Aug. 15, 1939. H. K. BERGHOLM 2,169,214

REFRIGERATION

Filed April 1, 1936

Fig. 1.

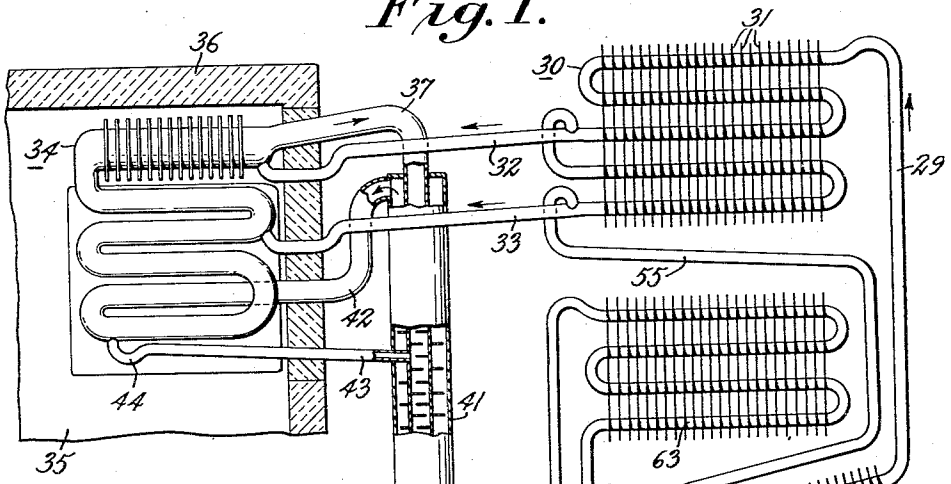
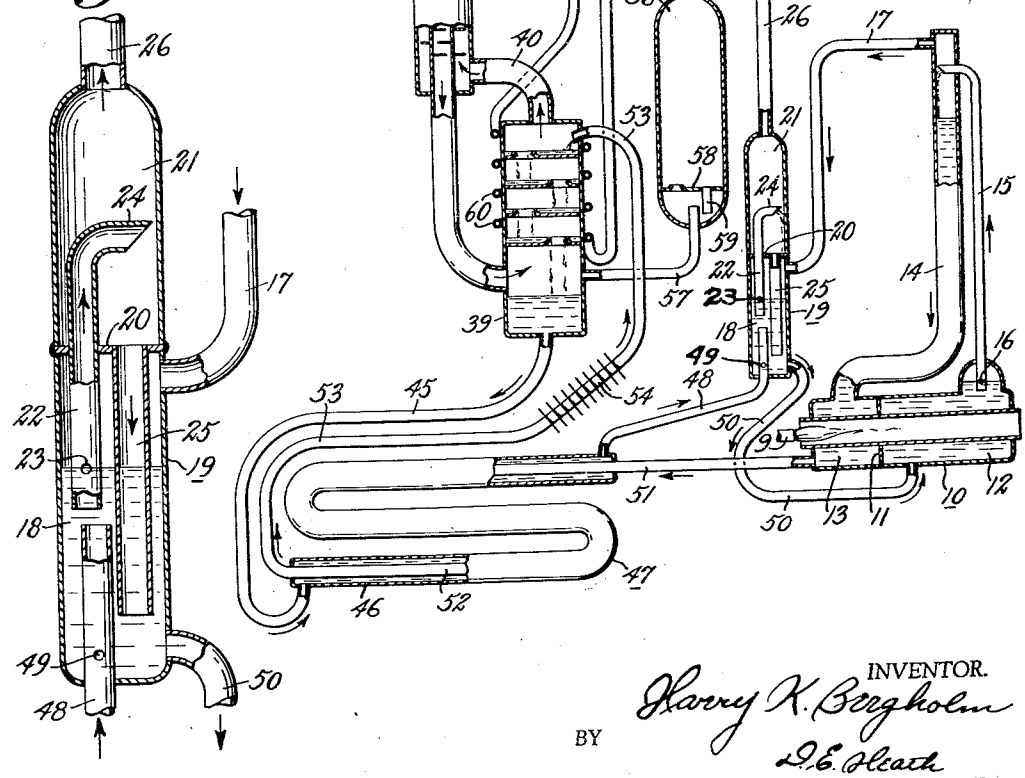


Fig. 2.



