1600 wds.
2 p. drawings

NOTE.—*The application for a Patent has become void.*
This print shows the Specification as it became open to public inspection.

PATENT SPECIFICATION

Convention Date (Germany): Dec. 29, 1926. **282,808**

Application Date (In United Kingdom): Dec. 29, 1927. No. 35,201/27.

Complete not Accepted.

COMPLETE SPECIFICATION.

Refrigerating Machines in which the Pumping of Liquid is Effected by Intermittently Increasing the Vapour Pressure.

We, Dr. LEO SZILARD, of 95, Prinzregentenstrasse, Berlin-Wilmersdorf, Germany, and Professor Dr. ALBERT EINSTEIN, of Haberlandstrasse 5, Berlin, Germany, both German citizens, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The construction of continuous refrigerating machines of the absorption type has hitherto been impeded by the necessity for special feed pumps to convey the liquid from the absorber to the heater or still, because of the considerable positive pressure usually prevailing in the still. The employment of a special feed pump is too expensive and cumbrous. Various proposals have been advanced for dispensing with a special feed pump, for example by conveying the liquid from the absorber to the still by means of ascending bubbles of gas (after the manner of the mammut pump); but this, and various other suggestions, proved unsuccessful in cases where the positive pressure in the still is considerable. In order to get round the difficulty in question, it has even been proposed to abandon the principle of operating purely by absorption, and to construct refrigerating machines in which the pressure between the absorber and still is balanced by means of a permanent gas.

A similar difficulty to that encountered in the absorption refrigerating machines is also met with in machines of the injection type, since these machines would need a special feed pump to pump the condensate back from the condenser into the boiler.

The present invention enables special feed pumps to be dispensed with in refrigerating machines, even when considerable degrees of positive pressure have to be overcome. It provides a refrigerating machine in which a liquid is forced into a chamber wherein a positive pressure exists, characterised in that the vapour pressure is intermittently increased between two closure members, by warming. As closure member there may be employed a valve or a porous substance from the capillaries of which the liquid is not displaced by the positive pressure.

But in order that the invention may be clearly understood, reference will now be made to the accompanying drawings.

Fig. 1 of the drawings represents, diagrammatically, a typical embodiment of the invention, in which 1 is an intermediate receiver communicating through a stop valve 4 with the pipe 2 leading from the absorber of an absorption refrigerating machine, and also communicating, through a second stop valve 5, with the pipe 3 leading to the still of the machine. The valve 4, in this case, is arranged to close when the pressure in the receiver 1 exceeds that in the pipe 2. Conversely, the valve 5 is arranged to open when the pressure in the receiver 1 exceeds that in the pipe 3, the pressure in which latter is the same as that prevailing in the still, with which it may be in direct communication. The arrangement operates in the following manner:—

Liquid coming from the absorber flows, by way of the pipe 2, through the opened valve 4 into the receiver 1, in which it collects above the closed valve 5. During this period the walls of the receiver may be cooled by means of cooling water. Thereafter the receiver 1 is warmed, and the vapour pressure of the liquid contained therein rises. As a result, the valve 4 closes, and when the vapour pressure has risen to such an extent as to exceed that in the still, the valve 5 opens to permit the liquid to flow from the receiver 1 through the pipe 3 to the still.

It will be evident that, in this case, the liquid is confined between two stop valves, and the arrangement necessarily operates intermittently, inasmuch as an increase in the vapour pressure is produced, from time to time, in the receiver

1 by warming. Now, although the increase in the vapour pressure is necessarily intermittent, there is no need for the warming of the walls of the receiver from outside to be effected intermittently, as will be hereinafter explained with reference to the embodiments of the invention according to Figs. 3 and 4.

Fig. 2 is a diagrammatic representation of a second embodiment of the invention. In this case the pipe 7 coming from the absorber and evaporator of the machine—or from the condenser, when a machine of the injection type is used—is shut off from the receiver 6 by a wall 9 of microporous earthenware. The receiver is similarly shut off, by a wall 10 of porous earthenware, from the pipe 8 leading to the still of the absorption machine—or the boiler of the injection machine. The walls of the receiver 6 may be cooled by means of cooling water whereupon the liquid flowing through the pin 7 will pass, under the influence of gravity, through the earthenware wall 9 and collect, above the earthenware wall 10, in the receiver 6. Said wall 10 becomes saturated with the liquid by capillarity, but the positive pressure in the pipe 8 is not able to displace this liquid from the pores of the earthenware wall 10 by gas and so force it into the receiver 6. If the liquid in the receiver 6 be now warmed, its vapour pressure rises, and liquid can no longer pass from the pipe 7 through the earthenware wall 9 into the receiver. On the other hand and despite the positive pressure in the receiver 6, the vapour cannot displace the liquid from the pores of the earthenware wall 9. However, when the pressure in the receiver gradually exceeds the pressure in the pipe 8, the liquid will be driven through the earthenware wall 10 into the pipe 8 whence it flows into the still or boiler. If no further heat be applied to the receiver 6, that vessel cools down again and liquid once more enters from the pipe 7.

Fig. 3 shows a third embodiment in which the increase of pressure in the receiver proceeds automatically in an intermittent manner. The pipe 11, leading for example from the absorber of an absorption machine, is shut off from the permanently cooled receiver 13 by the earthenware plate 12. The receiver 13 is provided with a branch pipe 16 which is closed at the bottom and the lower end 17 of which is permanently warmed. A pipe 18, acting as a syphon, leads from the receiver 13 into the pipe 16. At first, liquid flows from the pipe 11 through the earthenware plate 12 into the cooled receiver 13. When the level of the liquid rises as high as A—B, a certain amount of the liquid syphons over into the pipe 16. As this pipe is permanently kept warm at 17, the liquid that has syphoned over is evaporated there and, as the result of the increased vapour pressure, the liquid in the receiver 13 then passes through the earthenware plate 14 into the pipe 15, which is adapted to communicate, for example, directly with the still of an absorption machine.

