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REFRIGERATION

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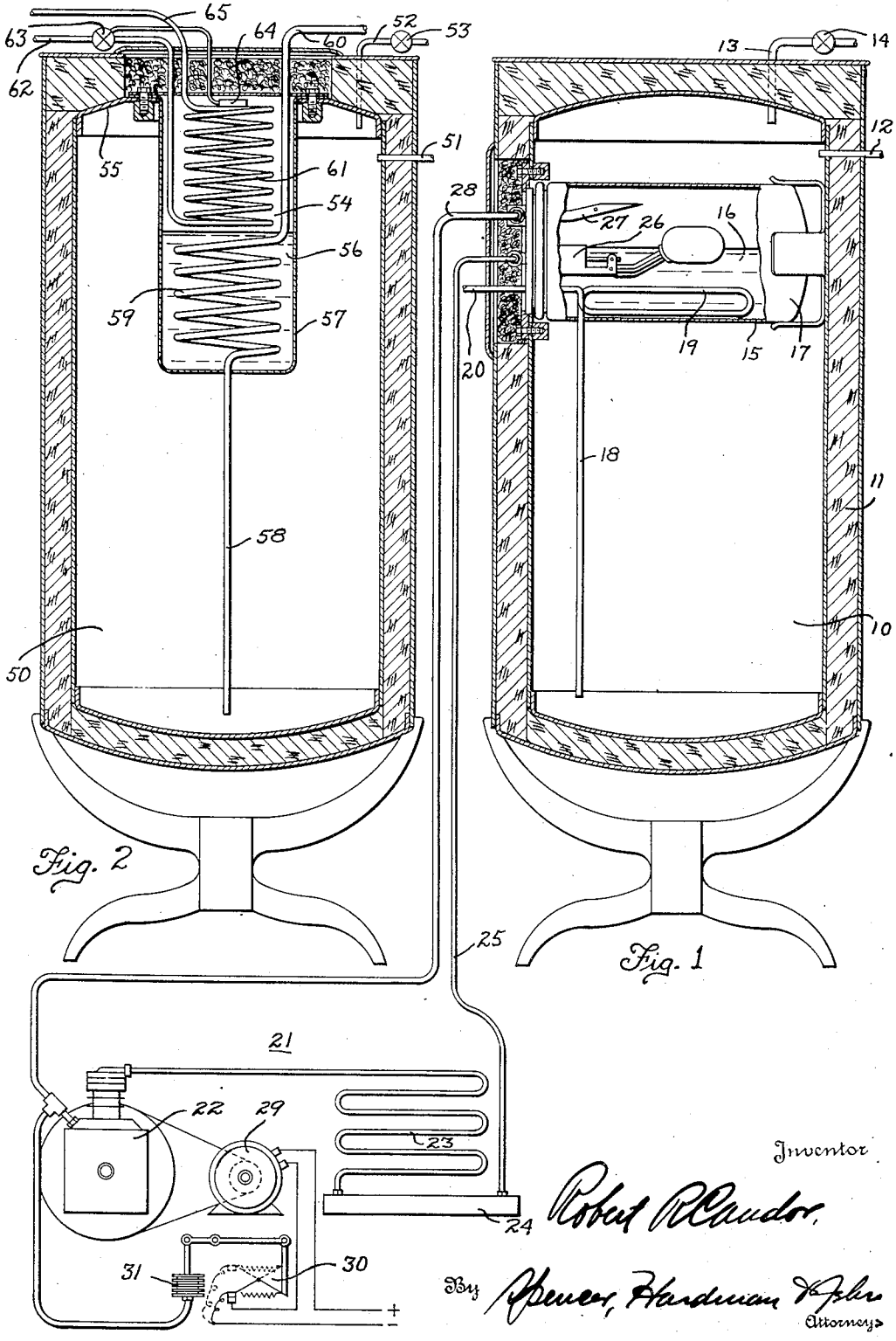


Fig. 2

Fig. 1

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REFRIGERATION

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This invention relates to refrigeration.

