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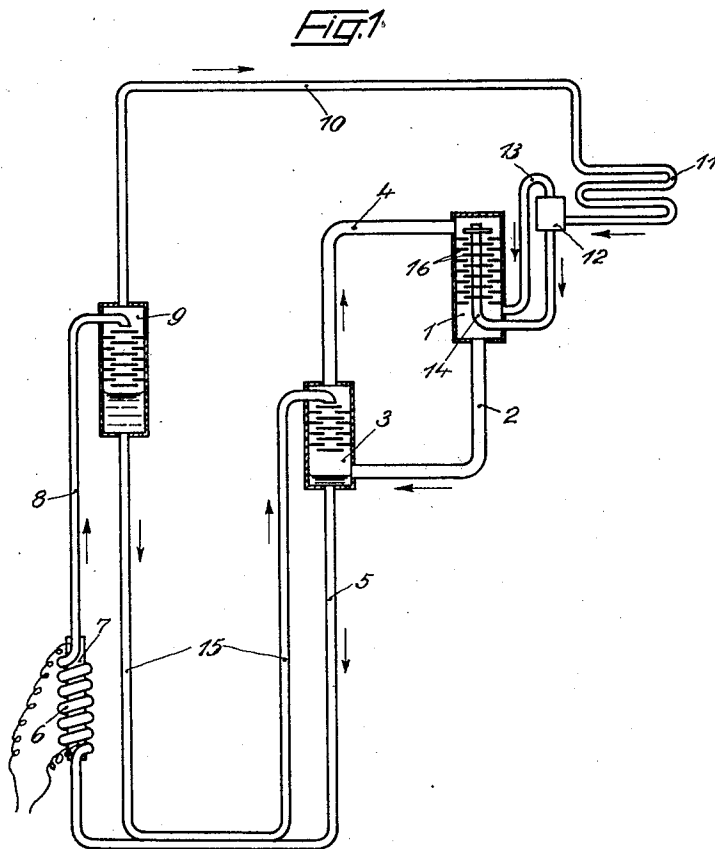
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ABSORPTION REFRIGERATING APPARATUS

