

CARBONATION MACHINE WITH FROTH CONTROL AND METHOD THEREOF

FIELD OF THE INVENTION

[0001] The present invention relates to carbonation machines. More particularly, the present invention relates to a carbonation machine with froth control and method thereof, facilitating carbonation of various liquids other than just pure water, where froth may be produced and build up during carbonation.

BACKGROUND OF THE INVENTION

[0002] Carbonation machines are commonly used in homes, offices, cafeterias, and other settings.

[0003] Typically, a carbonation machine is designed to carbonate water or other liquid that is in a bottle that is sealingly attached to the carbonation head of the carbonation machine to prevent inadvertent pressure release from the bottle. In the carbonation process carbon dioxide is injected as a jet (in a typical pressure of some 60 bars) into the water to obtain a sparkling beverage. The injected carbon dioxide creates turbulence in the bottle allowing good distribution and absorption of carbon dioxide in the water, while excess gas is released. Pressure built-up above the water surface inside the bottle may typically be released via designated one or more pressure release valves. When the carbonation process is over the bottle with the carbonated beverage may be removed from the carbonation head of the carbonation machine. Typically, the removal of the bottle from the carbonation head is carried out by tilting the bottle to actuate a pressure release mechanism or another arrangement for quick release of gas to release excess pressure from within the bottle. The release of excess gas during the removal of the bottle from the carbonation machine is usually uncontrolled.

[0004] Carbonating liquid other than pure water (e.g., milk, fruit juice, water with an additive or additives, such as sugar, syrup, pulp etc.) may entail safety problems, as the additive may hamper the proper operation of safety valves, for example by sticking or otherwise preventing parts of pressure release valves from successfully venting away excess pressure. Furthermore, liquids whose composition is different from pure water (e.g.,

due to the existence of additives or any additional constituents in water) may result in excessive frothing, that may erupt from the bottle, when disconnecting the bottle from the carbonation head of the carbonation machine, causing mess and inconvenience.

[0005] It may be, therefore, desired to provide a carbonation machine that is designed for carbonating various liquids, such as milk, fruit or vegetable juices, water with sugar and other additives, etc, which is designed to overcome the abovementioned shortcomings associated with known carbonation machines.

SUMMARY OF THE INVENTION

[0006] There is thus provided, in accordance with an embodiment of the invention, a carbonation machine that includes a carbonation head to sealingly couple to a bottle filled with liquid to be carbonated; a piping to transfer carbon dioxide into a space within the bottle to carbonate the liquid when the bottle is coupled to the carbonation head; and a manually operated valve mechanism configured to be moved to any position between a closed position to an open position for user-controlled release of pressure buildup within the bottle.

[0007] According to some embodiments of the present invention, the manually operated valve mechanism comprises a pinch valve mechanism.

[0008] According to some embodiments of the present invention, the pinch valve mechanism comprises a pinch bumper to pinch a drain tube to prevent flow through the drain tube when in the closed position, and to retract from the drain tube to allow flow through the drain tube to release pressure inside the bottle.

[0009] According to some embodiments of the present invention, the pinch valve mechanism is configured to allow gradual retracting of the pinch bumper to release pressure through the drain tube.

[0010] According to some embodiments of the present invention, the pinch bumper is held at an end of a seesaw arm pivotally supported by an axis mount.

[0011] According to some embodiments of the present invention, the pinch bumper is held by a receptacle.

[0012] According to some embodiments of the present invention, the pinch bumper is maintained in a default extended outwards position.

[0013] According to some embodiments of the present invention, the pinch bumper is maintained in a default extended outwards position by a preloaded spring.

[0014] According to some embodiments of the present invention, the preloaded spring is configured to yield to overpressure buildup inside the bottle above a predetermined overpressure threshold.

[0015] According to some embodiments of the present invention, the pinch valve mechanism includes a friction generator to generate friction so as to allow manually operating the manually operated valve mechanism to any position between the closed position and the open position and maintaining that position even when the manually operated valve mechanism is released.

[0016] According to some embodiments of the present invention, the pinch valve mechanism is operable by a pinch valve lever.

[0017] According to some embodiments of the present invention, the pinch valve lever is substantially orthogonally coupled to a rotatable axle.

[0018] According to some embodiments of the present invention, the pinch valve mechanism comprises an over-center spring positioned such that when the pinch valve mechanism approaches either the closed position or the open position, the over-center spring exerts a rotary force on an axle of the pinch valve mechanism so as to force the axle to rotate to a nearest end position, to affect either the closed position or the open position.

[0019] According to some embodiments of the present invention, the piping is configured to transfer carbon dioxide into the space which is above a top surface of the liquid, the carbonation machine further comprising a stirrer to stir the liquid to enhance absorption of carbon dioxide in the liquid.

[0020] According to some embodiments of the present invention, the stirrer is electrically operated.

