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Porter

[11] **3,710,852**

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[54] **DOUBLE EFFECT ABSORPTION HEATING AND COOLING SYSTEM**

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[52] **U.S. Cl.** **165/62,** 62/476, 165/63

[51] **Int. Cl.**.....**F25b 13/00**

[58] **Field of Search** 62/476; 165/62, 63

[56] **References Cited**

UNITED STATES PATENTS

2,853,275	9/1958	Sturley	165/24
3,177,930	4/1965	Anderson, Jr.	165/62
3,292,385	12/1966	Murray	62/101
3,605,432	9/1971	Wada	165/63

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[57] **ABSTRACT**

An absorption machine having a two-stage generator, wherein the machine is adapted to provide cooling, heating or simultaneous heating and cooling. The machine includes an improved hermetic valve useful in the heating mode.

9 Claims, 3 Drawing Figures

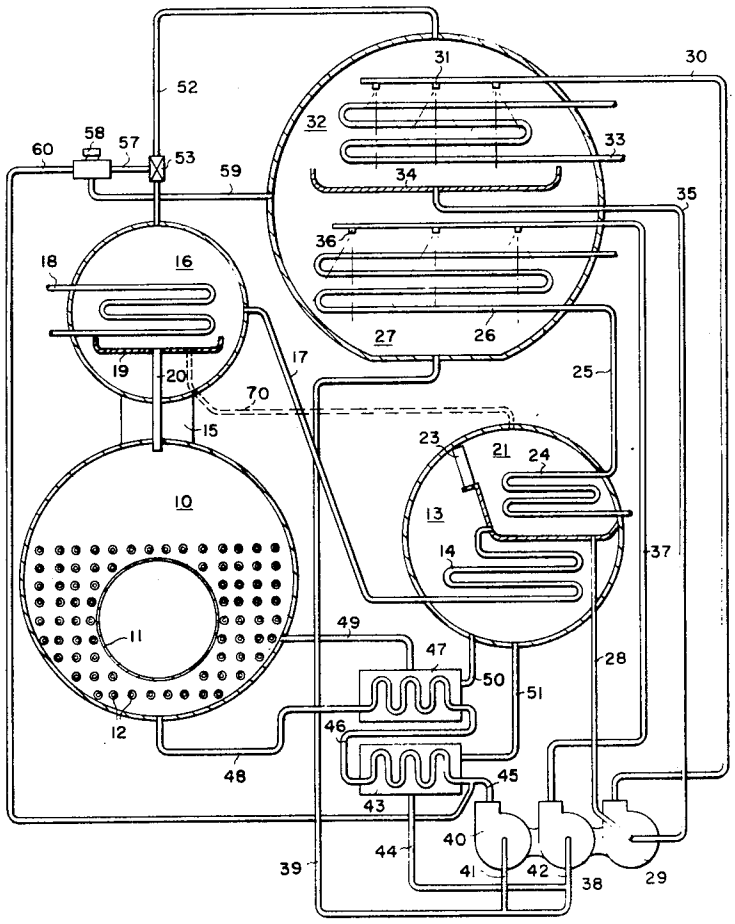

FIG. 1

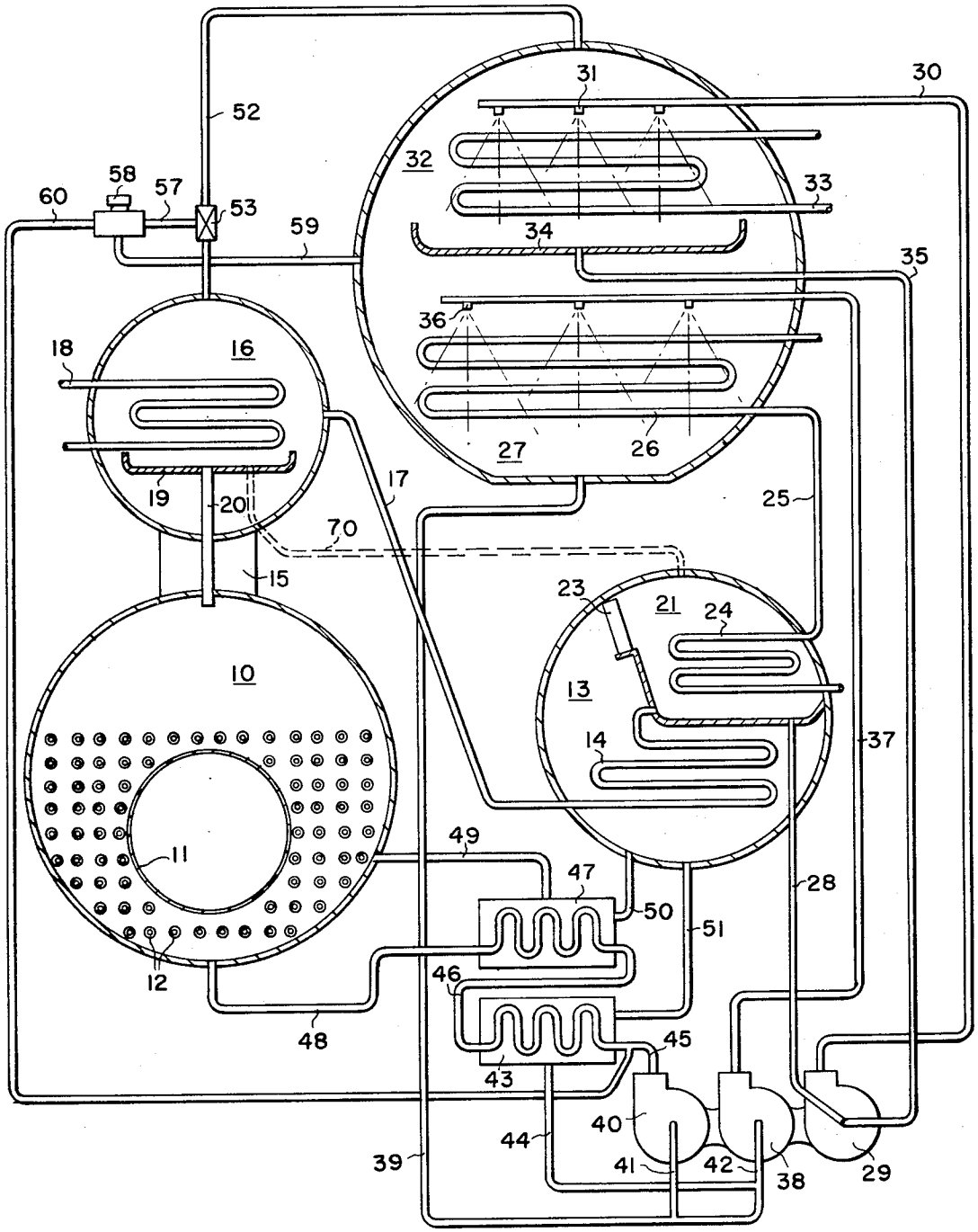

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FIG. 2

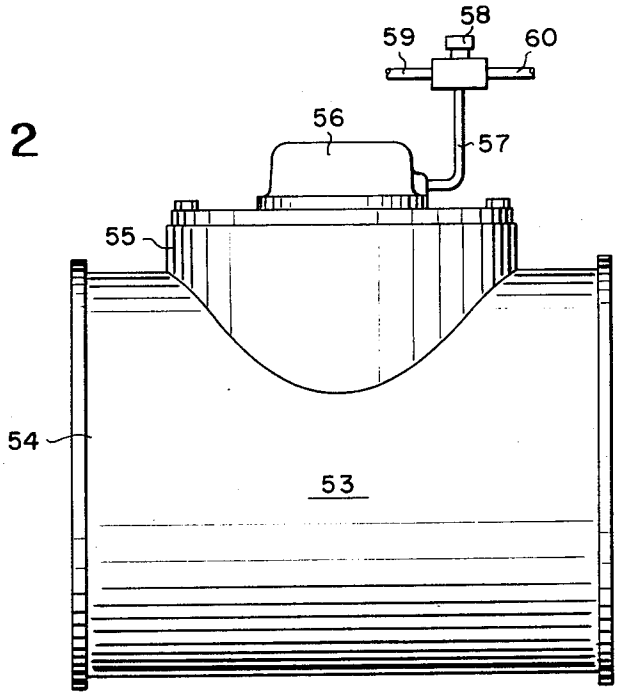
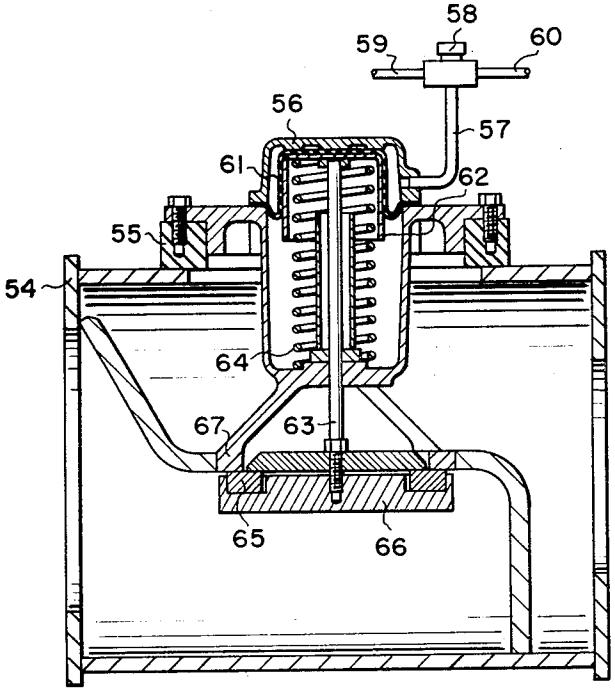


