United States Patent

Eber

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[45] **Aug. 15, 1972**

[54] **INERT GAS TYPE ABSORPTION REFRIGERATION APPARATUS EMPLOYING SECONDARY REFRIGERATION SYSTEM**

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[52] **U.S. Cl.** **62/333,** 62/490, 62/502, 165/105

[51] **Int. Cl.** **F25b 15/10,** F25d 17/00

[58] **Field of Search**..........62/99, 114, 119, 332, 333, 62/334, 476, 490, 502; 165/105

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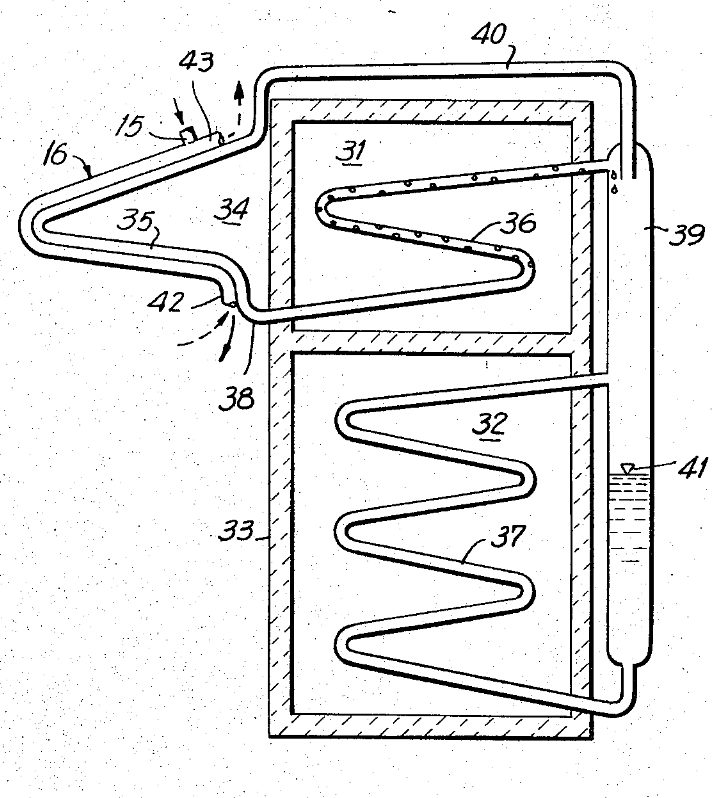
[57] **ABSTRACT**

A cooling element of primary absorption refrigeration apparatus of the inert gas type has a temperature gradient in which the temperature progressively increases from a first temperature to a second higher temperature in an elongated path of flow in which refrigerant fluid evaporates in the presence of such gas. A secondary refrigeration system partly filled with a mixture of volatile liquids has an evaporation portion to abstract heat from the objective of cooling and a condensation portion which, along its length, is in thermal exchange relation with the cooling element. The mixture of volatile liquids forms a refrigerant fluid mixture which possesses such physical properties that the refrigerant fluids will vaporize in the evaporation portion or condense in the condensation portion or vaporize and condense in both portions, respectively, at different temperatures between the first and second higher temperatures prevailing in the cooling element. The circulation of the refrigerant fluid mixture in the secondary refrigeration system is effected solely by vapor bubbles resulting from the vaporization and boiling of the mixture of refrigerant fluids in the evaporation portion.