[0021] According to some embodiments of the present invention, the carbonation head is configured to compress the carbon dioxide in the space up to a pressure threshold.

[0022] According to some embodiments of the present invention, the pressure threshold is 10 bars.

[0023] According to some embodiments of the present invention, the pressure threshold is 6 bars.

[0024] According to some embodiments of the present invention, the carbonation machine further includes a controller, configured to cause carbon dioxide to be added to the space within the bottle above the top surface of the liquid when pressure in the bottle drops below a predetermined pressure threshold.

[0025] According to some embodiments of the present invention, one or more parts of the machine that are designed to be placed in contact with the liquid are removable.

[0026] According to some embodiments of the present invention, said one or more parts comprises a detachable carbonation tube assembly.

[0027] According to some embodiments of the present invention, the detachable carbonation tube assembly comprises a carbonation tube within a carbonation tube sleeve, having a space defined between the carbonation tube and the carbonation sleeve.

[0028] According to some embodiments of the present invention, the detachable carbonation tube assembly further comprises a surplus reservoir and a drain tube configured to fluidically connect the space defined between the carbonation tube and the carbonation tube sleeve with the surplus reservoir.

[0029] According to some embodiments of the present invention, the surplus reservoir is detachable from the detachable carbonation tube assembly.

[0030] According to some embodiments of the present invention, the carbonation machine further includes a bore in the carbonation head and wherein a top portion of the carbonation tube sleeve is configured to tightly fit and be held inside the bore.

[0031] According to some embodiments of the present invention, the bore in the carbonation head comprises two gaskets each defining a tubular sealed space about the top portion of the carbonation tube sleeve, wherein top portion of the carbonation tube sleeve includes at least one bore within each of the tubular sealed spaced within the gaskets, for introducing carbon dioxide into the carbonation tube and for evacuating excess pressure within the bottle through the between the carbonation tube and the carbonation sleeve.

[0032] According to some embodiments of the present invention, the removable one or more parts of the machine that are designed to be placed in contact with the liquid are made of plastic or other material that is dishwasher safe.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] In order for the present invention to be better understood and for its practical applications to be appreciated, the following Figures are provided and referenced hereinafter. It should be noted that the Figures are given as examples only and in no way limit the scope of the invention. Like components are denoted by like reference numerals.

[0034] Fig. 1 is an isometric view of a carbonation machine with a froth control, according to some embodiments of the present invention, with a carbonation bottle attached to the carbonation head.

[0035] Fig. 2 is a frontal view of the carbonation machine of Fig. 1, exposing internal parts of the carbonation head.

[0036] Fig. 3 is a back view of the carbonation machine of Fig. 1, showing a gas canister connected inside the gas canister compartment.

[0037] Fig. 4 is a side view of the carbonation machine of Fig. 1, showing parts of the carbonation head with a stirrer.

[0038] Fig. 5 is a frontal view of the carbonation machine of Fig. 1, showing the stirrer and a surplus reservoir panel.

[0039] Fig. 6 is an exploded view of parts of the carbonation machine of Fig. 1.

[0040] Fig. 7A shows a pinch valve mechanism of a carbonation machine according to some embodiments of the present invention.

[0041] Fig. 7B shows a side-wall panel of a carbonation machine with a ring that supports an axle of the pinch valve mechanism of Fig. 7A.

[0042] Fig. 8A shows the pinch valve mechanism of Fig. 7 with the drain tube open.

[0043] Fig. 8B shows the pinch valve mechanism of Fig. 7 with the drain tube closed.

[0044] Fig. 9 is a schematic operational diagram of a carbonation machine, according to some embodiments of the present invention.

[0045] Fig. 10 shows a carbonation machine with a froth control, according to some other embodiments of the present invention.

[0046] Fig. 11 shows a vertical cross-section of the carbonation machine shown in Fig. 10.

[0047] Fig. 12 is a partial cross section view of the carbonation head of the carbonation machine of Fig. 10.

[0048] Fig. 13 shows a detachable carbonation sleeve of the carbonation machine shown in Fig. 10, with a drain tube in a closed state.

[0049] Fig. 14 shows a detachable carbonation sleeve of the carbonation machine shown in Fig. 10, with a drain tube in an open state.

[0050] Fig. 15 shows an isometric view of a detachable carbonation sleeve of the carbonation machine shown in Fig. 10.

[0051] Fig. 16 shows a side view of a detachable carbonation sleeve of the carbonation machine shown in Fig. 10.

[0052] Fig. 17 is a side view of some internal parts of a carbonation machine according to the present invention, with the interlock mechanism of in an open (unlocked) position.

[0053] Fig. 18 is a side view of some internal parts of a carbonation machine, with the interlock mechanism in a closed (locked) position.

DETAILED DESCRIPTION OF THE INVENTION

[0054] In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be understood by those of ordinary skill in the art that the invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, modules, units and/or circuits have not been described in detail so as not to obscure the invention.

