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ABSORPTION REFRIGERATION

Filed Jan. 24, 1935

2 Sheets-Sheet 1

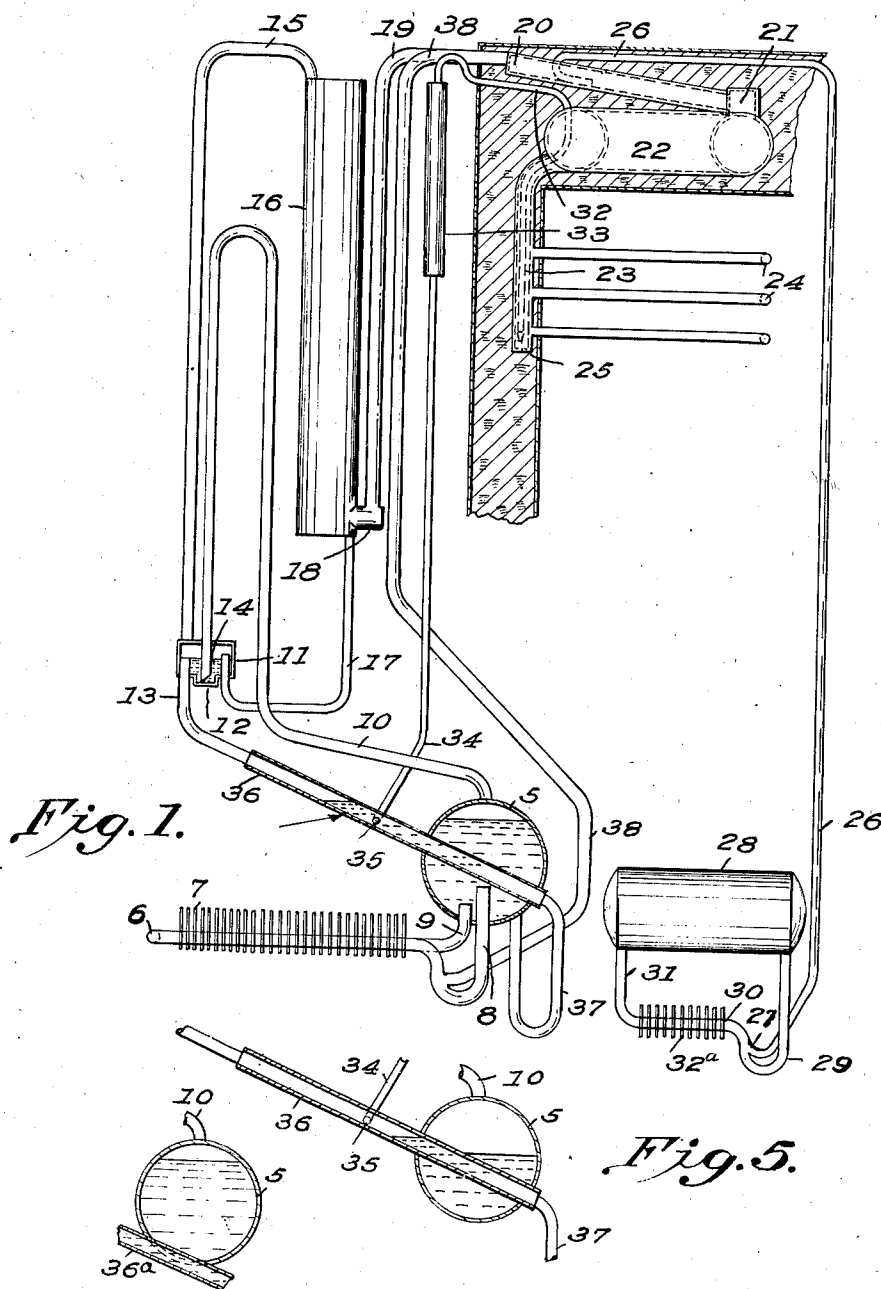


Fig. 1.

Fig. 5.

Fig. 3.

