

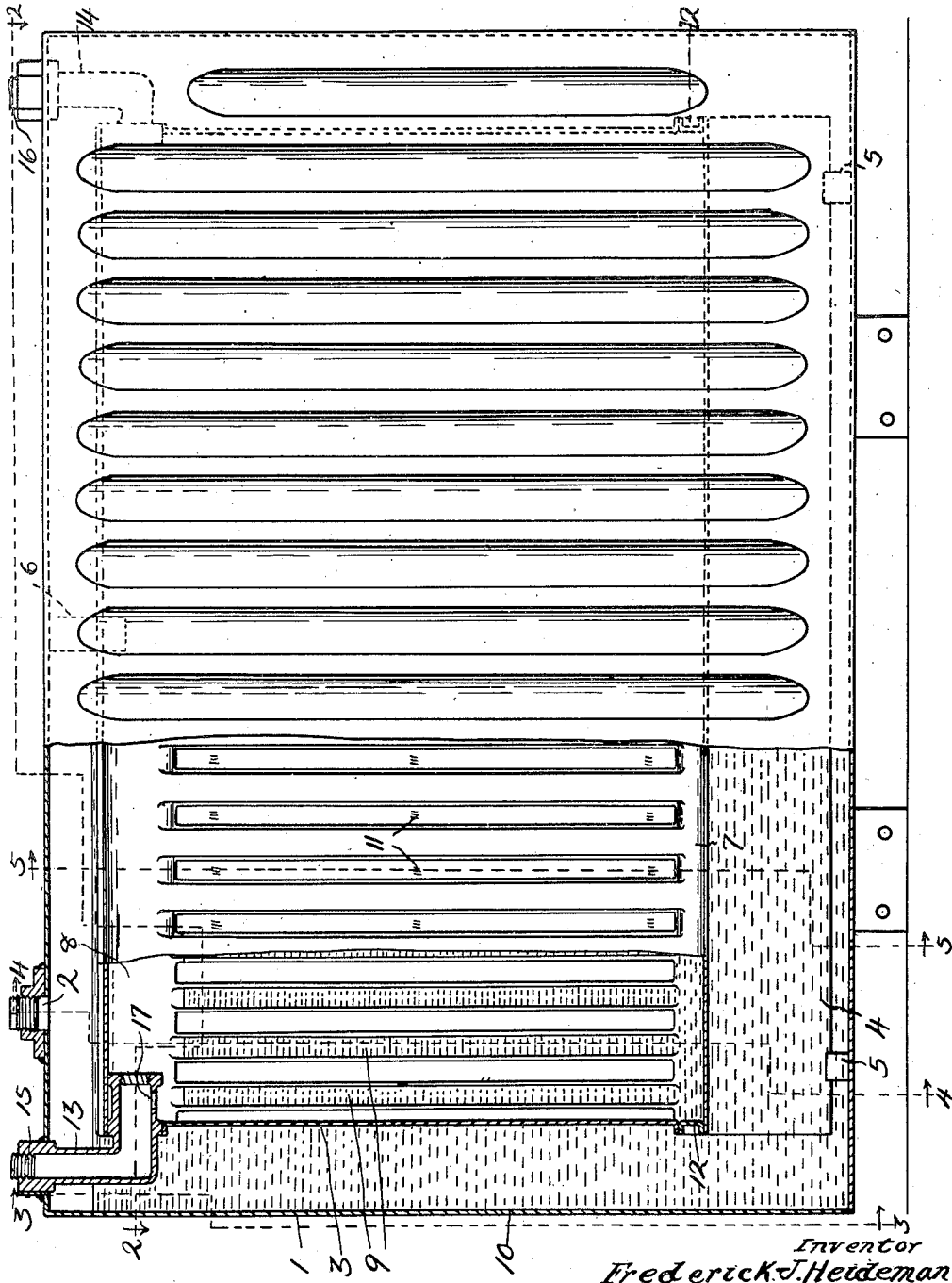
Nov. 6, 1934.

