United States Patent [19]

Blomberg et al.

[11] **3,802,219**

[45] **Apr. 9, 1974**

[54] **TILTABLE AIR-COOLED ABSORPTION REFRIGERATION APPARATUS OF THE INERT GAS TYPE**

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[22] Filed: **Mar. 16, 1972**

[21] Appl. No.: **235,367**

[30] **Foreign Application Priority Data**

Mar. 18, 1971 Sweden 3488/71

[52] **U.S. Cl.** **62/452,** 62/490, 165/110

[51] **Int. Cl.** **F25b 15/10**

[58] **Field of Search** 62/295, 452, 454, 455, 62/456, 457, 506, 507, 476, 490; 165/110, 111

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Assistant Examiner—Peter D. Ferguson
Attorney, Agent, or Firm—Edmund A. Fenander

[57] **ABSTRACT**

Absorption continuous absorption refrigeration apparatus of the inert gas type which, when it is operating to produce refrigeration, can be tilted to each side from the vertical through an angle in a range of at least 15°. Such tilting of the apparatus is accomplished by employing an air-cooled condenser having one or more pairs of hollow members which slope upward from the horizontal at an angle greater than 15° and are united at their lower ends and form an obtuse angle with respect to one another. Each pair of hollow members has an inlet at one level to receive refrigerant vapor and an outlet for liquefied refrigerant at a lower level at the region or regions the hollow members are united to one another.

5 Claims, 5 Drawing Figures

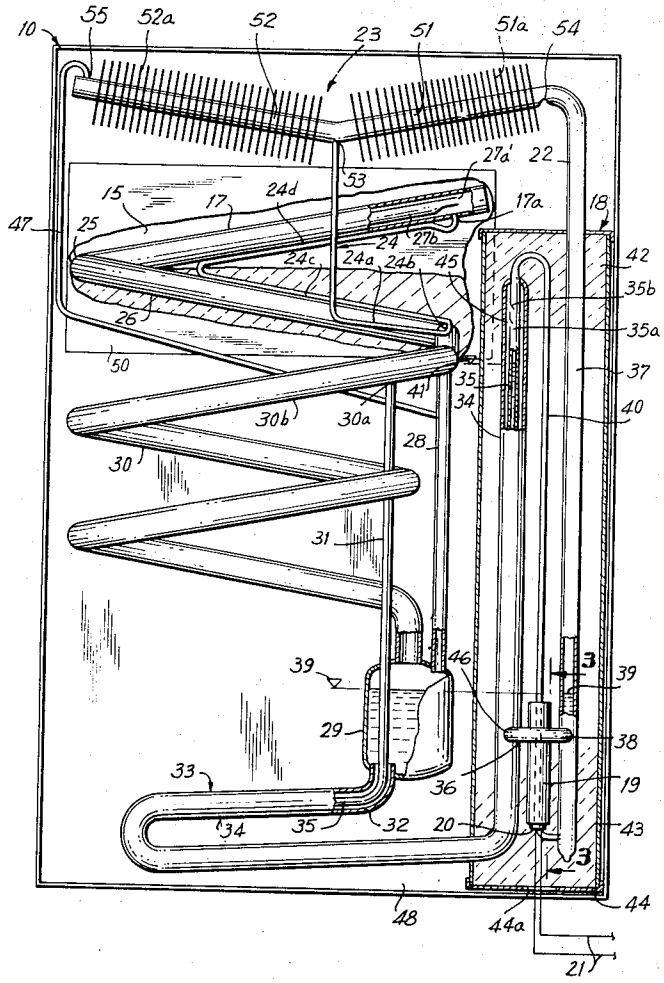
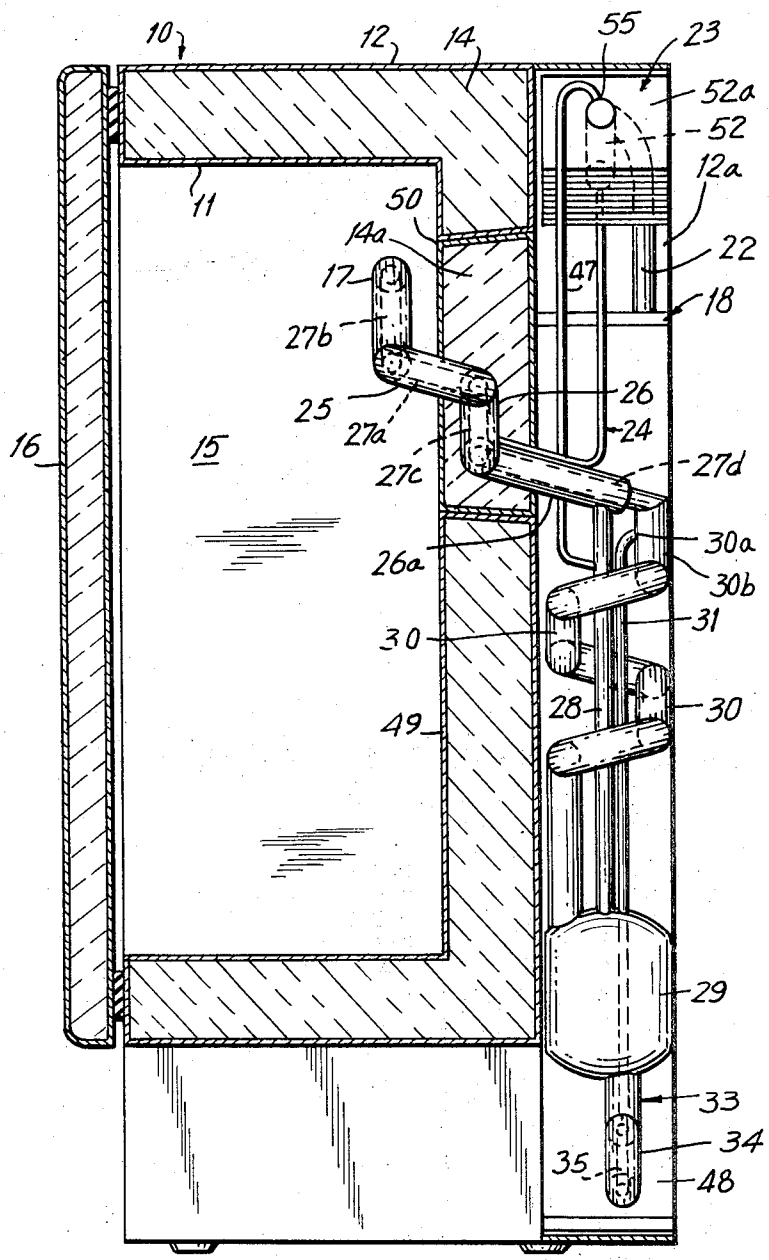


