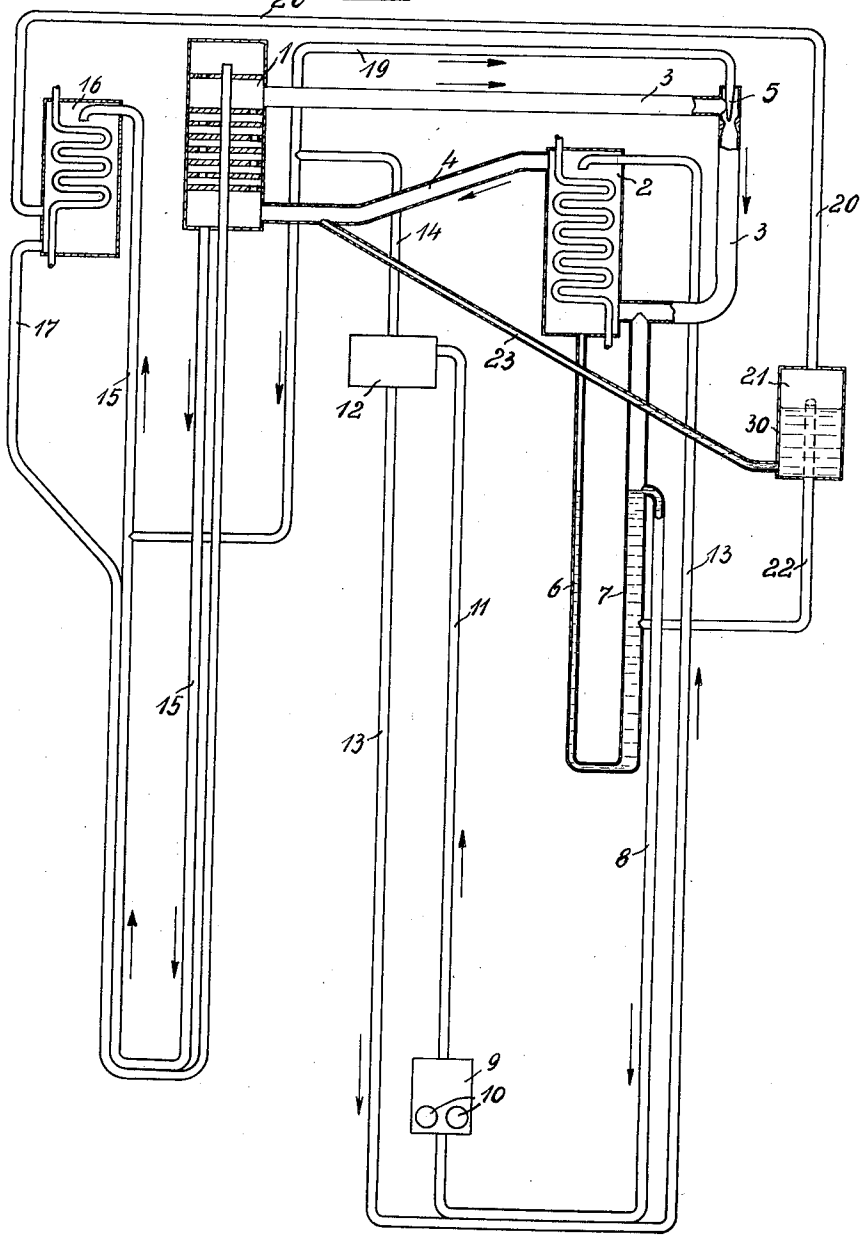
Sept. 5, 1933. E. ALTENKIRCH 1,925,361

ABSORPTION REFRIGERATING MACHINE

