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Reistad

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[54] **ABSORPTION REFRIGERATOR WITH ADDITIONAL MEANS FOR DEFROSTING THE REFRIGERATOR**

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[52] **U.S. Cl.** **62/490**

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

[58] **Field of Search** 61/110, 490, 491

[56] **References Cited**

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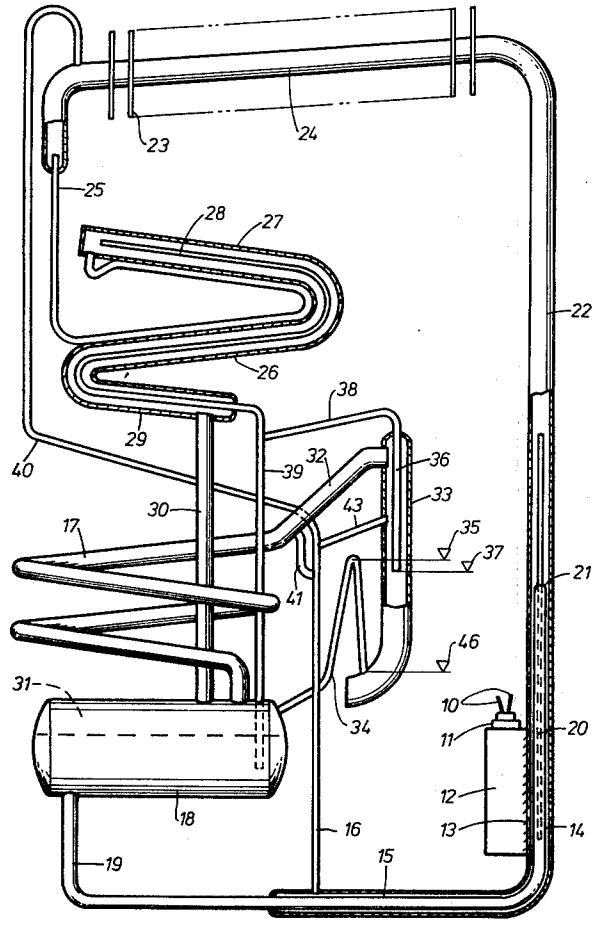
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Assistant Examiner—Peter D. Ferguson

[57] **ABSTRACT**

An absorption refrigeration apparatus operating with inert gas and having means for lifting liquid from one level to a higher level. This means can be used to achieve a well controlled defrosting of the refrigeration apparatus under all normal operating conditions thereof.