[0055] Although embodiments of the invention are not limited in this regard, discussions utilizing terms such as, for example, “processing,” “computing,” “calculating,” “determining,” “establishing”, “analyzing”, “checking”, or the like, may refer to operation(s) and/or process(es) of a computer, a computing platform, a computing system, or other electronic computing device, that manipulates and/or transforms data represented as physical (e.g., electronic) quantities within the computer’s registers and/or memories

into other data similarly represented as physical quantities within the computer's registers and/or memories or other information non-transitory storage medium (e.g., a memory) that may store instructions to perform operations and/or processes. Although embodiments of the invention are not limited in this regard, the terms "plurality" and "a plurality" as used herein may include, for example, "multiple" or "two or more". The terms "plurality" or "a plurality" may be used throughout the specification to describe two or more components, devices, elements, units, parameters, or the like. Unless explicitly stated, the method embodiments described herein are not constrained to a particular order or sequence. Additionally, some of the described method embodiments or elements thereof can occur or be performed simultaneously, at the same point in time, or concurrently. Unless otherwise indicated, the conjunction "or" as used herein is to be understood as inclusive (any or all of the stated options).

According to some embodiments of the present invention, a carbonation machine is provided, designed for carbonating liquid other than pure water (e.g., milk, fruit juice, water with an additive or additives, such as sugar, syrup, pulp etc.). Such carbonation machine is designed to direct carbon dioxide into the space in the carbonation bottle above the liquid top surface and compress the carbon dioxide to a pressure level of up to 10 bars, e.g., 6 bars, and use a stirrer to stir the liquid to enhance the absorption of the carbon dioxide in the liquid. During the absorption of carbon dioxide in the liquid pressure above the liquid may drop. A pressure sensor may detect the carbon dioxide pressure drop and the controller (107, Fig. 9) may actuate the carbonation mechanism of the carbonation machine to release additional carbon dioxide into the space inside the carbonation bottle, above the liquid top surface to maintain a proper pressure level of the carbon dioxide. According to some embodiments, the controller may be configured to cause carbon dioxide to be added to the space within the bottle above the top surface of the liquid when pressure in the bottle drops below a predetermined pressure threshold.

[0056] There are typically two ways to properly carbonate a liquid. One way typically involves increasing the pressure to 12 bar without releasing pressure and the other way involves pressurizing to 6 to 8 bar and allowing gas to flow through the water using the turbulence being caused by the flow to enhance the carbonation level. In a carbonation machine according to some embodiments of the invention, the generated turbulence with the stirrer increases the absorption of CO₂ in the water without the need to pass large quantities of gas through the water to create the turbulence.

[0057] According to some embodiments of the present invention, when the carbonation process is completed, remaining excess pressure within the carbonation bottle may be decompressed in a controlled manner using a pinch valve mechanism, allowing a user total control over the pressure release. The pinch valve mechanism allows the user to carefully vent excess gas out of the bottle by carefully turning the pinch valve mechanism to an open state, and manually stop the venting process if froth begins to spill out of the bottle.

[0058] The bottle with the carbonated liquid may be removed safely from the carbonation machine after the decompression is completed.

[0059] Fig. 1 is an isometric view of a carbonation machine 100, according to some embodiments of the present invention, with a carbonation bottle attached to the carbonation head.

[0060] Fig. 2 is a frontal view of the carbonation machine of Fig. 1, exposing internal parts of the carbonation head.

[0061] Fig. 3 is a back view of the carbonation machine of Fig. 1, showing a gas canister connected inside the gas canister compartment.

[0062] Carbonation machine 100 generally includes housing 102 with a carbonation head compartment 106 that houses a carbonation head mount 139a (see Fig. 2), to which a bottle 112 may be sealingly coupled, e.g., using one or more gaskets and carefully designing the carbonation head mount, for example using a pronged clamp 139 which is actuated by pronged clamp lever 138, see Fig. 5, so as to introduce, through piping of the carbonation head, and compress carbon dioxide into a space within the bottle 112 above the top surface of the liquid inside the bottle to carbonate that liquid.

[0063] Housing 102 also includes gas canister compartment 104, for housing a gas canister 116 filled with carbon dioxide, which is connected to the carbonation machine piping using a connector 122 (for example, a quick connector), to which the gas canister valve 120 is coupled. In some embodiments of the present invention, the gas canister 120 may be raised by a raising mechanism to engage with connector 122, for example, using raising lever 118.

[0064] In some embodiments of the present invention, the carbonation process is carried out automatically. In some other embodiments of the present invention, the carbonation process may be carried out manually.

