

Nov. 21, 1950

J. WYLLIE, JR

2,531,315

LIQUID COOLING APPARATUS

Filed Aug. 8, 1946

2 Sheets-Sheet 1

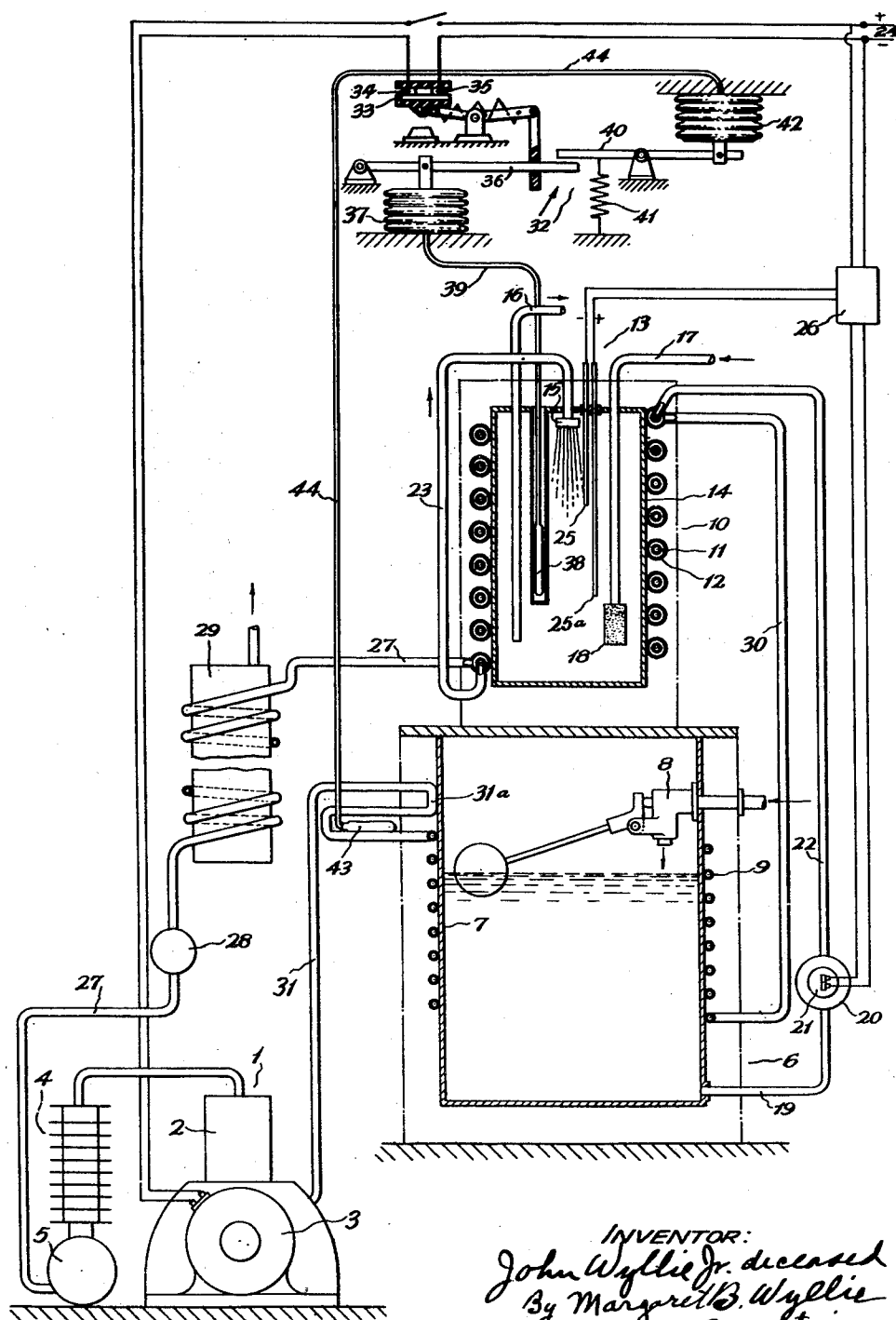


FIG. 1.

INVENTOR:
John Wyllie Jr. deceased
By Margaret B. Wyllie
executrix
Ray Ray L. Gehr atty.