FIG. 1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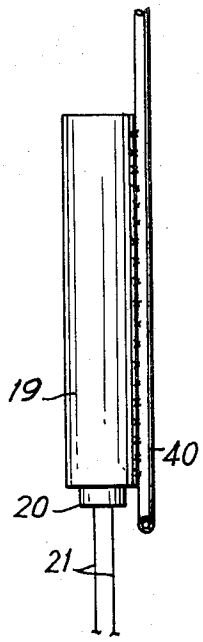
19
40
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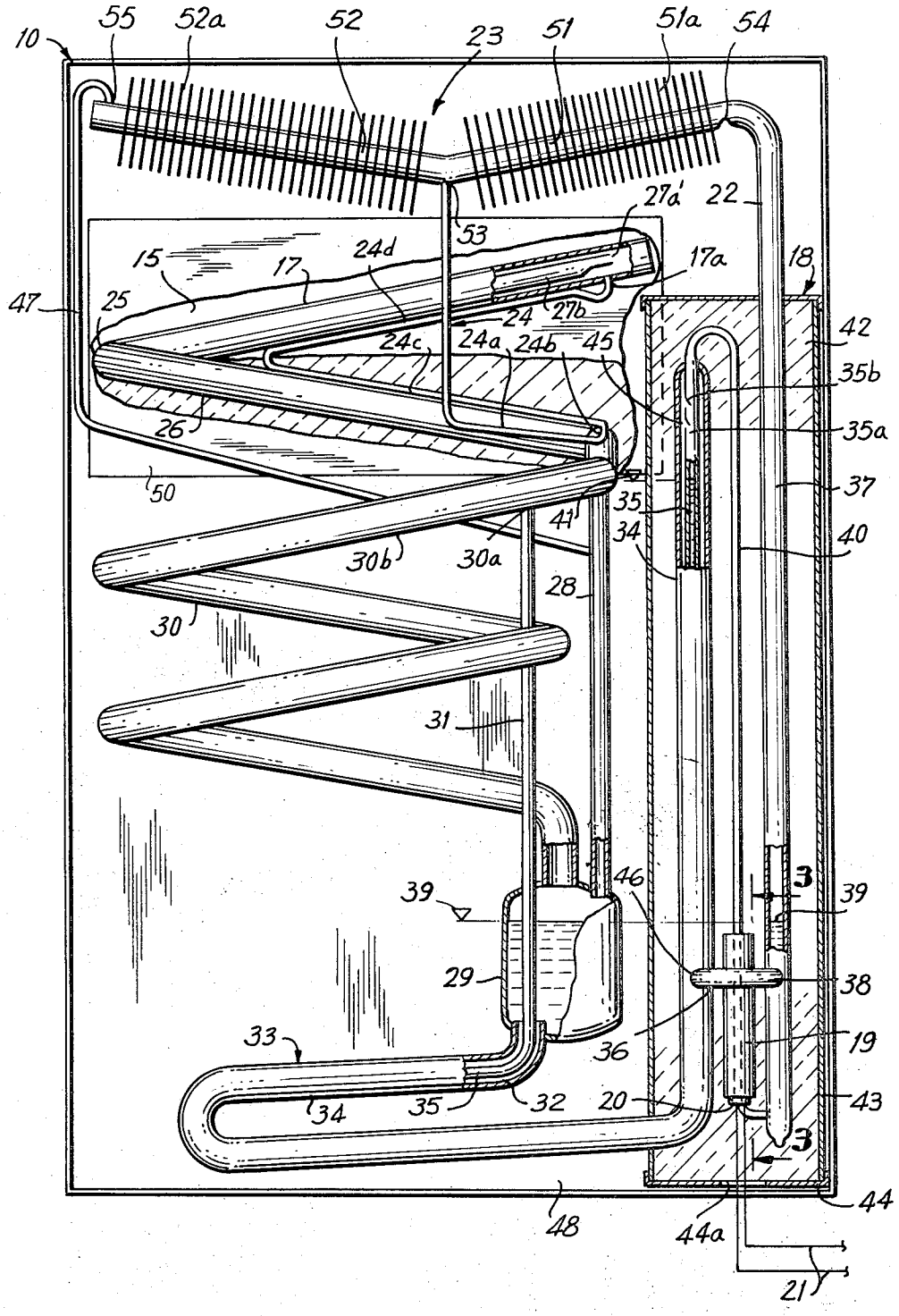
21