Filed May 22, 1929 3 Sheets-Sheet 1

Fig. 1



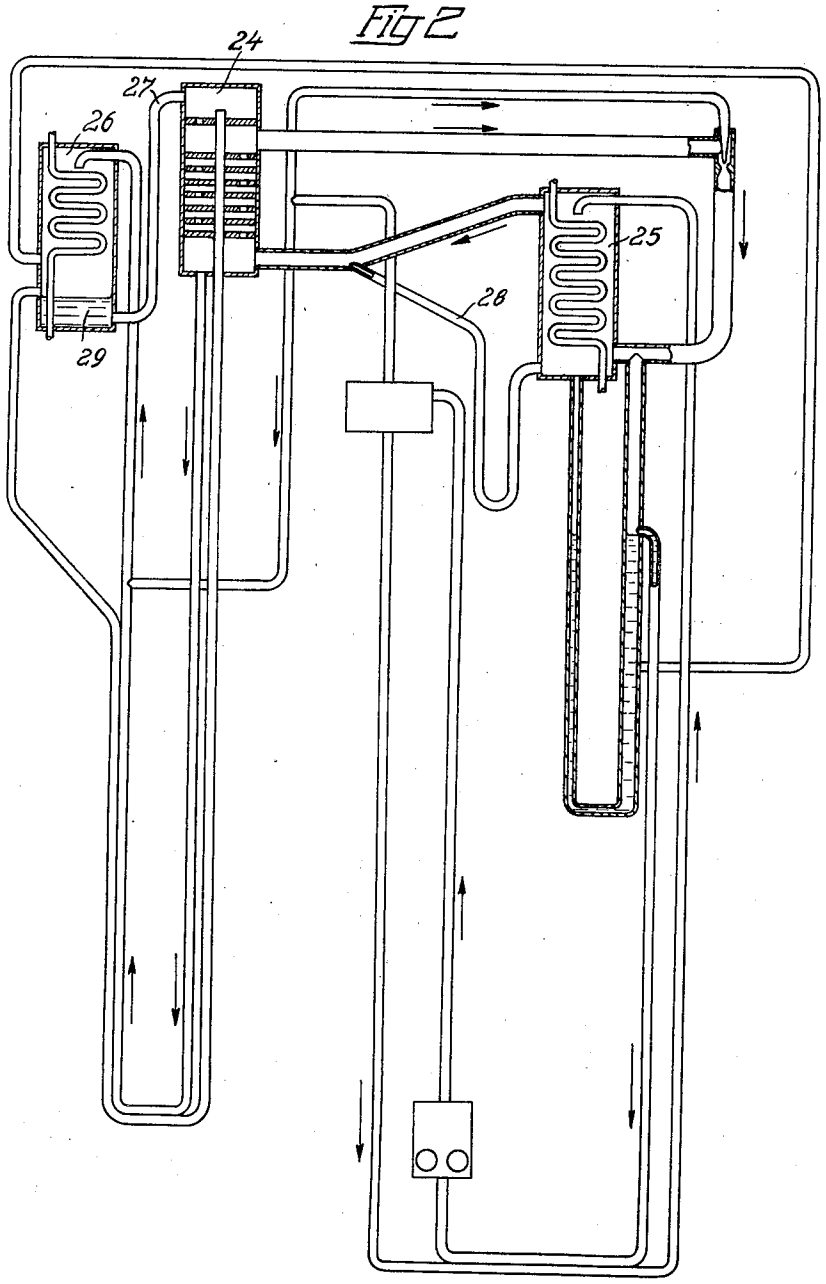
Inventor
Edmund Altenkirch
by Knight Bros
Attorneys

