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(54) **Cooler**

(57) A cooler (1) is switchable between a first mode of operation in which a refrigeration circuit is controlled in response to thickness of an ice bank formed on an evaporator (9) of the refrigeration circuit so that complete erosion of the ice bank (13) can be prevented, and a second mode of operation in which the refrigeration circuit is controlled in response to temperature of the coolant

(5) so that complete erosion of the ice bank (13) may occur. A compressor of the refrigeration circuit may be controlled in the first mode of operation to maintain a thickness of the ice bank (13) between upper and lower limits and in the second mode of operation to maintain the temperature of coolant (5) between upper and lower limits when the ice bank (13) has been completely eroded.

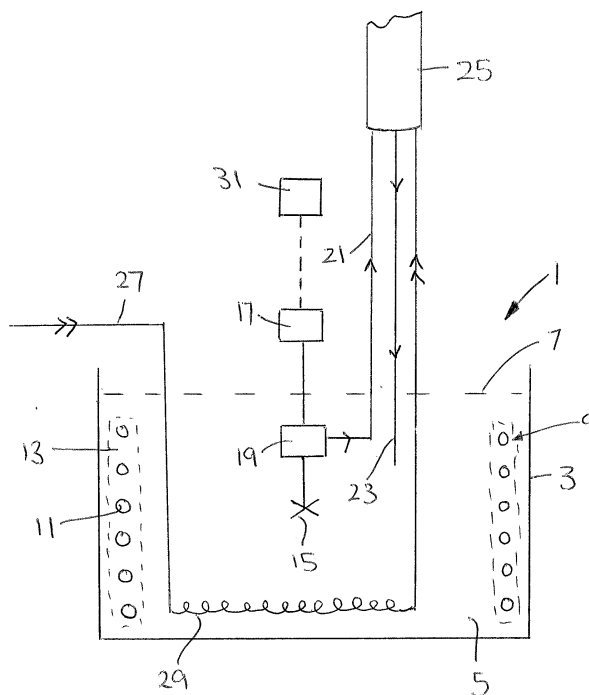


FIGURE 1

Description

[0001] This invention relates to coolers, more especially beverage coolers and beverage dispense systems employing such coolers. The invention has particular, but not exclusive application to dispense of alcoholic beverages such as beer, lager, cider and the like although it is envisaged the invention may have wider application to the dispense of other types of beverage both alcoholic and non-alcoholic.

[0002] Bulk containers such as kegs or barrels containing alcoholic beverages such as beer, lager, cider and the like are typically stored in a cold room or cellar remote from the serving area such as a bar so as to maintain the beverage at a constant temperature. A product line that connects the bulk container to a dispense head in the serving area for dispense of the stored product usually passes through an insulated sleeve between the storage area and the serving area to reduce heat exchange between the product and the ambient environment so as to maintain the product temperature.

[0003] The product may be further cooled in the storage area by passing the product line from the storage container through a cooler located within the storage area before it enters the insulated sleeve. Coolant in the cooler may be pumped around a cooling circuit extending between the storage area and the serving area. The cooling circuit is contained within the insulated sleeve and helps to prevent product in the product line warming up between the storage area and the serving area and/or may provide additional cooling in the serving area for the product to achieve a desired dispense temperature and/or for any other cooling requirements such as to produce ice or condensation on an external surface of the dispense head.

[0004] A common type of cooler employed in such dispense systems comprises a tank containing water in which an evaporator of a refrigeration circuit is immersed for cooling the water by heat exchange with a refrigerant circulated through the evaporator when a compressor of the refrigeration circuit is switched on. The evaporator is typically provided in the form of a helical or spiral coil around the inner wall of the tank and operation of the refrigeration circuit may cool the water so as to cause the water to freeze around the evaporator coil to build up a bank of ice. The compressor may be switched off when a pre-determined maximum thickness of the ice is achieved.

[0005] The ice bank gradually melts in response to a heat load placed on the cooler due to a cooling demand for product cooling within the cooler and/or to a cooling demand in the cooling circuit and, when the ice bank has eroded to a pre-determined minimum thickness, the compressor is switched back on until the ice bank has been re-built back to the pre-determined maximum thickness.