7 Claims, 4 Drawing Figures



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2 Sheets-Sheet 1

FIG.1

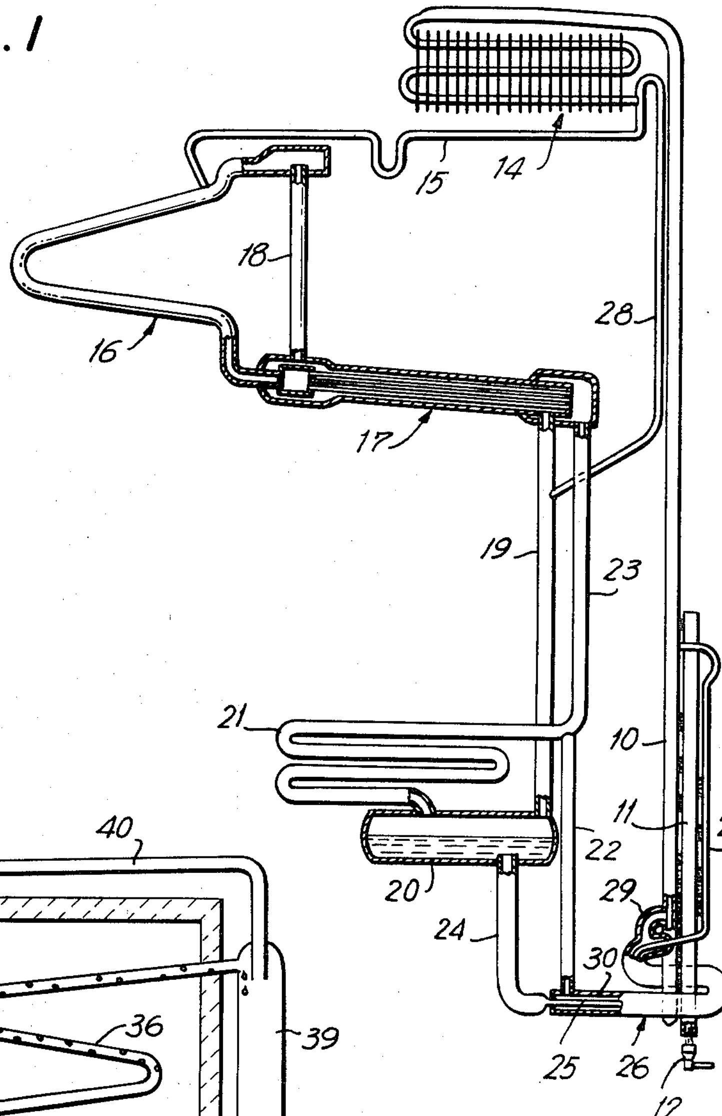

FIG.2

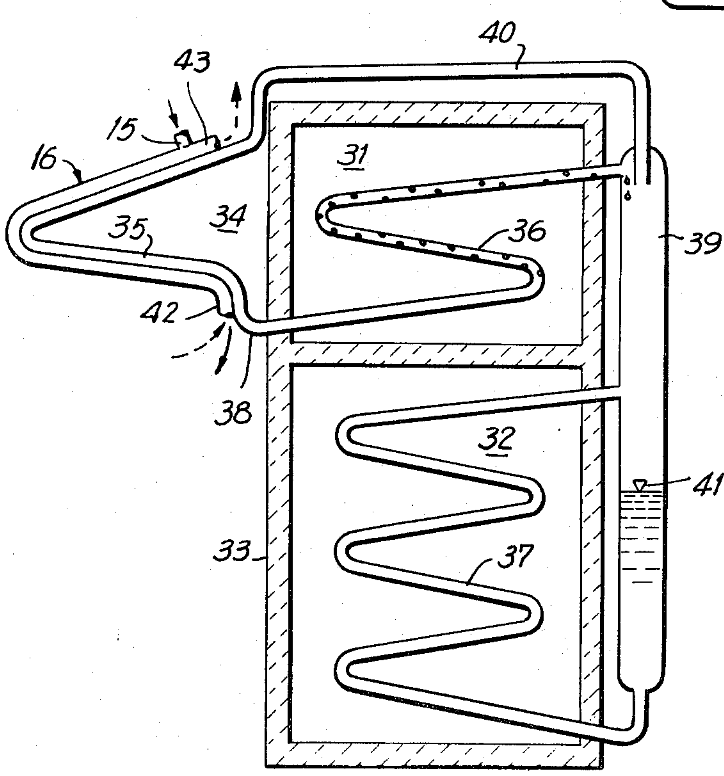

FIG. 3

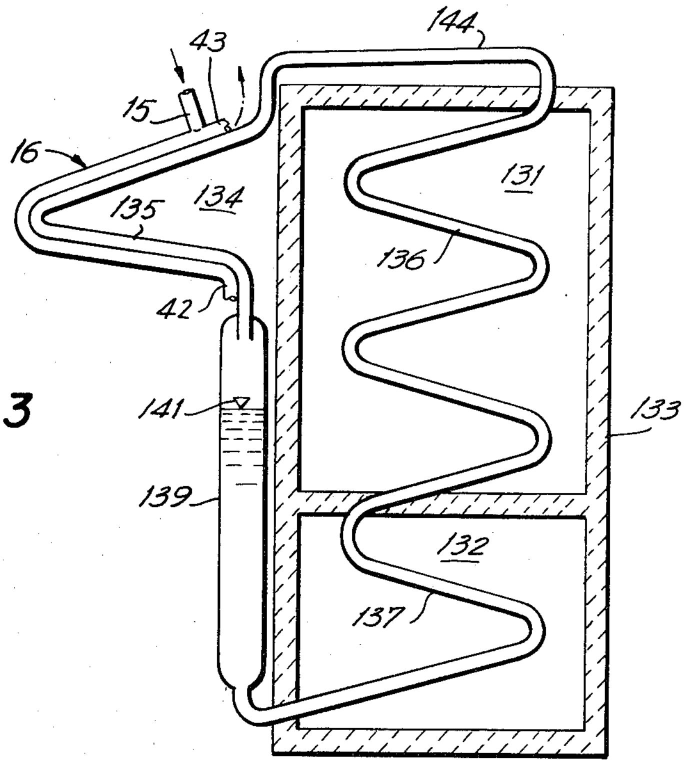
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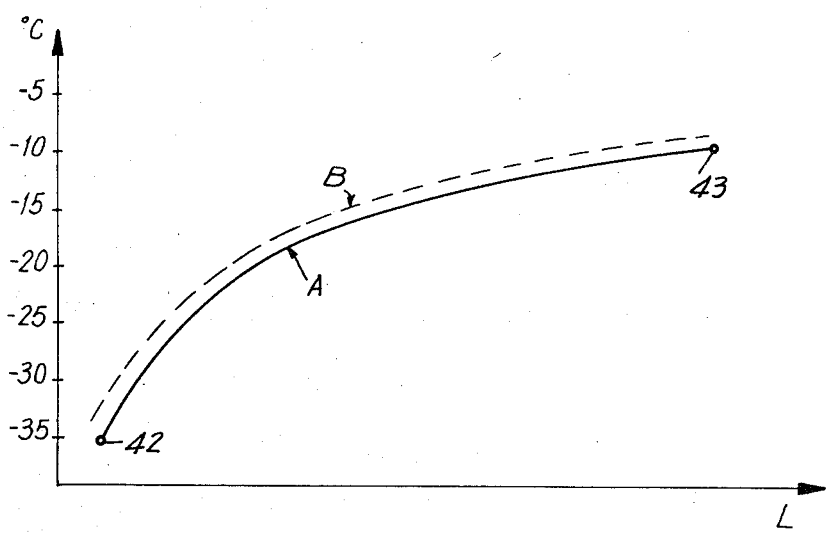
FIG. 4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INERT GAS TYPE ABSORPTION REFRIGERATION APPARATUS EMPLOYING SECONDARY REFRIGERATION SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

