(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 623 455 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
07.08.2013 Bulletin 2013/32

(51) Int Cl.:
B67D 1/00 *(2006.01)* ***B67D 1/04*** *(2006.01)*
B67D 1/08 *(2006.01)* ***B67D 1/12*** *(2006.01)*

(21) Application number: **12153871.4**

(22) Date of filing: **03.02.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(71) Applicant: **Carlsberg Breweries A/S**
1799 Copenhagen V (DK)

(72) Inventors:
- **Rasmussen, Jan Nørager**
  3650 Ølstykke (DK)
- **Vesborg, Steen**
  2820 Gentofte (DK)

(74) Representative: **Nielsen, Henrik Sten**
Budde Schou A/S
Vester Søgade 10
1601 Copenhagen V (DK)

(54) A method of dispensing carbonated beverage

(57) A method of dispensing carbonated beverage comprises the of providing a beverage dispensing system (12) comprising a pressure chamber (24), which chamber accommodates a collapsible beverage container (48) made of a flexible material. The collapsible beverage container includes a beverage space, a head space, a dispensing device (76), a tapping line (18), and an interruption valve (40). The method further comprises the step of maintaining a first elevated pressure within the pressure chamber, which chamber acts on the collapsible beverage container for crumpling the collapsible beverage container at a container crumpling pressure and establishing a second elevated pressure, the first elevated pressure being equal to the sum of the second elevated pressure and the container crumpling pressure. The method still further comprises the step of operating the dispersing device from the non-beverage dispensing position to the beverage dispensing position.

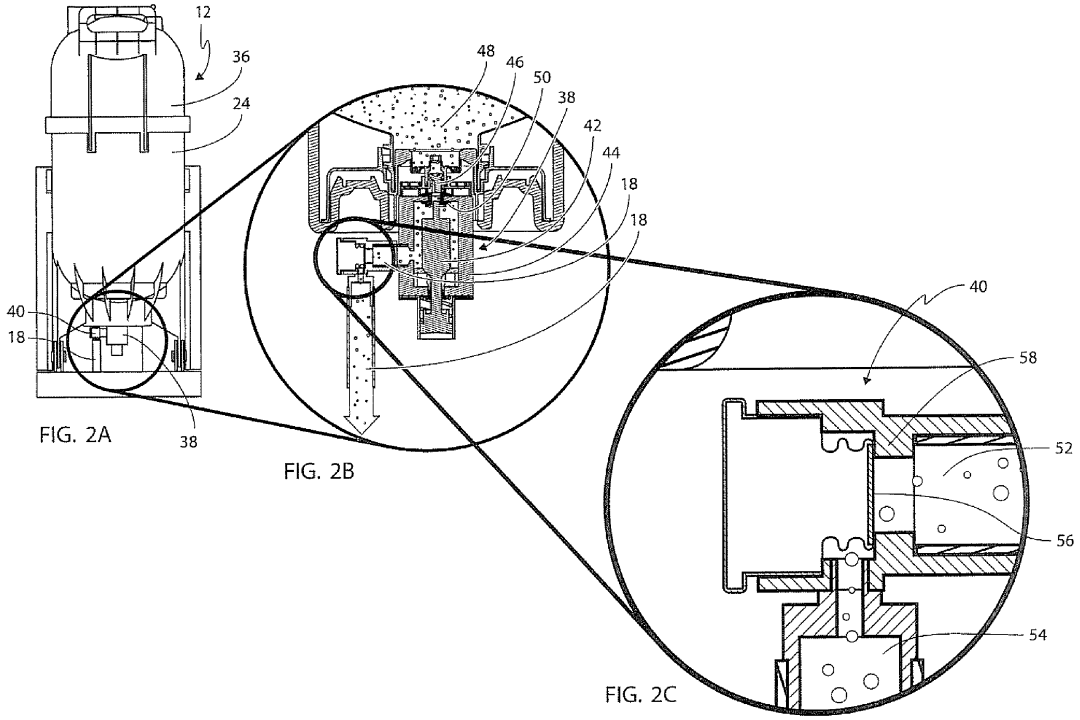


FIG. 2A

FIG. 2B

FIG. 2C

EP 2 623 455 A1

Description

[0001] The present invention relates to a method of dispensing carbonated beverage, a collapsible beverage container and a beverage dispensing system.

Background

[0002] Beverage dispensing systems are typically used in beverage dispensing establishments for efficiently dispensing large quantities of beverage. Typically, beverage dispensing systems are used to dispense carbonated alcoholic beverages such as draught beer and cider. However, also non-alcoholic carbonated beverages such as soft drinks may be dispensed using a beverage dispensing system. Beverage dispensing systems are mostly for professional users such as in establishments like bars, restaurants and hotels, however, increasingly also for private users such as in private homes.

[0003] Professional beverage dispensing systems typically dispense beverage provided in large beverage containers Such beverage containers may hold 20-50 litres of beverage for a professional beverage dispensing system for allowing typically 50-100 beverage dispensing operations before needing to exchange the beverage container. Conventional beverage containers are made of solid materials such as steel and refilled a number of times. Recently, beverage containers have been made collapsible and for single use only due to hygiene concerns when refilling solid beverage containers. An example of a beverage dispensing system using collapsible beverage containers is the DraughtMaster™ system provided by the applicant company. Such beverage dispensing systems using collapsible beverage containers typically have the beverage container installed in a pressure chamber. Some examples of prior art beverage dispensing systems follow below:

In WO 2007/019848, a beverage dispensing system is described. The beverage dispensing system comprises a pressure chamber, which is adapted to accommodate a beverage container of collapsible material.

[0004] In WO 2009/024147, a module for a modular beverage distribution system is disclosed. Each system comprises a frame, a pressure chamber and connectors for receiving pressure fluid and for supplying the pressure fluid to the pressure chamber and to the neighbouring module. The system has a separate rinsing line. By using a specially designed discharge valve, alternatively rinsing fluid or beverage may enter the tapping line. Rinsing fluid is provided from a separate pressurized reservoir. The discharge valve includes safety features for avoiding mixing rinsing fluid and beverage.

[0005] In WO 2010/029122, a method of cleaning the tapping line of a beverage dispensing system is disclosed in which a cleaning and flushing cartridge for internal use is described. The cleaning and flushing cartridge is installed in the pressure chamber similar to a beverage container and dispensed similar to a beverage.

[0006] WO 2010/060946 and WO 2011/117192 both relate to a method of cleaning the tapping line of a beverage dispensing system in which a cleaning and flushing cartridge for external use is described. The cleaning and flushing cartridge is installed outside the pressure chamber and has a pressure fluid source connected. The rinsing and flushing fluid is dispensed similar to a beverage.

[0007] WO 2010/060949 relates to a beverage dispensing system having a first and a second detector for generating a control pressure. The method comprises evaluating the control pressures from the control pressure outputs of detectors for determining the operational mode of the beverage dispensing system.

[0008] In WO 2010/020644, a method of installing a collapsible beverage container in a beverage distribution unit is disclosed. The method comprises the steps of positioning the collapsible beverage container in a sloped position, pivoting the collapsible beverage container in a rotational motion around a support surface and sliding the collapsible beverage container on the support surface.

[0009] When using long dispensing lines, a significant amount of beverage will remain in the tapping line when the beverage container is empty. In order to avoid that this beverage flows backwards through the tapping line, it is contemplated that a non-return valve may be used in the tapping line. Further, in order to prevent dripping, a spring loaded valve may be used. An example of a beverage dispenser including a plurality of valves is DE 296 04 703 U1, in which an electrical liquor dispensing system is disclosed. The tapping line has a non-return valve and a spring loaded lid. The liquor is propelled from a container through the tapping line by an electrical pump and explicitly not by pressurized gas.

[0010] When dispensing beverage from the beverage dispensing system using a collapsible beverage container, a pressure fluid, typically a gas, is allowed to enter the pressure chamber. During the dispensing of beverage from the pressure chamber, the pressure fluid acts on the collapsible beverage container and forces the beverage out of the pressure chamber while simultaneously crumpling the collapsible beverage container. The volume of the crumpled collapsible beverage container is thereby reduced corresponding to the amount of the dispensed beverage. The collapsible beverage container is made of flexible and preferably disposable materials such as thermoplastic materials.

[0011] The interior of the collapsible beverage container is divided into a beverage space constituting carbonated

beverage and initially occupying the majority of the interior of the beverage container and a head space filled with gas, primarily constituting CO_2 gas.

[0012] While performing a dispensing operation, the force applied to the beverage container by the pressure in the pressure chamber causes the beverage to flow out of the beverage container and into a tapping line. The tapping line leads to a dispensing device which may be located at a distant location such as one floor above the pressure chamber. The dispensing device typically has a tapping valve and a tapping handle for allowing an operator to control the tapping valve and thereby the beverage dispensing operation. The operator, such as a bartender or barmaid, uses the tapping device to control the rate of beverage dispensing.

[0013] A problem often observed when the beverage space of the beverage container is empty or almost empty is that the gas of the head space starts entering the tapping line. Such gas will result in gas bubble formation in the tapping line. The presence of gas bubbles in the tapping line will cause excessive frothing and aeration of the carbonated beverage at the tapping valve of the dispensing device. The carbonated beverage dispensed will thus be very foamy and will have a less than optimal taste and appearance. Typically, this beverage therefore has to be disposed of. This is also an indication for the bar employee to exchange the empty and crumpled collapsible beverage container with a new collapsible beverage container filled with beverage.

[0014] However, gas will still remain in the tapping line even after the beverage container has been exchanged. This will result in excessive foaming also for the first one or two servings of carbonated beverage. This beverage must be disposed of as well. Thus, the total loss of beverage may amount to 2-4 servings for each beverage container, i.e 1-2 at the beginning of each container and 1-2 at the end of each container, resulting in a loss of about 10% of the beverage included in a typical 20 liter collapsible beverage container

[0015] In case a modular beverage dispensing system is used, i.e. a system wherein a single tapping line is fed from a multitude of collapsible beverage containers, the problem is even larger since the beverage spaces of the different collapsible beverage containers may be empty at different times, resulting in even more beverage lost.

[0016] The object of the present invention is thus to dispense beverage while preventing that any gas from the head space is entering the tapping line.

