

FIG. 1

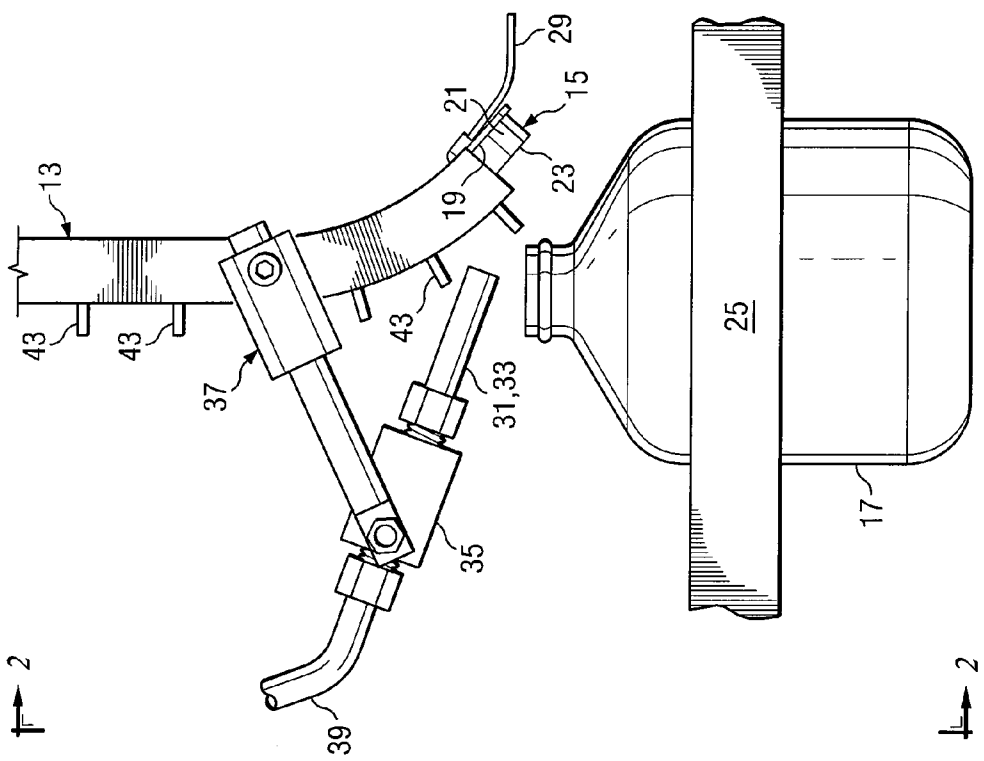
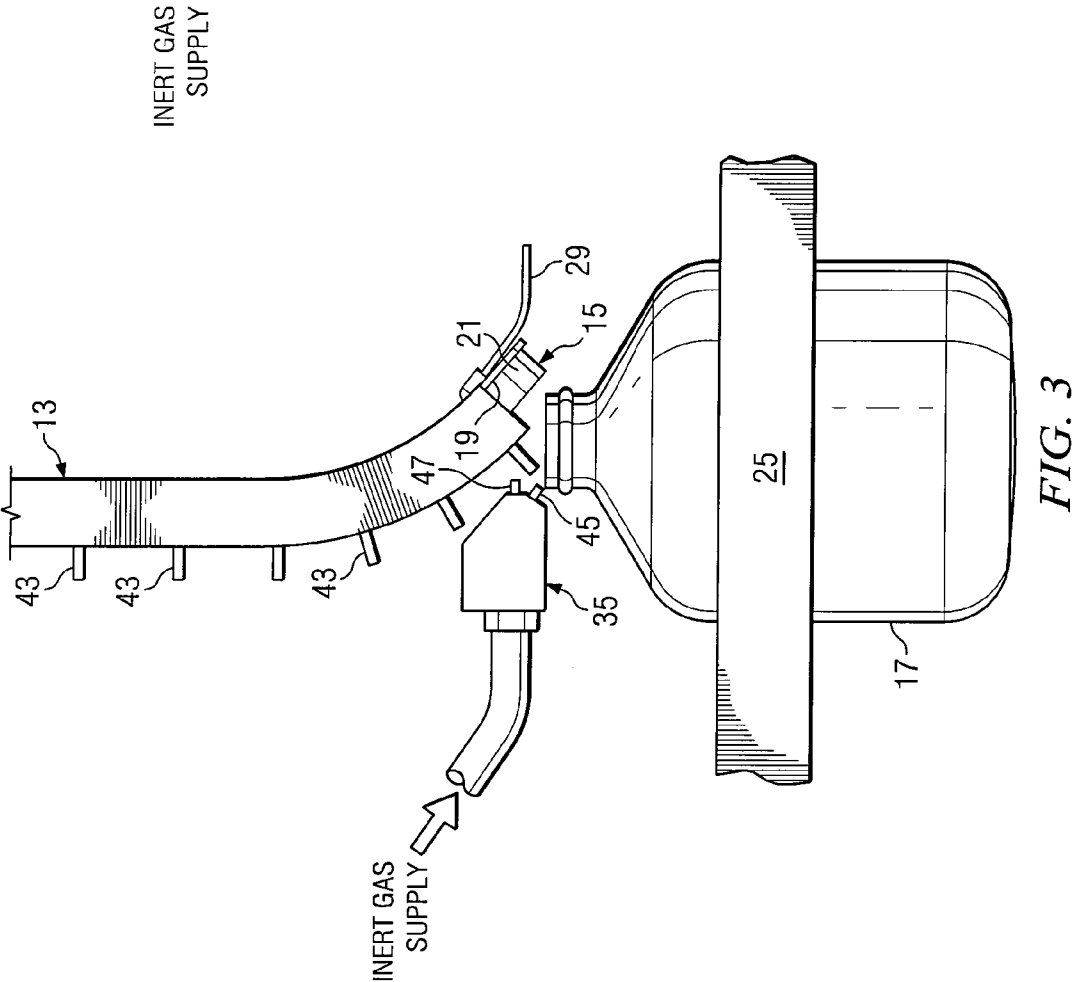
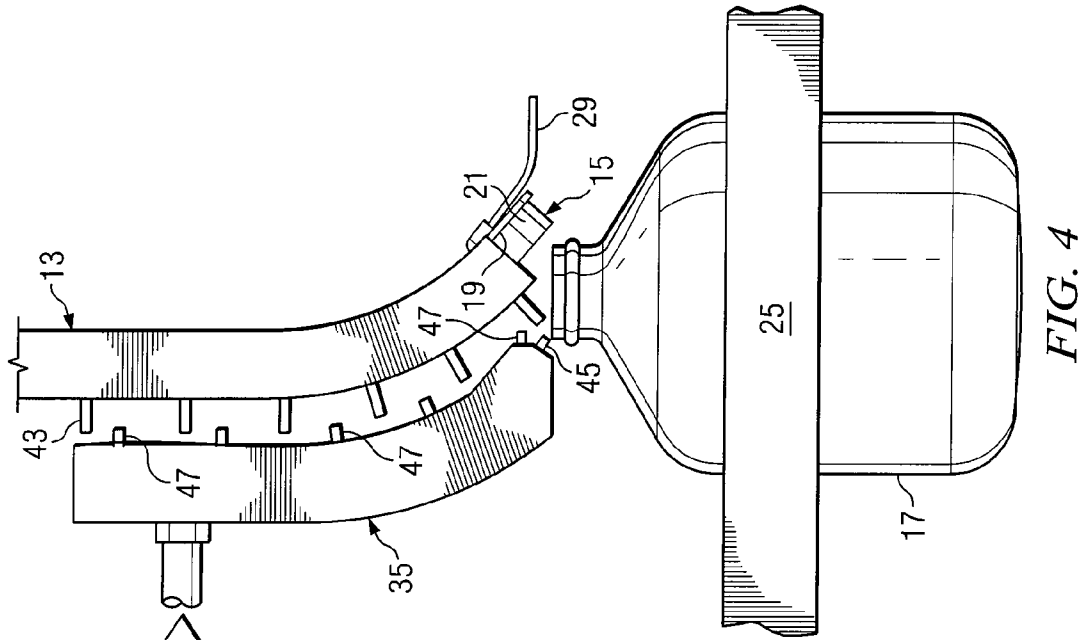
