April 12, 1932. R. W. DAVENPORT 1,853,724

EVAPORATING PROCESS AND APPARATUS

Filed July 24, 1928

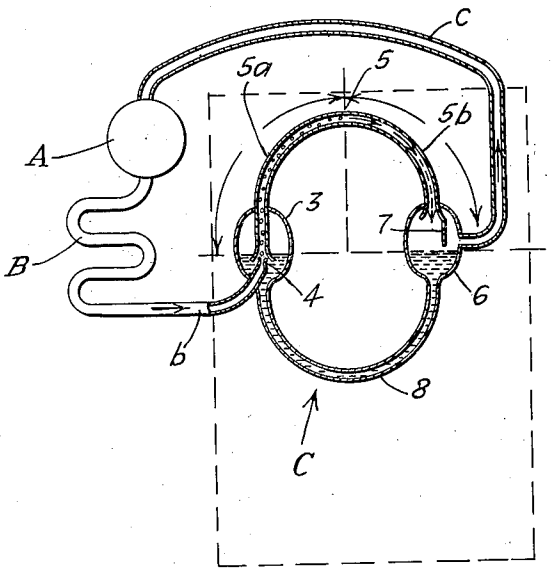

Fig. 1

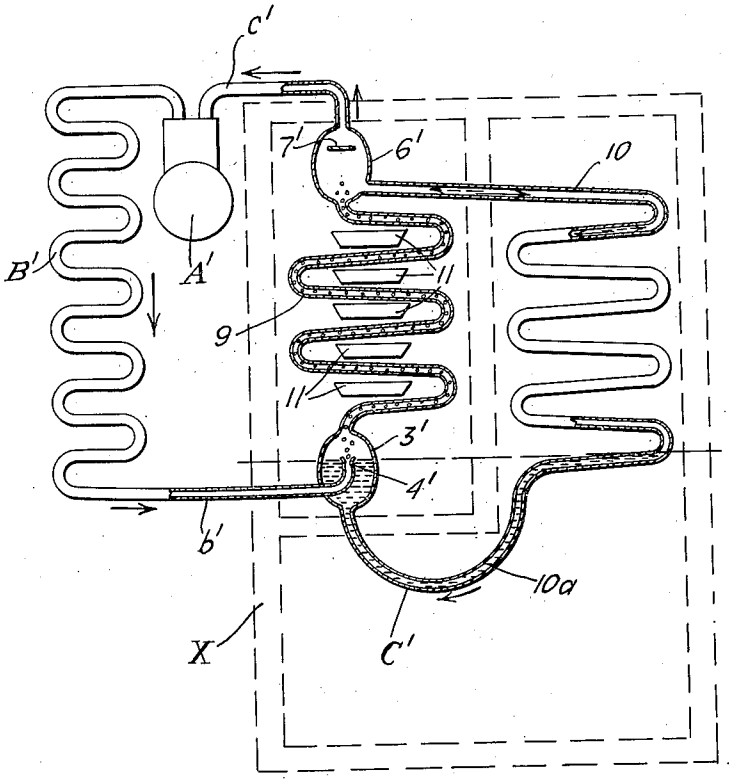

Fig. 2

INVENTOR.
Ransom W. Davenport
BY
Ira L. Nickerson
ATTORNEY.

Patented Apr. 12, 1932

1,853,724

UNITED STATES PATENT OFFICE

RANSOM W. DAVENPORT, OF DETROIT, MICHIGAN, ASSIGNOR TO CHICAGO PNEUMATIC TOOL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY

EVAPORATING PROCESS AND APPARATUS

Application filed July 24, 1928. Serial No. 294,999.

This invention relates to the evaporation of liquids and includes both a process and apparatus for carrying out the process. While the invention has features of general application, it is particularly adapted and intended for refrigerating purposes. More particularly it has to do with refrigerating systems operating on the vapor-gas principle disclosed in my U. S. Patent No. 1,619,196, issued March 1, 1927, disclosing the use of air or other insoluble gas in evaporators to prevent super-heating during vaporization of the liquid refrigerant and to secure lower temperatures with a given total pressure than is possible to secure by the conventional straight pumping methods. As previously disclosed the gas has been utilized to agitate and distend the liquid so as to increase the contact area of the gaseous and liquid fluids within the evaporator thereby to increase the quantity of vapor released from the liquid.

One object of the invention is still further to increase the contact area between the liquid and gaseous fluids in the evaporator. Another object is to improve the distribution of the evaporating liquid. Another object is to move or circulate the liquid in a given direction within the evaporator. A still further object is to utilize the activity of the evaporating liquid to effect the movement of the residual liquid and to spread the same as a thin film or coating upon the evaporating surfaces so as to augment the quantity of vapor released and to release the same in a continuous stream.