Sept. 5, 1933. E. ALTENKIRCH 1,925,361

ABSORPTION REFRIGERATING MACHINE

Filed May 22, 1929 3 Sheets-Sheet 2

Fig 2



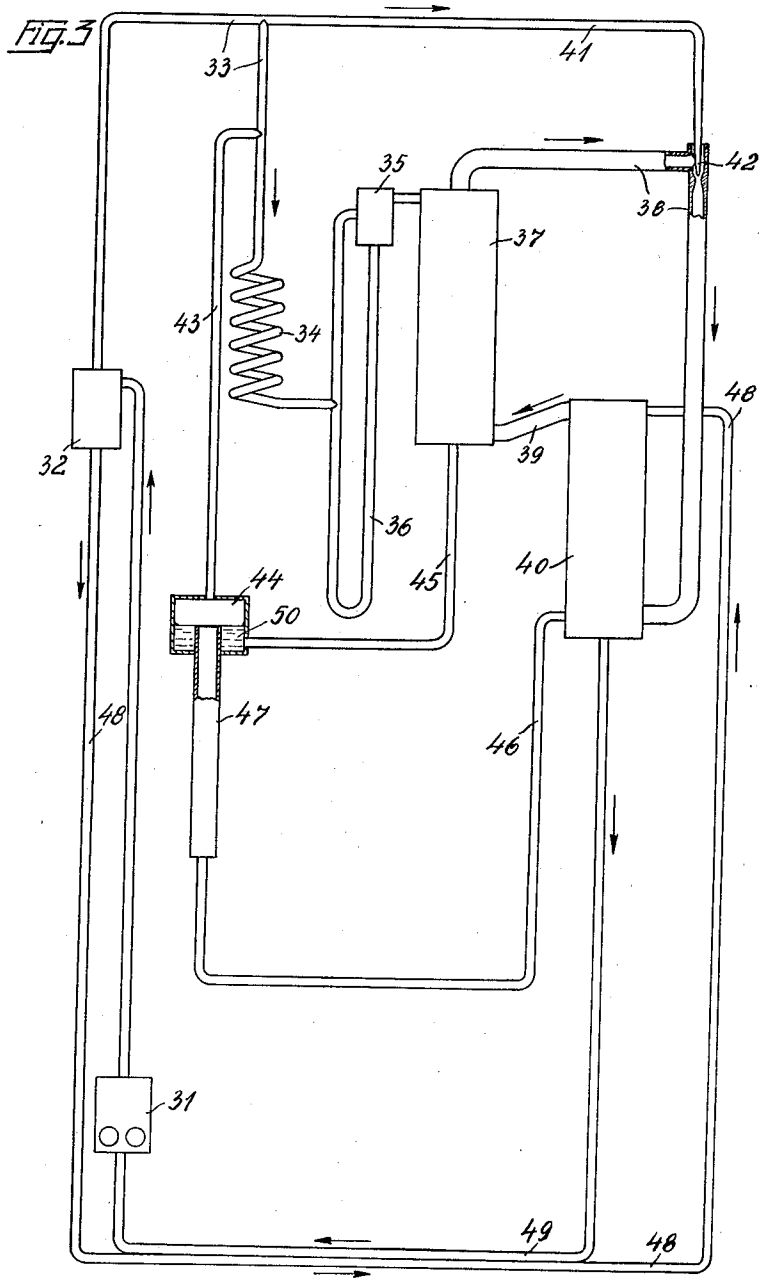
Inventor
Edmund Altenkirch
by Knight Bros
Attorneys

Sept. 5, 1933. E. ALTENKIRCH 1,925,361

ABSORPTION REFRIGERATING MACHINE

Filed May 22, 1929 3 Sheets-Sheet 3

Fig. 3



Inventor
Edmund Altenkirch
by Knight Bros
Attorneys

Patented Sept. 5, 1933 1,925,361

UNITED STATES PATENT OFFICE

1,925,361

ABSORPTION REFRIGERATING MACHINE

Edmund Altenkirch, Neuenhagen, near Berlin, Germany, assignor, by mesne assignments, to The Hoover Company, North Canton, Ohio, a corporation of Ohio

Application May 22, 1929, Serial No. 365,201, and in Germany May 22, 1928

15 Claims. (Cl. 62—119.5)

My invention relates to improvements in absorption refrigerating machines and more particularly to an absorption machine in which the refrigerant or the working medium evaporates into an inert auxiliary gas. The evaporation may take place from the condensate of the working medium or from a concentrated absorption solution thereof depending upon whether a condenser or a resorber is used to change the gaseous refrigerant to its liquid phase before it is brought into the presence of the inert gas in the evaporator. An example of the condenser type of machine is disclosed in my Patent No. 1,615,353 granted January 25, 1927 while the resorber type machine is disclosed in my copending application, Serial Nos. 99,890 and 101,745, filed April 5, 1926 and April 13, 1926, respectively.