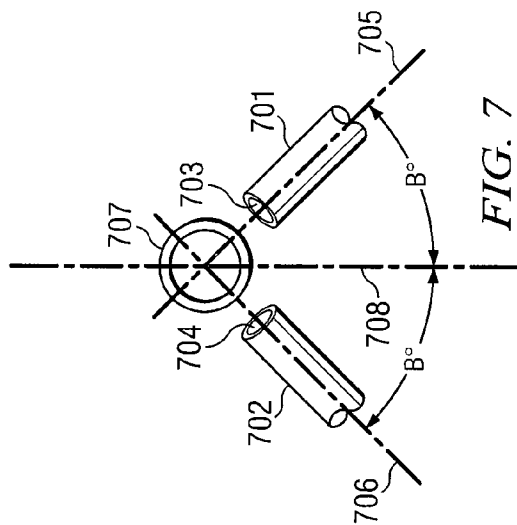
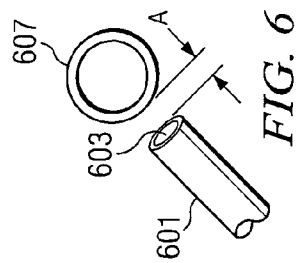
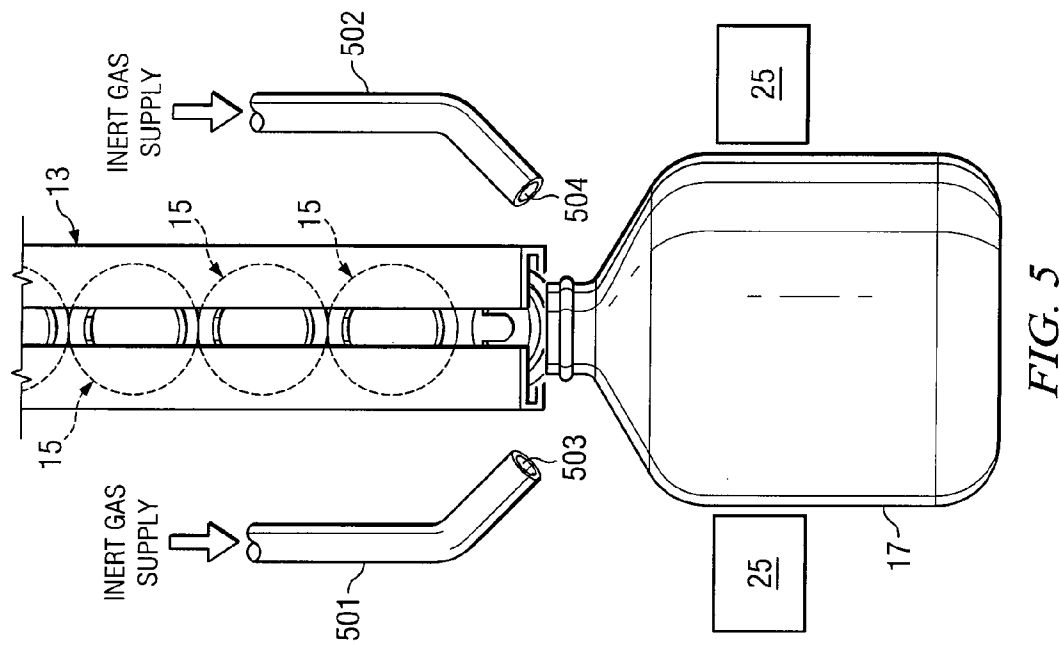


