

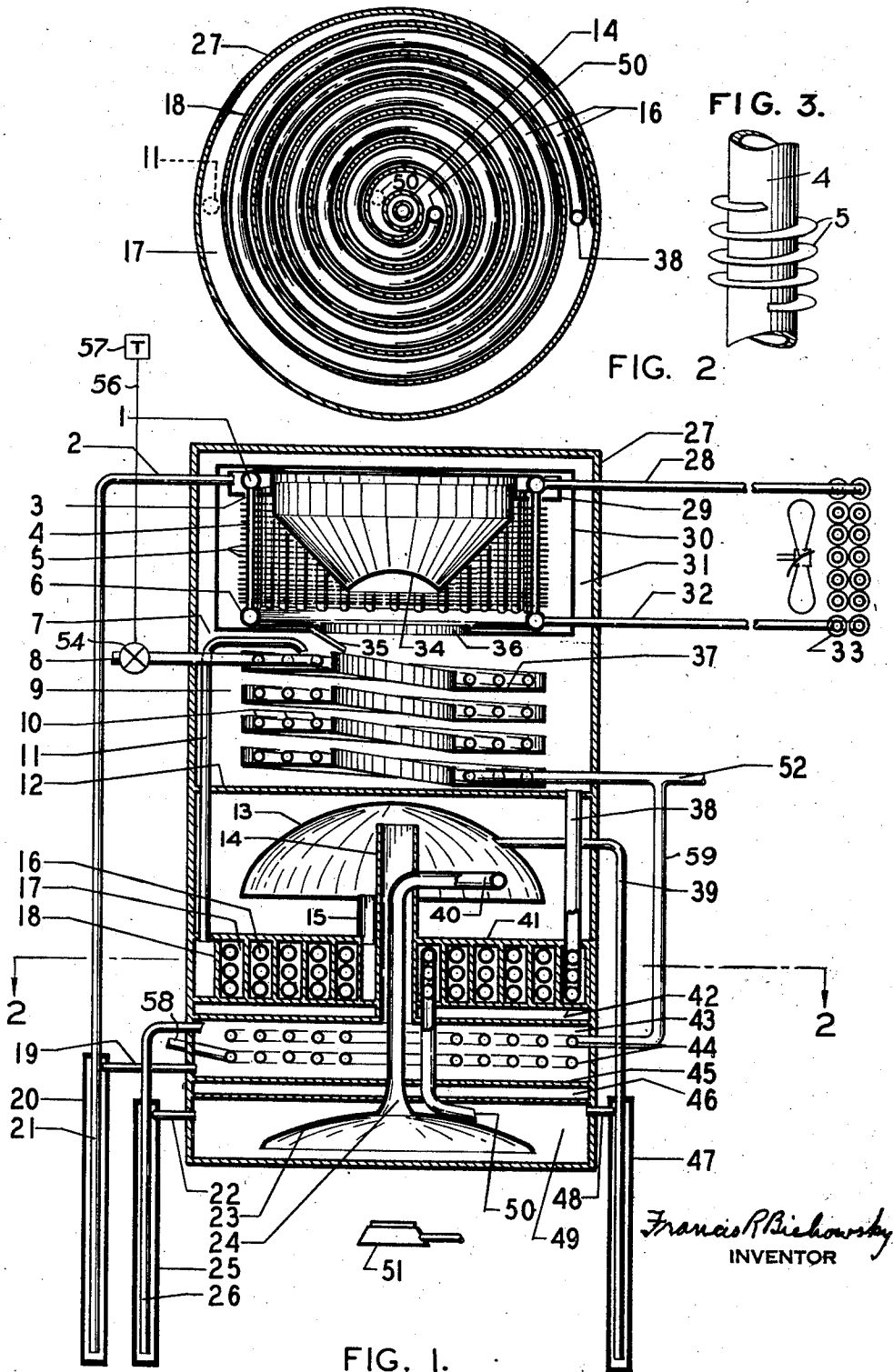
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F. R. BICHOWSKY

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MEANS FOR HEATING AND COOLING

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MEANS FOR HEATING AND COOLING

Francis R. Bichowsky, Washington, D. C.