In carrying out the invention, I prefer to use a closed cycle system in which are provided suitable means to move and condense the vapor and to feed the condensate to the evaporator through a feeding device of any suitable or desired type. It is merely necessary that the gas and the liquid from the condenser be available, either mixed or separate, for feeding into the evaporator. The evaporator itself is of novel construction and combines means for forming and holding the refrigerant liquid in a state of froth or "emulsion" and for spreading a liquid film in heat absorbing relation with the refrigerator.

In order to illustrate the invention, concrete embodiments thereof are shown in the accompanying drawings in which:

Fig. 1 is a somewhat diagrammatic illustration of a simple form of the invention; and

Fig. 2 is a similar view showing a more practical and preferred arrangement.

In Fig. 1, A is the pump or compressor, B the condenser discharging through pipe *b* into the evaporator indicated generally at C, the latter being maintained under reduced pressure by a connection *c* to compressor A. These elements are connected together to form a closed cycle sytem and the compressor and the condenser may be of any suitable or desired type.

Inasmuch as the novelty of the present invention resides in the evaporator and in the process steps relating to vaporization of the refrigerant, detailed description of the same will now be given. The products of the condenser B (condensate, residual vapor and gas) are discharged into an inlet chamber 3 of restricted size which contains a quantity of the liquid refrigerant. While the gaseous and the liquid products of the condenser may be directed into the inlet chamber 3 separately, if desired, in the present instance they enter together through a single feed device 4 which may be a Venturi nozzle discharging slightly below the surface of the body of liquid refrigerant. Since the discharge is through a restricted orifice considerable velocity is acquired with the result that the liquid in chamber 3 is transformed into a frothy mass or "emulsion" which is arranged to overflow into a conduit 5 extending to a second chamber 6 which is connected by a pipe C directly to pump A. If desired, the conduit 5 may extend partly into and through chamber 3 and have a flared outer end enclosing the feeding nozzle 4, the better to direct the "emulsified" liquid through conduit 5. Conduit 5 may be arched or curved to provide an ascending portion 5*a* and a descending portion 5*b*. The velocity of movement of the frothy "emulsion" together with the action of pump A in reducing the pressure causes much of the liquid to vaporize.

As the vapor and the gas release themselves from the frothy mass, the residual liquid gathers as a film or dew upon the walls of the conduit 5 and drains down the descending part 5b into discharge chamber 6. A baffle 7 in the chamber prevents the liquid from pasing directly into discharge pipe c. The outlet chamber 6 is connected with inlet chamber 4 by a second conduit 8 which preferably extends beneath both chambers to form a liquid seal or trap. Through this conduit 8 the unevaporated liquid passes back to the inlet chamber 3.

In the form shown in Fig. 2 the evaporator is somewhat more elaborate but the operation is substantially identical. The gas and vapor withdrawn through pipe c' by pump A' are discharged at higher temperature and pressure into condenser B' and thereafter are fed through pipe b' and discharged through a suitable feeding device 4' into inlet chamber 3' of evaporator C'. The resulting frothy mass or "emulsion" overflows from chamber 3' and passes through the ascending conduit 9 (where heat is absorbed to vaporize the entrained liquid). It discharges into outlet chamber 6' which has a baffle 7' for preventing the liquid from passing directly into pipe C'. Conduit 10 extends from outlet chamber 6' as a descending member for returning the residual liquid to inlet chamber 3' and has at its lower portion a loop 10a to form a trap or liquid seal. Obviously the greater part of the vaporization takes place in the ascending conduit or coil 9 and this portion of the evaporator may be utilized for the freezing of liquids either by placing the conduit 9 in an insulated chamber (of a refrigerator indicated diagrammatically at X) or within a brine tank and disposing trays 11 containing the liquids to be frozen in thermal proximity thereto. The descending conduit or coil 10, which receives the residual liquid from the "emulsion" passing through conduit 9 in the form of a thin film upon its walls, conducts the same by gravity into trap 10a and thence into inlet chamber 3', the liquid film meantime receiving heat from the food compartment of refrigerator X and thereby becoming at least partly vaporized since it continues to be under the reduced pressure created by pump A'.

Both the process and the apparatus are available for commercial as well as domestic refrigeration since provision is made both for the making of ice and the cooling of food. Obviously little or no liquid refrigerant will be available for the descending coil 10' so long as the amount of evaporation in the ascending coil 9 is large, which results from much heat to be transformed, as when the system is first put into operation or when fresh water is put into the trays 11 to be frozen. As soon as the liquid is frozen and much less heat is taken into coil 9, the evaporation in this portion of the evaporator becomes relatively negligible and the descending coil 10 may become wet throughout with the bulk of the evaporation taking place in this portion of the evaporator. Since the liquid in conduits 5b and 10 is in the form of a film and the conduits are otherwise unrestricted, the vapor of the liquid passes away to pumps A or A' in a continuous stream. The continuous streams of liquid and vapor are indicated by solid and broken arrows respectively in both figures of the drawings.