[0006] The ice bank provides a thermal reserve or cold store that enables the cooler to meet increased heat loads occurring during periods of high demand for prod-

uct cooling and/or other cooling requirements of the system within the insulated sleeve and/or serving area. Coolers of this type are commonly referred to as "ice bank coolers".

[0007] Between serving periods when there is no dispense of product, the demand for product cooling is reduced but there may still be a heat load due to a cooling demand placed on the cooling circuit to meet other cooling requirements of the system. As a result, the ice bank may still be eroded during such periods, albeit at a lower rate than occurs during serving periods when the heat load is generally higher, with the result that the compressor may be switched on to re-build the ice bank between serving periods.

[0008] Maintaining the ice bank between the pre-determined maximum and minimum thicknesses during such non-serving periods may involve switching the compressor on and off several times over an extended period of time between dispense periods such as overnight or longer where the dispense system is not in daily use such as in sporting stadia where the dispense system may only be used when an event is being staged which may only occur on a weekly basis.

[0009] Switching a compressor on and off is wasteful of energy and may also reduce the working life of the compressor. The present invention has been made from a consideration of the foregoing and seeks to provide a cooler in which such problems are reduced or eliminated.

[0010] Thus, the invention preferably seeks to provide a cooler, especially an ice bank cooler, in which energy consumption may be improved.

[0011] More especially, it is desired object of the invention to provide an ice bank cooler in which operation of the compressor to form the ice bank is controlled so that energy consumption may be reduced and/or compressor switch-ons may be reduced, particularly, but not necessarily, during periods of reduced cooling demand.

[0012] It is another desired object of the invention to provide a beverage dispense system employing such a cooler for the dispense of beverages including, but not limited to, alcoholic beverages such as beer, lager, cider and the like.

[0013] According to a first aspect of the invention, there is provided a cooler comprising a tank to contain a liquid coolant, a refrigeration circuit including an evaporator and a compressor, the evaporator being located in the tank so that, in use, coolant in the tank can form an ice bank on the evaporator, wherein, in a first mode of operation, the compressor is controlled in response to the ice bank and, in a second mode of operation, the compressor is controlled in response to temperature of the coolant.

[0014] The first mode of operation seeks to maintain a pre-determined minimum ice bank reserve on the evaporator while the second mode of operation allows the ice bank to be completely eroded.

[0015] By switching the compressor on before the ice bank is completely eroded during the first mode of oper-

ation, the cooler is able to respond to and meet rapid changes in the cooling demand placed on the cooler.

[0016] In contrast, by allowing the ice bank to be completely eroded during the second mode of operation, the cooler can make full use of the cooling capacity of the entire ice bank which may result in energy savings and/or reduce the number of compressor switch-ons with potential improved service life of the compressor.

[0017] Preferably, the compressor is switched off in the first mode operation when a pre-determined maximum ice bank reserve is formed on the evaporator.

[0018] Preferably, the compressor is switched on and off in the first mode of operation in response to any suitable means for monitoring the ice bank reserve. For example, ice bank thickness may be monitored by sensors or probes.

[0019] Preferably, the compressor is switched on in the second mode of operation in response to an increase in temperature of coolant in the tank indicating the ice bank has been completely eroded.

[0020] Preferably, the cooler includes an agitator for circulating coolant in the tank. The agitator may be operable continuously or intermittently in one or both modes of operation. The agitator may be controlled in response to coolant temperature in the tank.

[0021] Preferably, the cooler includes a pump for circulating coolant around a cooling circuit to provide a cooling load externally of the cooler. The pump may be operable continuously or intermittently in one or both modes of operation. The pump may be controlled in response to coolant temperature in the tank and/or cooling circuit, for example the temperature of a return flow of coolant to the tank.

[0022] Where provided the agitator and pump may be separate units each preferably having its own motor or a combined unit that may employ a single motor for both the agitator and pump. Where provided a motor can be of any suitable type, for example single speed, multi speed or variable speed. A variable speed motor may be infinitely adjustable or variable in steps, for example 10% of the maximum operating speed of the motor. Where permitted, speed of the motor may be controlled according to the operating requirements of the cooler in one or both modes of operation.