FIG. 3



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DOUBLE EFFECT ABSORPTION HEATING AND COOLING SYSTEM

BACKGROUND OF THE INVENTION

This invention pertains to absorption refrigeration machines, and more specifically, to the use of double effect absorption refrigeration machines to provide either heating or cooling, or to provide both simultaneously.

The prior art has suggested the use of a single effect absorption machine to provide either heating or cooling. For example, U.S. Pat. No. 2,853,275 describes a heating system whereby refrigerant vapor from the generator is passed through the condenser to the evaporator, the cooling water to the condenser having been terminated so that condensation in the condenser is prevented. In the cooling mode, the machine operates in a standard manner known in the art.

The use of a double effect absorption machine to provide simultaneous heating and cooling is disclosed in U.S. Pat. No. 3,292,385. The system described therein provides an additional coil in the second effect generator for indirect heat exchange between the water circulating in the additional coil and the fluid circulating in the tubes of the second effect generator in order to heat the water in the additional coil. One drawback of such a system is that the maximum temperature that may be produced in the heating coil while simultaneously producing cooling is limited by the operating temperatures of the condenser.

The present invention therefore seeks to provide a system of heating or cooling or simultaneous heating and cooling with a double effect absorption machine which avoids the disadvantages of prior art devices.

SUMMARY OF THE INVENTION

The present invention provides an absorption refrigeration machine having first and second effect generators, an evaporator, a condenser, and an absorber, all of which are operably interconnected to provide an absorption refrigeration cycle. The vapor passage between the first and second effect generators includes a chamber portion housing a heat exchange coil through which fluid may be circulated in heat exchange relationship with the vapor from the first effect generator. In this manner, the machine may provide simultaneous heating and cooling. A second vapor passage is provided from the chamber portion to the evaporator, and a vapor valve is positioned in the second vapor passage. When the vapor valve is in the open position, the first effect generator and the evaporator are in vapor communication whereby substantially all of the vapor produced in the first effect generator is passed to the evaporator to provide a heating only cycle of operation.

DESCRIPTION OF PREFERRED EMBODIMENTS

Certain embodiments of the present invention which are preferred will be explained in greater detail with reference to the accompanying drawings, in which:

FIG. 1 is a schematic view of a double effect absorption machine contemplated in the present invention.

FIG. 2 is an enlarged view of the vapor valve shown in FIG. 1.

FIG. 3 is a sectional view of the valve of FIG. 2 showing its internal mechanism.

With particular reference to FIG. 1, a double effect absorption machine is shown. A first effect generator **10** includes a fire tube **11** and heat transfer tubes **12**. While the first effect generator **10** is shown to be of the direct fired type, it will be understood that other means of providing heat energy to the generator can also be used, such as a steam coil in a manner well known in the art. A second effect generator is shown generally at **13** and includes a heat exchange coil **14**. The second effect generator **13** is in vapor communication with the first effect generator **10** by means of vapor passage **15**, chamber **16**, and vapor passage **17**.