Filed Jan. 5, 1929

2 Sheets-Sheet 1



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Fig. 2

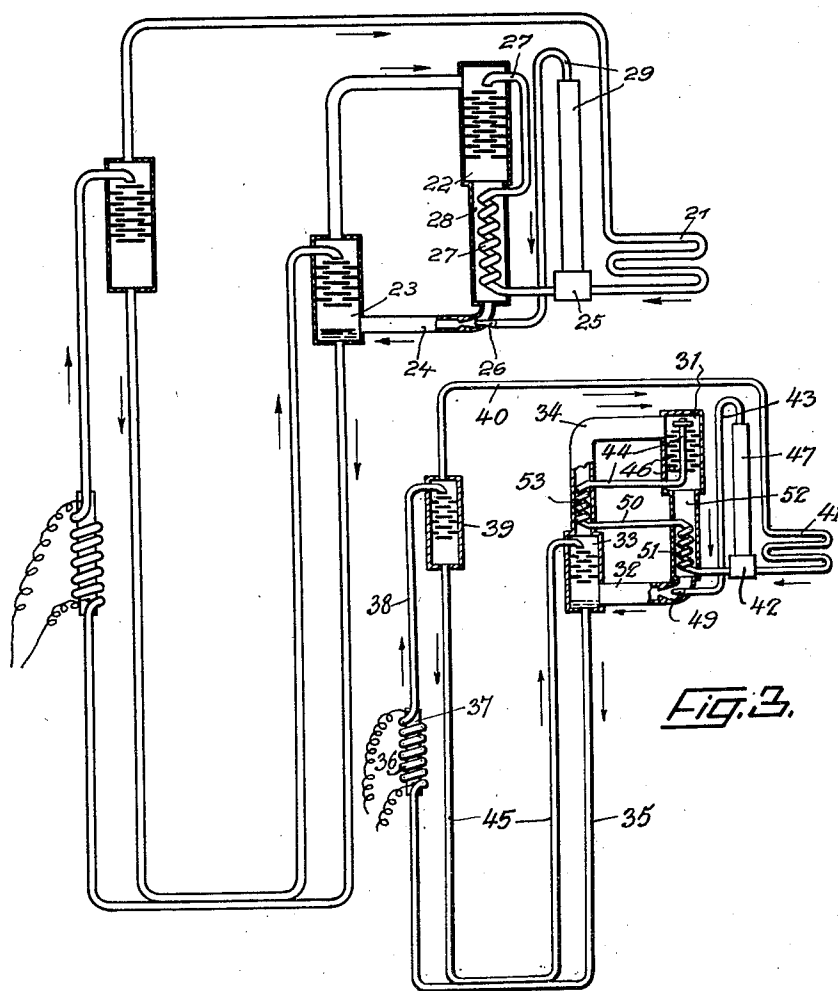


Fig. 3

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UNITED STATES PATENT OFFICE

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ABSORPTION REFRIGERATING
APPARATUS

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Germany, assignor, by mesne assignments, to
The Hoover Company, North Canton, Ohio, a
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Application January 5, 1929, Serial No. 330,530,
and in Germany January 14, 1928

6 Claims. (Cl. 62—119.5)

My invention relates to improvements in absorption refrigerating apparatus, and more particularly to machines of this type operating with a circulating inert gas.

5 Absorption apparatus are already known in which the working medium liquefied in a condenser or a reabsorber evaporates in the evaporator into an inert auxiliary gas.

10 My invention relates to apparatus of this type in which the liquefied working medium or the absorption solution and the inert gas traverse the evaporator in the same direction, generally from the top to the bottom.

15 According to my invention the liquefied working medium is prior to its entrance into the evaporator subjected to a preliminary cooling by cold generated in the evaporator. This results in the following advantages: Since the gas mixture when coming from the absorber and entering the evaporator has the lowest partial pressure of the working medium, it is immediately after its entrance in a position to generate the lowest temperatures. If, however, condensate or absorption solution of only the temperature of the cooling water (or the cooling air) finally reaches this range of the lowest obtainable temperature, the aforementioned advantages are not utilized. The cold then produced is wasted because it is used for the precooling of the working fluid and when this precooling is finished the partial pressure in the gas mixture has already risen considerably and thus become unfavorable for efficient refrigeration. If, on the contrary, according to my invention this liquid is precooled by the low temperature generated in the evaporator, for instance by introducing a pipe, conducting the liquid, into the evaporator from below and running it near to the top where it discharges the liquid the precooling occurs through the zones of the evaporator, in which on account of the already risen partial pressure in the gas mixture less low temperatures can be produced than its own temperature, and the possibility of producing the lowest temperature at the upper end is retained. This advantage becomes particularly noticeable, if the condenser or the reabsorber is cooled by outside air and this air is very hot, as for instance in summer.

20 In the drawings affixed hereto and forming part of my specification two embodiments of my invention are illustrated diagrammatically.

In the drawings

Fig. 1 shows a diagram of one construction of my improved absorption refrigerating apparatus,
55 Fig. 2, a modified construction thereof, and

Fig. 3, a still further modified construction, which will be more fully described with reference to the drawings.

Referring to Fig. 1, it will be seen that the lower end of an upright evaporator 1 is in communication with the lower part of the absorber 3 by a gas pipe 2. Through a pipe 4 communicating with the upper part of the absorber 3 and with the upper part of the evaporator 1, an inert gas (such as hydrogen) of lower specific weight than the gaseous working medium and admixed with the working medium (such as ammonia) returns into the evaporator.

