April 18, 1961 D. B. GARDNER 2,979,915

OFF SEASON LIQUID CHILLER CONTROL DEVICE

Filed Jan. 9, 1957 2 Sheets-Sheet 1

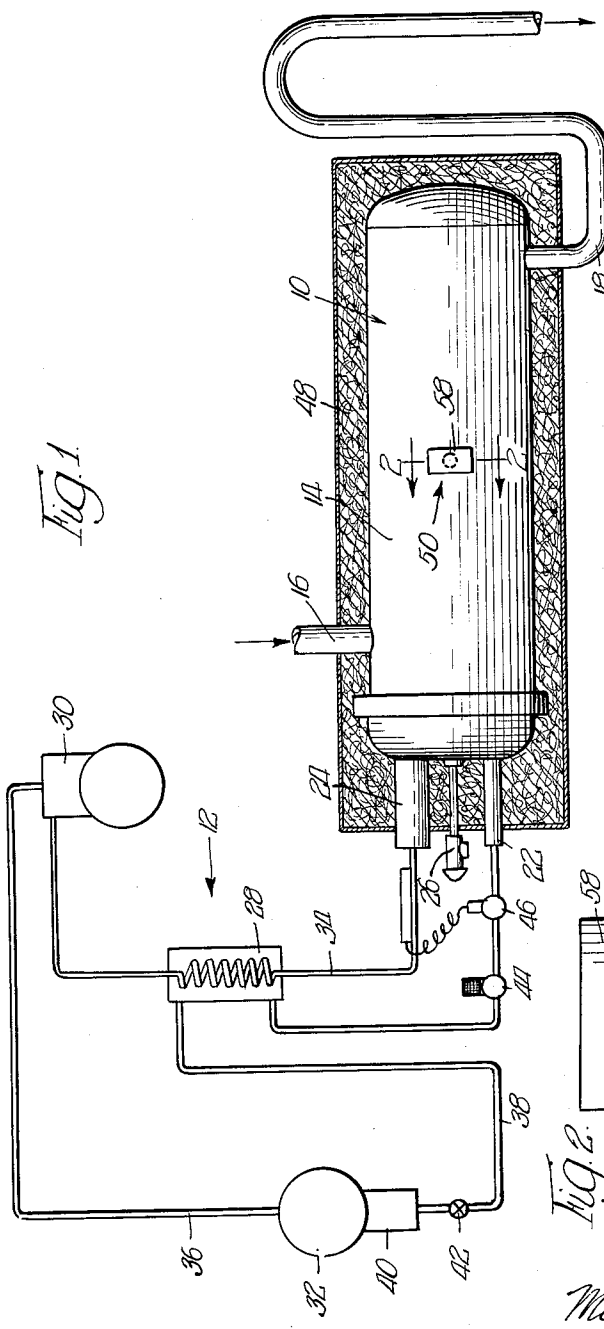

Fig. 1

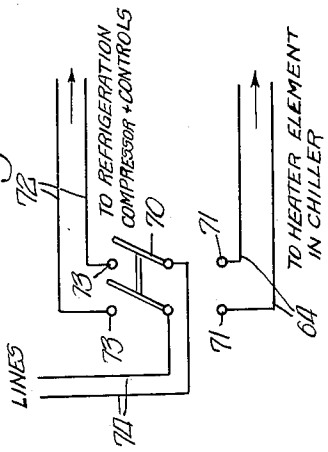

