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(54) A self cooling container and a cooling device

(57) The present invention relates to a container (10') for storing a beverage, the container having a container body (12) and a closure (16) and defining an inner chamber, the inner chamber defining an inner volume and including a specific volume of the beverage. The container (10') further includes a cooling device (20') having a housing defining a housing volume. The cooling device (20') includes at least two separate, substantially non-toxic reactants (29) causing an entropy-increasing reaction producing substantially non-toxic products in a stoichiometric number. The at least two separate substantially non-toxic reactants (29) initially being included in the cooling device (20') 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 (20') further includes an actuator for initiating the reaction between the at least two separate, substantially non-toxic reactants (29).

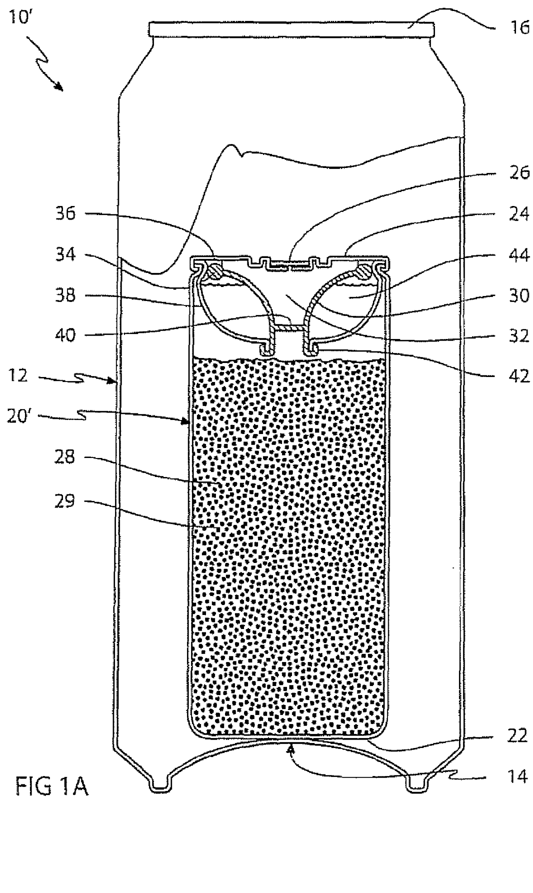

FIG 1A

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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-carbonate 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 homos 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 In the present context, it should be mentioned that the applicant company alone installs approximately 17000 refrigerators a year for providing cool beverages, and each refrigerator typically has a wattage of about 200W.

[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 clement, 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 US4401.3567, US7117684, EP0498428, US2882691, GB2384846, WO2008000271, GB2261501, US4209413, US4273667, US430.3121, US4470917, US4689164, US20080178865, JP2003207243, JP2000265165, US3309890, WO8502009, US3229478, US4599872, US4669273, WO2000077463, EP87859 (fam US4470917), US4277357, DE3024856, US5261241 (fan EP0498428), GB1596076, US6558434, WO02085748, US4993239, US4759191, US4752310, WO0110738, EP1746365, US7117684, EP0498428, US4784678, US2746265, US1897723, US2882691, GB2.384846, US4802343, US4993237, WO2008000271, GB2261501, US20080178865, JP2003207243, US3309890, US3229478, WO2000077463, WO02085748

[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

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

[0007] 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, substantial 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

[0008] 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

[0009] 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 sufficiency low temperatures

[0010] 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 by 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 Preferably, the Chemical reaction produces a heat reduction of 120-240l/ml of reactants, or most preferably 240-330l/ml of reactants. Such cooling efficiency is approximately the cooling efficiency achieved by melting of ice into water. 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 arc acceptable before beverage consumption. In the present context it may be noted that carbonated beverages typically allow a lover temperature of the cooling device compared to non-carbonated beverages since the formation of CO_2 bubbles rising in the beverage will increase the amount of turbulence in the beverage and therefore cause the temperature to equalize faster within the beverage.

[0011] Further, the term non-reversibie should be considered to be synonymous with the word irreversible The term non-reversible reaction should be understood to mean a reaction in which the reaction products and the reactants do not form a chemical equilibrium which is reversible by simply changing the proportions of the reactants and/or the reaction products and/or the external conditions such as pressure, temperature etc Examples of non-reversible reactions include reactions in which the reaction products constitute a complex, a precipitation or a gas Chemical reactions, such as reactions involving dissolving of a salt in a liquid such as water and disassociation of the salt into ions, which form an equilibrium, will come to a natural stop when the forward reaction and the backward reaction proceed at equal rate E. in most solutions or mixtures the reaction is limited by the solubility of the reactants A non-reversible reaction as defined above will continue until all of the reactants have reacted

[0012] German published patent application DE 21 50 305 A1 describes a method for cooling beverage bottles or cans A cooling cartridge including a soluble salt is included in the bottle or can By dissolving the salt in a specific volume of water a cooling effect is obtained by utilizing the negative solution enthalpy However, by using the negative solution enthalpy as proposed, the lowest temperature achieved was about 12°C, assuming an initial temperature of 21°C None of the examples of embodiments achieves the sought temperature of about 5°C By calculating the heat reduction in the beverage ($Q=c*m*\Delta T$), the example embodiments achieve heat reductions of only about 15-38J/ml of beverage All of the examples of embodiments also requires reactants having a total volume exceeding 33% of the beverage volume Further, all of the reactions proposed in the above-mentioned document are considered as reversible, since the reaction may be reversed by simply removing the water from the solution By removing the water, the dissolved salt ions will recombine and form the original reactants

[0013] The German utility model DE 299 11 156 U1 discloses a beverage can having an external cooling element The cooling element may be activated by applying pressure to mix two chemicals located therein The document only describes a single chemical reaction including dissolving and disassociation of potassiumcloride, salpeter and salmiacsalt in water which is stated to reach a temperature of 0°C or even -16°C of the cooling elements, although the description is silent about the starting temperature of the cooling element. The description is also silent about the dimensions used for the cooling element and which volumes of beverage and reactants are used

[0014] Many non-reversible entropy increasing reactions are known as such. One example is found on the below internet URL: http://web archive.org/web/20071129232734/http://chemed chem purdue edu/demo/demosheets/5.1 html. The above reference suggests the below reaction:

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

[0015] The above reference suggests that the reaction above is endothermal and entropy increasing and generates a temperature below the freezing temperature of water However, there is no indication that the above reaction may be used in connection with the cooling of beverage, nor is any information about the amounts of reactants required available, nor the use of an actuator to initiate the reaction

[0016] Different from most solution reactions, it should be noted that the above reaction may be initiated without the addition of any liquid water Some other non-reversible entropy increasing reactions require only a single drop of water to initiate

[0017] The use of ammonia is in the present context not preferred, since ammonia may be considered toxic, and will, in case it escapes into the beverage, yield a very unpleasant taste to the beverage Preferably, all reactants as well as reaction products should in addition to being non-toxic have a neutral taste in case of accidental release into the beverage

[0018] 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

[0019] One kind of activator is disclosed in the previously mentioned DE 21 50 305 A1, which uses a spike to penetrate a membrane separating the two chemicals US 2008/0016882 shows further examples of activators having the two chemicals separated by a peelable membrane or a small conduit

[0020] 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

[0021] 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: $Na_2SO_4\ 10H_2O + CaCl_{2.}\ 6H_2O \rightarrow 2NaCl + CaSO_{4.}\ 2H_2O + 14H_2O$. 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.

[0022] 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

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.

[0023] 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.

[0024] According to a further embodiment of the first aspect of the present invention at least two separate, substantially non-toxic reactants comprise a first reactant, a second reactant and a third reactant, the second and third reactants being present as separate granulates and the first reactant being applied as a coating covering the granulates of the second and third reactants By coating the second and the third reactants by the first reactant it can be ensured that the three reactants are held separated although the three reactants are mixed, since the second and the third reactants are prevented from reacting by the third reactant. In this way accidental activation of the chemical reaction may be avoided, e g by shock or in case a small amount of water enters the reaction chamber, the reaction will not be initiated since the coating will protect the second and third reactants It is preferred to use the first reactant as the coating, since a non-reacting coating would constitute a waste of volume and thereby necessitate a larger cooling device.

[0025] According to a further embodiment of the first aspect of the present invention the second and third reactants generate a first non-reversible entropy increasing reaction producing an intermediate reaction product, and the third reactant reacting with the intermediate reaction product generating a second non-reversible entropy increasing reaction In case the intermediate reaction products are toxic or otherwise unpleasant, such as bad smelling, the negative effect of the intermediate products may be avoided by allowing them to react with the third reactant and create an end product which is safe and which does not have any of the drawbacks of the intermediate reaction products

[0026] According to a further embodiment of the first aspect of the present invention the intermediate product is a gas and the second non-reversible entropy increasing reaction generating a complex or a precipitate. For instance, the intermediate product may be a toxic or smelly gas, which may be unsuitable for use in the present context The gas may then be pacified by reacting with the third reactant to form a complex or a precipitate which is safe.

[0027] According to a further embodiment of the first aspect of the present invention the first reactant is dissolvable by water or an organic solvent preferably a liquid such as water, the first, second and third reactants being prevented from reacting through the coating Upon initiation, a sufficient amount of water to at least partially dissolve the coating is introduced into the cooling device, thereby allowing all three reactants to dissolve and react with each other.

[0028] According to a further embodiment of the first aspect of the present invention the cooling device is accommodated within the container To ensure that a high percentage of the cooling energy is used for cooling the beverage and not lost to the surroundings, the cooling device may be located within the container, preferably in direct contact with the beverage and more preferably completely surrounded by beverage

Reactants

[0029] 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

[0030] 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

The reactants and products are substantially non-toxic

[0031] 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	$CaCO_3$
$NH_4C_2H_3O_2$	$Ca_3(PO_4)_2$
NH_4NO_3	$CaSO_4 \cdot 2H_20$
$(NH_4)_2SO_4$	$CoCO_3$
NH_4HSO_4	$Co(OH)_2$
$CaCl_2$	$CuBr$
$CrCl_2$	$Cu(OH)_2$
$CuBr_2$	$Fe(OH)_2$
$LiBr \cdot 2H_2O$	$Fe(OH)_3$
$LiCl \cdot H_2O$	$FePO_4 \cdot 2H_2O$
NH_2OH	$Fe_3(PO_4)_2$
KBr	Li_2CO_3
$KCO_3 \cdot 1\frac{1}{2} H_2O$	$MgCO_3$
$KOH \cdot 2H_2O$	$MnCO_3$
KNO_3	$Mn(OH)_2$
KH_2PO_3	$Ni(OH)_2$
$KHSO_4$	$SrCO_3$
$NaBr_2\ 2H_2O$	$SrSO_4$
$NaClO_3$	$Sn(OH)_2$
$NaOH \cdot H_2O$	$ZnCO_3$
$NaNO_3$	$Zn(OH)_2$
$NaSCN$	
$SnSO_4$	
$TiCl_3$	
$TiCl_4$	
$ZnBr_2 \cdot 2H_2O$	
$ZnCl_2$	
NH_4SCN	

[0032] Further suitable reactants are the following:

$NaAl(SO_4)2, 12H_20$
$NH_4Al(SO_4)2, 12H_20$

$LiOH H_20$
Na_2SiO_3
$Na_2SiO_3xH_20$, x=5-9
$Na_2O xSiO_2$ x=3-5
Na_4SiO_4
Na_6Si_2O7
Li_2SiO_3
Li_4SiO_4

[0033] Additional reactants and sets of reactants are listed in the below Table 1 and Table 2

[0034] 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.

[0035] The volumetric change during the non-reversible entropy-increasing reaction is no more than ±5%, preferably no more than ±4%, further preferably no more than ±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

[0036] 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 $Na_2(CH_2)_2(COO)_2$ $6H_2O$, Copper acetate monohydrate $Cu(CH_3COO)_2$ 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 $LiNO_3{\bullet}3H_2O$, $Na_2SO_4{\bullet}10H_2O$ (Glauber salt), $Na_2SO_4{\bullet}7H_2O$, $Na_2CO_3{\bullet}10H_2O$, $Na_2CO_3{\bullet}7H_2O$, $Na_2PO_4{\bullet}12H_2O$, $Na_2HPO_4{\bullet}12H_2O$, $Na_4P_2O_7{\bullet}10H_2O$, $Na_2H_2P_2O_7{\bullet}6H_2O$, $NaBO_3{\bullet}4H_2O$, $Na_2B_4O_7{\bullet}10H_2O$, $NaClO_4{\bullet}5H_2O$, $Na_2SO_3{\bullet}7H_2O$, $Na_2S_2O_3{\bullet}5H_2O$, $NaBr{\bullet}2H_2O$, $Na_2S_2O_6{\bullet}6H_2O$, $K_3PO_4{\bullet}3H_2O$ etc, preferably suitable alkaline earth metal salt hydrates are for example, $MgCl_2{\bullet}6H_2O$, $MgBr_2{\bullet}6H_2O$, $MgSO_4{\bullet}7H_2O$, $Mg(NO_3)_2{\bullet}6H_2O$, $CaCl_2{\bullet}6H_2O$, $CaBr_2{\bullet}6H_2O$, $Ca(NO_3)_2{\bullet}4H_2O$, $Sr(NO_3)_2{\bullet}4H_2O$, $Sr(OH)_2{\bullet}8H_2O$, $SrBr_2{\bullet}6H_2O$, $SrCl_2{\bullet}6H_2O$, $SrI_2{\bullet}6H_2O$, $BaBr_2{\bullet}2H_2O$, $BaCl_2{\bullet}2H_2O$, $Ba(OH)_2{\bullet}8H_2O$, $Ba(BrO_3)_2{\cdot}H_2O$, $Ba(ClO_3)_2{\cdot}H_2O$ etc Suitable transition metal salt hydrates are for example, $CrK(SO_4)_2{\bullet}12H_2O$, $MnSO_4{\bullet}7H_2O$, $MnSO_4{\bullet}5H_2O$, $MnSO_4{\bullet}H_2O$, $FeBr_2{\bullet}6H_2O$, $FeBr_3{\bullet}6H_2O$, $FeCl_2{\bullet}4H_2O$, $FeCl_3{\bullet}6H_2O$, $Fe(NO_3)_3{\bullet}9H_2O$, $FeSO_4{\bullet}7H_2O$, $Fe(NH_4)_2(SO_4)_2{\bullet}6H_2O$, $FeNH_{4(}CSO_4)_2{\bullet}12H_2O$, $CoBr_2{\bullet}6H_2O$, $CoCl_2{\bullet}6H_2O$, $NiSO_4{\bullet}6H_2O$, $NiSO_4{\bullet}7H_2O$, $Cu(NO_3)_2{\bullet}6H_2O$, $Cu(NO_3)_2{\bullet}3H_2O$, $CuSO_4{\bullet}5H_2O$, $Zn(NO_3)_2{\bullet}6H_2O$, $ZnSO_4{\bullet}6H_2O$, $ZnSO_4{\bullet}7H_2O$ etc Suitable aluminium salt hydrates are for example $Al_2(SO)_4)_3{\bullet}18H_2O$, $AlNH_4(SO_4)_2{\bullet}12H_2O$, $AlBr_3{\bullet}6H_2O$, $AlBr_3{\bullet}15H_2O$, $AlK(SO_4)_2{\bullet}12H_2O$, $Al(NO_3)_3{\bullet}9H_2O$, $AlCl_3{\bullet}6H_2O$ etc. A suitable lanthanum salt hydrate is $LaCl_3{\bullet}7H_2O$.

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

[0037] 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.

[0038] 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 NiSO4, Cu (NO3)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) 2Cr207 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, $SnCl_4$, $TiCl_4$, VCl_4 or a liquid organic compound such as CH_2Cl_2 etc.

[0039] The number of reactants participating in the reaction is at least two Some embodiments may use three or more reactants One possible reaction according to the present invention is

• $Na_2SO_4{\bullet}10H_2O(s) + CaCl_2{\bullet}6H_2O(s) \rightarrow 2Na^+(aq) + 2Cl^-(aq) + CaSO_4{\bullet}2H_2O(s) + 14H_2O(1)$

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

$$\Delta S = 2*(58\ J/K*mol) + 2*(57\ J/K*mol) + (194\ J/K*mol) + 14*(70\ J/K*mol) - ((592\ J/K*mol) + (365\ J/K*mol)) = 2\ 361\ kJ/K*mol$$

At room temperature (T = 298 K)

$$\Delta G = \Delta H - T*\Delta S = 94\ kJ/mol - 298\ K*0\ 447\ kJ/K*mol = -39\ kJ/mol$$

[0040] The negative sign indicates that the reaction is spontaneous.

