United States Patent

Ando et al.

[15] **3,648,481**

[45] **Mar. 14, 1972**

[54] **GENERATOR OF ABSORPTION REFRIGERATION APPARATUS**

[72] Inventors: **Tsuneo Ando**, Gifu; **Hironori Nakashima**, Aza-Koyamanishi, both of Japan

[73] Assignee: **Howa Sangyo Kabushiki Kaisha**, Sakurada-cho, Atsuta-ku, Nagoya-shi, Aichi-ken, Japan

[22] Filed: **June 9, 1970**

[21] Appl. No.: **44,749**

[30] **Foreign Application Priority Data**

June 13, 1969 Japan.....44/46128

[52] **U.S. Cl.**.....**62/236,** 62/490, 62/496, 62/497, 219/279, 219/536

[51] **Int. Cl.**.....**F25b 27/00,** F25b 33/00

[58] **Field of Search**.....62/110, 148, 236, 490, 495, 62/496, 497; 219/279, 535, 536

[56] **References Cited**

UNITED STATES PATENTS

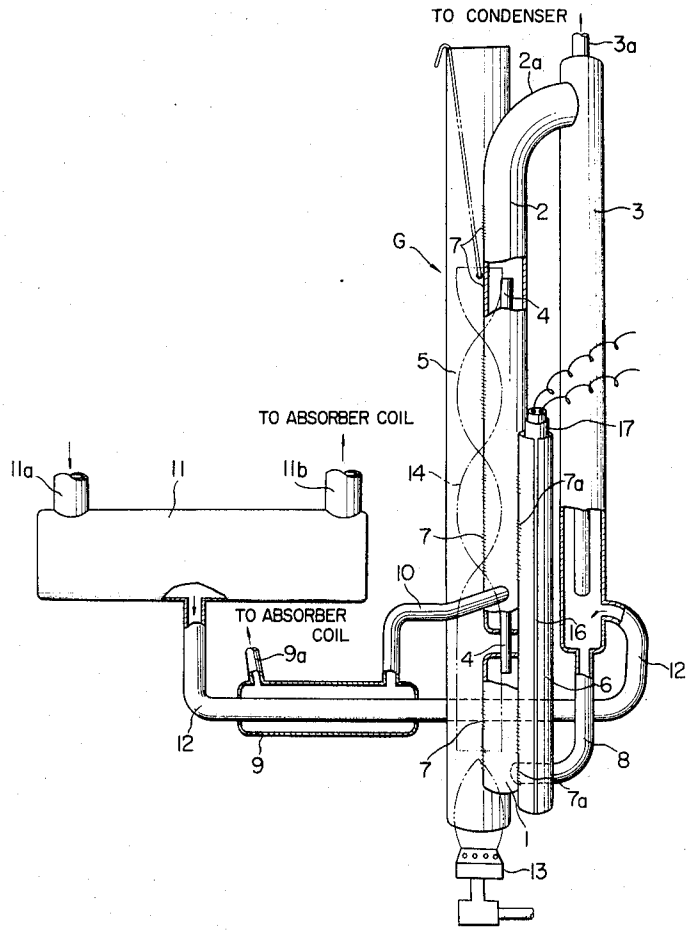
2,977,775	4/1961	Tamada et al.	62/497
2,999,373	9/1961	Stierlin	62/497
3,253,421	5/1966	Grubb	62/148
2,797,555	7/1957	Kogel	62/490
3,243,572	3/1966	Vogt et al.	219/536 X
3,130,564	4/1964	Cronelia et al.	62/490 X
3,177,677	4/1965	Boren et al.	62/148 X
3,225,560	12/1965	Doebeli	62/236

Primary Examiner—William F. O'Dea
Assistant Examiner—P. D. Ferguson
Attorney—Holman & Stern

[57] **ABSTRACT**

A generator of an absorption refrigeration apparatus having a pumping chamber to which a rich refrigerant solution is supplied from an absorber, and above which a boiler tube is vertically disposed in vertical alignment with the pumping chamber, with the boiler tube being connected at its top to a condenser via a vapor-liquid separator. A vapor lift tube extends from the pumping chamber upward into the boiler tube to open at its top within the tube. The boiler tube and pumping chamber are provided on their sides with dual heating a device for heating refrigerant solution in the tube and chamber. The arrangement of the parts is such that a compact general configuration of the generator is afforded.