[0065] In some embodiments of the invention, a user may fill a bottle 112 with liquid to be carbonated up to a top level (which may be marked, for example, on the bottle), leaving some space at the top of the bottle, and attach bottle 112 to the carbonation head 101 of the carbonation machine 100, maintaining the bottle 112 suspended over base 110 of the carbonation machine 100. The user then may move lever 114 to any position between a closed position and an open position and vice versa, by turning pinch valve lever 114 to the closed position (e.g., to assume a horizontal orientation) to shut off a drain tube that is fluidically linked to the inside of bottle 112 and to the open position (e.g., to assume a vertical orientation) to open the drain tube, or to any intermediate position therebetween, to control the drainage in an manual manner. Further explanation is provided hereinafter, see also Fig. 6, Fig. 7, Fig. 8A and Fig. 8B and corresponding description parts in the specification.

[0066] After turning pinch valve lever to the closed position the user may select a desired carbonation level (e.g., low, medium, high) by pressing the appropriate carbonation actuation button 108, which activates the carbonation process. A controller actuates a piston that causes carbon dioxide to be released from the gas cylinder and flow through designated piping into the bottle and be compressed in the space above the liquid top surface level.

[0067] Fig. 4 is a side view of the carbonation machine of Fig. 1, showing parts of the carbonation head with a stirrer 130. During the introduction of carbon dioxide into the internal top space of the bottle 112, via a conduit in stirrer shaft 132, stirrer 130 is activated to stir the liquid and enhance absorption of carbon-dioxide in the liquid to be carbonated. The combined operation of flowing carbon dioxide from the gas canister into the bottle 112 and rapidly rotating the stirrer 130 may be carried out continuously or intermittently (e.g., in cycles) in a predetermined manner. When the carbonation process is finished (e.g., after a predetermined time has passed or a predetermined number of carbonation cycles was concluded), and before removing the bottle from the carbonation head, the user may turn the pinch valve lever 114 to the open position (e.g., in the vertical orientation) to allow excess compressed carbon dioxide to be vented out through the drain tube. The user has a complete control of the pinch valve and may stop the venting at any time, for example if froth starts spilling out or for any other reason, and allow any residual froth inside the bottle to subdue before turning pinch valve lever 114 to an open position again.

[0068] Fig. 5 is a frontal view of the carbonation machine of Fig. 1, showing the stirrer and a surplus reservoir panel.

[0069] Fig. 6 is an exploded view of parts of the carbonation machine of Fig. 1.

[0070] The surplus reservoir is configured to receive and hold any undesired fluid or froth that may flow out of the bottle through the drain tube. A surplus reservoir conduit 140 is generally concealed behind surplus reservoir panel 142 and extends behind the panel down to drip tray opening 147 of drip tray grille 149 of drip tray 148. Any fluid or froth that leaks through the drain tube is collected and retained in the basin of drip tray 148. The parts shown in Fig. 6 that come in direct contact with the carbonated liquid – stirrer shaft 132 with stirrer 130, stirrer housing 134 with drain tube 136 and drain tube sleeve 135, surplus reservoir panel 142 with surplus reservoir conduit 140, drip tray 148 and drip tray grille 149 – as well as the bottle, are all detachable and may be washed and dried before placing them back. The length of stirrer shaft 132 is configured to be long enough to maintain the stirrer 130 under the top surface level of the liquid inside the bottle, when the bottle is attached to the carbonation head.

[0071] Fig. 7A shows a pinch valve mechanism 150 of a carbonation machine according to some embodiments of the present invention.

[0072] Fig. 7B shows a side-wall panel 103 of a carbonation machine with a ring 165 that supports wheel 159 of axle 158 of the pinch valve mechanism of Fig. 7A. Ribs 105 may be provided on side-wall panel 103 for reinforcement. Wheel 159 may be fitted with a friction generator, e.g., an O-ring 166, to generate friction with ring 165 when lever 114 is rotated, so as to allow rotating lever 114 to any position between the two end positions and releasing the lever, maintaining the lever and the pinch valve in that position, thereby allowing analog regulation of the pinch valve mechanism and consequently analog regulation of pressure release and flow through drain tube 132.

[0073] Fig. 8A shows the pinch valve mechanism of Fig. 7 with the drain tube open.

[0074] Fig. 8B shows the pinch valve mechanism of Fig. 7 with the drain tube closed.

[0075] The pinch valve mechanism 150 is configured to allow the user full control over the decompression of the carbon dioxide inside the carbonation bottle 112 prior to removing the bottle from the carbonation head. Pinch valve mechanism 150 generally includes a user operated pinch valve lever 114 which is linked via a transmission to a pincher, e.g., pinch bumper 152, such that when pinch valve lever 114 is moved to an

“open” position (e.g., in a vertical orientation), pinch bumper 152 is retracted away from drain tube 136, allowing free flow within the drain tube, and when pinch valve lever 114 is moved to a “closed” position (e.g., in a horizontal orientation), pinch bumper 152 advances to drain tube 136 and pinches drain tube 136, which is made of an elastic material (e.g., silicone) to block the tube and prevent flow within the tube.