Also housed in chamber **16** is heat exchanger **18**, below which may be positioned a pan **19** having a conduit **20** leading therefrom. The function of the pan **19** is to collect condensate from heat exchanger **18** and pass the condensate back to the first effect generator **10** via conduit **20**. If desired, the condensate may also be passed via a conduit **70** (shown in phantom) directly to the condenser **21**.

Condenser **21** is preferably housed in the same shell with second effect generator **13**. The generator **13** and condenser **21** are separated by wall **22**, but may be in vapor communication by way of eliminators **23**. Condenser **21** is provided with a cooling coil **24** through which cooling water may be circulated, after which the water is generally returned to a cooling tower (not shown). Before passing through coil **24**, the water may pass through heat exchange coil **26** in absorber section **27**.

Condensate may be removed from condenser **21** by means of conduit **28** communicating with the suction side of evaporator pump **29**. The condensate is pumped through conduit **30** to the spray headers **31** located in evaporator **32**. The evaporator **32** includes a heat exchange coil **33** which conducts a heat exchange fluid such as water from a load source through the evaporator and back to the load. The load source is typically one or more spaces in a building to be cooled or heated. Refrigerant which is not boiled off on heat exchange coil **33** is collected in the evaporator pan of **34**, and withdrawn from the evaporator through conduit **35** back to the suction side of evaporator pump **29** from where it is recirculated to spray headers **31**.

Refrigerant which is vaporized in the evaporator is drawn into the absorber **27** by the attraction of the absorbent solution being sprayed over heat exchange coil **26** from spray headers **36**. Spray headers **36** are fed by conduit **37** from the discharge side of absorber pump **38**. Dilute solution is withdrawn from absorber **27** through conduit **39** through which it is fed both to the suction side of generator pump **40** by means of conduit **41**, and the suction side of absorber pump **38** by means of conduit **42**. That portion of the dilute solution fed to absorber pump **38** is then recirculated via conduit **37** to spray headers **36** in the absorber **27**, after first having been mixed with absorbent solution from the shell side of heat exchanger **43** passing to the absorber pump **38** through conduit **44**.

Generator pump **40** provides dilute solution to the first effect generator **10** by means of conduit **45**, the tube side of heat exchanger **43**, conduit **46**, the tube side of heat exchanger **47** and conduit **48**. Absorbent solution which has been partially concentrated in first effect generator **10** passes through conduit **49**, the shell side of heat exchanger **47**, conduit **50**, and into second

effect generator 13. The partially concentrated solution is further concentrated in second effect generator 13 by means of heat exchange with vapor flowing through the coil 14. The refrigerant vapor produced in the second effect generator passes through eliminators 23 into the condenser section, and the concentrated solution is withdrawn from the second effect generator 13 by means of conduit 51, through the shell side of heat exchanger 43, and through conduit 44 into the absorber pump 38 to be distributed.

While various combinations of absorbent solution and refrigerant may be used in the present invention, it is preferred to use an absorbent solution comprised of lithium bromide in water, and to use water as the refrigerant. Moreover, as used herein the term concentrated solution refers to a solution which is concentrated in absorbent, whereas the term dilute solution refers to a solution which is dilute in absorbent, that is, rich in refrigerant.

Chamber 16 and evaporator 32 are connected by means of conduit 52. Disposed within conduit 52 is a normally closed valve 53 which will be described in greater detail hereinafter. It can be seen, however, that when valve 53 is open, a vapor passage is formed between the first effect generator 10 and the evaporator 32 through conduit 15, chamber 16, and conduit 52.

Referring particularly to FIGS. 2 and 3, it can be seen that valve 53 includes conduit portion 54, housing portion 55, which in turn includes housing cap 56. A fluid pressure line 57 connects housing cap 56 with solenoid valve 58. Solenoid valve 58 has a fluid supply line 60, preferably communicating with the outlet side of generator pump 40, and an outlet or vent line 59 between valve 58 and absorber 27.

A diaphragm 61 is captured between housing cap 56 and the upper flange of housing 55. Diaphragm 61 rides on a plunger cap 62 of plunger mechanism 63. Plunger mechanism 63 is urged in an upward or closed position by means of spring 64 which is held between the lower portion of housing 55 and the plunger cap 62. The lower portion of plunger mechanism 63 includes a disc portion 66 having an inset resilient ring 65. The ring 65 insures that the plunger mechanism 63 will sealingly engage valve seat 67 when the plunger mechanism is in the closed position.