INVENTOR.
Harry K. Bergholm

BY
D. E. Heath
ATTORNEY.

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REFRIGERATION

Harry K. Bergholm, Stockholm, Sweden, assignor, by mesne assignments, to Servel, Inc., New York, N. Y., a corporation of Delaware

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8 Claims. (Cl. 62—119.5)

My invention relates to refrigeration and more particularly to circulation of fluids in an absorption type refrigeration system.

It is an object of the invention to bring vapor and liquid into intimate contact by introducing the vapor below a surface level of the liquid, as in an analyzer, without gurgling, and, in general, to carry out circulation of vapor and liquid without gurgling or splashing.

Further objects and advantages of my invention will be apparent from the following description considered in connection with the accompanying drawing which forms a part of this specification and of which:

Fig. 1 is a more or less schematic view, partly in vertical section, of an absorption type refrigeration system embodying my invention; and

Fig. 2 is a cross-sectional view on an enlarged scale of a portion of the system shown in Fig. 1.

Referring to the drawing, reference character 10 designates a generator divided by a partition 11, into a circulation chamber 12 and a weak liquid chamber 13. A standpipe 14 extends upwardly from chamber 13 and a vapor liquid lift conduit 15 extends from within pump chamber 12 to the upper part of standpipe 14. The lower end of conduit 15 extends below the level of liquid maintained within chamber 12 and is provided with an aperture 16 near its lower end. A conduit 17 communicates with the upper part of standpipe 14 and with a chamber 18 formed in the lower part of an analyzer 19. A partition 20 separates chamber 18 from an upper chamber 21 in the analyzer. A vapor liquid lift conduit 22 extends through partition 20 and is provided near its lower open end with an aperture 23. The upper end 24 of conduit 22 within chamber 21 terminates adjacent the wall of the chamber. A drain pipe 25 extends through partition 20 to the lower part of chamber 18. The upper end of pipe 25 is preferably flush with the upper side of the partition so as to drain all liquid from chamber 21.

A conduit 26 communicates with the upper part of chamber 21 and leads upwardly to a rectifier 27 which may comprise a section of conduit provided with air cooling fins 28. A conduit 29 extends upwardly from rectifier 27 to the upper part of a condenser 30. Condenser 30 comprises downwardly extending conduits provided with air cooling fins 31.

Conduits 32 and 33 connect condenser 30 with an evaporator 34 located within the space to be cooled 35 of a refrigerator cabinet 36. Conduit 32 connects an intermediate point of condenser 30 with the upper part of the evaporator while conduit 33 connects the bottom of the condenser with an intermediate point of the evaporator. Both conduits 32 and 33 are provided with liquid traps or seals.

A conduit 37 is connected to the upper part of evaporator 34 and extends downwardly to form the inner conduit of a gas heat exchanger 38 and is connected to the lower part of an absorber 39. A conduit 40 connects the upper part of absorber 39 with the outer conduit 41 of the heat exchanger 38, while a conduit 42 connects the upper end of conduit 41 with the lower part of evaporator 34. A drain conduit 43 connects the lowest point of the evaporator with conduit 37 and is provided with a liquid trap 44.

A conduit 45 connects the bottom of absorber 39 with the outer conduit 46 of a liquid heat exchanger 47, while a conduit 48 connects the other end of conduit 46 with the pump chamber 18 of analyzer 19. Conduit 48 terminates within chamber 18 at a point some distance above the bottom thereof and is provided with a small aperture 49 near the bottom of chamber 18. A conduit 50 connects the lower part of chamber 18 with pump chamber 12 of generator 10. Conduit 51 connects chamber 13 of the generator with the inner pipe 52 of the liquid heat exchanger 47 and a conduit 53 connects the other end of conduit 52 with the upper part of absorber 39. A portion of conduit 53 may be provided with air cooling fins 54.