In absorption refrigeration apparatus of the inert gas type a secondary refrigeration system often is employed to transfer cooling effect from the cooling element of primary absorption refrigeration apparatus to the objective of cooling.

2. Description of the Prior Art

In absorption refrigeration apparatus of the inert gas type the construction of the cooling unit is dependent on several conditions which makes it difficult to fabricate the cooling unit in the most desirable way in each given situation. The cooling unit must be positioned a sufficient distance below the condenser to promote gravity flow of condensed refrigerant to the cooling unit, such flow being dependent upon the hydrostatic pressure of a column of liquid refrigerant.

Also, the cooling unit and condenser must be vertically spaced a sufficient distance so that, when the refrigeration apparatus is initially started, the light refrigerant condensate formed in the condenser will displace heavy absorption solution present in the condensate line at such time. Further, the cooling unit must be so constructed that liquid traps, which prevent unobstructed circulation of inert gas, are avoided.

In order to avoid an excessive pressure drop of circulating inert gas, the cooling unit piping employed desirably has a comparatively large diameter. The size of this piping in turn has a direct bearing with respect to the difficulties encountered in bending the piping. This is so because the smallest bending radius of piping is dependent upon the diameter of the piping. Lastly, the cooling unit must be located sufficiently high above the absorber to produce and develop a force within the apparatus to promote proper circulation of gas in the inert gas circuit.

By employing a secondary refrigeration system to transfer cooling effect from the cooling unit of the absorption refrigeration apparatus to the objective of cooling it is possible to overcome the limitations regarding the construction of the cooling unit. Secondary refrigeration systems of the kind in which heat transfer liquid is circulated by gravity due to temperature differences in different parts of the system are well known. Secondary systems of the kind in which a volatile liquid evaporates in a vaporization portion to effect cooling and condenses in a condensation portion cooled by the cooling unit of the primary absorption refrigeration apparatus also are old.

In a cooling unit of absorption refrigeration apparatus liquid refrigerant evaporates into inert gas circulating therethrough. The temperature at which liquid refrigerant evaporates into inert gas, at different regions along the path of flow of circulating inert gas, is dependent upon the partial pressure of refrigerant vapor in the inert gas. With continued evaporation of liquid refrigerant the partial pressure of refrigerant vapor in the inert gas and the temperature at which liquid refrigerant evaporates will both constantly increase. The quantity of liquid refrigerant that can be evaporated per degree of temperature increases with increasing temperature in relation to the saturation curve for pressure and temperature of the refrigerant, such curve having the same character for all refrigerants.

In view of what has been stated above, there will be some discrepancy between the temperature characteristics of the cooling unit of the primary absorption refrigeration apparatus and the condensation portion of the secondary refrigeration system which results in irreversibilities and losses. When a heat transfer fluid is circulated in a secondary system which always remains in a liquid state and has a constant specific heat, the aforementioned losses are slightly smaller than in a secondary system in which evaporation and condensation of a volatile heat transfer fluid is effected at a constant temperature. Nevertheless, the flexibility and heat-transferring capabilities in a secondary system, in which evaporation and condensation of a volatile heat transfer fluid are effected, are considerably greater than in a secondary system in which heat transfer is effected by a non-volatile liquid and hence systems employing volatile heat transfer fluids are preferable.