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This invention relates to improved apparatus for heating and cooling fluids. More specifically the invention is concerned with an improved apparatus of the vacuum absorption type for heating and cooling air. Refrigerants commonly employed are water, methyl alcohol, or the like and frequently used absorbents are solutions of lithium chloride, lithium bromide, zinc chloride, and similar salts.

It is among the objects of the present invention to provide vacuum absorption apparatus capable of being operated either to heat or to cool a fluid passed therethrough. Another object of the invention is to provide vacuum absorption apparatus in which both a primary and secondary refrigerant are employed and novel means for exchanging heat therebetween. A further object of the invention is to provide a novel means for separating the absorbent and primary refrigerant after admixture thereof. A primary object of the invention is to provide an apparatus which can be employed either for heating or for cooling the air in buildings.

To the accomplishment of the foregoing and related ends, the invention, then consists of the means hereinafter fully described and particularly pointed out in the claims, the annexed drawing and the following description setting forth in detail certain means for carrying out the invention, such disclosed means illustrating, however, but one of various ways in which the principle of the invention may be used.

In said annexed drawing: Figure 1 is a cross-sectional elevation of a vacuum absorption apparatus illustrating the principle of the present invention. Figure 2 is a plan view of the heat exchanger 17 in Figure 1 taken on the line 2-2. Fig. 3 is an enlarged perspective of the tube 4 shown in Fig. 1.

In Figure 1, an hermetically sealed vessel 27 is provided in the form of a closed cylinder. This vessel is separated into six compartments or zones by means of suitable partitions. The upper compartment 30 is hereinafter called the evaporator. The evaporator 30 is provided with a means 3 for introducing liquid refrigerant near the top thereof. Because of the vacuum obtaining in the chamber 30, refrigerant entering through the pipe 2 evaporates in the evaporator 30 and is thereby cooled. Heat is thereby abstracted from a secondary refrigerant circulating in the finned pipe 4 which may be dichlorodifluormethane or the like. The so-cooled secondary refrigerant is then circulated through a coil 33 over which air to be cooled is passed. In

communication with this coil 33 is a pipe 28 which distributes vaporized secondary refrigerant entering through a header tube 1 within the finned pipe 4. A footing tube 6 collects secondary refrigerant condensing in the pipe 4 and conveys it out of the evaporator section by the footing tube 6 and the pipe 32. The helical fins 5 on the pipe 4 (in Fig. 3) are so spaced that liquid primary refrigerant distributed to the fins 5 by the distributing means 3 is constrained by capillarity to follow the helix. A shield 34 is provided in the evaporator 30 to restrict evaporation and prevent flashing of said refrigerant into fine spray. Any small portion of the refrigerant which escapes evaporation flows by the drain pipe 35 into an absorber section 9. The absorber 9 is below and in open communication with the evaporator 30. An opening 36 between the two chambers is provided so that vapor produced in the evaporator 30 may flow into the absorber 9 or from the absorber 9 to the evaporator 30. A spiral channel 37 is formed for distributing the absorbent in the absorber 9 in a thin film so that a large surface of said absorbent is provided for the absorption of vapor. The spiral channel 37 contains a coil 10 in thermal communication therewith so that when a cooling liquid flows through the coil 10, entering by means of the header tube 8 and leaving by the footing tube 52, the absorbent flows in the absorber 9 down the spiral channel 37 and the heat of absorption produced is carried away by the water in the cooling coils 10.