In such machines it may happen under certain conditions that the pressure in the condenser or resorber drops below that in the remainder of the machine, temporarily. This occurs for example, in the case where a fan is used to circulate air over an air cooled condenser if the fan is started suddenly and lowers the temperature of the condenser quickly. The gaseous refrigerant therein then changes to the liquid phase more rapidly than refrigerant gas is supplied to it. Such a drop in pressure may also occur when the machine is shut down, since condensation may take place after the supply of gaseous refrigerant to the condenser, has ceased.

In apparatuses heretofore constructed, the occurrence of a slight reduction in the pressure in the condenser or the resorber disturbed the liquid levels in the boiler part of the system and often caused the weak solution to flow over into the condenser or resorber. When this occurs weak solution is delivered to the evaporator and refrigeration ceases, or if the machine is just being started after this action has occurred, a long starting period is required.

An object of the present invention is to overcome these defects by preventing the passage of solution from the boiler-absorber side of such a system into the condenser or resorber.

A further object of the invention is to provide convenient means for removing gases from the condenser or resorber in the event that the total pressure therein is higher than that in the absorber.

Another object is to provide simple means for regulating the pressure between parts of the apparatus which also functions to drain excess liquids from the evaporator.

In order to accomplish these and other objects, a pipe is connected to the gas space of the condenser or resorber and to that part of the apparatus which contains the inert gas. Gases may then pass into the condenser or resorber instead of the solution to bring about an equalization of the pressure, substantially, upon rapid liquefication of refrigerant gas therein. Upon the resumption of stable pressure conditions, the gases so transferred are returned to the part of the apparatus in which they normally belong.

Means may also be employed to reduce excess pressure in the liquefier or to vent inert gas from the liquefier back to the evaporator or absorber. (Note: The term "liquefier" is used to denote either a condenser or a resorber.) The surplus or excess of gas may, for instance, have been produced by an excessively strong development of gas in the generator or may be caused by the entraining of a portion of the inert auxiliary gas, admixed with the working medium in the evaporator and the absorber, into the liquefier or by its passing into it after the machine had been stopped. Wherever possible the same devices should be used to vent gases from the liquefier when excess pressure occurs therein, as are used to supply gas to it when a reduction in pressure occurs. The pressure regulating device should be so designed that gas is able to pass into the liquefier if a reduced pressure prevails in it but in case the total pressure therein is normal (that is equal—within certain limits—to the total pressure in the evaporator or the absorber), then no inert gas can pass to the liquefier. This may be accomplished by providing a liquid seal in the conduit which regulates the flow of gases to and from the liquefier.

If the conduits for conveying gases to and from the liquefier include a vessel for providing the liquid seal, this means may also serve to convey surplus quantities of liquid from the evaporator into the absorber system, thus overcoming a disadvantage common to both the condenser and resorber type of machine wherein excess solution find its way into the evaporator.

The manner of accomplishing these and other objects will be more apparent in view of the following description when considered in connection with the accompanying drawings in which,

Fig. 1 is a diagrammatic illustration of an embodiment of the invention as applied to an absorption machine of the resorber type in which a device for compensating for pressure differences between the liquefier and the remainder of the system is provided.

Fig. 2 is a diagrammatic embodiment of a resorber system illustrating another form of the invention and,

Fig. 3 diagrammatically illustrates the invention as applied to an absorption system in which a condenser is employed.

For the purpose of describing the invention, it will be assumed that a binary mixture consisting of water and ammonia is used although the invention is not limited to the use of these fluids.

