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(54) **METHOD AND APPARATUS FOR INERTING HEAD SPACE OF A CAPPED CONTAINER**

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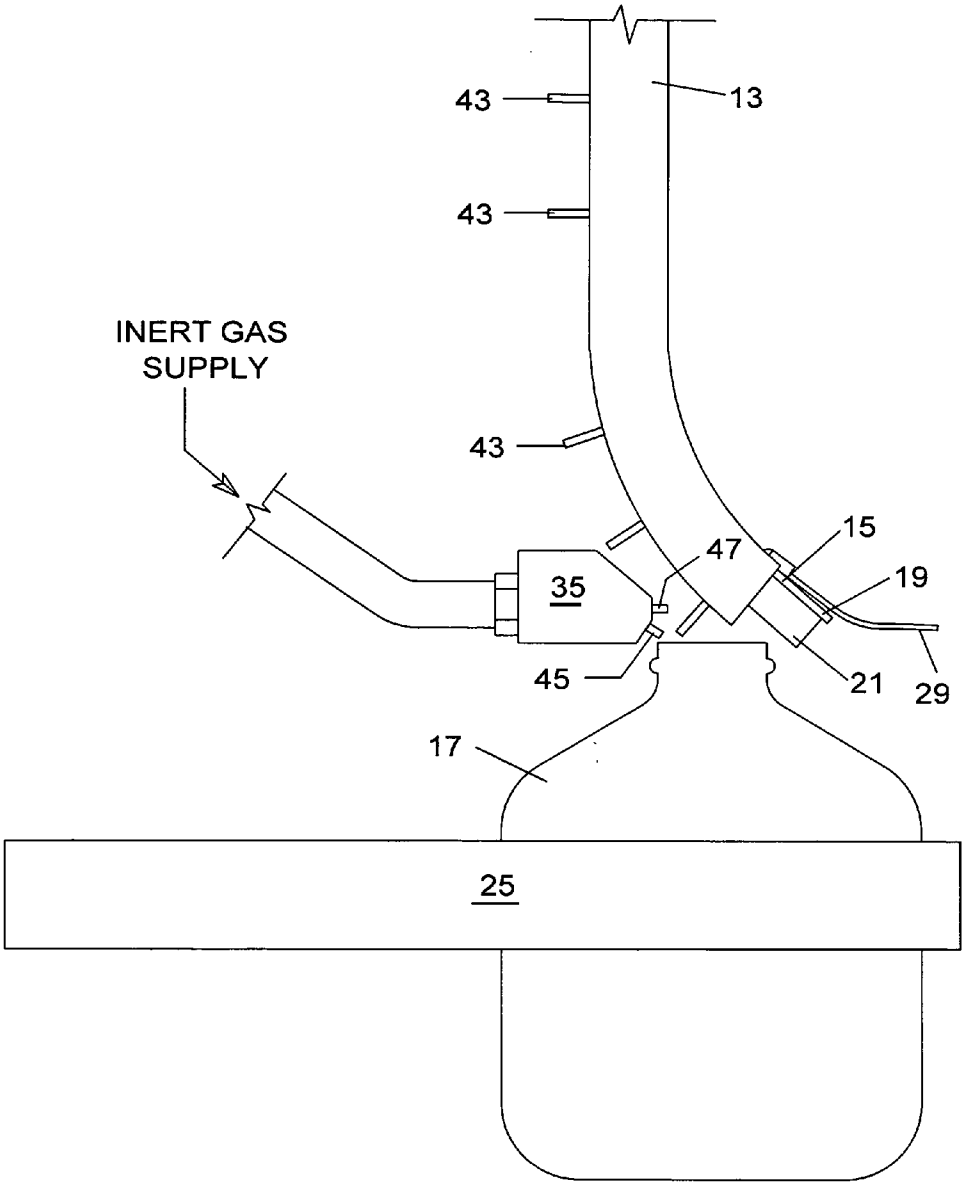
(57) **ABSTRACT**

A process to reduce oxygen in the head space of non-pressurized containers comprises injecting an inert gas into the container head space and into the cap during the capping process. In an alternative embodiment, inert gas is injected into the caps at one or more points along the conveyance rout to the capping point.



