Aug. 22, 1950 H. G. MOJONNIER 2,519,844

COOLING TANK

Filed May 3, 1946 2 Sheets-Sheet 1

Fig. 2.

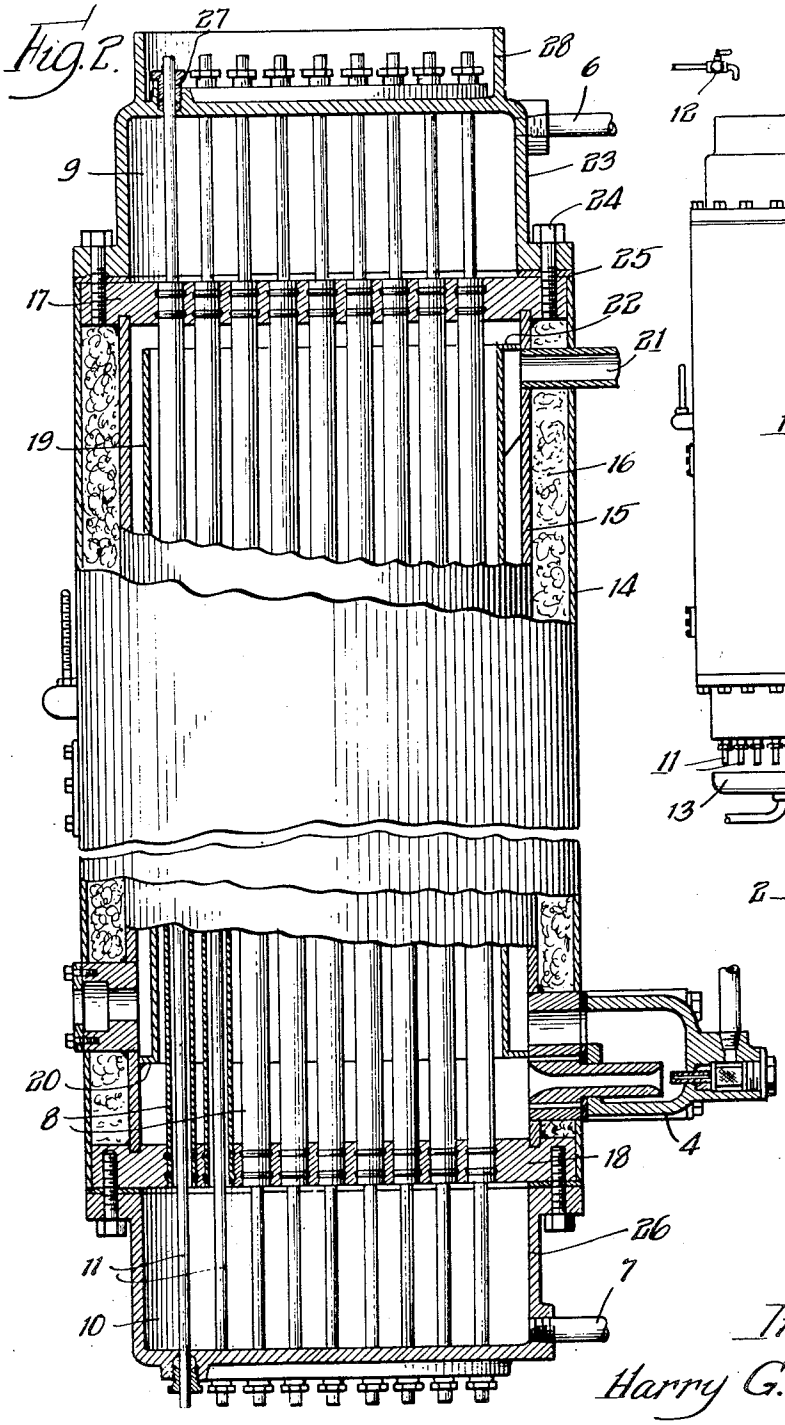
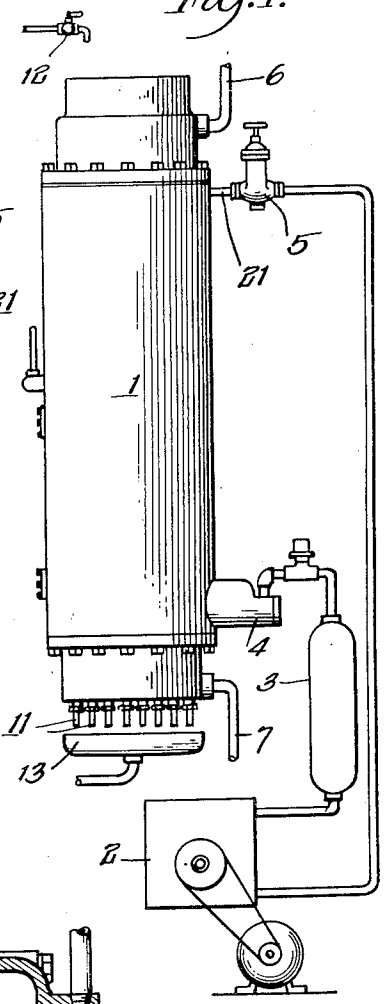