In primary absorption refrigeration apparatus employing known secondary refrigerating systems, considerable losses occur. The uniform cooling temperature in the secondary refrigeration system corresponds to the highest temperature prevailing in the cooling unit of the primary absorption refrigeration apparatus. If it is desired to operate such a secondary system at a low temperature the total cooling effect of the primary absorption refrigeration apparatus has to be effected at a temperature which is at a value below the temperature at which it is desired to operate the secondary system. Under these conditions the operation of the primary absorption refrigeration apparatus involves a considerable consumption of effect and a correspondingly low efficiency of the entire refrigerating structure. Accordingly, the aforementioned combination o primary and secondary refrigerating structures has been employed only when the range of operating temperatures of the cooling unit of the primary absorption refrigeration apparatus under all operating conditions encountered will be small, such as, for example, in refrigerators primarily employed for freezing purposes.

SUMMARY OF THE INVENTION

My invention relates to absorption refrigeration apparatus of the inert gas type having a secondary refrigeration system associated therewith which includes a condensation portion capable of operating at a plurality of temperatures, that is, in a temperature range rather than at one temperature which is characteristic of secondary refrigerating systems heretofore provided.

I accomplish this by providing a secondary refrigerating system which is partly filled with a mixture of volatile liquids which forms a refrigerant fluid mixture possessing such physical properties that the refrigerant fluids will vaporize in the evaporation portion or condense in the condensation portion or vaporize and condense in both portions, respectively, at different temperatures between the first and second higher temperatures prevailing in the cooling element of the primary absorption refrigeration apparatus.

By providing secondary refrigerating systems embodying my improvement the range of applications of such systems is materially increased, such as, for example, for use with refrigerators operating at two or more different temperatures. It is also possible to subdivide the refrigerating effect produced by a single primary absorption refrigeration apparatus by using one or more secondary refrigerating systems to effect cooling in a number of thermally insulated storage spaces of the same or different refrigerator cabinets.

By partly filling the secondary refrigerating system with a mixture of two volatile liquids, which may be referred to as refrigerants, a satisfactory correspondence can be obtained between the evaporation characteristic of the cooling element of the primary absorption refrigeration apparatus and the condensation characteristic of the condensation portion of the secondary refrigerating system.

The evaporation characteristic of the mixture of refrigerants in the evaporation portion of the secondary system, which may be two refrigerants, for example, depends upon a number of factors which includes the physical characteristics of the individual refrigerants in the mixture, the composition or make-up of the mixture, the working pressure of the secondary system, and the relation between the quantity of volatile liquid circulating in the secondary system and the quantity of vapor formed in the system. This last-mentioned relation in turn depends on the refrigerating load on the secondary system and the resistance offered in the system to flow of fluids therein which is determined, among other things, by the cross-sectional areas of the condensation and evaporation portions and conduits connecting these parts. The circulation of volatile liquids in the secondary system is promoted by vapor formed in the system.

Since the combinations of individual refrigerants that can be employed in accordance with my invention is virtually unlimited, I do not wish my invention to be restricted in any way with respect to the individual refrigerants and particular mixtures thereof.

In accord with my invention a mixture of refrigerants can be formed more or less theoretically by selecting individual refrigerants whose thermo-dynamic properties are well known and available, for example, from an enthalphy mixture diagram. Under these conditions, a more or less arbitrary assumption of the composition of the mixture of volatile liquids and the operating pressure of the system is made. The evaporation characteristic obtained for the mixture is compared, preferably graphically, with the corresponding characteristic of the cooling element of the primary absorption refrigeration apparatus. Then the assumptions initially made are corrected until a satisfactory correspondence is obtained between the characteristic of the mixture of volatile liquids and that of the cooling element of the primary refrigeration apparatus. By way of example and without limitation, a mixture of volatile liquids that can be employed in secondary refrigerating systems embodying my invention are available under the trademark "Freon" and include "Freon 12" and "-Freon 13" with "Freon 13" comprising approximately 30 percent by weight of the mixture.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing,

FIG. 1 is a view more or less diagrammatically illustrating an absorption refrigeration apparatus of the inert gas type to which the invention has been applied;

FIG. 2 is a vertical sectional view of a refrigerator and a cooling arrangement therefor provided by a secondary refrigeration system which embodies the invention and is associated with primary absorption refrigeration apparatus like that shown in FIG. 1;

FIG. 3 is a view similar to FIG. 2 illustrating another embodiment of the invention; and

FIG. 4 illustrates temperature curves obtained in accordance with the invention of a cooling element of primary absorption refrigeration apparatus and the condensation portion of a secondary refrigeration system associated therewith.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 I have shown an absorption refrigeration system of a uniform pressure type which is well known in the art and in which an inert pressure equalizing gas is employed. Such a refrigeration system comprises a generator or boiler **10** containing a refrigerant, such as ammonia, in solution in a body of absorption liquid, such as water. Heat may be supplied to the boiler **10** from a heating tube or flue **11** thermally connected therewith, as by welding. The heating tube **11** may be heated in any suitable manner, as by an electrical heating element or a liquid or gaseous fuel burner **12**, for example, which is adapted to project its flame into the lower end of the tube.

