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(54) A self cooling container

(57) The present invention relates to a container for storing a beverage, the container having a container body and a closure and defining an inner chamber, the inner chamber defining an inner volume and including a specific volume of the beverage. The container further includes a cooling device having a housing defining a housing volume. The cooling device includes at least two separate, substantially non-toxic reactants causing an entropy-increasing reaction producing substantially non-toxic products in a stoichiometric number. The at least two separate substantially non-toxic reactants initially being included in the cooling device are separated from one another and causing an entropy-increasing reaction and a heat reduction of the beverage of at least 50 Joules/ml beverage. The cooling device further includes an actuator for initiating the reaction between the at least two separate, substantially non-toxic reactants.

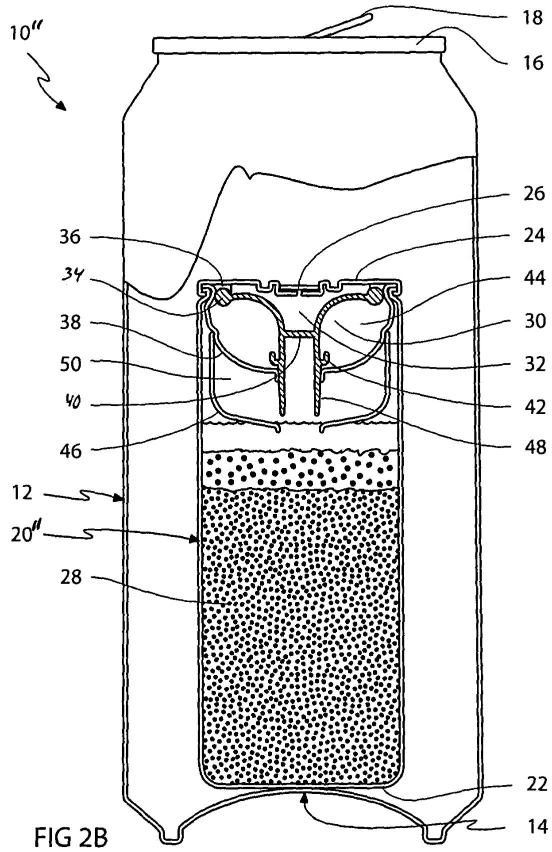

FIG 2B

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Description

[0001] Beverage cans and beverage bottles have been used for decades for storing beverages, such as carbonated beverages, including beer, cider, sparkling wine, carbonated mineral water or various soft drinks, or alternatively non-carbonated beverages, such as non-carbonated water, milk products such as milk and yoghurt, wine or various fruit juices. The beverage containers, such as bottles and in particular cans, are typically designed for accommodating a maximum amount of beverage, while minimising the amount of material used, while still ensuring the mechanical stability of the beverage container.

[0002] Most beverages have an optimal serving temperature significantly below the typical storage temperature. Beverage containers are typically stored at room temperatures in supermarkets, restaurants, private homes and storage facilities. The optimal consumption temperature for most beverages is around 5°C and therefore, cooling is needed before serving the beverage. Typically, the beverage container is positioned in a refrigerator or a cold storage room or the like well in advance of serving the beverage so that the beverage may assume a temperature of about 5°C before serving. Persons wishing to have a beverage readily available for consumption must therefore keep their beverage stored at a low temperature permanently. Many commercial establishments such as bars, restaurants, supermarkets and petrol stations require constantly running refrigerators for being able to satisfy the customers' need of cool beverage. This may be regarded a waste of energy since the beverage can may have to be stored for a long time before being consumed.

[0003] As discussed above, the cooling of beverage containers by means of refrigeration is very slow and constitutes a waste of energy. Some persons may decrease the time needed for cooling by storing the beverage container for a short period of time inside a freezer or similar storage facility having a temperature well below the freezing point. This, however, constitutes a safety risk because if the beverage container is not removed from the freezer well before it freezes, it may cause a rupture in the beverage can due to the expanding beverage. Alternatively, a bucket of ice and water may be used for a more efficient cooling of beverage since the thermal conductivity of water is significantly above the thermal conductivity of air.

[0004] It would be advantageous if the beverage container itself contains a cooling element, which may be activated shortly before consuming the beverage for cooling the beverage to a suitable low temperature. Within the beverage field of packaging, a particular technique relating to cooling of beverage cans and self-cooling beverage cans have been described in among others US4403567, US7117684, EP0498428, US2882691, GB2384846, W02008000271, GB2261501, US4209413, US4273667, US4303121, US4470917, US4689164, US20080178865, JP2003207243, JP2000265165, US3309890, W08502009, US3229478, US4599872, US4669273, W02000077463, EP87859 (fam US4470917), US4277357, DE3024856, US5261241 (fam EP0498428), GB1596076, US6558434, W002085748, US4993239, US4759191, US4752310, W00110738, EP1746365, US7117684, EP0498428, US4784678, US2746265, US1897723, US2882691, GB2384846, US4802343, US4993237, W02008000271, GB2261501, US20080178865, JP2003207243, US3309890, US3229478, W02000077463, W002085748.

[0005] The above-mentioned documents describe technologies for generating cooling via a chemical reaction, alternatively via vaporisation. For using such technologies as described above, an instant cooling can be provided to a beverage and the need of pre-cooling and consumption of electrical energy is avoided. Among the above technologies, the cooling device is large in comparison with the beverage container. In other words, a large beverage container has to be provided for accommodating a small amount of beverage resulting in a waste of material and volume. Consequently, there is a need for cooling devices generating more cooling and/or occupying less space within the beverage container.

[0006] An object of the present invention is to provide a cooling device which may be used inside a beverage container for reducing the temperature of a beverage from about 22°C to about 5°C, thereby eliminating or at least substantially reducing the need of electrical powered external cooling.

[0007] A further advantage according to the present invention is that the beverage container and the cooling device may be stored for an extended time such as weeks, months or years until shortly before the beverage is about to be consumed at which time the cooling device is activated and the beverage is cooled to a suitable consumption temperature. It is therefore a further object of the present invention to provide activators for activating the cooling device shortly before the beverage is about to be consumed.

[0008] The above objects together with numerous other objects which will be evident from the below detailed description of preferred embodiments of the cooling device according to the present invention and are according to a first aspect of the present invention obtained by a container for storing a beverage, the container having a container body and a closure and defining an inner chamber, the inner chamber defining an inner volume and including a specific volume of the beverage,

the container further including a cooling device having a housing defining a housing volume not exceeding approximately 33% of the specific volume of the beverage and further not exceeding approximately 25% of the inner volume,

the cooling device including at least two separate, substantially non-toxic reactants causing when reacting with one another a non-reversible, entropy-increasing reaction producing substantially non-toxic products in a stoichiometric number at least a factor 3, preferably at least a factor 4, more preferably at least a factor 5 larger than the stoichiometric number of the reactants,

the at least two separate substantially non-toxic reactants initially being included in the cooling device separated from one another and causing, when reacting with one another in the non-reversible, entropy-increasing reaction, a heat reduction of the beverage of at least 50 Joules/ml beverage, preferably at least 70 Joules/ml beverage, such as 70-85 Joules/ml beverage, preferably approximately 80-85 Joules/ml, within a period of time of no more than 5 min. preferably no more than 3 min., more preferably no more than 2 min., and

the cooling device further including an actuator for initiating the reaction between the at least two separate, substantially non-toxic reactants.

[0009] The container is typically a small container intended for one serving having a volume of about 20 to 75 centilitres of beverage. In some cases, however, it may be decided to use a cooling device with a larger container, such as a large bottle or vessel, which may accommodate one litre of beverage or a keg, which may accommodate five litres or more of beverage. In such cases, a cooling device is intended to give the beverage an instant cooling to suitable consumption temperature for the first serving of beverage, where after the beverage may be kept in a refrigerator for subsequent servings. The container is preferably made of aluminium, which is simple to manufacture, i.e. by stamping, and which may be recycled in an environmentally friendly way by melting of the container. Alternatively, collapsible or non-collapsible containers may be manufactured in polymeric materials such as PET plastics. Yet alternatively, the container may be a conventional glass bottle.

[0010] The cooling device is preferably fixated to the beverage container, such as fixated to the bottom of the container or the lid of the container. The cooling device should have a housing for separating the beverage and the reactant. The cooling device should not require a too large portion of the inner volume of the beverage container, since a too large cooling device will result in a smaller amount of beverage being accommodated in the beverage container. This would require either larger beverage containers or alternatively more beverage containers being produced for accommodating the same amount of beverage, both options being ecologically and economically undesired due to more raw material being used for manufacturing containers and more storage and transportation volume. It has been contemplated that a cooling device housing volume of about 33% of the beverage volume and 25% of the total inner volume of the beverage container would be still acceptable trade off between cooling efficiency and accommodated beverage volume. A too small cooling device would not be able to cool the beverage to sufficiently low temperatures.

[0011] The two reactants used in the cooling device should be held separately before activation of the cooling device and when the cooling device is activated, the two reactants are caused to react with one another. The reactants may be held separately by for instance being accommodated in two separated chambers or alternatively, one or both of the reactants may be provided with a coating preventing any reaction to start until activation. The two reactants should be substantially non-toxic, which will be understood to mean non-fatal if accidentally consumed in the relevant amounts used in the cooling device. It is further contemplated that there may be more than two reactants, such as three or more reactants. The reaction should be an entropy increasing reaction, i.e. the number of reaction products should be larger than the number of reactants. In the present context it has surprisingly been found out that an entropy increasing reaction producing products of a stoichiometric number of at least three, preferably four or more, preferably five larger than the stoichiometric number of the reactants will produce a more efficient cooling than a smaller stoichiometric number. The stoichiometric number is the relationship between the number of products divided with the number of reactants. The reaction should be non-reversible, i.e. understood to mean it should not without significant difficulties be possible to reverse the reaction, which would cause a possible reheating of the beverage. The temperature of the beverage should be reduced to at least 15°C or preferably 20°C, which for a water-based beverage corresponds to a heat reduction of the beverage of about 50 to 85 joules per liter of beverage. Any smaller temperature or heat reduction would not yield a sufficient cooling to the beverage, and the beverage would be still unsuitably warm when the chemical reaction has ended and the beverage is about to be consumed. The chemical reaction should preferably be as quick as possible, however still allowing some time for the thermal energy transport for avoiding ice formation near the cooling device. It has been contemplated that preferably the heat or temperature reduction is accomplished within no more than five minutes or preferably no more than two minutes. These are time periods which are acceptable before beverage consumption.

[0012] An actuator is used for activating the chemical reaction between the reactants. A reactant may include a pressure transmitter for transmitting a pressure increase, or alternatively a pressure drop, from within the beverage container to the cooling device for initiating the reaction. The pressure drop is typically achieved when the beverage container is open, thus the cooling device may be arranged to activate when the beverage container is being opened, alternatively, a mechanical actuator may be used to initiate the chemical reaction. The mechanical actuator may constitute a string or a rod or communicate with the outside of the beverage container for activating the chemical reaction. Alternatively, the mechanical actuator may be mounted in connection with the container closure so that when the container is opened, a chemical reaction is activated. The activation may be performed by bringing the two reactants in contact with each other, i.e. by providing the reactants in different chambers provided by a breakable, dissolvable or rupturable membrane, which is caused to break, dissolve or rupture by the actuator. The membrane may for instance be caused to rupture by the use of a piercing element. The reaction products should, as well as the reactants be substantially non-toxic.

[0013] The volume of the products should not substantially exceed the volume of the reactants, since otherwise, the cooling device may be caused to explode during the chemical reaction. A safety margin of 3 to 5%, or alternatively a venting aperture, may be provided. A volume reduction should be avoided as well. The reactants are preferably provided as granulates, since granulates may be easily handled and mixed. The granulates may be provided with a coating for preventing reaction. The coating may be dissolved during activation by for instance a liquid entering the reaction chamber and dissolving the coating. The liquid may be referred to as an activator and may constitute e.g. water, propylene glycol or an alcohol. It is further contemplated that a reaction controlling agent, such as a selective adsorption controlling agent or a retardation temperature setting agent may be used for reducing the reaction speed, alternatively, a catalyst may be used for increasing the reaction speed. It is further contemplated that a container may comprise guiding elements for guiding the flow of beverage towards the cooling device for increasing the cooling efficiency. The present cooling device may also be used in a so-called party keg, which is a beverage keg having internal pressurization and dispensing capabilities. In this way, the comparatively large party kegs must not be pre-cooled before being used. The cooling device may alternatively be provided as a widget which is freely movable within the container. This may be suitable for glass bottles where it may be difficult to provide a fixated cooling device.

[0014] According to a further embodiment of the first aspect of the present invention, the two separate reactants comprise one or more salt hydrates. Salt hydrates are known for producing an entropy increasing reaction by releasing water molecules. In the present context, a proof-of-concept has been made by performing a laboratory experiment. In the above-mentioned laboratory experiment, a dramatic energy change has been established by causing two salts, each having a large number of crystal water molecules added to the structure, to react and liberate the crystal water as free water. In the present laboratory experiment, the following chemical reaction has been tried out: $Na_2SO_4 \bullet 12H_2O + CaCl_2 \bullet 5H_2O \rightarrow 2NaCl + Ca_2SO_4 + 17H_2O$. The left side of the reaction scheme includes a total of two molecules, whereas the right side of the reaction schemes includes twenty molecules. Therefore, the entropy element - $T\Delta S$ becomes fairly large, as ΔS is congruent to k x ln20/2.

[0015] The above chemical reaction produces a simple salt in an aqueous solution of gypsum. It is therefore evident that all constituents in this reaction are non-toxic and non-polluting. In the present experiment, 64 grams of Na_2SO_4 and 34 grams of $CaCl_2$, the reaction has produced a temperature reduction of 20°C, which has been maintained stable for more than two hours. A prototype beer can has been manufactured having a total volume of 450 ml including 330 ml of beer and a bottle of 100 ml including the two reactants. After the opening of the can, the reactants were allowed to react resulting in a dramatic cooling of the beer inside the beverage can.

[0016] According to a third aspect of the present invention, the cooling device may be used in combination with a system for providing a container including a beverage of a first temperature constituting a specific low temperature such as a temperature of approximately 5°C, the system comprising:

i) a closed cabinet defining an inner cabinet chamber for storing a plurality of the containers and having a dispensing opening for the dispensing of the containers, one at a time, or alternatively having an openable door providing access to the inner cabinet chamber for the removal of one or more of the containers from within the inner cabinet chamber, the closed cabinet having thermostatically controlled temperature controlling means for maintaining the temperature within the inner cabinet chamber at a second temperature constituting an elevated temperature as compared to the first temperature and preferably a temperature at or slightly below the average ambient temperature,

ii) a plurality of the containers,

each of the containers having a container body and a closure and defining an inner chamber, the inner chamber defining an inner volume and including a specific volume of the beverage,

each of the containers further including a cooling device having a housing defining a housing volume not exceeding approximately 33% of the specific volume of the beverage and further not exceeding approximately 25% of the inner volume,

the cooling device including at least two separate, substantially non-toxic reactants causing when reacting with one another a non-reversible, entropy-increasing reaction producing substantially non-toxic products in a stoichiometric number at least a factor 3, preferably at least a factor 4, more preferably at least a factor 5 larger than the stoichiometric number of the reactants,

the at least two separate substantially non-toxic reactants initially being included in the cooling device separated from one another and causing, when reacting with one another in the non-reversible, entropy-increasing reaction, a cooling of the beverage from a second temperature constituting a temperature substantially higher than the first temperature and preferably constituting a temperature at or slightly below the average ambient temperature, to the first temperature within a period of time of no more than 5 min. preferably no more than 3 min., more preferably no more than 2 min., and the cooling device further including an actuator for initiating the reaction between the at least two separate, substantially non-toxic reactants, when opening the container.

[0017] Such system may be used to provide beverage containers of a very specific temperature, however, requiring much less energy compared to using a conventional refrigerator. In the present context, it should be mentioned that the applicant company alone installs approximately 140000 refrigerators a year for providing cool beverages. Such refrigerators must be constantly running and therefore consume a considerable amount of electrical energy during their lifetime. By instead providing a cabinet holding a well-defined temperature, typically room temperature of 22°C, a well-defined cooling of the beverage may be the result even if the ambient room temperature would differ from the typical room temperature.

[0018] According to the present invention, a cooling device is provided based on a chemical reaction between two or more reactants. The chemical reaction is a spontaneous non-reversible endothermic reaction driven by an increase in the overall entropy. The reaction absorbs heat from the surroundings resulting in an increase in thermodynamic potential of the system. ΔH is the change in enthalpy and has a positive sign for endothermic reactions. The spontaneity of a chemical reaction can be ascertained from the change in Gibbs free energy ΔG.

[0019] At constant temperature $\Delta G = \Delta H - T^*\Delta S$. A negative ΔG for a reaction indicates that the reaction is spontaneous. In order to fulfill the requirements of a spontaneous endothermic reaction the overall increase in entropy ΔS for the reaction has to overcome the increase in enthalpy ΔH.

Reactants

[0020] The cooling device according to the present invention includes at least two separate, substantially non-toxic reactants causing with one another a non-reversible entropy increasing reaction producing substantially non-toxic products in a stoichiometric number at least a factor 3, preferably a factor 4, more preferably a factor 5 larger than the stoichiometric number of the reactants.

The reactants are preferably solids but solid-liquid, liquid-liquid and solid-solid-liquid reactants are contemplated also to be relevant in the present context i.e in the context of implementing a cooling device for use in a beverage container. Solid reactants may be present as powder, granules, shavings, etc.

[0021] The reactants and products are substantially non-toxic.

[0022] In the context of the present invention non-toxic is not to be interpreted literally but should be interpreted as applicable to any reactant or product which is not fatal when ingested in the amounts and forms used according to the present invention. Suitable reactants form products which are a) easily soluble in the deliberated crystal water or b) insoluble in the deliberated crystal water. A list of easily soluble vs less soluble salt products is given below:

Easily soluble	Less soluble
$NaCl$	$BaSO_4$
KCl	$BaCO_3$
NH_4Cl	$Bi(OH)_3$
NH_4Br	$CaCO_3$
$NH_4C_2H_3O2$	$Ca_3(PO_4)_2$
NH_4NO_3	$CaSO_4$ ● $2H_20$
$(NH_4)_2SO_4$	$COCO_3$
NH_4HSO_4	$Co(OH)_2$
$CaCl_2$	$CuBr$
$CrCl_2$	$Cu(OH)_2$
$CuBr_2$	$Fe(OH)_2$
$LiBr$ ● $2H_2O$	$Fe(OH)_3$
$LiCl$ ● H_2O	$FePO_4$ ● $2H_2O$
NH_2OH	$Fe_3(PO_4)_2$
KBr	Li_2CO_3
KCO_3 ● 1½ H_2O	$MgCO_3$
KOH ● $2H_2O$	$MnCO_3$
KNO_3	$Mn(OH)_2$
KH_2PO_3	$Ni(OH)_2$
$KHSO_4$	$SrCO_3$
$NaBr_2$ $2H_2O$	$SrSO_4$

(continued)

Easily soluble	Less soluble
$NaClO_3$	$Sn(OH)_2$
$NaOH \bullet H_2O$	$ZnCO_3$
$NaNO_3$	$Zn(OH)_2$
NaSCN	
$SnSO_4$	
$TiCl_3$	
$TiCl_4$	
$ZnBr_2 \bullet 2H_2O$	
$ZnCl_2$	
NH_4SCN	

[0023] The salt product is preferably an easily soluble salt although less soluble products are preferable for salt products which are toxic to render them substantially non-toxic.

[0024] The volumetric change during the non-reversible entropy-increasing reaction is no more than $\pm$5%, preferably no more than $\pm$4%, further preferably no more than $\pm$3%, or alternatively the cooling device being vented to the atmosphere for allowing any excess gas produced in the non-reversible entropy-increasing reaction to be vented to the atmosphere.

[0025] Suitable solid reactants according to the present invention are salt hydrates and acid hydrates. The salt hydrates according to the invention are organic salt hydrates or inorganic salt hydrates, preferably inorganic salt hydrates. Some of the below salts are contemplated to be present only in trace amounts for controlling selective adsorption. Suitable organic salt hydrates may include Magnesium picrate octahydrate $Mg(C_6H_2(NO_2)_3O)_2$-$8H_2O$, Strontium picrate hexahydrate $Sr(C_6H_2(NO_2)_3O)_2$-$6H_2O$, Sodium potassium tartrate tetrahydrate $KNaC_4H_4O_6.4H_2O$, Sodium succinate hexahydrate $Na_2(CH_2)_2(COO)_2 \cdot 6H_2O$, Copper acetate monohydrate $Cu(CH_3COO)_2 \cdot H_2O$ etc. Suitable inorganic salt hydrates according to the invention are salt hydrates of alkali metals, such as lithium, sodium and potassium, and salt hydrates of alkaline earth metals, such as beryllium, calcium, strontium and barium, and salt hydrates of transition metals, such as chromium, manganese, iron, cobalt, nickel, copper, and zink, and aluminium salt hydrates and lanthanum salt hydrates. Suitable alkali metal salt hydrates are for example $LiNO_3 \cdot 3H_2O$, $Na_2SO_4 \cdot 10H_2O$ (Glauber salt), $Na_2SO_4 \cdot 7H_2O$, $Na_2CO_3 \cdot 10H_2O$, $Na_2CO_3 \cdot 7H_2O$, $Na_3PO_4 \cdot 12H_2O$, $Na_2HPO_4 \cdot 12H_2O$, $Na_4P_2O_7 \cdot 10H_2O$, $Na_2H_2P_2O_7 \cdot 6H_2O$, $NaBO_3 \cdot 4H_2O$, $Na_2B_4O_7 \cdot 10H_2O$, $NaClO_4 \cdot 5H_2O$, $Na_2SO_3 \cdot 7H_2O$, $Na_2S_2O_3 \cdot 5H_2O$, $NaBr \cdot 2H_2O$, $Na_2S_2O_6 \cdot 6H_2O$, $K_3PO_4 \cdot 3H_2O$ etc, preferably $Na_2SO_4 \cdot 10H_2O$ (Glauber salt). Suitable alkaline earth metal salt hydrates are for example, $MgCl_2 \cdot 6H_2O$, $MgBr_2 \cdot 6H_2O$, $MgSO_4 \cdot 7H_2O$, $Mg(NO_3)_2 \cdot 6H_2O$, $CaCl_2 \cdot 6H_2O$, $CaBr_2 \cdot 6H_2O$, $Ca(NO_3)_2 \cdot 4H_2O$, Sr $(NO_3)_2 \cdot 4H_2O$, $Sr(OH)_2 \cdot 8H_2O$, $SrBr_2 \cdot 6H_2O$, $SrCl_2 \cdot 6H_2O$, SrI_2•6H2O, $BaBr_2 \cdot 2H_2O$, $BaCl_2 \cdot 2H_2O$, $Ba(OH)_2 \cdot 8H_2O$, Ba $(BrO_3)_2 \cdot H_2O$, $Ba(ClO_3)_2 \cdot H_2O$ etc. Suitable transition metal salt hydrates are for example, $CrK(SO_4)_2 \cdot 12H_2O$, $MnSO_4 \cdot 7H_2O$, $MnSO_4 \cdot 5H_2O$, $MnSO_4 \cdot H_2O$, $FeBr_2 \cdot 6H_2O$, $FeBr_3 \cdot 6H_2O$, $FeCl_2 \cdot 4H_2O$, $FeCl_3 \cdot 6H_2O$, $Fe(NO_3)_3 \cdot 9H_2O$, $FeSO_4 \cdot 7H_2O$, $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$, $FeNH_4(SO_4)_2 \cdot 12H_2O$, $CoBr_2 \cdot 6H_2O$, $CoCl_2 \cdot 6H_2O$, $NiSO_4 \cdot 6H_2O$, $NiSO_4 \cdot 7H_2O$, $Cu(NO_3)_2 \cdot 6H_2O$, $Cu(NO_3)_2 \cdot 3H_2O$, $CuSO_4 \cdot 5H_2O$, $Zn(NO_3)_2 \cdot 6H_2O$, $ZnSO_4 \cdot 6H_2O$, $ZnSO_4 \cdot 7H_2O$ etc. Suitable aluminium salt hydrates are for example $Al_2(SO_4)_3 \cdot 18H_2O$, $AlNH_4(SO_4)_2 \cdot 12H_2O$, $AlBr_3 \cdot 6H_2O$, $AlBr_3 \cdot 15H_2O$, $AlK(SO_4)_2 \cdot 12H_2O$, Al $(NO_3)_3 \cdot 9H_2O$, $AlCl_3 \cdot 6H_2O$ etc. A suitable lanthanum salt hydrate is $LaCl_3 \cdot 7H_2O$.

Suitable acid hydrates according to the invention are organic acid hydrates such as citric acid monohydrate etc.

[0026] A salt or acid hydrate is preferably reacted with another salt or acid hydrate, it can however also be reacted with any non-hydrated chemical compound as long as crystal water is deliberated in sufficient amounts to drive the endothermic reaction with respect to the entropy contribution.

[0027] Suitable non-hydrated chemical compounds according to the invention may include acids, alcohols, organic compounds and non-hydrated salts. The acids may be citric acid, fumaric acid, maleic acid, malonic acid, formic acid, acetic acid, glacial acetic acid etc. The alcohols may be mannitol, resorcinol etc. The organic compounds may be urea etc. The non-hydrated salts according to the present invention may be such as anhydrous alkali metal salts, anhydrous alkaline earth metal salts anhydrous transition metal salts anhydrous aluminium salts and anhydrous tin salts and anhydrous lead salt and anhydrous ammonium salts and anhydrous organic salts. Suitable anhydrous alkali metal salt hydrates are for example $NaClO_3$, $NaCrO_4$, $NaNO_3$, $K_2S_2O_5$, K_2SO_4, $K_2S_2O_6$, $K_2S_2O_3$, $KBrO_3$, KCl, $KClO_3$, KIO_3, $K_2Cr_2O_7$, KNO_3, $KClO_4$, $KMnO_4$, CsCl etc. Suitable anhydrous alkaline earth metal salts are for example $CaCl_2$, Ca $(NO_3)_2$, $Ba(BrO_3)_2$, $SrCO_3$, $(NH_4)_2Ce(NO_3)_6$ etc. Suitable anhydrous transition metal salts are for example NiS04, Cu (N03)2. Suitable anhydrous aluminium salts are $Al_2(SO_4)_3$ etc. Suitable anhydrous tin salts are $SnI_2(s)$, $SnI_4(g)$ etc. Suitable anhydrous lead salts are $PbBr_2$, $Pb(NO_3)_2$ etc. Suitable ammonium salts are NH_4SCN, NH_4NO_3, NH_4Cl, (NH4) 2Cr2O7 etc. Suitable anhydrous organic salts are for example urea acetate, urea formate, urea nitrate and urea oxalate etc.

It is further contemplated that the anhydrous form of any hydrated salt or hydrated acid as listed above may be used as a non-hydrated chemical compound in a reaction according to the present invention.

A liquid reactant according to the present invention may be a liquid salt such as PBr_3, SCl_2, $SnCl_4$, $TiCl_4$, VCl_4 or a liquid organic compound such as CH_2CL_2 etc.

[0028] The number of reactants participating in the reaction is at least two. Some embodiments may use three or more reactants.

[0029] One possible reaction according to the present invention is

- $Na_2SO_4{\bullet}10H_2O(s)+CaCl_2{\bullet}6H_2O(s) \rightarrow 2Na^+(aq)+ 2Cl^-(aq) + CaSO_4{\bullet}2H_2O(s) + 14H_2O(l)$

$$\Delta H= 2*(-240\ kJ/mol) + 2*(-167\ kJ/mol) + (-2023\ kJ/mol) + 14*(-286\ kJ/mol) - ((-4327\ kJ/mol) + (-2608\ kJ/mol)) = 94\ kJ/mol$$

$$\Delta S=2*(58\ J/K*mol) + 2*(57\ J/K*mol) + (194\ J/K*mol) + 14*(70\ J/K*mol) - ((592\ J/K*mol) + (365\ J/K*mol)) = 2.361\ kJ/K*mol$$

[0030] At room temperature (T = 298 K)

$$\Delta G = \Delta H - T*\Delta S = 94\ kJ/mol - 298\ K*0.447\ kJ/K*mol = -39\ kJ/mol$$

[0031] The negative sign indicates that the reaction is spontaneous.

[0032] The stoichoimetric number of products to reactants is 19/2 = 9.5:1

[0033] Another possible reaction according to the present invention is

- $Na_2SO_4{\bullet}10H_2O(s) + Ba(OH)_2{\bullet}8H_2O(s) \rightarrow BaSO_4(s) + 2Na^+(aq) + 2OH^-(aq) + 18H_2O(l)$

$$\Delta H = -1473\ kJ/mol + 2*(-240\ kJ/mol) + 2*(-230\ kJ/mol) + 18*(-286\ kJ/mol) - (-4327\ kJ/mol+ (-3342\ kJ/mol)) = 108\ kJ/mol$$

[0034] ΔG at room temperature (T = 298 K) for this reaction can be directly calculated:

$$\Delta G =-1362\ kJ/mol + 2*(-262\ kJ/mol) + 2*(-157\ kJ/mol) + 18*(-237\ kJ/mol) - (-3647\ kJ/mol + (-2793\ kJ/mol)) = -26\ kJ/mol$$

[0035] Thus this reaction is spontaneous. The stoichoimetric number of products to reactants is 23/2 = 11.5:1

[0036] A further possible reaction according to the present invention is

- $Ba(OH)_2{\bullet}8H_2O(S) + 2NH_4SCN(s) \rightarrow Ba(SCN)_2 + 2NH_3(g) + 10H_2O(l)$

$$\Delta H = 102\ kJ/mol$$

$$\Delta S = 0.495 \text{ kJ/K*mol}$$

$$\Delta G = \Delta H - T^*\Delta S = 102 \text{ kJ/mol} - 298 \text{ K*}0.495 \text{ kJ/K*mol} = -45.5 \text{ kJ/mol}$$

[0037] The reaction is spontaneous. The stoichoimetric number of products to reactants is 13/3=4.33:1

[0038] Examples of further reactions are

a) $Ba(OH)_2{\bullet}8H_2O(s) + 2NH_4NO3(s) \rightarrow Ba(NO3)_2 + 2NH_3(g) + 10H_2O(l)$
b) $Ba(OH)_2{\bullet}8H_2O(S) + 2NH_4Cl(s) \rightarrow BaCl_2 + 2NH_3(g) + 10H_2O(l)$

Additives and activators

[0039] The reaction is preferably activated by the addition of a polar solvent, such as water, glycerin, ethanol, propylene glycol, etc but the reaction may also be activated simply by contacting the reactants.

[0040] In some reactions the reactants may be non-reactive when contacted or being mixed. For these reactions a suitable catalyst may be used to enable the reaction.

