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REFRIGERATING APPARATUS

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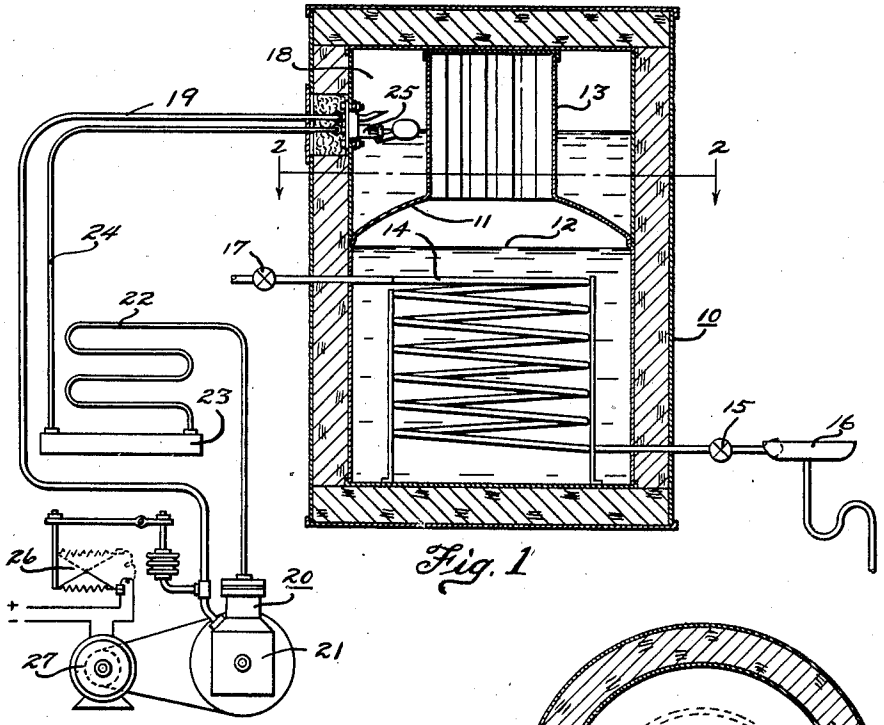


Fig. 1

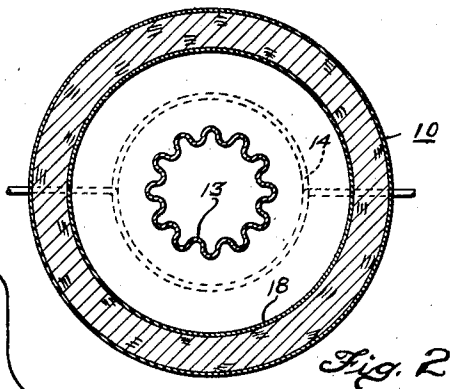


Fig. 2

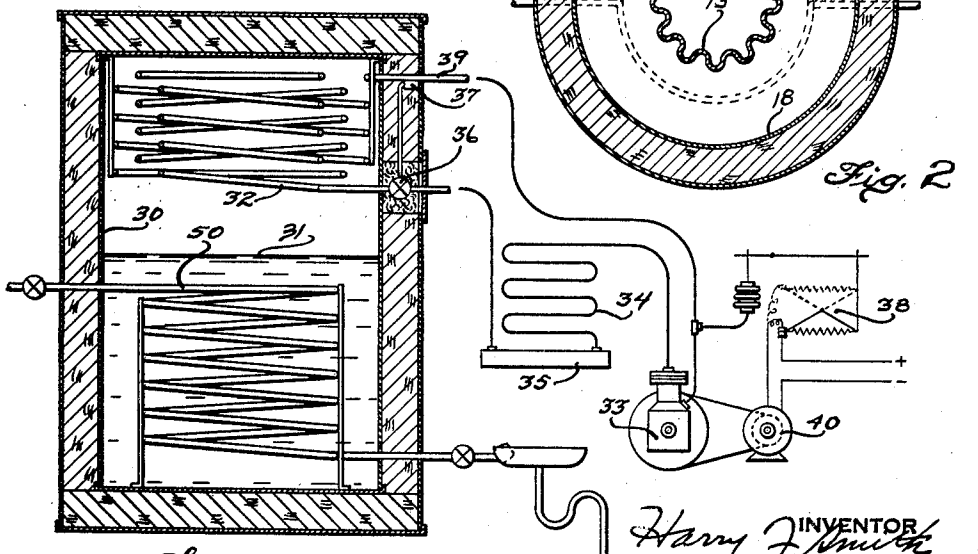


Fig. 3

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REFRIGERATING APPARATUS

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13 Claims. (Cl. 62—141)

This invention relates to refrigeration and more particularly to refrigerating apparatus for cooling liquids such as drinking water or the like.

