

Title of invention: Beverage dispensing machine

FIELD

5 [001] The present invention relates to a beverage dispensing machine with a reversible flow path.

BACKGROUND

10 [002] Dispensing machines used to prepare beverages and drinks usually have a pump to extract liquid from a container into a cup. One drawback of several such machines is a section of tubing that is exposed to ambient temperature. If a next dispense is after an extended period, the temperature of the liquid in this exposed tubing will change. This may affect the taste of the next beverage to be made, especially when the liquid is temperature sensitive. Prolonged storage of such temperature sensitive liquid in the exposed tubing may also affect its freshness. Common practice to manage this problem
15 includes discarding them prior to next dispense or thermally wrapping the exposed tubing.

[003] Another drawback is that liquid residue on the dispensing nozzle after each dispense may attract insects which may crawl into the tubing and discharged with the next liquid dispense; or the residue hardens/crystalises which blocks the nozzle. Common practice includes frequently cleaning and rinsing.

20 [004] There is thus a need to address the above shortcomings.

SUMMARY OF THE INVENTION

25 [005] According to a first aspect of the present invention, there is provided a beverage dispensing machine comprising: a plurality of dispensing modules each comprising: a cleaning valve; a beverage valve; a conduit arrangement to couple the cleaning valve to the beverage valve, the beverage valve to a beverage reservoir, and the cleaning valve to a venting port, and having an outlet for the dispensing module; a pump to establish fluid flow within the conduit arrangement; and a controller configured to operate the cleaning valve, the beverage valve and the pump to direct a flow path between the beverage
30 valve and the cleaning valve, the flow path direction being reversible to purge content within the conduit arrangement through either the dispensing module outlet or the venting port.

BRIEF DESCRIPTION OF THE DRAWINGS

35 [006] Representative embodiments of the present invention are herein described, by way of example only, with reference to the accompanying drawings, wherein:

[007] Figure 1 shows one implementation schematic of a beverage dispensing machine.

[008] Figure 2 shows the schematic for one dispenser module of the beverage dispensing machine of Figure 1.

[009] Figures 3A to 10F show various operation modes of the dispenser module of Figure 2.

[010] Figures 11, 12 and 13 show different embodiments to implement forward purging of content in the dispenser module of Figure 2.

[011] Figure 14 is a cross sectional view of the embodiment shown in Figure 13.

[012] Figure 15 is an exploded view of a receptacle seen in the embodiment of Figure 14.

[013] Figure 16 is a top view of the embodiment shown in Figure 13.

10 DETAILED DESCRIPTION

[014] In the following description, various embodiments are described with reference to the drawings, where like reference characters generally refer to the same parts throughout the different views.

[015] The present application relates to a beverage dispensing machine. The machine has a plurality of dispensing modules, each for a beverage stored in a reservoir in a temperature controlled environment (such as a refrigerator or a heater). Each dispensing module has a conduit arrangement in which a fluid flow path is established with a pump and valves located along the conduit arrangement operable by a controller to set the direction of the fluid flow path. The fluid flow path is reversible. In a forward direction, fluid flows towards an outlet of the dispensing module. In a reverse direction, fluid flows away from the outlet of the dispensing module. The fluid carried in or transported by the flow path and the destination of the fluid depends on the operation mode. In one mode, the fluid is beverage from the reservoir to which the dispensing module is connected. In another mode, the fluid is a cleaning fluid (which may be in liquid form, like water). In yet another mode, the fluid is a gas. For each of these operation modes, the flow path may transport its fluid to either the outlet of the dispensing module; a venting port (such as a drainage outlet or a gas inlet/outlet); or the beverage reservoir.

[016] The dispensing module has two valves: a cleaning valve and a beverage valve. The cleaning valve refers to a valve meant to control the supply of cleaning fluid into the conduit arrangement of the dispensing module to rinse at least the portion where beverage flows. In one implementation, the cleaning valve is coupled to an inlet that provides cleaning fluid to the conduit arrangement (hereafter also referred to as a “cleaning fluid inlet”), with the cleaning fluid inlet serving as a common source for all other dispensing modules of the beverage dispensing machine. The beverage valve refers to a valve meant to control the supply of beverage into the conduit arrangement of the dispensing module for sending to the outlet of the dispensing module, to serve as an ingredient for drinks that the beverage dispensing machine can make. In one implementation, the beverage valve is coupled to the beverage reservoir to which the dispensing module is associated. As such “cleaning valve” and “beverage valve” are coined terms to denote the respective function of these valves. In a scenario where each dispensing

module has more than two valves, the beverage valve is the one which is disposed closed to the beverage reservoir while the cleaning valve is disposed closest to the cleaning fluid inlet.

[017] The conduit arrangement refers to a network of tubes that couple respective components within each dispensing module, such as the cleaning valve to the beverage valve; the beverage valve to the beverage reservoir; and the cleaning valve to the venting port, to facilitate fluid flow within the dispensing module. This coupling thereby allows flow paths or channels to be established between the coupled components, with several of such flow paths crossing several coupled components. The coupling may be direct, with no devices therebetween, or indirect where there are one or more devices therebetween. The conduit arrangement also allows interconnection between adjacent dispensing modules.

[018] As mentioned above, a controller operates the cleaning valve, the beverage valve and the pump to set fluid flow direction within the conduit arrangement. During this operation, the controller determines the direction of the pump and which of the beverage valve and the cleaning valve require activation to establish a flow path direction between the beverage valve and the cleaning valve, which is reversible to purge content within the conduit arrangement through either the dispensing module outlet or the venting port. In a forward flow path, fluid flows towards an outlet of the dispensing module to purge content within the conduit arrangement through the dispensing module outlet. In a reverse flow path, fluid flows away from the outlet of the dispensing module to purge content within the conduit arrangement through the venting port.

[019] The beverage dispensing machine is described in greater detail below in conjunction with the accompanying Figures.

[020] Figure 1 shows one implementation schematic of a beverage dispensing machine 100. The schematic is not exhaustive but shows only selected components. A portion 104 of the beverage dispensing machine 100 is disposed in a temperature controlled environment, such as a chiller, while another portion 102 may be placed in a housing that is kept under ambient settings (i.e. at room temperature).

[021] The beverage dispensing machine 100 has several interconnected dispenser modules 106. For the sake of simplicity, only three are shown in Figure 1. Each of these dispenser modules 106 is coupled to a cleaning fluid inlet 110 and a venting port 112. The cleaning fluid inlet 110 provides cleaning fluid, such as water, to each of the dispenser modules 106, while the venting port 112 serves to provide an outlet for fluid drainage or to exhaust gas from each dispenser module 106; or a gas inlet for each dispenser module 106. In the implementation of Figure 1, the cleaning fluid inlet 110 and the venting port 112 are common to all the dispenser modules 106. However, in another implementation (not shown) each of the dispenser modules 106 may be connected to its own cleaning fluid inlet and venting port. The outlet for each of the dispenser modules 106 is disposed in the vicinity of a beverage collection part 114 of the beverage dispensing machine 100, where beverage from each of them is

collected in a container or cup. The various operation modes for each dispenser module 106 is described below with reference to Figures 2, 3A to 10F.