[0041] The stoichoimetric number of products to reactants is 19/2 = 9 5:1

[0042] Another possible reaction according to the present invention is

• $Na_2SO_4{\bullet}10H_2O(s) + Ba(OH)_2{\bullet}8H_2O(s) \rightarrow 7BaSO_4(s) + 2Na^+(aq) + 2OH^-(aq) + 18H_2O(l)$

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

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

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

[0043] Thus this reaction is spontaneous The stoichoimetric number of products to reactants is 23/2 = 11 5:1

[0044] A further possible reaction according to the present invention is

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

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

$$\Delta S = 0.495\ kJ/K*mol$$

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

[0045] The reaction is spontaneous The stoichoimetric number of products to reactants is 13/3 = 4.33:1

[0046] Examples of further reactions are

a) $Ba(OH)_2 \bullet 8H_2O(s) + 2NH_4NO_3(s) \rightarrow Ba(NO_3)_2 + 2NH_3(g) + 10H_2O(l)$

b) $Ba(OH)_2 \bullet 8H_2O(s) + 2NH_4Cl(s) \rightarrow BaCl_2 + 2NH_3(g) + 10H_2O(l)$

Additives and activators

[0047] 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.

[0048] 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

[0049] 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

[0050] 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

[0051] Instead of a coating the reactants can be suspended in a non-aqueous fluid such as an organic solvent

[0052] 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

[0053] 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

[0054] 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

[0055] 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

[0056] 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

[0057] 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

Presently preferred reaction

[0058] The presently preferred reaction is a reaction between strontium hydroxide octahydrate and ammonium nitrate To make the end product safe, magnesium nitrate hexahydrate is added as a third reactant Most preferably, the magnesium nitrate hexahydrate is used as a coating for separating the strontium hydroxide octahydrate and ammonium nitrate The above reactants react in a primary reaction and a NH3 pacification reaction. The primary reaction having a high cooling efficiency is as follows:

$$3Sr(OH)_2{\bullet}8H_2O(s) + 6NH_4NO_3(s) \rightarrow 3Sr^{2+} + 6NO_3 + 6NH_3 + 30H_2O$$

[0059] Since NH_3 may be considered as toxic, or at least not pleasantly smelling, it has to be pacified by a futher reaction. The NH_3 pacification reaction has a cooling efficiency which is lower than the cooling efficiency of the primary reaction:

$$3Sr^{2+} + 6NO_3^- + 6NH_3 + 30H_2O + Mg(NO_3)_2{\bullet}6H_2O(s) \rightarrow 3Sr^{2+} + 8NO_3^- + Mg(NH_3)_6^{2+} + 36H_2O$$

[0060] The end product is a white gel that smells slightly of ammonia and which is completely safe 88ml of the above reactants are required to cool down 330ml of beverage by 20 degrees centigrade. Thus, a common 440ml beverage can may be used for accommodating 330ml of beverage and 88 ml of reactants

Cooling of beverage

[0061] 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

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.

[0062] 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 oftime of no more than 5 min, preferably no more than 2 min

[0063] 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: $q = m \Delta T\ Cp$ Thus in order to cool I 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

[0064] According to further embodiments, the container body may comprise a beverage keg of polymeric or metallic material having a volume of 3-50 liters, the keg being either collapsible or rigid, and the closure being a keg coupling Alternatively, the container body may comprise a bottle of glass or polymeric material, the bottle having a volume of 0.2-3 liters, and the closure being a screw cap, crown cap or stopper Yet alternatively, the container body may comprise a beverage can and a beverage lid of metallic material, preferably aluminum or an aluminum alloy, the can having a volume of 0. 2-1 liters, and the closure being constituted by an embossing area of the beverage lid Yet alternatively, the container may comprise a bag, preferably as a bag-in-box, bag-in-bag or bag-in-keg

[0065] According to Further embodiments, the container comprises guiding elements for guiding the flow of beverage from the container body. The guiding elements may serve to guide the flow of the beverage via the cooling device towards the closure The cooling device may be located within the container, or alternatively the cooling device is located outside the container. The container body may constitute a double wailed container constituting an inner wall and an outer wall, and the cooling device may be located between the inner and outer wall

[0066] According to further embodiments, the container may comprise a pressure generating device either accommodated within the container or connected to the container via a pressurization hose The pressure generating device preferably comprises a carbon dioxide generating device for pressurization of the beverage in the beverage container

[0067] According to further embodiments, the container may comprise a tapping line and a tapping valve for selectively dispensing beverage from the beverage container The beverage container may be 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.

[0068] According to further embodiments, the cooling device forms an integral part of the beverage container or a part of the top of the beverage container, alternatively a part of the wall or bottom of the beverage container. The cooling device is fastened onto the base of the beverage container, alternatively the wall of the container, yet alternatively the top of the container, or alternatively the cooling device constitutes a widget, which is freely movable within the container.

[0069] According to a further embodiment, the cooling device may be 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

[0070] A problem in relation to the cooling of water based beverages by including a cooling device in contact with the beverage is the relatively low thermal conductivity and the relatively high heat capacity of water. This means that water may be considered to be a thermal insulator Concerning carbonated beverages the carbon dioxide gas bubbles generated in the beverage will further reduce the thermal conductivity of the carbonated beverage compared to a non-carbonated beverage. Thus, although the cooling device is capable of cooling the beverage immediately adjacent the cool walls of the cooling device, any beverage located further away from the cooling device will remain warm The main cooling effect in a beverage container is provided by conductive cooling and convective cooling The convective cooling may be increased in case the beverage container is shaken to allow the cool beverage near the walls of the cooling device to be substituted by warmer beverage further away from the cooling device, however, shaking a beverage container containing carbonated beverage is not advisable since it will generate excessive carbon dioxide bubble formation within the beverage The bubble formation will apart from causing the beverage to erupt during opening of the beverage container, further worsen the conducive cooling, since the carbon dioxide bubbles are excellent thermal insulators There is therefore a need to improve the conductive cooling of carbonated beverages using a cooling device

[0071] It is therefore a further object of the present invention to provide a cooling device capable of cooling the carbonated beverage to an optimal serving temperature within a short time period.

[0072] 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 are according to a above 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,

the cooling device defining an outer cooling surface contacting the bevereverage and further including an actuator for initiating the reaction between the at least two separate, substantially non-toxic reactants, and

the inner chamber defining an inner top half space containing beverage and an inner bottom half space containing beverage, any point within the top half space defining a maximum distance A to an adjacent point on the outer cooling surface, the maximum distance A being of the order of 0.5 cm-20 cm, such as 0.5 cm-15 cm, preferably approximately 1.0 cm

[0073] The applicant has surprisingly found out that the conductive cooling within the beverage may be improved by reforming the outer surface of the cooling device At the same time, the convective cooling plays a minor role due to the small volume of the beverage container The temperature of the outer cooling surface will sink rapidly to a temperature only slightly above freezing just after activation of the cooling device The beverage located adjacent the outer cooling surface of the cooling device will therefore assume a low temperature quickly The heat transfer between the cool beverage adjacent the outer cooling surface of the cooling device and the beverage located furthest away in relation to the outer cooling surface is considerably slower and is determined by the temperature gradient In order to maximize the heat transfer the temperature gradient should be maximized as well The temperature gradient may be maximized by minimizing the distance between the outer cooling surface of the cooling device and the beverage located furthest away in relation to the outer cooling surface Various shapes of the outer cooling surface, such as the shapes described herein, may be contemplated in order to achieve a small distance between the outer cooling surface of the cooling device and the beverage located furthest away in relation to the outer cooling surface, however, much material will be required and the dispensing or pouring behaviour of the beverage will be influenced by the additional flow resistance caused by the outer cooling contact surface The flow resistance may e.g. cause significantly slower pouring of the beverage or may even cause some beverage to be trapped within the outer surface and remain inside the beverage container Such beverage will be lost for the consumer

[0074] The applicant has thereby determined by conducting laboratory experiments that a maximum distance between any point within the top half space to an adjacent point on the outer cooling surface should be of the order of 0 5 cm-2 0 cm to achieve a quick cooling and at the same time allow a suitable dispensing behaviour of the complete beverage in the beverage container

[0075] Further, the convective heat transfer may be improved without the need to shake the beverage container by locating the cooling device near the top of the beverage container, In this way the beverage near the top of the beverage container, ie in the upper half space of the beverage container, will be slightly cooler than the beverage near the bottom of the beverage container, i.e. in the bottom half space of the beverage container As cool beverage has a higher density than warm beverage, the cool beverage at the top will sink towards the bottom, substituting the warm beverage at the bottom, which warm beverage will rise towards the top of the beverage container Top and bottom should in the present context be understood in relation to the normal resting position of the beverage container, e.g. for typical beverage containers such as cans having the top near the opening of the beverage container Having the cooling device near the opening of the beverage container has the additional benefit of further cooling the beverage which is about to be consumed or dispensed

[0076] According to a further embodiment of the above aspect of the present invention, any point within the bottom half space defining the maximum distance A to an adjacent point on the outer cooling surface, or, preferably, wherein any point within the inner chamber defining the maximum distance A to an adjacent point on the outer cooling surface Since the convective cooling plays a minor role in the cooling of the beverage, the outer cooling surface of the cooling device may extend into the lower half space of the beverage container as well for improving the conductive cooling in the complete beverage container Preferably, the outer cooling surface of the cooling device extends outside the beverage space, such as into the head space, in order to improve the conductive cooling of the beverage also when the beverage container is stored in an arbitrary position or orientation different from the normal vertical orientation, such as when the beverage container is stored in a horizontal position

[0077] According to a further embodiment of the above aspect of the present invention, the inner chamber defines an inner surface, the outer cooling surface defining an area being at least 3 times the area of the inner surface, preferably at least 4 times the area of the inner surface, such as 5 times the area of the inner surface The conductive cooling may be increased significantly by increasing the area of the outer cooling surface in relation to the inner surface of the inner chamber of the beverage container The inner surface defines the volume of the inner chamber and thereby the amount of beverage to be cooled

[0078] According to a further embodiment of the above aspect of the present invention, the cooling device defining an interior beverage space at least partly enclosed by the outer cooling surface, the interior beverage space defining a transversal dimension between adjacent points of the outer surface, the transversal dimension defining a maximum distance of 2A. It is contemplated that the cooling device may comprise holes or gaps defining interior beverage spaces The distance between opposing wall parts of such interior beverage spaces should be such that the distance between adjacent or opposing points on the outer surface should not exceed 2A, i.e. should be in the order of 10 cm-4.0 cm, such as 10 cm-3 0 cm, preferably approximately 20 cm In this way be above maximum distance is fulfilled and the temperature gradient is kept high

[0079] According to a further embodiment of the above aspect of the present invention, the outer surface of the cooling device defines a top surface, a bottom surface and a substantially cylindrical surface enclosing the top and bottom surfaces A cylindrical surface may be preferred due to the simple manufacturing of such surfaces A cylindrical surface may eg be manufactured from a flat cooling device by joining opposing edges to form a tube

[0080] According to a further embodiment of the above aspect of the present invention, the outer surface of the cooling device defines a top surface, a bottom surface and a corrugated surface enclosing the top and bottom surfaces A corrugated surface, such as a surface having a star shape, will yield a larger outer cooling surface compared to a cylindrical surface. Such corrugated surfaces may be manufactured by folding a flat cooling device

[0081] According to a further embodiment of the above aspect of the present invention, the outer surface of the cooling device defines a top surface, a bottom surface and an intermediate surface enclosing the top and bottom surfaces, the intermediate surface having an annular shape, a helical shape, a helicoid shape or a spiral-shape Further shapes may have an even larger outer contact cooling surface, however, the manufacturing of such cooling devices may involve some more steps compared to the earlier embodiments In particular, the last three shapes above involve 3D shaping of the cooling device

[0082] According to a further embodiment of the above aspect of the present invention, the at least two separate substantially non-toxic reactants initially being included in the cooling device are separated from one another by a water soluble membrane and the actuator including a first actuator chamber being filled by water or an aqueous solution equivalent to the beverage Water is preferred as a constituent of the actuator, since water is non-toxic and cheap Water will also aid in the mixing of the reactants after activation and thereby allow the reaction to start more quickly than it would without water Water is also produced as a reaction products of several of the enthalpy increasing reactions presented herein, and any part of the water soluble membrane not dissolved by the water of the actuator will at least be dissolved by the water being produced as reaction product The first actuator chamber should initially be separated from the water soluble membrane and from the reactants. The water soluble membrane should be rigid when kept dry and deteriorates when contacting water and may be eg starch Further embodiments are described in the detailed description

[0083] According to a further embodiment of the above aspect of the present invention, the first actuator chamber is flexible, deformable and separated from the water soluble membrane by a pressure activated seal, the cooling device initially being kept at a low pressure and the reaction being initiated when the pressure activated seal being ruptured when the pressure inside the first actuator chamber is increased above a specific high pressure, the low pressure typically being atmospheric pressure or below, the specific high pressure typically being atmospheric pressure or above. The present embodiment is preferred for manual activation, i e. when the water of the first actuator chamber is being forced into contact with the water soluble membrane by compressing the first actuator chamber Alternatively, the present embodiment may be used in connection with vacuum containers, which when being opened will be subjected to an increased pressure Pressure activated seals open when the pressure difference across the seal exceeds a specific value

[0084] According to a further embodiment of the above aspect of the present invention, the first actuator chamber is capable of withstanding pressure variations while the first actuator chamber is closed, the actuator further including a second actuator chamber being filled with a foam generating material, the second actuator chamber being located between the first actuator chamber and the water soluble membrane and separated from the first actuator chamber by a pressure activated seal, the second actuator chamber preferably being separated from the water soluble membrane by one or more pressure activated seals. Capable of withstanding pressure variations should be interpreted to mean that the pressure activated seal should open before any significant deformation of the first actuator chamber occurs The foam generator allows the water to reach the water soluble membrane independently of the orientation of the actuator since the foam will fill the complete first and second actuator chambers and propagate towards the water soluble membrane. The foam is aqueous and will thus dissolve the water soluble membrane. Preferably, a weaker pressure activated seal is used between the foam generator and the water soluble membrane, which seal will break at least by the pressure generated by the foam.

[0085] According to a further embodiment of the above aspect of the present invention, the beverage is a carbonated beverage and the first actuator chamber is filled by gasified water or a gasified aqueous solution equivalent to the beverage, typically constituting carbonated water, the cooling device initially being kept at a high pressure and the reaction being initiated when the pressure activated seal being ruptured when the pressure outside of the first actuator chamber is decreased below a specific low pressure, the high pressure typically being the pressure of the carbonated beverage such as 2-3 bars whereas the specific low pressure typically being atmospheric pressure. The present embodiment is preferred for automatic activation when opening containers containing carbonated beverage, i e when the water of the first actuator chamber is being forced into contact with the water soluble membrane by releasing a pressure initially subjected to the first actuator chamber Gasified water, and in particular carbonated water having the same carbonisation as the beverage, will respond to temperature variation in a similar way as the beverage In this way it is avoided that the actuator is activated by temperature variations. When the beverage container is opened the pressure inside the container decreases while the pressure inside the first actuator chamber remains constant, thus causing the pressure activated seal to open

[0086] According to a further embodiment of the above aspect of the present invention, the first actuator chamber comprises a substantially rigid ampoule being encapsulated within the second actuator chamber. The first actuator chamber may preferably be a substantially rigid ampoule being capable of withstanding pressure variations and which ampoule is completely contained within the second actuator chamber The ampoule may e.g be made of thin glass.