Nov. 21, 1950

J. WYLLIE, JR
LIQUID COOLING APPARATUS

2,531,315

Filed Aug. 8, 1946

2 Sheets-Sheet 2

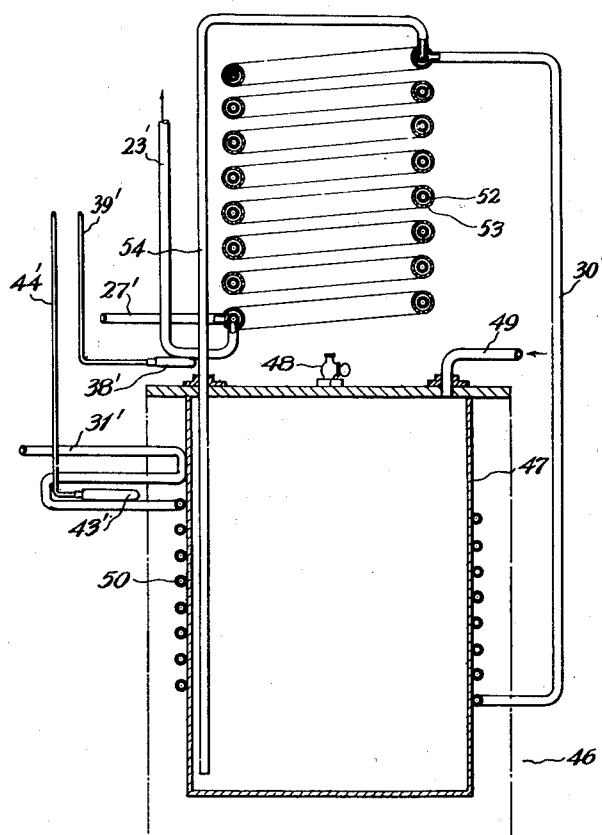


FIG. 2.

INVENTOR:
John Wyllie, Jr. deceased
By Margaret B. Wyllie,
Executrix
By Ray S. Lehrs, atty.

UNITED STATES PATENT OFFICE

2,531,315

LIQUID COOLING APPARATUS

John Wyllie, Jr., deceased, late of Detroit, Mich.,
by Margaret B. Wyllie, executrix, Detroit, Mich.,
assignor to Temprite Products Corporation, De-
troit, Mich., a corporation of Michigan

Application August 8, 1946, Serial No. 689,249

5 Claims. (Cl. 62-7)

1

The invention relates to liquid cooling apparatus suitable for use in the dispensing of draft beverages (as, for example, by coin-controlled beverage vending machines) or in the cooling of other liquids under similar conditions of intermittent service.

For such cooling purposes it is desirable, in order to secure effective cooling and close temperature regulation under the varying load conditions, to use an instantaneous type of cooler, that is, one having conduit means providing a definite path for the flow of liquid to be cooled and a refrigerant expansion chamber associated with the conduit means with a metal wall separating the interiors of the conduit means and expansion chamber and forming a heat flow path between said interiors. It is, however, desirable also that the apparatus have the characteristics of a storage type cooler to permit cooling of stored liquid during reduced load on the apparatus and the use of a condensing unit of moderate size to serve the entire apparatus.

The production and operational control of such a system having such combined characteristics presents a problem that has not heretofore had a satisfactory solution and it is the primary object of the present invention to provide a combined instantaneous and storage type liquid cooling apparatus having relatively simple automatic control means by virtue of which the apparatus attains a maximum output of cooled liquid for a given power capacity with relatively close temperature regulation of the dispensed liquid.

A further object of the invention is to provide apparatus such as last referred to which is especially adapted for use in coin-controlled vending machines for dispensing draft beverages.

With the above and other more or less incidental or ancillary objects in view the invention consists in certain forms, arrangements and combinations of parts hereinafter explained in connection with the accompanying drawings and definitely pointed out in the appended claims.

In the drawings,

Fig. 1 is a view, more or less diagrammatic, showing partly in elevation and partly in vertical section, an embodiment of the invention as applied to cooling and carbonating apparatus for a beverage dispensing system.

Fig. 2 is a vertical section, also more or less diagrammatic, showing a modified form of the instantaneous and precooler units of the apparatus shown in Fig. 1.