The cooling liquid leaving the pipe 52 may go to waste or preferably, as shown in my co-pending application Serial No. 286,989, filed July 28, 1939, now issued as U. S. Patent 2,289,924, October 13, 1942, may flow to the coil 44 by the pipe 59, and to waste by pipe 58. There is provided a passage 7 connecting the absorber chamber 9 with the space 31 left between the shell of the evaporator 30 and the outer vessel 27 which serves as a dead end space in which any small amount of inert gas is forced by the flow of water vapor from the evaporator 30 to the absorber 9. A partition 12 separates the chambers 30 and 9 from the lower portion of the vessel 27. This partition is pressure-tight thus maintaining any difference in pressure which exists in the upper and lower sections of the vessel 27. The partition 12 forms the bottom of the absorber and the weakened absorbent is transported therefrom by the pipe 38 to the heat exchanger 17.

The heat exchanger 17 is of any construction but, in the illustrated example, is formed by con-

necting several pipes 16 to a header tube 38 and winding said pipes, together with a spacing sheet 18, so as to form a spiral coil of pipes in which the pipes 16 are spaced by the sheet 18.

The spiral pipes 16 and sheet 18 are capped top and bottom by the plates 41, 42. In this way two passages are formed, one within the multiple pipe 16 and the other comprising the spaces between the multiple pipe 16, the spiral sheet 18 and the top and bottom sheets 41, 42.

Liquor entering the exchanger by the header tube 38 thus flows by the multiple pipe 16 out through the header tube 50 which leads downward into a regenerator 49. The regenerator 49 is placed at the bottom of the vessel 27 so as to be readily heated by a heating device 51. Provided on the inside of the regenerator section 49 and above the boiling liquid is a shield 23 pierced by a tube 24 which leads upward and through the center of the spiral exchanger 17 into a pipe 40 protruding into the circular chamber 13 which is a device for separating intermingled liquid and vapor. Vapor produced by the boiling absorbent in the regenerator 49 enters the tube 24 carrying with it a portion of the liquid absorbent in accordance with the vapor-lift principle. The mixed vapor and liquid absorbent are directed by an extension 40 of the pipe 24 in a tangential manner against the inside of the vapor separator 13, thus separating the vapor and the intermingled liquid, the liquid flowing by the pipe 15 to the passage in the heat exchanger 17 formed by the multiple pipe 16 and the spiral sheet 18. The hot absorbent then flows following the channel formed by the multiple pipe 16 and the spiral sheet 18 counter-current to the absorbent in the multiple pipe 16. Heat is, therefore, exchanged between the hot absorbent and the absorbent entering by pipe 38 so that the absorbent leaving by the pipe 11 is cooled while the absorbent entering by the header tube 38 is heated. The cooled absorbent then flows by the pipe 11 upward into the absorber 9 being forced to flow upward by the difference in pressure between that in the vapor separator 13 and that in the absorber 9. The vapor separated in the vapor separator 13 flows by the pipe 14 inclosing the pipe 24 into a condenser section 43. The condenser section 43 is provided with cooling coils 44 upon which the vaporized refrigerant condenses and collects on the floor 45 which is insulated by the space 46, from the regenerator 49. Condensed liquid collecting on the floor 45 flows through the pipe 19 to the pipe 20 which forms a leg capable of, in part, supporting the vessel 27. Inside of the pipe 20 a pipe 21 is provided which connects with the pipe 2 and serves to convey refrigerant from the condenser 43 to the evaporator 30. The vertical distance between the condenser 43 and the evaporator 30, and between the heat exchanger 17 and the absorber 9 and the levels of liquid in the regenerator 49, the vapor separator 13, the condenser 43, the absorber 9, and the evaporator 30 are such that liquid flows under the difference in pressure in the upper section of the vessel 27 and the lower section thereof from the latter into the former. The pipe 20 with its contained pipe 21 serves as an hydraulic loop to compensate automatically for any slight differences in pressure which may exist above the amount necessary to allow liquid to flow by the pipes 19, 20, 21 and 2 up to the distributing means 29.