[022] Figure 2 shows the schematic for one dispenser module 106 of the beverage dispensing machine 100. The dispenser module 106 has two valves: a cleaning valve 214 and a beverage valve 216; a pump 218 to establish fluid flow; and a conduit arrangement 222 within which the fluid flows, the conduit arrangement 222 comprising a network of tubes that couple the cleaning valve 214, the beverage valve 216 and the pump 218 to the inlets and outlets associated with the dispenser module 106. This network of tubes include a conduit 224 to couple the pump 218 to the beverage valve 216; a conduit 226 to couple the beverage valve 216 to the beverage reservoir 250; a conduit 228 to couple the beverage valve 216 to the cleaning valve 214; a conduit 230 to couple the cleaning valve 214 to the venting port 112; a conduit 232 to couple the cleaning valve 214 to the cleaning fluid inlet 110; and a conduit 234 serving to provide an outlet 236 for the dispenser module 106. The pump 218 is disposed between the beverage valve 216 and the dispensing module outlet 236, with the beverage valve 216 disposed downstream of the cleaning valve 214 towards the dispensing module outlet 236. This allows cleaning fluid drawn from the cleaning fluid inlet 110 to drive the content purge through the dispensing module outlet 236.

[023] Several portions of the conduit arrangement 222 have reversible fluid flow paths. A double ended arrow is used for the conduits 224, 228, 230, 234 where the fluid flow is reversible, while a single ended arrow is used for the conduit 226, 232 where the fluid flow is in a single direction.

[024] The reversible fluid flow within the conduits 224, 228, 230, 234 is brought about by different operation modes as selected by a controller 238 of the dispenser module 106. In these operation modes, the controller 238 operates the cleaning valve 214, the beverage valve 216 and the pump 218 to set a direction of the fluid flow path between the beverage valve 216 and the cleaning valve 214. The fluid flow path within the conduit 224 is reversible through the controller 238 changing the direction of the pump 218; and a selective activation of the beverage valve 216 and the cleaning valve 214, to purge content within the conduit arrangement 222 through either the dispensing module outlet 236 or the venting port 112. In a forward flow path, fluid flows towards the dispensing module outlet 236 via the conduits 224, 234 to purge content through the dispensing module outlet 236. In a reverse flow path, fluid flows away from the dispensing module outlet 236 via the conduits 234, 224, 228, 230 to purge content through the venting port 112. As the fluid flows within the conduit 224 and when there is a change in the fluid flow path, other conduits in the conduit arrangement 222 which are in fluid communication will also follow the direction of the flow path established by the controller 238.

[025] The various operation modes provided by the controller 238 are broadly described as follows, where appropriate, in terms of flow path direction and the fluid being transported between the cleaning valve 214 and the beverage valve 216.

[026] As mentioned above, the flow path is reversible. In a forward flow path, fluid flows towards the dispensing module outlet 236 to purge content through the dispensing module outlet 236. In a

reverse flow path, fluid flows away from the dispensing module outlet 236 to purge content through the venting port 112.

[027] The fluid transported by the flow path depends on the operation mode. In one operation mode, the fluid is beverage from the beverage reservoir 250, where purging through the dispensing module outlet 236 provides a means to use the purged beverage to make a drink or to dispose beverage that has been in the conduit 224 for too long. In a cleaning mode, the fluid is a cleaning fluid (which may be in liquid form, like water). In another cleaning mode, the fluid is a gas. For each of these operation modes, the flow path may transport its respective fluid to either the dispensing module outlet 236, through the controller 238 establishing the forward flow path; or the venting port 112 (such as a drainage outlet or a gas inlet/outlet), through the controller 238 establishing the reverse flow path.

[028] The controller 238 also allows establishing of an idle mode and a standby mode.

[029] In the idle mode, at least the conduit 224 is kept empty or filled with cleaning liquid. The advantage of keeping the conduit 224 empty is that it is immediately ready to transport beverage from the beverage reservoir 250 into the conduit 224, thereby reducing the amount of time required for the beverage dispensing machine 100 to make a drink using this beverage as an ingredient. The advantage of filling the conduit 224 with cleaning fluid is that it prevents insects from entering the dispensing module outlet 236, especially when the beverage in the beverage reservoir 250 is sweet.

[030] In some operating configurations, the standby mode sees at least the conduit 224 filled with the beverage from the beverage reservoir 250, e.g. retained from an earlier dispensing operation. This is advantageous in that there is little lag time and the beverage dispensing machine 100 can continuously discharge the beverage since it is already present in the conduit 224. The beverage dispensing machine 100 is kept in this standby mode for a set duration, especially when the beverage is temperature sensitive (e.g. milk) and can turn bad when kept outside of the temperature controlled environment 104 for too long.

[031] The various operation modes are described in greater detail below with reference to Figures 3A to 10F. In one implementation, the controller 238 provides one or more dedicated buttons (not shown) that selects one of these operation modes for the beverage dispensing machine 100.

[032] In these operation modes the cleaning fluid inlet 110 is a municipal water supply, so that the cleaning fluid is water. Alternatively, the cleaning fluid inlet 110 is coupled to a reservoir drawing from the municipal water supply, with the reservoir having a heating element and a variable pump, which delivers heater water at various pressure levels. In another implementation (not shown), the cleaning fluid inlet 110 may also be coupled to other cleaning fluid sources, such as detergent through a valve that determines which of these sources is active at a given instance. The venting port 112 is a drainage outlet or a gas inlet/outlet to draw or exhaust air. A gas compressor may also be present, so that the venting port 112 receives pressurised air. The venting port 112 may also be connected to other non-toxic and inert gas supplies, such as nitrogen.

Configuration 1: Continuous dispensing, water shield, forward purge mode

[033] In this mode, the beverage dispensing machine 100 of Figure 2 starts in an idle state where there is cleaning fluid in the conduit 224 (also called “water shield” when the cleaning fluid used is water). The cleaning fluid in the conduit 224 is drawn from the cleaning fluid inlet 110.

5 [034] In Figure 3A, the pump 218 is commanded by the controller 238 to operate in a forward direction 302 to start purging the water out of the conduit 224 with air for a pre-determined amount of time. The controller 238 sends a command to operate the cleaning valve 214 and the beverage valve 216 to establish fluid communication with the venting port 112 to draw the air that is required to assist with the water purge. That is, gas is drawn from the venting port 112 to drive the content purge through
10 the dispensing module outlet 236.

[035] The forward flow path in the conduit 224 thus starts from the conduit 230 (that couples the venting port 112 to the cleaning valve 214), extends into the conduit 228 (that couples the cleaning valve 214 to the beverage valve 216), then to the conduit 234 (that provides the dispensing module outlet 236). In Figure 3A, the cleaning valve 214 is disconnected from the cleaning fluid inlet 110.
15 Figure 3A thus concludes with content purge being performed on the cleaning fluid within the conduit arrangement 222 before the beverage valve 216 is operated to draw beverage from the beverage reservoir 250.

[036] In Figure 3B, the controller 238 keeps the pump 218 operating in the forward direction and activates the beverage valve 216 to start dispensing beverage (such as milk) from the beverage
20 reservoir 250 through the conduit 226 (that couples the beverage reservoir 250 to the beverage valve 216) and disconnects the conduit 228. The forward flow path in the conduit 224 is maintained and the beverage is purged through the dispensing module outlet 236. Beverage is dispensed for a pre-determined amount of time, such as to make a drink.

[037] In Figure 3C, the beverage dispensing machine 100 is in a standby mode after the beverage
25 dispensing cycle of Figure 3B. The pump 218 is switched off by the controller 238 and the beverage reservoir 250 disconnected, leaving beverage in the conduits 224 and 234. While the conduit 224 is in fluid communication with the venting port 112, the beverage is retained in the conduits 224 and 234 as the dispensing module outlet 236 and the venting port 112 are at the same atmospheric pressure.

[038] A timeout counter will start counting. If beverage is requested before timeout occurs, the
30 dispensing module will return to the operation described with respect to Figure 3B. However, if timeout occurs, the dispensing module 106 operates as described below with reference to Figure 3D.