FIG. 2





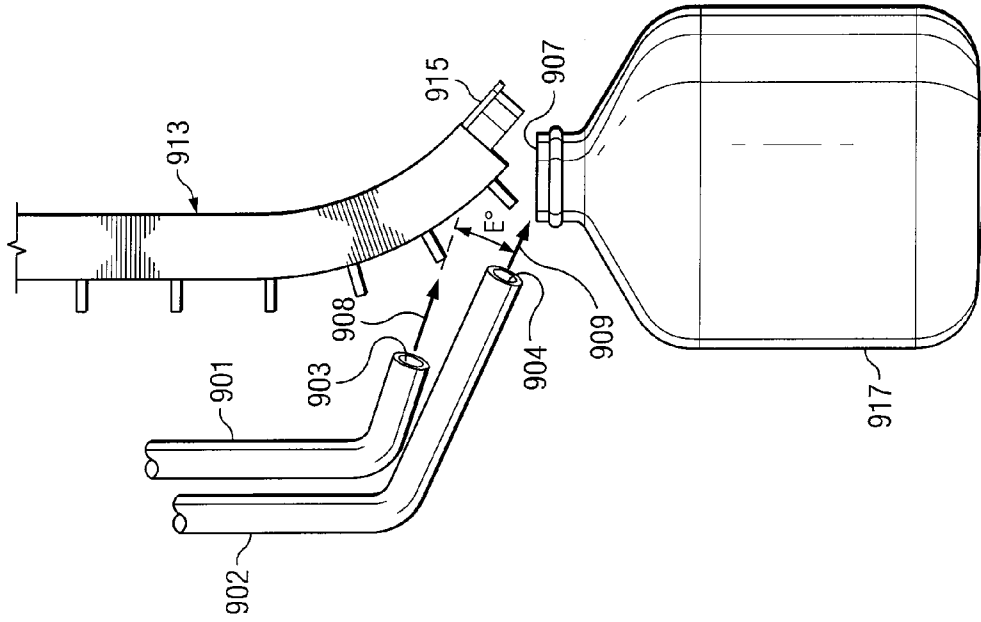


FIG. 9

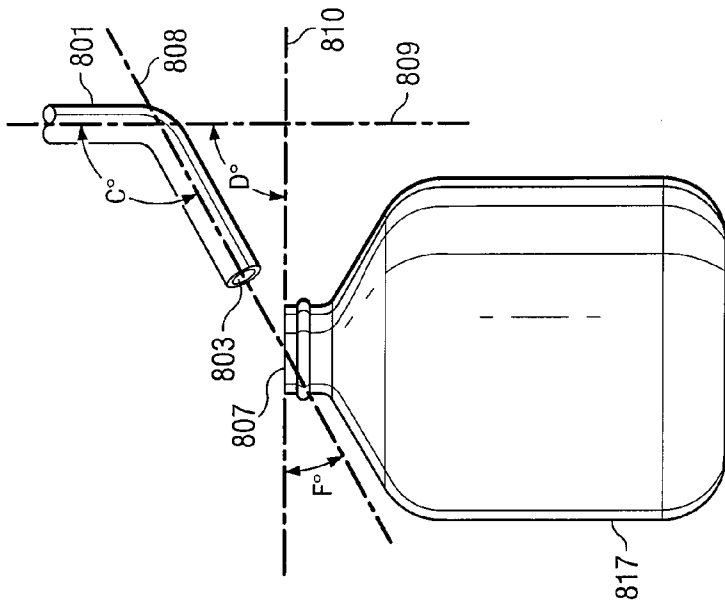


FIG. 8

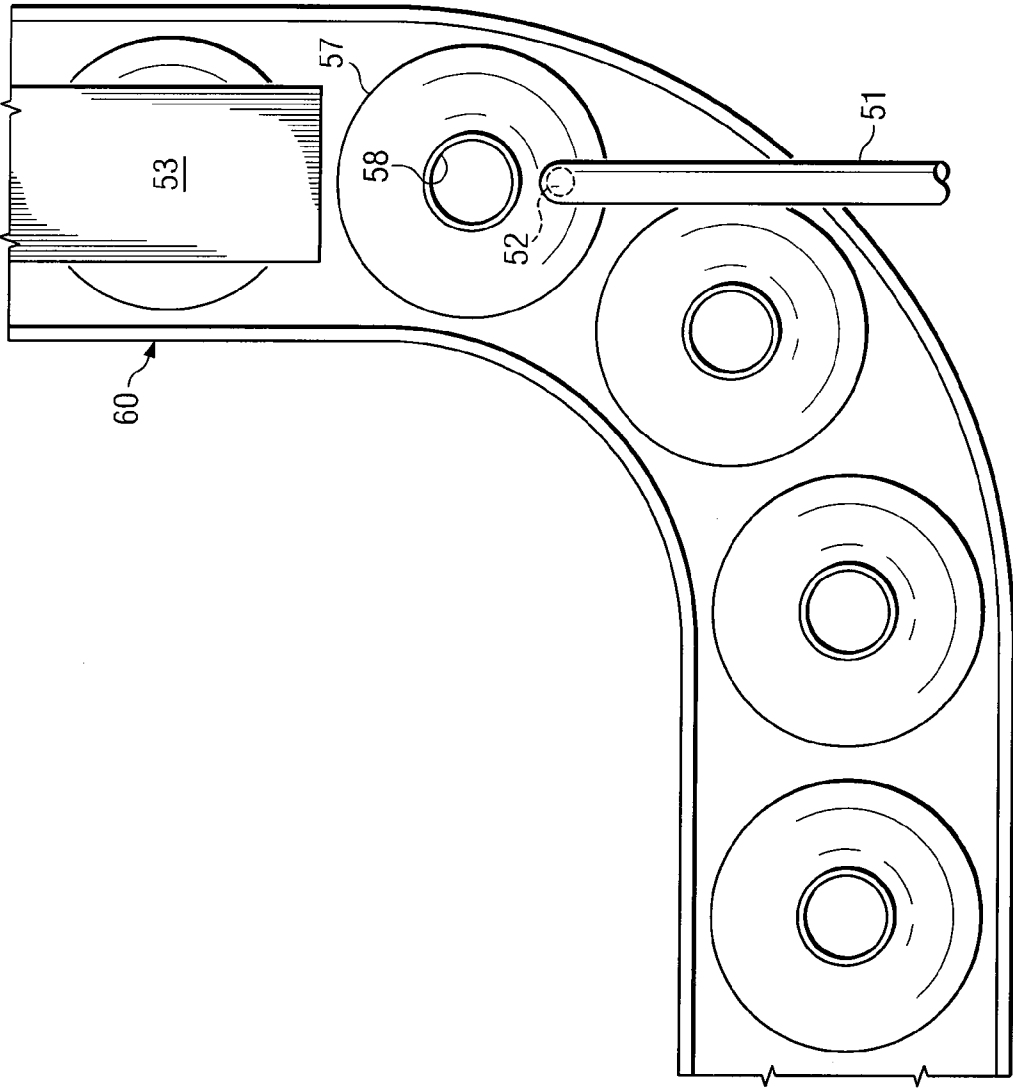


FIG. 10

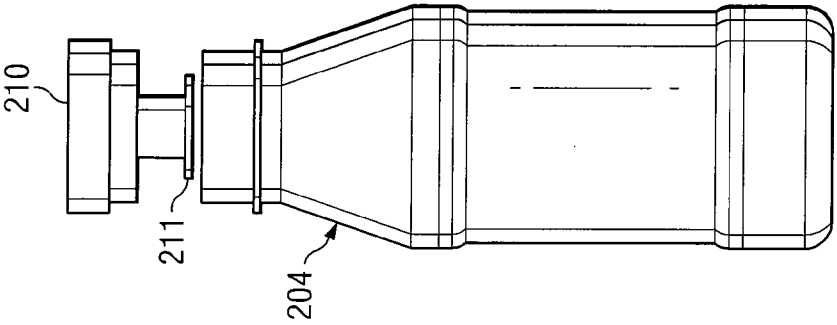


FIG. 12

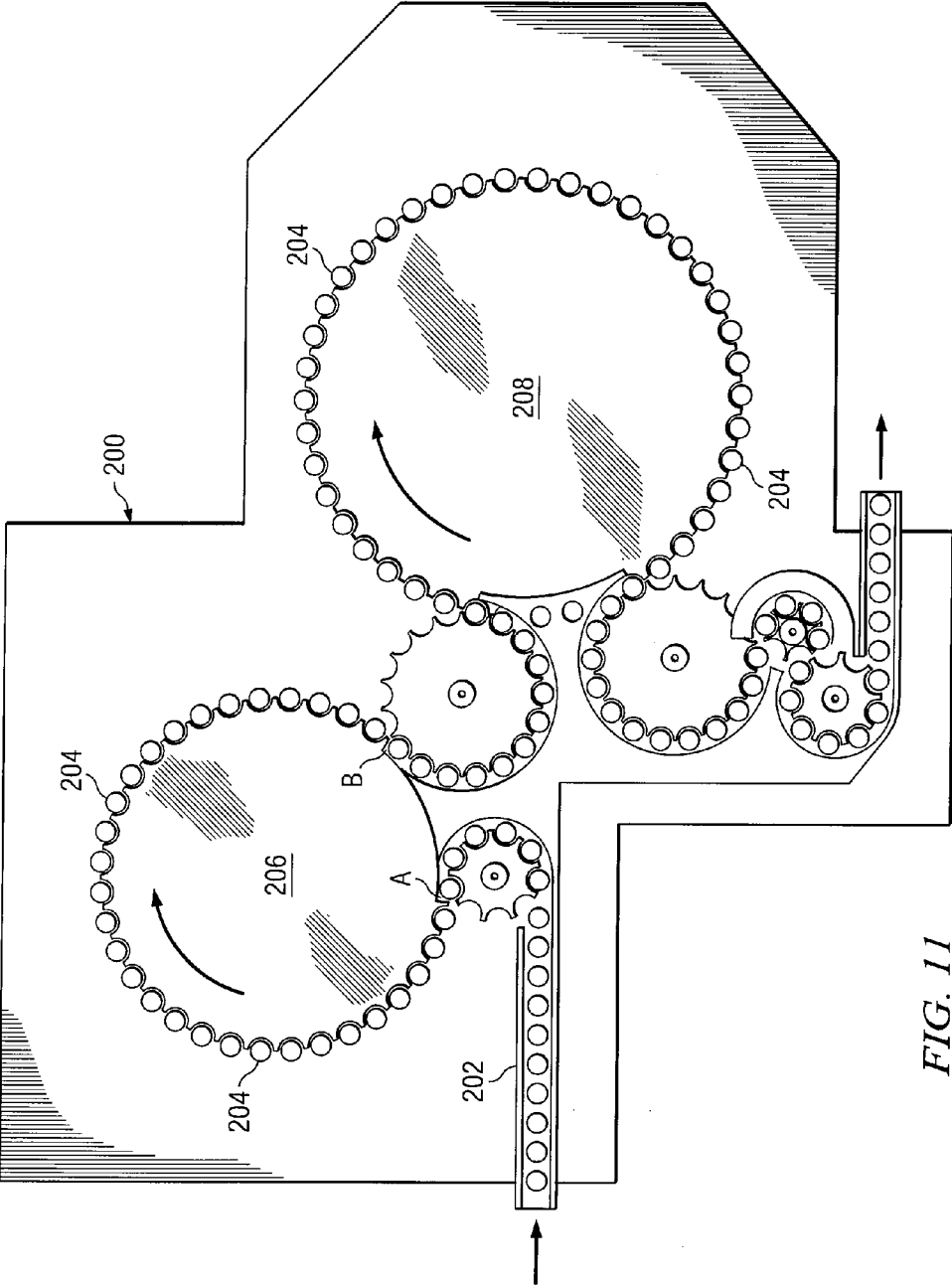


FIG. 11

**METHOD AND APPARATUS FOR FLUSHING A CONTAINER WITH AN INERT GAS**

**RELATED APPLICATION**

[0001] This application is a continuation-in-part application claiming the benefit of pending U.S. patent application Ser. No. 11/029,326 filed Jan. 5, 2005, entitled Method and Apparatus for Inerting Head Space of a Capped Container and U.S. patent application Ser. No. 11/535,150 filed Sep. 26, 2006 entitled Method and Apparatus for Inerting Head Space of a Capped Container.

**TECHNICAL FIELD OF THE INVENTION**

[0002] This invention relates to bottling of potable fluids subject to microbial attack. In particular, the invention relates to a method and apparatus for extending the shelf life of such potable fluids stored in non-pressurized containers with snap-on caps by flushing the container with an inert gas. Some embodiments may incorporate a flushing process whereby the container is flushed prior to filling with the potable fluid. Also, certain aspects of the invention may involve at least partially displacing the oxygen in the cap and in the container head space with an inert gas.

**BACKGROUND OF THE INVENTION**

[0003] It has long been recognized that removing gaseous oxygen from sealed containers containing potable liquids can extend their shelf lives by reducing the rate of spoiling from microbial attack. Vacuum packaging and the use of bags have been used to eliminate gas altogether from packaging, but inerting, or the filling of the unfilled container space with an inert gas, is also widely used.

[0004] In a popular method of inerting, a small dose of liquid nitrogen is injected into a filled container just prior to capping. The nitrogen vaporizes, which displaces oxygen from the container's head space during capping. Some liquid nitrogen remains in the container after capping and vaporizes in the sealed container, which pressurizes the container. However, this method is not useful for non-pressurized containers such as milk and juice bottles. The snap-on caps for these containers are not designed to withstand the pressures developed by the vaporized nitrogen, and the increased pressure created by the vaporized nitrogen breaks the seal between the cap and bottle, allowing air to be sucked back into the container during handling and shipping, renewing microbial attack. As a result, shelf life of non-pressurized capped containers is not significantly extended using this method.

