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(54) **Manufacture of small containers of carbonated liquids.**

(57) A method of bottling or canning in a small (i.e. one-portion) non-valved bottle or can a liquid which is required to have foaming properties comprising the steps of filling the bottle or can substantially to the brim with the liquid, then adding a quantity of liquid nitrogen, then optionally directing a flow of gaseous nitrogen or gaseous carbon dioxide across the surface of the contents of the bottle or can and then immediately sealing the bottle or can.

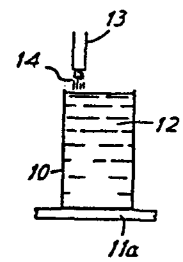

FIG.1c

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Croydon Printing Company Ltd.

MANUFACTURE OF SMALL CONTAINERS OF CARBONATED LIQUIDS

This invention relates to the manufacture of small containers containing carbonated liquids and has a particularly useful but not exclusive application in relation to small (i.e. single portion) containers of beer and other carbonated beverages. Such containers may be in the form of ring-pull cans, or bottles with crown closures, for example which cannot be charged with additional gas after the container has been closed.

Foam is an important element in the consumer-appeal of most beers and of some other carbonated beverages and other carbonated liquids. The most important means by which foam is produced by any of these liquids is the release of carbon dioxide from super-saturated solution. Super-saturation arises when a previously-closed, pressurized container is opened to atmosphere or when the liquid contents are discharged from within it through a tap or similar device. Bubbles of carbon dioxide gas are then released by turbulent flow, by nucleation on solid surfaces or particles, or by diffusion into existing gas bubbles.

In the case of beers and other carbonated beverages, bubbles aggregate to produce foam which rests on top of the beverage in the drinking-glass (or other drinking container). More bubbles are released, and foam consequently produced, as the beverage is drawn into and flows within the mouth, producing a variety of sensory impressions including viscosity. As the beverage is tipped from the glass, foam clings to its walls, giving an attractive pattern known as 'lacing'.

The volume, stability, bulk viscosity and lacing of foam are governed by a number of factors, important among which are the content of solutes in the aqueous phase and the size-distribution of gas bubbles. In general, small gas bubbles with suitable colloids adsorbed at the gas/liquid interface tend to produce the most stable and viscous foams; moreover the fine texture of these foams reflects incident light in a manner that is pleasing to the eye.

Numerous inventions have been described for promoting suitable foam formation when carbonated beverages are dispensed from bulk containers such as beer barrels. They include (a) orifices, (b) mechanical and ultrasonic devices which induce turbulence and (c) fine jets which entrain ambient air by the Venturi effect. Air is highly effective in producing small bubbles because the gas/water interfacial tension of nitrogen or oxygen is considerably less than that of carbon dioxide. The efficiency of air in producing foam can be improved by first dissolving it under pressure in the liquid. Thus it is known that superior foams are formed on beer poured from small containers where there has been inadequate exclusion of air during filling of the containers. This is undesirable, however, because oxygen causes flavour deterioration and colloidal haze, and promotes unwanted microbial growth. An alternative (described in detail by TCN Carroll, page 116 in volume 16 of the Technical Quarterly of the Master Brewers' Association of the Americas, 1979) is to force gaseous nitrogen under pressure into solution in the beer, which is the 'secret' behind a famous brand of draught stout. The mass of nitrogen actually required in solution is normally less than one-hundredth of the mass of carbon dioxide. However, although it produces excellent foam, dissolved nitrogen has to be supplemented by a continuous supply of gaseous nitrogen to the headspace that is vacated within the cask as the beverage is dispensed; otherwise the nitrogen in solution progressively diffuses into the gaseous headspace leaving the liquid depleted in content of dissolved nitrogen. Nitrogen is however relatively insoluble in water, and equilibrates between the beverage and the sealed headspace (vacuity) above it, the volume of which is commonly in the range 5% - 10% of the total container volume, so that much more nitrogen is required than will actually dissolve in the beverage. Furthermore, if nitrogen is dissolved in the beverage in a reservoir before a filling operation carried out in currently used equipment for filling small containers with carbonated beverages, most of the nitrogen is removed by 'gas washing' because due to the much lower solubility of nitrogen than carbon dioxide in the liquid, any bubbles liberated by liquid movement entrain nitrogen leaving the nitrogen content of the solution depleted.

There remains then the problem of providing a satisfactory way of increasing foam formation on certain beers and other carbonated beverages when they are poured from small containers. It is particularly desirable in relation to beer in cans because it is a common observation that pouring beer from a can generates less foam than pouring from a bottle, and in relation to beers of low carbonation, whether the small containers are cans or bottles, because some consumers, though they enjoy the appearance of foam, prefer the flavours of 'flatter' beers which are capable of releasing relatively little carbon dioxide in the mouth.