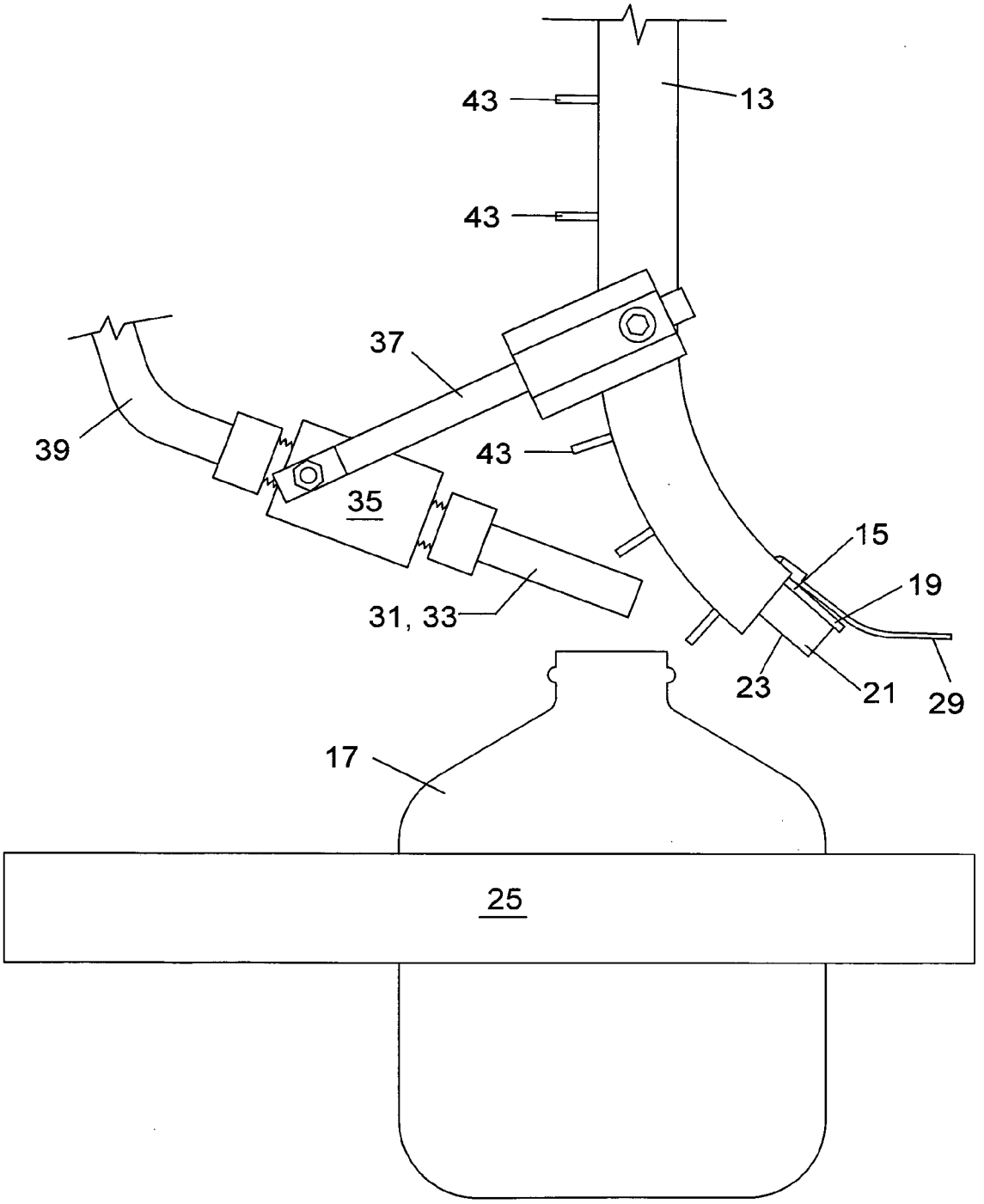


FIG. 1

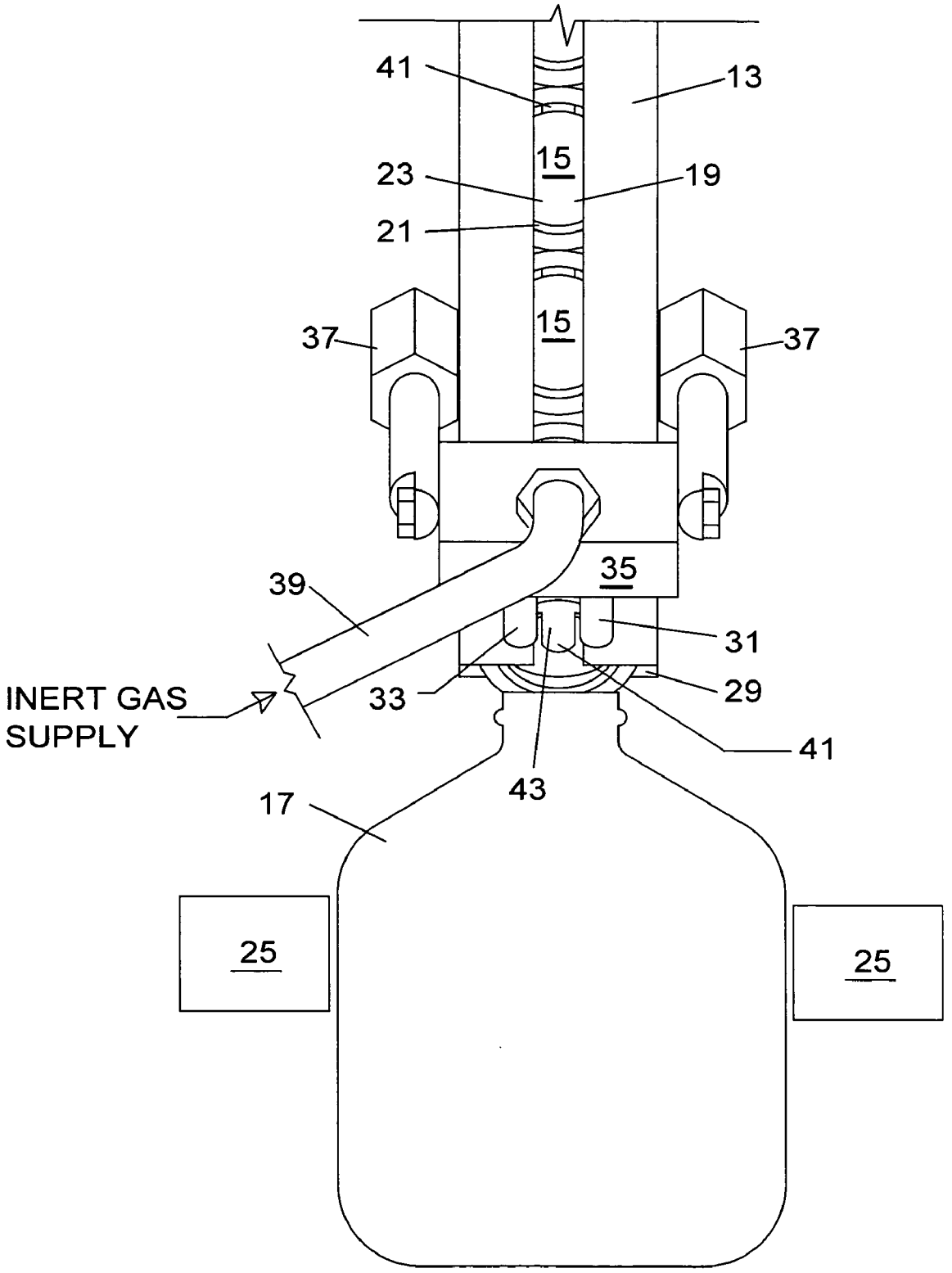

41
13
15
23
19
21
15
37
37
35
39
31
INERT GAS
SUPPLY
33
29
41
43
17
25
25

FIG. 2

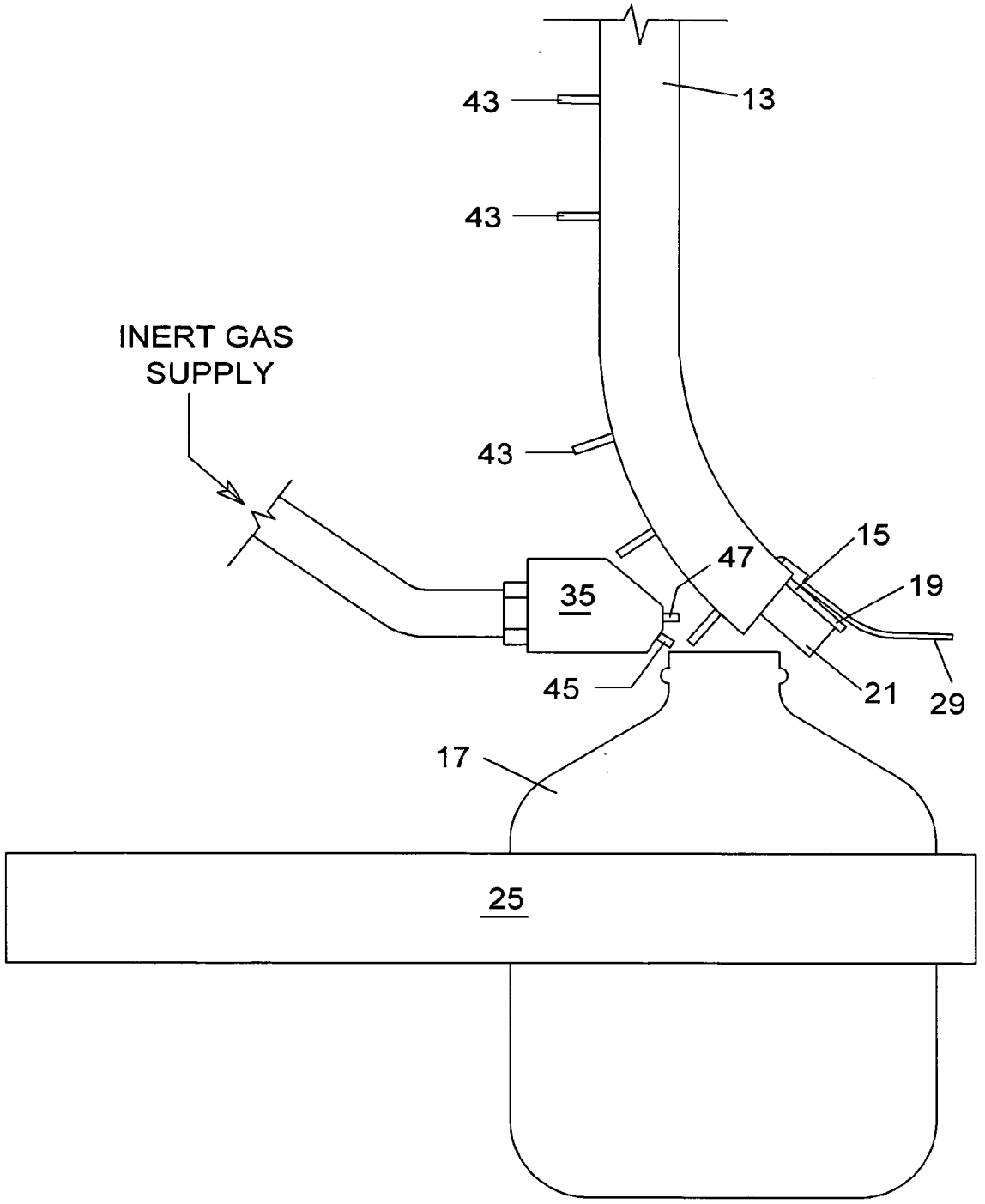


FIG. 3

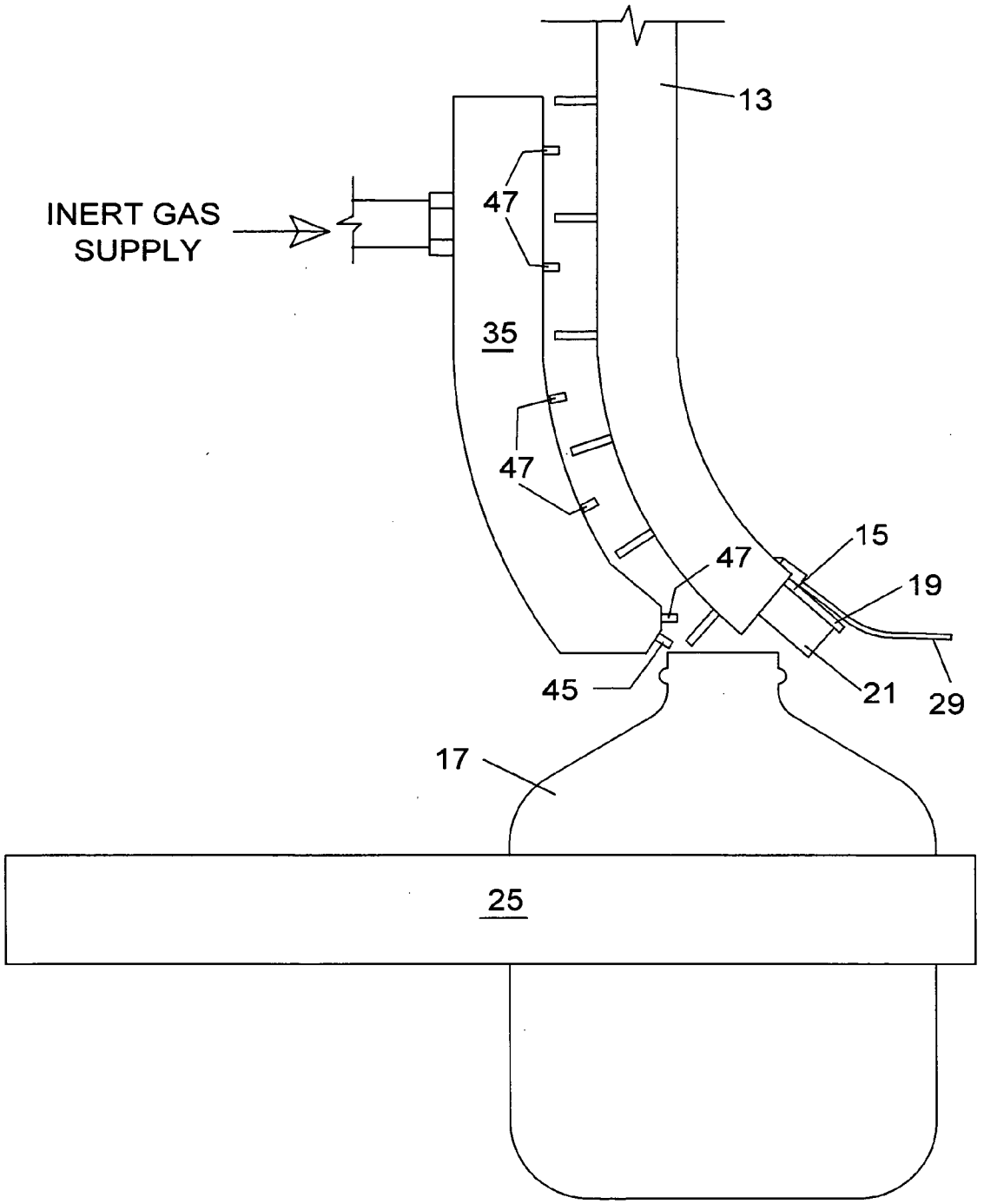


FIG. 4

METHOD AND APPARATUS FOR INERTING HEAD SPACE OF A CAPPED CONTAINER

TECHNICAL FIELD

[0001] 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 at least partially displacing the oxygen in the cap and in the container head space with an inert gas.

BACKGROUND OF THE INVENTION

[0002] 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.

[0003] 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.

[0004] 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 used 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.

[0005] A need remains for a inexpensive method and apparatus for inerting a non-pressurized 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.

SUMMARY OF THE INVENTION

[0006] In general, an invention having the desired features and advantages is achieved by injecting 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. Preferably, the apparatus for injecting the apparatus includes at least one injector oriented downward at an angle between about fifteen and forty degrees from horizontal, and preferably between about twenty and twenty-five degrees, and aimed into the top of the container neck just at or before the point at which the cap initially contacts the container. The velocity of nitrogen flow should be low enough to prevent splashing of container contents, and preferably is low enough to avoid visibly disturbing the fluid surface. However, in every case the flow rate must be enough to reduce the oxygen level in the sealed container to an amount below about fourteen percent oxygen by volume, and preferably below about twelve percent by volume. While nitrogen is preferred for economic reasons, other inert gases known in the art can also be used.

[0007] An alternate embodiment of the apparatus employs separate injectors, one directed into the container and another into the cap at or near the point where the cap engages the container. In yet another embodiment, inert gas is injected into the cap at more than one point along the cap's conveyance route immediately prior to engaging and sealing the container. The flow rates for the different injection streams can be equivalent or differ substantially from each other.

