(54) Title of the Invention: **Beverage dispense systems**

Abstract Title: **A beverage cooler comprising an ice bank which has a selectable size**

A cooler for a beverage dispense system includes a reservoir 4 of coolant 6 for forming an ice bank 7 on an evaporator 8 of a refrigeration system. The size of the ice bank 7 is controlled by a controller 14 responsive to an array of sensors 16a-e for switching the refrigeration system on and off. The sensors 16a-e are arranged at different distances from the evaporator and the controller 14 can respond to different combinations of the sensors to vary the size of the ice bank 7. The cooler may thus match cooling requirements of different beverage dispense systems and/or changes in cooling requirements of a given beverage dispense system. In one aspect, the sensors comprise pairs of sensor probes.
BEVERAGE DISPENSE SYSTEMS

The present invention concerns improvements in or relating to beverage dispense systems. More especially the present invention concerns draught dispense systems where the beverage is stored in a bulk container from which it is cooled and dispensed on demand, and in particular, but not exclusively, where the cooling is by means of a cooler commonly known as an ice bank cooler.

With constantly rising energy prices, energy efficiency is becoming a major objective in all business sectors and with customers demanding beverages which are consistently cooled and generally to lower temperatures than previously, more emphasis is being placed on the efficiency and effectiveness of beverage coolers.

Beverage coolers take several forms, but the most common is the ice bank cooler wherein a tank of water has immersed within it the evaporator of a refrigeration system and a number of tubes through which beverage(s) flow. Ice formed on the evaporator forms an ice bank cooling reserve and heat from the beverage is transferred to it from the beverage tubes via the water in the tank.

While the principle of operation of the ice bank cooler is simple, its inability to adapt to differing cooling requirements can lead to considerable waste of energy. Most refrigeration systems employed in ice bank beverage coolers are at their most efficient when ice is about to form on the evaporator surface and, as the thickness of ice increases, cooling efficiency deteriorates rapidly due to the insulation effect of the ice on the evaporator. This is because the refrigeration compressor is required to work harder and for longer periods to maintain freezing temperature at the ice/water interface as the ice thickness increases.

It therefore follows that it is desirable to maintain an ice bank as small as possible consistent with the cooling capacity required of the cooler.

Most ice bank coolers are manufactured so as to maintain a quantity of ice between a predetermined upper limit and a predetermined lower limit, the refrigeration system being controlled to cut out at the upper limit and restart when the ice has
become eroded down to the predetermined lower limit. Thus there is no facility to adjust the ice bank size to optimise energy efficiency.

Changes to the ice bank size may be desirable to optimise the cooling reserve for instance when trading patterns seasonally change, following changes in ambient temperatures or when a cooler is transferred from one location to another. It may also be desirable to reduce the number of different cooler sizes manufactured by adjusting the ice bank size(s) of a smaller number of coolers to match the requirements of different locations.

Ice bank size is generally controlled in beverage coolers by sensing the thickness of ice formed on the evaporator of the refrigeration system at a single location although systems have been developed in which the ice thickness is sensed at two or more positions within the cooler water bath in order to overcome problems resulting from uneven erosion of the ice. However, this is only to ensure as far as is possible that the ice bank size is within the stated cooler capacity.

It is a desired aim of the present invention to provide a means of controlling the ice bank size of a beverage cooler in a manner that addresses the above issues.

According to a first aspect of the invention, a cooler for a beverage dispense system is provided including a reservoir of coolant, a refrigeration system including an evaporator adapted to be immersed in the coolant for forming an ice bank from the coolant thereon, and means for controlling the size of the ice bank, wherein the size of the ice bank can be varied.

By this aspect of the invention, the size of the ice bank formed on the evaporator can be varied such that the performance of the cooler may be adapted according to cooling requirements. In this way, a single cooler may be provided that is capable of being configured to match the cooling requirements of different beverage dispense systems and/or changes in cooling requirements of a given beverage dispense system.
It may be that the refrigeration system is controlled in response to the size of the ice bank formed on the evaporator. For example the control means may be responsive to sensor means for monitoring ice bank size to start and stop the refrigeration system.

In some embodiments, the refrigeration system may be started when the ice bank size is less than a pre-determined maximum size of ice bank and is stopped when the pre-determined maximum size of ice bank is formed on the evaporator. It may be that the control means is configured to avoid short cycling of the refrigeration system. For example, a time delay may be provided when the refrigeration system is switched off during which the refrigeration system cannot be switched on.