Fig. 4 is a diagrammatic representation of a fourth embodiment of the invention. In this case, the liquid first passes, from the pipe 19, through the earthenware plate 20 and the funnel 21 into a tipple 22 which is shown in the position it occupies when tilted over to the right. The liquid then collects, in the first place, in the left compartment of the tipple and, when the latter has tilted over towards the left, is discharged, partly through the pipe 24 into a permanently warmed vessel 25, the bulk, however, into the bottom of the receiver 23, where it collects on the earthenware plate 26. That portion of liquid passing into the warm vessel 25 is evaporated therein, and, as the result of the increased vapour pressure, the liquid in the receiver 23 is forced through the earthenware plate 26 into the pipe 28. The walls of the receiver 23 are permanently cooled by means of cooling water; consequently the vapour pressure in the vessel 23 falls again after a time, so that more liquid can now pass from the pipe 19 through the earthenware wall 20. The tipple being then tilted over towards the left, this liquid is discharged into the right-hand compartment until the tipple tilts again; and in this manner the operation is repeated intermittently.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A refrigerating machine in which a liquid is forced into a chamber wherein a positive pressure exists, characterised in that the vapour pressure is intermittently increased, between two closure members, by warming.

2. A refrigerating machine according to claim 1, characterised in that a valve is employed as closure member.

3. A refrigerating machine according to claim 1 or 2, characterised in that there is employed as closure member a porous substance from the capillaries of which the liquid is not displaced by the positive pressure.

4. A refrigerating machine according to any of claims 1 to 3, characterised in that a sectional portion or branch between the two closure members is kept per-

manently warm, and that liquid is intermittently brought into contact with the warmed portion or branch by the action of a syphon.

5. A refrigerating machine according to any of claims 1 to 3, characterised in that a sectional portion or branch between the two closure members is kept permanently warm, and that liquid is intermittently brought into contact with the warmed portion or branch by the action of a tipple.

6. A refrigerating machine substantially as described with reference to any of the figures of the accompanying drawings.

Dated this 29th day of December, 1927.

H. D. FITZPATRICK & Co.,
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49, Chancery Lane, London, W.C. 2, and
94, Hope Street, Glasgow.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1929.