In the evaporator 1 and the absorber 2 (Fig. 1) an inert gas (such as air) is admixed with the ammonia. From the evaporator 1 the gas mixture flows through a pipe 3 to the absorber 2 propelled by the action of a nozzle 5 in the pipe 3. From the upper end of the absorber it returns through a pipe 4 to the evaporator 1. Below the absorber 2 is arranged a U-shaped pipe consisting of the two legs 6 and 7 through which the strong absorption solution passes before it is delivered through a pipe 8 into the generator 9, which is heated by a cartridge 10. The gas expelled by the application of heat ascends mixed with absorption solution in a rising pipe 11 into the gas separating chamber 12, where gas and absorption liquid separate. While the liquid returns through the pipe 13 into the absorber 2, the gas flows through a pipe 14 into a pipe 15 in which is contained absorption liquid, which under the action of the gas thus introduced is lifted into the resorber 16 located at a higher level. The absorption solution together with the gaseous working medium thus pass into the upper part of the resorber 16. Within this vessel the liquid flows downward over a coiled pipe 17 traversed by cooling water and absorbs the gas. The strong absorption solution flows from the lower part of the resorber 16 through a pipe 17, which in conjunction with the pipe 15 forms a heat exchanger, into the upper part of the evaporator 1. After the solution in the evaporator 1 has again given up the gas, it is discharged through the U-shaped pipe 15, through which it passes again into the resorber 16 under the action of the introduced gaseous working medium. From the pipe 14 branches a gas pipe 19, which terminates in the nozzle 5 mentioned before.

The gas space of the resorber, i. e. the space above the strong absorption solution accumulating in the resorber, is, by a gas pipe 20, 22, in communication with the leg 7 of a U-shaped pipe located below the absorber 2. This leg 7 has such a diameter, that any ascending air or gas bubbles cannot eject liquid from this pipe. As a rule the absorbable gases supplied by the pipe 20 are at once absorbed in the leg 7, because the solution contained in the U-shaped pipe 6, 7 is substantially weaker than the solution in the resorber 16, inasmuch as its saturation corresponds with the partial pressure of the ammonia prevailing in the absorber 2. The quantities of air or gas penetrating through the liquid in the leg 7 pass into the pipe 3, and thus into the gas mixture circulation system.

Between the two gas pipe portions 20, 22 is located a vessel 21, in which is contained a store of liquid 30 consisting of absorption solution. Pipe 20 opens into the vessel at the top and is continued by a pipe 22, which at the level of the store of liquid forms an overflow for the latter. Below the surface of the store of sealing liquid 30 opens into the vessel 21 a pipe 23, the other end of which is connected to the lowest point of the gas pipe 4 leading from the absorber 2 to the evaporator 1. The quantity of liquid constantly contained in the vessel 21 is such, that at a definite excess pressure in the gas space of the resorber 16 it fills the connecting pipe 23 up to a predetermined pressure height, and thus prevents any passage of gas into the pipe 4.

The point at which the pipe 22 opens into the leg 7 of the U-shaped pipe 6, 7 is located at least at such a distance below the point where the pipe 8 supplying the absorption liquid into the boiler 9, branches off that the column of liquid (taking into account the difference in the specific weights) standing in the connecting pipe 23 balances the column of liquid in the leg 7 exposed to the same pressure.

The apparatus operates in the following manner:

If for any reason a slight reduction in pressure occurs in the resorber 16, inert gas passes from the gas pipe 4 through the connecting pipe 23, store of liquid 30, the pipe 20 and thus into resorber 16.

If, on the other hand, a pressure higher than normal is developed in the resorber by an accumulation of surplus gas quantities, this surplus is able to pass through the pipe 20, by displacement of the store of liquid in the pipe 23, into the pipe 22 and the leg 7 of the U-shaped pipe 6, 7. As far as these quantities of gas are not absorbed by the absorption liquid in the leg 7, they pass into the gas pipe 3 and thus into the absorber 2. The highest point of the connecting pipe 23, i. e. the point where it branches from the gas mixture pipe 4, is located so much higher than the place where the pipe 23 opens into the store of liquid 30, that even at the highest excess pressure occurring in service in the liquefier 16 the column of liquid accumulating in the pipe 23 suffices to prevent the passage of gas into the chamber containing the inert gas.

