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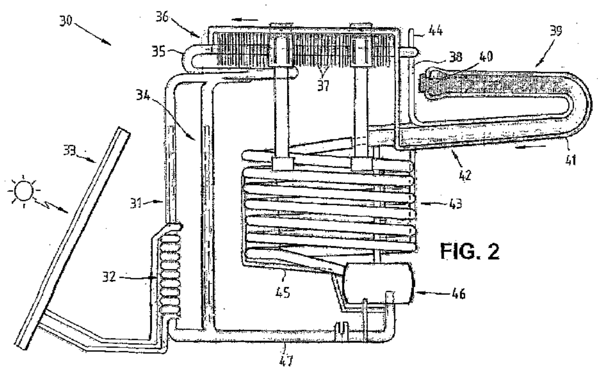

FIG. 2

(57) Abstract: A cooling method and apparatus which uses an absorption cycle with ammonia as the refrigerant and in which a generator (31,34) converts a liquid ammonia solution into ammonia gas or vapour for supply to a condenser (36) in which the ammonia gas or vapour is condensed into a liquid ammonia solution. The liquid ammonia solution is supplied to an evaporator (39) in which liquid ammonia is evaporated into ammonia gas or vapour to thereby absorb heat and an absorber (43) absorbs the ammonia gas or vapour back into an ammonia solution. The evaporator (39) includes a reservoir or bulb (40) which retains portion of the liquid ammonia solution which is converted back into an ammonia gas or liquid by exposure to ambient heat and returned to the condenser (36) for recycling.

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COOLING METHOD AND APPARATUS

Technical Field

This invention relates to a cooling method and apparatus and in particular to a cooling method and apparatus which uses an external heat input. The present invention in a particular aspect relates to cooling apparatus which can function as an air conditioner. The following description is primarily directed to cooling apparatus, particularly air conditioners, for which the heat input is derived from solar energy however it will be appreciated that the apparatus of the present invention has other cooling applications and may be powered by other external heat sources including an ambient heat source.

Background Art

In a conventional refrigeration cycle, a compressor is used to compress and thereby increase the pressure of a refrigerant gas. The high pressure refrigerant gas is then condensed in a condenser back into a liquid refrigerant with the assistance of a coolant usually air which is passed over the coils of the condenser. This release heat from the refrigerant gas flowing through the condenser and causes the high pressure gas to be condensed back into a liquid by heat exchange. The high pressure liquid refrigerant then passes through an expansion valve in which it will drop to a low pressure and cool and then passes into an evaporator in which it evaporates and absorbs heat as it changes from a liquid to a vapour thereby reducing the temperature of air flowing over the evaporator. This form of refrigeration cycle is commonly used in air conditioners.

In an absorption refrigeration cycle, a different method is used for cooling that requires no moving parts and is powered only by heat. The ammonia absorption cycle was one of the first methods employed for the production of refrigeration. The original systems were installed in the early 1800's whilst a more advanced ammonia absorption system was invented by Ferdinand Carre, Paris France in 1850. His original invention consisted of a direct fired generator, a condenser, an evaporator, an absorber, and an aqua-ammonia pump, all of which with many subsequent improvements remain the principle parts of an ammonia absorption system. The original ammonia absorption system was very inefficient and it was impossible to obtain ammonia liquid for use in such a system at above 90% purity. Consequently, the system was difficult to operate as excess water collected in the evaporator, raising the evaporation temperature. At that time however, reciprocating machines had not been developed to the point where they could approach the compression ratios required for low temperature applications in the conventional refrigeration cycle and thus the ammonia absorption cycle was used in the refrigeration industry despite its disadvantages. As reciprocating compressors were improved, the ammonia absorption system passed into obsolescence.

In the middle thirties, improved ammonia absorption systems were installed which would operate on waste steam, waste heat, or by direct firing with natural gas or other gases. These systems employed a bubble column design and spray type absorbers and provided ammonia at 99.96% purity for refrigeration duty. This advance in technology which provided the high purity (commercial grade) ammonia overcame the major operating problems of the early systems.

There are a number of solar powered air conditioners or refrigerators which are known or which have been proposed. Some of those air conditioners or refrigerators operate on an absorption cycle with heat from solar collectors being as a heat source in the absorption cycle. Although the majority of absorption cycles are based on a water/lithium bromide cycle, many applications exist where an ammonia/water cycle can be used, especially where lower temperatures are desirable. Since the refrigerant (such as ammonia) is ultimately absorbed at one point in the cycle a solar powered refrigerator is known as an absorption refrigerator. In both the water/lithium bromide cycle and ammonia/water cycle, water is used as working fluid, but in quite different ways: as a solvent for the ammonia-system, and as refrigerant for the lithium bromide system.

Current solar powered air conditioners and refrigerators of the above type have not proved particularly effective. It is therefore an object of the invention to provided an improved cooling method and apparatus which operates on an absorption cycle and which address the disadvantages of the prior art or which at least provided an effective alternative thereto. The present invention in a particular aspect aims to provide cooling apparatus of the above type which is embodied in an air conditioner which can be operated by solar energy input.