[039] Figure 3D shows the dispensing module 106 performing a content purge on the beverage within the conduit arrangement 222 after a timeout from commencement of the standby mode described in Figure 3C. Upon timeout, the controller 238 will activate the cleaning valve 214 and the pump 218 to
35 run in the forward direction 302 to start purging the beverage out of the conduits 224 and 234 through the dispensing module outlet 236. The purged beverage is replaced with water transported in a flow path starting from the cleaning fluid inlet 110, through the conduit 232 (that couples the cleaning fluid

inlet 110 to the cleaning valve 214), the conduit 228 (that couples the cleaning valve 214 to the beverage valve 216) and the beverage valve 216. This water flow is performed for a pre-determined amount of time to rinse out the beverage. In this manner, the controller 238 operates the cleaning valve 214, the beverage valve 216 and the pump 218 to establish a flow path between the cleaning fluid inlet 110 and the dispensing module outlet 236.

[040] After the rinsing, the dispensing module 106 returns to the idle state shown in Figure 2, with water retained in at least the conduit 224.

Configuration 2: Continuous dispensing, water shield, reverse purge mode

[041] In this mode, the beverage dispensing machine 100 of Figure 2 starts in an idle state where there is cleaning fluid in the conduit 224 (also called “water shield” when the cleaning fluid used is water). The cleaning fluid in the conduit 224 is drawn from the cleaning fluid inlet 110.

[042] In Figure 4A, the pump 218 is commanded by the controller 238 to operate in a reverse direction 402 to start purging the water out of the conduit 224 with air for a pre-determined amount of time. The controller 238 sends a command to operate the cleaning valve 214 and the beverage valve 216 to establish fluid communication with the dispensing module outlet 236 to draw the air that is required to assist with the water purge. That is, gas is drawn from the dispensing module outlet 236 to drive the content purge through the venting port 112.

[043] The reverse flow path in the conduit 224 thus starts from the conduit 234, then to the conduit 224, the beverage valve 216, the conduit 228, the cleaning valve 214, the conduit 230 and to the venting port 112. Figure 4A thus concludes with content purge being performed on the cleaning fluid within the conduit arrangement 222 before the beverage valve 216 is operated to draw beverage from the beverage reservoir 250.

[044] In Figure 4B, the controller 238 reverses the pump 218 to operate in the forward direction 404 and activates the beverage valve 216 to start dispensing beverage (such as milk) from the beverage reservoir 250 through the conduit 226 and disconnects the conduit 228. The flow path in the conduit 224 is reversed, compared to Figure 4A, and the beverage is purged through the dispensing module outlet 236. Beverage is dispensed for a pre-determined amount of time, such as to make a drink.

[045] In Figure 4C, the beverage dispensing machine 100 is in a standby mode after the beverage dispensing cycle of Figure 4B. The pump 218 is switched off by the controller 238 and the beverage reservoir 250 disconnected, leaving beverage in the conduits 224 and 234. While the conduit 224 is in fluid communication with the venting port 112, the beverage is retained in the conduits 224 and 234 as the dispensing module outlet 236 and the venting port 112 are at the same atmospheric pressure.

[046] A timeout counter will start counting. If beverage is requested before timeout occurs, the dispensing module will return to the operation described with respect to Figure 4B. However, if timeout occurs, the dispensing module 106 operates as described below with reference to Figure 4D.

[047] Figure 4D shows the dispensing module 106 performing a content purge on the beverage within the conduit arrangement 222 after a timeout from commencement of the standby mode described in Figure 4C. Upon timeout, the controller 238 will command the pump 218 to run in the reverse direction 402 and activate the cleaning valve 214 to start purging the beverage out of the conduits 224 and 234 through the venting port 112. The purged beverage is replaced with air drawn from the dispensing module outlet 236 for a pre-determined amount of time.

[048] Following the beverage purge of Figure 4D, the dispensing module 106 performs a rinsing operation as shown in Figure 4E to remove beverage residue on the conduits 234, 224 and 228. The controller 238 will activate the cleaning valve 214 and change the pump 218 to run in the forward direction 404 to fill the conduits 224, 228 and 234 with water drawn from the cleaning fluid inlet 110 for a pre-determined amount of time.

[049] In Figure 4F, the controller 238 has the pump 218 run in the reverse direction 402 to purge the water, introduced in Figure 4E, out of the venting port 112 and replace with air drawn from the dispensing module outlet 236 for a pre-determined amount of time.

[050] In Figure 4G, the controller 238 activates the cleaning valve 214 and has the motor 218 run in the forward direction 404 to start to fill the conduits 224, 228 and 234 with water drawn from the cleaning fluid inlet 110 for a pre-determined amount of time. After the rinsing, the dispensing module 106 returns to the initial idle state shown in Figure 2, with water retained in at least the conduit 224.

Configuration 3: Continuous dispensing, air shield, forward purge mode

[051] In this mode, the beverage dispensing machine 100 of Figure 2 starts in an idle state where there is air in the conduit 224 (also called “air shield”).

[052] In Figure 5A, the controller 238 commands the pump 218 to operate in the forward direction 502 and activates the beverage valve 216 to start dispensing beverage (such as milk) from the beverage reservoir 250 through the conduit 226 and disconnects the conduit 228. Beverage is dispensed for a pre-determined amount of time, such as to make a drink.

[053] In Figure 5B, the beverage dispensing machine 100 is in a standby mode after the beverage dispensing cycle of Figure 5A. The pump 218 is switched off by the controller 238 and the beverage reservoir 250 disconnected, leaving beverage in the conduits 224 and 234.

[054] A timeout counter will start counting. If beverage is requested before timeout occurs, the dispensing module 106 will return to the operation described with respect to Figure 5A. However, if timeout occurs, the dispensing module 106 operates as described below with reference to Figure 5C.

[055] Figure 5C shows the dispensing module 106 performing a content purge on the beverage within the conduit arrangement 222 after a timeout from commencement of the standby mode described in Figure 5B. Upon timeout, the controller 238 will activate the cleaning valve 214 and the pump 218 to run in the forward direction 502 to start purging the beverage out of the conduits 224 and 234 through the dispensing module outlet 236. The purged beverage is replaced with water transported in a flow

path starting from the cleaning fluid inlet 110, through the conduit 232, the conduit 228 and the beverage valve 216. This water flow is performed for a pre-determined amount of time to rinse out the beverage.

[056] In this manner, the controller 238 operates the cleaning valve 214, the beverage valve 216 and the pump 218 to establish a flow path between the cleaning fluid inlet 110 and the dispensing module outlet 236.

[057] In Figure 5D, the controller 238 maintains the pump 218 in its forward direction to start purging the water, introduced into the conduit arrangement 222 in the operation of Figure 5C, out through the dispensing module outlet 236. The cleaning valve 214 and the beverage valve 216 are operated so that a fluid flow path starts from the venting port 112 to the conduit 230, 228, 224 and 234, which replaces the water with air drawn from the venting port 112 for a pre-determined amount of time. Figure 5D concludes with the dispensing module 106 being returned to the initial idle state shown in Figure 2, with air being present in at least the conduit 224.

Configuration 4: Continuous dispensing, air shield, reverse purge mode

[058] In this mode, the beverage dispensing machine 100 of Figure 2 starts in an idle state where there is air in the conduit 224 (also called “air shield”).

[059] In Figure 6A, the controller 238 commands the pump 218 to operate in the forward direction 602 and activates the beverage valve 216 to start dispensing beverage (such as milk) from the beverage reservoir 250 through the conduit 226 and disconnects the conduit 228. Beverage is dispensed for a pre-determined amount of time, such as to make a drink.

[060] In Figure 6B, the beverage dispensing machine 100 is in a standby mode after the beverage dispensing cycle of Figure 6A. The pump 218 is switched off by the controller 238 and the beverage reservoir 250 disconnected, leaving beverage in the conduits 224 and 234.

[061] A timeout counter will start counting. If beverage is requested before timeout occurs, the dispensing module 106 will return to the operation described with respect to Figure 6A. However, if timeout occurs, the dispensing module 106 operates as described below with reference to Figure 6C.