[0041] In some embodiments the solid reactants are coated or microencapsulated. Suitable external coatings are heat resistant but dissolvable upon contact with an activation fluid capable of dissolving the coating. Suitable coatings include carbohydrates such as starch and cellulose, polyethers such as polyethylene glycol (PEG) but also shellac or plastics. Suitable activation fluids include water alcohols, organic solvents, acids. As an alternative to a coating, the solid reactants may be embedded in a soluble gel or foam.

[0042] By use of a coating the reactants can be premixed in order to increase the reaction rate. Furthermore, coating of reactants prevents premature activation of the cooling effect due to storage conditions or heat treatment of the beverage. In some embodiments a part of the reactant mass is coated with thicker coating in order to slow down the reaction and prolong the cooling provided by the reaction. In other embodiments more than one coating may be applied to the reactants or different coatings may be applied to different reactants or parts of the reactant mass. Instead of a coating the reactants can be suspended in a non-aqueous fluid such as an organic solvent.

[0043] A retardation temperature setting agent having a suitable melting temperature may be used with the current invention. A suitable melting temperature may be such a temperature that the retardation temperature setting agent is liquid at temperatures above a freezing point or any desirable temperature yielding a desired cooling of the beverage to be cooled and solidifies as the temperature descends below this point thus retarding the reaction in order to prevent freezing of the beverage in the beverage container. The retardation temperature setting agent may be any chemical compound with a suitable melting temperature above the freezing temperature of water such as a temperature between 0°C to +10°C such as 2°C to 6°C such that the solidified form of the retardation temperature setting agent decreases the reaction rate of the reaction according to the present invention. Examples of suitable retardation temperature setting agents include polyethylene glycol, a fatty acid, or a polymer

[0044] The reactants can be in the form of granulates of varying sizes to tailor the reaction rate to the specific application. The granules may also be coated as described above.

[0045] For some reactions it is preferable to add a solvent such as glycerol or a trace contaminant to prevent the formation of crystals of a product from coating remaining reactants thus inhibiting further reaction. An adsorbent can be used to selectively adsorb a product in order to control the reaction rate and/or ensure complete reaction. For some reactions the liquid activator used to initiate the reaction may also serve as a selective adsorption-controlling agent to control the reaction.

[0046] In reactions producing acidic or basic products a pH-regulating buffer may be included. The buffer may also be used to promote the dissolution of products in form of gas.

[0047] It is contemplated that one or more reactants may be formed *in situ* from precursors. This can be advantageous for preventing premature activation or preactivation of the cooling device after it has been placed in the container.

[0048] It is further contemplated that the following additives may be relevant for some reactions in the context of controlling the reaction. 3,7-diamino-5-phenothiazinium acetate, 18 crown 6 ether, 1,3-dimethyl-2-imidazolidinone

Cooling of beverage

[0049] Dependent on the reaction used the heat capacity of the reaction mixture and the beverage, the initial temperature of the beverage and the amounts of beverage and reactants respectively a wide range of cooling effects may be obtained.

[0050] A cooling device according to the present invention may contain any amount of reactant as long as the volume off the cooling device does not exceed 30% of the container volume.

[0051] The cooling effect of the cooling device in the beverage container should be sufficient to cool a volume of beverage at least 10°C within a period of time of no more than 5 min., preferably no more than 2 min.

[0052] For a beverage consisting mainly of water the specific heat capacity can be approximated with the specific heat capacity for liquid water: 4.18 kJ / kg · K. The cooling effect q needed for cooling the beverage is given by the equation: $q = m \cdot \Delta T \cdot Cp$. Thus in order to cool 1 kg of beverage 20°C the cooling device must absorb 83.6 kJ of heat from the beverage to be cooled. Thus in the present invention a heat reduction of the beverage should be at least 50 Joules/ml beverage, preferable at least 70 Joules/ml beverage such as 70-85 Joules/ml beverage preferable approximately 80-85 Joules/ml beverage within a time period of no more than 5 min, preferably no more than 3 min, more preferably no more than 2 min.

[0053] The invention and its many advantages will be described in more detail below with reference to the accompanying schematic drawings, which for the purpose of illustration show some non-limiting embodiments and in which

Fig. 1 shows a self-cooling beverage container having a cooling device having a gas permeable membrane.
Fig. 2 is a self-cooling container having a cooling device with an auxiliary reactant chamber.
Fig. 3 is a self-cooling container having a cooling device with a soluble plug.
Fig. 4 is a self-cooling container having a cooling device with a piercable membrane.
Fig. 5 is a self-cooling beverage container having a cooling device with a cap.
Fig. 6 is a self-cooling beverage container having a cooling device with a rupturable diaphragm.
Fig. 7 is a self-cooling beverage container having a cooling device with a telescoping valve.
Fig. 8 is a self-cooling beverage container having a cooling device with a water-soluble diaphragm.
Fig. 9 is a self-cooling beverage container having a cooling device with a flexible cylinder.
Fig. 10 is a self-cooling beverage container having a cooling device with a pair of caps.
Fig. 11 is a self-cooling beverage container having a cooling device with a cap and a rupturable diaphragm.
Fig. 12 is a self-cooling beverage container having a cooling device with a piercable membrane and a rupturable membrane.
Fig. 13 is a self-cooling beverage container having a cooling device constituting a widget.
Fig. 14 is a self-cooling beverage container having a cooling device constituting a widget and an action control fluid.
Fig. 15 is a self-cooling beverage container having a cooling device constituting a widget having an additional reactant chamber.
Fig. 16 is a cooling box having a rectangular shape and including a cooling device having a can shape.
Fig. 17 is a cooling box having a brown shape including a centrally located cooling device.
Fig. 18 shows the filling process of self-cooling beverage container having a cooling device mounted of the container.
Fig. 19 shows the filling process of a self-cooling beverage container having a cooling device constituting a widget.
Fig. 20 shows a filling process of a self-cooling beverage container having a lid mounted cooling device.
Fig. 21 shows a self-cooling party keg system.
Fig. 22 shows a beverage dispensing system having a keg with a cooling device for achieving instant cooling.
Fig. 23 shows a beverage dispensing system having a beverage keg having a cooling device with a piercable membrane.
Fig. 24 shows a beverage bottle having a button activatable cooling device.
Fig. 25 shows a beverage bottle having a pressure activated cooling device.
Fig. 26 shows a beverage bottle having a cap mounted cooling device, which is activated by the user,
Fig. 27 shows a cooling device constituting a drink stick with an internal cooling device
Fig. 28 shows a bottle sleeve to be mounted on the neck of a beverage bottle.
Fig. 29 shows a bottle sleeve to be mounted around the body of the beverage bottle.
Fig. 30 shows a reaction crystal having a selective adsorbant inhibiting growth at the corners and,
Fig. 31 is a dispensing and refrigerator system for accommodating a plurality of beverage cans.

[0054] The figures illustrate numerous exemplary embodiments of a cooling device according to the present invention.

[0055] Fig. 1 a shows a partial intersected view of a self-cooling container 10^I according to the present invention. The self-cooling container 10^I comprises a beverage can 12 made of thin metal sheet of e.g. aluminium or an aluminium alloy. The beverage can 12 has a cylindrical body, which is closed off by a beverage can base 14 and a lid 16. The lid 16 comprises a tab and an embossed area constituting a closure. (The tab and the embossed area are not visible in the present view.) The beverage can 12 includes a cooling device, which is located juxtaposed to the beverage can base 14 inside the beverage can 12. The cooling device 20^I comprises a cylinder of thin metal sheet similar to the beverage can 12, however significantly smaller in size. The size of the cooling device corresponds to about 20% to 30% of the total volume of the beverage can 12, preferably about 25% of the volume of the beverage can 12, for achieving a sufficient cooling efficiency while not substantially reducing the amount of beverage which may be accommodated inside the beverage can 12. A beverage, preferably a carbonated beverage such as beer, sparkling wine or various soft drinks, is filled into the beverage can 12 and accommodates typically 70% of the volume of the beverage can 12 allowing for about 5% space between the lid 16 and the upper surface of the beverage. The cooling device 20^{I} extends between a bottom 22 and a top 24. The bottom 22 is preferably fixated to the beverage can base 14 so that the cooling device 20 assumes a stable position inside the beverage can 12. Alternatively, the cooling device 20^{I} constitutes an inherent part of the beverage can 12. For example, the beverage can 12 including the cooling device 20 may be stamped out of metal sheet in one piece. The top 24 of the cooling device 20 as well as the lid 16 of the beverage can 12 constitutes separate parts, which are applied after the respective cooling device 20^{I} and the beverage can 12 has been filled. The top 24 of the cooling device 20^{I} seals off the interior of the cooling device 20^{I} such that no beverage may enter. The top 24 comprises a gas permeable membrane 26, which allows gasses such as air or carbon dioxide, but prevents liquid, such as beverage, to enter the interior of the cooling device 20^{I}. The interior of the cooling 20^{I} is divided into a pressure space 32 located adjacent to the gas permeable membrane 26, a main reactant chamber 28 located near the bottom 22 and a water chamber 44 located between the pressure space 32 and the main reactant chamber 28. The main reactant chamber 28 constitutes a greater part of the cooling device 20^{I} and is filled with granulated reactants. The granulated reactants comprises at least two separate reactants which when reacting with each other will draw energy from the surrounding beverage and thereby cause a cooling of the beverage. The reaction will typically be initiated when the two reactants contact each other. The exact compositions of the reactants will be described in detail later in the chemistry part of the present description. At least one of the compounds constitutes a granulate having a water-soluble coating, which is preventing the reactants from contacting each other and thus preventing any reaction to start. The water soluble coating may be e.g. starch. In an alternative embodiment the granulate or the granulates may be prevented from reacting by being embedded in a soluble gel or foam. Further alternatively, the reactants may be provided as shallow, highly compacted discs or plates separated from one another through the above mentioned coating, gel or foam.

[0056] The pressure space 32 is separated from the water chamber 44 by a flexible diaphragm 30. The flexible diaphragm 30 has a funnel shape and extends from a rounded circumferential reinforcement bead 34 constituting the periphery of the flexible diaphragm 30 to a circular wall 40 constituting the centre of the flexible diaphragm 30. The circular wall 40 separates the pressure space 32 from the main reactant chamber 28. The rounded circumferential reinforcement bead 34 is positioned juxtaposed to a washer 36, which seals the rounded circumferential reinforcement bead to the top 24. The water chamber 44 is separated from the main reactant chamber 28 by a rigid cup-shaped wall 38 extending from the top 24 inwards and downwards. The flexible diaphragm comprises a circumferential gripping flange 42 extending downwards at the circular wall 40. The circumferential gripping flange 42 grips around the end of the cup-shaped wall 38, thus sealing the water chamber 44 from the main reactant chamber 28.

[0057] The cooling device is prepared by filling the main reactant chamber 28 with the granulate reactants and filling the water chamber 44 with water, then the top is attached and sealed to the cooling device 20^{I}. Subsequently, the beverage can 12 is filled with beverage, pressurised and sealed by the lid 16. The pressure in the beverage can 12 ensures that the cooling device 20^{I} is not activated, since equal pressure is maintained inside the beverage can 12 and inside the cooling device 20^{I}.

[0058] Fig. 1b shows a partial intersected view of a self-cooling container 10^{I} when the beverage can 12 has been opened and the chemical reaction in the cooling device 20^{I} has been activated. The beverage can 12 is opened by operating the tab 18 from its normal horizontal position juxtaposed the lid 16 to a vertical position extending outwardly in relation to the lid 16. By operating the tab 18 to the vertical position, the tab 18 will protrude into the embossing in the lid 16 causing the embossing to rupture and define a beverage outlet (not shown) in the beverage can 12. When the beverage can 12 has been opened, the high pressurized CO_2 gas inside the beverage can 12 will escape to the outside atmosphere. The atmospheric pressure in the beverage can 12 will cause gas to slowly escape from the pressure space 32 through the gas permeable membrane 26 to the beverage can 12. At the same time, the high pressure inside the main reactant chamber 28 will apply a pressure onto the flexible diaphragm 30, thereby causing the flexible diaphragm 30 to move towards the top 24. The rounded circumferential reinforcement bead 34 and the washer 36 will seal the pressure space 32 and the main reactant chamber 28 fluid tight. When the flexible diaphragm 30 has assumed the activated position, i.e. moved towards the top 24, the circumferential gripping flange 42 will detach from the rigid cup-shaped wall 38 and allow the water contained in the water chamber 44 to flow into the main reactant chamber 28. The water entering the main reactant chamber will dissolve the water soluble coating of the reactant granulates and thereby cause the chemical reaction to start. The reaction is an endothermic reaction, which will draw energy from the beverage, i.e. the beverage will become colder while thermal energy flows from the beverage to the cooling device 20^{I}. More details on the chemical reaction will follow later in the description. The thermal energy drawn by the cooling device 20^{I} will chill the beverage in the beverage can 12. After a few seconds, the relative temperature of the beverage will fall about ten degrees C°, typically twenty degrees C°, and the beverage consumer may enjoy a chilled beverage shortly after opening the beverage can 12. A beverage can 12 stored without refridgeration in a store may typically have a temperature of about 22 degrees C. After opening, the beverage quickly cools down to about 6 degrees C, counting for thermal losses etc. The time needed for the chilling typically is less than 5 minutes, more typically 3 minutes. When the beverage consumer has finished drinking the beverage, the beverage can 12 may be disposed and the metal in the beverage can 12 may be recycled in an environmentally friendly way.

[0059] Fig. 2a shows a partial intersected view of a further embodiment of a self-cooling container 10^{II} comprising all of the features of the self-cooling container 10^{I} of Fig. 1. The self-cooling container 10^{II} of the present embodiment, however, further comprises an auxiliary cup-shaped wall 46 mounted outside and below the main cup-shaped wall 38. An auxiliary gripping flange 48 constituting an elongation of the main gripping flange 42 together with an auxiliary cup-shaped wall 46 and a main cup-shaped wall 38 defines an auxiliary reactant chamber 50. The auxiliary reactant chamber 50 is filled with an auxiliary reactant granulate, which constitutes one of the reactants of the reaction. The other reactant is located in the main reactant chamber 28 , thereby eliminating the need of a coating of the reactant granulates.

[0060] Fig. 2b shows the self-cooling container 10^{II} of Fig. 2a when the beverage can has been opened and the chemical reaction has been activated. In the activated state, the circumferential gripping flange has detached from the cup-shaped wall 38 as shown in Fig. 1a, thereby allowing the water in the water chamber 44 to flow into the main reactant chamber 28. At the same time, the auxiliary gripping flange 48, which is connected to the flexible diaphragm 30 via the circumferential gripping flange 42 will detach from the auxiliary cup-shaped wall 46 and allow the auxiliary reactant to enter the main reactant chamber 28, thereby activating the chemical reaction. The present embodiment requires an additional chamber but has the benefit of not requiring any coating of the reactant granulates, since the reactants are stored in separate chambers.

[0061] Fig. 3a shows a self-cooling container 10^{III} similar to the self-cooling container 10^{II} shown in Fig. 2. The self-cooling container 10^{III} has a pressure space 32, however, instead of a gas permeable membrane, a water-soluble plug 27 is accommodated in the top 24 of the cooling device 20. The water-soluble plug 27 may be of any water-soluble material, which is non-toxic and may form a pressure proof plug of sufficient rigidity, which dissolves within a few minutes when subjected to an aqueous solution such as beverage. It is contemplated that non-toxic implies that the material being allowed for usage in consumables by e.g. a national health authority or the like. Such materials may include sugar, starch or gelatine. The soluble plug 27 allows the cooling device 20 to be prepared and pressurised an extended time period such as days or weeks before being used in a beverage can. The soluble plug 27 prevents the pressure inside the cooling device 20 i.e. inside the main reactant chamber 28, the water chamber 44 and the pressure space 32 to escape to the outside through the top 24. The flexible membrane is in the present embodiment made of rubber and comprises a support diaphragm 31 as well made of rubber and which is located juxtaposed to the cup-shaped wall 38 and extending between the circular wall 40 and the rounded circumferential reinforcement bead 34 . To equalize the pressure between the flexible diaphragm 30 and the support diaphragm 31 a pressure inlet 52 is located on the flexible membrane to allow the pressure to equalise between the pressure space 32 and the space between the support diaphragm 31 and the flexible membrane 30.

[0062] Fig. 3b shows a self-cooling container 10^{III} comprising a beverage can 12 and a cooling device 20 located inside the beverage can 12 before the chemical reaction has been activated. The soluble plug 26' will prevent the pressure inside the pressure 32 to escape to the outside of the cooling device 20, while the beverage can 12 is filled with beverage and carbonated/pressurised. After a certain time period or alternatively during pasteurisation, the soluble plug 26' is dissolved and fluid communication is allowed between the interior of the beverage can 12 and the pressure space 32 of the cooling device 20. The pressure inside the beverage can 12 keeps the cooling device 20^{III} in its pre-activated state, i.e. the chemical reaction is not started.

[0063] Fig. 3c shows a self-cooling container 10^{III} according to Fig. 3b when the beverage can 12 has been opened and the chemical reaction has been activated. When the beverage can 12 has been opened, the pressure inside the beverage can 12 as well as inside the pressure space 32, falls to the ambient pressure outside the beverage can 12. This causes the chemical reaction in the cooling device 20 to activate as previously described in connection with Fig. 2.

[0064] Fig. 4a shows a further embodiment of a self-cooling container 10^{IV}. The self-cooling container 10^{IV} comprises a beverage can 12' similar to the beverage can described in connection with Fig. 1 to 3. The beverage can 12' has a beverage can base 14', a lid 16' and a cooling device 20', which is fixated onto the lid 16' and extending into the beverage can 12'. The cooling device 20^{IV} comprises a cylindrical aluminium tube extending towards a beverage can base 14. A pressure inlet 52 is defined in the lid 16' for allowing fluid communication between the outside atmospheric pressure and a pressure space 32, which is defined inside the cooling device between the lid 16' and a diaphragm 30'. The diaphragm 30' is made of a flexible material such as rubber and forms a fluid tight barrier between the pressure space 32' and a water chamber 44'. The water chamber 44 is separated from a main reactant chamber 28' by a rupturable diaphragm 54. The rupturable diaphragm 54 is made of a flexible material similar to the diaphragm 30' The rupturable diaphragm 54 may be ruptured, i.e. irreversibly opened by a piercing element 56 constituting a needle, which is located inside the main reactant chamber 28' and pointing towards the rupturable diaphragm 54. The main reactant chamber 28' is filled with a coated granulate reactant similar to the embodiments described in connection with Fig. 1 to 3. The main reactant chamber 28' is separated from the beverage can 12' by a bottom 22' which is located near, however not contacting, the beverage can base 14'. The bottom 22' is made of the same material as the outer wall of the cooling device 20, i.e. preferably aluminium. The bottom 22' is connected to the outer wall of the cooling device 20^{IV} via a corrugation 58 allowing the bottom 22' to be flexible and bistable, i.e. able to define a mechanical stable inwards and outwards bulging state, respectively. When the beverage can 12' is filled and pressurised, the pressure inside the beverage can 12' will cause the bottom 22', the rupturable diaphragm 54' and the diaphragm 30' to bulge in an inwards direction.

[0065] Fig. 4b shows the self-cooling container 10^{IV} comprising a beverage can 12', which has been opened by operating the tab 18. By operating the tab 18, an embossing in the lid 16 is ruptured and an opening is formed in the lid 16 allowing the beverage to be poured out and the pressure to escape. When the pressure escapes, the bottom 22' of the cooling device 20^{IV} will bulge towards the beverage can base 14 due to the internal pressure in the cooling device 20^{IV}. The bottom 22' is made bistable, so that when bulging towards the beverage can base 14, a subatmosphere pressure is resulting in the main reactant chamber 28' causing the rupturable diaphragm 54 and the diaphragm 30 to bulge towards the beverage can base 14. The rupturable diaphragm 54 will therefore bulge into the piercing element 56 causing the rupturable diaphragm 54 to burst. The rupturable diaphragm 54 may be a bursting diaphragm or alternatively have a predetermined breaking point or alternatively have a built-in tension so that when the piercing element 56 enters the rupturable diaphragm 54, an opening is created between the water chamber 44' and the main reactant chamber 28' causing the water in the water chamber 44' to enter the main reactant chamber 28', thereby activating the chemical reaction resulting in a cooling of the beverage. The chemical reaction will draw energy from the surrounding verge and thereby cause a relative cooling of at least 10 degrees C°, preferably 20 degrees C° or more.

[0066] Fig. 5a shows a self-cooling container 10^{V}, similar to the self-cooling container 10^{IV} of Fig. 4. Instead of a rupturable diaphragm, the self-cooling container 10^{V} has a main cap 60 made of plastic material separating the water chamber 44 and the main reactant chamber 28' The main cap 60 is held in place by a main cap seat 62 constituting an inwardly protruding flange which is fixed to the inner wall of the cooling device 20^{V} and which is applying a light pressure onto the main cap 60. The main cap 60 constitutes a shallow circular plastic element forming a fluid tight connection between the water chamber 44' and the main reactant chamber 28'.

[0067] Fig. 5b shows the self-cooling container 10^{V} according to Fig. 5a, which has been opened and activated similar to the beverage can described in Fig. 4b. When the beverage can 12' has been opened, the bottom 22' of the cooling device 20^{V} will bulge towards the beverage can base 14, which will cause a pressure drop inside the main reactant chamber 28' resulting in the main cap 60 being ejected from the main cap seat 62 and falling into the main reactant chamber 28', thereby allowing fluid communication between the water chamber 44' and the main reactant chamber 28'. Water will therefore flow from the water chamber 44 into the main reactant chamber 28', thereby activating the chemical reaction and causing the beverage to be cooled. As the granulate reactant is being dissolved, the main cap 60 may fall towards the bottom 22' of the cooling device 20^{V}.

[0068] Fig. 6a shows a self-cooling container 10^{VI} similar to the self-cooling container 10^{V} shown in Fig. 5, however, instead of a main cap seat and a main cap, the present embodiment comprises a support mesh 66 and a rupturable diaphragm 54 separating the water chamber 44' and the main reactant chamber 28'. The support mesh constitutes a grid made of metal or plastics, which is placed in a juxtaposed position in relation to a rupturable diaphragm 54, where the diaphragm is facing the main reactant chamber 28 and the rupturable diaphragm 54 is facing the water chamber 44. The rupturable diaphragm 54 constitutes a burst membrane, which prevents fluid communication between the water chamber 44' and the main reactant chamber 28'. The support mesh 56 prevents the rupturable diaphragm 54' from bulging upwardly towards the pressure inlet 52 and rupture in case the pressure in the main reactant chamber exceeding the pressure in the water chamber 44.

[0069] Fig. 6b shows a self-cooling container 10^{VI} when the beverage can 12' has been opened. By opening the beverage can, the pressure is reduced inside the beverage can 12' causing the bottom 22' to bulge towards the beverage can base 14, thereby reducing the pressure inside the main reactant chamber 28'. The reduced pressure inside the main reactant chamber 28 causes the rupturable diaphragm 54' to bulge towards the beverage can base 14'. The rupturable diaphragm 54' is a burst membrane, which is caused to rupture without use of a piercing element. The rupturable diaphragm 54' may constitute a non resilient which is caused to burst by the pressure difference between the main reactant chamber 28 and the water chamber 44', thereby establishing a fluid communication between the water chamber 54' and the main reactant chamber 28'. The water entering the main reactant chamber 28' from the water chamber 44' will activate the chemical reaction causing a cooling effect on the surrounding beverage as described previously in the figures 4 to 5.

[0070] Fig. 7a shows a self-cooling container 10^{VII} similar to the self-cooling container 10^{VI} of fig. 6, however, instead of a rupturable diaphragm and a piercing element, a telescoping valve 68 is separating the water chamber 44' and the main reactant chamber 28'. The telescoping valve 68 constitutes a plurality of valve elements 69 70 71. The valve elements constitute circular cylindrical flange elements. The first valve element 69 having the largest diameter is fixated to the inner wall of the cooling device 20^{VII}. The first valve element 69 is protruding slightly towards the bottom 22' of the cooling device 20^{VII} and constitutes an inwardly protruding bead. The second valve element 70 constitutes a flange element having an upper outwardly protruding bead sealing against the first valve element and an inwardly protruding bead sealing against the outwardly protruding bead of the first valve element 69. The third valve element 71 constitutes a cup-shaped element having an upper outwardly protruding bead sealing against the outwardly protruding bead of the second valve element 70 and a lower horizontal surface sealing against the lower inwardly protruding bead of the second valve element 70.

[0071] Fig. 7b shows the self-cooling container 10^{VII} of Fig. 7a when the beverage can 12' has been opened. As previously described in Fig. 6b, the opening of the beverage can 12' causes the bottom 22 of the cooling device 20' to bulge outwardly, thereby causing the pressure in the main reactant chamber 28' to be reduced, thereby causing the second and third valve elements 70 71 to move in a direction towards the bottom 22 of the cooling device 20^{VII} so that the outwardly protruding bead of the second valve element 70 seals against the inwardly protruding bead of the first valve element 71 and the outwardly protruding bead of the third valve element 71 seals against the inwardly protruding bead of the second valve element 70. The second and third valve elements 70 71 are provided with circumferentially distributed valve apertures 72, which allow fluid communication between the water chamber 44' and the main reactant chamber 28'. Thus, water is allowed to flow from the water chamber 44 to the main reactant chamber 28.

[0072] Fig. 8a shows a self-cooling container 10^{VIII} comprising similar to the self-cooling container 10^{IV} described in connection with Fig. 4, however, an auxiliary reactant chamber 50' is provided between the water chamber 44' and the main reactant chamber 28'. The water chamber 44' is separated from the auxiliary reactant chamber 50 by a support 74 and a rupturable diaphragm 54". The support 74 seals between the inner wall of the cooling device 20' and the rupturable diaphragm 54, which is centrally located and covering a descending pipe 76, which is protruding towards the main reactant chamber 28'. The auxiliary reactant chamber 50' and the main reactant chamber 28' are separated by a water soluble diaphragm 78.

[0073] Fig. 8b shows the self-cooling container 10^{VIII} as described in Fig. 8a when the beverage can 12' has been opened. The opening of the beverage can causes the bottom 22 of the cooling device 20' to bulge outwardly as described above in connection with Fig. 4 to Fig. 7. The reduced pressure in the main reactant chamber 28' causes the water soluble diaphragm 78 to bulge towards the bottom 22' and the resulting low pressure in the auxiliary reactant chamber 50' causes the rupturable diaphragm 54" to burst and allowing the water in the water chamber 44' to enter the descending pipe 76 and flow towards the water soluble diaphragm 78. When the water soluble diaphragm is dissolved by the water from the descending pipe, the auxiliary reactants, constituting the first of the two reactants required for the chemical reaction to activate and stored in the auxiliary reactant chamber 50, will be allowed to react with the main reactant, constituting the second of the two reactants required for the chemical reaction to activate and stored in the main reactant chamber 28'. The resulting activation of the chemical reaction is caused by the mutual contacting of the reactants. The reaction yields the cooling effect.

[0074] Fig. 9a shows a self-cooling container 10^{IX} similar to the self-cooling container 10^{IV} of Fig. 4, however comprising a cooling device 20^{IX} being made completely of polymeric material. The cooling device 20" constitutes a polymeric cylinder having three parts, the first part being a rigid cylinder part 80 which is fixated to the lid 16 of the beverage can 12'. The lid is gas tight, thus not providing any fluid communication between the outside and the upper rigid cylinder part 80. The upper rigid cylinder part 80 protrudes into the beverage can 12' and is connected to the second cylinder part constituting an intermediate flexible cylinder 82, which is in turn connected to the third cylinder part constituting a lower rigid cylinder part 81, which is sealed off close to the beverage can base 40. The upper rigid cylinder part 80 constitutes a water chamber and a lower rigid cylinder part is filled with a reactant granulate. When the beverage can 12' is filled and pressurised, the pressure will cause the intermediate flexible cylinder to be squeezed off, forming a squeeze off valve, due to the lower pressure inside the cooling device 20^{IX} compared to the pressure in the beverage can 12.

[0075] Fig. 9b shows the self-cooling container 10^{IX} of Fig. 9a when the beverage can 12' has been opened. The lower pressure in the beverage can 12' will cause the intermediate flexible cylinder 82 to assume a non-squeezed state allowing fluid communication between the upper rigid cylinder part 80 and the lower rigid cylinder part 81.This way the intermediate cylinder 82 forms a channel so that the water contained in the upper rigid cylinder part will flow into the lower rigid cylinder part, thereby activating the coated granulate reactant stored in the lower rigid cylinder part 81.

[0076] Fig. 9c shows the self-cooling container 10^{IX} comprising a beverage can 12' having a cooling device 20^{IX} similar to Fig. 9a and Fig. 9b, however, additionally providing an optional circumferential gripping member 83 located on the inner wall on the intermediate flexible cylinder 82. The gripping member 83 is accommodating a separation element 84 constituting a small disc shaped element of plastic material, which provides a more secure sealing between the water stored in the upper rigid cylinder part 80 and the reactant granulate stored in the lower rigid cylinder part 81. The gripping member 83 and the separation element 84 are preferably made of substantially rigid plastics. The gripping member 83 comprise gripping elements which may interlock with corresponding beads on the separation element 83.

[0077] Fig. 9d shows a close-up of the gripping member 83 and the separation element 84 of Fig. 9c when the beverage can 12' is an unopened and pressurised state.

[0078] Fig. 9e shows a close-up view of Fig. 9d, when the beverage can 12' has been opened and the reduced pressure from the outside of the intermediate flexible cylinder 82 causes the walls of the intermediate flexible cylinder 82 to separate and causes the separation element to detach from the gripping member 83, thus allowing fluid communication between the upper rigid cylinder part 80 and the lower rigid cylinder part 81. By using the gripping member 83 and the separation element 84, a well defined separation is accomplished between the upper rigid cylinder part 80 and the lower rigid cylinder part 81 when the cooling device 20" is activated and the walls of the intermediate flexible cylinder 82 are separated.

[0079] Fig. 10a shows a cooling device 10^{X} similar to the cooling device 10^{V} of Fig. 5. The cooling device 20^{X} has an auxiliary reactant chamber 50', which is located between the water chamber 44' and the main reactant chamber 28'. The auxiliary reactant chamber 50' is separated from the main reactant chamber 28' by a main cap 60' and a main cap seat 62'. The auxiliary reactant chamber is separated from the water chamber 44' by an auxiliary cap 86 and an auxiliary cap seat 88. The main cap seat 62 and the main cap 60 as well as the auxiliary cap seat 88 and the auxiliary cap 86 work in the same way as the main cap seat and the main cap described in connection with Fig. 5.

