Aug. 21, 1928. 1,681,254

S. OTTO ET AL

EVAPORATOR FOR REFRIGERATING APPARATUS

Filed Oct. 23, 1926 2 Sheets-Sheet

Fig. 1.

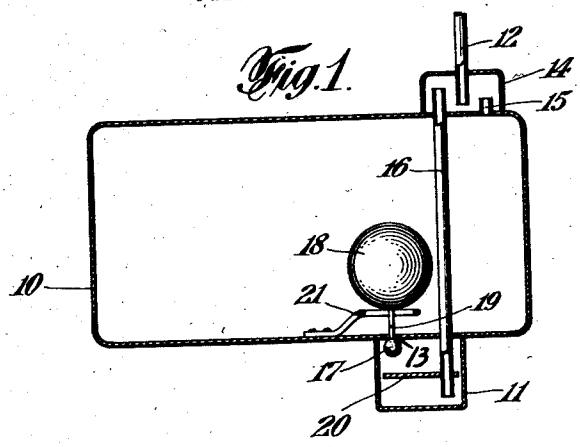


Fig. 2.

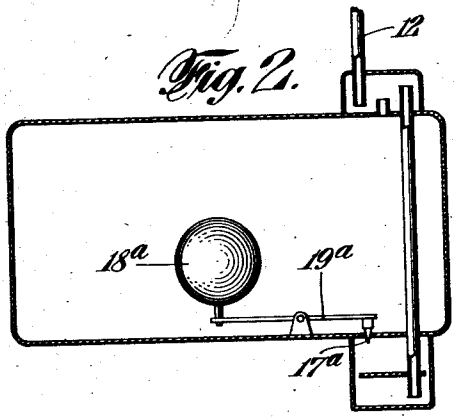
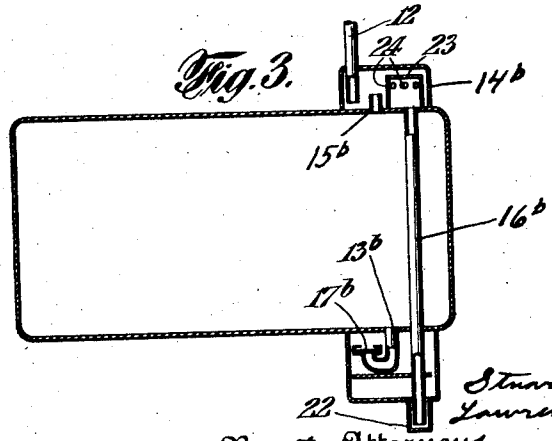


Fig. 3.



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Fig. 4.

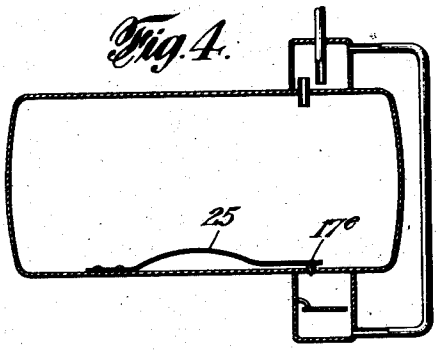


Fig. 7.

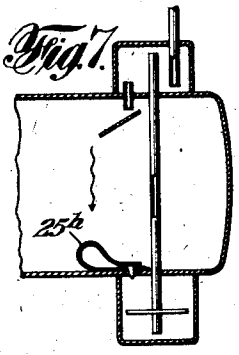


Fig. 5.

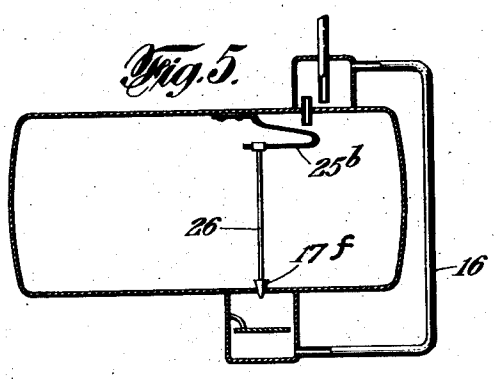


Fig. 8.

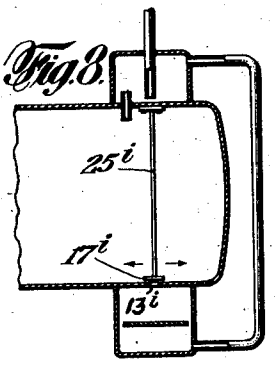


Fig. 6.