[062] Figure 6C shows the dispensing module 106 performing a content purge on the beverage within the conduit arrangement 222 after a timeout from commencement of the standby mode described in Figure 6B. Upon timeout, the controller 238 will command the pump 218 to run in the reverse direction 604 and activate the cleaning valve 214 to start purging the beverage out of the conduits 224 and 234 through the venting port 112. The purged beverage is replaced with air drawn from the dispensing module outlet 236 for a pre-determined amount of time.

[063] Following the beverage purge of Figure 6C, the dispensing module 106 performs a rinsing operation as shown in Figure 6D to remove beverage residue on the conduits 234, 224 and 228. The controller 238 will activate the cleaning valve 214 and change the pump 218 to run in the forward

direction 602 to fill the conduits 224, 228 and 234 with water drawn from the cleaning fluid inlet 110 for a pre-determined amount of time.

[064] In Figure 6E, the controller 238 has the pump 218 run in the reverse direction 604 to purge the water, introduced in Figure 6D, out of the venting port 112 and replace with air drawn from the dispensing module outlet 236 for a pre-determined amount of time. Figure 6E concludes with the dispensing module 106 being returned to the initial idle state shown in Figure 2, with air being present in at least the conduit 224.

Configuration 5: Protect dispensing, water shield, forward purge mode

[065] In this mode, the beverage dispensing machine 100 of Figure 2 starts in an idle state where there is cleaning fluid in the conduit 224 (also called “water shield” when the cleaning fluid used is water). The cleaning fluid in the conduit 224 is drawn from the cleaning fluid inlet 110. During protect dispensing, a segment of operation sees water used as a “chaser” to dispense beverage within the conduit arrangement 222, which does not feature in the continuous dispensing operation used in configurations 1 to 4 described above. Another distinction is during protect dispensing, the standby mode has no beverage in the conduits 224 and 234 but water in the “water shield” mode.

[066] In Figure 7A, the pump 218 is commanded by the controller 238 to operate in a forward direction 302 to start purging the water out of the conduit 224 with air for a pre-determined amount of time. The controller 238 sends a command to operate the cleaning valve 214 and the beverage valve 216 to establish fluid communication with the venting port 112 to draw the air that is required to assist with the water purge. That is, gas is drawn from the venting port 112 to drive the content purge through the dispensing module outlet 236.

[067] The forward flow path in the conduit 224 thus starts from the conduit 230, extends into the conduit 228, then to the conduit 234 (that provides the dispensing module outlet 236). In Figure 7A, the cleaning valve 214 is disconnected from the cleaning fluid inlet 110. Figure 7A thus concludes with content purge being performed on the cleaning fluid within the conduit arrangement 222 before the beverage valve 216 is operated to draw beverage from the beverage reservoir 250.

[068] In Figure 7B, the controller 238 keeps the pump 218 operating in the forward direction and activates the beverage valve 216 to start dispensing beverage (such as milk) from the beverage reservoir 250 through the conduit 226 and disconnects the conduit 228. The forward flow path in the conduit 224 is maintained and the beverage is purged through the dispensing module outlet 236. Beverage is dispensed for a pre-determined amount of time, such as to make a drink.

[069] In Figure 7C, which is a continuation of the drink making operation of Figure 7B, the pump 218 continues to operate in the forward direction. However, instead of continuing to use the beverage valve 216 to drive the dispensation of beverage (which does not stop the supply of beverage into the conduit 224), the controller 238 activates the cleaning valve 214 to start using water drawn from the cleaning fluid inlet 110 to act as a “chaser” or driver that purges the remaining beverage in the conduits

224 and 234 out through the dispensing module outlet 236 for a pre-determined amount of time, up to the waterfront being proximate to the dispensing module outlet 236, thereby ejecting almost all the beverage out of the conduit arrangement 222. Surface tension within the conduit minimises and confines mixing or dilution at where the waterfront meets the beverage. As such, the remaining beverage purged out of the dispensing module outlet 236 is largely undiluted and usable to make a drink. The controller 238 can be programmed to calibrate that the beverage in the conduits 224 and 234 at the start of the operation of Figure 7C, and subsequently purged out of the dispensing module outlet 236, is of sufficient volume to make a drink. Beverage wastage is therefore reduced compared to the operation described in Figures 3A to 3D (more specifically Figure 3C) and 4A to 4G (more specifically Figure 4C). However, similar to the operation in Figures 3A to 3D (more specifically Figure 3D) and 4A to 4G (more specifically Figure 4E), the controller 238 operates the cleaning valve 214, the beverage valve 216 and the pump 218 to establish a flow path between the cleaning fluid inlet 110 and the dispensing module outlet 236. Figure 7C may thus end with water in the conduits 224 and 234 being murky due to the beverage it has facilitated purging.

[070] Figure 7D thus begins with murky water from the operation of Figure 7C. The dispensing module 106 is now in a standby state after the beverage dispensing cycle described in Figure 7C. The pump 218 is switched off by the controller 238, with murky water in the conduits 224 and 234.

[071] A timeout counter will start counting. If beverage is requested before timeout occurs, the dispensing module 106 will return to the operation described with respect to Figure 7A. Otherwise, if timeout occurs, the dispensing module 106 will operate as described in Figure 7E

[072] Figure 7E shows the dispensing module 106 performing a content purge on the murky water within the conduit arrangement 222 after a timeout from commencement of the standby mode described in Figure 7D. Upon timeout, the controller 238 will activate the cleaning valve 214 and the pump 218 to run in the forward direction 702 to start purging the murky water out of the conduit arrangement 222 through the dispensing module outlet 236. The purged murky water is replaced with fresh water for a pre-determined amount of time, transported in a flow path starting from the cleaning fluid inlet 110, the conduits 232, 228 and the beverage valve 216. In this manner, the controller 238 operates the cleaning valve 214, the beverage valve 216 and the pump 218 to establish a flow path between the cleaning fluid inlet 110 and the dispensing module outlet 236. Figure 7E concludes with the dispensing module 106 being returned to the initial idle state shown in Figure 2, with water being present in at least the conduit 224.

Configuration 6: Protect dispensing, water shield, reverse purge mode

[073] In this mode, the beverage dispensing machine 100 of Figure 2 starts in an idle state where there is cleaning fluid in the conduit 224 (also called “water shield” when the cleaning fluid used is water). The cleaning fluid in the conduit 224 is drawn from the cleaning fluid inlet 110.

[074] In Figure 8A, the pump 218 is commanded by the controller 238 to operate in a reverse direction 402 to start purging the water out of the conduit 224 with air for a pre-determined amount of time. The controller 238 sends a command to operate the cleaning valve 214 and the beverage valve 216 to establish fluid communication with the dispensing module outlet 236 to draw the air that is required to assist with the water purge. That is, gas is drawn from the dispensing module outlet 236 to drive the content purge through the venting port 112.

[075] The reverse flow path in the conduit 224 thus starts from the conduit 234, then to the conduit 224, the beverage valve 216, the conduit 228, the cleaning valve 214, the conduit 230 and to the venting port 112. Figure 8A thus concludes with content purge being performed on the cleaning fluid within the conduit arrangement 222 before the beverage valve 216 is operated to draw beverage from the beverage reservoir 250.

[076] In Figure 8B, the controller 238 reverses the pump 218 to operate in the forward direction 804 and activates the beverage valve 216 to start dispensing beverage (such as milk) from the beverage reservoir 250 through the conduit 226 and disconnects the conduit 228. The flow path in the conduit 224 is reversed, compared to Figure 8A, and the beverage is purged through the dispensing module outlet 236. Beverage is dispensed for a pre-determined amount of time, such as to make a drink.