[0080] Fig. 10b shows the self-cooling container 10^{X} of Fig. 10a when the beverage can 10^{X} has been opened and the bottom 22' of the cooling device 20^{X} has been caused to bulge outwardly due to the reduced pressure inside the beverage can 12'. This causes the auxiliary cap 62 and the main cap 60' to fall downwardly in direction towards the bottom 22' due to the pressure force, which causes the water, the auxiliary reactant and the main reactant to mix and thereby activate the chemical reaction.

[0081] Fig. 11 a shows a self-cooling container 10^{XI} similar to the self-cooling container 10^{X} described in connection with Fig. 10, however, instead of an auxiliary cap seat and an auxiliary cap, a support mesh 66 and the rupturable diaphragm 54' is provided. The support mesh 66 and the rupturable diaphragm 54' works in the same as in the previously described self-cooling container 10^{VI} of Fig. 6.

[0082] Fig. 11b shows the self-cooling container 10^{XI} of Fig. 11 a when the beverage can 12' has been opened and the cooling device 20^{XI} has been activated.

[0083] Fig. 12a and Fig. 12b show a self-cooling container 10^{XII} similar to the self-cooling container 10^{X}, where the rupturable diaphragm 54 and the piercing element 56 of Fig. 4 have been combined with the support mesh 66 and the rupturable diaphragm 54' of Fig. 6.

[0084] Fig. 13a shows a self-cooling container 10^{XIII} comprising a beverage can 12" having a submerged cooling device 20^{XII} constituting a cooling widget. The cooling device 20^{XII} defines a cylinder of preferably polymeric material, which may move freely in the beverage inside the beverage can 12". The cooling device 20" comprises a pressure space 32", a water chamber 44" and a main reactant chamber 28". The pressure space 32" comprises a pressure inlet 52' for allowing a small amount of beverage to enter the cooling device 20". The pressure space 32' and the water chamber 44" are separated by a flexible diaphragm 40". The water chamber 44" and the main reactant chamber 28' are separated by a plug seat 90 and a main plug 89 centrally located in the plug seat 90. The plug seat 90 seals between the main plug 89 and the inner wall of the cooling device 20". The main plug 89 is connected to the diaphragm 30". The overpressure in the beverage can 12' keeps the diaphragm 30" in relaxed and non-activated state. The main plug 89 separates the water in the water chamber 44" and granulates reactants in the main reactant chamber 28".

[0085] Fig. 13b shows the self-cooling container 10^{XIII} as described in Fig. 13a when the beverage can 12" has been opened. When the beverage can 12" has been opened, the pressure inside the beverage can 12" and pressure space 32" is reduced and the pressure in the water chamber 44" causes the diaphragm 30" to bulge towards the pressure inlet 52". When the diaphragm 30" bulges towards the pressure inlet 52', the main plug 89, which is connected to the diaphragm 30" will disconnect from the plug seat 90 and fluid communication is accomplished between the water chamber 44" and the main reactant chamber 28", allowing water to enter the main reactant chamber 44 and activating the chemical reaction which is causing the beverage to be cooled.

[0086] Fig. 14a shows a self-cooling container 10^{XIV} similar to the self-cooling container 10^{XIII} shown in Fig. 13, however where the cooling device 20^{XIV} additionally comprising an auxiliary reactant chamber 50" including a reaction control fluid for reducing the reaction time. The auxiliary reactant chamber 50" is located between the water chamber 44" and the main reactant chamber 28". The water chamber 44" and the auxiliary reactant chamber 50" are supported by a main plug seat 90 and a main plug 89 and the auxiliary reactant chamber 50" and the main reactant chamber 28" are supported by an auxiliary plug seat 94 and an auxiliary plug 92. The auxiliary plug 92 is connected to the main plug 89.

[0087] Fig. 14b shows the self-cooling container 10^{XIV} of Fig. 14a when the beverage can 12" has been opened. The pressure loss when opening the beverage can 12" will cause the diaphragm 30 to bulge towards the pressure inlet 22'. Since both the main plug 89 and the auxiliary plug 92 are connected to the diaphragm 30", both the water chamber 44" and the auxiliary reactant chamber 50" will establish fluid communication with the main reactant chamber 28". This causes the water in the water chamber 44' and the reaction control fluid in the auxiliary reactant chamber 50" to flow into the main reactant chamber 28", which is filled with the coated granulate reactant. When both the reactants are mixed together in water, the chemical reaction is activated and the cooling is initiated. The reaction control fluid prolongs the cooling effect and may be used for e.g. preventing ice formation inside the beverage can 12.

[0088] Fig. 15a and 15b shows a self-cooling container 10^{XV} similar to the self-cooling container 10^{XIV} shown in Fig.

14, however, instead of using a flow control fluid, the second reactant is stored in the auxiliary reactant chamber 50", thereby excluding the use of a coating of the reactant. When activation is established by opening the beverage can 12" and the first granulate reactant in the main reactant chamber 28 is mixed with the second granulate reactant in a water solution, the chemical reactions is activated.

[0089] Fig. 16a shows a self-cooling container 10^{XVI} constituting a cooling box comprising an insulating carrier 96 being made of rigid insulating material, such as Styrofoam or the like. The insulating carrier 96 has a cavity 97 defining a space suitable for accommodating six standard beverage cans 12"', i.e. typically sized beverage cans having a shape corresponding to the beverage cans described above and designated the reference numeral 12, however exclusive of the cooling device. The inner cavity 97 defines a flat bottom surface and an inner continuous sidewall which has bulges 98 for defining a plurality of interconnected arcs corresponding to the outer surface of six beverage cans defining positions for individual placement of the beverage cans 12"' when placed in the well known 3x2 "sixpack" configuration so that a stable and secure positioning is achieved. The inner cavity 97 is thus configured for accommodating six beverage cans 12"' in two rows with three beverage cans 12"' in each row. A spacer 99 is provided for filling up the inner space between the six beverage cans 12"' for added stability. The spacer 99 is preferably made in a non-thermal insulating or weakly thermal insulating material such as plastics, metal or cardboard. In the self-cooling container $1O^{XVI}$, one of the beverage cans 12"' has been substituted by a cooling device 20^{XVI} having an external shape corresponding to a beverage can 12"'. The cooling device 20^{XVI} has an activation button 100, which is pressed for activating the chemical reaction inside the cooling device 20^{XVI}. The inside of the cooling device 20^{XVI} may correspond to any of the previous cooling devices shown in fig 1-15, except that the activation is performed by a mechanical action from the outside, i.e. by pressing the button 100.

[0090] The button may be directly coupled to e.g. a rupturable diaphragm or the like separating the two reactant, thus by pressing the button the diaphragm is ruptured allowing the two reactants to contact each other. Alternatively the button 100 may be acting on a pressure space, and the change of pressure causes a flexible diaphragm to move and start the chemical reaction.

[0091] Fig. 16b shows a top view of the self-cooling container 10^{XVI} comprising the insulating carrier 96 accommodating the five beverage cans 12 and the cooling device 20^{XVI}. The self-cooling container 10^{XVI} may be stored in room temperature. When the beverage in the beverage cans is about to be consumed, the activation button 100 on the cooling device 20^{XVI} is pressed and the cooling is activated. An optional cover on the insulation carrier 96 may be provided as an additional insulation.

[0092] Fig. 17a shows a self-cooling container 10^{XVII} constituting an alternative configuration of the self-cooling container 10^{XVI}. The cooling device 20^{XVII}, corresponding to the cooling device 20^{XVI} of fig 16, is accommodated in a centrally located spacer 99' and 6 beverage containers are accommodated in an insulation carrier 96' surrounding the spacer 100'. The insulation carrier 96' has a rounded outer shape and an inner cavity 97' having bulges 98' for accommodating the six beverage cans 12"' in a circumferential configuration around the centrally located spacer 99.

[0093] Fig. 17b and c shows a perspective view and a top view, respectively, of the self-cooling container 10^{XVI}.

[0094] Fig. 18a-f show the steps of filling and pressurising a beverage can 12 of the type shown in the Figures 1 to 3, including a cooling device 20 of the type shown in fig 1-3.

[0095] Fig. 18a shows the process of ventilating the beverage can 12 prior to filling. The beverage can 12 includes a cooling device 20 and a lid flange 104. The beverage can is typically ventilated three times by inserting a ventilating hose 102 and injecting carbon dioxide (CO_2) into the beverage can 12. The carbon dioxide will substitute the air inside the beverage can 12. Any amount of residual air inside the beverage can 12 may result in deterioration of the beverage. Subsequent to the ventilation, the beverage can 12 is filled with beverage as shown in fig 20b.

[0096] Fig. 18b shows the beverage filling process, in which a filling hose 103 is inserted and beverage is injected into the beverage can 12. The beverage is pre-carbonated and having a low temperature of just a few degrees centigrade above the freezing point for accommodating a maximum amount of carbon dioxide dissolved in the beverage.

[0097] Fig. 18c shows the filled beverage can 12 when the filling hose 103 has been removed. The beverage is kept in a carbon dioxide atmosphere having a temperature just above the freezing point to be able to be saturated with carbon dioxide without the need of a high pressurized environment.

[0098] Fig. 18d shows a beverage can 12, where a lid 16 has been sealed on to the lid flange 104. The lid 16 is folded on to the lid flange 104 forming a pressure tight sealing.

[0099] Fig. 18e shows the beverage can 12 inside a pasteurisation plant 106. The pasteurisation plant comprises a water bath of about 70 degrees centigrade. The pasteurisation process is well known for retarding any microbiological growth in food products. During pasteurisation, the pressure inside the beverage can will rise to about 60 bar due to the heating of the beverage and the resulting release of carbon dioxide from the beverage. The cooling device should be made sufficiently rigid to be able to withstand such high pressures.

[0100] Fig. 18f shows the beverage can 12 in room temperature. The pressure inside the beverage can 12 is about 3 to 5 bar, which is sufficient for preventing activation of the cooling device 20. When the beverage can is being opened, the pressure inside will escape to the surrounding athmosphere, the beverage can 12 will assume atmospheric pressure of 1 bar and the cooling device 20 will activate as previously discussed in connection with fig 1-15..

[0101] Fig. 19a-e show the steps of filling and pressurising a beverage can 12 of the type shown in the Figures 13 to 15, including a cooling device of the type shown in figures 13 to 15. The process is similar to the filling process described above in connection with fig 18, except for the positioning of the cooling device 20 in fig 21c, which occurs after filling but before applying the lid 16.

[0102] Fig. 20a to 20f show the steps of filling and pressurising a beverage can 12 of the type shown in the Figures 4 to 12, including a cooling device of the type shown in fig 4 to 12. As the cooling device 20 is attached to the lid 16, the cooling device and the lid is attached to the beverage can 12 in one piece in fig 20d.

[0103] Fig. 21 a shows a party keg system 110 having a built-in pressurisation system and a self-cooling beverage container. The party keg constitutes a simple beverage dispensing system for typically single use and accommodating about three to ten litres of beverage and typically five litres of beverage. Party kegs are often used for minor social events such as private parties and the like. Party kegs often include a pressurisation and carbonisation system and one such party keg system has been described in the pending and not yet published European patent application No. 08388041.9. The party keg mentioned in 08388041.9, however, does not provide any internal cooling, thus requiring external cooling until the beverage is about to be consumed. The party keg 110 comprises a housing 112, which preferably is made of a light insulating material, such as styrofoam or the like. The housing comprises an upper space 114 and a lower space 116, which are separated by a closure 118. A beverage keg 120 including a suitable amount of beverage is accommodated in the lower space 116 and fixated to the closure 118. The beverage keg 120 has an upwards oriented opening 122, which is fixated to the closure 118 by a fixation flange 123. A tapping line 124 is extending through the opening 122 into the beverage keg 120. The tapping line constitutes an ascending pipe and extends through the closure 118 via the upper space 114 to the outside of the housing 112. Outside the housing 112, a tapping valve 126 is used for controlling the flow of beverage through the tapping valve 126. When the tapping valve 126 is in open position, beverage will flow through the tapping line 124 and leave the party keg system 110 via a beverage tap 127, while the beverage may be collected in a glass or the like. A gasket 128 seals the tapping line 124 to the closure 118. A pressure generator 130 is located in the upper space 114. The pressure generator may be a cartridge of pressurised carbon dioxide or alternatively, a chemical pressure generator. The pressure generator 130 is connected to the beverage keg 120 by a pressurising hose 132. The pressurising hose 132 is connected to the interior of the beverage keg 120 via the opening 122 and is sealed to the closure 118 by the gasket 128. A pressurisation knob extending between the pressure generator 130 and the outside of the housing 112 is used for initiating the pressurisation of the beverage keg 120. The beverage keg 120 is filled with beverage and additionally accommodates a cooling device 20^{XXI}. The cooling device includes a main reactant chamber 28 and an auxiliary reactant chamber 50, which are separated by a water-soluble diaphragm 78. A fluid inlet 136 is located next to the water-soluble diaphragm. The fluid inlet 136 will allow pressurised fluid to enter the cooling device 20^{XXI}. The fluid inlet 136 comprise a check valve 138, preventing any reactant from flowing out of the fluid inlet 136 and contact the beverage due to pressure variations in the beverage keg 120.

[0104] Fig. 21b shows the party keg system 110 on Fig. 23a when it has been activated by operating the pressurisation knob 134. When the pressurisation knob 134 has been operated, pressurised carbon dioxide will enter the beverage keg 120 and pressurise the beverage accommodated inside. Beverage will thus enter the fluid inlet 136 of the cooling device 20^{XXI} and dissolve the water-soluble diaphragm 78. This causes the main reactant located in the main reactant chamber 28 to mix with the auxiliary reactant located in the auxiliary reactant chamber 50 and thereby activate the cooling reaction. The functional principle of the cooling device 20 is similar to the functional principle of the cooling device 20^{VIII} of Fig. 8, however, in an opposite direction, i.e., whereas the cooling device 20^{VIII} of Fig. 8 is initiated by a reduction of pressure, the cooling device 20^{XXI} of Fig. 21 is activated by an increase in pressure. This way, the party keg system 110 must not be pre-cooled and may be stored in room temperature. When the beverage is about to be consumed, the operator presses the pressurisation knob, which automatically initiates the cooling reaction and after a few minutes, a cool beverage may be dispensed by operating the tapping valve 126. It is further contemplated that the housing of the party keg system may be omitted or replaced by a simpler housing if for instance no insulation is needed.

[0105] Fig. 22a shows a beverage dispensing system 140 for private or professional use. Such beverage dispensing systems are well known in the art and have been previously described in the international PCT application 2007/019853. The beverage dispensing system 140 comprises a pivotable enclosure 142, which is attached to a base plate 144. The interior of the enclosure 142 defines a pressure chamber 146. The pressure chamber 146 is separated from the base plate 144 by a pressure lid 148. The pressure lid 148 is sealed in relation to the base plate 144 by sealings 150. The side of the pressure lid 148 facing inwardly towards the pressure chamber 146 constitutes a coupling flange 152. The coupling flange 152 is used for fixating a beverage keg 120', which is accommodated within and fills the greater part of the pressure chamber 146. The beverage keg 120' constitutes a collapsible keg which is allowed to collapse due to the pressure force while the beverage is dispensed. A cooling and pressurisation generator 156 is connected to the pressure chamber 146 for providing cooling and pressurisation for the beverage located inside the beverage keg 146. A tapping line 124' connects the pressure chamber 146 to a tapping valve 126. The end of the tapping line 124 facing the pressure chamber 146 is provided with a cannula 151 for piercing through the coupling flange 152 for allowing fluid communication between the interior of the beverage keg 120' and the tapping valve 126. A tapping handle 154 is used for operating the tapping valve 126 between the shut-off position and the beverage dispensing position. In the beverage dispensing position, the handle 154 is moved from its normal vertical orientation to a horizontal orientation, and beverage is allowed to flow through the tapping valve 126 and leave the beverage dispensing system 140 through a beverage tap 127'. The interior of the beverage keg 120' accommodates beverage and a cooling device 20^{XXII}. The cooling device 20^{XXII} comprises a main reactant chamber 28 and an auxiliary reactant chamber 50. The main reactant chamber 28 and the auxiliary reactant chamber 50 are separated by a rupturable diaphragm 54.

[0106] The top of the cooling device 20^{XXI} is provided with a flexible diaphragm 30 to which a piercing element 56 is connected. The piercing element 56 extends towards the rupturable diaphragm 54.

[0107] Fig. 22b shows the beverage dispensing system 140 of Fig. 24a and the pressure chamber 146 has been pressurised. The pressure in the pressure chamber 146 acts to deform the beverage keg 120 and causes the flexible diaphragm 30 to bulge inwards towards the rupturable diaphragm 54. The rupturable diaphragm 54 will thereby burst by the protruding piercing element 56 and the chemical reaction for providing cooling is activated. This way, a rapid cooling of the beverage inside the beverage keg 120' is accomplished and a cold beverage may be dispensed from the beverage keg 126' by operating the tapping handle 154 within a few minutes from activation. This way, the beverage keg must not be cooled and the long waiting period for allowing the beverage to cool in a conventional way is avoided. The cooling device 20^{XXII} will rapid-cool the beverage when the beverage keg has been installed

[0108] Fig. 23a shows a beverage dispensing system 140' similar to the beverage dispensing system 140 shown in Fig. 24 except the cooling device 20^{XXIII}, which works similar to the cooling device of Fig. 21. The cooling device 20 comprises a main reactant chamber 28 and an auxiliary reactant chamber 50, which are separated by a water-soluble diaphragm 78. The water-soluble diaphragm 78 is connected to the coupling flange 152 by an activation channel 160. The coupling flange 152 comprises a dual sealing membrane 162, which seals the activation channel 160 from the interior of the beverage keg 120' and the outside of the coupling flange 152. Fig. 23a shows the installation procedure of the beverage keg 120' when the enclosure 142 is swung back for allowing access to the pressure chamber 146.

[0109] Fig. 25b shows the beverage dispensing system 140 when the pressure lid 148 has been attached to the enclosure 142 and the enclosure 142 has been swung back to the normal position sealing off the pressure chamber 146. When the pressure lid 148 is attached, the dual sealing membrane 162 is pierced and fluid is allowed to enter the activation channel 60 and tapping line 124'. When the pressure chamber 146 is pressurised, beverage will enter the activation channel 160 and dissolve the water soluble membrane 78 at the end of the activation channel 160. Thus, activation is accomplished and the chemical reaction will activate for generating cooling to the beverage as discussed in connection with Fig. 22.

[0110] Fig. 24 shows a bottle 164 having a bottle cap 166 with an integrated cooling device 20^{XXVI}. The bottle cap 166 has a cap flange 170 which is mounted on a threading 168 near the mouth of the bottle 164. The cooling device 20^{XXVI} is fixated to the bottle cap 166 and extending into the bottle 164. The cooling device 20^{XXVI} has an activation button 96' for activating the cooling before the bottle cap 166 is removed from the bottle 164.

[0111] Fig. 25 shows a bottle 164 having a cooling device similar to the cooling device shown in Fig. 26a except that a flexible diaphragm 30 is provided at the bottom of the cooling device 20. When the bottle cap 166 is twisted for allowing the pressurised gas to escape from the bottle 164, the flexible diaphragm 30 will bulge outwards and thereby initiate the chemical reaction similar to the self-cooling beverage container shown in connection with Fig. 4a.

[0112] Fig. 26a shows a bottle 164 having a bottle cap 166 and an outer cap 172. The outer cap 174 is connected to a tooth rod, which is located within a cooling device 20^{XXVI}. An intermediate diaphragm 174 separates the two reactants within the cooling device 20.

[0113] Fig. 26b shows the bottle 164 of Fig. 27 when the outer cap 172 is twisted. By twisting the outer cap, the tooth rod 176 is rupturing the intermediate diaphragm 174, thereby mixing the two reactants and activating the chemical reaction for generating cooling. After a few minutes, the outer cap 172 as well as the bottle cap 166 may be removed and the chilled beverage may be accessed.

[0114] Fig. 27a shows a drink stick 180 constituting a cooling stick having an integrated cooling device 20. The drink stick 180 comprises a knob 182, which may be used as a handle and an elongated flexible bode 184 for accommodating the cooling device. The cooling device 20 comprises a rupturable reservoir 186 comprising a first reactant. A second reactant is accommodated within an elongated flexible reservoir 184 outside the rupturable reservoir 186.

[0115] Fig. 27b shows the activation of the drink stick 180 of Fig. 28a. The drink stick 180 is activated by bending the drink stick 180 in the direction of the arrows. By bending the drink stick 180, the rupturable reservoir 186 is ruptured and the first reactant is mixed with a second reactant, thereby activating the chemical reaction generating a cooling effect.

[0116] Fig. 27c shows the drink stick 180 of Fig. 28b when the rupturable reservoir has been ruptured and the chemical reaction has been activated.

[0117] Fig. 27d shows the drink stick 180 of Fig. 28c when it has been inserted into a bottle 164. The bottle 164 may be a conventional beverage bottle containing beer or soft drink having a room temperature. Due to the cooling effect of the drink stick 180, the beverage in the bottle 164 is cooled down to temperatures significantly lower than room temperature. It is further contemplated that the drink stick 180 may be used with other beverage containers for giving instant cooling to any beverage. For example the drink stick 180 may be provided in a bar for use with a chilled long drink, such as gin and tonic, for allowing the drink to remain cooled for a longer time period.

[0118] In an alternative embodiment the above drink stick 180 may have a conical shape and being used together with an ice mould for instant manufacture of ice cubes by inserting the activated drink stick into the water filled ice mould. Alternatively, the drink stick may be have a cubic shape for direct usage as an ice cube in drinks etc.

[0119] Fig. 28a shows a first embodiment of a bottle sleeve 188 which is suitable for being applied on the outside of a bottle 164 for use as e.g. a wine cooler. The bottle sleeve 188 comprises a main reactant chamber 28 and a water chamber 44, which are separated by a rupturable diaphragm 54. The bottle sleeve 188 is fixated to the bottle by a fixation ring 189, which corresponds to a first groove 190 in the bottle sleeve 188. The fixation ring 189 is firmly attached to the bottle 164. The first groove 190 is located juxtaposed the main reactant chamber 28. A second groove 191 is located above the first groove 190 juxtaposed the water chamber 44.

[0120] Fig. 28b shows a bottle sleeve 188 when it has been activated by pushing it downwards in direction of the arrows. By pushing the bottle sleeve 188 downwards, the fixation ring 189 will detach from the first groove 190 and be accommodated in the second groove 191. Thereby, the rupturable diaphragm 54 will be ruptured by the fixation ring 192 and the water in the water chamber 44 will mix with the reactant in the main reactant chamber 28 and the cooling reaction is activated.

[0121] Fig. 28c shows a perspective view of a bottle 164 with an attached bottle sleeve 190.

[0122] Fig. 29a shows a bottle sleeve constituting a wine cooler 192 in a flat configuration. The wine cooler 192 comprises an outer layer 193, an inner layer 194 and a rupturable diaphragm 54 located between the outer layer and the inner layer. The space between the outer layer and the rupturable diaphragm constitutes a water chamber 44 and the space between the rupturable diaphragm and the inner layer 194 constitutes a main reactant chamber 28. The outer layer and the inner layer 192 and 194 are flexible and constitute bistable layers having a first stable positioning the flat configuration shown in Fig. 29a.

[0123] Fig. 29b shows the wine cooler 192 in its second bistable position forming a circular sleeve shape, where the outer layer 193 is facing outwards and the inner layer 194 is facing inwards. The second stable position may be accomplished by subjecting the bottom sleeve 190 to a slight bending force. When the second configuration, i.e. the circular configuration is assumed, the rupturable diaphragm 54 is being ruptured and thereby, the water and the reactant are being mixed for generating cooling.

[0124] Fig. 29c shows the wine cooler 192 in a perspective view.

[0125] Fig. 29d shows the wine cooler 192 being attached to the outside of a beverage bottle 164. The beverage inside the beverage bottle 164 is thereby being efficiently cooled down to a drinking temperature.

[0126] It is contemplated that the efficiency of the above self-cooling beverage containers and cooling devices are strongly dependent on the heat transfer properties (heat transfer factor) of the cooling device. The heat transfer factor may be modified by changing the geometry, in particular the surface area in beverage contact, of the cooling device, e.g. by providing metal fins onto the cooling device, the heat transfer factor may be increased, thus the cooling efficiency is increased. Consequently, by encapsulating the cooling device in e.g. Styrofoam or a hydrophobic material, the heat transfer factor may be reduced, i.e. the cooling efficiency is decreased. Alternatively, a catalyser may be used for increasing the efficiency of the chemical cooling reaction, or an selective adsorption-controlling agent may be used for reducing the efficiency of the chemical cooling reaction.

[0127] It is further contemplated that the entire cooling device may be of flexible material, such as rubber or plastics, and itself constitute a flexible diaphragm.

[0128] A variant of the cooling device may be activated by pulling a string connected to a mixing member through the cooling device.

[0129] The cooling device shaped as a pipe within a pipe to cool a beverage flowing through the inner pipe with reaction compartments in the space between the inner pipe and the outer pipe.

[0130] The cooling device shaped so as to be mountable around a tapping line for cooling beverage running through the tapping line.

[0131] The cooling device may have a breakable seal to avoid accidental activation.

[0132] The cooling device containing an arming device, the arming device comprising a membrane permeable to the beverage, a saturated salt solution and a non-permeable membrane separating the salt solution from the interior of the cooling device. Upon submersion of the cooling device in the container the water from the beverage enters through the permeable membrane by osmosis into the saturated salt solution which increases in volume thus exerting pressure on the membrane which is transmitted to the interior of the cooling device which results in increased interior pressure which can be used to activate the reaction as described above.

[0133] Fig. 30 shows a simplified cubic crystal 195 as produced as an insoluble product of a non-reversible entropy increasing reaction according to the present invention. The crystal 195 has a with a total of 6 crystal faces, one of which is designated the reference numeral 196. Furthermore the crystal 195 defines a total of 8 corners one of which is

designated the reference numeral 198. On the faces of 196 of the crystal 195 growths, one of which is designated the reference numeral 197 is present.
On the corners 198 growth of the crystal is inhibited by deposits, one of which is designated the reference numeral 199. The deposits are formed from a selective adsorbent selectively adhering to the corners 198 of the crystal 195.
The use of a selective adsorbent for preventing crystal growth is indicated in reactions where a non-soluble product may encapsulate remaining reactants as it is formed thus halting the process.

[0134] In Fig. 31, a dispensing and refrigerator system according to present invention is shown designating the reference numeral 200 in its entirety. The system comprises a refrigerator cabinet 202 comprising a cabinet, in which an inner space is defined as illustrated in the lower right hand part of Fig. 31 illustrating a cut-away part of the refrigerator cabinet 202 disclosing a plurality of beverage cans, one of which is designated the reference numeral 204, which is supported on beverage can sliding chutes, one of which is designated the reference numeral 206 and which supports a total of eight beverage cans 204. Within the refrigerator cabinet 202, a refrigerator unit 208 and a heater unit 210 are enclosed serving the purpose of cooling and heating, respectively, the inner chamber of the refrigerator cabinet 202 for providing a specific and preset thermostatically controlled temperature within the inner chamber of the refrigerator cabinet 202, such as a temperature of 16°-20°C, in particular a temperature approximately at or slightly above or slightly below the ambient temperature.

[0135] Provided the ambient temperature is substantially constant and above a certain lower limit, the heater unit 210 may be omitted, as the inner chamber of the refrigerator cabinet 202 is permanently cooled to a temperature slightly below the ambient temperature. As the inner temperature of the refrigerator cabinet 202 is set at a specific thermostatically controlled temperature, each of the beverage cans 204 may be contain a cooling device implemented in accordance with the teachings of the present invention for providing a cooling within a fairly short period of time, such as a period of time of a few minutes, e.g. 1-5 min., preferably approximately 2 min. from the temperature at which the beverage cans are stored within the refrigerator cabinet 202 to a specific cooling temperature, such as a temperature of 5°C.

[0136] The refrigerator cabinet 202 shown in Fig. 31 is provided with a dispensing aperture 212 to which a dispenser chute is connected, which dispenser chute is designated the reference numeral 216. The system 200 shown in Fig. 31 is advantageously provided with additional well-known elements or components, such as a coin receptor or a card or chip reader for operating a dispensing mechanism included within the refrigerator cabinet 202 for controlling the dispensing of the beverage cans 204 from the system 200 one at a time after verification of payment or verification of receipt of confirmation of transfer of a specific amount.

[0137] By the provision of a thermostatically controlled refrigerator cabinet 202, in which the individual beverage cans 204 are stored at a preset and constant temperature, preferably slightly below the ambient temperature, the overall consumption of electrical energy from the main supply is dramatically reduced as compared to a conventional beverage can dispenser, in which the beverage cans are all cooled to the specific low temperature of use, i.e. a temperature of e.g. +5°C for providing to the user a beverage can of a convenient cooled beverage. By the reduction of the cooling to a temperature at or slightly below the ambient temperature, only a fraction of the electrical power consumption is to be used by the beverage dispensing system according to the present invention as shown in Fig. 31 as compared to a conventional beverage can refrigerator and dispenser system. Whereas a convention beverage can dispenser and refrigerator system has to cool the beverage cans to a temperature of 5°C from e.g. an ambient temperature of 25°C or even higher, the system 200 according to the present invention merely serves to cool the beverage cans to a temperature of e.g. 20°C reducing as a rough calculation the energy consumption by at least 80% as compared to a comparable, conventional dispenser and refrigerator system cooling the beverage cans from 25°C to 5°C.

[0138] It is to be understood that the beverage dispenser system 200 shown in Fig. 31 may be modified into a conventional fridge or refrigerator having an openable front door through which the individual beverage cans may be supported on sets of shelves, on which the beverage cans are resting and from which the beverage cans may be caught by the users after opening the refrigerator front door.

[0139] By cooling the individual beverage cans contained within the refrigerator cabinet or within a conventional fridge as described above to a specific and preset temperature, the cooling device included in the individual beverage can and implemented in accordance with the teachings of the present invention may be designed to provide a preset and accurate cooling of the individual beverage can from the temperature within the refrigerator cabinet 202 to the temperature at which the user is to drink or pour the beverage from the beverage can.

[0140] Although the invention has above been described with reference to a number of specific and advantageous embodiments of beverage containers, beverage cans, bottles, cooling devices, dispensing and cooling systems etc., it is to be understood that the present invention is by no means limited to the above disclosure of the above described advantageous embodiments, as the features of the above-identified embodiments of the self-cooling container and also the features of the features of the above described embodiments of the cooling device may be combined to provide additional embodiments of the self-cooling container and the cooling device. The additional embodiments are all construed to be part of the present invention. Furthermore, the present invention is to be understood encompassed by any equivalent or similar structure as described above and also to be encompassed by the scope limited by the below points characterising the present invention and further the below claims defining the protective scope of the present patent application.