6 Claims, 3 Drawing Figures



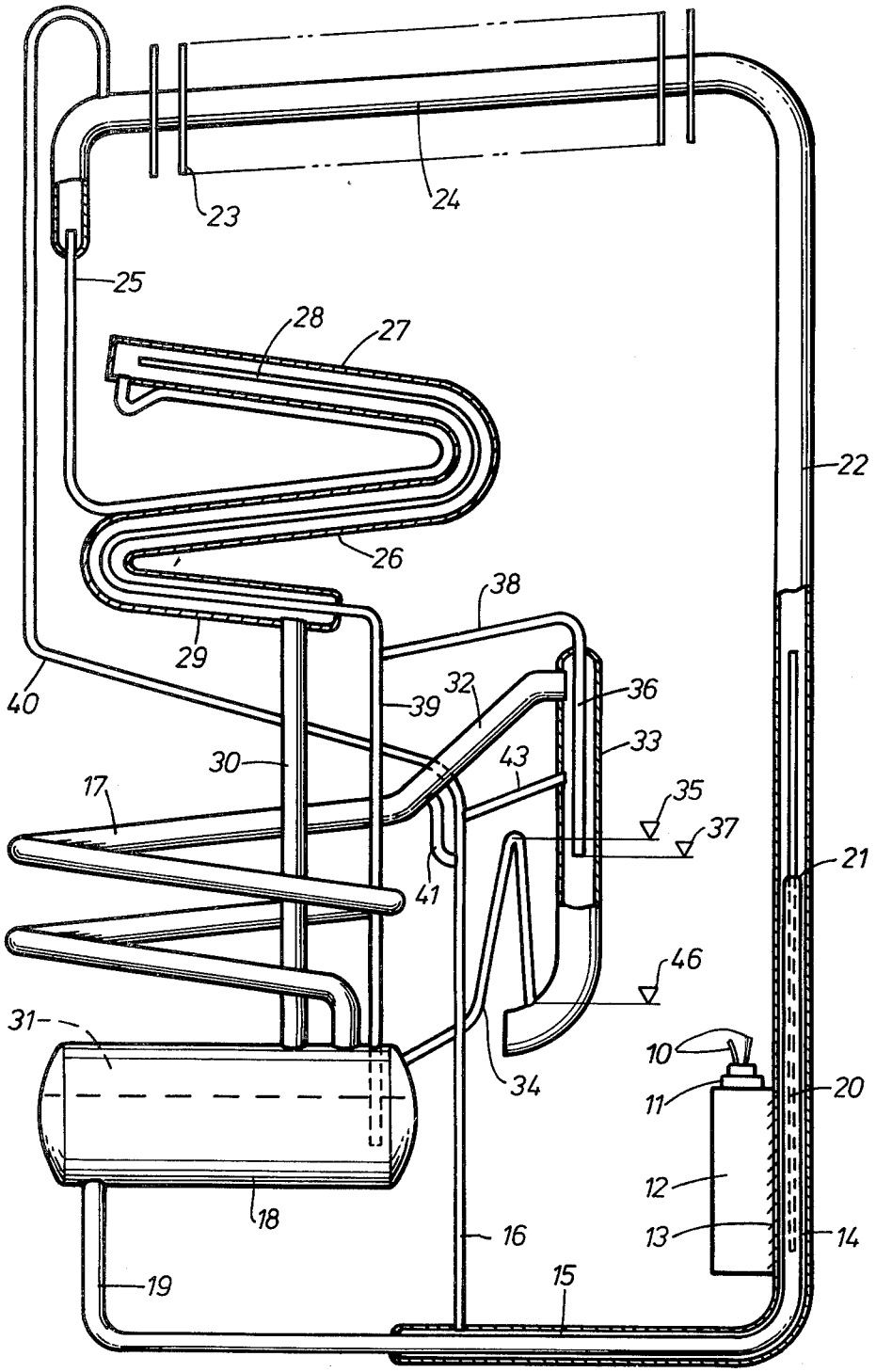

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Fig. 1

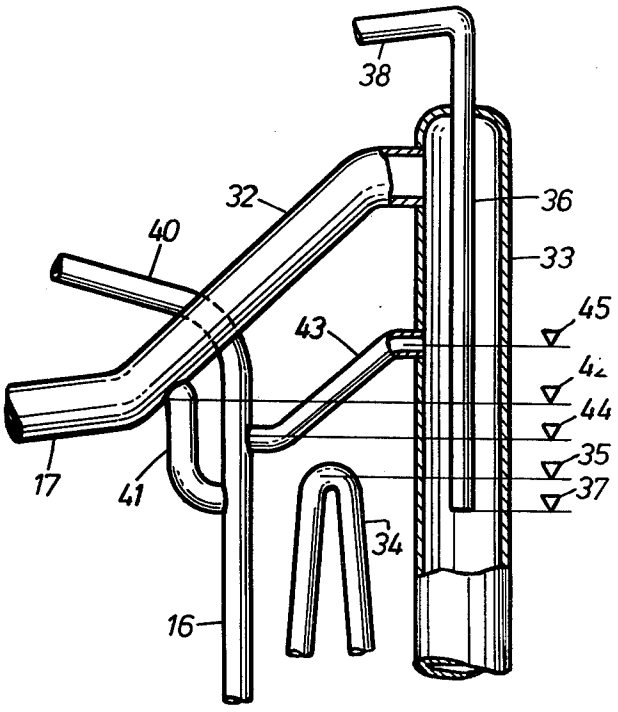

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Fig. 2

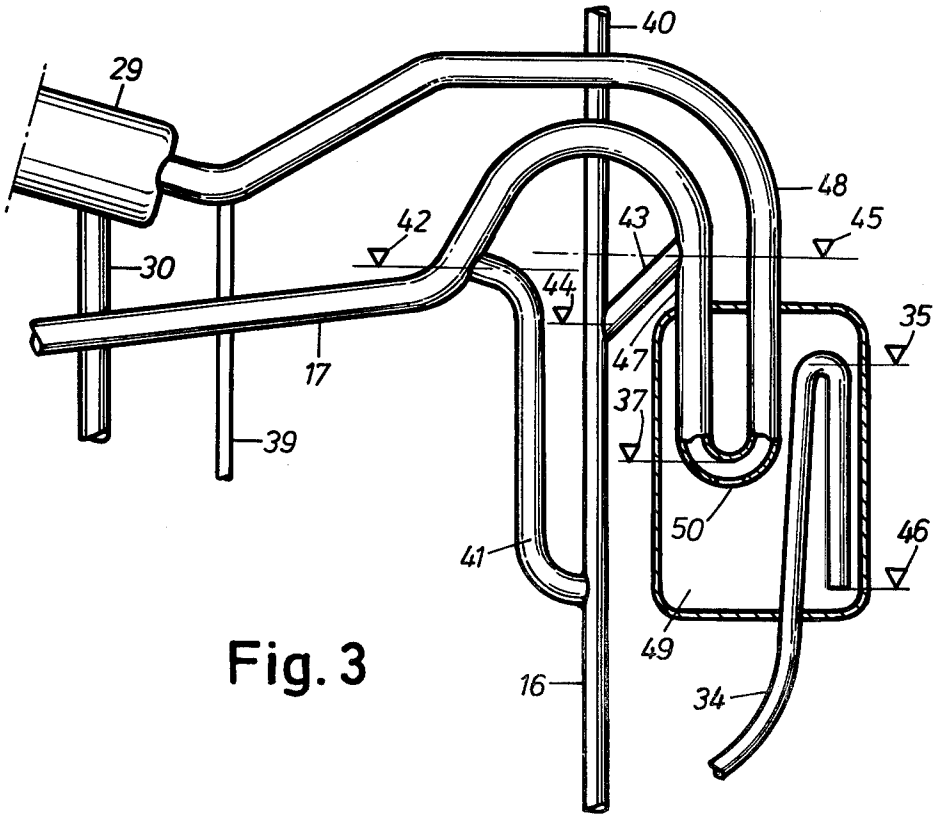

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Fig. 3

ABSORPTION REFRIGERATOR WITH ADDITIONAL MEANS FOR DEFROSTING THE REFRIGERATOR

BACKGROUND OF THE INVENTION

An absorption refrigeration apparatus is known which operates with inert gas and has means using collected liquid for control of apparatus functions. In prior art, liquid has been supplied to such means either by a heat operated pump or from a conduit in which condensate is present and which is leading such condensate to the means. It is also known in the gas circulation system of an absorption refrigeration apparatus to have a liquid seal being normally open to permit circulation of gas and being temporarily closed to block the gas circulation. After the blocking period, the seal is emptied by a siphon. During the blocking period, generation of cold in the evaporator system of the apparatus ceases and thus defrosting of the evaporator part occurs. After the liquid seal has been emptied, liquid is again collected in it either by leading condensate of the working media present in the gas circulation system into the liquid seal or by leading vapor of the working media from the boiler system of the refrigeration apparatus towards the liquid seal, which vapor is caused to condense to a certain extent in the supply conduit. Both these methods for solving the problem of bringing about defrosting of the refrigeration apparatus involve certain disadvantages. For example, if condensate from the gas circulation system is used, defrosting will be very much dependent on the operational conditions of the apparatus because the condensation of working media in the conduits concerned varies to a great extent with different ambient temperatures or with the loads on the refrigerator operated by the apparatus. If instead of the foregoing method the other method of condensation of hot vapors from the vapor space in the boiler system of the apparatus is used, this will entail the disadvantage that part of the heat is removed from the boiler system, among other disadvantages. Also regulation of the quantities of condensate collected may involve difficulties. In addition to these disadvantages, it is difficult to construct the apparatus such that a modification intended for automatic defrosting can be readily obtained from a manufacturing point of view by adding an extra part to an embodiment intended to operate without defrosting.

It is an object of the present invention to provide means in the refrigeration apparatus for lifting liquid from one level to a higher level without heat supply to the lifting means.

