PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in or relating to Refrigeration Systems

We, CARRIER ENGINEERING COMPANY LIMITED, a Company incorporated under the laws of Great Britain, of 24, Buckingham Gate, London, S.W.1, England, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to refrigeration systems.

In co-pending Application No. 18376/47 (Serial No. 639,413) there is disclosed and claimed an absorption refrigeration system to which the control arrangements of the invention are particularly adapted. It will be understood, of course, the present invention is not limited to its use in connection with the absorption refrigeration system described in the co-pending application above referred to but may be embodied in any type of continuous cycle absorption system to control the same within desired limits.

The chief object of the present invention is to provide an improved control arrangement.

An object of the invention is to provide a continuous cycle absorption refrigeration system including novel and improved control arrangements for regulating the refrigerating capacity, the concentration and distribution of solution, the temperature of chilled water, and the quantity of cooling water directed through elements of the system.

A further object is to provide a continuous cycle absorption refrigeration system including means for resetting or adjusting the controls of the system in response to a change in load imposed upon the system.

A still further object is to provide a continuous cycle absorption refrigeration system including means for preventing crystallization of the absorbing medium of the solution.

A still further object is to provide a continuous cycle absorption refrigeration system including safety controls against failure of elements of the system, failure of electrical current supplied to elements of the system, freezing of the solution, freezing of chilled water, and flooding of the generator or flooding of the system. Other objects of the invention will be readily perceived from the following description.

A continuous cycle absorption refrigeration system according to the present invention comprises in combination an absorber, an evaporator, a generator, and a condenser with means for circulating solution from the absorber to the generator and from the generator to the absorber, means for controlling the refrigerating capacity of the system, said means including a control member disposed to regulate the rate of flow of solution circulating through the system, and means for controlling the operation of said member in response to temperature of cooling medium leaving the evaporator.

The invention also comprises a continous cycle absorption refrigeration system characterised by the combination of an absorber, an evaporator, a generator, a condenser with a pump for withdrawing weak solution from the absorber and for supplying weak solution to the generator, means disposed in a line connecting the generator and the absorber adapted to receive a stream of weak solution from the pump thereby entraining strong solution and supplying the mixture to the absorber, and second means for controlling the capacity of the absorber, said second means including a valve for throttling solution flow, and thermal responsive means responsive to temperature of cooled medium leaving the evaporator for controlling the operation of said valve, throttling of said valve decreasing the amount of weak solution supplied to the generator and proportionately decreasing the amount of strong solution supplied to the absorber by the first means.

The term "weak solution" is used

[Price 2/-]

herein to define a solution containing a large amount of refrigerant so that the solution is weak in absorbing properties. The term "strong solution" defines a solution which is relatively deficient in refrigerant and consequently a solution which possesses enhanced properties of refrigerant absorption.

Various combinations of refrigerant and absorbent may be used in the system described. A solution consisting of lithium bromide and water is highly satisfactory. Other salt solutions may be used if desired in the system. When the system is operated at high temperature (above freezing temperature) a solution of lithium chloride and water or a solution of sodium hydroxide and water, for example, may be used. When the system is used to obtain low temperature, ammonia, for example, may be employed as a refrigerant.

In order that the invention may be more clearly understood reference will now be made to a preferred embodiment thereof in an absorption refrigeration system arranged as illustrated in the accompanying diagrammatic drawings.

Figure 1 is a diagrammatic view illustrating the flow of solution through the various elements of the refrigeration system;

Figure 2 is a diagrammatic view illustrating the position and the operation of the various controls in the system;

Figure 3 is a diagram illustrating the operation of the refrigeration system and the manner in which the cycle may be adjusted to permit operation at partial load, and

Figure 4 is a diagrammatic view illustrating a modified control arrangement.

In the drawings like references designate the same or similar parts.