Fig. 1.



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Fig. 3.

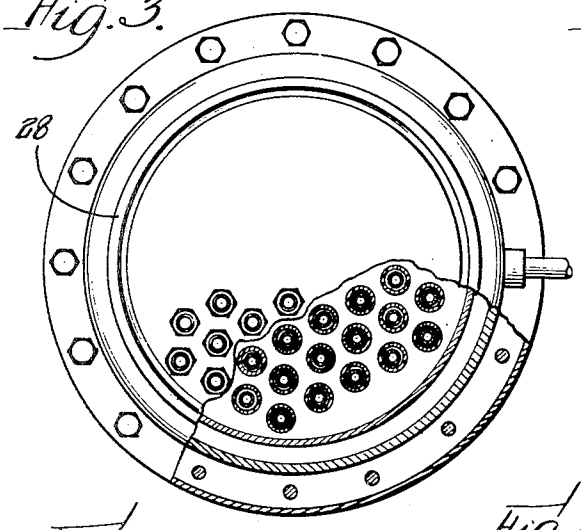


Fig. 4.

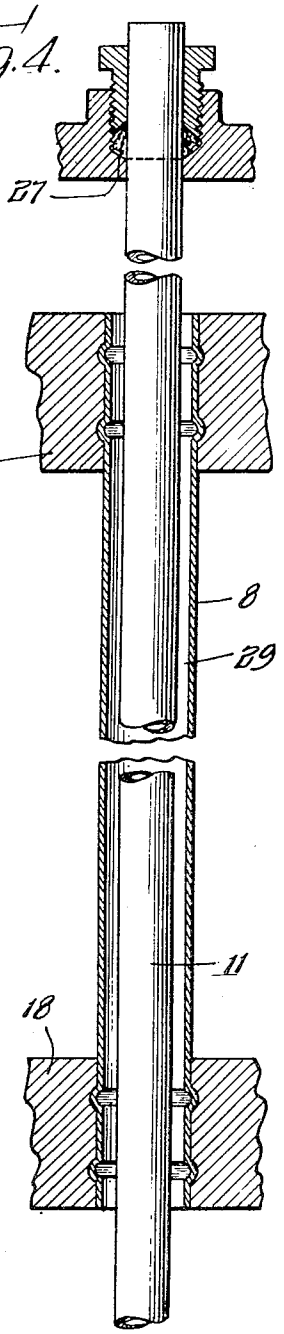


Fig. 7.