[0087] According to a further embodiment of the above aspect of the present invention, the pressure activated seal comprises a burst membrane or alternatively a plug, advantageously a plug of liquid metal such as alloys including Gallium and/or Indium A small plug of Gallium and/or Indium alloys may be used to ensure a proper seal between the first and second actuator chambers

[0088] According to a further embodiment of the above aspect of the present invention, the water soluble membrane is configured in a layered structure or alternatively in a honeycomb structure or yet alternatively as a coating. It may be preferred to arrange the reactants in an pre-mixed configuration in order for the enthalpy increasing reaction to start quicker

[0089] According to a further embodiment of the above aspect of the present invention, the cooling device is manufactured at least partly of plastic foils. It is currently preferred to make the cooling device at least partly of plastic foils, preferably laminated plastic foils In this way the cooling device may be deformed in order to achieve a suitable outer cooling surface fitting within the beverage container

[0090] 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 are according to a first aspect of the present invention obtained by a cooling device, preferably a cooling bag, cooling rod or cooling container,

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, and

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

[0091] It is contemplated that the above cooling device may be provided as a stand-alone part which may be used as a cooling bag or cooling stick for cooling a variety of different objects, some of which are mentioned in the appending points Such cooling bag may constitute an alternative to the use of ice cubes, since the cooling efficiency of the cooling device will be approximately that of ice

[0092] 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 are according to a first aspect of the present invention obtained by a method of producing a cooling device according to any of the points 52-78 including the steps of arranging:

a first foil,
a second foil located opposite the first foil,
a water soluble membrane between the first and second foils
a first reactant between the first foil and the water soluble membrane,
a second reactant between the water soluble membrane and the second foil, and
a first water-filled actuator chamber located in the vicinity of the water soluble membrane

[0093] It is contemplated that the above method may be used to produce the cooling device according to the present invention in a continuous process. It is understood by the skilled person that the above method may be varied according to the specific embodiments described below

BRIEF DESCRIPTION OF THE DRAWINGS

[0094] 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,
Fig 31 is a dispensing and refrigerator system for accommodating a plurality of beverage cans

Fig 32 is a refrigerator system for accommodating a plurality of beverage cans

Fig 33 is a series of schematic drawings of a first cooling device according to the present invention before and after activation

Fig. 34 is a series of schematic drawings of a second cooling device according to the present invention before and after activation

Fig 35 is a series of schematic drawings of a third cooling device according to the present invention before and after activation

Fig 36 is a series of schematic drawings of a fourth cooling device according to the present invention before and after activation.

Fig 37 is a cooling device according to the present invention being mounted inside a beverage container

Fig 38 is a series of drawings describing alternative outer cooling surfaces of a cooling device according to the present invention

Fig 39 is a series of drawings showing a further outer cooling surface of a cooling device according to the present invention.

Fig 40 is a series of drawings showing yet a further outer cooling surface of a cooling device according to the present invention

Fig. 41 is a drawing of a cooling device having a cooling device holder

Fig 42 is a series of drawings showing the filling of a beverage container according to the present invention

Fig 43 is a perspective view of cooping device as shown in Fig 33

Fig 44 is a perspective view of a cooling device as shown in Fig 34

Fig 45 is a perspective view of a cooling device as shown in Fig. 35.

Fig. 46 is a perspective view of a cooling device as shown in Fig. 36.

Fig 47 is a manufacturing plant for manufacturing a cooling device as shown in Fig 43, and

Fig 48 is a further manufacturing plant for manufacturing a cooling device as shown in Fig 43.

Fig 49 is a perspective view of a cooling device as shown in Fig 43, wherein the cooling device is moulded to form a blister pack

DETAILED DESCRIPTION OF THE DRAWINGS

[0095] The figures illustrate numerous exemplary embodiments of a cooling device according to the present invention.

[0096] Fig. 1a shows a partial intersected view of a self-cooling container 10^1 according to the present invention The self-cooling container 10^1 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 20^1 comprises a cylinder of thin metal sheet similar to the beverage can 12, however significantly smaller in size. Alternatively, the cooling device 20^1 may constitute a laminate being made of plastic or similar polymeric material coated with thin aluminium foil 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 20^1 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 20^1 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 20^1 and the beverage can 12 has been filled The top 24 of the cooling device 20^1 seals off the interior of the cooling device 20^1 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 20^1. The interior of the cooling 20^1 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 33 and the main reactant chamber 28 The main reactant chamber 28 constitutes a greater part of the cooling device 20^1 and is filled with granulated reactants 29. The granulated reactants 29 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

[0097] 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.

[0098] The cooling device is prepared by filling the main reactant chamber 28 with the granulate reactants 29 and filling the water chamber 44 with water, then the top is attached and sealed to the cooling device 20^1 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 20^1 is not activated, since equal pressure is maintained inside the beverage can 12 and inside the cooling device 20^1

[0099] Fig. 1b shows a partial intersected view of a self-cooling container 10^1 when the beverage can 12 has been opened and the chemical reaction in the cooling device 20^1 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 20^1 More details on the chemical reaction will follow later in the description The thermal energy drawn by the cooling device 20^1 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 refrigeration 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.

[0100] Fig. 1c shows a partial intersected view of an alternative embodiment of a self-cooling container 10^1 shortly after the beverage can 12 has been opened and the chemical reaction in the cooling device 20^1 has been activated, similar to Fig 1b Fig 1c additionally shows a first close-up view showing the upper part of the reactant chamber 28 and a second close up view showing the lower part of the reactant chamber 28 From the close up views it can be seen that at the present time the water, designated by dashed lines in Fig 1c, has contacted the granulated reactants 29 of the upper part of reactant chamber 28, whereas the lower part of the reactant chamber 28 remains dry

[0101] The granulate reactants 29 have a core and a coating which is completely covering the core The granulate reactants 29 are divided up in two types: one type granulate reactants 29 has a coating of a first reactant designated 29A and a core of a second reactant designated 29B, and another type granulate reactants 29 has a coating of the first reactant designated 29A and a core of a third reactant designated 29C

[0102] In the second close-up view showing the lower part of the reactant chamber 28 the chemical reaction cannot initiate, since the cores 29B and 29C cannot interact with each other In the first close-up view showing the upper part of the reactant chamber 28 the granulate reactants 29 are subjected to water, and the coating 29c begins to deteriorate causing all three reactants 29ABC to mix and react with each other

[0103] The reactant B and C may initially react and produce a reaction product which is pacified by reacting with reactant A.

[0104] Fig 2a shows a partial intersected view of a further embodiment of a self-cooling container 10^{11} comprising all of the features of the self-cooling container 10^{1} of Fig. 1 The self-cooling container 10^{11} 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

[0105] Fig 2b shows the self-cooling container 10^{11} 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.

[0106] Fig 3a shows a self-cooling container 10^{111} similar to the self-cooling container 10^{11} shown in Fig 2 The self-cooling container 10^{111} 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

[0107] Fig 3b shows a self-cooling container 10^{111} 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^{111} in its pre-activated state, i.e. the chemical reaction is not started

[0108] Fig. 3c shows a self-cooling container 10^{111} 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

[0109] 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 film 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

[0110] 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

[0111] 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'.

[0112] 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}

[0113] 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.

[0114] 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 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

[0115] 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

[0116] 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

[0117] 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.

[0118] 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

[0119] 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 14. 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

[0120] 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

[0121] 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

[0122] 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

[0123] 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

[0124] 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.

[0125] Fig 10b shows the self-cooling container 10^{X} of Fig 10a when the beverage can 12 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

[0126] Fig 11a 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.

[0127] Fig 11b shows the self-cooling container 10^{XI} of Fig. 11a when the beverage can 12' has been opened and the cooling device 20^{XI} has been activated.

[0128] 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.

[0129] 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"

[0130] 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

[0131] 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.

[0132] 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 arc 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 eg preventing ice formation inside the beverage can 12.

[0133] 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.

[0134] 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 10^{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 figures 1-15, except that the activation is performed by a mechanical action from the outside, i.e. by pressing the button 100 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.

[0135] 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

[0136] 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 99. 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

[0137] Fig 17b and c shows a perspective view and a top view, respectively, of the self-cooling container 10^{XVI}

[0138] 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 figures 1-3

[0139] 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.

[0140] 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

[0141] 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

[0142] Fig 18d shows a beverage can 17, 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.

[0143] 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 6 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 In addition, the reactants used inside the cooling device should remain unaffected of the increased temperature and pressure, i.e. they should not combust, react, melt, boil or otherwise change their state making a later initiation of the reaction impossible or ineffective. It should also be noted that for non-pasteurised beverages, such as mineral water, the reactants should still remain unaffected up to a temperature of at least 30 to 35 degrees centigrade, which is a temperature which may be achieved during indoor or outdoor storage

[0144] 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 atmosphere, the beverage can 12 will assume atmospheric pressure of 1 bar and the cooling device 20 will activate as previously discussed in connection with figures 1-15

[0145] 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.

[0146] 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 figures 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

[0147] Fig 21a 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 13D 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

[0148] 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.

[0149] 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} which is held by a fixing rod 158 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 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

[0150] 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

[0151] 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

[0152] 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 scaling 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.

[0153] 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

[0154] 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

[0155] Fig 26a shows a bottle 164 having a bottle cap 166 and an outer cap 172 The outer cap 172 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

[0156] 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.

[0157] 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 reservoir 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.

[0158] 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

[0159] Fig 27c shows the drink stick 180 of Fig 28b when the rupturable reservoir has been ruptured and the chemical reaction has been activated

[0160] 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

[0161] 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

[0162] 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

[0163] 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 189 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

[0164] Fig 28c shows a perspective view of a bottle 164 with an attached bottle sleeve 190

[0165] 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

[0166] 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 wine cooler 192 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

[0167] Fig. 29c shows the wine cooler 192 in a perspective view

[0168] 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

[0169] 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

[0170] 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.

[0171] A variant of the cooling device may be activated by pulling a string connected to a mixing member through the cooling device

[0172] The cooling device shaped as a pipe within a pipe to cool a beverage flowing through the inner pipe with reaction compartment in the space between the inner pipe and the outer pipe

[0173] The cooling device shaped so as to be mountable around a tapping line for cooling beverage running through the tapping line.

[0174] The cooling device may have a breakable seal to avoid accidental activation.

[0175] 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

[0176] 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.

[0177] 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

[0178] 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

[0179] 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

[0180] 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

[0181] In Fig 32. a refrigerator system according to present invention is shown designated the reference numeral 200' in its entirety 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 203' through which the individual beverage cans 204 may be supported on sets of shelves 206', on which the beverage cans 204 are resting and from which the beverage cans 204 may be caught by the users after opening the refrigerator front door 202'

[0182] The refrigerator system 200' is similar to the refrigerator system 200 of Fig 31 except that the refrigerator system 200' comprises a refrigerator cabinet door 203' which is openable for exposing the interior of the refrigerator cabinet A plurality of beverage bottles, one of which is designated the reference numeral 204', and kegs, one of which is designated 204", are supported on beverage can shelves, one of which is designated the reference numeral 206' The shelves 206' replace the shutes of the system described in connection with Fig 31. 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, such as a temperature of 16°-20°C, in particular a temperature approximately at or slightly above or slightly below the ambient temperature.

[0183] 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 to the temperature at which the user is to drink or pour the beverage from the beverage can

[0184] The following figures 33-48 show some particular advantageous embodiments according to the present invention:

[0185] Fig 33a shows a schematic view of a cooling device 300^1 according to the present invention. The cooling device 300^1 comprises a first reactant chamber 302 which is filled with a first reactant 304 The cooling device 300^1 further comprises a second reactant chamber 306 located adjacent the first reactant chamber 302 The second reactant chamber 306 is filled by a second reactant 308 The first reactant 304 and the second reactant 308 should be capable of reacting with one another in a non-reversible, entropy increasing reaction as previously described, which reaction is an endothermic reaction which will draw energy from the surroundings The reactants 304, 308 are provided in the form of granulates Optionally, an anti-caking agent may be included in order to prevent the reactants from sticking together and a bitter taste compound in order for the user to detect any accidental leakage of reactants into the beverage. The first reactant chamber 302 and the second reactant chamber 306 are separated by a water soluble membrane 310. The water soluble membrane 310 is constituted by a film of a material which will dissolve when subjected to water or aqueous solutions such as beverage The water soluble membrane may comprise e g starch, water soluble metal soaps such as LiC17H35COO and Zn(C17H35COO)2, shellac, salt, or similar. The water soluble membrane 310 will as long it is not subjected to water prevent the reactants 304, 308 from reacting. The cooling device 300^I should have a flat and elongated shape such that the first reactant chamber 302 and the second reactant chamber 306 are having a large contacting surface separated by the water soluble membrane 310. The walls of the first reactant chamber 302 and the second reactant chamber 306 should be flexible, i.e. capable of transmitting pressure variations by deforming. Preferably, the whole cooling device is encapsulated within a barrier layer, such as a CO2 barrier.

[0186] The cooling device^1 further comprises an actuator 312. The actuator 312 comprises a first actuator chamber 314 and a second actuator chamber 218 The walls of the first actuator chamber 314 should be non-flexible, i.e capable of withstanding pressure variations generated by temperature variations without deforming The first actuator chamber 314 is filled with carbonated water 316 having a carbonization level corresponding to the carbonization of the beverage inside the beverage container. The beverage is consequently a carbonate beverage such as beer, soda, cola, tonic or the like The pressure inside the first actuator chamber 314 should correspond to the pressure inside the filled and sealed beverage container together with which the cooling device 300^I is to be used The pressure inside the first actuator chamber 314 therefore is about 2-3 bar in room temperature The first actuator chamber 314 is located adjacent the second actuator chamber 318 The second actuator chamber 318 is separated from the first actuator chamber 314 by a burst membrane 322 The burst membrane 322 may be a film of plastic or metal which is intended to break or rupture when the pressure difference across the membrane exceeds a predetermined value. The second actuator chamber is filled by a foam generator 320 The foam generator 320 is preferably provided in the form of a granulate The foam generator 320 should be a substance which when mixed with water generates a substantial amount of aqueous foam Example of such material is $NaC_{12}H_{23}SO_4$ Further examples are $NaC_{12}H_{23}SO_3$ and $NaC_{12}H_{23}C_6H_4SO_3$ The first actuator chamber 314 and the second actuator chamber 318 have the same elevated pressure The carbonate water 316 should be in equilibrium with the beverage The second reactant chamber 306 is located adjacent the first reactant chamber 302 and the second reactant chamber 308. The second actuator chamber 318 further comprises an optional separation membrane 324 which is located adjacent the water soluble membrane 310. The separation membrane 324 separates the second actuator chamber 318 and the first and second reactant chambers 302, 306 and thereby prevents any mixing of the reactants 304, 308 and the foam generator 320 The separation membrane 324 is a burst membrane which may be weaker than the above-mentioned burst membrane 322 In alternative embodiments the separation membrane 324 is a water soluble membrane similar to the water soluble membrane 310. It is contemplated that in some embodiments the water soluble membrane 310 and the separation membrane 324 may be constituted by a single common water soluble membrane

[0187] The cooling device 300^I shown in Fig. 33a is in a non-activated state when it is subjected to an outside pressure equal to the pressure of the carbonate water 316 The outside pressure_may e g be the pressure inside a beverage container (now shown) which is here illustrated by the inwardly arrows The outside pressure is transmitted to the burst membrane 322 either by the burst membrane 324 or by a flexible part of the second actuator chamber 318.