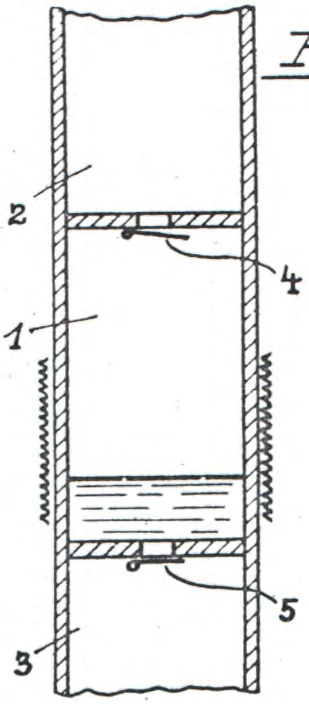

Fig. 1

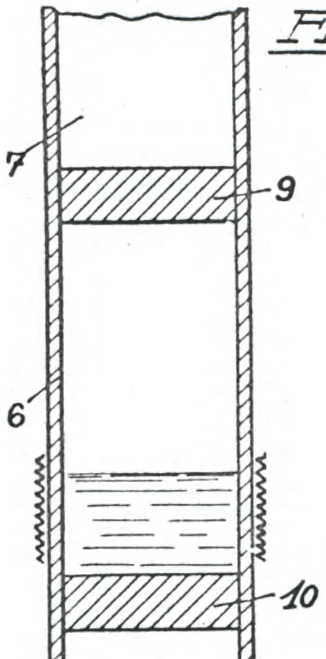

Fig. 2

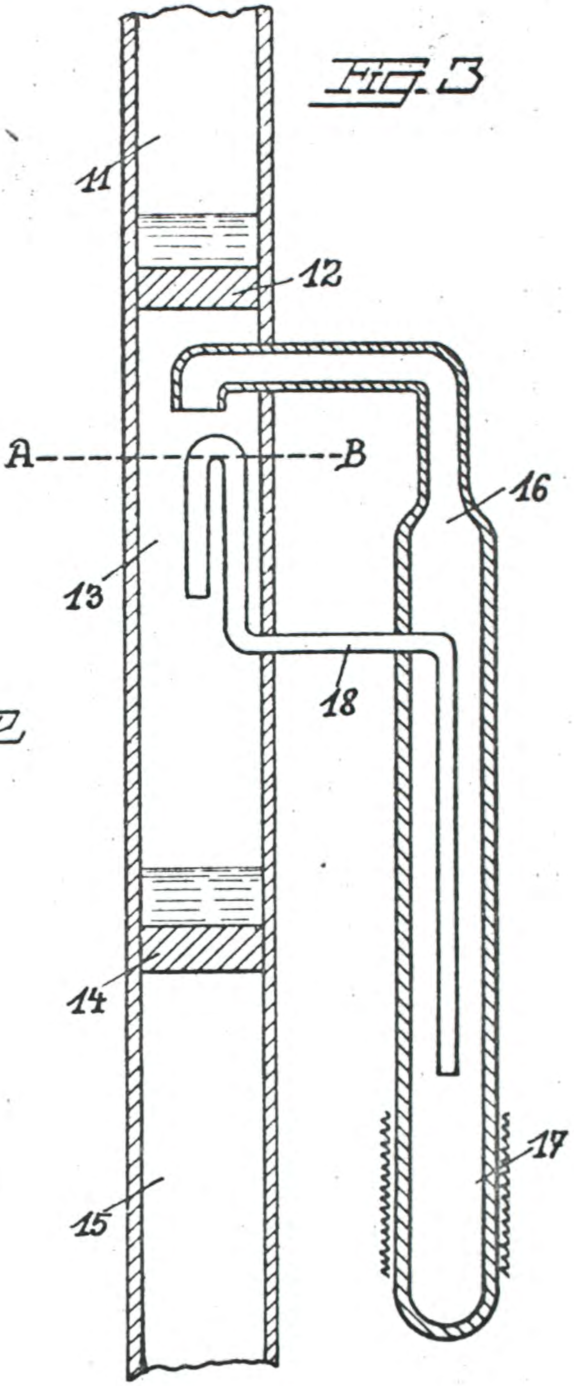

Fig. 3

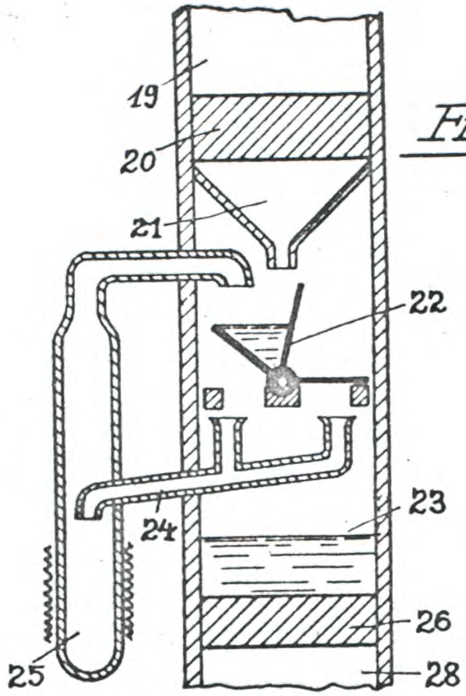

Fig 4

Charles & Read Ltd. Photo Litho.

1750 wds
1 p. drawings

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NOTE.—*The application for a Patent has become void.*
This print shows the Specification as it became open to public inspection under Section 91 (3) (a) of the Acts.

PATENT SPECIFICATION

Convention Date (Germany): Jan. 24, 1927.

284,222

Application Date (in United Kingdom): Jan. 24, 1928. No. 2268/28.

Complete not Accepted.

COMPLETE SPECIFICATION.

Refrigerating Machine with Organic Solvent.

We, Professor Dr. ALBERT EINSTEIN, of 5, Haberlandstrasse, Berlin, Germany, and Dr. LEO SZILARD, of 95, Prinzregentenstrasse, Berlin - Wilmersdorf, Germany, both German citizens, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

Among refrigerating machines of the class in which cold is generated direct with the aid of applied heat, the absorption machines occupy the premier position at the present time. In these absorption machines, ammonia and water have hitherto been almost exclusively employed, the water forming the absorbent, and the ammonia the refrigerating medium; but it has also been proposed to employ sulphuric acid as the absorbent and water as the refrigerating medium. In all the known or proposed refrigerating machines wherein the vapour of the refrigerating medium is taken up by a second liquid absorbent medium, a special chemical affinity has existed between the refrigerating medium and the absorbent. The chemical combination between these two is responsible for the fact that the partial pressure of the refrigerating medium situated above the dilute solution in the absorbent medium is considerably reduced, on which account the phenomenon may also be regarded as one of absorption, and not merely solution, of the refrigerating medium in the absorbent.

In fig. 1 of the accompanying drawing, the concentration of the ammonia in the aqueous solution is plotted as abscissas, in terms of Mol. %. The ordinates of the plotted curve denote the partial pressure of the ammonia above the aqueous solutions, at 20° C. The straight, broken line indicates what the partial pressure of the ammonia would be if the same were approximately proportional to the Mol. % concentration. As can be seen, so long as dilute solutions are in question, the partial pressure of the ammonia is enormously reduced by the water; and this is the reason why pure water so avidly absorbs ammonia under these conditions.

The cause of the enormous lowering of the vapour pressure in the ammonia-water system is the chemical fixation of the ammonia in the dilute aqueous solution. Similarly, the chemical fixation of the water by the concentrated sulphuric acid is the cause of the avid absorption of the water by such concentrated acid. Evidence of the occurrent chemical reaction is also afforded by the heat disengaged when the two liquids in question are mixed together. Ammonia and sulphuric acid are, in themselves, chemically active compounds, a fact which makes itself unpleasantly apparent in that the materials of the plant are corroded by both substances, unless special care be devoted to the selection of the materials with which the liquid comes into contact.

The present invention provides a refrigerating machine in which—in contrast to existing machines of this kind—a liquid inert in itself is employed as the solvent medium in the absorber.

The vapour of a refrigerating medium is dissolved by the organic liquid in the absorber, without the existence of any special chemical affinity between the refrigerating medium and the solvent being necessary; and still less will chemical reaction take place between refrigerating medium and solvent, since, owing to the sluggish manner in which the reactions of the organic liquids proceed, such reaction is out of the question in the short time available. It is even preferable to employ, as solvent and refrigerating medium, homonegeous liquids, that is to say, liquids which are certain not to enter into mutual reaction—for example, methyl alcohol and octyl alcohol. The more readily volatile methyl alcohol forms the refrigerating medium, and the less readily volatile octyl alcohol the solvent.