FIG. 3

FIG.2


10
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52a
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23
51
51a
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27a'
22
53
15
17
24d
17a
18
47
25
24
27b
42
24c
24a
24b
45
35b
26
35a
50
37
41
35
34
40
30b
30a
28
30
31
39
46
3
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36
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34
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32
20
43
3
44
48
44a
21

FIG. 4

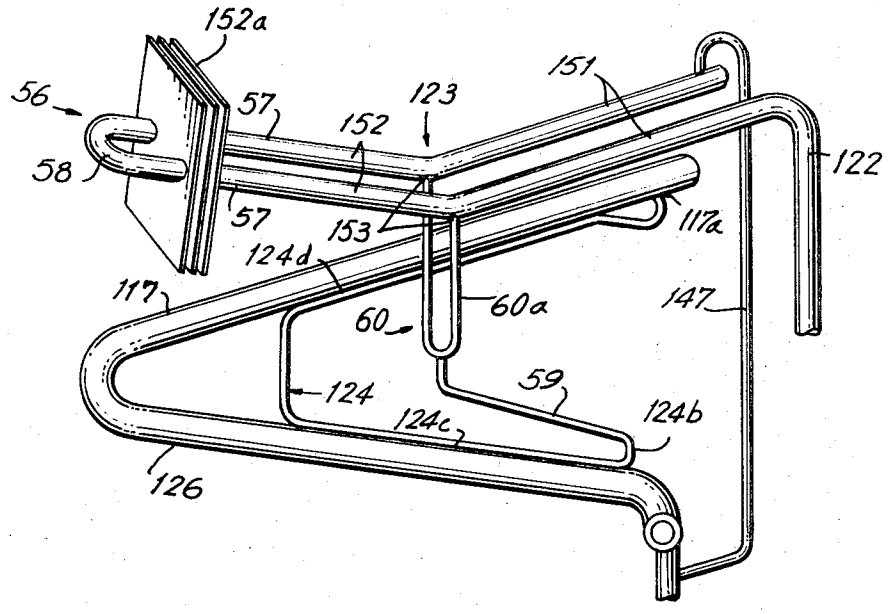
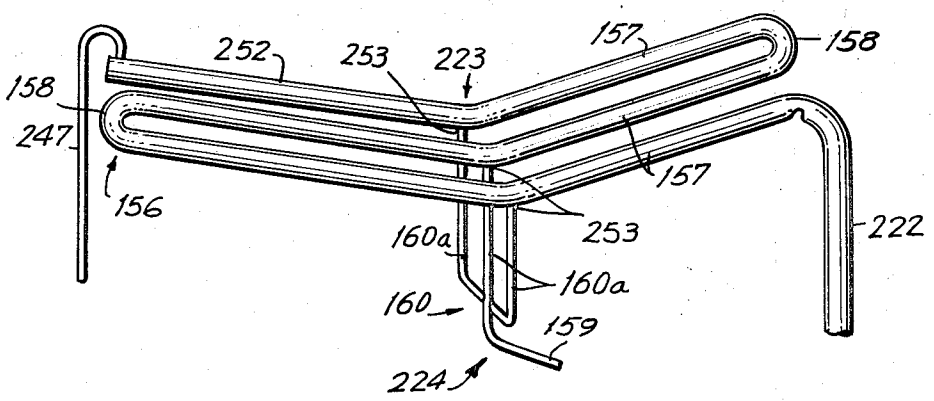

152a
56
57
123
151
58
152
122
57
153
117a
124d
117
60
60a
147
124
59
124b
124c
126

FIG. 5


252
253
223
157
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160a
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TILTABLE AIR-COOLED ABSORPTION REFRIGERATION APPARATUS OF THE INERT GAS TYPE

BACKGROUND OF THE INVENTION

1. Field of the Invention

In continuous air-cooled absorption refrigeration apparatus of the inert gas type refrigerant expelled from absorption solution in a generator flows to a condenser in which it is liquefied. Liquefied refrigerant is conducted from the condenser to an evaporator in which, due to evaporation and diffusion thereof into an inert gas, a refrigerating effect is produced.