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1,979,617

MECHANICAL REFRIGERATION UNIT

Filed March 22, 1933 . 3 Sheets-Sheet 1



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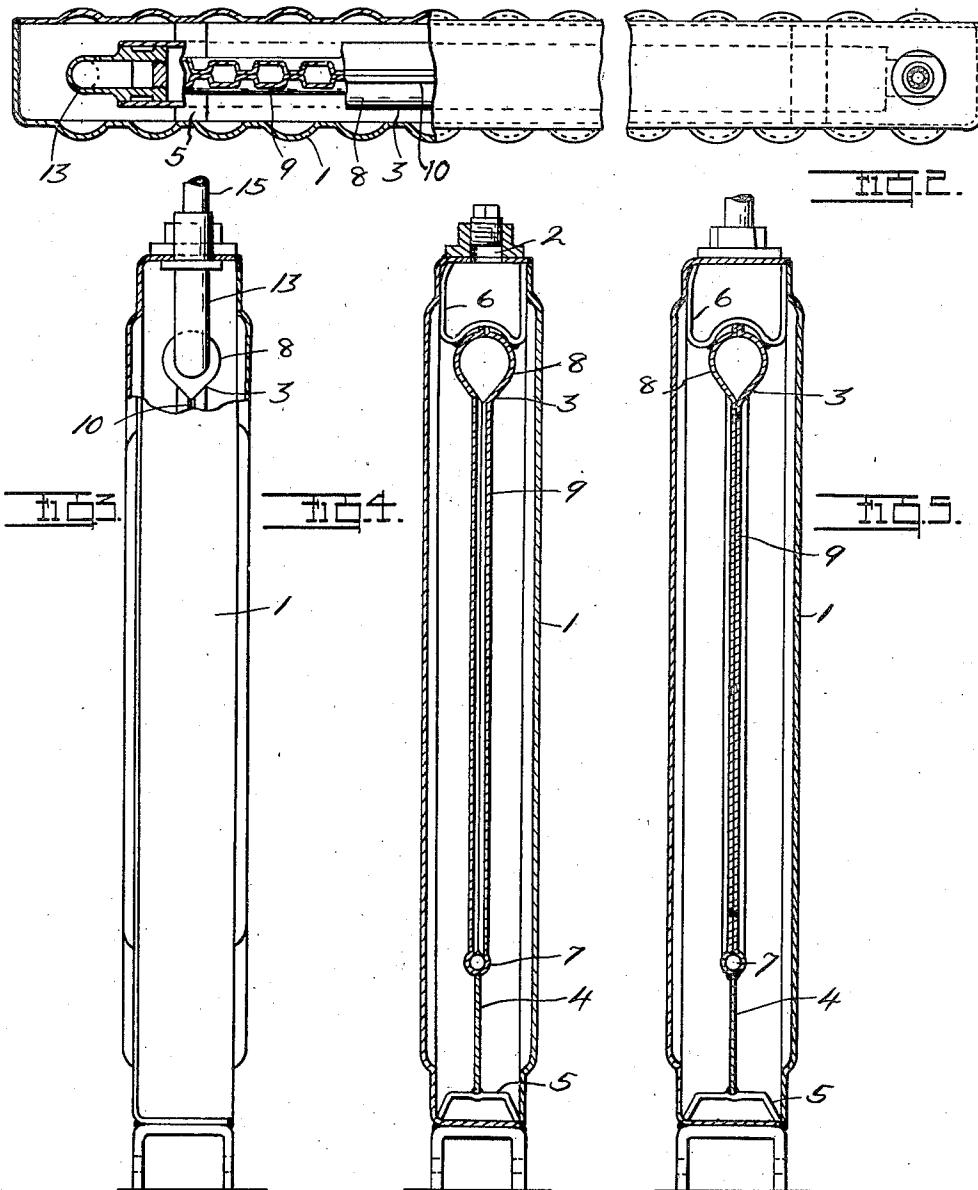
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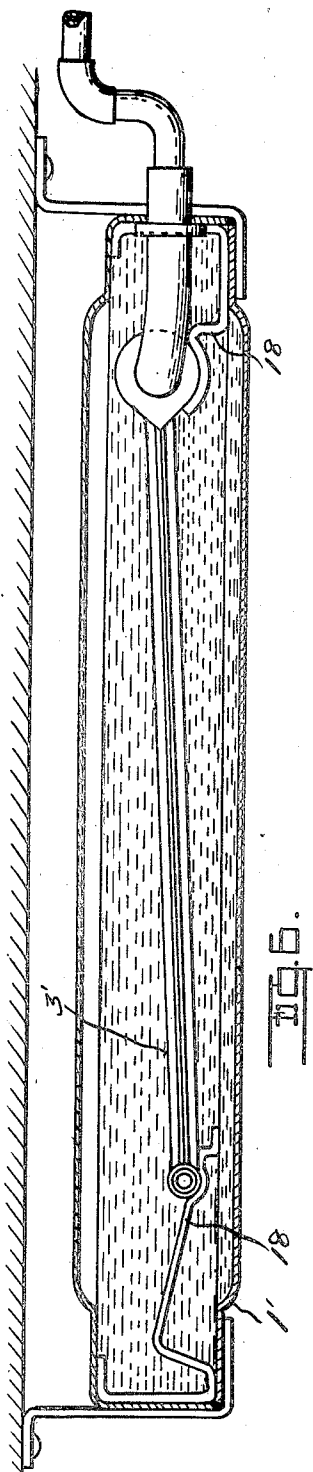
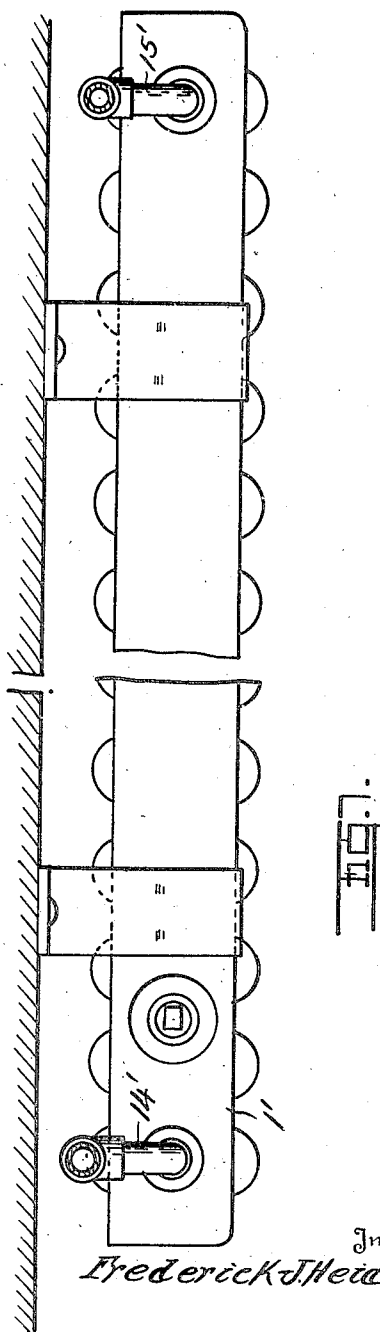
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