[077] In Figure 8C, which is a continuation of the drink making operation of Figure 7B, the pump 218 continues to operate in the forward direction.

[078] The operation of Figure 8C is the same as that of Figure 7C. Accordingly, instead of continuing to use the beverage valve 216 to drive the dispensation of beverage, the controller 238 activates the cleaning valve 214 to start using water drawn from the cleaning fluid inlet 110 to act as a “chaser” or driver that purges the remaining beverage in the conduits 224 and 234 out through the dispensing module outlet 236 for a pre-determined amount of time, up to the waterfront being proximate to the dispensing module outlet 236, thereby ejecting almost all the beverage out of the conduit arrangement 222. Surface tension within the conduit minimises and confines mixing or dilution at where the waterfront meets the beverage. As such, the remaining beverage purged out of the dispensing module outlet 236 is largely undiluted and usable to make a drink. The controller 238 can be programmed to calibrate that the beverage in the conduits 224 and 234 at the start of the operation of Figure 8C, and subsequently purged out of the dispensing module outlet 236, is of sufficient volume to make a drink. Beverage wastage is therefore reduced, as explained above with respect to Figure 7C. Like Figure 7C, the controller 238 in Figure 8C operates the cleaning valve 214, the beverage valve 216 and the pump 218 to establish a flow path between the cleaning fluid inlet 110 and the dispensing module outlet 236. Figure 8C may thus end with water in the conduits 224 and 234 being murky due to the beverage it has facilitated purging.

[079] Figure 8D thus begins with murky water from the operation of Figure 8C. The dispensing module 106 is now in a standby state after the beverage dispensing cycle described in Figure 8C. The pump 218 is switched off by the controller 238, with murky water in the conduits 224 and 234.

[080] A timeout counter will start counting. If beverage is requested before timeout occurs, the dispensing module 106 will return to the operation described with respect to Figure 8A. Otherwise, if timeout occurs, the dispensing module 106 will operate as described in Figure 8E.

[081] Figure 8E shows the dispensing module 106 performing a content purge on the murky water within the conduit arrangement 222 after a timeout from commencement of the standby mode described in Figure 8D.

[082] Upon timeout, the controller 238 will command the pump 218 to run in the reverse direction 802 and activate the cleaning valve 214 to start purging the beverage out of the conduits 224 and 234 through the venting port 112. The purged beverage is replaced with air drawn from the dispensing module outlet 236 for a pre-determined amount of time.

[083] Following the murky water purge of Figure 8E, the dispensing module 106 performs a rinsing operation as shown in Figure 8F to remove murky water residue on the conduits 234, 224 and 228. The controller 238 will activate the cleaning valve 214 and change the pump 218 to run in the forward direction 804 to fill the conduits 224, 228 and 234 with water drawn from the cleaning fluid inlet 110 for a pre-determined amount of time.

[084] In Figure 8G, the controller 238 has the pump 218 run in the reverse direction 802 to purge the water, introduced in Figure 8F, out of the venting port 112 and replace with air drawn from the dispensing module outlet 236 for a pre-determined amount of time.

[085] In Figure 8H, the controller 238 activates the cleaning valve 214 and has the motor 218 run in the forward direction 804 to start to fill the conduits 224, 228 and 234 with water drawn from the cleaning fluid inlet 110 for a pre-determined amount of time. Figure 8G concludes with the dispensing module 106 being returned to the initial idle state shown in Figure 2, with water retained in at least the conduit 224.

Configuration 7: Protect dispensing, air shield, forward purge mode

[086] In this mode, the beverage dispensing machine 100 of Figure 2 starts in an idle state where there is air in the conduit 224 (also called “air shield”). During protect dispensing, a segment of operation sees water used as a “chaser” to dispense beverage within the conduit arrangement 222, which does not feature in the continuous dispensing operation used in configurations 1 to 4 described above. Another distinction is during protect dispensing, the standby mode has no beverage in the conduits 224 and 234 but air in the “air shield” mode.

[087] In Figure 9A, the controller 238 commands the pump 218 to operate in the forward direction 902 and activates the beverage valve 216 to start dispensing beverage (such as milk) from the beverage reservoir 250 through the conduit 226 and disconnects the conduit 228. Beverage is dispensed for a pre-determined amount of time, such as to make a drink.

[088] In Figure 9B, which is a continuation of the drink making operation of Figure 9A, the pump 218 continues to operate in the forward direction.

[089] The operation of Figure 9B is the same as that of Figure 7C. Accordingly, instead of continuing to use the beverage valve 216 to drive the dispensation of beverage, the controller 238 activates the cleaning valve 214 to start using water drawn from the cleaning fluid inlet 110 to act as a “chaser” or driver that purges the remaining beverage in the conduits 224 and 234 out through the dispensing module outlet 236 for a pre-determined amount of time, up to the waterfront being proximate to the dispensing module outlet 236, thereby ejecting almost all the beverage out of the conduit arrangement 222. Surface tension within the conduit minimises and confines mixing or dilution at where the waterfront meets the beverage. As such, the remaining beverage purged out of the dispensing module outlet 236 is largely undiluted and usable to make a drink. The controller 238 can be programmed to calibrate that the beverage in the conduits 224 and 234 at the start of the operation of Figure 9B, and subsequently purged out of the dispensing module outlet 236, is of sufficient volume to make a drink. Beverage wastage is therefore reduced, as explained above with respect to Figure 7C. Like Figure 7C, the controller 238 in Figure 9B operates the cleaning valve 214, the beverage valve 216 and the pump 218 to establish a flow path between the cleaning fluid inlet 110 and the dispensing module outlet 236. Figure 9B may thus end with water in the conduits 224 and 234 being murky due to the beverage it has facilitated purging.

[090] In Figure 9C, the controller 238 maintains the pump 218 in its forward direction to start purging the murky water, from the operation of Figure 9B, out through the dispensing module outlet 236. The cleaning valve 214 and the beverage valve 216 are operated so that a fluid flow path starts from the venting port 112 to the conduit 230, 228, 224 and 234, which replaces the murky water with air drawn from the venting port 112 for a pre-determined amount of time.

[091] Figure 9D shows the dispensing module 106 in a standby state after purging of the murky water in Figure 9C. The pump 218 is switched off by the controller 238, with air being in the conduits 224 and 234. This air is murky due to beverage residue in the conduits 224 and 234.

[092] A timeout counter will start counting. If a beverage is requested before timeout occurs, the dispensing module 106 will return to the operation described with respect to Figure 9A. Otherwise, if timeout occurs, the dispensing module 106 will operate as described in Figure 9E.

[093] Figure 9E shows the dispensing module 106 performing a content purge on the murky air within the conduit arrangement 222 after a timeout from commencement of the standby mode described in Figure 9D.

[094] Upon timeout, the controller 238 will activate the pump 218 to run in the forward direction 702 and activate the cleaning valve 214 to start purging the murky air out of the conduit arrangement 222 through the dispensing module outlet 236. The purged murky air is replaced with water for a pre-determined amount of time, transported in a flow path starting from the cleaning fluid inlet 110, the conduits 232, 228 and the beverage valve 216. In this manner, the controller 238 operates the cleaning valve 214, the beverage valve 216 and the pump 218 to establish a flow path between the cleaning fluid inlet 110 and the dispensing module outlet 236.

[095] In Figure 9F, the controller 238 maintains the pump 218 in its forward direction to start purging the water, from the operation of Figure 9E, out through the dispensing module outlet 236. The cleaning valve 214 and the beverage valve 216 are operated so that a fluid flow path starts from the venting port 112 to the conduit 230, 228, 224 and 234, which replaces the water with air drawn from the venting port 112 for a pre-determined amount of time. Figure 9F concludes with the dispensing module 106 being returned to the initial idle state shown in Figure 2, with air retained in at least the conduit 224.