Summary of the Invention

The present invention provides in one preferred aspect although not necessarily the broadest aspect, cooling apparatus of the type which operates on an absorption cycle using ammonia as the refrigerant, said apparatus including a generator for supplying ammonia gas or vapour, a condenser for condensing the ammonia gas or vapour into a liquid ammonia solution, an evaporator in which liquid ammonia is evaporated into ammonia gas or vapour which thereby absorbs heat and an absorber for absorbing said ammonia gas or vapour into an ammonia solution and wherein said evaporator includes means for retaining a portion of said liquid ammonia received from said condenser for return and recycling through said apparatus.

The means for retaining a portion of the liquid ammonia suitably comprises a reservoir in said evaporator. Most suitably, the reservoir comprises a recess, bulb or indent at an end of the evaporator in which liquid ammonia can collect. The reservoir suitably is provided at an end of the evaporator remote from an inlet thereto. Preferably a return line or pipe connects the reservoir to the condenser. Preferably the return line or pipe is adapted to return ammonia collecting in the reservoir to the condenser inlet. Suitably the return pipe or line is exposed to ambient heat such that the ammonia liquid flowing in the return pipe or line is vapourised before returning to the condenser where it condenses in the condenser for subsequent passage to the evaporator. Preferably the return pipe is in heat exchange contact with the evaporator. Ammonia collecting in the reservoir for recycling suitably comprises only a small proportion of the ammonia in the apparatus.

Typically the cooling apparatus is embodied in air conditioning apparatus and means, such as one or more fans, are provided to cause air to circulate over the evaporator.

Preferably the generator of the apparatus is heated by solar energy and for this purpose the apparatus is associated with a solar energy collector of any form. Preferably a heat exchanger is associated with the generator to transfer heat generated by solar energy to the generator. The generator however may additionally include other heating means such as a gas flame or electric heater.

The apparatus may also include an additional generator arranged in parallel with the abovementioned generator and an auxiliary heating source such as an electric element or gas flame may be used to heat the additional generator for creating an ammonia vapour from an ammonia water solution in the generator for passage to the condenser.

In a further aspect, the present invention provides a method of cooling comprising the steps of

converting a liquid ammonia solution into ammonia gas or vapour;

condensing said ammonia gas or vapour into a condensed ammonia solution;

evaporating said condensed ammonia solution to convert said liquid into ammonia gas of vapour and thereby absorb heat;

retaining a portion of condensed ammonia liquid in said evaporation step for reconversion into ammonia gas or vapour ; and

absorbing said ammonia gas from said evaporator to convert said ammonia gas or vapour into a liquid ammonia solution for subsequent conversion into said ammonia gas or vapour.

Suitably the liquid ammonia solution is converted into ammonia gas or vapour by a solar heat source or other heat source.

Preferably the retained liquid is converted into ammonia gas or vapour under the influence of ambient heat.

In another aspect, the present invention provides cooling apparatus of the type which operates on an absorption cycle using ammonia as the refrigerant, said apparatus including at least a first generator for supplying ammonia gas or vapour, a condenser for condensing the ammonia gas or vapour into a liquid ammonia solution, an evaporator in which liquid ammonia is evaporated into ammonia gas or vapour and absorbs heats heat and an absorber for absorbing said ammonia gas or vapour from said evaporator and wherein said first generator is heated directly or indirectly by a solar energy collector.

Suitably the first generator or another generator arranged in parallel to the first generator is adapted to be heated selectively by a further heat source such as a gas powered heat source or electrically powered heat source.

Brief Description of the Drawings

Reference will now be made to the accompanying drawings which illustrate preferred embodiments of the invention and which enable the invention to be more readily understood and put into practical effect. The embodiments have been described in relation to cooling apparatus which is embodied in an air conditioner for which the heat source is provided by solar energy. It will be appreciated however that the invention may be applied to other cooling applications and using other heat sources including ambient heat. In the drawings:-

Fig. 1 is a block diagram of a first embodiment of cooling apparatus using an absorption cycle according to the present invention;

Fig. 2 illustrates in side view a further embodiment of cooling apparatus according to the present invention embodied in an air conditioner;

Figs. 3 and 4 are side and top views of the apparatus of Fig. 2; and

Figs. 5 and 6 illustrate in side and top views, alternative cooling apparatus according to the present invention

Detailed Description of the Preferred Embodiment

Referring to the drawings and firstly to Fig. 1, there is illustrated in block diagram form air conditioning or air chilling apparatus 10 according to the present invention which uses an absorption refrigeration cycle with ammonia as the refrigerant and water as the absorbent. The apparatus 10 includes a heat source such as a solar collector 11 that provides heat to a generator 12 for the purposes of generating ammonia gas, the generator 12 comprising a metal tank 13 with one section having a series of coils 14 therein though which steam generator by the solar collector 11 may pass. Steam may be created from water in a water jacket which communicates with the coils 14, the water being heated by the solar energy collector 11 to create steam. In the absence of sufficient solar energy, an additional heat source may be used such as a gas flame, or an electrical coil for the creation of steam.