1,979,617

MECHANICAL REFRIGERATION UNIT

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Application March 22, 1933, Serial No. 662,128

9 Claims. (Cl. 62—126)

This invention relates to mechanical refrigeration, and particularly to heat absorption units in which submergence of an evaporator in a suitable liquid serves to store and prolong the refrigerative effect.

It has been recognized that submergence of an evaporator in a normally liquid medium characterized by a high latent heat and a suitably low freezing point, and properly proportioned in volume to said evaporator, adapts the evaporator to effect a large withdrawal of heat from said liquid, as it freezes, and correspondingly permits a large heat absorption by said medium when it again liquefies, and it has been further recognized that such an arrangement can be advantageously employed to maintain a uniform refrigerant action over a considerable period of time with minimum wear of moving parts, while further permitting electrical energization of said parts during low demand hours, when the expense is a minimum.

Constructions of this character are herein termed "stored refrigeration units" and to the operation of withdrawing heat from such constructions, the term "charging" is herein applied.

In prior units of stored refrigeration, the power consumption in charging, has been unduly high, owing to the comparatively slow rate of heat withdrawal from the submerging liquid, and for some purposes it has not been convenient or practical to prolong charging to the extent necessary to establish a desired cooling capacity.

Thus for example, if a truck of large load capacity requires storage of refrigeration for its full load and for a run of long duration, the unit or units furnishing such refrigeration must be of large capacity, and the overnight period within which said unit or units may be most conveniently and economically charged has not heretofore been adequate.