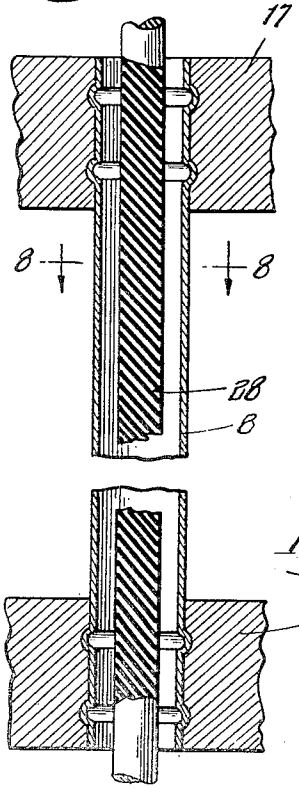


Fig. 5.

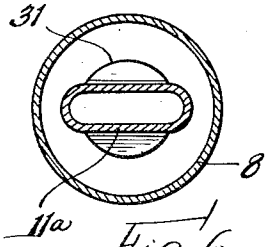


Fig. 6.

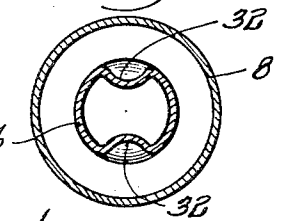
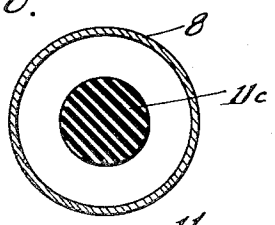


Fig. 8.



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2,519,844

COOLING TANK

Harry G. Mojonnier, Oak Park, Ill.

Application May 3, 1946, Serial No. 667,227

11 Claims. (Cl. 62—141)

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The present invention pertains in general to refrigerating apparatus and in particular to improvements in evaporator or cooling tank structures employed in such apparatus, wherein the fluid being cooled flows through elongated tubes forming a part of the evaporator.

In certain forms of cooling or evaporating apparatus, the fluid or liquid to be cooled is caused to pass through tubes or like confined passages while subjected to the action of a refrigerant.

Due to inattention of operating personnel, it is possible that an apparatus of this type may be damaged due to freezing of the liquid being cooled within the tubes. As is well known, the volume of a frozen liquid increases as it changes to the solid state. This expansion of the frozen liquid produces large stresses which may be sufficient to rupture the tube through which such fluid normally flows. Even in the absence of damage to the apparatus, such freezing is extremely detrimental in that a considerable loss of time is incurred in thawing the frozen fluid to restore the apparatus to normal operating condition.

It is an object of the present invention to provide an improved cooling apparatus of the above type wherein provisions are made to minimize the probability of freezing of the fluid being cooled.

Another object of the invention is to provide an improved cooling apparatus having means for preventing damage to the cooling tubes therein, in the event that the fluid flowing through such tubes freezes.

A further object of the invention is to provide an improved cooling apparatus incorporating means for enabling rapid thawing of the fluid being cooled, in the event that such fluid freezes in the apparatus.

Still another object of the invention is to provide a cooling apparatus, in accordance with the preceding objects, in which the means for minimizing the probability of freezing of the fluid being cooled also serves to increase the operating efficiency of the structure.

The above objects of the invention, together with further objects and advantages thereof, will best be appreciated and understood upon a perusal of the specification herein taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a general layout, diagrammatic in form, of a cooling system incorporating an evaporator which is constructed in accordance with the principles of the invention,

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Fig. 2 is an enlarged side elevational view, partly in section, of the evaporator unit included in Fig. 1,

Fig. 3 is a top view of the evaporator shown in Fig. 2 with a portion broken away to disclose the cooling tubes therein,

Fig. 4 is a detailed sectional view illustrating one form of construction of the evaporator tubes, and associated freeze protective means,

Figs. 5 and 6 are cross sectional views of the tubes illustrating alternative forms of construction of the freeze protective means,

Fig. 7 is a detailed sectional view illustrating a further form of construction of the freezing protective means, and

Fig. 8 is a cross sectional view taken along the line 8—8 of Fig. 7.