The evaporator is positioned in a thermally insulated compartment of a cabinet while other components of the refrigeration apparatus are disposed in a vertically extending apparatus space at the rear of the cabinet between the lateral sides thereof. Natural draft is produced in the apparatus space and causes upward circulation of ambient air due to heat radiated by the absorber and condenser, so that surrounding cool air can flow over their surfaces and assure adequate cooling of these parts. By cooling the condenser in this manner refrigerant vapor is cooled and liquefied therein.

2. Description of the Prior Art

In continuous absorption refrigeration apparatus of the type under consideration in which an inert gas is employed as a pressure equalizing agent, the vertical location and size of the components and their positions relative to one another in the apparatus space is dependent in part upon the function of each component and dependent in part by the limited height available which is determined by the vertical height of the cabinet with which the refrigeration apparatus is associated.

The condenser, which is formed of piping having heat transfer fins or heat dissipating members fixed thereto and may comprise a looped coil or one or more lengths of piping connected to one another, usually is located in the extreme top part of the apparatus space. For effectively air cooling the condenser the pipes thereof are distributed over the entire cross-sectional area of the apparatus space between the lateral sides of the cabinet. Therefore, it has been the practice to employ lengths of piping for the condenser which are relatively long and extend across the rear of the refrigerator cabinet from one side to the opposite side thereof.

The height of the cabinet determines the height of the apparatus space at its rear which prohibits the condenser piping from being inclined downward to any great extent to promote gravity flow of liquid refrigerant formed in the condenser. Heretofore, it has been determined that the cabinet can be safely inclined with respect to the condenser and other components of the apparatus within certain maximum limits in planes parallel to the rear wall of the cabinet and safely inclined within certain other limits in vertical planes normal to the rear cabinet wall.

In order to make certain that liquid refrigerant formed in the condenser will not obstruct flow of gas therein, it has been determined that the condenser piping should be at a certain inclination which only slightly exceeds the maximum angle at which the cabinet can be inclined.

When a condenser is employed which is in the form of a U-shaped member disposed in a horizontal plane with its two legs spaced from one another and in different vertical planes, the height of a condenser of this type is taken up by one relatively long straight pipe length which extends across the entire width of the cabinet at a small inclination and by another relatively long straight pipe length at a lower level which also extends across the cabinet at a small inclination. In refrigeration apparatus of large size condenser pipe lengths often are connected in parallel and liquid refrigerant formed therein is conducted by a single conduit to the evaporator of the apparatus.

In all of these known refrigeration apparatus capable of operating continuously it is generally regarded impossible for the apparatus to function properly and produce useful refrigeration when the angles at which the refrigeration apparatus are inclined from its upright position become larger than the angles of inclination that can be tolerated and occur as the result of small errors in installing the refrigeration apparatus on the cabinet. Such large angles of inclination of the refrigeration apparatus occur, for example, when the refrigerator is installed in a boat which rolls and in mobile trailers which sometimes are parked on sloping terrain. When refrigeration apparatus in a mobile trailer is kept operating while the trailer is being moved from place to place, it will fail to operate properly when inclined at large angles from an upright position which is objectionable.

SUMMARY OF THE INVENTION

It is an object of our invention to provide continuous air-cooled absorption refrigeration apparatus which, when it is operating to produce useful refrigeration, can be tilted from an upright position at angles substantially larger than heretofore.

Another object is to provide such tiltable refrigeration apparatus capable of producing useful refrigeration when installed in boats subject to rolling and in mobile trailers which assume different angular positions when they are parked and when being moved from place to place.

More particularly, it is an object to provide such continuous air-cooled absorption refrigeration apparatus which, when it is operating to produce useful refrigeration, can be tilted to each side from the vertical through an angle in a range of at least 15°. We accomplish this by employing an air-cooled condenser having one or more pairs of hollow members which slope upward from the horizontal and are united at their lower ends and form an angle therebetween. Each pair of hollow members has an inlet at one level to receive refrigerant vapor and an outlet for liquefied refrigerant at a lower level at the region the hollow members are united to one another.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side view, in section, of a refrigerator and an air-cooled absorption refrigeration system of the inert gas type associated therewith which embodies our invention;

FIG. 2 is a rear elevational view, partly broken away, of the refrigerator shown in FIG. 1;

FIG. 3 is a fragmentary view taken at line 3—3 of FIG. 2; and

FIGS. 4 and 5 are fragmentary perspective views of parts similar to parts of the refrigeration system shown in FIG. 2 illustrating modifications of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2, we have shown our invention in connection with a refrigerator comprising a cabinet 10 having an inner liner 11 arranged to be supported within an outer shell 12 and insulated therefrom at 14 in any suitable manner. The inner liner 11 defines a thermally insulated compartment 15 to which access is afforded at a front opening adapted to be closed by an insulated door 16 hinged in any suitable manner (not shown) at the front of refrigerator cabinet 10.

The thermally insulated compartment 15 is arranged to be cooled by an evaporator 17 of continuous absorption refrigeration apparatus of the inert gas type. Refrigeration apparatus of this type comprises a generator 18 containing a refrigerant, such as ammonia, in solution in a body of absorption liquid, such as water. As shown in FIGS. 2 and 3 heat is supplied to the generator 18 from a heating tube 19 which may be heated by an electrical heating element 20, for example, which is disposed within the tube and connected by conductors 21 to a source of electrical supply. The heat supplied to the generator 18 and absorption solution expels refrigerant vapor out of solution, and, in a manner to be described hereinafter, refrigerant vapor passes upward from the generator through a vapor supply line or conduit 22 into an air-cooled condenser 23 in which the vapor is liquefied by surrounding cool air which flows in physical contact therewith. The liquefied refrigerant flows from the condenser through a conduit 24 into the upper closed end of the evaporator 17 at 17*a*.