[0023] In one arrangement, the cooler can be switched manually between the first and second modes. In another arrangement, the cooler can be switched automatically between the first and second modes.

[0024] A time switch may be employed to switch automatically between the first and second modes. The time switch may be adjustable to pre-set the switching time (s). Where automatic switching is employed, a manual over-ride switch may be provided to switch from one mode to the other during a pre-set period.

[0025] In both arrangements (manual and automatic), the switching may be achieved via a control panel. The control panel may be positioned locally to or remotely from the cooler and a wired or wireless link may be pro-

vided for switching between the first and second modes.

[0026] According to a second aspect of the invention, there is provided a cooler comprising a tank to contain a liquid coolant, a refrigeration circuit including an evaporator and a compressor, the evaporator being located in the tank so that, in use, coolant in the tank can form an ice bank on the evaporator, wherein, in a first mode of operation, the refrigeration circuit is controlled to maintain an ice bank on the evaporator and, in a second mode of operation, the refrigeration circuit is controlled to maintain temperature of the coolant between upper and lower limits without maintaining the ice bank.

[0027] The cooler may comprise separately or in combination any of the features of the cooler previously described in connection with the first aspect of the invention.

[0028] According to a third aspect of the invention, there is provided a cooler that is switchable between a first mode of operation in which a refrigeration circuit is controlled in response to thickness of an ice bank formed by coolant on an evaporator of the refrigeration circuit whereby complete erosion of the ice bank can be prevented, and a second mode of operation in which the refrigeration circuit is controlled in response to temperature of the coolant whereby the ice bank may be eroded to a greater extent than in the first mode of operation and may be eroded completely.

[0029] Thickness of the ice bank may be maintained between upper and lower limits in the first mode of operation and may be eroded below the lower limit in the second mode of operation. Temperature of the coolant may be maintained between upper and lower limits when the ice bank has been completely eroded in the second mode of operation. Reformation of the ice bank may be prevented in the second mode of operation. Switching means for switching the cooler between the first and second modes of operation may be manual and/or automatic. Automatic operation of the switching means may be controlled via a timer. The timer may be programmable to set and/or change a time at which the cooler is switched from one mode to the other. Manual switching may be provided in addition to automatic switching and may override automatic switching.

[0030] The cooler may comprise separately or in combination any of the features of the cooler previously described in connection with the first aspect of the invention.

[0031] According to a fourth aspect of the invention, there is provided a beverage dispense system employing a cooler according to the first or second or third aspects of the invention.

[0032] According to a fifth aspect of the invention, there is provided a method of controlling a cooler of the type having a tank containing liquid coolant and a refrigeration circuit including a compressor and an evaporator in which coolant contained in the tank can form an ice bank on the evaporator, the method comprising the steps of controlling operation of the compressor in response to the ice bank in a first mode of operation and controlling operation of the compressor in response to coolant temper-

ature in a second mode of operation.

[0033] Preferably, the compressor is controlled to maintain the ice bank between upper and lower limits in the first mode of operation.

[0034] Preferably, the compressor is controlled to maintain coolant temperature between upper and lower limits when the ice bank is completely eroded in the second mode of operation.

[0035] Preferably, the upper limit of the ice bank is established on changing over from the first mode of operation to the second mode of operation. In this way, the maximum ice bank reserve is available for meeting cooling demand on the cooler before operation of the compressor is required in response to coolant temperature in the second mode of operation.

[0036] Preferably, the upper limit of the ice bank is established on changing over from the second mode of operation to the first mode of operation. In this way, the maximum ice bank reserve is available for meeting cooling demand on the cooler before operation of the compressor is required in response to erosion of the ice bank to the lower limit in the first mode of operation.

[0037] According to a sixth aspect of the invention, there is provided a method of operating an ice bank cooler to control an ice bank within the cooler, wherein in a first mode of operation the ice bank is maintained between upper and lower limits to meet cooling demand on the cooler and, in a second mode of operation, the ice bank is permitted to erode below the lower limit to meet cooling demand on the cooler without reforming the ice bank wherein the cooler is switched from the first mode of operation to the second mode of operation to conserve energy when cooling demand on the cooler is low.