Fig. 2 is approximately typical of the

course of the curve of vapour pressure of an octyl-methyl alcohol mixture. The abscissas represent the Mol. % concentration, and the ordinates the partial pressure, of the methyl alcohol at 20° C. It is assumed that, in the case of low concentrations, the partial pressure of the methyl alcohol can be calculated from the Mol. % concentration and vapour pressure of pure methyl alcohol by linear interpolation. This assumption is not strictly correct but represents, with a sufficient degree of approximation, the diagram for the behaviour of the partial pressure of linear mixtures consisting of two homologous liquids. The octyl alcohol, which enters the absorber in an almost pure state, then dissolves the vapour of the methyl alcohol, of which it takes up as much as 22 Mol. % when the temperature in the absorber is 20° C. and the temperature of the methyl alcohol in the evaporator is −5° C. (The curve in fig. 2 is taken as basis for the partial pressure of the methyl alcohol above the solution in octyl alcohol.) The octyl alcohol in the absorber continues to absorb further quantities of methyl alcohol until the partial pressure above the solution is equal to the vapour pressure of the methyl alcohol in the evaporator. From the absorber, the solution rich in methyl alcohol passes into the heater or still, where the solution is warmed and where, owing to the low vapour tension of the octyl alcohol, nearly all the methyl alcohol is driven off. The vapour of the methyl alcohol condenses in a condenser and flows back into the evaporator.

The substitution of an organic solvent with a comparatively low vapour tension in place of water as the absorbent liquid effects the result that the refrigerating medium can be extensively eliminated from the solvent in the still. This is a point of special importance in cases where the condenser temperature is high, that is, primarily, where the cooling cannot be effected with running water, for example, in cooling tanks. At the temperatures necessarily employed in the still in order to raise the partial pressure of the refrigerating medium to the level of the pressure in the condenser, the water in ammonia-water plants would be largely evaporated at the same time. Moreover, even when the condenser temperature is low, the substitution of an organic liquid of higher boiling point for water operates so that the amount of refrigerating medium per 1 mol. of organic liquid circulating between the absorber and the still is comparatively large. With a condenser temperature of about 20° C. then, in the example under consideration, 0.22 mol. of methyl alcohol will be carried away from the absorber per 1 mol. of octyl alcohol. In the still the octyl alcohol is readily freed from all but 5% of methyl alcohol, so that only a 5% solution flows back from the still into the absorber, and therefore 0.17 Mol, of refrigerating medium is carried off per 1 Mol, of octyl alcohol.

These points of view led to the suggestion of replacing the ammonia-water system by the sulphuric acid-water system. Nevertheless the employment of a chemically inert organic solvent is certainly to be preferred to the use of sulphuric acid. In comparison with the ammonia-water system, it enables operations to be conducted with low vapour pressures, under which conditions there is no difficulty in maintaining the circulation of the liquid between the absorber and the still by means of a mammut pump or the like.

In addition to the case of refrigerating machines of the absorption type, the absorbent liquid may also be replaced by an organic refrigerating medium in refrigerating machines wherein substantially only the auxiliary medium is absorbed that carries away the vapours of the refrigerating medium by convection. Such refrigerating machines are described in the Application of 16th December, 1926, relating to refrigerating machines operating without absorption of the refrigerating medium.

Organic solvents primarily coming under consideration, in addition to the higher - molecular paraffins, comprise ethers (e.g. isoamyl ether) and esters of the lower-molecular compounds containing hydroxyl- or amino-groups, such as glycol. When it is desired to do without a special liquid pump, bromoform is preferred on account of its high specific gravity.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A refrigerating machine in which the circulation of a vapour is maintained by taking up the vapour in an absorber, by means of a liquid solvent, and then re-evaporating it in a still, characterised in that the vapour or the solvent, or both, are organic media, whereby no chemical combination takes place between the vapour and solvent during the process of solution, and hence the partial pressure of the vapour above the solution is not specifically lowered.

2. A refrigerating machine according to claim 1, characterised in that the expelled vapour is liquefied in a condenser, and

this liquid then generates cold in re-evaporating, exactly as in the case of the known absorption refrigerating machines operating with ammonia and water.

3. A refrigerating machine according to claim 2, characterised in that the vapour expelled in the still is led, in gaseous form, into the evaporator, which contains a third liquid, and in that said vapour becomes saturated in the evaporator with the vapours of the third liquid, which is carried over therewith into the absorber where it does not, however, dissolve in the solvent, but condenses separately.

Dated this 24th day of January, 1928.

H. D. FITZPATRICK & Co.,
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94, Hope Street, Glasgow.

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Fig. 1

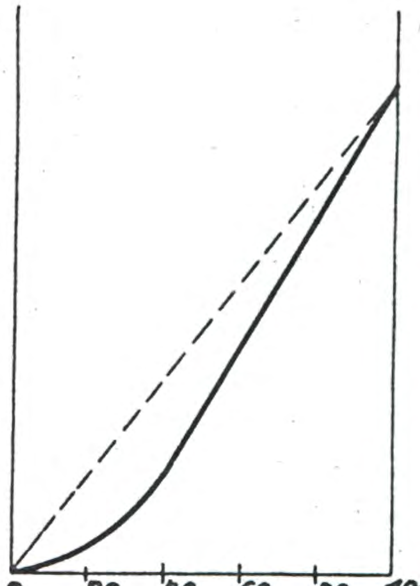
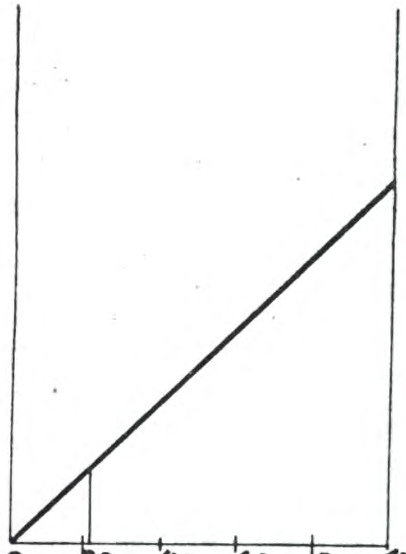


Fig. 2



Charles & Read Ltd. Photo Litho

2500 wds
3 p. drawings

PATENT SPECIFICATION

Convention Date (Germany): Dec. 16, 1926.

