

Aug. 11, 1931.

D. G. SMELLIE

1,818,587

REFRIGERATION

Filed Feb. 21, 1927

2 Sheets-Sheet 1

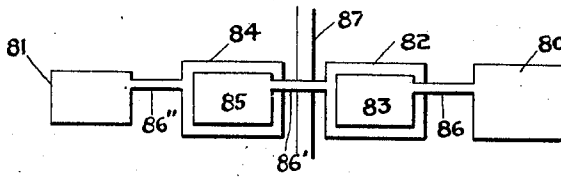


Fig. 1.

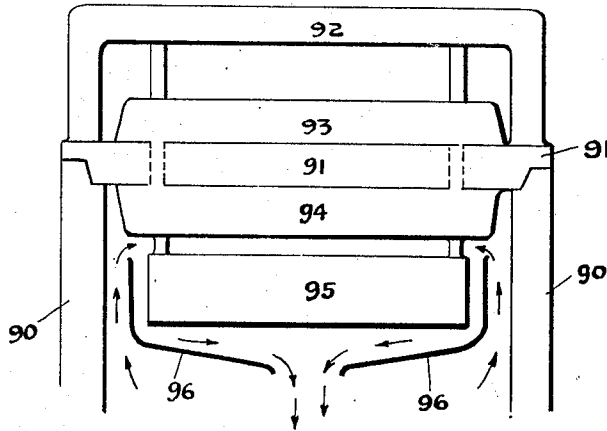


Fig. 2.

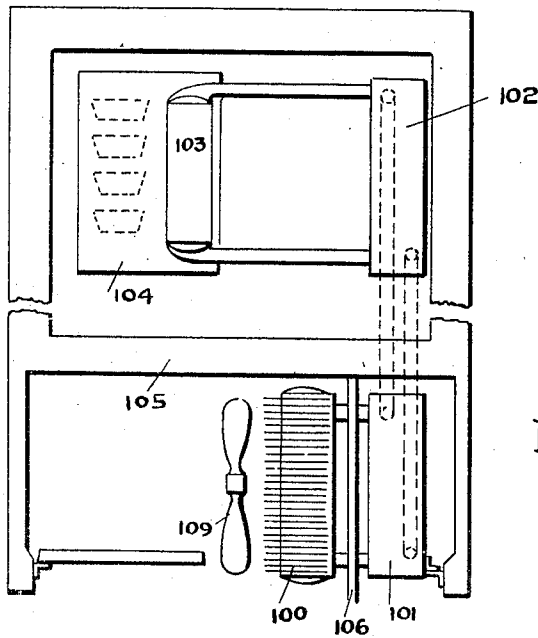


Fig. 3.

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2 Sheets-Sheet 2

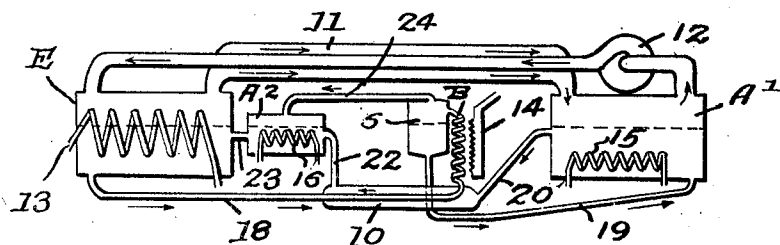


Fig. 4.

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REFRIGERATION

Application filed February 21, 1927. Serial No. 169,765.

This invention relates to an absorption refrigerating apparatus and more particularly to an arrangement for efficiently and economically producing relatively low temperature by a series of refrigerating units.

In investigating apparatuses for producing refrigeration, it has been found, particularly in connection with systems designed to operate at relatively low pressures, that it is necessary in order to obtain relatively low temperatures that a plurality of units be operated in series. The operation of a plurality of absorption refrigerating units in series, so that the cooling means of one takes up heat from the heat dissipating means of another, has been found to be advantageous in connection with refrigerating systems of the resorber type like that disclosed in U. S. patent to Altenkirch No. 1,767,639 patented June 24, 1930, for example, and also in connection with apparatus of the type described in my co-pending application, Serial No. 490,497 for absorption refrigeration, filed October 22, 1930, which application is a continuation in part of the present case.