An object of the invention is to provide an improved unit of stored refrigeration of the submerged evaporator type, adapting the submerging liquid to yield up its heat units at a greatly increased rate, and thus materially decreasing the requisite charging period, as compared to present practice.

Another object is to so construct an evaporator of the submerged type and to so arrange it within a container for the submerging liquid, that the entire surface of the evaporator is fully effective throughout charging to withdraw heat from said liquid.

Charging of a stored refrigeration unit ordinarily involves a complete freezing of the body of eutectic solution which submerges the evap-

orator and refrigerant use of the unit involves a gradual melting of said body. This melting is downwardly progressive, and while it is desirable to elevate the evaporator in the submerging liquid, it is not desirable to confine a frozen portion of said liquid beneath the evaporator, since such portion may contact a warmer region in the liquid by floating to the surface.

It is a further object of the invention to adapt an evaporator to form a partition in the submerging liquid, and to present to said liquid large continuous areas of contact, and to permit a frozen lower portion of the liquid, subsequent to melting of the upper portion thereof, to rise to the surface in blocks separated by the evaporator.

A further object is to position an immersed evaporator in the upper part of a container for the immersing liquid to compensate for heat rise in said liquid, and to extend downwardly from the evaporator throughout its length a metal plate, forming with the evaporator a partition between large portions of said liquid.

A further object is to establish a highly heat conductive rigid joint between the evaporator and said plate, whereby the latter facilitates heat withdrawal from the liquid underlying the evaporator, and to further utilize said plate for properly positioning the evaporator in the container.

A further object is to maintain a circulation space between said plate and the bottom of the container for the submerging liquid, so that a differential heat absorption by said liquid at opposite sides of the evaporator, may be compensated by a flow through said space.

A further object is to provide elements lending themselves to a rapid assembly for engaging the lower edge of said plate and the top portion of the evaporator to hold the latter properly positioned without reducing the large effective heat-absorbing area of the evaporator.

A further object is to safeguard the evaporator against accumulation in the tubes thereof of such lubricant as circulates with the refrigerant, to prevent diminution of the lubricant delivery to the compressor and to avoid increased resistance to refrigerant vaporization in the evaporator due to surface tension of lubricant accumulations.

These and various other objects the invention attains by the construction hereinafter described and illustrated in the accompanying drawings, wherein:

Fig. 1 is a side elevational view of the improved unit in partial section.

Fig. 2 is a top plan view of the same in partial section on the line 2—2 of Fig. 1.

Fig. 3 is an end elevation in partial section.

Fig. 4 is a vertical cross sectional view, taken upon the line 4—4 of Fig. 1.

Fig. 5 is a vertical cross sectional view, taken upon the line 5—5 of Fig. 1.

Fig. 6 is a cross sectional view of a modification of the unit, designed for use in a horizontal position.

Fig. 7 is an end view of the same.

In these views, the reference character 1 designates a sheet metal container for a liquid of low freezing point and high latent heat value, preferably an eutectic solution. Said container preferably has a height and length considerably exceeding its thickness, and has in its top a normally plugged opening 2 for filling purposes.

Submerged in said liquid is an evaporator 3, which also has a length and width largely exceeding its thickness, and presents to the submerging liquid uninterrupted side faces of large area. The evaporator is disposed substantially midway between the side walls of the container 1 and is raised well above the bottom of the latter, being spaced a lesser distance from the ends and top of the container.

Rigidly secured to the bottom of the evaporator and preferably continuously welded to the latter is a vertical metal plate 4 which extends adjacent to the container bottom, but is held above the latter by a number of arched positioning members 5 which extend between the container side walls and are formed midway between said walls with shallow channels (see Figs. 4 and 5) within which the plate 4 is welded. At its top, the evaporator is engaged by several positioning members 6 of a substantial U-shape, and engaging the sides and top of the container 1. Preferably said members 6 are welded to the evaporator.