Heretofore refrigerating apparatus has been constructed for cooling liquids, such as drinking water, in which the liquid to be cooled is cooled substantially as fast as it is consumed and substantially at the same instant that it is consumed. Such apparatus generally have been known as "instantaneous coolers". In such cases, the capacity of the refrigerating apparatus necessarily must be equal to the peak load demand, and in such cases the capacity of the refrigerating apparatus necessarily is larger than required for the normal non-peak load periods. It is among the objects of this invention to provide a refrigerating apparatus for cooling liquids which has all of the advantages of the foregoing type of "instantaneous coolers" but which need not be constructed of the capacity for the peak load, and which utilizes the idle capacity of the apparatus during the periods of small or no demand for pre-cooling a quantity of liquid for use during the peak load.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, wherein a preferred form of the present invention is clearly shown.

In the drawing:

Fig. 1 is a view, partly in cross section and partly diagrammatic of an apparatus embodying features of this invention; and

Fig. 2 is a cross sectional view of a portion of a slightly modified form of apparatus.

In apparatus heretofore constructed capable of cooling the liquid substantially as fast as utilized, and commonly referred to as an "instantaneous cooler", a body of liquid refrigerant is maintained at a predetermined temperature, and a liquid discharge conduit passes in thermal contact with said body of liquid refrigerant, the conduit being of sufficient length and cross sectional area so that the liquid discharged from the conduit is at the desired temperature, which temperature is relatively close to the temperature of the liquid refrigerant. According to my invention such type of apparatus is combined with a storage reservoir in such a manner that the body of liquid refrigerant is utilized during periods of small or no demand for cooling the liquid in the reservoir, and the construction is such that the body of liquid refrigerant is available for cooling the liquid flowing through the discharge conduit to the desired or predetermined temperature during periods of heavy demand.

In one form of apparatus embodying my invention, a storage reservoir is provided at 10, and the reservoir may be a cylindrical tank provided with an insulating jacket 11. The reservoir 10 is provided with a liquid inlet 12, and, if necessary, an air discharge conduit 13 with a valve 14, which valve is opened during the filling period of the apparatus to discharge the air originally in the apparatus, and which valve is closed after air has been discharged. A refrigerant evaporator 15 is associated with the reservoir 10, and this evaporator contains a body 16 of liquid refrigerant. The evaporator has a metal wall 17, preferably cylindrical in form, in contact with the body 16 of liquid refrigerant and with the liquid to be cooled in the reservoir 10.

A liquid discharge conduit 18 is provided which receives liquid from the reservoir 10 near the bottom thereof, where the water or liquid is coldest, and thence passes through a cooling zone 19 in thermal contact with the body of liquid refrigerant 16 in such a manner that the conduit is thermally insulated in said zone from the water or liquid in the reservoir 10 by the body of liquid refrigerant 16. From thence the water or liquid is discharged from said discharge conduit through the outlet 20.

A refrigerant liquefying unit 21 is connected to the evaporator 15 in such a manner as to liquefy the refrigerant evaporated from the body 16 of liquid refrigerant. In the particular embodiment shown in Fig. 1, the refrigerant liquefying unit includes a compressor 22 discharging compressed refrigerant to the evaporator 23 which in turn discharges condensed refrigerant to the receiver 24. From thence liquid refrigerant flows through the liquid refrigerant line 25 through the float controlled valve 26 into the evaporator 15. The evaporated refrigerant is discharged from the evaporator through the funnel 27 and passes through the evaporated refrigerant line 28 to the compressor 22. The compressor is driven by an electric motor 29, preferably intermittently, in such a manner as to maintain the body of liquid refrigerant 16 at a predetermined temperature. To this end a snap switch 30 starts and stops the motor 29 in accordance with the temperature of the body 16 and this is conveniently accomplished by means of a bellows 31 which is responsive to the refrigerant vapor pressure in the line 28 and which actuates the snap switch 30 and thus maintains the body 16 of liquid refrigerant at a predetermined temperature in a manner readily understood by those skilled in the art.

The liquid discharge conduit in the cooling zone 19 is of sufficient length and cross sectional area in proportion to the rate of flow of liquid therethrough, so that the liquid discharged at 20 is substantially of the same temperature as the temperature of the body 16, there being at the most only a very slight temperature differential of two or three degrees, and the setting of the bellows 31 and switch 30 is such that the temperature of the liquid discharged at 20 is preferably between 45° F. and 50° F.