A pipe 39 is provided opening into the vapor separator 13 at a level below the entrance of the pipe 14. The pipe 39 continues on the inside of

a pipe 47, the pipe 47 being connected by the pipe 48 to the regenerator 49. The pipe 47 with its inner pipe 39 forms a second leg for the support of the unit and functions as follows: In the event of an unusual rate of boiling, the liquid in the vapor separator 13 may rise to such a point that it tends to overflow with the vapor down the pipe 14. To prevent this, the pipe 39 conveys excess liquor from the vapor separator 13 back to the regenerator 49. A pipe 26 is provided communicating at a level above the normal liquid level in the condenser 43 and leading downward within a pipe 25 which latter serves as a third leg for the apparatus. This leg is placed out of the plane of the drawing but is shown in the plane for purposes of simplification. The pipe 25 connects by the pipe 22 to the regenerator 49. The pipes 26, 25, 22 allow any excess liquid collecting in the condenser 43 to flow therefrom back to the regenerator 49.

While the mode of operation of the specific apparatus illustrated has been described, my method broadly comprises recirculating a secondary refrigerant in heat exchange relation with fluids to be cooled or heated and in heat exchange relation with a primary refrigerant; passing said primary refrigerant from heat exchange relation with said secondary refrigerant into absorbing medium; circulating a portion of the so-formed mixture of absorbing medium and primary refrigerant through a heated zone, thence into a vapor-liquid separating zone and returning the separated liquid to said absorption zone in heat exchange relation with the mixture of primary refrigerant and absorbing medium leaving said absorption zone; passing the vapor leaving said vapor-liquid separator zone through a condenser and returning the resulting material to heat exchange relation with said secondary refrigerant; and controlling the heat supplied to said secondary refrigerant by controlling the amount of heat removed from said condenser and from said absorber. The heat supplied to said secondary refrigerant may be either positive or negative; if positive heat is supplied, the fluid is heated, and if negative heat is supplied, the fluid is cooled.

In order to utilize this invention for heating it is only necessary to decrease the flow of cooling water passing through the cooling coils by means of valves shown in my co-pending application Ser. No. 286,989, filed July 28, 1939, now issued as U. S. Patent 2,289,924 of October 13, 1942. When the temperature of the absorbent in the absorber is raised by the heat of absorption to the point where it exceeds the temperature at which the absorption of water vapor can proceed, water vapor is given off by the absorbent. To change automatically a thermostat 57 is provided to control by the connecting means 56 and the valve 54 the flow of water through the coils in the absorber and condenser. When the temperature of a space to be conditioned exceeds a predetermined value, the flow of cooling water is increased; when the temperature of a space to be conditioned falls below a certain value, the flow of cooling water is decreased.

When the flow of cooling water is decreased the temperature of the absorbent in the absorber rises above that temperature at which the absorbent can absorb water vapor and the cooling action in the apparatus is reversed. Water vapor rises from the absorbent in the spiral channel in the absorber into the evaporator where it condenses on the finned coils therein thus serving to heat the secondary refrigerant. This secondary

refrigerant then transfers the heat to the point of utilization thus heating the air or other fluid which it is desired to heat. After condensing on the coils in the evaporator the liquid flows down the spiral fins and through the drain pipe into the absorber.

Since the flow of cooling water through the condenser is decreased, vapor which would otherwise condense therein flows upward in the pipe 21 after breaking the liquid seal in said pipe and passes into the evaporator at the distributing device and is condensed on the finned coils thus adding more heat to the secondary refrigerant. This condensate also flows to the absorber by way of the drain pipe. During this latter operation the hydrostatic balance set up by the various loops and relative levels of chambers is disturbed and steam flows through these loops. This temporary disturbance of function does not prevent the unit from heating and the seals reestablish themselves automatically when water is turned on. While the cooling water is off the flow of vapor from the lower chambers to the upper chambers is maintained since the pressure of the entire system rises relatively and the lower chambers, i. e., the regenerator, the vapor separator and the condenser are still at a relatively higher pressure than the upper chambers, i. e., the evaporator and the absorber.

Other modes of applying the principle of this invention may be employed instead of those explained, provided those stated by any of the following claims or their equivalent is employed.