Referring to the drawings, Figure 1 illustrates diagrammatically an absorption refrigeration system including the improved control arrangements of our invention. The system may include a horizontally extending shell 2 having an absorber 3 disposed in the bottom thereof and an evaporator 4 disposed in the upper portion of the shell. A second shell 5 is supported above shell 2 and includes a generator 6 disposed at the bottom thereof and a condenser 7 disposed in the upper portion of shell 5. Weak solution is withdrawn from absorber 3 by pump 8 through line 9 and is forwarded to the generator 6 through lines 10, 11, heat exchanger 12 and line 13. Strong solution is withdrawn from generator 6 through line 14, overflow arrangement 15, line 16, heat exchanger 12, line 17, and ejector 18 which forwards strong solution through line 19 to spray arrangement 20 adapted to spray the solution over the tubes 21 of absorber 3.

A pump 22 passes cooling or condensing water through line 23 to the tubes 21 of absorber 3. Condensing water after its passage through the tubes of absorber 3 is directed through line 24 to the tubes 25 of condenser 7. This is a preferred arrangement, of course, and it will be understood the water may be passed in the reverse direction or in parallel lines through the tubes 21, 25 of the absorber and condenser. Any suitable means may be provided to supply water for cooling purposes. The condensing water leaves the tubes 25 of condenser 7 through line 26 and may be directed to a cooling tower or to waste as desired.

Chilled water leaves evaporator 4 through line 27 and is circulated through the heat exchange coil of an air conditioning system, for example, by means of pump 28 in which system it acts as cooling medium. The chilled water is returned from the air conditioning system through line 29 and is sprayed by means of spray arrangement 30 in the evaporator 4. The pressure in shell 2 is such that the water sprayed therein is flash-cooled, the vapour passing downward to be absorbed by the solution in absorber 3 while the cooled water is collected in evaporator 4 and may be withdrawn therefrom as described above through line 27. A line 31 serves to forward condensate from condenser 7 to evaporator 4. A precooler arrangement 32 is provided in line 31 in order to assure that the condensate forwarded to the evaporator is maintained at a desired temperature.

Any suitable purge arrangement 33 may be provided to withdraw non-condensible gases from the absorber and the condenser.

The absorption refrigeration system described above is disclosed and claimed in the co-pending application above referred to and reference is made to such application for a more complete description thereof.

To attain most satisfactory operation it is desirable that the refrigerating capacity of the system be changed immediately upon change in load. The temperature of the chilled water may be used to indicate a change in load since a decrease in temperature thereof from a predetermined point indicates that the load upon the system has decreased. If the temperature of the chilled water leaving the evaporator decreases, the capacity of the system may be decreased accordingly by throttling the volume of strong solution passing to the absorber.

Referring to Figures 1 and 2, a valve 34 is disposed, for example, in line 10 between pump 8 and ejector 18. Valve 34 may be regulated by means of a thermostat control 35 governed by a bulb 36 placed in or adjacent to line 27. As the temperature of chilled water passing through line 27 decreases, fluid in bulb 36 contracts and actuates the thermostat 35 to tend to move valve 34 toward a closed position thereby decreasing the amount of weak solution being forwarded to generator 6 through lines 11 and 13. Movement of valve 34 toward a closed position decreases the amount of weak solution passing to ejector 18, proportionately to the decrease in temperature of chilled water. The reduction in the amount of weak solution passing to ejector 18 reduces the velocity of such solution through the nozzle of such ejector and consequently a smaller quantity of strong solution is entrained or induced. The throttling action of valve 34 accordingly reduces the rate of flow of combined weak and strong solution passing to the absorber 3. The absorbing capacity of absorber 3 is controlled by the decreased wetting action provided by the reduced rate of flow of combined solution and by the reduced rate of flow of strong solution according to the load imposed upon the system.

A valve 37 is provided in steam line 38 to regulate the quantity of steam passing into the tubes 39 of generator 6 in accordance with the load imposed upon the system. Valve 37 is actuated by thermostat control 40 governed by a bulb 41 disposed in or adjacent to line 14 connecting generator 6 with overflow arrangement 15. As the load decreases and the rate of flow of solution passing from the generator 6 reduces the temperature of the strong solution in line 14 increases; such increase in temperature indicates that too much steam is being supplied to generator 6, heating the solution and increasing its concentration to an extent not required and in fact to an extent not desirable. Bulb 41 responding to the temperature of solution in line 14 actuates thermostat control 40 to move valve 37 toward a closed position throttling the amount of steam passing through the tubes 39 of generator 6 until it balances with the new load.

