

Ice Dispensing System

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present invention claims the benefit of and priority to US Provisional Patent Application Serial No. 63/032,748, filed on 1 June 2020, the disclosure of which is incorporated by reference herein in its entirety.

BACKGROUND

Field of the invention

[0002] The present invention generally relates to an automated food and beverage production device. In particular, the present invention relates to an ice dispensing system in the food and beverage industry.

Description of related art

[0003] In the area of food and beverage production, there are numerous devices related to producing and distributing ice. These devices are mainly focused on producing and/or storing a certain amount of ice for a restaurant.

[0004] US 2,526,262 discloses an automatic ice-cube producing and storing machine. One limitation of this machine is that it only focuses on producing and storing ice. Furthermore, this machine removes or delivers the ice to another place by free falling only. The movement of ice is then limited to downward movement during operation. If the ice is moved to another location from the storage location, manpower is required. It is desirable to have a system that can be used in a restaurant or in the food and beverage production industry, and that operates completely autonomously for transferring ice from one location to another.

[0005] There are also a lot of devices focusing mainly on ice dispensing for a restaurant. US 6,135,173 discloses an ice dispenser for a refrigerator. US 5,526,854 discloses a through-the-door water and ice dispenser. Each of the two aforementioned dispensers uses a helix-shaped screw that can be rotated to push the ice into a dispensing hole. The limitation of the two dispensers is that the quantity of ice dispensed is not consistent every time. The dispensing time of any given quantity differs and depends on the amount of ice remaining in

the container. If the container is full, it would take one to two revolutions of the screw to obtain the ice. On the other hand, if there is very little ice, it would take more revolutions for the ice to reach the dispensing hole. In some cases, the ice is pushed to the corners of the machine. Such ice would never be reached by the helix-shaped screw. It is desirable to have a fully automatic ice dispensing system that can also ensure a predetermined quantity of ice to be dispensed, allowing food and beverage producing processes to be fully automated and enabling the quantity of ice to be customized.

[0006] Other desirable features and characteristics of the fully automatic ice dispensing system as disclosed herein will become apparent from the subsequent detailed description and the appended claims, taken in conjunction with the accompanying drawings and this background of the disclosure.

SUMMARY OF THE INVENTION

[0007] A first aspect of the present invention is to provide a first ice dispensing system for delivering a selected quantity of ice to a user.

[0008] The system comprises one or more ice producing machines and an ice transferring subsystem. The ice transferring subsystem comprises an ice container and an ice dispensing channel. The ice transferring subsystem is configured to: vertically move the ice container to reach a selected ice producing machine selected from the one or more ice producing machines for subsequently receiving ice from the selected ice producing machine and depositing the received ice into the ice container; vertically move the ice container loaded with the ice to reach the ice dispensing channel; unload the ice from the ice container to the ice dispensing channel for delivering the ice to the user; and in vertically moving the ice container to reach the selected ice producing machine, adjust a vertical position of the ice container so as to adjust an inner depth of the ice container allowable for storing the ice, wherein the inner depth is determined such that a predicted load of ice carried by the ice container under the determined inner depth is the selected quantity of ice.

[0009] It is preferable that the ice transferring subsystem is further configured as follows. In vertically moving the ice container loaded with the ice to reach the ice dispensing channel, the loaded ice container is elevated from the selected ice producing machine to the ice dispensing channel when the selected ice producing machine is positioned lower than the ice dispensing channel. Thereby, it allows the user to conveniently procure the ice from the ice dispensing channel without a need to install the selected ice producing machine at a higher position than the ice dispensing channel in utilizing gravity for ice delivery. To utilize this

advantage, at least one of the one or more ice producing machines is lower than the ice dispensing channel in position. Optionally, all of the one or more ice producing machines are lower than the ice dispensing channel in position.

[0010] In certain embodiments, the ice transferring subsystem further comprises a belt and a motor. The belt is used for vertically moving the ice container. The ice container is connected to the belt. The motor is used for driving the belt. The ice transferring subsystem may further comprise a first wheel and a second wheel. The second wheel is positioned higher than the first wheel. The belt is engaged with the first and second wheels and is rotatable synchronously with rotation of each of the first and second wheels. The first wheel is coupled to the motor such that the motor is arranged to indirectly drive the belt. In certain embodiments, each of the first and second wheels is a gear, and the belt is a geared belt.

[0011] The ice container may be a bowl. It is also possible that the ice container may be rectangular in shape.

[0012] In certain embodiments, the ice transferring subsystem further comprises one or more light detecting modules each for detecting whether a bulk of accumulated ice in the ice container has a height reaching the determined inner depth. An individual light detecting module comprises a light source and a photodetector. The light source may be a light emitting diode (LED), a laser diode, etc.

[0013] In certain embodiments, the system further comprises one or more ice transferring slides configured such that ice generated by the selected ice producing machine slides along a respective ice transferring slide to drop into the ice container.

[0014] The one or more ice transferring slides may include a multi-input single-output slide for collecting ice individually from plural ice producing machines and dropping the collected ice into the ice container.