[0076] In order to obtain effective blockage of drain tube 136 a transmission including wheels and levers may be provided, for example, as shown in Figs. 7, 8A and 8B. Pinch valve lever 114 is substantially orthogonally coupled to rotatable axle 158. Offset cantilever 163 extends radially from axle 158 and serves as a receptacle holder of a ball joint link 162 at one end of bar 164. Bar 164 has on the opposite end another ball joint link 162 held by a corresponding receptacle holder at an end of seesaw arm 156, which is pivotally supported by axis mount 160. Seesaw arm 156 has at an opposite end bumper receptacle 151 which contains pinch bumper 152, in a default extended outwards position, facilitated by preloaded bumper spring 153.

[0077] Drain tube 136 extends inside sleeve 135 and includes one or more apertures 137 through which a blade 155 of bumper 152 may enter and press drain tube 136 against an opposite internal wall of sleeve 135 for effectively blocking drain tube 136.

[0078] When pinch valve lever 114 is rotated to the open position, as illustrated in Fig. 8A, offset cantilever 163 is aligned horizontally with axle 158 causing bumper 152 at the opposite end of seesaw arm 156 to be rotated away from drain tube 136, allowing flow through the tube. When pinch valve lever 114 is rotated to the closed position, as illustrated in Fig. 8B, offset cantilever 163 is raised above axle 158 causing bumper 152 at the opposite end of seesaw arm 156 to be pressed onto drain tube 136 to block the tube. This embodiment is one example. In another embodiment, the entire mechanism may be built in reverse, so that movement in the exact opposite direction would open and close the pinch valve.

[0079] Over-center spring 154 may be provided, to enhance the use of the pinch valve mechanism 150. Over-center spring 154 may be designed and positioned such that when the pinch valve mechanism 150 (as is lever 114) approaches close either to the closed position or the open position, spring 154 exerts a stronger rotary force on axle 158 of the pinch valve mechanism 150, so as to force the axle to complete its rotation to the nearest end position, to affect either the closed or the open position.

[0080] Pinch valve lever 114, according to some embodiments of the present invention, is designed to perform several tasks. When pinch valve lever 114 is fully rotated to a first end position – fully opened position – along the allowed movement of the lever, e.g., in the upright position, the user may insert the neck of the bottle 112 with the liquid for carbonation into the carbonation head mount 139a to start a carbonation process, or remove the bottle after carbonation. When pinch valve lever 114 is in the opposite position – fully rotated to the other end of the allowed movement (for example, to a horizontal position) to a fully closed position, the bottle tilt mechanism (not shown) is locked in the vertical position. When in the locked position bottle 112 cannot be removed from carbonation head mount 139a, and carbonation may commence, with carbon dioxide being introduced into the space above the liquid level inside the bottle. When carbonation is completed, the user may slightly rotate pinch valve lever 114 to gradually retract blade 155 of pinch bumper 152 of pinch valve mechanism 150 and carefully release excess pressure from the bottle through drain tube 136. If the user notices a sudden rise of froth inside bottle 112, the user may reverse pinch valve lever 114 to block drain tube 136 or to slow down the pressure release through that pipe by pressing pressure of blade 155 against drain tube 136. When the froth buildup inside bottle 112 subsides pinch valve lever 114 may be turned towards the open position allowing gas to escape through drain tube 136.

[0081] Preloaded spring 153 that presses out pinch bumper 152 may be designed (e.g., by selecting a proper spring parameters to act as a safety spring, by yielding to overpressure over a predetermined overpressure threshold that may build up inside bottle 112, causing blade 155 of pinch bumper 152 to retract from fully pinching of drain tube 136 and allowing overpressure to be released.

[0082] According to some embodiments of the present invention, all parts of the carbonation machine that are designed to be placed in contact with the liquid are removable, may be dismantled and washed (e.g., in a dishwasher).

[0083] Fig. 9 is a schematic operational diagram of a carbonation machine, according to some embodiments of the present invention.

[0084] After attaching the carbonation bottle 112 filled with liquid to be carbonated up to a predetermined level, tilt sensor 109 is used to verify that the bottle is properly placed. The user then selects the desired carbonation level by pressing on any of the carbonation actuation buttons (e.g., H-high, M-medium, L – low). Pump 111 is then activated to

actuate piston 115 to release carbon dioxide from gas canister 116, which flows into the space above the liquid top surface level in bottle 112. Stirrer 130 may be electrically operated, e.g., electrical motor 121 may be provided to rotate stirrer 130 to increase absorption of carbon dioxide in the liquid inside the bottle. Pressure sensor 113 is used to sense and determine whether the pressure level inside the bottle exceeds a predetermined threshold (e.g., 6 bars). If the sensor 113 senses that pressure within the bottle exceeds the predetermined threshold, controller 107 activates solenoid 117 to cause piston 115 to disengage from the valve of gas canister 116 to stop additional carbon dioxide from flowing into the bottle 112. According to embodiments of the invention, when the pressure above the liquid drops below a threshold level due to absorption into the liquid, the controller 107 may be configured to activate piston 115 allowing more gas to flow into the bottle.