A strong ammonia-water mixture is contained within the generator tank 13 and the heat from steam in the heated jacket or coils 14 which is at a temperature of up to 423K or 150°C causes the ammonia-water mixture in the tank 13 to boil. As a result of the boiling, the strong mixture gives off ammonia vapor which leaves the generator 13 containing a very small percentage of warm water.

The boiling strong liquid travels up a percolator pipe 15 and into a separator tank 16, where the liquid is separated into hot liquid (water) and hot gas (ammonia) phases. The hot ammonia gas then continues up a fractionator column 17 separating further with concentrated hot ammonia vapour leaving the fractionator column 17 into a condenser 18. As the ammonia vapour leaving the fractionator column 17 is not highly superheated, the condenser 18 can operate efficiently at 308K or +35°C.

As the ammonia gas is cooled in the condenser 18, water vapour is condensed out to remove the water vapor. The water vapor condenses and flows or drips back into the separator tank 16, exiting along an inverted enlarged "T" pipe 19 with the ammonia gas continuing along the condenser 17 where it cools and changes phase to liquefy into almost pure liquid ammonia. At the bottom of the condenser 17, liquid ammonia flows down into an evaporator 20.

This anhydrous ammonia (water free ammonia) passing into the evaporator 18 will evaporate in the presence of hydrogen or helium gas equalizing the pressure between the condenser 18 and evaporator 19. As the ammonia vaporises, it absorbs heat in the evaporator causing the evaporator 18 to be chilled toward -70°C. The refrigerated evaporator 18 surface then chills the surrounding air (or a glycol solution). A fan 21 may be provided adjacent the evaporator 19 to blow chilled air into a surrounding space for air conditioning purposes.

A portion of the now heavy mixture passes using gravity into the top of a jacket heat exchanger 22 with warmer ammonia gas returning vertically to be cooled in a second smaller condenser (not shown) where it also cools and returns to the evaporator 20.

A thermo siphon 23 draws off the liquid from the separator tank 16 and discharges it to the base of the heat exchange jacket 22, where it combines with ammonia and hydrogen or helium gas from the evaporator. This solution then passes through an absorber 22, the absorber 22 removing the remaining heat with the assistance of the heat exchanger 20 and fan 25 with the cooled ammonia being dissolved and re absorbed with water. The combined solution collects in an absorber vessel 26 at the base of the absorber 24 in which the condensed water returning through the center pipe 27 of the jacket heat exchanger 10 is combined with the ammonia solution from the absorber 22. The combined solution then passes via pipe 25 into the generator 13 where the cycle begins again.

The system maintains a thermal balance with total heat input balancing with the total heat rejected to provide a simple check on the apparatus 10.

Referring now to Figs. 2 to 4, there is illustrated air conditioning or cooling apparatus 30 according to a practical embodiment of the present invention. The apparatus 30 includes a gas/vapour generator 31 which is heated through a heat exchanger in the form of an external coil 32 which surrounds the generator 31, the coil 32 containing steam which is created by a solar collector 33 of any form but which in this embodiment comprises a flat plate solar collector. The apparatus 30 may further include an additional gas generator 34 which is similar to the generator 31 and which is arranged in parallel with the generator 34. The generator 34 in this case may be heated by an auxiliary heat source such as gas flame or electric element where for example there is insufficient collection of solar energy. Alternatively or additionally, the generator 34 may be heated by ambient air. The generators 31 and 34 are connected to the inlet line 35 to a condenser 36 which is provided with fins 37 for efficient dissipation of heat.

As in the embodiment of Fig. 1 a strong ammonia/ water solution in the generator 31 and/or generator 34 is heated by the solar energy provided by the collector 33 or by other heat source to cause the solution to boil and release ammonia gas or vapor which leaves the generator/s 31 and/or 34 to pass into the condenser 36 in which the ammonia gas or vapour is cooled. The ammonia gas or vapour passes along the condenser 36 where it cools with the temperature of the condenser decreasing with the ammonia gas or vapour liquefying by changing phase into almost pure liquid ammonia.

The condenser 36 has an outlet connected by outlet pipe 38 to an evaporator 39. The anhydrous ammonia from the condenser 36 flows into the evaporator 39 and passes through the evaporator 39 chilling the evaporator 39 as it evaporates. The evaporator 39 includes an enlarged ammonia reservoir or recess at its free end which is the form of an enlarged bulb 40. A return tube or pipe 41 passes along the evaporator 39 to be exposed to ambient air and connects the bulb 40 to the inlet 35 to the condenser 36.

The ammonia vaporises as it warms and mixes with hydrogen or helium gas in the evaporator 39, and as the ammonia vaporises it absorbs the heat in the evaporator 98 and passes through a heat exchanger 42 and into an absorber 43 comprise a series of coils. A further small pipe 44 also connects the outlet of the condenser 36 to the absorber 43 towards the outlet end thereof. Ammonia gas or vapour from the evaporator 39 recombines with water and weak ammonia solution supplied through pipe 45 in the absorber 43 to form a strong ammonia water solution which collects in an absorber vessel 46 connected to the outlet of the absorber 43 for resupply to the generator/s 31 and/or 34 via supply pipe 47 to continue the cooling or refrigeration cycle.