[0005] Methods have been developed for inerting the head space in non-pressurized containers such as the classic gable-top paper container. U.S. Pat. No. 6,634,157 issued to Anderson et al. on Oct. 21, 2003 discloses an apparatus and method for filling these containers. It makes use of a special nozzle inserted into the container after filling with product and prior to sealing the container. The inerting step must be carried out as a separate step between filling and sealing the container, and therefore adds more time to the overall packaging cycle, which reduces throughput. Also, the apparatus for positioning, operating and removing the nozzle is complex and relatively expensive.

**SUMMARY OF THE INVENTION**

[0006] In general, an invention having the desired features and advantages is achieved by flushing an empty container

prior to filling it with a liquid product. As a further step toward maintaining low oxygen levels within the sealed container, one may inject an inert gas such as nitrogen simultaneously into the head space of a filled container and the cap used to seal the container during the capping procedure.

[0007] In one example embodiment, a method is provided for extending shelf life of a potable liquid in a container sealed by a cap enclosing an opening of the container. The container and cap cooperate to define a head space above the potable liquid. One step of the method is flushing the container with an inert gas to reduce the oxygen level within the container to a first percentage lower than ambient air. Another step is filling the container with the potable liquid while the oxygen level in the container is maintained below that of ambient air. Another step is changing the relationship between the cap and opening from a first position to a second position, wherein a distance between the cap and opening is smaller at the first position than at the second position. Another step is introducing an inert gas toward the opening when the cap and opening are at the second position. Another step is sealing the cap on the container with the inert gas enclosed in the head space.

[0008] In another example embodiment, an apparatus is provided for introducing an inert gas into a head space of a container. The container and cap cooperate to define the head space above a potable liquid in the container. The apparatus includes an inert gas source and at least one flushing device for flushing the container with the inert gas. The apparatus further includes a capping device for disposing a cap onto the container to seal the container. The apparatus also includes at least one head space inerting device operable to introduce an inert gas into the head space as the cap and the container are brought closer together.