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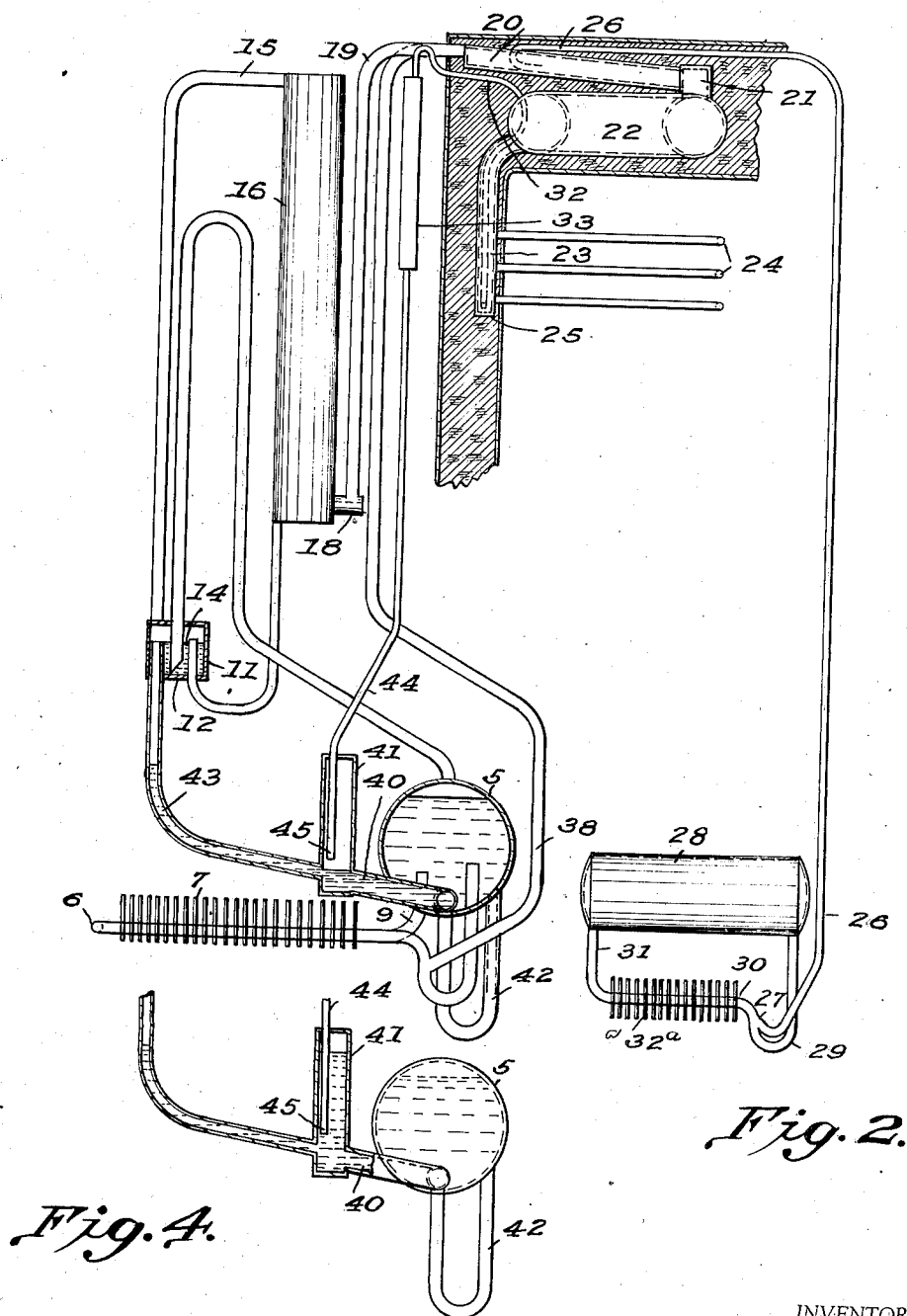


Fig. 2.

Fig. 4.

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ABSORPTION REFRIGERATION

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9 Claims. (Cl. 62—120.5)

This invention relates to an intermittent absorption refrigeration system and, more especially, to an absorption type refrigerator using what is known in the art as a dead end circuit.

There are two distinct and separate types of intermittent absorption refrigeration systems, one known as the 1—2—3 system and the other as the 1—3—2 system.

The 1—2—3 system basically consists of a still absorber, condenser and evaporator connected in operative cycle in the order named.

The 1—3—2 system, or dead end system, basically consists of a still absorber, evaporator and condenser connected in operative cycle in the order named.

The 1—2—3 system is not readily adapted to successful commercial manufacture, due primarily to space limitations of the conventional refrigerating cabinet.

In this system the condenser should be located above the evaporator to permit gravitational flow of condensate to the evaporator. With this arrangement of the system, it is impractical to air cool the condenser for the reason that the condenser would be less efficient when located in the upper portion of the system, than if located near the floor in the cooler air.