A conduit 55 connects the lower part of condenser 30 with a storage vessel 56 and the lower part of vessel 56 is connected to the lower part of absorber 39 by means of a conduit 57. An apertured disc 58 is located near the bottom of vessel 56 and is provided with a downwardly extending conduit which terminates near the bottom of vessel 56.

Absorber 39 may be provided directly with air cooling fins or a cooling coil 60 may be located in heat exchange relation with the outside of the absorber and connected by means of conduits 61 and 62 with the upper and lower ends, respectively, of a condenser 63.

The operation of the apparatus is as follows:

The above described system of conduits and vessels is charged with a suitable amount of absorption fluid, refrigerant, and a pressure equalizing gas which is inert with respect to both the absorption fluid and the refrigerant. While many different fluids may be used, I prefer to use water as the absorption medium, ammonia as the refrigerant, and hydrogen as the inert gas.

Water has the property of absorbing large quantities of ammonia while hydrogen is inert with respect to both ammonia and water and is absorbed but slightly by water.

Application of heat to generator 10 by means of any suitable heating element, such as the gas burner 9, causes ammonia, which has been dissolved in the absorption liquid contained in the generator, as will be subsequently explained, to be driven from the solution in the form of a vapor. The vapor collects in the upper part of pump chamber 12 and passes through aperture 16 in conduit 15 and entrains slugs of liquid within the conduit and lifts them to the upper part of standpipe 14 in well known manner. The upper end of the conduit 15 is arranged so that the liquid is deposited on the wall of the standpipe so that it flows downwardly over the wall without splashing into the liquid in the standpipe. Ammonia gas, and a small amount of water vapor, is also driven from the solution contained in chamber 13 and passes upwardly through the stand pipe 14. The mixture of ammonia and water vapors from both chambers 12 and 13 passes from the upper part of standpipe 14 through conduit 17 to the lower chamber 18 of analyzer 19. Chamber 18 is supplied with enriched absorption liquid, that is absorption liquid in which refrigerant gas has been absorbed, and the gas admitted to chamber 18 passes through aperture 23 in conduit 22 and lifts a portion of this liquid through conduit 22 to upper chamber 21, in a manner similar to that described in connection with vapor liquid lift conduit 15. The gaseous mixture of ammonia and water is brought into intimate contact with the strong absorption liquid during the passage through conduit 22. Inasmuch as this absorption liquid already contains refrigerant, the refrigerant gas is not absorbed, but water vapor which accompanies the refrigerant gas from the generator is condensed and returns with the strong solution through conduit 25 to the lower chamber 18.

The refrigerant gas, freed to a great extent from water vapor, passes upwardly through conduit 26 to rectifier 27. In the rectifier the vapor is cooled sufficiently to condense most of the remaining water vapor, which drains back through conduit 26 to the analyzer. Ammonia, having a lower boiling point than water, is not condensed in the rectifier, and the practically pure ammonia vapor passes through conduit 29 to the upper part of condenser 30. Here the ammonia is cooled and condenses during its passage through the condenser. That portion of the ammonia which has been condensed by the time it reaches conduit 32 flows therethrough to the upper part of evaporator 34. The remainder of the ammonia gas is condensed in the lower part of the condenser and flows through conduit 33 to an intermediate point in evaporator 34.

Hydrogen gas is admitted into the lower part of the evaporator through conduit 42 and comes in intimate contact with the liquid ammonia introduced into the evaporator. The ammonia evaporates and diffuses into the hydrogen, which evaporation results in absorption of heat from the chamber 35.

The mixture of ammonia and hydrogen passes from the top of evaporator 34 through conduit 37 to the lower part of absorber 39. Weak absorption liquid is introduced into the upper part of the absorber through conduit 53 and passes downwardly over apertured trays provided in the absorber, thus coming into intimate contact with the gaseous mixture of ammonia and hydrogen which passes upwardly through the absorber. The ammonia gas is absorbed by the water, while the hydrogen gas passes through the absorber and returns to the evaporator through conduits 40, 41 and 42. During its passage through the heat exchanger 38, the cold gaseous mixture in conduit 37 absorbs heat from the hydrogen in conduit 41, thus cooling the hydrogen before it is admitted to the evaporator.