Referring in detail to the form of apparatus illustrated in Fig. 1, the numeral 1 designates

2

as an entirety a conventional motor-driven refrigerant condensing unit comprising a compressor 2, an electric motor 3, condenser 4 and, preferably, liquid refrigerant receiver 5.

Associated with the condensing unit is a precooler of storage type designated as an entirety by the numeral 6 and comprising a suitably heat-insulated tank 7 which may be supplied with water to be cooled in any desired manner. In the case of beverage vending machines a source of water under pressure may not be readily available and the tank will then be filled periodically by the person supervising the apparatus. When such a water source is available the tank 7 can be fitted as shown with a float-operated supply valve 8 adapted to be connected with the source of water supply. The side wall of the metal tank 7 is fitted with a refrigerant expansion coil 9 in close metal-to-metal contact with tank 7 so as to extract heat from the tank and its contents.

The numeral 10 designates as an entirety an instantaneous liquid cooler comprising a helical coil 11 which is threaded through a refrigerant coil 12 formed of larger diameter tubing than is the coil 11 so as to form an expansion chamber between the walls of the two coils.

Arranged within the coils of the cooler 10 is a carbonator designated as an entirety by the numeral 13 and comprising a suitably heat-insulated metal tank 14, the side wall of which has intimate contact with the refrigerant coil 12 of the cooler 10. The tank 14 is fitted with a spray nozzle 15 for the introduction of water to be carbonated and with a discharge conduit 16 having its open inlet end near the bottom of the tank chamber. For the introduction of CO₂ gas the tank is fitted with an inlet pipe 17 which discharges into the tank chamber through a porous stone element 18 or other suitable gas diffusing device.

The lower part of the tank 7 of the precooler 6 is connected by a conduit 19 to a liquid pump 20 having an electric driving motor 21, and the pump in turn is connected through a conduit 22 with the liquid inlet to the instantaneous cooler 10 at the upper end of its liquid coil 11. The lower, discharge end of the coil 11 is connected by conduit 23 with the spray nozzle 15.

The pump motor 21, as well as the condenser motor 3, is energized by current from a supply line 24. To effect automatic control of the carbonator it is provided with high level and low level electrodes 25, 25^a which are connected in the pump motor circuit, together with a suitable relay switch device 26. These electrode and re-

3

lay devices, which are well known for such use, serve to start motor 21 when the liquid level in the carbonator falls below the lower end of electrode 25* and to stop said motor when the liquid level in the carbonator rises to the lower end of electrode 25.

A conduit 27 serves to connect the receiver 5 of unit 1 with the refrigerant inlet of the instantaneous cooler 10 at the lower end of its coil 12. The conduit is fitted with an expansion valve 28 adapted to respond to changes in temperature within the expansion chamber formed between the coils 11 and 12. Preferably valve 28 is of the automatic type responsive to the pressure within the said expansion chamber. Between the valve 28 and the coil 12 the conduit 27 is given several turns around container 29 to indicate provision for cooling flavoring extracts suitable for mixture with the carbonated water of the apparatus. Such container, of course, constitutes a quite small heat load.

The upper, outlet end of the coil 12 of the instantaneous cooler is connected by conduit 30 with the lower end of the coil 9 of the pre-cooler while the upper outlet end of coil 9 is in turn connected by conduit 31 with the intake of the compressor 2 of the condensing unit. The operation of the condensing unit is automatically controlled by a thermostatic switch 32 which may be connected as shown into one branch of the circuit connecting motor 3 to the electric supply line 24 previously referred to. Switch 32, which also is diagrammatically shown, comprises a movable element 33 arranged to cooperate with terminals 34, 35, when actuated by the lever 36 which in turn is moved by the bellows 37 connected to the thermostatic bulb 38 through capillary tube 39. The connection between element 33 and lever 36 should have a lost motion action and this is conveniently afforded by the conventional spring-biased toggle linkage shown in the drawing. The bulb 38 is arranged in a suitable well of the carbonator so as to respond to temperature changes of the liquid therein. When the temperature rises the bellows 37 is expanded and switch 32 is closed. To effect the opening of the switch in the normal operation of the apparatus a lever 40 is arranged to engage the lever 36 and under the action of tension spring 41 moves the lever 36 and switch element 33 in a direction to open the switch. Such action of the lever 40 and spring 41 is subject to the control of a bellows 42 which is actuated by a thermostatic bulb 43 operatively connected to the bellows by conduit 44. The bulb 43 is arranged to contact the conduit 31 adjacent the discharge end of the coil 9 of the pre-cooler 6 so that the actuation of the bellows 42 is responsive to the temperature of the refrigerant discharged from coil 9. When the switch 32 is closed it will ordinarily remain so until the temperature of the refrigerant discharged from coil 9 is lowered to a point at which the collapse of bellows 42 will permit the spring 41 to overcome the toggle spring of the switch 32 and open it in the manner noted above.