It has been found that the freezing coils should be placed in the upper portion of the cabinet in order to provide efficient refrigeration; with the condenser located above the evaporator and freezing coils, the refrigerating compartment would be located near the floor which is inconvenient and annoying. In order to overcome this objection the cabinet would of necessity have to be built much higher than the standard units to meet the requirements of household use.

The 1—3—2 system, on the other hand, lends itself to economical and efficient operation and manufacture, as the condenser may be placed in any convenient location in the cabinet, including the bottom portion thereof, having the benefit in this location of the cool floor air, thus, permitting the refrigerating chamber of the cabinet to be of a convenient height from the floor, whereby articles may be readily inserted or removed without inconvenience.

The 1—3—2 system (which we shall for convenience hereinafter call the dead end circuit) has not met with any great degree of commercial success in the past for two important reasons; the first being the dead end or condenser unit. All dead end circuit systems in the past have used a receptacle or receiver, i. e., the vapor after leaving the generator absorber passed through the

evaporator to the dead end receiver where the vapor was stored (under pressure) and slowly condensed therein. However, if the temperature in the room in which the refrigerator was placed was relatively high a sufficient condensing of the ammonia vapor would be impossible, thereby reducing the charge returned to the evaporator in the form of condensed ammonia or ammonia liquor and allowing the large volume of vapor that did not condense, to return through the system to the still absorber, thus rendering the operation of the unit extremely inefficient.

The second disadvantage of the prior dead end systems was the lack of a correctly timed drain that would clean the freezing tubes and evaporator of condensed water vapor or residue remaining therein after the refrigerating cycle without a condensate wasting over the drain. It should be noted that unless the freezing tubes or the evaporator (depending upon the method used to chill the chamber) are completely cleared of residue liquor, this residual liquor increases or builds up with each refrigerating cycle, until the system becomes completely inoperative. It is, therefore, essential that an effective drain occur at the proper time during the heating or generating cycle, in order to remove any and all of the residue liquor remaining in the freezing coils or evaporator.

A primary object, therefore, of the present invention is to provide a dead end condenser unit, wherein the vapor and condensate circulate therethrough to rapidly and efficiently condense the vapor that enters the condensing unit, thereby insuring a practically complete charge of condensate to return to the evaporator after the heat has been removed from the still and pressure has been reduced in the system, i. e., heat off.

Another object of the present invention is to provide a dead end condenser unit wherein the heat transfer to atmosphere is more rapid than the heat input of the generator absorber.

A further object of this invention is to provide an efficient method of draining the freezing coils and/or evaporator of any residue liquor, that may remain therein after the refrigerating cycle has been completed.

Other objects of the invention will be more fully understood from the following description when taken in connection with the drawings in which:

Fig. 1 is a flow sheet of the dead end intermittent absorption refrigerating system embodying these improvements.

Fig. 2 is a modification of the system shown in Fig. 1.

Figs. 3 and 4 show modification of the secondary still arrangement.

Fig. 5 is a variation of the liquid level with respect to the level shown in Fig. 1.

Referring now to the drawings by numerals and reference, wherein like numerals correspond to like parts, the reference numeral 5 denotes a still absorber, containing a bi-fluid, preferably of ammonia and water in desired proportions.

A burner, (not shown) which may be of any suitable type, such as a gas burner or oil burner or electrical resistance, is located below or in the still absorber. Depending from the bottom of the still absorber and in fluid communication therewith is a horizontal circulatory loop 6 having radiating fins 7 secured thereto. The down-leg 8 of the circulating loop is in the form of a U and extends below the plane of the horizontal section 6, the up-leg 9 leading directly into the still absorber.

The bi-fluid, preferably ammonia-water solution, contained within the still absorber is reduced to a vapor by the application of heat to the still absorber. The boiled-off ammonia vapor passes through inverted U conduit 10 which terminates at or near the bottom of a liquid seal trap 11. A sump 12 is formed in the bottom of the trap 11, into which the conduit 10 terminates.

The liquid level in the trap is maintained approximately intermediate the top and bottom thereof by having the over-flow conduit 13 project upward about midway of the said trap.

The vapor from conduit 10 bubbles through the liquid 14 in the trap 11 and rises into and flows through partially inverted U-shaped conduit 15. This conduit 15 terminates in a rectifier or dehydrator 16 which is preferably formed of concentric tubes joined at their ends having space therebetween; thus, providing the rectifier with large radiating surfaces.