The evaporator 17 forms the upper straight part of an outer looped coil having a bend 25 and a lower straight part which forms the outer passageway of a gas heat exchanger 26, the upper and lower straight parts of the outer coil being in different vertical planes. An inner looped coil extends lengthwise within the outer looped coil and includes a bend 27*a* and upper and lower straight parts 27*b* and 27*c*, the part 27*b* being disposed within the evaporator 17 and the part 27*c* forming the inner passageway of the gas heat exchanger 26.

The liquefied refrigerant evaporates and diffuses into an inert pressure equalizing gas, such as hydrogen, which flows upward through the inner looped coil and passes from the upper open end 27*a'* thereof into the presence of the refrigerant. Due to evaporation of refrigerant into inert gas in the evaporator 17, a refrigerating effect is produced with consequent absorption of heat from the surroundings.

The rich gas mixture of refrigerant and inert gas formed in the evaporator 17, that is, the annular passageway between the upper straight parts of the outer and inner looped coils, flows from the lower end thereof through the coil bends and the outer passageway of the gas heat exchanger 26, that is, the annular passageway between the lower straight parts of the outer and inner looped coils. The lower ends of the outer and inner looped coils respectively include parts 26*a* and 27*d* which are transverse to the vertical plane of the gas heat exchanger 26 and form the lower part thereof.

As best seen in FIG. 1, the rich gas, together with any unevaporated refrigerant, flows from the outer passageway of the gas heat exchanger 26 through a conduit 28 into an absorber comprising a vessel 29 and a looped coil 30. In the absorber vessel 29 and looped coil 30 refrigerant vapor is absorbed into liquid absorbent, such as water, which enters through a conduit 31. The hydrogen or inert gas, which is practically insoluble and weak in refrigerant, is returned to the upper closed end of evaporator 17 from the upper end of the absorber coil 30 through the inner passageway 27*d* and 27*c* of the gas heat exchanger 26 and inner passageway 27*b* of the evaporator 17.

Absorption liquid enriched in refrigerant in the absorber flows from the vessel 29 through an outer passageway 32 of an elongated liquid heat exchanger 33 which, within the generator 18, includes an outer vertical pipe 34 and an inner vertical pipe 35. Rich absorption liquid flows from the passageway 32 through a horizontal conduit 36 into a vertical standpipe 37. The conduit 36 is connected to standpipe 37 at a point 38 which is at a level below the liquid surface level 39 of the column of liquid held in the pipe 37. As seen in FIG. 2, the liquid surface level 39 is at approximately the same level as the liquid surface level in the absorber vessel 29.

The extreme lower end of the pipe 37 is connected to the lower end of a pump pipe or vapor-liquid lift tube 40 heat conductively connected to the heating tube 19, as by welding, for example. Liquid is raised by vapor-liquid lift action through the tube or pump pipe 40 into the upper part of the pipe 35. The absorption liquid from which refrigerant vapor has been expelled flows downward by gravity through the inner pipe 35, the latter extending through the liquid heat exchanger 33 and forming an inner passageway thereof. The pipe 35 is connected to the conduit 31 from which weak absorption liquid overflows into the upper end of absorber coil 30 at a point 30*a* which is below the liquid surface level 41 in pipe 35.

The generator 18, together with a part of the liquid heat exchanger 33, are embedded in a body of insulation 42 retained in a metal shell or casing 43 having an opening 44*a* in the bottom 44 thereof. The electrical heating element 20, with the conductors 21 connected thereto, is arranged to be positioned within the heating tube 19 through the opening 44*a* in any suitable manner (not shown).

In the operation of the refrigeration apparatus, vapor generated in the vapor-liquid lift pump 40 flows from the upper end thereof to a gas separation chamber 35*a* at the extreme upper end of the standpipe 35 and passes through openings 35*b* in the side wall thereof into the outer passage 45 formed between the inner and outer pipes 35 and 34, respectively. The vapor in the passage 45 depresses the liquid level therein to a point 46 and flows through enriched absorption liquid in conduit 36 and pipe 37 by bubble action. After the generated vapor is analyzed in this manner in the conduit 36 and pipe 37, the refrigerant vapor passes from the upper part of the pipe 37 and vapor supply line 22 to the condenser 23, as previously explained.

In order to pre-cool liquid refrigerant before it flows into the presence of inert gas at the upper closed end of the evaporator 17, the conduit 24 is heat conductively connected to the gas heat exchanger 26 at 24*a*, 24*b* and 24*c* and heat conductively connected to the evaporator 17 and 24*d*. The condenser 23 is connected by a conduit 47 to a part of the gas circuit, as to the conduit 28, for example, so that any inert gas which may pass through the condenser 23 can flow to the gas circuit.