[0085] When the carbonation process is completed the user may operate pinch valve lever 114 and release any residual pressure within bottle 112 before removing the bottle from the carbonation machine.

[0086] Fig. 10 shows a carbonation machine with a froth control, according to another embodiment of the present invention.

[0087] Fig. 11 shows a vertical cross-section of the carbonation machine shown in Fig. 10.

[0088] Carbonation machine 200 generally includes housing 102 with a carbonation head compartment 106 that houses a carbonation head mount 226a, to which a bottle 112 may be sealingly coupled.

[0089] Fig. 12 is a partial cross section view of the carbonation head of the carbonation machine of Fig. 10.

[0090] Fig. 13 shows a detachable carbonation sleeve of the carbonation machine shown in Fig. 10, with a drain tube in a closed state.

[0091] Fig. 14 shows a detachable carbonation sleeve of the carbonation machine shown in Fig. 10, with a drain tube in an open state.

[0092] Fig. 15 shows an isometric view of a detachable carbonation sleeve of the carbonation machine shown in Fig. 10.

[0093] Fig. 16 shows a side view of a detachable carbonation sleeve of the carbonation machine shown in Fig. 10.

[0094] Housing 102 includes gas canister compartment 104, for housing a gas canister filled with carbon dioxide, which is connected to the carbonation machine piping using a connector having a socket 209 into which the valve of the gas canister is inserted. In some embodiments of the present invention, the gas canister may be raised by a raising mechanism to engage with socket 209, for example, using raising lever 118.

[0095] According to some embodiments of the invention, a user may fill a bottle with liquid to be carbonated up to a top level (which may be marked, for example, on the bottle), leaving some space at the top of the bottle, and attach the bottle to the carbonation head 101 of the carbonation machine 200, maintaining the bottle suspended over base 110 of the carbonation machine 200.

[0096] Carbonation machine 200 may include a detachable carbonation tube assembly 202 that includes carbonation tube 205 housed within carbonation tube sleeve 220, a drain tube 224 that is fluidically linked with space 221 defined between carbonation tube 205 and carbonation tube sleeve 220 partially inserted inside drain tube sleeve 225, and that includes an exposed portion and ends inside surplus reservoir 208, which is coupled to carbonation tube sleeve 220.

[0097] A bottle with liquid to be carbonated may be attached to the carbonation head mount 226a of the carbonation head 101 of carbonation machine 200. A user may activate carbonation by pressing carbonation actuator 108 which causes the release of carbon dioxide from the valve of a gas canister that is inserted in and firmly held within socket 209. The released carbon dioxide flows through conduit 211 that is linked to carbonation tube 205, and is used in carbonating liquid inside the bottle.

[0098] The liquid to be carbonated inside the bottle may be pure water or other liquid, and may also include additives, such as syrup, sugar, etc. In the case of liquid other than pure water, froth may build up on the top surface of the liquid during the carbonation process.

[0099] The user may initiate controlled evacuation of froth from the bottle into surplus reservoir 208 via drain tube 224. To manage the evacuation of froth the user then may turn pinch valve knob 201, which is supported by rack 228, to any position between a closed position, thereby transferring motion via a transmission to pinch valve lever 214 to rotate the pinch valve lever 214 about pivot 232 to cause pinch bumper 222 to press against drain tube 224 to shut off drain tube 224, and an open position in which pinch bumper 222 is removed from drain tube 224, and vice versa, Pinch valve lever 214 may be energized

using spring 216, so as to force pinch valve lever 214 to the closed position as a default state. The user can control the release of pressure and excess froth by controlling the rotation of knob 201 thus regulating the flow through the drain tube 224.

[00100] According to some embodiments of the present invention, carbonation tube assembly 202 may be designed to be detachable. Separating detachable carbonation tube assembly 202 from the carbonation machine allows cleaning carbonation tube assembly 202 from froth residue, and other contaminants that may stick to the carbonation tube 205, the drain tube 224 or the surplus reservoir 208. In some embodiments of the present invention, the detachable carbonation tube assembly may be made of plastic or other material/s that are dishwasher safe, so that the user may place the detachable carbonation tube assembly in a dishwasher and wash it. In some embodiments of the present invention, detachable carbonation tube assembly 202 may be further disassembled to separate parts.

[00101] Fig. 17 is a side view of some internal parts of a carbonation machine according to the present invention, with the interlock mechanism of in an open (unlocked) position.

[00102] Fig. 18 is a side view of some internal parts of a carbonation machine, with the interlock mechanism in a closed (locked) position.