[0188] Fig 33b shows the cooling device 300^I of Fig. 33a when the outside pressure has been removed: The outside pressure may be removed e g. when the beverage container is being opened When the outside pressure is removed, i.e. when the cooling device 300^I is subjected to the ambient pressure of the atmosphere, the pressure within the carbonate water 316 will cause the burst membrane 322 to rupture Additionally, the optional separation membrane 324 constituting a burst membrane will rupture. The rupture of the burst membrane 322 will cause the carbonated water 316 to mix with the foam generator 320, which results in the establishment of a large quantity of foam 326 inside the actuator 312. The foam 326, which is water based, will reach the separation membrane 324 which will rupture in case it has not already ruptured In case the separation membrane is constituted by a water soluble membrane, the foam 326 will cause the separation membrane 324 to be dissolved. When the separation membrane 324 has been ruptured, the foam 326, which is water based, will continue to dissolve the water soluble membrane 310 at least partly The water soluble membrane

324 is separating the first reactant chamber 302 and the second reactant chamber 306 The dissolving of the water soluble membrane 310 will be causing the first reactant 304 to react with the second reactant 308 and thereby the cooling device 300^1 is activated. The foam 326 will continue to dissolve the water soluble membrane 310 such that after some time all of the first reactant 304 has reacted with the second reactant 308 In some embodiments the first and second reactants 302, 308 will as a reaction product generate water which will contribute to dissolve the water soluble membrane 310 In this way the foam must itself only dissolve a small portion of the water soluble membrane 310 in order to start the reaction, and consequently the actuator 312 can be made smaller A typical size of the actuator 312 is in the range of 5-10 mm As a safety feature, the reactants may include a gelling agent such as gelatine, acrosil, polyacrylate which turn the used reactants into a gel after the endothermal reaction is complete In this way any misuse of the used reactants is prevented and the beverage can may be compacted using a standard can compactor

[0189] Fig. 34a shows a cooling device 300^{II} similar to the cooling device 300^{I} of Fig 33a The cooling device 300^{II} differs from the cooling device 300^{I} of the previous embodiment in that_it includes a different actuator 312' The actuator 312' includes a second actuator chamber 318' which is filled with foam generator 320 The second actuator chamber 318' further includes a first actuator chamber 314' which is flexible and completely enclosed within the second actuator chamber 318'. The first actuator chamber 314 constitutes a non-flexible ampoule filled by carbonate water 316 having the same pressure as the surrounding beverage The first actuator chamber 314' is capable of withstanding pressure variations generated by temperature variations without deforming. The first actuator chamber 314' is further sealed off from the second actuator chamber 318' by a plug 328 The plug is preferably made of liquid metal such as a Gallium / indium bead having a melting point around 66 degrees C in order to provide high sealing properties Alternatively, a plug made of wax may be used The second actuator chamber 318' is made of flexible material and thereby the pressure acting on the second actuator chamber 318' is transmitted to the first actuator chamber 314' The pressure in the second actuator chamber 318' keeps the plug 328 fixated onto the first actuator chamber 314'.

[0190] Fig 34b shows the cooling device 300^{II} when the outside pressure has been removed, i.e when the beverage container has been opened. When the outside pressure has been removed, the pressure inside the second actuator chamber 318' will sink as well due to the flexible wall of the second actuator chamber 318' The higher pressure remaining inside the first actuator chamber 314' caused by the carbonated water 316 and the non deforming walls of the first actuator chamber 314' will cause the plug 328 to loosen from the first actuator chamber 314' thereby allowing the carbonate water 316 to enter the second actuator chamber 318' and to contact the foam generator 320 When the water 316 contacts the foam generator 320 an aqueous foam 326 will be produced, which wall dissolve the water soluble membranes 324 and 310 as described in connection with the previous embodiment

[0191] Fig 35a shows yet a further embodiment of a cooling device 300^{III} being similar to the two previous embodiments except that a further variant of an actuator 312" is used. The actuator 312" is similar to the actuator 312' of Fig. 34a and b, however, in the present embodiment the first actuator chamber 314" constituting a small bag made of a material which in itself constitutes a burst membrane 322" The first actuator chamber 314" is as in the previous embodiments filled by carbonate water 316 and pressurized to a pressure being similar to the pressure of the carbonated beverage together with which the cooling device is to be used As long as the outside pressure, indicated by arrows, is high, the pressure inside the second actuator chamber 318" will remain high and the first actuator chamber 314" will not burst

[0192] Fig 35b shows the cooling device 300^{III} when the outside pressure has been removed, i e when the beverage container has been opened When the outside pressure has been removed, the pressure inside the second actuator chamber 318" will sink and the elevated pressure within the first actuator chamber 314" will cause the burst membrane 322' to rupture and the water 316 inside the first actuator chamber to contact the foam generator 320 located within the second actuator chamber 318" The first actuator chamber 314" may in an alternative embodiment be made entirely of thin glass

[0193] Fig 36a shows a cooling device 300^{IV} similar to the previous embodiments except that yet a further alternative actuator 312"' is used The actuator 312"' is similar to the previous embodiments, except that the actuator 312"' comprises only the first actuator chamber 314"' filled by non-carbonate water 330. The second actuator chamber and the foam generator have been omitted. The wall of the first actuator chamber 314 is made of flexible material, which is a difference compared to the previously presented embodiments Further, Fig 36a shows the cooling device 300^{1V} when not subjected to an elevated pressure The cooling device 300^{IV} comprises a separation membrane 324 separating the first actuator chamber 314"' and the water soluble membrane 310. The separation membrane 324 constitutes a burst membrane similar to the burst membranes 322 presented above in connection with figures 33 to 35

[0194] Fig 36b shows the cooling device 300^{IV} when subjected to an outside pressure as shown by the arrow. When subjected to an outside pressure, the first actuator chamber 314"' will be compressed and the burst membrane 322 will rupture allowing the non-carbonated water 330 to contact the water soluble membrane 310 which as shown in the previous embodiments allows the first reactant 304 to contact the second reactant 308 thereby initiating the enthalpy increasing reaction It should be noted that the present embodiment differs from the three previous embodiments in that it is activated by an increase of outside pressure, whereas the three previous embodiments are activated by a decrease in the outside pressure The present embodiment may therefore advantageously be used together with products which are stored and low pressure such as beverages or other product packages under vacuum Yet further the_present embodiment may be used as a manually activated cooling device such as a cooling stick or cooling sleeve as previously described Such devices may be activated manually the user, e.g by applying pressure by the users hand or thumb onto the first actuator chamber 314"'

[0195] Fig 37 shows the assembly of a beverage container 334 and a cooling device 300 having an outer cooling surface 301 The cooling device 300 may be of the type previous described in connection with figures 33-36 The present cooling device 300 is presently shown having an annular shaped outer cooling surface 301. The cooling device 300 should have an external dimension so that it may be inserted through an opening 335 of the beverage container 334 The length of the outer cooling surface 301 is smaller than the length of the beverage container 344 and therefore the cooling device 300 is held in place within the container 334 by oppositely oriented supports 332, 332' which are attached to the opposing ends of the outer cooling surface 301 The support 332 constitutes a ring 331 which is adapted to be fixated around the outer cooling surface 301 and a number of legs 333 oriented away from the outer cooling surface 301 The support 332, which is oriented in an upwardly direction and is optionally having shorter legs 333 than the support 332 facing downwardly, i e in the opposite direction of the opening 335. In this way the outer cooling surface 301 may be accommodated in the upper half-space, i e near the opening 335, of the beverage container 301 Accommodating the outer cooling surface 301 in the upper half-space of the beverage container 334 will firstly allow the beverage in the upper half space, i.e. the beverage closest to the opening 335 to be cooled first, and secondly, allow a temperature difference within the beverage container which in turn will improve the convective cooling of the beverage in the lower half space of the beverage container 334, since the warm beverage near the bottom of the beverage container 334 will rise towards the cool beverage neat the top of the beverage, container 334 A lid 336 is provided for scaling of the opening 335 The lid has an removable tab 338 which may be removed for dispensing the beverage and for activating the cooling device 300.

[0196] The two reference numerals 300 and 301 for the cooling device are merely used to distinguish between the aspects relating to the internal working principle of the cooling device and the outer contact cooling surface of the cooling device, respectively

[0197] Fig. 37b shows the container 344 when the outer cooling surface 301 has been installed inside the beverage container 334 The legs 333 of the support 332 keep the outer cooling surface 301 in a proper position inside the container 334 by supporting the outer cooling surface 301 onto the inner walls of the container 334 As discussed above, the outer cooling surface 301 is preferably located closer to the lid 336 than to the opposite located bottom of the container 344 in order to cool the beverage located near the lid 336, which beverage is about to be consumed Further, by introducing a slight temperature difference inside the container the effect of convection may be improved

[0198] Fig. 38a shows an outer cooling surface 301^{I} having a toroid or tubular shape The toroid or tubular shape will allow some beverage to be accommodated within the interior space 338 within the outer cooling surface 301. In this way the outer contact surface of the cooling device to the beverage is increased An increased outer contact surface will increase the conductive cooling of the beverage compared to a cylindrical cooling device An activator 312 is located on the side surface of the outer cooling surface 301^{I}

[0199] Fig 38b shows a further embodiment of a outer cooling surface 301^{II} having a slightly different external configuration compared to the previous embodiment, however, may have a working principle according to any of the previously mentioned embodiments of a cooling device 300 The outer cooling surface 301^{II} has a spiral form allowing some beverage to be accommodated in the inner space 338'. In the present embodiment the actuator 312 is located in the centre of the outer cooling surface 301^{II}

[0200] Fig. 38c shows a cooling device 301^{III} having a corrugated outer surface, i.e a star shape, which will exhibit a significantly larger external cooling contact surface compared to a circular cylinder. The actuator 312 is located in the centre of the cooling device.

[0201] Fig 38d shows a outer cooling surface 301^{IV} having a corrugated shape or star shape and in addition an interior space 338 which will exhibit an even larger external cooling surface than the previous embodiment. All of the above-mentioned embodiments 301^{I} to 301^{IV} have an external surface which is large compared to the volume of the cooling device and thereby the cooling effect from such cooling device will be larger than a cooling device having the shape of a flat circular cylinder

[0202] Fig 39 shows a beverage container 334 which has a lid 336 and a cooling device 300 The cooling device 300 is having an outer cooling surface 301^{V} which is constituted by an elongated strip located within the beverage container 334 The strip should be flexible, but self-supporting in order to exhibit a large cooling surface The strip may preferably constitute a helix

[0203] Fig 40 shows a beverage container 334 including a cooling device 300. The cooling device 300 may be of the type presented previously in connection with Fig 1 and is having a outer cooling surface 301^{VI} having a helicoid shape extending from the bottom of the beverage container to the lid 336 of the beverage container in order to have a large contact surface with the beverage

[0204] It is contemplated that all of the cooling devices 300 may be provided in all of the above-mentioned cooling device shapes 301

[0205] Fig. 41a shows the assembling of an activator 312 and the outer cooling surface 301 of the cooling device 300. The cooling device 300 may optionally be accommodated in a holster such as the cooling device holder 340. The cooling device holder 340 may be made of a non-permeable material having barrier layer, such as a laminate bag, in order to preventing any reactant leaking from the cooling device 300 into the beverage and preventing any CO2 or beverage from leaking into the cooling device 300 The cooling device holder 340 may be a container or foil made of aluminium or the like

[0206] Fig 41b shows the assembled actuator 312 and cooling device holder 340 with the cooling device (not shown) located within the cooling device holder.

[0207] Fig 41c shows a cut view of the actuator similar to the actuator shown in connection with Fig 1a

[0208] Fig 41d shows a top cut out view of the cooling device 300 having a toroidal shape The cooling device 300 has a first reactant chamber 302 facing outwardly, a second reactant chamber 304 facing inwardly and a water soluble membrane 310 located there between separating the first reactant chamber 302 and the second reactant chamber 304

[0209] Fig 41c shaws a further embodiment of a toroid shaped cooling device 300 The cooling device 300 comprises a large number of hexahedral cells having a honeycomb structure and constituting either a first reactant chamber 302 or a second reactant chamber 304 The hexahedral cells are separated by a water soluble membrane 310 The present embodiment has the advantage that the reactants are located in a pre-mixed configuration thereby allowing a large contact surface between the reactants as soon as the water soluble membrane 310 has been dissolved allowing a quick and complete reaction between the two reactants It is further contemplated that the reactants may be provided as granulates which are individually coated by a water soluble membrane

[0210] Fig. 41g shows a further embodiment of a cooling device 300 in which a plurality of first and second reactant chambers are located one above the other in a layered structure and separated by a plurality of water soluble membranes 310 extending in a radial direction

[0211] Fig 42a shows the flushing of a beverage container 334 before filling with beverage To prevent any oxygen from remaining inside the beverage container 334 before filling, a flushing pipe 342 is inserted into the beverage container 334 and the beverage container 334 is flushed by carbon dioxide as indicated by the arrows in the figure

[0212] Fig. 42b shows the filling of the beverage container 334 by beverage 346 After flushing, a filling pipe 344 is inserted into the beverage container 334 and a suitable amount of beverage is let into the beverage container 334 A suitable amount should still allow a small head space 347 to be present when the outer contact surface 301 of the cooling device 300 is accommodated inside the filled beverage container 334. The flushing and filling may be performed in a normal high speed filling machine

[0213] Fig. 42c shows a pressure lock 348 and a filling station 354 Before entering the filling station 354, the beverage container 344 is stored inside the pressure lock 348 The beverage container 334 comprises a beverage 346 and a head space 347 The volume of the head space 347 should be no less than the total volume of the cooling device 300 in order to eliminate any spillage The pressure lock 348 comprises a first door 350 through which the beverage container is introduced and a second door 352 through which the beverage container enters the filling station 354 After the beverage container 334 has been accommodated inside the pressure lock 348, both the first door and the second door are kept closed and the pressure is increased within the pressure lock from ambient pressure to an elevated pressure corresponding to the carbonization pressure of the beverage

[0214] Inside the filling station 354 a cooling device 300 is located fixated within a guide tube 356 The guide tube 356 holds the legs of the support in a contracted state, which corresponds to the width of the opening of the beverage container 334 A lid 336 is located above the cooling device 300

[0215] Fig. 42d shows the filling station 354 when the cooling device 300 has been released into the beverage container 334 When the cooling device 300 enters the beverage container 334, the legs of the support 332 will expand and fixate the cooling device 300 inside the beverage container 334

[0216] Fig 42e shows a pasteurization station 356 The pasteurization station 356 is filled with hot water 357 of a temperature of about 72 degrees C in order to kill a substantial amount of the microorganisms within the beverage. Due to the temperature increase of the pasteurization the pressure inside the beverage container 334 will increase as well The temperature dependent pressure increase does not however affect the actuator (not shown) of the cooling device 300 since the temperature of the actuator will be roughly the same as the temperature of the beverage The pressure inside the actuator of the cooling device 300 will therefore increase roughly by the same amount as the pressure outside the cooling device due to the presence of carbonated water inside the actuator of the cooling device 300 The actuator will thus not be affected by pasteurization or similar temperature dependent pressure changes

[0217] Fig 42f shows the beverage container 334 including the cooling device 300 when ready to be shipped to the consumer

[0218] Fig. 43a shows a cooling device 300^{I} during manufacture. The manufacture of the cooling device 300^{1} may be a continuous process The cooling device 300^{I} comprises the first foil 358 of a flexible plastic material, the water soluble membrane 310 in the form of a film or sheet located below the first foil and the second foil 360 of a flexible plastic material located below the water soluble membrane 310 The water soluble membrane 310 has a slightly smaller width that the first foil 358 and the second foil 360, which foils completely enclose the water soluble membrane 310 The space between the first foil 358 and the water soluble membrane 310 is filled by the first reactant 304 and the space between the water soluble membrane 310 and the second foil 360 is filled by the second reactant 308. The reactants 304, 308 are provided in the form of granulates Alternatively, the reactants 304, 308 may be provided in the form of rods, plates or blocks

[0219] The actuator 312 is located near one edge of the cooling device 300^{I}, at which end no reactants are provided The first foil 358 and the second foil 360 also cover the actuator 312 located near one edge of the cooling device 300^{I} The actuator 312 comprises the second actuator chamber 318 which is filled by foam generator 320. The second actuator chamber 318 is separated from the first and second reactants 304, 308 and from the water soluble membrane 310 by a separation membrane 324, constituting a weak burst membrane The second actuator chamber is further separated from the first actuator chamber 334 by a burst membrane 322 The first actuator chamber 314 is filled by carbonated water 316 having a carbonization pressure substantially being equal to that of carbonated beverage The first actuator chamber 314 is covered by a first reinforcing foil and an opposite second reinforcing foil 462, 464 in order to increase the stiffness of the first actuator chamber 314 such that the first actuator chamber 314 is less flexible and may withstand higher pressures without deforming compared to the rest of the cooling device 300^{I}

[0220] Fig 43b shows a cut out side view of the cooling device 300^{I} in a non-activated state in which the actuator 312 is subjected to a pressure substantially equal to the pressure within the beverage container (not shown) being the pressure of carbonated beverage in equilibrium

[0221] Fig 43c shows the cooling device 300^{I} when the actuator 312 has been activated by reducing the pressure outside the actuator 312 to about 1 atmosphere pressure, e.g by opening the beverage container (not shown). The pressure difference between the outside and the inside of the first actuator chamber 314 of the actuator 312 being sufficient to breaking the burst membrane 322 and allowing the water within the first actuator chamber 314 to mix with the foam generator 320 as described previously. The foam will subsequently penetrate the separation membrane 324 and dissolve the water soluble membrane 310 allowing the reactants 304, 308 to react.