282,428

Application Date (in United Kingdom): Dec. 16, 1927. No. 34,096 / 27.

Complete Accepted: Nov. 15, 1928.

COMPLETE SPECIFICATION.

Improvements relating to Refrigerating Apparatus.

We, ALBERT EINSTEIN, of 5, Haberlandstrasse, Berlin, W. 30, Germany, a citizen of Switzerland, and LEO SZILARD, of 95, Prinzregentenstrasse, Berlin-Wilmersdorf, formerly of Faradayweg 16, Berlin-Dahlem, Germany, a Hungarian citizen, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to refrigerating apparatus having a refrigerant evaporated in the evaporator by the introduction of a pressure equalising auxiliary medium thereinto and separated from said medium by the absorption of the latter and condensation of the refrigerant as described in British Patent Specification No. 250,983.

According to the present invention the refrigerating process in such apparatus is carried out by utilising ammonia as the auxiliary medium, water as the absorption medium and butane or methyl-bromide as the refrigerant.

When utilising the above substances in the refrigeration process the condensation of the refrigerant and the absorption of the auxiliary medium is preferably effected in known manner in the same vessel which is hereinafter called a condenser-absorber.

As no condensation of the auxiliary gas is required, the apparatus is further worked with ammonia as the auxiliary gas at any desired small total pressure. The total pressure is practically the same in all parts of the apparatus except the pressure differences counterbalanced by the hydrostatic pressure of liquid columns.

The invention will be hereinafter more particularly described with reference to the accompanying drawings in which:—

Fig. 1 shows diagrammatically one embodiment of the invention.

Fig. 2 is a modification of the invention.

Fig. 2a is a section on the line A—A of Fig. 2.

Figs. 3 and 4 are further modified arrangements of the invention.

Referring to Fig. 1 showing one embodiment of the invention, 1 designates the evaporator containing a cooling agent 2, in this case methyl bromide. Through the pipe 3 gaseous ammonia enters the evaporator and flows from this pipe 3 into the cooling agent through a distributor 4. Divided into numerous small bubbles the gaseous ammonia then rises through the liquid cooling agent 2 and in this manner becomes saturated very completely with the vapour of the methyl bromide. The mixture of the two gases then flows through the conduit 5 into the condenser-absorber 6 into which water is dropping continuously through the conduit 7. Preferably the water flows along the wall 8 of the condenser which wall is cooled by external cooling water.

The saturation pressure of the ammonia being strongly reduced in the presence of water the gaseous ammonia will be absorbed by the water, the gas content of the condenser 6 being thus deprived of said gaseous ammonia. As the total pressure remains constant in this process, the partial pressure of the methyl bromide will be correspondingly increased on account of the removal of the gaseous ammonia, especially adjacent the walls, so that the vapour of methyl bromide will become super-saturated and will be condensed on the walls of the condenser simultaneously with the absorption of ammonia. Gaseous ammonia and vapour of methyl bromide tend simultaneously to approach the walls of the condenser and the condensation proceeds very rapidly; the velocity of condensation depending in the first place on the speed with which the heat is removed from the walls of the condenser. The condensed methyl bromide has a higher specific weight than the ammonia solution and collects in the condenser as at 9, whereas the ammonia mixture 10 floats above.

The methyl bromide in the condenser communicates with that in the evaporator by means of the conduit 11. 12 designates a cooling jacket for cooling the condenser 6. The ammonia solution is transferred into the vessel 15 through the pipe 13 by means of gas bubbles ris-

[*Price* 1/-]

ing in the pipe 14, said gas bubbles being formed by heating said pipe 14 so that gaseous ammonia is driven out from the water rich in ammonia. In the vessel 15 the bubbles of gas are separated from the water, and the gas thus liberated enters the condenser 6 through the pipe 16, the quantity of such gas being only small and being ineffective for the useful work of the apparatus.

The water rich in ammonia is deprived of ammonia in the generator 17 which it enters from the vessel 15 through the pipe 18, the generator being disposed at a lower level than the vessel 15 which communicates with the condenser 6 through the pipe 16. As the total gas pressure in the vessel 15 is equal to that in the condenser 6 and to that in the evaporator 1 above the liquid level of the methyl bromide, the gas pressure in the generator 17 is higher by an amount corresponding to the hydrostatic pressure of the liquid column h in the pipe 18. By this means the gaseous ammonia will be forced from the generator 17 through the pipe 3 into the evaporator beneath the liquid level of the methyl bromide, provided that the hydrostatic pressure of the column h is higher than that of the column h_2 of the methyl bromide.

On account of the super pressure in the generator 17, the water deprived of ammonia is again forced into the condenser 6 through the pipe 7. Throttling means must be provided, as otherwise too much liquid would be driven into the condenser from the generator on account of the super pressure. Preferably the opening 19 of the pipe 7 is provided with a porous cap through which liquid may pass but through which no gas can flow when the liquid level in the generator has descended below said cap, the capillary action preventing the liquid from being pressed out of the pores by the gas.

As the water poor in ammonia should enter the condenser through the pipe 7 in a cold condition, the pipes 7 and 14 may be combined in a heat exchanger (not shown in Fig. 1) whereby the pipe 7 may be further cooled. In the same manner the pipes 5 and 11 may also be combined in a heat exchanger. In this way vapour of methyl bromide will be continuously carried away from the evaporator by the gaseous ammonia, cold being produced by the evaporation of the methyl bromide.