In the embodiment of the invention disclosed in Figs. 1–4, there is shown a cooling system, Fig. 1, comprising an evaporator 1 through which a refrigerant is circulated by a compressor 2 through a condenser 3, an injector 4 and a back pressure regulating valve 5. The liquid or fluid to be cooled is admitted to the evaporator through a pipe 6 and is withdrawn from the evaporator through a pipe 7. As may best be seen in Fig. 2, the fluid to be cooled flows through a series of tubes 8 extending between header chambers 9 and 10 located at the top and bottom of the evaporator 1. The refrigerant, which enters the evaporator through injector nozzle 4 in liquid form, and leaves through the valve 5 in gaseous form, flows along the outer walls of such tubes. Each of the tubes 8, through which the fluid to be cooled flows, has a freeze protective member 11 extending therethrough from the top to the bottom of evaporator 1. As will be later described, these members may be solid cylinders of resilient material, but in the embodiment of Figs. 1–4 are tubular in form in order to enable hot air or hot water to be circulated therethrough to thaw out the tubes 8 in the event of freezing. Hot water may be admitted to tubes 11 by means of a faucet 12, located above the evaporator 1, and may be collected by a drip pan 13, located beneath the evaporator. The tubes 11 are preferably of thin walled structure, for a purpose later to be described.

Referring now in particular to Fig. 2, the evaporator 1 may be of the general type disclosed in my copending application, Serial No. 671,650 filed May 22, 1946, and comprises an outer cylindrical casing 14 within which an inner casing 15 is concentrically located. The space between the casings 14 and 15 is filled with insulating ma-

terial 16, which may be cork or the like. The inner casing 15 extends between a pair of tube sheets 17 and 18 to which it is secured by welding or the like. Each of the tube sheets has a series of circular openings extending therethrough having annular spaced grooves therein. The tubes 8 extend between the sheets 17 and 18, to which they are secured by rolling grooves therein which engage the annular spaced grooves in the circular openings. All of the tubes 8 are encased within an inner casing 19 extending substantially the entire length between, but terminating somewhat short of, the tube sheets 17 and 18. The lower end of casing 19 is provided with a turned-out flange 20 which engages the inner wall of casing 15 and is secured thereto by welding or the like.

When the refrigerant enters the evaporator through the injector 4, it flows upwardly within the casing 19 and surrounds the cooling tubes 8. As the refrigerant flows over these tubes a heat transfer takes place between the fluid being cooled and the refrigerant, causing the latter to be vaporized. A portion of the refrigerant will flow over the top of casing 19 and fall between such casing and the inner wall of casing 15 and thence will be recirculated through Venturi action of the injector 4. The level of the liquid refrigerant in the evaporator is normally midway between the headers 9 and 10, the space above the level of the liquid consisting chiefly of vaporized refrigerant. The vapor leaves the evaporator through pipe 21, which extends to the back pressure regulating valve 5 shown in Fig. 1, and is compressed by compressor 2, and then is cooled and liquified in condenser 3 in a recirculation cycle. Casing 19 is provided with a baffle 22 which encloses the entrance to pipe 21 on all but the lower side in order to prevent liquid refrigerant from entering the pipe.

The upper header chamber 9 is formed by a dome-shaped cap member 23 secured to the upper tube sheet 17 by means of bolts, such as 24, extending through openings in an outwardly turned flange of the cap into threaded holes in the tube sheet. The junction between the tube sheet and cap member is sealed by a gasket 25. A similar dome-shaped cap member 26 is secured to the tube sheet 18 in like manner to form the lower header chamber 10. As will be understood, the liquid or fluid to be cooled, such for example as water, enters the upper header chamber 9 by means of a pipe 6, and flows downwardly through the parallel connected tubes 8 into the lower header chamber 10, from which it is withdrawn through the outlet pipe 7.

