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REFRIGERATING SYSTEM

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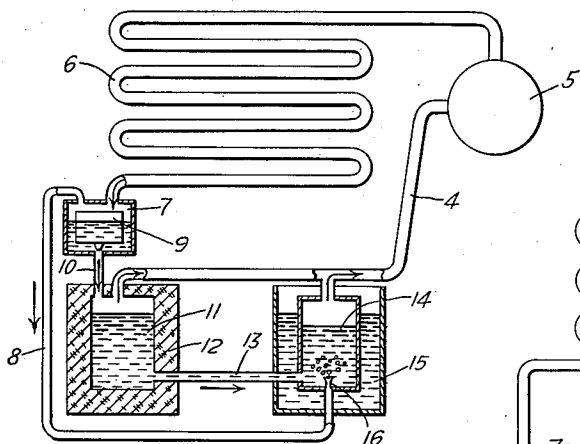


Fig. 1

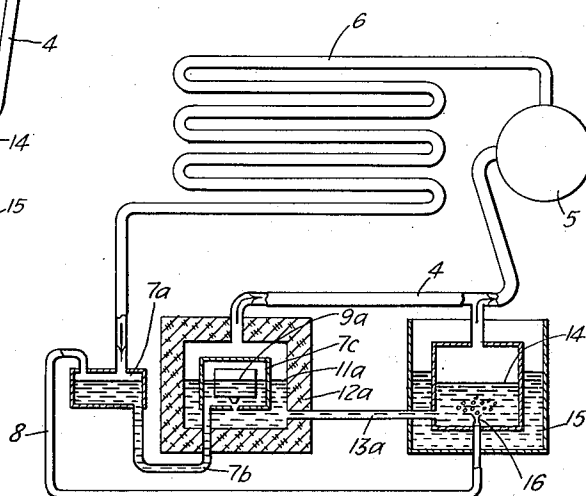


Fig. 2

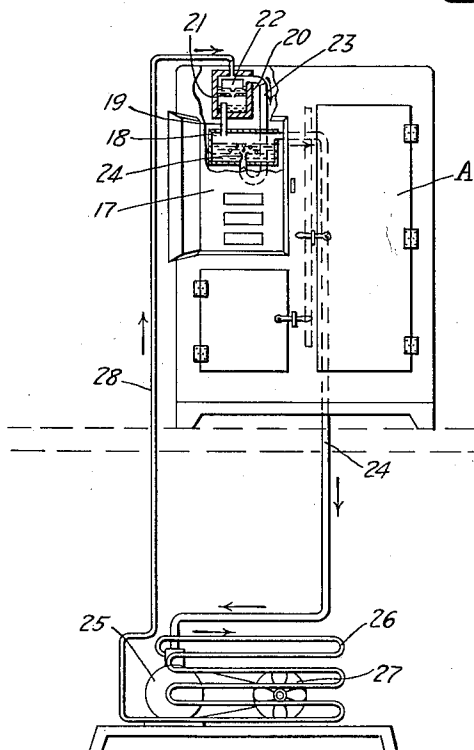


Fig. 3

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REFRIGERATING SYSTEM

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This invention relates to processes and apparatus for transforming heat with particular reference to refrigerating systems. More specifically it concerns refrigerating systems operating on the vapor-gas principle disclosed in my U. S. Patent No. 1,619,196 issued March 1, 1927.

Heretofore it has been proposed to utilize the vapor-gas principle for producing a variety of refrigerating temperatures in the same system, sometimes by providing a single evaporator taking heat from its surroundings at progressively higher temperatures as the top of the evaporator is approached, sometimes by providing one evaporator operating on the vapor-gas principle and another on the conventional Rankine cycle with both evaporators taking heat from the refrigerator but at different temperature levels.

Among the objects of the invention are to adapt the vapor-gas principle of refrigeration to the cooling of brine and other single temperature operations, and in general to effect improvements and economies in processes and apparatus for securing such functions.

The present invention differs from previously known arrangements, both of the vapor-gas and of the conventional type, particularly in that while a plurality of evaporators are involved in a single system, one of the evaporators (the straight pumping one) takes heat from the liquid refrigerant between its exit from the condenser and its entrance into the low temperature zone and the other evaporator takes heat from the substances to be cooled or frozen. This arrangement, therefore, is well adapted to cooling brine for freezing water or preserving ice cream or for other purposes in which it is requisite or desirable that the whole refrigeration take place at a single temperature.