It is of the utmost importance that the pressure of the ammonia in the generator is chosen in a suitable manner. When working with very small pressure of the ammonia, the cooling effect of the apparatus will be very small. On the contrary the pressure of the ammonia vapour in the generator has a definite upper limit. This may be easily proved by a calculation which also gives an idea of the manner of dimensioning the apparatus. Assuming the temperature of the cooling water to be 25° C. and consequently that of the condenser also to be 25° C. and the temperature in the evaporator −5° C., then it is, for instance, quite impossible to operate with a pressure of ammonia vapour of 10 atm. in the generator as the total pressure is approximately the same in all parts of the apparatus. As substantially only gaseous ammonia is evolved in the generator, the partial pressure of the ammonia in the same would, consequently, be equal to the total pressure, i.e., 10 atm. In the evaporator the partial pressure of the ammonia must be smaller than the pressure of saturation of ammonia at −5°, that is to say smaller than approximately 3 1/2 atm. As the total pressure in the evaporator is also 10 atm., then the partial pressure of the cooling agent in the evaporator must, consequently, amount to 6 1/2 atm. However, the partial pressure of the ammonia in the condenser is always above zero so that in this vessel less than 10 atm., must be taken up by the cooling agent.

When assuming a temperature of the condenser of 25° C., the vapour of the cooling agent must, consequently, be saturated at a lower pressure than 10 atm., but it has been shown above that the pressure of saturation at −5° cannot amount to more than 6 1/2 atm. The ratio of the pressures of saturation of the cooling agent at 25° and −5° should consequently be smaller than 10: 6,5, i.e., 1.54. A substance that can be used as cooling agent under these circumstances and for which this ratio is so low is probably impossible to find. From this it is evident that it is necessary in all cases to operate with pressures of gaseous ammonia that are far below 10 atm. Consequently, any condensation of the gaseous ammonia driven out cannot take place at room temperature or normal temperature of cooling water, so that the ammonia in all cases enters the evaporator containing the cooling agent with certainty in a gaseous state. When operating with relatively high temperatures of gaseous ammonia then at low temperatures in the evaporator, condensation and re-evaporation of the gaseous ammonia may occur. It is evident that in this case heat of evaporation of the ammonia does not partake in the cooling effect of the apparatus as on evaporation of the condensed ammonia only the heat is removed that is liberated on condensation.

Fig. 2 shows another embodiment of the invention. It is also assumed in this case that the cooling agent has the higher specific gravity. In this embodiment the water rich in ammonia leaves the condenser 20 and is raised to the point P by the aid of gas bubbles in the pipe 21 which forms a heat exchanger together with the pipe 22 through which the water weak in ammonia leaves the generator 23. From pipe 21 the water still rich in ammonia flows over the fins of the pipe 21 in the pipe 24, which is shown in section in Fig. 2a, downwardly into the generator 23. The gaseous ammonia driven out which may contain steam rises in the pipe 24 and will in this manner come into intimate contact with the water rich in ammonia dropping downwards. In this manner cooling of said gaseous ammonia will be effected and, further, the vapour of ammonia will be deprived of any steam entrained therewith, in that ammonia will be vaporised from the water rich in ammonia by absorption of heat from the mixture of gaseous ammonia and steam. The separation of steam will be effected firstly by the cooling abovementioned and secondly by the fact that the partial pressure of the steam in the water rich in ammonia is decreased. The vapour of ammonia thus cooled and deprived of water is conducted into the evaporator through the pipe 25. The manner of operation of the apparatus shown in Fig. 2 is otherwise the same as that of the embodiment shown in Fig. 1.

Fig. 3 shows diagrammatically a third embodiment. Contrary to the two embodiments described above the cooling agent is in this embodiment assumed to be butane which has a smaller specific weight than the mixture of ammonia water. The water rich in ammonia 26 flows through the pipe 27 and the heat exchanger 28 into the generator 29 in which the ammonia is driven out by heating and supplied to the evaporator through the pipe 30. The gaseous ammonia in the generator stands under a pressure of a liquid column h_1 and this pressure is sufficient to permit the gaseous ammonia to enter the evaporator as at 31 beneath the liquid level of the cooling agent (the butane). It is only necessary that the height of the liquid column h_1 is greater than that of h_2.

Opening into the container 33 is a pipe 32 extending upwards from the generator 29. Through said pipe 32 the water poor in ammonia is raised by means of gas bubbles into the container 33 in which the water is deprived of its gas bubbles. From this container 33 the gas flows through the pipe 34 into the condenser 35 and is lost for useful work in the apparatus. Heat may be supplied to the portion 36 of the pipe 32 in order to produce the gas bubbles necessary to transport the water. From the container 33 the water poor in ammonia flows under the action of gravity through the pipe 37 into the condenser 35 in which it drops downwardly. The pipe 37 extends above the heat exchanger 28, and the water poor in ammonia contained therein is further cooled by cooling water, before it enters the condenser. This is indicated in the drawing by the fact that the pipe 37 is shown passing through the cooling jacket of the condenser. The gaseous ammonia leaving the generator may in known manner be conducted through an ascending branch of the pipe 30 through a cooler whereby the ammonia is deprived of any steam entrained therewith (not shown in Fig. 3).

Fig. 4 shows an embodiment in which the cooling agent has the lower specific weight as in the embodiment shown in Fig. 3. Contrary to the embodiments described above the mixture of vapours from the evaporator enters the ammonia water solution in the condenser through the pipe 38 at 39 in which gas bubbles rise in the liquid, the ammonia being absorbed and the cooling agent being condensed. The circulation of the liquid between the condenser 40 and the generator 41 is maintained essentially on account of the difference in specific weight between the mixture rich in ammonia and that poor in ammonia.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. Refrigerating apparatus having a refrigerant evaporated in the evaporator by the introduction of a pressure equalising auxiliary medium therein and separated from said medium by the absorption of the latter and condensation of the refrigerant in which the refrigerant consists of butane. the auxiliary medium of ammonia, and the absorption medium of water.