A liquid drain conduit 17, also of U-shape form, has one leg thereof in fluid communication with the bottom of the rectifier 16 and the other leg terminating into the liquid trap 11 at a point slightly above the terminal of conduit 13. A vapor take-off port 18 is in open communication with the rectifier at a point slightly above the bottom portion thereof so that the vapor entering the rectifier 16 is dehydrated of entrained moisture due to condensation on the enlarged radiating surfaces of the rectifier; the water returning to the trap 11 through conduit 17 and thence through conduit 13 to the still absorber. The dehydrated vapor passes through the take-off port 18, flowing through conduit 19 which terminates in the evaporator header 20. This header is preferably inclined downwardly and away from the entry point of conduit 19 and terminates in an evaporator dome 21 formed in the upper portion of the evaporator 22.

Depending from and in open communication with the evaporator 22 are parallel down-legs or freezing coil supply pipes 23. Secured to the down-legs 23 and in open circuit therewith are a plurality of spaced U-shaped horizontal freezing coils 24. As illustrated, one of the supply legs 23 extends below the lowest freezing coil, thus forming a liquid sump 25.

Communicating with the bottom of the evaporator header 20 is a conduit 26, the opposite end of which communicates with a depending circulatory loop 27 of a condenser receiver 28.

The vapor generated flows into the evaporator freezing coils completely filling the same, and causes a small amount of condensation when the

vapor contacts the cold freezing coils, after the vapor in the system has reached a pressure that will permit condensing. Due to the vapor pressure that is rising in the system during the generating period or cycle, the remaining vapor is forced through conduit 26 into the condenser circulatory loop 27 of the condenser receiver 28. The circulatory loop 27 comprises a down-leg 29, which is of U-shaped form, a horizontal section 30 and an up-leg 31. The conduit 26 is directed upwardly and enters the circulatory loop adjacent the horizontal section 30.

The vapor thus circulates through the condenser circulatory loop 30, entering the condenser receiver 28 through the up-leg 31; the vapor traveling through the loop being progressively cooled, condensed and begins to fill the loop 30 with condensate. The force of the incoming vapor carries this condensate with it into the condenser receiver, creating a constant condensation and circulation of condensate and vapor during the entire heating period. Radiating fins 32a may be secured to the horizontal section 30 of the circulatory loop to give large radiating surface providing for rapid heat exchange.

The condenser and circulatory loop therefor are of extreme importance to the safe and economical performance of the system. This structure is claimed in the co-pending application of W. J. Guzik, Serial Number 72,611.

The circulation of the liquefied condensate in the condenser-receiver unit has a direct bearing on the pressure increase of the system. As heat is applied to the still absorber the pressure in the entire system increases during the heating period and would continue to increase or rise provided there was no circulation of the vapor and condensate in the condenser and circulatory loop. During this portion of the cycle, due to this circulation, the heat output of the condenser and circulatory loop is greater than the heat input to the generator absorber during the same portion of the cycle. Notwithstanding that the heat applied to the generator absorber continues, the pressure in the system recedes during the later portion of the generating period.

At the expiration of the generating or heating cycle, i. e., heat off, the condensate stored in the condenser receiver 28 is forced by the pressure created therein up through pipe 26 into the evaporator 22 and freezing coils 24.

A drain conduit 32 is incased in one of the evaporator supply legs 23 and preferably within the leg that is provided with the sump 25, terminating adjacent the bottom portion of the sump.

The drain conduit 32 continues upwardly through the evaporator and is turned downwardly at an elevation approximately that of the point of entry of the conduit 19 into the header 20. This drain conduit 32 terminates in an enlarged section or chamber 33. In open communication with the lower portion of the enlarged chamber 33 is depending pipe section 34 of the drain which terminates at 35 in a secondary still 36.

The secondary still 36 comprises an enlarged inclined pipe section passing through the walls of the primary still-absorber 5. The upper end of the secondary still is in communication with the trap overflow conduit 13, while the lower end of the secondary still is in communication with a U-shaped conduit 37 which leads into the bottom of the primary still.

The point of entry 35, of the drain section 34 75

is below the normal high level of the liquid in the secondary still 36.

As illustrated in Figs. 1 and 5 of the drawings, the liquid levels of the primary and secondary stills cover the entry ports of the drains for a period after heat has been applied to the still-absorber. As heat is applied and vapor is driven off the liquid levels in the primary and secondary stills recede until the lower end of the drain is uncovered as illustrated in Fig. 5. However, the point of entry 35 of the drain section 34 may be located below the low liquid level of the primary and secondary still.