I therefore particularly point out and distinctly claim as my invention:

1. Vacuum absorption refrigeration apparatus including a unitary hermetically sealed vessel divided into two parts one of which is maintained at a higher pressure than the other, the high pressure part containing a regenerator and a condenser and the low pressure part containing an evaporator and an absorber, thermally operated means for transferring the absorbent from the absorber to the regenerator, said means including an open unrestricted channel connecting the absorber and the regenerator, and means for allowing thermal communication between the hot absorbent and the cool absorbent.

2. Vacuum absorption refrigerator comprising hermetically sealed apparatus divided into two parts one of which is maintained at a higher pressure than the other, the high pressure part containing a regenerator and a condenser and the low pressure part containing an evaporator and an absorber; means for transferring weakened absorbent from the absorber to the regenerator including means for allowing thermal communication between the cool absorbent and hot absorbent, and means for separating the boiling absorbent leaving the regenerator into vapor and liquid including a vapor separator and a tube extending from the regenerator into the lower portion of said vapor separator and directed tangentially toward the inside of said vapor separator.

3. Vacuum absorption refrigerator comprising hermetically sealed apparatus divided into two parts one of which is maintained at a higher pressure than the other, the low pressure part containing an absorber and an evaporator and the high pressure part containing a regenerator and a condenser; means for separating boiling absorbent leaving the regenerator into liquid and vapor, said means comprising a vapor separator,

a pipe extending through the base of the vapor separator for transferring the boiling absorbent thereto from the regenerator, and a second pipe concentric with said first pipe and surrounding the same for transferring vapor from the separator to the condenser.

4. Vacuum absorption refrigerator comprising hermetically sealed apparatus divided into two parts one of which is maintained at a higher pressure than the other, the low pressure part containing an absorber and an evaporator and the high pressure part containing a regenerator and a condenser; means for separating boiling absorbent leaving the regenerator into liquid and vapor, said means comprising a vapor separator and means extending through the base thereof for transferring the boiling absorbent thereto from the regenerator, said last named means including a pipe which directs boiling absorbent tangentially against the side of said vapor separator.

5. Vacuum absorption refrigerator comprising hermetically sealed apparatus divided into two parts one of which is maintained at a higher pressure than the other, the low pressure part containing an absorber and an evaporator and the high pressure part containing a regenerator and a condenser; means for separating boiling absorbent leaving the regenerator into liquid and vapor, said means including a vapor separator and a pipe which extends through the base of the vapor separator and directs boiling absorbent tangentially against the inside of said vapor separator; and means for removing liquid collecting on the bottom of said vapor separator including a passage therefrom in thermal communication with absorbent-refrigerant mixture leaving the absorber.

6. Vacuum absorption refrigerator comprising hermetically sealed apparatus divided into two parts one of which is maintained at a higher pressure than the other, the low pressure part containing an absorber and an evaporator and the high pressure part containing a regenerator and a condenser; means for separating boiling absorbent leaving the regenerator into liquid and vapor, said means including a vapor separator and means extending through the base thereof for transferring the boiling absorbent from the regenerator to the vapor separator; and means for removing the vaporized refrigerant collecting in the upper part of the vapor separator including a pipe extending upwardly into said vapor separator to a point above the entrance point of the vapor-liquid mixture but at the middle of said vapor separator horizontally, said pipe extending downwardly into a condenser containing cooling coils.

7. Vacuum absorption refrigerator comprising hermetically sealed apparatus divided into two parts one of which is maintained at a higher pressure than the other, the low pressure part containing an absorber and an evaporator and the high pressure part containing a regenerator and a condenser; means for separating boiling absorbent leaving the regenerator into liquid and vapor, said means including a vapor separator and means extending through the base thereof for transferring the boiling absorbent from the regenerator to the vapor separator; means for removing the vaporized refrigerant collecting in the upper part of the vapor separator including a pipe extending upwardly into said vapor separator to a point above the entrance point of the vapor-liquid mixture but at the middle of said vapor

separator horizontally and extending downwardly into a condenser containing cooling coils; and an hydraulic loop in open communication between the condenser and the regenerator.