The evaporator is formed of sheet metal and preferably of a single metal sheet, folded on itself to form mating halves. Said sheet is fashioned at its fold to form a tubular chamber 7 and said halves are correspondingly marginally indented, remote from said fold, to jointly form an elongated tubular chamber 8 of considerably greater diameter than the chamber 7. A plurality of tubes 9 interconnecting the chambers 7 and 8 are also formed jointly by said mating halves, through correspondingly indenting said halves. The chambers 7 and 8 extend respectively along the bottom and top of the evaporator, when the unit is assembled, the tubes 9 vertically connecting said chambers.

At the ends and top of the evaporator the mating halves thereof have contiguous edge portions 10 between which a welded or other fluid sealed connection is established throughout their length.

The mating halves of the evaporator make contact between the tubes 9, but it is not essential that this contact be of a fluid-sealing character. Therefore this contact is maintained only by spot welding at suitable points, as is indicated at 11. The welds 11, as shown, are established at several points in each alternate one of the channels formed between the tubes 9.

The extremities of the passage 7 are closed in any suitable fluid-sealed manner, as by welding or otherwise rigidly securing plugs 12 in said ends.

In the ends of the chamber 8 are inserted hollow L-shaped fittings 13 and 14 which terminally

project through the top of the container 1 for respective engagement by a liquid refrigerant delivery pipe 15 and a gaseous refrigerant outlet pipe 16. Said fittings are welded or otherwise fluid sealed, both to the ends of the evaporator and the top of the container 1.

The fitting 13 projects sufficiently into the chamber 8 to overlie the tube 9, nearest to said fitting, this projecting portion being terminally closed at 13a and formed with an outlet 17 opening downwardly into said tube. The fitting 14 opens into the chamber 8 axially thereof.

Preferably the side walls of said container are vertically corrugated to increase their strength and heat transfer area.

In use of the described unit, the container 1 is substantially filled with a liquid of low freezing point and high latent heat value, preferably a eutectic solution, leaving only adequate clearance for such expansion as said liquid must undergo, upon freezing.

The pipes 15 and 16 are connected respectively to the liquid line and suction line of an ordinary mechanical refrigeration system.

In charging the unit, there occurs a continuous evacuation of gas from the chamber 8 with resultant boiling and further gasification of the refrigerant in the evaporator. Heat is thereby withdrawn from the submerging liquid which is eventually reduced in temperature to its freezing point or lower. As the solution solidifies, it gives off its latent heat, and since the liquid employed has a high latent heat value, solidification of said liquid involves a very large withdrawal of heat by the refrigerant.

The charging operation is completed upon the submerging liquid being completely frozen, the unit then being ready for refrigerative use.

In such use, heat is gradually absorbed by the frozen body, effecting a gradual melting thereof. Because of the high latent heat value of said body, its absorption of heat in the process of melting will be large, and hence its capacity for refrigeration per unit of volume will be large. The unit is designed to receive a definite volume of the eutectic solution (or other submerging liquid), and such volume together with the external area of the unit predetermines the cooling capacity.

The large continuous lateral surfaces of the described evaporator lend themselves to a rapid absorption of heat from the submerging liquid, and charging of the unit is further greatly expedited by the fact that heat absorption by this evaporator proceeds uniformly and continuously at all contact points of the liquid with said surfaces. As compared to units employing evaporators of a coiled or tortuous tube type, the described unit is capable of charging approximately eight times faster.

The formation of the described evaporator from a single sheet of metal with the halves thereof jointly forming the several communicating refrigerant chambers, permits very economical quantity production of said evaporator, and secures the further advantages of large surface areas for contact with the submerging liquid, and of giving the evaporator the nature of a partition, at each side of which blocks of the frozen liquid may rise to the surface of said liquid.

The described provision for positioning the evaporator in the container lends itself to rapid assembly as well as to accuracy of such positioning. Attachment of the positioning members 5 and 6 to the evaporator prior to final assembly and avoidance of attachment of said members to

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the container 1 simplifies the construction and expedites assembly.

Arrangement of the described inlet fitting 13 so that the incoming refrigerant is all directed into the adjacent endmost tube 9 is a feature of importance in avoiding undue accumulation in the evaporator of such lubricant as is carried by the circulating refrigerant, this being particularly true when the chamber 8 is flooded. The incoming refrigerant and lubricant are compelled by the described arrangement to travel downwardly through the endmost tube 9, flowing together through the tube 7 to the outlet end of the evaporator, where the lubricant may rise to the outlet 14, when any liquid discharge takes place. If the incoming flow were not thus downwardly diverted, said flow, during flooding of the chamber 8 would be longitudinal of said chamber directly from the inlet to the outlet, with a possibility of the lubricant settling and accumulating in the tubes 9, if at all heavier than the refrigerant.