Connected to the up-leg 9 of the still absorber cooling loop 6 and to the evaporator header 20 is a balancing tube 38. The function of this balancing tube 38 is to create a gas return path from the evaporator direct to the loop 6 during the refrigerating period of the cycle.

The action of the drain 34 is of substantial importance to the successful operation of the system and will, therefore, be described in detail.

The draining without over draining of the freezing coils 24 during the initial period of the generating or heating cycle is not only highly desirable but, indeed, quite necessary for an efficient and economical operation of an intermittent absorption refrigerating system.

As before stated, the lower entry point 35 of the drain conduit 34 into the secondary still 36 is below the level of the liquid in the still absorber and secondary still for a period of time during the generating cycle. It will also be noted that the opposite end of the drain conduit 32 projects downwardly through the evaporator and into one of the freezing coil supply legs.

Inasmuch as some residue liquor remains in the freezing coils and supply legs after each refrigerating cycle, and as the end 32 of the drain conduit is immersed in the residue liquor sump 25, a liquid seal is established at each end of the drain conduit at the commencement of the heating cycle; and, further, the residue liquor in the freezing coils and supply legs therefor is relatively cold, while the liquid seal in the secondary still is relatively hot.

The vapor pressure generated in the still absorber during the early period of the heating cycle is obviously greater than the pressure generated in the secondary still during the same period. However, as the pressure on the liquor in the freezing coil supply legs and in the secondary still increases, the liquids in each end are forced toward each other in the drain conduit. As the liquor rises in the opposite ends of the drain conduit, a liquid head is formed and, as the head rises or increases, a greater pressure on the two liquids is required to continue the rise of the liquor.

At the time of the sealing of the drain conduit ends, a low pressure exists throughout the entire system but, as the pressure in the system rises, the pressure in the drain conduit cannot increase in like proportion, due to the resistance set up by the two liquid heads in the ends of the drain conduit, thus maintaining a low pressure area within the drain conduit.

As before stated, there is a temperature differential between the liquid in the upper and lower drain sections, the section leading to the secondary still being of relatively warm rich ammoniacal liquor, while the upper liquid residue from the sump is relatively cool and weak. Consequently, as continued heat is applied to the primary still, there is a heat transfer to the liquid

in the secondary still which causes vapor to be boiled off from the secondary still liquid, which rises in the section 34 of the drain, filling the intermediate section and discharging into the enlarged portion 33. The enlarged section 33 acts as an expansion chamber; thus, maintaining in the drain sections a relatively low pressure during the early portion of the generating cycle, i. e., heat on.

It will be noted that the height of the drain conduit 34 is greater than the height of drain conduit 32. Therefore, as the liquid head in these two sections rises, due to the increasing pressure in the system, it is obvious that the liquor in drain conduit 32 will spill over the apex and fall into the enlarged section 33, thus, draining the freezing coils 24 and supply legs 23.

If a complete drain occurs, the drain conduit 32 is uncovered and permits the vapor to fill the drain sections, obviously pressure balancing the entire system and will remain in balance until the entry of drain conduit 32 is again liquid sealed when the pressures in the system and the drain conduit sections will become unbalanced, i. e., the pressure rise in the system during the generating cycle increases faster than the pressure rise in the drain sections.

If a complete drain does not occur, i. e., if a partial drain takes place, the system does not balance and a subsequent drain may occur, provided sufficient pressure is built up to force the liquor up drain conduit 32 and into the enlarged section.

In the interim vapor is being generated in the secondary still 36, a portion of the vapor entering drain conduit 34 through entry port 35 gradually increasing the pressure in the drain conduit sections until a pressure is built up in the drain sections equal to the pressure in the system. When this occurs a pressure balance is established through the system and no further drain can occur.

A pressure balance may also be obtained by uncovering the drain entry port 35 due to the receding liquid level in the primary and secondary still caused by the boiling off of vapor during the generating cycle as shown in Fig. 5.

Referring to Fig. 3, the secondary still 36a may be located adjacent to outer portion of the primary still, the heat exchange being provided by metal contact.

It will be understood by those skilled in the art that the capacity of the enlarged conduit or chamber 33 governs the time of the drain, that is, by enlarging the capacity of the chamber, the time of the drain is advanced or speeded up, and, by reducing the capacity of the chamber, the time of the drain is retarded.

