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(57) **ABSTRACT**

This invention relates to a freezing receptacle for use within a cooling apparatus. The receptacle is configured to hold part of a beverage container to be contained within the receptacle. The freezing receptacle includes a mechanism to assist cooling of the beverage container. The invention also includes a method of cooling using a cooling apparatus having a refrigeration compartment and a freezing receptacle, the method includes the steps of a) placing a beverage container within the freezing receptacle configured to hold a part of the beverage container; b) freezing the contents of the beverage container with the freezing receptacle; and c) refrigerating the contents of the beverage container within the refrigeration compartment.

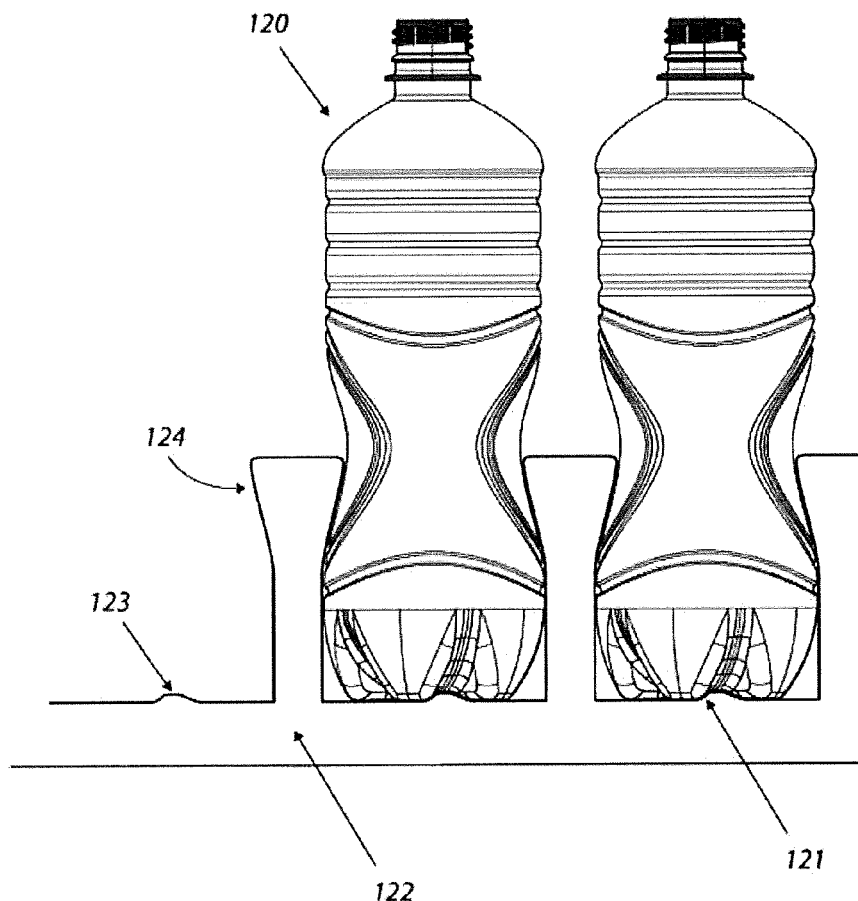


Figure 1

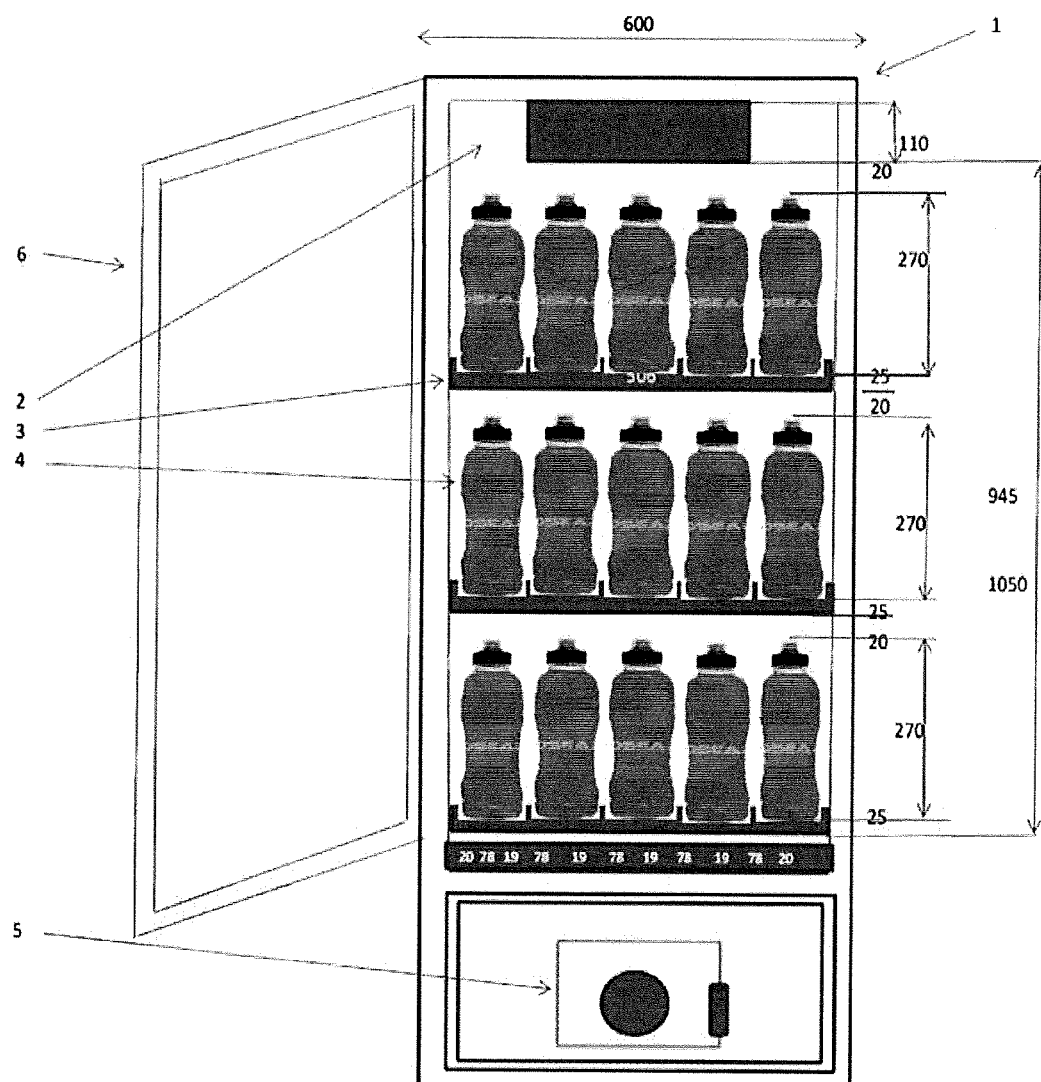


Figure 2

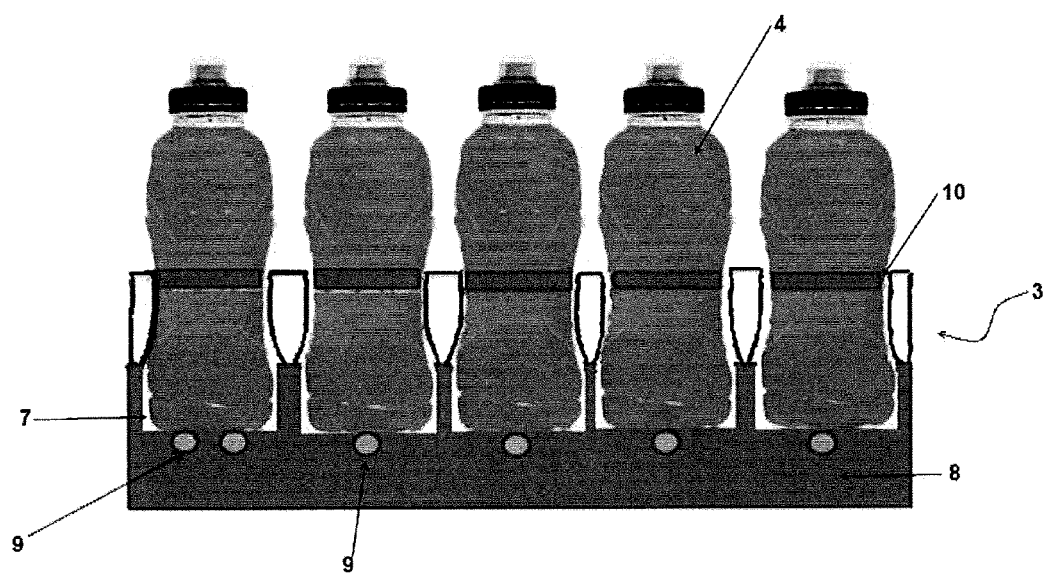


Figure 3

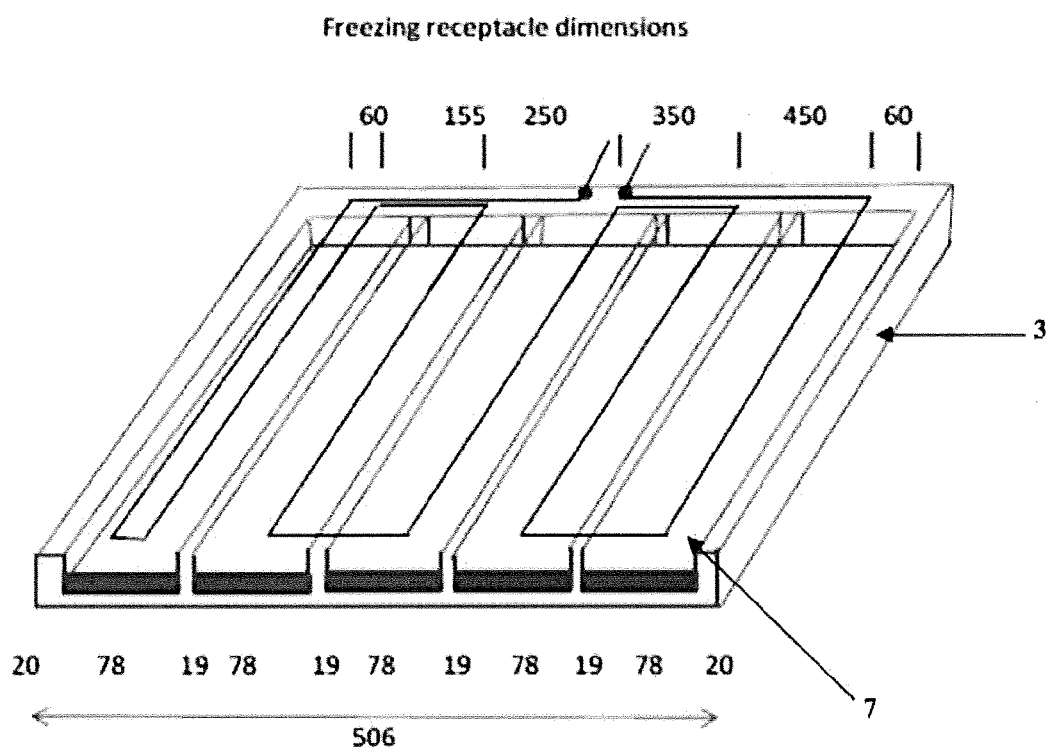


Figure 4B

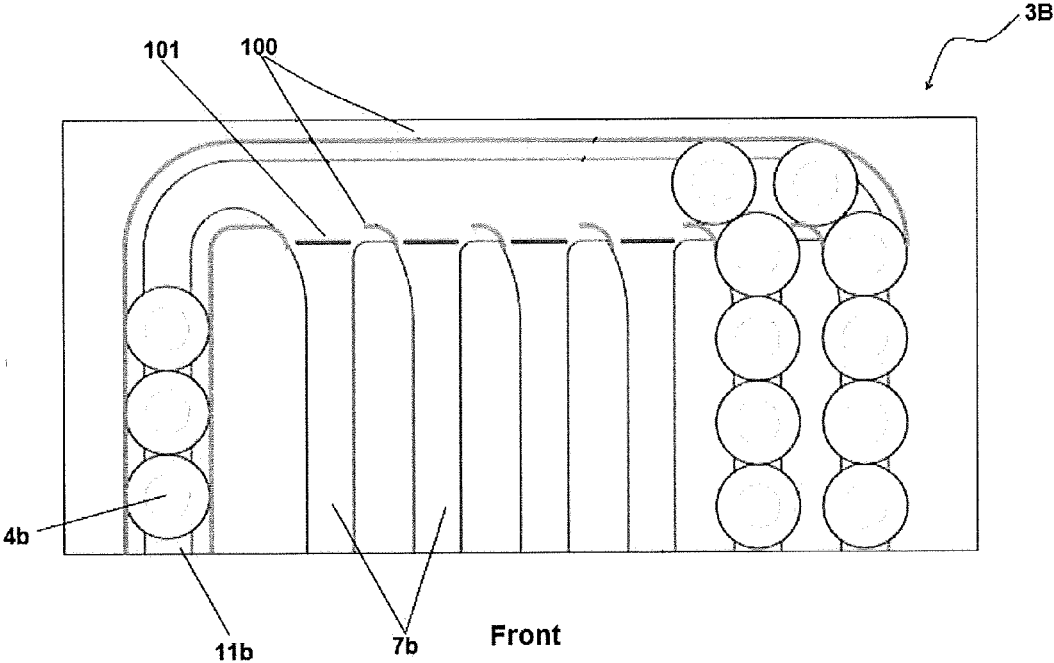


Figure 5

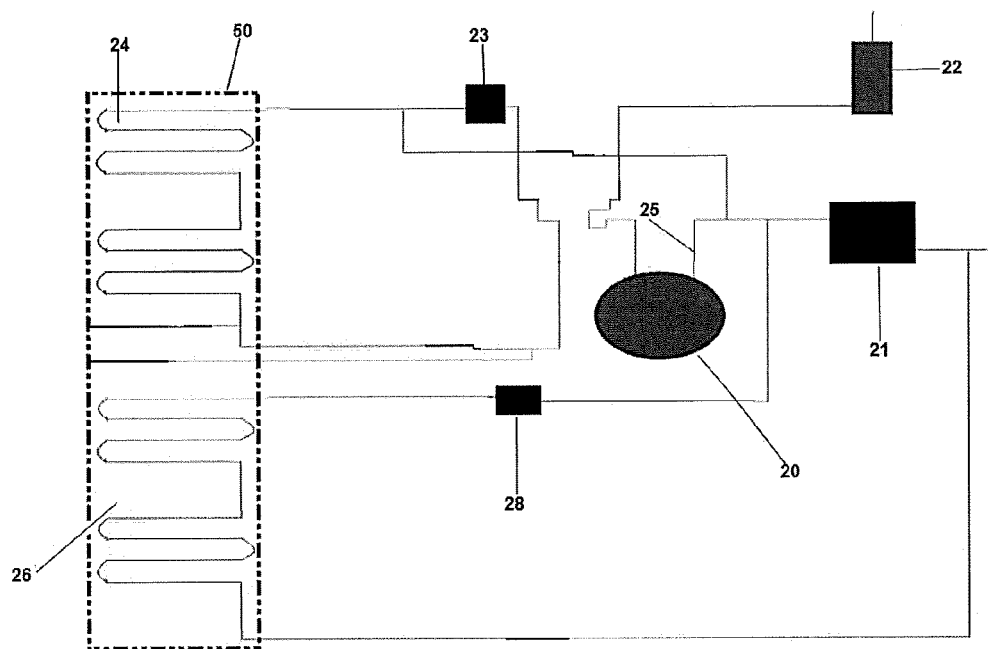


Figure 6

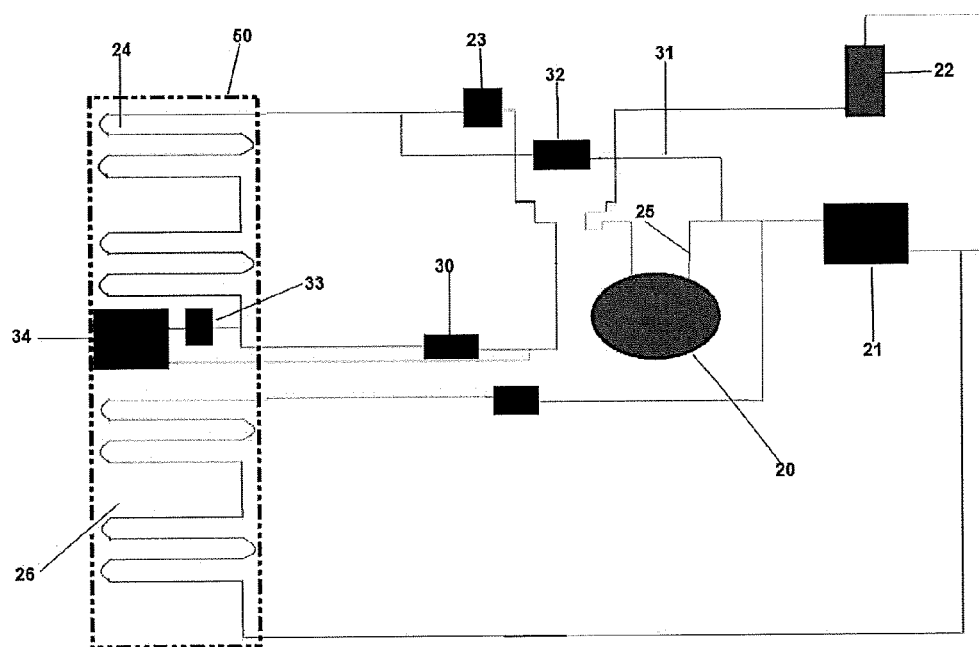


Figure 7

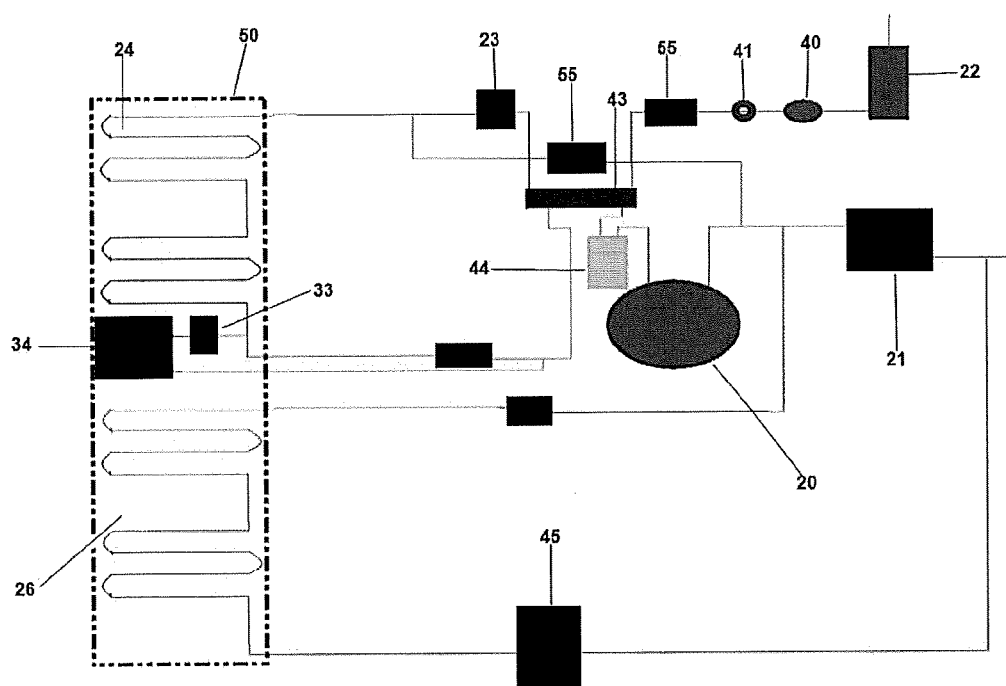


Figure 8

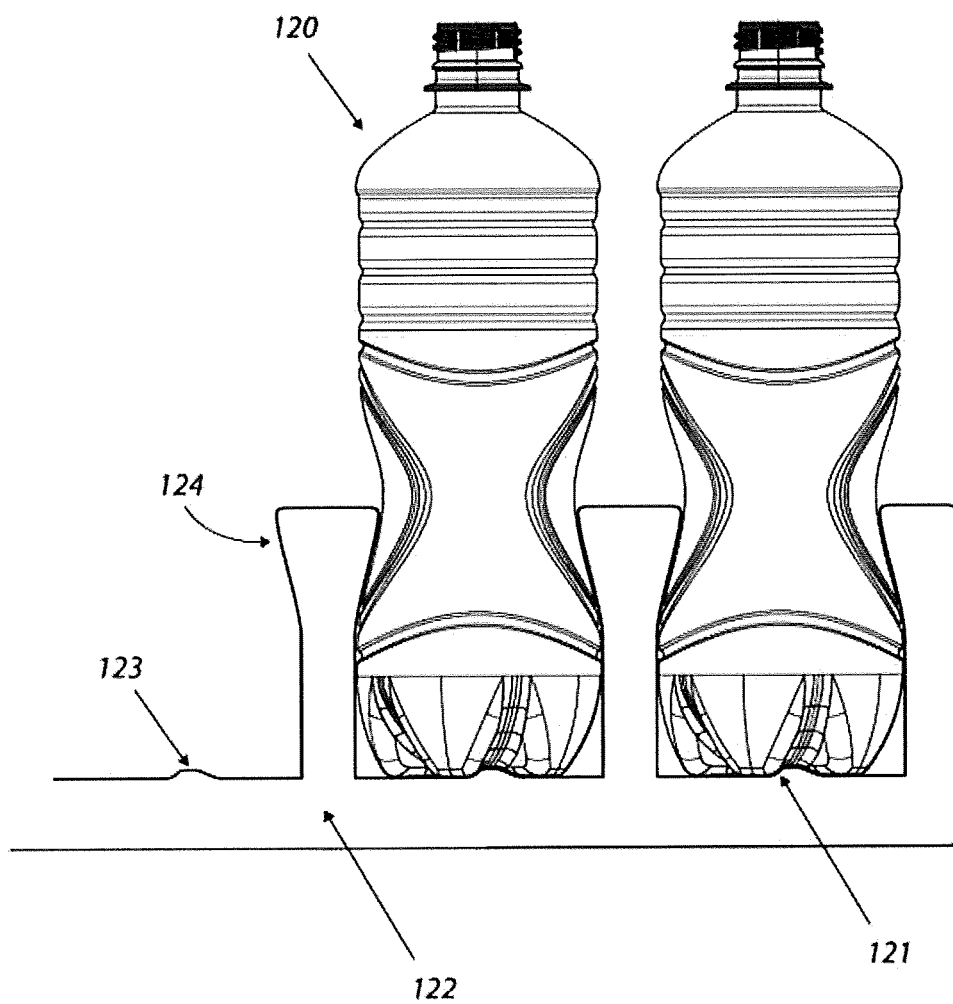


Figure 9

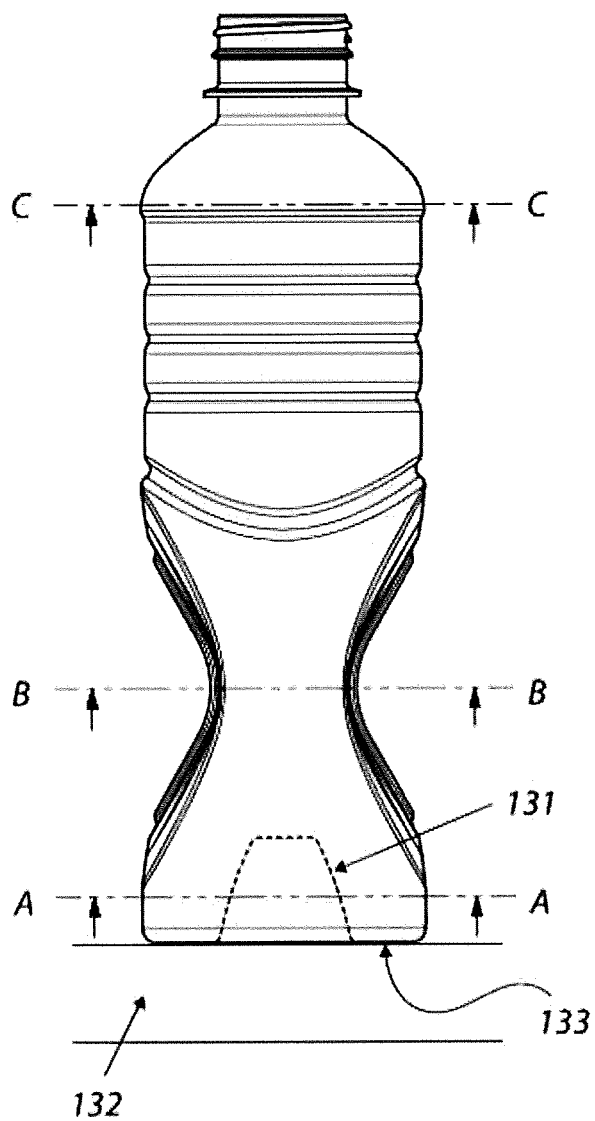


Figure 9A

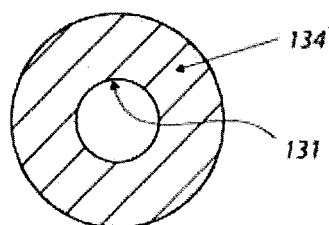


Figure 9B

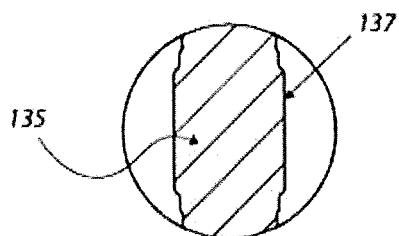


Figure 9C

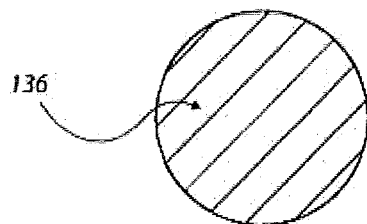


Figure 10

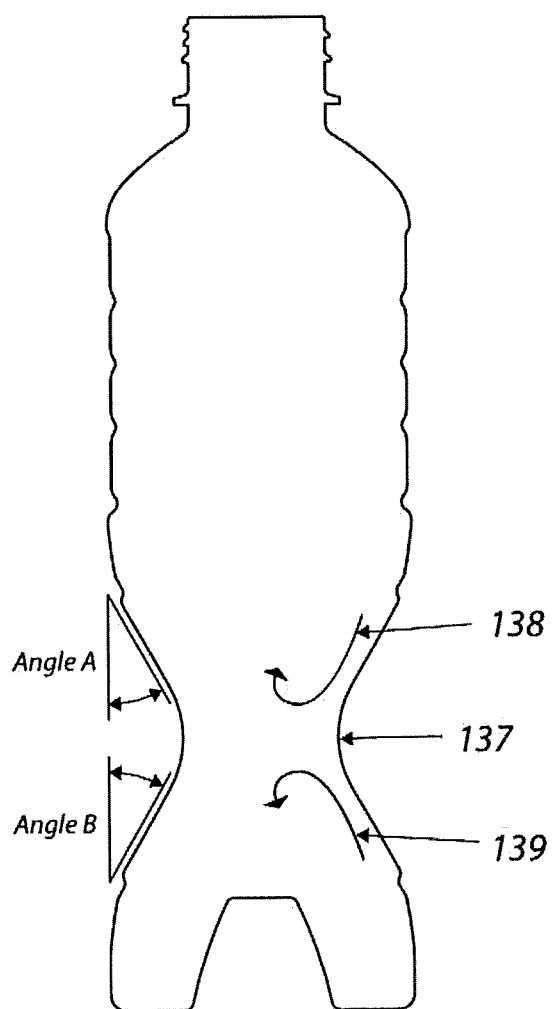


Figure 11

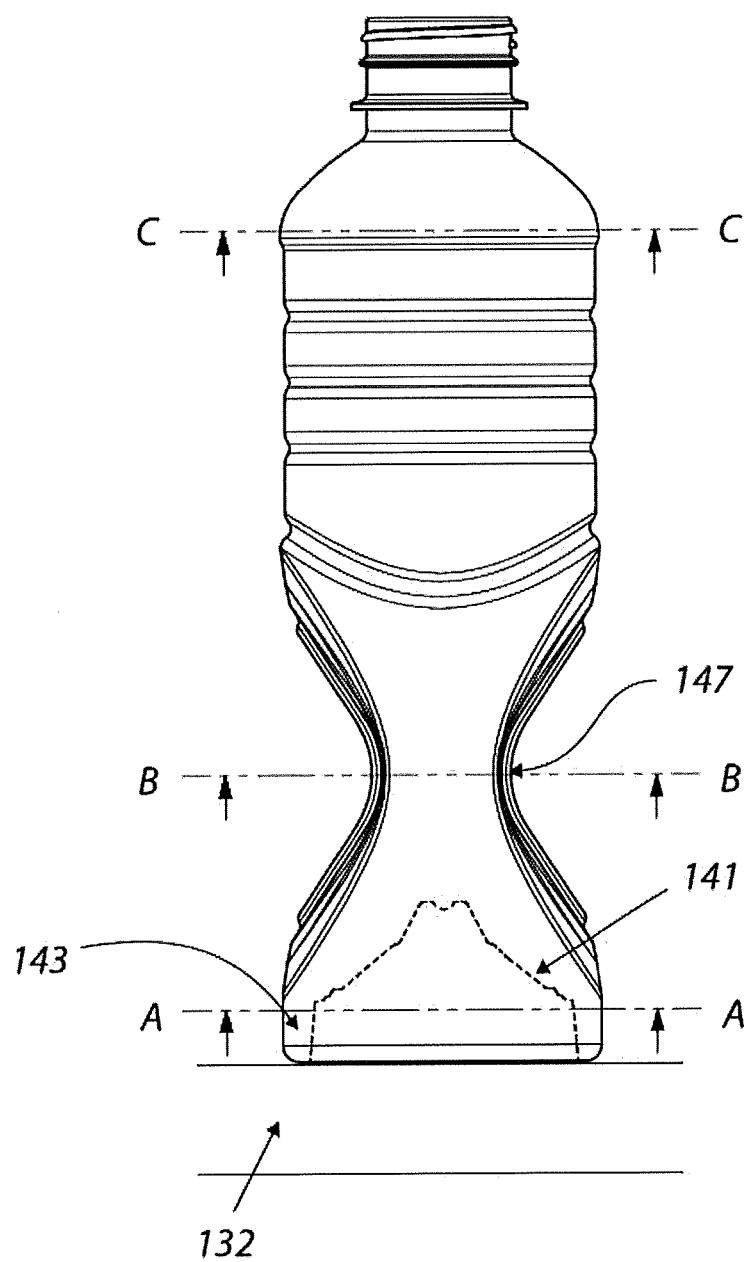


Figure 11A

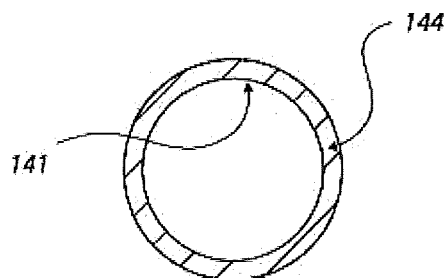


Figure 11B

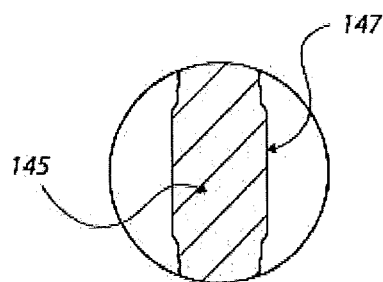


Figure 11C

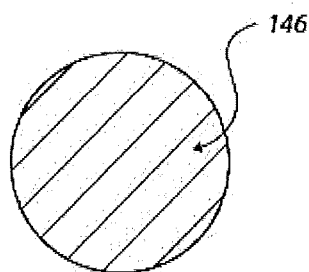


Figure 12

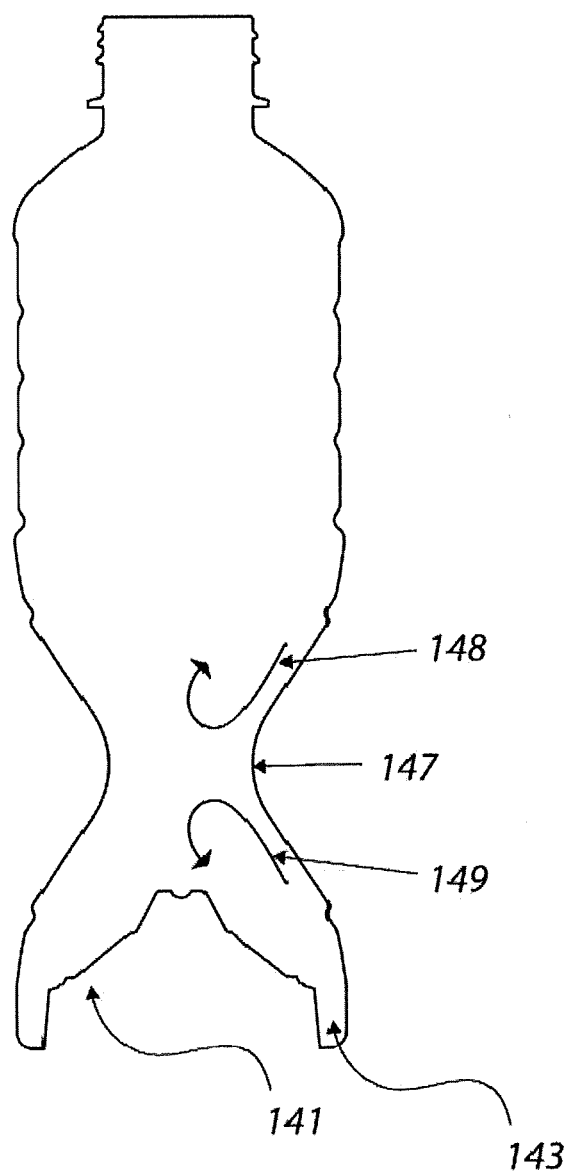


Figure 13

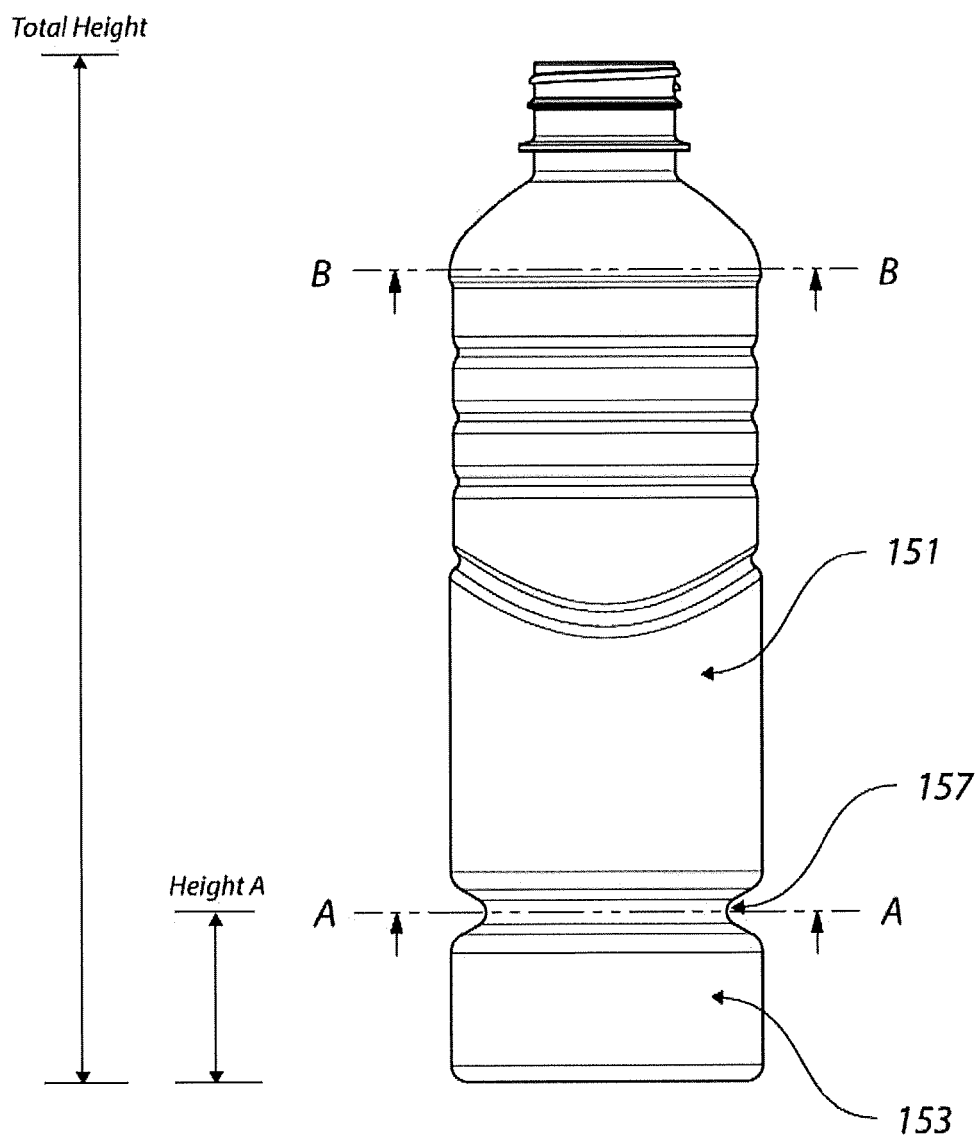


Figure 13A