8. Vacuum absorption refrigerator comprising hermetically sealed apparatus divided into two parts one of which is maintained at a higher pressure than the other, the low pressure part containing an absorber and an evaporator and the high pressure part containing a regenerator and a condenser; means for separating boiling absorbent leaving the regenerator into liquid and vapor, said means including a vapor separator and means extending through the base thereof for transferring the boiling absorbent from the regenerator to the vapor separator; means for removing the vaporized refrigerant collecting in the upper part of the vapor separator including a pipe extending upwardly into said vapor separator to a point above the entrance point of the vapor-liquid mixture but at the middle of said vapor separator horizontally and extending downwardly into a condenser containing cooling coils; and an hydraulic loop in open communication between the condenser and the regenerator, said loop including a pipe passing from the condenser to the evaporator.

9. Vacuum absorption refrigerator comprising hermetically sealed apparatus divided into two parts one of which is maintained at a higher pressure than the other, the low pressure part containing an absorber and an evaporator and the high pressure part containing a regenerator and a condenser; means for separating boiling absorbent leaving the regenerator into liquid and vapor, said means including a vapor separator and means extending through the base thereof for transferring the boiling absorbent from the regenerator to the vapor separator; means for removing the vaporized refrigerant collecting in the upper part of the vapor separator including a pipe extending upwardly into said vapor separator above the entrance point of the vapor-liquid mixture but at the middle of said vapor separator horizontally and extending downwardly into a condenser containing cooling coils; and a pipe leaving the side of the vapor separator at a point above the entrance of the regenerated absorbent and passing into the regenerator.

10. Vacuum absorption refrigeration apparatus including an absorber, a regenerator, a condenser and an evaporator which latter comprises vertical tubes containing secondary refrigerant, said tubes being formed with helically wound fins thereon, and means for introducing primary refrigerant at the top of the helix defined by the fins.

11. Vacuum absorption refrigeration apparatus including an absorber, a regenerator, a condenser and an evaporator which latter comprises vertical tubes containing secondary refrigerant, said tubes being formed with helically wound fins thereon, means for introducing primary refrigerant at the top of the helix defined by the fins and said evaporator containing an approximately V-shaped shield so-positioned in the evaporator that the upper portion of said shield is substantially above the highest point in the evaporator where refrigerant is evaporated and the lower portion of said shield is substantially above the lowest point at which refrigerant is evaporated but below said highest point.

12. Vacuum absorption refrigeration apparatus including an evaporator having vertical tubes wound with helical fins, and means for introduc-

ing a refrigerant onto the helical fins, said fins being so-spaced that the liquid is retained by surface tension within the passage defined thereby during its downward traverse thereof.

13. Vacuum absorption refrigeration apparatus including a regenerator, a condenser and a vapor separator; a passage between said regenerator and said vapor separator; and a second passage between said condenser and said vapor separator, said first passage being in thermal communication with said second passage outside the vapor separator.

14. Vacuum absorption apparatus comprising an hermetically sealed vessel divided into two parts one of which is maintained at a higher pressure than the other, a regenerator, transfer means for fluid between the regenerator and a vapor separator, said means comprising a pipe projecting from said regenerator into and in open communication with said vapor separator and so-positioned that fluid passing into said vapor separator is projected tangentially against the inside thereof, an overflow pipe between said vapor separator and said regenerator, communicating means in thermal communication with the regenerator-vapor separator transfer means between said vapor separator and a condenser, means for transferring condensate from said condenser into an evacuated evaporator comprising a liquid seal, an hydraulic loop between said regenerator and said condenser, means for transferring liquid from said vapor separator to an absorber comprising thermal communication means between said liquid and an absorbent-refrigerant mixture having a lower temperature relative thereto, thermal communication means in said evaporator between evaporating refrigerant and a secondary refrigerant, means for utilizing the thus-produced heat absorbent qualities of said secondary refrigerant, means for transferring refrigeration from said evaporator into an absorber, a cooling coil in said absorber, absorbent-refrigerant contact means in said absorber, and absorbent-refrigerant mixture transfer means between said absorber and said regenerator comprising thermal communication means between said mixture and liquid being transferred from said vapor separator to said absorber.