The store of liquid in the vessel 21 thus operates like a valve, which in the case of reduced as well as excess pressure in the resorber 16, acts to bring about the necessary pressure equalization or compensation in the system formed by the evaporator and the absorber. Under these circumstances, it will be apparent that upon the resumption of normal pressure conditions in the liquefier after inert gas has been supplied thereto, the inert gas will be gradually vented from the liquefier back to the evaporator-absorber system as refrigerant gas is supplied to the liquefier from the boiler and separator, and replaces the inert gas therein. By means of this device the operation of the absorption machine attains a high degree of safety.

Any steam generated by the evaporation of solvent in the evaporator and taken up by the gas mixture, may also pass into the absorber 2 through the gas pipe 19 and the nozzle 5 as well as the pipe 3. In the pipe 4 leading to the lower end of the evaporator 1 a portion of the steam condensers and the condensate accumulates at the lowest point of pipe 4. Since the connecting pipe 23 branches from this point the water of condensation is promptly discharged into the vessel 21, where it serves for maintaining the store of liquid.

The surplus quantities of liquid in the evaporator also find a possibility to drain off into the absorber system through the pipe 23. This is a further advantage of the arrangement of the connecting pipe 23, inasmuch as it renders the otherwise necessary special pipe for the return of surplus quantities of liquid from the resorber into the absorption system superfluous.

The second embodiment, Fig. 2, differs from the one described mainly by the feature, that a liquid seal is not provided by a special vessel (as illustrated at 21 in Fig. 1), but by a store of liquid in the lower part of the resorber 26, and that the connecting pipe equalizing the pressure is formed by a pipe 27 issuing from the top of the gas space of the evaporator 24 and opening into the resorber 26 below the level of the store of liquid 29. The discharge of surplus quantities of liquid

from the resorber system, which in the first described embodiment of the invention was also dealt with by the connecting pipe 23, takes place here through a pipe 28 designed as liquid seal, which issues from the gas mixture return pipe at the bottom of the evaporator 24 and opens into the lower part of the absorber 25.

The apparatus functions in a similar manner as the one described before, so that it requires no further description.

Fig. 3 illustrates the application of the invention to an absorption machine, likewise operating with an admixture of gas, which instead of a resorber contains a condenser. The gaseous working medium driven from the absorption solution in the generator 31 rises, mixed with the absorption liquid, into a separator 32, where it separates from the liquid and is supplied to the condenser 34 through a pipe 33, while the weak absorption solution flows into the absorber 40 through a pipe 48. From the absorber a pipe 49 returns the strong solution into the generator 31.

From the condenser 34 the liquefied working medium passes through an accumulator vessel 35, to which is joined a return pipe 36, into the top of the evaporator 37, into which enters from below, through a gas pipe 39, the inert auxiliary gas freed in absorber 40 from most of its gaseous working medium. The gas mixture forming during the evaporation flows through a pipe 38 to the lower end of the absorber 40. Into the pipe 38 opens a gas pipe 41 branching from the pipe 33. This gas pipe terminates in a nozzle 42, which maintains in well known manner the circulation of the gas mixture in the direction of the arrows shown. From the lower end of the evaporator 37 a U-shaped conduit system including pipe 45, conduit 47 and pipe 46 leads to the lower part of the absorber 40. This pipe system serves to return to the absorber any quantities of liquid accumulating in the evaporator. In the run of the aforementioned U-shaped system 45, 46 is provided a vessel 44, the upper part of which is in communication with the gas pipe 33 by a pipe 43, and which contains a store of liquid 50, which is replenished by the surplus quantities of liquid in the evaporator. The quantity of this store is limited by an overflow pipe 47 forming part of the conduit system aforementioned. The overflow pipe 47 is so amply dimensioned, that in the event a reduction in pressure occurs in condenser 34 and in pipe 43, it is able to accommodate the contents of the pipe 46. Simultaneously gas passes into the pipe 43 through the pipe 45 and the store of liquid 50, so that the pressure is equalized. In case of an excess pressure in the condenser 34, on the other hand merely a displacement of the store of liquid 50 into the pipe 45 takes place, but no passage of gas, since the U-shaped pipe 46 forming a liquid seal prevents the passage of gas into the absorber 40.