Configuration 8: Protect dispensing, air shield, reverse purge mode

[096] In this mode, the beverage dispensing machine 100 of Figure 2 starts in an idle state where there is air in the conduit 224 (also called “air shield”).

[097] In Figure 10A, the controller 238 commands the pump 218 to operate in the forward direction 1002 and activates the beverage valve 216 to start dispensing beverage (such as milk) from the beverage reservoir 250 through the conduit 226 and disconnects the conduit 228. Beverage is dispensed for a pre-determined amount of time, such as to make a drink.

[098] In Figure 10B, which is a continuation of the drink making operation of Figure 10A, the pump 218 continues to operate in the forward direction.

[099] The operation of Figure 10B is the same as that of Figure 7C. Accordingly, instead of continuing to use the beverage valve 216 to drive the dispensation of beverage, the controller 238 activates the cleaning valve 214 to start using water drawn from the cleaning fluid inlet 110 to act as a “chaser” or driver that purges the remaining beverage in the conduits 224 and 234 out through the dispensing module outlet 236 for a pre-determined amount of time, up to the waterfront being proximate to the dispensing module outlet 236, thereby ejecting almost all the beverage out of the conduit arrangement 222. Surface tension within the conduit minimises and confines mixing or dilution at where the waterfront meets the beverage. As such, the remaining beverage purged out of the dispensing module outlet 236 is largely undiluted and usable to make a drink. The controller 238 can be programmed to calibrate that the beverage in the conduits 224 and 234 at the start of the operation of Figure 10B, and subsequently purged out of the dispensing module outlet 236, is of sufficient volume to make a drink. Beverage wastage is therefore reduced, as explained above with respect to Figure 7C. Like Figure 7C, the controller 238 in Figure 10B operates the cleaning valve 214, the beverage valve 216 and the pump 218 to establish a flow path between the cleaning fluid inlet 110 and the dispensing module outlet 236. Figure 10B may thus end with water in the conduits 224 and 234 being murky due to the beverage it has facilitated purging.

[100] In Figure 10C, the pump 218 is commanded by the controller 238 to operate in a reverse direction 1004 to start purging the murky water out of the conduit 224 with air for a pre-determined amount of time. The controller 238 sends a command to operate the cleaning valve 214 and the beverage valve 216 to establish fluid communication with the dispensing module outlet 236 to draw

the air that is required to assist with the water purge. That is, gas is drawn from the dispensing module outlet 236 to drive the content purge through the venting port 112. The reverse flow path in the conduit 224 thus starts from the conduit 234, then to the conduit 224, the beverage valve 216, the conduit 228, the cleaning valve 214, the conduit 230 and to the venting port 112.

[101] Figure 10D shows the dispensing module 106 in a standby state after purging of the murky water in Figure 10C. The pump 218 is switched off by the controller 238, with air being in the conduits 224 and 234. This air may be murky due to beverage residue in the conduits 224 and 234.

[102] A timeout counter will start counting. If a beverage is requested before timeout occurs, the dispensing module 106 will return to the operation described with respect to Figure 10A. Otherwise, if timeout occurs, the dispensing module 106 will operate as described in Figure 10E.

[103] Figure 10E shows the dispensing module 106 performing a content purge on the murky air within the conduit arrangement 222 after a timeout from commencement of the standby mode described in Figure 9D.

[104] Upon timeout, the controller 238 will activate the cleaning valve 214 and activate the pump 218 to run in the forward direction 1002 to start filling the conduit arrangement 222 with water for a pre-determined amount of time, transported in a flow path starting from the cleaning fluid inlet 110, the conduits 232, 228 and the beverage valve 216. The murky air from the operation of Figure 10C is purged out through the dispensing module outlet 236. In this manner, the controller 238 operates the cleaning valve 214, the beverage valve 216 and the pump 218 to establish a flow path between the cleaning fluid inlet 110 and the dispensing module outlet 236.

[105] In Figure 10F, the controller 238 has the pump 218 run in the reverse direction 1004 to purge the water, introduced in Figure 10E, out of the venting port 112 and replace with air drawn from the dispensing module outlet 236 for a pre-determined amount of time. Figure 10F concludes with the dispensing module 106 being returned to the initial idle state shown in Figure 2, with air being present in at least the conduit 224.

[106] Returning to Figure 1, the beverage dispensing machine 100 thus provides many possible different operation modes to cater to different usage scenarios and user preference.

[107] The full protect dispensing mode provided by configurations 5 to 8 allows for general usage, where at least a portion of the conduit arrangement 222 (see Figure 2) for each dispensing module 106 that transports beverage is rinsed after every dispense. There is minimal wastage of beverage, and the user is given the flexibility of choosing using an air or water shield after the conduit arrangement 222 is rinsed.

[108] The continuous dispensing mode provided by configurations 1 to 4 allows for high usage situations requiring short dispensing cycle times. This is because the continuous dispensing mode has a short cycle time between each dispense, therefore achieving high throughput. Consecutive dispensing without rinsing of the conduit arrangement 222 is possible until one of the following pre-set conditions is met:

1. Beverage in dispensing line reaches a pre-set threshold temperature

2. Time-Out: Dispensing line is fully rinsed after a time-out, e.g. if set for 10 min, each dispensing module 106 will perform a rinse after every 10min of idle time/inactivity. It is thus possible that the dispensing line is not rinsed if there is continuous dispensing. Time-Out may also be calibrated against the ambient temperature, i.e. higher ambient temperature, shorter time out

3. Time-Out is based on each beverage. i.e. if a beverage was last dispensed 10min ago, the rinsing cycle will initiate after an on-queue order is completed, before serving the next order on the queue

[109] The forward and reverse purging modes provided in each of the configurations 1 to 8 provide different rinsing modes for the conduit arrangement 222.

[110] The forward purging mode provides a clean rinse to the conduit arrangement 222, while purge of residual beverage in the conduit arrangement 222 provides a high food safety factor. To ensure that purged content from rinsing does not end up in a drink, the beverage dispensing machine 100 has a diversion mechanism to collect such purged content from the dispensing module outlet 236 to channel it, for example, back to the venting port 112. Figures 11 to 16 each show a possible implementation of this diversion mechanism.

[111] In the implementations of Figures 11 and 12, the forward purge is done after a dispensing head used to hold the outlets of the dispensing modules 106 is moved to a dedicated position away from a dispensing station where drinks are made. The dedicated position receives the purged residual beverage, which is directed to a drainage outlet. Figures 11 and 12 each show one embodiment of this implementation.

[112] Figure 11 is a prototype for the dispensing portion 1102 of the beverage dispensing machine 100 (confer portion 102 of the beverage dispensing machine 100 shown in Figure 1). The dispensing portion 1102 has a rail 1108. A dispensing head 1110 holds the dispensing module outlets for the plurality of the dispensing modules 106 (refer Figure 1). The dispensing portion 1102 has a drainage station 1104 and a dispensing station 1106, which are separate to each other. The dispensing head 1110 slides along the rail 1108 between the drainage station 1104 and the dispensing station 1106, staying in the dispensing station 1106 when drinks are made; and moving to the drainage station 1104 when there is content purge resulting from rinsing of the conduit arrangement 222. The drainage station 1104 has a drainage area through which such purged content is channelled to the coupled venting port 112. With reference to Figures 12 to 14, the dispensing head 1110 may be housed in a protective sheath (confer feature 1210 for Figure 12; and feature 1310 for Figure 13).