[0009] Certain aspects of the present invention may have advantages over other methods and apparatus for inerting. Less equipment and space is needed than for apparatus using an inert gas filled environment. The apparatus for carrying out the method of the invention can easily be adapted to existing capping equipment. The flushing process provides improved reduction of oxygen in the container once the container is filled and sealed. The inerting process provides improved reduction of oxygen within the container. The head-space inerting process can be carried out between filling and capping the container without adding any time to the overall process. The combination of empty-bottle flushing and head-space inerting provides an overall reduction in oxygen levels, which may be superior to either process performed alone. One or more, or none, of these advantages may be provided by any particular embodiment of the invention. Additional features and advantages of the invention will become apparent in the following detailed description and in the drawings.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0010] FIG. 1 is a front schematic elevation of an inerting apparatus according to an example embodiment;

[0011] FIG. 2 is a right side elevation of the apparatus shown in FIG. 1;

[0012] FIG. 3 is a front elevation for an alternate apparatus embodiment;

[0013] FIG. 4 is a front elevation for another apparatus embodiment;

[0014] FIG. 5 is an elevation of a container and portion of an inerting apparatus according to an example embodiment;

[0015] FIG. 6 is a plan view of a container opening and inerting apparatus according to an example embodiment;

[0016] FIG. 7 is a plan view of a container opening and inerting apparatus according to an example embodiment;

[0017] FIG. 8 is an elevation of a container and inerting apparatus according to an example embodiment;

[0018] FIG. 9 is an elevation of a container and inerting apparatus according to an example embodiment; and

[0019] FIG. 10 is a plan view of multiple containers and inerting apparatus according to an example embodiment in a capping and inerting process;

[0020] FIG. 11 is a plan view of a system for flushing and head-inerting containers in accordance with an example embodiment; and

[0021] FIG. 12 is an elevation of a container and a flushing apparatus in accordance with an example embodiment.

#### DETAILED DESCRIPTION OF THE INVENTION

[0022] A need remains for an effective method and apparatus for inerting a beverage container. Such a method preferably should work with established capping apparatuses and require a minimum of space for the inerting apparatus. In addition, a method and apparatus that can perform the inerting without adding additional time to the overall filling/sealing procedure would be considered advantageous.

[0023] FIGS. 1 and 2 show a typical apparatus for capping one-gallon plastic milk bottles. The apparatus 11 is shown in schematic with nonessential equipment removed for visibility. Throughout the figures, which are not drawn to scale, equivalent elements are given identical reference numbers. While snap-on caps are shown, it is believed screw-on caps can also make use of the method of the invention for low pressure service, i.e. service in which the pressure in the sealed head space can range from slightly below to slightly above atmospheric pressure when capped, but not at high enough pressure to require a container with features designed to handle elevated pressure (e.g. bottles for carbonated beverages). Therefore, the term 'cap having a top member and a skirt depending from the top member and defining a skirt volume' is intended to include both the snap-on caps shown and screw-on caps and caps of other suitable configurations.

[0024] A chute 13 is used to transport caps 15 to the bottles 17. Each cap 15 has a top member 19 and a skirt 21 depending from the top member 19 and defining a partially enclosed skirt volume 23 with the top member 19. At the end of the chute 13, a pivotable arm (not shown) holds the next cap 15 to be used in the proper position for being put onto a bottle 17. As the bottle 17 moves along the conveyor track 25 past the cap 15, the skirt 21 engages the bottle 17. The moving bottle biases the cap 15 so that it is released by the pivotable arm and passes under a plate 29 that biases the cap downward, sealing it onto the bottle 17.

[0025] The apparatus 11 of the invention comprises a pair of injectors 31, 33 made from nominal half-inch copper tubing mounted on a header block 35 which in turn is attached by an adjustable linkage 37 to the chute 13. Flexible tubing 39 connects the header block 35 to a supply of pressurized nitrogen, preferably through a control loop having a control valve and flow controller (not shown), although other schemes can be used such as manually operated throttling valve and a pressure gauge located between the valve and the header block 35. An alternative embodiment is envisioned but not shown, wherein the header block 35 is absent and the injectors 31 and 33 are individually supplied by flexible tubing or other suitable conduit to the pressurized inert gas supply.

[0026] Because the injectors must be located close to the chute 13, the injectors 31 and 33 are separated by a gap 41 to allow tags 43 extending from the caps 15 to pass between the injectors unobstructed. While simple copper tubing is shown, other types of injectors known in the art can also be used, including other cross sectional types such as dispersion fans. Jets and devices that produce a narrow gas stream are not prohibited but are not preferred since a narrow, high velocity gas stream is more likely to produce splashing or otherwise disturb the surface of the container contents. Regardless of the injector shape, one feature of this illustrated example is the proper orientation of the injectors 31, 33 so that the inert gas stream is directed at or just below the point where the cap skirt 21 initially engages the bottle, in order to ensure that both the bottle head space and the cap skirt volume are properly flushed by the inert gas. The adjustable linkage 37 allows the user to experiment with orientation for best results with various equipment models, when the apparatus 11 is retrofit on existing capping equipment. However, the adjustable linkage can be replaced with a fixed mounting bracket or other unadjustable hardware for a particular piece or model of equipment or when manufactured as an integral part of the capping equipment.

[0027] The flow of nitrogen is set from about fifty to about two hundred standard cubic feet an hour (SCFH) to ensure the desired reduction of the oxygen level in the head space of a one-gallon milk container. The injectors operate continuously, so that there is some waste of the inert gas in the time interval between containers. The injectors are angled at about fifteen to forty degrees from horizontal, and preferably from about twenty to twenty-five degrees from vertical, and oriented so that a significant part of the flow stream flushes the skirt volume 23. This is necessary because trials have shown that the gas trapped in the skirt volume 23 tends to displace gas from the head space during capping rather than being pushed out into the surrounding environment, so that the gas composition in the cap has a significant impact on the final gas composition in the sealed head space.

[0028] FIG. 3 shows an apparatus for use with another embodiment of the invention. This embodiment differs from the preferred embodiment in that the inert gas is injected separately into the head space and the skirt volume by two independent injectors 45 and 47. While this apparatus also works well, it is more sensitive to proper construction and orientation for optimal performance. Therefore, this embodiment is better suited to a fixed installation as shown, rather than being adjustable, although adjustability can still be used. FIG. 4 extends the use of multiple injectors even farther. In this embodiment, the inert gas is injected into the

caps at more than one point along the delivery chute. The flow rates of the various injection streams can be set equal to each other, or varied as desired. Also, in the embodiments of FIGS. 3 and 4 it is possible, although not shown, to use different inert gases for the different injectors. For example, argon may be preferred for use in flushing the head space, as argon is significantly denser than air and will form a fairly stable and distinct layer within the head space, so that filling the head space will effectively prevent oxygen in the air from settling back into the head space. While carbon dioxide will also work well from a technical standpoint, it is not preferred as it tends to affect the taste of the container contents. Argon's density and tendency to stratify, which help when inerting the head space, work against it in attempting to effectively inert the skirt volume, which is inverted. Here, nitrogen may be more desirable, as it more nearly matches the density of air, and does not stratify, so that it will tend to remain in the skirt volume longer.

[0029] The flow of inert gas may be selected so that the oxygen level in the sealed container is less than about fourteen percent by volume, and preferably less than about twelve percent by volume. By contrast, the prior art does not mention any allowable upper limit for oxygen content, and generally implies that proper inerting requires removal of essentially all oxygen from the head space. The inventor has discovered that practical extension of shelf life occurs even when oxygen levels in the head space are as high as about fourteen percent, with shelf life increasing with decreasing oxygen level. As the oxygen level is reduced below six percent by volume, there is a diminishing return to how much shelf life is extended with reduced oxygen level. The discovery that, in certain circumstances, the head space need not be flushed completely free of oxygen makes these example embodiments practical. For example, in certain situations, it is not necessary to insert an inert gas injector into the head space in order to ensure complete flushing of the head space, so the apparatus can be achieved without interfering with the conventional operation of the capping equipment, so there is no throughput penalty. Since complete removal of oxygen is not required, there is no need to create an oxygen-free environment around the container during capping, which eliminates the need for expensive, complicated and bulky apparatus for creating an artificial contained atmosphere around the bottles.