[00103] In order to avoid inadvertent discharge of the detachable carbonation tube assembly 202, an interlock mechanism is provided to hold it in place, when the carbonation machine is in operation, which includes a one-way valve arrangement to prevent excess pressure that may build up in the carbonated bottle or within the detachable carbonation tube assembly 202 from reentering the carbonation head. The interlock mechanism may be controlled by pinch valve knob 201. When pinch valve knob 201 is turned to the open position, fins 219 are moved beneath carbonation actuation button 108 so as to prevent carbonation actuation button 108 from being depressed down. When pinch valve knob 201 is rotated to the closed position, fins 219 are removed so as to allow depressing carbonation actuation button 108. In the closed position, the bottle tilt mechanism is locked, preventing tilting and removal of the bottle.

[00104] The top sleeve of detachable carbonation tube assembly 202 is designed to be tightly fit and held in place within a matching bore 206 inside carbonation head 101. Two confined annular spaces are, each, defined within either of two tubular gaskets 210 surrounding the top sleeve of detachable carbonation tube assembly 202. The top confined

annular space, within groove 230a is fluidically linked to conduit 211 delivering carbon dioxide from the gas canister. Gas entry bore 234a is provided on the top sleeve of detachable carbonation tube assembly 202 within the top confined annular space defined within groove 230a to allow the incoming carbon dioxide to flow into the liquid contained in the bottle through carbonation tube 205 whose tip is designed to be dipped into the liquid in the bottle, below the liquid surface.

[00105] In the case of over pressurizing the bottle, if for some reason pressure within the bottle is not released properly through the pinch valve and instead the pressure is released via the lower exit bore 234b within lower groove 230b (see Fig. 15) to a burst disc that is designed to burst when a threshold pressure is reached to release the pressure.

[00106] Grooves 230 may be provided about the top sleeve of detachable carbonation tube assembly 202, configured to be located within the confined annular spaces within tubular gaskets 210, when the detachable carbonation tube assembly 202 is fully inserted in its place inside the tightly matching bore 206 inside carbonation head 101 to enhance flow within the sealed space inside gaskets 210.

[00107] The design of the detachable carbonation tube assembly 202 and the surrounding bore 206, the tubular gaskets 210, and matching annular grooves 230 and bores 234, are aimed at facilitating pressure forces that act substantially perpendicularly to carbonation tube sleeve 220, avoiding creation of pressure vectors that are in parallel to sleeve 220, That may cause detachable carbonation tube assembly 202 to pop out inadvertently of the carbonation head bore 206.

[00108] Following is an index of elements shown in the figures:

- 100, 200 – carbonation machine;
- 101– carbonation head;
- 102 – housing;
- 103 – side-wall panel;
- 104 – gas canister compartment;
- 105 – reinforcement rib;
- 106 – carbonation head compartment;
- 107 – controller;
- 108 – carbonation actuation button/s;

109 – tilt sensor;
110 – base;
111 – pump;
112 – bottle;
113 –pressure sensor;
114 – pinch valve lever;
115 – piston;
116 – gas canister;
117 –solenoid;
118 –raising lever;
119 – stirrer motor;
120 – gas canister valve;
121 – motor;
122 – connector;
130 – stirrer;
132 – stirrer shaft;
134 – stirrer housing;
135 – sleeve;
136 – drain tube;
137 – aperture;
138 – pronged clamp lever;
139 – pronged clamp;
139a – carbonation head mount;
140 – surplus reservoir conduit;
142 – surplus reservoir panel;
144 – pressure switch;
146 – CO₂ inlet;
147 – drip tray opening;
148 – drip tray;

- 149 – drip tray grille;
- 150 – pinch valve mechanism;
- 151 – bumper receptacle;
- 152 – pinch bumper;
- 153 – preloaded bumper spring;
- 154 – over-center spring;
- 155 – bumper blade;
- 156 – seesaw arm;
- 158 – axle;
- 159 – wheel;
- 160 – axis mount;
- 162 – ball joint link;
- 163 – offset cantilever;
- 164 – bar;
- 165 – ring;
- 166 – O-ring;
- 201 – pinch valve knob;
- 202 – detachable carbonation tube assembly;
- 205 – carbonation tube;
- 206 - bore inside carbonation head;
- 208 – surplus reservoir;
- 209 – socket;
- 210 – gasket;
- 211 – conduit;
- 214 – pinch valve lever;
- 216 – spring;
- 218 – carbonation head;
- 219 – carbonation actuator locking fin;
- 220 – carbonation tube sleeve;

221 - sleeve space;
222 – pinch bumper;
224 – drain tube;
225 – drain tube sleeve;
226 – pronged clamp;
226a – carbonation head mount;
228 – pinch valve rack;
230a, 230b – annular grooves;
232 – pivot;
234a – gas entry bore;
234b - gas exit bore;