[0222] Fig 44a shows the cooling device 300^{II} being similar to the previously described embodiment except that the first actuator chamber 314' constitutes an ampoule of carbonated water 316 which is sealed by a plug (not shown) The first actuator chamber is thus located within the second actuator chamber 318'

[0223] Fig. 44b shows a side cut out view of the cooling device 300^{II} in a non-activated state in which the pressure inside and outside the first actuator chamber 314' is substantially equal and the plug (not shown) seals the first actuator chamber 314'

[0224] Fig 44c shows a side cut out view of the cooling device 300^{II} in an activated state in which the pressure outside the first actuator chamber 314' is reduced and the pressure inside the first actuator chamber 314' causes the plug (not shown) to be ejected

[0225] Fig 45a shows a cooling device 300^{III} being similar to the previous embodiment presented in connection with Fig 44 and having the first actuator chamber 314" completely encapsulated within the second actuator chamber 318", however, instead of the first actuator chamber 314 constituting an ampoule having a plug, the first actuator chamber 314" of the present embodiment constitutes a bag or ampoule made of a rupturable membrane material. The material may e.g. be glass

[0226] Fig 45b shows the cooling device 300^{III} in a non-activated state in which the pressure inside and outside the first actuator chamber 314" is substantially equal

[0227] Fig 45c shows a side cut out view of the cooling device 300^{II} in an activated state in which the pressure outside the first actuator chamber 314" is reduced and the pressure inside the first actuator chamber 314" causes the first actuator chamber 314" to rupture, allowing the water inside the first actuator chamber 314" to contact the foam generator 320.

[0228] Fig 46a shows the cooling device 300^{IV} in which the second activator chamber has been omitted and the first actuator chamber 314"' is separated from the water soluble membrane 310 by the burst membrane 324

[0229] Fig. 46b shows the cooling device 300 in a non-activated state in which the first actuator chamber 314" is non-compressed

[0230] Fig 46c shows the cooling device 300 in an activated state in which the first actuator chamber 314" is compressed, the burst membrane 324 has been ruptured due to the increased pressure in the first actuator chamber 314" and water is dissolving the water soluble membrane 310 separating the reactants

[0231] Fig 47 shows a production plant 365 for producing the cooling device 300^{I} The production plant comprises the first foil 358 and the second foil 360 being continuously provided from respective rolls A first reactant dispenser 366 applies a layer of the first reactant 304 onto the first foil 358 and a second reactant dispenser 368 applies a layer of the second reactant 308 onto the second foil 360 A part of the first and second foils 358, 360 which is intended to form the actuator are not provided with reactants. Two respective rollers both designated the reference numeral 370 are thereafter compressing and fixating the first and second reactants 304, 308 on the respective first and second foils 358, 360

Subsequently, the first and second foils 358, 360 are juxtaposed such that the first and second reactants 304, 308 are facing each other and a foil of water soluble membrane 310 is positioned between the first and second reactants 304, 308. Subsequently, melder rolls 372 weld the first foil and the second foil together forming the reactant chambers 302, 306 and actuator chambers 314, 318 A foam generator dispenser 376 fills an amount of foam generator into the second activator chamber 318 and a water dispenser 374 fills an amount of carbonate water into the first activator chamber 314 Finally, a die 378 is used to shape and seal the first and second activator chambers 314, 318 The manufacture and subsequent storage of the cooling device 300^1 should be performed under an elevated pressure corresponding to the pressure of carbonated beverage such as 2 or 3 bar above the ambient atmospheric pressure for avoiding a premature activation of the cooling device 300^I

[0232] The burst membranes may be achieved by allowing the welds between the first and Second activator chambers 314, 318 and between the second activator chamber 318 and the water soluble membrane 310 will have predetermined breaking points which will open during activation Such predetermined breaking points may be achieved by welding of two materials which are not fully compatible, i.e which form a weld having less strength than the surrounding foil material. A first reinforcing foil and a second reinforcing foil may optionally be put on top of the first foil 358 and the second foil 360 Alternatively, the foils 358 360 may be pre-reinforced at the location of the first actuator chamber

[0233] Fig 48 shows a perspective view of an alternative manufacturing plant 365'. The alternate manufacturing plant 365 is similar to the manufacturing plant 365 of Fig. 47, however, the first and second reactants are provided from rolls 366' 368' in the form of pre-manufactured foils Further, the foam generator is provided from a roll 376' in the form of a pre-manufactured foil In this way the manufacturing plant may be build more compact since some rollers may be omitted

[0234] Fig 49 shows a perspective view of a variant of the cooling device 300^I during manufacture The alternate cooling device 300^I is similar to the cooling device 300^I of Fig 43, however, the first and second foils 358, 360 form a blister pack, i e the second foil 360 is flat and non-flexible, while the first foil 358 is flexible and defines cavities for storing the reactants, water and foam generator

[0235] Although the invention has above been described with reference to a number of specific and advantageous embodiments of beverage containers, beverage cans, battles, 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 figures 1-32

[0236]

10 Self-cooling beverage container	84 Separation element
12 Beverage can	86 Auxiliary cap
14 Beverage can base	88 Auxiliary cap seat
16 Lid	89 Main plug
18 tab	90 Plug seat
20 Cooling device	92 Auxiliary plug
22 Bottom	94 Auxiliary plug seat
24 Top	96 Insulating carrier
26 Gas permeable membrane	97 Inner cavity
28 Main reactant chamber	98 Bulges
30 Flexible diaphragm	99 Spacer
31 Support diaphragm	100 Activation button
32 Pressure space	102 Ventilation hose
34 Rounded circumferential reinforcement bead	103 Filling hose

(continued)

36 Washer	104 Lid flange
38 Rigid cup-shaped wall	106 Pasteurisation plant
40 Circular wall	110 Party keg system
42 Circumferential gripping flange	112 Housing
44 Water chamber	114 Upper space
46 Auxiliary cup-shaped wall	116 Lower space
48 Auxiliary gripping flange	118 Closure
50 Auxiliary reactant chamber,	120 Beverage keg
52 Pressure inlet	122 Opening
54 Rupturable diaphragm	123 Fixation flange
56 Piercing element	124 Tapping line
58 Corrugation	126 Tapping valve
60 Main cap	127 Beverage tap
62 Main cap seat	128 Gasket
66 Support mesh	130 Pressure generator
68 Telescoping valve	132 Pressurization hose
69 First valve element	134 Pressurization knob
70 Second valve element	136 Fluid inlet
71 Third valve element	138 Check valve
72 Valve apertures	140 Beverage dispensing system
74 Support	142 Enclosure
76 Descending pipe	144 Base plate
78 Water soluble diaphragm	146 Pressure chamber
80 Upper rigid cylinder part	148 Pressure lid
81 Lower rigid cylinder part	150 Sealing
82 Intermediate flexible cylinder	152 Coupling flange
83 Gripping member	154 Tapping handle
156 Cooling and pressurization generator	191 Second groove
158 Fixing rod	192 Wine cooler
160 Activation channel	193 Outer layer
162 Dual sealing membrane	194 Inner layer
164 Bottle	195 Cubic crystal
166 Bottle cap	196 Crystal face
168 Treading	197 Crystal growth
170 Cap flange	198 Corner
172 Outer cap	208 Refrigerator unit
174 Intermediate diaphragm	210 heater unit
176 Toothed rod	212 Dispensing aperture
180 Drink stick	216 Dispensing chute

(continued)

182 Knob	199 Deposit
184 Elongated flexible reservoir	200 dispensing and refrigerator system
186 Rupturable reservoir	202 refrigerator cabinet
188 Bottle sleeve	204 beverage cans
189 Fixation ring	206 sliding chutes
190 First groove	

List of parts with reference to figures 33-48:

[0237]

300 Cooling device	340 Cooling device holder
301 Outer surface of cooling device	342 Flushing pipe
302 First reactant chamber	344 Filling pipe
304 First reactant	346 Beverage
306. Second reactant chamber	347 Head space
308 Second reactant	348 Pressure lock
310 Water soluble membrane	350 First door
312 Actuator	352 Second door
314 First actuator chamber	354 Filling station
316 Carbonate water	355 Guide tube
318 Second actuator chamber	356 Pasteurization plant
320 Foam generating granulates	357 Hot water
322 Burst membrane	358 First foil
324 Water soluble membrane	360 Second foil
326 Foam	362. First reinforcing foil
328 Plug	364 Second reinforcing foil
330 Non-carbonated water	365 Production plant
331 Ring	366 First reactant dispenser
332 Support	368 Second reactant dispenser
333 Legs	370 Roller
334 Beverage container	372 Welder
335 Opening	374 Water dispenser
336 Lid	376 Foam generator dispenser
338 Inner space	378 Die

TABLE 1

Reactant 1	Reactant 2	Reactant 3	Reactant 4	Measured cooling per gram of coolant [l/g]
Na_2SO_4, $10H_2O$	$MgCl_2$, $6H_2O$			92

(continued)

Reactant 1	Reactant 2	Reactant 3	Reactant 4	Measured cooling per gram of coolant [l/g]
Na_2SO_4, $10H_2O$	$CaCl_2$, $6H_2O$			148
Na_2SO_4, $10H_2O$	$SrCl_2$, $6H_2O$			141
Na_2SO_1, $10H_2O$	$Mg(NO_3)_2$, $6H_2O$			106
Na_2SO_4, $10H_2O$	$Ca(NO_3)_2$, $4H_2O$			172
Na_2SO_4, $10H_2O$	$LiNO_3$			126
Na_2SO_4, $10H_2O$	$LiNO_3$. $3H_2O$			-
Na_2SO_4, $10H_2O$	$Sr(NO_3)$, $5H_2O$			-
$MgSO_4$, $7H_2O$	$Ca(NO_3)_2$, $4H_2O$			49
$MgSO_4$, $7H_2O$	$SrCl_2$, $6H_2O$			-
$KAl(SO_4)_2$, $12H_2O$	$CaCl_2$, $6H_2O$			88
$NaAl(SO_4)_2$, $12H_2O$	$CaCl_2$, $6H_2O$			-
$NH_4Al(SO_4)_2$, $12H_2O$	$Ca(NO_3)_2$, $4H_2O$			-
$ZnSO_4$, $7H_2O$	$CaCl_2$, $6H_2O$			84
Na_2CO_3, $10H_2O$	$Mg(NO_3)_2$, $6H_2O$			119
Na_2CO_3, $10H_2O$	NH_4Cl			240
Na_2CO_3, $10H_2O$	NH_4SCN			-
Na_2CO_3, $10H_2O$	NH_4NO_3			-
$Ba(OH)_2$, $8H_2O$	NH_4SCN			-
$Sr(OH)_2$, $8H_2O$	NH_4NO_3			190
$Sr(OH)_2$, $8H_2O$	NH_4Cl			181
$Sr(OH)_2$, $8H_2O$	NH_4NO_3	$Mg(NO_3)_2$, $6H_2O$		183
$Sr(OH)_2$, $8H_2O$	NH_4NO_3	Glysine		173
$Sr(OH)_2$, $8H_2O$	NH_4NO_3	$NaHCO_3$		176
$Sr(OH)_2$, $8H_2O$	$LiOH\ H_2O$	NH_4NO_3		195
$Sr(OH)_2$, $8H_2O$	NH_4SCN			183
$Sr(OH)_2$, $8H_2O$	NH_4NO_3	Na_2SiO_3, $9H_2O$	H_3BO_3	204
Na_2SiO_3, $9H_2O$	NH_4NO_3	$Sr(OH)_2$, $8H_2O$		218
Na_2SiO_3, $9H_2O$	NH_4Cl	$Sr(OH)_2$, $8H_2O$		-
Na_2SiO_3. $9H_2O$	NH_4NO_3	$Sr(OH)_2$, $8H_2O$	NH_4SCN	-
Na_2SiO_3. $9H_2O$	NH_4Cl	$Sr(OH)_2$. $8H_2O$	NH_4SCN	-
Na_2SiO_3 $9H_2O$	NH_4Cl	$Sr(OH)_2$, $8H_2O$	$NH_4Al(SO4)_2$, $12H_2O$	-
Na_2SiO_3, $9H_2O$	NH_1NO_3	$Mg(NO_3)_2$, $6H_2O$		155
Na_2 SiO_3, $9H_2O$	NH_4NO_3	$Ca(NO_3)_2$, $4H_2O$		128
Na_2 SiO_3. $9H_2O$	NH_4SCN			235
Na_2 SiO_3, $9H_2O$	$MgSO_4$, $7H_2O$	NH_4NO_3		198
KH_2PO_4	$CaCl_2$, $6H_2O$			27
Na_2HPO_4, $12H_2O$	$CaCl_2$, $6H_2O$			153

(continued)

Reactant 1	Reactant 2	Reactant 3	Reactant 4	Measured cooling per gram of coolant [l/g]
NaH_2PO_4, $2H_2O$	$CaCl_2$, 6H20			-
$NaHCO_3$	Citric acid	H_2O		102
$Ca(NO_3)_2$, $4H_2O$	Oxalic acid	$NaHCO_3$		147
$Ca(NO_3)_2$, $4H_2O$	Oxalic acid	$KHCO_3$		-
$Ca(NO_3)_2$, $4H_2O$	Citric acid	$NaHCO^3$		-

Table 2:

Reactant	-	Cooling per mol [kCal/gmol]
NH4 Cl	-	3,82
(NH4), S04, H2O	-	4,13
H3BO3	-	5,4
CaCl2, 6H2O	-	4,11
Ca(NO3)2, 4H2O	-	2,99
Fe(NO3)2, 9H2O	-	9,1
LiCl, 3H2O	-	1,98
Mg(NO3), 6H2O	-	3,7
MgSO4, 7H2O	-	3,18
Mn(NO3)2, 6H2O	-	6,2
K Al(SO4),12H2O	-	10,1
K Cl	-	4,94
KI	-	5,23
KNO3	-	8,633
K2C2O4	-	4,6
K2C2O4, H2O	-	7,5
K2S2O5, 1/2142O	-	10,22
K2S2O5	-	11,0
K2SO4	-	6,32
K2S206	-	13,0
K2S2O3	-	4,5
Na2B4O7, 10H2O	-	16,8
Na2CO3, 7H2O	-	10,81
Na2CO3, 10H2O	-	16,22
Mal, 2H2O	-	3,89
NaNO3	-	5,05
NaN02	-	3,6
Na3 PO_4, 12H2O	-	15,3
Na HPO4, 7H2O	-	12,04

(continued)

Reactant	-	Cooling per mol [kCal/gmol]
Na2 HPO4, 12H2O	-	23,18
Na4, P2O7, 10H2O	-	11,7
Na2 H2P2O7, 6H2O	-	14,0
Na2SO3, 7H2O	-	11,1
Na2S2O6, 2H2O	-	11,86
Na2S203,5H2O	-	11,30
Sr(NO3)2, 4H2O	-	12,4
Zn(NO3)2, 6H2O	-	6,0
Acetylurea C2H6N2O2	-	6,812
Benzoic Acid	-	6,501
Oxalic Acid	-	8,485
Raffinose C18H32O161 5H2O	-	9,7
Kaliumtartrat, 4H2O	-	12,342
Urea Oxalat	-	17,806

POINTS CHARACTERIZING THE INVENTION:

[0238]

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 ± 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