The amount of cooling or condensing water passing through the tubes 21 of absorber 3 and the tubes 25 of condenser 7 is controlled by means of a valve 42 placed in line 26; valve 42 is actuated by means of a thermostat control 43 governed by a bulb 44 placed in or adjacent to condensate line 31. Valve 42, if desired, may be disposed in position in lines 23 or 24 in Figure 2, it is illustrated as disposed in line 24. If cooling water is passed in parallel lines through tubes 21 of absorber 3 and tubes 25 of condenser 7, a similar valve may be provided in the line supplying condensing water to the tubes of the absorber or to the line through which the water is withdrawn.

The concentration of the strong solution leaving generator 6 depends upon the temperature and pressure of solution in shell 5. Pressure in shell 5 may be maintained by means of condenser 7. The pressure in shell 5 is dependent upon the condensing temperature of condenser 7. As the temperature of the vapour condensate in line 31 decreases, it serves as an indication that too large an amount of condensing water is being permitted to flow through the tubes of condenser 7. Bulb 44 regulates thermostat control 43 to throttle valve 42 decreasing the amount of condensing water flowing through the tubes of absorber 3 and condenser 7. The condensing temperature may be controlled by regulating the temperature of the cooling water within desired limits.

By means of valves 37 and 42 temperature and pressure of the solution in shell 5 is controlled and thereby indirectly provides control of concentration of solution.

While generally it is desirable to maintain the concentration of the solution constant in accordance with temperature and pressure conditions in shell 5 in some cases it may be desirable to decrease the concentration of the solution at partial load. For this purpose reset means are provided to change the control point of thermostat 40. The control point or range of thermostat 40 may be varied by air pressure through line 46 connected to air line 47 which operates valve 34. The reset means so provided serves to change the control point of thermostat 40. As air pressure in line 47 decreases it resets the control point of thermostat 40 to the desired temperature of the solution leaving the generator in accordance with the pressure in shell 5 thereby indirectly decreasing the concentration of the solution to the desired degree.

It is desirable to shut down the machine if solution pump 8 fails, for example, to prevent damage to the remaining elements of the system. As shown in Figure 2, a pressure switch 48 is provided responsive to the pressure created by pump 8. When pump 8 is started, the pressure on the pump discharge operates the pressure switch which in turn causes automatic air shut-off valve 49 in the main air line 50 to open permitting air to be supplied to the various elements of the control system as indicated. If, during operation, pump 8 fails to operate for any

reason, loss of discharge pressure actuates pressure switch 48 which in turn causes the automatic air shut-off valve 49 to close. Closing of valve 49 discontinues the supply of air to the various controls allowing them to return to normal position to close valves 34, 37 and 42, preventing passage of solution through the system, passage of steam through the tubes of the generator and passage of condensing water through the tubes of the absorber and the condenser. As shown in Figure 2, filter 51 and pressure regulator 52 may be provided in main air line 50. Such elements are well known and need not be described in detail.

As illustrated in Figure 2, the various thermostat controls 35, 40, 43, are connected to main air line 50 and are operable in response to a predetermined air pressure therein. The various bulb controls 36, 41 and 44 serve to govern the operation of such thermostats to regulate the operation of valves 34, 37 and 42 in response to the various conditions which arise during operation of the system. In addition, of course, various functional and safety controls may be provided, as hereinafter discussed, to attain most efficient and effective operation of the system.

The refrigeration cycle of the absorption system and the manner in which it is affected by the various control arrangements is illustrated diagrammatically in Figure 3. Figure 3 illustrates the refrigeration cycle at full load as well as the temperatures of chilled water supplied to and leaving the evaporator, steam supplied to the generator, and cooling water entering the absorber and leaving the condenser.