[00109] Different embodiments are disclosed herein. Features of certain embodiments may be combined with features of other embodiments; thus, certain embodiments may be combinations of features of multiple embodiments. The foregoing description of the embodiments of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. It should be appreciated by persons skilled in the art that many modifications, variations, substitutions, changes, and equivalents are possible in light of the above teaching. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

[00110] While certain features of the invention have been illustrated and described herein, many modifications, substitutions, changes, and equivalents will now occur to those of ordinary skill in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

CLAIMS

1. A carbonation machine comprising:
 - a carbonation head to sealingly couple to a bottle filled with liquid to be carbonated;
 - a piping to transfer carbon dioxide into a space within the bottle to carbonate the liquid when the bottle is coupled to the carbonation head;
 - and
 - a manually operated valve mechanism configured to be moved to any position between a closed position to an open position for user-controlled release of pressure buildup within the bottle.
2. The carbonation machine of claim 1, wherein the manually operated valve mechanism comprises a pinch valve mechanism.
3. The carbonation machine of claim 2, wherein the pinch valve mechanism comprises a pinch bumper to pinch a drain tube to prevent flow through the drain tube when in the closed position, and to retract from the drain tube to allow flow through the drain tube to release pressure from inside the bottle.
4. The carbonation machine of claim 3, wherein the pinch valve mechanism is configured to allow gradual retracting of the pinch bumper to release pressure through the drain tube.
5. The carbonation machine of claim 3, wherein the pinch bumper is held at an end of a seesaw arm pivotally supported by an axis mount.
6. The carbonation machine of claim 5, wherein the pinch bumper is held by a receptacle.
7. The carbonation machine of claim 6, wherein the pinch bumper is maintained in a default extended outwards position.

8. The carbonation machine of claim 7, wherein the pinch bumper is maintained in the default extended outwards position by a preloaded spring.
9. The carbonation machine of claim 8, wherein the preloaded spring is configured to yield to overpressure buildup inside the bottle above a predetermined overpressure threshold.
10. The carbonation machine of claim 3, wherein the pinch valve mechanism includes a friction generator to generate friction so as to allow manually operating the manually operated valve mechanism to any position between the closed position and the open position and maintaining that position even when the manually operated valve mechanism is released.
11. The carbonation machine of claim 2, wherein the pinch valve mechanism is operable by a pinch valve lever.
12. The carbonation machine of claim 11, wherein the pinch valve lever is substantially orthogonally coupled to a rotatable axle.
13. The carbonation machine of claim 12, wherein the pinch valve mechanism comprises an over-center spring positioned such that when the pinch valve mechanism approaches either the closed position or the open position, the over-center spring exerts a rotary force on an axle of the pinch valve mechanism so as to force the axle to rotate to a nearest end position, to affect either the closed position or the open position.
14. The carbonation machine of claim 1, wherein the piping is configured to transfer carbon dioxide into the space which is above a top surface of the liquid, the carbonation machine further comprising a stirrer to stir the liquid to enhance absorption of carbon dioxide in the liquid.
15. The carbonation machine of claim 14, wherein the stirrer is electrically operated.

16. The carbonation machine of claim 14, wherein the carbonation head is configured to compress the carbon dioxide in the space up to a pressure threshold.

17. The carbonation machine of claim 1, further comprising a controller, configured to cause carbon dioxide to be added to the space within the bottle above the top surface of the liquid when pressure in the bottle drops below a predetermined pressure threshold.

18. The carbonation machine of claim 1, wherein one or more parts of the machine that are designed to be placed in contact with the liquid are removable.

19. The carbonation machine of claim 18, wherein said one or more parts comprises a detachable carbonation tube assembly.

20. The carbonation machine of claim 19, wherein the detachable carbonation tube assembly comprises a carbonation tube within a carbonation tube sleeve, having a space defined between the carbonation tube and the carbonation sleeve.

21. The carbonation machine of claim 20, further comprising a bore in the carbonation head and wherein a top portion of the carbonation tube sleeve is configured to tightly fit and be held inside the bore.

22. The carbonation machine of claim 21, wherein the bore in the carbonation head comprises two grooves each defining a tubular sealed space about the top portion of the carbonation tube sleeve, wherein top portion of the carbonation tube sleeve includes at least one bore within each of the tubular sealed spaced within the gaskets, for introducing carbon dioxide into the carbonation tube and for evacuating excess pressure within the bottle through the between the carbonation tube and the carbonation sleeve.

23. The carbonation machine of claim 18, wherein the removable one or more parts of the machine that are designed to be placed in contact with the liquid are made of plastic or other material that is dishwasher safe.

24. The carbonation machine of claim 18, wherein the detachable carbonation tube assembly further comprises a surplus reservoir and a drain tube configured to fluidically connect the space defined between the carbonation tube and the carbonation tube sleeve with the surplus reservoir.

25. The carbonation machine of claim 24, wherein the surplus reservoir is detachable from the detachable carbonation tube assembly.