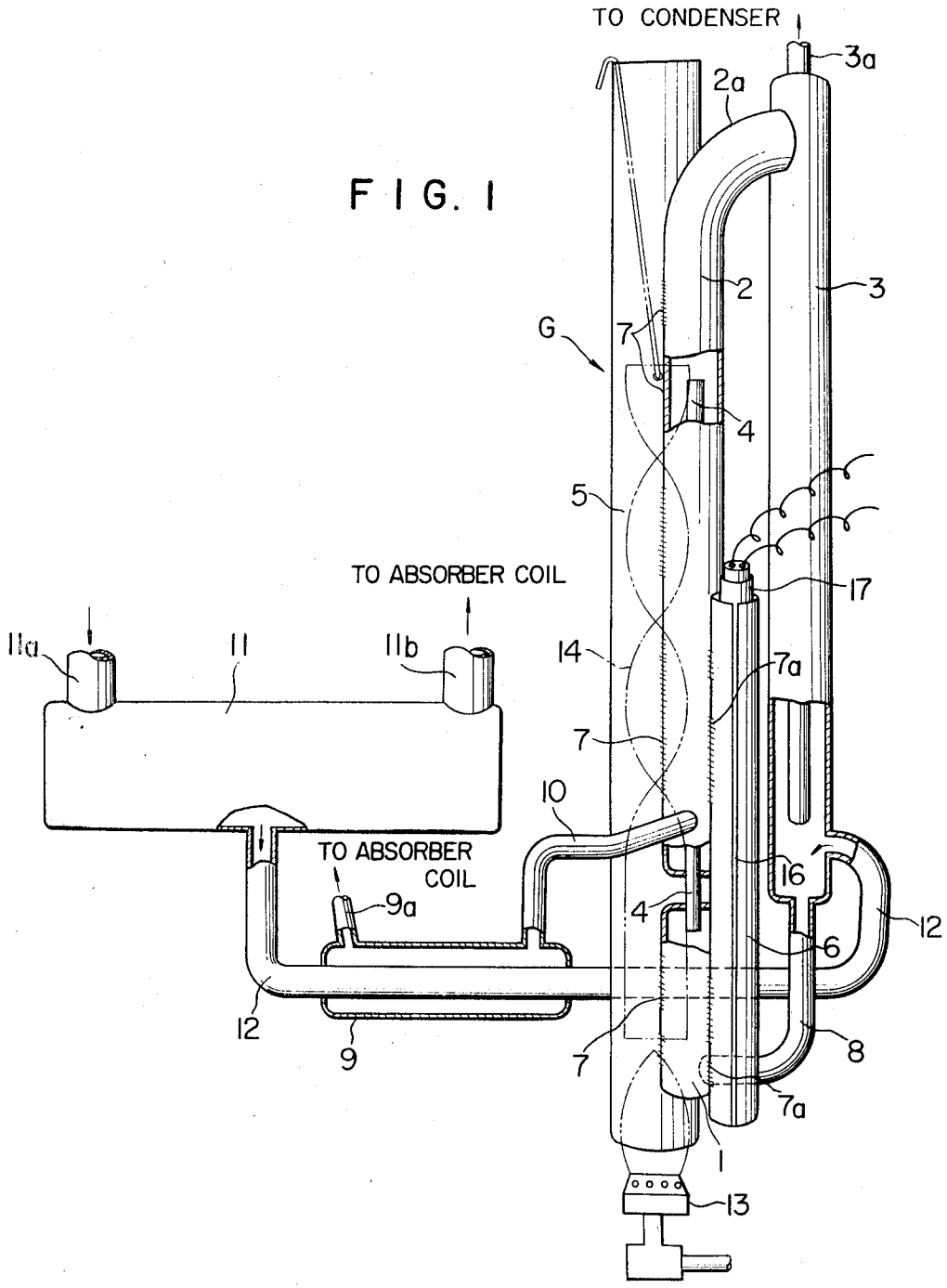
5 Claims, 3 Drawing Figures



Patented March 14, 1972 **3,648,481**

2 Sheets-Sheet 1

FIG. 1



INVENTORS
Tsuneo Ando
Hisanori Nakashima

BY Holman, Glascock, Downing & Seebold
ATTORNEYS

FIG. 2

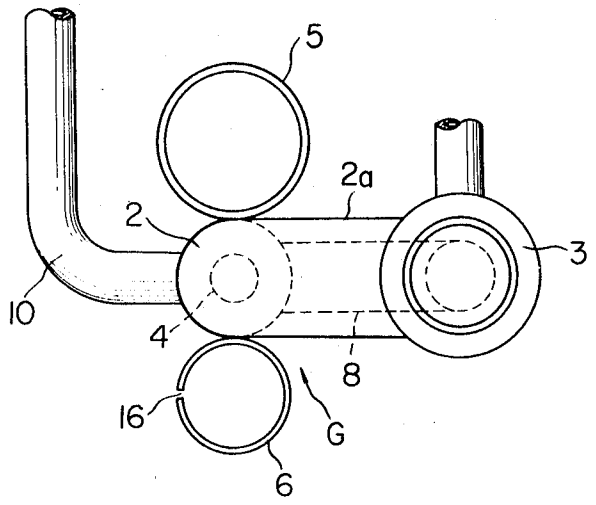
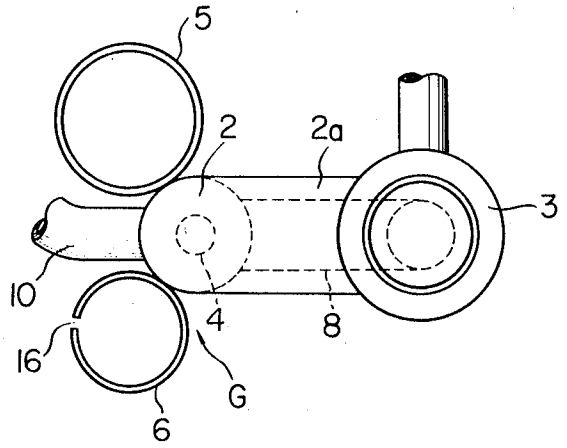


FIG. 3



INVENTORS
Tsuneo Ando
Hironori Nakashima
BY Holman, Glascock, Downing & Seebold
ATTORNEYS

GENERATOR OF ABSORPTION REFRIGERATION APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to absorption refrigeration apparatus and, more particularly, to a generator of an absorption refrigeration apparatus of the type employing two cylindrical heating devices on the side wall of a boiler of the generator.

In conventional generators of absorption refrigeration apparatus, there are usually provided separately a boiler for a refrigerant solution and a pumping or vapor lift tube. The boiler and tube are usually joined to the side wall of a heating device in heat exchange relationship thereto. Because the boiler and lift tube are separately disposed around the heating device, considerable space is needed for the generator. Furthermore, because the vapor lift tube extends upwards along the heating device and is thereafter bent toward the boiler so as to be joined therewith, the pumping or vapor lifting action is not so effective and the general configuration of the generator is relatively irregular, which is the cause of the generator assembly being unstable in construction and operation. These problems are more serious with a generator having two heating devices, such as one having selectively usable gas and electric heating devices.

SUMMARY OF THE INVENTION

In view of the above described circumstances, it is an object of the present invention to provide a novel generator of an absorption refrigeration apparatus, which is superior in the pumping or vapor lifting function to the conventional ones.