It may be that the sensor means comprises an array of sensor probes immersed in the coolant at progressively increasing distances from the evaporator and the control means responds to a change in circuit resistance between a pair of sensor probes to switch the refrigeration system on and off. For example, the control means may respond to a low circuit resistance indicating both sensor probes are immersed in liquid coolant to start the refrigeration system and to a high circuit resistance indicating one of the sensor probes is surrounded by frozen coolant forming the ice bank to stop the refrigeration system.

It may be that the array of sensor probes includes two or more pairs of sensor probes and means is provided for selecting a pair of probes for controlling the size of ice bank that can be formed on the evaporator. For example, where three sensor probes are provided, the first and second sensor probes may provide a first pair of probes and the second and third probes may provide a second pair of probes. In this way, the control means may be set to respond to the first pair of probes to provide a maximum ice bank size according to the distance of the first probe from the evaporator or to respond to the second pair of probes to provide a maximum ice bank size according to the distance of the second probe from the evaporator.

Any suitable means may be provided to set the control means to provide the required ice bank size. For example a switch device may be provided for selecting a required pair of probes from at least two pairs of probes. Where provided the
switch device which may be operable manually or automatically. Automatic operation may be provided by a timer or other suitable means, for example a microprocessor which may include a memory in which cooler settings may be stored for recall when required.

In other embodiments, the refrigeration system may be started when the ice bank has a pre-determined minimum size or less and is stopped when a pre-determined maximum size of ice bank is formed on the evaporator. The difference between the minimum and maximum sizes of ice bank may avoid short cycling of the refrigeration system. Alternatively, a time delay may be provided when the refrigeration system is switched off during which the refrigeration system cannot be switched on.

It may be that the sensor means comprises an array of sensor probes such as conductivity probes immersed in the coolant at progressively increasing distances from the evaporator and the control means responds to a change in circuit resistance between a first pair of sensor probes to switch the refrigeration system on and between a second pair of sensor probes to switch the refrigeration system off. For example, the control means may respond to a low circuit resistance between the first pair of sensor probes indicating both sensor probes are immersed in liquid coolant to start the refrigeration system, i.e. the ice bank size is less than the pre-determined minimum size, and to a high circuit resistance between the second pair of probes indicating one of the sensor probes is surrounded by frozen coolant forming the ice bank to stop the refrigeration system, i.e. the ice bank size has reached the pre-determined maximum size.

It may be that the array of sensor probes includes three or more pairs of sensor probes and means is provided for selecting a pair of probes for controlling the size of ice bank that can be formed on the evaporator. For example, where four sensor probes are provided, the first and second sensor probes may provide a first pair of probes, the second and third sensor probes may provide a second pair of probes and the third and fourth sensor probes may provide a third pair of probes.
The first pair of probes may define the minimum ice bank size according to the distance of the first probe from the evaporator and the second and third pairs of probes may define different maximum ice bank sizes according to the distance of the second and third probes from the evaporator. It may be that the control means responds to the first pair of probes to start the refrigeration system when the ice bank has the pre-determined minimum size or less and responds to the second or third pair of probes to stop the refrigeration system when the maximum ice bank size according to the selected probe pair has been formed.

Alternatively, the third pair of probes may define the maximum ice bank size according to the distance of the third probe from the evaporator and the first and second pairs of probe may define different minimum ice bank sizes according to the distance of the first and second probes from the evaporator. It may be that the control means responds to the first or second pair of probes to start the refrigeration system when the ice bank has the pre-determined minimum size or less according to the selected probe pair and to stop the refrigeration system when the maximum ice bank thickness according to the third probe pair has been formed.

Any suitable means may be provided to set the control means to provide the required ice bank size. For example a switch device may be provided for selecting the required pairs of probes from at least three pairs of probes. Where provided the switch device which may be operable manually or automatically. Automatic operation may be provided by a timer or other suitable means, for example a microprocessor which may include a memory in which cooler settings may be stored for recall when required.

According to a second aspect of the invention, a control system is provided for controlling the size of an ice bank in a cooler for a beverage dispense system, the control system including a plurality of pairs of sensor probes immersed in a reservoir of coolant, and a controller responsive to a selected pair of sensor probes to switch off a refrigeration system having an evaporator immersed in the reservoir of coolant when an ice bank is formed on the evaporator having a size determined by the selected pair of sensor probes.
By this aspect of the invention, control system enables the size of the ice bank formed on the evaporator to be varied by configuring the controller to respond to different pairs of sensor probes. In this way the size of the ice bank can be regulated according to cooling requirements and a single cooler may be provided that is capable of being configured to match the cooling requirements of different beverage dispense systems and/or changes in cooling requirements of a given beverage dispense system.