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 bev-

erage 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 $LiNO_3 \cdot 3H_2O$, $Na_2SO_4 \cdot 10H_2O$ (Glauber salt), $Na_2SO_4 \cdot 7H_2O$, $Na_2CO_3 \cdot 10H_2O$, $Na_2CO_3 \cdot 7H_2O$, $Na_3PO_4 \cdot 12H_2O$, $Na_2HPO_4 \cdot 12H_2O$, $Na_4P_2O_7 \cdot 10H_2O$, $Na_2H_2P_2O_7 \cdot 6H_2O$, $NaBO_3 \cdot 4H_2O$, $Na_2B_4O_7 \cdot 10H_2O$, $NaClO \cdot 5H_2O$, $Na_2SO_3 \cdot 7H_2O$, $Na_2S_2O_3 \cdot 5H_2O$, $NaBr \cdot 2H_2O$, $Na_2S_2O_6 \cdot 6H_2O$, $K_3PO_4 \cdot 3H_2O$, preferably $MgCl_2 \cdot 6H_2O$, $MgBr_2 \cdot 6H_2O$ $MgSO_1 \cdot 7H_2O$, $Mg(NO_3)_2 \cdot 6H_{2O}$, $CaCl_2 \cdot 6H_2O$, $CaBr_2 \cdot 6H_2O$, $Ca(NO_3)_2 \cdot 4H_2O$, $Sr(OH)_2 \cdot 8H_2O$, $SrBr_2 \cdot 6H_2O$, $SrCl_2 \cdot 6H_2O$, $Sr(NO_3)_2 \cdot 4H_2O$, $SrI_2 \cdot 6H_2O$, $BaBr_2 \cdot 2H_2O$, $BaCl_2 \cdot 2H_2O$, $Ba(OH)_2 \cdot 8H_2O$, $Ba(BrO_3)_2 \cdot H_2O$, $Ba(ClO_3)_2 \cdot H_2O$, $CrK(SO_4)_2 \cdot 12H_2O$, $MnSO_4 \cdot 7H_2O$, $MnSO_4 \cdot 5H_2O$, $MnSO_4 \cdot H_2O$, $FeBr_2 \cdot 6H_2O$, $FeBr_3 \cdot 6H_2O$, $FeCl_2 \cdot 4H_2O$, $FeCl_3 \cdot 6H_2O$, $Fe(NO_3)_3 \cdot 9H_2O$, $FeSO_4 \cdot 7H_2O$, $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$, $FeNH_4(SO_4)_2 \cdot 12H_2O$, $CoBr_2 \cdot 6H_2O$, $CoCl_2 \cdot 6H_2O$, $NiSO_4 \cdot 6H_2O$, $NiSO_4 \cdot 7H_2O$, $Cu(NO_3)_2 \cdot 6H_2O$, $Cu(NO_3)_2 \cdot 3H_2O$, $CuSO_4 \cdot 5H_2O$, $Zn(NO_3)_2 \cdot 6H_2O$, $ZnSO_4 \cdot 6H_2O$, $ZnSO_4 \cdot 7H_2O$, $Al_2(SO_4)_3 \cdot 18H_2O$, $AlNH_4(SO_4)_2 \cdot 12H_2O$, $AlBr_3 \cdot 6H_2O$, $AlBr_3 \cdot 15H_2O$, $AlK(SO_4)_2 \cdot 12H_2O$, $Al(NO_3)_3 \cdot 9H_2O$, $AlCl_3 \cdot 6H_2O$ 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 nan-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 33-44, 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 $LiNO_3{\cdot}3H_2O$, $Na_2SO_4{\cdot}10H_2O$ (Glauber salt), $Na_2SO_4{\cdot}7H_2O$, $Na_2CO_3{\cdot}10H_2O$, $Na_2CO_3{\cdot}7H_2O$, $Na_3PO_4{\cdot}12H_2O$, $Na_2HPO_4{\cdot}12H_2O$, $Na_4P_2O_7{\cdot}10H_2O$, $Na_2H_2P_2O_7{\cdot}6H_2O$, $NaBO_3{\cdot}4H_2O$, $Na_2B_4O_7{\cdot}10H_2O$, $NaClO_4{\cdot}5H_2O$, $Na_2SO_3{\cdot}7H_2O$,

$Na_2S_2O_3 \cdot 5H_2O$, $NaBr \cdot 2H_2O$, $Na_2S_2O_6 \cdot 6H_2O$, $K_3PO_4 \cdot 3H_2O$ preferably $MgCl_2 \cdot 6H_2O$, $MgBr_2 \cdot 6H_2O$ $MgSO_4 \cdot 7H_2O$, $Mg(NO_3)_2 \cdot 6H_2O$, $CaCl_2 \cdot 6H_2O$, $CaBr_2 \cdot 6H_2O$, $Ca(NO_3)_2 \cdot 4H_2O$, $Sr(OH)_2 \cdot 8H_2O$, $SrBr_2 \cdot 6H_2O$, $SrCl_2 \cdot 6H_2O$, $Sr(NO_3)_2 \cdot 4H_2O$, $SrI_2 \cdot 6H_2O$, $BaBr_2 \cdot 2H_2O$, $BaCl_2 \cdot 2H_2O$, $Ba(OH)_2 \cdot 8H_2O$, $Ba(BrO_3)_2 \cdot H_2O$, $Ba(ClO_3)_2$ H_2O, $CrK(SO_4)_2 \cdot 12H_2O$, $MnSO_4 \cdot 7H_2O$, $MnSO_4 \cdot 5H_2O$, $MnSO_4 \cdot H_2O$, $FeBr_2 \cdot 6H_2O$, $FeBr_3 \cdot 6H_2O$, $FeCl_2 \cdot 4H_2O$, $FeCl_3 \cdot 6H_2O$, $Fe(NO_3)_3 \cdot 9H_2O$, $FeSO_4 \cdot 7H_2O$, $Fc(NH_4)_2(SO_4)_2 \cdot 6H_2O$, $FeNH_4(SO_4)_2 \cdot 12H_2O$, $CoBr_2 \cdot 6H_2O$, $CoCl_2 \cdot 6H_2O$, $NiSO_4 \cdot 6H_2O$, $NiSO_4 \cdot 7H_2O$, $Cu(NO_3)_2 \cdot 6H_2O$, $Cu(NO_3)_2 \cdot 3H_2O$, $CuSO_4 \cdot 5H_2O$, $Zn(NO_3)_2 \cdot 6H_2O$, $ZnSO_4 \bullet 6H_2O$, $ZnSO_4 \bullet 7H_2O$, $Al_2(SO_4)_3 \bullet 18H_2O$, $AlNH_4(SO_4)_2 \bullet 12H_2O$, $AlBr_3 \bullet 6H_2O$, $AlBr_3 \bullet 15H_2O$, $AlK(SO_4)_2 \bullet 12H_2O$, $Al(NO_3)_3 \bullet 9H_2O$, $AlCl_3 \bullet 6H_2O$ and/or $LaCl_3 \bullet 7H_2O$.

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 bottle or the body part of 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 nan-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.

52 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, substantiate 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 front 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 min ,
said cooling device defining an outer cooling surface contacting said bevererage and further including an actuator for initiating said reaction between said at least two separate, substantially non-toxic reactants, and
said inner chamber defining an inner top half space containing beverage and an inner bottom half space containing beverage, any point within said top half space defining a maximum distance A to an adjacent point on said outer cooling surface, said maximum distance A being of the order of 0 cm-20 cm, such as 0.5 cm-1.5 cm, preferably approximately 1.0 cm

53 The container according to point 52, wherein any point within said bottom half space defining said maximum distance A to an adjacent point on said outer cooling surface, or, preferably, wherein any point within said inner chamber defining said maximum distance A to an adjacent point on said outer cooling surface

54 The container according to any of the points 52-53, wherein said inner chamber defines an inner surface, said outer cooling surface defining an area being at least 3 times the area of said inner surface, preferably at least 4 times the area of said inner surface, such as 5 times the area of said inner surface.

55 The container according to any of the points 52-54, wherein said cooling device defining an interior beverage space at least partly enclosed by said outer cooling surface, said interior beverage space defining a transversal dimension between adjacent points of said outer surface, said transversal dimension defining a maximum distance of 2A

56 The container according to any of the points 52-55, wherein said outer surface of said cooling device defines a top surface, a bottom surface and a substantially cylindrical surface encosing said top and bottom surfaces

57 The container according to any of the points 52-55, wherein said outer surface of said cooling device defines a top surface, a bottom surface and a corrugated surface enclosing said top and bottom surfaces.

58 The container according to any of the points 52-55, wherein said outer surface of said cooling device defines a top surface, a bottom surface and an intermediate surface enclosing said top and bottom surfaces, said intermediate surface having an annular shape, a helical shape, a helicoid shape or a spiral-shape

59 The container according to any of the points 52-58, wherein said at least two separate substantially non-toxic reactants initially being included in said cooling device are separated from one another by a water soluble membrane and said actuator including a first actuator chamber being filled by water or an aqueous solution equivalent to said beverage.

60 The container according to point 59, wherein said first actuator chamber is flexible, deformable and separated from said water soluble membrane by a pressure activated seal, said cooling device initially being kept at a low pressure and said reaction being initiated when said pressure activated seat being ruptured when the pressure inside said first actuator chamber is increased above a specific high pressure, said low pressure typically being atmospheric pressure or below, said specific high presure typically being atmospheric pressure or above

61 The container according to points 59, wherein said first actuator chamber is capable of withstanding pressure variations while said first actuator chamber is closed, said actuator further including a second actuator chamber being filled with a foam generating materials said second actuator chamber being located between said first actuator chamber and said water soluble membrane and separated from said first actuator chamber by a pressure activated seal, said second actuator chamber preferably being separated from said water soluble membrane by one or more pressure activated seals

62 The container according to point 61, wherein said beverage is a carbonated beverage and said first actuator chamber is filled by gasified water or a gasified aqueous solution equivalent to said beverage, typically constituting carbonated water, said cooling device initially being kept at a high pressure and said reaction being initiated when said pressure activated seal being ruptured when the pressure outside of said first actuator chamber is decreased below a specific low pressure, said high pressure typically being the pressure of_the carbonated beverage such as 2-3 bars whereas said specific low pressure typically being atmospheric pressure.

63 The container according to any of the points 61-62, wherein said first actuator chamber comprises a substantially

rigid ampoule being encapsulated within said second actuator chamber

64 The container according to any of the points 60-63, wherein said pressure activated seal comprises a burst membrane or alternatively a plug, advantageously a plug of liquid metal such as alloys including Gallium and/or Indium.

65 The container according to any of the points 59-64, wherein said water soluble membrane is configured in a layered structure or alternatively in a honeycomb structure or yet alternatively as a coating

66 The container according to any of the preceding points, wherein said cooling device is manufactured at least partly of plastic foils

67 A cooling device, preferably a cooling bag, cooling rod or cooling container,
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, and
said cooling device further including an actuator for initiating said reaction between said at least two separate, substantial non-toxic reactants.

68 The cooling device according to point 67, wherein said at least two separate substantially non-toxic reactants initially being included in said cooling device separated front one another by a water soluble membrane and said actuator including a first actuator chamber being filled by water or an aqueous solution equivalent to said beverage

69 The cooling device according to any of the points 67-68, wherein said first actuator chamber is flexible, deformable and separated from said water soluble membrane by a pressure activated seal, said cooling device initially being kept at a low pressure and said reaction being initiated when said pressure activated seal being ruptured when the pressure inside of said first actuator chamber is increased above a specific high pressure, said low pressure typically being atmospheric pressure or below, said specific high presure typically being atmospheric pressure or above

70 The cooling device according to any of the points 67-68, wherein said first actuator chamber is capable of withstanding pressure variations white said first actuator chamber is closed, said actuator further including a second actuator chamber being filled with a foam generating material, said second actuator chamber being located between said first actuator chamber and said water soluble membrane and separated from said first actuator chamber by a pressure activated seal, said second actuator chamber preferably being separated from said water soluble membrane by one or more pressure activated seals

71 The cooling device according to point 70, wherein said first actuator chamber is filled by gasified water, such as carbonated water, said cooling device initially being kept at a high pressure and said reaction being initiated when said pressure activated seal being ruptured when the pressure outside of said first actuator chamber is decreased below a specific low pressure, said high pressure typically being the pressure of the carbonated beverage such as 2-3 bar whereas said specific low pressure typically being atmospheric pressure.

72 The cooling device according to any of the points 69-71, wherein said pressure activated seal comprises a burst membrane

73 The cooling device according to any of the points 69-71, wherein said pressure activated seal comprises a plug, advantageously a plug of liquid metal such as alloys including Gallium and/or Indium.

74 The cooling device according to any of the points 70-7.3, wherein said first actuator chamber comprises a substantially rigid ampoule located encapsulated within said second actuator chamber

75 The cooling device according to any of the points 68-74, wherein said water soluble membrane is configured in layered structure or alternatively in a honeycomb structure or yet alternatively as a coating

76 The cooling device according to any of the points 68-74, wherein said coaling device is manufactured of plastic foils

77 The cooling device according to any of the points 67-76, wherein said cooling device constitutes a cooling bag suitable for the treatment of sports injuries, or, a cooling rod for use in drinks, or, a cooling container for prolonging the pot life of two component glue or paint

78 A method of producing a cooling device according to any of the points 52-78 including the steps of arranging:

a first foil,
a second foil located opposite said first foil,
a water soluble membrane between said first and second foils
a first reactant between said first foil and said water soluble membrane,
a second reactant between said water soluble membrane and said second foil, and
a first water-filled actuator chamber located in the vicinity of said water soluble membrane.

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 ,
said cooling device defining an outer cooling surface contacting said bevererage and further including an actuator for initiating said reaction between said at least two separate, substantially non-toxic reactants, and
said inner chamber defining an inner top half space containing beverage and an inner bottom half space containing beverage, any point within said top half space defining a maximum distance A to an adjacent point on said outer cooling surface, said maximum distance A being of the order of 0.5 5 cm-2 0 cm, such as 0.5 cm-1.5 cm, preferably approximately 10 cm.

2. The container according to claim 1, wherein any point within said bottom half space defining said maximum distance A to an adjacent point on said outer cooling surface, or, preferably, wherein any point within said inner chamber defining said maximum distance A to an adjacent point on said outer cooling surface

3. The container according to any of the claims 1-2, wherein said inner chamber define an inner surface, said outer cooling surface defining an area being at least 3 times the area of said inner surface, preferably at least 4 times the area of said inner surface, such as 5 times the area of said inner surface

4. The container according to any of the claims 1-3, wherein said cooling device defining an interior beverage space at least partly enclosed by said outer cooling surface, said interior beverage space defining a transversal dimension between adjacent points of said outer surface, said transversal dimension defining a maximum distance of 2A.

5. The container according to any of the claims 1-4, wherein said outer surface of said cooling device define a top surface, a bottom surface and a substantially cylindrical surface encosing said top and bottom surfaces

6. The container according to any of the claims 1-4, wherein said outer surface of said cooling device define a top surface, a bottom surface and a corrugated surface enclosing said top and bottom surfaces

7. The container according to any of the claims 1-4, wherein said outer surface of said cooling device define a top surface, a bottom surface and an intermediate surface encosing said top and bottom surfaces, said intermediate surface having an annular shape, a helical shape, a helicoid shape or a spiral-shape

8. The container according to any preceding claim, wherein said at least two separate substantially non-toxic reactants initially being included in said cooling device are separated from one another by a water soluble membrane and said actuator including a first actuator chamber being filled by water or an aqueous solution equivalent to said beverage

9. The container according to claim 8, wherein said first actuator chamber is flexible, deformable and separated from said water soluble membrane by a pressure activated seal, said cooling device initially being kept at a low pressure and said reaction being initiated when said pressure activated seal being ruptured when the pressure inside said first actuator chamber is increased above a specific high pressure, said low pressure typically being atmospheric pressure or below, said specific high presure typically being atmospheric pressure or above

10. The container according to any of the claims 8, wherein said first actuator chamber is capable of withstanding pressure variations while said first actuator chamber is closed, said actuator further including a second actuator chamber being filled with a foam generating material, said second actuator chamber being located between said first actuator chamber and said water soluble membrane and separated from said first actuator chamber by a pressure activated seal, said second actuator chamber preferably being separated from said water soluble membrane by one or more pressure activated seals.

11. The container according to claim 10, wherein said beverage is a carbonated beverage and said first actuator chamber is filled by gasified water or a gasified aqueous solution equivalent to said beverage, typically constituting carbonated water, said cooling device initially being kept at a high pressure and said reaction being initiated when said pressure activated seal being ruptured when the pressure outside of said first actuator chamber is decreased below a specific low pressure, said high pressure typically being the pressure of the carbonated beverage such as 2-3 bars whereas said specific low pressure typically being atmospheric pressure

12. The container according to any of the claims 10- 11, wherein said first actuator chamber comprise a substantially rigid ampoule being encapsulated within said second actuator chamber.