Another object of the invention is to provide a novel generator of an absorption refrigeration apparatus, which is compact in general configuration and therefore stable in construction and operation.

Still another object of the invention is provide a generator of the type including selectively operable dual heating devices, in which heat transfer from the heating devices to the refrigerant solution in the generator is more intense at lower parts of the generator than at upper parts of the same.

In accordance with the present invention, briefly stated, there is provided a pumping chamber below a boiler tube, into which a vapor lift pipe of a smaller diameter extends upwards from the pumping chamber in substantially coaxial relationship to the boiler tube so as to open into an upper space within the tube. On the side surfaces of the chamber and tube, there are secured heating devices for heating a refrigerant solution within the generator. Because the vapor lift tube passes within the boiler tube, hot refrigerant and its solution, while flowing upwards through the lift pipe, give their heat to a weak solution surrounding the lift pipe to heat the same from inside in addition to the heat from outside the boiler tube. It will be appreciated that such dual heating will improve the refrigerant vapor expelling function in the generator. It will also be appreciated that the provision of the vapor lift pipe within the boiler tube makes the general arrangement of the parts compact and stable.

The foregoing and other objects, as well as advantageous features of the invention will become more clearly apparent from the following detailed description with respect to preferred embodiments of the invention, when read in conjunction with the accompanying drawing, in which like parts are designated by like reference numerals and characters.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 is an elevation, partly in perspective, and partly broken away, showing an example of a generator assembly according to the invention;

FIG. 2 is a fragmentary plan view of the assembly shown in FIG. 1; and

FIG. 3 is a view similar to FIG. 2, but showing a modified arrangement.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the accompanying drawing, the generator shown and generally designated therein by reference character G is incorporated in and constitutes an important component of an absorption refrigeration apparatus, the essential components of which, other than the generator G, are known and include an absorber including an absorber vessel **11**, a heat exchanger **9**, an absorber coil (not shown), a condenser (not shown), an evaporator (not shown) etcetera.

The generator has a pumping chamber **1** and a boiler tube **2**. The pumping chamber **1** may be in the form of a vertically extending tube of the same diameter as that of the boiler tube **2** and is in axial alignment with the tube **2**. The interior of the chamber **1** is in communication with the interior of the boiler tube **2** through a vapor lift pipe **4** extending upwards into the boiler tube **2** to terminate at its open upper end in the upper interior of the latter. It will be noted that the chamber **1** and the tube **2** are rigidly connected by means of the pipe **4**.

An upper end part **2***a* of the boiler tube **2** is connected to an upper part of a vapor-liquid separator **3** which is also in the form of a vertically extending tube. A conduit **3***a* leading at its upper part to the condenser (not shown) extends downward at its lower part into the separator **3** and has its lower end open to the interior of the separator **3** near the lower end thereof.

A gas-heating flue **5** extends vertically and parallel along and is welded at **7** to the side walls of the pumping chamber **1** and the boiler tube **2**. The welds **7** are made denser or thicker in the downward direction so that better heat exchange is obtainable between the gas-heating flue **5** and the pumping chamber **1** than between the gas-heating flue **5** and the boiler tube **2**, and that better heat exchange is obtainable at lower parts of the boiler tube **2** than at upper parts of the same.

An electrical heating sleeve **6** extends vertically and parallel along and is welded at **7***a* to the side walls of the pumping chamber **1** and the boiler tube **2**. The welds **7***a* therebetween are also made denser or thicker in the downward direction so that better heat exchange is obtained at lower parts than at upper parts. The arrangement of the electrical heating sleeve **6** relative to the gas heating flue **5** is best shown in FIG. **2**, from which it will be noted that the electrical heating sleeve **6** and the gas-heating flue **5** are on diametrically opposite sides of the pumping chamber **1** and boiler tube **2**, and that a plane passing through the longitudinal axes of the flue **5** and sleeve **6** is perpendicular to a plane passing through the longitudinal axes of the boiler tube **2** and separator **3**.