The solution enriched in the absorber (water being for instance assumed as solvent) is through a pipe 5 conducted into the boiler 6, in which it is heated by means of an electric heating rod 7. By the gas bubbles there formed the liquid is conveyed through a rising pipe 8 into the upper part of a rectifier 9, from the lower part of which the impoverished absorption liquid returns to the top of the absorber 3 through a pipe 15 forming a heat exchanging device with the pipe 5. The gaseous working medium separated in the rectifier 9 from the absorption liquid is by a pipe 10 passed to the air-cooled condenser 11 from which after its liquefaction it drains into a second rectifier 12. Any remainders of gas not condensed in the condenser and entrained into the rectifier 12 pass through an S-shaped pipe 13 branching off this rectifier and terminating at the lower part of the evaporator 1, so that this uncondensed refrigerant returns into the cycle of the gas mixture between evaporator and absorber without reducing the action of the evaporator. By this removal of residues of gas from the liquid supplied to the evaporator 1, the uniformity or regularity of feeding the evaporator with liquid operating medium is improved or in some cases made possible at all. The condensed working medium freed from gaseous remnants traverses a U-shaped pipe 14, which enters the evaporator at the bottom and extends almost up to its top. A heat exchange then takes place between the liquid ascending in the pipe 14 and the gas mixture and the not yet evaporated working medium traversing the evaporator from top to bottom, which results in a strong precooling of the liquid refrigerating agent supplied through pipe 14. The working medium issuing in the cooled state at the top of the pipe 14 commences to evaporate at a very low temperature. The liquid not immediately evaporated runs down over the baffle plates 16 located in the evaporator and is gradually evaporated at

rising temperature and at rising partial pressure of the gas mixture.

The modification of my improved absorption refrigerating apparatus diagrammatically illustrated in Fig. 2 of the drawings differs from the just described apparatus in so far as the heat exchange between the gas mixture and the working medium condensed in the condenser 21 takes place within the ducts leading from the evaporator 22 to the absorber 23, and secondly by the feature that the residues of gas discharged from the auxiliary rectifier 25 through a first wide and later narrow S-shaped pipe 29 are introduced by means of a nozzle 26 into the pipe 24 in such a way, that they effect or at least assist in the circulation of the gas mixture. Pipe 27 which conveys the condensed refrigerant from auxiliary rectifier 25 to the evaporator 22 is provided with a coiled portion located in a chamber 28 directly joining the lower end of evaporator 22, which chamber forms already a part of the conduit leading from the evaporator to the absorber 23 and does not produce useful refrigeration to the outside. The coiled pipe portion 27 leads the cooled liquid refrigerant to the upper part of the evaporator 22. The preliminary cooling of the condensate comes about in this system firstly by the fact, that the liquid refrigerant in the coiled portion of the pipe 27 enters into heat exchange with the gas mixture cooled in the evaporator 22 and rich in evaporated working medium, and secondly by the ammonia, not evaporated in the evaporator and diluted by the water which is entrained into the evaporator partly by the steam raised in the boiler or generator, and partly by the gas circulation in the evaporator. This diluted cold ammonia passes over the coiled portion of the pipe 27 and transfers cold of vaporization to the liquid to be precooled. In this way is obtained a particularly extensive utilization of the refrigeration output up to comparatively high temperatures.

Without changing the nature of my invention, the pipe supplying the liquid working medium to the evaporator might be passed first through the gas mixture conveying pipe between evaporator and absorber as shown in Fig. 2 and besides also through the whole length of the evaporator itself as shown in Fig. 1. In this way the advantage of both possibilities of construction, viz. lowest attainable temperature and extensive utilization, are combined.

It may further be advisable to cool the gas mixture discharged from the absorber by the refrigerant condensate precooled in the manner described and to condense the water vapor contained in the gas mixture prior to the gas mixture reaching the evaporator. For this purpose it is expedient to conduct the liquid refrigerant, after it has been precooled by the cold gases discharged from the evaporator, through the conduit which leads the gas mixture from the absorber to the evaporator. Since by this heat exchange the temperature of the precooled liquid refrigerant would again rise slightly, the liquid refrigerant is thence conducted through the lower part of the evaporator and to its top where it is discharged into the evaporator, so that it is efficiently and completely cooled in the manner described with reference to Fig. 1. This particular aforementioned modification is shown in Fig. 3 which, the same as Figs. 1 and 2, comprises a boiler, a rectifier, an absorber, an evaporator, a condenser and an auxiliary rectifier, all arranged substantially in the same relation to

