittent absorption class, in combination with a cabinet enclosing the cold space, a plurality of evaporators in heat exchanging relation to said space, a receiver insulated from said space and to which refrigerant condensate is delivered from the condenser of the apparatus, conduits through which the receiver drains into the evaporators, a receptacle through which each of said conduits extends and containing a liquid whose freezing point is above the temperature of the evaporating

refrigerant and below a temperature value above which it is desired the temperature of the cold space shall not go, a conduit connecting the lowermost parts of the evaporators and constituting a sump into which any liquid within the evaporators may drain, a conduit rising therefrom and joining the evaporator, and a siphon tube having its receiving end disposed within said sump and rising through the last mentioned conduit and through the receiver and leading therefrom over, downwardly and into the generator absorber.

13. In refrigeration apparatus of the intermittent absorption class, in combination with a cabinet enclosing the refrigeration compartment, a receiver situated adjacent the upper portion of said compartment and insulated therefrom and to which the refrigerant condensate is adapted to be delivered from the condenser of the apparatus, said receiver consisting of an elongated vessel, two evaporators consisting of double wall elongated vessels below the receiver and in heat exchanging relation to the refrigeration compartment, the inner walls of said vessels enclosing freezing chambers while the spaces between the inner and outer walls of the respective vessels constitute the refrigerant spaces, elongated receptacles below the plane of the receiver and above the plane of the evaporators, the axes of the receiver, evaporators and said receptacles being substantially parallel, and conduits leading from the lowermost part of one end of the receiver laterally into the corresponding ends of the receptacles and longitudinally through the receptacles and laterally out the other ends thereof to where they join the adjacent ends of the evaporators, said tubes being inclined downwardly throughout their lengths from the receiver to the evaporators so as to drain from the former to the latter, said receptacles being insulated from the refrigeration compartment and containing a liquid whose freezing point is above the temperature of the evaporating refrigerant and below a temperature value above which it is desired the temperature of the freezing chambers shall not go.

14. In refrigeration apparatus of the intermittent absorption class, in combination with a cabinet enclosing the refrigeration compartment, a receiver situated adjacent the upper portion of said compartment and insulated therefrom and to which the refrigerant condensate is adapted to be delivered from the condenser of the apparatus, said receiver consisting of an elongated vessel, two evaporators consisting of double wall elongated vessels below the receiver and in heat exchanging relation to the refrigeration compartment, the inner walls of said vessels enclosing freezing chambers while the spaces between the inner and outer walls of the respective vessels constitute the refrigerant

spaces, elongated receptacles below the plane of the receiver and above the plane of the evaporators, the axes of the receiver, evaporators and said receptacles being substantially parallel, conduits leading from the lowermost part of one end of the receiver laterally into the corresponding ends of the receptacles and longitudinally through the receptacles and laterally out the other ends thereof to where they join the adjacent ends of the evaporators, said tubes being inclined downwardly throughout their lengths from the receiver to the evaporators so as to drain from the former to the latter, said receptacles being insulated from the refrigeration compartment and containing a liquid whose freezing point is above the temperature of the evaporating refrigerant and below a temperature value above which it is desired the temperature of the freezing chambers shall not go, a conduit through which the lowermost portions of the evaporators communicate and constituting a sump into which any liquid in the evaporators drains, another conduit rising therefrom and joining the receiver, and a siphon whose short leg extends downwardly through the receiver and through the last mentioned conduit and terminates in said sump while its long leg terminates in the absorber of the apparatus.

15. In refrigeration apparatus of the class set forth, a cabinet enclosing the refrigeration compartment, an evaporator in the nature of a closed vessel situated within said compartment, a receiver at a higher elevation than the evaporator, a conduit through which communication is established between the receiver and the evaporator and which is arranged to drain toward the latter, and a receptacle containing a cooling agent and arranged in heat exchanging relation to said conduit, the receptacle and the receiver being insulated from the refrigeration compartment.

16. In refrigeration apparatus of the class set forth, the combination of a cabinet enclosing the refrigeration compartment, a double wall vessel within said compartment and enclosing the freezing space, a receiver, a conduit leading from the low part of the receiver to the high part of the space between the walls of said vessel, and a receptacle through which said conduit passes, said receptacle containing a cooling agent, the receiver and said receptacle being insulated from the refrigeration compartment.

17. In refrigeration apparatus of the intermittent absorption class, the combination of a generator-absorber, means for heating the same, a receiver, a delivery conduit leading from the generator-absorber to the receiver, a condenser associated with and incorporating a part of said conduit, a vapor return conduit leading from the receiver to the generator-absorber, an evaporator in the nature

of a closed vessel situated below the plane
of the receiver and above that of the genera-
tor-absorber, a conduit leading from the low
part of the receiver to the high part of the
evaporator and arranged to drain toward
the latter, a receptacle in intimate heat ex-
changing relation to said conduit and con-
taining a cooling agent, and a liquid return
siphon leading from the low part of the
evaporator to the generator absorber.

In testimony whereof, I hereunto affix my
signature.

LEE S. CHADWICK.