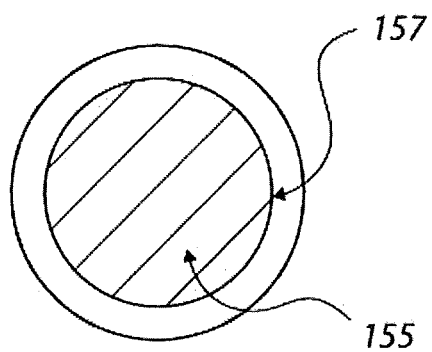


Figure 13B

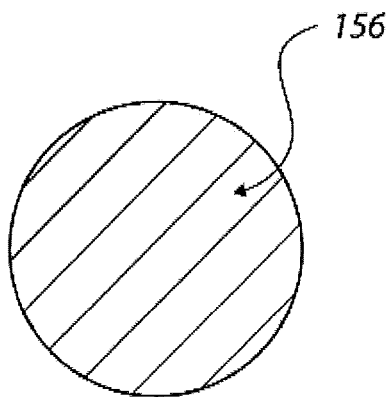


Figure 14

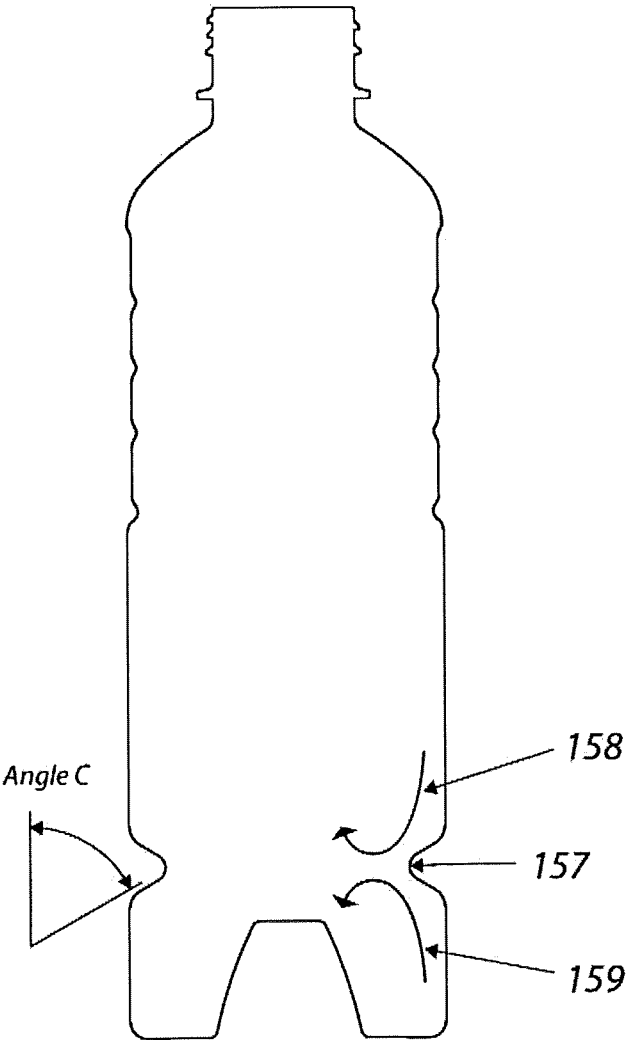


Figure 15

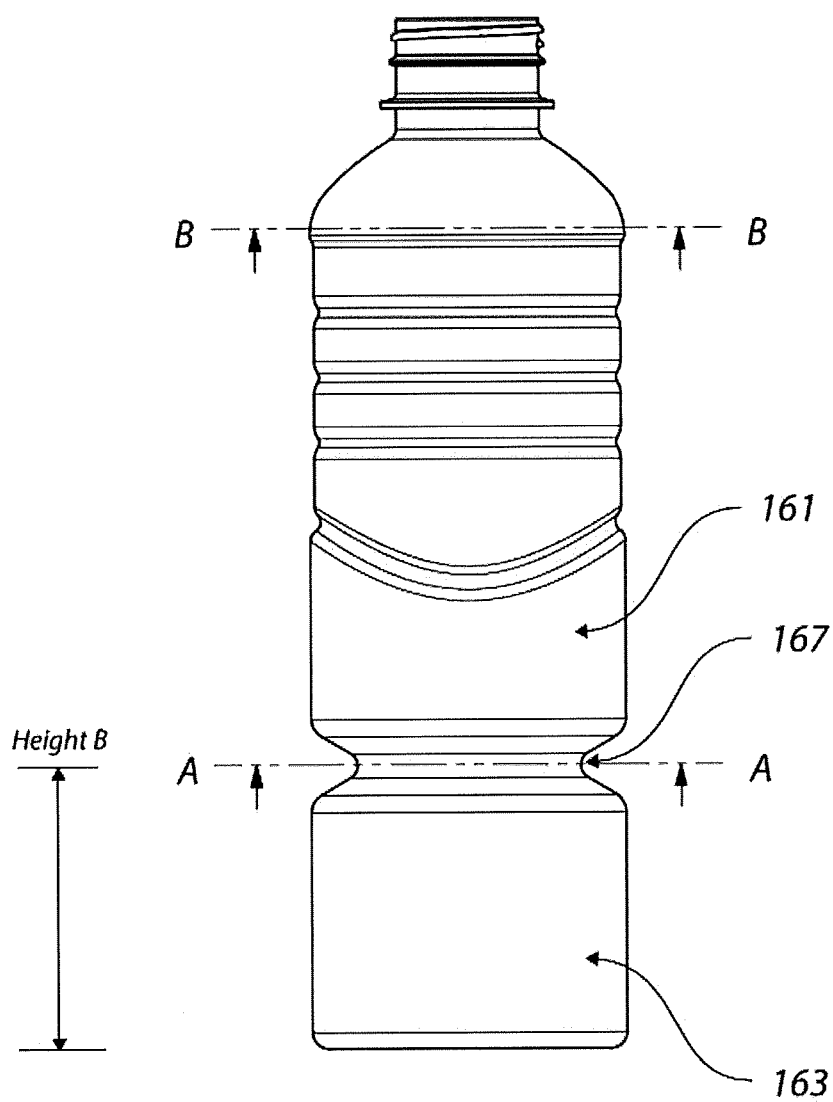


Figure 15A

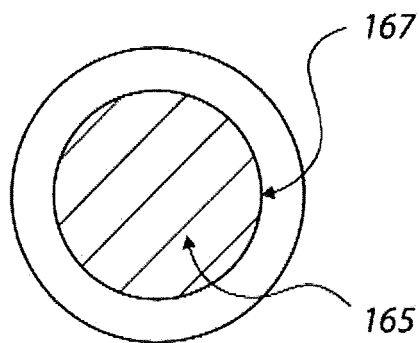


Figure 15B

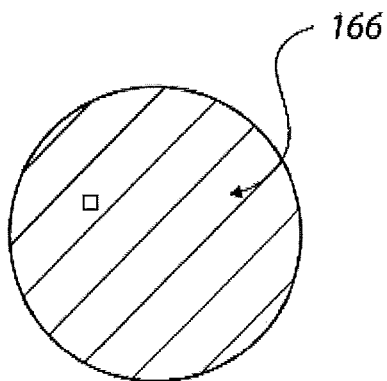


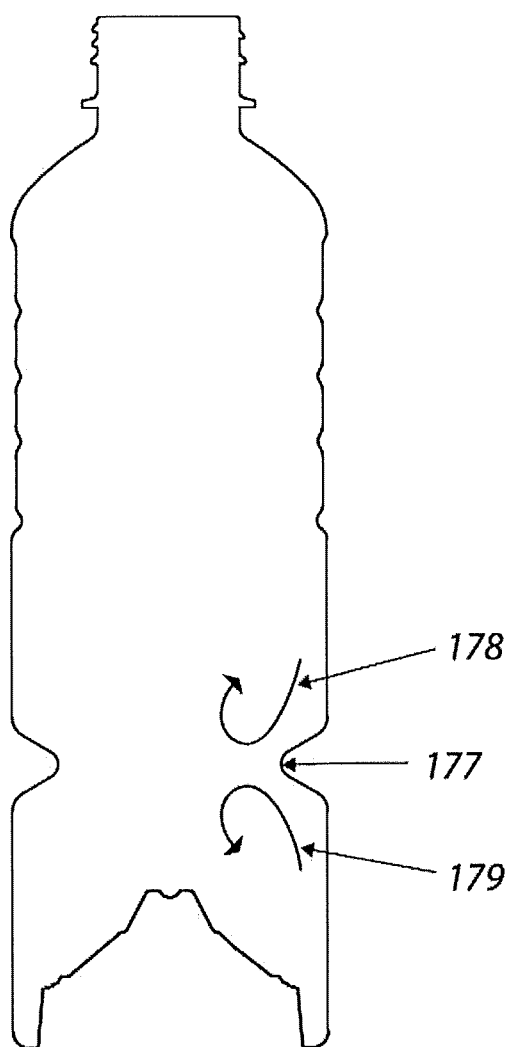
Figure 16

Figure 17

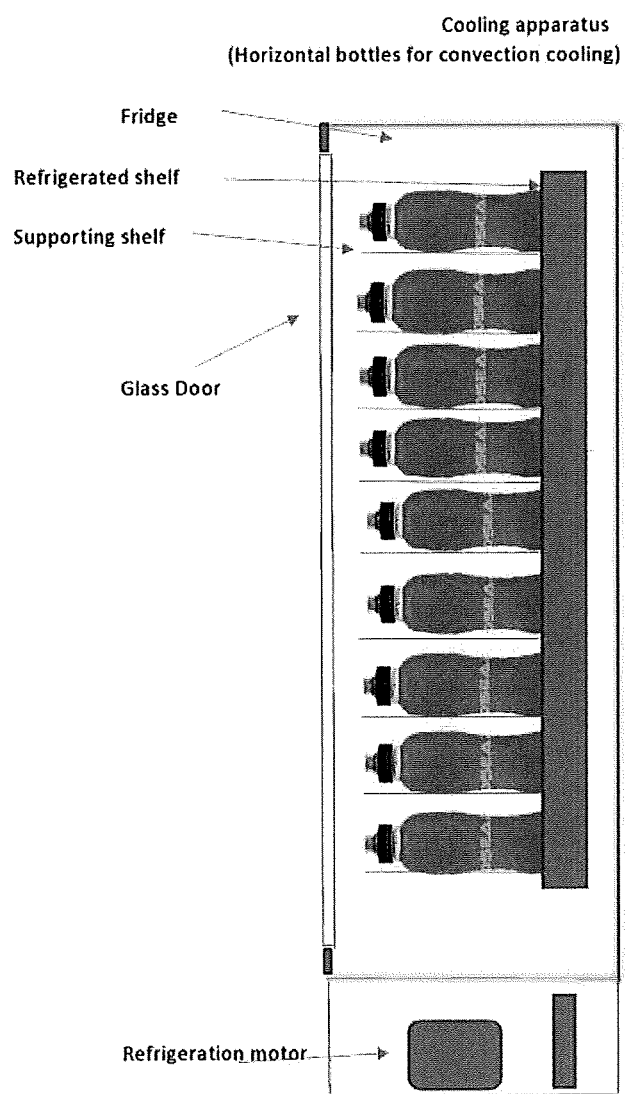


Figure 18

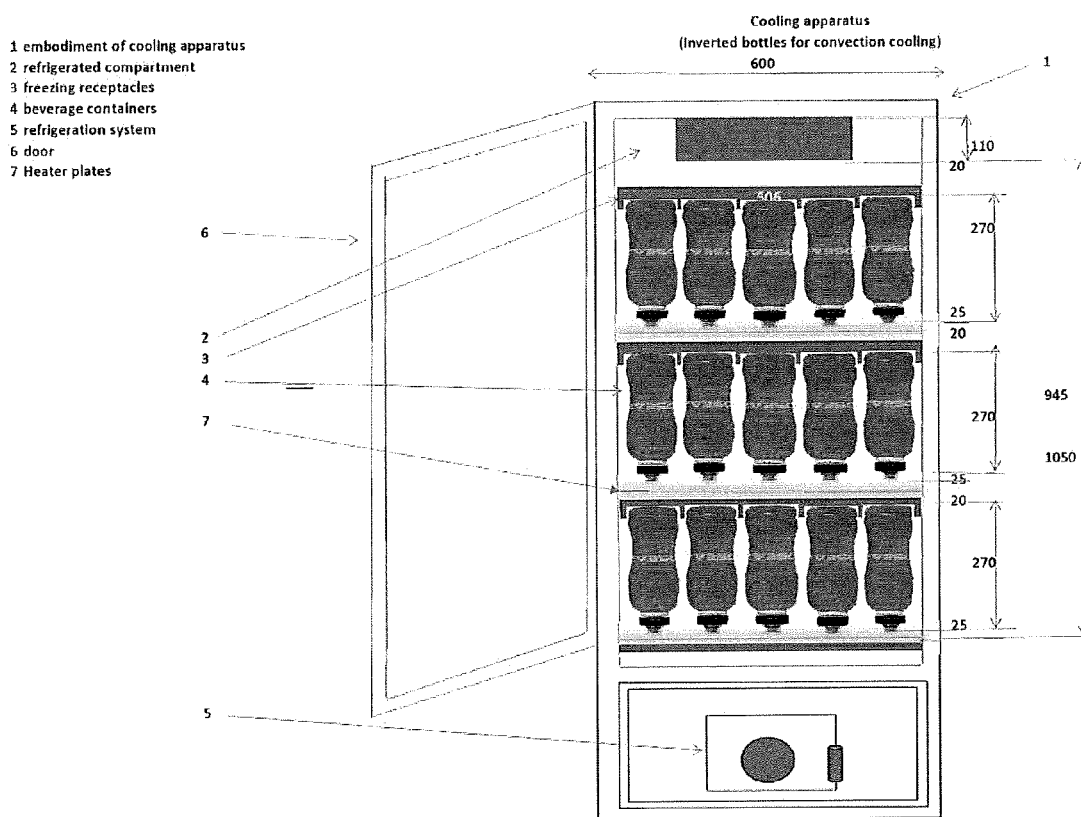
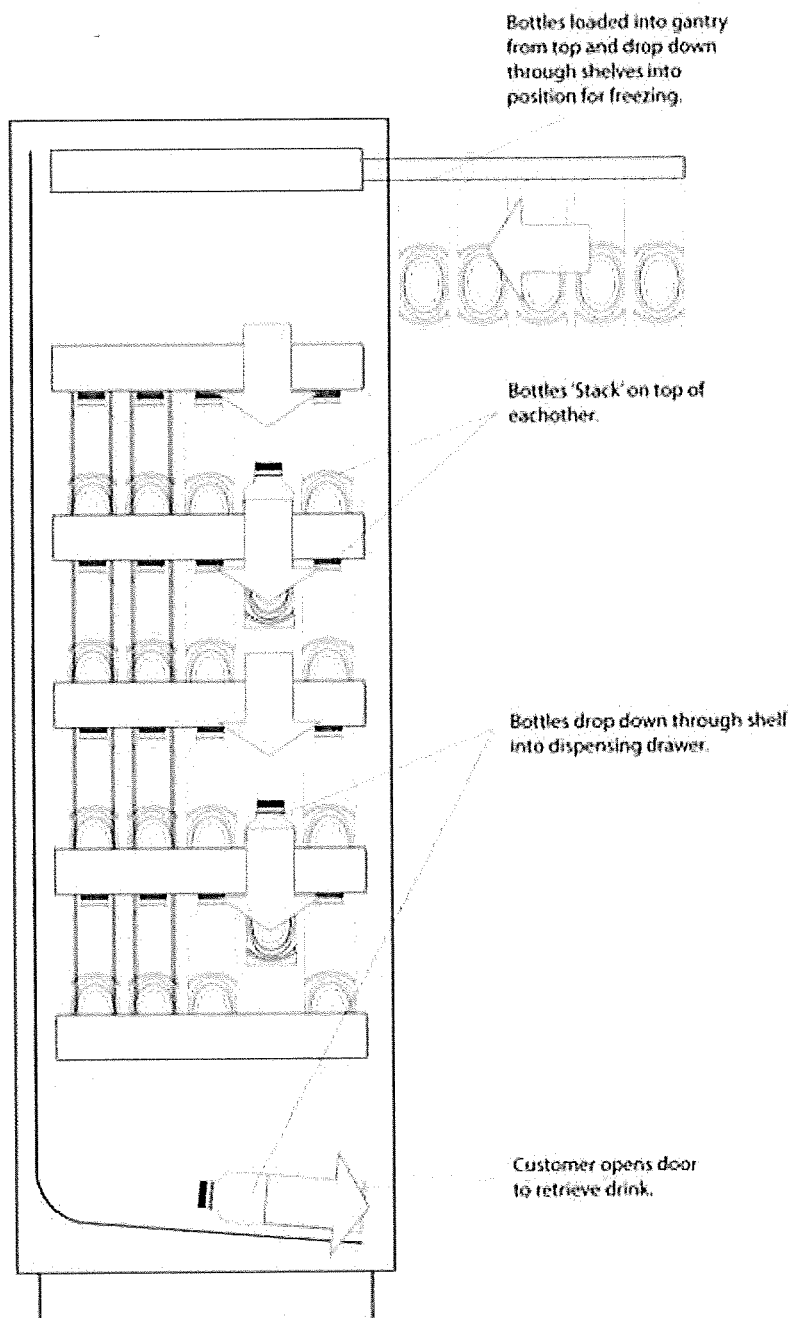


Figure 19



REFRIGERATION APPARATUS

TECHNICAL FIELD

[0001] The present inventions relates to a refrigeration apparatus.

[0002] In particular, the present invention is used for refrigerating beverage containers.

BACKGROUND ART

[0003] It is common practice for products to be bottled and sold commercially on a large scale. These products can include the likes of alcohol, soft drinks, juice, dairy products, food, medicine and other consumable products.

[0004] In many instances, it is desired for the product to be stored and sold cold. There are many reasons for this, such as health and safety reasons for the likes of milk, or some products simply tastes better when cold, like beer or soft drinks.

[0005] For products that are more desirable when it is cold, it is common practice for the merchandisers to store these products in a refrigerator until the consumer purchases the product.

[0006] With this common practice, the general problem exists that the product, after it has been purchased and taken out of the refrigerator, does not stay cold for very long due to the product's heat transfer according to the atmospheric conditions.

[0007] The most trivial solution to the above problem is to freeze the product before removing it for consumption. This is usually conducted at home and not in the retail situation. While it is useful in keeping the products cool for a longer period of time, it has a number of obvious disadvantages.