The controller may control a maximum size of ice bank that can be formed on the evaporator by responding to a change in circuit resistance between the selected pair of sensor probes to switch the refrigeration system off when the maximum size of ice bank has been formed. The maximum size of ice bank that can be formed may be varied by selecting different pairs of sensor probes.

The controller may respond to a change in circuit resistance between a pair of sensor probes such as conductivity probes to switch the refrigeration system on when the size of any ice bank is less than the maximum size defined by the selected pair of sensor probes.

In some embodiments the controller may respond to the same pair of sensor probes to switch the refrigeration system off and on according to the size of the ice bank formed on the evaporator. In these embodiments, a time delay may be provided when the refrigeration system is switched off during which time the refrigeration system is prevented from being switched on again. In this way short cycling of the refrigeration system in response to small changes in the ice bank size may be prevented.

In other embodiments the controller may respond to different pairs of sensor probes to switch the refrigeration system off and on. In these embodiments, one pair of sensor probes may define the maximum size of ice bank that will cause the controller to switch the refrigeration system off and the other pair of sensor probes may define a minimum size of ice bank that will cause the controller to switch the refrigeration system on.
The difference between the maximum and minimum sizes may provide sufficient time delay to prevent short cycling of the refrigeration system. If necessary, however, a time delay may be provided during which the refrigeration system is prevented from being switched on again. The maximum and minimum sizes of ice bank may be varied by selecting different pairs of sensor probes.

The controller may include or respond to means for selecting the pair of sensor probes defining the maximum size of ice bank and, where required, the pair of sensor probes defining the minimum size of ice bank. Such means may take the form of a switch device which may be operable manually or automatically. Automatic operation may be provided by a timer or other suitable means, for example a microprocessor which may include a memory in which cooler settings may be stored for recall when required.

The control system of the second aspect of the invention may include any feature(s) of the cooler of the first aspect of the invention.

According to a third aspect of the invention, a method of controlling a cooler for a beverage dispense system includes providing a reservoir of coolant, immersing an evaporator of a refrigeration system in the coolant, switching the refrigeration system on to cause a bank of ice to form on the evaporator and switching the refrigeration system off when a pre-determined size of ice bank has formed on the evaporator, wherein the pre-determined size of ice bank can be selected such that the ice bank size can be varied.

The method of the third aspect may employ any feature(s) of the control system of the second aspect of the invention and/or the cooler of the first aspect of the invention.

The invention will now be described in more detail, by way of example only, with reference to the accompanying drawings in which:-

Figure 1 shows a beverage dispense system employing an ice bank cooler embodying the invention;
Figures 2a, 2b and 2c show control of the maximum ice bank thickness using two sensor probes; and

Figures 3a, 3b and 3c show control of the maximum ice bank thickness using three sensor probes.

Referring to Figure 1 of the drawings, a beverage dispense system includes a cooler 1 located, for example in a storage area 2, remotely from a dispense location 3. In other embodiments (not shown) the cooler 1 may be located at the dispense location 3.

The cooler 1 includes a reservoir 4 having around its internal walls the evaporator 5 of a refrigeration system (not shown) such that operation of the refrigeration system causes coolant 6 contained within the reservoir 4 to freeze, so forming a bank 7 of frozen coolant upon the evaporator 5.

In this exemplary embodiment, the coolant 6 is water and forms an ice bank 7 on the evaporator 5. In other embodiments the water may include an additive that suppresses the freezing point of the water. For example, the coolant may be a water/glycol mixture, a water/alcohol mixture or a water/salt (brine) mixture. Other additives such as corrosion inhibitors may also be provided in the coolant 6.

A product tube or tubes 8 is submerged in the water 6 through which beverage passes from a storage source (not shown) via inlet tube 9 and outlet tube 10 into an insulated bundle of tubes 11, commonly known as a python. Heat from the beverage is conducted to the ice bank 7 via the water 6 which is agitated by an agitator 12. Agitation of the water 6 improves the rate of heat transfer from the beverage to the ice bank 7 and maintains an even temperature within the water 6.

Chilled beverage from the cooler 1 is conducted within the insulated sleeve 11 to the dispense location 3 in readiness for dispense from a tap or taps 17. In order to minimise the warming effect of ambient conditions upon the beverage within the insulated sleeve 11, water 6 is pumped by a pump 18 via a flow line 19 to the...
dispense location, returning to the water bath 4 via return line 20. It is desirable that flow line 19, return line 20 and beverage line 10 are in thermal contact within the insulated sleeve 11.