[0015] The respective transferring slide may comprise an outlet and a plurality of bendable fingers. The outlet is used for outputting the ice received from the selected ice producing machine to the ice container. The plurality of bendable fingers is located at the outlet for decelerating the ice before dropping into the ice container. The plurality of bendable fingers may be made of rubber or silicone rubber.

[0016] In certain embodiments, the ice transferring subsystem further comprises an extended arm rigidly attached to the belt and pivotally connected to the ice container such that the ice container is indirectly, rotatably attached to the belt.

[0017] In certain embodiments, the ice transferring subsystem further comprises a platform and an extended arm. The ice container is fixed on the platform. The extended arm

is rigidly attached to the belt and pivotally connected to the platform such that the ice container is indirectly, rotatably attached to the belt.

[0018] In certain embodiments, the ice transferring subsystem further comprises a hinge, an extended arm and a knob. The ice container is divided into an upper part and a lower part. The upper part is attached to the belt through the hinge such that the upper part is rotatable about the hinge. The lower part is rigidly attached to the belt such that the lower part is not rotatable. The upper part is hollow for storing ice, and has an opening on a bottom side of the upper part to thereby allow the ice to be unloaded through the opening. The lower part used for blocking the opening when the upper and lower parts are aligned. The knob is located around an inlet of the ice dispensing channel. The knob, the extended arm and the ice container are arranged such that when the extended arm and the ice container are upwardly moved by the belt and when the extended arm is blocked by the knob, the upper part is rotated about the hinge to reveal the opening, causing the ice loaded in the upper part to be unloaded into the inlet of the ice dispensing channel through the opening.

[0019] In certain embodiments, the ice transferring subsystem further comprises a strip and a switch. The strip is mounted on the ice container. The switch is configured to be triggered by the strip. The switch is installed at a location defining a reference start-up level for the ice container, whereby the ice container is determined to be located at the reference start-up level when the strip triggers the switch. The switch may be a mechanical switch or a photoelectric switch. In case the switch is a photoelectric switch, the strip is selected to be opaque. The strip may be made of plastic.

[0020] In certain embodiments, the ice transferring subsystem further comprises one or more ultraviolet (UV) light sources arranged to irradiate the ice container for discouraging pathogen incubation inside the ice container.

[0021] The system further comprises one or more computing processors for controlling the one or more ice producing machines and the ice transferring subsystem. The one or more computing processors may be housed in a control and power module, which is used for controlling the system and supplying electrical power thereto.

[0022] In certain embodiments, the system further comprises a shaved ice machine for shaving ice into crushed form. The shaved ice machine has an ice-receiving slide for receiving ice, and an ice-discharging slide for outputting ice in crushed form. The ice transferring subsystem is further configured to: after the ice received from the selected ice producing machine is deposited into the ice container, vertically move the ice container to reach the ice-receiving slide and unload the ice from the ice container to the shaved ice

machine via the ice-receiving slide; and vertically move the ice container from the ice-receiving slide to reach the ice-discharging slide for allowing the ice in crushed form to be deposited from the shaved ice machine into the ice container before the ice container is vertically moved to reach the ice dispensing channel.

[0023] In certain embodiments, the ice transferring subsystem is formed with a plurality of individual ice dispensing channels for delivering the ice to different locations. The ice dispensing channel is user-selectable and is selected from the plurality of individual ice dispensing channels.

[0024] A second aspect of the present invention is to provide a second ice dispensing system for delivering a selected quantity of ice to a user.

[0025] The system comprises one or more ice producing machines and an ice transferring subsystem. The ice transferring subsystem comprises an ice container and an ice dispensing channel. The ice transferring subsystem is configured to: vertically move the ice container to reach a selected ice producing machine selected from the one or more ice producing machines for subsequently receiving ice from the selected ice producing machine and depositing the received ice into the ice container; vertically move the ice container loaded with the ice to reach the ice dispensing channel; unload the ice from the ice container to the ice dispensing channel for delivering the ice to the user; and in vertically moving the ice container loaded with the ice to reach the ice dispensing channel, elevate the loaded ice container from the selected ice producing machine to the ice dispensing channel when the selected ice producing machine is positioned lower than the ice dispensing channel, thereby allowing the user to conveniently procure the ice from the ice dispensing channel without a need to install the selected ice producing machine at a higher position than the ice dispensing channel in utilizing gravity for ice delivery. In particular, at least one of the one or more ice producing machines is lower than the ice dispensing channel in position.

[0026] Other aspects of the present invention are disclosed as illustrated by the embodiments hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The accompanying figures, where like reference numerals refer to identical or functionally similar elements throughout the separate views and which together with the detailed description below are incorporated in and form part of the specification, serve to illustrate various embodiments and to explain various principles and advantages in accordance with a present embodiment.