The present invention modifies and improves previous and related inventions on the new principle of taking only a part of the refrigerator heat into the frothed or "emulsified" liquid and the rest of it into a film of liquid refrigerant formed and distributed by the activity of the emulsion and spread thinly over the extensive surfaces warmed by the refrigerator. This arrangement requires less work to be done on the liquid, and the liquid area in contact with the heated surface can be increased in better proportion to the contact area between the liquid and vapor. It is also evident that less weight of air or gas is required in a given time to produce and maintain the given contact areas. It is to be noted that this invention differs from that set forth in my copending application Serial No. 123,912, filed July 21, 1926, for processes of and apparatus for transforming heat in that the non-agitated or non-emulsified portion of the liquid is in the present invention spread out as a film and in that the stream of vapor formed by the evaporation of the film flows continuously to the pump and shows that the boundary between the vapor and the liquid streams is always free and extensive. This contrasts with my aforementioned application Serial No. 123,912 in which the non-emulsified liquid mass is required to boil and the released vapor must force its way out against liquid head and resistance, not in a continuous stream, but as irregular and occasional bubbles.

While the invention has been herein disclosed both as to its process and apparatus aspects in what are now considered to be preferred forms, it is to be understood that the invention is not limited to the specific details thereof but covers all changes, modifications, and adaptations within the scope of the appended claims.

I claim as my invention:

1. The process of refrigeration which comprises discharging liquid and gas under pressure into a chamber so as to form a frothy mass or emulsion, supplying heat at lower temperatures to said chamber, conducting the overflow from said chamber into an elongate vessel and supplying heat thereto to vaporize the liquid component of the emulsion, reducing the pressure in said vessel to effect release of a continuous stream of vapor, and

returning to said chamber the liquid not evaporated in said elongate vessel.

2. The process of refrigeration which comprises discharging liquid and gas under pressure into a chamber so as to form a frothy mass or emulsion, moving said emulsion toward a zone of continued low pressure to cause vaporization of the liquid component of the emulsion, disposing a portion of the liquid from the emulsion as a film to present a maximum of extended surface subjected to said low pressure, and returning the unvaporized portion of the liquid to said chamber.

3. Refrigerating apparatus providing a chamber containing evaporable liquid, means for discharging into said chamber additional liquid and a gas so as to form an "emulsion", a conduit for receiving the overflow from said chamber, means subjecting said conduit to suction pressure to effect vaporization of the liquid in said conduit, and a conduit also under suction pressure for receiving the liquid as a thin layer or film distributed thereon and for returning the unvaporized portion of such liquid to said chamber, said last-named conduit providing a liquid seal for said chamber.

4. Refrigerating apparatus of the closed cycle type comprising a compressor, a condenser, and an evaporator, said evaporator providing an inlet chamber connected to said condenser and an outlet chamber connected to said compressor, and conduits providing separate fluid paths between said chambers, one of said conduits providing an extended surface area and a liquid seal.

5. Refrigerating apparatus of the closed cycle type comprising a compressor, a condenser, an evaporator, said evaporator providing an inlet chamber connected to said condenser and an outlet chamber connected to said compressor, separate conduits interconnecting said chambers, one of said conduits extending beneath the lowermost of said chambers to provide a liquid seal, the connection from said condenser terminating as a nozzle within said inlet chamber for discharging a gas under pressure to produce an ascending column of emulsion or liquid froth in one of said conduits, the seal conduit serving as a return for any unvaporized liquid which separates out from the emulsion or froth and forms a film upon the latter conduit.

6. Refrigerating apparatus comprising an evaporator having ascending and descending parts, means for discharging into said evaporator beneath said ascending part an evaporable liquid and a gas to form an emulsion in said ascending part and a film of liquid over the walls of said descending part, means subjecting said evaporator to suction pressure, said descending part being in the form of a coil of pipe whose internal walls form an extended area and which terminates in a depressed portion or trap for returning to the vicinity of said discharge the liquid not evaporated in said ascending and descending parts.

7. Refrigerating apparatus of the closed cycle type operating on the vapor-gas principle having an evaporator providing an inlet chamber containing refrigerant liquid, means discharging a vapor-gas liquid stream into said liquid, an ascending conduit for the emulsion or froth overflowing from said chamber, receptacles for liquid to be frozen adjacent said conduit, an outlet chamber into which said conduit discharges, and a return conduit from said outlet chamber to said inlet chamber providing a liquid seal for the latter but otherwise unobstructed, the walls of said return conduit being wet with a film of residual liquid from said emulsion or froth, said return conduit being arranged for cooling the food compartment of a refrigerator cabinet.

Signed by me at Detroit, in the county of Wayne and State of Michigan this 19th day of July, 1928.

RANSOM W. DAVENPORT.