In this embodiment, the agitator 12 and pump 18 are combined in a single unit and driven by a motor 13. The motor 13 may be a single speed motor or a variable speed motor such as a twin speed motor or an infinitely variable speed motor. In other embodiments, the agitator 12 and pump 18 may be driven by separate motors which may be single speed or variable speed similar to the motor 13.

The refrigeration system (not shown) is controlled by an ice bank controller 14 which switches the refrigeration system on or off in response to signals from an array of sensor probes. In this embodiment, the array consists of five sensor probes 16a, 16b, 16c, 16d, 16e disposed at successively greater distances from the evaporator 5.

The sensor probes 16a, 16b, 16c, 16d, 16e may be uniformly spaced apart and are shown in Figure 1 in a linear arrangement for clarity. However the sensor probes may also be distributed singly or in groups around the perimeter of the evaporator 5 in greater or smaller numbers than those illustrated.

The sensor probes 16a, 16b, 16c, 16d, 16e are preferably conductivity probes and ice bank controller 14 operates by sensing and responding to the electrical resistance between two or more of the sensor probes 16a, 6b, 16c, 16d, 16e. Water is highly conductive when compared with ice and thus, as the ice bank controller 14 passes a small electric current through two sensor probes, the circuit is completed by either ice or water, depending upon the thickness of the ice bank 7 and the resulting circuit resistance determines the response of the controller 14.

One method of ice bank sensing to control the refrigeration system to provide a pre-determined maximum thickness of the ice bank 7 on the evaporator 5 using two sensor probes will now be described with reference to Figures 2a, 2b and 2c. For convenience the method is described using sensor probes 16a, 16b to provide a maximum ice bank thickness corresponding to the distance of the sensor 16a from
the evaporator 5 and it will be understood the method could be applied to other combinations of the sensor probes 16a, 16b, 16c, 16d, 16e.

Figure 2a shows the cooler 1 on start-up (for example on installation or following a de-frost routine) with water present in the water bath 4 and no ice bank 7 formed on the evaporator 5 so that both probes 16a, 16b are immersed in water. As a result, a low circuit resistance exists when a small electric current is passed between the probes 16a, 16b and the controller 14 responds to start the refrigeration system causing the ice bank 7 to form on the evaporator 5.

Figure 2b shows the cooler 1 when the ice bank 7 formed on the evaporator 5 has a thickness sufficient to surround the first probe 16a while the second probe 16b is still immersed in water. As a result, a high circuit resistance exists when a small electric current is passed between the probes 16a, 16b confirming that the ice bank 7 has the required predetermined maximum thickness corresponding to the distance of the probe 16a from the evaporator 5 and the controller 14, having sensed the change to high resistance, responds to the change in resistance by switching off the refrigeration system.

Figure 2c shows the cooler 1 when the ice bank 7 has been eroded by the transfer of heat from the beverage and/or ambient so that the first probe 16a is no longer surrounded by ice and both probes 16a, 16b are again immersed in water. As a result, a low circuit resistance again exists when a small electric current is passed between the probes 16a, 16b and the controller 14, having sensed the change to low resistance, responds to the change in resistance by restarting the refrigeration system until the ice bank 7 has again formed to surround the probe 16a causing the controller 14 to respond to switch off the refrigeration system. The cycle will repeat as required.

It can be seen from the description of Figures 2a, 2b and 2c that once the predetermined maximum ice bank thickness has been formed, a small change in the pre-determined maximum ice bank thickness determines whether the refrigeration system is switched on or off and this can result in frequent starts for the
refrigeration system with potential compressor failure. It is therefore preferable to provide a means of reducing the frequency of refrigeration system start/stop cycles.

One means to achieve this is by the introduction of a time delay into the refrigeration system start up. A timer may be incorporated into controller 14 which delays output from the controller 14 following input from the sensor probes 16a, 16b so that the refrigeration system is not re-started immediately the ice bank 7 has eroded sufficiently to expose the sensor probe 16a allowing the ice bank 7 to erode further and reduce the thickness of the ice bank 7 before the refrigeration system is re-started.

It will also be appreciated from the description of Figures 2a, 2b and 2c that the pre-determined maximum ice bank thickness can be altered by using different combinations of the sensor probes 16a, 16b, 16c, 16d, 16e. For example, a maximum ice bank thickness may be provided corresponding to:

- the distance of probe 16a from the evaporator 5 using probes 16a, 16b
- the distance of probe 16b from the evaporator 5 using probes 16b, 16c
- the distance of probe 16c from the evaporator 5 using probes 16c, 16d
- the distance of probe 16d from the evaporator 5 using probes 16d, 16e.