[0008] Firstly, the frozen product will need to melt first before it can be consumed, so a thirsty person may need to wait for a considerable time before they can start consuming the product within the container, which is not desirable.

[0009] There have been attempts to solve the problem. U.S. Pat. No. 5,284,028 issued to Wilco R. Stuhmer describes a beverage container having a main beverage chamber and an ice chamber consisting of a polymeric film pouch located within the main chamber. By filling the ice chamber with ice, a beverage in the beverage chamber can be kept cold by virtue of the heat transfer from the beverage to the ice through the polymeric film. This configuration prevents dilution of the beverage just prior to consumption.

[0010] Wilco R. Stuhmer further developed a refrigerator which will allow the storage of such beverage bottles and this is described in U.S. Pat. No. 6,311,499. This patent describes a dual-temperature refrigerating device for partially freezing beverage inside a sealed beverage container. One compartment within the device is held at a temperature below freezing and another compartment is kept at a temperature above freezing. An opening between the two compartments allows a beverage container to be placed so that it is simultaneously exposed to below-freezing temperatures and above-freezing temperatures.

[0011] Although such a refrigerator works effectively in terms of keeping a part of the bottle's contents frozen, it is not very commercially useful. The refrigerator as described in Stuhmer's patent has a number of disadvantages.

[0012] First of all, it is very expensive to manufacture. The refrigerator needs to have two separate compartments, at different temperatures. This means that the structure of the