Since the condenser 34 consists of a coil of small sized pipe, as shown, the inert gas is vented or purged therefrom in the usual way by the passage of slugs of liquid refrigerant formed therein upon the resumption of a normal supply of refrigerant gas to the condenser from the separator 32.

Various modifications and changes may be made without departing from the spirit and the scope of the invention.

I claim as my invention:

1. In an absorption refrigerating machine comprising a generator, a liquefier, an evaporator, and an absorber, said evaporator and said absorber being connected to form a circulation system for a gaseous working medium and an inert gas, said absorber and said generator being connected to form a circulation system for the liquid, a store of liquid subject to the pressure prevailing in the gas space of said liquefier, and a pipe located external to said circulation system for the liquid, and opening with one end below the surface of said store of liquid and with the other end in said first circulation system.

2. In an absorption refrigerating machine comprising a generator, a liquefier, an evaporator, and an absorber, said evaporator and said absorber being connected to form a circulation system for a gaseous working medium and an inert gas, a store of liquid subject to the pressure prevailing in the gas space of said liquefier, and a pipe opening with one end below the surface of said store of liquid and with the other end in said circulation system, the ends of said pipe being located at different heights so that a column of liquid is formed in this pipe.

3. In an absorption refrigerating machine comprising a generator, a liquefier, an evaporator, and an absorber, said evaporator and said absorber being connected to form a circulation system for a gaseous working medium and an inert gas, a store of liquid subject to the pressure prevailing in the gas space of said liquefier, and a pipe opening with one end below the surface of said store of liquid and with the other end in said circulation system, said absorber and said generator being connected to form a liquid circulation system, the vessel containing said store of liquid being connected by a pipe with the gas chamber of said liquefier, and by a second pipe to the said liquid circulation system.

4. In an absorption refrigerating machine comprising a generator, a liquefier, an evaporator, and an absorber, said evaporator and said absorber being connected to form a circulation system for a gaseous working medium and an inert gas, a store of liquid subject to the pressure prevailing in the gas space of said liquefier, and a pipe opening with one end below the surface of said store of liquid and with the other end in said circulation system, said absorber and said generator being connected by a liquid circulation system, and a pipe for returning surplus quantities of liquid from said evaporator into said generator, the vessel containing said store of liquid being interposed in said pipe.

5. In an absorption refrigerating machine comprising a generator, a liquefier, an evaporator, and an absorber, said evaporator and said absorber being connected to form a circulation system for a gaseous working medium and an inert gas, a store of liquid subject to the pressure prevailing in the gas space of said liquefier, and a pipe opening with one end below the surface of said store of liquid and with the other end in said circulation system, the place of opening of said pipe into said gas circulation system being located low enough to enable the accumulation and discharge of liquid, which forms in the gas pipe leading from the absorber to the evaporator from steam contained in the gas mixture circulating in the said gas pipe, and a pipe for returning surplus quantities of liquid from said evaporator into said generator, the vessel containing said store of liquid being interposed in said pipe.

6. In absorption refrigerating apparatus of the type in which an inert auxiliary gas is employed, the combination of an evaporator, an absorber, conduit means connected to the evaporator and

the absorber to provide a circuit for the flow of the inert gas between them, a generator for expelling refrigerant gas from an absorption solution, a device for changing gaseous refrigerant to a more dense fluid phase, means for normally maintaining the total pressure in said device slightly higher than that in said absorber and means responsive to a temporary reduction in pressure in said device for supplying inert gas to the same from the evaporator absorber circuit.

7. In absorption refrigerating apparatus employing an inert auxiliary gas, the combination of an evaporator, an absorber, conduit means for connecting the evaporator and absorber and for maintaining a quantity of inert gas therein, a device for changing gaseous refrigerant to a more dense fluid phase connected to said evaporator, means for normally maintaining the total pressure in said device slightly higher than that in said absorber, and means for causing the flow of inert gas from the supply maintained in the evaporator and absorber into said device upon a predetermined drop of the total pressure in said device below the total pressure in said evaporator and absorber.