List of parts with reference to the figures

[0141]

10. Self-cooling beverage container	69. First valve element
12. Beverage can	70. Second valve element
14. Beverage can base	71. Third valve element
16. Lid	72. Valve apertures
18. Tab	74. Support
20. Cooling device	76. Descending pipe
22. Bottom	78. Water soluble diaphragm
24. Top	80. Upper rigid cylinder part
26. Gas permeable membrane	81. Lower rigid cylinder part
28. Main reactant chamber	82. Intermediate flexible cylinder
30. Flexible diaphragm	83. Gripping member
31. Support diaphragm	84. Separation element
32. Pressure space	86. Auxiliary cap
34. Rounded circumferential reinforcement bead	88. Auxiliary cap seat
36. Washer	89. Main plug
38. Rigid cup-shaped wall	90. Plug seat
40. Circular wall	92. Auxiliary plug
42. Circumferential gripping flange	94. Auxiliary plug seat
44. Water chamber	96. Insulating carrier
46. Auxiliary cup-shaped wall	97. Inner cavity
48. Auxiliary gripping flange	98. Bulges
50. Auxiliary reactant chamber	99. Spacer
52. Pressure inlet	100. Activation button
54. Rupturable diaphragm	102. Ventilation hose
56. Piercing element	103. Filling hose
58. Corrugation	104. Lid flange
60. Main cap	106. Pasteurisation plant
62. Main cap seat	110. Party keg system
66. Support mesh	112. Housing
68. Telescoping valve	114. Upper space
116. Lower space	174. Intermediate diaphragm
118. Closure	176. Toothed rod
120. Beverage keg	180. Drink stick
122. Opening	182. Knob
123. Fixation flange	184. Elongated flexible reservoir
124. Tapping line	186. Rupturable reservoir

(continued)

126. Tapping valve	190. Bottle sleeve
127. Beverage tap	192. Fixation ring
128. Gasket	194. Second groove
130. Pressure generator	196. First groove
132. Pressurization hose	166. Bottle cap
134. Pressurization knob	168. Threading
136. Fluid inlet	170. Cap flange
138. Check valve	172. Outer cap
140. Beverage dispensing system	174. Intermediate diaphragm
142. Enclosure	176. Toothed rod
144. Base plate	180. Drink stick
146. Pressure chamber	182. Knob
148. Pressure lid	184. Elongated flexible reservoir
150. Sealings	186. Rupturable reservoir
152. Coupling flange	188. Bottle sleeve
154. Tapping handle	189. Fixation ring
156. Cooling and pressurization generator	190. First groove
158. Fixing rod	191. Second groove
160. Activation channel	192. Wine cooler
162. Dual sealing membrane	193. Outer layer
164. Bottle	194. Inner layer
166. Bottle cap	195. Cubic crystal
168. Threading	196. Crystal face
170. Cap flange	197. Crystal growth
172. Outer cap	198. Corner
199. Deposit	208. Refrigerator unit
200. dispensing and refrigerator system	210. heater unit
202. refrigerator cabinet	212. dispensing aperture
204. beverage cans	216. Dispensing chute
206. sliding chutes	

POINTS

[0142]

1. A container for storing a beverage, said container having a container body and a closure and defining an inner chamber, said inner chamber defining an inner volume and including a specific volume of said beverage,
said container further including a cooling device having a housing defining a housing volume not exceeding approximately 33% of said specific volume of said beverage and further not exceeding approximately 25% of said inner volume,
said cooling device including at least two separate, substantially non-toxic reactants causing when reacting with one another a non-reversible, entropy-increasing reaction producing substantially non-toxic products in a stoichiometric number at least a factor 3, preferably at least a factor 4, more preferably at least a factor 5 larger than said

stoichiometric number of said reactants,
said at least two separate substantially non-toxic reactants initially being included in said cooling device separated from one another and causing, when reacting with one another in said non-reversible, entropy-increasing reaction, a heat reduction of said beverage of at least 50 Joules/ml beverage, preferably at least 70 Joules/ml beverage, such as 70-85 Joules/ml beverage, preferably approximately 80-85 Joules/ml, within a period of time of no more than 5 min. preferably no more than 3 min., more preferably no more than 2 min., and
said cooling device further including an actuator for initiating said reaction between said at least two separate, substantially non-toxic reactants.

2. The container according to point 1, said actuator including a pressure transmitter e.g. a gas permeable membrane or a flexible membrane for transmitting a pressure increase within said inner chamber to said cooling device for initiating said reaction or alternatively for transmitting a pressure drop within said inner chamber to said cooling device for initiating said reaction.

3. The container according to point 1, said actuator including a mechanical actuator for initiating said reaction between said at least two separate, substantially non-toxic reactants.

4. The container according to any of the points 1-3, said reactants being contained within separate compartments within said cooling device separated by a breakable, dissolvable or rupturable membrane caused to be broken, dissolved or ruptured by said actuator, or alternatively separated by a displaceable plug.

5. The container according to point 4, said actuator including a membrane breaker or piercer for breaking or piercing said membrane.

6. The container according to any of the points 3-5, said actuator being accessible from the outside relative to said container and preferably being activated through said closure.

7. The container according to any of the points 1-6, said non-reversible, entropy-increasing reaction producing a volumetric change from said at least two separate, substantially non-toxic reactants to said substantially non-toxic products, a volumetric change of no more than $\pm$ 5%, such as preferably no more than $\pm$ 4%, further preferably no more than $\pm$ 3%, or alternatively said cooling device being vented to the atmosphere for allowing any access gas reduced in said non-reversible, entropy-increasing reaction to be vented to the atmosphere.

8. The container according to any of the points 1-7, said at least two separate, substantially non-toxic reactants being present as separate granulates or present as at least one granulate and at least one liquid or present as separate liquids.

9. The container according to point 8, said granulate or said granulates being prevented from reacting through one or more external coatings such as a coating of starch, a soluble plastics coating or the like, said one or more external coatings being dissolvable by water or an organic solvent preferably a liquid such as a water-soluble coating, or alternatively said granulate or said granulates being prevented from reacting by being embedded in a soluble gel or foam.

10. The container according to any of the points 1-9, said cooling device further including a chemical activator such as water, an organic solvent, such as alcohol, propylene glycol or acetone.

11. The container according to point 9, said liquid activator further serving as a reaction-controlling agent such as a selective adsorption-controlling agent, or a retardation temperature setting agent.

12. The container according to any of the preceding points, said container body comprising a beverage keg of polymeric or metallic material having a volume of 3-50 litres, said keg being either collapsible or rigid, and said closure being a keg coupling.

13. The container according to any of the preceding points, said container body comprising a bottle of glass or polymeric material, said bottle having a volume of 0.2-3 liters, and said closure being a screw cap, crown cap or stopper.

14. The container according to any of the preceding points, said container body comprising a beverage can and a

beverage lid of metallic material, preferably aluminum or an aluminum alloy, said can having a volume of 0.2-1 liters, and said closure being constituted by an embossing area of said beverage lid.

15. The container according to any of the preceding points, said container comprising a bag, preferably as a bag-in-box, bag-in-bag or bag-in-keg.

16. The container according to any of the preceding points, said container comprising guiding elements for guiding the flow of beverage from said container body.

17. The container according to point 16, said guiding elements serving to guide the flow of the beverage via said cooling device towards said closure.

18. The container according to any of the points 1-17, wherein said cooling device is located within said container.

19. The container according to any of the points 1-17, wherein said cooling device is located outside said container.

20. The container according to any of the preceding points, wherein said container body constitutes a double walled container constituting an inner wall and an outer wall, the cooling device being located between the inner and outer wall

21. The container according to any of the preceding points, said container further comprising a pressure generating device either accommodated within said container or connected to said container via a pressurization hose, said pressure generating device preferably comprise a carbon dioxide generating device for pressurization of said beverage in said beverage container.

22. The container according to any of the preceding points, said container further comprising a tapping line and a tapping valve for selectively dispensing beverage from said beverage container.

23. The container according to any of the preceding points, wherein said beverage container is filled with carbonated beverage such as beer, cider, soft drink, mineral water, sparkling wine, or alternatively non-carbonated beverage such as fruit juice, milk products such as milk and yoghurt, tap water, wine, liquor, ice tea, or yet alternatively a beverage constituting a mixed drink.

24. The container according to any of the preceding points 1-23, wherein said cooling device is accommodated inside the beverage container before filling the beverage into the beverage container.

25. The container according to any of the points 1-23, said container comprising, wherein said cooling device forms an integral part of the beverage container.

26. The container according to any of the points 1-23, wherein said cooling device constitutes a part of the top of the beverage container, alternatively a part of the wall or bottom of the beverage container.

27. The container according to any of the points 1-23, wherein said cooling device is fastened onto the base of the beverage container, alternatively the wall of the container, yet alternatively the top of the container.

28. The container according to any of the points 1-23, wherein said cooling device constitute a widget, which is freely movable within the container.

29. The container according to any of the points 1-28, said at least two separate, substantially non-toxic reactants comprising one or more salt hydrates, preferably inorganic salt hydrates deliberating in said non-reversible, entropy-increasing reaction a number of free water molecules.

30. The container according to point 29, said one or more salt hydrates being selected from salt hydrates of alkali metals, such as lithium, sodium and potassium, and salt hydrates of alkaline earth metals, such as beryllium, calcium, strontium and barium, and salt hydrates of transition metals, such as chromium, manganese, iron, cobalt, nickel, copper, and zink, and aluminium salt hydrates and lanthanum salt hydrates, preferably $LiNO_3•3H_2O$, $Na_2SO_4•10H_2O$ (Glauber salt), $Na_2SO_4•7H_2O$, $Na_2CO_3•10H_2O$, $Na_2CO_3•7H_2O$, $Na_3PO_4•12H_2O$, $Na_2HPO_4•12H_2O$, $Na_4P_2O_7•10H_2O$, $Na_2H_2P_2O_7•6H_2O$, $NaBO_3•4H_2O$, $Na_2B_4O_7•10H_2O$, $NaClO_4•5H_2O$, $Na_2SO_3•7H_2O$, $Na_2S_2O_3•5H_2O$, $NaBr•2H_2O$, $Na_2S_2O_6•6H_2O$, $K_3PO_4•3H_2O$, preferably $Na_2SO_4•10H_2O$(Glauber salt),

$MgCl_2 \cdot 6H_2O$, $MgBr_2 \cdot 6H_2O$ $MgSO_4 \cdot 7H_2O$, $Mg(NO_3)_2 \cdot 6H_2O$, $CaCl_2 \cdot 6H_2O$, $CaBr_2 \cdot 6H_2O$, $Ca(NO_3)_2 \cdot 4H_2O$, $Sr(OH)_2 \cdot 8H_2O$, $SrBr_2 \cdot 6H_2O$, $SrCl_2 \cdot 6H_2O$, $Sr(NO_3)_2 \cdot 4H_2O$, $SrI_2 \cdot 6H2O$, $BaBr_2 \cdot 2H_2O$, $BaCl_2 \cdot 2H_2O$, $Ba(OH)_2 \cdot 8H_2O$, $Ba(BrO_3)_2 \cdot H_2O$, $Ba(ClO_3)_2 \cdot H_2O$, $CrK(SO_4)_2 \cdot 12H_2O$, $MnSO_4 \cdot 7H_2O$, $MnSO_4 \cdot 5H_2O$, $MnSO_4 \cdot H_2O$, $FeBr_2 \cdot 6H_2O$, $FeBr_3 \cdot 6H_2O$, $FeCl_2 \cdot 4H_2O$, $FeCl_3 \cdot 6H_2O$, $Fe(NO_3)_3 \cdot 9H_2O$, $FeSO_4 \cdot 7H_2O$, $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$, $FeNH_4(SO_4)_2 \cdot 12H_2O$, $CoBr_2 \cdot 6H_2O$, $CoCl_2 \cdot 6H_2O$, $NiSO_4 \cdot 6H_2O$, $NiSO_4 \cdot 7H_2O$, $Cu(NO_3)_2 \cdot 6H_2O$, $C_U(NO_3)_2 \cdot 3H_2O$, $CuSO_4 \cdot 5H_2O$, $Zn(NO_3)_2 \cdot 6H_2O$, $ZnSO_4 \cdot 6H_2O$, $ZnSO_4 \cdot 7H_2O$, $Al_2(SO_4)_3 \cdot 18H_2O$, $AlNH_4(S0_4)_2 \cdot 12H_2O$, $AlBr_3 \cdot 6H_2O$, $AlBr_3 \cdot 15H_2O$, $AlK(SO_4)_2 \cdot 12H_2O$, $Al(NO_3)_3 \cdot 9H_2O$, $AlCl_3 \cdot 6H_2O$ and/or $LaCl_3 \cdot 7H_2O$.

31. A method of providing a container including a beverage of a first temperature constituting a specific low temperature such as a temperature of approximately 5°C, said container having a container body and a closure and defining an inner chamber, said inner chamber defining an inner volume and including a specific volume of said beverage,
said container further including a cooling device having a housing defining a housing volume not exceeding approximately 33% of said specific volume of said beverage and further not exceeding approximately 25% of said inner volume,
said cooling device including at least two separate, substantially non-toxic reactants causing when reacting with one another a non-reversible, entropy-increasing reaction producing substantially non-toxic products in a stoichiometric number at least a factor 3, preferably at least a factor 4, more preferably at least a factor 5 larger than the stoichiometric number of said reactants,
said at least two separate substantially non-toxic reactants initially being included in said cooling device separated from one another and causing, when reacting with one another in said non-reversible, entropy-increasing reaction, a cooling of said beverage from a second temperature constituting a temperature substantially higher than said first temperature and preferably constituting a temperature at or slightly below the average ambient temperature, to said first temperature within a period of time of no more than 5 min. preferably no more than 3 min., more preferably no more than 2 min., and
said cooling device further including an actuator for initiating said reaction between said at least two separate, substantially non-toxic reactants, when opening said container, the method comprising:

i) providing a closed cabinet defining an inner cabinet chamber for storing a plurality of said containers and having a dispensing opening for the dispensing of said containers, one at a time, or alternatively having an openable door for providing access to said inner cabinet chamber for the removal of one or more of said containers from within said inner cabinet chamber,
ii) thermostatically controlling the temperature of said inner cabinet chamber to said second temperature,
iii) storing said plurality of containers in said inner cabinet chamber for an extended period of time for allowing the beverage contained in each of said containers to stabilize at said second temperature,
iv) dispensing said container from said inner cabinet chamber, and
v) opening said container for causing said non-reversible, entropy increasing reaction and causing said cooling of said beverage contained in said container to said first temperature.

32. A system for providing a container including a beverage of a first temperature constituting a specific low temperature such as a temperature of approximately 5°C, the system comprising:

i) a closed cabinet defining an inner cabinet chamber for storing a plurality of said containers and having a dispensing opening for the dispensing of said containers, one at a time, or alternatively having an openable door providing access to said inner cabinet chamber for the removal of one or more of said containers from within said inner cabinet chamber, said closed cabinet having thermostatically controlled temperature controlling means for maintaining the temperature within said inner cabinet chamber at a second temperature constituting an elevated temperature as compared to said first temperature and preferably a temperature at or slightly below the average ambient temperature,
ii) a plurality of said containers,
each of said containers having a container body and a closure and defining an inner chamber, said inner chamber defining an inner volume and including a specific volume of said beverage,
each of said containers further including a cooling device having a housing defining a housing volume not exceeding approximately 33% of said specific volume of said beverage and further not exceeding approximately 25% of said inner volume,
said cooling device including at least two separate, substantially non-toxic reactants causing when reacting with one another a non-reversible, entropy-increasing reaction producing substantially non-toxic products in a stoichiometric number at least a factor 3, preferably at least a factor 4, more preferably at least a factor 5 larger

than the stoichiometric number of said reactants,
said at least two separate substantially non-toxic reactants initially being included in said cooling device separated from one another and causing, when reacting with one another in said non-reversible, entropy-increasing reaction, a cooling of said beverage from a second temperature constituting a temperature substantially higher than said first temperature and preferably constituting a temperature at or slightly below the average ambient temperature, to said first temperature within a period of time of no more than 5 min. preferably no more than 3 min., more preferably no more than 2 min., and
said cooling device further including an actuator for initiating said reaction between said at least two separate, substantially non-toxic reactants, when opening said container.

33. A cooling device for use in or in combination with a container for storing a beverage, said container having a container body and a closure and defining an inner chamber, said inner chamber defining an inner volume and including a specific volume of said beverage,
said cooling device having a housing defining a housing volume not exceeding approximately 33% of said specific volume of said beverage and further not exceeding approximately 25% of said inner volume,
said cooling device including at least two separate, substantially non-toxic reactants causing when reacting with one another a non-reversible, entropy-increasing reaction producing substantially non-toxic products in a stoichiometric number at least a factor 3, preferably at least a factor 4, more preferably at least a factor 5 larger than the stoichiometric number of said reactants,
said at least two separate substantially non-toxic reactants initially being included in said cooling device separated from one another and causing, when reacting with one another in said non-reversible, entropy-increasing reaction, a heat reduction of said beverage of at least 50 Joules/ml beverage, preferably at least 70 Joules/ml beverage, such as 70-85 Joules/ml beverage, preferably approximately 80-85 Joules/ml, within a period of time of no more than 5 min. preferably no more than 3 min., more preferably no more than 2 min., and
said cooling device further including an actuator for initiating said reaction between said at least two separate, substantially non-toxic reactants.

34. The cooling device according to point 33, said actuator including a pressure transmitter e.g. a gas permeable membrane or a flexible membrane for transmitting a pressure increase within said inner chamber to said cooling device for initiating said reaction or alternatively for transmitting a pressure drop within said inner chamber to said cooling device for initiating said reaction.

35. The cooling device according to point 33, said actuator including a mechanical actuator for initiating said reaction between said at least two separate, substantially non-toxic reactants.

36. The cooling device according to any of the points 33-35, said reactants being contained within separate compartments within said cooling device separated by a breakable, dissolvable or rupturable membrane caused to be broken, dissolved or ruptured by said actuator, or alternatively separated by a displaceable plug.

37. The cooling device according to point 36, said actuator including a membrane breaker or piercer for breaking or piercing said membrane.

38. The cooling device according to any of the points 33-37, said actuator being accessible from the outside relative to said container and preferably being activated through said closure.

39. The cooling device according to any of the points 33-38, said non-reversible, entropy-increasing reaction producing a volumetric change from said at least two separate, substantially non-toxic reactants to said substantially non-toxic products, a volumetric change of no more than $\pm$ 5%, such as preferably no more than $\pm$ 4%, further preferably no more than $\pm$ 3%, or alternatively said cooling device being vented to the atmosphere for allowing any access gas reduced in said non-reversible, entropy-increasing reaction to be vented to the atmosphere.

40. The cooling device according to any of the points 33-39, said at least two separate, substantially non-toxic reactants being present as separate granulates or present as at least one granulate and at least one liquid or present as separate liquids.

41. The cooling device according to point 40, said granulate or said granulates being prevented from reacting through one or more external coatings such as a coating of starch, a soluble plastics coating or the like, said one or more external coatings being dissolvable by water or an organic solvent preferably a liquid such as a water-soluble coating,

or alternatively said granulate or said granulates being prevented from reacting by being embedded in a soluble gel or foam.

42. The cooling device according to any of the points 33-41, said cooling device further including a chemical activator such as water, an organic solvent, such as alcohol, propylene glycol or acetone.

43. The cooling device according to point 42, said liquid activator further serving as a reaction-controlling agent such as a selective adsorption-controlling agent, or a retardation temperature setting agent.

44. The cooling device according to any of the preceding points, said container body comprising a beverage keg of polymeric or metallic material having a volume of 3-50 liters, said keg being either collapsible or rigid, and said closure being a keg coupling.

45. The cooling device according to any of the points 33-4.4, said at least two separate, substantially non-toxic reactants comprising one or more salt hydrates, preferably inorganic salt hydrates deliberating in said non-reversible, entropy-increasing reaction a number of free water molecules.

46. The cooling device according to point 45, said one or more salt hydrates being selected from salt hydrates of alkali metals, such as lithium, sodium and potassium, and salt hydrates of alkaline earth metals, such as beryllium, calcium, strontium and barium, and salt hydrates of transition metals, such as chromium, manganese, iron, cobalt, nickel, copper, and zink, and aluminium salt hydrates and lanthanum salt hydrates, preferably $LiNO_3•3H_2O$, $Na_2SO_4•10H_2O$ (Glauber salt), $Na_2SO_4•7H_2O$, $Na_2CO_3•10H_2O$, $Na_2CO_3•7H_2O$, $Na_3PO_4•12H_2O$, $Na_2HPO_4•12H_2O$, $Na_4P_2O_7•10H_2O$, $Na_2H_2P_2O_7•6H_2O$, $NaBO_3•4H_2O$, $Na_2B_4O_7•10H_2O$, $NaClO_4•5H_2O$, $Na_2SO_3•7H_2O$, $Na_2S_2O_3•5H_2O$, $NaBr•2H_2O$, $Na_2S_2O_6•6H_2O$, $K_3PO_4•3H_2O$ preferably $Na_2SO_4•10H_2O$ (Glauber salt), $MgCl_2•6H_2O$, $MgBr_2•6H_2O$ $MgSO_4•7H_2O$, $Mg(NO_3)_2•6H_2O$, $CaCl_2•6H_2O$, $CaBr_2•6H_2O$, $Ca(NO)_2•4H_2O$, $Sr(OH)_2•8H_2O$, $SrBr_2•6H_2O$, $SrCl_2•6H_2O$, $Sr(NO_3)_2•4H_2O$, $SrI_2•6H2O$, $BaBr_2•2H_2O$, $BaCl_2\text{-}2H_2O$, $Ba(OH)_2•8H_2O$, $Ba(BrO_3)_2•H_2O$, $Ba(ClO_3)_2•H_2O$, $CrK(SO_4)_2•12H_2O$, $MnSO_4•7H_2O$, $MnSO_4•5H_2O$, $MnSO_4•H_2O$, $FeBr_2•6H_2O$, $FeBr_3•6H_2O$, $FeCl_2•4H_2O$, $FeCl_3•6H_2O$, $Fe(NO_3)_3•9H_2O$, $FeSO_4•7H_2O$, $Fe(NH_4)_2(SO_4)_2•6H_2O$, $FeNH_4(SO_4)_2•12H_2O$, $CoBr_2•6H_2O$, $CoCl_2•6H_2O$, $NiSO_4•6H_2O$, $NiSO_4•7H_2O$, $Cu(NO_3)_2•6H_2O$, $Cu(NO_3)_2•3H_2O$, $CuSO_4•5H_2O$, $Zn(NO_3)_2•6H_2O$, $ZnSO_4•6H_2O$, $ZnSO_4•7H_2O$, $Al_2(SO_4)_3•18H_2O$, $AlNH_4(SO_4)_2•12H_2O$, $AlBr_3•6H_2O$, $AlBr_3•15H_2O$, $AlK(SO_4)_2•12H_2O$, $Al(NO_3)_3•9H_2O$, $AlCl_3•6H_2O$ and/or $LaCl_3•7H_2O$.

47. The cooling device according to any of the points 43-46, said device being configured as a metal can of the size of a beverage can, or configured as a cooling box for receiving a number of beverage containing containers, or configured as a cooling stick to be positioned in a beverage bottle or the like, or configured as a sleeve to be positioned encircling a part of a container, e.g. the neck of a bottle or the body part of a metal can or bottle or configured as a part of the closure or cap of a bottle.

48. A container for storing a beverage, said container having a container body and a closure and defining an inner chamber, said inner chamber including a specific volume of said beverage, said container further including a cooling device defining a volume not exceeding 30% of said volume of said beverage, said cooling device including at least two separate, substantially non-toxic reactants causing when reacting with one another a non-reversible, entropy increasing reaction producing substantially non-toxic products in a stoichiometric number at least a factor 3, preferably at least a factor 4, and further preferably at least a factor 5 larger than the stoichiometric number of said reactants, said at least two separate substantially non-toxic reactants initially being included in said cooling device separated from one another and being caused to react with one another when opening said container for causing said non-reversible entropy increasing reaction and generating a cooling of said liquids by at least 20°C within a period of time of no more than 5 min., preferably 3 min., further preferably 2 min. and providing said cooling lasting for at least 10 min. preferably at least 15 min, further preferably at least 20 min.

49. The container according to point 48, further having any of the features of the container according to any of the points 2-30.

50. A cooling device for use in or in combination with a container for storing a beverage, said container having a container body and a closure and defining an inner chamber, said inner chamber defining an inner volume and including a specific volume of said beverage, said cooling device further defining a volume not exceeding 30% of said volume of said beverage, said cooling device including at least two separate, substantially non-toxic reactants causing when reacting with one another a non-reversible, entropy increasing reaction producing substantially non-

toxic products in a stoichiometric number at least a factor 3, preferably at least a factor 4, and further preferably at least a factor 5 larger than the stoichiometric number of said reactants, said at least two separate substantially non-toxic reactants initially being included in said cooling device separated from one another and being caused to react with one another when opening said container for causing said non-reversible entropy increasing reaction and generating a cooling of said liquids by at least 20°C within a period of time of no more than 5 min., preferably 3 min., further preferably 2 min. and providing said cooling lasting for at least 10 min. preferably at least 15 min, further preferably at least 20 min.

51. The cooling device according to point 50, further having any of the features of the cooling device according to any of the points 33-47.

Claims

1. A container for storing a beverage, said container having a container body and a closure and defining an inner chamber, said inner chamber defining an inner volume and including a specific volume of said beverage,
said container further including a cooling device having a housing defining a housing volume not exceeding approximately 33% of said specific volume of said beverage and further not exceeding approximately 25% of said inner volume,
said cooling device including at least two separate, substantially non-toxic reactants causing when reacting with one another a non-reversible, entropy-increasing reaction producing substantially non-toxic products in a stoichiometric number at least a factor 3, preferably at least a factor 4, more preferably at least a factor 5 larger than the stoichiometric number of said reactants,
said at least two separate substantially non-toxic reactants initially being included in said cooling device separated from one another and causing, when reacting with one another in said non-reversible, entropy-increasing reaction, a heat reduction of said beverage of at least 50 Joules/ml beverage, preferably at least 70 Joules/ml beverage, such as 70-85 Joules/ml beverage, preferably approximately 80-85 Joules/ml, within a period of time of no more than 5 min. preferably no more than 3 min., more preferably no more than 2 min., and
said cooling device further including an actuator for initiating said reaction between said at least two separate, substantially non-toxic reactants.

2. The container according to claim 1, said actuator including a pressure transmitter e.g. a gas permeable membrane or a flexible membrane for transmitting a pressure increase within said inner chamber to said cooling device for initiating said reaction or alternatively for transmitting a pressure drop within said inner chamber to said cooling device for initiating said reaction or alternatively said actuator including a mechanical actuator for initiating said reaction between said at least two separate, substantially non-toxic reactants.

3. The container according to any of the claims 1-2, said reactants being contained within separate compartments within said cooling device separated by a breakable, dissolvable or rupturable membrane caused to be broken, dissolved or ruptured by said actuator, or alternatively separated by a displaceable plug, or alternatively said actuator including a membrane breaker or piercer for breaking or piercing said membrane, and/or said actuator being accessible from the outside relative to said container and preferably being activated through said closure.

4. The container according to any of the claims 1-3, said non-reversible, entropy-increasing reaction producing a volumetric change from said at least two separate, substantially non-toxic reactants to said substantially non-toxic products, a volumetric change of no more than ± 5%, such as preferably no more than ± 4%, further preferably no more than ± 3%, or alternatively said cooling device being vented to the atmosphere for allowing any access gas reduced in said non-reversible, entropy-increasing reaction to be vented to the atmosphere.

5. The container according to any of the claims 1-4, said at least two separate, substantially non-toxic reactants being present as separate granulates or present as at least one granulate and at least one liquid or present as separate liquids, and said granulate or said granulates preferably being prevented from reacting through one or more external coatings such as a coating of starch, a soluble plastics coating or the like, said one or more external coatings being dissolvable by water or an organic solvent preferably a liquid such as a water-soluble coating, or alternatively said granulate or said granulates being prevented from reacting by being embedded in a soluble gel or foam.

6. The container according to any of the claims 1-5, said cooling device further including a chemical activator such as water, an organic solvent, such as alcohol, propylene glycol or acetone, and said liquid activator preferably serving as a reaction-controlling agent such as a selective adsorption-controlling agent, or a retardation temperature setting agent.

7. The container according to any of the claims 1-6, said at least two separate, substantially non-toxic reactants comprising one or more salt hydrates, preferably inorganic salt hydrates deliberating in said non-reversible, entropy-increasing reaction a number of free water molecules.

8. The container according to claim 7, said one or more salt hydrates being selected from salt hydrates of alkali metals, such as lithium, sodium and potassium, and salt hydrates of alkaline earth metals, such as beryllium, calcium, strontium and barium, and salt hydrates of transition metals, such as chromium, manganese, iron, cobalt, nickel, copper, and zink, and aluminium salt hydrates and lanthanum salt hydrates, preferably $LiNO_3 \bullet 3H_2O$, $Na_2SO_4 \bullet 10H_2O$ (Glauber salt), $Na_2SO_4 \bullet 7H_2O$, $Na_2CO_3 \bullet 10H_2O$, $Na_2CO_3 \bullet 7H_2O$, $Na_3PO_4 \bullet 12H_2O$, $Na_2HPO_4 \bullet 12H_2O$, $Na_4P_2O_7 \bullet 10H_2O$, $Na_2H_2P_2O_7 \bullet 6H_2O$, $NaBO_3 \bullet 4H_2O$, $Na_2B_4O_7 \bullet 10H_2O$, $NaClO_4 \bullet 5H_2O$, $Na_2SO_3 \bullet 7H_2O$, $Na_2S_2O_3 \bullet 5H_2O$, $NaBr \bullet 2H_2O$, $Na_2S_2O_6 \bullet 6H_2O$, $K_3PO_4 \bullet 3H_2O$, preferably $Na_2SO_4 \bullet 10H_2O$ (Glauber salt), $MgCl_2 \bullet 6H_2O$, $MgBr_2 \bullet 6H_2O$ $MgSO_4 \bullet 7H_2O$, $Mg(NO_3)_2 \bullet 6H_2O$, $CaCl_2 \bullet 6H_2O$, $CaBr_2 \bullet 6H_2O$, $Ca(NO)_2 \bullet 4H_2O$, $Sr(OH)_2 \bullet 8H_2O$, $SrBr_2 \bullet 6H_2O$, $SrCl_2 \bullet 6H_2O$, $Sr(NO_3)_2 \bullet 4H_2O$, $SrI_2 \bullet 6H2O$, $BaBr_2 \bullet 2H_2O$, $BaCl_2 \bullet 2H_2O$, $Ba(OH)_2 \bullet 8H_2O$, $Ba(BrO_3)_3 \cdot H_2O$, $Ba(ClO_3)_2 \cdot H_2O$, $CrK(SO_4)_2 \bullet 12H_2O$, $MnSO_4 \bullet 7H_2O$, $MnSO_4 \bullet 5H_2O$, $MnSO \bullet H_2O$, $FeBr_2 \bullet 6H_2O$, $FeBr_3 \bullet 6H_2O$, $FeCl_2 \bullet 4H_2O$, $FeCl_3 \bullet 6H_2O$, $Fe(NO_3)_3 \bullet 9H_2O$, $FeSO_4 \bullet 7H_2O$, $Fe(NH_4)_2(SO_4)_2 \bullet 6H_2O$, $FeNH_4(SO_4)_2 \bullet 12H_2O$, $CoBr_2 \bullet 6H_2O$, $CoCl_2 \bullet 6H_2O$, $NiSO_4 \bullet 6H_2O$, $NiSO_4 \bullet 7H_2O$, $Cu(NO_3)_2 \bullet 6H_2O$, $Cu(NO_3)_2 \bullet 3H_2O$, $CuSO_4 \bullet 5H_2O$, $Zn(NO_3)_2 \bullet 6H_2O$, $ZnSO_4 \bullet 6H_2O$, $ZnSO_4 \bullet 7H_2O$, $Al_2(SO_4)_3 \bullet 18H_2O$, $AlNH_4(SO_4)_2 \bullet 12H_2O$, $AlBr_3 \bullet 6H_2O$, $AlBr_3 \bullet 15H_2O$, $AlK(SO_4)_2 \bullet 12H_2O$, $Al(NO_3)_3 \bullet 9H_2O$, $AlCl_3 \bullet 6H_2O$ and/or $LaCl_3 \bullet 7H_2O$.