refrigerator will need to meet certain standards in terms of thermal insulation, as well as a costly set up in terms of having two separate coolers (or coolers with dual control) in order to provide the different temperature compartments.

[0013] Secondly, the way the bottle sits for such a refrigerator is not viable commercially. The opening between the two compartments is where the bottle is placed. This means that only a limited amount of bottles can be placed in the refrigerator at any one time.

[0014] Thirdly, again, with the way the bottle sits in this refrigerator, it makes it difficult for the user to load and unload bottles out of the refrigerator. Furthermore, it will be prone to breaking if unloaded incorrectly. Therefore, it is not practical for everyday use to an average consumer.

[0015] Fourthly, there are some reasonably high maintenance costs in relation to this refrigerator. The two compartments means two separate cooling systems, as well as the actual structure of the refrigerator itself makes it hard to maintain.

[0016] Lastly the two separate cooling systems in this refrigerator will require a large amount of energy in order for the freezer to work effectively.

[0017] In light of the above, it is advantageous to provide a refrigerator which allows the contents of the bottle to be partially frozen, but at the same time being commercially viable, relatively cheap to manufacture and maintain, easy to operate and load/unload and energy efficient.

[0018] All references, including any patents or patent applications cited in this specification are hereby incorporated by reference. No admission is made that any reference constitutes prior art. The discussion of the references states what their authors assert, and the applicants reserve the right to challenge the accuracy and pertinency of the cited documents. It will be clearly understood that, although a number of prior art publications are referred to herein, this reference does not constitute an admission that any of these documents form part of the common general knowledge in the art, in New Zealand or in any other country.

[0019] Throughout this specification, the word "comprise", or variations thereof such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

[0020] It is an object of the present invention to address the foregoing problems or at least to provide the public with a useful choice.

[0021] Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

DISCLOSURE OF THE INVENTION

[0022] According to one aspect of the present invention there is provided a freezing receptacle for use within a cooling apparatus:

wherein the freezing receptacle is configured to hold part of a beverage container to be contained within the receptacle, and

the freezing receptacle includes a mechanism to assist cooling of the beverage container

[0023] According to one aspect of the present invention there is provided a cooling apparatus including:

a refrigeration compartment; and
a freezing receptacle as described above.

[0024] According to another aspect of the present invention there is provided a method of cooling using a cooling apparatus wherein the cooling apparatus includes a refrigeration compartment; and a freezing receptacle as described above; characterised by the steps of

[0025] a) placing a beverage container within the freezing receptacle which is configured to hold a part of the beverage container;

[0026] b) freezing the contents of the beverage container within the freezing receptacle; and

[0027] c) refrigerating the contents of the beverage container within the refrigeration compartment.

[0028] The term cooling apparatus should be understood to be any apparatus, device or system which is used to artificially remove heat via any heat transfer mechanisms or systems.