When solenoid valve 58 allows fluid to pass through conduit 57, fluid pressure is built up in chamber 68 formed by diaphragm 61 and housing cap 56. The increase in fluid pressure on diaphragm 61 then urges a plunger mechanism 63 downwardly, compressing spring 64, and moving disc portion 66 away from the valve seat 67, allowing vapor to flow through conduit portion 54 of valve 53.

When it is desired to close valve 53, solenoid 58 interrupts the flow of fluid through conduit 57, venting remaining pressure through conduit 59 into the absorber. This action allows plunger mechanism 63 to be urged upwardly by the expansion of spring 64, bringing disc portion 66 and ring 65 into a closed relationship with valve seat 67.

OPERATION

In general, the primary function of an absorption machine is to provide refrigeration for a building, and most usually is a building having several rooms such as an office building. Whenever cooling is required from the absorption machine in the present invention, valve 53 will always be fully closed. Dilute solution is fed into the first effect generator 10 through conduit 48. A source of heat energy such as gas or oil is consumed, with its heat being fed into fire tube 11 and heat exchange tubes 12 in the first effect generator. The heat causes the refrigerant in the solution to be boiled off and the heated refrigerant vapor passes out of the first effect generator via vapor passage 15, the partially concentrated solution being drawn off through conduit 49, heat exchanger 47, conduit 50 into the second effect generator 13.

Vapor from conduit 15 passes into chamber 16, and since valve 53 is closed, passes through conduit 17 into the heat exchange coil 14 and the second effect generator. The heat from the vapor in the heat exchange coil 14 causes further boiling of the intermediate solution in second effect generator 13 causing the intermediate solution to become more concentrated. The vapor phase passes through eliminators 23 into the condenser 21. The concentrated solution is removed from the second effect generator via conduit 51 and passes through heat exchanger 43 to conduit 44 and to the suction side of the absorber pump. The vapor is condensed in condenser 21 through the heat exchange with the cooling water flowing through heat exchange coil 24. Condensed vapor, along with any liquid flowing from heat exchange coil 14 is collected in the bottom of the condenser 21 in the area of wall 22. From the condenser the liquid is drawn off through conduit 28 to the suction side of evaporator pump 29.

Evaporator pump 29 receives the condensate from the condenser, and also the condensed liquid from the evaporator pan 34 and discharges them through conduit 30 to the evaporator spray headers 31. In the lower pressure of the evaporator 32, the refrigerant from spray headers 31 passes over heat exchange coil 33, cooling the water from the refrigeration load and providing chilled water to the building for air conditioning purposes. The vaporous refrigerant created in the evaporator is drawn into the absorber section 27 to mix with absorbent solution being sprayed from spray headers 36. The intermediate solution from spray headers 36 mixes with the refrigerant vapor and collects in the lower portion of absorber 27 as dilute absorbent solution, having passed in heat exchange relationship with the cooling water flowing through heat exchanger coil 26. The dilute solution is withdrawn from the absorber via conduit 39 and delivered to the suction side of generator pump 40 in part, and is also in part delivered to the suction side of absorber pump 38.

The dilute solution is pumped by generator pump 40 through heat exchangers 43 and 47 to the first effect generator 10 to complete the absorption refrigeration cycle.

It can be seen that the heated vapor present in chamber 16 provides a potential source of heating for the building installation. Accordingly, heat exchange coil 18 is provided in chamber 16, through which a heat transfer fluid such as water may be circulated to various rooms within the building for heating purposes. When there is no requirement for heating in any of the zones in the building, the flow of heat transfer fluid

through heat exchanger **18** may be terminated, whereby all of the heat available in the vapor may be passed to heat exchange coil **14** in the second effect generator **13**. Thus, the machine of the present invention is well adapted to providing both heating and cooling to the building simultaneously in accordance with the individual demands of the particular zones within the installation.

In the event that no cooling is required in the building, but there is a requirement for heating, and it is desired to utilize the entire capacity of the absorption machine for heating purposes, then solenoid **58** may be activated to allow fluid pressure through conduit **60** to conduit **57** to actuate valve **53**. The fluid pressure acts upon diaphragm **61** compressing spring **64** and opening the valve. At the same time, the cooling water through heat exchange coil **26** in absorber **27** and heat exchange coil **24** in condenser **21** is terminated.