[113] Figure 12 shows an embodiment where the dispensing head is realised as a protective sheath 1210 that holds the dispensing module outlets for the plurality of the dispensing modules 106 (refer Figure 1). The protective sheath 1210 is rotatably coupled to a base 1202. A drainage pipe 1204 is also coupled to the base 1202. A motor (not shown) is configured to rotate the protective sheath 1210 for alignment with the drainage pipe 1204 to collect the purged content, resulting from rinsing of the conduit arrangement 222, from the dispensing module outlet. A tube (not shown) may directly connect

the drainage pipe 1204 back to the venting port 112 or the drainage pipe 1204 is connected to its own dedicated drainage port (not shown).

[114] Figures 13 to 16 show another embodiment where the dispensing head is realised as a protective sheath 1310 that holds the dispensing module outlets for the plurality of the dispensing modules 106 (refer Figure 1). Figure 13 is a perspective view; Figure 14 is a cross sectional view; and Figure 16 is a top view. The protective sheath 1310 is coupled a column 1302. A receptacle 1304 is slidably coupled to the column 1302. The receptacle 1304 extends for alignment with the dispensing module outlet during the content purge (resulting from rinsing of the conduit arrangement 222) through the dispensing module outlet (as shown on the right in both Figures 13 and 14); and retracting otherwise (as shown on the left in both Figures 13 and 14). Compared to the embodiments of Figures 11 and 12, the dispensing head of Figures 13 to 16 remains stationary during the content purge resulting from rinsing of the conduit arrangement 222.

[115] Like the implementation of Figure 12, a tube may directly connect the receptacle 1304 back to the venting port 112 or the drainage pipe 1204 is connected to its own dedicated drainage port (not shown).

[116] This tubing may be disposed within the column 1302 but is not shown in Figure 14 for the sake of simplicity.

[117] Figure 15 shows an exploded view of the receptacle 1304. It was found that when a dispensing module outlet 236 (confer Figure 2) housed within the protective sheath 1210 performs a forward content purge, some of the purged content may spread into adjacent dispensing module outlets at the exit point. Cross contamination may thus occur when such spread occurs, which is of particular concern should the purged content from a dispensing module outlet 236 contain beverage to which certain consumers are allergic. The receptacle 1304 is designed to at least minimise such spread between adjacent dispensing module outlets by having internal columns 1520 (3 are shown in Figure 15), so that each dispensing module outlet 236 purges into its own column 1520, with the column wall preventing the spread to adjacent dispensing module outlets. Each column wall stretches a fraction of the length of the receptacle 1304, starting from the end of the receptacle 1304 that is adjacent to the dispensing module outlets when it is extended. Each column wall does not need to extend the full length of the receptacle 1304 because the spillage of purged content from one dispensing module outlet 236 into adjacent dispensing module outlets mainly occurs at the exit point. While Figure 15 shows that the columns are arranged side-by-side, in another configuration (not shown), the individual columns may be stacked, with the opening of each column offset to each other.

[118] The column 1302 is rotatable about its base 1640, as shown in Figure 16. The column 1302 swivels to dispense beverage, such as into one cup 1642 in a queue placed on the base 1640. As the column 1302 swivels, the controller 238 may be configured to simultaneously perform a forward purge rinsing of the conduit arrangement 222, as described in one of the different configuration operations 1 to 8. That is, while the column 1302 is swivelling, the receptacle 1304 may

simultaneously slide to align with the dispensing module outlet as the column 1302 to collect the purged content resulting from rinsing of the conduit arrangement 222; or may simultaneously slide to retract, depending on which stage of the forward purge rinsing operation that the dispenser module 106 is at when the column 1302 starts to swivel. It is not a requirement that the receptacle 1304 slides while the column 1302 swivels. Rather, this simultaneous movement serves to reduce beverage dispensing down time compared to if each movement occurs separately.

[119] The combination of the mechanised protective sheath 1210 and the drainage pipe 1204 (from Figure 12); and the slidable receptacle 1304 (from Figures 13 to 16) provide a catchment mechanism to collect the purged content from the dispensing module outlet. In addition, the embodiments of Figures 12 and 13 to 16 are advantageous for reducing cycle time needed between rinsing the conduit arrangement 222 and dispensing beverage.

[120] The reverse purging mode allows for the dispensing head to stay stationary while the pump 218 reverse purges residual beverage in the conduit arrangement 222 to drainage (confer venting port 112 shown in Figure 2). This provides a shorter cycle time compared to the forward purging mode. Provided all food safety factors are complied, reverse purging also allows for residual beverage in the conduit arrangement 222 to be returned to its respective beverage reservoir, thereby reduce wastage. Alternatively, as shown in the configurations 1 to 8, the beverage is purged out.

[121] Post rinsing, a user can select whether to fill the rinsed conduit arrangement 222 with either water or air. For frequent beverage dispensation, using air (i.e. "air shield") is preferred for cycle time consideration (shorter rinsing time and shorter time to next dispense). For infrequent beverage dispensation, a dusty environment, or End-of-Day cleaning, water shield is preferred. As mentioned above, with water shield having the rinsed conduit arrangement 222 filled with water, this prevents insects or dust from entering in-between dispensing.

[122] The following are cycle time related parameters associated with the beverage dispensing machine 100:

- i. Dispensing line water filling duration
 - a. Time needed to fill the tube with water after rinsing for water shield mode
 - b. This is dependent on dispensing tube length for each unit
- ii. Dispensing line air filling duration
 - a. Time needed to fill the tube with air (using air as a chaser)
 - b. This is dependent on dispensing tube length for each unit
- iii. Dispensing line forward purging duration
 - a. Time needed to use air as a chaser to purge water out
 - b. This is dependent on the drainage tube length for each unit
- iv. Full rinsing cycle duration.
 - a. Dependent on the above setup
 - b. Also dependent on the type of beverage used

[123] In the application, unless specified otherwise, the terms "comprising", "comprise", and grammatical variants thereof, intended to represent "open" or "inclusive" language such that they include recited elements but also permit inclusion of additional, non-explicitly recited elements.

[124] While this invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes can be made and equivalents may be substituted for elements thereof, without departing from the scope of the invention. In addition, modification may be made to adapt the teachings of the invention to situations and materials, without departing from the essential scope of the invention. Thus, the invention is not limited to the examples that are disclosed in this specification but encompasses all embodiments falling within the scope of the appended claims.

Appendix

Default Beverage Dispensing Operation

Steps

- 5 **1.** Power on the unit
- 2.** Unit initializes, move the dispensing head to the Drainage station and starts rinsing cleaning cycle – 30 sec
- 3.** Once rinsing cycle completes, the Dispensing head will move to a dispensing station and ready for use
- 10 **4.** By default, the unit will be configured as follows
 - a. Continuous Dispensing mode
 - b. Time-Out = 10 min
 - c. Forward Purging
 - d. Water-Shield Protect
- 15 **5.** Place a receptacle in the dispensing station and select
 - a. the desired beverage type
 - b. the desired beverage volume
- 6.** If the initial rinse at Step 2 is more than 30 min ago, the unit will perform a short rinse (10 sec) for the tubing where the desired beverage is to be dispensed.
- 20 **7.** Unit will start to dispense according to the selection of point 5
- 8.** Unit will continue to dispense if beverage is requested before Time-Out is reached (default 10min)
- 9.** Once Time-Out is reached, the Dispensing head will move to the drainage station and perform Forward Purging, complete rinsing in Air-Shield mode, and return to dispensing station
- 25 **10.** Unit is now ready again for Dispensing
- 11.** If Beverage A was last dispensed 10min ago, and it has been dispensing Beverage B for the last 10 min, initiate the rinsing cycle for Beverage A tube after it has completed its on-hand order before resuming with the next order on the queue

30 Options Available For Beverage Dispensing

1. Cleaning

After powering up or when a cleaning cycle is triggered, the machine will enter a full rinsing cycle where the dispensing head will move to the dedicated drainage station and forward purging all the tubes with water by switching on the cleaning valves and pumps.