With the evaporator 17 positioned in the compartment 15 of the cabinet 10, the other components of the refrigeration apparatus are located in a vertically extending apparatus space 48 at the rear of the cabinet which is defined by the rear portions 12*a* of the lateral side walls of the outer shell 12 which project beyond the rear insulated wall 49. The top of the outer shell 12 extends rearward to the forward part of the apparatus space 48. Natural draft is produced in the space 48 and causes upward circulation of ambient air due to heat radiated by absorber vessel 29 and coil 30 and by the condenser 23, so that surrounding cool air can flow directly over their surfaces and assure adequate cooling of these parts or components. The top and bottom of the space 48 are open to enable air to flow freely upward therein.

As best shown in FIGS. 1 and 2, the gas heat exchanger 26, which extends across the cabinet 10 between the lateral sides thereof, is disposed within a body of insulation 14*a* retained in a removable wall section 50 of the rear insulated wall 49 to facilitate the insertion of the evaporator 17 within the cabinet. The lower part of the gas heat exchanger 26, which is transverse thereto and formed by the lower ends 26*a* and 27*d* of the outer and inner looped coils, respectively, projects rearwardly from the body of insulation 14*a* into the apparatus space 48. The removable wall section 50 closes an opening in the rear insulated wall 49 and is removably secured thereto in any suitable manner (not shown).

In accordance with our invention, in order that the refrigeration apparatus can be tilted from an upright position at angles substantially larger than heretofore without impairing its ability to produce useful refrigeration, the condenser 23 comprises a pair of hollow members 51 and 52 which slope upward and are united at 53 at their lower ends and form an angle therebetween. The hollow members 51 and 52 have an inlet for refrigerant at one level at 54 at the region the vapor supply line 22 is connected to the condenser 23. Further, the hollow members 51 and 52 have an outlet for liquefied refrigerant at a lower level at the region 53 at which the members are united to one another. As seen in FIG. 2, each of the hollow members 51 and 52 in an upward direction from its outlet end at 53 to its opposite higher end, with the condenser 23 in its normal vertical position, has substantially the same angle of inclination to the horizontal at all regions thereof.

The hollow members 51 and 52 are provided with a plurality of heat transfer fins or heat dissipating members 51*a* and 52*a*, respectively. Further, the conduit 47 for venting inert gas from the condenser 23 to the gas circuit is connected at 55 to the highest level of the condenser at the end thereof remote from the refrigerant inlet 54. The conduit 24 is connected to the refrigerant outlet 53 for conducting liquid refrigerant from the condenser 23 to the evaporator 17 at the point 17*a*.

Refrigeration apparatus like that shown in FIGS. 1 and 2 and just described has been constructed and operated to produce useful refrigeration in which the hollow members 51 and 52 are inclined upward from the horizontal at angles greater than 15°, whereby the apparatus can be operated when it is tilted to each side from the vertical through an angle in a range of at least 15°. When the apparatus is tilted in this manner in the vertical plane of the hollow members 51 and 52 in either direction from the vertical, the condenser continues to function in a normal manner and the passageway for vapor in the hollow members 51 and 52 will not be obstructed or blocked by liquid. Stated another way, both hollow members 51 and 52, which have substantially the same angle of inclination to the horizontal at all regions thereof, are operable at the same time for the condenser 23 to continue to function in a normal manner irrespective of the direction the apparatus is tilted from the vertical. An important feature of the invention which makes this possible is that the condenser 23 is so constructed and formed that substantially all of the liquid refrigerant flowing from the outlet ends of the hollow members 51 and 52 is formed only in these members by condensation of refrigerant vapor therein.

In order for the other components of the refrigeration apparatus to function properly it is necessary that flow of vapor is not obstructed or blocked by liquid in conduits through which both liquid and vapor are conducted. Liquid and vapor flow at the same time in the evaporator 17, gas heat exchanger 26 and the absorber 30 which comprise conduits or looped coils formed of piping inclined to the horizontal at angles corresponding to the angles at which the hollow members 51 and 52 of the condenser 23 are inclined to the horizontal. The evaporator 17, gas heat exchanger 26 and the absorber 30 and liquid supply lines 24 and 35,31 therefor, which are illustrated in FIGS. 1 and 2 and described above, are disclosed and claimed in co-pending P. E. Blomberg application Ser. No. 235,366, filed Mar. 16, 1972.

Also, it is necessary that conduits in which liquid normally is present are not suddenly depleted of liquid or that the heights of the liquid columns change sufficiently so that the normal manner in which the apparatus functions is completely changed. For example, in order to insure that the vapor-liquid lift pipe or pump 40 will function properly when the refrigeration apparatus is tilted through relatively large angles from the vertical in the manner contemplated by our invention, the absorber vessel 29 is located as close as possible to the generator shell 43 and bottom 44 thereof. By doing this large changes in the level of the liquid body in the absorber vessel 29 and the height of the liquid column in the pump pipe 40 are avoided when the refrigeration apparatus is tilted through the largest permissible angle. Further, the absorber coil 30 and generator 18 are located as near as possible to one another so that the distance between the liquid level 41 in the conduit 35 and overflow point 30*a* of conduit 31 will be relatively small. This will insure flow of weak absorption liquid into the upper end of the absorber coil 31 even when the apparatus is tilted through the largest permissible angle.