The operation of the apparatus shown in Fig. 1 is as follows: Liquid enters through the inlet 12 into the reservoir 10. During idle periods or during no demand periods, there is sufficient thermal exchange between the liquid in the tank 10 and the body 16 through the metal wall 17 so that the liquid in the reservoir 10 gradually is cooled between peak loads (which, for example, in a restaurant usually occurs every 24 hours at noon time) to a temperature relatively close to the temperature of the body 16. When a demand for liquid to be cooled is made on the apparatus, liquid flows from the reservoir 10 through the discharge conduit 18, and if this liquid is not sufficiently cold, the proper cooling is insured while the liquid passes through the cooling zone 19 because of the preferential cooling action between the zone 19 and the body 16, so that the liquid being discharged at 20 is at the desired predetermined temperature. The thermal exchange areas of the zone 19 and of the metal wall 17 are so proportioned, that if a heavy demand is made on the apparatus, substantially the entire cooling capacity of the apparatus is concentrated in the zone 19 to the exclusion of any substantial exchange through the wall 17. This is accomplished because the thermal exchange through the wall 17 is of a relatively slow character, the cooling action upon the liquid in the reservoir 10 being only sufficient to cool the body of liquid during a relatively long period of time, say 24 hours; whereas the thermal exchange through the zone 19 is almost of the instantaneous type, in which the quick cooling action occurs between the body 16 and the liquid passing through the conduit 19 substantially as fast as the liquid is used.

In the modification shown in Fig. 2, the storage reservoir, preferably cylindrical, is indicated at 50 and is provided with a liquid inlet at 51 and an air relief pipe 52 having a valve 53. A refrigerant evaporator 54, preferably cylindrical, is mounted on or suspended from the top or end wall 55 of the reservoir 50. The evaporator 54 contains a body 56 of liquid refrigerant and has a metal wall 57 in contact with said body 56 and with the liquid to be cooled in the reservoir 50. A liquid discharge conduit 58 receives liquid from the reservoir 50 at the lower end, where the water or liquid is coldest, and passes through a cooling zone 59 in thermal contact with the body 56 of liquid refrigerant, in such a manner that the discharge conduit is thermally insulated in the zone 59 from the liquid in the reservoir 50 by the body 56 of liquid refrigerant. The liquid passing through the zone 59 is discharged through the outlet 60.

The evaporator 54 has connected therewith a refrigerant liquefying unit for liquefying the refrigerant evaporated from the body of liquid refrigerant. In this particular embodiment, the refrigerant liquefying unit includes a heat exchanger 61 in the gas space of the evaporator 54 which is maintained at a sufficiently cold temperature to condense the refrigerant evaporated from the body 56. Any suitable refrigerant may be used for cooling the heat exchanger 61, but preferably the exchanger 61 is made in the form of a coil or secondary evaporator having a liquid refrigerant inlet 62 provided with an automatic expansion valve 63 which feeds a secondary liquid refrigerant to the coil or exchanger 61. The valve 63 is actuated from a thermostatic bulb 64 to maintain the coil 61 substantially full of secondary liquid refrigerant. The secondary liquid refrigerant line 62 is connected to a receiver similar to the receiver 24 of a compressor-condenser-receiver unit similar to the unit 21. The secondary evaporated refrigerant line 65 is connected to the compressor of a unit similar to the unit 21.