Referring to Figure 3, it will be noted that the ordinates indicate the concentrations of the solution in weight percent of lithium bromide, the preferred absorbent. The abscissæ indicate the vapour pressure of water in the solution in millimetres. The arcuate lines are the lines of constant temperatures of the solution which correspond to the pressure and concentration at any point of the chart at saturated conditions. Any point of the chart being projected horizontally from the zero concentration line indicates the temperature of the water in equilibrium with the solution at this point.

Under conditions of full load for which the system is designed, it will be noted that the temperature of steam supplied to the generator is about 270°, the temperature of condensing water entering the absorber is 80° F., while the temperature of condensing water leaving the condenser has been raised to 90° F. In other words, the temperature of the condensing water has been raised by its passage through the absorber and the condenser. The temperature of chilled water entering the evaporator as indicated is about 55° F., such water being flash-cooled as indicated to a temperature of about 45° F. (temperature of chilled water leaving the evaporator). The freezing line serves to indicate generally the temperature and concentration at which the absorbent begins to crystallise and to precipitate from solution.

The refrigeration cycle is shown by solid lines. Point A is deemed the beginning of the cycle for purposes of illustration, and indicates the point at which the mixture of weak solution and strong solution is formed in the ejector. Solid line A—B indicates the passage of solution from the ejector 18 through the absorber 3 to the heat exchanger 12. The dotted line B—A serves to show weak solution at a lower temperature returning to point A and mixing with the strong solution at such point. At point B (where the weak solution enters the heat exchanger) it will be noted the temperature of the solution is about 95° F., and that the pressure has been decreased.

Ordinate B—C illustrates the passage of weak solution through the heat exchanger. Temperature of the weak solution is increased by its passage through the heat exchanger. The continuation C—D of ordinate B—C serves to illustrate the increase in temperature during the preheating period in the generator (the temperature increase required to bring the solution to its boiling point in the generator). Abscissa DE illustrates evaporation of solution in the generator at a constant pressure with an increase in temperature and concentration of solution. Ordinate EF illustrates the passage of strong solution through the heat exchanger, showing the decrease in temperature and pressure caused by its heat exchange relationship with weak solution (indicated by ordinate BC). Line FA is dotted to indicate the passage of strong solution from the heat exchanger to the ejector (point A) where it is mixed with weak solution from the absorber as indicated by dotted line BA.

As described above, this diagram illustrates the refrigeration cycle under design conditions (operation at full load). If, for example, the load imposed upon the system decreases, the temperatures of condensing water and steam remaining constant, then the cycle illustrated by the solid lines will change in a manner corresponding to the change in load. Such a decrease in load is indicated by the dotted lines at the right side of the diagram.

Assume that the load imposed upon the system has decreased. Bulb 36 reflecting such change in load actuates thermostat control 35 to move valve 34 toward a closed position throttling the flow of weak solution to the generator and likewise decreasing the flow of the mixed solution tc the absorber. Since the steam flow through the generator is sufficient to maintain a desired temperature of leaving strong solution at full load, the temperature and concentration of leaving solution will increase. Such increase in temperature is reflected by bulb 41 which actuates thermostat control 40 to tend to move valve 37 toward a closed position decreasing the quantity of steam supplied to the generator and thus decreasing the pressure maintained in shell 5 with a consequent further increase in concentration of solution leaving the generator. Such changes in temperature and pressure have been illustrated by dotted lines E—Ex and Ex—Ey. Actually the lines connecting points E and Ey might well be shown as a single line since the effects illustrated by such lines actually are the resultant of the two different forces. We have illustrated the line in two components to set forth more clearly that a number of factors are affected by the decrease in load imposed upon the system.

The ordinate Ey—Fy illustrates the passage of strong solution at partial load through the heat exchanger. It will be noted that such line not only may come dangerously close to the freezing line but actually cross it. Thus a highly dangerous and unsatisfactory operating condition is created by the attempted operation at partial load. It is essential that such line indicating the passage of strong solution through the heat exchanger be moved to the left rather than tc the right of the diagram in order to move point F (or its corresponding points) away from the freezing line.