According to this invention there is provided a method of canning or bottling a liquid product in a small (e.g. one-portion) non-valved can or bottle, in which method the can or bottle is almost filled with the liquid product and a quantity of liquid nitrogen is then added to the liquid product in the container, and the container is then immediately sealed.

While the invention has an important application in relation to carbonated beverages, it can equally advantageously be applied in the manufacture of small containers of other liquids which are required to foam.

Since the contents of one-portion containers of beverages are intended to be consumed entirely, and not re-sealed in the container, the containers are non-valved and there is no requirement for the beverage to be capable of re-generating a head pressure of gaseous nitrogen after the container has been opened.

The mass of liquid nitrogen injected per container must be sufficient, after it has boiled and dissolved, to satisfy the headspace and solution requirements without exceeding the container's bursting pressure at any time in its subsequent history. In practice, in the case of beers, a limiting requirement will usually be survival in a pasteurizer at about 60^{o}C.

Most commercially-used small containers are capable of withstanding the extra internal pressure caused by nitrogen at an effective level of addition for foaming purposes. Depending on the strength of the container and, to some extent, on the nature of contents of the container and whether the contents are carbonated quantities of up to 1.14 gm of liquid nitrogen per litre of the liquid in the container have been found to give progressively improved foaming properties. Quantities of .25 gm liquid nitrogen have given excellent results in the case of 440-ml containers of lagers and other beers, which is about half the rate just mentioned. Quantities of .5 gm have, while imparting good foaming properties, occasionally caused 440-ml cans to become mis-shapen and/or to leak during a subsequent pasturization process.

In one example, a bottle of brimful capacity

400ml, containing 380ml of lager beer, was passed along a powered conveyor below a constant jet of liquid nitrogen. The size of the jet and the speed of the conveyor were selected so that 0.25 grammes of liquid nitrogen fell into the beer. The bottle was immediately capped and transported to a testing laboratory. There it was subjected to a standard pouring test as 18°C, the whole volume being transferred to a drinking glass, steadily, during 7 seconds. The same test was applied to a control bottle, identical in all respects other than the nitrogen injection. The nitrogen-treated beer gave a finer-textured foam which collapsed at about half the rate of the control; when poured from the glass it left an extensive pattern of lacing whereas the control did not.

In a particular example a seamless one-piece aluminium can of 440-ml capacity was filled up to about 3mm (1/8 inch) from the brim with lager beer. 0.25 gm liquid nitrogen in the form of a thin jet was added to the beer, following which a current of nitrogen gas was directed across the surface of the beer and the can was then immediately sealed in the conventional manner by the application of a lid thereto. The sealed can was then inverted and the contents pasteurized at 60°C. The weight of the can was then checked to ensure that there was no leakage of its contents. Subsequently the can was opened for testing of the foaming qualities of the beer by the Trufoam test described by P J Wilcon and A P Mundy in the Journal of the Institute of Brewing 1984 Vol. 90, page 385. The test involves pouring a standard quantity of the beer into a standard glass under standard temperature conditions, the glass and its contents being disposed between a vertically aligned light source and a photoelectric cell. The foam on the beer forms a barrier between the light source and the cell. When the foam collapses enough to reveal some of the liquid surface the cell emits a signal, and the time taken from the pouring of the beer to the emission of the signal indicates the life of the foam.

In one series of tests, two sets of three 440-ml cans A, B and C of a particular beer were prepared. Each of the cans A was a control sample in which gaseous nitrogen was blown across the surface of the beer immediately before the can was sealed, but no liquid nitrogen was added to the beer. Cans B and C were treated in the same manner but 0.25 gm of liquid nitrogen was added to the beer in cans B and 0.5 gm of liquid nitrogen was added to the beer in cans C before the lids were sealed on the cans.

The beer in the two cans of each set was subjected to the Trufoam test and the results were as follows:

Cans A	1)	1 min. 45 sec.
	2)	1 min. 51 sec.
Cans B	1)	3 min. 27 sec.
	2)	3 min. 33 sec.
Cans C	1)	8 min. 42 sec.
	2)	8 min. 01 sec.

In the second series of tests carried out in the same way but using a different beer the results were as follows:

Cans A	1)	2 min. 03 sec.
	2)	2 min. 19 sec.
Cans B	1)	6 min. 05 sec.
	2)	6 min. 59 sec.
Cans C	1)	14 min. 25 sec.
	2)	14 min. 00 sec.