- [0028] FIG. 1A depicts a three-dimensional (3D) perspective view of an ice dispensing system in accordance with an exemplary embodiment of the present invention.
- [0029] FIG. 1B depicts a side view of the ice dispensing system.
- [0030] FIG. 2 depicts a cross-sectional view of the ice dispensing system, revealing structural details thereof.
- [0031] FIG. 3A depicts a cross-sectional view of an ice container and vicinity thereof in the disclosed system, where the ice container is positioned at a first vertical position such that ice is allowed to be deposited into the ice container until a high ice level in the ice container is reached.
- [0032] FIG. 3B depicts a cross-sectional view of the ice container and vicinity thereof, where the ice container is positioned at a second vertical position such that ice is allowed to be deposited into the ice container until a medium ice level in the ice container is reached.
- [0033] FIG. 3C depicts a cross-sectional view of the ice container and vicinity thereof, where the ice container is positioned at a third vertical position such that ice is allowed to be deposited into the ice container until a low ice level in the ice container is reached.
- [0034] FIG. 4 depicts a top view of the ice container approaching an ice transferring slide, where the ice transferring slide includes a plurality of bendable fingers for decelerating ice in motion when the ice falls into the ice container.
- [0035] FIG. 5 depicts a sequence of actions taken by a first configuration of the ice container in unloading the ice therein to a cup.
- [0036] FIG. 6 depicts a sequence of actions taken by a second configuration of the ice container in unloading the ice therein to the cup.
- [0037] FIG. 7 depicts a sequence of actions taken by a third configuration of the ice container in unloading the ice therein to the cup.
- [0038] FIG. 8 exemplarily depicts a process performed by an ice transferring subsystem of the disclosed system for receiving ice from one or more ice producing machines and delivering the received ice to the user.
- [0039] FIG. 9 exemplarily depicts a process performed by the ice transferring subsystem for receiving ice from the one or more ice producing machines and delivering the ice in crushed form to the user.
- [0040] Skilled artisans will appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been depicted to scale.

DETAILED DESCRIPTION

[0041] The following detailed description is merely exemplary in nature and is not intended to limit the invention or the application and uses of the invention. Furthermore, there is no intention to be bound by any theory presented in the preceding background of the invention or the following detailed description.

[0042] Disclosed herein is an ice dispensing system for delivering a selected quantity of ice to a user. The selected quantity may be selected from a plurality of choices, or may be a preselected amount, weight or volume of ice. The selected quantity may be user-selectable or may be determined without the user's involvement. Advantageously, the disclosed system is fully automatic and dispenses the quantity of ice as selected. As another advantage, the disclosed system allows a user to conveniently procure the ice without a need to put an ice producing machine at a considerably high position for utilizing gravity in ice delivery. Hence, the location factor of where to put the ice producing machine can be considered independently from where to retrieve the ice. Furthermore, it allows more freedom in placing the system such that the ice is delivered to the user without a hassle of requiring the user to, e.g., bend his or her waist in procuring the ice.

[0043] The disclosed system is exemplarily illustrated with the aid of FIGS. **1A**, **1B** and **2**. FIG. **1A** is a perspective view of an exemplary ice dispensing system **100** and FIG. **1B** is a side view thereof. FIG. **2** depicts a cross-sectional view of the system **100**, revealing structural details thereof. A reference vertical direction **900** is defined as an upward pointing direction according to the gravitational force. Herein in the specification and appended claims, positional and directional words such as "above," "below," "higher," "upper," "lower," "top," "bottom" and "horizontal" are interpreted with reference to the reference vertical direction **900**.

[0044] The system **100** comprises one or more ice producing machines **120** and an ice transferring subsystem **140**.

[0045] The one or more ice producing machines **120** are used for producing ice, and may be individually or collectively used for ice generation. As an example for illustration, FIG. **1A** depicts four ice producing machines **121-124** in total, where the two ice producing machines **121**, **122** are positioned at an upper horizontal level while the other two ice producing machines **123**, **124** are located at a lower horizontal level. Nevertheless, the disclosed system is not limited only to using four such machines and arranging the machines

pair-wisely; the disclosed system may use any practical number of ice producing machines and any location scheme of arranging the machines.

[0046] The ice transferring subsystem **140** comprises an ice container **142** and an ice dispensing channel **180**. The ice container **142** is used for temporarily storing the ice. Those skilled in the art may determine appropriate shape and size of the ice container **142** according to practical situations. For example, the ice container **142** may be a bowl or may be rectangular in shape. The ice dispensing channel **180** is used for delivering ice to the user. Preferably, the ice dispensing channel **180** is realized as a slide for utilizing gravity in automatically delivering the ice to the user.

[0047] In the system **100**, the ice transferring subsystem **140** is configured to perform a process for receiving ice from the one or more ice producing machines **120** and delivering the received ice to the user through the ice dispensing channel **180**. FIG. 8 is a flowchart showing exemplary steps of the process.

[0048] In a step **810**, the ice container **142** is vertically moved to reach a selected ice producing machine for receiving ice therefrom. The selected ice producing machine is selected from the one or more ice producing machines **120**. Unless otherwise specified, hereinafter consider the specific case that the ice producing machine **121** is the selected ice producing machine in illustrating operational details of the system **100**.