[0030] The invention has several advantages over the prior art. The method can be carried out simultaneously and independently of the conventional capping process, so throughput is essentially unchanged. The apparatus is simple and inexpensive to install, and requires relatively little space, especially in comparison to methods and apparatus that create an enclosed low-oxygen atmosphere surrounding the containers during capping. Existing capping equipment can be easily retrofitted to practice the method of the invention.

[0031] In still another embodiment, the inert gas may be introduced into the head space via one or more conduits as illustrated in FIGS. 5-10. These conduits may be similar to those previously described herein. However, in certain cases, the conduits may comprise tubes having relatively uniform cross-sectional areas along their respective lengths. The conduits may comprise tubes constructed, for example, from stainless steel.

[0032] As illustrated in FIG. 5, for example, first and second conduits 501 and 502 are provided to introduce inert gas into the head space defined by a container 17 and a cap 15, the head space being the space located above the potable liquid. First conduit 501 has an exit opening 503 and second conduit 502 has an exit opening 504. The conduits direct the inert gas from a source (not expressly shown) to the respective exit openings and generally in the direction of the opening of the container 17. In certain embodiments, this is done as the container is being brought into close proximity and/or contact with the cap 15 exiting the cap chute 13. However, the inert gas may be directed toward the container opening at other points during the processing. It should be noted that although two conduits are shown, various embodiments may incorporate only one conduit or more than two conduits.

[0033] Each of the conduits 501 and 502 is shown with a bend. However, a bend is not required and the conduits may have any suitable configuration. The configuration of the conduits may depend, for example, on other processing equipment. Also, one conduit may be configured differently than the other conduit.

[0034] As illustrated in FIG. 6, for example, the exit opening 603 of a conduit 601 is preferably remote from a space defined by a projection of container opening 607. Thus, the end opening is laterally spaced a distance A from the edge of the container opening 607. FIG. 6 is a top view of the container opening 607 in an example process. Thus, in the example process, the exit opening 603 does not physically penetrate the space defined by the upward projection of the container opening 607. This should prevent any condensation that may occur within or on the conduit 601 from dripping down into the container opening 607. Consequently, contamination from condensation drips may be avoided. The distance A may be determined based at least in part on one or more criteria including, without limitation, the desired flow pressure and/or velocity of inert gas exiting the conduit, the desired flow pressure and/or velocity of inert gas as it reaches the container opening, and the size and/or shape of the opening.

[0035] FIG. 7 illustrates an example configuration of two conduits with respect to their angular offsets from the direction of movement of a container during processing. Dashed line 708 represents a direction of movement of the container at the time the inert gas is introduced into the head space. This may occur, for example as the container moves close to the cap chute. First and second conduits 701 and 702 have first and second exit openings 703 and 704 respectively. Dashed lines 705 and 706 represent the respective lateral axes of first and second conduits 701, 702. The lateral axes are determined with respect to a plane defined by a projection of line 708 perpendicular to the plane defined by the container opening 707. First conduit lateral axis 705 is angularly offset from axis 708 by B degrees. Similarly, second conduit lateral axis 706 is offset from axis 708 by B degrees. Although the angular offsets are shown as being the same, the respective offsets may be different. Also, as shown in FIG. 10 for example, a conduit might have zero offset from the direction of movement and still not penetrate the container opening projection. Returning to FIG. 7, the lateral angular offset B is preferably in the range of from 30 to 50 degrees. More preferably, the range is from 40 to 45 degrees. Although the angular offset may be determined in this

manner, the offset may also be determined with respect to the lateral flow direction of the inert gas as compared with the direction of movement of the container. Generally, it is expected that the inert gas exits the conduits in the same lateral direction as their respective lateral axes. However, in certain configurations, this might not be the case. For instance, a deflector (not shown) might be desired to change the flow direction of the inert gas after exiting from the conduit but prior to reaching the head space.

[0036] FIG. 8 illustrates a side view of a conduit **801** with respect to a container **817**. Conduit **801** has an exit opening **803**. Conduit **801** has a vertical portion and a non-vertical portion joined by a bend. The vertical portion defines an axis **809** and the non-vertical portion defines an axis **808**. A plane **810** is defined by container opening **807**. Axis **809** is vertical with respect to plane **810**. Thus, angle D is substantially 90 degrees. It should be noted that this is an example only and the conduit **801** may be configured in any suitable manner.

[0037] In the illustrated example, the non-vertical portion has a vertical angular offset may be defined by either angle C or angle F. Preferably, the offset defined by angle F is in the range of from 15 to 40 degrees. More preferably, the range is from 25 to 35 degrees. Thus, defined by angle C, the offset is preferably from 140 to 165 degrees and more preferably from 145 to 155 degrees.

[0038] FIG. 9 illustrates an example embodiment in which the vertical offsets of two conduits **901** and **902** are different from one another. Inert gas exits first conduit **901** through exit opening **903** and in a first flow direction **908**. Inert gas also exits second conduit **902** through exit opening **904** and in a second flow direction **909**. The first and second flow directions **908** and **909** define a flow offset of E degrees. The first flow direction **908** is more toward the cap **915** (exiting from cap chute **913**) than the second flow direction **909**. Also, it may be stated that the first flow direction **908** is more toward the cap **915** than toward the container opening **907** of container **917**. The second flow direction is also illustrated as being more toward the cap **915** than toward the container opening **907**. However, either or both of the first and second flow directions may be more toward the container opening **907** than toward cap **917** (and still be offset from one another by E degrees).

[0039] FIG. 10 illustrates a process flow of a plurality of container **57** having openings **58**. The container may be moved along a transport apparatus **60** toward a cap chute **53**. As the container approach cap chute **53**, it can be seen that a lateral axis of conduit **51** may be aligned with the direction of movement of the respective containers. Thus, a single conduit may supply inert gas through exit opening **52** directly toward the cap/container opening as the cap is being applied to the container. In certain other illustrations wherein two conduits are shown (and are angularly offset from the direction of movement of the container), the respective inert gas flow directions may cooperate with one another to produce a combined flow in the direction of movement of the container.

[0040] In at least one embodiment of the invention, the container (e.g., bottle **17**) may be flushed with an inert gas. Preferably, the flushing takes place prior to the container being filled with a potable liquid. The container may be flushed with any suitable inert gas such as nitrogen. Pref-

erably, the container is flushed in such a way as to reduce or remove oxygen that is trapped in the container during the filling process.