Summary of the invention

[0017] The above object together with numerous other objects, which will be evident from the below detailed description, are according to a first aspect of the present invention obtained by a method of dispensing carbonated beverage, the method comprising the steps of:

providing a beverage dispensing system, the beverage dispensing system comprising a pressure chamber, the pressure chamber accommodating a collapsible beverage container made of a flexible material, the collapsible beverage container including a beverage space consisting of carbonated beverage and a head space consisting of gas, a dispensing device including a tapping valve and defining a beverage dispensing position and a non-beverage dispensing position, a tapping line interconnecting the collapsible beverage container within the pressure chamber and the dispensing device, and an interruption valve defining an open position and a closed position, the open position allowing carbonated beverage to flow from the beverage space to the dispensing device when the pressure chamber is pressurized, the closed position preventing carbonated beverage to flow from the beverage space to the dispensing device,

maintaining a first elevated pressure within the pressure chamber, the first elevated pressure acting on the collapsible beverage container for crumpling the collapsible beverage container at a container crumpling pressure and establishing a second elevated pressure within the collapsible beverage container, the first elevated pressure being equal to the sum of the second elevated pressure and the container crumpling pressure, the interruption valve assuming the open position when the second elevated pressure exceeds a specific non-zero pressure reference, the interruption valve assuming the closed position when the second elevated pressure falls below the specific non-zero pressure reference, and

operating the dispensing device from the non-beverage dispensing position to the beverage dispensing position for causing the carbonated beverage to be dispensed at the dispensing device and the collapsible beverage container to crumple, provided the interruption valve assuming the open position.

[0018] The beverage dispensing system may be a non-modular system in which one pressure chamber is connected to one dispensing device via a single tapping line, or a modular system in which a plurality of pressure chambers are selectively connected to one or more dispensing devices via one or more tapping lines. The pressure chamber is typically a pressure proof container connected to a fluid pressure source, typically a high pressure air source. The pressure chamber typically has a pressure lid in order to be able to insert and remove the collapsible beverage container The collapsible beverage container is typically made of a semi rigid metallic or polymeric material having a thickness such that it is capable of retaining its shape during transport and handling but which may collapse and crumple when subjected to an outer pressure. In most cases a blow molded plastic container will be used The beverage container may be initially sealed during transport and handling. In a new collapsible beverage container, i.e. a non crumpled container, the beverage space typically occupies about 90% to 95% of the total volume of the beverage container and the head space is occupying

the remaining 5%-10%.

[0019] The tapping line leads from the collapsible beverage container within the pressure chamber to the dispensing device outside the pressure chamber. The dispensing device typically comprise a tapping valve and an tapping handle for the user to be able to selectively dispense or not dispense beverage by switching between the beverage dispensing position in which the tapping valve is open and the non-beverage dispensing position in which the tapping valve is closed.

[0020] The first elevated pressure to be maintained in the pressure chamber is established after the collapsible beverage container has been installed in the pressure chamber. The first elevated pressure is typically held substantially constant until the collapsible beverage container is to be exchanged at which time the pressure is let out The first elevated pressure acts uniformly on the wall of the collapsible beverage container in order to establish the second elevated pressure inside the collapsible beverage container. The second elevated pressure is thus the pressure within the beverage The first elevated pressure is thus transmitted via the wall of the collapsible beverage container to establish the second elevated pressure. In the present context the applicant has surprisingly found out that the second elevated pressure will be smaller than the first elevated pressure and that the difference between the first elevated pressure and the second elevated pressure is constituted by the pressure required to crumple the collapsible beverage container, i.e. the crumpling pressure, for overcoming the internal resistance against a change of the shape of the wall. Further, it has surprisingly found out that the crumpling pressure is dependent on the level of crumpling of the collapsible beverage container, i.e. a new (full) non-crumpled collapsible beverage container will have a much lower resistance against crumpling than an already crumpled beverage container. Thus, the crumpling pressure increases during beverage diseasing as the volume of the beverage space and thereby the total volume of the collapsible beverage container is reduced. The increase in crumpling pressure is non-linear for most materials and most collapsible beverage containers will exhibit an exponential increase in the required crumpling pressure when the beverage space of the beverage container is almost empty. This effect may be explained by the fact that the first few beverage dispensing operations of a new collapsible beverage container will result in an elastic deformation of the wall of the collapsible beverage container. Such elastic deformation is linear of nature. When the beverage space of collapsible beverage container is almost empty and the collapsible beverage container is significantly crumpled, the deformation of the wall of the collapsible beverage container will exhibit a plastic deformation, which is non-linear and requires a significantly higher crumpling pressure. Thus, the second elevated pressure will reduce. In the present context it is understood that the crumpling characteristic of a typical collapsible beverage container will be at least somewhat stochastic, i.e. two seemingly identical collapsible beverage containers may crumple slightly different depending on the internal wall structure of each collapsible beverage container.

[0021] The above fact may be utilized by employing an interruption valve. The interruption valve is preferably situated in the tapping line adjacent the beverage container. As long as the second elevated pressure is higher than the specific non-zero pressure reference, the interruption valve will be open and allow beverage to pass when the dispensing device assumes the beverage dispensing position. Later, when the collapsible beverage container is almost empty and thus seriously crumpled, the crumpling pressure will have increased and provided the first elevated pressure is held substantially constant, the second elevated pressure will be much smaller. When the second elevated pressure falls below the specific non-zero pressure reference, the interruption valve will be closed and beverage will not be allowed to pass even when the dispensing device assumes the beverage dispensing position. This will allow a very well defined end of the beverage dispensing operations when the collapsible beverage container is empty or nearly empty

[0022] The non-zero pressure reference is chosen such that the beverage dispensing is interrupted well before the beverage space is empty such that there is no risk that gas from the head space will enter the tapping line The specific non-zero pressure reference may thus not be zero, since this would mean that the container crumpling pressure is equal to the first pressure, which first pressure is typically sufficient to completely flatten the collapsible beverage container In case the first elevated pressure is not significantly higher than the crumpling pressure such that the second elevated pressure is allowed to approach zero, the beverage dispensing will be very slow due to the lack of driving pressure and such situations should also be avoided. Yet further, in case the specific non-zero pressure reference is higher than the first pressure, the interruption valve will always be closed and beverage dispensing never allowed.

[0023] By choosing a suitable specific non-zero pressure reference, the interruption valve may be closed when the second elevated pressure is still high enough for dispensing and the beverage space still includes a small amount of beverage. In this way, no gas will be introduced into the tapping line. When a new collapsible beverage container is installed, the tapping line will be free from gas and the first servings of carbonated beverage will not suffer from any excessive foaming. The only lost beverage will be the small amount remaining in the crumpled beverage container, however, this amount will be much smaller than the amount of carbonated beverage lost due to excessive foaming. Calculations made by the applicant using typical 20 liter beverage container have shown that the average loss amounts to a few per mille only, compared to several percent using the prior art beverage dispensing systems. Taking into account the total amount of carbonated beverage dispensed worldwide, a vast amount of carbonated beverage can be saved

[0024] According to a further embodiment of the first aspect, the interruption valve is located in the collapsible beverage container, the tapping line or the dispensing device. In one preferred embodiment, the interruption valve is located in the collapsible beverage container In this way there is no need for any modifications of the permanent parts of the

beverage dispensing system. In the case that the interruption valve is located in the beverage container, it is contemplated that it may be used for sealing the beverage container during transport and handling, thereby omitting the need for a separate seal. It is further contemplated that the interruption valve may be provided as a re-usable accessory which is mounted on the collapsible beverage container In another preferred embodiment, the interruption valve is preferably fixedly mounted in the tapping line adjacent the collapsible beverage container. In this way, ordinary collapsible beverage containers may be used. The pressure in the tapping line may be considered to be equal to the pressure within the collapsible beverage container, at least at a location adjacent the collapsible beverage container. However, in case the tapping line leads to another floor of a building, it is contemplated that the pressure will fall. In yet another preferred embodiment, the interruption valve is located in the dispensing device. In this way, a visual indication may be given that the beverage container is empty. In this embodiment, a non-return valve may be used adjacent the beverage container to avoid a return flow of beverage. Further, the pressure may be slightly lower at the interruption valve than inside the collapsible beverage container depending on the height difference between the collapsible beverage container and the dispensing device.

[0025] According to a further embodiment of the first aspect, the interruption valve employs a loaded spring or a sealed pressurized gas volume in order to establish the specific non-zero pressure reference When the second elevated pressure falls below the specific non-zero pressure reference, the interruption valve changes from the open position to the closed position. The specific non-zero pressure reference may be established by a loaded spring having a suitable spring constant and pre-load such that the valve remains open when the second elevated pressure is higher than the specific non-zero pressure reference but closes rapidly when the second elevated pressure falls below the specific non-zero pressure reference Alternatively, a sealed pressurized gas volume may substitute the spring.

[0026] According to a further embodiment of the first aspect, the interruption valve is fluidly connected to the first elevated pressure of the pressure chamber via a pressure regulator for establishing the specific non-zero pressure reference. A particular beneficial solution is to make the specific non-zero pressure reference dependent on the first elevated pressure via a pressure regulator acting as a pressure reduction valve. In this way, the non-zero pressure reference may be made dependent on the first elevated pressure, i.e. the pressure in the pressure chamber. In this way, the first elevated pressure may be increased while still allowing the interruption valve to be closed when the collapsible beverage container has been crumpled to such extent that only a very small amount of beverage remains.

[0027] According to a further embodiment of the first aspect, the interruption valve includes a pressure probe for determining the second elevated pressure and an electromagnetic valve for assuming the open and closed positions, respectively, dependent on the second elevated pressure. The pressure probe may be mounted in the tapping line in order to constantly monitor the second elevated pressure. As soon as the second elevated pressure falls below the specific non-zero pressure reference, an electrical signal may be sent to the electromagnetic valve in order for the interruption valve to close. It is contemplated that a control unit may be used to compensate the specific non-zero pressure reference in order to take account of any changes in the first elevated pressure.

[0028] According to a further embodiment of the first aspect, the first elevated pressure is in the range of 2-5 bar above atmospheric pressure, preferably 3-4 bar above atmospheric pressure Such pressures are suitable for achieving a good driving pressure for the beverage which will overcome the crumpling pressure of the collapsible beverage and still allow beverage to be dispensed at a reasonable velocity at a higher location than the location of the beverage container.

[0029] According to a further embodiment of the first aspect, the second elevated pressure is in the range of 1-4 bar above atmospheric pressure, preferably 2-3 bar above atmospheric pressure. By considering the crumpling pressure, the second elevated pressure must still allow beverage to be dispensed at a reasonable velocity at a higher location than the location of the beverage container.

[0030] According to a further embodiment of the first aspect, the beverage container is positioned in an upside down orientation within the pressure space such that the beverage space is located adjacent the tapping line and the head space is located spaced apart from the tapping line. With upside down position is meant a position in which the outlet of the beverage container is directed downwardly. In this way, the beverage space will be located adjacent the outlet and the head space will be located as far as possible from the outlet and consequently the head space will not reach the outlet until the beverage space is depleted This will also completely avoid the use of a ascension pipe.