It is an object of the present invention to so arrange a series of absorption refrigerating units in a refrigerator box or cabinet of the household kind, as to provide for an effective heat transfer from the inside of the cabinet to the exterior, while causing each unit to transfer heat over a relatively small temperature range, for which it is particularly adapted.

Other objects and advantages will be apparent from the following description taken in connection with the accompanying drawing, in which:

Figure 1 is a diagrammatic illustration of a preferred arrangement of three refrigerating units mounted in a refrigerator box;

Figure 2 is a diagrammatic illustration of an arrangement for mounting three units connected in series in a refrigerator cabinet of the household type;

Figure 3 is a diagrammatic illustration of a modified arrangement, and

Figure 4 is a diagrammatic representation of a refrigerating unit suitable for use as the refrigerating units of Figures 1 to 3.

Referring first to Figure 1, an arrangement is shown in which three separate units are employed, the first unit consisting of an absorber or other heat dissipating means 80, operatively connected as represented by the connection 86 to an evaporator or other cooling means 83; the next unit comprising an absorber or other heat dissipating means 82, connection 86' and the cooling means 85; while the last unit comprises an absorber or other heat dissipating means 84, cooling means 81 and connection 86''. Each of these units may be similar to the arrangement shown in Figure 4 and described below, or like the unit described in the co-pending application, Serial No. 490,497, or any other small sized, compact absorption refrigerating system. By providing an insulating wall as indicated at 87 in Figure 1, or by enclosing the portion of the system on the left hand side of this wall as shown in Figure 1, the difference in temperature between the atmosphere or other substance to be cooled surrounding the unit 81—84, and that on the right hand side of the partition 87 may be maintained. With such an arrangement the inside unit 81—84 is the initial heat absorber within the refrigerator space; the outside unit 83—80 finally dissipating the heat units into the surrounding air; and the intermediate unit 85—82 forming a connecting link between the two. The devices designated 81, 85 and 83 are evaporators similar to the evaporator designated 20 in Figure 4, and the devices designated 84, 82 and 80 are absorbers similar to the absorber 21 of Figure 4, while the connections designated 86, 86' and 86'' diagrammatically represent the accessory part essential to complete the various refrigerating units.

The evaporator 85 is associated with the absorber 84 to form a cooling system therefor, and evaporator 83 is associated with and cools the absorber 82. It is now obvious that during the operating of the unit thus connected, heat will pass from the inside of the refrigerator box into the evaporator 81 at a low temperature, then in turn through the absorber 84, evaporator 85, absorber 82, evaporator 83 and absorber 80, be finally dis-

sipated into the surrounding air or other cooling medium at a high temperature.

In an arrangement of this order various units should preferably be designed relative to each other so that the mean temperature between absorber-evaporator 84—85 is substantially the same or lower than normal temperature within the refrigerator box; while the mean temperature of the absorber generator 82—83 should be substantially the same or higher than the normal temperature surrounding the refrigerator box; the outside unit 83—80 should be designed so that the absorber 80 will operate at the highest practical temperature so that rapid dissipation of heat units into the surrounding air will be had; while the inside unit 81—84 should be designed so that the evaporator 81 will operate at the lowest temperature feasible so that rapid absorption of heat units from within the refrigerator box will be had.

By thus arranging and designing various units, the heat insulating casings for the various elements will to a great extent be obviated.

In Figure 2 an arrangement is diagrammatically shown illustrating the application of this invention to a refrigerator box of the ordinary household type, and in this figure 90 indicates the side walls thereof. A separate top 91 is adapted to seat on the top of the side wall.

Mounted entirely on this removable top 91 is a refrigerating system such as is described in connection with Figure 1, and having the same general arrangement.

In Figure 2 the removable top 91 corresponds to the refrigerator or insulating wall 87 of Figure 1. Likewise the elements 92 correspond to the absorber 80, the element 93 to the absorber-evaporator 82—83, the element 94 to the absorber-evaporator 84—85, and the element 95 to the evaporator 81. The mode of operation as well as the design of the various units making up this assembly may be the same as are described in connection with Figure 1. A deflector 96 is shown in Figure 2 and provides means for causing air to circulate around the elements 94 and 95 as indicated by the arrows.