When the refrigeration apparatus is started weak absorption liquid may be present in the conduit 24 through which liquefied refrigerant is supplied to the evaporator 17 from the condenser 23. In order for the condensed refrigerant to displace weak absorption liquid in the conduit 24 the heights of the two legs of the conduit 24 extending downward from the outlet 53 of the condenser 23 and downward from the liquid overflow point 17*a* at the evaporator 17 desirably must be related to one another in a particular manner. The leg of the conduit 24 extending downward from the condenser region 53 to the lowest part 24*b* thereof may be

referred to as the first leg of the conduit **24** which in a broad sense is U-shaped and forms a liquid trap. The leg of the conduit **24** extending downward from the evaporator region **17***a* to the lowest part **24***b* thereof may be referred to as the second leg of the conduit **24.**

The two legs of the U-shaped conduit **24** are of such length that the ratio of the lengths of the first leg to the second leg is about 1.5 to 1.0. The refrigeration apparatus is constructed so that this ratio will be maintained even when the apparatus is tilted through the largest permissible angle.

In FIG. **2** the evaporator **17** is illustrated as a straight conduit or pipe length having a relatively large inclination to the horizontal. In FIG. **1** it will be seen that the evaporator **17** is adjacent to the rear wall **49** of the cabinet **10** and parallel thereto. It should be understood, however, that the evaporator **17** can be located adjacent to a lateral side wall of the cabinet **10** and parallel thereto. As seen in FIG. **2,** the hollow members **51** and **52** substantially bridge the apparatus space **48** at the rear of the cabinet **10** between the lateral sides thereof.

In FIG. **4** we have shown another embodiment of our invention in which a condenser **123** comprises a U-shaped pipe **56** having spaced arms **57** and a connection **58** therebetween. Each of the arms **57** has a bend **153** intermediate its ends. The parts **151** and **152** of each arm **57** extend from the bend **153** at an angle to one another. It will be evident that the parts **151** and **152** of the arms **57** correspond to the hollow members **51** and **52** in the first described embodiment shown in FIG. **2.** The parts **151** and **152** of the arms **57** are provided with heat transfer members, only a few of which are shown in FIG. **4** on the parts **152** at **152***a*.

In FIG. **4** the gas heat exchanger, evaporator, vapor supply conduit, absorption liquid conduit and condenser vent conduit are referred to by the same reference numerals as the corresponding parts in FIG. **2** with **100** added thereto. The first leg of the U-shaped condensate conduit **124,** which extends upward from the lowest part **124***b* thereof, includes a first portion **59** and a second higher portion **60** which is fork-shaped and has a lower closed end and a pair of hollow elements **60***a* extending upward therefrom, each of which is connected to a different one of the outlets at the bends **153** of the arms **57.** The second leg of the U-shaped conduit **124** extends upward from the lowest part **124***b* thereof to the point **117***a* of the evaporator **117** and includes the parts **124***c* and **124***d* heat conductively connected to the gas heat exchanger **126** and evaporator **117,** respectively.

In FIG. **5** we have shown a further embodiment of our invention in which parts similar to those shown in FIG. **4** are referred to by the same reference numerals with **100** added thereto. While the condenser **123** in FIG. **4** comprises a U-shaped pipe **56,** the condenser **223** in FIG. **5** comprises a looped pipe coil **156** having three spaced arms **157** and connections **158** therebetween. Each of the arms **157** has a bend **253** intermediate its ends. Although not shown, the arms **157** may be provided with heat transfer fins similar to the fins **152***a* seen in FIG. **4.** In the embodiment of FIG. **4** all of the hollow members **151,152** in an upward direction from their outlet ends at **153** to their opposite higher ends, with the condenser **123** in its normal vertical position, have substantially the same angle of inclination to the horizontal at all regions thereof. Also, in the embodiment of FIG. **5** all of the hollow members at opposite sides of the bends **253** of the arms **157** in an upward direction from their outlet ends at **253** to their opposite higher ends, with the condenser **223** in its normal vertical position, have substantially the same angle of inclination to the horizontal at all regions thereof.

Only a part of the condensate supply conduit **224** is shown in FIG. **5** which includes the fork-shaped portion **160** which has a closed end and hollow elements **160***a* extending upward therefrom, each of which is connected to a different one of the outlets at the bends **253** of the arms **157.** Liquefied refrigerant flows downward through the hollow elements **160***a* in the fork-shaped part **160** and continues to flow through the single conduit **159** to the evaporator, the single conduit **159** corresponding to the conduit **59** in FIG. **4.**

The two legs of the U-shaped conduits **124** and **224** in FIGS. **4** and **5,** respectively, are of such length that the ratio of the lengths of the first or right-hand legs to the second or left-hand legs is about 1.5 to 1.0, as explained above in describing the embodiment of FIG. **2,** so that liquid refrigerant will displace any weak absorption liquid that may be present in the refrigerant supply conduit.