[0029] In preferred embodiments, the mechanism that assists the cooling of the beverage container is in the form of a thermal conduction plate.

[0030] Heat can be transferred between physical systems via three main mechanisms. Thermal conduction, thermal convection and thermal radiation.

[0031] Thermal conduction can be broadly described as the transfer of energy between objects that are in physical contact.

[0032] Thermal convection can be broadly described as the transfer of energy between an object and its environment, due to fluid motion.

[0033] Thermal radiation can be broadly described as the transfer of energy to or from a body by means of the emission or absorption of electromagnetic radiation.

[0034] Typical heat transfer of cooling systems can include non-cyclic, cyclic, vapour-compression cycle, vapour absorption cycle (use of refrigerants), gas cycle, thermoelectric and magnetic and the like.

[0035] The term refrigeration compartment should be understood to mean any compartment, space or receptacle which is artificially kept cool via any heat transfer mechanisms or systems.

[0036] Preferably the refrigeration compartment has an entry configured to allow a user to load and unload items into/from the refrigeration compartment.

[0037] In some embodiments the entry can be closed via a door or gate. Such doors or gates include any standard refrigerator or vending machine doors and the like.

[0038] In these embodiments the doors or gates may be lockable in situations when the entry is not desirable to be opened. For example, if the cooling apparatus is used in a vending machine application, then the entry to the cooling apparatus needs to be secured. However, for these embodiments there will be an access to obtain the beverage which is purchased, much like a conventional vending machine.

[0039] In other embodiments, the entry is a permanent opening accessible by the user. This particular embodiment is especially useful for supermarkets or shops and the like.

[0040] Preferably the atmosphere within the refrigeration compartment is at a temperature which cools the contents stored within, but does not freeze the contents.

[0041] Preferably the atmosphere within the refrigeration compartment is above 0° C., so that the contents of the beverage container exposed in the refrigeration compartment does not freeze.

[0042] In one embodiment, the atmosphere within the refrigeration compartment is -1 to +5° C. as this is a standard commercial range—particularly for water based products. The ideal temperature will depend on the composition of the fluid. However, it should be appreciated that some fluids such as alcohol freeze at lower temperatures may be held at a colder temperature range than other fluids such as water.

[0043] The term freezing receptacle should be understood to be any, structure, apparatus or device which is configured to contain at least a part of a beverage container, while artificially cooling the contents of the beverage container via thermal conduction

[0044] Preferably the freezing receptacle incorporates at least one thermal conduction plate.

[0045] The freezing receptacle is preferably designed to sit substantially horizontally and level within the cabinet.

[0046] In some embodiments the freezing receptacle is configured to contain only a part of the structure of the beverage container so that the rest of the structure of the beverage container is exposed to the atmosphere of the refrigeration compartment so that different parts of the beverage container is cooled at different rates or to different temperatures.

[0047] Preferably, the thermal conduction plate freezes the contents of the portion of the beverage container contained adjacent to it.

[0048] Preferably the freezing receptacle incorporating at least one thermal conduction plate operates at a temperature (at contact point with the beverage containers) of between -40 to -10° C. This temperature range is relevant as for instance using a lower temperature to aid more rapid freezing may be more suitable with some fluids to freeze the fluid in the bottom section of the beverage container in the optimum time. These temperatures can be varied to meet different performance criteria. It should be noted that below -40° C. may be uneconomical to achieve.

[0049] Preferably, the freezing receptacle is in physical contact with the outer surfaces of the structure of the beverage container in order to provide cooling via thermal conduction.

[0050] Preferably, the freezing receptacle is of a structure configured so that a number of beverage containers can be contained within the structure of the freezing receptacle in a row or multiple rows, much like a shelving system for a vending machine. This is to allow a large number of drinks to be stored within the freezing receptacle.

[0051] In one embodiment, the freezing receptacle is configured to allow the beverage containers to slide forward to the front of the receptacle. This can be achieved by an angled construction where the beverage containers can slide forward under its own weight, as the beverage container in front is removed.

[0052] The freezing receptacle may be configured to be substantially complementary to a part of the dimensions of the beverage container so the beverage container can be fitted into the freezing receptacle while maintaining physical contact between at least a part of the container and the receptacle.

[0053] In one embodiment, the freezing receptacle is a channel or channels that substantially matches the cross section of the part of the beverage containers to be stored. So that the beverage containers can be recessed into the struc-

ture of the freezing receptacle and maintain maximum contact with the freezing thermal conduction plate to ensure maximum thermal transfer.

[0054] In this embodiment, there is a small gap between the side structures of the freezing receptacle and the beverage container. The gap is approximately 1 mm. This is to allow fitment of variations of the beverage container and allow some movement.

[0055] In some embodiments of the present invention the freezing receptacle is in the form of a shelf which can be fitted in to and removed from a cooling apparatus as this allows existing cooling apparatus such as fridge cabinets to have these freezing receptacles retro-fitted into them. Further, this allows freezing receptacles to be removed for the purposes of cleaning and or maintenance.

[0056] However, in preferred embodiments the receptacles are fixed in a predetermined location which would be defined by the size/height of beverage containers to be used. This could vary and therefore merchandisers could have different shelf configurations.

[0057] Some freezing receptacles may include a biasing means which allows the receptacle to be temporarily expanded to receive a beverage container under a force, but will bias back to its original position once the container is within the receptacle. This is to ensure that the fit between container and the receptacle is always snug, and to ensure there is always physical contact between the container and thermal conduction plate.

[0058] The surface area of the freezing receptacle that is in contact with the beverage container has a direct relationship to the rate of cooling/freezing and the like. In a preferred embodiment, the contact surface area between the base of the beverage container and the freezing thermal conduction plate is maximised.

[0059] Preferably, the freezing receptacle is of a structure that is robust enough to support the weight of the beverage containers and their contents within its structure without significant deflection to maintain the physical contact between the freezing thermal conduction plate and the beverage container.

[0060] Preferably, the freezing receptacle will have insulation to the base and sides and incorporate thermal breaks where required to reduce condensation forming on the outside surfaces.

[0061] Preferably, the freezing receptacle will contain a cooling mechanism in the form of a specially designed circuit or pipes to reticulate the refrigerant gas on the side of the freezing receptacle structure that is not in contact with the beverage containers. This cools the freezing receptacle to the desired temperate which in turn removes heat from the beverage containers via thermal conduction.

[0062] In some embodiments, there may be more than one freezing receptacle in the refrigerating apparatus. This allows a larger volume of beverage containers to be stored.

[0063] In these embodiments, the freezing receptacles can be configured as an assembly to be installed into the refrigerating apparatus.

[0064] In an alternative embodiment, the freezing receptacles are separate modules that can be retrofitted into existing refrigerating apparatuses.

[0065] As an example only, each freezing receptacle may have a nominal refrigerating capacity of 50 watts/hr at -15° C. saturated suction temperature and $+35^{\circ}$ C. saturated condensing temperature. The first figure -15° C. relates to

the evaporating temperature of the refrigerant in the receptacle, the second $+35^{\circ}$ C. relates to the condensing temperature of the refrigerant which is affected by the ambient temperature the system is operating in.

[0066] There could be various operating parameters dictated by variables such as volume and desired time to complete the cycle, and the above is one example. The cooling system design may need to be adjusted to accommodate different ambient temperatures and operating conditions with components selected accordingly to perform under these conditions.

[0067] The total refrigerating capacity of the refrigeration system will vary with the size and internal volume of the refrigerating compartment and the volume of product to be refrigerated within it. The design rating of the refrigeration system for the cabinet will remain reasonably linear with the freezing receptacle design if the refrigerating compartment is up or down scaled. However, the option to vary system capacity is available to reduce freezing times and or accommodate more beverage containers if required.

[0068] In one embodiment, there may be provided a feeding channel into which the beverage containers can be loaded. The feeding channel will then be connected to a number of substantially parallel rows which act to align the beverage containers so that they can be readily accessible from the cooling apparatus.

[0069] In some embodiments, the cooling apparatus may have one way barriers (say gates) at the end of each channel. This feature allows the beverage containers to be removed from the cooling apparatus and not readily placed back therein—except via the feeding channel.

[0070] This feature also ensures that the coldest beverage containers (that is the ones that have been in the cooling apparatus for the longest) are the ones which are the most accessible.

[0071] In some embodiments there are a number of display channels which depend from the feeding channel.

[0072] An option is to provide contact cooling at the base of the beverage container with the bottle inverted, so as to set up convection in the beverage container. Tests have shown this method can reduce the time taken to lower the beverage temperature from ambient temperature to 0 deg C. once it is placed in the refrigeration apparatus.

[0073] Bottles are loaded into the fridge shelving system with the base of the bottle facing upwards. Shelving may be arranged so that each shelf supports the top of the bottle (inserted into it upside down) and holds it firmly into the shelf above it where the contact freezing occurs.

[0074] This method invokes “convection” within the bottle which compared to “heat transfer” with the conduction method results in a faster freezing time. Heater plates are located between each shelf or alternatively heat can be introduced into the fridge compartment via other methods to maintain the desired temperature in the ambient space to control the ice growth within the bottle to the desired level.

[0075] Freezing the bottle when it is positioned within the specially designed refrigerated shelf in the horizontal plane can further reduce the freezing time due to a higher convection heat transfer coefficient.

[0076] In one embodiment of the present invention, the beverage containers are in the form of a waisted bottle with a passage that is closed by application of force such as that described in the Applicant's PCT application number PCT/NZ2013/000190. This beverage container is designed to

separate beverage in a compartment on one side of the closed passage that can be frozen while beverage on the other side of the closed passage can be maintained in its liquid form.

[0077] In another preferred embodiment the beverage container does not have a closed passageway but incorporates structures that influence the thermal convection liquid flow within a single complex compartment of the container.

[0078] In some embodiments the mass volume of the contents in closest contact with the thermal conduction plate should be minimized to encourage freezing.

[0079] In operation, the user places a beverage container in the cooling apparatus via the feeding channel of the cooling apparatus.

[0080] The beverage container is placed within the freezing receptacle in the refrigeration compartment so that the container fits snugly into the freezing receptacle, while maintaining maximum physical contact between the surface areas of the receptacle and container.

[0081] Only a part of the beverage container sits in the freezing receptacle, while the other part of the container is exposed to the refrigeration compartment's atmosphere of 3 to 5° C. or a temperature more suitable for any specific product.

[0082] The refrigerant contained in the refrigeration system contacts the side and base of the freezing thermal conduction plate that is not in contact with the beverage container, cooling the thermal conduction plate to its desired temperature range of -40 to -10° C. (as desired). The thermal conduction plate thus removes heat from the contents of the beverage container and freezing the contents that are contained within the receptacle, while the contents that are not contained within the receptacle will be cooled and maintained at the desired temperature usually between 3 to 5° C. in the atmosphere compartment of the cooling apparatus, and stay in its liquid state.

[0083] In some embodiments, the beverage container sits on top of the freezing receptacle which supports and can also cool the beverage container from below (and/or the side).

[0084] In other embodiments, the beverage container may be held from its top by the freezing receptacle or by its side.

[0085] It is envisaged that in some embodiments the user would push the beverage container into a feeding channel which forms a part of the freezing receptacle. This causes other beverage containers already within the receptacle to move to the ends of a channel or channels depending from the feeding channel.

[0086] In some embodiments the present invention may be used with beverage containers containing carbonated fluids. It should be appreciated that bottles made from plastics material often need strengthening in various parts of the bottle including the base if they are to hold carbonated fluids. Often the strengthening is in the form of corrugations, spokes or channels.

[0087] However, bottles having this design may not have the ideal surface contact with the freezing receptacle to freeze with the required efficiency. Thus, in some embodiments the freezing receptacle may have a complimentary shape to the beverage containers to optimise the surface contact. For example, if the base of the beverage container has an indent, there may be a correspondingly shaped protrusion on the base of the freezing receptacle. The protrusion could also act as a guide further stabilising the bottles within the freezing receptacle.

[0088] Someone requiring a chilled beverage container in accordance with the present invention can then access the container from the ends of those channels. Access may or may not be governed by gates on the channels.

[0089] The invention can be used to merchandise and retail the drink products in a refrigerated cabinet (merchandise) that may have a glass door and be accessed by the public and staff for both purchasing and loading requirements. This invention can be used by a self-service or vending style of merchandise of the type that is used widely by the beverage industry to retail its products.