13. The container according to any of the claims 9-12, wherein said pressure activated seal comprise a burst membrane or alternatively a plug, advantageously a plug of liquid metal such as alloys including Gallium and/or Indium

14. The container according to any of the claims 8-13, wherein said water soluble membrane is configured in a layered structure or alternatively in a honeycomb structure or yet alternatively as a coating

15. The container according to any of the preceding claims, wherein said cooling device is manufactured at least partly of plastic foils

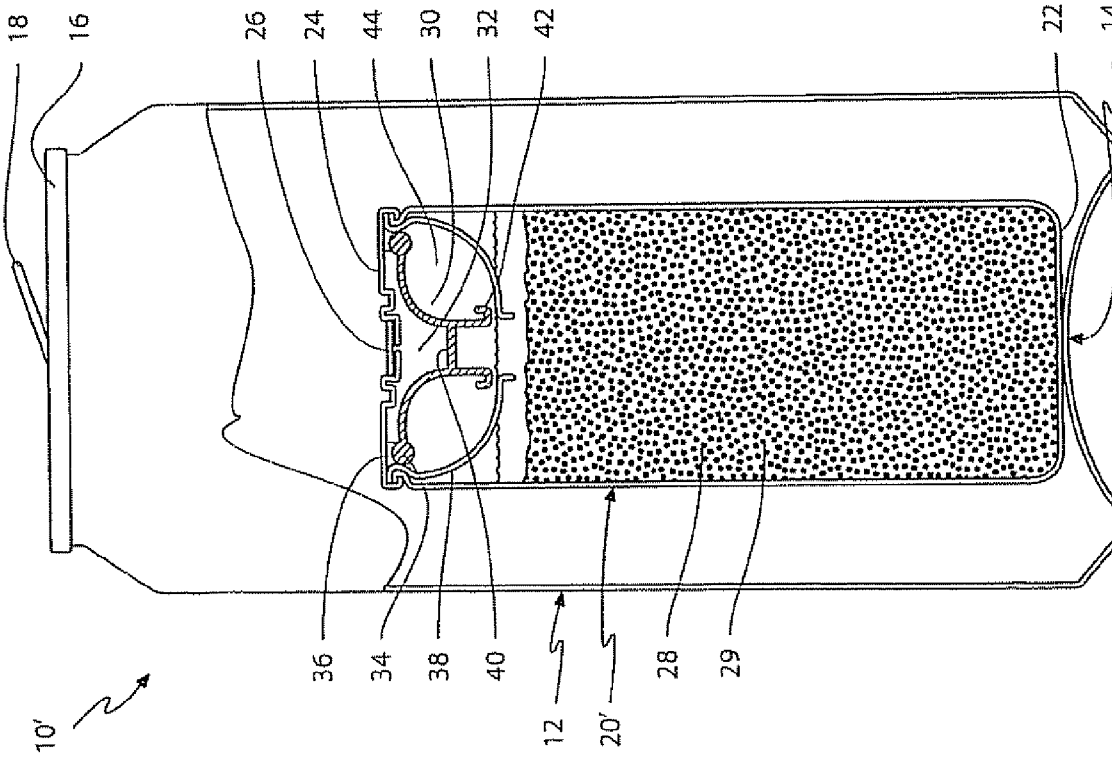
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FIG 1B

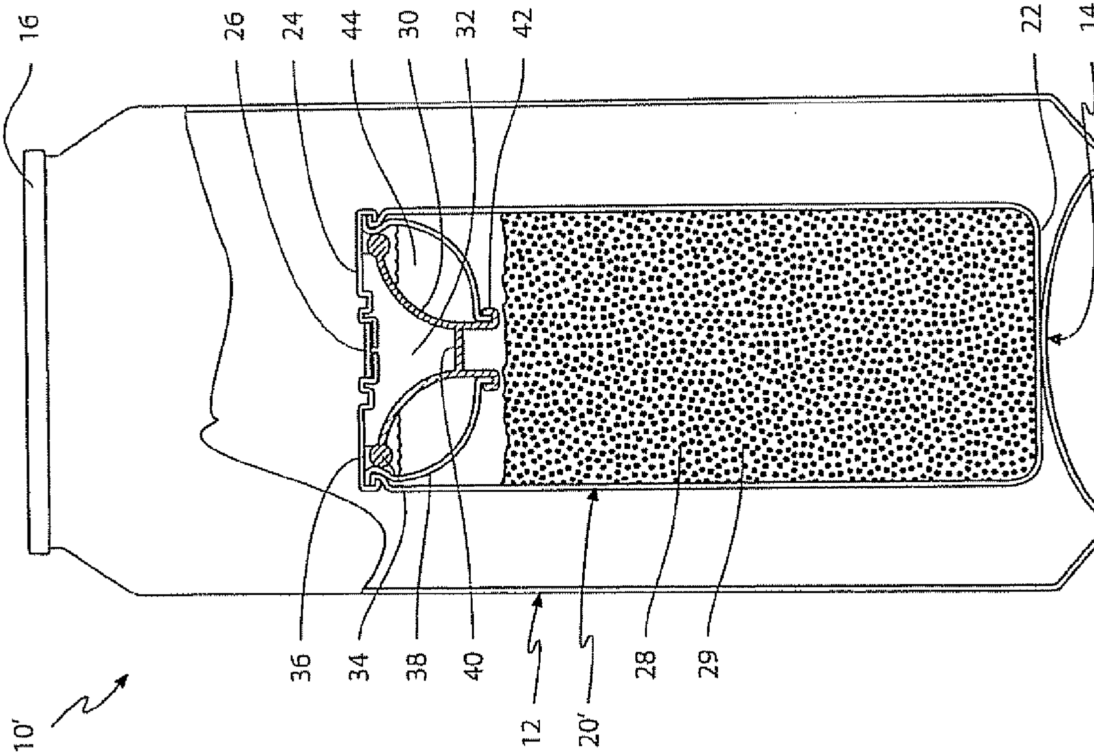
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FIG 1A

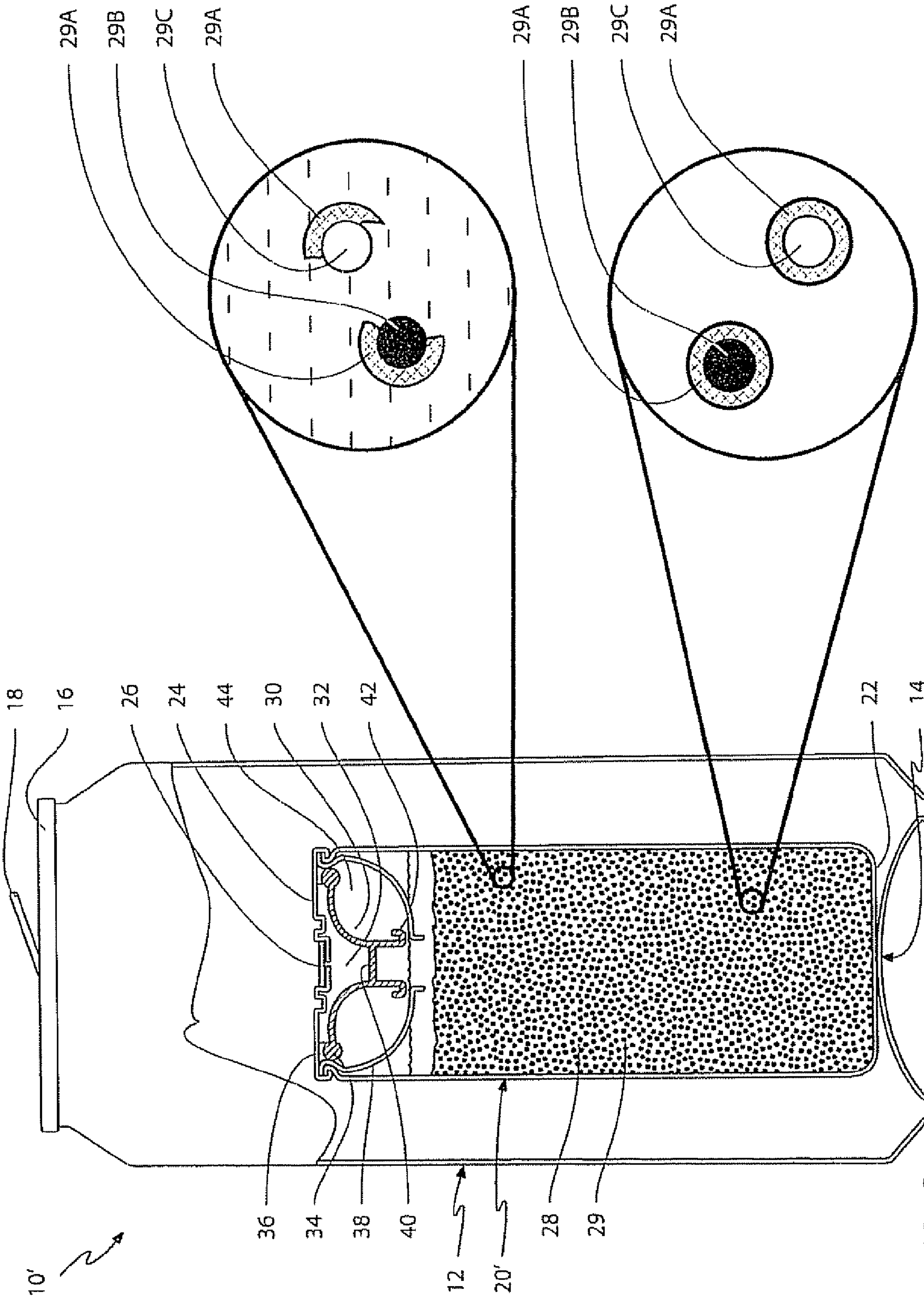
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FIG 1C