It is therefore preferable to provide a means of setting the required maximum ice bank thickness according to the requirements of the dispense system.

One means to achieve this may be via a user interface such as a switch device 21 which may be incorporated in the controller 14 or provided separate therefrom and connected by a wired or wireless link for inputting selection of the required maximum ice bank thickness. By means of such switch device 21, the ice bank may be controlled in the case of two probe operations, for example, by sensor probes 16a and 16b or 16b and 16c, etc for a progressively larger ice bank. Alternatively, sensor probe 16e may remain constantly in circuits while ice bank size is determined by selection of any one of sensor probes 16a to 16d in combination with sensor probe 16e.
This arrangement provides four settings of ice bank size according to the distance of the sensor probes 16a, 16b, 16c, 16d from the evaporator 5 that can be selected according to the cooling requirements of the dispense system using the switch device 21 or other suitable user interface.

Another method of ice bank sensing to control the refrigeration system to provide a pre-determined maximum thickness of ice bank 7 on the evaporator 5 using three sensor probes will now be described with reference to Figures 3a, 3b and 3c. For convenience, the method is described using sensor probes 16a, 16b, 16c to provide a maximum ice bank thickness corresponding to the distance of the sensor 16b from the evaporator 5 and it will be understood the method could be applied to other combinations of the sensor probes 16a, 16b, 16c, 16d, 16e.

Figure 3a shows the cooler 1 on start-up (for example on installation or following a de-frost routine) with water present in the water bath 4 and no ice bank 7 formed on the evaporator 5 so that the probes 16a, 16b, 16c are immersed in water. As a result, a low circuit resistance exists when a small electric current is passed between probes 16b, 16c and the controller 14 responds to start the refrigeration system causing the ice bank 7 to form on the evaporator 5. It will be noted that a low circuit resistance also exists if a small electric current is passed between probes 16a, 16c.

As the ice bank forms, the sensor probe 16a is firstly surrounded by ice while the sensor probes 16b, 16c are still immersed in water. As a result, a high circuit resistance will exist between probes 16a and 16c and the low circuit resistance will remain between the probes 16b, 16c. The controller 14 ignores the change in circuit resistance between sensor probes 16a, 16c and the refrigeration system remains switched on and continues to form the ice bank 7 on the evaporator 5.

Figure 3b shows the cooler 1 when the ice bank 7 formed on the evaporator 5 has a thickness sufficient to surround both the first probe 16a and the second probe 16b while the third probe 16c is still immersed in water. As a result, a high circuit resistance exists when a small electric current is passed between the probes 16b, 16c confirming that the ice bank 7 has the required predetermined
maximum thickness corresponding to the distance of the probe 16b from the evaporator 5 and the controller 14, having sensed the change to high resistance, responds to the change in resistance by switching off the refrigeration system.

As the ice bank 7 is eroded by the transfer of heat from the beverage and/or ambient the second probe 16b is firstly exposed so that the second and third probes 16b, 16c are both immersed in water while the first probe 16a is still surrounded by ice. As a result, a low circuit resistance will again exist between the probes 16b, 16c and a high circuit resistance will remain between probes 16a, 16c. The controller 14 ignores the change in resistance between sensor probes 16b, 16c and the refrigeration system remains switched off and the ice bank 7 continues to erode.

Figure 3c shows the cooler 1 when the ice bank 7 has eroded so that the first probe 16a is no longer surrounded by ice and all the probes 16a, 16b, 16c are again immersed in water. As a result, a low circuit resistance will exist when a small electric current is passed between the probes 16a, 16c and the controller 14, having sensed the change to low resistance, responds to re-restart the refrigeration system until the ice bank 7 has again formed to surround the first and second probes 16a, 16b causing the controller 14 to respond to switch off the refrigeration system. The cycle will repeat as required.