[0049] In the step **810**, advantageously and highly preferably, a vertical position **143** of the ice container **142** is adjusted so as to adjust an inner depth **144** of the ice container **142** allowable for storing the ice. Furthermore, the inner depth **144** is determined such that a predicted load of ice carried by the ice container **142** under the determined inner depth **144** is the selected quantity of ice to be delivered to the user. Thereby, the user is enabled to obtain a desired amount of ice as reflected in the selected quantity of ice that is received. Note that the vertical position **143** is variable and is dynamically set according to the selected quantity of ice.

[0050] Those skilled in the art will appreciate that the inner depth **144** is determinable according to the aforementioned vertical position **143** and other details of the system **100**. One specific case of inner depth determination is illustrated as follows.

[0051] In certain preferable embodiments, the ice transferring subsystem **140** further comprises one or more light detecting modules (e.g., light detecting modules **150**, **155**) each for detecting whether a bulk of accumulated ice in the ice container **142** has a height reaching the determined inner depth **144**. In general, the light detecting module **150** (**155**) is realized with a light source **151** (**152**) and a photodetector **153** (**154**). The light source **151** (**152**) may

be implemented as a LED or a laser diode. Furthermore, the light sources **151**, **152** and photodetectors **153**, **154** are installed outside the ice container **142** and are stationary. To allow light beams generated by the light sources **151**, **152** to pass through the ice container **142** for probing the ice, the ice container **142** may be transparent, or the ice container **142** may be formed with gap-like opening(s) **148** on the container casing.

[0052] As the ice producing machine **121** is the selected ice producing machine, consider the light detecting module **150**. As a convenient example for illustrating determination of the inner depth **144**, the bottom of the ice container **142** is selected to define the vertical position **143**. The inner depth **144** is determined to be a vertical distance between the bottom of the ice container **142** and a vertical position of the light detecting module **150**.

[0053] Although the inner depth **144** is determinable according to the vertical position **143** of the ice container **142** and the vertical position of the light detecting module **150**, it is first required to have an accurate determination of the vertical position **143** of the ice container **142**. Since the ice container **142** is movable, the vertical position **143** can usually be accurately measured as a traveling distance from a certain reference position as the ice container **142** moves. In certain embodiments, the reference position is set up in the system **100** as follows. Refer to FIG. 2. A strip **146** is mounted on the ice container **142**. A switch **145** is installed at a location of the ice transferring subsystem **140** defining a reference start-up level (i.e. the reference position) for the ice container **142**. Furthermore, the switch **145** is configured to be triggered by the strip **146**. As a result, the ice container **142** is determined to be located at the reference start-up level when the strip **146** triggers the switch **145**.

[0054] The switch **145** may be a mechanical switch, a photoelectric switch, etc. If the switch **145** is a mechanical switch, the strip **146** is rigid and is usually made of a rigid material. If the switch **145** is a photoelectric switch, the strip **146** is opaque and may be formed by plastic.

[0055] FIGS. 3A-3C depict various cross-sectional views of the ice container **142** and vicinity thereof under conditions of storing ice at a high ice level, a medium ice level and a low ice level, respectively. In FIG. 3A, the ice container **142** is moved and positioned with a first vertical position **143a**, giving a first inner depth **144a**, which is a distance between the first vertical position **143a** and a line joining the light source **151** and the photodetector **153**. Similarly, in FIG. 3B and FIG. 3C, the ice container **142** is positioned at a second vertical position **143b** and a third vertical position **143c** so as to yield a second inner depth **144b** and a third inner depth **144c**, respectively. FIGS. 3A-3C are depicted to have the ice in the ice container **142** to attain the high ice level, the medium ice level and the low ice level,

respectively. It follows that the first inner depth **144a** is longer than the second inner depth **144b**, which is in turn longer than the third inner depth **144c**. As a result, it demonstrates that the selected quantity of ice delivered to be user is greatest for the case of FIG. **3A**, is smaller for the case of FIG. **3B**, and is further smaller for the case of FIG. **3C**.

[0056] After the step **810** is completed, the ice transferring subsystem **140**, in a step **820**, receives ice from the ice producing machine **121** and deposits the received ice into the ice container **142**. When the ice accumulated in the ice container **142** reaches a height that is detected by the light detecting module **150**, the accumulated ice fills up a part of the ice container **142** with the determined inner depth **144**. The light detecting module **150** is triggered, causing the system **100** to command the ice producing machine **121** to stop delivering ice to the ice container **142**. As a result, the load of ice in the ice container **142** is maintained to be the selected quantity of ice desired to be delivered to the user.

[0057] The ice container **142** loaded with the ice is then vertically moved to reach the ice dispensing channel **180** in a step **830**. Afterwards, in a step **840**, the load of ice in the ice container **142** is unloaded to the ice dispensing channel **180** through an inlet thereof **181**. The user receives the ice through an outlet **182** of the ice dispensing channel **180**. Preferably, the ice dispensing channel **180** is arranged such that the inlet **181** is positioned higher than the outlet **182** in order to utilize gravity for automatically delivering the load of ice to the user. It is preferable that the ice dispensing channel **180** is implemented as a slide.