[0038] Preferably, the cooler is operable to maintain coolant temperature in the cooler between upper and lower limits in the second mode of operation without reforming the ice bank, for example by switching a compressor of a refrigeration unit on and off in response to coolant temperature..

[0039] The invention will now be described in more detail by way of example only with reference to the accompanying drawing in which the single Figure depicts a cooler embodying the invention.

[0040] Referring to the accompanying drawing, a cooler 1 is shown. The cooler 1 may be employed in a dispense system for beverages. The cooler 1 comprises a tank 3 having, for example, a generally rectangular shape in plan view. Other configurations of the tank 3 may be employed. The tank 3 contains a liquid coolant 5. An upper surface or level of the coolant 5 is indicated by line 7. The coolant 5 may be water but the invention is not limited thereto.

[0041] An evaporator 9 of a refrigeration circuit for cooling the water 5 is positioned within the tank 3. The evaporator 9 preferably comprises a helix of coils 11 having, for example, a generally rectangular shape in plan view. Other configurations of the evaporator 9 may be employed. The coils 11 of the evaporator 9 are preferably

positioned adjacent to the inner wall of the tank 3 and are immersed within the water 5. The water 5 is cooled by heat exchange with refrigerant passing through the coils 11 when a compressor (not shown) of the refrigeration circuit is switched on.

[0042] When the rate of cooling exceeds the heat load on the dispense system, the water in the tank 3 gradually freezes and builds-up an ice bank 13 (shown by dotted lines) around the coils 11 until a sensor (not shown) detects that a pre-determined maximum reserve of ice has been achieved whereupon the compressor (not shown) is switched off.

[0043] The ice bank 13 is then gradually melted to cool the water in response to the heat load placed on the system until a sensor (not shown) detects a pre-determined minimum reserve of ice has been reached whereupon the compressor (not shown) is switched back on to rebuild the ice bank 13 until the pre-determined maximum reserve of ice is reached and the compressor is switched off.

[0044] The sensors for detecting the maximum and minimum reserve of ice may be of any suitable type, for example the sensors may detect the thickness of the ice bank 13 formed on the coils 11 of the evaporator 9 directly, for example by contact with the ice bank, or indirectly, for example by monitoring conductivity or temperature within the ice bank.

[0045] An agitator 15 having, for example, the form of a paddle or impeller is immersed within the water and is operable by an electric motor 17 located externally of the tank 3 to circulate the water 5 in the tank 3 so that the water washes over the coils 11 of the evaporator 9 and any ice bank 13 formed thereon. The arrangement of the coils 11 relative to the inner wall of the tank 3 may be such that water can wash over the coils 11 and any ice bank 13 formed thereon on both sides of the helix. In this embodiment, the agitator 15 is combined with a submersible pump 19 that is also operable by the motor 17 to circulate the water from the tank 3 through a cooling circuit including a supply line 21 and a return line 23.

[0046] The motor 17 may be a single speed motor. More preferably the motor speed is adjustable according to the cooling requirements. Thus, the motor 17 may be a twin speed motor that can be switched between high and low speeds. Alternatively, the motor 17 may be a variable speed motor where the motor speed may be infinitely variable or variable in steps of, for example, 10% of maximum running speed.

[0047] The cooler 1 is normally located remotely from a serving area (not shown), for example in a cellar or cold room, and the supply line 21 and return line 23 are contained within a sleeve 25 that extends from the cellar or cold room to the serving area and is preferably insulated to reduce heat exchange between the water pumped around the cooling circuit and the surrounding environment.

[0048] Also contained within the sleeve 25 is a product line 27 for delivery of product from a storage container

(not shown) such as a keg or barrel located in the cellar or cold room to a dispense point in the serving area. The product line 27 is bundled with the supply and return lines 21, 23 of the cooling circuit within the sleeve 25 to form what is commonly referred to as a "python".