It can be seen from the description of Figures 3a, 3b and 3c that the three probe system of ice bank sensing allows both the maximum ice bank thickness and the minimum ice bank thickness to be controlled by using sensor probes 16b, 16c to control the maximum ice bank thickness and sensor probes 16a, 16c to control the minimum ice bank thickness. In this way, frequent starts of the refrigeration system due to small changes in the pre-determined maximum ice bank thickness may be avoided. A timer to delay re-starting the refrigeration system as provided with the two probe system of ice bank sensing shown in Figures 2a, 2b and 2c may therefore not be required when using the three probe system of ice bank sensing shown in Figures 3a, 3b and 3c.
It will also be appreciated from the description of Figures 3a, 3b and 3c that the pre-determined maximum ice bank thickness can be altered by using different combinations of the sensor probes 16a, 16b, 16c, 16d, 16e. For example, a maximum ice bank thickness may be provided corresponding to:

- the distance of probe 16b from the evaporator 5 using probes 16a, 16b, 16c
- the distance of probe 16c from the evaporator 5 using probes 16b, 16c, 16d
- the distance of probe 16d from the evaporator 5 using probes 16c, 16d, 16e.

Means of setting the required maximum ice bank thickness according to the requirements of the dispense system such as a user interface, for example a switch device, as described above for the two probe system of ice bank sensing may be employed.

By the use of the three probe system of ice bank sensing it may be possible to select a range of predetermined maximum ice bank thicknesses and/or a range of predetermined minimum ice bank thicknesses in a variety of combinations. For instance sensor probes 16c, 16d and 16e may provide a maximum thickness corresponding to the distance of sensor probe 16d from the evaporator 5 and a minimum thickness corresponding to the distance of sensor probe 16c from the evaporator 5. By switching control to sensor probes 16a, 16d and 16e the maximum ice bank thickness remains unchanged corresponding to the distance of sensor probe 16d from the evaporator 5 while allowing much greater ice erosion and reducing the minimum ice bank thickness corresponding to the distance of sensor probe 16a from the evaporator 5 before the refrigeration system is restarted. Other combinations of the sensor probes to provide selection of the maximum and/or minimum ice bank thicknesses will be apparent to those skilled in the art.

It can be seen that the invention provides a means of controlling ice bank thickness within a beverage cooler to optimise efficiency and versatility. It can also be appreciated that there are many potential combinations of sensor probe connections, subject to a suitable selection means and that this may be, for example, by rotary or dip type switch or jumper plugs, either singly or in combination and that they may be user accessible or secured for engineer use only.
or even factory pre-set where the object is simply to provide one basic cooler with a range of performance options.

It can be further appreciated that the sensor probes need not be limited to five as described in the exemplary embodiments and that other embodiments may employ less than five sensor probes and yet more embodiments may employ more than five sensor probes. The number of sensor probes and the configuration of the sensor probes and controller may be altered to provide any desired range of ice bank sizes that can be selected. The spacing between the sensor probes may be in regular increments although this may not be essential and the spacing need not be in regular increments.

While the invention has been described using conductivity probes to monitor circuit resistance between pairs of probes to control the refrigeration system in response to ice bank size such that the ice bank size can be varied, it will be understood that other sensors may be employed for the same purpose. For example it may be that sensors responsive to a change in temperature according to whether they are immersed in liquid or frozen coolant may be employed to control the refrigeration system and the invention extends to and includes all types of sensors and/or combinations of sensors capable of providing an indication of ice bank thickness for controlling the refrigeration system.

The invention has been described in its simplest form but those skilled in the art will be aware that many enhancements may be provided such as:-

- remote switching by either hard wired satellite switch box 22, radio control or via modem or web.
- auto adjust with memory to maintain optimum ice bank size.
- various visual or audible warnings/indications for over temperature, compressor run time, energy efficiency.

The invention has been described in the context of a remote beverage cooler but it will be appreciated that any form of cooler employing an ice bank may benefit from the invention.
The invention includes any feature or combination of features described herein.
CLAIMS

1. A cooler for a beverage dispense system includes a reservoir of coolant, a refrigeration system including an evaporator adapted to be immersed in the coolant for forming an ice bank from the coolant thereon, and means for controlling the size of the ice bank, wherein the size of the ice bank can be varied.

2. A cooler according to claim 1 wherein the control means is configured such that the performance of the cooler can be adapted according to cooling requirements.

3. A cooler according to claim 1 or claim 2 wherein the cooler is capable of being configured to match the cooling requirements of different beverage dispense systems and/or changes in cooling requirements of a given beverage dispense system.

4. A cooler according to any preceding claim wherein the refrigeration system is controlled in response to the size of the ice bank formed on the evaporator.

5. A cooler according to claim 4 wherein the control means is responsive to sensor means for monitoring ice bank size to start and stop the refrigeration system.

6. A cooler according to any preceding claim wherein the refrigeration system is started when the ice bank size is less than a pre-determined maximum size of ice bank and is stopped when the pre-determined maximum size of ice bank is formed on the evaporator.