From this description it is apparent that the draining action can be controlled to occur approximately at a predetermined pressure point and also while the pressure in the system is increasing.

In the modification of the system as disclosed in Figs. 2 and 4, it will be noted that the system is directed to the drain elements and, more particularly to the secondary still.

The secondary still 40, comprising a dome 41 located adjacent the still absorber 5 is in fluid communication therewith through U-shaped conduit 42. As shown, a portion of the secondary still 40 is located below the still absorber and in the heat zone of the still burner. The overflow conduit 43 enters the dome 41 below its high liquid level and at the side thereof. The drain 75

conduit 44 has its entry port 45 located below the high liquid level and enters the dome at the side thereof and may be directed downwardly.

The function of this modified drain is similar to the drain described in Figs. 1 and 5, with the exception that a delayed pressure is built up in the top portion of the dome, which forces the liquid to recede below the drain entry. At the time that the liquid seal recedes below the drain conduit entry, the vapor generated in the dome is liberated into the drain conduit and immediately thereafter the system is in pressure balance and no further drain can occur during that generating cycle.

A drain may occur only during the early part of the generating cycle or until the generated vapor in the dome portion is sufficient to force the liquid therein below the drain conduit, thus, uncovering the drain entry and permitting a balanced system, i. e., relatively equal pressures throughout the system.

What I claim is:—

1. In an intermittent absorption refrigeration apparatus including a primary generator absorber, a secondary generator and an evaporator, a valveless drain back means for draining back residue liquor from the evaporator to the secondary generator thereof, said drain back comprising a conduit with open ends in communication with said secondary generator and the evaporator, said conduit having an enlarged section intermediate its ends, and means adjacent the secondary generator open end of said conduit for expediting uncovering of said end by lowering the liquid away from said end, said means operating to cause uncovering of the said end in advance of the lowering of the liquid level in the primary generator absorber itself by the boiling away of the liquid therein.

2. In an intermittent absorption refrigeration apparatus having a primary generator absorber, a secondary generator and evaporator, valveless drain back means connecting the secondary generator and the evaporator for draining back residue liquid from the latter to the former, said means comprising a conduit having an open lower end in communication with the secondary generator and means cooperating with said open end of said conduit and with the secondary generator for causing the liquid to uncover said open end before the boiling away effect of the liquid in the primary generator absorber would uncover such open end.

3. An intermittent absorption refrigerating apparatus having a primary generator absorber, a secondary generator, an evaporator and valveless drain back means therebetween comprising a conduit with open ends in communication with the secondary generator and the evaporator, and means in proximity to the secondary generator

open end of the conduit for causing said end to be uncovered in advance of the uncovering of said end by the lowering of liquid in the primary generator absorber caused by the boiling away of liquid in the primary generator absorber.

4. In an intermittent absorption refrigerator having a primary generator absorber, evaporator and condenser all connected in operative cycle, a secondary generator having a portion thereof in heat exchange relation with the primary generator absorber and a drain back conduit having one end thereof opening into the lower portion of the evaporator and the other end opening into the secondary generator.

5. In an intermittent absorption refrigerator including a primary generator absorber, a heating unit therefor, and an evaporator and condenser all connected in the order named, a secondary generator having a portion thereof in heat exchange relation with the heating unit, a circulatory coil below the generator absorber in fluid communication therewith, one end of the secondary generator being in open communication with said circulatory coil and a drain back conduit in open communication with the evaporator and the said secondary generator.

6. An intermittent absorption refrigerator as claimed in claim 5 wherein the said drain back is provided with an enlarged intermediate section.

7. In an intermittent absorption refrigerator including a primary generator absorber, a heating unit therefor, an evaporator and condenser all connected in operative relation, a secondary generator having a portion thereof in heat exchange relation with the heating unit, the lower end of said portion being formed in a depending U shape and terminating in open communication with the primary generator-absorber, a dome section being provided at the opposite end of said secondary generator and a drain back conduit in open communication with the said evaporator and the said dome of the secondary generator.

8. An intermittent absorption refrigerator as claimed in claim 7 wherein the said drain back is provided with an enlarged intermediate section.

9. In an intermittent absorption refrigerator including a primary generator-absorber, evaporator and condenser, a secondary generator including a dome section and having a depending U shaped section in open communication with the said generator-absorber, a drain back conduit in open communication with the evaporator and the dome section of the secondary generator whereby the lower end of said drain back is uncovered by a drop in liquid level due to the building up of pressure in said dome during the early part of the generating cycle.

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