[0049] In this embodiment, the product line 27 is connected to a coil 29, for example a helical coil, immersed within the water in the tank 3 for cooling product between the storage container and the sleeve 25. Other configurations of the coil 29 may be employed. In other embodiments, the coil 29 may be omitted. The product may be an alcoholic beverage such as beer, lager, cider but the invention is not limited thereto. A single product line is depicted for simplicity but it will be understood that more than one product line may be provided. Where more than one product line is provided, some, all or none of the product lines may be connected to a separate coil immersed within the tank 3 for cooling product in the associated product line prior to passing through the sleeve 25 to the serving area.

[0050] The water pumped around the cooling circuit prevents the product in the product line 27 warming up to any appreciable extent within the sleeve 25 and may be used to provide additional cooling in the serving area. Additional cooling may be used, for example, to further cool product in the product line 27 to achieve a desired dispense temperature and/or to cool the dispense head to create ice or condensation on an outer surface of the dispense head. As a result, the temperature of the water returned to the tank 3 in the return line 23 can be higher than the temperature of the water in the tank 3 thereby adding to the cooling demand in the cooler 1.

[0051] In use, the heat load on the cooler 1 during a serving period when the cooler 1 responds to cooling demands from both the cooling circuit and from the dispense of product is greater than the heat load between serving periods when product is not being dispensed and the cooler may only have to respond to the cooling demand from the cooling circuit. Moreover, the cooling demand from the cooling circuit may be reduced between serving periods compared to that arising during a serving period due to a reduced cooling requirement in the python and/or the serving area leading to a further reduction in the heat load on the cooler 1 between serving periods. Switching the compressor on and off to maintain a minimum reserve of ice bank at all times is wasteful of energy and the present invention proposes employing different modes of operation in order to reduce energy consumption as now described.

[0052] In a first mode of operation of the cooler 1, the compressor responds to the sensor(s) monitoring the ice bank reserve as described above to maintain the ice bank between the minimum and maximum limits. In this mode of operation, the motor 17 driving the combined agitator 15 and pump 19 operates continuously or intermittently at fixed or variable speed in response to the temperature of the water in the tank 3 or in the cooling circuit, for example the temperature of the water returned to the

tank 3 in the return line 23, or in the python so as to maintain the temperature between upper and lower limits.

[0053] Operation of the agitator 15 circulates the water in the tank 3 to wash over the ice bank 13 which is gradually eroded to meet the cooling demand in the tank 3 and the python and the compressor is cycled on and off to maintain a reserve of ice sufficient to meet the cooling demand without completely eroding the ice bank 13. This ensures that energy is not wasted by overcooling the python, especially when high volumes of pre-cooled beverage are being dispensed.

[0054] In a second mode of operation of the cooler 1, the compressor does not respond to the sensor monitoring the minimum ice bank reserve and the motor 17 driving the combined agitator 15 and pump 19 operates as in the first mode of operation to maintain the water temperature in the tank 3 between the upper and lower limits. As a result, the ice bank 13 can be eroded below the minimum reserve without re-starting the compressor and may eventually be eroded completely. As a consequence, operation of the agitator 15 no longer controls the water temperature which may therefore increase above the upper limit when the agitator 15 is switched on.

[0055] When this occurs, the compressor is switched on in response to the water temperature in the tank 3, or in the cooling circuit, for example in the return line 23 to the tank 3 or in the python so as to reduce the water temperature and is then cycled on and off to maintain the water temperature between upper and lower limits necessary to meet the cooling demand in the python so that no ice or very minimal ice is formed on the evaporator. This ensures that the cooling efficiency of the evaporator in this mode of operation is not reduced and energy wasted by the insulating effect of ice on the evaporator.

[0056] By allowing the ice bank 13 to erode below the minimum reserve in the second mode of operation without re-starting the compressor in response to the ice bank reserve, the additional cooling provided by erosion of the ice bank 13 below the minimum reserve may reduce or eliminate operation of the compressor in the second mode of operation. Moreover, operating the compressor in response to water temperature when the ice bank has been completely eroded with little or no reformation of the ice bank may further reduce operation of the compressor in the second mode of operation.

[0057] By reducing or eliminating operation of the compressor in the second mode of operation, energy consumption may be reduced and/or the working life of the compressor may be increased. The number of times the compressor is switched on in the second mode of operation may depend on a number of factors such as the condition (thickness) of the ice bank 13 when switching from the first mode of operation to the second mode of operation, the length of time before switching back to the first mode of operation, and the heat load on the cooler during the second mode of operation.