9. A method of providing a container including a beverage of a first temperature constituting a specific low temperature such as a temperature of approximately 5°C, said container having a container body and a closure and defining an inner chamber, said inner chamber defining an inner volume and including a specific volume of said beverage,
said container further including a cooling device having a housing defining a housing volume not exceeding approximately 33% of said specific volume of said beverage and further not exceeding approximately 25% of said inner volume,
said cooling device including at least two separate, substantially non-toxic reactants causing when reacting with one another a non-reversible, entropy-increasing reaction producing substantially non-toxic products in a stoichiometric number at least a factor 3, preferably at least a factor 4, more preferably at least a factor 5 larger than the stoichiometric number of said reactants,
said at least two separate substantially non-toxic reactants initially being included in said cooling device separated from one another and causing, when reacting with one another in said non-reversible, entropy-increasing reaction, a cooling of said beverage from a second temperature constituting a temperature substantially higher than said first temperature and preferably constituting a temperature at or slightly below the average ambient temperature, to said first temperature within a period of time of no more than 5 min. preferably no more than 3 min., more preferably no more than 2 min., and
said cooling device further including an actuator for initiating said reaction between said at least two separate, substantially non-toxic reactants, when opening said container, the method comprising:

i) providing a closed cabinet defining an inner cabinet chamber for storing a plurality of said containers and having a dispensing opening for the dispensing of said containers, one at a time, or alternatively having an openable door for providing access to said inner cabinet chamber for the removal of one or more of said containers from within said inner cabinet chamber,
ii) thermostatically controlling the temperature of said inner cabinet chamber to said second temperature,
iii) storing said plurality of containers in said inner cabinet chamber for an extended period of time for allowing the beverage contained in each of said containers to stabilize at said second temperature,
iv) dispensing said container from said inner cabinet chamber, and
v) opening said container for causing said non-reversible, entropy increasing reaction and causing said cooling of said beverage contained in said container to said first temperature.

10. A system for providing a container including a beverage of a first temperature constituting a specific low temperature such as a temperature of approximately 5°C, the system comprising:

i) a closed cabinet defining an inner cabinet chamber for storing a plurality of said containers and having a dispensing opening for the dispensing of said containers, one at a time, or alternatively having an openable door providing access to said inner cabinet chamber for the removal of one or more of said containers from

within said inner cabinet chamber, said closed cabinet having thermostatically controlled temperature controlling means for maintaining the temperature within said inner cabinet chamber at a second temperature constituting an elevated temperature as compared to said first temperature and preferably a temperature at or slightly below the average ambient temperature,
ii) a plurality of said containers,
each container having a container body and a closure and defining an inner chamber, said inner chamber defining an inner volume and including a specific volume of said beverage,
each of said containers further including a cooling device having a housing defining a housing volume not exceeding approximately 33% of said specific volume of said beverage and further not exceeding approximately 25% of said inner volume,
said cooling device including at least two separate, substantially non-toxic reactants causing when reacting with one another a non-reversible, entropy-increasing reaction producing substantially non-toxic products in a stoichiometric number at least a factor 3, preferably at least a factor 4, more preferably at least a factor 5 larger than the stoichiometric number of said reactants,
said at least two separate substantially non-toxic reactants initially being included in said cooling device separated from one another and causing, when reacting with one another in said non-reversible, entropy-increasing reaction, a cooling of said beverage from a second temperature constituting a temperature substantially higher than said first temperature and preferably constituting a temperature at or slightly below the average ambient temperature, to said first temperature within a period of time of no more than 5 min. preferably no more than 3 min., more preferably no more than 2 min., and
said cooling device further including an actuator for initiating said reaction between said at least two separate, substantially non-toxic reactants, when opening said container.

11. A cooling device for use in or in combination with a container for storing a beverage, said container having a container body and a closure and defining an inner chamber, said inner chamber defining an inner volume and including a specific volume of said beverage,
said cooling device having a housing defining a housing volume not exceeding approximately 33% of said specific volume of said beverage and further not exceeding approximately 25% of said inner volume,
said cooling device including at least two separate, substantially non-toxic reactants causing when reacting with one another a non-reversible, entropy-increasing reaction producing substantially non-toxic products in a stoichiometric number at least a factor 3, preferably at least a factor 4, more preferably at least a factor 5 larger than the stoichiometric number of said reactants,
said at least two separate substantially non-toxic reactants initially being included in said cooling device separated from one another and causing, when reacting with one another in said non-reversible, entropy-increasing reaction, a heat reduction of said beverage of at least 50 Joules/ml beverage, preferably at least 70 Joules/ml beverage, such as 70-85 Joules/ml beverage, preferably approximately 80-85 Joules/ml, within a period of time of no more than 5 min. preferably no more than 3 min., more preferably no more than 2 min., and
said cooling device further including an actuator for initiating said reaction between said at least two separate, substantially non-toxic reactants.

12. The cooling device according to claim 11, said actuator including a pressure transmitter e.g. a gas permeable membrane or a flexible membrane for transmitting a pressure increase within said inner chamber to said cooling device for initiating said reaction or alternatively for transmitting a pressure drop within said inner chamber to said cooling device for initiating said reaction, or alternatively said actuator including a mechanical actuator for initiating said reaction between said at least two separate, substantially non-toxic reactants.

13. The cooling device according to any of the claims 11-12, said reactants being contained within separate compartments within said cooling device separated by a breakable, dissolvable or rupturable membrane caused to be broken, dissolved or ruptured by said actuator, or alternatively separated by a displaceable plug or alternatively said actuator including a membrane breaker or piercer for breaking or piercing said membrane and/or said actuator being accessible from the outside relative to said container and preferably being activated through said closure.

14. The cooling device according to any of the claims 11-13, said non-reversible, entropy-increasing reaction producing a volumetric change from said at least two separate, substantially non-toxic reactants to said substantially non-toxic products, a volumetric change of no more than $\pm$ 5%, such as preferably no more than $\pm$ 4%, further preferably no more than $\pm$ 3%, or alternatively said cooling device being vented to the atmosphere for allowing any access gas reduced in said non-reversible, entropy-increasing reaction to be vented to the atmosphere.

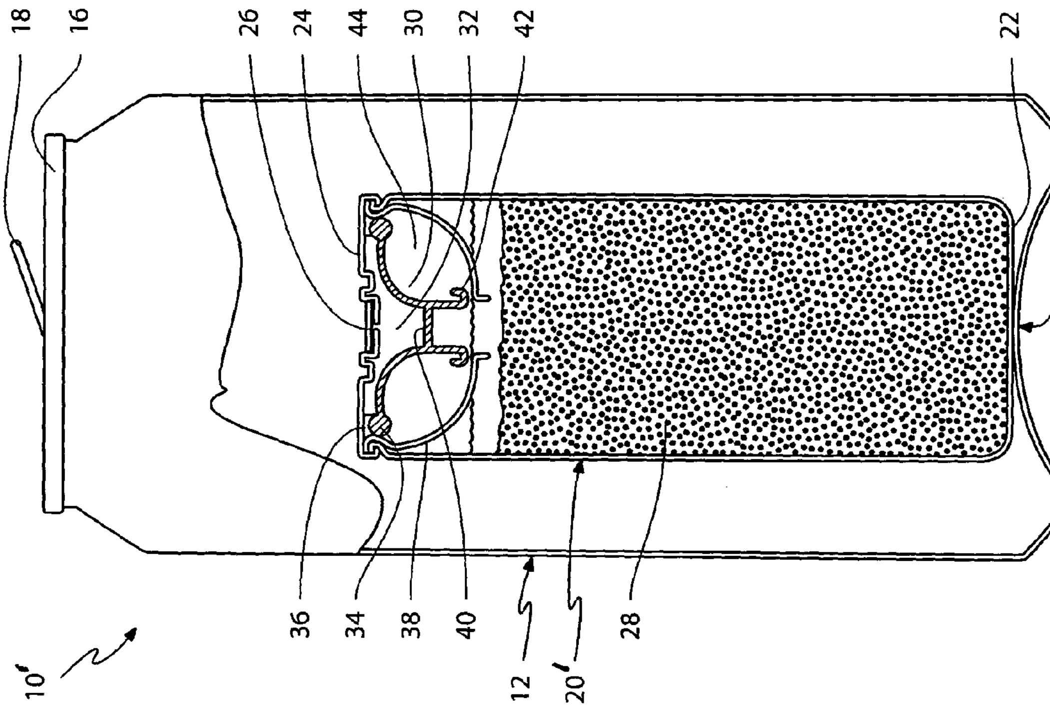
15. The cooling device according to any of the claims 11-14, said at least two separate, substantially non-toxic reactants being present as separate granulates or present as at least one granulate and at least one liquid or present as separate liquids, and said granulate or said granulates preferably being prevented from reacting through one or more external coatings such as a coating of starch, a soluble plastics coating or the like, said one or more external coatings being dissolvable by water or an organic solvent preferably a liquid such as a water-soluble coating, or alternatively said granulate or said granulates being prevented from reacting by being embedded in a soluble gel or foam.

16. The cooling device according to any of the claims 11-15, said cooling device further including a chemical activator such as water, an organic solvent, such as alcohol, propylene glycol or acetone, and said liquid activator preferably serving as a reaction-controlling agent such as a selective adsorption-controlling agent, or a retardation temperature setting agent.

17. The cooling device according to any of the claims 11-16, said at least two separate, substantially non-toxic reactants comprising one or more salt hydrates, preferably inorganic salt hydrates deliberating in said non-reversible, entropy-increasing reaction a number of free water molecules.

18. The cooling device according to claim 17, said one or more salt hydrates being selected from salt hydrates of alkali metals, such as lithium, sodium and potassium, and salt hydrates of alkaline earth metals, such as beryllium, calcium, strontium and barium, and salt hydrates of transition metals, such as chromium, manganese, iron, cobalt, nickel, copper, and zink, and aluminium salt hydrates and lanthanum salt hydrates, preferably $LiNO_3•3H_2O$, $Na_2SO_4•10H_2O$ (Glauber salt), $Na_2SO_4•7H_2O$, $Na_2eO_3•10H_2O$, $Na_2CO_3•7H_2O$, $Na_3PO_4•12H_2O$, $Na_2HPO_4•12H_2O$, $Na_4P_2O•10H_2O$, $Na_2H_2P_2O_7•6H_2O$, $NaBO_3•4H_2O$, $Na_2B_4O_7•10H_2O$, $NaClO_4•5H_2O$, $Na_2SO_3•7H_2O$, $Na_2S_2O_3•5H_2O$, $NaBr•2H_2O$, $Na_2S_2O_6•6H_2O$, $K_3PO_4•3H_2O$ preferably $Na_2SO_4•10H_2O$ (Glauber salt), $MgCl_2•6H_2O$, $MgBr_2•6H_2O$ $MgSO_4•7H_2O$, $Mg(NO_3)_2•6H_2O$, $CaCl_2•6H_2O$, $CaBr_2•6H_2O$, $Ca(NO_3)_2•4H_2O$, $Sr(OH)_2•8H_2O$, $SrBr_2•6H_2O$, $SrCl_2•6H_2O$, $Sr(NO_3)_2•4H_2O$, $SrI_2•6H2O$, $BaBr_2•2H_2O$, $BaCl_2•2H_2O$, $Ba(OH)_2•8H_2O$, $Ba(BrO_3)_2•H_2O$, $Ba(ClO_3)_2•H_2O$, $CrK(SO_4)_2•12H_2O$, $MnSO_4•7H_2O$, $MnSO_4•5H_2O$, $MnSO_4•H_2O$, $FeBr_2•6H_2O$, $FeBr_3•6H_2O$, $FeCl_2•4H_2O$, $FeCl_3•6H_2O$, $Fe(NO_3)_3•9H_2O$, $FeSO_4•7H_2O$, $Fe(NH_4)_2(SO)_2•6H_2O$, $FeNH_4(SO_4)_2•12H_2O$, $CoBr_2•6H_2O$, $CoCl_2•6H_2O$, $NiSO_4•6H_2O$, $NiSO_4•7H_2O$, $Cu(NO_3)_2•6H_2O$, $C_U(NO_3)_2•3H_2O$, $CuSO_4•5H_2O$, $Zn(NO_3)_2•6H_2O$, $ZnSO_4•6H_2O$, $ZnSO_4•7H_2O$, $Al_2(SO_4)_3•18H_2O$, $AlNH_4(SO_4)_2•12H_2O$, $AlBr_3•6H_2O$, $AlBr_3•15H_2O$, $AlK(SO_4)_2•12H_2O$, $Al(NO_3)_3•9H_2O$, $AlCl_3•6H_2O$ and/or $LaCl_3•7H_2O$.

19. The cooling device according to any of the claims 11-18, said device being configured as a metal can of the size of a beverage can, or configured as a cooling box for receiving a number of beverage containing containers, or configured as a cooling stick to be positioned in a beverage bottle or the like, or configured as a sleeve to be positioned encircling a part of a container, e.g. the neck of a bottle or the body part of a metal can or bottle or configured as a part of the closure or cap of a bottle.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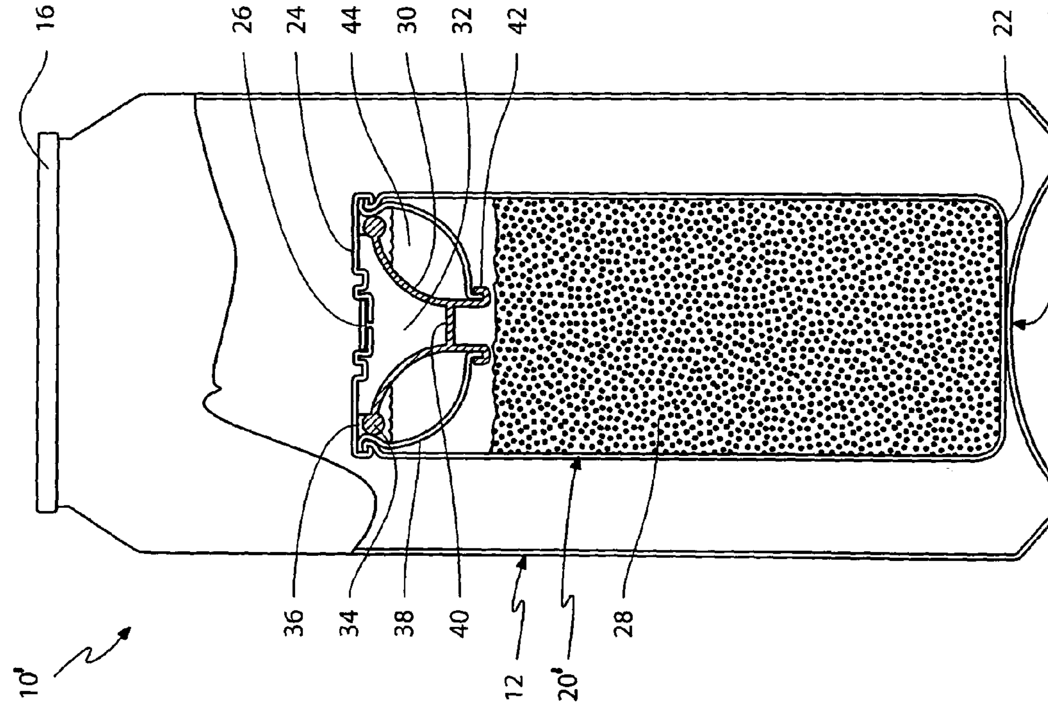
20'
28

FIG 1B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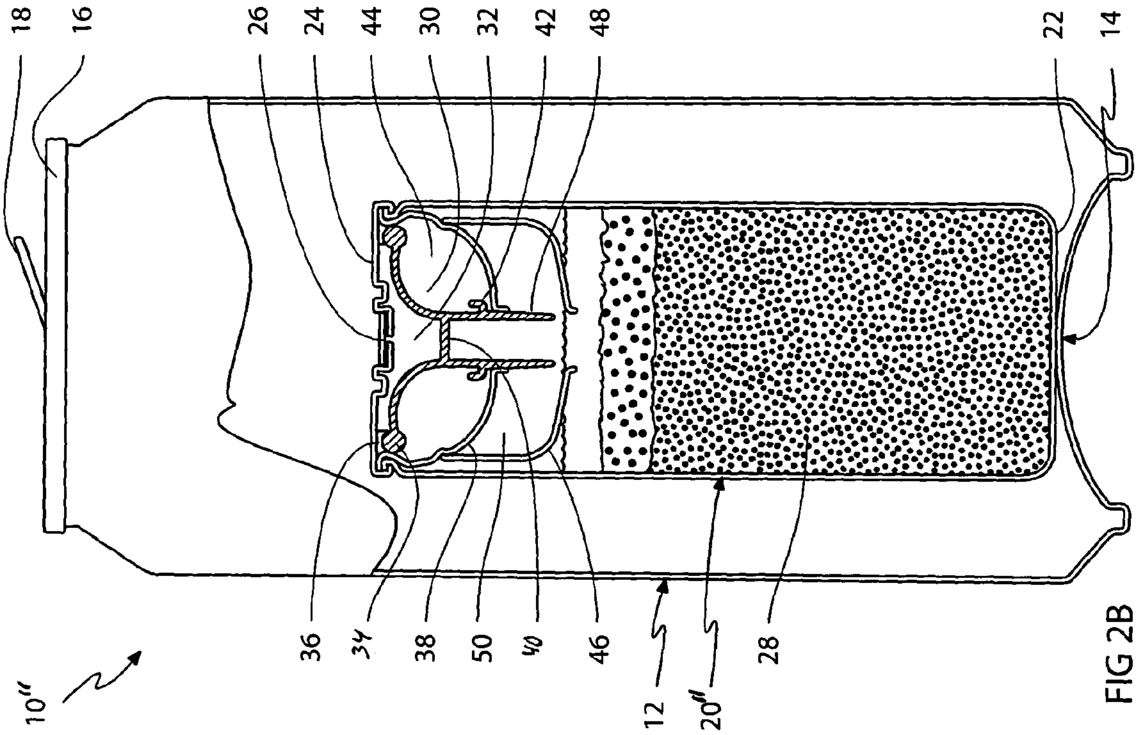
20'
28

FIG 1A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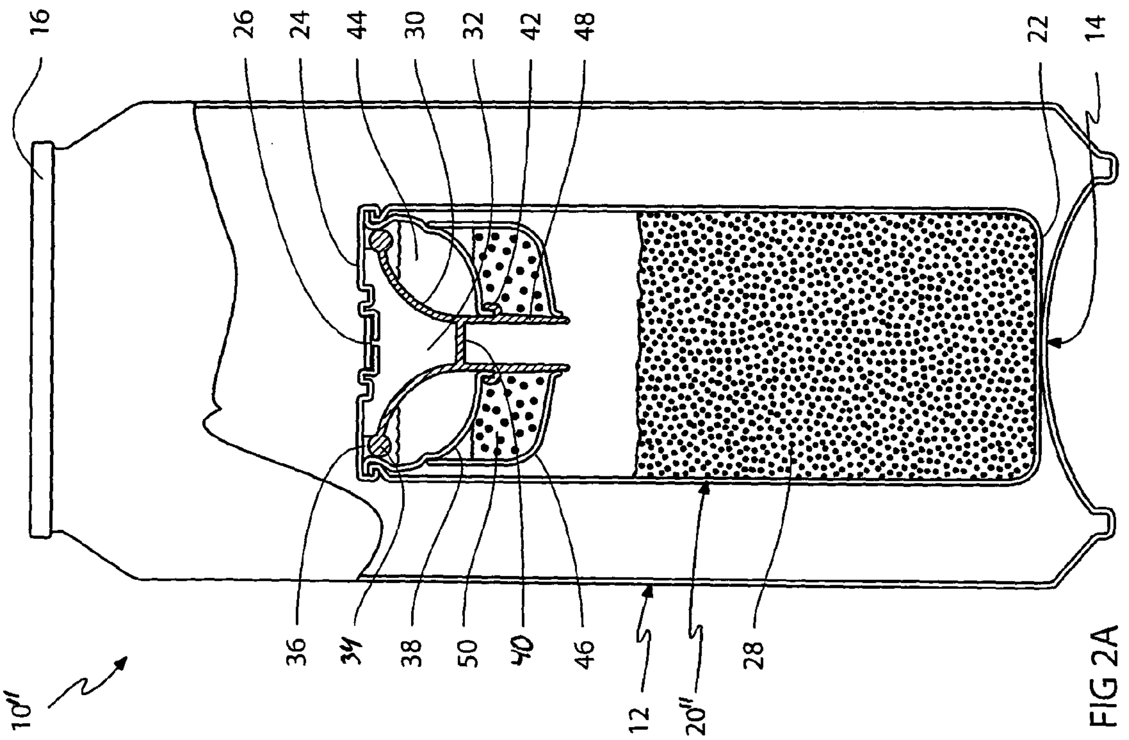
20''
28