As previously stated, and as best shown in Fig. 4, each of the tubes 8 is provided with a freeze protective tube 11 disposed therein in annular spaced relationship. As also previously stated, in the embodiment of Figs. 1–4, the tubes 11 are circular in cross section and extend through the dome-shaped cap members 23 and 26, suitable packing glands, as indicated at 27, being provided to insure a fluidtight connection and prevent leakage of liquid from the header chambers. As best shown in Fig. 2, the cap member 23 is provided with an upwardly projecting annular rim 28 forming a distributor well from which hot water may be distributed from the faucet 12 for passage downwardly through the tubes 11 into the drip pan 13.

In operation, it will be seen that due to the provision of the tubes 11 within the cooling tubes 8, the fluid to be cooled in its passage through the tubes 8 is caused to move therethrough in the

form of an annular film within the passage 29, Fig. 4, provided between the tubes. By this means the speed of flow of the cooled liquid or fluid is increased while in thermal contact with the walls of the tubes 8 and with the refrigerant, producing a high thermal efficiency. Also, the enforced passage of the fluid through the tubes in the form of an annular film along the tube surfaces causes the tube surfaces to be continuously wiped by the flowing fluid, preventing stagnation or the formation of insulation pockets. In instances wherein liquid flows through a tube in a solid circular body, the rate of flow along the center of the tube may be greater than that along the tube walls, due to friction. By reason of the present arrangement wherein the liquid flows as a film through the annular passage 29 a substantially constant flow rate of all of the liquid is insured. This movement of the liquid through the tubes 8 in the form of a film promotes high thermal efficiency of the unit, as stated, and also minimizes the probability of freezing of the liquid within the tubes.

As previously stated, the freeze protecting tubes 11 are of relatively thin walled structure. Thus, the cooling tubes 8 may, for example, be formed of stainless steel tubing having a wall thickness, in an illustrative example, of .054". On the other hand, the tubes 11 may be formed of relatively softer brass tubing, having a wall thickness of .015". As will be understood, the foregoing dimensions are set forth by way of illustration and not by way of limitation.

Due to the relatively thin walled character of the freeze protective tubes 11, in the event the liquid within the annular passages 29 should, through inadvertence of the operator, freeze solid and expand, said tubes 11 will yield, thereby protecting the cooling tubes 8 from breakage. When freezing of the fluid being cooled occurs, the effective inner diameter of cooling tubes 8 decreases progressively as freezing continues due to the fact that ice forms on the inner walls of tubes 8 first and the depth of such ice formation gradually increases. The presence of such an ice formation may be detected by observing the change which occurs in the rate of flow of the fluid being cooled, or by noting the change which occurs in the difference in pressure between the entrance and exit points of such fluid. Upon noting such a change, steps may be taken immediately to remedy the cause and to thaw the ice formation before complete stoppage of flow occurs. The tubes 11 provide ready means for effecting thawing of the ice formed within the annular passages 29, which ice either wholly or partially blocks such passages, in that hot water or air may be readily passed through tubes 11, from the faucet 12 or otherwise, to effect thawing of the frozen fluid. The close proximity of the freeze protective members to the ice formation enables such formation to be thawed without unduly raising the temperature of the refrigerant. By this means the shut-down time of the evaporator, in the event of freezing, is minimized. As will be understood, the slight collapse of the tubes 11, to accommodate the expansion due to freezing, does not stress the metal beyond the elastic limit.

Ordinarily the thin walled tubes 11, even if of circular cross section, as in Figs. 1–4, will yield sufficiently to accommodate the expansion of the freezing liquid. In certain instances, however, it may be desirable to provide a special configura-

tion of the tube cross section to promote yielding in the event freezing takes place.