[0058] In the step **830**, the loaded ice container **142**, i.e. the ice container **142** loaded with the ice, is elevated from the selected ice producing machine to the ice dispensing channel **180** when the selected ice producing machine is positioned lower than the ice dispensing channel **180**. Advantageously, it allows that user to conveniently procure the ice from the ice dispensing channel **180** without a need to install the selected ice producing machine at a higher position than the ice dispensing channel **180** in utilizing gravity for ice delivery. To utilize this advantage, preferably at least one of the one or more ice producing machines **120** is lower than the ice dispensing channel **180** in position. It is generally more preferable that all of the one or more ice producing machines **120** are lower than the ice dispensing channel **180** in position. As demonstrated in FIGS. **1A** and **1B**, the four ice producing machines **121-124** are positioned lower than the ice dispensing channel **180**. In particular, the four ice producing machines **121-124** are lower than the ice dispensing channel **180** in the sense that respective ice-releasing outlets **221-224** of the four ice producing machines **121-124** for outputting ice are positioned lower than the inlet **181** of the ice dispensing channel **180**.

[0059] Other details of the system **100** are elaborated as follows.

[0060] In one implementation, the ice transferring subsystem **140** is realized with a belt **160** for vertically moving the ice container **142**. The ice container **142** is connected to and carried by the belt **160**. A motor **165** is used to drive the belt **160**.

[0061] Preferably, the belt **160** is held in tension by two wheels **161**, **162**, denoted as a first wheel **161** and a second wheel **162**. The two wheels **161**, **162** are positioned to vertically separate from each other such that the belt **160** is positioned upright. Without loss of generality, assume that the first wheel **161** is lower than the second wheel **162**. The belt is engaged with the two wheels **161**, **162** and is rotatable synchronously with rotation of each of the two wheels **161**, **162**. The two wheels **161**, **162** drive the belt **160** to controllably rotate in a clockwise direction or an anti-clockwise direction to thereby enable the ice container **142** to move upwardly and downwardly, as depicted in FIG. 2. Furthermore, the two wheels **161**, **162** receive rotational torque from the motor **165**, which acts as a rotary actuator. Preferably, the motor **165** is coupled to the first wheel **161**, which is positioned lower than the second wheel **162**, thereby allowing convenient installation of the motor **165**, which is usually heavy, in the ice transferring subsystem **140**. Note that the motor **165** indirectly drives the belt **160**.

[0062] In certain embodiments, each of the first and second wheels **161**, **162** is a gear. The belt **160** is a geared belt.

[0063] Apart from using a mechanism made up of the belt and the two wheels, other mechanisms may be used to vertically move the ice container **142** upwardly and downwardly. For example, a rigid track (not shown in FIGS. 1A, 1B and 2) may be installed in the ice transferring subsystem **140** and the ice container **142** is allowed to move along the track.

[0064] Optionally, the system **100** further comprises one or more ice transferring slides **171**, **172** configured such that ice generated by the selected ice producing machine slides along a respective ice transferring slide to drop into the ice container **142**. Each ice transferring slide may be used to transport ice generated by one ice producing machine to the ice container **142**. Alternatively, the one or more ice transferring slides **171**, **172** may include one or more multi-input single-output slides each used for collecting ice individually from plural ice producing machines and dropping the collected ice into the ice container **142**. For example, ice transferring slides **171**, **172** as shown in FIG. 1A are multi-input single-output slides. The ice transferring slide **171** serves the ice producing machines **121**, **122**. Similarly, the ice transferring slide **172** serves the ice producing machines **123**, **124**. Using the one or more ice transferring slides **171**, **172** in the system **100** may yield an advantage of saving material costs in manufacturing the system **100**.

[0065] Consider the ice transferring slide **171** for illustrating a representative ice transferring slide as disclosed in the present invention. Refer to FIG. 4, which depicts a top view of the ice container **142** approaching the ice transferring slide **171**. The ice transferring slide **171** has an outlet **177** for outputting the ice received from the selected ice producing machine to the ice container **142**. Preferably and advantageously, the ice transferring slide **171** further comprises a plurality of bendable fingers **178** located at the outlet **177** for decelerating the ice (which is in motion) before the ice drops into the ice container **142**. As a result of deceleration, the chance of defacing and damaging the ice from typically cubic shape is reduced, thereby avoiding objection raised by the user to the outlook of received ice cubes. Another advantage of the plurality of bendable fingers **178** is to decrease a gap between the ice transferring slide **171** and the ice container **142**, further making the transfer of ice from the ice transferring slide **171** to the ice container **142** smoothly. The plurality of bendable fingers **178** may be made of rubber or silicone rubber.

[0066] In certain embodiments, the ice transferring slide **171** is formed by a U-shaped piece of resistant material, such as plastic and metal, for transferring the ice pushed out of the selected ice producing machine by a helix screw into the ice container **142**.

[0067] It is possible to have several different realizations of the ice container **142** for facilitating the unloading of the ice from the ice container **142** to the ice dispensing channel **180** in carrying out the step **840**. FIGS. 5-7 depict respective sequences of actions taken by first, second and third configurations of the ice container **142** in unloading the ice therein to a cup **910**.