The reset control may be used for this purpose. Upon a decrease in load, bulb 36 actuates thermostat 35 decreasing the air pressure in line 47 to tend to move valve 34 toward a closed position. The decrease in air pressure in line 47 is reflected through line 46 upon thermostat 40. The decrease in air pressure adjusts the control point of thermostat 40 to lower the solution temperature to which it is responsive. This decrease in solution temperature would be reflected on the diagram by moving the line indicating the passage of strong solution through the heat exchanger toward the left to move it away from the freezing line. The reset control resets or adjusts thermostat 40 to actuate valve 37 at temperatures under partial loads different from the temperature to which it is responsive under full load.

If the cooling water temperatures are maintained constant and the same quantity of cooling water is passed through the tubes of the absorber under such conditions, the cycle range is broadened to a degree not necessary at as this time the cooling capacity should be decreased. In addition, broadening of the cycle range is undesirable since it may cause abrupt and irregular variation of the controls. Such condition is indicated by the dotted lines at the left of the diagram shown in Figure 3 connecting points B_1, Bx, Dx and D_1.

Under the conditions described above, the temperature of the vapour condensate leaving the condenser will decrease; the decrease in temperature of condensate, reflected by bulb 44, will cause thermostat 43 to be actuated to move valve 42 toward a closed position throttling the flow of condensing water through the tubes of the absorber and the condenser. The change in the temperature is illustrated by the dot-and-dash line; it will be noted that the temperature of condensing water entering the absorber remains at 80° F. while the temperature of condensing water leaving the condenser has increased to 100° F.

The decrease in the amount of condensing water supplied to the absorber and the condenser accordingly moves points Bx and Dx toward the right to points B^1 and D^1, in effect, "squeezing" the range for more efficient and satisfactory operation at partial load.

The refrigeration cycle at partial load is illustrated by the dot-and-dash lines connecting points A^1, B^1, C^1, D^1, E^1 and F^1. Such points correspond generally to points A, B, C, D, E and F illustrating operation of the system at full load; it will be noted the cycles illustrated are similar in contour but that the cycle illustrating operation of the system at partial load is still further from the freezing line (the dangerous condition).

The various controls which automatically operate to effect these changes in the refrigeration cycle provide immediate and accurate control of the operation of the system from full load, for example, 150 tons of refrigeration, to partial loads as small as 10 tons. The controls permit smooth economical operation at any partial load within the range described above. While the diagram shown in Figure 3 illustrates the refrigeration cycle at one partial load, it will be understood the controls function automatically to adjust or to correct the cycle to any condition of partial load within the range described above.

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Overflow arrangement 15 aids in controlling solution distribution in the system since it assures that a minimum quantity of solution is maintained in the generator at all times; the performance of ejector 18 is governed to some extent by the column of strong solution maintained in line 16 and by the pressure maintained in shell 5.

As described above, pressure in shell 5 may be regulated by throttling the flow of condensing water through the condenser 7. Concentration of solution in the generator 6 is maintained at approximately a desired point by the automatic control of temperature and pressure maintained in shell 5; concentration of solution in the absorber 3 may be varied or influenced by throttling the flow of cooling water through the tubes of the absorber. Resetting of the steam control decreases the temperature of solution leaving the generator and in combination with the control of cooling water to the machine governs indirectly the flow of solution. Narrowing concentration range of the solution at partial loads, as described above, prevents the decrease in temperature of chilled water from moving valve 34 too far toward a closed position.

In order to permit satisfactory operation of the system at higher concentrations of solution in the generator, means may be provided for bypassing a portion of the heat exchanger 12. Such means are disclosed and claimed, for example, in copending Application No. 18377/47 (Serial No. 639,414).

As illustrated diagrammatically in Figure 4, a line 57 around the condenser 7 may be provided to permit a portion of the cooling water passing through line 24 from the absorber 3 to bypass condenser 7. A valve 58 may be disposed in bypass 57 to regulate the quantity of cooling water passing through condenser 7 and bypass 57. The flow of cooling water through the condenser and the absorber may be varied as desired to obtain desired performance of the condenser and the absorber.