35 1.1 Water-protect rinsing mode

Leftover rinsed water is kept in the dispensing line after full rinsing cycle. The dispenser is now ready for use.

1.2 Air-protect rinsing mode

Leftover rinsed water is drawn out of dispensing line into drainage by reversing pumps. The dispenser is now ready for use.

2. Ordering

User places a receptacle under a dispensing station and then selects the type of beverage to dispense. The machine will then decide what to do depending on the position of the dispensing head.

2.1 Dispenser head at drainage station:

2.1.1 Water-protect rinsing mode

If the dispensing line is filled with water, water is forward purged into the drainage. After that, it will move to the respective dispensing station. Once it reaches, machine is ready to dispense.

2.1.2 Air-protect rinsing mode

If the dispensing line is filled with air, it will move to the respective dispensing station. Once it reaches, machine is ready to dispense.

2.2 Dispensing head at dispensing station

2.2.1 Water-protect rinsing mode

2.2.1.1 Stationary drainage movement mode

Pump reverses to bring dispensing line's beverage to drainage. Once it finishes, machine is ready to dispense.

2.2.1.2 Dedicated drainage movement mode

The dispensing head will move to the dedicated drainage station and to forward purge the dispensing line. After that, it will move to the respective dispensing station. Once it reaches, machine is ready to dispense.

2.2.2 Air-protect rinsing mode

Machine is ready to dispense.

2.3 Dispensing head is not at drainage station nor at dispensing station

2.3.1 Water-protect rinsing mode

2.3.1.1 Stationary drainage movement mode

The dispensing head will move to the respective dispensing station. While moving, pump reverses to bring dispensing line's beverage to drainage. Once it finishes and reaches dispensing location, machine is ready to dispense.

2.3.1.2 Dedicated drainage movement mode

The dispensing head will move to the dedicated drainage station and to forward purge the dispensing line. After that, it will move to the respective dispensing station. Once it reaches, machine is ready to dispense.

2.3.2 Air-protect rinsing mode

5 Dispensing head will move to the respective dispensing station. Once it reaches, machine is ready to dispense.

3. Dispensing

10 At the respective dispensing stations, beverage will be dispensed by switching on the beverage valve and pumping the beverage forward.

3.1 Protect dispensing mode

3.1.1 Water-protect rinsing mode

The dispensing line will be filled with water by switching on the cleaning valve and pumping the water forward. Dispensing is now complete.

15 3.1.2 Air-protect rinsing mode

The dispensing line will be filled with water by switching on the cleaning valve and pumping the water forward. Thereafter, leftover rinsed water is drawn out of dispensing line into drainage by reversing pumps. Dispensing is now complete.

3.2 Non-stop dispensing mode

20 Dispensing is now complete.

4. Post-dispense

4.1 Protect dispensing mode

25 After the first dispense, the dispenser's countdown timer to the full rinsing cycle will start. Once the idle time is exceeded, machine returns to process "1. Cleaning".

4.2 Non-stop dispensing mode

Dispensing tubes will be filled with beverage. After every dispense, the dispenser's idle countdown timer will reset. Once the idle time is exceeded, machine returns to process "1. Cleaning"

30 4.2.1 Temperature-protect zero-wastage mode

A temperature sensor attached to the dispensing line to monitor the temperature. Once target temperature is exceeded, the sensor will trigger the pump to reverse to bring dispensing line's beverage back into chilled receptacle. Machine returns to process "1. Cleaning".

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CLAIMS

1. A beverage dispensing machine comprising:
a plurality of dispensing modules each comprising:
 - 5 a cleaning valve;
 - a beverage valve;
 - a conduit arrangement to couple the cleaning valve to the beverage valve, the beverage valve to a beverage reservoir, and the cleaning valve to a venting port, and having an outlet for the dispensing module;
 - 10 a pump to establish fluid flow within the conduit arrangement; and
 - a controller configured to operate the cleaning valve, the beverage valve and the pump to direct a flow path between the beverage valve and the cleaning valve, the flow path direction being reversible to purge content within the conduit arrangement through either the dispensing module outlet or the venting port.
- 15 2. The beverage dispensing machine of claim 1, wherein the conduit arrangement further couples the cleaning valve to a cleaning fluid inlet; and wherein the controller is further configured to operate the cleaning valve, the beverage valve and the pump to establish a flow path between the cleaning fluid inlet and the dispensing module outlet.
- 20 3. The beverage dispensing machine of claim 2, wherein the controller is further configured, to operate the cleaning valve, the beverage valve and the pump to keep the conduit arrangement empty or filled with cleaning fluid from the cleaning fluid inlet during an idle mode.
- 25 4. The beverage dispensing machine of claim 3, wherein the content purge is performed on the cleaning fluid within the conduit arrangement before the beverage valve is operated to draw beverage from the beverage reservoir.
- 30 5. The beverage dispensing machine of any one of the preceding claims, wherein the controller is further configured, to operate the cleaning valve, the beverage valve and the pump to retain beverage from the beverage reservoir within a portion of the conduit arrangement between the beverage valve and the dispensing module outlet during a standby mode.
- 35 6. The beverage dispensing machine of claim 5, wherein the content purge is performed on the beverage within the conduit arrangement after a timeout from commencement of the standby mode.

7. The beverage dispensing machine of any one of the preceding claims, wherein gas is drawn from the venting port to drive the content purge through the dispensing module outlet.
8. The beverage dispensing machine of any one of the claims 1 to 6, wherein gas is drawn from the dispensing module outlet to drive the content purge through the venting port.
9. The beverage dispensing machine of any one of the claims 2 to 8, wherein cleaning fluid is drawn from the cleaning fluid inlet to drive the content purge through the dispensing module outlet.
10. The beverage dispensing machine of any one of the preceding claims, further comprising a temperature controlled environment to house the beverage reservoir and the beverage valve.
11. The beverage dispensing machine of any one of the claims 2 to 10, wherein the pump is disposed between the beverage valve and the dispensing module outlet; and wherein the beverage valve is disposed downstream of the cleaning valve towards the dispensing module outlet.
12. The beverage dispensing machine of claim 11, wherein the conduit arrangement comprises
a conduit to couple the pump to the beverage valve;
a conduit to couple the beverage valve to the beverage reservoir;
a conduit to couple the beverage valve to the cleaning valve;
a conduit to couple the cleaning valve to the venting port; and
a conduit to couple the cleaning valve to the cleaning fluid inlet.
13. The beverage dispensing machine of any one of the preceding claims, further comprising a diversion mechanism to collect the purged content from the dispensing module outlet.
14. The beverage dispensing machine of claim 13, further comprising
a base to which the dispensing module outlets for the plurality of the dispensing modules are rotatably coupled, wherein the diversion mechanism comprises
a drainage pipe coupled to the base; and
a motor configured to rotate the plurality of the dispensing modules for alignment with the drainage pipe to collect the purged content from the dispensing module outlet.
15. The beverage dispensing machine of claim 14, wherein the drainage pipe is coupled to the venting port.
16. The beverage dispensing machine of claim 13, further comprising

a column to which the dispensing module outlets for the plurality of the dispensing modules are coupled, wherein the diversion mechanism comprises

a receptacle slidably coupled to the column, the receptacle extending for alignment with the dispensing module outlet during the content purge through the dispensing module outlet; and retracting
5 otherwise.

17. The beverage dispensing machine of claim 13, further comprising

a drainage area coupled to the venting port, wherein the redirection mechanism comprises

a rail along which the dispensing module outlets for the plurality of the dispensing modules
10 slide to the drainage area during the content purge through the dispensing module outlet.

18. The beverage dispensing machine of any one of the preceding claims, further comprising a protective sheath for housing the dispensing module outlets for the plurality of the dispensing modules.

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