With valve **53** in the open position, substantially all of the vapor produced in first effect generator **10** passes through a vapor passage **15**, chamber **16**, and conduit **52**, into the evaporator **32**. The heated vapor passes in heat exchange relationship with the heat transfer fluid in heat exchange coil **33** thereby providing heated fluid to the spaces in the building which are to be heated. The heat exchange causes the vapor to condense and fall to the evaporator pan **34**, from where it will spill over into absorber **27**.

The condensed refrigerant passing into absorber **27** will mix with the absorbent solution being sprayed from spray headers **36** to form dilute solution in the lower portion of the absorber **27**. The dilute solution then passes via conduit **39** back to generator pump **40** to be delivered back to the first effect generator **10**. The concentrated solution, or in this case more correctly intermediate solution, produced in the first effect generator **10** is drawn off via conduit **49** through heat exchanger **47** and through conduit **50** into the second stage generator **13**. However, since there is no cooling water flowing in the condenser **21** during the heating only mode, the pressure and temperature in the shell will become stabilized and vapor will not continue to flow through heat exchange coil **14**, and therefore the solution is not further concentrated in the second effect generator. The solution then passes through conduit **51**, heat exchanger **43**, and conduit **44** to the absorber pump **42** for further delivery to the absorber spray headers **46** through conduit **47**. It can therefore be seen that with valve **53** in the open position, the machine can only be operated on a heating cycle.

When it is desired to change over from a heating only cycle to a cooling cycle or a heating and cooling cycle, solenoid valve **58** is activated to terminate the fluid flow through line **60** and line **57**. The existing pressure is bleed off through line **59**, the fluid flowing into absorber **27**, thereby removing the fluid pressure from diaphragm **61** allowing the spring **64** to extend to bring valve **53** to the closed position. The absorber and condenser cooling water can then be restarted and the machine operated in a cooling or simultaneous heating and cooling mode as has been described in detail herein before.

It can be seen that valve **53** is operated by fluid pressure internal to the absorption system, for example, by absorbent solution pressure acting upon diaphragm **61**. Thus the valve **53** is completely hermetic in its structure and operation.

While in the foregoing specification, the present apparatus method has been described in considerable detail, it will be understood that such details are for the purposes of illustration and not by way of limitation, and that various modifications can be made by those skilled in the art without departing from the spirit or scope of the present invention, which is defined in the appended claims.

I claim:

1. An absorption refrigeration machine including a first effect generator, a second effect generator, a condenser, an evaporator, and an absorber in operable communication to produce an absorption refrigeration cycle including first vapor passage means between said first and second effect generators; heat exchange means in said first vapor passage means; second vapor passage means between said first effect generator and said evaporator, valve means disposed in said second vapor passage means whereby said machine is operable in a heating only cycle when said valve means is open.

2. An absorption refrigeration machine including a first effect generator, a second effect generator, a condenser, an evaporator, and an absorber operably connected to provide an absorption refrigeration cycle, including first vapor passage means between said first and second effect generators; heat exchange means disposed in said first vapor passage adjacent said first effect generator adapted to pass a fluid in heat exchange relationship with the vapor from said first effect generator to heat said fluid whereby said machine provides silultaneous heating and cooling; second vapor passage means between said first effect generator and said evaporator, valve means disposed in said second vapor passage, substantially all of the vapor produced in said first effect generator being passed to said evaporator when said valve means is open whereby said machine provides heating only.

3. The apparatus of claim **2** wherein said valve means is hermetic.

4. The apparatus of claim **2** wherein said valve means is operable in response to absorbent solution pressure.

5. The apparatus of claim **2** having a first shell housing said first effect generator, a second shell housing said heat exchange means, a third shell housing said evaporator and said absorber, and a fourth shell housing said second effect generator and said condenser.

6. The apparatus of claim **5** wherein said second shell forms a portion of said first and second vapor passage means.

7. The apparatus of claim **6** wherein said valve means is mounted downstream of said heat exchange means.

8. The apparatus of claim **2** wherein said first and second vapor passage means have a common portion.

9. The apparatus of claim **8** wherein said heat exchange means is disposed in said common portion of said first and second vapor passage means.

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