The heat supplied to the boiler **10** and its contents expels refrigerant vapor out of solution, and the vapor thus generated flows to an air-cooled condenser **14** in which it is condensed and liquefied. Liquid refrigerant flows from condenser **14** through a conduit **15** into a cooling element **16** in which it evaporates and diffuses into an inert pressure equalizing gas, such as hydrogen, which enters the lower part thereof from a gas heat exchanger **17**. Due to evaporation of refrigerant fluid into inert gas, a refrigerating effect is produced and heat is abstracted from the surroundings.

The rich gas mixture of refrigerant vapor and inert gas formed in cooling element **16** flows from the upper part thereof through a conduit **18**, gas heat exchanger **17**, conduit **19** and absorber vessel **20** into the lower part of an absorber coil **21**. In absorber coil **21** the rich gas mixture flows countercurrent to downwardly flowing absorption liquid which enters through a conduit **22**. The absorption liquid absorbs refrigerant vapor from inert gas, and inert gas weak in refrigerant flows from the upper part of absorber coil **21** in a path of flow including conduit **23** and gas heat exchanger **17** into the lower part of cooling element **16**.

The circulation of gas in the gas circuit just described is due to the difference in specific weight of the columns of gas rich and weak, respectively, in refrigerant vapor. Since the column of gas rich in refrigerant vapor and flowing from the upper end of the cooling element **16** to the absorber coil **21** is heavier than the column of gas weak in refrigerant vapor and flowing from absorber coil **21** to the lower end of the cooling element **16**, a force is produced or developed within the system for causing circulation of gas in the manner described.

Absorption solution flows downwardly through coil 21 into the absorber vessel 20, and such solution, which is enriched in refrigerant, passes from the vessel through a conduit 24 and an inner passage or pipe 25 of liquid heat exchanger 26 into the lower end of a vapor lift pipe or tube 27 which is in thermal exchange relation with the heating tube 11, as by welding. Liquid is raised by vapor-liquid lift action through pipe 27 into the upper part of boiler 10. Refrigerant vapor expelled out of solution in boiler 10, together with refrigerant vapor entering through pipe 27, flows upwardly from the boiler to the condenser 14, as previously explained.

The outlet end of condenser 14 is connected by an upper extension of conduit 15 and a conduit 28 to a part of the gas circuit, as to the upper part of conduit 19, for example, so that any inert gas which may pass through the condenser 14 can flow into the gas circuit. The absorption liquid from which refrigerant vapor has been expelled flows from the boiler 10 through a connection 29, an outer pipe or passage 30 of the liquid heat exchanger 26 and conduit 22 into the upper part of the absorber coil 21. The circulation of absorption solution in the liquid circuit just described is effected by raising of liquid through pipe 27.

In accordance with my invention, in order to abstract heat more effectively from the upper and lower thermally segregated spaces 31 and 32, respectively, of an upright cabinet 33, I provide a hermetically sealed secondary refrigerating system 34 in FIG. 2 which has a condensation portion 35 in thermal exchange relation with the cooling element 16 and evaporation or vaporization portions 36 and 37 arranged to abstract heat from the spaces 31 and 32. The spaces 31 and 32 respectively serve as a freezer section and a section for storing foods, as will be explained presently.

The lower end of the condensation portion 35 is connected by a conduit 38 to the lower end of the vaporization portion 36, the upper end of which is connected to the upper end of a standpipe 39 disposed exteriorly of the cabinet 33. The upper end of standpipe 39 is connected by a conduit 40 to the upper end of the condensation portion 35. The lower end of the vaporization portion 37 is connected to the lower end of the standpipe 39 and the upper end thereof is connected to an intermediate region of the standpipe between its upper and lower ends.

The secondary condenser 35, vaporization portions 36 and 37, standpipe 39 and connecting conduits 38 and 40 form a closed fluid circuit which, after being evacuated, is partly filled with a mixture of volatile liquids, such as "Freon 12" and "Freon 13", for example, in the proportions referred to above. The secondary refrigerating system is initially charged with the mixture of volatile liquids so that the liquid surface level in the standpipe 39 will reach the level 41, as shown in FIG. 2.

During operation of the primary absorption refrigeration apparatus inert gas weak in refrigerant and flowing from the gas heat exchanger 17 is introduced into the lower end of the cooling element 16 at 42. Inert gas flows upward through the cooling element 16 in counter flow to downwardly flowing liquid refrigerant which flows into the cooling element through the conduit 15. Inert gas saturated with refrigerant vapor passes from the upper end of the cooling element 16 at 43. The cooling element 16 comprises a conduit which provides an elongated path of flow for the inert gas and has a temperature gradient in which the temperature progressively increases from a first temperature at its lower end at 42 to a second higher temperature at its opposite upper end 43 in the path provided by flow of the cooling element. This is so because, since the inert gas flows upward in the cooling element 16 from its lower end 42 to its upper end 43, the gas in the lower end contains a lesser amount of refrigerant vapor than the gas in the upper end. The partial vapor pressure of the refrigerant is a gradient, so that the temperature of liquid refrigerant in the cooling element 16 also is a gradient, the evaporating temperature being lower at the lower end 42 of the cooling element and higher at the upper end 43 thereof.