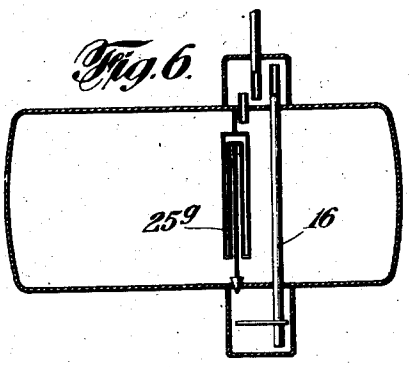
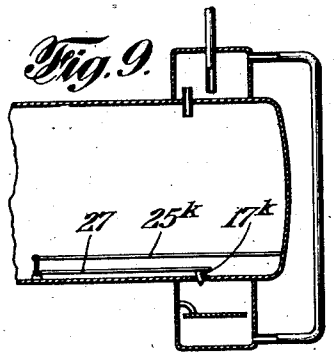


Fig. 9.



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Patented Aug. 21, 1928. 1,681,254

UNITED STATES PATENT OFFICE.

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EVAPORATOR FOR REFRIGERATING APPARATUS.

Application filed October 23, 1926. Serial No. 143,549.

This invention relates to refrigerating apparatus of the absorption type and more particularly to the evaporator in which the volatile refrigerant is evaporated, and from which the gas is delivered to the absorber.

In a common form of apparatus of this type, the refrigerant is alternately absorbed in and driven off from a liquid of very much higher boiling point, by the alternate cooling and heating of said liquid. During the heating period the pressure of the refrigerant gas is raised to such a point that it liquefies in a condenser and flows in liquid form to the evaporator. It often happens that a small amount of the absorbent liquid is also evaporated during the heating period and passes over to the evaporator to remain there as a residue at the end of the absorbing or cooling period, as it is not volatile to any considerable extent at the low temperature existing in the evaporator during said absorbing period. If additional liquid is delivered to the evaporator during each heating period and such liquid is not returned to the evaporator, a condition will eventually be reached where the evaporator does not operate efficiently, due to the reduced amount of liquid in the absorber and the accumulation of such substantially non-volatile liquid in the evaporator, thereby weakening the volatilization of the refrigerant.

The present invention has for its main object to effect the automatic return of liquid from the evaporator to the absorber, during each cycle of operation, and to thereby maintain at all times the proper operating conditions.

The invention is an improvement on the apparatus disclosed and broadly claimed in the Otto and Jankus Patent 1,582,882, issued April 27th, 1926, in which the evaporator is provided with a sump in which the substantially non-volatile absorbent liquid may collect and from which it is returned by gas pressure to the absorber during the absorbing or cooling period.

As an important feature of the present invention, there is provided a valve for controlling the communication between the body of the evaporator and the sump. This valve is automatically operated so that it will be closed during at least a part of the cooling period, whereby the sump itself may serve as the pressure chamber and the pressure generated in the sump cannot be relieved except by forcing the liquid out of the sump to a point from which it will be returned to the absorber.

In the ordinary refrigerating system the refrigerant commonly employed is ammonia and the absorbent liquid is water. The water is heavier than the solution of ammonia in water and such solution is heavier than anhydrous liquid ammonia. Therefore, the liquid in the evaporator will ordinarily have a higher percentage of water at the bottom of the evaporator than at the top, if it is not stirred up. Furthermore, as the ammonia evaporates from the evaporator the percentage of water in the residue increases. At the end of the evaporating period the remaining liquid in the evaporator will include all of the water which has passed over to the evaporator and it is this residue which has collected in the sump and which must be returned to the absorber. As one important feature of the present invention, there is provided a baffle plate in the sump, so as to prevent agitation of liquid in the sump and facilitate stratification, whereby the liquid containing the largest percentage of water will accumulate at the bottom of the sump for return to the absorber.

As a further important feature, the control valve between the sump and the body of the evaporator is operated by a float, which does not permit the valve to open until the liquid in the evaporator has been reduced to a comparatively small quantity so that the percentage of ammonia in the liquid admitted to the sump is reduced as low as possible. This float also acts to close the valve as liquefied refrigerant accumulates in the evaporator during the heating period, thus the comparatively pure anhydrous ammonia delivered from the absorber does not mix with the watery liquid in the sump.

As a further important feature, the control valve is operated by thermostatic means, whereby during the evaporating period when the temperature in the evaporator is the lowest, the valve is kept closed and does not open

for admission of liquid to the sump until about the end of the evaporating period, when the temperature rises.