Heretofore refrigerating apparatus has been provided in which a relatively long liquid conduit has been submerged in a body of liquid refrigerant in an evaporator, and in which the liquid refrigerant, evaporated during the cooling of the water is re-liquefied in a compressor-condenser unit, the re-liquefied refrigerant being returned to the evaporator in closed circuit relationship. In such apparatus, an automatic control has been provided which is intended to maintain the body of liquid refrigerant at a proper temperature above the freezing point of the drinking water or other liquid to be cooled, so that the water or liquid to be cooled is not likely to be frozen within the apparatus. However, it sometimes occurs through the failure of the automatic temperature control, that the apparatus creates temperatures in the body of liquid refrigerant below the freezing point of water or other liquid being cooled and thus freezes the water or liquid in the submerged conduit. When this happens, the conduit is likely to burst, and cause water to be carried on to the compressor-condenser unit where it quickly ruins the mechanism. It is among the objects of this invention to provide a refrigerating apparatus which has all of the advantages of such prior mechanisms and yet is absolutely certain to prevent the entrance of water or other liquid being cooled into the compressing mechanism or its associated refrigerant circuit.

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 diagrammatic and partly in vertical cross-section of an apparatus embodying features of my invention;

Fig. 2 is a horizontal cross-section taken along the line 2—2 of Fig. 1; and

Fig. 3 is a diagrammatic view of a slightly modified form of the invention.

An apparatus embodying features of my invention includes in general a liquid or drinking water cooler 10, which includes a secondary refrigerant chamber 11 having a body 12 of volatile refrigerant forming an evaporator of the secondary refrigerating system and a condensing wall or surface 13 which is adapted to condense the secondary refrigerant evaporated from the body 12 and return the condensed refrigerant to the body 12. Within the body of liquid refrigerant 12 there is submerged a liquid or drinking water pipe 14 which is of sufficient length to insure proper cooling of the liquid or water passing therethrough, and this pipe discharges through the valve 15 to a discharge device 16 which may be conveniently in the form of a bubbler faucet or other faucet or the like. The pipe 14 may be connected to any suitable supply of liquid such as a city water main or the like and may, if desired be provided with a pressure regulating valve 17 adapted to maintain substantially constant pressure of liquid at the discharge device 16.

A primary refrigerating system is associated with the cooler 10 and may comprise, in general, a primary evaporator 18 in thermal exchange with the secondary condenser 13. The evaporator 18 discharges through the pipe 19 to the compressor-condenser unit 20 which includes, for example, a reciprocating compressor 21 and a condenser 22 discharging into a liquid refrigerant receiver 23. From thence the liquid refrigerant flows through the pipe 24 to the expansion valve 25, which in this particular embodiment, is in the form of a float controlled valve, the float being responsive to liquid level conditions in the evaporator 18.

Means are provided for maintaining the desired substantially constant temperature in the body of liquid refrigerant 12. This may be accomplished, in this particular embodiment, by providing a snap switch 26 which is responsive to the pressures in the line 19, and which starts and stops the motor 27 which drives the compressor 21. Since the snap switch 26 is responsive to pressures in line 19, it is also responsive to pressure-temperature conditions in the evaporator 18, and thus tends to maintain substantially constant temperature in the evaporator 18. This in turn, by condensation of refrigerant on the condenser 13, tends to maintain a constant temperature in the body of liquid refrigerant 12, since the heat transfer rate in the apparatus tends to be substantially constant, and therefore the temperature differential between the bodies 12 and 18 tends to be substantially constant.

In the modification shown in Fig. 3, a substantially cylindrical chamber 30 contains a body of secondary liquid refrigerant 31, which forms the secondary evaporator, in which the water pipe 50 is submerged, the water pipe 50 corresponding to the pipe 14 in Fig. 1. A coiled pipe or tube 32 forms on its outer surface the condenser for the

secondary refrigerant system and condenses the refrigerant evaporated from the body 31. The internal surface of the tube 32 forms the evaporator for the primary refrigerating system which includes the compressor 33, condenser 34, liquid refrigerant receiver 35, thermostatic expansion valve 36 which is controlled in accordance with temperatures of the refrigerant at the bulb 37. The operation of the compressor 33 is controlled by a snap switch 38 responsive to pressures within the evaporated refrigerant line 39 and controls the starting and stopping of the motor 40 which drives the compressor 33. As in the modification shown in Fig. 1, the automatic control of the primary refrigerating system in Fig. 3 tends to maintain a substantially constant refrigerant temperature in the body 31 and thus, because of the length of the pipe 50, the liquid leaving the pipe 50 is reduced to the desired temperature, which, if the flow of liquid is properly regulated, will be a few degrees warmer than the temperature of the refrigerant 31.