[0031] According to a further embodiment of the first aspect, specific non-zero pressure reference is in the range of 0.1-3 bar, preferably 0.5-1 bar, absolute pressure. For most cases such pressure values will be suitable in order to achieve a well defined end of beverage dispensing when the collapsible beverage container is empty or almost empty

[0032] According to a further embodiment of the first aspect, the crumpling pressure being dependent on the level of crumpling of the collapsible beverage container, the crumpling pressure being in the range of 0-1 bar absolute pressure when the beverage container is in an initial non-crumpled state whereas the crumpling pressure is in the range of 2-5 bar when the beverage container is in a crumpled state in which the volume of the beverage container is reduced to 5% of the volume of the beverage container in the initial non-crumpled state. As already stated above, the crumpling pressure being dependent on the level of crumpling, i.e. the more crumpled the beverage container is, the higher pressure is required in order to further crumple the beverage container. Initially, the crumple pressure will be very low, or even zero,

since the deformation will be elastic and thereby have a linear relationship with the applied force. However, when only 5% of the original volume remains, the applied force is very high and additional deformation will require even higher force since the deformation may be permanent, i.e. a plastic deformation The crumpling pressure thus typically is exponentially dependent on the dispensed volume of beverage Thus, the collapsible beverage container is typically made using such material, volume and wall thickness such that when only 5% of the volume remains, i.e. the crumpling pressure is in the range of 2-5 bar.

[0033] According to a further embodiment of the first aspect, when the interruption valve assuming the closed position, the beverage space has a volume of between 1 and 100 ml, preferably between 10 and 50 ml, such as 40 ml. In order to avoid gas entering the tapping line, at least a tiny amount of beverage should remain in the beverage container when the interruption valve assumes the closed position. However, too much beverage remaining in the beverage container would constitute a waste since such beverage will not be dispensed Thus, in order to have a safety margin in order to take into account the stochastic differences in the crumpling behavior of different collapsible beverage containers, it is preferred to allow about 40ml of beverage to remain in the the beverage container when the interruption valve assumes the closed position

[0034] According to a further embodiment of the first aspect, the collapsible beverage container is made of the flexible material constituting a thermoplastic material such as PET. PET is a suitable material since it is sufficiently flexible to be crumpled, it is suitable for food and beverage and it may be disposed of in an environmentally friendly way, e.g. by combustion or recycling.

[0035] The above object together with numerous other objects, which will be evident from the below detailed description, are according to a second aspect of the present invention obtained by a collapsible beverage container for use together with a beverage dispensing system, the beverage dispensing system comprising a pressure chamber for accommodating the collapsible beverage container, the pressure chamber being capable of maintaining a first elevated pressure within the pressure chamber, the collapsible beverage container being made of a flexible material and including a beverage space consisting of carbonated beverage and a head space consisting of gas, the first elevated pressure acting on the collapsible beverage container for crumpling the collapsible beverage container at a container crumpling pressure and establishing a second elevated pressure within the collapsible beverage container, the first elevated pressure being equal to the sum of the second elevated pressure and the container crumpling pressure, the collapsible beverage container including an interruption valve defining an open position and a closed position, the open position allowing carbonated beverage to flow out from beverage space when the pressure chamber is pressurized, the closed position preventing carbonated beverage to flow out from the beverage space, the interruption valve assuming the open position when the second elevated pressure exceeds a specific non-zero pressure reference, the interruption valve assuming the closed position when the second elevated pressure falls below the specific non-zero pressure reference.

[0036] The collapsible beverage container according to the second aspect includes the interruption valve. It is contemplated that the collapsible beverage container according to the second aspect, which includes the interruption valve, may be used together with any of the methods described above in connection with the first aspect.

[0037] The above object together with numerous other objects, which will be evident from the below detailed description, are according to a third aspect of the present invention obtained by a beverage dispensing system comprising:

a pressure chamber for accommodating a collapsible beverage container made of a flexible material, the collapsible beverage container including a beverage space consisting of carbonated beverage and a head space consisting of gas, the pressure chamber being capable of maintaining a first elevated pressure within the pressure chamber, the first elevated pressure acting on the collapsible beverage container for crumpling the collapsible beverage container at a container crumpling pressure and establishing a second elevated pressure within the collapsible beverage container, the first elevated pressure being equal to the sum of the second elevated pressure and the container crumpling pressure,

a dispensing device including a tapping valve and defining a beverage dispensing position and a non-beverage dispensing position, and

a tapping line interconnecting the collapsible beverage container within the pressure chamber and the dispensing device, the tapping line including an interruption valve defining an open position and a closed position, the open position allowing carbonated beverage to flow from the beverage space to the dispensing device when the pressure chamber is pressurized, the closed position preventing carbonated beverage to flow from the beverage space to the dispensing device, the interruption valve assuming the open position when the second elevated pressure exceeds a specific non-zero pressure reference, the interruption valve assuming the closed position when the second elevated pressure falls below the specific non-zero pressure reference

[0038] The beverage dispensing system according to the third aspect includes the interruption valve in the tapping line. It is contemplated that the beverage dispensing system according to the third aspect may be used together with any of the methods described above in connection with the first aspect. The beverage dispensing system according to

the third aspect constitutes an alternative solution to the collapsible beverage container according to the second aspect.

[0039] The above object together with numerous other objects, which will be evident from the below detailed description, are according to a fourth aspect of the present invention obtained by a beverage dispensing system comprising:

a pressure chamber for accommodating a collapsible beverage container made of a flexible material, the collapsible beverage container including a beverage space consisting of carbonated beverage and a head space consisting of gas, the pressure chamber being capable of maintaining a first elevated pressure within the pressure chamber, the first elevated pressure acting on the collapsible beverage container for crumpling the collapsible beverage container at a container crumpling pressure and establishing a second elevated pressure within the collapsible beverage container, the first elevated pressure being equal to the sum of the second elevated pressure and the container crumpling pressure,

a dispensing device including a tapping valve and defining a beverage dispensing position and a non-beverage dispensing position, the dispensing device including an interruption valve defining an open position and a closed position, the open position allowing carbonated beverage to flow from the beverage space to the dispensing device when the pressure chamber is pressurized, the closed position preventing carbonated beverage to flow from the beverage space to the dispensing device, the interruption valve assuming the open position when the second elevated pressure exceeds a specific non-zero pressure reference, the interruption valve assuming the closed position when the second elevated pressure falls below the specific non-zero pressure reference, and

a tapping line interconnecting the collapsible beverage container within the pressure chamber and the dispensing device.

[0040] The beverage dispensing system according to the fourth aspect includes the interruption valve in the dispensing device. It is contemplated that the beverage dispensing system according to the fourth aspect may be used together with any of the methods described above in connection with the first aspect. The beverage dispensing system according to the fourth aspect constitutes an alternative solution to the collapsible beverage container according to the second aspect and to the beverage dispensing system according to the third aspect.

Brief description of the drawings

[0041]

Fig 1 is a perspective view of a modular beverage dispensing system
Fig 2 is a perspective view of a beverage dispensing system having an interruption valve in the tapping line
Fig 3 is a cut-out view of an interruption valve employing a sealed gas volume
Fig 4 is a cut-out view of a an interruption valve employing a loaded spring
Fig 5 is a cut-out view of an interruption valve employing a pressure probe and an electromagnetic valve
Fig 6 is a cut-out view of an interruption valve employing a pressure reduction valve and a fluid connection to the pressure chamber
Fig 7 is a cut-out view of a collapsible beverage container having an interruption valve
Fig 8 is a cut-out view of an alternative beverage dispensing system having an interruption valve in the tapping line
Fig 9 is a perspective view of a tapping device having an interruption valve
Fig 10 is a plot showing the container crumpling pressure as a function of the volume of the dispensed beverage from the colapsible beverage container
Fig 11 is a plot showing the results of a proof of concept experiment conducted by the applicant

Detailed description of the drawings

[0042] Fig 1 shows a perspective view of an embodiment of a modular beverage distribution system 10 for use with a discharge valve as shown in figs. 6-7 of the international application WO 2009/024147. The modular beverage distribution system 8' comprises three modules 12a, 12b, 12c, each mounted to a bottom wall 14 and a rear wall 16 constituting a frame. The bottom wall 14 rests on a mounting rack 19. The three modules 28', 30', 32' are mounted in series on the mounting rack 19.

[0043] Each of the modules 12a, 12b, 12c, is connected to a tapping line 18 and a gas supply line 20. An optional rinsing line may be available as described in more detail in the above mentioned WO 2009/024147. The tapping line 18 and the gas supply line 20 are mounted near the bottom wall 61" of each module. Each module 12a, 12b, 12c comprises for each of the above mentioned lines 18 20 an inlet constituting a first type connector, an outlet constituting a second type connector and a branch pipe constituting a third type connector. The branch pipe leads to the discharge valve of each module. The outlets of the first module 12a are directly connected to the inlets of the second module 12b and the

outlets of the second module 12b are directly connected to the inlets of the third module 12c.

[0044] The gas supply line 20 is connected directly to a pressure generator 22. The gas supply line 20 is further connected to a pressure chamber 24 of the beverage dispensing module 12a via a security valve (not shown). The gas supply line 20 is connected to a pressure inlet 26 of the beverage dispensing module 12b via a pressure outlet 28. The fluid path 47' may also provide driving pressure to the discharge valve which is discussed in fig 2. The pressure outlet 48' of the last beverage dispensing module 12c is left without connection but has a check valve to avoid pressure fluid escaping.

[0045] The tapping line inlet 30 of the beverage dispensing module 12a is left without connection, however a check valve is provided to prevent beverage to flow out. The tapping line inlet 30 of the first module 12a is connected to the tapping line 18, which is connected to a tapping line inlet 30' of the beverage dispensing module 12b via the tapping line outlet 32 of the beverage dispensing module 12a. The tapping line outlet 32' of the beverage dispensing module 12b is similarly connected to a tapping line inlet 30" of the beverage dispensing module 12c. The tapping line outlet 32' of the tapping line 18 of the beverage dispensing module 12c is connected via a cooling system 34 to a dispensing device (not shown). The tapping line 18 is connected to a discharge valve of each beverage dispensing module 12a, 12b, 12c, as shown in fig 2.

[0046] Fig 2a shows a beverage dispensing system 12 which may be part of a modular beverage dispensing system as shown in connection with fig 1, however, it may as well be part of a stand-alone beverage dispensing system. The beverage dispensing system 12 comprises a pressure chamber 12 for accommodating a collapsible beverage container and a pressure lid 36 for allowing access to the pressure chamber 24. The pressure chamber is connected to a tapping line 18 The tapping line 18 comprise a discharge valve 38 and an interruption valve 40.

[0047] Fig 2b shows a close up view of the lower part of the beverage dispensing system 12 including the optional discharge valve 38. The discharge valve 38 comprises a rod or piston 42, which is located inside a coupling housing 44 and which is adapted to act on a closure element 46 of the collapsible beverage container 48 included in the pressure chamber The closure element 46, which is optional, is in the present embodiment not a part of the coupling housing 44, but part of the collapsible beverage container 48. The discharge valve 38 is operable between three possible positions, which constitute a first position, an opposite second position and an intermediate position. As will be described in greater detail below, the intermediate position constitutes the beverage dispensing position, whereas the first and second positions constitute an optional rinsing position and the closed position, respectively.