Fig. 3

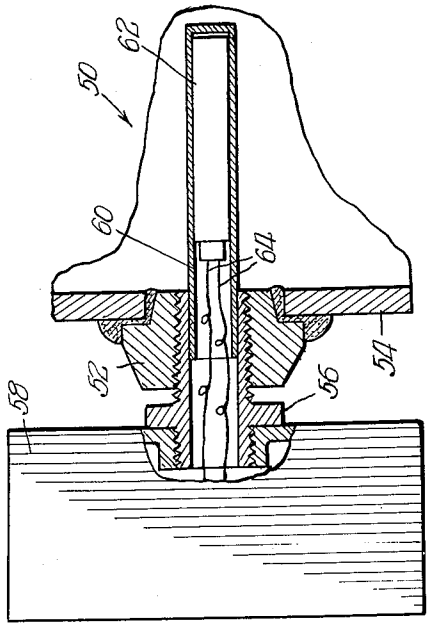

Fig. 2

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Fig. 5

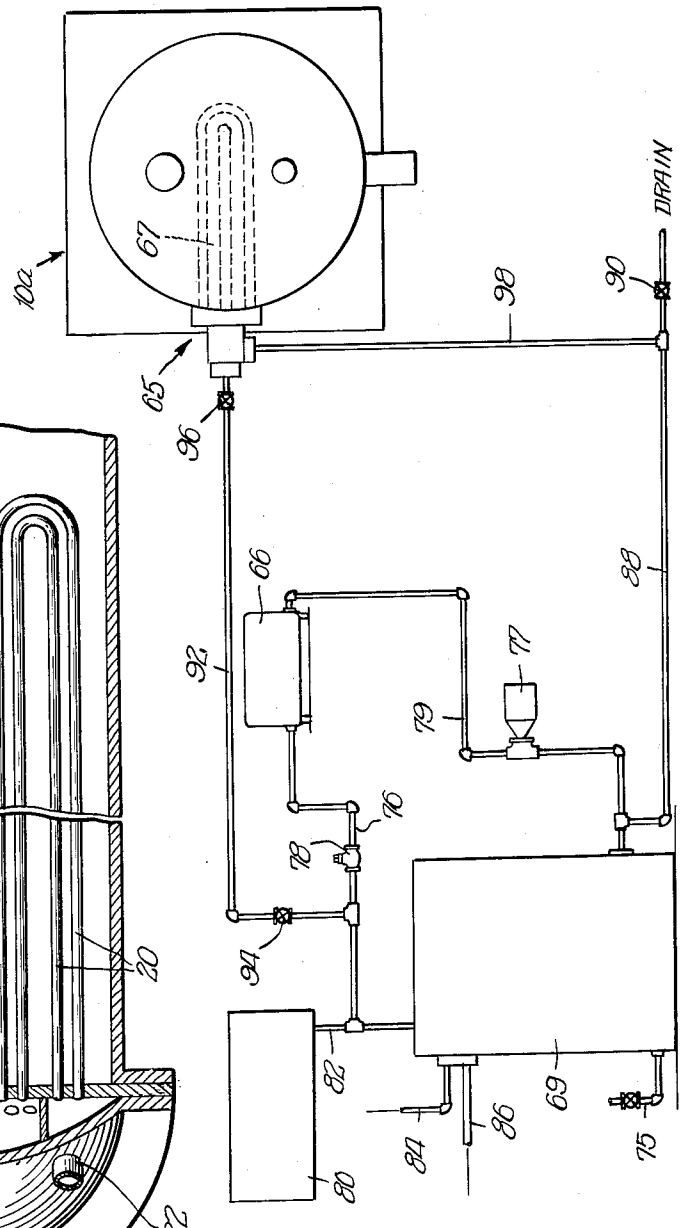
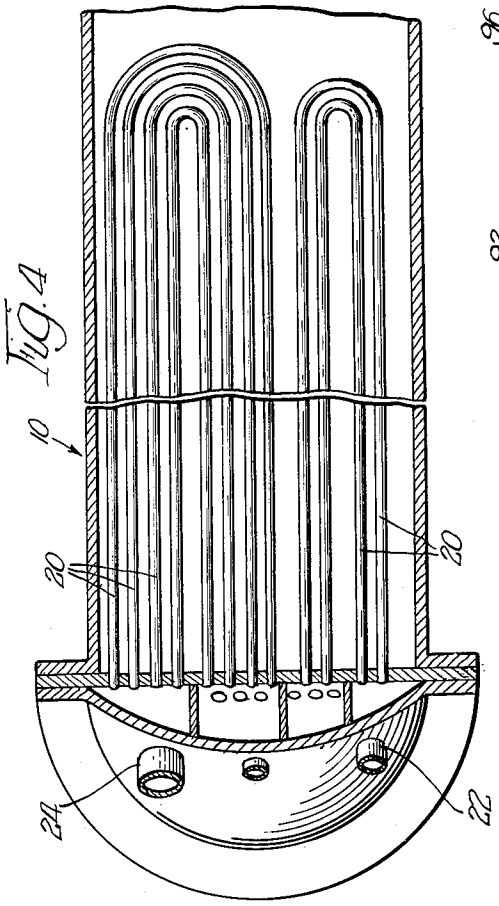