These results demonstrate clearly the improved foaming properties resulting from the addition of a small quantity of liquid nitrogen to the beer.

The sequence of steps in a basic production method according to the invention is illustrated in the

Figures 1A to 1E of the accompanying drawings.

In the production process, empty one-piece aluminium cans 10 of one-portion (440-ml) capacity are fed along a conveyor on to the turntable 11 of a rotary filling machine of the carousel type which initially fills the cans with beer 12 to a level about 1/8" from the brim. The cans of beer are then transferred to an output conveyor 11<u>a</u> and pass under a nozzle 13 which is emitting a continuous jet 14 of liquid nitrogen, the flow of nitrogen being adjusted in relation to the time taken for a can to pass under the nozzle so as to add the required weight of liquid nitrogen, e.g. 0.25 gm, to the beer in the can. From conveyor 11<u>a</u>, the cans are transferred sequentially to the turntable 11<u>b</u> of a sealing machine in which gaseous nitrogen or carbon dioxide 15 is then blown across the surface of the beer and a lid 16 is immediately sealed on the can. Subsequently the cans are inverted and passed through a pasteurizing apparatus.

The process is equally applicable to bottles of one-portion capacity containing beers or other carbonated or non-carbonated liquids which are required to have good foaming qualities.

CLAIMS

1. A method of canning or bottling a liquid product in a small non-valved can or bottle comprising placing a predetermined quantity of the liquid product in the can or bottle and adding to the liquid product in the can or bottle a predetermined quantity of liquid nitrogen, and then sealing the can or bottle.

2. A method as claimed in claim 1, further comprising the step of directing a current of gaseous nitrogen or carbon dioxide across the liquid in the can or bottle immediately after the addition of the liquid nitrogen and immediately before sealing the can or bottle.

3. A method as claimed in claim 1 or claim 2, wherein the quantity of liquid nitrogen added is in the range up to 1.14 gm per litre of the liquid product.

4. A method as claimed in claim 3, wherein the quantity of liquid nitrogen added is approximately 0.57 gm per litre of the liquid product.

5. A method as claimed in any one of claims 1 to 4, wherein the liquid product is a carbonated liquid.

6. A method as claimed in any one of claims 1 to 5, wherein the liquid product is a beer.

7. A method as claimed in any one of claims 1 to 6, wherein the liquid nitrogen is added in the form of a thin jet.

8. A method of canning or bottling a liquid product in a small can or bottle which method is substantially as hereinbefore described with reference to the accompanying drawings.

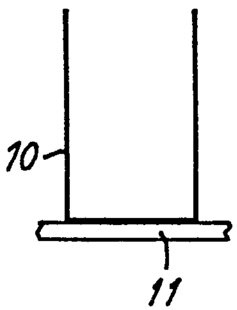

FIG 1A

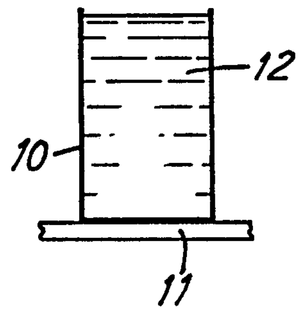

FIG.1B

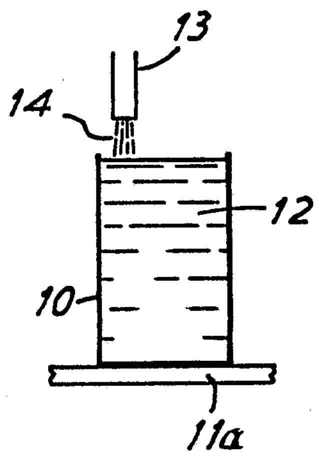

FIG.1C

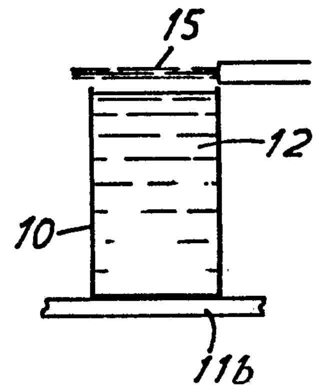

FIG.1D

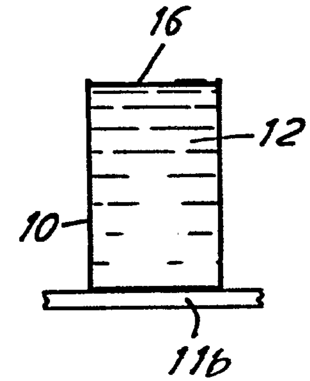

FIG.1E