[0090] Additional features of the present invention may include:

[0091] Drink ready indicators—incorporated as part of the label on each bottle a coloured dot or button that changes colour when the drink has attained the correct temperature and is ready to drink.

[0092] Use of infrared sensors to determine when ice is at correct height that could release a gate system of locked doors to allow ready to drink bottles to be accessed.

[0093] Bottles loaded from the front via a locked loading door—bottles are frozen to drink ready stage as new product is loaded those that have been in the cabinet the longest move towards the rear of the cabinet where they drop down a chute system at the rear of the cabinet and are dispensed via a slide out draw at the base of the cabinet.

[0094] It can be seen that the present invention has a number of advantages over the prior art. They are:

[0095] Allows ease of loading and unloading.

[0096] Apparatus can be designed to accommodate a suitable volume of containers that could be less or more to meet demand in different markets.

[0097] Efficient way of freezing/refrigerating the beverage container.

[0098] Commercially viable to manufacture.

[0099] Relatively less maintenance required.

[0100] Allows apparatus to be manufactured so as to align with current accepted retail merchandising practices.

BRIEF DESCRIPTION OF DRAWINGS

[0101] Further aspects of the present invention will become apparent from the following description which is given by way of example only and with reference to the accompanying drawings in which:

[0102] FIG. 1 Shows the general arrangement of the cooling apparatus.

[0103] FIG. 2 Is an end on view of a freezing receptacle incorporating at least one thermal conduction plate showing beverage containers in position at the end of the display channels.

[0104] FIG. 3 Provides typical dimensions in millimetres that channels within a freezing receptacle.

[0105] FIG. 4a Is a top view of a configuration of a freezing receptacle.

[0106] FIG. 4b Is a top view of an alternative configuration of a freezing receptacle.

[0107] FIGS. 5, 6 and 7 Show different variations of operation cooling apparatus in accordance with the present invention, and

[0108] FIG. 8 illustrates an alternative embodiment to the present invention particularly suitable for use with carbonated beverages.

[0109] FIG. 9 shows a configuration of the invention that influences the thermal convection of the liquid within the container.

[0110] FIG. 10 shows a modified configuration of the invention that more drastically influences the convection of the liquid within the container.

[0111] FIG. 11 shows an alternative version of geometry designed to influence the thermal convection of the liquid within the container.

[0112] FIG. 12 shows a more alternative version of geometry designed to influence the thermal convection of the liquid within the container, and

[0113] FIG. 13 shows an alternative bottle configuration, and

[0114] FIGS. 13A & 13B represent section views through the bottle of FIG. 13, and

[0115] FIG. 14 shows an alternative bottle configuration, and

[0116] FIG. 15 shows an alternative bottle configuration, and

[0117] FIGS. 15A & 15B represent section views through the bottle of FIG. 15, and

[0118] FIG. 16 shows an alternative bottle configuration, and

[0119] FIG. 17 shows a cooling apparatus designed to encourage convection of liquid,

[0120] FIG. 18 shows a horizontal stacking of bottles to encourage convection cooling,

[0121] FIG. 19 shows a possible operation of a drop down fridge in accordance with the present invention.

BEST MODES FOR CARRYING OUT THE INVENTION

[0122] FIG. 1 shows an embodiment of the cooling apparatus (1).

[0123] The cooling apparatus (1) has the outside structure of a conventional refrigerator, including a door (6) which allows access to the interior of the cooling apparatus (1).

[0124] The interior of the cooling apparatus is defined as the refrigerator compartment (2). In this refrigeration compartment (2), a number of freezing receptacles incorporating thermal conduction plates (3) are adapted to be installed, and act as shelving to contain the beverage containers (4).

[0125] The freezing receptacles (3) contain the bottom portion of the beverage container (4) within their structures, freezing the contents of the portion of the beverage container (4), while leaving the rest of the beverage container (4) and its content exposed to the atmosphere of the refrigerator compartment (2).

[0126] In this embodiment, the freezing receptacles (3) are cooled by a refrigeration system (5) providing refrigerants to the thermal conduction plates (3), bringing them to between -40 to -10 degrees Celsius and preferably to about -15°C . to -18°C . in temperature. As the thermal conduction plates (3) are in physical contact with the beverage container (4) via thermal conduction, this in turn freezes the beverage. The contents of the portion of this beverage containers (4) that is not in physical contact with the freezing receptacles (3) are left in its liquid form and are prevented from freezing via the refrigeration compartment atmosphere.

[0127] FIG. 2 is an end on view of a freezing receptacle (3) showing beverage containers (4) in position at the end of the display channels (7).

[0128] In the base (8) of the freezing receptacle (3) are a number of refrigerant pipes (9) which carry refrigerant through the receptacle. A range of refrigerants could be used and prove suitable for this application from HFC, HFO or natural refrigerants. New refrigerants are being developed to meet international requirements to reduce global warming potential therefore actual refrigerant chosen could be determined by commercial or environmental considerations.

[0129] It can be seen that when the beverage containers (4) are in position, only the portion of the beverage containers below their waist (10) is in contact with the freezing receptacle (3).

[0130] FIG. 3 provides typical dimensions in millimetres of the channels (7) within a freezing receptacle (3).

[0131] FIG. 4a is a top view of a configuration of a freezing receptacle (3).

[0132] In this configuration, there is provided a feeding channel (11) into which the beverage containers (4) are inserted. The beverage containers (4) are pushed along into the display channels (7) until they meet the ends thereof. At the ends of the display channels (7) are gates (12) which prevent the beverage containers (4) from falling off the receptacle (3) until being removed by a user.

[0133] It can be seen that the configuration of the freezing receptacle (3) is such that the beverage containers (4) are oriented and presented well with and being kept upright and stable.

[0134] FIG. 4b is a top view of an alternative configuration of a freezing receptacle (3b).

[0135] In this configuration, the feeding channel (11b) is on the left hand side of the receptacle (3). Beverage containers (4b) are inserted into the feeding channels (11b). Beverage containers (4b) are then pushed along into the display channels (7b) until they meet the ends thereof. Rail guides (100) guide and locate the containers (4b) into the channels (7b). At the back of the channels (7b) are shelf bumps (101) which act to prevent the beverage containers (4b) from jamming in the display channels (7b).

[0136] It should be noted that the display channels (7b) are also freezing channels and it is possible for the beverage containers (4b) to be loaded or returned to any freezing channel.

[0137] FIGS. 5, 6 and 7 show different variations of operation of a cooling apparatus in accordance with the present invention.

[0138] FIG. 5 is a base system which operates as follows.

[0139] High pressure hot discharge vapour is pumped from the compressor (20) to an external condenser (21). Heat is removed from the vapour by the condenser fan (21) and the refrigerant changes state from vapour to liquid when cooled below the saturated condensing temperature of the refrigerant. Liquid then flows from the condenser (21) to a liquid receiver (22). Liquid then passes from the liquid receiver (22) to the expansion device (23).

[0140] As liquid flows through the expansion device (23) it undergoes a pressure drop. Liquid refrigerant begins to boil at the corresponding saturation temperature in relation to the pressure. A refrigerant is now in a state of liquid/vapour mixture. As the refrigerant moves through the evaporator (24) it continues to boil as heat energy is transferred from the refrigerated space (50) to the refrigerant. By the

time the refrigerant exits the evaporator (24), all of the liquid refrigerant has boiled and the refrigerant is now in a superheated vapour state.

[0141] Superheated suction vapour is then drawn from the evaporator (24) to the compressor (20) and the cycle begins again.

[0142] A separate line (27) is also taken from the discharge line (25). This line (27) passes through a solenoid valve (28) which is controlled by the ambient temperature within the refrigerated space (50). When the valve opens hot discharge vapour is allowed to pass to the internal condenser plates (26). As the discharge vapour passes through the condenser plates (26), heat energy is removed from the refrigerant and it changes state to a liquid.

[0143] Liquid then flows back from the internal condenser plates (26) and rejoins the liquid line after the external condenser (21). This allows a portion of the heat energy absorbed by the evaporator (24) to be reintroduced into the ambient air of the refrigerated space (50). This allows for the ambient temperature to be maintained above the freezing point of the product while having no effect on the evaporator temperature. So the portion of the product in contact with the evaporator (24) is allowed to freeze while the portion of the product not in contact will remain in the liquid state.

[0144] FIG. 6 works very similarly to the device illustrated in FIG. 5 with the addition of a hot gas defrost sequence.

[0145] When the defrost begins the solenoid valve (30) in the suction line closes. There is a line (31) taken from the discharge line (25) through another solenoid valve (32), and into the line feeding the evaporators (24) after the expansion device (23). This solenoid (32) opens as the suction line solenoid closes (30).

[0146] Hot discharge vapour will now flow directly into the evaporators (24) and they will defrost. As the vapour passes through the evaporators (24) heat is transferred from the refrigerant to the refrigerated space (50). The refrigerant changes state to a liquid when it reaches its saturated condensing temperature. The liquid refrigerant then passes through an expansion device (33) and into a fan assisted evaporator (34) inside the refrigerated space (50). The pressure drop through the expansion device (33) allows the liquid refrigerant to begin boiling as described in FIG. 5. At the exit of the evaporator all of the liquid refrigerant has boiled and it is now in a superheated vapour state.

[0147] Superheated suction vapour is then drawn back to the compressor (20). When the defrost time period has elapsed the hot gas solenoid valve (32) will shut, the system will be allowed to run for a predetermined amount of time to clear most of the liquid refrigerant from the evaporators freezer plates (24). After this period has elapsed the solenoid valve (30) in the suction line will open and normal operation will resume.

[0148] FIG. 7 shows a liquid line filter drier (40) in the liquid line after the liquid receiver (22). The filter drier (40) will filter contaminants from the refrigerant as it passes through. It will also absorb moisture from the refrigerant to ensure the system is dry.

[0149] There is also a liquid line sightglass (41) which is a visual check to ensure there is enough refrigerant in the system for operation. Liquid flow and level can be seen through the sightglass (41). The drawing also shows a solenoid valve (55) in the liquid line after the liquid sight-

glass (41). At times it may be desirable to shut off liquid flow to the evaporators (24) by closing this solenoid valve (55).

[0150] FIG. 7 also shows a liquid to suction heat exchanger (43). Warm liquid refrigerant passes through one side of the heat exchanger (43), and cool vapour passes through the other side. Heat energy is transferred from the liquid to the vapour through the heat exchanger walls. The purpose of this is to give additional subcooling to the liquid refrigerant. By doing so it is ensured that a solid liquid column will be present at the inlet to the expansion device (23). Otherwise it is possible a portion of the refrigerant will boil before reaching the expansion device (23) resulting in energy efficiency penalties.

[0151] The other function of the liquid to suction heat exchanger (43) is to ensure no liquid refrigerant is present in the suction line before the vapour enters the compressor (20) which can be detrimental to the compressor's operation. By absorbing additional heat from the liquid through the heat exchanger (43) it is less likely liquid will pass through to the compressor (20) as any remaining liquid in the suction line will likely boil in the heat exchanger (43).

[0152] FIG. 7 also shows a suction accumulator (44) in the suction line before the compressor (20). In the event that liquid refrigerant does pass through the liquid to suction heat exchanger (43) it will be trapped in the bottom of the suction accumulator (44). Vapour will be drawn from the top of the suction accumulator (44) back to the compressor (20). Any liquid refrigerant trapped in the suction accumulator (44) will boil to a vapour as it absorbs heat energy through the suction accumulator walls.

[0153] FIG. 7 also shows a flow modulating valve (45) in the line returning liquid refrigerant from the internal condenser plates to the liquid line. The purpose of this valve (45) is to limit the flow through the heater plates (26) to give better control over the ambient temperature in the refrigerated space (50). It will also aid with maintaining a suitable condensing pressure on the high pressure side of the system.

[0154] The high pressure side encompasses the piping and parts between the compressor discharge connection and the expansion device (23) feeding the evaporators (24). The low pressure side of the system encompasses all the piping and parts from the expansion valve outlet (33) to the compressor (20) suction connection. The lines and parts feeding the internal condensers (26) would be considered as part of the high pressure side of the system. During Hot gas defrost the evaporators (24) would also be considered part of the high pressure side of the system up to the inlet of the expansion device (33) feeding the defrost evaporator. The defrost evaporator (34) would be considered part of the low pressure side of the system.