2. Refrigerating apparatus having a refrigerant evaporated in the evaporator by the introduction of a pressure equalising medium therein and separated from said medium by the absorption of the latter and condensation of the refrigerant, in which the refrigerant consists of methyl-bromide the auxiliary medium of ammonia, and the absorption medium of water.

3. Refrigerating apparatus according to

Claim 1 or 2 in which the condensation of the refrigerant and the absorption of the auxiliary medium is effected in one and the same vessel, namely a condenser-absorber.

4. Refrigerating apparatus according to Claims 1 or 2, and 3, in which the absorbed auxiliary medium is again expelled in a generator and on passing from said generator is led in heat exchanging relation with concentrated solution of auxiliary medium in absorption medium flowing into the generator from the condenser-absorber.

5. Refrigerating apparatus according to Claim 4 in which the auxiliary medium leaving the generator comes in direct contact with the concentrated solution flowing to said generator.

6. Refrigerating apparatus having a refrigerant evaporated in the evaporator by the introduction of a pressure equalising auxiliary medium, constructed, arranged, and operating substantially as described with reference to the accompanying drawings.

Dated the 16th day of December, 1927.

FRANK WATSON,
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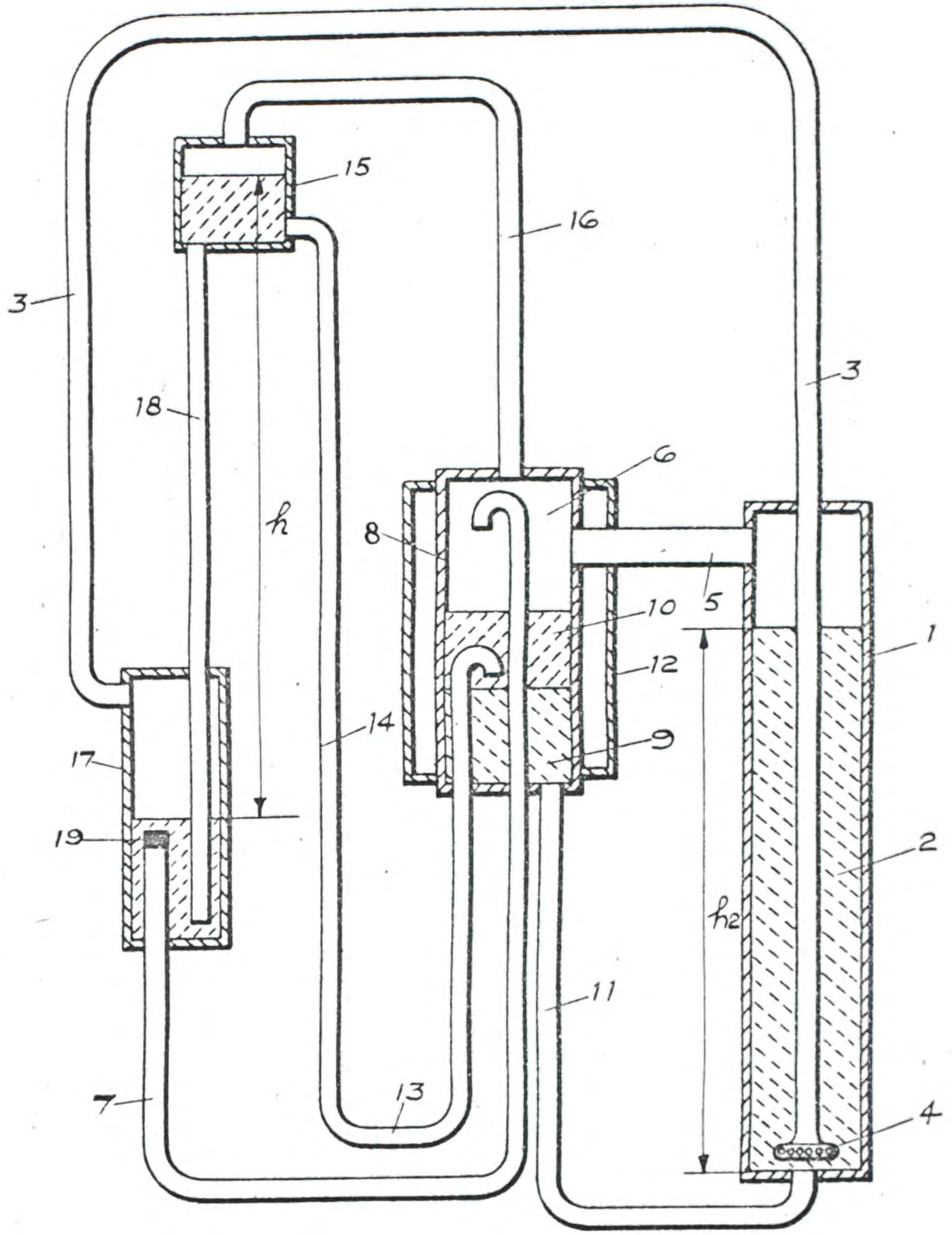
FIG. 1.



[This Drawing is a full-size reproduction of the Original]

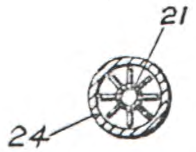


FIG. 2a.