A rich or strong solution transfer conduit **8** connects the bottom of the separator **3** to a lower part of the pumping chamber **1**. As is shown in FIG. **2**, the conduit **8** extends in the plane passing through the longitudinal axes of the separator **3** and the chamber **1**.

A lower part of the boiler tube **2** is in communication with the heat exchanger **9** through a lean or weak solution transfer conduit **10**. It will be noted from FIG. **2** that the beginning or upstream end portion of the conduit **10** extends in the same plane passing through the axes of the separator **3** and the chamber **1**. From the foregoing, it will be appreciated that the structure including the generator assembly G, and the associated conduits are in a compact and symmetrical arrangement and, therefore, are stable in structure and in operation.

From the absorber vessel **11** extends a rich liquid conduit **12** which passes through the heat exchanger **9** and is led to a lower part of the separator **3**.

The gas heating flue **5** contains therein a baffle **14** for improving heat transfer. Under the flue **5**, there is provided a gas burner **13**.

The electrical heating sleeve **6** is formed with a longitudinal slit **16** and made of a resilient material such as a steel sheet. Within the sleeve **6** there is disposed a cartridge-type electric heater **17** which is resiliently gripped by the sleeve **6** and in tight engagement with the same so as to establish a heat exchange relation between the sleeve **6** and the heater **17**.

FIG. 3 shows a modified arrangement of the generator assembly G, in which the gas heating flue 5 and the electrical heating sleeve 6 are displaced in a direction remote from the separator 3. It is to be noted that in this modification, the plane passing through the longitudinal axes of the flue 5 and the sleeve 6 remains substantially perpendicular to the plane passing through the axes of the boiler tube 2 and the separator 3. It will be understood that this modification also affords compactness and stability.

The generator of the above described organization according to the invention, incorporated within an absorption refrigeration apparatus, operates in the following manner when heated by gas by the gas burner 13.

Hot combustion gas produced by the burner 13 flows upwards through the flue 5, and the heat in the gas is intercepted by the baffle 14 and transferred across the wall of the flue 5 and then across the walls of the boiler tube 2 and the pumping chamber 1 into the liquids therewithin so as to heat the latter.

In this case, since the welds between the flue 5 and the pumping chamber 1 are dense, an effective heat transmission is carried out through the welds so that the solution rich in refrigerant, such as dense ammonia water, is boiled in the boiling chamber 1 to expel the refrigerant dissolved therein. The refrigerant gas thus expelled is accumulated as bubbles in the upper part of the boiling chamber and caused to flow upwards through the lift pipe 4 in a condition in which it is intermixed with steam and water so as to be supplied into the boiler tube 2 through the upper opening of the pipe 4.

It is to be noted that since the lift pipe 4 is of small diameter relative to that of the pumping chamber 1, a strong upward flow of the expelled refrigerant and the intermixed boiled water is created through the lift pipe 4 with an intense pumping action.

The refrigerant and the water intermixed therewith, supplied into the boiler tube 2, then enter the vapor-liquid separator 3, in which the refrigerant gas is separated from the water and thence flows through the conduit 3*a* to the condenser (not shown) of the refrigeration apparatus.

On the other hand, a weak solution is accumulated in the boiler tube 2 and receives heat from the gas heating flue 5 through the welds 7 and from the fluid flowing through the pipe 4, whereby the weak solution in the boiler tube 2 is also boiled so as to liberate refrigerant additionally therefrom. The weak solution accumulated in the boiler tube 2 flows through the weak solution transfer conduit 10 into the heat exchanger 9 and is passed by means of a conduit 9*a* to the absorber coil (not shown).

The refrigerant which has condensed in the condenser is thereafter supplied into the evaporator (not shown) to be evaporated therein. The evaporated refrigerant flows into the absorber vessel 11 through a conduit 11*a* and is directed through a conduit 11*b* to the absorber coil to be absorbed into the weak solution which is supplied to the absorber coil through the pipe 9*a*.