[0155] FIG. 8 illustrates an alternative embodiment of the present invention. The embodiment in FIG. 8 is particularly suitable for use with a bottle (120) that is designed to withhold the pressures of carbonation. The bottle (120) has an indent (121) at the base thereof, in this particular embodiment off-center with respect to the longitudinal axis, and projects inwardly toward the center of the bottle, which gives additional strength to the bottle (120). The freezer receptacle (122) has a complimentary protrusion (123) which optimises surface contact between the freezer thermal conduction plate (122), and the indent (121) of the bottle (120).

[0156] It can also be seen that the sides (124) of the receptacle (122) are also complimentary in shape to the lower part of the bottle (120).

[0157] FIG. 9 illustrates another embodiment of the present invention. In this example there is a larger central indentation (131) in the base of the container which may optionally engage accordingly with a protruding thermal conduction plate. In this embodiment the freezer receptacle preferably operates at a temperature between -25°C . and -35°C . but more preferably between -28°C . and -31°C ., with a substantial area of contact between the base of the container (133) and the thermal conduction plate (132).

[0158] FIG. 9A illustrates a section view through line A of FIG. 9 about 1 cm above the base of the container. This illustrates that the larger central indentation (131) reduces the sectional area (134) of container near the base of the container resulting in decreased time taken to cool and freeze said contents. The sectional area (134) is preferably reduced to between 85% and 15% of the container maximum diameter sectional area (135, FIG. 9C). Shown is a sectional area reduction to 80% of the container maximum diameter sectional area (136, FIG. 9C).

[0159] FIG. 9B illustrates a section view through line B of FIG. 9. This illustrates the reduced sectional area (135) of the container through the narrow open passage (137) between the top and bottom of the container. This reduced sectional area (135) of the narrow passage is less than the containers maximum diameter sectional area (136, FIG. 9C). The sectional area of (135) being preferably between 80% and 50% of the maximum diameter sectional area (136, FIG. 9C), and more preferably between 70% and 60% the maximum diameter sectional area. This narrowing will reduce the heat transfer between the warmer top part of the container and the cooler bottom part of the container, decreasing the time to freeze the containers contents. Shown is a reduction in sectional area (135) to 60% of the maximum diameter sectional area 36).

[0160] FIG. 9C illustrates a section view through line C of FIG. 9. This illustrates the maximum sectional area (136) at the containers widest point.

[0161] FIG. 10 illustrates a vertical cross-section cut away of the embodiment from FIG. 9. In this configuration a container waist (137) provides a narrow passage that influences the thermal convection of the liquid within the container. This keeps the warmer liquid (138) in the upper portion of the container and the cooler liquid (139) in the lower portion of the container, decreasing the time to freeze the containers lower contents.

[0162] The thermal convective flows (138, 139) in the container contents are guided by the angles (Angle A, Angle B) of the sidewall from the longitudinal axis, which are both preferably within the range of 20° to 65° but more preferably within the range of 30° to 60° . Shown are two angles of 40° (Angle A, Angle B). These angles redirect the warmer container contents (138) back toward the warmer top part of the container and redirect the cooler container contents (139) back toward the cooler bottom part of the container. This reduces the mixing of the warm and cold internal convective flows and decreases the time to freeze the lower contents of the container.

[0163] FIG. 11 illustrates a variation of the present invention detailed in FIG. 9. This illustrates an even narrower open passage (147) between the top and bottom of the bottle than the narrow passage in FIG. 10 (137). In this example

there is an even larger central indentation (141) in the base of the container that may optionally engage accordingly with a protruding thermal conduction plate. The freezing receptacle preferably operates at a temperature between -25°C . and -35°C . but more preferably between -28°C . and -31°C . Due to the very large central indentation (141) a very thin volume of the container contents (143) remains adjacent to the thermal conduction plate (132). This greatly diminished volume decreases the time to freeze the containers contents near the thermal conduction plate. There is an accelerated growth of ice in the rest of the lower portion once initial ice formation is activated.

[0164] FIG. 11A illustrates a section view through line A of FIG. 11 about 1 cm above the base of the container. This illustrates an even larger central indentation (141) reducing the sectional area (144) of container near the base of the container resulting in decreased time taken to cool and freeze said contents. The sectional area (144) is preferably reduced to between 85% and 15% of the containers maximum diameter sectional area (145, FIG. 11C). Shown is a sectional area reduction to 20% of the containers maximum diameter sectional area (145, FIG. 11C).

[0165] FIG. 11B illustrates a section view through line B of FIG. 11. This illustrates the further reduced sectional area (145) of the container through the narrow open passage (147) between the top and bottom of the bottle. This reduced sectional area (145) of the narrower passage is less than the containers maximum diameter sectional area (145, FIG. 11C). The sectional area of (145) being preferably between 80% and 50% of the maximum diameter sectional area (146, FIG. 11C), and more preferably between 70% and 60% of the maximum diameter sectional area. This increased narrowing will reduce the heat transfer between the warmer top part of the container and the cooler bottom part of the container even more than is achieved in FIG. 9B (135), decreasing the time to freeze the containers lower contents. Shown is a reduction in sectional area (145) to 50% of the maximum diameter sectional area (146).

[0166] FIG. 11C illustrates a section view through line C of FIG. 11. This illustrates the maximum sectional area (146) at the containers widest point.

[0167] FIG. 12 illustrates a cut away of the embodiment from FIG. 11. In this configuration a container waist (147) provides a very narrow passage that drastically influences the thermal convection of the liquid within the container. This keeps the warmer liquid (148) in the upper portion of the container and the cooler liquid (159) in the lower portion of the container, further decreasing the time to freeze the containers lower contents over the container waste shown in FIG. 10 (137).

[0168] FIG. 13 illustrates another embodiment of the present invention. This embodiment shows the narrow passage (157) between the warmer top part of the container (151) and the cooler bottom part of the container (153) in a circular format instead of the previous oval format in FIG. 9B (135) and FIG. 11C (145).

[0169] The height of the narrow passage (Height A) is variable, but preferably in the range of 10% to 60% of the total height of the container (Total Height). And more preferably between the range of 20% to 40% of the total height of the container (Total Height).

[0170] FIG. 13A illustrates a section view through line A of FIG. 13. This shows a circular variation of the narrow open passage (157). This illustrates the reduced sectional

area (155) of the container through the narrow open passage (157) between the top and bottom of the container. The sectional area of (155) being preferably between 80% and 40% of the maximum diameter sectional area (156, FIG. 13B), and more preferably between 70% and 50% of the maximum diameter sectional area. This narrowing will reduce the heat transfer between the warmer top part of the container and the cooler bottom part of the container, decreasing the time to freeze the containers lower contents. Shown is a reduction in sectional area (155) to 60% of the maximum diameter sectional area (156).

[0171] FIG. 13B illustrates a section view through line B of FIG. 13. This illustrates the maximum sectional area (156) at the containers widest point.

[0172] FIG. 14 illustrates a vertical cross-section cut away of the embodiment from FIG. 13. In this configuration a circular container waist (157) provides a narrow passage that influences the thermal convection of the liquid within the container. This keeps the warmer liquid (158) in the upper portion of the container and the cooler liquid (159) in the lower portion of the container, decreasing the time to freeze the containers lower contents.

[0173] The thermal convective flows (158, 159) in the container contents are guided by the angle (Angle C) of the sidewall from the longitudinal axis, which is preferably within the range of 20° to 75° but more preferably within the range of 30° to 60°. Shown is an angle of 70° (Angle C). These angles redirect the warmer container contents (158) back toward the warmer top part of the container and redirect the cooler container contents (159) back toward the cooler bottom part of the container. This reduces the mixing of the warm and cold internal convective flows and decreases the time to freeze the containers lower contents.

[0174] FIG. 15 illustrates a variation of the present invention detailed in FIG. 13. This embodiment shows an even narrower open passage in a circular format (167) between the warmer top part of the container (161) and the cooler bottom part of the container (163).

[0175] The height of the narrow passage (Height B) is variable, but preferably in the range of 10% to 60% of the total height of the container (Total Height). And more preferably between the range of 20% to 40% of the total height of the container (Total Height).

[0176] FIG. 15A illustrates a section view through line A of FIG. 15. This shows a circular variation of the narrower open passage (167). The sectional area shown (165) is at 50% of the maximum diameter sectional area (166, FIG. 15B)

[0177] FIG. 15B illustrates a section view through line B of FIG. 15. This illustrates the maximum sectional area (166) at the containers widest point.

[0178] FIG. 16 illustrates a cut away of the embodiment from FIG. 15. In this configuration a circular container waist (177) provides a narrower passage that influences the thermal convection of the liquid within the container than described in FIG. 14 (157). This keeps the warmer liquid (178) in the upper portion of the container and the cooler liquid (179) in the lower portion of the container, decreasing the time to freeze the containers lower contents. This narrower version of the invention further decreases cooling and freezing times in the lower portion of the container.

[0179] FIG. 17 illustrates inverted positioning of bottles within the fridge to encourage convection cooling.

[0180] FIG. 18 illustrates horizontally stacked positioning of bottles within the fridge to encourage convection cooling.

[0181] FIG. 19 illustrates a drop dispensing fridge in accordance with another embodiment of the present invention.

[0182] Aspects of the present invention have been described by way of example only and it should be appreciated that modifications and additions may be made thereto without departing from the scope of the appended claims.

1. A freezing receptacle for use within a cooling apparatus, wherein the freezing receptacle is configured with a channel to hold a part of a beverage container to be contained within the receptacle, the freezing receptacle comprises:

componentry to assist cooling of the beverage container; and

a biasing means to allow the receptacle to be temporarily expanded to receive the beverage container under a force and return to substantially an original position when the beverage container is within the receptacle.

2. The freezing receptacle as claimed in claim 1 wherein the freezing receptacle is in the form of a shelf.

3. The freezing receptacle as claimed in claim 1 wherein the channel includes at least one feeding channel.

4. The freezing receptacle as claimed in claim 3 wherein the channel includes at least one display channel.

5. The freezing receptacle as claimed in claim 1 which includes barriers at open ends of display channels.

6. The freezing receptacle as claimed in claim 1, wherein the channel is configured to be substantially complementary to part of dimensions of the beverage container so the beverage container can be fitted into the freezing receptacle while maintaining physical contact between at least a part of the beverage container and the freezing receptacle.

7. The freezing receptacle as claimed in claim 1, including insulation to its base and sides and incorporates thermal breaks where required to reduce condensation forming on outside surfaces.

8. The freezing receptacle as claimed in claim 1, wherein the componentry to assist cooling of the beverage container includes a thermal conduction plate.

9. A cooling apparatus, said apparatus comprising:

a refrigeration compartment; and

a freezing receptacle wherein the freezing receptacle is configured with a channel to hold a part of a beverage container to be contained within the receptacle, the freezing receptacle including:

componentry to assist cooling of the beverage container; and

a biasing means to allow the freezing receptacle to be temporarily expanded to receive the beverage container under a force and return to substantially its original position when the beverage container is within the receptacle

10. A method of cooling using a cooling apparatus, wherein the cooling apparatus includes a refrigeration compartment and a freezing receptacle, wherein the freezing receptacle is configured with a channel to hold a part of a beverage container to be contained within the receptacle, the freezing receptacle including componentry to assist cooling of the beverage container; and a biasing means to allow the receptacle to be temporarily expanded to receive the beverage container under a force and return to substantially its

original position when the beverage container is within the receptacle, said method comprising the following steps:

- a) placing a beverage container within the freezing receptacle configured to hold a part of the beverage container,
- b) freezing the contents of the part of the beverage container within the freezing receptacle,
- c) refrigerating the contents of the beverage container within the refrigeration compartment.

11. The method of cooling as claimed in claim **10** wherein the atmosphere within the refrigeration compartment is between $-1-5^{\circ}$ C.

12. The method of cooling as claimed in claim **10** wherein the freezing receptacle operates in a temperature range of -40 to -10° C.

13. (canceled)

14. (canceled)

15. (canceled)

16. (canceled)

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