[0058] Switching the cooler between the first and sec-

ond modes of operation may be effected manually or automatically by any suitable means. For example a timer may be employed that can be set to switch between the modes at preselected times that can be altered according to system requirements. Where a timer is employed, a manual over-ride may be provided to allow changeover from one mode to the other mode at times other than the pre-set times in order to meet a change in system requirements. A security feature such as locking means operated by a key or code may be provided to prevent unauthorised switching between the modes for either manual or automatic switching.

[0059] Switching may be via a control panel 31 provided at any suitable location, for example in the serving area. The control panel 31 may include controls for starting and stopping the compressor, the agitator and pump according to the selected mode of operation and the condition of the system. These controls may communicate with the compressor, agitator and pump via a wired link or a wireless link.

[0060] When switching from the one mode of operation to the other mode of operation, the compressor may be operated to form the ice bank to the pre-determined maximum reserve irrespective of any ice bank reserve existing at the changeover. By forming the maximum ice bank reserve when switching from one mode of operation to the other mode of operation, the maximum reserve of ice is available at the start of each mode of operation to meet heat loads on the cooler. In this way, the cooler can meet high cooling demand for product dispense in the first mode of operation and, during the second mode of operation, the cooler may meet the cooling demand without completely eroding the ice bank with the result that the compressor is not switched on again until switching back to the first mode of operation.

[0061] Alternatively, when switching from the first mode of operation to the second mode of operation, the compressor may not be operated irrespective of the ice bank reserve existing at the changeover until the ice bank reserve has completely eroded and the water temperature has increased above the upper control limit. Similarly, when switching from the second mode of operation to the first mode of operation, if the ice bank reserve has not been eroded below the pre-determined minimum reserve during the second mode of operation, the compressor may not be operated until the ice bank reserve has eroded to the minimum reserve.

[0062] It will be understood that the invention is not limited to the embodiment above-described.

[0063] Thus, any coolant capable of forming an ice bank on the evaporator may be employed, for example a mixture of water and a freezing point suppressant such as glycol or salt to provide a coolant capable of cooling product to a temperature below 0°C may be employed. The coolant may contain other additives such as a corrosion inhibitor.

[0064] The product line may be configured to cool the product in the cooler as described or the product line may

pass directly from the storage container to the sleeve without passing through the cooler. The dispense system may include more than one product line for the same or different products and some, all or none of the product lines may be configured to cool the product in the cooler according to the cooling requirements for the product before entering the sleeve.

[0065] The agitator and pump may be combined in a single unit as described or a separate agitator and pump may be provided each with its own motor which may be a single speed motor or a twin speed motor that can be switched between high and low speeds or a variable speed motor where the motor speed may be infinitely variable or variable in steps of, for example, 10% of maximum running speed. Where the agitator and pump are separate, the agitator may be operable in response to the temperature of the water in the tank with the pump being operable in response to the temperature of the water in the cooling circuit, for example the temperature of the water returning to the tank from the python. The agitator and/or pump may be operable in response to cooling demand in the tank and/or cooling circuit. Alternatively one or both of the agitator and pump may be operable continuously.

[0066] The evaporator may be arranged so that coolant in the tank can wash over one or both sides of the ice bank. Washing over both sides increases the surface area of the ice and thereby increases the rate of cooling of the coolant. The agitator may be configured to circulate the coolant to wash over one or both sides of the ice bank by changing the speed of the motor driving the agitator. For example, below a pre-determined speed, coolant may wash over one side only when cooling demand is low and, above the pre-determined speed, coolant may wash over both sides when cooling demand is high. Cooling demand may be low during periods of low dispense in the first mode of operation and in the second mode of operation when there is no dispense.

[0067] Other modifications that can be made will be apparent to those skilled in the art.