Purge arrangement 33 is illustrated in Figure 1 and serves to remove non-condensible gases from the absorber and condenser. Upon an overnight shutdown the level of solution in absorber rises; upon start-up in the morning, for example, purge 33 may remove liquid from the absorber which is undesirable. To avoid this danger, a ball valve 59 of well known construction may be provided in the line connecting purge arrangement 30 with absorber 3 as shown in Figure 1. An increase in level of liquid in the absorber raises the ball (not shown) of valve 59 to close the line to the purge thus preventing liquid from being sucked up by the purge when the system is again operated.

Under some conditions additional water may be introduced to the system during an overnight shut down to dilute the solution. A suitable line 61 is illustrated in Figure 1 for this purpose. A valve 62 is disposed in line 61 to control flow of water therethrough. Assuming it is intended to shut down the system overnight, for example, steam may be cut off while the evaporator continues to operate. A certain amount of water is absorbed by the solution but in some cases an insufficient quantity may be absorbed. Valve 62 may be opened to add a desired quantity of water to the solution in the absorber to dilute the same.

The control arrangements of the present invention permit operation of the absorption refrigeration system from full load to very minor partial loads. Under such varying conditions of operation the control arrangements provided by the present invention function adequately and smoothly to change the operation of the system automatically in accordance with the load imposed upon the system. The control arrangements serve to regulate the capacity of the system, the concentration of solution, the temperature of chilled water leaving the system, flow of condensing water through the tubes of the absorber and the condenser, steam flow through the tubes of the generator and provide various safety controls effective to increase the economical and efficient operation of the system.

The reset control means is not limited in its use to effect a decrease in concentration of the solution at partial load since it may be employed, if desired to maintain the concentration of the solution at any desired point or within any desired range. The means illustrated in Figures 1 and 2, if desired, may be replaced with other control members to govern the concentration of the solution.

In place of air line 46 air line 46' may be provided connected to air line 45 which operates valve 42 to obtain the desired reset control.

The reset control may be used to adjust thermostat 40 to compensate for the increase in temperature of solution leaving the generator, and the decrease in pressure in shell 5, both of which factors would serve to increase the concentration of solution leaving the generator, and in addition, a desired amount to provide a further safety or over-safety factor to assure safe operation under conditions of partial load. Such adjustment or resetting changes the temperatures to which thermostat 40 responds. It will be understood by reference

to the diagram shown in Figure 3 that a change in temperature will compensate for the change in pressure at partial load. Accordingly, under partial load after resetting of control 40 point E of the cycle is adjusted to point E' which indicates different pressure and temperature of solution leaving the generator.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A continuous cycle absorption refrigeration system comprising the combination of an absorber, an evaporator, a generator and a condenser, with means for circulating solution from the absorber to the generator and from the generator to the absorber, means for controlling the refrigerating capacity of the system, said means including a control member disposed to regulate the rate of flow of solution circulating through the system, and means for controlling the operation of said member in response to temperature of refrigerant leaving the evaporator.

2. A continuous cycle absorption refrigeration system comprising the combination of an absorber, an evaporator, a generator, a condenser with a pump for withdrawing weak solution from the absorber and for supplying the weak solution to the generator, means disposed in a line connecting the generator and the absorber adapted to receive a stream of weak solution from the pump thereby entraining strong solution and supplying the mixture to the absorber, and second means for controlling the capacity of the absorber, said second means including a valve for throttling solution flow, and thermal responsive means responsive to temperature of cooled medium leaving the evoporator for controlling the operation of said valve, throttling of said valve decreasing the amount of weak solution supplied to the generator and proportionately decreasing the amount of strong solution supplied to the absorber by the first means.

3. A refrigeration system according to Claim 2 in which the valve is disposed in the line connecting the pump and the entraining means and between the pump and the point of juncture of a weak solution line leading to the generator with the line connecting the pump and the entraining means.