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

Fig. 1 is a diagrammatic illustration of one form of the system;

Fig. 2 is a diagrammatic view similar to Fig. 1 showing a modified arrangement; and

Fig. 3 is a side elevational view partly in

section of a practical embodiment of the system.

All forms of the system herein disclosed for illustrative purposes are arranged to utilize the vapor-gas principle disclosed in my U. S. Patent 1,619,196 above referred to. Consequently, the refrigerant medium consists of a volatile liquid or liquefied gas and a substantially incondensable gas which is inert to and insoluble in the liquid or its vapor. Any suitable liquid may be selected. If a very low temperature is desired volatile liquids or liquefied gases having a low boiling point may be utilized, such as ammonia, sulphur dioxide and the like. If the desired temperature is only moderately low, and high operating pressures in the apparatus are to be avoided, liquids having a relative high boiling point may be chosen, such as the halogenated hydrocarbons including the ethyl and methyl chlorides.

While my improved process is susceptible of operation with systems of the open cycle type, it is preferable to operate on a closed cycle. In the arrangement disclosed in Fig. 1 vapor and gas withdrawn through connection 4 by a pump or compressor 5 are discharged at higher temperature and pressure into a suitable condenser 6 where heat is extracted, the contents of the condenser being discharged into a chamber 7 where the residual vapor and gas are separated from the condensed liquid. The vapor and gas pass off through a connection 8 while the separated and warm liquid under control of a feeding member, such as float valve 9, passes through connection 10 into a container 11 having insulated walls 12. Container 11 is maintained under suction pressure of pump 5 through connection 4 to effect cooling of the liquid contained therein by straight pumping. The cool liquid from container 11 passes through a connection 13 to evaporator 14 which contains a body of the volatile refrigerant liquid in thermal contact with a body of low freezing liquid 15, such as brine. The vapor and gas passing from separator chamber 7 through connection 8 are expanded through a suitable restricted opening, such as a Venturi nozzle 16, into the body of volatile

liquid in evaporator 14 so that the latter operates on the vapor-gas principle.

The refrigerating effects produced by the above arrangement are as follows: The liquid in container 11 is cooled to a temperature approximately corresponding with the total suction pressure. This cooling is made practically adiabatic by insulating the container or evaporator and no heat transfer is involved. The cool liquid then passes through connection 13 into the main evaporator 14 into which the vapor-gas expands through nozzle 16. Here the liquid is cooled to approximately the temperature corresponding with the partial vapor pressures obtaining in evaporator 14, although the vapor-gas mixture is withdrawn therefrom through pipe 4 at the same total pressure as from container 11. As the temperature thus obtained in evaporator 14 is lower than that obtainable in container 11, especially when high-boiling liquids are employed, and as the liquid which is fed to evaporator 14 has already been cooled considerably, a lower temperature may be maintained with a given total suction pressure that is possible with previously known arrangements when applied to single temperature work.

In the modified arrangement shown in Fig. 2, the separator chamber 7^a for the products of condenser 6 has no feed control device but has a trapped connection 7^b with a chamber 7^c disposed within the container 11^a which has insulated walls 12^a. Feeding of liquid from the interconnected chambers 7^a and 7^c is controlled by a float valve 9^a in chamber 7^c. With this arrangement it is apparent that the separated liquid has already given up some of its heat to the liquid in container or evaporator 11^a before it is fed into the latter through the operation of float valve 9^a. Once in container 11^a, the liquid is further cooled by the withdrawal of its vapor through pump connection 4 and this further cooled liquid passes through connection 13^a to the vapor-gas evaporator 14. By this arrangement the preliminary cooling of refrigerant liquid is under high-side pressure and heat transfer is involved.

In the practical arrangement disclosed in Fig. 3, there is a still further modification. This figure discloses a refrigerator cabinet A suitable for household use having therein a brine tank 17 for extracting heat from the interior of the cabinet. The brine tank has in its upper portion an evaporator 18 containing liquid refrigerant and connected by a pipe 19 to a container 20 for liquid having insulated walls. The upper portion of the container has a partition 21 with a port therethrough controlled by a float valve 22, the portion of the container above partition 21 serving as a separating chamber for the products of the condenser. A connection 23 leads from the top of the separating cham-

ber for conducting separated gas and vapor to an expansion or Venturi nozzle 24 so that evaporator 18 operates on the vapor-gas principle. Connection 19 between evaporator 18 and container 20 not only serves as an overflow for liquid in the latter but places container 20 under the suction pressure of the pump so that liquid therein is cooled through straight pumping. A second connection 24^a leads from the upper part of evaporator 18 to a pump or compressor 25 which may be mounted with condenser 26 and operating motor 27 as an apparatus unit and disposed at a distance from cabinet A, either above or below the latter. In the present instance the unit is indicated as disposed in the basement with a connection 28 leading from the condenser to the top of the separating chamber above float valve 22.

From the above, it will be apparent that the present invention is arranged to adapt refrigerating systems operating on the vapor-gas principle so as to produce the entire useful refrigerating effect at a single temperature, that this result is economically effected by cooling the warm condensate prior to its admission to the vapor-gas evaporator, that the pre-cooling of the liquid may be effected in stages by straight pumping, and that both the straight pumping for the preliminary evaporator and the greater refrigerating effect produced in the final or vapor-gas evaporator take place at the same total pressure produced by the pump or compressor.

While my improved process and apparatus for practicing the same have been herein disclosed 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. A refrigerating process utilizing as a working medium an evaporable liquid and a gas substantially inert to and insoluble in said liquid comprising withdrawing gas and the vapor of the liquid from above a body of the liquid, extracting heat from the gas-vapor mixture to condense the vapor, feeding the residual vapor-gas mixture and the warm condensate toward the body of vaporizing liquid, separating the gas-vapor from the condensate, cooling the condensate by evaporating it under reduced pressure of its own vapor only and substantially without access of heat from surroundings, feeding the cooled condensate to the body of liquid, expanding the vapor-gas mixture into said body while reducing the pressure above said body, and continuously repeating the above steps.

2. A refrigerating system utilizing as a working substance an evaporable liquid and a gas substantially inert to and insoluble in

the liquid comprising, a compressor, a condenser, and an evaporator, said evaporator containing a body of said liquid, means for feeding vapor, gas and liquid from said condenser to said evaporator, means for separating at least a part of the condensed liquid from the vapor and gas issuing from said condenser, and means for cooling said separated liquid adiabatically by withdrawing vapor therefrom before feeding the liquid to said evaporator.

3. A refrigerating system utilizing as a working substance an evaporable liquid and a gas substantially inert to and insoluble in the liquid, comprising, a compressor, a condenser, and an evaporator, said evaporator containing a body of said liquid, and means for feeding vapor, gas and liquid from said condenser to said evaporator comprising means for separating at least a part of the condensed liquid from the vapor and gas issuing from said condenser, a thermally insulated container for said separated liquid, a connection from said compressor to said container for withdrawing vapor of the liquid therefrom to cool the liquid, means permitting movement of the cooled liquid from said container to said evaporator, and means discharging the separated gas and vapor into said evaporator beneath the surface of the liquid therein to cause said evaporator to operate on the vapor-gas principle.

4. A refrigerating system utilizing as a working substance an evaporable liquid and a gas substantially inert to and insoluble in the liquid comprising, a compressor, a condenser, and an evaporator, said evaporator containing a body of said liquid, and means for feeding vapor, gas and liquid from said condenser to said evaporator comprising means for separating at least a part of the condensed liquid from the vapor and gas issuing from said condenser, a thermally insulated container for said separated liquid, a connection from said compressor to said container for withdrawing vapor of the liquid therefrom to cool the liquid, means permitting movement of the cooled liquid from said container to said evaporator, means discharging the separated gas and vapor into said evaporator beneath the surface of the liquid therein to cause said evaporator to operate on the vapor-gas principle, and a body of low freezing liquid in contact with said evaporator.

5. A refrigerating system utilizing as a working substance an evaporable liquid and a gas substantially inert to and insoluble in the liquid comprising, a compressor, a condenser, and an evaporator, said evaporator containing a body of said liquid, and means for feeding vapor, gas and liquid from said condenser to said evaporator comprising means for separating at least a part of the condensed liquid from the vapor and gas is-

suing from said condenser, a thermally insulated container for said separated liquid, a float device for controlling the feeding of liquid to said container, means utilizing said compressor to effect vaporization and consequent cooling of the liquid in said container, a connection from said container to said evaporator, and means utilizing both said compressor and the separated vapor and gas to effect absorption of heat by the liquid in said evaporator.

6. A refrigerating system utilizing an evaporable liquid and an inert gas comprising a compressor, a condenser, and an evaporator connected together to form a closed cycle system, said evaporator containing a body of said liquid, said system providing a chamber into which said condenser discharges for separating the residual gas and vapor from the condensed liquid, a thermally insulated container into which the condensed liquid is fed, a connection from said container to said evaporator, means utilizing said compressor to effect cooling of the liquid in said container, and means utilizing both said compressor and said separated vapor and gas to effect a still greater cooling of the liquid in said evaporator.

7. A refrigerating system utilizing an evaporable liquid and an inert gas comprising a compressor, a condenser, and an evaporator connected together to form a closed cycle system, said evaporator containing a body of said liquid, said system providing a chamber into which said condenser discharges for separating the residual gas and vapor from the condensed liquid, a connection from said chamber to the bottom of said evaporator for expanding the air and vapor into the body of liquid in said evaporator, a thermally insulated container for the condensed liquid, means controlling the feeding of the liquid from said chamber to said container, and connections from said container to said compressor and to said evaporator.

8. A refrigerating system utilizing an evaporable liquid and an inert gas comprising a compressor, a condenser, and an evaporator connected together to form a closed cycle system, said evaporator containing a body of said liquid, said system providing a chamber into which said condenser discharges for separating the residual gas and vapor from the condensed liquid, a connection from said chamber to the bottom of said evaporator for expanding the air and vapor into the body of liquid in said evaporator, a thermally insulated container for the condensed liquid, means providing for the feeding of liquid by gravity from said chamber to said container and thence to said evaporator, and a connection from the top of said container to said compressor to effect cooling of the liquid in said container by straight pumping.

9. A refrigerating system utilizing an evaporable liquid and an inert gas comprising a compressor, a condenser, and an evaporator connected together to form a closed cycle system, said evaporator containing a body of said liquid, said system providing a chamber into which said condenser discharges for separating the residual gas and vapor from the condensed liquid, a connection from said chamber to the bottom of said evaporator for expanding the air and vapor into the body of liquid in said evaporator, a thermally insulated container for the condenser liquid, means providing for the feeding of liquid by gravity from said chamber to said container and thence to said evaporator, a float device controlling the feeding of liquid from said chamber to said container, and a connection from the top of said container to said compressor to effect cooling of the liquid in said container by straight pumping. 70
10. A refrigerating system of the closed cycle type utilizing as a working medium a volatile liquid and an inert gas comprising a compressor, a condenser, and an evaporator, means for separating the condensed liquid from the gas and vapor issuing from said condenser, means for feeding the liquid by stages to said evaporator, means for cooling said liquid without access of heat from surroundings during one of the stages by vaporizing a portion of the same through the action of said compressor, and means for expanding the separated gas and vapor into said evaporator to cause the latter to operate on the vapor-gas principle. 75
11. A refrigerating system of the closed cycle type utilizing as a working medium a volatile liquid and an inert gas comprising a compressor, a condenser, and an evaporator, means for separating the condensed liquid from the gas and vapor issuing from said condenser, means for feeding the liquid by stages to said evaporator, means for cooling said liquid without transfer of heat from surroundings during one of the stages by vaporizing a portion of the same through the action of said compressor, a body of brine in thermal contact with said evaporator, and means for expanding the separated gas and vapor into said evaporator to cause the latter to operate on the vapor-gas principle. 80
12. In a refrigerating system of the closed cycle type utilizing an evaporable liquid and an inert gas, a plurality of evaporators containing the liquid, means for reducing the pressure in said evaporators to cause the liquid therein to vaporize and arranged to operate one of said evaporators by straight pumping and another evaporator on the vapor-gas principle, means for insulating the first evaporator against access of heat from surroundings, and means for feeding cooled liquid from the first evaporator to the second evaporator. 85
- Signed by me at Detroit, in the county of Wayne and State of Michigan this 17 day of November, 1927. 90
- RANSOM W. DAVENPORT. 95
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