[0068] Refer to FIG. 5, which shows a first ice container **142a** as the first configuration of the ice container **142**. The ice transferring subsystem **140** further comprises an extended arm **545** rigidly attached to the belt **160** and pivotally connected to the first ice container **142a** through a hinge **546** such that the first ice container **142a** is indirectly, rotatably attached to the belt **160**. Initially, the first ice container **142a** containing a load of ice is positioned upright when the first ice container **142a** approaches the inlet **181** of the ice dispensing channel **180** (inset a). The first ice container **142a** rotates towards the inlet **181** (inset b) for unloading the load of ice into the inlet (inset c). After the load of ice is unloaded, the first ice container **142a** rotates away from the inlet **181** and returns to an upright position (inset d). The load of ice is deposited into the cup **910** through the outlet **182** of the ice dispensing channel **180**.

[0069] Refer to FIG. 6, which shows a second ice container **142b** as the second configuration of the ice container **142**. The ice transferring subsystem **140** further comprises

a platform **647**, a hinge **646** and an extended arm **645**. The second ice container **142b** is fixed on, and is hence driven by, the platform **647**. The extended arm **645** is rigidly attached to the belt **160** and is pivotally connected to the platform **647** through the hinge **646** such that the second ice container **142b** is indirectly, rotatably attached to the belt **160**. Initially, the second ice container **142b** containing a load of ice is positioned upright when the second ice container **142b** approaches the inlet **181** of the ice dispensing channel **180** (inset a). The second ice container **142b**, driven by the platform **647**, rotates towards the inlet **181** (inset b) for unloading the load of ice into the inlet (inset c). After the load of ice is unloaded, the platform **647** drives the second ice container **142b** to rotate away from the inlet **181** and returns to an upright position (inset d). The load of ice is deposited into the cup **910** through the outlet **182** of the ice dispensing channel **180**.

[0070] Refer to FIG. 7, which shows a third ice container **142c** as the third configuration of the ice container **142**. The ice transferring subsystem **140** further comprises a hinge **746**, an extended arm **745** and a knob **747**. The knob **747** is located around the inlet **181** of the ice dispensing channel **180**. The third ice container **142c** is divided into an upper part **711** and a lower part **712**. The upper part **711** is attached to the belt **160** through the hinge **746** such that the upper part **711** is rotatable about the hinge **746**. On the other hand, the lower part **712** is rigidly attached to the belt **160**, and is hence stationary and not rotatable. The upper part **711** is hollow and is used to store ice. The upper part **711** has an opening **713** on a bottom side of the upper part **711**, allowing the ice stored in the upper part **711** to be unloaded through the opening **713**. The lower part **712** is hard, and is used to block the opening **713** when the upper and lower parts **711**, **712** are aligned. The upper part **711** is rigidly connected to the extended arm **745**. The knob **747**, the extended arm **745** and the third ice container **142c** are arranged as follows. Initially, the third ice container **142c** containing a load of ice is positioned upright with the upper and lower parts **711**, **712** aligned. The third ice container **142c** and the extended arm **745** move upwardly by the belt **160** to approach the inlet **181** of the ice dispensing channel **180** (inset a). When the extended arm **745** hits the knob **747** and is blocked by the knob **747**, the upper part **711** is rotated about the hinge **746** whereas the lower part **712** remains not rotated, thereby revealing the opening **713** (inset b). The rotation of the upper part **711** causes the load of ice to be unloaded from the upper part **711** into the inlet **181** through the opening **713**. The upper part **711** continues to rotate as it moves up (inset c), emptying the upper part **711**. When the third ice container **142c** continues to go up, the extended arm **745** is able to go around the knob **747**. The upper part **711** returns back to an upright position and re-aligns with the lower part **712**, closing the opening **713** (inset d). The

load of ice is deposited into the cup **910** through the outlet **182** of the ice dispensing channel **180**. Note that an interface **714** between the upper part **711** and the lower part **712** is curved so that when the upper part **711** rotates, the ice therein falls to the ice dispensing channel **180** naturally. Optionally, a limit switch **785** is installed above the knob **747**. When the third ice container **142c** hits the limit switch **785**, it signals that the third ice container **142c** has unloaded the load of ice such that the third ice container **142c** may not continue to go upward. Alternatively, it is also possible that the distance moved by the third ice container **142c** from the reference start-up level is estimated by counting the number of rotations made by the motor **165** without a need to install the limit switch **785**.

[0071] In certain embodiments, the ice transferring subsystem **140** is further configured to return to the reference start-up level as defined by the installation location of the switch **145**.

[0072] Refer to FIG. 4. Optionally, one or more UV light sources **420** are installed in the ice transferring subsystem **140**, and are arranged to irradiate the ice container **142** for discouraging pathogen incubation inside the ice container **142**. Generally, the one or more UV light sources **420** are moved with the ice container **142**. Conveniently, one or more individual UV light sources may be installed inside the ice container **142**.

[0073] The system **100** further comprises one or more computing processors **230** for controlling various components of the system **100**. The one or more computing processors **230** are configured to control at least the one or more ice producing machines **120** and the ice transferring subsystem **140**. The one or more computing processors **230** may include a general-purpose processor, a microcontroller, a specialized processor, etc.