Fig. 4



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OFF SEASON LIQUID CHILLER CONTROL DEVICE

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4 Claims. (Cl. 62—132)

My invention relates to an off season liquid chiller control device and method, and more particularly, to a method and device for preventing the accumulation of liquid refrigerant in the evaporator tubes of the chiller during off season periods, or periods of prolonged shutdown.

A major problem confronting the owner or operator of, for instance, large capacity liquid chillers, is created during periods when operation of the chilling equipment is not required, such as during the winter months when the apparatus is not put into operation over a period of many weeks.

It is generally known in the art that most valves in a refrigeration system allow at least a small amount of leakage, whether they are manually or automatically operated. When a refrigeration system stops, conventionally a valve in the refrigerant liquid line is closed, which causes the system to concentrate the liquid refrigerant in the condenser. It is known that when this happens, the refrigerant tends to leak by this valve in either liquid or gaseous form and collects in liquid form in the coolest portion of the system, which ordinarily is the evaporator, conventionally located within the liquid chiller.

Short intervals of non-operation do not effect the efficiency of the system nor endanger the compressor, but during long periods of shutdown, there is some danger that relatively large quantities of liquid refrigerant will accumulate in the evaporator, especially if special efforts have not been taken to insure that the refrigerant is isolated in the condenser. If this accumulation occurs, when the compressor is again started, it is possible to move, or "slug," the accumulated liquid refrigerant from the evaporator into the compressor with consequent damage to the compressor.

The principal object of my invention is to provide a device and method for insuring that refrigerant does not accumulate in the evaporator tubing of liquid chillers and the like.

Another object of the invention is to provide a device and method for protecting the refrigeration systems of liquid chillers against accumulation of liquid refrigerant in the evaporator therefor which permits automatic operation of the refrigeration system thoughout the entire year.

A further object of the invention is to provide a device for controlling the temperature of the evaporator during shutdown periods to prevent accumulation of liquid refrigerant therein.

Yet a further object of the invention is to provide a liquid chiller temperature control which is susceptible of a wide variety of embodiments, which is of general application to apparatus of this character, which is efficient in operation, and which is of the utmost simplicity of design thereby making for inexpensive installation and manufacturing cost.

In accordance with the principles of my invention, the liquid to be chilled that remains in the liquid chiller upon shutdown is heated sufficiently to raise and maintain the temperature of the evaporator above that of the condenser. I prefer to heat this remaining liquid to approximately 10 degrees Fahrenheit above room temperature (assuming 68 degrees Fahrenheit to be "room temperature") and maintain it at this temperature during the period of shutdown. This insures that the refrigerant will be driven from the evaporator through the system to the condenser where it collects.

Other objects, uses, and advantages will be obvious or become apparent from a consideration of the following description and the accompanying drawings.

In the drawings:

Figure 1 is a diagrammatic view of a chiller for liquids such as water together with the refrigeration system therefor, illustrating my invention applied to the chiller;

Figure 2 is a diagrammatic cross-sectional view along line 2—2 of Figure 1;

Figure 3 is a diagrammatic illustration of a preferred form of switch for controlling the operation of the chiller refrigeration system and the temperature control device shown in Figures 1 and 2;

Figure 4 is a diagrammatic perspective view, partially in section and with parts broken away, illustrating some of the structural features of the chiller; and

Figure 5 is a diagrammatic view illustrating a modified form of the invention and the system for operating same.

Reference numeral **10** of Figure 1 generally indicates a liquid chiller and reference numeral **12** generally indicates a diagrammatically illustrated refrigeration system therefor. The chiller **10** may be of the type manufactured by Bell & Gossett Company of Morton Grove, Illinois, and generally comprises a substantially cylindrical hollow body or tank **14** to which inlet conduit **16** and outlet conduit **18** are connected for bringing the liquid to be chilled, such as water, to the chiller and conveying same therefrom to the point of use.