In Figure 3 an arrangement is diagrammatically shown for illustrating how the invention may be applied in a slightly different way from that illustrated in Figure 2. In this arrangement the refrigerator space proper takes up only the upper portion of the cabinet, while the lower portion thereof forms an enclosure for those elements of the refrigerating unit which should be outside of the refrigerator space. In this arrangement the partition 105 corresponds to the insulating wall 87 of Figure 1. Likewise the element 100 corresponds to the absorber 80 of Figure 1, the element 101 to the absorber-evaporator 82—83, the element 102 to the

absorber-evaporator 84—85 and the element 103 to the evaporator 81. Here again the mode of operation and the design of the various elements should be the same as that described in connection with Figure 1. However, here the evaporator 103 is shown as enclosed in a brine tank 104 and a fan 109, which of course must be suitably mounted and driven, is also provided for cooling the absorber 100. A partition 106 is shown to shield the absorber-evaporator 101 against any hot air which may be blown in that direction by the fan 109.

Figure 4 illustrates an apparatus having an evaporator and an absorber, and which may be conveniently used for the individual units making up the systems shown in Figures 1 to 3 inclusive. The apparatus of Figure 4 consists of an evaporator E, a boiler or generator in the form of a coil as shown at B, a gas separating chamber S, two absorbers A¹ and A², two heat exchangers, one for the solution designated by the reference character 10, and one for the gas designated by the numeral 11. A fan or blower for circulating the gases in heat exchanger 11 is shown at 12. These various devices may be of any suitable well-known construction, and are connected by pipes as shown.

The evaporator E may be provided with a coil as is shown at 13, for conducting heat from a device to be cooled to evaporator to circulate brine or the like therethrough. It is, of course, to be understood that the invention is not limited to this indirect manner of cooling, but the evaporator may be placed in an icebox or the like, so as to cool it directly.

The boiler B is in the form of a small coil of pipes which may be heated by an electric heater, such as is shown at 14 or by a gas flame or other suitable source of heat. This coil not only acts to expel gas from the solution therein, but also acts as a pump. For a full disclosure of this device reference may be made to Altenkirch Patent 1,728,742. Both absorber A¹ and A² may be provided with coils such as are shown at 15 and 16 for conveying heat away therefrom by circulating cooling water through them. Obviously other forms of water cooled absorbers may be used, such as those in which the water is circulated through a jacket around the body of the absorber, or if desired the absorbers may be air cooled, in which case suitable heat radiating fins should be placed upon them.

As shown the separator may be an ordinary vessel. In addition to the heat supplied to the boiler B, heat may also be supplied to separator S by a gas flame or the like if desired.

The heat exchangers may be of any conventional type. As shown they are made up of two concentrically disposed pipes so that the heat may readily be conveyed from the

fluid in one to the fluid in the other. Fan 12 may be of any suitable construction and driven by an electric motor or the like.

The apparatus shown in Figure 4 operates as follows:

Assume that a quantity of aqua ammonia of a concentration, say of between 20 and 40 percent has been placed in the apparatus through suitable charging valves, not shown, until it has filled the heat exchanger and the lower half of the evaporator E, absorbers A¹ and A², boiler B and separator S, and that air is in the remainder of the machine at approximately atmospheric pressure. Upon heat being supplied to the boiler B and upon the fan 12 being started, gases will circulate from the evaporator through the outer conduit of the heat exchanger 11 into the absorber A¹ and back to the evaporator through the fan 12, and inner conduit of the heat exchanger 11. Circulation of the absorption solution will also begin because of the formation of bubbles in the boiler B. The solution circulation is as follows: from the evaporator E through the conduit 18, boiler B, gas separating chamber S, conduit 19, absorber A¹, conduit 20, outer conduit of the heat exchanger 10, conduit 22, absorber A², conduit 23 back into the evaporator.