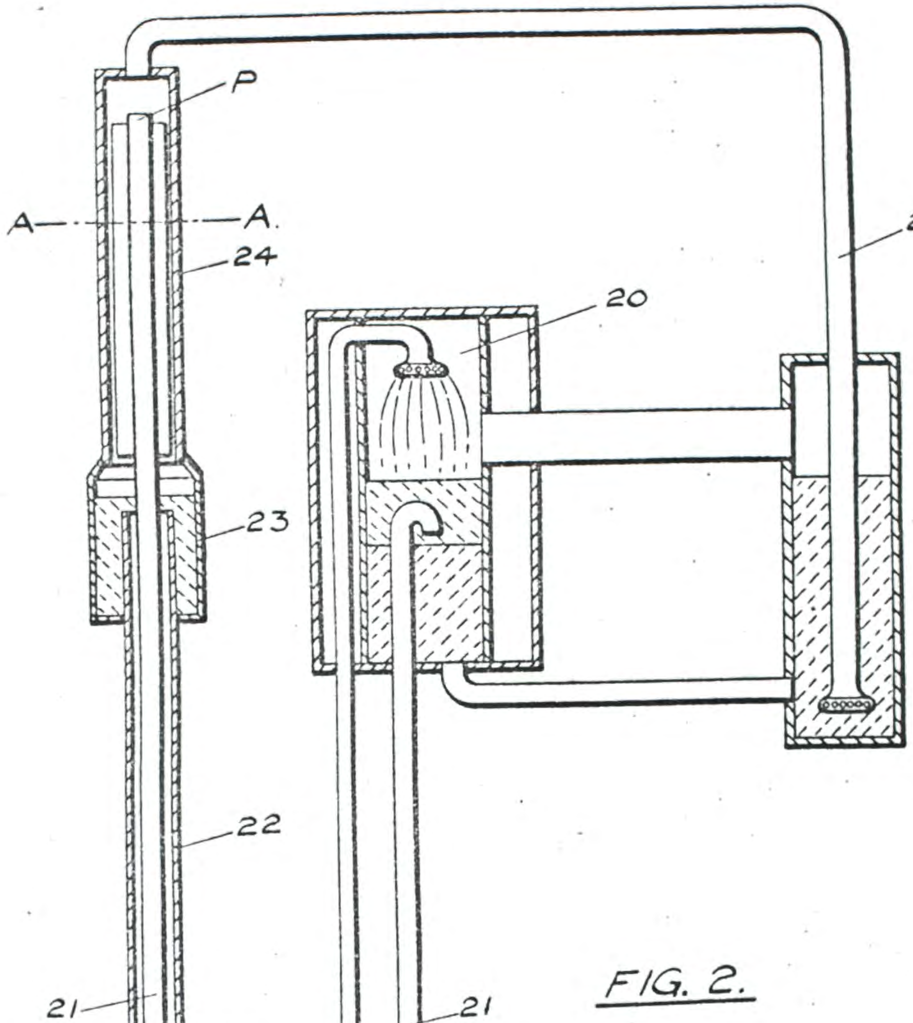


FIG. 2.

Charles & Read Ltd. Photo Litho.

[This Drawing is a reproduction of the Original on a reduced scale]

FIG. 3.

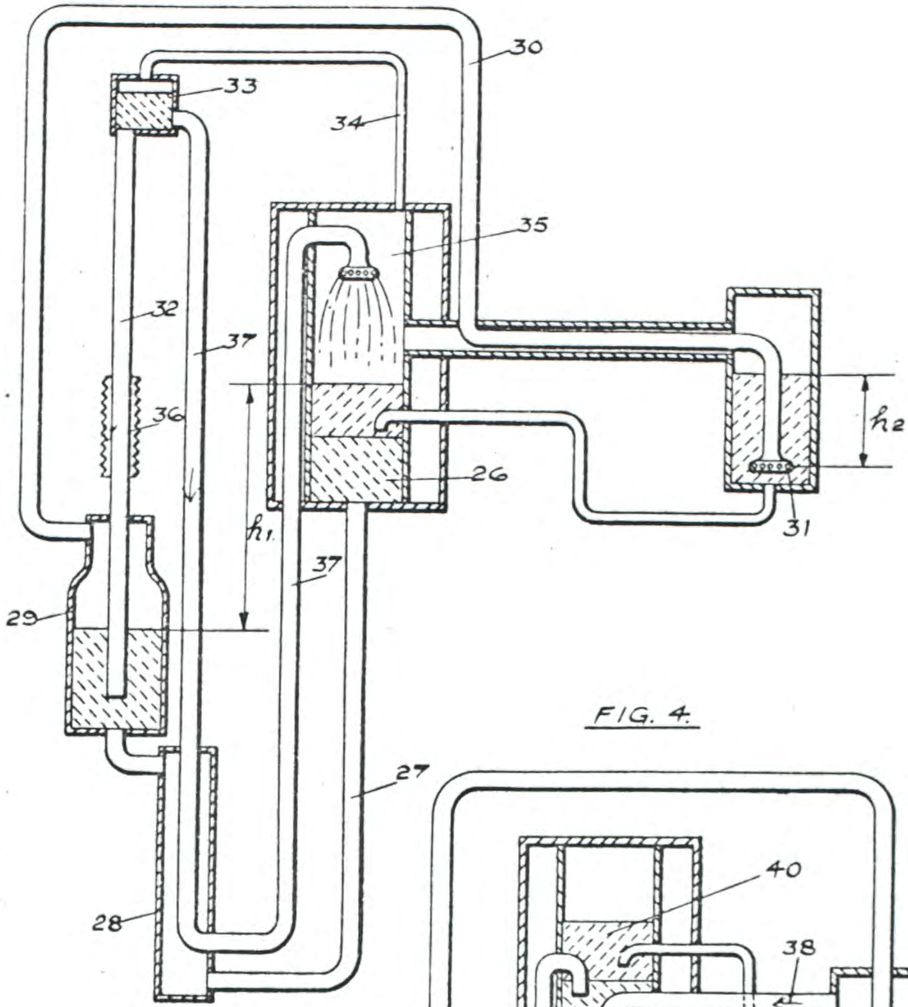


FIG. 4.