each other. 52 in Fig. 3 is the equivalent of the precooling chamber 28 of Fig. 2, through which the liquid refrigerant coming from the auxiliary rectifier 42 is conducted by a pipe coil 51, so that a precooling of the liquid refrigerant occurs. Thence the liquid refrigerant is conducted through a pipe coil 53 located in conduit 34 which leads the gas mixture from absorber 43 to the top of evaporator 31. Thus the gas mixture is freed from entrained water vapor. The liquid refrigerant which has been slightly heated in coil 53 by this heat exchange is now conducted by means of pipe 44 into the lower part of evaporator 31 in which pipe 44 rises to near the top, where the refrigerant is discharged into the evaporator. On its travel through the different zones of the evaporator from the bottom to the top the cooling of the refrigerant to the desired temperature is effected the same as described with reference to Fig. 1. In Fig. 3, the same as in Fig. 2, circulation of the gas mixture between the absorber and the evaporator is maintained by means of a jet blowing from nozzle 49 the residual gas obtained from the auxiliary rectifier 42.

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 apparatus of the continuously operable type, in combination, a boiler, a condenser, an evaporator and an absorber containing an absorption solution and a partly condensed and partly gaseous working medium, and also containing an inert gas admixed with the gaseous working medium in the absorber and the evaporator, connecting pipes between said absorber and said evaporator for permitting a circulation of the mixture of gaseous working medium and the inert gas, a connecting pipe between said condenser and said evaporator for conveying the condensed working medium into the evaporator, said last-named pipe running through at least a portion of said evaporator in which it is exposed to the cold generated therein, and terminating at the upper evaporator end near the admission point of the gas pipe a conducting inert gas from the absorber to the evaporator, for cooling the condensed working medium by the low temperatures produced in the evaporator before it is discharged into the evaporator, whereby a zone of extremely low temperature is produced in the evaporator portion adjacent to the entrance point of the working medium and of the inert gas.
2. In an absorption refrigerating apparatus of the continuously operable type, in combination, a boiler, a condenser, an evaporator and an absorber containing an absorption solution and a partly condensed and partly gaseous working medium, and also containing an inert gas admixed with the gaseous working medium in the absorber and the evaporator, connecting pipes between said absorber and said evaporator for permitting a circulation of the mixture of gaseous working medium and the inert gas, a connecting pipe between said condenser and said evaporator for conveying the condensed working medium into the evaporator, said last-named pipe running through said evaporator from its lower end and terminating at its upper end near the admission point of the gas pipe conducting inert gas from the absorber to the evaporator, for cooling the condensed working medium by the low temperatures produced in the evaporator

before it is discharged into the evaporator, said last-named pipe extending for a part of its length also through a portion of the conduit conducting the gas mixture from the evaporator to the absorber to bring about a preliminary cooling of the condensed working medium before its final cooling in the evaporator, whereby a zone of extremely low temperature is produced in the evaporator portion adjacent to the entrance point of the working medium and of the inert gas.

3. In an absorption refrigerating apparatus of the continuously operable type, in combination, a boiler, a condenser, an evaporator and an absorber containing an absorption solution and a partly condensed and partly gaseous working medium, and also containing an inert gas admixed with the gaseous working medium in the absorber and the evaporator, connecting pipes between said absorber and said evaporator for permitting a circulation of the mixture of gaseous working medium and the inert gas, a connecting pipe between said condenser and said evaporator for conveying the condensed working medium into the evaporator, said last-named pipe running through said evaporator from its lower end and terminating at its upper end near the admission point of the gas pipe conducting inert gas from the absorber to the evaporator, for cooling the condensed working medium by the low temperatures produced in the evaporator before it is discharged into the evaporator, whereby a zone of extremely low temperature is produced in the evaporator portion adjacent to the entrance point of the working medium and of the inert gas, said last-named pipe extending for a part of its length also through a portion of the conduit conducting the gas mixture from the evaporator to the absorber, to bring about a preliminary cooling of the condensed working medium before its final cooling in the evaporator, and means for conducting said preliminary cooled working medium separately through the gas mixture flowing from the absorber to the evaporator for freeing said gas mixture of entrained moisture.