FIG 2B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28

FIG 2A

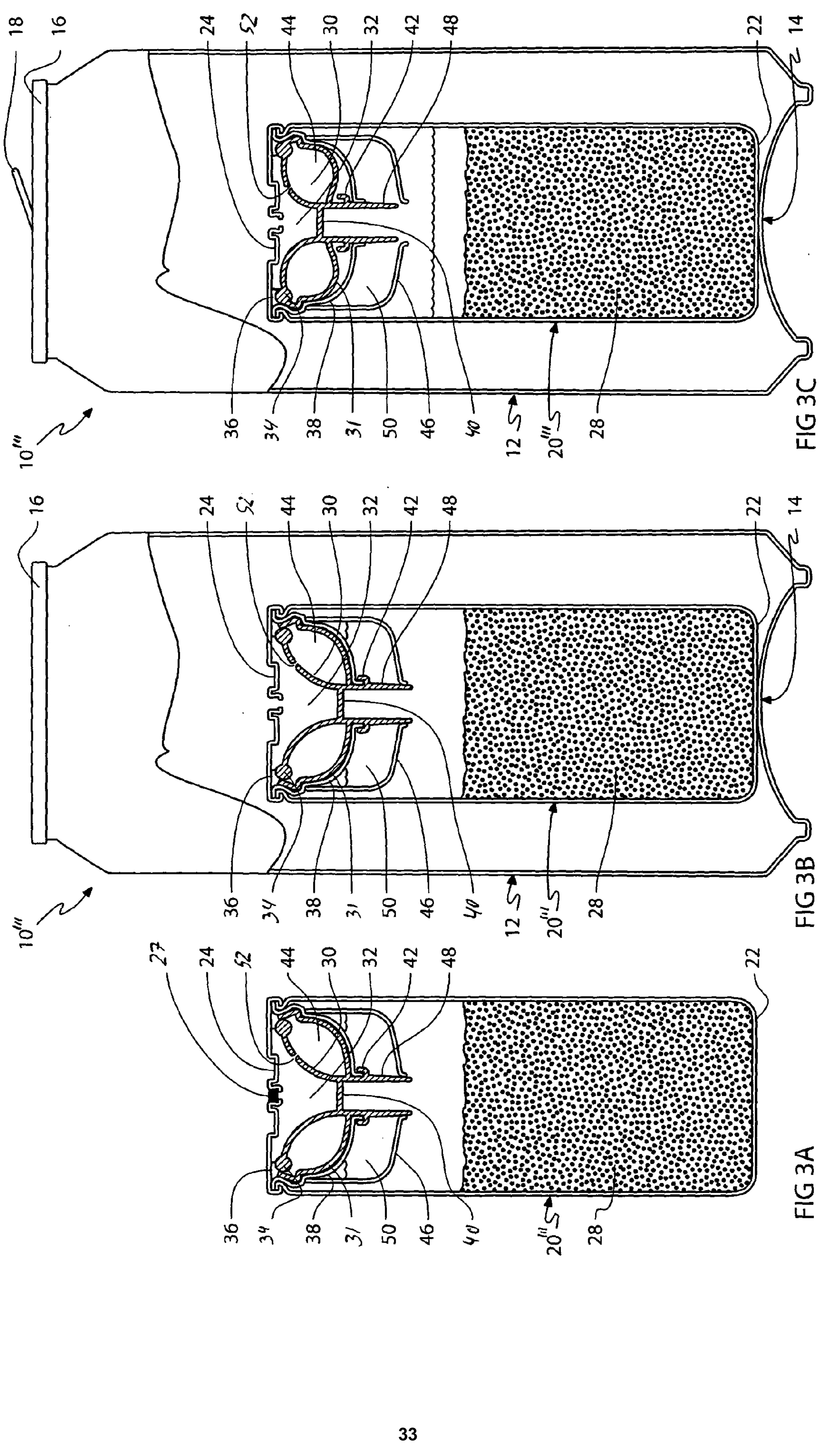

FIG 3A

FIG 3B

FIG 3C

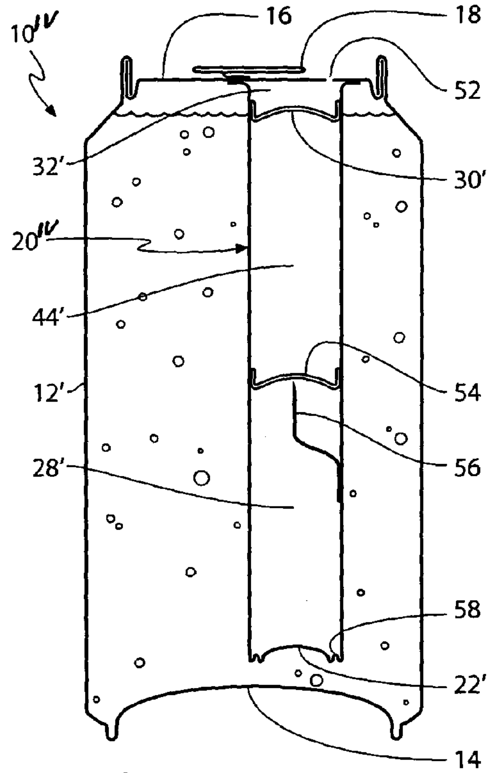

FIG 4A

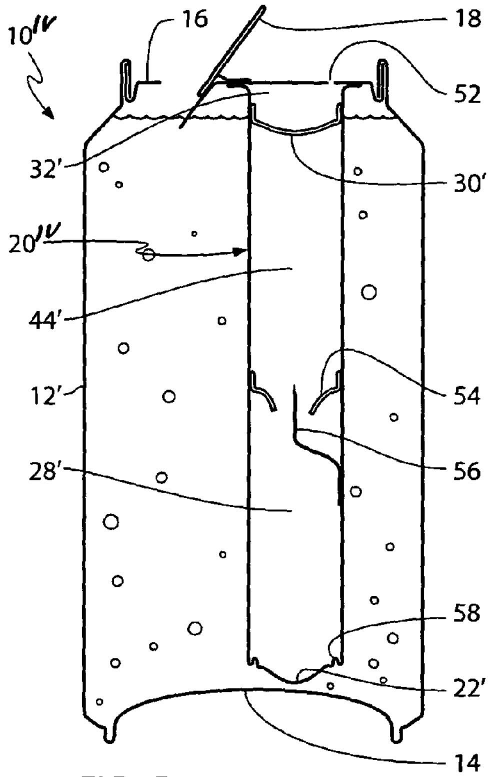

FIG 4B

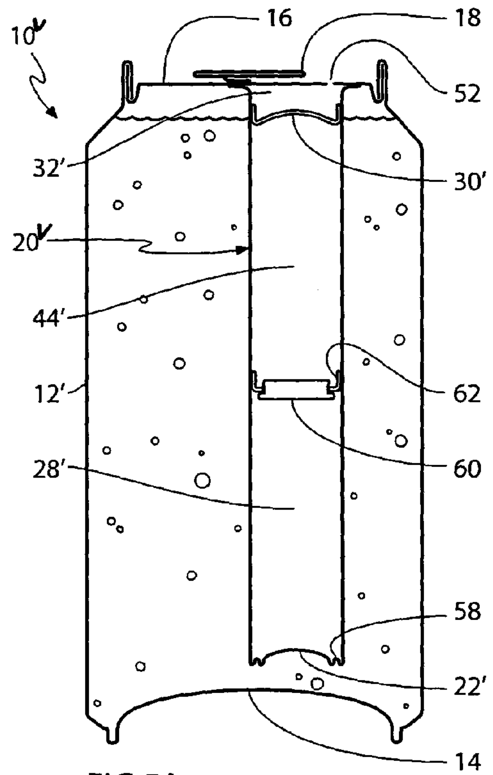

FIG 5A

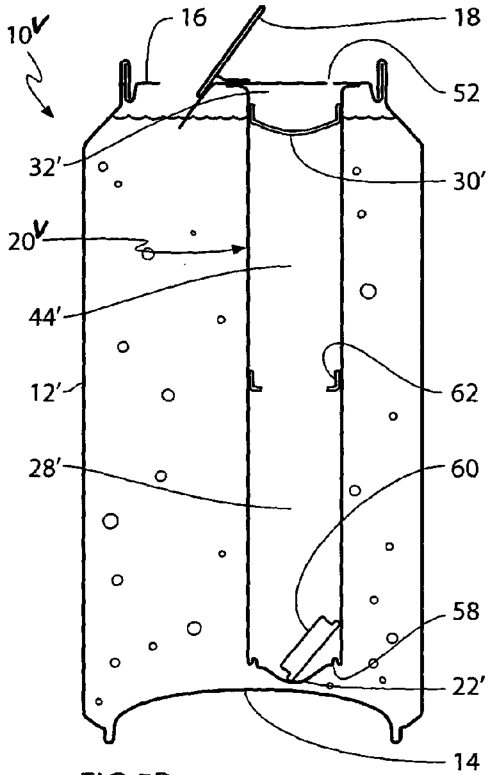

FIG 5B

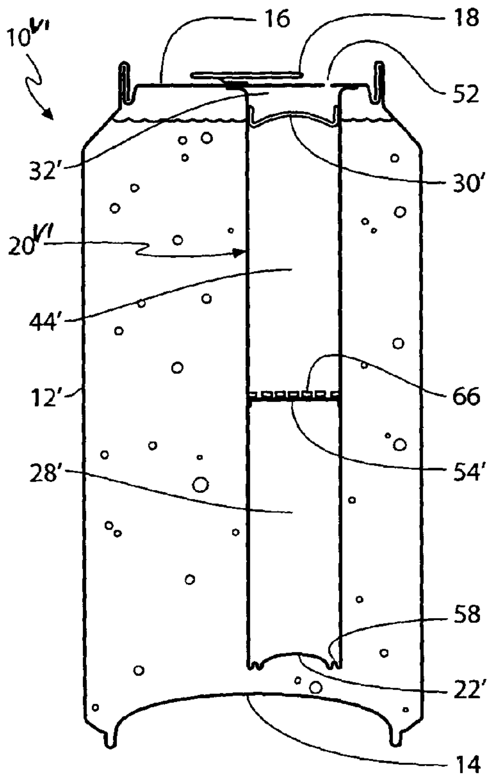

FIG 6A

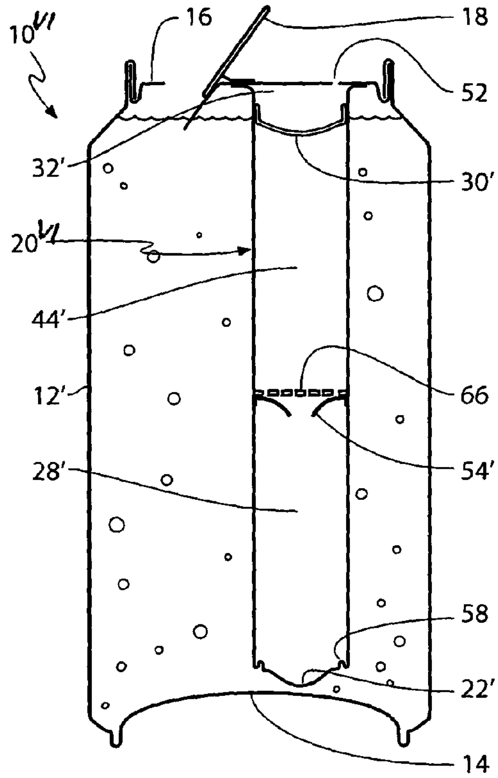

FIG 6B

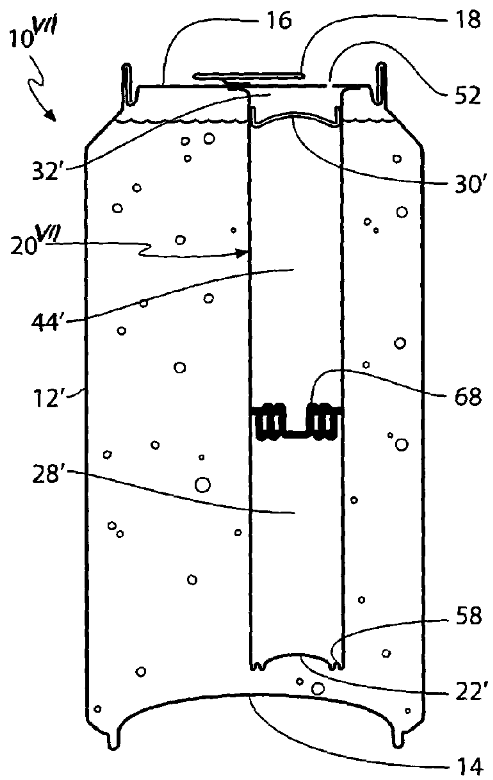

FIG 7A

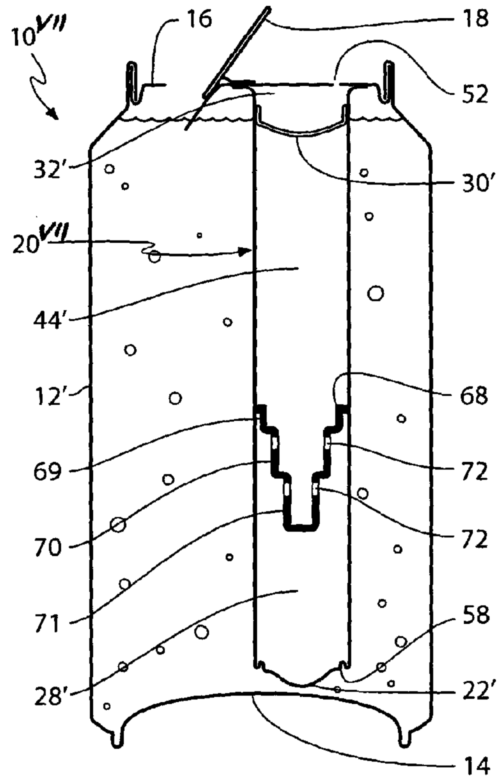

FIG 7B

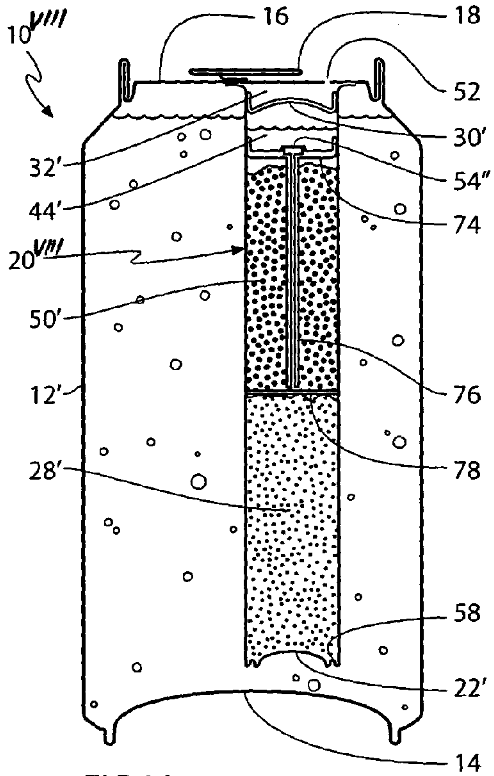

FIG 8A

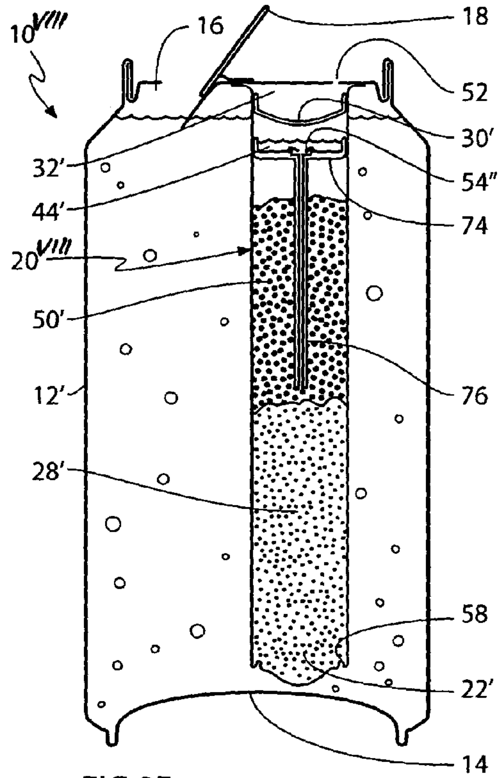

FIG 8B

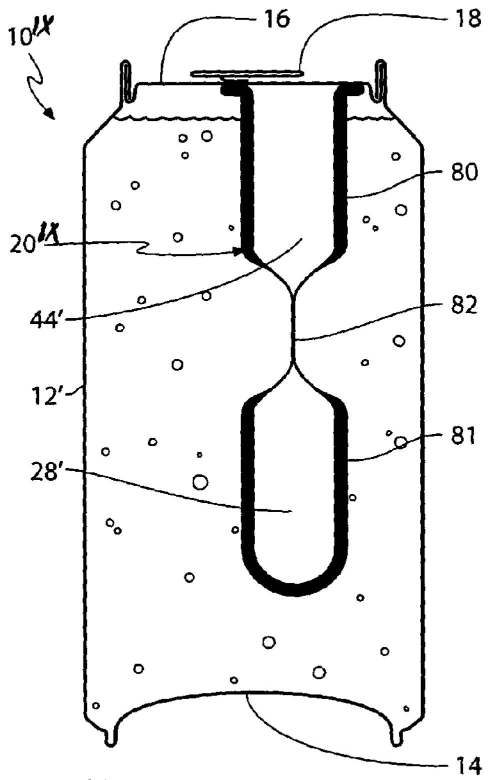

FIG 9A

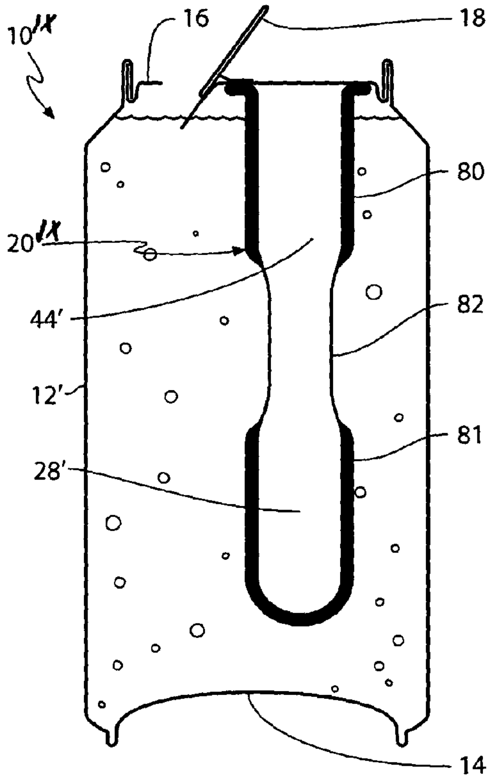

FIG 9B

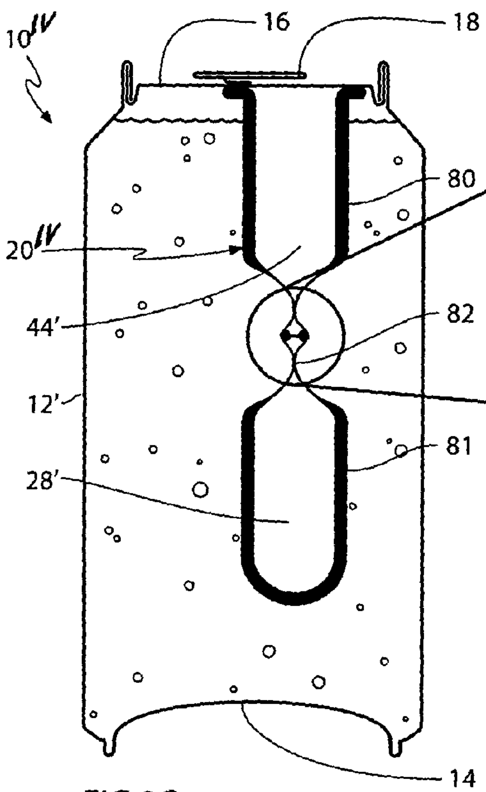

FIG 9C

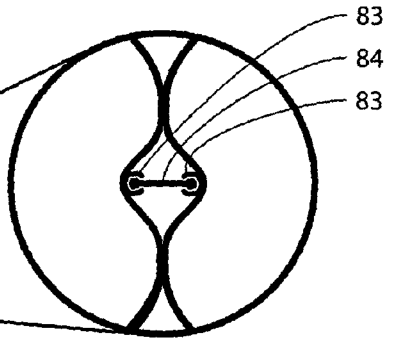

FIG 9D

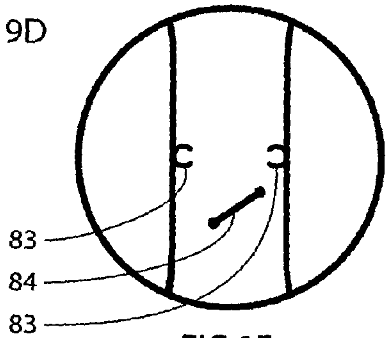

FIG 9E

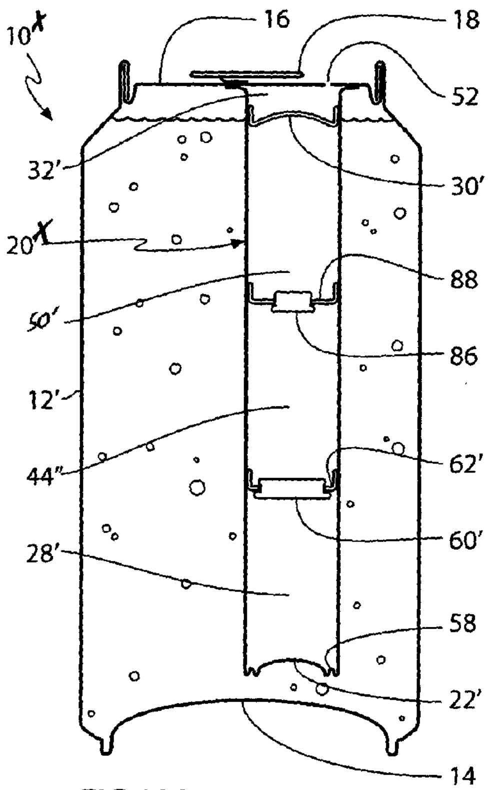

FIG 10A

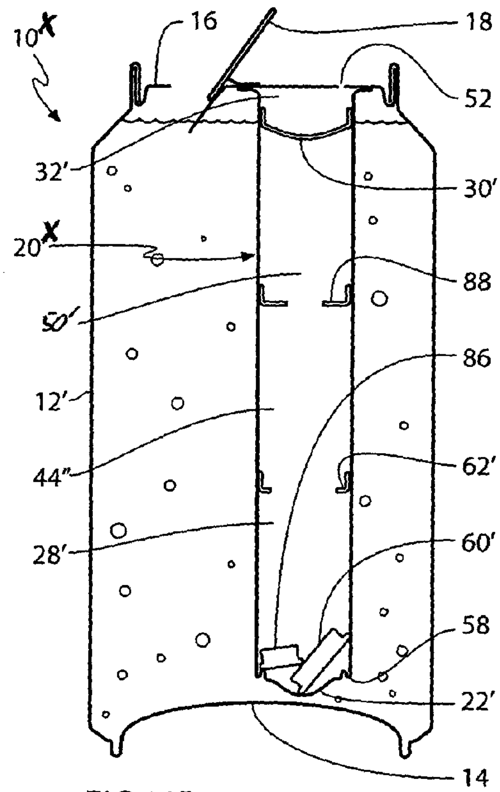

FIG 10B

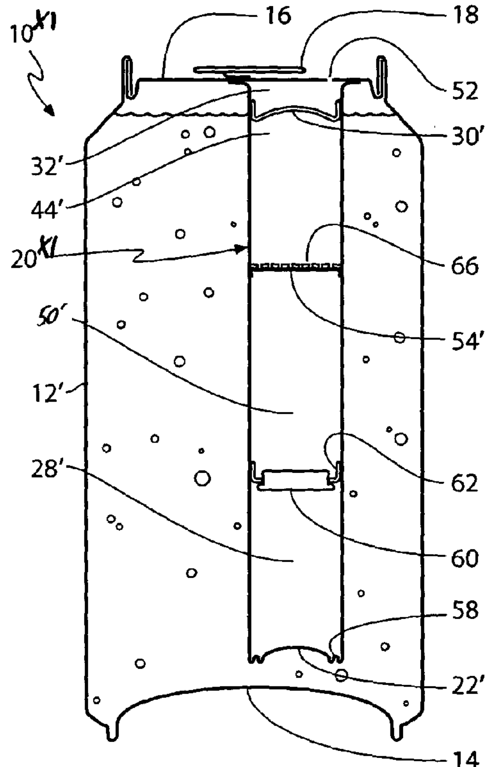

FIG 11A

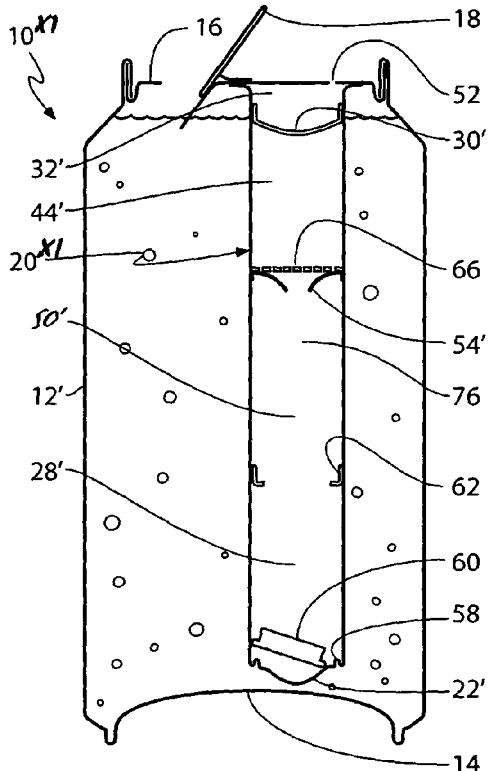

FIG 11B

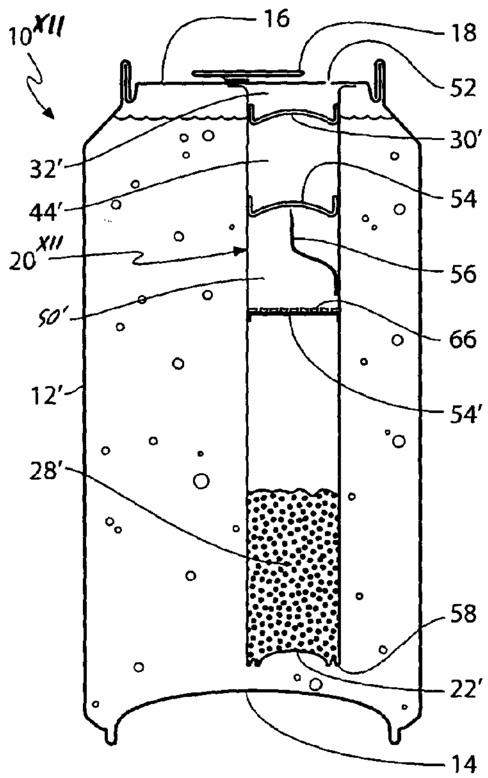

FIG 12A

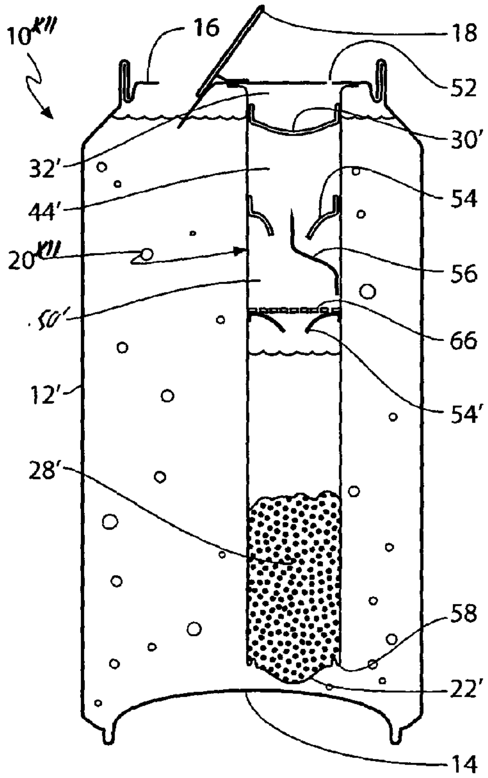

FIG 12B

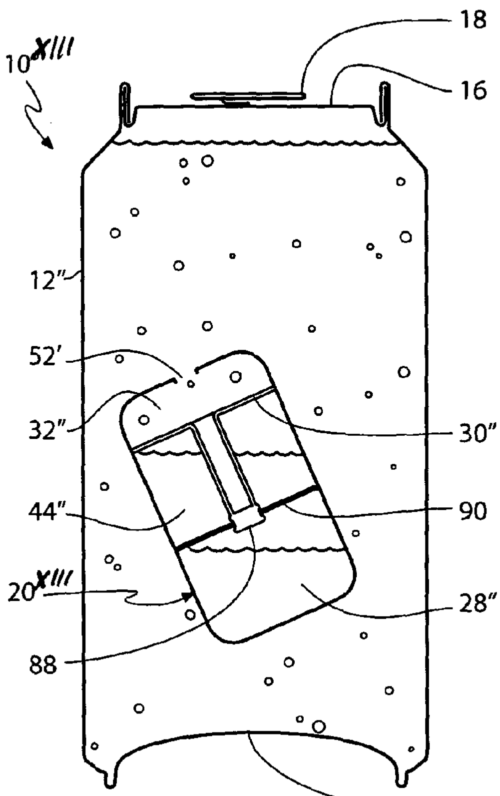

FIG 13A

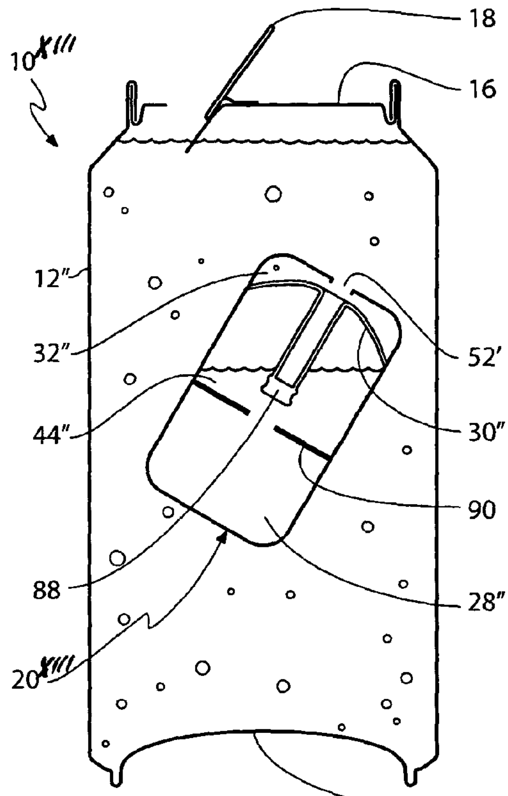

FIG 13B

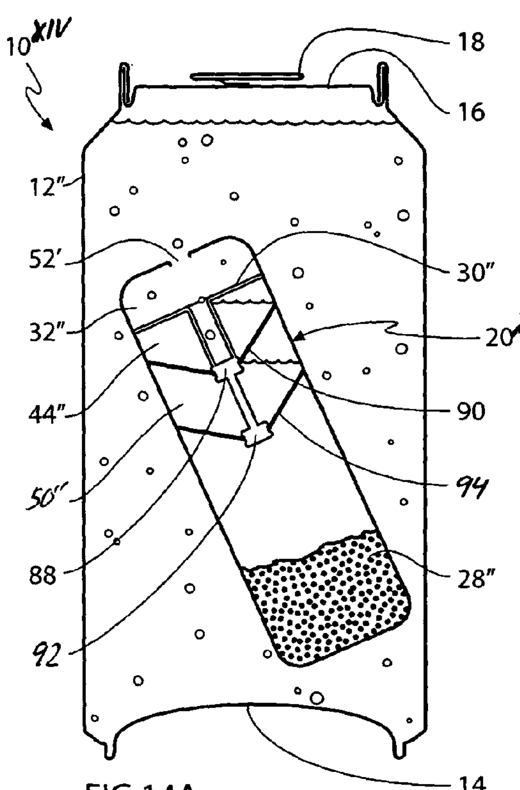

FIG 14A

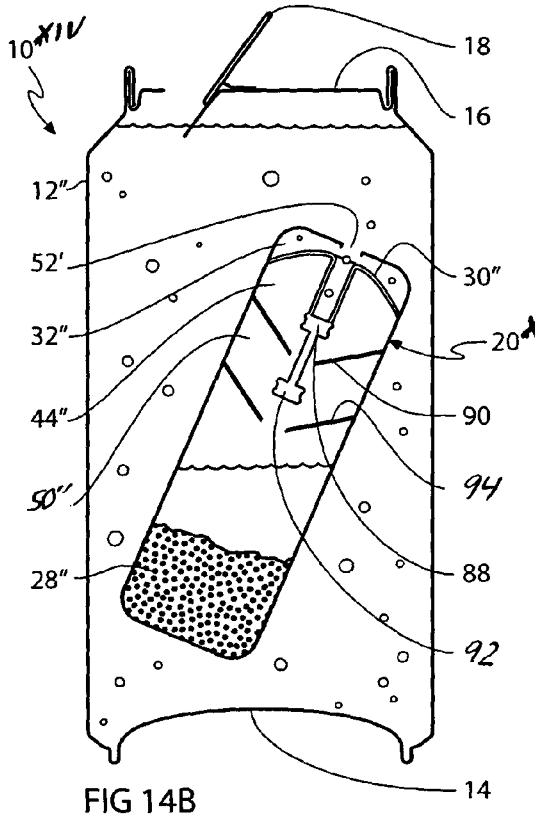