[0041] For instance, in a filling process in which the head space is inerted with gas, the level of oxygen in the head space may rise over time due to the oxygen trapped in the container during the filling process. In one instance, it was observed that in an inerted head space initially having about 2% oxygen, over the course of about one hour the oxygen level rose to about 15% due to the oxygen that had been trapped in the container during the filling process. Flushing the container to reduce the oxygen level in the empty container to about 0.5% to 5% (more preferably to about 1%) reduced the head space oxygen level (after an hour) to about 10%.

[0042] Moreover, flushing an empty container prior to filling may reduce dissolved oxygen in the potable liquid introduced into the container during the filling process. For example, it was observed that flushing an empty bottle with nitrogen prior to filling reduced dissolved oxygen in milk and juices from an average of about 10.6 mg/l to about 9.5 mg/l in about two hours after the filling, head-space inerting, and capping process was complete. Further, the dissolved oxygen level continued to drop over time.

[0043] A time period for the flushing process may be established based at least in part on the size of the container. For example, a container having a volume of about one gallon has a preferred flushing time of about 1-10 seconds. More preferably, the time is from about 2-6 seconds. Most preferably, the time is from about 3-4 seconds. As an example, for a smaller sized container of about 16 oz., a 0.5 second flushing time may be sufficient.

[0044] An example flushing system is shown in FIG. 11. The system **200** incorporates a transport apparatus **202** for moving bottles **204** from one point to another. System **200** has flushing station **206** and filling station **208**. As can be seen, the bottles **204** preferably travel through flushing station **206** prior to filling station **208**. Multiple inert gas sources (not expressly shown) are provided in the flushing station. A number of inert gas sources may be provided to coincide with the number of bottles present in the flushing station during the normal processing operation. For example, in one configuration, inert gas sources are provided to flush every bottle from a starting point A to and ending point B. This is not critical, however, and numerous configurations may be employed to flush the bottles a single time or repeated times.

[0045] FIG. 12 shows a bottle **204** with an associated inert gas source **210**. The inert gas source **210** directs inert gas downward into bottle **204** to displace oxygen present in the empty bottle **204**. Preferably, the gas source **210** includes a drip shield **211** to prevent condensate from dropping into the bottle **204**.

[0046] The inert gas may be directed into the bottle without the source penetrating the interior space of the bottle. However, in certain configurations, it may be desirable to move the gas source from a first position in which the gas exit is outside the bottle's interior space to a second position in which the gas exit is within the bottle's interior space. Inert gas may be introduced during the movement of

the gas exit or, alternatively, gas may only be introduced when the gas exit is at the second point. In certain situations, it has been found that certain additional oxygen level reduction may be achieved by inserting the gas source to a point within the bottle of from about 0.25 to about 1 inch inside the bottle opening, or more preferably from about 0.5 to about 0.75 inches. The exit opening of the gas source may

also be sized to correspond to the type of container being flushed and/or the size of the opening of the container. Moreover, the flow rate, pressure, and velocity of the inert gas flow may also be adjusted to provide desired flushing performance. Table 1 shows the results of a flushing test using one gallon containers and flushing the containers with nitrogen.

CONTAINER	PRESSURE PSI	FLOW SCFH	VELOCITY FT/MIN	TUBE SIZE INCH	TIME SEC	O2 LEVEL	NOTES
Gallon	35	300	3550	1/8"	1	17.8	Jun. 29, 2006
Gallon	35	300	3550	1/8"	2	13.5	Jun. 29, 2006
Gallon	35	300	3550	1/8"	1	16.3	Tube inserted 1/2" into container Jun. 29, 2006
Gallon	35	300	3550	1/8"	2	13.3	Tube inserted 1/2" into container Jun. 29, 2006
Gallon	35	300	3550	1/8"	3	12.1	Jun. 29, 2006
Gallon	35	600	4700	1/8"	1	15.4	Jun. 29, 2006
Gallon	45	300	4300	1/8"	1	15.2	Jun. 30, 2006
Gallon	45	300	4300	1/8"	2	12.4	Jun. 30, 2006
Gallon	45	300	4300	1/8"	3	10.6	Jun. 30, 2006
Gallon	45	300	4300	1/8"	4	8.3	Jun. 30, 2006
Gallon	45	600	5100	1/8"	1	13.6	Jun. 30, 2006
Gallon	45	600	5100	1/8"	2	11.7	Jun. 30, 2006
Gallon	45	600	5100	1/8"	3	10.1	Jun. 30, 2006
Gallon	45	600	5100	1/8"	4	7.1	Jun. 30, 2006
Gallon	35	600	>9999 MAX	1/4"	1	8.6	Jun. 29, 2006
Gallon	35	300	5300	1/4"	1	8.3	Jun. 29, 2006
Gallon	35	300	5300	1/4"	2	5.5	Jun. 29, 2006
Gallon	35	300	5300	1/4"	3	3.9	Jun. 29, 2006
Gallon	45	300	5500	1/4"	1	7.1	Jun. 30, 2006
Gallon	45	300	5500	1/4"	2	4.2	Jun. 30, 2006
Gallon	45	300	5500	1/4"	3	3.1	Jun. 30, 2006
Gallon	45	300	5500	1/4"	4	2.6	Jun. 30, 2006
Gallon	45	600	>9999 MAX	1/4"	1	5.2	Jun. 30, 2006
Gallon	45	600	>9999 MAX	1/4"	2	3.4	Jun. 30, 2006
Gallon	45	600	>9999 MAX	1/4"	3	1.5	Jun. 30, 2006
Gallon	45	600	>9999 MAX	1/4"	4	1.4	Jun. 30, 2006
Gallon	35	300	4500	3/8"	1	9.9	Jun. 29, 2006
Gallon	35	300	4500	3/8"	2	4	Jun. 29, 2006
Gallon	35	300	4500	3/8"	3	3.1	Jun. 29, 2006
Gallon	35	300	4500	3/8"	4	1.1	Jun. 29, 2006
Gallon	45	300	4000	3/8"	1	5.5	Jun. 30, 2006
Gallon	45	300	4000	3/8"	2	2	Jun. 30, 2006
Gallon	45	300	4000	3/8"	3	1.1	Jun. 30, 2006
Gallon	45	300	4000	3/8"	4	0.4	Jun. 30, 2006
Gallon	45	600	>9999 MAX	3/8"	1	4.2	Jun. 30, 2006
Gallon	45	600	>9999 MAX	3/8"	2	0.9	Jun. 30, 2006
Gallon	45	600	>9999 MAX	3/8"	3	0.4	Jun. 30, 2006
Gallon	45	600	>9999 MAX	3/8"	4	0.3	Jun. 30, 2006
Gallon	35	600	6700	1/2"	1	5.3	Jun. 29, 2006
Gallon	35	300	3100	1/2"	1	4.6	Jun. 29, 2006
Gallon	35	300	3100	1/2"	2	2.2	Jun. 29, 2006
Gallon	35	300	3100	1/2"	3	1.1	Jun. 29, 2006
Gallon	35	300	3100	1/2"	4	0.4	Jun. 29, 2006
Gallon	45	300	2800	1/2"	1	5	Jun. 30, 2006
Gallon	45	300	2800	1/2"	2	1.9	Jun. 30, 2006
Gallon	45	300	2800	1/2"	3	1.2	Jun. 30, 2006
Gallon	45	300	2800	1/2"	4	0.5	Jun. 30, 2006
Gallon	45	600	6000	1/2"	1	4.3	Jun. 30, 2006
Gallon	45	600	6000	1/2"	2	0.7	Jun. 30, 2006
Gallon	45	600	6000	1/2"	3	*2.3	Damage neck finish while capping Jun. 30, 2006
Gallon	45	600	6000	1/2"	4	0.1	Jun. 30, 2006
Gallon	35	600	4400	3/4" NPT	1	6	Jun. 29, 2006
Gallon	35	600	4400	3/4" NPT	1	11.3	Tube 2 1/2" away Jun. 29, 2006

[0047] Returning to FIG. 11, after flushing, the bottles 204 may be transported to filling station 208 for filling, head-space inerting, and capping. These processes may be performed, for example, in accordance with the methods and apparatus described above in connection with FIGS. 1-10.