[0048] The closure element 46 is located in a specific space in the collapsible beverage container 48 between an inlet constriction and an outlet constriction. The inlet constriction and the outlet constriction both provide openings or apertures for allowing beverage to flow from the collapsible beverage container 48. Both the inlet constriction and the outlet constriction constitute valve seats, which the closure element 46 may seal against. The closure element 46 will either establish a seal against the inlet constriction or the outlet constriction, or remain in the intermediate position, shown in which constitutes the beverage dispensing position.

[0049] When the rod or piston 42 is in the beverage dispensing position, i.e. in the active or intermediate position, the closure element 46 is located in the intermediate position between the inlet constriction and the outlet constriction as the bottom end of the closure element 46 is resting on a top surface of the coupling housing sealing gasket 50 which, as is evident from fig 2B, seals against the bottom surface of the collapsible beverage container 48 In the intermediate position shown in fig 2B, the rod or piston 42 is in a lower position, in which the rod or piston is disengaged from contact with the coupling housing sealing gasket 50 allowing free passage through the coupling housing sealing gasket 50. Consequently, the beverage may flow from the beverage container 48 past the closure element 46 and through the coupling housing sealing gasket 50, and the interior of the coupling housing 44, to the tapping line 18.

[0050] When the coupling housing 44, and thereby also the rod or piston 42, is separated from the beverage container 48, the beverage, indicated by the signature of "circles" in the figure, will exert a force on the closure element 46 pushing the closure element 46 against the outlet constriction defining the closed position, i.e. the second passive position, thereby sealing off the beverage container 48.

[0051] The beverage container 168 is fitted with the base part 186 and the connector component 202, wherein the top part of the discharge valve 72 is received. The closure element 46, the inlet constriction and the outlet constriction are components of the beverage container 48. From the beverage dispensing position shown in fig 2B, the rod or piston 42 may be shifted towards the beverage container 48, or alternatively towards the tapping line 18.

[0052] The pressure chamber may be pressurized only when beverage dispensing is allowed, i.e. when a beverage container 48 has been installed and the pressure chamber has been swung into vertical orientation. Consequently, the pressure inside the pressure chamber may be used for holding the rod or piston 42 in the beverage dispensing position shown in fig 2B. In the following, it is assumed that the closure element 46 is located in the intermediate position, i.e. allowing beverage to pass.

[0053] Fig 2C shows a close-up view of the interruption valve 40. The interruption valve 40, which forms part of the tapping line, comprises an inlet section 52 and an outlet section 54. In-between the inlet section 52 and the outlet section 54, a valve plate 56 is located. When the interruption valve 40 is in the closed position as shown in fig 2C, the valve

plate bears against a valve seat 58, which forms part of the inlet section 52 in order to completely seal off the inlet section 52.

[0054] Fig 3A shows an interruption valve 40 employing a sealed gas volume 60. The interruption valve 40 is in the closed position. The sealed gas volume 60 has a predetermined pressure and communicates with the valve plate 56 via a sealed bellows 62 such that the valve plate 56 applies a specific non-zero pressure force against the valve seat 58.

[0055] Fig 3B shows an interruption valve 40 employing a sealed gas volume 60. The interruption valve 40 is in the open position. When the pressure in the inlet section 52, which is considered to correspond to the pressure in the collapsible beverage container, exceeds the pressure in the sealed gas volume 60, the valve plate 56 will move away from the valve seat 58 and allow beverage to pass from the inlet section 52 to the outlet section 54. When the pressure in the inlet section 52 again falls below the pressure in the sealed gas volume 60, the valve plate 56 will move towards the valve seat 58 and effectively prevent beverage to pass from the inlet section 52 to the outlet section 54.

[0056] Fig 4A shows an interruption valve 40' employing a spring 63. The interruption valve 40' is in the closed position. The spring 63 has a predetermined spring constant and pre-load force and is mechanically connected to the valve plate 56 such that the valve plate 56 applies a specific non-zero pressure force against the valve seat 58.

[0057] Fig 4B shows an interruption valve 40' employing a spring 63 The interruption valve 40' is in the open position. When the pressure in the inlet section 52, which is considered to correspond to the pressure in the collapsible beverage container, exhibits a pressure force onto the valve plate 56 which exceeds the pre-load force of the spring 63, the valve plate 56 will move away from the valve seat 58 and allow beverage to pass from the inlet section 52 to the outlet section 54. When the pressure in the inlet section 52 again exhibits a pressure force onto the valve plate 56, which falls below the pre-load force of the spring 63, the valve plate 56 will move towards the valve seat 58 and effectively prevent beverage to pass from the inlet section 52 to the outlet section 54.

[0058] Fig 5A shows an interruption valve 40" employing an electromechanical actuator 64. The interruption valve 40" is in the closed position. The electromechanical actuator 64 is mechanically connected to the valve plate 56 and applies a sufficiently high pressure force against the valve seat 58 such that no beverage may pass. A pressure probe 66 is located in the inlet section 52 and measures the pressure of the beverage in the inlet section 56, which is considered to correspond to the pressure in the collapsible beverage container. The pressure is constantly evaluated by a control unit 68 and compared the specific non-zero pressure reference.

[0059] Fig 5B shows an interruption valve 40" employing an electromechanical actuator 64. The interruption valve 40" is in the open position. When the pressure measured by the pressure probe in the inlet section 52 exceeds the specific non-zero reference value, the control unit 68 will send a signal to the electromagnetic actuator for the valve plate 56 to move away from the valve seat 58 and allow beverage to pass from the inlet section 52 to the outlet section 54. When the pressure in the inlet section 52, measured by the pressure probe 66, again falls below the specific non-zero reference value, the electromagnetic actuator 64 will again make the valve plate 56 move towards the valve seat 58 and effectively prevent beverage to pass from the inlet section 52 to the outlet section 54. It is contemplated that the control unit may modify the specific non-zero reference value depending on the collapsible beverage container used and on the pressure in the pressure chamber.

[0060] Fig 6A shows an interruption valve 40'" employing a gas volume 70 similar to the embodiment shown in connection with fig 3. The interruption valve 40'" is in the closed position. The gas volume 70 communicates with the valve plate 56 via a sealed bellows 62, but distinguishes from the embodiment shown in connection with fig 3 in that the gas volume 70 is not sealed but connected via a pressure line 72 and a pressure reduction valve 74 to the pressure chamber, such that the valve plate 56 applies a specific non-zero pressure force, which is dependent on the pressure in the pressure chamber, against the valve seat 58.

[0061] Fig 6B shows an interruption valve 40'" employing a gas volume 70. The interruption valve 40'" is in the open position. When the pressure in the inlet section 52, which is considered to correspond to the pressure in the collapsible beverage container, exceeds the pressure in the gas volume 70, the valve plate 56 will move away from the valve seat 58 and allow beverage to pass from the inlet section 52 to the outlet section 54. When the pressure in the inlet section 52 again falls below the pressure in the gas volume 70, the valve plate 56 will move towards the valve seat 58 and effectively prevent beverage to pass from the inlet section 52 to the outlet section 54. In this way the specific non-zero pressure reference may be modified depending on the pressure in the pressure chamber in order to establish an optimal closing occasion independent on the pressure in the pressure chamber

[0062] Fig 7 shows a collapsible beverage container 48' having an interruption valve 40"" and being mounted on a discharge valve 38 as described in fig 2. The collapsible beverage container 48 is located within a pressure chamber The interruption valve 40"" is similar to the valve described in connection with figs 2C and 3. The interruption valve 40"", which forms part of the collapsible beverage container 48', comprise a valve plate 56'. When the interruption valve 40"" is in the closed position, the valve plate bears against a valve seat 58' in order to completely seal off the collapsible beverage container 48'. The sealed gas volume 60' has a predetermined pressure and communicates with the valve plate 56' via a sealed bellows 62' such that the valve plate 56' applies a specific non-zero pressure force against the valve seat 58. When the pressure in the collapsible beverage container 48' exceeds the pressure in the sealed gas volume 60', the valve plate 56' will move away from the valve seat 58' and allow beverage to pass. When the pressure

in the collapsible beverage container 48' again falls below the pressure in the sealed gas volume 60', the valve plate 56' will move towards the valve seat 58' and effectively prevent beverage to pass.

[0063] Fig 8 shows an alternative beverage dispensing system 12' having an interruption valve 40 in the tapping line 18 similar to the embodiment shown in connection with fig 2. However, the discharge valve has been omitted such that a straight passage is achieved from the beverage container 48 through the tapping line 18, except for the provision of the interruption valve 40. It is understood that the interruption valve 40 may be located in the tapping line 18 as indicated in the figure or alternatively the interruption valve 40 may be located in the beverage container 48 as indicated in fig 7.

[0064] Fig 9 shows a modular beverage dispensing system 10' including beverage dispensing modules 12 and a dispensing device 76. The dispensing device includes a bar counter 78 and a number of beverage taps 80, each including a tapping valve (not shown) and a tapping handle. The beverage dispensing operations are controlled by the tapping handle The tapping lines 18 lead via a cooling system 34 to the taps 80. Each tapping line 18 is provided with an interruption valve 40'"", which may be included in the respective tap 80 or located adjacent the tap 80. The interruption valve 40'"" may resemble any of the interruption valves shown in figs 3-6. A non-return valve 79 may be installed in the tapping line 18 in order to avoid a return flow of beverage to the pressure chamber when exchanging beverage container.

[0065] Fig 10 shows a plot of pressure versus volume of the dispensed beverage from the collapsible beverage container. The curve 82 illustrates a constant first elevated pressure corresponding to the pressure in the pressure chamber. The curve 84 (dashed) illustrates the container crumpling pressure of the collapsible beverage container, i.e. the pressure required to crumple the beverage container, as a function of the volume of the dispensed beverage. When no or only very little beverage has been dispensed, the crumpling pressure is substantially constant When a significant amount of beverage has been dispensed, the crumpling pressure increases exponentially The curve 86 illustrates the second elevated pressure within the collapsible beverage container as a function of the volume of the dispensed beverage.

[0066] As the crumpling pressure increases, the second elevated pressure decreases, as the sum of the crumpling pressure 84 and the second elevated pressure 86 is equal to the first elevated pressure 82. The curve 88 illustrates the specific non-zero pressure reference. When the second elevated pressure 86 falls below the specific non-zero pressure reference 88, the interruption valve closes and the beverage dispensing is interrupted This position is indicated by a circle.