In both modifications, should the automatic control fail to stop the operation of the compressor, so that the temperature of the bodies 12 or 31 should fall below the freezing temperature of the water or other liquid being cooled, and should the water or other liquid freeze in the pipes 14 or 50 and burst the same, it would be impossible for the water or other liquid to enter the primary refrigerating system because the water could only enter the secondary refrigerant system and there is nothing in the construction which would permit entrance of fluid from the secondary system to the primary system. Thus the costly damage to the primary system, particularly the moving parts thereof, is avoided by my invention. Notwithstanding these advantages, I obtain substantially as efficient and as quick a heat transfer between the liquid to be cooled and the refrigerant in the primary system as was possible with the prior devices above described. This is due, in part, to the fact that there is a swift transfer of heat from the conduit containing the liquid to be cooled to the primary evaporator by reason of the evaporation and condensation of the secondary refrigerant, which is a relatively violent or instantaneous action.

Where the water or liquid cooler is so connected with the primary refrigerating system that the primary evaporator temperatures at 18 and 32 can be maintained sufficiently high, I prefer to use for a secondary refrigerant a wholly volatile refrigerant which does not react chemically in the presence of water, such refrigerant being, for example, a hydrocarbon or derivative thereof, such as butane, methyl chloride or dichlorodifluoromethane. When other evaporators are to be connected to the primary system which require lower evaporator temperatures than would be normally required in evaporators 18 and 32, then I may provide an automatic pressure regulating valve, now well known in the art of refrigeration, at or near the suction outlet of the evaporators 18 and 32 so that the evaporators 18 and 32 are maintained at their proper relatively high temperatures. However, if desired, instead of using such automatic pressure regulating valves, I may add an inert normally uncondensable gas in the secondary refrigerant space which increases the operating temperature differential between the secondary evaporators 12 or 31 and the primary evaporators 18 or 32, respectively. In this latter case, the amount of inert uncondensable gas can be regulated to provide just the proper temperature differential so that the primary evaporators 18 and 32 can be operated at the same relatively low temperatures as the other added primary evaporators in the primary system and yet the secondary evaporators 12 and 31 are maintained at the desired relatively high temperature required for preventing freezing of the liquid to be cooled in the pipes 14 or 50. Thus, depending on operating conditions, the secondary refrigerant may be a substance wholly volatile within the operating temperature range, or it may be a combination of such a refrigerant and an added inert gas uncondensable within the pressure and temperature range of operation.

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 including a secondary evaporator containing a body of secondary liquid refrigerant, a conduit having an inlet and an outlet for liquid to be cooled submerged in said body of liquid refrigerant, a closed primary refrigerating system provided with a primary evaporator and a primary refrigerant liquefying unit, said primary evaporator having a surface forming a secondary condenser for the secondary refrigerant evaporated from said secondary evaporator, and means for controlling the operation of said closed primary refrigerating system to maintain a substantially constant temperature of said body of liquid refrigerant.

2. A refrigerating apparatus comprising an evaporator containing a volatile liquid refrigerant, means including moving mechanism for maintaining desired temperatures in said liquid refrigerant, a pipe having an inlet and an outlet for liquid to be cooled in contact with the volatile liquid refrigerant in said evaporator, and means for preventing the flow of said liquid to be cooled to said mechanism if said conduit should introduce said liquid to be cooled into said refrigerant.

3. A refrigerating apparatus comprising an evaporator containing a volatile liquid refrigerant, a conduit having an inlet and an outlet for liquid to be cooled submerged in said refrigerant, a refrigerant compressor, means for causing said compressor to maintain said liquid refrigerant at a cold temperature, and means for preventing the flow of said liquid to be cooled into said compressor if said conduit should burst in said evaporator.

4. In an apparatus for cooling liquids, in combination, a vertically disposed sealed casing, a body of liquid volatile secondary refrigerant in the lower portion of said casing and secondary refrigerant vapor in the upper part of said casing, a pipe for liquid to be cooled submerged in said body and having an inlet and an outlet passing through said casing, a primary refrigerant evaporator in thermal contact with said secondary refrigerant vapor in the upper part of said casing, and a primary refrigerant liquefying means in primary refrigerant flow relationship with said evaporator.

5. In an apparatus for cooling liquids, in combination, a vertically disposed sealed casing, a body of liquid volatile secondary refrigerant in the lower portion of said casing and secondary refrigerant vapor in the upper part of said casing, a pipe for liquid to be cooled submerged in said body and having an inlet and an outlet passing through said casing, a primary refrigerant evap-

orator in thermal contact with said secondary refrigerant vapor in the upper part of said casing, a primary refrigerant liquefying means in primary flow relationship with said evaporator, and means automatically controlling said unit to maintain said body of volatile secondary refrigerant at a predetermined temperature.