Some of the ammonia is removed from the cycle by being collected as almost pure ammonia in the recess or bulb 40 and instead of passing to the absorber 43, it passed into the return pipe 41 where it is heated by the ambient heat of the building or room in which the apparatus 30 is located (or by a glycol solution (see below). As this ammonia turns to a vapour due to the ambient heat on the evaporator 39, a portion of ammonia vapour moves along the pipe 41 partially cooling and this cooled transition stage ammonia returns to the inlet 35 of the condenser 36. As the ammonia cools in the pipe 41, drops of ammonia form which cause a partial vacuum in the pipe 41 which draws more vapour into the pipe 41. The ammonia vapour on flowing into the condenser 36 via the inlet 35 continues to cool through the condenser 36 and eventually becomes liquid ammonia. The returned ammonia thus liquefied then returns to the evaporator 39 via the pipe 38 with any other liquid ammonia condensing in the condenser 36. Thus the inclusion of the small bulb or recess 40 at the start of the evaporator 39 allows the evaporator 39 to retain some pure ammonia to continue the additional cycle

The apparatus 30 can refrigerate a glycol solution to transfer the refrigeration effect to other devices, is able to reverse cycle, or is able to refrigerate ambient air. The device can chill down to -70 deg C for a comparable use of energy as other equipment. With the addition of the ambient heat cycle, the equipment can provide additional refrigeration effect using only ambient heat. The apparatus may have an electric auxiliary heater of 65w (any voltage), or can also be directly powered from a small gas powered heat source for example associated with the generator 34. The apparatus 30 does not require a fan however split units that use the refrigerated glycol can use electricity to drive a fan and a pump. The use of solar hot water to heat the ammonia solution in combination with the effect of ambient heat on the ammonia retained in the evaporator bulb 40 when returning to the condenser will enhance the refrigeration effect.

Referring now to Figs. 5 and 6, there is illustrated a further embodiment of cooling apparatus 50 in which like components to the components of the apparatus of Figs. 2 to 4 have been given like numerals but marked with a prime "'". The apparatus 50 includes one or more gas or vapour generators 31', 34' in which liquid ammonia is heated such as by solar heat energy and converted into a gas or vapour and which passes to condenser 36'. Ambient air passing over the fins of the condenser 36' causes the ammonia gas or vapour to condense into liquid ammonia which flows to the evaporator 39'. Some liquid ammonia is retained in recess or bulb 40' at the end of the evaporator 39'. The liquid ammonia in the presence of hydrogen or helium evaporates causing absorption of heat and therefore cooling of the space surrounding the evaporator 39'. A fan (not shown) blowing air over the evaporator 39' can cause cooling of a room space for air conditioning purposes. The ammonia retained in the recess or bulb 40' is returned to the condenser through line 41' (shown in dotted outline) for recycling through the apparatus 50.

The ammonia (and hydrogen or helium) vapour passes into the absorber 43' and the ammonia is absorbed into ammonia solution fed to the upper end of the absorber 43' from tube 49 which is connected to the liquid ammonia supply line 46' to the generator 31',34'. The hydrogen or helium gas is released when the ammonia is absorber to returns to the evaporator 39'. The strong ammonia solution then collects in the vessel 45' to again pass into the generator 31', 34' to recommence the cycle.

In each of the above embodiments, no pump is normally required as liquid flows through the apparatus under the influence of gravity. A pump however may be required in a split system a referred to above.

The cooling apparatus described above is suitable for application as an air conditioner in homes, offices, small buildings, shopping centers, factories, motor homes, trains, buses, and coaches in which case a suitable fan or the like is provided to circulate air over the cooling evaporator.

Most apparatus can also be supplied as 2-way powered or 3-way powered system such as solar and gas, solar and diesel, solar and electricity, gas, diesel or electricity being a booster for overcast days. Most apparatus use the ambient heat of the building to additionally boost the efficiency of the cooling with ambient heat coming from sunlight, people, lights and electronic equipment. Waste heat from petrol or diesel motors can be used with solar collectors. This makes the technologies portability very convenient for remote and mobile applications. The system can operate automatically from 0% to100% load with minimal loss of efficiency. As the load requirement is reduced there is a corresponding linear reduction in the consumption of heat.

The surplus hot water from the solar collector 33 can replace or supplement an existing hot water supply to a building as 30% of the energy bill is usually proportional to cooling a building, with another 30%, to provide the hot water for the building. With the apparatus of the invention, energy costs for air conditioning and supply of hot water is substantially reduced or eliminated.

The reference to prior art herein is not to be taken as acknowledgement that such prior art constitutes common general knowledge in the art.

The terms "comprising" or "comprises" as used throughout the specification and claims are taken to specify the presence of the stated features, integers and components referred to but not preclude the presence or addition of one or more other feature/s, integer/s, component/s or group thereof.

Whilst the above has been given by way of illustrative embodiment of the invention, all such variations and modifications thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of the invention as herein defined in the appended claims.