[0067] Fig 11 shows a plot of a proof-of concept experiment performed by the applicant. The curve 90 illustrates the pressure in the collapsible beverage container, i.e. the second elevated pressure, as a function of time during a number of dispensing operations using a constant pressure in the pressure chamber, i.e. the first elevated pressure, of 3 5 bar. The beverage dispensing operations are begun at time α_1 when the dispensing device is switched from the non-beverage dispensing position to the beverage dispensing position. The beverage dispensing yields a relative pressure drop of about 1 bar. At time β_1 the dispensing device is switched back from the beverage dispensing position to the non-beverage dispensing position, thereby closing the tapping valve. This results in a shock wave and pressures up to 4,5 bar, however, the pressures quickly sink towards the initial pressure of about 3,5 bar. Further, similar beverage dispensing operations are performed at times α_2, β_2, α_3 and β_3. At time β_3, the crumpling pressure has increased such that the second elevated pressure no longer reaches the initial pressure of 3,5 bar, but just 2,5 bar. At time α_4, the dispensing device is again switched from the beverage dispensing position to the non-beverage dispensing position resulting in a constant pressure drop from 2,5 bar to 0,5 bar, at which time the interruption valve closes and beverage dispensing is finally interrupted.

List of parts with reference to the figures

[0068]

10 Modular beverage dispensing system	52. Inlet section
12. Beverage dispensing system (module)	54. Outlet section
14. Bottom wall	56. Valve plate
16. Rear wall	58 Valve seat
18. Tapping line	60 Sealed gas volume
19. Mounting rack	62. Bellows
20. Gas supply line	63. Spring
22 Pressure generator	64. Electromagnetic actuator
24. Pressure chamber	66. Pressure probe
26. Pressure inlet	68. Control unit
28. Pressure outlet	70. Gas volume

(continued)

30. Tapping line inlet	72. Pressure line
32. Tapping line outlet	74 Pressure reduction valve
34. Cooling system	76. Dispensing device
36. Pressure lid	78. Bar counter
38. Discharge valve	79. Non-return valve
40 Interruption valve	80. Beverage taps
42. Rod	82. First elevated pressure
44. Coupling mechanism	84. Container crumple pressure
46. Closure element	86. Second pressure
48. Collapsible beverage container	88. Specific non-zero pressure reference
50. Sealing gasket	90. Curve

Claims

1. A method of dispensing carbonated beverage, said method comprising the steps of:

providing a beverage dispensing system, said beverage dispensing system comprising a pressure chamber, said pressure chamber accommodating a collapsible beverage container made of a flexible material, said collapsible beverage container including a beverage space consisting of carbonated beverage and a head space consisting of gas, a dispensing device including a tapping valve and defining a beverage dispensing position and a non-beverage dispensing position, a tapping line interconnecting said collapsible beverage container within said pressure chamber and said dispensing device, and an interruption valve defining an open position and a closed position, said open position allowing carbonated beverage to flow from said beverage space to said dispensing device when said pressure chamber is pressurized, said closed position preventing carbonated beverage to flow from said beverage space to said dispensing device,
maintaining a first elevated pressure within said pressure chamber, said first elevated pressure acting on said collapsible beverage container for crumpling said collapsible beverage container at a container crumpling pressure and establishing a second elevated pressure within said collapsible beverage container, said first elevated pressure being equal to the sum of said second elevated pressure and said container crumpling pressure, said interruption valve assuming said open position when said second elevated pressure exceeds a specific non-zero pressure reference, said interruption valve assuming said closed position when said second elevated pressure falls below said specific non-zero pressure reference, and
operating said dispensing device from said non-beverage dispensing position to said beverage dispensing position for causing said carbonated beverage to be dispensed at said dispensing device and said collapsible beverage container to crumple, provided said interruption valve assuming said open position.

2. The method according to claim 1, wherein said interruption valve is located in said collapsible beverage container, said tapping line or said dispensing device.

3. The method according to any of the preceding claims, wherein said interruption valve employs a loaded spring or a sealed pressurized gas volume in order to establish said specific non-zero pressure reference.

4. The method according to any of the claims 1-3, wherein said interruption valve is fluidly connected to said first elevated pressure of said pressure chamber via a pressure regulator for establishing said specific non-zero pressure reference

5. The method according to any of the claims 1-3, wherein said interruption valve includes a pressure probe for determining said second elevated pressure and an electromagnetic valve for assuming said open and closed positions, respectively, dependent on said second elevated pressure.

6. The method according to any of the preceding claims, wherein said first elevated pressure being in the range of 2-5 bar above atmospheric pressure, preferably 3-4 bar above atmospheric pressure,

7. The method according to any of the preceding claims, wherein said second elevated pressure being in the range of 1-4 bar above atmospheric pressure, preferably 2-3 bar above atmospheric pressure.

8. The method according to any of the preceding claims, wherein said beverage container is positioned in an upside down orientation within said pressure space such that the beverage space is located adjacent the tapping line and the head space is located spaced apart from the tapping line.

9. The method according to any of the preceding claims, wherein said specific non-zero pressure reference is in the range of 0.1-3 bar, preferably 0.5-1 bar, absolute pressure.

10. The method according to any of the preceding claims, wherein said crumpling pressure being dependent on the level of crumpling of said collapsible beverage container, said crumpling pressure being in the range of 0-1 bar absolute pressure when said beverage container being in an initial non-crumpled state whereas said crumpling pressure being in the range of 2-5 bar when said beverage container being in a crumpled state in which the volume of said beverage container is reduced to 5% of the volume of said beverage container in said initial non-crumpled state.

11. The method according to any of the preceding claims, wherein, when said interruption valve assuming said closed position, said beverage space has a volume of between 1 and 100 ml, preferably between 10 and 50 ml, such as 40 ml.

12. The method according to any of the preceding claims, wherein said collapsible beverage container is made of said flexible material constituting a thermoplastic material such as PET.

13. A collapsible beverage container for use together with a beverage dispensing system, said beverage dispensing system comprising a pressure chamber for accommodating said collapsible beverage container, said pressure chamber being capable of maintaining a first elevated pressure within said pressure chamber, said collapsible beverage container being made of a flexible material and including a beverage space consisting of carbonated beverage and a head space consisting of gas, said first elevated pressure acting on said collapsible beverage container for crumpling said collapsible beverage container at a container crumpling pressure and establishing a second elevated pressure within said collapsible beverage container, said first elevated pressure being equal to the sum of said second elevated pressure and said container crumpling pressure, said collapsible beverage container including an interruption valve defining an open position and a closed position, said open position allowing carbonated beverage to flow out from beverage space when said pressure chamber is pressurized, said closed position preventing carbonated beverage to flow out from said beverage space, said interruption valve assuming said open position when said second elevated pressure exceeds a specific non-zero pressure reference, said interruption valve assuming said closed position when said second elevated pressure falls below said specific non-zero pressure reference

14. A beverage dispensing system comprising:

a pressure chamber for accommodating a collapsible beverage container made of a flexible material, said collapsible beverage container including a beverage space consisting of carbonated beverage and a head space consisting of gas, said pressure chamber being capable of maintaining a first elevated pressure within said pressure chamber, said first elevated pressure acting on said collapsible beverage container for crumpling said collapsible beverage container at a container crumpling pressure and establishing a second elevated pressure within said collapsible beverage container, said first elevated pressure being equal to the sum of said second elevated pressure and said container crumpling pressure,
a dispensing device including a tapping valve and defining a beverage dispensing position and a non-beverage dispensing position, and
a tapping line interconnecting said collapsible beverage container within said pressure chamber and said dispensing device, said tapping line including an interruption valve defining an open position and a closed position, said open position allowing carbonated beverage to flow from said beverage space to said dispensing device when said pressure chamber is pressurized, said closed position preventing carbonated beverage to flow from said beverage space to said dispensing device, said interruption valve assuming said open position when said second elevated pressure exceeds a specific non-zero pressure reference, said interruption valve assuming said closed position when said second elevated pressure falls below said specific non-zero pressure reference.

15. A beverage dispensing system comprising:

a pressure chamber for accommodating a collapsible beverage container made of a flexible material, said collapsible beverage container including a beverage space consisting of carbonated beverage and a head space consisting of gas, said pressure chamber being capable of maintaining a first elevated pressure within said pressure chamber, said first elevated pressure acting on said collapsible beverage container for crumpling said collapsible beverage container at a container crumpling pressure and establishing a second elevated pressure within said collapsible beverage container, said first elevated pressure being equal to the sum of said second elevated pressure and said container crumpling pressure,

a dispensing device including a tapping valve and defining a beverage dispensing position and a non-beverage dispensing position, said dispensing device including an interruption valve defining an open position and a closed position, said open position allowing carbonated beverage to flow from said beverage space to said dispensing device when said pressure chamber is pressurized, said closed position preventing carbonated beverage to flow from said beverage space to said dispensing device, said interruption valve assuming said open position when said second elevated pressure exceeds a specific non-zero pressure reference, said interruption valve assuming said closed position when said second elevated pressure falls below said specific non-zero pressure reference, and

a tapping line interconnecting said collapsible beverage container within said pressure chamber and said dispensing device.