Also, the closed ends of the fork-shaped parts **60** and **160** in FIGS. **4** and **5** are at such a level with respect to the point **117***a* at which liquid refrigerant overflows from the conduits **124** and **224** into the evaporator **117** that liquid refrigerant will always be present at the closed ends of the fork-shaped parts when the refrigeration apparatus is upright or tilted through the largest permissible angle. It is necessary to maintain a liquid seal at the closed ends of the fork-shaped parts **60** and **160** so that refrigerant vapor cannot pass in an unobstructed path of flow through the hollow elements **60***a* and **160***a* to the condenser vent conduits **147** and **247,** respectively. However, liquid refrigerant in the hollow element **60***a* and **160***a* should never rise above the outlets at the bends **153** and **253** of the pipe arms **57** and **157,** respectively.

In continuous absorption refrigeration apparatus of the inert gas type provided heretofore, it has only been possible to incline the apparatus about 3° from the vertical without impairing the ability of the apparatus to produce useful refrigeration. This restriction is due to the fact that relatively long straight sections of condenser piping extend across the entire width of the refrigerator and can only be inclined slightly to promote gravity flow of liquid refrigerant. This is so because an excessive inclination of the long straight sections of condenser piping positions the lower end of the condenser at a vertical height which is too low for the reason that this vertical height determines the vertical location of the evaporator which, because of its position in the cabinet interior, must be as close as possible to the ceiling of the space being cooled.

As seen in FIG. **2** and described above, the condenser **23** comprises a relatively long length of piping and yet is inclined at a large angle to the horizontal. This is accomplished by dividing the condenser **23** into two parts **51** and **52,** each of which has a large angle of inclination. As pointed out above, refrigeration apparatus like that shown and described has been constructed and operated to produce useful refrigeration in which the hollow members **51** and **52** are inclined upward from the horizontal at angles greater than 15°. With such inclina-

tion of the members **51** and **52** the apparatus can be operated when it is tilted to each side from the vertical through an angle in a range of at least 15°. Stated another way, the apparatus, when being operated to produce useful refrigeration, is tiltable through a predetermined angle to each side from a vertical plane passing through the refrigerant outlet **53** which is dependent upon the angle the hollow members **51** and **52** are inclined and slope upward from the horizontal when the apparatus is upright. Further, the refrigerant supply conduit **24** includes at least one part **24***d* which, when the apparatus is upright, slopes upward from the horizontal through an angle greater than the predetermined angle.

We claim:

1. A condenser for absorption refrigeration apparatus of the inert gas type comprising

a. a plurality of pairs of hollow members which are disposed alongside one another,

b. the hollow members of each pair sloping upward and united at their lower ends and forming an angle therebetween,

c. each pair of hollow members having an inlet for refrigerant at one level and an outlet for refrigerant at a lower level at the region said members are united to one another, and

d. said pairs of hollow members being connected in series relation to provide an elongated path of flow for refrigerant.

2. A condenser for absorption refrigeration apparatus of the inert gas type comprising

a. a plurality of pairs of hollow members which are disposed alongside one another,

b. the hollow members of each pair sloping upward and united at their lower ends and forming an angle therebetween,

c. each pair of hollow members having an inlet for refrigerant at one level and an outlet for refrigerant at a lower level at the region said members are united to one another,

d. a U-shaped pipe having spaced arms and a connection therebetween,

e. each of said arms having a bend intermediate its ends, the parts of each arm extending from the bend being at an angle to one another,

f. the parts of each arm and bend therein defining a different one of said pairs of hollow members, and

g. the refrigerant outlet for each arm being disposed at the bend therein.

3. A condenser as set forth in claim **2** including conduit means connected to the refrigerant outlets of both of said arms for conducting refrigerant therefrom.

4. A condenser for absorption refigeration apparatus of the inert gas type including

a. at least two hollow members which slope upward and are united at their lower ends and form an angle therebetween,

b. said hollow members having an inlet for refrigerant vapor at one level and an outlet for liquid refrigerant at a lower level at the region said members are united to one another, the refrigerant in said hollow members being converted from vapor phase to liquid phase by condensation of vapor therein,

c. each of said hollow members in an upward direction from its outlet end to its opposite higher end, with said condenser in its normal vertical position, having substantially the same angle of inclination to the horizontal at all regions thereof, and

d. said condenser being so constructed and formed that substantially all of the liquid refrigerant flowing from the outlet ends of said hollow members is formed only in such members by condensation of refrigerant vapor therein.

5. A condenser for absorption refrigeration apparatus of the inert gas type comprising

a. a plurality of pairs of hollow members which are disposed alongside one another,

b. the hollow members of each pair sloping upward and united at their lower ends and forming an angle therebetween,

c. each pair of hollow members having an inlet for refrigerant vapor at one level and an outlet for liquid refrigerant at a lower level at the region said members are united to one another, the refrigerant in each pair of said hollow members being converted from vapor phase to liquid phase by condensation of vapor therein,

d. each of said hollow members in an upward direction from its outlet end to its opposite higher end, with said condenser in its normal vertical position, having substantially the same angle of inclination to the horizontal at all regions thereof, and

e. said condenser being so constructed and formed that substantially all of the liquid refrigerant flowing from the outlet ends of each pair of said hollow members is formed only in such members by condensation of refrigerant vapor therein.

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