In considering the operation of the apparatus which has been described it may be assumed that the thermostatic switch 32 is adjusted to cut in at say 42° and to cut out at 35°, and that the atmosphere surrounding the apparatus is above 42° F. In starting operation of the apparatus, as by closing a manual switch (not shown) in the supply line 24, if the carbonator is empty and the pre-cooler tank has just been filled with water at a temperature of, say, about 90° F., warm water

4

will be forced through the instantaneous cooler and into the carbonator by the motor-driven pump 20; and since the temperature of both of the thermostatic bulbs 38 and 43 will be above the cut-in point of 42° F., the condensing unit will start to operate. The expansion valve 28 having been set for a low side pressure corresponding to a temperature of 35° F. (or slightly lower) in the cooler coil 12, the liquid refrigerant delivered by the valve to the coil 12 will first be used to cool whatever water is in the coil 11 of the instantaneous cooler, and simultaneously the refrigerating effect will be applied in part to the reduction of the temperature of the water in the carbonator and thereafter to maintaining it at a low temperature. In initially starting the apparatus from a warm state the first water entering the carbonator may not be properly carbonated and accordingly it will be desirable to waste the first liquid drawn from the carbonator. Thereafter, if the draft of carbonated beverage is such as to place sufficient load on the instantaneous cooler and the carbonator, the entire refrigerating effect of the compressor will be absorbed by them if the compressor is of the moderate capacity preferred in carrying out the invention.

Let it be assumed, now, that either no drinks are being drawn from the carbonator or else that they are being drawn at a low rate, so that the cooling requirements of the instantaneous cooler and carbonator now are less than the capacity of the compressor. Notwithstanding this surplus compressor capacity the instantaneous cooler will not freeze up because the temperature in it cannot go below 35° F. provided for by the automatic expansion valve setting. What will happen under the stated conditions is that un-evaporated liquid refrigerant will pass out of the instantaneous cooler to the expansion coil 9 of the pre-cooler. Here, subject to the high temperature of the water in the pre-cooler tank, the refrigerant still in the liquid state will be evaporated and cooling of the water in the tank will result. Thus although the demand of the instantaneous cooler may have been satisfied, the condensing unit continues to operate for the purpose of reducing the temperature of the water in the storage tank. If during the cooling of the storage tank and its contents any demand is placed upon the instantaneous cooler, whether by reason of heat leakage or by the drawing of beverage from the carbonator, this demand will take precedence over the demand of the pre-cooler because the instantaneous cooler has "first call" on the refrigerating effect of the refrigerant supplied by the condensing unit.

To secure to the fullest extent the advantages of the improved apparatus the capacity of the condensing unit should not be made sufficiently large to meet the full or normal maximum dispensing rate of the apparatus when the pre-cooler storage tank is filled with warm water. Thus the size of the condensing unit preferably would be determined on the assumption that the water in the pre-cooler tank will be kept at a temperature not higher than a normal maximum of, say for example, 65° F. to enable the compressor and the instantaneous cooler properly to cool the water at the normal maximum dispensing rate; and further the refrigerant coil 9 of the pre-cooler preferably should be constructed to absorb the full capacity of the compressor only when the water in the pre-cooler tank may be above such normal maximum of 65° F. Under these conditions the condensing unit, once started, would

5

continue to operate until the demands of the instantaneous cooler had been met and also until the contents of the precooler tank had been reduced to 65° F. At this point the heat load on the system will drop below the potential refrigerating capacity of the amount of the refrigerant being circulated, and some unevaporated refrigerant will leave the cooling coil 9 and pass into the suction line 31 and in doing so will chill the thermostatic bulb 43 and cause the switch 32 to open and stop the condensing unit.