[0048] Some consideration may be given to the time and/or distance of the transport of bottles from the flushing station to the filling station. Preferably, this transport time and/or distance is such to maintain a relatively high level of inert gas in the bottle. If the transport time and/or distance is too great, then an unacceptable level of oxygen may return to the empty bottle prior to filling. Preferably, the transport time and/or distance is limited to keep the oxygen level in the empty bottle to less than 2% prior to filling. In some situations it has been determined that the transport distance between the flushing station and the filling station should be limited to about 2-5 feet, or preferably to about 3 feet. In another configuration it was determined that the transport time between the flushing and filling stations should be limited to about less than about 20 minutes, or more preferably to less than about 15 minutes, or most preferably to less than about 5 minutes.

[0049] The invention has been shown in several embodiments. It should be apparent to those skilled in the art that the invention is not limited to these embodiments, but is capable of being varied and modified without departing from the scope of the invention.

What is claimed is:

1. A method for extending shelf life of a potable liquid in a container sealed by a cap enclosing an opening of the container, the container and cap cooperating to define a head space above the potable liquid, comprising the steps of:

flushing the container with an inert gas to reduce the oxygen level within the container to a first percentage lower than ambient air;

filling the container with the potable liquid while the oxygen level in the container is maintained below that of ambient air;

changing the relationship between the cap and opening from a first position to a second position, wherein a distance between the cap and opening is smaller at the first position than at the second position;

introducing an inert gas toward the opening when the cap and opening are at the second position; and

sealing the cap on the container with the inert gas enclosed in the head space.

2. The method of claim 1, wherein the flushing step is performed prior to the filling step.

3. The method of claim 1, wherein the filling step is partially performed prior to the flushing step.

4. The method of claim 1, wherein the flushing step comprises reducing the oxygen level in the container to less than 2%.

5. The method of claim 1, wherein the flushing step comprises reducing the oxygen level in the container to about 1% or less.

6. The method of claim 1, wherein the flushing step comprises reducing the oxygen level in the container to an amount determined at least in part by the volume of the container.

7. The method of claim 1, wherein the flushing step comprises reducing the level of dissolved oxygen within the potable liquid in the container.

8. The method of claim 1, wherein a duration of the flushing step is determined based at least in part on the volume of the container.

9. The method of claim 1, wherein the flushing step comprises flushing the container for a period of about 1-10 seconds.

10. The method of claim 1, wherein the flushing step comprises flushing the container for a period of about 2-6 seconds.

11. The method of claim 1, wherein the flushing step comprises flushing the container for a period of about 3-4 seconds.

12. The method of claim 1, wherein the flushing step comprises flushing the container for a period of at least one second.

13. The method of claim 1, wherein the flushing step comprises flushing the container for a period of at least 0.5 seconds.

14. The method of claim 1, wherein the flushing step comprises directing an inert gas from a source outside of the interior space of the container toward an opening in the container.

15. The method of claim 1, wherein the flushing step comprises directing an inert gas from a source located inside the interior space of the container into the interior space of the container.

16. The method of claim 1, wherein the flushing step comprises flushing the container a plurality of times.

17. The method of claim 16, wherein at least one flushing is accomplished using a first flushing apparatus and another flushing is accomplished using a second flushing apparatus.

18. The method of claim 1, further comprising limiting a time period between the flushing step and the filling step based on a desired amount of trapped oxygen in the container.

19. The method of claim 1, further comprising limiting a distance which the container travels between the flushing and filling step based at least in part on a desired amount of trapped oxygen in the container.

20. The method of claim 1, further comprising directing condensate from the inert gas source away from an opening in the container.

21. An apparatus for reducing the amount of oxygen in a head space of a container having a cap, the container and cap cooperating to define the head space above a potable liquid in the container, the apparatus comprising:

an inert gas source;

at least one flushing device for flushing the container with the inert gas;

a capping device for disposing a cap onto the container to seal the container; and

at least one head space inerting device operable to introduce an inert gas into the head space as the cap and the container are brought closer together.

22. The apparatus of claim 21, wherein the inert gas source supplies both the flushing device and the head space inerting device.

23. The apparatus of claim 21, wherein the at least one flushing device comprises a plurality of flushing devices.

24. The apparatus of claim 23, wherein a first flushing device is operable to flush a first container, while a second flushing device is flushing a second container.

25. The apparatus of claim 23, wherein a first flushing device is operable to perform a second flushing of a container that has already been flushed by a second flushing device.

26. The apparatus of claim 21 wherein the flushing device is operable to direct inert gas into the container to displace at least some of the oxygen in the interior of the container to reduce a level of trapped oxygen within the container to less than about two percent.

27. The apparatus of claim 21 wherein the flushing device is operable to direct inert gas into the container to displace at least some of the oxygen in the interior of the container to reduce a level of trapped oxygen within the container to less than about one percent.

28. The apparatus of claim 21 wherein the flushing device is operable to direct inert gas into the container to displace at least some of the oxygen in the interior of the container to reduce a level of trapped oxygen within the container to less than about 0.5 percent.

29. The apparatus of claim 21, wherein the flushing device has a gas exit, and wherein the flushing device is movable from a first position to a second position, the gas exit being exterior to the container in the first position and within the interior of the container in the second position.

30. The apparatus of claim 21, wherein the flushing device has a gas exit and wherein the flushing device is operable to flush the container when the gas exit is located inside the container at a distance of from about 0.25-1.00 inches.

31. The apparatus of claim 21, wherein the flushing device has a gas exit and wherein the flushing device is operable to flush the container when the gas exit is located inside the container at a distance of about 0.5 inches.

32. The apparatus of claim 21, further comprising a filling device for at least partially filling the container with the potable liquid.

33. The apparatus of claim 32, wherein a distance between the flushing device and the filling device is limited to maintain a predetermined maximum amount of trapped oxygen within the container.

34. The apparatus of claim 32, wherein a container moving from the flushing device to the filling device travels for a predetermined amount of time, and wherein the predetermined amount of time is limited to maintain a predetermined maximum amount of trapped oxygen within the container.

35. The apparatus of claim 21, the flushing device comprising a drip shield for preventing condensate from entering an opening of the container.

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