15. Vacuum absorption apparatus comprising a regenerator, transfer means for fluid between the regenerator and a vapor separator, said means comprising a pipe projecting from said regenerator into and in open communication with said vapor separator and so-positioned that fluid passing into said vapor separator is projected tangentially against the inside thereof, an overflow pipe between said vapor separator and said regenerator, communicating means in thermal communication with the regenerator-vapor separator transfer means between said vapor separator and a condenser, means for transferring condensate from said condenser into an evacuated evaporator comprising a liquid seal, an hydraulic loop between said regenerator and said condenser, means for transferring liquid from said vapor separator to an absorber comprising thermal communication means between said liquid and an absorbent-refrigerant mixture having a lower temperature relative thereto, thermal communication means in said evaporator between evaporating refrigerant and a secondary refrigerant, means for utilizing the thus-produced heat absorbent qualities of said secondary refrigerant, means for transferring refrigerant from said

evaporator into an absorber, a cooling coil in said absorber, absorbent-refrigerant contact means in said absorber, and absorbent-refrigerant mixture transfer means between said absorber and said regenerator comprising thermal communication means between said mixture and liquid being transferred from said vapor separator to said absorber.

16. Vacuum absorption apparatus comprising an evaporator, an absorber situated below said evaporator, a heat exchanger, a condenser situated below said absorber, a regenerator situated below said condenser, heating means for the regenerator, cooling means for the absorber and the condenser, fluid transfer means between the regenerator and the condenser comprising a valve, fluid transfer means between the condenser and the evaporator comprising an hydraulic loop, fluid transfer means between the condenser and the regenerator comprising an hydraulic loop, fluid transfer means between the vapor separator and the absorber, fluid transfer means between the absorber and the regenerator, means for thermal communication between fluids passing from the vapor separator to the absorber and fluids passing from the absorber to the regenerator, and fluid transfer means between the evaporator and the absorber.

17. In a vacuum absorption refrigeration apparatus wherein the absorbent is reconcentrated by boiling means, means for separating liquid and vapor including a vapor separator of circular cross-section, a tube directed to convey a mixture of vapor and liquid from the boiling means into the separator and to inject the said mixture against the inside wall of the separator, and a second tube adapted to withdraw separated vapor from the separator at a point above the point of injection of the aforesaid mixture, said second tube being concentric with and in part surrounding said first tube.

18. In a vacuum absorption refrigerator, in combination with a regenerator, condenser and absorber, a spirally wound heat exchanger for exchanging heat between weakened absorbent entering and concentrated absorbent leaving the regenerator, a vapor separator disposed above the heat exchanger, and two concentric pipes passing through the center of the heat exchanger, the inner of said pipes being adapted to convey a mixture of liquid and vapor from the regenerator to the vapor separator, and the outer of said pipes being adapted to withdraw separated vapor from the separator at a point above the point of injection of the liquid-vapor mixture and to convey the same to the condenser.

19. A vacuum absorption apparatus comprising a unitary hermetically sealed vessel divided into two parts one of which is maintained at a higher pressure than the other, the high pressure part containing a regenerator and a condenser and the low pressure part containing an evaporator and an absorber, means for separating the boiling absorbent leaving the regenerator into vapor and liquid including a vapor separator, means for transferring absorbent from the regenerator to the absorber by vapor lift action, means for transferring weakened absorbent from the absorber to the regenerator including an open unrestricted channel and means for allowing thermal contact between cool absorbent and the hot absorbent leaving the vapor separator.

20. Vacuum absorption refrigeration apparatus including a regenerator, a vapor separator, a condensing chamber and a heat exchanger, the latter two elements being disposed between the former two, and a pipe connecting the regenerator with the vapor separator, said pipe passing centrally through the condenser chamber and centrally through the heat exchanger.

FRANCIS R. BICHOWSKY