The gaseous circulation between and through the evaporator and the absorber takes place by virtue of the fact that the mixture of hydrogen and ammonia passing downwardly through conduit 37 is heavier than the relatively pure hydrogen passing upwardly through conduits 40, 41 and 42.

The strong absorption liquid formed in absorber 39 passes therefrom through conduit 45 and through conduit 46 of the heat exchanger and through conduit 48 to lower chamber 18 of the analyzer. As previously described, the strong liquid here comes in contact with the vapor discharged from the generator and serves to remove a substantial portion of the water vapor from the ammonia vapor. From chamber 18 the strong absorption liquid passes through conduit 50 to the circulation chamber 12 of the generator and, as previously described, is lifted through vapor liquid lift conduit 15 to the upper part of standpipe 14. Vapor liquid lift conduit 15 maintains a sufficient head of liquid in the standpipe to cause flow from chamber 13 through conduits 51, 52 and 53 to the upper part of absorber 39. While passing through liquid heat exchanger 47, the hot absorption liquid within conduit 52 is cooled by the cooler absorption liquid in conduit 46 before being admitted to the absorber.

Vessel 56 provides a storage space for hydrogen. In the event that the atmospheric temperature rises, a higher pressure within the system will be necessary for condensation of ammonia to take place within the condenser. This higher pressure is obtained by virtue of the fact that, when the temperature increases, a portion of the ammonia will pass through the condenser without being liquefied and will pass through conduit 55 to storage vessel 56 and displace therefrom the stored hydrogen, which passes through conduit 57 into the main part of the system. This increases the pressure to a point sufficiently high so that ammonia will be condensed within the condenser.

The absorption of ammonia gas by water within absorber 39 results in the generation of heat, which is removed by vaporizing a suitable liquid contained in the cooling coil 60. The vapor thus formed passes through conduit 61 to condenser 63, which is cooled by the atmosphere to condense the vapor, which returns through conduit 62 to the lower end of cooling coil 60.

It will be seen that the vapor admitted to the analyzer through conduit 17 from the generator does not bubble freely through the absorption liquid contained in the analyzer, but is confined or limited to a path formed by conduit 22 which terminates adjacent the wall of the upper chamber 21 so that liquid raised by the gas is deposited against the wall and flows downwardly along the wall, whereby gurgling or splashing is reduced or eliminated. Moreover, the contact between the gas and the liquid passing through conduit 22 of the analyzer is more intimate and lasts for a greater length of time than if conduit 17 were merely terminated a short distance

beneath the liquid level in the analyzer to produce bubbling of the vapor through the liquid.

The aperture **49** is provided in conduit **48** near the bottom of chamber **18** to facilitate starting of the apparatus. Strong absorption liquid has a lower specific gravity than does weak absorption liquid. It will be noted that the absorber and conduits **45**, **46** and **48** constitute a downward loop or U, and that flow takes place therethrough from the absorber to the upper end of conduit **48** within the analyzer by gravity. If the solution contained in the leg of this U connected to the absorber is stronger than that contained in the other leg, a higher level of liquid will be required in the absorber to cause flow, due to the difference in specific gravities of the solution of different strengths. When starting, the solution in the absorber may be considerably stronger, and hence lighter, than the solution adjacent the analyzer. In order for flow to start under these conditions, it would be necessary for the liquid level to rise in the absorber to an undesirable height. However, the provision of aperture **49** makes it possible for the apparatus to start operating without the level in the absorber being raised. Of course, during the starting period, the liquid level in the analyzer is so low that no liquid is raised through conduit **22** but this condition is soon changed, inasmuch as the strength of the solution in the absorber and in the analyzer becomes equal as soon as circulation between the two is well established.