8. In absorption refrigerating apparatus employing an inert auxiliary gas, the combination with an evaporator, and an absorber, having an inert gas therein, of a device for changing gaseous refrigerant to a more dense fluid phase, means for normally maintaining the total pressure in said device slightly higher than that in said absorber and means for causing inert gas to pass from the supply in the evaporator and absorber into said device upon a predetermined reduction in the total pressure in said device below that in the absorber.

9. In absorption refrigerating apparatus employing an inert auxiliary gas, the combination with an evaporator and an absorber having inert gas therein, of a device for changing gaseous refrigerant to a more dense fluid phase, means for normally maintaining the total pressure in said device slightly higher than that in said absorber and means for transferring inert gas from the supply in the evaporator and the absorber to said device, or vice versa upon the existence of a predetermined difference in total pressure between said device and the absorber.

10. In absorption refrigerating apparatus employing an inert auxiliary gas, the combination with an evaporator and an absorber, having an inert gas therein, of a device for changing gaseous refrigerant to a more dense fluid phase, means for normally maintaining the total pressure in said device slightly higher than that in said absorber, and means for causing inert gas to pass from the supply in the evaporator and absorber into said device upon a predetermined reduction in the total pressure in said device below that in the absorber while precluding the passage of inert gas as aforesaid under normal operating conditions.

11. In an absorption refrigerating machine comprising a generator, a device for changing the refrigerant to a more dense fluid phase, an evaporator and an absorber, said evaporator and absorber being connected to form a circulating system for a mixture of gaseous refrigerant and a neutral gas, and a storage vessel containing a store of absorption liquid, and a pipe terminating at one end below the surface of said liquid store and at the other end in said mixture circulating system; said absorber and generator being connected to form a liquid circulating system, a second pipe connecting said storage vessel with the gas space of said changing device to render the liquid store subject to the gas pressure prevailing in said device, and a third pipe for connecting said vessel with said liquid circulating system, a U-shaped pipe located in the course of said latter system, and being disposed below said absorber and terminating with one shank at the bottom of said absorber and with its other shank in said mixture circulating system ahead of the absorber, said third pipe connecting the surface of said liquid store with said last-named pipe shank and terminating in the latter below the surface of the liquid contained therein.

12. In an absorption refrigerating machine comprising a generator, a device for changing gaseous refrigerant to a more dense fluid phase, an evaporator, and an absorber, said evaporator and said absorber being connected to form a circulation system for a gaseous working medium and an inert gas, a store of liquid, said absorber and said generator being connected to form a liquid circulation system, the vessel containing said store of liquid being connected by a pipe with the gas chamber of said device to render the liquid store subject to the pressure prevailing in the gas space of said device, and by a second pipe to the said liquid circulation system, and a third pipe terminating below the surface of the liquid store in said device for returning surplus quantities of liquid from said evaporator into said vessel.

13. The method of stabilizing the operation of a continuously operable absorption refrigerating apparatus having a device for changing a refrigerant to a more dense fluid phase and an absorber, which method includes the steps of causing gas to flow from the absorber to said device when the pressure in the latter is lower than that in the absorber, causing gas to flow from said device to the absorber when the pressure in said device is higher than that in the absorber and resisting the flow in one direction by passing the gas through a liquid.

14. The method of stabilizing the operation of a continuously operable absorption refrigerating apparatus having a device for changing a refrigerant to a more dense fluid phase, an absorber and an inert gas in said absorber, which method includes the steps of causing the inert gas to flow from the absorber to said device when the pressure in the said device is lower than that in the absorber, causing the inert gas to flow from said device to the absorber when the pressure in said device is higher than that in the absorber and resisting the flow of gas in both directions by passing the same through a liquid.

15. In absorption refrigerating apparatus employing an inert auxiliary gas, the combination with an evaporator and an absorber, having inert gas therein, of a device for changing gaseous refrigerant to a more dense fluid phase, a conduit means connecting said device to the evaporator and the absorber and adapted to convey inert gas from the absorber to said device or vice versa upon the existence of a difference in total pressure between said device and said absorber, and means for interposing a liquid in said conduit means to resist the flow of inert gas through said conduit means.

EDMUND ALTENKIRCH.