Various alternative forms of construction of the freezing protective members are shown in Figs. 5–8. In Fig. 5 a structure is shown wherein the tube 11*a*, corresponding in function to the tube 11 previously described, has that portion thereof which is disposed within the tube 8 of generally oval cross section as shown. Such oval cross section facilitates the yielding of the tube when subjected to the ice pressure. As will be understood, the ends of the tubes 11*a*, where they pass through the cap members, will preferably be retained in circular cross section, as indicated at 31, to facilitate application of the packing glands and connections 27, Fig. 2.

When the tube 11*a* is provided with an oval configuration, as shown in Fig. 5, the tube 8 may be similarly ovalled, if desired, to retain a relatively thin oval passageway between the tubes, for the reasons previously set forth.

In Fig. 6 the tube 11*b*, corresponding to the tube 11, as previously set forth, is provided with flutes or grooves, as indicated at 32, along that portion of the tube length which is disposed within the tube 8, to facilitate shifting of the tube wall when subjected to ice pressure.

In Figs. 7 and 8 a still further embodiment is set forth wherein the freeze protective member 11*c* is in the form of a solid rubber block yieldable to accommodate ice expansion. When the freeze protective members are of solid construction they need not extend through the cap members 23 and 26, and consequently may be supported by the tube sheets 17 and 18, or by the tubes 8, in any suitable manner.

It is obvious that various changes may be made in the specific embodiments set forth for purposes of illustration without departing from the spirit of the invention. The invention is accordingly not to be limited to the precise embodiments shown and described, but only as indicated in the following claims.

The invention is hereby claimed as follows:

1. A cooling unit for use with refrigerating apparatus comprising a tank structure, a first set of elongated passages extending through the tank structure, a second set of elongated passages each extending through the tank structure adjacent to and in heat exchange relationship with a corresponding passage of said first set, said first set of passages being adapted to transmit a fluid to be cooled and means for recirculating a refrigerant medium within said tank structure in heat exchange relationship with said medium to be cooled, said second set of passages enabling a heated medium at times to be transmitted therethrough in thermal contact with the medium being cooled in order to thaw such medium in the event that it becomes frozen within said first set of passages, and said second set of passages having a wall strength resistant to pressure materially less than the strength of said first set of passages whereby to absorb stresses produced when said fluid freezes.

2. A cooling unit for use with refrigerating apparatus comprising a tank structure, a first set of elongated passages extending through the tank structure, a second set of elongated passages each extending lengthwise through a corresponding passage of said first set, said first set of passages being adapted to transmit a fluid to be cooled and means for recirculating a refrigerant medium within said tank structure in heat exchange relationship with said medium to be cooled, said second set of passages enabling a heated medium at times to be transmitted therethrough in heat exchange relationship with the medium being cooled in order to thaw such medium in the event that it becomes frozen within said first set of passages and said second set of passages having a wall strength resistant to pressure materially less than the strength of said first set of passages whereby to absorb stresses produced when said fluid freezes.

3. A cooling unit for use with refrigerating apparatus comprising a tank structure, a first set of tubes extending through the tank structure, a second set of tubes each extending through the tank structure within a corresponding tube of said first set, said first set of tubes being adapted to transmit a fluid to be cooled, and means for recirculating a refrigerant medium within said tank structure in heat exchange relationship with said medium to be cooled, said second set of tubes being resilient and having a strength resistant to pressure materially less than said first set of tubes whereby to absorb the stresses which would otherwise be produced in said first set of tubes when freezing occurs therein and thereby preventing injury to the first set of tubes.

4. A cooling unit for use with a refrigerating apparatus comprising a tank structure, said tank structure being formed with header chambers at opposite ends thereof, a plurality of tubes arranged in parallel within the tank structure, said tubes extending between and communicating with said header chambers and being adapted to transmit a fluid to be cooled therebetween, means for recirculating refrigerant within the tank structure into engagement with the outer surfaces of the walls of said tubes to effect cooling thereof, and a plurality of pipes associated respectively with said tubes, said pipes extending through the tubes and through said header chambers whereby the passages within said pipes are accessible externally of the tank structure for the reception of a fluid to be passed therethrough.