Claims

1. Cooling apparatus of the type which operates on an absorption cycle using ammonia as the refrigerant, said apparatus including a generator for supplying ammonia gas or vapour, a condenser for condensing the ammonia gas or vapour into a liquid ammonia solution, an evaporator in which liquid ammonia is evaporated into ammonia gas or vapour which thereby absorbs heat and an absorber for absorbing said ammonia gas or vapour into an ammonia solution and wherein said evaporator includes means for retaining a portion of said liquid ammonia received from said condenser for return and recycling through said apparatus.

2. Cooling apparatus as claimed in claim 1 wherein said reservoir comprises a recess or bulb at an end of the evaporator in which liquid ammonia can collect.

3. Cooling apparatus as claimed in claim 2 wherein said reservoir is provided at an end of said evaporator remote from the inlet thereto.

4. Cooling apparatus as claimed in claim 3 wherein a return line or pipe connects the reservoir to the condenser

5. Cooling apparatus as claimed in claim 4 wherein said return line or pipe is adapted to return ammonia collecting in the reservoir to the condenser inlet.

6. Cooling apparatus as claimed in claim 4 or claim 5 wherein said return pipe or line is exposed to ambient heat such that liquid ammonia flowing in the return pipe or line is vaporised before returning to the condenser.

7. Cooling apparatus as claimed in claim 6 wherein said return pipe is in heat exchange contact with said evaporator.

8. Air conditioning apparatus including cooling apparatus as defined in any one of the preceding claims, said air conditioning apparatus including means for

circulating air over the evaporator.

9. Air conditioning apparatus as claimed in claim 8 wherein said circulating means comprise one or more fans.

10. Air conditioning apparatus as claimed in claim 9 wherein said generator of the cooling apparatus is adapted to be heated by solar energy.

11. Air conditioning apparatus as claimed in claim 10 and including a solar energy collector for supplying solar energy to said generator.

12. Air conditioning apparatus as claimed in claim 11 and including a heat exchanger is associated with the generator to transfer heat generated by solar energy to the generator.

13. Air conditioning apparatus as claimed in any one of claims 8 to 12 and including additional heating means for heating the or a further said generator..

14. Air conditioning apparatus as claimed in claim 13 wherein said further generator is arranged in parallel with the first generator, said further generator being adapted to be heated by said additional heating means.

15. Air conditioning apparatus as claimed in claim 14 wherein said additional heating means comprises one of a gas flame or electric heater.

16. Cooling apparatus of the type which operates on an absorption cycle using ammonia as the refrigerant, said apparatus including at least a first generator for supplying ammonia gas or vapour, a condenser for condensing the ammonia gas or vapour into a liquid ammonia solution, an evaporator in which liquid ammonia is evaporated into ammonia gas or vapour and absorbs heats heat and an absorber for absorbing said ammonia gas or vapour from said evaporator and wherein said first generator is heated directly or indirectly by a solar energy collector.

17. Cooling apparatus as claimed in claim 16 wherein said first generator or another generator arranged in parallel to the first generator is adapted to be heated selectively by a further heat source such as a gas powered heat source or electrically powered heat source.

18. A method of cooling comprising the steps of

converting a liquid ammonia solution into ammonia gas or vapour;

condensing said ammonia gas or vapour into a condensed ammonia solution;

evaporating said condensed ammonia solution to convert said liquid into ammonia gas of vapour and thereby absorb heat;

retaining a portion of condensed ammonia liquid in said evaporation step for reconversion into ammonia gas or vapour; and

absorbing said ammonia gas from said evaporator to convert said ammonia gas or vapour into a liquid ammonia solution for subsequent conversion into said ammonia gas or vapour.

19. A method of cooling as claimed in claim 18 wherein said liquid ammonia solution is converted into said ammonia gas or vapour by a solar heat source.

20. A method of cooling as claimed in claim 19 wherein said retained liquid is converted into ammonia gas or vapour under the influence of ambient heat.