The chiller **10** includes a plurality of refrigerant tubes **20** (see Figure 4) mounted therein in any suitable manner through which the cooling fluid, such as Freon 12 passes in performing its function of cooling the liquid to be chilled. Suitable supporting baffles (not shown) are ordinarily provided. The chiller **10** is conventionally provided with a refrigerant inlet conduit **22**, a refrigerant outlet conduit **24** and a refrigerant charging valve **26** which is only diagrammatically illustrated. The conduits **22** and **24** are connected into the refrigeration system **12** which, as indicated in Figure 1, may include a suitable heat exchanger **28**, a compressor **30**, and a condenser **32**. The conduit **24** communicates with the compressor **30** through appropriate piping **34** which in turn communicates with the condenser **32** through appropriate piping **36**. The condenser **32** communicates with the conduit **22** through appropriate piping **38** that passes through heat exchanger **28** and has mounted therein a strainer **40**, a shutoff valve **42**, a solenoid valve **44**, and a thermostatic expansion valve **46**. The chiller **10** may be surrounded by appropriate insulation **48** in an amount determined by the operating conditions of the particular installation.

The chiller and the refrigeration therefor illustrated may be composed of conventional elements and devices in a manner well known in the art and the diagrammatic illustration of Figure 1 is provided for illustrative purposes only.

The chiller and its refrigeration system illustrated in Figure 1 is modified in accordance with the principles of my invention to provide a heater or heat exchange device that will heat up the water or other liquid remaining in the chiller during the shutdown period to the desired temperature. One form of appropriate heater or

heat exchange device is generally indicated by reference numeral 50 of Figures 1 and 2.

The device 50 comprises an adapter element 52 fixed to the wall 54 of the chiller in any appropriate manner, as by welding, in which is screw threadedly mounted a fitting 56. A control box 58 is fixed to the outer end of fitting 56 in any suitable manner. Fixed to the inner end of the fitting 56 is a metallic container 60 which forms a well for electric heater element 62 that is received therein. The container 60 may be formed from a heat conducting substance such as copper and may be fixed to the fitting 56 in any suitable manner, as by brazing. The heater 62 may comprise a 75 or 100 watt, 220 volt single phase cartridge heater provided with appropriate wiring 64 that extends into the control box 58. The control box 58 may be arranged in any conventional or suitable manner to provide electric current for the heater 62, though the arrangement illustrated in Figure 3 is preferred. Preferably, a double throw switch 70 is mounted between the terminals 71 of the wiring 64 and the terminals 73 of the wiring 72 that controls the refrigeration compressor and controls, the switch 70 being connected to power lines 74 that are in turn connected to a source of electrical energy.

The outlet piping 18 of the chiller may be formed with the S curve indicated in Figure 1 to act as a convection flow check when heater 62 is turned on.

In operation, when the switch 70 is operated to shut off the chiller 10, it is moved to connect the heater device 62 to the source of electrical energy. Preferably, the heater device 62 is designed to heat the water or other liquid remaining in the chiller to approximately 10 degrees Fahrenheit above room temperature (which ordinarily approximates 68 degrees Fahrenheit) and maintain this liquid at that temperature throughout the period of shutdown.

By heating the liquid to be chilled that remains in the chiller after shutdown has occurred, the accumulation of liquid refrigerant within the evaporator tubes of the chiller is prevented. The temperatures specified are preferred, though the arrangement of the refrigeration system illustrated are exemplary only. The essential factor is that the temperature of the evaporator tubing should be maintained at a temperature above that of the condenser. If this is done, refrigerant on the low pressure side of the system will move through the system to the condenser and remain there during the period of idleness. It is helpful to position the chiller at the lowest point in the system with regard to elevation, with the condenser positioned above the chiller and the compressor positioned above the condenser. However, these relative locations may be altered without adversely affecting the beneficial results provided by my invention.

The principal reason why my invention effectively prevents the accumulation of liquid refrigerant in the chiller evaporator tubes is that the refrigerant tends to move to and accumulate in the coolest part of the refrigeration system. Heretofore, the coolest part has been the evaporator tubes. By heating these evaporator tubes so that the temperature of the evaporator will be above that of the condenser, the refrigerant will naturally seek the condenser, which is where the refrigerant should be during shutdown periods.