It is another object of the present invention to provide a simple additional part to the refrigeration apparatus which is connected into the system to thereby achieve a well controlled defrosting under all normal operating conditions.

The invention will now be more fully described with reference to the accompanying drawings, in which:

FIG. 1 is a diagrammatic view of the absorption refrigeration apparatus having the additional automatic defrosting installation, and with the heat insulation removed from the boiler;

FIG. 2 is a view of certain details of construction of the automatic defrosting installation of FIG. 1 on an enlarged scale; and

FIG. 3 is a modified embodiment of the automatic defrosting installation shown in FIGS. 1 and 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, the refrigeration apparatus shown is the known type utilizing water, ammonia, and hydrogen in the cycle. In this cycle, the water, ammonia, and hydrogen act as an absorption solution, a refrigerant, and a pressure equalizing inert gas, respectively. However, other media may be used.

The refrigeration apparatus during the normal generation of cold can be controlled by a thermostat (not shown), which connects and disconnects the electrical circuit depending upon the required cooling need. Electric power is supplied through the wires **10** to the electric heating cartridge **11** positioned in a metal sleeve **12** which is in heat conductive relationship with the boiler **14** along the line **13.** The outer conduit **15** of the heat exchanger contains absorption solution weak in refrigerant and supplied from the outer pipe of the boiler. This solution is conveyed through a conduit **16** and eventually to the upper part of the absorber **17** of the apparatus. In the absorber, the solution flows downwardly while absorbing refrigerant vapor from the rising rich mixture of refrigerant vapor and inert gas. When the solution has passed through the absorber **17** in which it is enriched in refrigerant, it is collected in an absorber vessel **18** from which it is supplied by a conduit **19** to the liquid circulating pump **20** in the boiler **14.** The pump **20** forms an inner conduit in the liquid heat exchanger. As seen in FIG. **1,** the pump **20** is located concentrically in the vertical part, the upper end **21** of which is closed.

Vapors emanating from the pump **20** and boiler **14** are conveyed in a vapor conduit **22** to the condenser **24** of the refrigeration apparatus provided with fins **23.** The evaporator of the apparatus comprises evaporator parts **26** and **27** and a conduit **25** is heat-conductively connected to both evaporator parts **26** and **27** and the refrigerant condensate formed in the condenser **24** passes through the conduit **25** to the highest point in the evaporator system at one end of the evaporator part **27.** At the same location, weak inert gas is supplied which has been pre-cooled in the inner conduit **28** of the evaporator system and comes from the absorber **17.** Thus, the refrigerant and the weak gas are in parallel flow through the evaporator part **27** which forms the low temperature evaporator, and thereafter through the evaporator part **26** which forms the high temperature evaporator, and through a gas heat exchanger **29** to the conduit **30.** The latter leads to a vapor space **31** in the absorber vessel **18** from which the gas is led upwardly through the absorber **17.**

The gas mixture which is weak in refrigerant appears at the upper end of the absorber **17** and is conveyed through a conduit **32** to the top part of a vessel **33** which, in a known manner, serves as a liquid seal in the gas conduit. A siphon **34** extends to the bottom part of the vessel **33** and transfers the liquid content of the vessel **33** to the absorber vessel **18** when the liquid in the vessel **33** has risen above the level **35.** The vessel **33** is provided with a conduit **36** which is open in its bottom end, the latter being on a level **37** located slightly below the highest level **35** of the siphon **34.** As long as the liquid in the vessel **33** is at a level below the level **37** adjacent to the bottom opening of the conduit **36,** the weak gas is conveyed from the conduit **32** downwardly in the vessel **33** and upwardly through the conduit **36** which

outside of the vessel **33** has a laterally disposed part **38** that is inclined downwardly to connect with the conduit **39.** The latter conduit is an extension of the gas conduit **29** passing through the evaporator system and extends as far downwardly to be submerged in the liquid held in the absorber vessel **18.**

The vessel **33** is provided with a liquid seal formed by collected liquid. In this regard, FIG. **1** discloses a vent conduit **40** connected at one end to the condenser **24** and directly connected to the conduit **16** in which weak absorption solution is supplied to the absorber **17.** As seen in FIGS. **1** and **2,** the vent conduit **40** and the conduit **16** form the same pipe and a connecting conduit **41** is shown between the conduit **16** and the absorber **17.** The connecting conduit **41** is connected to the absorber **17** at a level **42.** The connecting conduit **43** forms a bubble pump between the conduit **16** and the vessel **33.** As seen in FIG. **2,** the conduit **43** is connected to the conduit **16** at a level **44** located below the level **42** and to the vessel **33** at a level **45** above the level **42** where the liquid intake to the absorber **17** is situated.