Other features of importance will be pointed out hereinafter, or will be apparent from a consideration of the specific forms illustrated in the accompanying drawings.

In these drawings:

Figure 1 is a vertical section through an evaporator embodying features constructed in accordance with the present invention, and

Figures 2 to 9, inclusive, are similar sections showing other forms.

The evaporator illustrated in Figure 1 includes a main body portion 10 communicating with the lower part of which there is a sump, depression or auxiliary chamber 11. The evaporator serves as a receiver for liquefied gas delivered through a conduit 12, and this conduit serves for the return flow of the gas resulting from the evaporation of the refrigerant in the evaporator.

The main body portion 10 of the evaporator is illustrated in its simplest form, as a drum or cylinder, but neither this form nor the details of construction of the body portion form any part of the present invention, as the body portion of the evaporator may be of any desired type and may include a plurality of compartments, heat absorbing coils or other features commonly employed in evaporators. The evaporator may be designed for use in direct contact with the air in the upper part of the refrigerator or may be immersed in or jacketed by a brine chamber to render the temperature in the box more nearly uniform during the heating and cooling periods of the cycle of operations.

The conduit 12 may be supplied with liquefied refrigerant from any suitable source and may deliver the gaseous refrigerant to any suitable absorber. There may be employed a combined boiler-absorber, a condenser and piping arrangement, such, for instance, as shown in the Otto and Jankus Patent 1,582,882, above referred to.

In the construction here illustrated, the sump 11 is connected to the body portion 10 of the evaporator, at the lower part of the latter, by a passage 13, through which liquid may drain into the sump from the body of the evaporator. At the upper part of the evaporator there is provided a cup or chamber 14, which is in open communication with the upper part of the body of the evaporator. The cup is shown as placed on top of the body instead of within it, although this is not essential, and the communication between the cup and the body portion is shown as a conduit 15 which terminates at a point above the bottom of the cup, so that liquid may accumulate in the cup and overflow through conduit 15.

The conduit 12 leads into this cup and terminates at a point below the upper end of the conduit 15. A third conduit 16 leads from the upper portion of the cup 14 to the lower portion of the sump 11 but does not directly communicate with the body of the evaporator. This conduit 16 preferably extends through the evaporator so as to prevent the direct absorption of heat by the conduit and the boiling of liquid therein. The parts so far referred to in detail are similar in function to the corresponding parts in the Otto and Jankus patent and, so far as concerns certain features of our invention, may be constructed exactly as shown in said patent.

As one important feature of the construction illustrated there is provided a valve 17, for controlling the passage 13, and this is connected to means which operates to open and close the valve in accordance with the conditions in the body of the evaporator. The valve 17 is shown as of the ball type, movable downwardly to open, and connected to a float 18 within the body of the evaporator. The connecting means is shown as a stem 19 which may be flexible or rigid. The float has a comparatively small range of movement within the evaporator, so that when the evaporator is filled, as at the end of the heating period, the float exerts a comparatively strong upward pull on the valve 17 to keep the latter tightly closed. The float 18 or the stem 19 may be guided in any suitable manner, as, for instance, by a bracket 21 which serves as a seat for the float when the latter is in lowermost position.

In the operation of the apparatus the strong liquor is heated in the boiler-absorber or other heating vessel and the refrigerant gas, which is driven off, is cooled in a condenser and liquefied due to the existing pressure. The liquefied gas, together with any condensed water vapor which may pass over with it, enters the evaporator through the conduit 12 and overflows from the cup 14 through the conduit 15 to the body of the evaporator. At the end of the heating period the boiler-absorber is cooled or other change is effected whereby the pressure in the evaporator is lowered and the liquefied refrigerant in the body of the evaporator is permitted to evaporate and pass through the conduit 15, the cup 14 and the conduit 12 to the boiler-absorber or other vessel in which the gas is absorbed. During this absorbing or cooling period the refrigerant will evaporate to produce the desired refrigerating effect. Water which may have been carried over into the evaporator will not evaporate, at least to any appreciable extent. Toward the end of the evaporating period the level in the body of the evaporator will reach such a point that the float 18 will permit the valve 17 to open and the residual liquid or a portion thereof will drain into the sump 11. At the end of the evaporating period all of the residual liquid may be in the sump or there may still be a

small amount of liquid in the evaporator. After the valve opens the further evaporation of liquid in the sump does not force liquid up the conduit 16 as the gas may freely escape through the passage 13.