The liquid enriched in refrigerant within the absorber coil flows down into the absorber vessel 11 through the conduit 11*b* and is accumulated in the vessel as is well known in the art.

In the bottom of the separator 3, there is accumulated a weak solution from which refrigerant gas has been liberated. The rich solution in the vessel 11 flows through the rich solution transfer conduit 12 into the heat exchanger 9 and exchanges heat with the hot weak solution from the boiler tube 2 to be heated, thereafter entering the separator 3 to be mixed with the liquid existing within the same. The rich solution then flows into the pumping chamber 1 through the conduit 8. Since the conduit 8 opens into the pumping chamber 1 at a low part of the latter, a good heating effect of the liquid is obtained within the chamber 1. The boiled liquid in the chamber 1 liberates the refrigerant and performs the same function as described hereinbefore.

In the operation of the apparatus through the use of the electrical heating device, the electric heater 17 is energized, and the heat thereby produced in the heater is transferred through the sleeve 6 and welds 7 to the solution within the pumping chamber 1 and boiler tube 2, in which the solution is heated in the same manner as described hereinbefore and performs the same function.

While the invention has been described above with respect to preferred examples, it will be understood that the invention may be carried out in other forms without departing from the scope of the invention.

We claim:

1. In an absorption refrigeration apparatus including a generator having vertically elongated refrigerant solution boiling means provided with cylindrical electric and gas heaters disposed therealong, said generator including a vapor-liquid separator communicatively connected to the boiling means downstream of the same and extending in parallelism with the boiling means, a refrigerant condenser connected to the vapor-liquid separator, a refrigerant evaporator connected to the condenser, an absorber vessel connected to the evaporator, an absorber coil connected at one end thereof to the absorber vessel, a weak solution transfer conduit connecting the boiling means to the other end of the absorber coil, a rich liquid conduit supplying rich solution stored in the absorber vessel into the vapor-liquid separator, and a rich solution transfer conduit connecting the vapor-liquid separator to the bottom of the boiling means, the improvement in which the refrigerant solution boiling means comprises a vertically disposed pumping chamber connected at its bottom part to the rich solution transfer conduit to be supplied with rich refrigerant solution thereinto, an elongated vertical boiler tube disposed above said pumping chamber in vertical alignment therewith and communicating at its top with the vapor-liquid separator, said boiler tube being connected to the weak solution transfer conduit at its bottom part and having a diameter equal to that of the pumping chamber, and a vapor lift tube communicatively connecting said pumping chamber to said boiler tube and extending upwards into the boiler tube to open into an upper space within the boiler tube, and to provide an annular space about the portion of the vapor lift pipe located within the boiler tube, said electric and gas heaters being rigidly secured by welds to the pumping chamber and the boiler tube on opposite sides thereof and at positions such that a plane passing through the longitudinal axes of the heaters is substantially perpendicular to a plane passing through the longitudinal axes of the separator and the boiler tube, and the longitudinal axes of the rich and weak refrigerant solution conduits lying in the plane passing through the longitudinal axes of the boiler tube and the separator.

2. The generator as claimed in claim 1, wherein the gas and electric heaters are on diametrically opposite sides of said boiler tube and pumping chamber.

3. The generator as claimed in claim 1, wherein the plane passing through the longitudinal axes of said heaters does not pass through the longitudinal axis of said boiler tube and is more remote from said separator than said axis of the boiler tube.

4. The generator as claimed in claim 1, wherein the welds which secure the gas and electric heaters to the sides of said chamber are denser or thicker in the downward direction so as to obtain increased heat exchange relation in that direction.

5. The generator as claimed in claim 1, wherein said electric heater comprises an outer sleeve having a longitudinal slit, said sleeve being of a resilient sheet material, and an inner cartridge-type heating element resiliently gripped within said sleeve.

* * * * *