In the modification shown in Fig. 2, liquid to be cooled enters at 51 and fills the reservoir 50. During periods of small demand or of no demand, the slow heat exchange through the metal wall 57 gradually cools the liquid in the reservoir 50 similarly to the cooling effect in reservoir 10. When there is a demand for cooled drinking water or the like, liquid is withdrawn from the reservoir 50 through the liquid discharge conduit 58 and is cooled to the predetermined desired temperature in the zone 59 because, in this modification also, the area and length of the conduit in the zone 59 are selected to insure the desired temperature of the water, so that the water discharged through the outlet 60 is substantially the same as that of the body of liquid refrigerant 66 or is only slightly warmer as was the case with regard to the apparatus shown in Fig. 1. The refrigerant liquefying capacity of the refrigerant liquefying unit 61 is such that it maintains the liquid refrigerant 66 at a predetermined temperature during the normal flow of liquid through the conduit 58, and this is insured by providing a sufficient area in the conduit 61 and a sufficient refrigerating capacity in the unit corresponding to the unit 21 which is connected to the conduit 61. In this case the unit corresponding to 21 is provided with an automatic control similar to control 30, 31 to maintain, indirectly, the body 56 of liquid refrigerant at the desired predetermined temperature. In the modification shown in Fig. 2, the area of the wall 57 and the length and area of the discharge conduit in the zone 59 are proportioned similarly to the areas of the wall 17 and the area and length of conduit in the zone 19 to obtain results substantially similar to those obtained by the modification shown in Fig. 1.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. A refrigerating apparatus for cooling liquids comprising a storage reservoir for liquid to be cooled, a liquid inlet in said reservoir, a refrigerant evaporator containing a body of liquid refrigerant and having a metal wall in contact with said body of liquid refrigerant and with the liquid to be cooled in said reservoir, and a liquid discharge conduit receiving liquid from said reservoir and passing through a zone in thermal contact with said body of liquid refrigerant, said conduit being insulated in said zone from the liquid in said reservoir by said body of liquid refrigerant.

2. A refrigerating apparatus for cooling liquids comprising a storage reservoir for liquid to be

cooled, a liquid inlet in said reservoir, a refrigerant evaporator containing a body of liquid refrigerant and having a metal wall in contact with said body of liquid refrigerant and with the liquid to be cooled in said reservoir, a liquid discharge conduit receiving coolest liquid from said reservoir and passing through a zone in thermal contact with said body of liquid refrigerant, said conduit being insulated in said zone from the liquid in said reservoir by said body of liquid refrigerant, and a refrigerant liquefying unit connected to said evaporator to liquefy refrigerant evaporated from said body of liquid refrigerant.

3. A refrigerating apparatus for cooling liquids comprising a storage reservoir for liquid to be cooled, a liquid inlet in said reservoir, a refrigerant evaporator containing a body of liquid refrigerant and having a metal wall in contact with said body of liquid refrigerant and with the liquid to be cooled in said reservoir, and a liquid discharge conduit receiving liquid from said reservoir and passing through a zone in thermal contact with said body of liquid refrigerant, said conduit being insulated in said zone from the liquid in said reservoir by said body of liquid refrigerant, said liquid discharge conduit being of sufficient length in said zone to cool the liquid passing therethrough substantially to the same temperature as the temperature of said body of liquid refrigerant.

4. A refrigerating apparatus for cooling liquids comprising a storage reservoir for liquid to be cooled, a liquid inlet in said reservoir, a refrigerant evaporator containing a body of liquid refrigerant and having a metal wall in contact with said body of liquid refrigerant and with the liquid to be cooled in said reservoir, a liquid discharge conduit receiving liquid from said reservoir and passing through a zone in thermal contact with said body of liquid refrigerant, said conduit being insulated in said zone from the liquid in said reservoir by said body of liquid refrigerant, and means to maintain said body of liquid refrigerant at a substantially constant temperature.

5. A refrigerating apparatus for cooling liquids comprising a storage reservoir for liquid to be cooled, a liquid inlet in said reservoir, a refrigerant evaporator containing a body of liquid refrigerant and having a metal wall in contact with said body of liquid refrigerant and with the liquid to be cooled in said reservoir, a liquid discharge conduit receiving liquid from said reservoir and passing through a zone in thermal contact with said body of liquid refrigerant, said conduit being insulated in said zone from the liquid in said reservoir by said body of liquid refrigerant, and means to maintain said body of liquid refrigerant at a substantially constant temperature, said liquid discharge conduit being of sufficient length in said zone to cool the liquid passing therethrough substantially to the same temperature as the temperature of said body of liquid refrigerant.

6. A refrigerating apparatus for cooling liquids comprising a storage reservoir for liquid to be cooled, a liquid inlet in said reservoir, a refrigerant evaporator containing a body of liquid refrigerant and having a metal wall in contact with said body of liquid refrigerant and with the liquid to be cooled in said reservoir, a liquid discharge conduit receiving liquid from said reservoir and passing through a zone in thermal contact with said body of liquid refrigerant, said conduit being insulated in said zone from the liquid in said reservoir by said body of liquid refrigerant, and a refrigerant liquefying unit connected to said evaporator to liquefy refrigerant evaporated from said body of liquid refrigerant, said refrigerant liquefying unit being of sufficient capacity to maintain said body of liquid refrigerant at a predetermined temperature during normal flow of liquid through said liquid discharge conduit.