FIG 14B

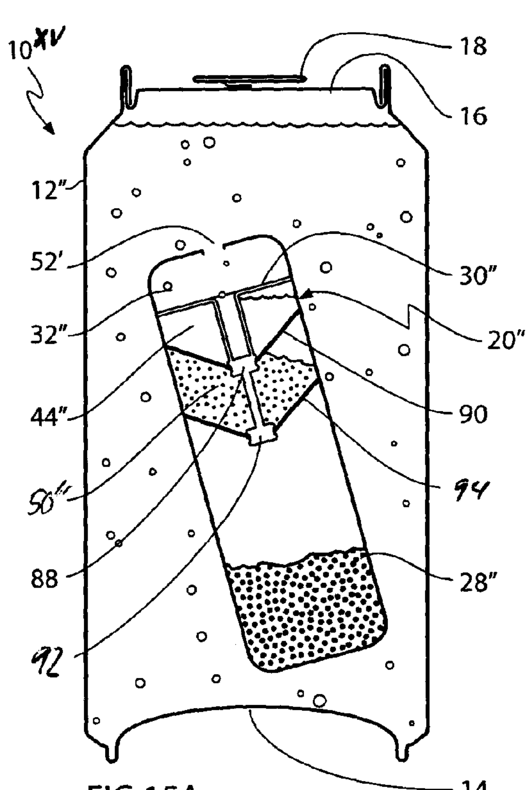

FIG 15A

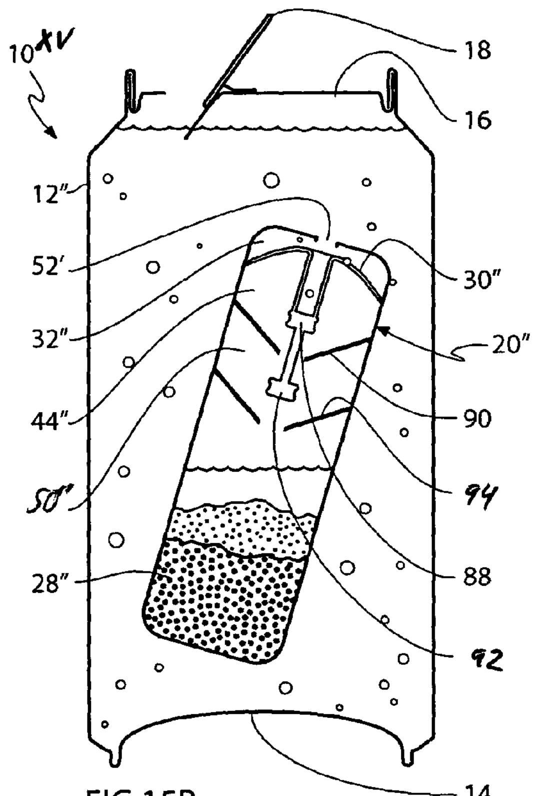

FIG 15B

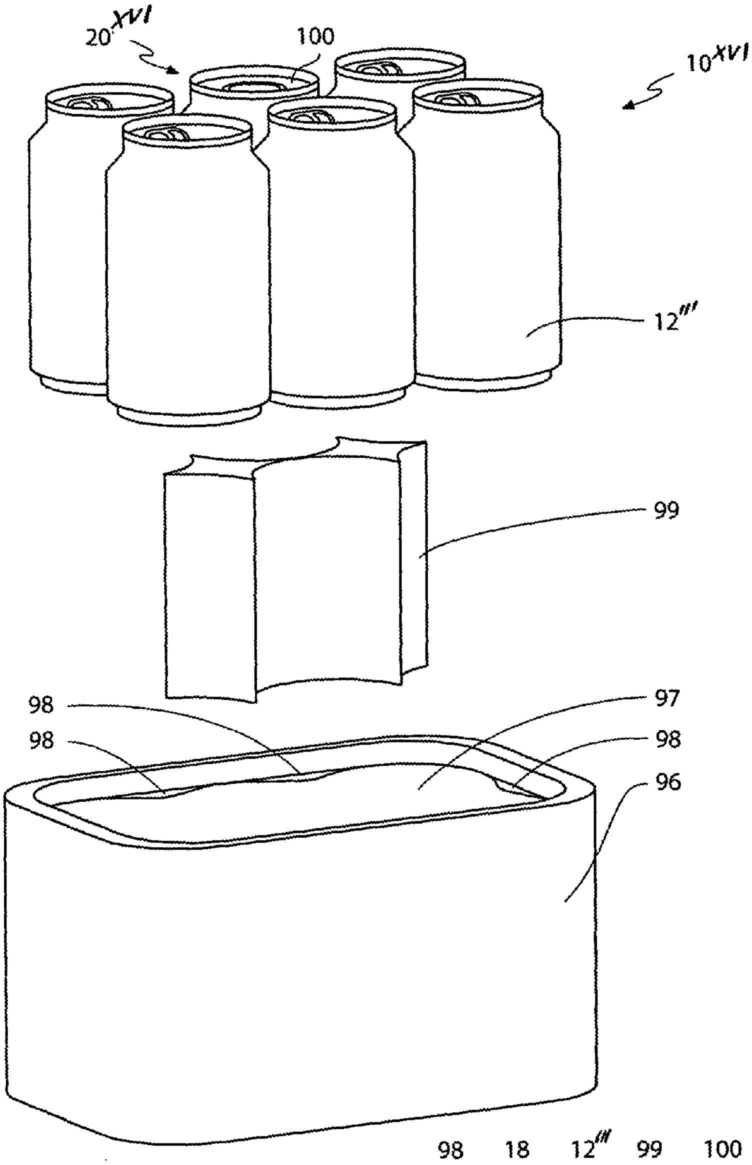

FIG 16A

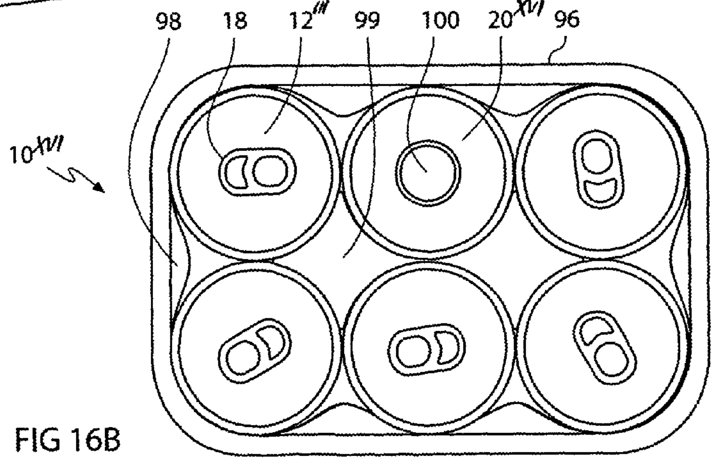

FIG 16B

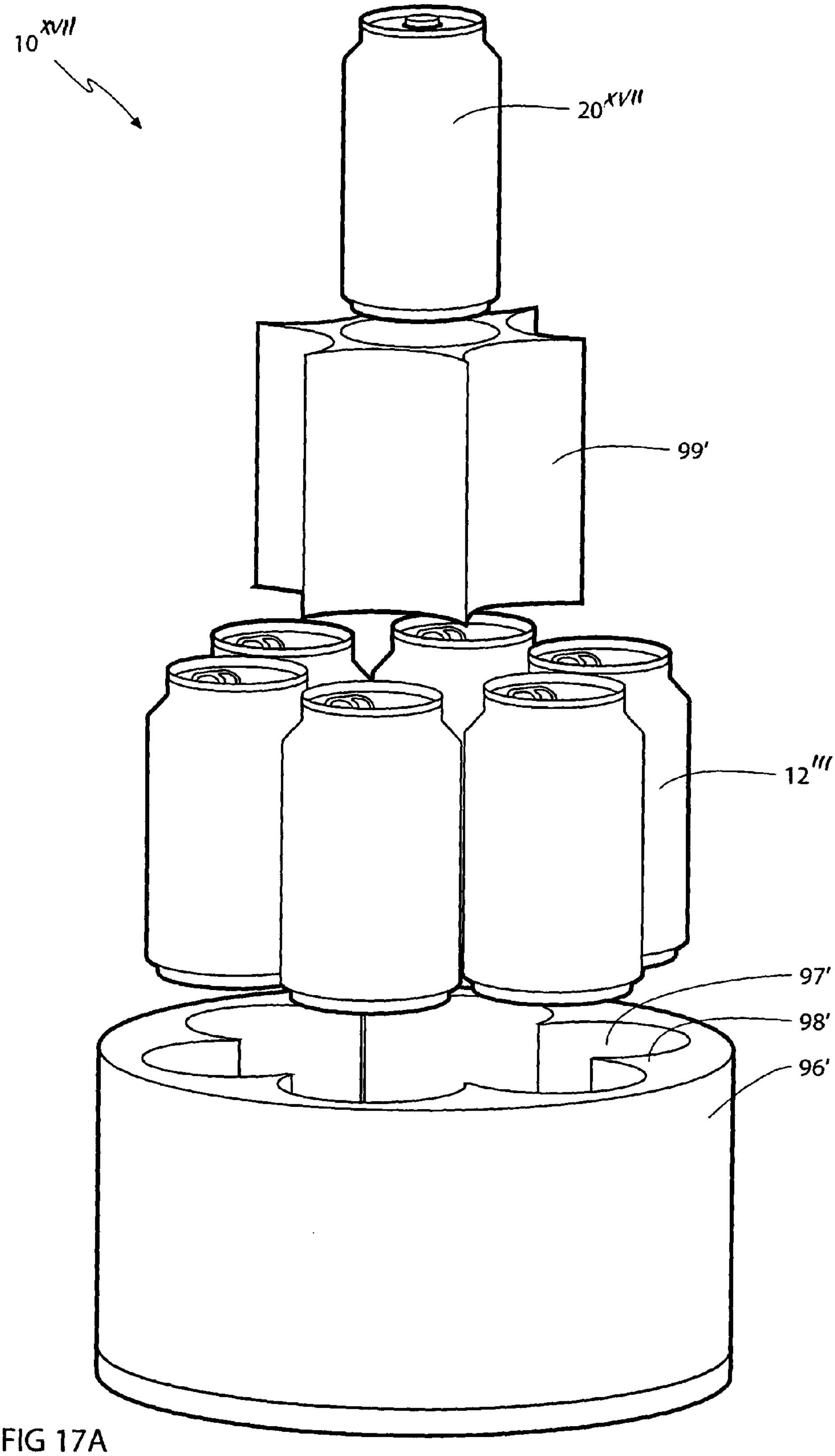

FIG 17A

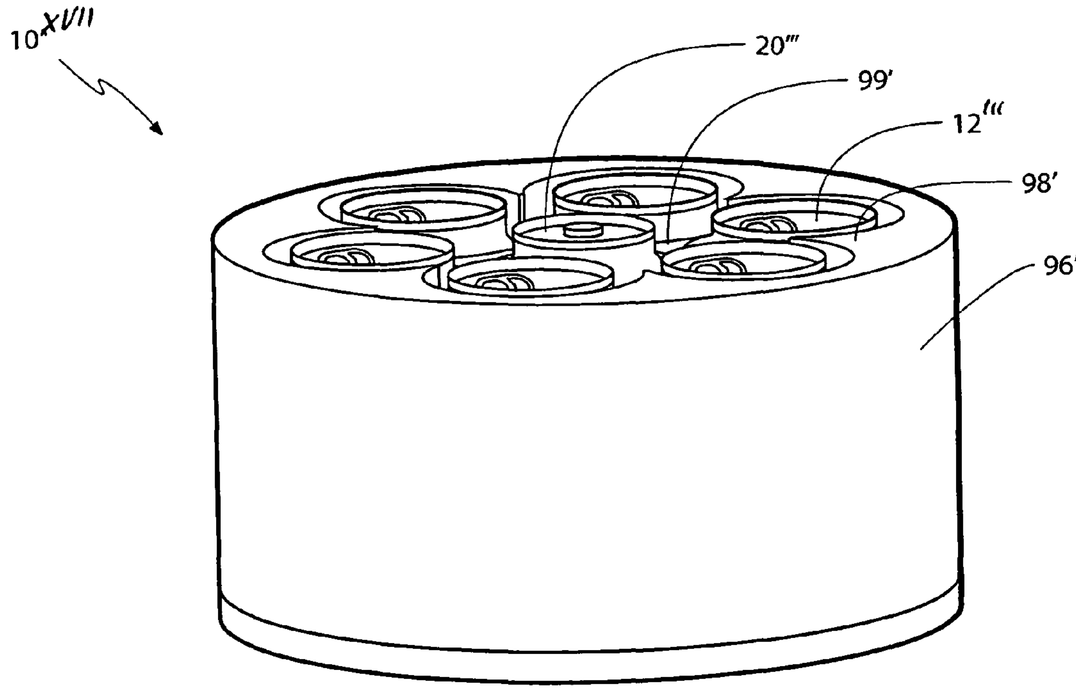

FIG 17B

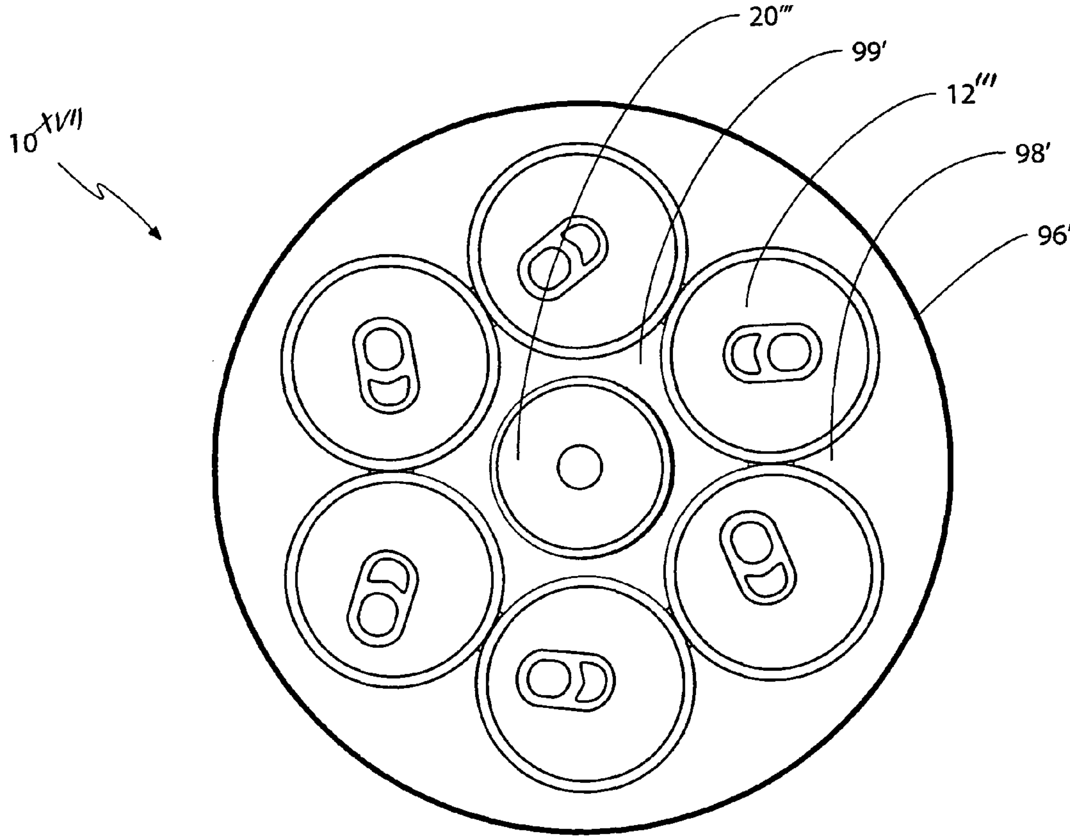

FIG 17C

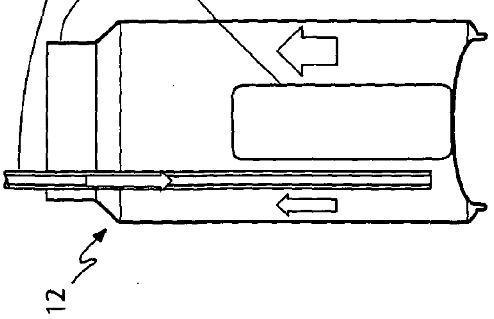

FIG 18A

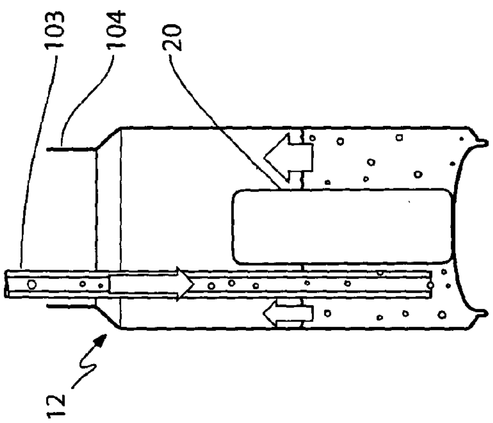

FIG 18B

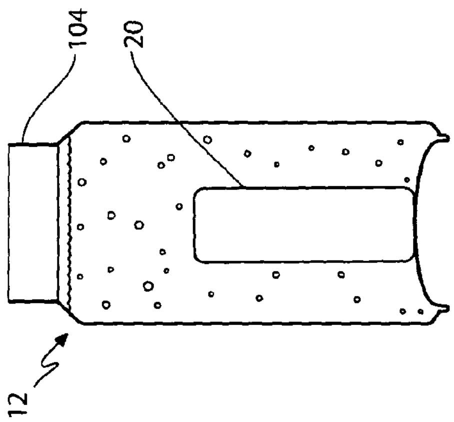

FIG 18C

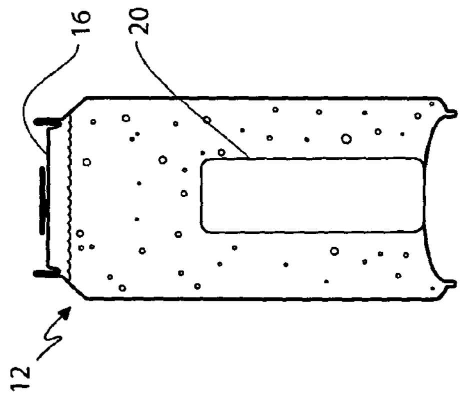

FIG 18D

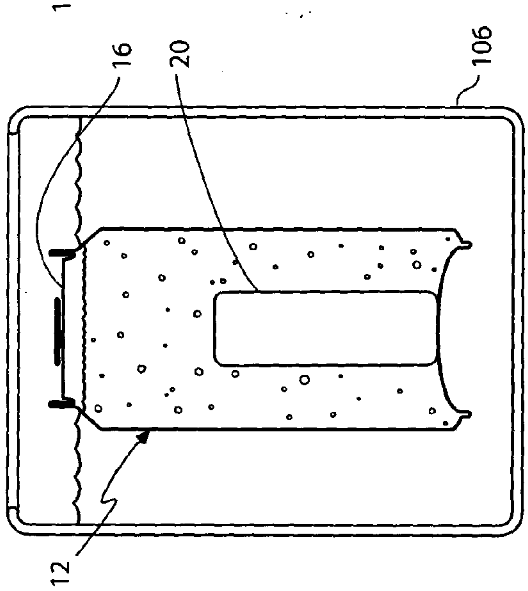

FIG 18E

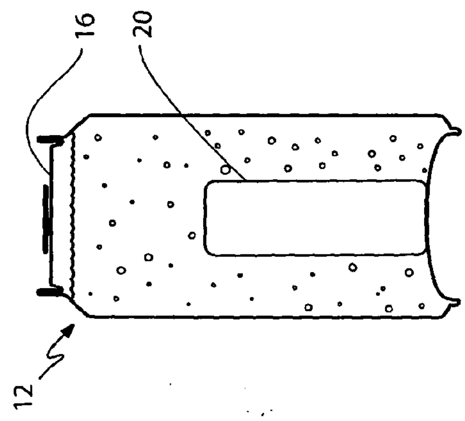

FIG 18F

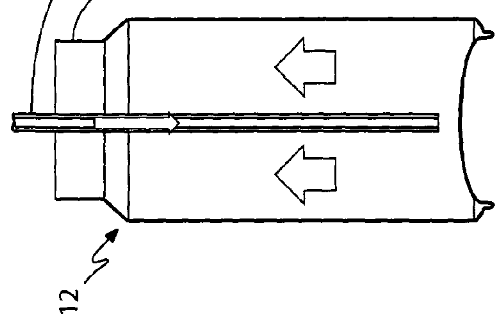

FIG 19A

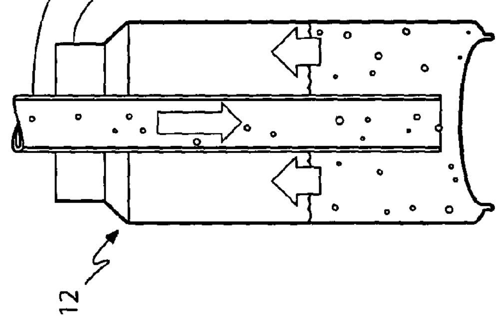

FIG 19B

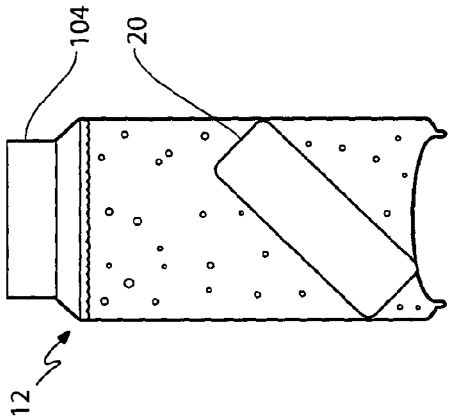

FIG 19C

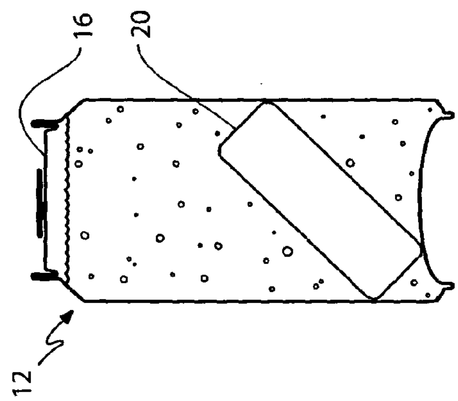

FIG 19D

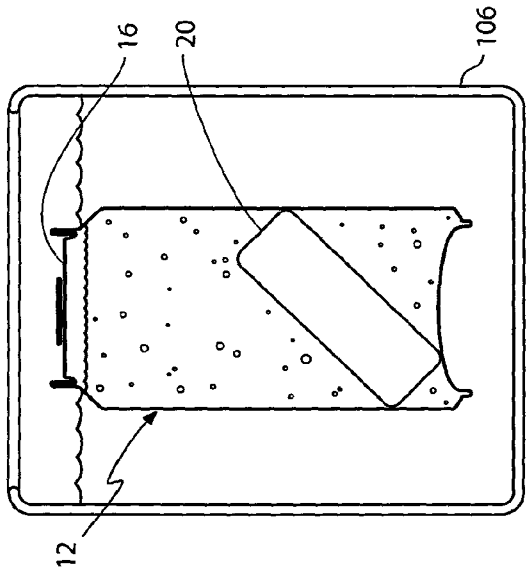

FIG 19E

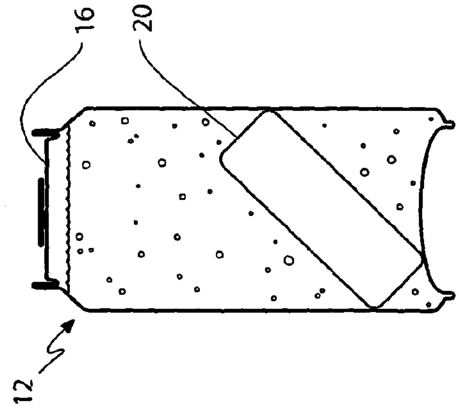

FIG 19F

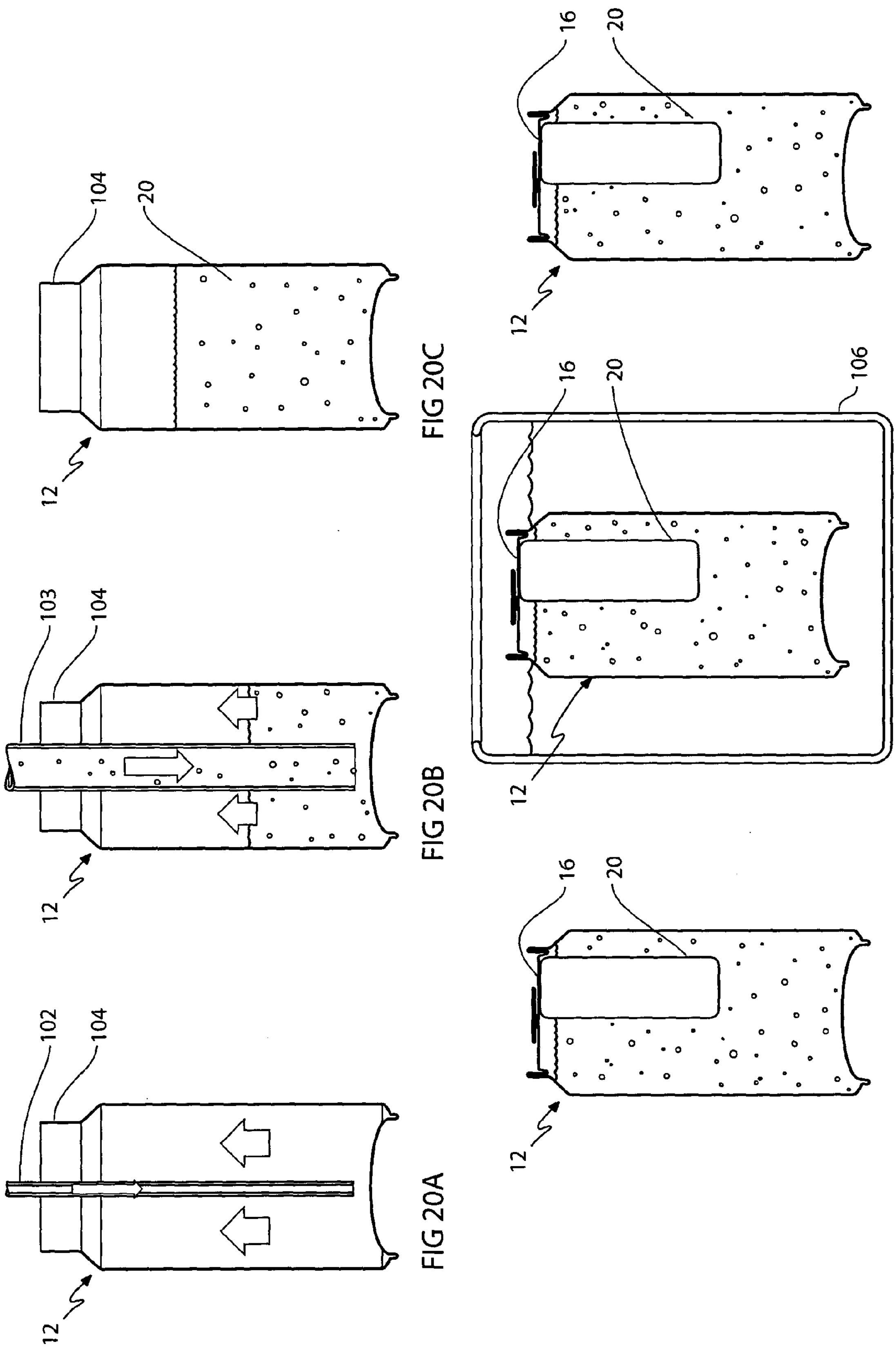

FIG 20A

FIG 20B

FIG 20C

FIG 20D

FIG 20E

FIG 20F

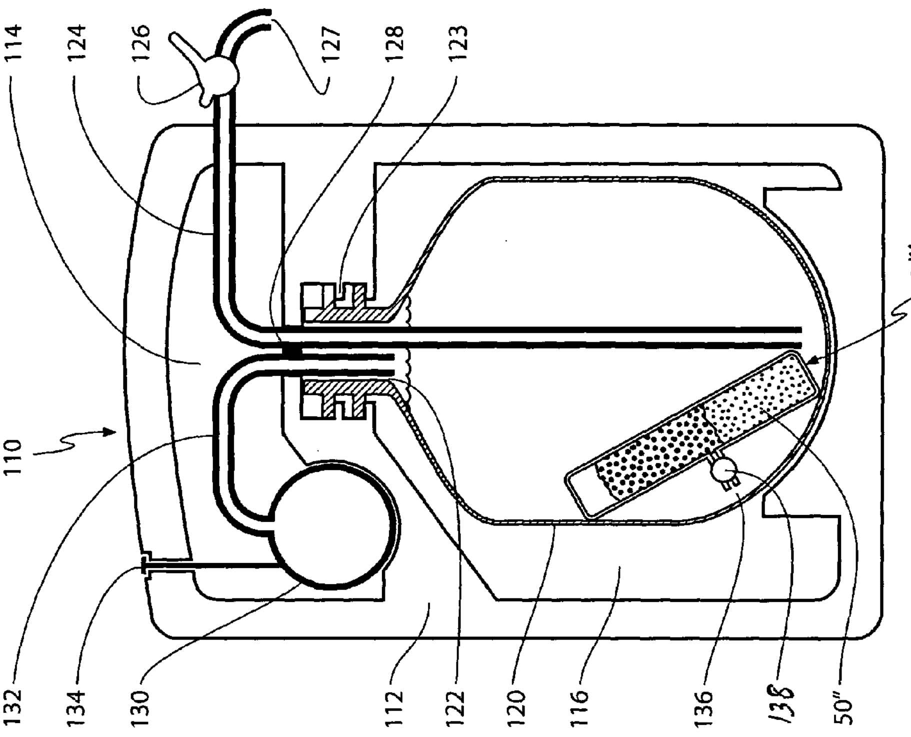

FIG 21B

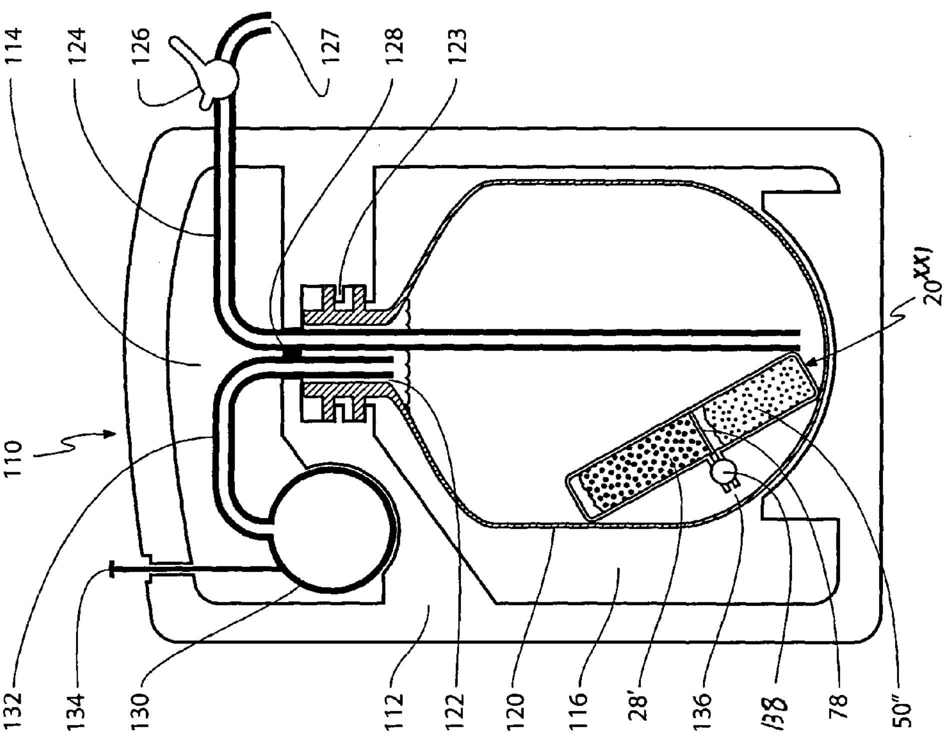

FIG 21A

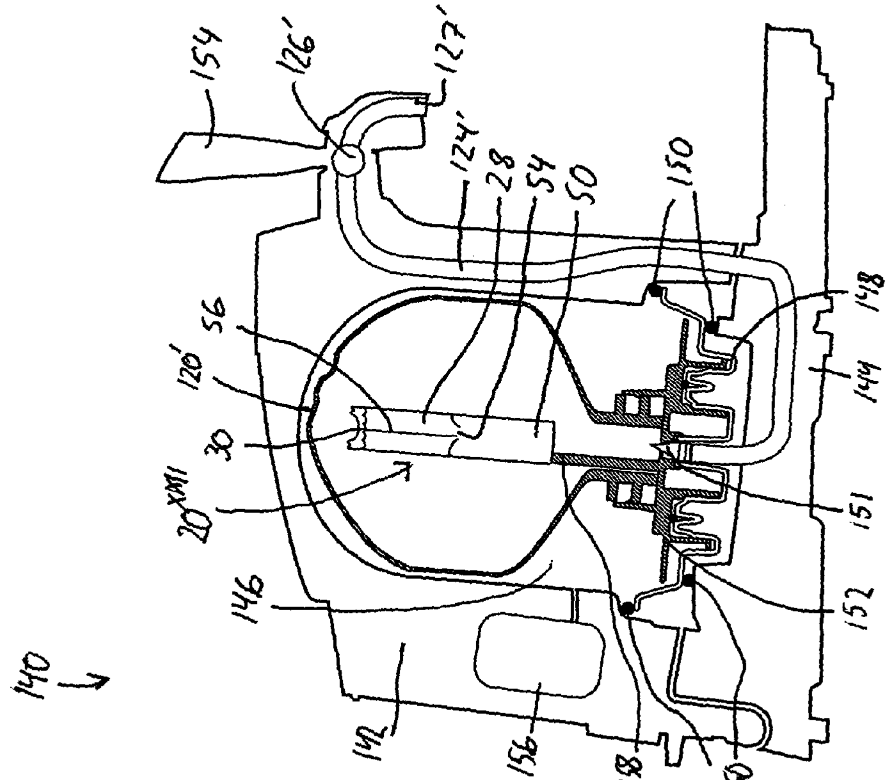

FIG 22B

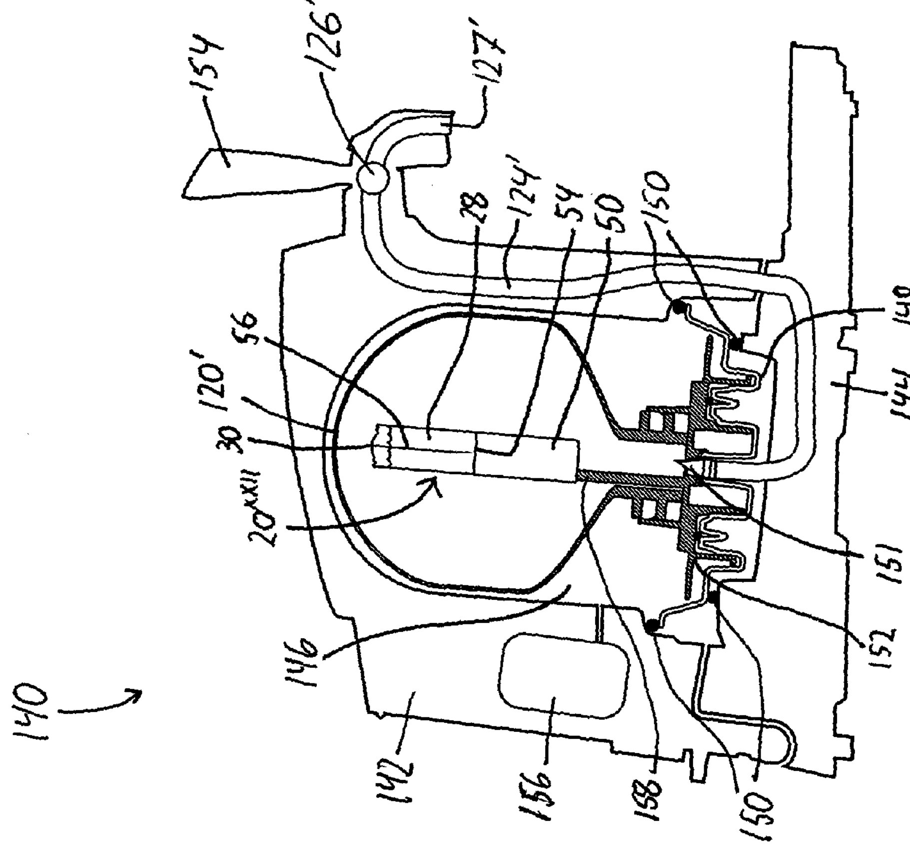

FIG22A

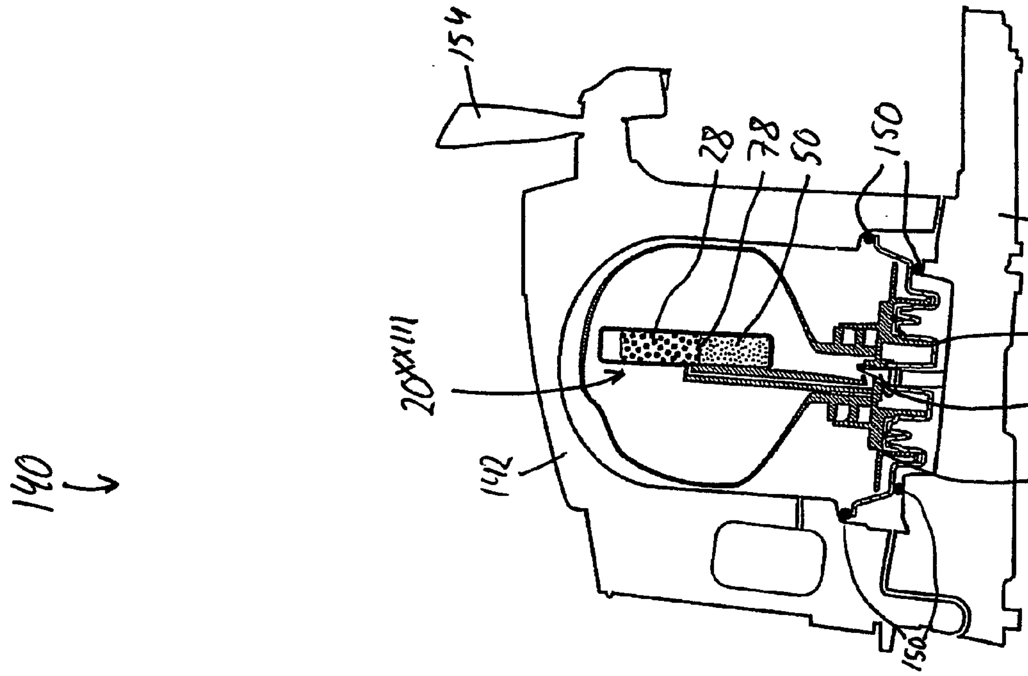

FIG 23:B

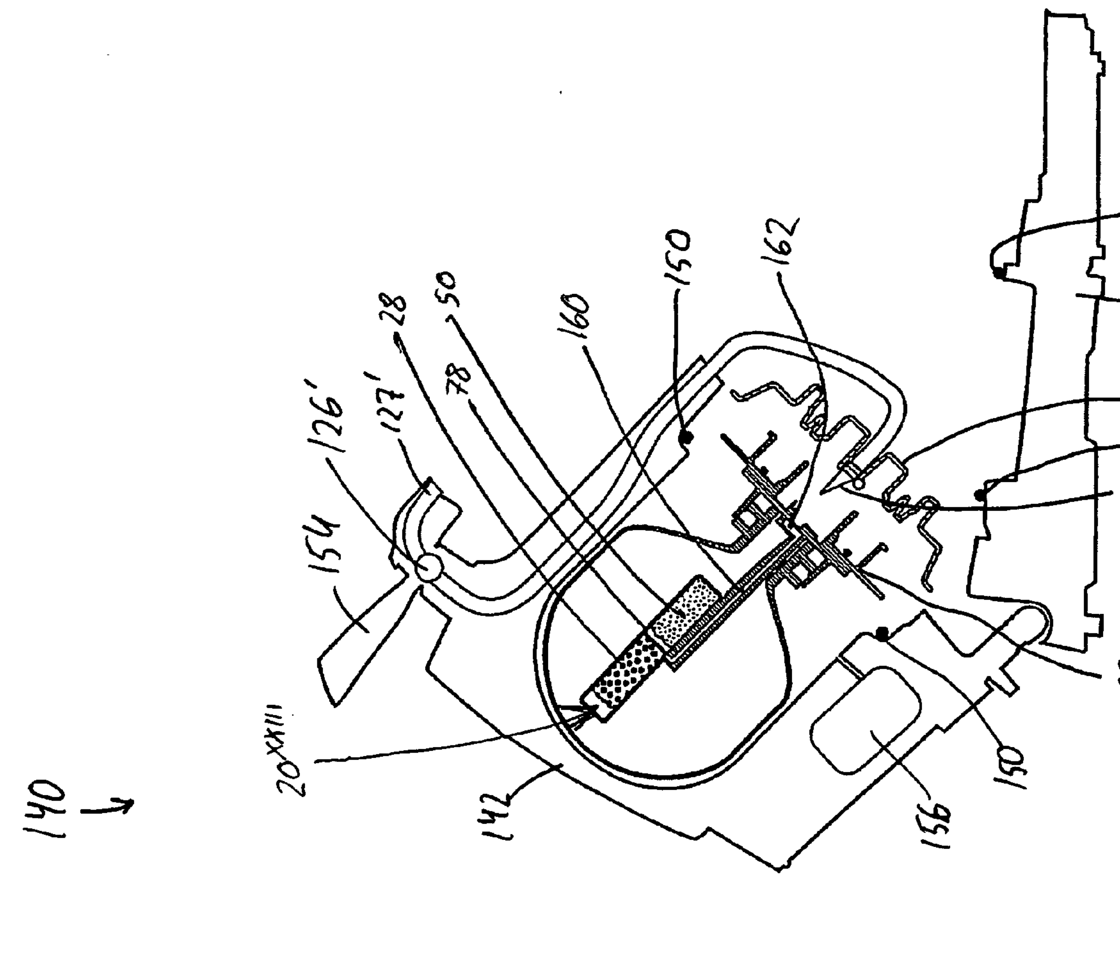