6. In an apparatus for cooling liquids, in combination, a sealed casing, a body of liquid volatile secondary refrigerant in the lower portion of said casing and secondary refrigerant vapor in the upper part of said casing, a conduit having an inlet and an outlet for liquid to be cooled in said casing in contact with said body of liquid volatile secondary refrigerant, a primary evaporator in said casing above said body, a primary refrigerant liquefying means outside said casing, and a refrigerant flow connection between said liquefying means and said evaporator.

7. In an apparatus for cooling liquids, in combination, a sealed casing, a body of liquid volatile secondary refrigerant in the lower portion of said casing and secondary refrigerant vapor in the upper part of said casing, a conduit having an inlet and an outlet for liquid to be cooled in said casing in contact with said body of liquid volatile secondary refrigerant, a primary evaporator in said casing above said body, said primary evaporator being formed by a pipe coiled in the upper part of said casing.

8. In an apparatus for cooling liquids, in combination, a vertically disposed sealed casing, a body of liquid volatile secondary refrigerant in the lower portion of said casing and secondary refrigerant vapor in the upper part of said casing, a pipe for liquid to be cooled submerged in said body and having an inlet and an outlet passing through said casing, a coil in the upper part of said casing above said body of liquid volatile secondary refrigerant, said coil containing volatile liquid primary refrigerant, and primary refrigerant liquefying means outside said casing connected to said coil.

9. In an apparatus for cooling liquids, in combination, a vertically disposed sealed casing, a body of liquid volatile secondary refrigerant in the lower portion of said casing and secondary refrigerant vapor in the upper part of said casing, a pipe for liquid to be cooled submerged in said body and having an inlet and an outlet passing through said casing, a coil in the upper part of said casing above said body of liquid volatile secondary refrigerant, said coil containing volatile liquid primary refrigerant, primary refrigerant liquefying means outside said casing connected to said coil, and means automatically controlling said liquefying means to maintain the refrigerating effect of said apparatus between predetermined limits.

10. A refrigerating apparatus including a secondary evaporator containing a body of secondary volatile liquid refrigerant, heat exchange means forming at least a part of a secondary condenser for condensing refrigerant evaporated in said evaporator, a conduit having an inlet and outlet for liquid to be cooled in heat exchange relation with said liquid refrigerant, a closed primary refrigerating system provided with a primary evaporator formed at least in part by said heat exchange means and containing a primary refrigerant, said primary refrigerating system including a primary refrigerant liquefying unit, the primary refrigerant in said primary evaporator being in heat exchange relation with the secondary refrigerant in said secondary condenser, the construction preventing the admission of liquid into the closed primary refrigerating system if the liquid in the conduit should accidentally freeze and burst said conduit.

11. A refrigerating apparatus comprising, in combination, a secondary evaporator containing a body of secondary volatile liquid refrigerant, heat exchange means forming at least a part of a secondary condenser for condensing refrigerant evaporated in said evaporator, a conduit having an inlet and an outlet for liquid to be cooled in thermal contact with said liquid refrigerant, a closed primary refrigerating system provided with a primary evaporator formed at least in part by said heat exchange means and containing a primary refrigerant, said primary refrigerating system including a primary refrigerant liquefying unit, an automatic control for the liquefying unit, the primary refrigerant in said primary evaporator being in thermal contact with the secondary refrigerant in said secondary condenser, the construction preventing the admission of liquid into the closed primary refrigerating system if the liquid to be cooled in the conduit should accidentally freeze and burst said conduit.

12. A refrigerating apparatus comprising, in combination, a secondary evaporator containing secondary volatile refrigerant, heat exchange means forming at least a part of a secondary condenser for condensing refrigerant evaporated in said evaporator, a conduit having an inlet and an outlet for liquid to be cooled in thermal contact with said liquid refrigerant, a closed primary refrigerating system having a primary evaporator formed at least in part by said heat exchange means and containing a primary refrigerant which cools the secondary refrigerant in said secondary condenser, a primary compressor and a primary condenser for liquefying and circulating in a closed circuit the primary refrigerant evaporated in said primary evaporator.

13. A refrigerating apparatus comprising, in combination, a secondary evaporator containing secondary volatile refrigerant, heat exchange means forming at least a part of a secondary condenser for condensing refrigerant evaporated in said evaporator, a conduit having an inlet and an outlet for liquid to be cooled in thermal contact with said liquid refrigerant, a closed primary refrigerating system having a primary evaporator formed at least in part by said heat exchange means and containing a primary refrigerant which cools the secondary refrigerant in said secondary condenser, a primary compressor and a primary condenser for liquefying and circulating in a closed circuit the refrigerant evaporated in said primary evaporator, and means for automatically maintaining a predetermined temperature in said primary evaporator.

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