The conduit forming the condensation portion 35 extends lengthwise of the cooling element 16 and is in thermal exchange relation therewith in any suitable manner, as by welding, for example. The cooling effect produced by the cooling element 16 is transmitted to the condensation portion 35 which causes evaporation of the volatile liquids in the vaporization portions 36 and 37, thereby taking up heat from air in the freezer and storage sections 31 and 32, respectively.

The vapor bubbles formed in both vaporization portions 36 and 37 flow through the upper part of standpipe 39 and conduit 40 into the condensation portion 35 in which it is condensed and liquefied by the cooling element 16. Condensation of vapor in the condensation portion 35 takes place in such manner that the mixture of refrigerant fluids in the secondary system is in the form of condensate at the lower end of the condensation portion. Vapor components having different evaporating temperatures are condensed in different parts of the condensation portion 35. Vapor components with a high evaporating temperature, or vapor components which for the most part have a high evaporating temperature, are initially condensed in the upper part of the condensation portion. The condensation of vapor components remaining in the vapor mixture and having lower evaporating temperatures is effected at an increasingly higher rate toward the lower end of the condensation portion 35.

Condensate formed in the condensation portion 35 flows therefrom into the lower end of the vaporization portion 36. Components of the refrigerant fluid mixture having low evaporating temperatures vaporize in the vaporization portion 36. The vapor bubbles formed in the vaporization portion 36 function to force and raise liquid therein for gravity flow from the upper end of the portion 36 into the standpipe 39, the internal diameter of the vaporization portion 36 being sufficiently small to effect such raising of liquid. Vapor is separated from liquid in the standpipe 39, the vapor flowing through the conduit 40 to the condensation portion 35 and the liquid refrigerant flowing into the lower end of the vaporization portion 37.

Components of the refrigerant fluid mixture having a high evaporating temperature evaporate in the vaporization portion 37. The vapor bubbles formed in the vaporization portion 37 also function to force and raise liquid therein, the internal diameter of the vaporization portion 37 being sufficiently small to effect such raising of liquid by vapor-liquid lift action in a manner similar to that described above in describing the manner in which the vaporization portion **36** functions. It will be seen in FIG. **2** that liquid and lifting vapor from the upper end of the vaporization portion **37** flows into the standpipe **39** and the vaporization portions **36** and **37** provide two paths of flow for circulating refrigerant fluid having a part common to both of them. The secondary refrigerating system **34**, as pointed out above, is partly filled with a mixture of volatile liquids which form the refrigerant fluid mixture. The circulation of the refrigerant fluid mixture in the secondary system **34** is effected solely by the vapor bubbles formed in the vaporization portions **36** and **37** in the manner just explained. This is so because, in the secondary system **34** of FIG. **2**, an inert gas is not relied upon to effect circulation of the refrigerant fluid mixture. The vapor bubbles are formed as the result of evaporation of the refrigerant fluid mixture which takes up heat thereby transmitting cooling effect and cooling the separate compartments **36** and **37**. Hence, the vapor bubbles resulting from the vaporization and boiling of the volatile fluid itself, which is a boiling mixture of at least two volatile fluids, effects circulation of the refrigerant fluid mixture in the secondary refrigerating system **34**.

Since there is unobstructed communication between the condensation portion **35** and vaporization portions **36** and **37**, these portions will all operate at substantially the same pressure. In view of the fact that the liquid refrigerant mixture flowing to the low temperature vaporization portion **36** contains more components having a low evaporating temperature than the liquid refrigerant mixture flowing to the higher temperature vaporization portion **37**, the vaporization portion **36** inherently will operate at a lower temperature than the vaporization portion **37** which is disposed below the vaporization portion **36**. Further, liquid refrigerant will evaporate in each of the vaporization portions **36** and **37** at increasingly higher temperatures from their lower ends to their upper ends. This is an advantage rather than a disadvantage because the secondary refrigeration system in its entirety can operate at an exceptionally high efficiency.

It will be understood that the embodiment of the invention being described is shown very diagrammatically in FIG. **2** and simply illustrates the form the secondary refrigeration system can take. For example, the vaporization portions **36** and **37** may assume different shapes and heat transfer members or fins may be provided to promote heat transfer from the objective of cooling, that is, the air in the thermally segregated spaces **31** and **32** and the meat and food products stored therein. Also, the vaporization portions **36** and **37** can be heat conductively connected to inner metallic liners or wall surfaces of the spaces **31** and **32**, either at their inner exposed sides or at the opposite outer sides at which regions they are enveloped in insulation.