FIG 23:A

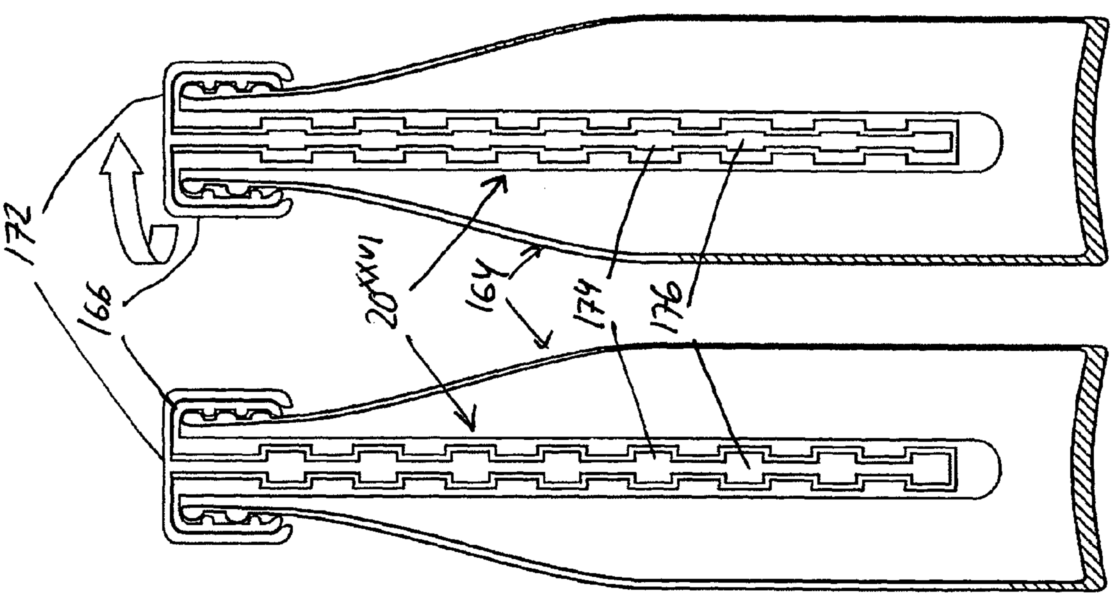

FIG 26A

FIG 26B

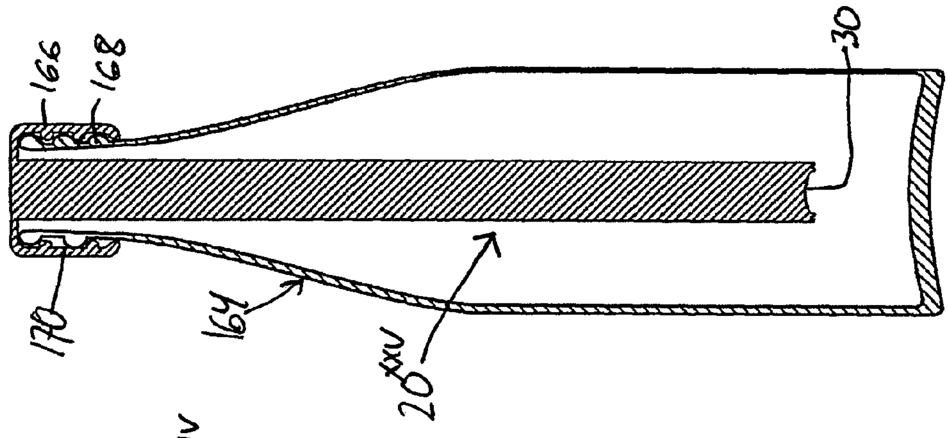

FIG 25

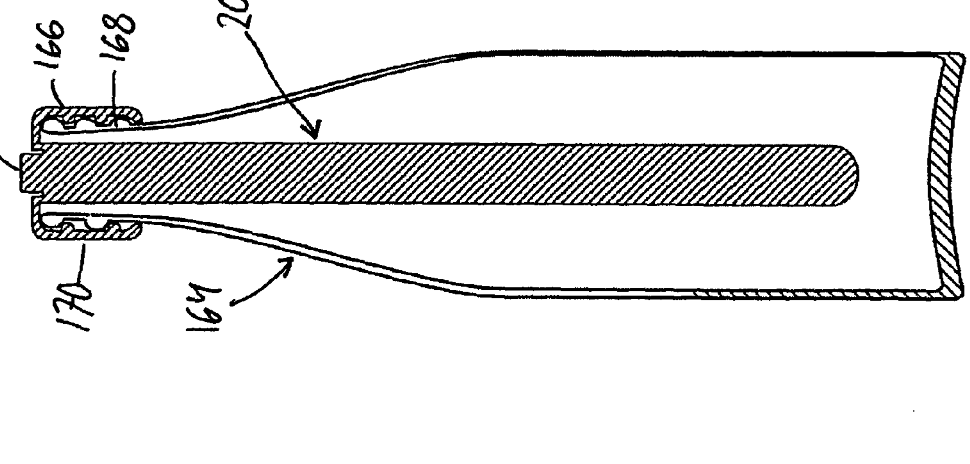

FIG 24

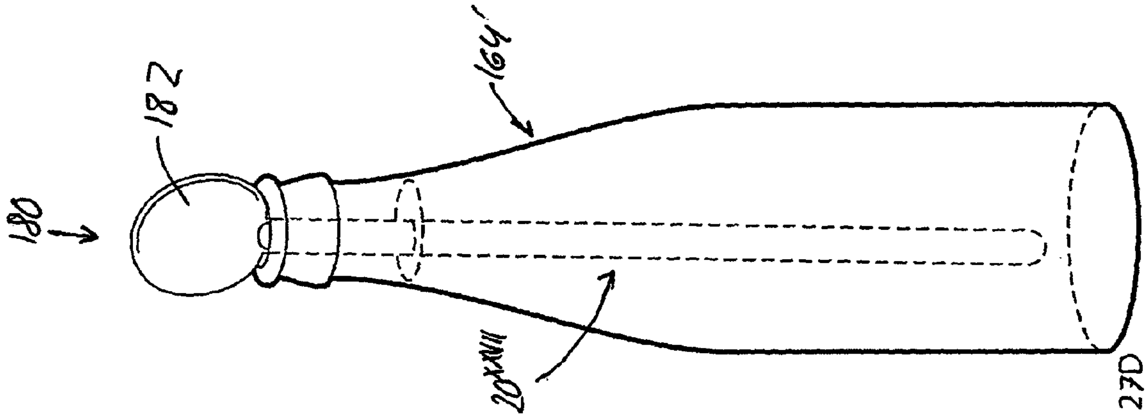

FIG 27D

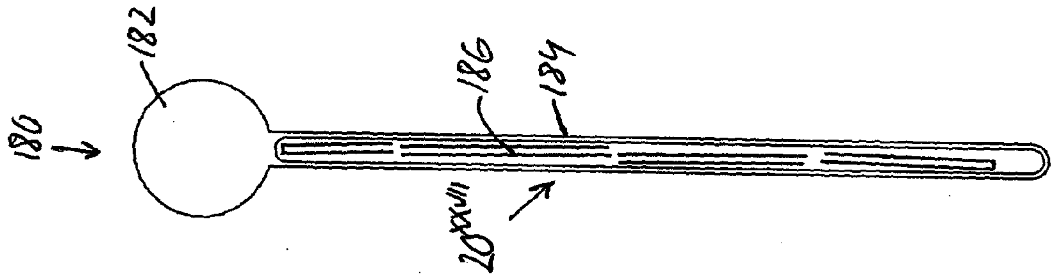

FIG 27C

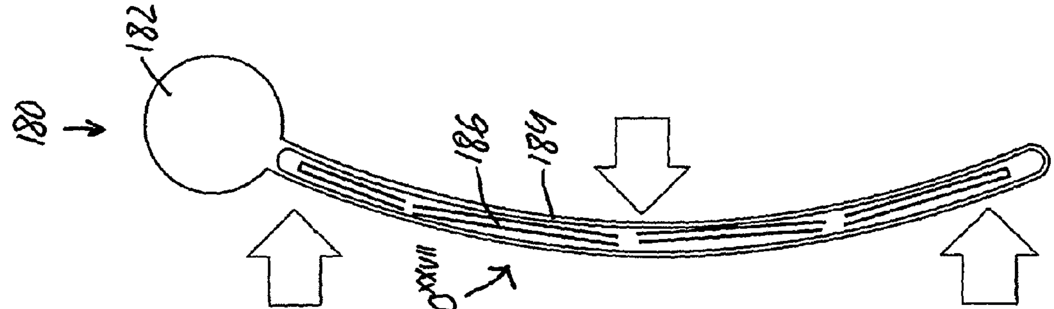

FIG 27B

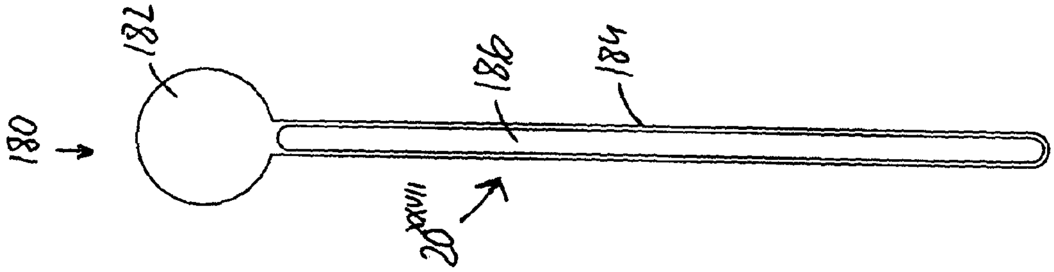

FIG 27A

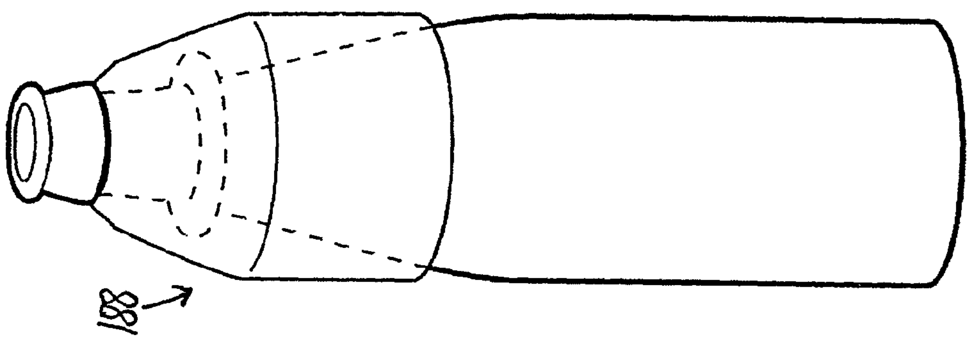

FIG 28C

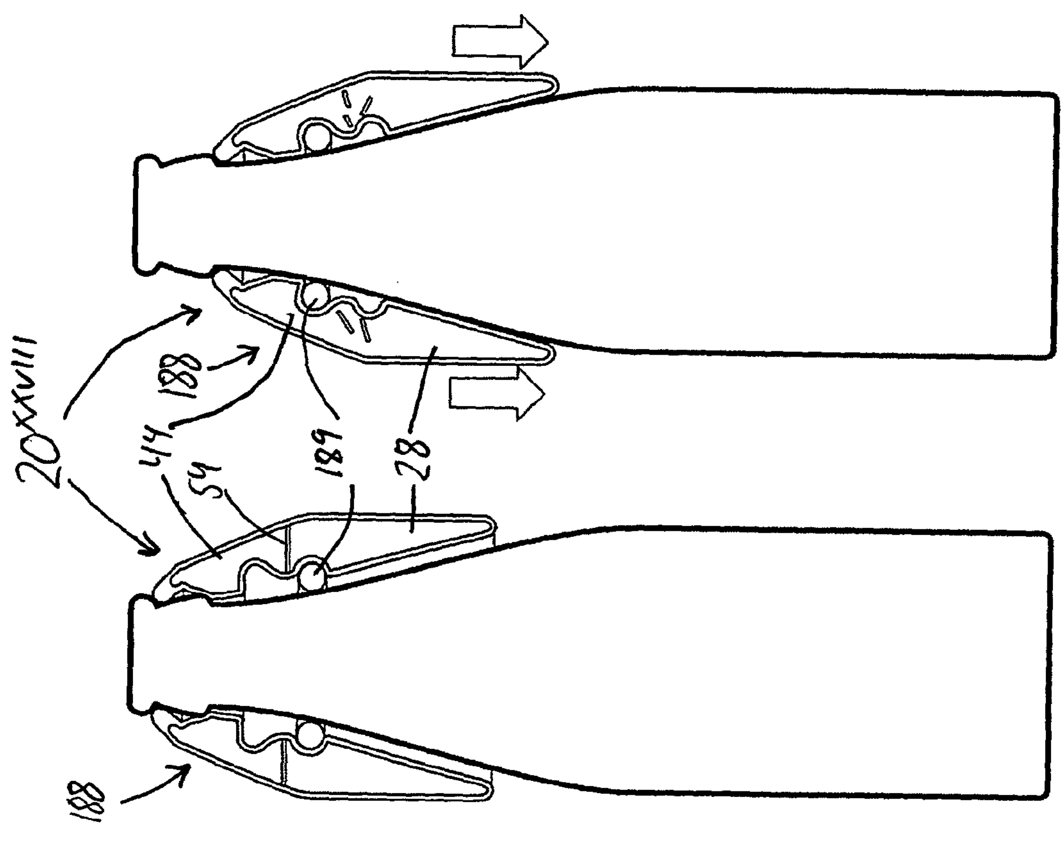

FIG 28B

FIG 28A

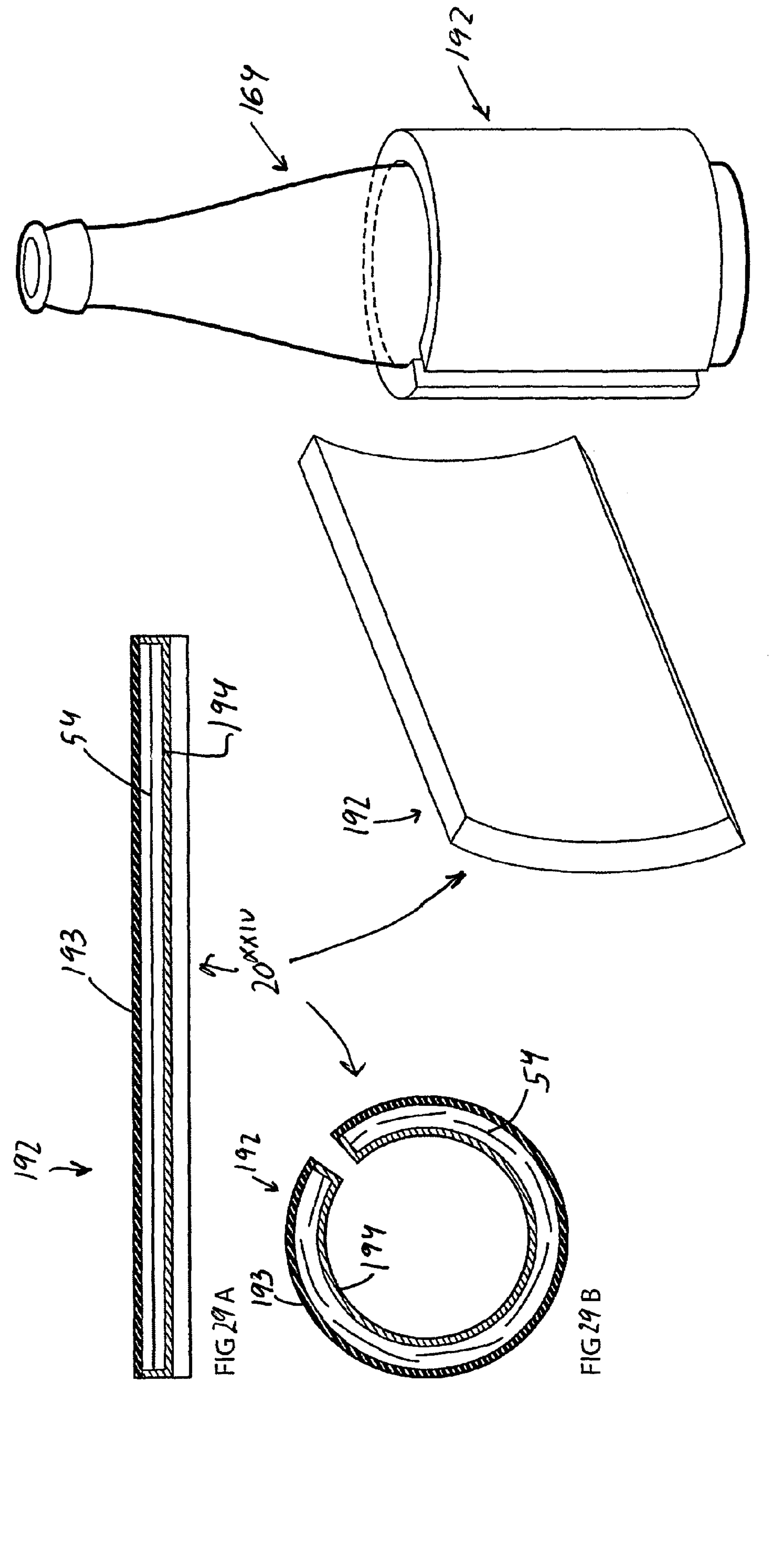

FIG 29 A

FIG 29 B

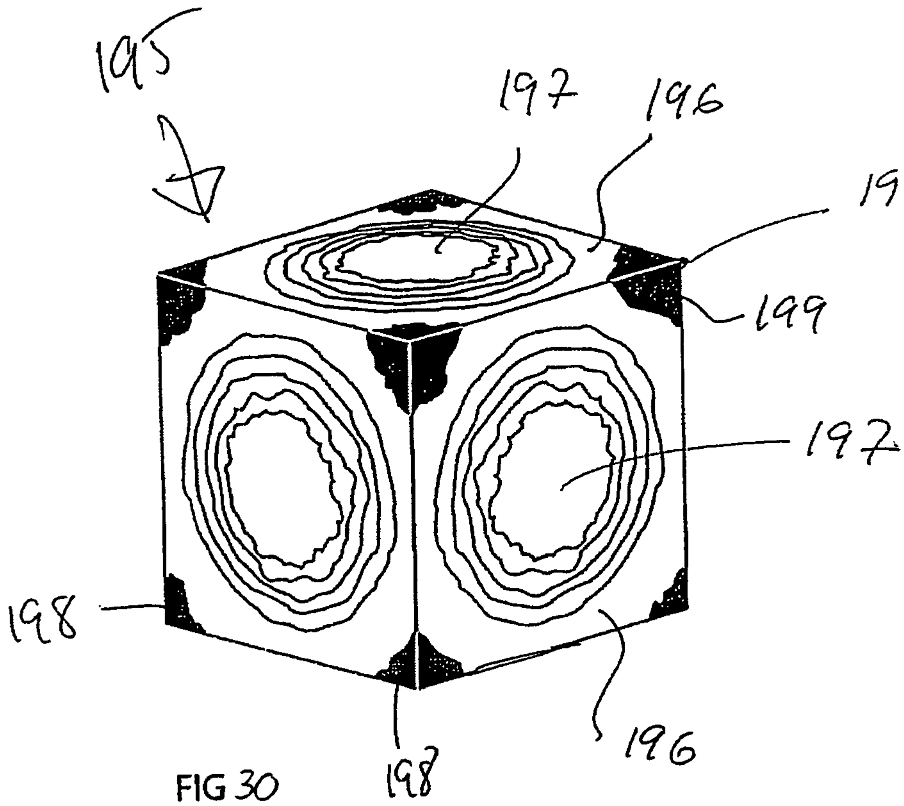

FIG 30

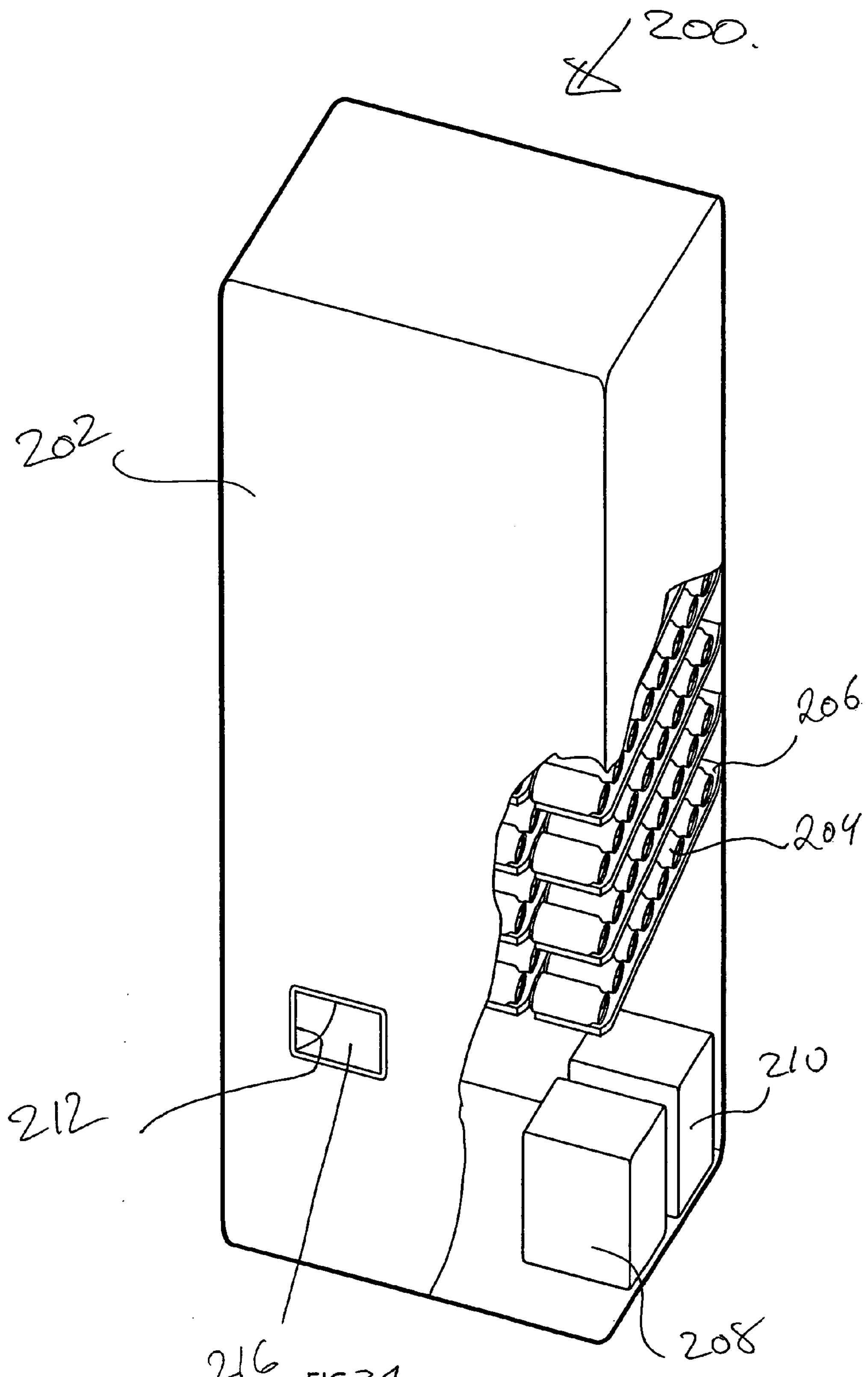

FIG 31

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EUROPEAN SEARCH REPORT

Application Number
EP 08 38 8046

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Y	US 2008/016882 A1 (NEUWEILER JEFFREY C [US]) 24 January 2008 (2008-01-24) * figures 1-3 *	1,9-11	
Y	"5.1 Endothermic Reactions -- Ba(OH)2 H2O+NH4SCN" [Online] 29 November 2007 (2007-11-29), 20071129 , XP007909050 Retrieved from the Internet: URL:http://web.archive.org/web/20071129232734/http://chemed.chem.purdue.edu/demos/demosheets/5.1.html> [retrieved on 2009-07-02] * the whole document *	1,9-11	TECHNICAL FIELDS SEARCHED (IPC) F25D
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	14 July 2009	Dezso, Gabor

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