4. In an absorption refrigerating apparatus of the continuously operable type, in combination, a boiler, a condenser, an evaporator and an absorber containing an absorption solution and a partly condensed and partly gaseous working medium, and also containing an inert gas admixed with the gaseous working medium in the absorber and the evaporator, connecting pipes between said absorber and said evaporator for permitting a circulation of the mixture of gaseous working medium and the inert gas, a connecting pipe between said condenser and said evaporator for conveying the condensed working medium into the evaporator, said last-named connecting pipe terminating in said evaporator near the admission point of the gas pipe conducting inert gas from the absorber to the evaporator, means for precooling the condensed working medium supplied to the evaporator by the low temperatures produced in the evaporator, whereby a zone of extremely low temperature is produced in the evaporator portion adjacent to the entrance point of the working medium and of the inert gas, a gas separator connected in the pipe between the condenser and the evaporator for freeing the condensed working medium from entrained gas, and a gas pipe connecting said separator with the gas mixture conduit leading the gas mixture from the evaporator to the

absorber, said last-named gas pipe having a nozzle in the mixture conduit for blowing the gas derived from the separator in a jet into said gas mixture conduit for producing circulation of gas mixture in the desired direction.

5. In an absorption refrigerating apparatus of the continuously operable type, in combination, a boiler, a condenser, an evaporator and an absorber containing an absorption solution and a partly condensed and partly gaseous working medium, and also containing an inert gas admixed with the gaseous working medium in the absorber and the evaporator, connecting pipes between said absorber and said evaporator for permitting a circulation of the mixture of gaseous working medium and the inert gas, a connecting pipe between said condenser and said evaporator for conveying the condensed working medium into the evaporator, said last-named pipe running through said evaporator from its lower end and terminating at its upper end near the admission point of the gas pipe conducting inert gas from the absorber to the evaporator, for cooling the condensed working medium by the low temperatures produced in the evaporator before it is discharged into the evaporator, whereby a zone of extremely low temperature is produced in the evaporator portion adjacent to the entrance point of the working medium and of the inert gas, said last-named pipe extending for a part of its length also through a portion of the conduit conducting the gas mixture from the evaporator to the absorber to bring about a preliminary cooling of the condensed working medium before its final cooling in the evaporator, a gas separator connected in the pipe between the condenser and the evaporator for freeing the condensed working medium from entrained gas, and a gas pipe connecting said separator with the gas mixture conduit leading the gas mixture from the evaporator to the absorber, said last-named gas pipe having a nozzle located in said mixture conduit for blowing the gas derived from the separator in a jet into said gas mixture conduit for producing circulation of gas mixture in the desired direction.

6. In an absorption refrigerating apparatus of the continuously operable type, in combination, a boiler, a condenser, an evaporator and an absorber containing an absorption solution and a partly condensed and partly gaseous working medium, and also containing an inert gas admixed with the gaseous working medium in the absorber and the evaporator, connecting pipes between said absorber and said evaporator for permitting a circulation of the mixture of gaseous working medium and the inert gas, a connecting pipe between said condenser and said evaporator for conveying the condensed working medium into the evaporator, said last-named pipe running through said evaporator from its lower end and terminating at its upper end near the admission point of the gas pipe conducting inert gas from the absorber to the evaporator, for cooling the condensed working medium by the low temperatures produced in the evaporator before it is discharged into the evaporator, whereby a zone of extremely low temperature is produced in the evaporator portion adjacent to the entrance point of the working medium and of the inert gas, said last-named pipe extending for a part of its length also through a portion of the conduit conducting the gas mixture from the evaporator to the absorber to bring about a preliminary cooling of the condensed working me-

dium before its final cooling in the evaporator, and means for conducting said preliminary cooled working medium separately through the gas mixture flowing from the absorber to the
5 evaporator, for freeing said gas mixture of entrained moisture, a gas separator connected in the pipe between the condenser and the evaporator for freeing the condensed working medium of entrained gas, and a gas pipe connecting said
10 separator with the gas mixture conduit leading the gas mixture from the evaporator to the absorber, said last-named gas pipe having a nozzle located in said mixture conduit for blowing
the gas derived from the separator in a jet into
said gas mixture conduit for producing circulation of gas mixture in the desired direction.
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