It has been specified that the thermostatic switch 32 be set for a cut-out temperature of 35° F. and that the expansion valve 28 be set for a low side pressure at the carbonator corresponding to a temperature of about 35° F. Since there is a certain amount of pressure drop in the instantaneous cooler and in the precooler from the pressure maintained in the entrance of the cooler coil by the automatic expansion valve 28, under normal operating conditions the refrigerant reaching the point in the system adjacent the bulb 43 will be at a somewhat lower pressure than that corresponding to 35° F. This action arises from the variation in temperature of the water in the pre-cooler tank 7. As long as that temperature is sufficiently high in relation to the temperature of the refrigerant in coil 9, the resulting heat transfer between the tank and coil causes a more or less super-heated state of the vaporized refrigerant in the discharge end of the coil adjacent bulb 43; but as the water temperature in tank 7 is lowered by operation of the compressor, a point is reached where there is insufficient heat transfer to completely vaporize the liquid refrigerant in coil 9. This liquid refrigerant, entering coil 31a at a pressure somewhat lower than that maintained at the entrance to coil 12 by expansion valve 28, affects bulb 43 and causes the cut-out of the thermostatic switch already noted.

As soon as the compressor stops operating, the suction line 31 will rapidly rise above the cut-in temperature of 42° F., but this will not cause the switch 32 to cut in because the bulb 43 can actuate the switch only in the cut-out direction. However, if from either heat leakage into the carbonator or draft of beverage therefrom the carbonator warms up to 42° F. this will cause the thermostatic bulb 38 to actuate the switch 32 in the closing direction and the cycle which has already been described will be repeated. In other words, the requirements of the instantaneous cooler and carbonator will be met first, and then the liquid refrigerant will pass over to the precooler where it may still further reduce the temperature of the storage water. Generally speaking, the size of the precooler tank 7 will determine the length of the operating cycle of the compressor and it is apparent that the combination with the instantaneous cooler of the storage type precooler not only in effect increases the working capacity of the instantaneous cooler but serves also to extend the working cycle of the apparatus to a tolerable length and prevent "short cycling."

It will be noted in the drawing that the refrigerant suction line 31 after passing the thermostatic bulb 43 is again brought into heat exchange relation with the storage tank 7 at point 31a. Thus if the operation of the thermostatic switch should tend to be somewhat sluggish at cut-out this arrangement will dry out any refrigerant which may have passed the bulb 43 prior to opening of the switch 32. With such a construc-

6

tion it is obvious that the part of conduit 31 contacted by bulb 43 should not be in direct heat exchange relation with the tank 7.

With respect to the operation of the thermostatic switch 32, while, as has been stated, the thermostatic bulb 38 serves only to close the switch in the normal operation of the apparatus, it may be observed that under abnormal conditions causing unduly low temperatures in the carbonator resultant contraction of the bellows 37 might serve also to open the switch.

In the modified construction shown in Fig. 2 of the drawing the precooler 46 comprises a closed tank 47 fitted with a manual air relief valve 48 and provided with an open inlet conduit 49 adapted to be connected to a water main or other suitable source of water under pressure so as to maintain the tank filled with water. As in the first construction the tank is fitted with a refrigerant cooling coil 50.

In the modified construction the instantaneous cooler 51 consists of a liquid cooling coil 52 threaded through a refrigerant coil 53, the upper inlet end of coil 52 being connected by conduit 54 with the lower part of the interior chamber of the storage tank 47 of the precooler while the lower discharge end of coil 52 is connected with conduit 55 which may lead to any desired point of draft. Also, as in the first construction, the lower inlet end of the refrigerant coil 53 connects with conduit 27' leading, as in the case of conduit 27 in Fig. 1, to the expansion valve and thence to the discharge of the condensing unit; and the upper discharge end of the refrigerant coil 53 is connected by conduit 30' to the inlet end of the expansion coil 50 of the precooler, while the outlet end of coil 50 is connected by conduit 31' with the intake of the condenser unit.

The control devices for the modified construction comprise thermostatic bulb 38' responsive to the liquid discharge temperature of the instantaneous cooler and bulb 43' responsive to the temperature of the discharge refrigerant of the precooler, these thermostatic bulbs being connected with switch mechanism which is like that shown in Fig. 1 and need not, therefore, be further described.