5. A cooling unit for use with refrigerating apparatus comprising a tank structure, said tank structure being formed with header chambers at opposite ends thereof, a plurality of tubes arranged in parallel within the tank structure, said tubes extending between and communicating with said header chambers and being adapted to transmit a fluid to be cooled therethrough, a casing encompassing said tubes, said casing being spaced inwardly from the side walls of the tank structure, means for recirculating refrigerant through said casing and through the chamber defined between the casing and the side walls of the tank so as to bring the refrigerant into thermal engagement with said tubes, and a plurality of pipes extending respectively through said tubes and through the header chambers, said pipes having a strength resistant to pressure materially less than the tubes, and said pipes forming passages for the transmission of a heating medium therethrough to effect the heating of fluid within the tubes.

6. In a cooling apparatus, means for transmitting a fluid which is to be cooled, said transmitting means including a tube over one surface of which said fluid flows, a pair of tube sheets supporting the opposite ends of the tube, refrigerant circulating means for cooling the other surface of said tube to thereby extract heat from said fluid, resilient means comprising a metal tube extending longitudinally of said first men-

tioned tube of a strength resistant to pressure materially less than that of said first mentioned tube and spaced from one surface of said first mentioned tube, the space between said one surface of said first mentioned tube and said resilient means defining a channel through which said fluid flows, said resilient means serving to absorb stresses which would otherwise be produced by freezing of said fluid in said channel, said resilient means being shaped to provide a passage through which a heating material may be passed for heating said resilient means to thaw fluid frozen in said channel, and a pair of tube sheets disposed outwardly of said first named tube sheets and supporting the opposite ends of said resilient means.

7. In a cooling apparatus, transm'ssion means for a fluid which is to be cooled, said transmission means including a tube through which said fluid flows, a pair of tube sheets supporting the opposite ends of the tube, refrigerant circulating means for cooling the outer surface of said tube to extract heat from said fluid, a resilient member disposed within and extending lengthwise of said tube and shaped to conform to the inner wall of said tube and disposed closely adjacent thereto, whereby the fluid flows in a thin film along said inner wall, said member having a wall surface of a strength resistant to pressure materially less than the strength of the tube, whereby to absorb stresses which would otherwise be produced in said tube and which would result in injury thereto when said fluid freezes, and a pair of tube sheets disposed outwardly of said first named tube sheets and supporting the opposite ends of said resilient member.

8. In a cooling apparatus, transmission means for a fluid which is to be cooled, said transmission means including a plurality of tubes through which said fluid flows, means for cooling the outer surface of said tubes to extract heat from said fluid, and a hollow resilient member disposed within and extending lengthwise of each of said tubes, each said member having a wall surface of a strength resistant to pressure materially less than the strength of its associated tube whereby to absorb stresses which would otherwise be produced in said tube when said fluid freezes, and said member being arranged to receive a heated medium to effect rapid thawing of such frozen fluid.

9. A cooling unit for use with refrigerating apparatus comprising a tank structure, a plurality of tubes arranged in parallel within the tank structure, said tubes being adapted to transmit a fluid to be cooled, means for recirculating a cooling medium within said tank so as to bring said cooling medium into heat exchange relationship with said tubes, and a plurality of pipes extending respectively longitudinally through said tubes and through the wall of said tank structure, said pipes having a strength resistant to pressure materially less than said tubes.

10. A cooling unit as defined in claim 3, wherein the tubes of said second set are oval shaped in transverse cross section.

11. A cooling unit as defined in claim 3, wherein each of the tubes of said second set has a longitudinally extending groove to facilitate the deformation thereof responsive to applied pressure.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,380,987	Lippincott	June 7, 1921

FOREIGN PATENTS

Number	Country	Date
418,816	Great Britain	Nov. 1, 1934