7. A cooler according to any preceding claim wherein the control means is configured to avoid short cycling of the refrigeration system.

8. A cooler according to claim 7 wherein a time delay is provided when the refrigeration system is switched off during which the refrigeration system cannot be switched on.

9. A cooler according to claim 5 wherein the sensor means comprises an array of sensor probes immersed in the coolant at progressively increasing distances from the
evaporator and the control means responds to a change in circuit resistance between a pair of sensor probes to switch the refrigeration system on and off.

10. A cooler according to claim 9 wherein the control means responds to a first or low circuit resistance indicating both sensor probes are immersed in liquid coolant to start the refrigeration system and to a second or high circuit resistance indicating one of the sensor probes is surrounded by frozen coolant forming the ice bank to stop the refrigeration system.

11. A cooler according to claim 9 or claim 10 wherein the array of sensor probes includes two or more pairs of sensor probes and means is provided for selecting a pair of probes for controlling the size of ice bank that can be formed on the evaporator.

12. A cooler according to claim 11 wherein three sensor probes are provided, the first and second sensor probes providing a first pair of probes, and the second and third probes providing a second pair of probes.

13. A cooler according to claim 12 wherein the control means can be set to respond to the first pair of probes to provide a maximum ice bank size according to the distance of the first probe from the evaporator or to respond to the second pair of probes to provide a maximum ice bank size according to the distance of the second probe from the evaporator.

14. A cooler according to any preceding claim wherein selector means is provided to set the control means to provide the required ice bank size.

15. A cooler according to claim 14 wherein a switch device is provided for selecting a required pair of probes from at least two pairs of probes.

16. A cooler according to claim 15 wherein the switch device is operable manually or automatically.

17. A cooler according to claim 16 wherein automatic operation is provided by a timer.
18. A cooler according to any preceding claim wherein a memory function is provided in which cooler settings can be stored for recall when required.

19. A cooler according to any of claims 1 to 5 wherein the refrigeration system is started when the ice bank has a pre-determined minimum size or less and is stopped when a pre-determined maximum size of ice bank is formed on the evaporator.

20. A cooler according to claim 19 wherein the difference between the minimum and maximum sizes of ice bank avoids short cycling of the refrigeration system.

21. A cooler according to claim 19 wherein a time delay is provided when the refrigeration system is switched off during which the refrigeration system cannot be switched on.

22. A cooler according to claim 5 wherein the sensor means comprises an array of sensor probes arranged at progressively increasing distances from the evaporator and the control means responds to a change in circuit resistance between a first pair of sensor probes to switch the refrigeration system on and between a second pair of sensor probes to switch the refrigeration system off.

23. A cooler according to claim 22 wherein the control means responds to a first or low circuit resistance between the first pair of sensor probes indicating both sensor probes are immersed in liquid coolant to start the refrigeration system when the ice bank size is less than the pre-determined minimum size, and to a second or high circuit resistance between the second pair of probes indicating one of the sensor probes is surrounded by frozen coolant forming the ice bank to stop the refrigeration system when the ice bank size has reached the pre-determined maximum size.

24. A cooler according to claim 22 or claim 23 wherein the array of sensor probes includes three or more pairs of sensor probes and means is provided for selecting a pair of probes for controlling the size of ice bank that can be formed on the evaporator.

25. A cooler according to claim 24 wherein four sensor probes are provided, the first and second sensor probes providing a first pair of probes, the second and third
sensor probes providing a second pair of probes and the third and fourth sensor probes providing a third pair of probes.

26. A cooler according to claim 25 wherein the first pair of probes defines the minimum ice bank size according to the distance of the first probe from the evaporator and the second and third pairs of probes define different maximum ice bank sizes according to the distance of the second and third probes from the evaporator.

27. A cooler according to claim 26 wherein the control means responds to the first pair of probes to start the refrigeration system when the ice bank has the pre-determined minimum size or less and responds to the second or third pair of probes to stop the refrigeration system when the maximum ice bank size according to the selected probe pair has been formed.

28. A cooler according to claim 25 wherein the third pair of probes defines the maximum ice bank size according to the distance of the third probe from the evaporator and the first and second pairs of probes define different minimum ice bank sizes according to the distance of the first and second probes from the evaporator.

29. A cooler according to claim 28 wherein the control means responds to the first or second pair of probes to start the refrigeration system when the ice bank has the pre-determined minimum size or less according to the selected probe pair and to stop the refrigeration system when the maximum ice bank thickness according to the third probe pair has been formed.

30. A cooler according to any of claims 22 to 29 wherein selector means is provided to set the control means to provide the required ice bank size.