It will also be understood that in practicing the invention all of the parts shown in FIG. **2** are thermally insulated from the surroundings. Hence, all of the conduits disposed outside the cabinet **32**, the standpipe **39** and cooling element **16** and condensation portion **35**, which are heat conductively connected to one another, are provided with suitable insulation in order that the secondary system will function properly.

FIG. **3** diagrammatically illustrates another embodiment of my invention in which parts similar to those shown in FIG. **2** are referred to by the same reference numeral to which "**100**" is added. In FIG. **3** all of the parts of the secondary refrigeration system **134** are connected in series to provide a single path of flow for the refrigerant fluid mixture.

The important feature of the FIG. **3** embodiment is that the vaporization portion **137** in the bottom space **132** operates at a lower temperature than the vaporization portion **136** in the top space **131**. Hence, the bottom space **132** serves as a freezer while the top space **131** serves as a storage compartment for storing foods at a temperature which preferably is above the freezing temperature.

In FIG. **3** the refrigerant fluid mixture is condensed in the condensation portion **135** in the same manner that refrigerant is condensed in the condensation portion **35** in FIG. **2**, as explained above; and the condensate, which comprises fluid components having different evaporating temperatures, flows into the standpipe **139** to the level **141** therein. From the standpipe **139** condensate flows into the lower end of vaporization portion **137**. Components of the refrigerant fluid mixture having low evaporating temperatures vaporize in the vaporization portion **137**. The vapor bubbles formed in the vaporization portion **137** flow upwardly therethrough.

Components of the refrigerant fluid mixture having high evaporating temperatures, vaporize in the vaporization portion **136**. While both the vaporization portions **137** and **136** may be of the "flooded-type," as determined by the liquid level **141** in the standpipe **139**, the internal diameter of the vaporization portion **136** also can be sufficiently small to force and raise liquid therein by vapor-liquid lift action. Refrigerant vapor, together with any unevaporated refrigerant, will then flow through conduit **144** from the upper end of vaporization portion **136** to the condensation portion **135**. As in the first described embodiment, all of the parts of the secondary refrigeration system shown in FIG. **3** operate at substantially the same pressure. Since the liquid refrigerant mixture flowing to the low temperature vaporization portion **137** contains more components having a low evaporating temperature than the liquid refrigerant mixture flowing to the higher temperature vaporization portion **136**, the vaporization portion **137** inherently will operate at a lower temperature than the vaporization portion **136** which is disposed above the vaporization portion **137**. As in the first-described embodiment, liquid will evaporate in each of the vaporization portions **136** and **137** at increasingly higher temperatures from their lower ends to their upper ends.

In each of the embodiments of FIGS. **2** and **3**, it will be understood that the low and high temperature vaporization portions of the secondary refrigeration systems will operate at "average" or "mean" temperatures. This is so because liquid refrigerant evaporates in the low and high temperature vaporization portions at increasingly higher temperatures from their lower ends to their upper ends. As in the first-described embodiment, all of the parts in FIG. **3** which are disposed outside the cabinet **133** are provided with suitable insulation in order that the secondary system will function properly.

In FIG. 3 I have illustrated temperature curves A and B to show the manner in which the secondary refrigeration system embodying my invention functions. More particularly, temperature curves A and B show the temperature conditions prevailing lengthwise of the cooling element **16** of the primary absorption refrigeration apparatus and the condensation portion **35,135** of the secondary refrigeration system which is in heat exchange relation therewith.

Curve A, a solid line, illustrates the temperatures prevailing in the cooling element **16** along the length L from its lower end **42** to its upper end **43**. Curve B, a dotted line, illustrates the temperatures prevailing in the condensation portions **35** and **135** along their lengths between regions at the same levels as the lower and upper ends **42** and **43**, respectively, of the cooling element **16**.

It will be noted that curves A and B are essentially parallel throughout their lengths. In order to achieve high efficiency in secondary heat transfer systems like those shown in FIGS. **2** and **3**, it is necessary that, at each point along the length of the cooling element **16**, a given temperature differential prevails between the temperature of the cooling element **16** and the condensation portions **35** and **135**, thus maintaining the parallelism of the curves A and B. Deviations of the parallelism of the curves A and B, which depend on the refrigerant fluids forming components or constituents of the refrigerant fluid mixture in the secondary system, may occur to a certain degree which either may be small or great. However, such deviations of curves A and B from parallelism can occur without in any material manner reducing the effectiveness of the secondary refrigeration systems from the ideal condition represented by the curves A and B in FIG. 4.