In the modification shown by Figs. 6 and 7, the evaporator 3' and container 1' are constructed as already described, but the evaporator occupies a diagonal relation to the horizontally disposed container, establishing the chamber 8 at a somewhat higher level than the chamber 7. This insures that substantially the entire evaporator will occupy a lower level than its inlet and outlet so as to maintain flooding of the tubes 9' and chamber 7', and further insures that the vaporized refrigerant will travel, through its own buoyancy to the chamber 8.

The evaporator is held in the desired inclined position by a plurality of metal straps 18 welded (or otherwise rigidly engaged) with the chambers 7 and 8, and fashioned to bear upwardly, downwardly, and endwise upon the container walls.

Eutectic solutions best suited for use in the container 1 will be those having latent heat values between one hundred and nineteen B. t. u.'s per pound and one hundred and thirty nine B. t. u.'s per pound, and having freezing points between negative twenty degrees F. and twenty-eight degrees F.

While the illustrated embodiment of the invention is well calculated to adequately fulfill the objects and advantages primarily stated, it is to be understood that the invention is susceptible to variation, modification and change within the spirit and scope of the subjoined claims.

What I claim is:

1. A mechanical refrigeration unit comprising a container having a length and height largely exceeding its width, a liquid in said container characterized by a low freezing point and a high latent heat, an evaporator substantially submerged in said liquid within said container, and having substantially unbroken side faces spaced from the sides of said container, and a plate engaging said evaporator and extending substantially from end to end of the evaporator, and projecting downwardly from the evaporator, in substantial parallelism with the sides of said container.

2. A mechanical refrigeration unit as set forth in claim 1, said plate being spaced from the bottom of said container to afford a cross flow of the submerging liquid beneath said plate.

3. In a mechanical refrigeration unit as set forth in claim 1, positioning means for said evaporator engaging said plate.

4. In a mechanical refrigeration unit as set forth in claim 1, positioning means for the evaporator engaged beneath said plate at spaced points thereof and holding said plate spaced above the bottom of the container to provide for a cross flow of the submerging liquid.

5. In a mechanical refrigeration unit as set forth in claim 1, positioning means for the evaporator engaging the lower portion of said plate and coacting positioning means engaging the top face of the evaporator.

6. An evaporator comprising an upper elongated chamber, a lower elongated chamber, a plurality of tubes connecting said chambers, and means for delivering a refrigerant to one end of said upper chamber and withdrawing it from the other end of said upper chamber, said delivery means being fashioned to direct the refrigerant into the tube nearest to the inlet end of said upper chamber.

7. A mechanical refrigeration unit comprising a closed container having substantially parallel side walls, a liquid in said container characterized by a low freezing point and a high latent heat, an evaporator substantially submerged within said liquid and having side faces spaced from the side walls of the container, said evaporator being also spaced from the top and bottom of the container, and a plate engaging and extending substantially from end to end of the evaporator, and projecting downwardly therefrom, said evaporator and plate being substantially imperforate from side to side thereof, whereby they offer a minor resistance to flotation of portions of said liquid frozen against opposite sides of the evaporator and plate.

8. An evaporator comprising an elongated upper chamber, an elongated lower chamber, a plurality of tubes connecting said chambers, a refrigerant inlet fitting projecting into the upper chamber at one end thereof, longitudinally of said chamber, and having an outlet above and facing one of said tubes, the upper chamber having an outlet for gaseous refrigerant.

9. A mechanical refrigerating unit comprising a liquid-sealed container, a liquid in said container characterized by a low freezing point and a high latent heat, an evaporator substantially submerged within such liquid, and spaced from the walls and top and bottom of the container, and members for maintaining the specified position of the evaporator rigidly connected to the evaporator at its top and bottom and projecting upwardly, downwardly, and laterally from the evaporator and engaging said container to position the evaporator both vertically and horizontally relative to said container.

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