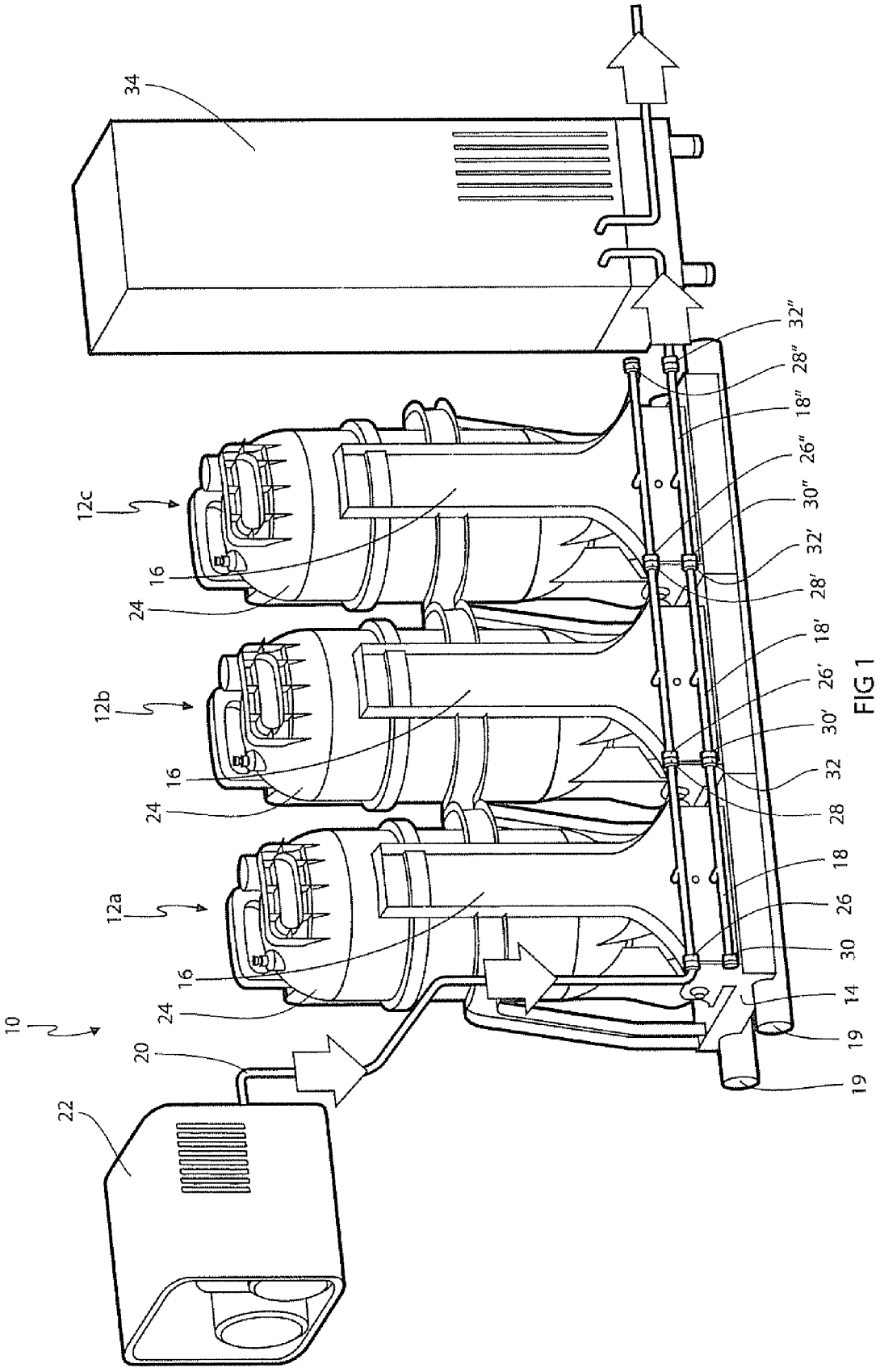
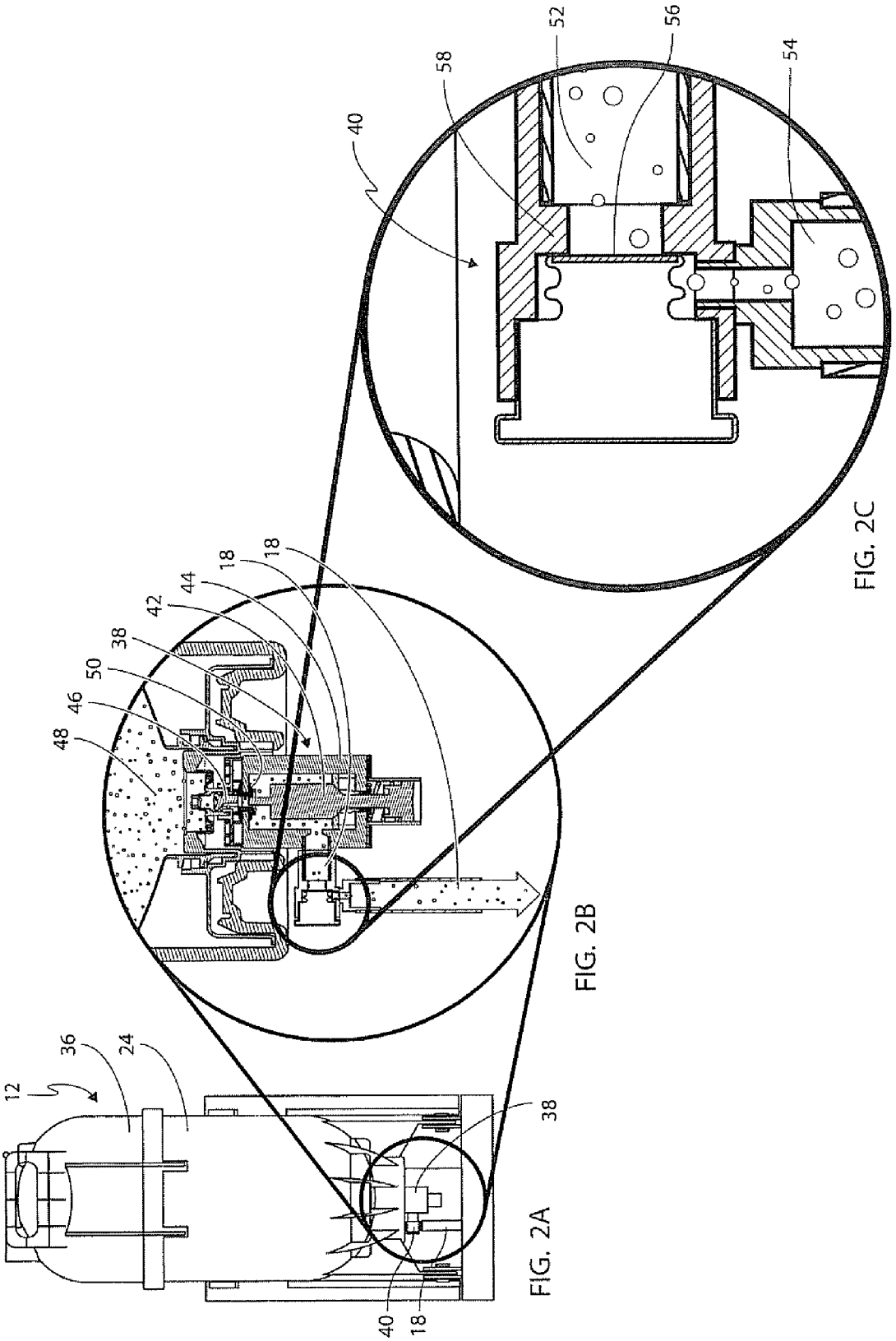

34
12c
12b
12a
10
16
24
20
22
32″
28″
18″
26″
30″
32′
28′
18′
26′
30′
32
28
18
26
30
14
19
19