31. A cooler according to claim 31 wherein a switch device is provided for selecting a required pair of probes from at least two pairs of probes.

32. A cooler according to claim 32 wherein the switch device is operable manually or automatically.
33. A cooler according to claim 33 wherein automatic operation is provided by a timer.

34. A cooler according to any of claims 19 to claim 33 wherein a memory function is provided in which cooler settings can be stored for recall when required.

35. A control system for controlling the size of an ice bank in a cooler for a beverage dispense system, the control system including a plurality of pairs of sensor probes immersed in a reservoir of coolant, and a controller responsive to a selected pair of sensor probes to switch off a refrigeration system having an evaporator immersed in the reservoir of coolant when an ice bank is formed on the evaporator having a size determined by the selected pair of sensor probes.

36. A control system according to claim 35 wherein the control system is arranged such that the size of the ice bank formed on the evaporator can be varied by configuring the controller to respond to different pairs of sensor probes.

37. A control system according to claim 36 wherein the size of the ice bank can be regulated according to cooling requirements and the cooler can be configured to match the cooling requirements of different beverage dispense systems and/or changes in cooling requirements of a given beverage dispense system.

38. A control system according to any of claims 35 to 37 wherein the controller controls a maximum size of ice bank that can be formed on the evaporator by responding to a change in circuit resistance between the selected pair of sensor probes to switch the refrigeration system off when the maximum size of ice bank has been formed.

39. A control system according to claim 38 wherein the maximum size of ice bank that can be formed can be varied by selecting different pairs of sensor probes.

40. A control system according to claim 35 wherein the controller responds to a change in circuit resistance between a pair of sensor probes to switch the refrigeration system on when the size of any ice bank is less than the maximum size defined by the selected pair of sensor probes.
41. A control system according to claim 40 wherein the controller responds to the same pair of sensor probes to switch the refrigeration system off and on according to the size of the ice bank formed on the evaporator.

42. A control system according to claim 41 wherein a time delay is provided when the refrigeration system is switched off during which time the refrigeration system is prevented from being switched on again to prevent short cycling of the refrigeration system.

43. A control system according to claim 40 wherein the controller responds to different pairs of sensor probes to switch the refrigeration system off and on.

44. A control system according to claim 43 wherein one pair of sensor probes defines the maximum size of ice bank that will cause the controller to switch the refrigeration system off and the other pair of sensor probes defines a minimum size of ice bank that will cause the controller to switch the refrigeration system on.

45. A control system according to claim 44 wherein the difference between the maximum and minimum sizes provides sufficient time delay to prevent short cycling of the refrigeration system.

46. A control system according to claim 45 wherein a time delay is provided during which the refrigeration system is prevented from being switched on again.

47. A control system according to any of claims 44 to 46 wherein the maximum and minimum sizes of ice bank can be varied by selecting different pairs of sensor probes.

48. A control system according to any of claims 44 to 47 wherein the controller includes or responds to means for selecting the pair of sensor probes defining the maximum size of ice bank and, where required, the pair of sensor probes defining the minimum size of ice bank.
49. A control system according to claim 48 wherein the selector means is a switch device.

50. A control system according to claim 49 wherein the switch device is operable manually or automatically.

51. A control system according to claim 50 wherein automatic operation is provided by a timer.

52. A control system according to any of claims 35 to 51 wherein a memory function is provided in which cooler settings can be stored for recall when required.

53. A method of controlling a cooler for a beverage dispense system includes providing a reservoir of coolant, immersing an evaporator of a refrigeration system in the coolant, switching the refrigeration system on to cause a bank of ice to form on the evaporator and switching the refrigeration system off when a pre-determined size of ice bank has formed on the evaporator, wherein the pre-determined size of ice bank can be selected such that the ice bank size can be varied.
**Patents Act 1977: Search Report under Section 17**

### Documents considered to be relevant:

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| X        | 1-6, 9-10, 18-19, 34 & 53 | GB2250641 A  
LANCER CORP) See claim 7 |
| X        | 1-6, 9-10, 18-19, 34 & 53 | US4939908 A  
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IMI CORNELIUS) See abstract and pages 3, 7-8 and 11 |
| X        | 1, 4-6 & 19 | GB2446792 A  
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| X        | 1, 4-6, 9 & 19 | GB2317680 A  
RYAN) See fig.4 and related description |

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### Field of Search:

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- **X**
Worldwide search of patent documents classified in the following areas of the IPC

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The following online and other databases have been used in the preparation of this search report

WPI, EPODOC