I claim:

1. Absorption refrigeration apparatus having
   a. a circuit for circulation of inert gas including a cooling element comprising first conduit means in which refrigerant fluid evaporates in the presence of such gas,
   b. means for conducting refrigerant fluid to said first conduit means into the presence of inert gas therein,
   c. said first conduit means providing an elongated path of flow for the inert gas and having a temperature gradient in which the temperature progressively increases from a first temperature at one end to a second higher temperature at the opposite end in the path of flow of said cooling element,
   d. a secondary refrigeration system which includes an evaporation portion and a condensation portion,
   e. said secondary refrigeration system being partly filled with a mixture of volatile liquids which form a refrigerant fluid mixture that boils and vaporizes in said evaporation portion and forms vapor bubbles, the heat of vaporization to form the vapor bubbles being abstracted from the objective of heating whereby cooling thereof is effected,
   f. said condensation portion comprising second conduit means which, along its length,is in thermal exchange relation with said first conduit means,
   g. said mixture of refrigerant fluids possessing such physical properties that said refrigerant fluids will vaporize and condense in said evaporation and condensation portions, respectively, at different temperatures between the first and second higher temperatures prevailing in said cooling element, and
   h the circulation of said mixture of refrigerant fluids in said secondary refrigeration system being effected solely by the vapor bubbles resulting from the vaporization and boiling of said refrigerant fluid mixture itself.

2. Apparatus as set forth in claim **1** in which said mixture of refrigerant fluids possesses such physical characteristics that the temperature characteristic of said condensation portion of said secondary refrigeration system is approximately the same as that of said cooling element.

3. Apparatus as set forth in claim **1** including structure providing at least two insulated spaces which are thermally segregated from one another and define the objective of cooling, said evaporation portion of said secondary refrigeration system including at least two sections which operate at different temperatures and each of which is arranged to abstract heat from a different one of said insulated spaces.

4. Apparatus as set forth in claim **3** in which said condensation portion and evaporation portion are connected in series in said secondary refrigeration system and provide an unobstructed path of flow for said mixture of refrigerant fluids therein, one of said spaces being at one level and another at a higher level, a first section of said evaporation portion operating at one temperature and a second section thereof at a higher temperature, and said first section of said evaporation portion being arranged to abstract heat from said one space at one level and said second section thereof being arranged to abstract heat from said other space at said higher level.

5. Apparatus as set forth in claim **1** including structure providing at least two insulated spaces which are thermally segregated from one another and define the objective of cooling, said secondary refrigeration system comprising first and second branches connected to receive said mixture of volatile liquids, and said first branch including one section of said evaporation portion which operates at a first mean temperature and is arranged to abstract heat from one of said two insulated spaces and said second branch including another section of said evaporation portion which operates at a second higher mean temperature and is arranged to abstract heat from the other of said two insulated spaces.

6. Absorption refrigeration apparatus having
   a. a circuit for circulation of inert gas including a cooling element comprising first conduit means in which refrigerant fluid evaporates in the presence of such gas,
   b. means for conducting refrigerant fluid to said first conduit means into the presence of inert gas therein,
   c. said first conduit means providing an elongated path of flow for the inert gas and having a temperature gradient in which the temperature progressively increases from a first temperature at one end to a second higher temperature at the opposite end in the path of flow of said cooling element,
   d. a secondary refrigeration system which includes an evaporation portion and a condensation portion,

e. said secondary refrigeration system being partly filled with a mixture of volatile liquidswhich form a refrigerant fluid mixture that boils and vaporizes in said evaporation portion and forms vapor bubbles, the heat of vaporization to form the vapor bubbles being abstracted from the objective of heating whereby cooling thereof is effected,

f. said condensation portion comprising second conduit means which, along its length, is in thermal exchange relation with said first conduit means,

g. said mixture of refrigerant fluids possessing such physical properties that said refrigerant fluids will vaporize in said evaporation portion at different temperatures between the first and second higher temperatures prevailing in said cooling element, and

h. the circulation of said mixture of refrigerant fluids in said secondary refrigeration system being effected solely by the vapor bubbles resulting from the vaporization and boiling of said refrigerant fluid mixture itself.

7. Absorption refrigeration apparatus having

a. a circuit for circulation of inert gas including a cooling element comprising first conduit means in which refrigerant fluid evaporates in the presence of such gas,

b. means for conducting refrigerant fluid to said first conduit means into the presence of inert gas therein,

c. said first conduit means providing an elongated path of flow for the inert gas and having a temperature gradient in which the temperature progressively increases from a first temperature at one end to a second higher temperature at the opposite end in the path of flow of said cooling element,

d. a secondary refrigeration system which includes an evaporation portion and a condensation portion,

e. said secondary refrigeration system being partly filled with a mixture of volatile liquids which form a refrigerant fluid mixture that boils and vaporizes in said evaporation portion and forms vapor bubbles, the heat of vaporization to form the vapor bubbles being abstracted from the objective of heating whereby cooling thereof is effected,

f. said condensation portion comprising second conduit means which, along its length, is in thermal exchange relation with said first conduit means,

g. said mixture of refrigerant fluids possessing such physical properties that said refrigerant fluids will condense in said condensation portion at different temperatures between the first and second higher temperatures prevailing in said cooling element, and

h. the circulation of said mixture of refrigerant fluids in said secondary refrigeration system being effected solely by the vapor bubbles resulting from the vaporization and boiling of said refrigerant fluid mixture itself.

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