FIG 1


12
36
24
38
40
18
FIG. 2A
18
44
42
38
50
46
48
FIG. 2B
52
56
58
54
40
FIG. 2C

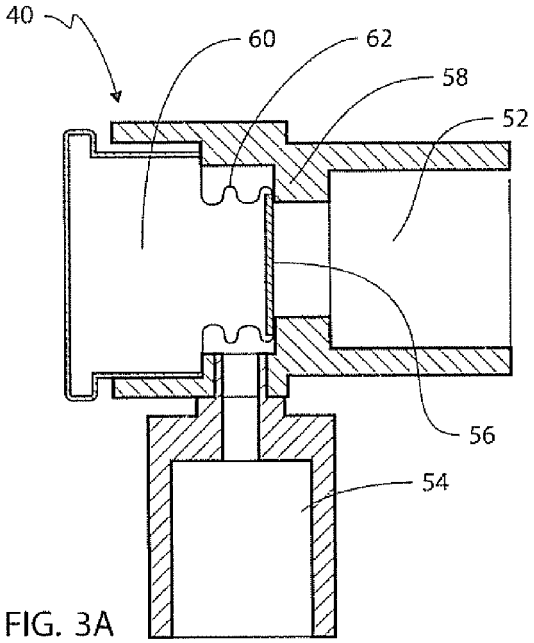


FIG. 3A

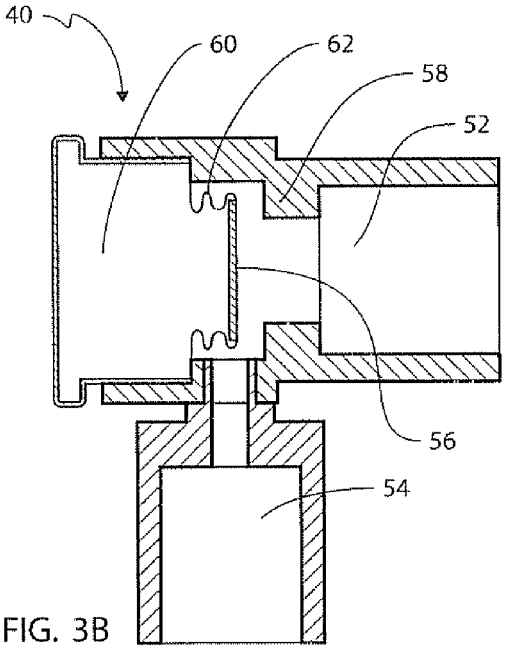


FIG. 3B

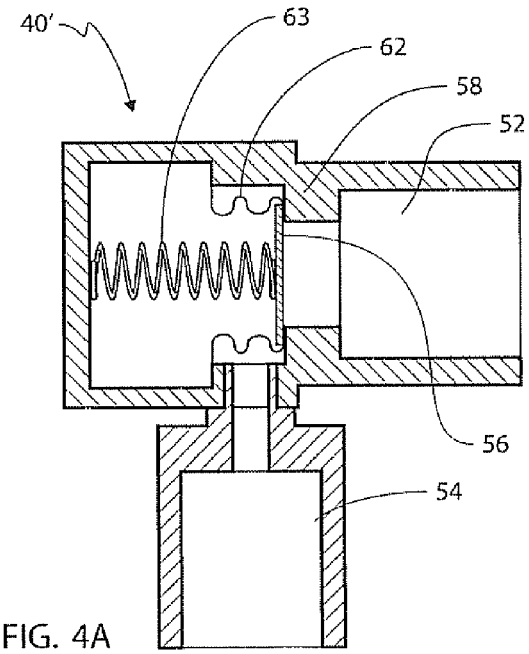


FIG. 4A

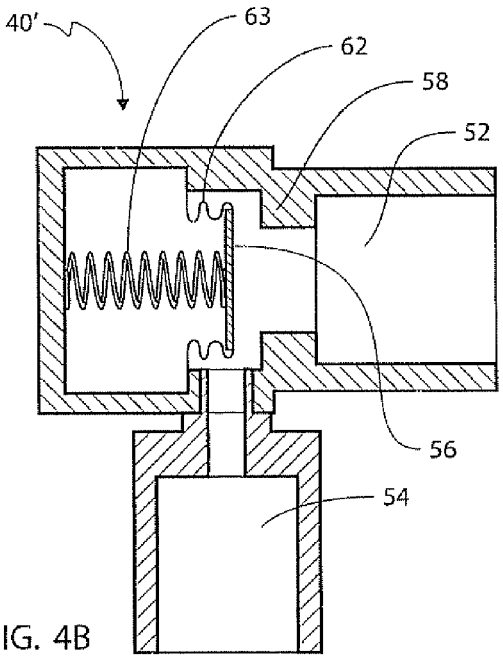


FIG. 4B

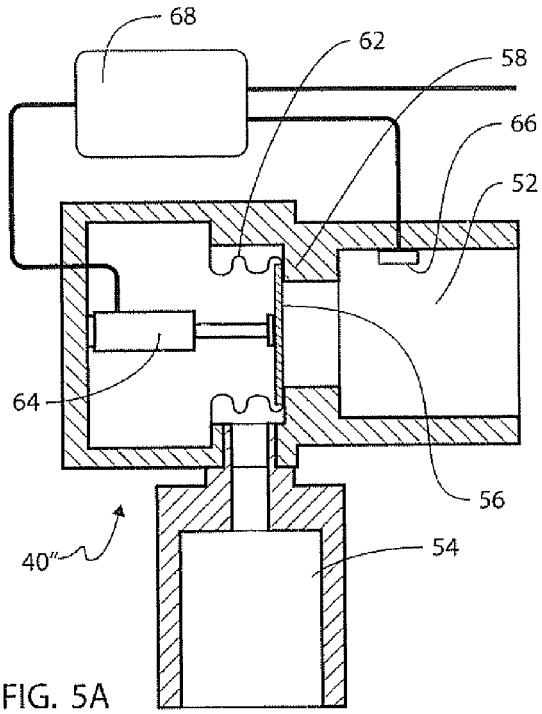


FIG. 5A

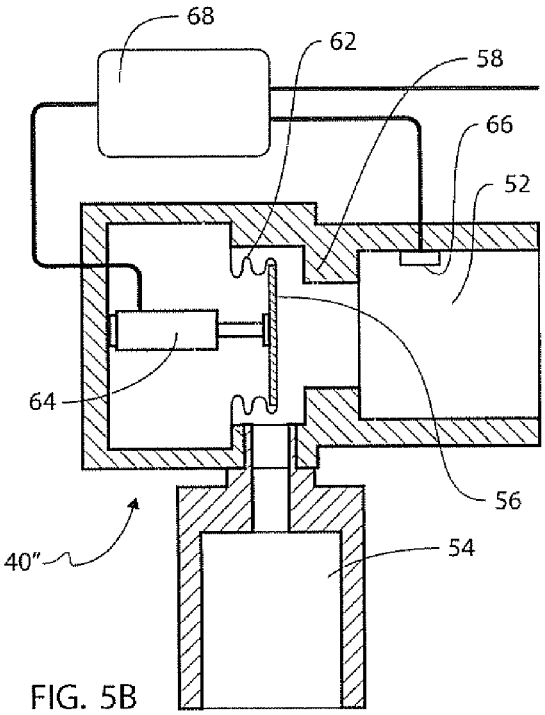


FIG. 5B

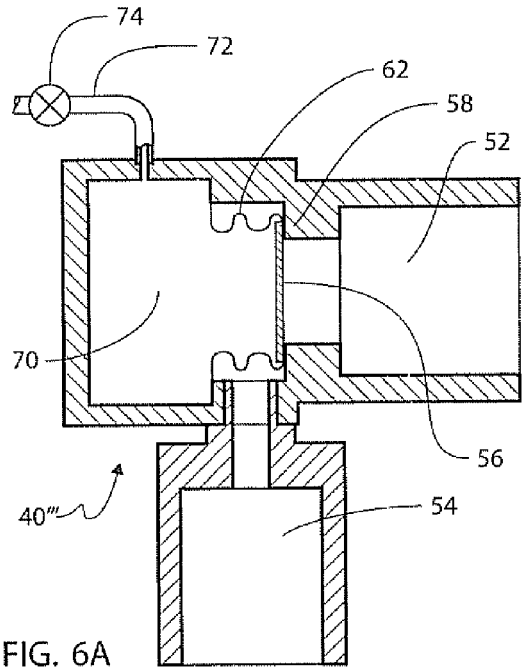


FIG. 6A

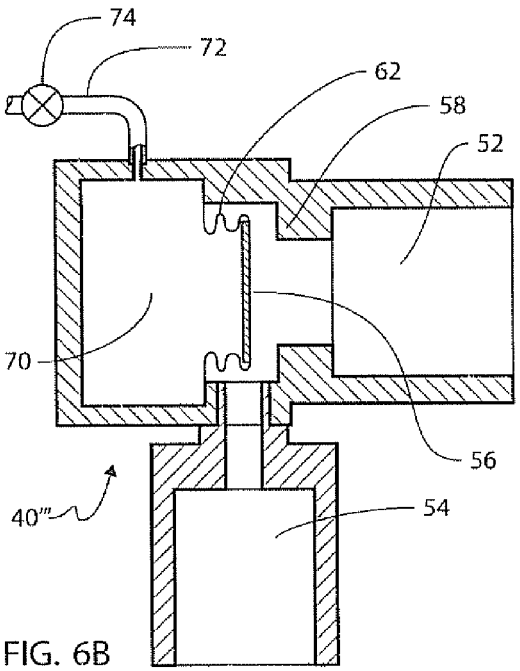


FIG. 6B

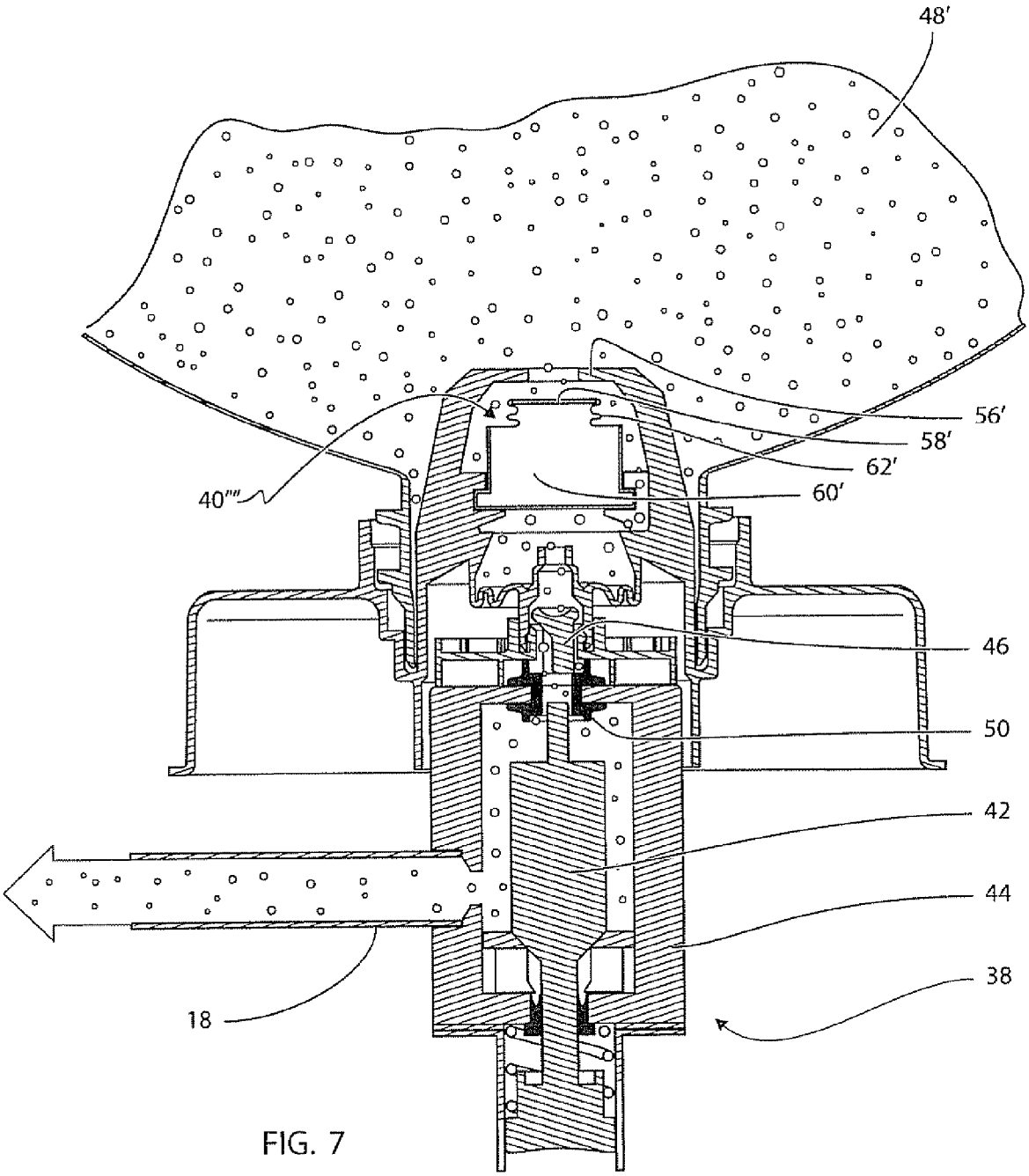


FIG. 7

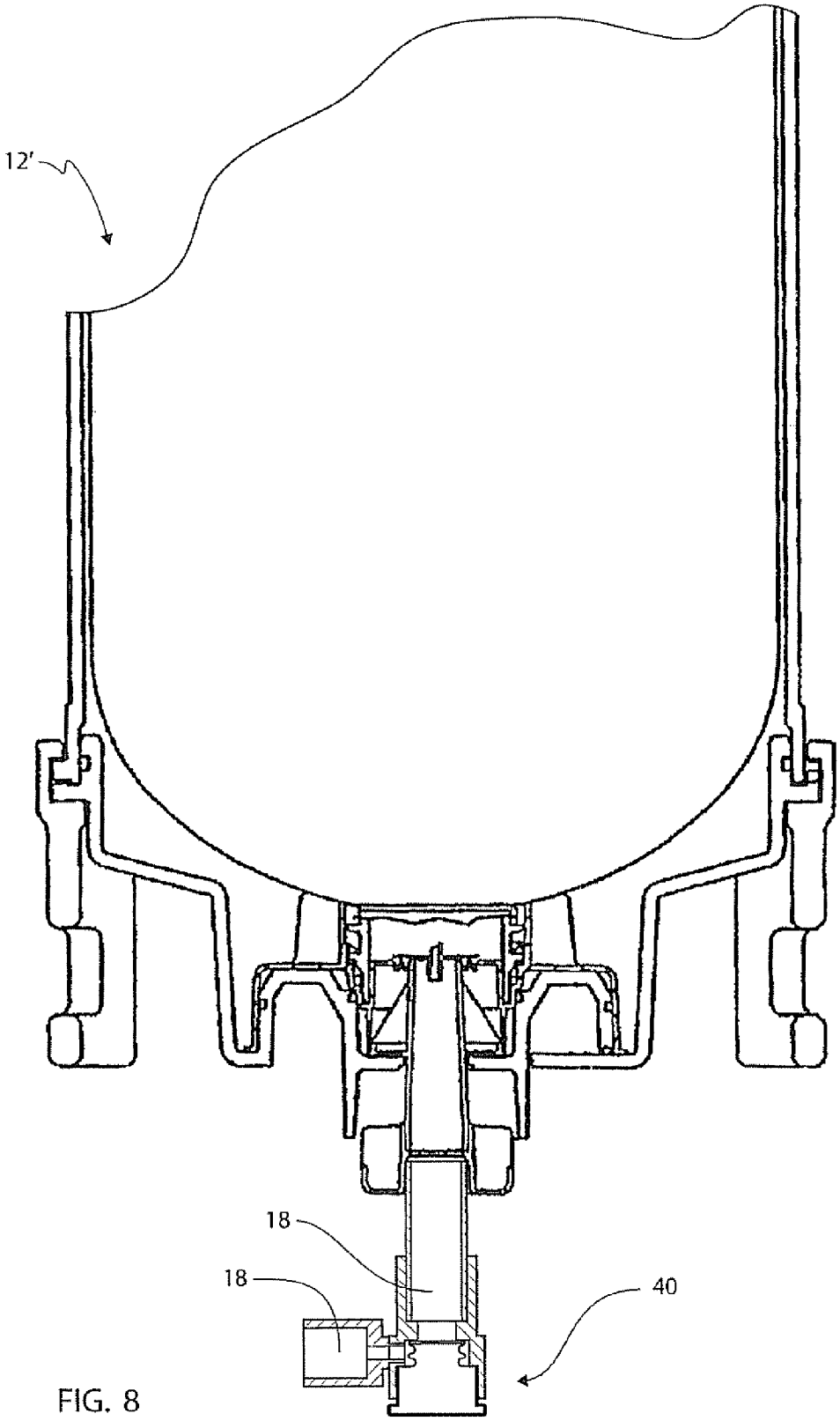


FIG. 8

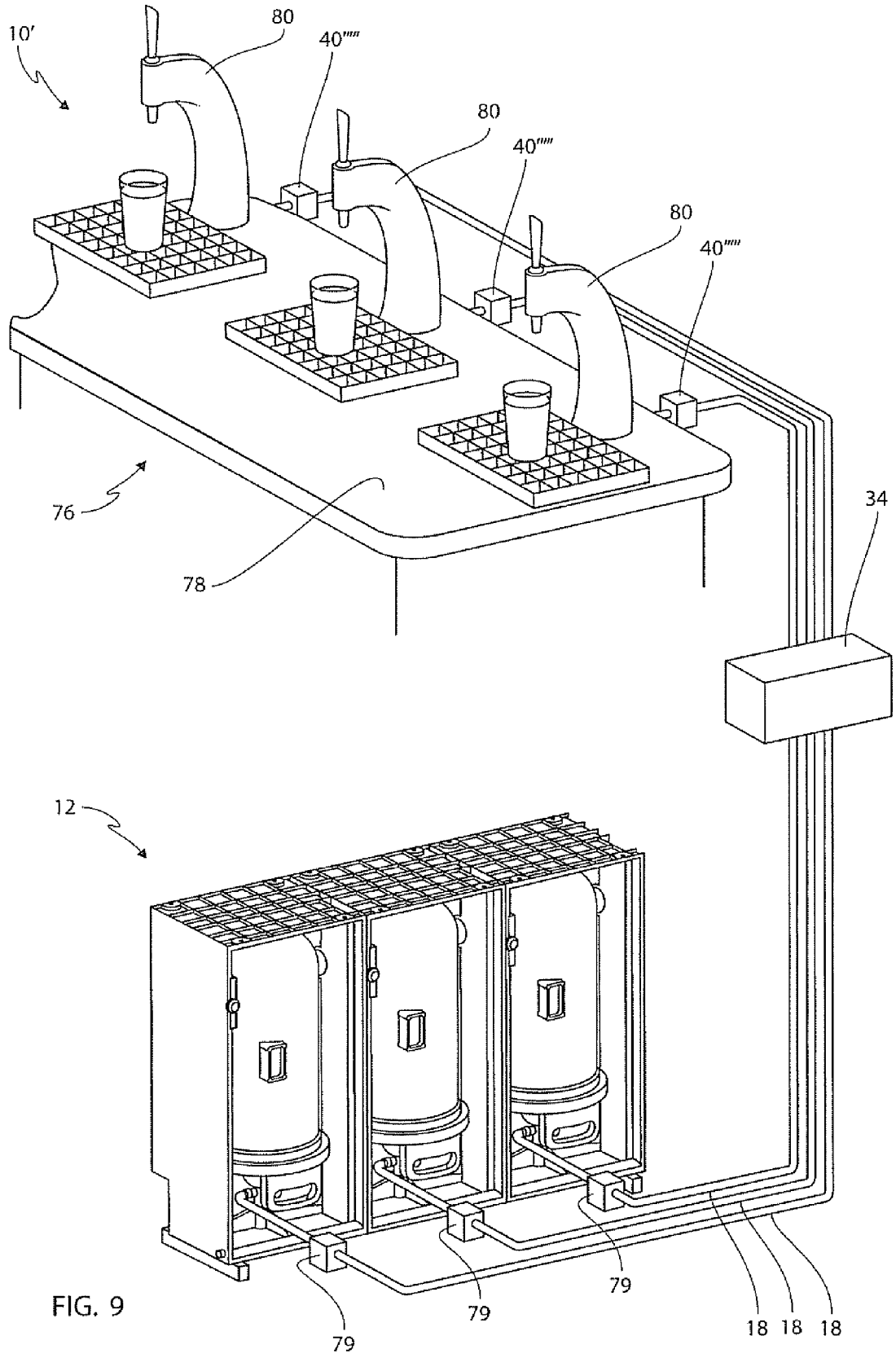


FIG. 9

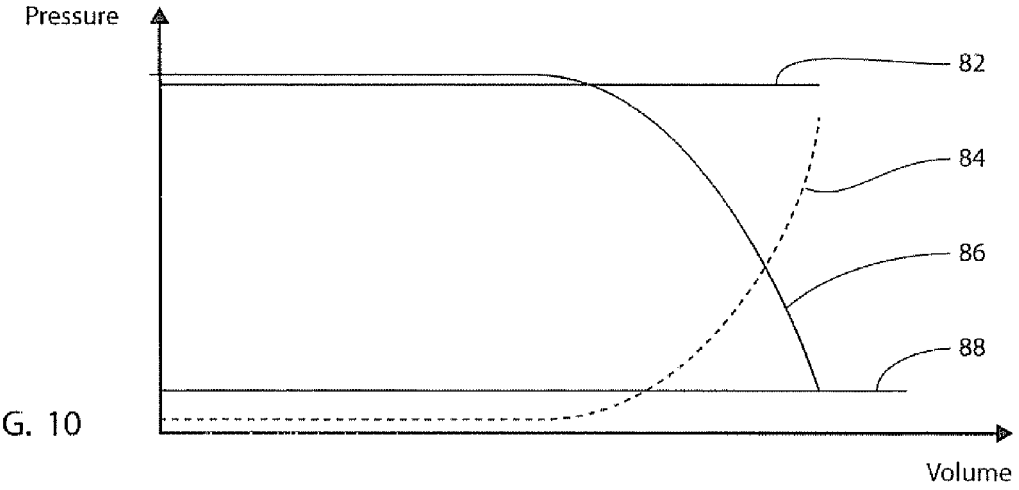

Pressure
82
84
86
88
Volume

FIG. 10

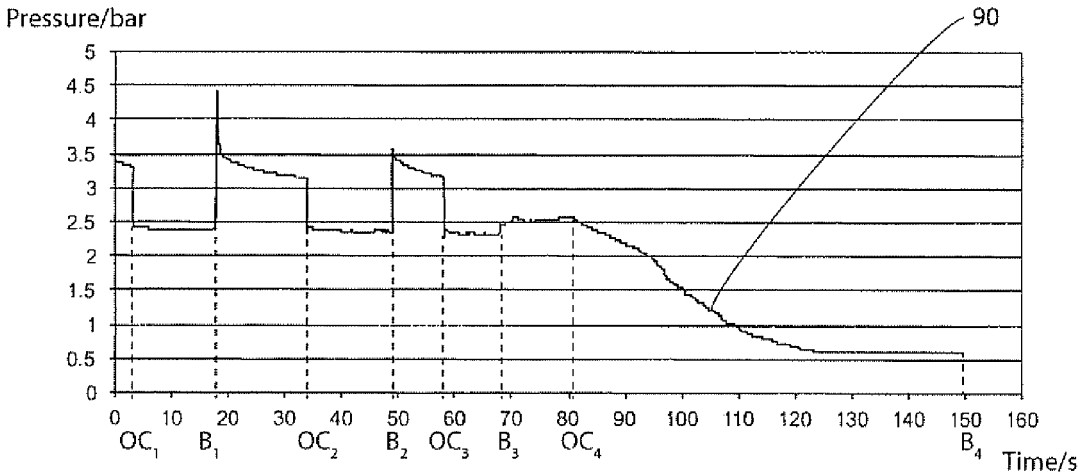

Pressure/bar
90
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
OC1 B1 OC2 B2 OC3 B3 OC4 B4
Time/s

FIG. 11

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 12 15 3871

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2009/024147 A2 (CARLSBERG BREWERIES AS [DK]; VESBORG STEEN [DK]; RASMUSSEN JAN NOERAGE) 26 February 2009 (2009-02-26) * page 20, line 8 - page 22, line 26; figures 6,7 *	13	INV. B67D1/00 B67D1/04 B67D1/08 B67D1/12
A	DE 27 36 281 A1 (BIER DRIVE AG) 22 February 1979 (1979-02-22) * claims 1-6 *	1-15	
A	WO 2011/002295 A1 (HEINEKEN SUPPLY CHAIN BV [NL]; WOLTHERS WOLTER [NL]) 6 January 2011 (2011-01-06) * abstract *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