Claims

1. A cooler comprising a tank (3) to contain a liquid coolant (5), a refrigeration circuit including an evaporator (9) and a compressor, the evaporator (9) being located in the tank (3) so that, in use, coolant (5) in the tank (3) can form an ice bank (13) on the evaporator (9), **characterised in that**, in a first mode of operation, the compressor is controlled in response to the ice bank (13) and, in a second mode of operation, the compressor is controlled in response to temperature of the coolant (5).
2. A cooler according to claim 1 wherein, in the first mode of operation, the compressor is controlled in response to ice bank thickness to prevent complete

erosion of the ice bank (13) and, in the second mode of operation the compressor is controlled in response to coolant temperature to allow complete erosion of the ice bank (13).

3. A cooler according to any preceding claim wherein, in the second mode of operation, the compressor is controlled to maintain the temperature of coolant (5) in the tank (3) between upper and lower limits when the ice bank (13) has been completely eroded, for example the compressor may be switched on and off in the second mode of operation after the ice bank (13) has been eroded so that little or no ice is formed on the evaporator (9).
4. A cooler according to any preceding claim wherein, the compressor is operated to establish a pre-determined ice reserve on the evaporator (9) on switching from the first mode of operation to the second mode of operation and/or on switching from the second mode of operation to the first mode of operation.
5. A cooler according to any preceding claim wherein, the cooler (1) includes an agitator (15) for circulating coolant (5) in the tank (3) and/or a pump (19) for circulating coolant (5) around a cooling circuit externally of the cooler (1), wherein the agitator (15) and/or the pump (19) is operable continuously or intermittently in one or both modes of operation.
6. A cooler according to claim 5 wherein, a motor (17) for driving the agitator (15) and/or pump (19) is single speed, multi speed or variable speed.
7. A cooler according to claim 5 or claim 6 wherein, the agitator (15) and pump (19) are combined in a unit having a single motor (17) for driving both the agitator (15) and pump (19) in response to coolant temperature.
8. A cooler according to any of claims 5 to 7 wherein, the agitator (15) is operable to circulate coolant (5) in the tank (3) across one or both sides of the evaporator (9), for example by controlling speed of the agitator (15).
9. A cooler according to any preceding claim wherein, the cooler (1) is switchable manually and/or automatically between the first and second modes of operation, for example a programmable timer may be employed to switch the cooler (1) automatically between the first and second modes and/or a manual switch may be provided to permit the cooler (1) to be switched manually from one mode to the other mode and optionally to over-ride automatic switching of the cooler (1) from one mode to the other mode.
10. A cooler according to any preceding claim wherein,

a control panel (31) is provided for controlling operation of the cooler (1), for example the control panel (31) may be positioned locally to or remotely from the cooler (1) and a wired or wireless link may be provided for switching between the first and second modes.

11. A cooler comprising a tank (3) to contain a liquid coolant (5), a refrigeration circuit including an evaporator (9) and a compressor, the evaporator (9) being located in the tank (3) so that, in use, coolant (5) in the tank (3) can form an ice bank (13) on the evaporator (9), **characterised in that**, in a first mode of operation, the refrigeration circuit is controlled to maintain an ice bank (13) on the evaporator (9) and, in a second mode of operation, the refrigeration circuit is controlled to maintain temperature of the coolant (5) between upper and lower limits without maintaining the ice bank (13).
12. A method of controlling a cooler (1) of the type having a tank (3) containing liquid coolant (5) and a refrigeration circuit including a compressor and an evaporator (9) in which coolant (5) contained in the tank (3) can form an ice bank (13) on the evaporator (9), the method comprising the steps of controlling operation of the compressor in response to the ice bank (13) in a first mode of operation and controlling operation of the compressor in response to coolant temperature in a second mode of operation.
13. A method according to claim 12 wherein, the compressor is controlled to maintain a thickness of the ice bank (13) between upper and lower limits in the first mode of operation and/or to maintain temperature of the coolant (5) between upper and lower limits when the ice bank (13) is completely eroded in the second mode of operation.
14. A method according to claim 13 wherein, the upper limit of the ice bank (13) is established on changing over from the first mode of operation to the second mode of operation and/or on changing over from the second mode of operation to the first mode of operation.
15. A method of operating an ice bank cooler (1) to control an ice bank (13) within the cooler (1), **characterised in that** the ice bank (13) is maintained between upper and lower limits to meet cooling demand on the cooler (1) in a first mode of operation and the ice bank (13) is permitted to erode below the lower limit to meet cooling demand on the cooler (1) in a second mode of operation without reforming the ice bank (13), wherein the cooler (1) is switched from the first mode of operation to the second mode of operation to conserve energy when cooling demand on the cooler (1) is low.