[0074] In certain embodiments, the system **100** further comprises a control and power module **130** for controlling the system **100** and supplying electrical power thereto. The one or more computing processors **230** may be housed in the control and power module **130**.

[0075] As an optional feature, the system **100** may further comprise a shaved ice machine **290** for shaving ice into crushed form. The shaved ice machine **290** has an ice-receiving slide **280** for receiving ice in block form, and an ice-discharging slide **285** for outputting ice in crushed form. Preferably and conveniently, the one or more computing processors **230** are further configured to control the shaved ice machine **290**.

[0076] Modified from FIG. 8, FIG. 9 depicts a process performed by the ice transferring subsystem **140** for receiving ice from the one or more ice producing machines **120** and delivering the ice in crushed form to the user through the ice dispensing channel **180**. The process performs the steps **810** and **820** as disclosed above. After the ice received from the

selected ice producing machine is deposited into the ice container **142** in the step **820**, the ice container **142** is vertically moved to reach the ice-receiving slide **280** in a step **881**.

Afterwards, the ice is unloaded from the ice container **142** to the shaved ice machine **290** in a step **882**. After the step **882** is performed, the ice container **142** is vertically moved from the ice-receiving slide **280** to the ice-discharging slide **285** of the shaved ice machine **290** in a step **883**. At the ice-discharging slide **285**, the ice in crushed form is deposited from the shaved ice machine **290** into the ice container **142** in a step **884**. Afterwards, the ice container **142** is vertically moved to reach the ice dispensing channel **180** in the step **830**. The step **840** is performed thereafter.

[0077] In addition to the ice dispensing channel **180**, the system **100** may be installed with one or more additional ice dispensing channels. Note that the ice dispensing channel **180** and the one or more additional ice dispensing channels may be installed at different heights. Advantageously, users of different heights, e.g., children and adults, can conveniently and comfortably withdraw ice from the system **100**. For illustration, FIG. **10** depicts a variant of the system **100** (labeled as **100a**) formed with a plurality of individual ice dispensing channels **1011**, **1012** for delivering ice to different locations. The ice dispensing channel **180**, from which the user receives the ice, is user-selectable and is selected from the plurality of individual ice dispensing channels **1011**, **1012**.

[0078] While exemplary embodiments have been presented in the foregoing detailed description of the invention, it should be appreciated that a vast number of variations exist. It should further be appreciated that the exemplary embodiments are only examples, and are not intended to limit the scope, applicability, operation, or configuration of the invention in any way. Rather, the foregoing detailed description will provide those skilled in the art with a convenient road map for implementing an exemplary embodiment of the invention, it being understood that various changes may be made in the function and arrangement of steps and method of operation described in the exemplary embodiment without departing from the scope of the invention as set forth in the appended claims.

CLAIMS

What is claimed is:

1. An ice dispensing system for delivering a selected quantity of ice to a user, the system comprising:
 - one or more ice producing machines; and
 - an ice transferring subsystem comprising an ice container and an ice dispensing channel, the ice transferring subsystem being configured to:
 - vertically move the ice container to reach a selected ice producing machine selected from the one or more ice producing machines for subsequently receiving ice from the selected ice producing machine and depositing the received ice into the ice container;
 - vertically move the ice container loaded with the ice to reach the ice dispensing channel;
 - unload the ice from the ice container to the ice dispensing channel for delivering the ice to the user; and
 - in vertically moving the ice container to reach the selected ice producing machine, adjust a vertical position of the ice container so as to adjust an inner depth of the ice container allowable for storing the ice, wherein the inner depth is determined such that a predicted load of ice carried by the ice container under the determined inner depth is the selected quantity of ice.
2. The system of claim 1, wherein the ice transferring subsystem further comprises:
 - a belt for vertically moving the ice container, the ice container being connected to the belt; and
 - a motor for driving the belt.
3. The system of claim 2, wherein the ice transferring subsystem further comprises:
 - a first wheel and a second wheel positioned higher than the first wheel, the belt being engaged with the first and second wheels and being rotatable synchronously with rotation of each of the first and second wheels, the first

wheel being coupled to the motor such that the motor is arranged to indirectly drive the belt.

4. The system of claim 3, wherein:
each of the first and second wheels is a gear; and
the belt is a geared belt.
5. The system of claim 1, wherein the ice container is a bowl.
6. The system of claim 1, wherein the ice container is rectangular in shape.
7. The system of claim 1, wherein the ice transferring subsystem further comprises:
one or more light detecting modules each for detecting whether a bulk of
accumulated ice in the ice container has a height reaching the determined inner
depth, an individual light detecting module comprising a light source and a
photodetector.
8. The system of claim 7, wherein the light source is a light emitting diode (LED) or a
laser diode.
9. The system of claim 1 further comprising:
one or more ice transferring slides configured such that ice generated by the
selected ice producing machine slides along a respective ice transferring slide
to drop into the ice container.
10. The system of claim 9, wherein the one or more ice transferring slides include a multi-
input single-output slide for collecting ice individually from plural ice producing
machines and dropping the collected ice into the ice container.
11. The system of claim 9, wherein the respective transferring slide comprises:
an outlet for outputting the ice received from the selected ice producing machine
to the ice container; and
a plurality of bendable fingers located at the outlet for decelerating the ice before
dropping into the ice container.