4. A refrigeration system according to any of Claims 1 to 3, having means for supplying heating medium to the generator, a control member adapted to regulate the quantity of heating medium supplied to the generator, and means responsive to variations in temperature of solution leaving the generator for controlling the operation of said member.

5. A refrigeration system according to any of Claims 1 to 3, having a line for supplying heating medium to the tubes of the generator, a control valve disposed in said line adapted to regulate the quantity of heating medium supplied to the generator, and means responsive to variations in temperature of solution leaving the generator for controlling the operation of said valve.

6. A refrigeration system according to any of Claims 1 to 5, having means for supplying cooling fluid to the absorber and the condenser, a control member adapted to regulate the quantity of cooling fluid supplied to the condenser, and means responsive to the temperature of vapour condensate leaving the condenser for controlling the operation of said control member.

7. A refrigeration system according to Claim 6, characterized by the absorber and condenser comprising tubes for the passage of cooling fluid, whilst the generator comprises tubes for the passage of heating fluid.

8. A refrigeration system according to Claim 7, in which the control member controls the flow of cooling fluid through the tubes of the absorber and the condenser.

9. A refrigeration system according to Claim 7 or Claim 8, in which a strong solution line connects the generator and the absorber.

10. A refrigeration system according to Claims 4 and 6, in which the control member regulating the cooling fluid comprises a valve disposed in the cooling fluid line leading to the condenser and the control member regulating the heating fluid comprises a valve disposed in the line supplying heating medium to the tubes of the generator.

11. A refrigeration system according to any of Claims 1 to 10, having a vapour condensate line connecting the condenser and the evaporator.

12. A refrigeration system according to any of Claims 1 to 11, having a horizontally disposed shell, a member disposed in said shell co-operating therewith to form the absorber, said shell also containing a second member co-operating therewith to form an evaporator, a second shell disposed adjacent the first shell, a member in said second shell co-operating therewith to form the generator, and a second member in said second shell co-operating therewith to form the condenser.

13. A refrigeration system according to any of Claims 2 to 12, having a solution overflow arrangement disposed in the line

tc the diagram shown in Figure 3 that a change in temperature will compensate for the change in pressure at partial load. Accordingly, under partial load after resetting of control 40 point E of the cycle is adjusted to point E' which indicates different pressure and temperature of solution leaving the generator.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A continuous cycle absorption refrigeration system comprising the combination of an absorber, an evaporator, a generator and a condenser, with means for circulating solution from the absorber to the generator and from the generator to the absorber, means for controlling the refrigerating capacity of the system, said means including a control member disposed to regulate the rate of flow of solution circulating through the system, and means for controlling the operation of said member in response to temperature of refrigerant leaving the evaporator.

2. A continuous cycle absorption refrigeration system comprising the combination of an absorber, an evaporator, a generator, a condenser with a pump for withdrawing weak solution from the absorber and for supplying the weak solution to the generator, means disposed in a line connecting the generator and the absorber adapted to receive a stream of weak solution from the pump thereby entraining strong solution and supplying the mixture to the absorber, and second means for controlling the capacity of the absorber, said second means including a valve for throttling solution flow, and thermal responsive means responsive to temperature of cooled medium leaving the evoporator for controlling the operation of said valve, throttling of said valve decreasing the amount of weak solution supplied to the generator and proportionately decreasing the amount of strong solution supplied to the absorber by the first means.

3. A refrigeration system according to Claim 2 in which the valve is disposed in the line connecting the pump and the entraining means and between the pump and the point of juncture of a weak solution line leading to the generator with the line connecting the pump and the entraining means.

4. A refrigeration system according to any of Claims 1 to 3, having means for supplying heating medium to the generator, a control member adapted to regulate the quantity of heating medium supplied to the generator, and means responsive to variations in temperature of solution leaving the generator for controlling the operation of said member.

5. A refrigeration system according to any of Claims 1 to 3, having a line for supplying heating medium to the tubes of the generator, a control valve disposed in said line adapted to regulate the quantity of heating medium supplied to the generator, and means responsive to variations in temperature of solution leaving the generator for controlling the operation of said valve.