The operating conditions are then reversed and the gas is again driven off from the absorber, reliquefied and returned to the body of the evaporator. As the level rises the float closes the valve 17 so that the watery liquid in the sump will not become mixed with the fresh, substantially anhydrous ammonia which is being delivered from the condenser.

At the beginning of the cooling or evaporating period, when the pressure in the evaporator is reduced, evaporation will take place not only in the body of the evaporator but also in the sump. The evaporation in the sump may not begin at the beginning of the evaporating period, due to the larger percentage of water in the liquid in the sump and the slightly higher pressure, but this liquid will contain enough ammonia so that at the reduced pressure there will be sufficient evaporation to develop gas pressure in the sump. This gas pressure cannot escape except by forcing the liquid out of the sump through the conduit 16 to the cup 14. As the liquid accumulates in the cup it will close the lower end of the conduit 12 and this liquid will be sucked out of the cup by the conduit 12. This operation will continue, possibly intermittently, until substantially all of the liquid in the sump 11 has been forced up into the cup 14 and returned to the absorber. Thus, during each cycle of operations residual liquid is collected in the sump and later returned from the sump without passing into the refrigerant in the body of the evaporator.

To facilitate stratification in the sump and to prevent the final portion of the liquid entering the sump from mixing with the liquid in the bottom of the sump which had not been returned during the preceding cycle and which is therefore presumably richer in water, there is provided a baffle 20, disposed in a substantially horizontal plane in the sump, intermediate of the upper and lower ends. This baffle is so constructed or positioned that liquid may flow past it but it substantially prevents convection currents or intermixing of the bodies of liquid above and below the baffle.

The construction illustrated in Figure 2 is substantially the same as illustrated in Figure 1, except that the float 18^a is connected to the valve 17^a by a lever 19^a. The lever is pivoted intermediate of its ends and thus the valve opens upwardly rather than downwardly as in Figure 1.

In Figure 3 there is provided a gravity operated type of valve. The communication between the lower part of the body of the evaporator and the sump is in the form of a J pipe 13^b. The upturned free end of this pipe has a disk valve 17^b which seats by gravity to close the end of the pipe. The disk is light to permit liquid to flow through the pipe 13^b into the sump when the latter is empty, but seats at all times when the pressure in the sump is equal to or more than in the body of the evaporator. As soon as evaporation begins a gas pressure develops in the sump, the valve which has closed by gravity prevents the liquid in the lower part of the sump from being forced out except through the conduit 16, as hereinbefore described.

This construction shows as an additional feature a cup 22 at the lower part of the sump and into which the conduit 16^b extends. This cup is of very much smaller cross-sectional area than the body of the sump. It insures substantially complete removal of liquid from the sump during the evaporating period and it also permits the valve 17^b to be opened by a lower pressure in the J pipe than would otherwise be required.

As an additional feature, which may be applied to any of the forms here illustrated, the upper end of the pipe 16^b is shown as communicating with a dome 23 in the cup 14^b. This dome constitutes a mere enlargement of the conduit 16 and has apertures 24 in the sides thereof above the upper end of conduit 15^b. The chamber 23 retains an amount of liquid which seals the upper end of the conduit 16^b and thus prevents delivery of further quantities of liquid past the valve 17^b, and the surging of these liquids up into the cup 14 at frequent intervals during the normal operation. The weight of the liquid in the conduit 16 will overcome the pressure exerted on the valve 17^b through the J pipe so that the valve remains closed until the liquid in the main chamber of the evaporator has evaporated.

In Figures 4 to 9, inclusive, there are illustrated other constructions in which instead of relying upon a float or the action of gravity, the automatic valve operating mechanism is operated thermostatically.

In Figure 4, a bar 25 is secured to the bottom of the receiver and to the valve 17^e. This bar is made of materials or bimetallic strips which upon being heated above a predetermined temperature will bend to open the valve 17^e and when cooled below that temperature will bend in the opposite direction and close the valve. The lower the temperature below said critical point the greater will be the force exerted to hold the valve to its seat. This bar 25 lies along the lower portion of the chamber so as to be subjected to the temperature of the liquid in the bottom of the receiver.

In Figure 5 a thermostatic bar 25^b is secured to the top of the chamber and is connected to a long valve stem 26 connected to the valve 17^f controlling the entrance to the sump. It straightens on cooling to open the

valve. This thermostatic bar 25^b is entirely within the upper part of the chamber so as to be subjected to the temperature at that point.