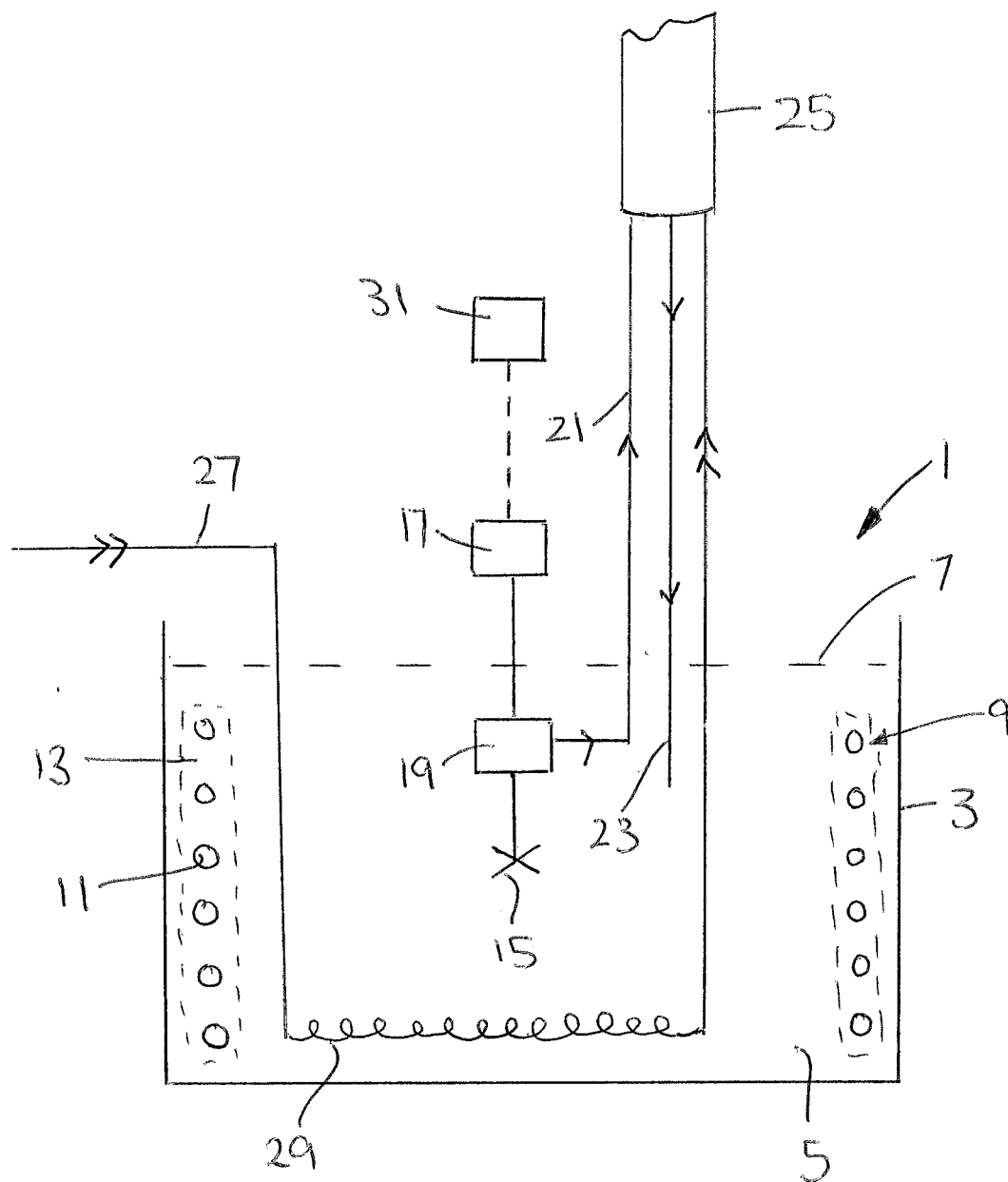


FIGURE 1