In the modified construction, as will be apparent, the flow of the liquid to be cooled is unobstructed from the inlet conduit 49 into the precooler tank, thence through conduit 54 and the instantaneous cooler, and need be subject to control only at the point of draft from the liquid discharge conduit 55. The thermostatic control of the operation of the modified construction is substantially the same as that of the first described construction and therefore the description need not be repeated.

To those familiar with liquid cooling apparatus and the various kinds of cooling applications it will be apparent that the apparatus which has been described has distinct advantages and is susceptible of various applications or uses. In particular, the improved apparatus is especially adapted to meet the requirements of automatic beverage vending machines where the power capacity of the refrigerant compressor is necessarily quite limited. Under such conditions it has all the advantages of an instantaneous cooler but without its usual disadvantages under those conditions and at the same time it has the advantage of a storage cooler without the latter's lack of close temperature control. The construction of the apparatus both with respect to

the cooler units and the thermostatic control mechanism is simple and relatively inexpensive. The automatic type of expansion valve which may be used is well known for its dependable operation.

It will also be apparent to those familiar with liquid cooling apparatus that the particular embodiments of the invention which have been shown and described may be modified in various ways within the bounds of the invention as defined in the appended claims.

What is claimed is:

1. In liquid cooling apparatus, the combination of a liquid precooler comprising a liquid chamber and a refrigerant expansion chamber in heat-absorbing relation thereto; an instantaneous type liquid cooler comprising conduit means providing a definite path for the flow of liquid to be cooled and a refrigerant expansion chamber associated with the conduit means; means for conducting liquid from the precooler to the instantaneous cooler to replace liquid drawn from the latter; a motor-driven refrigerant condensing unit; refrigerant conduit means for conducting liquid refrigerant from the discharge of the condensing unit to the refrigerant chamber of the instantaneous cooler; means for controlling the passage of refrigerant through the said conduit, said means being responsive to change of pressure in the refrigerant expansion chamber of the instantaneous cooler; means for conducting refrigerant from the expansion chamber of the instantaneous cooler to the expansion chamber of the precooler and from the latter chamber to the intake of the condensing unit; and means for starting and stopping the refrigerant condensing unit responsive to the temperature of the liquid discharged from the instantaneous cooler to start the unit and responsive to the temperature of refrigerant discharged from the precooler to stop the unit.

2. Liquid cooling apparatus as claimed in claim 1 in which the capacity of the refrigerant condensing unit is sufficient only to carry the maximum heat load imposed on the instantaneous cooler.

3. Liquid cooling apparatus as claimed in claim 1 in which the precooler is of the storage type having a liquid-holding capacity largely in excess of that of the instantaneous cooler.

4. In liquid cooling and carbonating apparatus,

the combination of a liquid precooler comprising a liquid chamber and a refrigerant expansion chamber in heat-absorbing relation thereto; liquid carbonating means comprising a carbonating chamber; an instantaneous type liquid cooler comprising conduit means forming a definite path for the flow of liquid to be cooled and a refrigerant expansion chamber in heat-absorbing relation to said conduit means and to the carbonating chamber; means for conducting liquid from the outlet of the precooler to the inlet of the instantaneous cooler and from the outlet of the latter into the carbonating chamber; a motor-driven refrigerant-liquefying means; refrigerant conduit means for conducting liquid refrigerant from the liquefying means to the refrigerant chamber of the instantaneous cooler; means responsive to change of pressure in the refrigerant chamber of the instantaneous cooler for controlling admission of refrigerant to the chamber; means for conducting refrigerant from the expansion chamber of the instantaneous cooler to the expansion chamber of the precooler and from the latter chamber to the liquefying means; and means for starting and stopping the refrigerant liquefying means responsive to the temperature of the liquid discharged from the instantaneous cooler into the carbonating chamber to start the liquefying means and responsive to the temperature of the refrigerant discharged from the precooler to stop the liquefying means.

5. A liquid cooling and carbonating apparatus as claimed in claim 4 in which the carbonating chamber has a liquid-holding capacity substantially in excess of that of the instantaneous cooler.

MARGARET B. WYLLIE,
Executrix of the Last Will and Testament of John Wyllie, Jr., deceased.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,278,225	Taylor	Mar. 31, 1942
2,278,226	Taylor	Mar. 31, 1942
2,317,484	Richmond et al.	Apr. 27, 1943