While I have described one more or less specific embodiment of my invention, it is to be understood that variations thereof fall within its scope as set forth in the following claims.

What is claimed is:

1. In an absorption refrigeration apparatus, an absorber, an analyzer having an upper and a lower chamber, a conduit for conveying strong absorption liquid by gravity from said absorber to said lower chamber, said conduit extending downwardly from said absorber and thence upwardly and terminating above the bottom of said lower chamber, means for establishing restricted communication between the interior of said conduit and the interior of said lower chamber at a point below the termination of said conduit in said lower chamber, a generator, means for conveying absorption liquid from said lower chamber to said generator, means for heating said generator to vaporize fluid therein, means for conveying vapor from said generator to said lower chamber, a vapor liquid lift operative by said vapor to lift absorption liquid from said lower chamber to said upper chamber, and means for conveying absorption liquid from said upper chamber to said lower chamber.

2. An absorption type refrigeration system including a generator an absorber, an analyzer having a lower chamber and an upper chamber, members including said lower chamber for circulation of absorption liquid between said generator and said absorber, a vapor liquid lift conduit connecting said lower chamber to said upper chamber, a conduit for vapor from said generator to said lower chamber, whereby vapor is introduced into said lower chamber to raise liquid therein through said vapor liquid lift conduit into said upper chamber, said vapor liquid lift conduit being constructed and arranged so that liquid is discharged from the upper end thereof against a wall of said upper chamber, a drain conduit for liquid from said upper chamber to said lower chamber, and a conduit for withdawing vapor from said upper chamber.

3. A refrigeration system having a part wherein refrigerant vapor is expelled from absorption liquid, a part wherein refrigerant vapor is absorbed in absorption liquid, a further part wherein expelled vapors pass in contact with absorption liquid, members connecting said parts in circuit so that liquid can circulate through said parts and from one to another, and means for causing circulation of liquid in said circuit so that liquid flows from said part wherein absorption takes place first to said part wherein vapor and liquid contacts and then to said part wherein vapor is expelled, said part wherein vapor and liquid contact containing a body of liquid which is in said circuit and having an upright passage through which vapor passes upward and carries with it absorption liquid from said body and which extends above and discharges above the maximum level to which liquid might rise to interfere with fluid issuing therefrom, and said last-mentioned part being formed so that liquid emerging from the upper end of said passage returns by gravity directly to said body, whereby gurgling is obviated and without effect upon the rate of circulation of absorption liquid in said circuit.

4. A refrigeration system as set forth in claim 3 in which said means for causing circulation of liquid is a vapor liquid lift.

5. A refrigeration system as set forth in claim 3 in which said part wherein vapor and liquid contacts is formed to provide a surface leading to said body of liquid and on which liquid is deposited at close range from the upper end of said passage, whereby splashing is obviated.

6. A method of refrigeration which includes expelling refrigerant vapor from absorption liquid, liquefying the expelled vapor, evaporating the liquefied refrigerant fluid, absorbing the evaporated refrigerant fluid into absorption liquid, causing circulation of absorption liquid through and between a place where the expelling is carried out and a place where the absorption is carried out, conducting expelled vapors into the presence of absorption liquid at a place of vapor and liquid contact in the path of flow of liquid from said place of absorption to said place of expulsion, and causing liquid to rise upward with vapor at said place of contact for a desired distance and then separate from the vapor above the maximum level to which liquid can rise to impede the rising liquid and vapor and causing the separated liquid to descend directly to the level at which it joined the vapor, whereby gurgling is obviated and without effect upon the rate of circulation of absorption liquid through and between said places.

7. A method of refrigeration as set forth in claim 6 in which the circulation of absorption liquid through and between said places of absorption and expulsion is carried out by vapor lift action.

8. A method of refrigeration as set forth in claim 6 in which, upon separation of liquid from vapor at said place of vapor and liquid contact the liquid is conducted back to the level at which it joined the vapor by gravity flow on a wall surface so that splashing does not occur.

HARRY K. BERGHOLM.