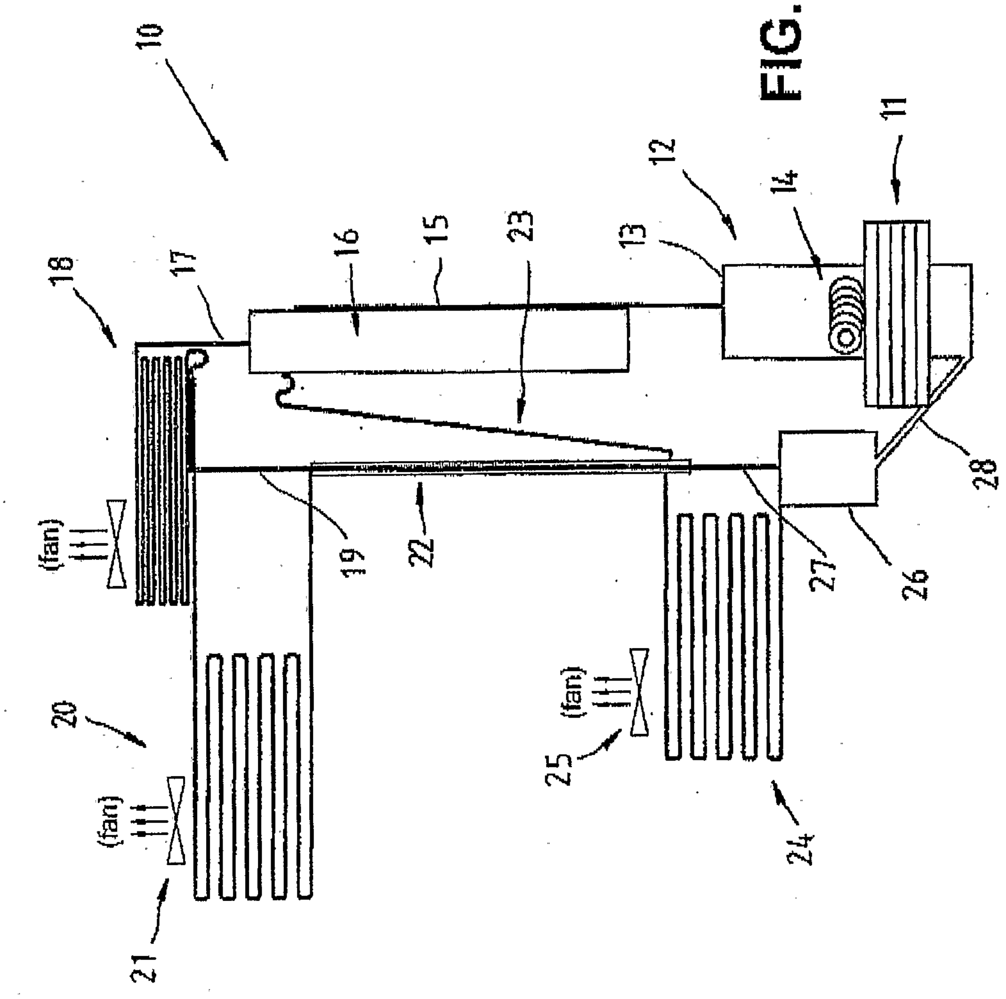

FIG. 1

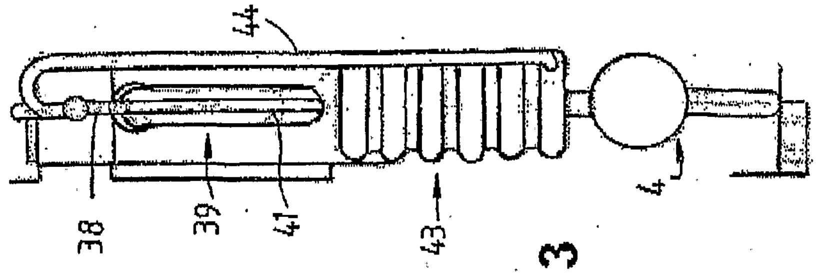

FIG. 3

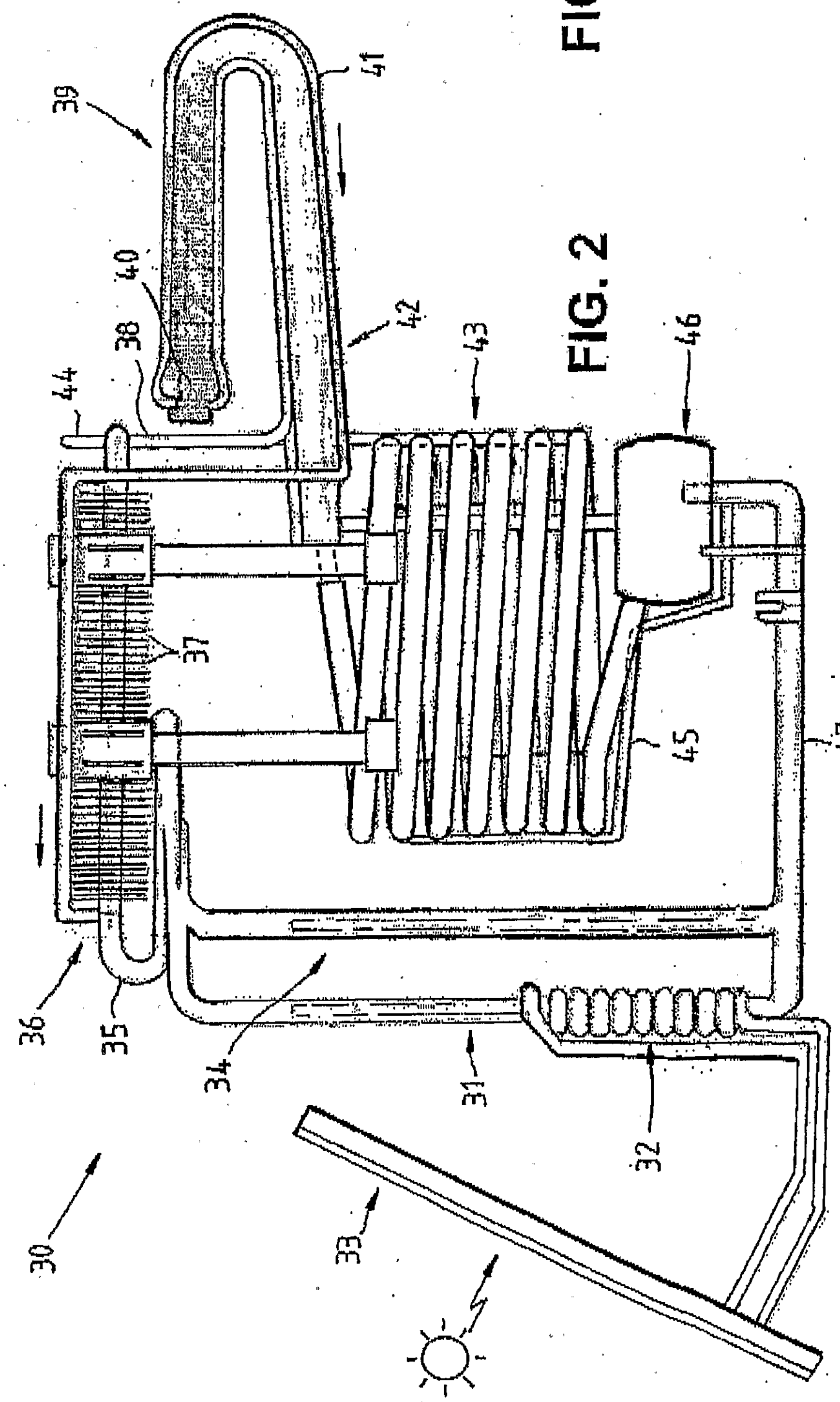

FIG. 2

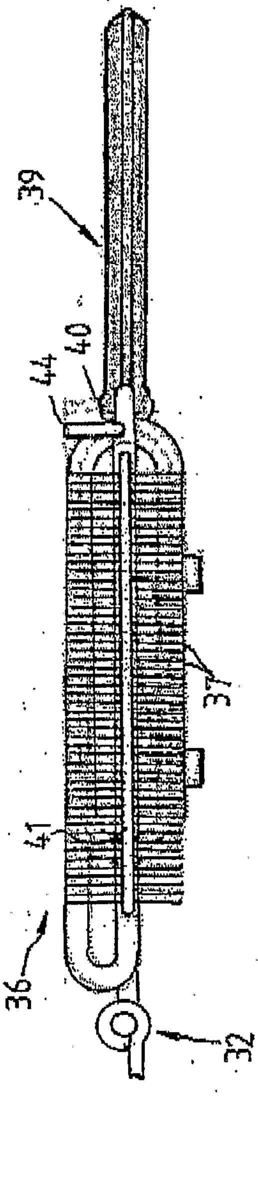

FIG. 4

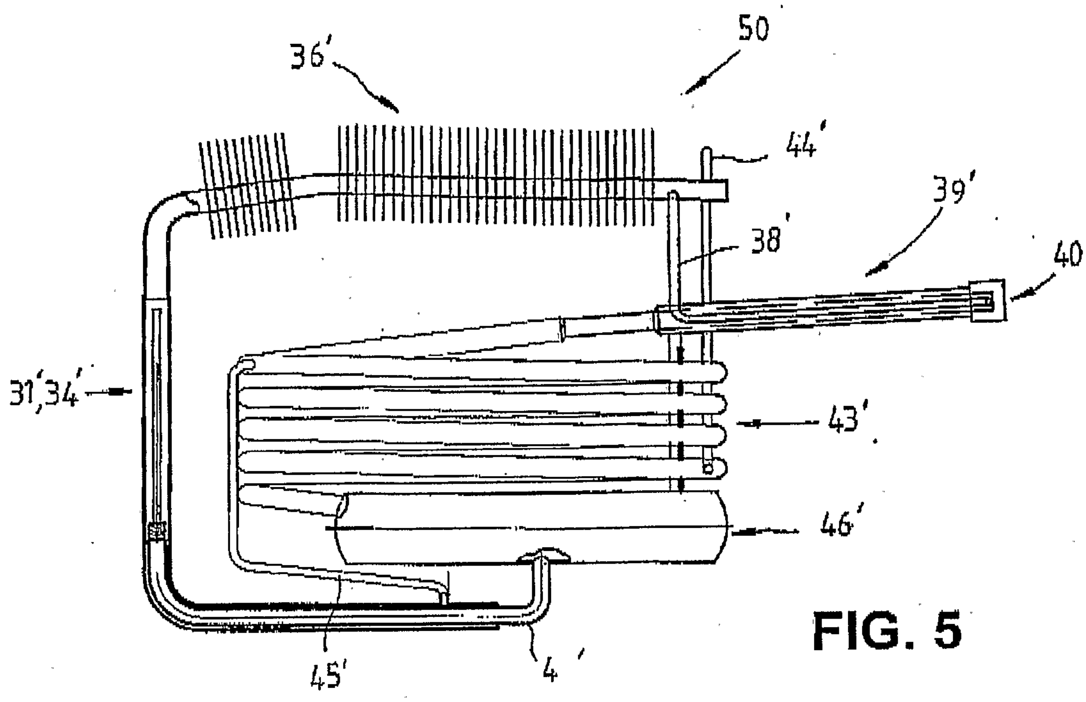

FIG. 5

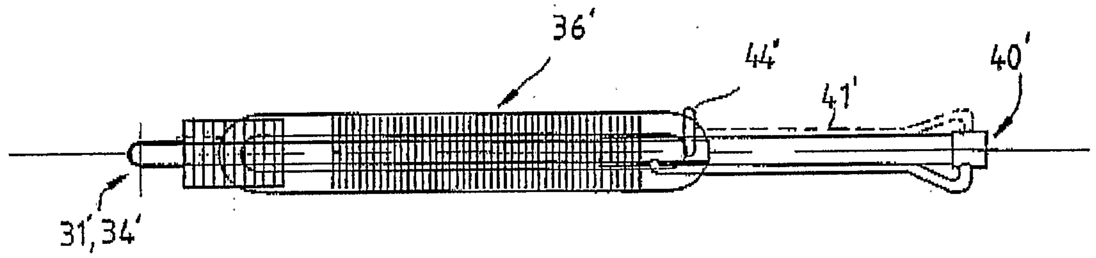

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2009/001577

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

F25B 15/04 (2006.01) *F25B 17/04* (2006.01) *F25B 39/02* (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPODOC & WPI - IPC & EC: F25B 15/04, 39/02, 41/00, 17/04 & Keywords (condens+, evaporat+, ammonia, solar, sun+, return+, retain, drain, bleed+, draw+ off, partial pressure, recycl+ liquid?, incomplet+ evaporat+)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	JP 2000-146350 A (OSAKA GAS CO LTD et al.) 26 May 2000	
X	Abstract and translation from http://www.ipdl.inpit.go.jp/homepg_e.ipdl	1, 2, 18
Y	as above	3, 8-15
	JP 11-201575 A (OSAKA GAS CO LTD et al.) 30 July 1999	
X	Abstract and translation from http://www.ipdl.inpit.go.jp/homepg_e.ipdl	1, 2, 18
Y	as above	3, 8-15
	JP 11-148742 A (OSAKA GAS CO LTD et al.) 2 June 1999	
X	Abstract and translation from http://www.ipdl.inpit.go.jp/homepg_e.ipdl	1, 2, 18
Y	as above	3, 8-15
	JP 2004-125273 A (OSAKA GAS CO LTD) 22 April 2004	
Y	Abstract and translation from http://www.ipdl.inpit.go.jp/homepg_e.ipdl	3, 8, 9

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

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Date of the actual completion of the international search	Date of mailing of the international search report
1 March 2010	- 4 MAR 2010