Figure 5 diagrammatically illustrates the modified form of heater applied to the chiller 10*a* which is similar in structure to the chiller 10. Reference numeral 65 generally indicates a heated fluid type of heat exchanger which includes diagrammatically illustrated tubing 67 that extends into the interior of the chiller 10*a* in a manner similar to that of the device 50. The heater 65 as illustrated is incorporated in a gravity operated circuit for supplying same with hot water from a conventional boiler 69, the main purpose of which is to heat radiators 66 of a building or other structure as well as a domestic faucet water. Water is supplied to the boiler through suitable piping 75 and is heated in a conventional manner

by a suitable burner operated by controls that maintain a constant boiler water temperature. Whenever thermostatic controls call for heat, a circulating pump 77 is operated to pump heated water through piping 79 to the radiator or radiators 66. Water from the radiators 66 (only one of which is shown) returns to the boiler through appropriate piping 76, including a flow control valve 78 and communicating with a conventional expansion tank 80 through a pipe 82. Domestic hot water is drawn from the boiler through appropriate piping 84 and cold water enters the boiler through piping 86. Drain piping 88 may also be provided which includes a suitable control valve 90.

The heater 65 is supplied with hot water through appropriate piping 92 in which is interposed a suitable form of gate valve 94 and an appropriate vent valve 96. The water passing from heater 65 flows to the drain piping 88 through appropriate piping 98 and when valve 90 is closed it is drawn by pump 77 back to the piping 79. Gate valve 94 is adjusted to permit a liquid flow that will heat the liquid remaining in the chiller to approximately 10 degrees Fahrenheit above room temperature.

It will be appreciated that the system diagrammatically illustrated in Figure 5 provides results similar to those of the system of Figures 1 and 2 in heating the chiller evaporator to a temperature above that of a refrigeration system condenser. Of course, a steam heat exchanger similar to the hot water heat exchanger 65 may be employed in a similar system connected with a steam boiler. In either type of heated fluid system, appropriate flow controls can be interposed in the piping to the heat exchanger and electrical controls positioned in or on the chiller to provide any desired predetermined temperature. It will be appreciated that there are many ways to control the operation of a heat exchange device such as device 65 by control devices for controlling the fluid flow in response to the temperature of the water or the like that is in the chiller.

The foregoing description and the drawings are given merely to explain and illustrate my invention and the manner in which it may be performed, and the invention is not to be limited thereto except in so far as the appended claims are so limited since those skilled in the art who have my disclosure before them will be able to make modifications and variations therein without departing from the scope of the invention.

I claim:

1. In apparatus of the class described, the combination of a chiller tank through which a liquid is adapted to be circulated, a refrigerating system adapted to cool said liquid including a compressor, a condenser, and an evaporator connected in series in a closed loop with a vaporizable refrigerant therein and with the evaporator being located in said chiller tank, and heating means for maintaining the temperature of the evaporator sufficiently above that of the condenser when the system is shut down and the apparatus is completely out of use for long periods of time whereby condensation of refrigerant does not take place in the evaporator while the system is shut down.

2. In apparatus of the class described, the combination of a chiller tank through which a liquid is adapted to be circulated, a refrigerating system adapted to cool said liquid including a compressor, a condenser, and an evaporator connected in series in a closed loop with a vaporizable refrigerant therein and with the evaporator located in said chiller tank, a source of electrical power for operating said compressor, electrical controls for controlling said system in response to demand, said controls being selectively connectible to said source of electrical power, and heating means for maintaining the temperature of said evaporator above that of said condenser when the system is shut down, said power is disconnected from said compressor and controls, and the apparatus is completely out of use for long periods of time.

3. Apparatus as set forth in claim 2 in which said heating means includes a heating device mounted in the chiller tank and constructed and arranged to supply heat to said evaporator at a rate that will be sufficient merely to maintain at all times the temperature of said evaporator above that of the condenser.

4. Apparatus as set forth in claim 1 in which said heating means comprises a continuously operating low wattage electrical heater having heat exchange relationship with the liquid in the cooler.

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