B67D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 May 2012	Desittere, Michiel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

1 EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 15 3871

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

15-05-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2009024147 A2	26-02-2009	AT 537108 T	15-12-2011
		AU 2008290973 A1	26-02-2009
		CA 2697308 A1	26-02-2009
		CN 101827779 A	08-09-2010
		DK 2181063 T3	02-04-2012
		EA 201070280 A1	30-08-2010
		EP 2181063 A2	05-05-2010
		EP 2444366 A2	25-04-2012
		JP 2010536669 A	02-12-2010
		PT 2181063 E	23-03-2012
		US 2010276452 A1	04-11-2010
		WO 2009024147 A2	26-02-2009
DE 2736281 A1	22-02-1979	DD 137572 A5	12-09-1979
		DE 2736281 A1	22-02-1979
		EP 0006887 A1	23-01-1980
		JP 54030527 A	07-03-1979
		MX 146950 A	14-09-1982
		NL 7808285 A	13-02-1979
		WO 7900091 A1	08-03-1979
WO 2011002295 A1	06-01-2011	AR 077634 A1	14-09-2011
		CA 2767155 A1	06-01-2011
		EP 2448858 A1	09-05-2012
		TW 201105567 A	16-02-2011
		WO 2011002295 A1	06-01-2011

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2007019848 A **[0003]**
- WO 2009024147 A **[0004] [0042] [0043]**
- WO 2010029122 A **[0005]**
- WO 2010060946 A **[0006]**
- WO 2011117192 A **[0006]**
- WO 2010060949 A **[0007]**
- WO 2010020644 A **[0008]**
- DE 29604703 U1 **[0009]**