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2009/001577

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims N
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box 1.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2009/001577

C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	US 2221971 A (HAYWOOD) 19 November 1940	
X	See in particular Figs. 1 and 2	16-20
Y	as above	8-15

Supplemental Box 1
(To be used when the space in any of Boxes I to IV is not sufficient)

Continuation of Box No: III

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

In assessing whether more than one invention is claimed, I have considered those features which potentially distinguish the claimed subject matter from the prior art. Where different claims have different distinguishing features they define different inventions. There are two different inventions as follows:

- Claims 1-15 and 18-20 relate to a method of and (apparatus for) cooling comprising converting a liquid ammonia solution into ammonia gas or vapour, condensing the ammonia gas or vapour into a condensed ammonia solution; evaporating the condensed ammonia solution to convert the liquid into ammonia gas or vapour and thereby absorb heat; retaining a portion of the condensed ammonia in the evaporation step to reconversion into ammonia gas or vapour; and absorbing the ammonia gas from the evaporator to convert the ammonia gas or vapour into a liquid ammonia solution for subsequent conversion into ammonia gas or vapour. It is considered that retention of the condensed ammonia in the evaporation step comprises a first distinguishing feature.
- Claims 16 and 17 relate to a cooling apparatus of the type which operates on an absorption cycle using ammonia as the refrigerant, the apparatus comprising a first generator for supplying ammonia gas or vapour, a condenser for condensing the ammonia gas or vapour into a liquid ammonia solution, an evaporator in which liquid ammonia is evaporated into ammonia gas or vapour and absorbs heat and absorber for absorbing the ammonia gas or vapour from the evaporator, wherein the first generator is heated directly or indirectly by a solar energy collector. It is considered that use of a solar energy collector to heat the first generator comprises a second distinguishing feature.

According to PCT Rule 13.2, unity of invention is fulfilled when there is a technical relationship among the claims involving one or more of the same or corresponding special technical features. A special technical feature is a feature which makes a contribution over the prior art.

The only feature common to all of the claims is: an ammonia absorption refrigeration system comprising a generator, a condenser, an evaporator and an absorber. However this concept is generic in the art. Consequently the common feature cannot constitute a special technical feature within the meaning of PCT Rule 13.2 since it makes no contribution over the prior art. Therefore the claims do not satisfy the requirement of unity of invention *a posteriori*.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2009/001577

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member
JP	2000146350	NONE
JP	11201575	NONE
JP	11148742	NONE
JP	2004125273	NONE
US	2221971	NONE

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX