June 24, 1930. B. H. COFFEY 1,765,657

ART OF REFRIGERATION

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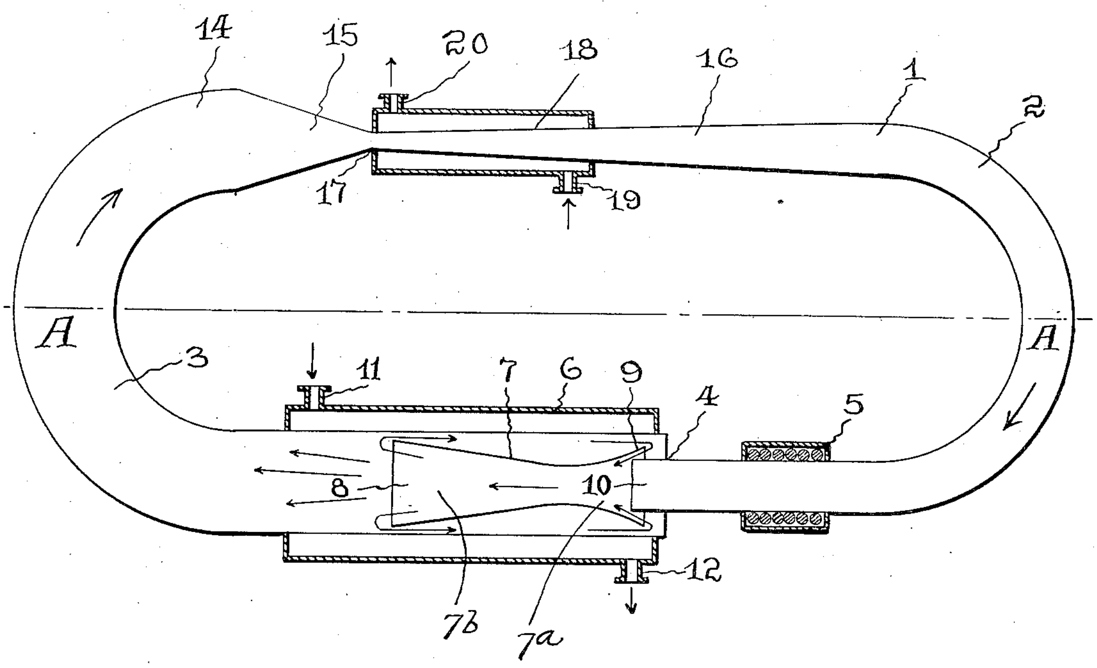

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ART OF REFRIGERATION

Application filed December 21, 1925. Serial No. 76,697.

My invention is for an improvement in the art of refrigeration and relates more particularly to means for circulating and condensing the refrigerant.

This invention is complementary to my invention disclosed in my Letters Patent No. 1,565,795, dated December 15, 1925.

The objects of my invention are to provide a means for circulating the refrigerant without piercing the walls of the container or conduit to supply the net negative work of the refrigerating cycle and to provide a suitable and efficient condenser system.

It is of course understood that the circulating means of this application may be substituted for the circulating means shown in each of the various modifications illustrated in my copending application above referred to.

The preferred form of my invention is illustrated in the accompanying drawing, in which

The figure is a diagrammatic sectional elevation of a refrigerating system, in which I show my forcing circulating and condensing devices, referred to a horizontal plane A—A, for purposes of clearer exposition, but which is not intended to be the preferred operating position.

Similar characters of reference refer to similar parts.

The refrigerating system includes a closed conduit, consisting substantially of two sections 2 and 3 shown of different diameters, to simplify the drawing and specification. The smaller section 2 projects into the larger section 3 at point 4. Each section is substantially U-shaped and the legs thereof are respectively joined so that a closed conduit 1 results. A liquid refrigerant such as carbonic acid, ammonia or sulphur dioxide is placed in the conduit, filling it to some such height as the line A—A. The air in the conduit is expelled and the vapor of the liquid refrigerant will fill this space. A uniform pressure corresponding to its temperature will then exist in the system while the liquid is at rest. At some determined point and preferably on the lower leg of the smaller section 2 is mounted a heater 5 whereby the liquid refrigerant may be heated.

On the lower leg of the larger section 3 a combined condenser and circulator comprising surface and jet cooling elements and a forcing element is mounted. It extends along the greater part of the lower leg in contact therewith, the length depending upon the amount of surface cooling required. Pipe connections 11, 12 are provided so that a continuous flow of cooling water may be maintained thru the condenser jacket 6.

The end of the lower leg of section 2, as above noted, projects axially into the larger section 3 forming a mouth 10. A converging-diverging nozzle 7 comprising a combining nozzle 7^a and a forcing nozzle 7^b is supported concentrically within the walls of the leg 3 within the area acted upon by the water jacket 6.

The upper leg 14 of section 3 has an expanding nozzle 15, the end of which joins the compressing nozzle 16 of the upper leg of section 2 at the throat 17, of any preferred shape.

Surrounding or in contact with the outside surface of the diverging nozzle 16 is a brine cooler 18 with inlet and outlet pipe connections 19, 20 whereby brine may be circulated thru the cooler in the directions indicated by the arrows; any other source of low temperature heat, as direct expansion, will satisfy the requirements of the cycle equally well.

In operation, the heater 5 and cooling water are started. The pressure and temperature are equal in each section and the refrigerant is thermally and statically balanced. As heat is added to the refrigerant, evaporation occurs and vapor bubbles are formed. These bubbles will pass from heater 5 in opposite directions at low velocity both toward the condenser and toward the upper leg 16 of section 2; and those moving toward the condenser will collapse as they come into contact with the cold refrigerant which has been cooled by the water in the condenser jacket at this point. The condensed vapor resulting from the collapse of the vapor bubbles will, however, retain its kinetic energy of motion and as it passes thru nozzle 7 will be transformed from low velocity and low pressure to lower velocity and higher pressure. As the vapor bubbles pass from the mouth 10 of section 2 and suddenly collapse as above stated, an area of low pressure will be created. Liquid refrigerant which has been cooled by the water in the condenser jacket 6 will rush into this area of low pressure from the rear end 9 of the nozzle 7, as indicated by the arrows. Thus there will be set up in the lower leg of section 3 a continuous circuit of liquid refrigerant entering the end 9 of the nozzle 7 and emerging from end 8. Part of this liquid will flow back between the nozzle 7 and the inner surface of the wall of lower leg 3 toward the area of low pressure, cooling in transit before it again enters nozzle 7 thru end 9. The water jacket 6 is made large enough so that the liquid refrigerant within the condenser may be kept at a constant low temperature. As the heater 5 reaches its highest constant temperature, vapor bubbles will form rapidly and leaving the mouth 10 at high velocity and low pressure will meet the recirculating current of high pressure cold refrigerant in the combining nozzle 7^a, as explained above. The intimate contact of the mixing currents will instantaneously condense the vapor with consequent contraction thus maintaining the inflow of cold refrigerant. The kinetic energy within the vapor, after condensation, is transferred to the liquid particles of the condensate, the velocity of which on being lowered in the diverging forcing nozzle 7^b will cause a pressure rise progressively increasing as the area of passage increases and velocity diminishes, thus forcing part of the refrigerant thru section 3 and up to the converging nozzle 15. The jacket 6 extends beyond the end of nozzle 7 and therefore the refrigerant which flows thru section 3 will be further cooled and will therefore reach the nozzle 15 at a lower temperature than that which exists in the nozzle 7. This action is in effect that of the injector in which steam and water mix in converging-diverging nozzles.

As the refrigerant passes thru the expanding nozzle 15 the velocity will be increased with consequent decrease in pressure and temperature. At the end of the nozzle 15 a brine cooler 18 is located thru which brine is circulating in the direction of the arrows. Heat will be absorbed by the refrigerant from the brine as the refrigerant flows thru the brine cooler. Having absorbed heat the refrigerant flows on thru the compressing nozzle 16. The velocity of the refrigerant is here decreased and its pressure and temperature are increased. Since pressure is built up in the section 3 in excess of the pressure formed by the expansion of the vapor at heater 5 by reason of the nozzle 7, and as there is no means to build up such excess pressure in section 2, it is evident that the refrigerant flowing through section 3 and into nozzle 16 in a clockwise direction will have greater pressure than the refrigerant which starts to flow counter-clockwise from the heater 5 when starting the apparatus and therefore the clockwise flow of refrigerant will entrain the vapor bubbles in section 2 and carry them back with it to the heater 5, thus completing a cycle. As long as the heater 5 and the condenser 6 are in operation the refrigerant will continue to flow through the above defined cycle. After normal operation begins, the clockwise velocity becomes so high that all bubbles formed at heater 5 flow clockwise toward the condenser.

Having thus described my invention what I claim is:

1. In a refrigerating system the combination of a closed and unbroken conduit having a refrigerant of mixed vapor and liquid therein, an expanding nozzle, a compressing nozzle, said nozzles being joined in said conduit, a brine cooler in contact with said expanding nozzle, means to impart heat energy to said refrigerant and means to transform said heat energy into kinetic energy at high pressure.

2. In a refrigerating system the combination of a closed and unbroken conduit having two sections of unequal diameter at contiguous end portions, a condenser in contact with the larger of said end portions, the smaller of said end portions projecting within the larger of said sections to form a mouth, a nozzle in the larger of said sections surrounding said mouth and a brine cooler in contact with said conduit.

3. In a refrigerating system, a conduit having a condenser therein, said condenser having a jet condensing element and having a surface condensing element surrounding said jet condensing element whereby heat may be abstracted from a hot fluid by the jet element and transferred to a cold fluid by the surface element.

4. In a refrigerating system, a circulator comprising a heating element, a forcing element and a condenser, said condenser having a jet condensing element and a surface condensing element surrounding said jet condensing element and in cooperative relation therewith.

5. In a refrigerating system of the character described, an endless conduit having a liquid refrigerating medium therein, means to impart kinetic energy at high velocity and low pressure to said liquid refrigerating medium, means to transform said kinetic energy at high velocity and low pressure to low velocity and high pressure, and means to impart heat to said medium.

6. In a refrigerating system of the character described, an endless conduit containing a refrigerant liquid and refrigerant vapor,

means to impart kinetic energy at high velocity and low pressure to said refrigerant, means to transform said kinetic energy at high velocity and low pressure to kinetic energy at low velocity and high pressure, means to absorb heat from said refrigerant at said low velocity and high pressure, and means to impart heat to said refrigerant.

7. In a refrigerating system of the character described, an endless conduit containing a liquid refrigerant, means to impart kinetic energy at high velocity and low pressure to said liquid refrigerant, means to transform said kinetic at high velocity and low pressure to kinetic energy at low velocity and high pressure, means to absorb heat from said liquid refrigerant at said low velocity and high pressure, means to decrease the temperature of said liquid refrigerant, and means to impart heat to said liquid refrigerant at said decreased temperature.

8. In a closed circuit refrigerating system, a circulator comprising a heating element, a forcing element and a jet condensing element adapted to act upon a refrigerant contained therein, in combination with a surface condensing element surrounding the jet condensing element, acted upon by cooling means.

In testimony whereof I affix my signature.

BARTON H. COFFEY.