As the solution is circulated by the novel action of the boiler referred to ammonia is expelled therefrom, and as this ammonia gas separates from the liquid in the separating chamber S it passes through the conduit 24 into the absorber A². The solution thus weakened is conveyed from the separator through the conduit 19 into the absorber A¹ where it comes in contact with the inert gas such as air (or hydrogen) which is laden with ammonia gas from the evaporator and at the temperature prevailing in the absorber A¹. The weak solution picks up and absorbs the ammonia out of the inert gas. It is, of course, obvious that if refrigeration is to be produced evaporation of the refrigerant in the evaporator E must take place at a lower temperature than that at which it is absorbed in the absorber A¹. It is therefore necessary that the solution conveyed through the absorber be considerably weaker than that in the evaporator since the total pressure in the two is the same. The function of the boiler B is to weaken the solution to enable it to pick up ammonia in the absorber A¹. The solution in the absorber A¹ after being strengthened is conveyed through the conduit 20, outer conduit of the heat exchanger 10, conduit 22, into the absorber A². Now in the absorber A², as well as in the separator S conduit 24 and boiler B, there is no inert gas. Thus in the evaporator and in the absorber A¹ the ammonia partial pressure is less than the total pressure in the machine by the amount of the inert gas partial pressure therein, while the ammonia vapor

pressure in the boiler and absorber A² is approximately equal to the total pressure in the machine. Under these conditions the solution entering the absorber A² may pick up an additional amount of ammonia gas, this amount being conveyed from the boiler through the conduit 24. This solution, which is the strongest in any part of the apparatus, is then conveyed to the evaporator through the conduit 23 and evaporation again takes place to the inert gas as recited above.

It will be obvious from the description of Figure 4 that where an apparatus of this type is used as a refrigerating unit in the arrangement of Figure 1, the absorber A¹ occupies the place of the absorber 80 of Figure 1, while the evaporator E takes the place of the elements designated 83 of Figure 1, and so on for the various units there shown. When so used in connection with Figure 1 it will probably be unnecessary to provide coils as indicated at 13 and 15 of Figure 4.

It is to be understood that the arrangement of Figure 4 merely indicates one way of carrying out the invention illustrated in Figures 1 to 3. The particular refrigerating unit of Figure 4 forms no part of the present invention, but is more fully described and claimed in my co-pending application Serial No. 490,497 referred to above.

While it is preferable to operate the devices herein disclosed at substantially atmospheric pressure, the invention is not limited in this respect. Any suitable refrigerating unit designed for high capacity and operating to transfer heat over relatively small temperature differences may be used to advantage by connecting a plurality of the units in series in accordance with the principles of this invention. It is therefore to be understood that various changes may be made in the arrangement and construction of parts and in the form of the individual units employed without departing from the spirit of the invention or the scope of the annexed claims.

I claim:

1. In a refrigerating system, the combination of a refrigerating enclosure and a series of absorption refrigerating units each having a heat absorbing station and a heat dissipating station, the initial absorbing station of the series being located within said enclosure and the final dissipating station being located outside of said enclosure, and each of the other absorbing stations being arranged in connection with a contemporary dissipating station to form an effective heat transferring unit and thereby creating a unitary refrigerating system.

2. In a refrigerator comprising an enclosure, an absorption refrigerating unit arranged to form substantially the upper wall of said enclosure, the heat absorbing element of the unit being stationed within said en-

closure and the element for dissipating the heat being stationed at a relatively higher elevation and outside of said enclosure, thereby forming an arrangement in which the heat units have a general upward movement in passing from within said enclosure until the point of final dissipation into the atmosphere is reached.

3. In a refrigerator comprising an enclosure, and a series of absorption refrigerating units arranged in cascade and mounted, in relation to said enclosure, with the initial heat absorbing element inside thereof and the element through which the heat is finally dissipated into the atmosphere outside thereof, the dissipating end being at a higher elevation, relative to the absorbing element, and the intermediate elements, which contribute to form said series, being in such relation with the interior and exterior of said enclosure so that the normal temperature of the surrounding atmosphere is substantially the same as the mean temperature at which such intermediate elements operate.

4. In a refrigerator comprising an upper compartment and a lower compartment, a brine tank is said upper compartment, a primary absorption refrigerating unit in said upper compartment and arranged to extract heat units from said brine tank, an intermediate refrigerating unit extending through the partition wall between said upper and lower compartments and arranged to operate as a cooling system for said primary refrigerating unit and in addition extract heat units from said upper compartment, a secondary refrigerating unit in said lower compartment and arranged to operate as a cooling system for said intermediate refrigerating unit, and means for cooling said secondary refrigerating unit.

Signed at Chicago, in the county of Cook, and State of Illinois, this 26th day of November, 1926.

DONALD G. SMELLIE.