It should be noted that the use of hydrogen as an inert gas, and ammonia and water as the other working medium results in that the solubility of hydrogen in the solution is bound by the physical laws, and the solubility is directly proportional to the partial pressure of hydrogen above the free liquid surface. The solubility further depends on temperature; however, in practice, this dependence is insignificant. The transport is accomplished with such an amount of hydrogen and so constantly under different operating conditions that it can be used to operate the bubble pump **43** and transfer the desired quantities of weak absorption solution to the vessel **33.** The level **42** at the absorber intake can be adjusted relative to the levels **44** and **45** at the inlet and outlet of the bubble pump **43** as well as adjusting the relation between the levels **35, 37,** and **46,** the latter being the end of the siphon **34** opening into the vessel **33.** These adjustments result in the defrosting of the evaporator of the absorption refrigerator at the desired time and during the same time approximately for each defrosting. By changing the relation between the levels near the bubble pump, the liquid supply to the vessel **33** can be varied and by adjusting the levels in the vessel **33,** it is also possible to modify the filling time of the liquid seal. Accordingly, as described above, there are two possible ways of adjusting the desired times for defrosting.

When the gas mixture in the absorber leaves the absorber part **32,** it contains substantially all hydrogen with some ammonia vapor and a small portion of water vapor. When the gas is cooled in the inner conduit **28** of the gas heat exchanger **29,** a small quantity of water vapor and ammonia vapor will condense. The resultant condensate flows downwardly through the conduit **39** and is drained in the absorber vessel **18.** The condensate instead of flowing to the absorber vessel **18** may be conducted to another part of the absorber, for example, to the highest point of the absorber. However, the condensate should never be permitted to flow down into the vessel **33.** If the condensate found its way into the vessel **33,** the time for filling the vessel from the level **46** to the level **37** would be much shorter than otherwise; but the time for filling from the level **37** to the level **35** would remain the same as has been disclosed hereinbefore. In accordance with the teachings of the present invention, the time represented by the difference of the levels **46–37** is about **20** times longer than the time represented by the difference between the levels **37–35;** and obviously, it would not be desirable to increase the filling velocity during the interval **46–37.**

The condenser **24** contains ammonia in vapor and liquid phase and in addition contains an insignificant quantity of water in vapor and liquid phase and a quantity of hydrogen depending upon the ambient temperature. With regard to the latter, there is more hydrogen in the condenser at low ambient temperature than at high ambient temperature. Hydrogen is conveyed to or from the condenser by the vent conduit **40** at variations of the ambient temperature. Furthermore, additional hydrogen will be continually supplied to the boiler **14** with the rich solution from the absorber vessel.

As seen in FIGS. **1** and **2,** the defrosting time depends largely on the differences in the distance between the levels **35** and **37,** i.e., the distance from the top of the siphon **34** to the level **37** at the lower opening of the conduit **36** through which the gas flow is blocked during defrosting. In large scale production, the relative position of the levels **35** and **37** may differ somewhat and this may influence the defrosting time from one apparatus to another.