[0008] The present invention has 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 inerting process can be carried out between filling and capping the container without adding any time to the overall process. Additional features and advantages of the invention will become apparent in the following detailed description and in the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] **FIG. 1** is a front schematic elevation of a preferred apparatus used to practice the process of the invention.

[0010] **FIG. 2** is a right side elevation of the apparatus shown in **FIG. 1**.

[0011] **FIG. 3** is a front elevation for an alternate apparatus embodiment.

[0012] **FIG. 4** is a front elevation for another apparatus embodiment.

DETAILED DESCRIPTION OF THE INVENTION

[0013] **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.

[0014] 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 conveyer 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**.

[0015] 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.

[0016] 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, a critical feature 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.

[0017] 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.

[0018] **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 then 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.

[0019] In all the embodiments, the flow of inert gas is 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 returns to how much shelf life is extended with reduced oxygen level. The discovery that the head space need not be flushed completely free of oxygen makes the present methods and apparatus practical. For example, 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.

[0020] 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.

[0021] 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.

1) A method for extending shelf life of a potable liquid in a container sealed by a cap having a top member and a skirt depending from the top member and defining a skirt volume, the container defining a head space above the potable liquid, comprising the step of:

a) bringing the container and the cap into a close relationship;

b) injecting an inert gas simultaneously into the container head space and the skirt volume; and

c) sealing the cap on the container with a gas composition in the head space comprising less than about fourteen percent oxygen by volume.

2) A method as recited in claim 1, wherein the cap initially contacts the container in an inclined orientation during the sealing step (c), and the inert gas is injected at or near the point where the cap and the container initially come into contact during the sealing step (c).

3) A method as recited in claim 1, wherein the gas composition in the sealed head space is less than about twelve percent oxygen by volume.

4) A method as recited in claim 1, wherein the inert gas is injected by at least one injector, and the at least one injector injects inert gas into both the container head space and the cap skirt volume.

5) A method as recited in claim 1, wherein the inert gas is injected by at least a first injector and a second injector, the first injector injecting inert gas into the container head space and the second injector injecting inert gas into the cap skirt volume.

6) A method as recited in claim 5, wherein the same inert gas is injected by the first injector and the second injector.

7) A method as recited in claim 5, including a first inert gas and a second inert gas, wherein the first injector injects the first inert gas into the container head space and the second injector injects the second inert gas into the cap skirt volume.

8) A method as recited in claim 1, further comprising the step of injecting an inert gas into the cap skirt volume prior to the step (a) of bringing the container and the cap into a close relationship.

9) A method as recited in claim 5, wherein the gas composition in the sealed head space is less than about twelve percent oxygen by volume.

10) A method as recited in claim 8, wherein the gas composition in the sealed head space is less than about twelve percent oxygen by volume.

11) An apparatus for use with a method for extending shelf life of a potable liquid in a container sealed by a cap having a top member and a skirt depending from the top member and defining a skirt volume, the container defining a head space above the potable liquid, the apparatus comprising:

a) a pressurized supply of an inert gas;

b) means for injecting the inert gas into the container head space, connected to the pressurized supply of inert gas; and

c) means for injecting the inert gas into the cap skirt volume, connected to the pressurized supply of inert gas.

12) An apparatus as recited in claim 11, wherein at least one injector is both the means for injecting the inert gas into the container head space and the means for injecting the inert gas into the cap skirt volume.

13) An apparatus as recited in claim 11, wherein at least one first injector is the means for injecting the inert gas into the container head space, further comprising at least one second injector for injecting the inert gas into the cap skirt volume.

14) An apparatus as recited in claim 13, further comprising a plurality of second injectors, positioned so as to inject the inert gas into cap skirt volume at more than one location along a route traveled by the caps prior to engaging with and sealing the container.

15) An apparatus as recited in claim 14, further comprising a second pressurized supply of inert gas connected to the means for injecting inert gas into the cap skirt volume.

16) An apparatus as recited in claim 15, wherein the first inert gas and the second inert gas differ in chemical composition.

17) An apparatus as recited in claim 11, further comprising a header block connected to the inert gas supply, and wherein the means for injecting the inert gas into the container head space and the means for injecting the inert gas into the cap skirt volume are connected to the header block.

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