12. The system of claim 11, wherein the plurality of bendable fingers is made of rubber or silicone rubber.
13. The system of claim 2, wherein the ice transferring subsystem further comprises:
an extended arm rigidly attached to the belt and pivotally connected to the ice container such that the ice container is indirectly, rotatably attached to the belt.
14. The system of claim 2, wherein the ice transferring subsystem further comprises:
a platform on which the ice container is fixed; and
an extended arm rigidly attached to the belt and pivotally connected to the platform such that the ice container is indirectly, rotatably attached to the belt.
15. The system of claim 2, wherein:
the ice transferring subsystem further comprises a hinge, an extended arm and a knob;
the ice container is divided into an upper part and a lower part, the upper part being attached to the belt through the hinge such that the upper part is rotatable about the hinge, the lower part being rigidly attached to the belt such that the lower part is not rotatable, the upper part being hollow for storing ice, the upper part having an opening on a bottom side of the upper part to thereby allow the ice to be unloaded through the opening, the lower part being used for blocking the opening when the upper and lower parts are aligned;
the knob is located around an inlet of the ice dispensing channel; and
the knob, the extended arm and the ice container are arranged such that when the extended arm and the ice container are upwardly moved by the belt and when the extended arm is blocked by the knob, the upper part is rotated about the hinge to reveal the opening, causing the ice loaded in the upper part to be unloaded into the inlet of the ice dispensing channel through the opening.
16. The system of claim 1, wherein the ice transferring subsystem further comprises:
a strip mounted on the ice container; and
a switch configured to be triggered by the strip, the switch being installed at a location defining a reference start-up level for the ice container, whereby the

ice container is determined to be located at the reference start-up level when the strip triggers the switch.

17. The system of claim 16, wherein the switch is a mechanical switch.
18. The system of claim 16, wherein the switch is a photoelectric switch.
19. The system of claim 18, wherein the strip is made of plastic.
20. The system of claim 1, wherein the ice transferring subsystem further comprises one or more ultraviolet (UV) light sources arranged to irradiate the ice container for discouraging pathogen incubation inside the ice container.
21. The system of claim 1 further comprising:
 - a control and power module for controlling the system and supplying electrical power thereto.
22. The system of claim 1 further comprising:
 - one or more computing processors for controlling the one or more ice producing machines and the ice transferring subsystem.
23. The system of claim 22, wherein the one or more computing processors are housed in a control and power module used for controlling the system and supplying electrical power thereto.
24. The system of claim 1 further comprising:
 - a shaved ice machine for shaving ice into crushed form, the shaved ice machine having an ice-receiving slide for receiving ice, and an ice-discharging slide for outputting ice in crushed form;wherein the ice transferring subsystem is further configured to:
 - after the ice received from the selected ice producing machine is deposited into the ice container, vertically move the ice container to reach the ice-receiving slide and unload the ice from the ice container to the shaved ice machine via the ice-receiving slide; and

vertically move the ice container from the ice-receiving slide to reach the ice-discharging slide for allowing the ice in crushed form to be deposited from the shaved ice machine into the ice container before the ice container is vertically moved to reach the ice dispensing channel.

25. The system of claim 1, wherein the ice transferring subsystem is formed with a plurality of individual ice dispensing channels for delivering the ice to different locations, the ice dispensing channel being user-selectable and being selected from the plurality of individual ice dispensing channels.

26. The system of any of the preceding claims, wherein:

the ice transferring subsystem is further configured to:

in vertically moving the ice container loaded with the ice to reach the ice dispensing channel, elevate the loaded ice container from the selected ice producing machine to the ice dispensing channel when the selected ice producing machine is positioned lower than the ice dispensing channel, thereby allowing the user to conveniently procure the ice from the ice dispensing channel without a need to install the selected ice producing machine at a higher position than the ice dispensing channel in utilizing gravity for ice delivery;

and

at least one of the one or more ice producing machines is lower than the ice dispensing channel in position.

27. An ice dispensing system for delivering a selected quantity of ice to a user, the system comprising:

one or more ice producing machines; and

an ice transferring subsystem comprising an ice container and an ice dispensing channel, the ice transferring subsystem being configured to:

vertically move the ice container to reach a selected ice producing machine selected from the one or more ice producing machines for subsequently receiving ice from the selected ice producing machine and depositing the received ice into the ice container;

vertically move the ice container loaded with the ice to reach the ice dispensing channel;

unload the ice from the ice container to the ice dispensing channel for delivering the ice to the user; and

in vertically moving the ice container loaded with the ice to reach the ice dispensing channel, elevate the loaded ice container from the selected ice producing machine to the ice dispensing channel when the selected ice producing machine is positioned lower than the ice dispensing channel, thereby allowing the user to conveniently procure the ice from the ice dispensing channel without a need to install the selected ice producing machine at a higher position than the ice dispensing channel in utilizing gravity for ice delivery;

wherein at least one of the one or more ice producing machines is lower than the ice dispensing channel in position.