6. A refrigeration system according to any of Claims 1 to 5, having means for supplying cooling fluid to the absorber and the condenser, a control member adapted to regulate the quantity of cooling fluid supplied to the condenser, and means responsive to the temperature of vapour condensate leaving the condenser for controlling the operation of said control member.

7. A refrigeration system according to Claim 6, characterized by the absorber and condenser comprising tubes for the passage of cooling fluid, whilst the generator comprises tubes for the passage of heating fluid.

8. A refrigeration system according to Claim 7, in which the control member controls the flow of cooling fluid through the tubes of the absorber and the condenser.

9. A refrigeration system according to Claim 7 or Claim 8, in which a strong solution line connects the generator and the absorber.

10. A refrigeration system according to Claims 4 and 6, in which the control member regulating the cooling fluid comprises a valve disposed in the cooling fluid line leading to the condenser and the control member regulating the heating fluid comprises a valve disposed in the line supplying heating medium to the tubes of the generator.

11. A refrigeration system according to any of Claims 1 to 10, having a vapour condensate line connecting the condenser and the evaporator.

12. A refrigeration system according to any of Claims 1 to 11, having a horizontally disposed shell, a member disposed in said shell co-operating therewith to form the absorber, said shell also containing a second member co-operating therewith to form an evaporator, a second shell disposed adjacent the first shell, a member in said second shell co-operating therewith to form the generator, and a second member in said second shell co-operating therewith to form the condenser.

13. A refrigeration system according to any of Claims 2 to 12, having a solution overflow arrangement disposed in the line

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connecting the generator and absorber.

14. A refrigeration system according to any of Claims 1 to 13, having means for purging the condenser and the absorber of non-condensible gases.

15. A refrigeration system according to any of Claims 12 to 14, in which the evaporator is arranged above the absorber in said first shell, said evaporator being adapted for the flash cooling of medium conveyed thereto from the condenser, and the absorber being so arranged that flashed vapour passing downward thereto from the evaporator is adapted to be absorbed by solution therein, whilst the condenser is arranged above the generator in said second shell, the said generator being adapted to vaporise refrigerant to pass upward to be condensed in said condenser.

16. A refrigeration system according to Claim 4, in which means are provided for adjusting the control point of the control member for the heating medium supplied to the generator in response to change in load imposed upon the system.

17. A refrigeration system, according to any of Claims 1 to 16, having means for preventing crystal formation in the solution when the system is operated at partial load.

18. A refrigeration system according to any of Claims 2 to 17, having heat exchange means for disposing strong and weak solutions in heat exchange relation, and a loop in the line connecting the generator and the absorber to assure the presence of an adequate quantity of strong solution in said heat exchange means.

19. A refrigeration system according to Claim 1, 2 or Claim3, having air-governed control arrangements for regulating the operation of the system, and means responsive to pressure created by the pump for supplying solution from the absorber to the generator for discontinuing air supply to the control arrangements, whereby failure of said pump automatically actuates said controls to discontinue operation of the system.

20. A refrigeration system according to Claim 19 in which said pressure responsive means comprises a pressure switch disposed adjacent the pump discharge, said switch being connected to a shut-off valve disposed in the main air line leading to the control arrangements wherey pressure created by said pump actuates said switch to open the valve to supply air to the control arrangements, failure of said pump actuating said switch to close the valve discontinuing supply of air to the control arrangements, and discontinuing operation of the system.

21. A refrigeration system according to any of Claims 7 to 9, having means for bypassing a portion of the cooling fluid from the absorber around the condenser without passage through the condenser tubes, and control means for regulating the quantity of cooling fluid bypassing the condenser.

22. A refrigeration system according to Claim 16, in which the thermal responsive means controlling the valve for throttling the flow of solution are connected to the means for controlling the member regulating the quantity of heating medium supplied to the generator, whereby the control point of the said member is adapted to be reset in response to variation in temperature of cooled medium leaving the evaporator.

23. A continuous cycle absorption refrigeration system according to Claim 1, arranged and adapted to operate substantially as described.

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