FIG. **3** shows another embodiment of the present invention which has been developed in order to make the apparatus less sensitive to production tolerances. In this alternate construction, the gas blocking unit is provided with a larger horizontal cross-sectional area between the first and the second levels than between the second and third levels. In this construction, weak liquid is supplied through conduit **16** and conduct **41** to the absorber **17.** Inert gas flows downwardly through the conduit **40** and will press some liquid up through conduit **43** into the left hand branch **47** of a U-shaped conduit. The upper end of branch **47** is connected to the absorber **17** so that inert gas, weak in refrigerant, passes into the U-shaped conduit, the other branch **48** of which is connected to the evaporator (not shown) through the gas heat exchanger **29.** The U-shaped conduit **47, 48** is located in a vessel **49** and opens into the vessel through hole **50** in the bight of the U. As seen in FIG. **3,** a siphon **34** is arranged with its inlet opening located just above the bottom of the vessel **49** at the level **46.** The rounded top of the siphon is positioned inside the vessel **49** at the level **35.** Liquid pumped into the U-shaped conduit **47, 48** through the conduit **43** flows through the hole **50** and is collected in the vessel up to the level **37.** When further liquid is supplied to the U-shaped conduit, it cannot rise within the entire vessel **49** because above the liquid level there is an upper enclosed space containing inert gas and vapor. Thus, above the level **37,** the liquid will rise only inside the two legs **47, 48** of the U-shaped conduit. When the liquid reaches the level **35,** the siphon **34** will be active and lower the liquid to the level **46.** The liquid in the apparatus rises slowly from the bottom of the vessel **49** to the level **37.** Thereafter, the liquid rises very fast and therefore, it is possible to have a comparatively large distance between the levels **37** and **35.**

It should be apparent that the present refrigeration apparatus can be easily manufactured in large scale production. Moreover, although the illustrations herein are on one plane for the sake of clarity, it is within the scope of the present invention to position the parts of

the refrigeration apparatus in other ways relative to each other, which are more suitable from the point of view of ease of manufacture.

What is claimed is:

1. In an absorption refrigeration apparatus having an inert gas and provided with a circuit for absorption liquid working medium, a gas circulation system including an evaporator and absorber, a vapor expulsion unit, a condenser connected to said vapor expulsion unit for delivering liquid to the evaporator to produce a refrigerating effect, the improvement comprising; a vessel in said apparatus, means for transfering the liquid working medium from one part of the refrigeration apparatus to said vessel located at a higher level than said one part, a vent pipe conducting gas from said condenser, a first conduit connecting said vent pipe to said vessel, said first conduit functioning as a bubble pump by means of said inert gas being drawn from said condenser through said vent pipe, and a second conduit connected to said vent pipe and having liquid therein, the level of liquid in said bubble pump when no gas is supplied being located above the connection of said vent pipe to said pump but below the connection of said pump to said vessel.

2. In an absorption refrigeration apparatus having an inert gas and provided with a circuit for absorption liquid working medium, a gas circulation system including an evaporator and absorber, a vapor expulsion unit, a condenser connected to said vapor expulsion unit for delivering liquid to the evaporator to produce a refrigerating effect, the improvement comprising; a defrosting arrangement for said refrigeration apparatus having a vessel and wherein said gas circulation system is provided with a liquid seal in said vessel, said seal being temporarily open to permit the circulation of a gas and temporarily blocked during defrosting, a siphon for emptying said liquid seal in said vessel after said blocking period, a vent pipe conducting gas from the condenser, a first conduit connecting said vent pipe to said vessel, said first conduit functioning as a bubble pump by means of said inert gas being drawn from said condenser through said vent pipe, a second conduit connected to said vent pipe and conducting weak absorption liquid to said vent pipe, and a branch pipe connecting said second conduit to said absorber, said bubble pump being connected to said seal at a point higher than the inlet of said branch pipe to said absorber.

3. An absorption refrigeration apparatus as claimed in claim 1 wherein said absorber is provided with one gas-conveying conduit connected to the top of said seal, and another gas-conveying conduit in said seal having a part extending outside said seal, said one gas-conveying conduit and said part of the other gas-conveying conduit being operatively connected to said liquid seal and inclined relative to said seal whereby liquid working media in said conduits flow in the direction from the liquid seal through said conduits.

4. An absorption refrigeration apparatus as claimed in claim 1 wherein said absorber is provided with an extension in the form of a U-shaped pipe having legs which are gas-conveying conduits, said conduits being operatively connected to said liquid seal and being inclined so that the liquid working media flow in the direction from the liquid seal through said conduits.

5. An absorption refrigeration apparatus as claimed in claim 1 wherein a gas-blocking means is provided in said vessel with a larger liquid collecting area below the gas flow blocking level than above this level.

6. An absorption refrigeration apparatus as claimed in claim 5 further comprising a siphon in said vessel having a top level above the gas flow blocking level so as to lower the liquid in the vessel to a predetermined level below the gas flow blocking level.

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