7. A refrigerating apparatus for cooling liquids comprising a storage reservoir for liquid to be cooled, a liquid inlet in said reservoir, a refrigerant evaporator containing a body of liquid refrigerant and having a metal wall in contact with said body of liquid refrigerant and with the liquid to be cooled in said reservoir, a liquid discharge conduit receiving liquid from said reservoir and passing through a zone in thermal contact with said body of liquid refrigerant, said conduit being insulated in said zone from the liquid in said reservoir by said body of liquid refrigerant, and a refrigerant liquefying unit connected to said evaporator to liquefy refrigerant evaporated from said body of liquid refrigerant, and an automatic control for said refrigerant liquefying unit for maintaining said body of liquid refrigerant at said predetermined temperature.

8. A refrigerating apparatus for cooling liquids comprising a vertical cylindrical reservoir for liquid to be cooled and having a liquid inlet adjacent the top thereof, a refrigerant evaporator in the upper portion of said reservoir, said evaporator containing a body of liquid refrigerant and having a metal wall extending into the upper portion of said reservoir in contact with said body of liquid refrigerant and with the liquid to be cooled in said reservoir, and a liquid discharge conduit receiving liquid from said reservoir and passing through a zone in thermal contact with said body of liquid refrigerant, said conduit being insulated in said zone from the liquid in said reservoir by said body of liquid refrigerant.

9. A refrigerating apparatus for cooling liquids comprising a vertical cylindrical reservoir for liquid to be cooled and having a liquid inlet adjacent the top thereof, a refrigerant evaporator suspended from the top of said reservoir, said evaporator containing a body of liquid refrigerant and having a metal wall extending into the upper portion of said reservoir in contact with said body of liquid refrigerant and with the liquid to be cooled in said reservoir, and a liquid discharge conduit receiving liquid from said reservoir and passing through a zone in thermal contact with said body of liquid refrigerant, said conduit being insulated in said zone from the liquid in said reservoir by said body of liquid refrigerant.

10. A refrigerating apparatus comprising a cylindrical storage reservoir having a pressure inlet, a cylindrical evaporator in said reservoir, said evaporator having a body of liquid refrigerant and a vapor space above said body of liquid refrigerant, a discharge conduit receiving liquid from said reservoir and extending through a cooling zone in thermal exchange with said body of liquid refrigerant, and a heat exchanger in said vapor space for condensing refrigerant evaporated from said body of liquid refrigerant.

11. A refrigerating apparatus comprising a cylindrical storage reservoir having a pressure inlet, a cylindrical evaporator in said reservoir, said evaporator having a body of liquid refrigerant and a vapor space above said body of liquid

refrigerant, a discharge conduit receiving liquid from said reservoir and extending through a cooling zone in thermal exchange with said body of liquid refrigerant and being thermally insulated from liquid to be cooled in said reservoir, and a heat exchanger in said vapor space for condensing refrigerant evaporated from said body of liquid refrigerant.

12. A refrigerating apparatus comprising a cylindrical storage reservoir having a pressure inlet and an end wall, a cylindrical evaporator in said reservoir secured to said end wall, said evaporator having a body of liquid refrigerant and a vapor space above said body of liquid refrigerant, a discharge conduit receiving liquid from said reservoir and extending through a cooling zone in thermal exchange with said body of liquid refrigerant, and a heat exchanger in said vapor space for condensing refrigerant evaporated from said body of liquid refrigerant.

13. A refrigerating apparatus comprising a cylindrical storage reservoir having a pressure inlet, a cylindrical evaporator in said reservoir, said evaporator having a body of liquid refrigerant and a vapor space above said body of liquid refrigerant, a discharge conduit receiving liquid from said reservoir and extending through a cooling zone in thermal exchange with said body of liquid refrigerant, and a heat exchanger in said vapor space for condensing refrigerant evaporated from said body of liquid refrigerant, said heat exchanger forming a secondary refrigerant evaporator, and a refrigerant liquefying unit connected in refrigerant circulating relationship with said secondary evaporator.

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