In Figure 6 the thermostatic element 25^g is made up of parallel rods, one secured to the top of the receiver and another having a different coefficient of expansion to the valve at the bottom of the receiver, so that by their differential expansion they open and close the valve. A thermostatic element of this kind is subjected to the temperature existing throughout the height of the receiver.

In Figure 7 there is employed a thermostatic element 25^h similar in operation and position to that shown in Figure 4 except that it is bowed and the valve seat is in one end of the element. Thus the relation to the valve and its seat may be determined or regulated before the parts are put into the chamber. Its ends separate on heating, rather than coming together as in Figure 5.

In Figure 8 the thermostatic bimetallic element 25^i is secured to the top of the receiver and the lower end carries the valve 17^i. The valve and valve seat are so constructed that variation in temperature sways the lower end of the element 25^i to move the valve into or out of registry with the valve port 13^i.

In Figure 9 the valve 17^k is secured to a bell crank lever 27 and the short arm of this lever is connected to a thermostatic element 25^k which upon expanding tilts the lever to open the valve. This rod 25^k is not of bimetallic strips as in the other forms. This is subjected to the action of the fluid in the lower part of the receiver the same as in Figures 4 and 7.

In Figures 4, 5, 8 and 9, the conduit 16 which leads from the bottom of the sump to the upper part of the cup is placed outside of the receiver, whereas in Figures 1, 2, 3 and 7 it is placed inside. The conduit may be in either position with any of the forms illustrated, although to prevent boiling in the conduit it is preferable that it be inside the receiver.

In any of the forms illustrated the sump may have a tube extending down a short distance from the liquid entrance opening, so that the space in the sump above the lower open end of such tube constitutes a pressure chamber from which gas cannot escape if the valve be open.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. An evaporator for absorption refrigerating apparatus, having a sump, a liquid inlet to the upper part of the sump, a liquid outlet from the lower part of the sump, a baffle between said upper and lower parts, and means for preventing the escape of gas from said sump through said inlet whereby increase of gas pressure in said sump forces liquid through said outlet.

2. An evaporator for absorption refrigerating apparatus, including an evaporation chamber, a sump in communication with the lower part of the evaporator, an outlet conduit leading from the lower part of said sump, and means for controlling communication between said evaporator and said sump, whereby unevaporated liquid residue may flow from said chamber into said sump only during a limited interval in the cycle of operations at the end of the evaporating period and the beginning of the refilling period, and thereafter gases generated in the sump by evaporation of liquid therein force liquid out of said sump through said conduit.

3. An evaporator for absorption refrigerating apparatus, including an evaporation chamber, a sump in communication with the lower part of the evaporator, an outlet conduit leading from the lower part of said sump, a valve between said evaporator and said sump, and a float for controlling said valve, said float operating to open the valve only when the liquid level is low in said evaporation chamber.

4. An evaporator for absorption refrigerating apparatus, including an evaporation chamber, a sump in communication with the lower part of the evaporator, an outlet conduit leading from the lower part of said sump, a normally closed communication between said evaporator and said sump whereby gas pressure in said sump may force liquid therefrom through said conduit, and means for intermittently opening said communication to permit a limited quantity of unevaporated liquid residue to flow from said chamber into said sump.

5. An evaporator for refrigerating apparatus of the intermittently operating absorption type, including an evaporation chamber adapted to receive liquid refrigerant from a boiler-absorber and return gasified refrigerant thereto, and means for intermittently returning unevaporated liquid from said evaporator to the boiler-absorber, including a comparatively small chamber, a delivery conduit leading therefrom, means for delivering liquid from said evaporation chamber to said small chamber only when the level of the liquid in the evaporation chamber is low, and preventing return flow when the liquid level is high, whereby gas pressure generated in said small chamber causes a delivery of liquid from said small chamber through said conduit during the evaporation period.

6. An evaporator for refrigerating apparatus of the intermittently operating absorption type, including an evaporation chamber, a small collecting chamber for unevaporated liquid residue, a communication between the lower portion of said evaporation chamber

and the upper part of said collection chamber, a delivery conduit leading from the lower portion of said collection chamber, and means whereby liquid residue may freely flow from said evaporation chamber to said collection chamber during a limited interval at the end of the evaporating period and the beginning of the refilling period, and the return of said residue liquid to the evaporation chamber is prevented.

Signed at Brooklyn, in the county of Kings and State of New York, this 19 day of October, 1926.

STUART OTTO.
LAWRENCE BRUEHL.