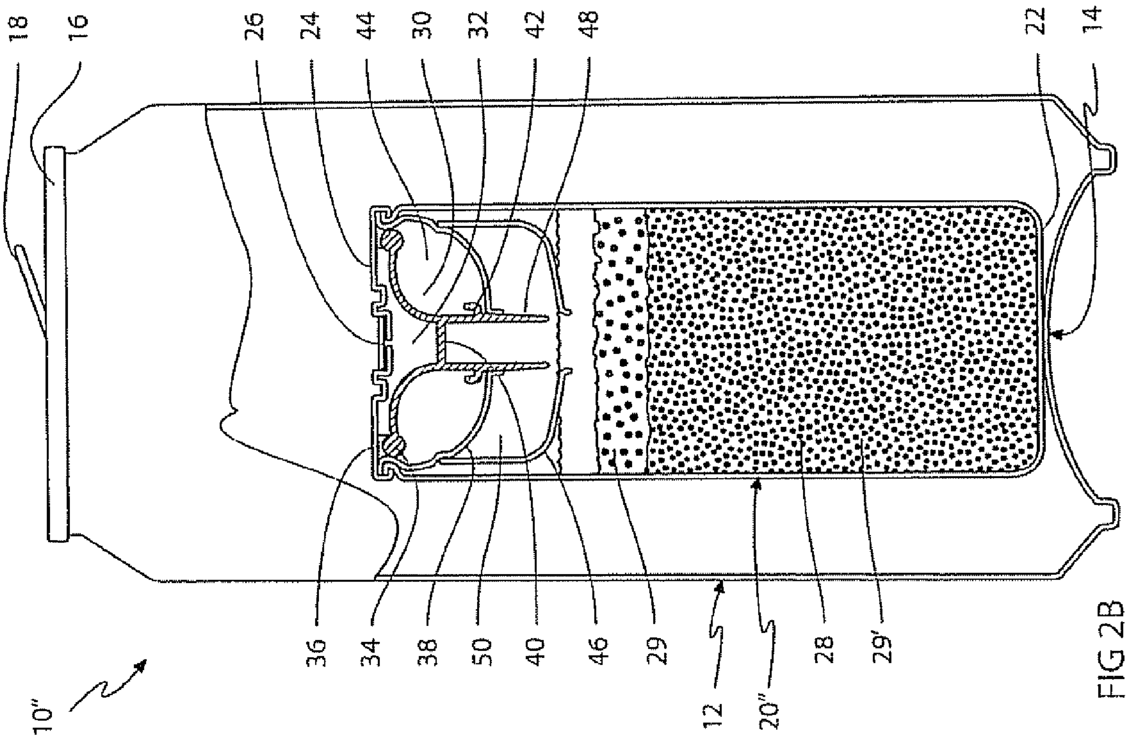

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FIG 2B

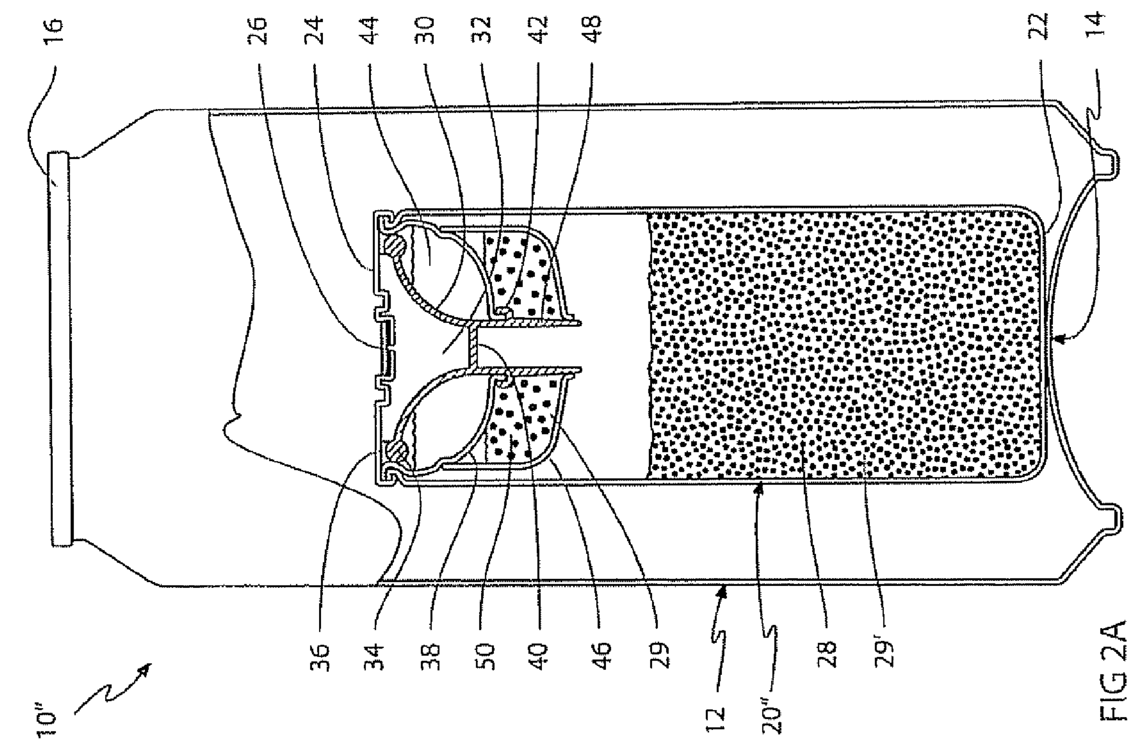

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FIG 2A

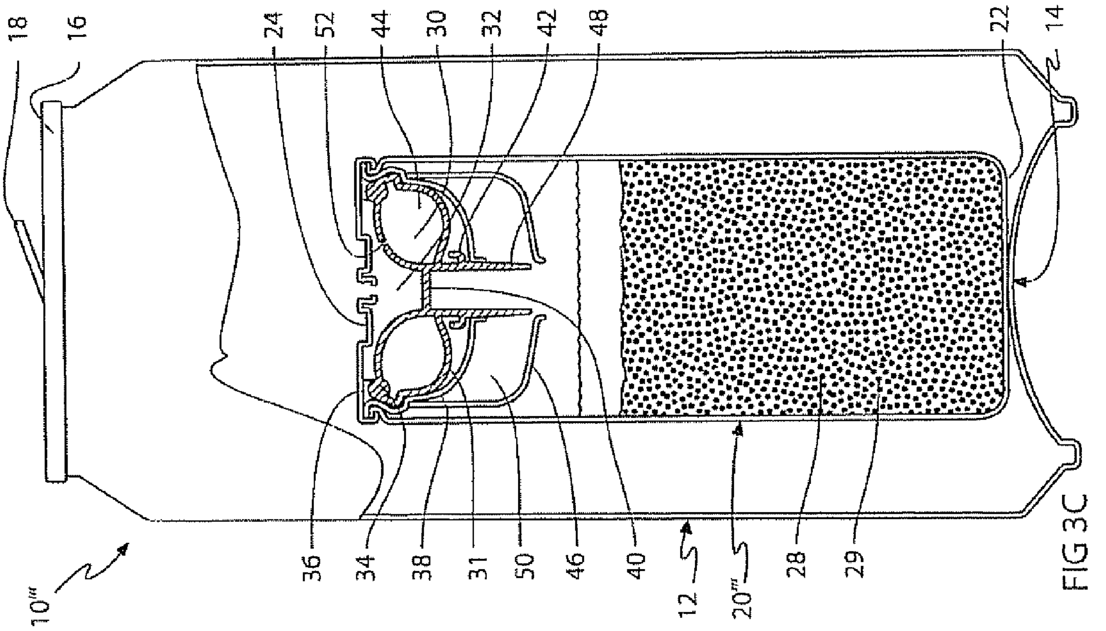

FIG 3C

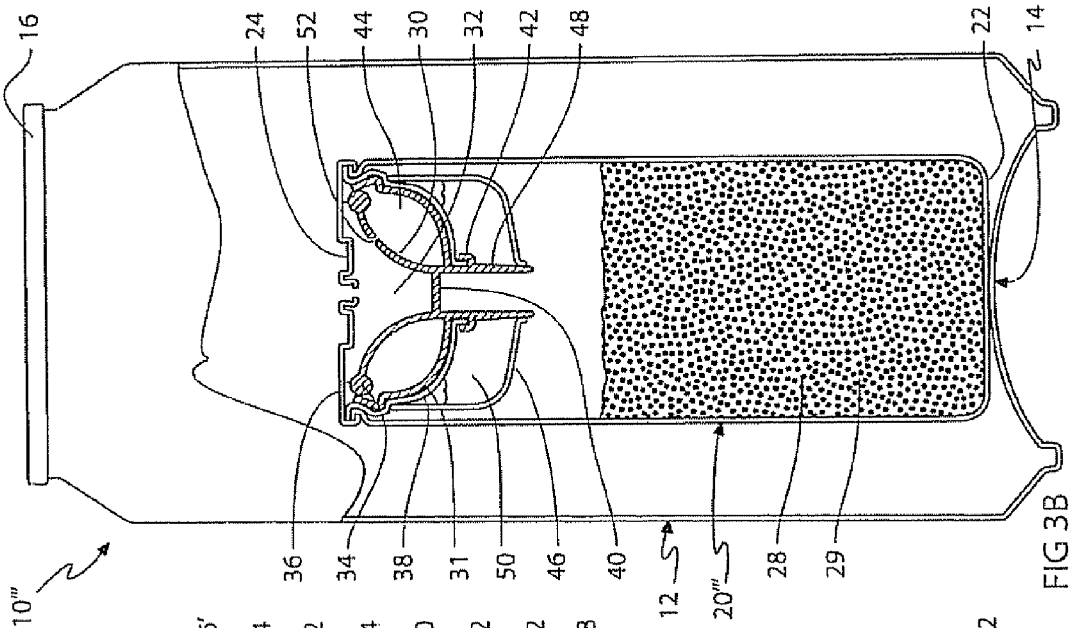

FIG 3B

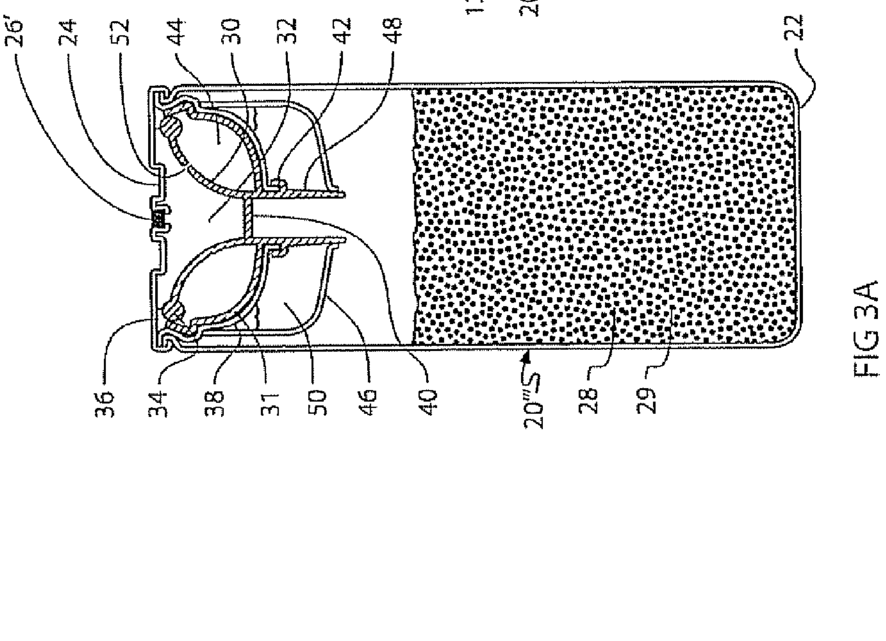

FIG 3A

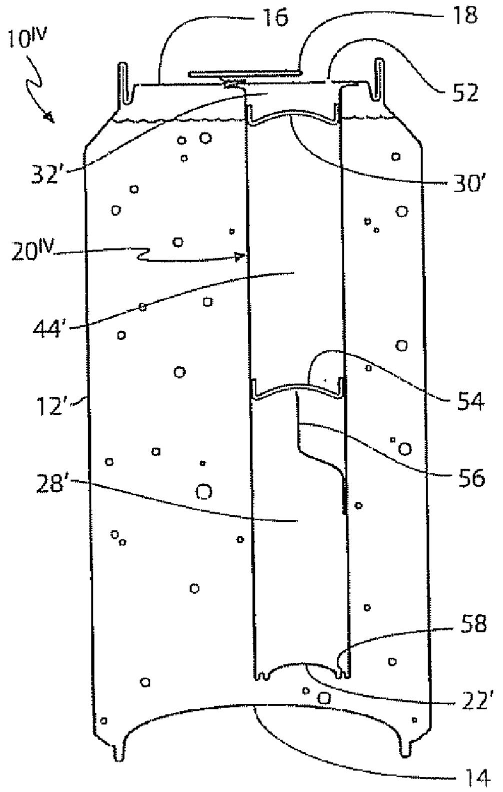

FIG 4A

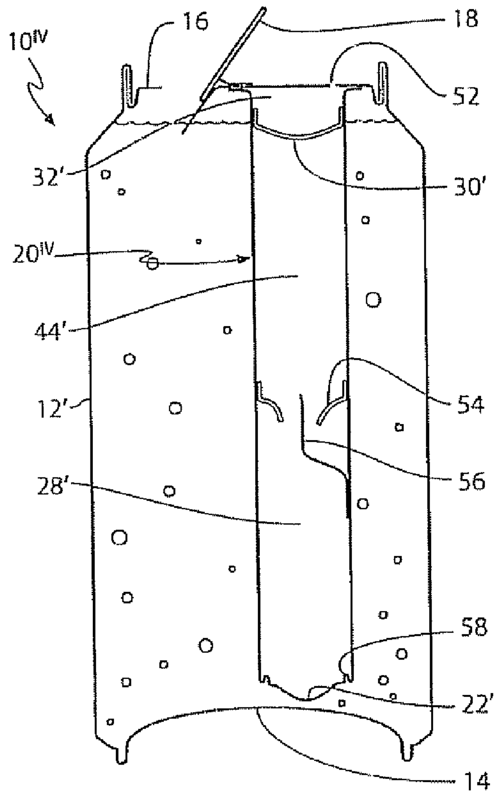

FIG 4B

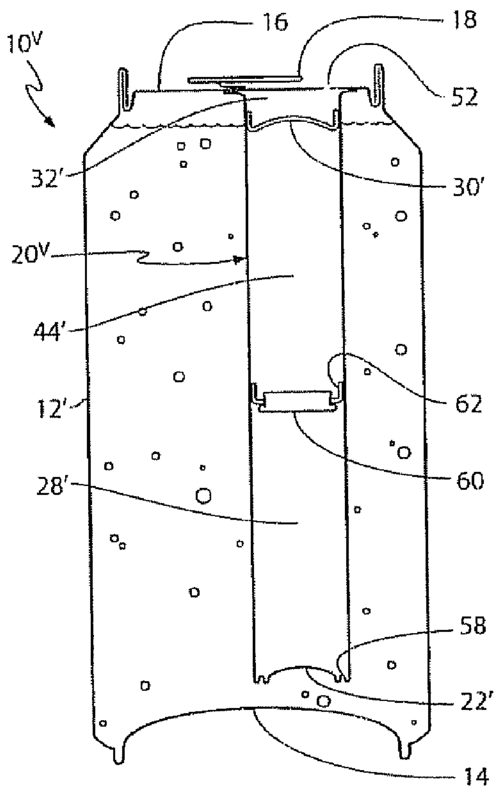

FIG 5A

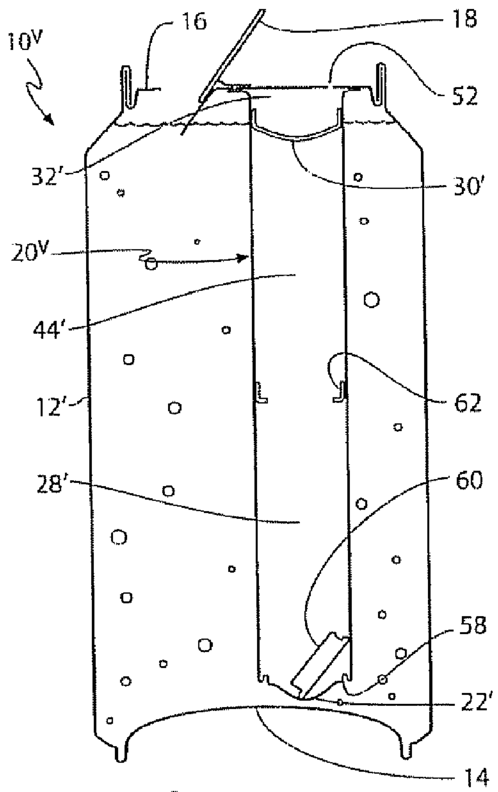

FIG 5B

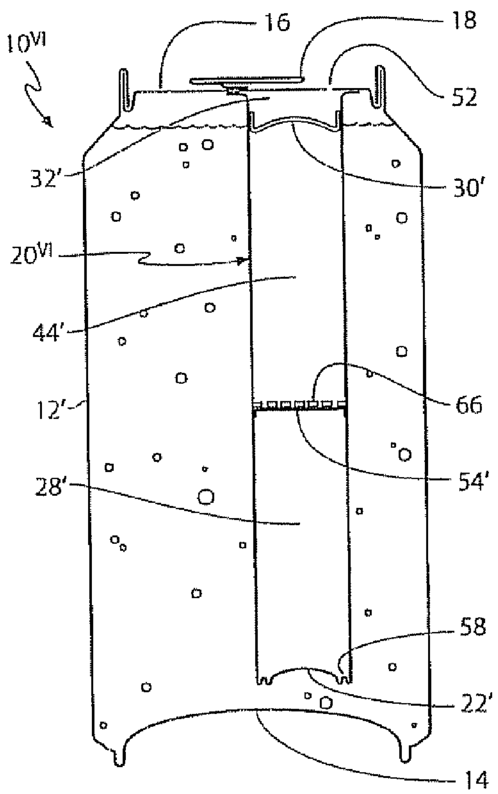

FIG 6A

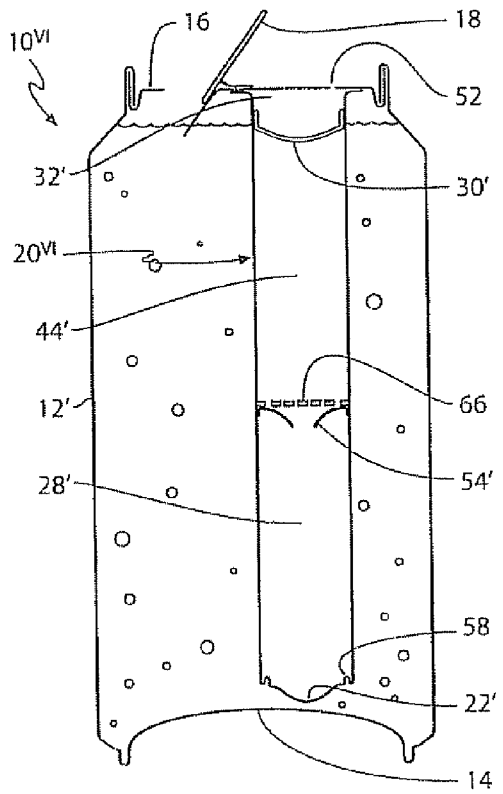

FIG 6B

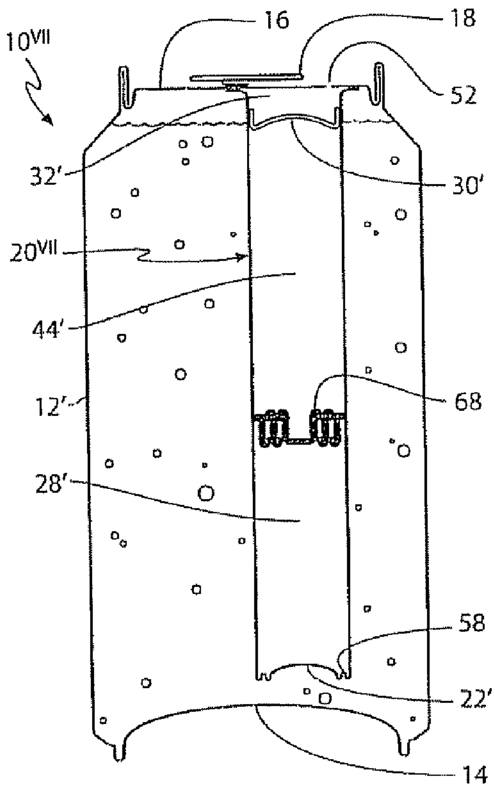

FIG 7A

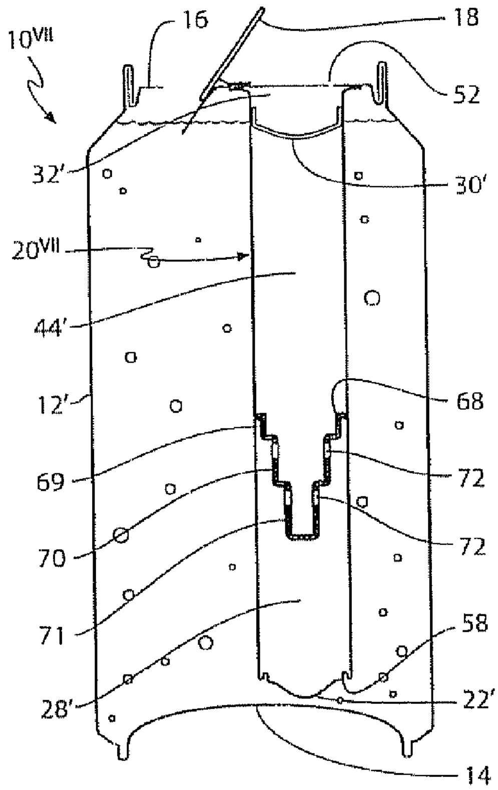

FIG 7B

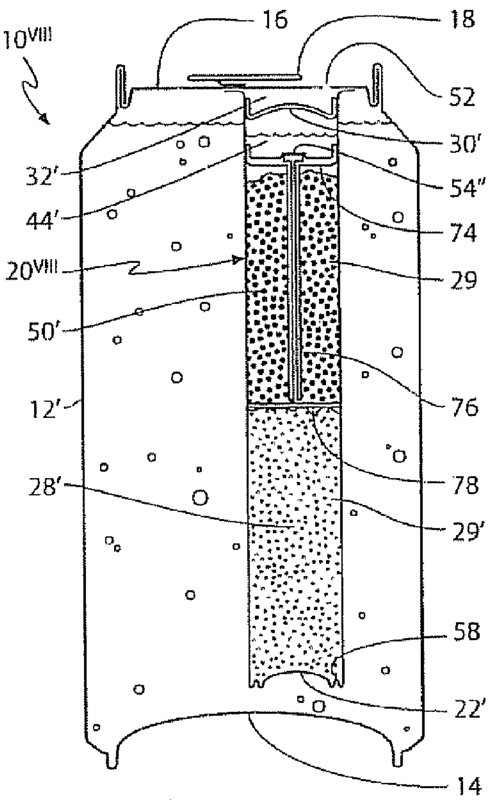

FIG 8A

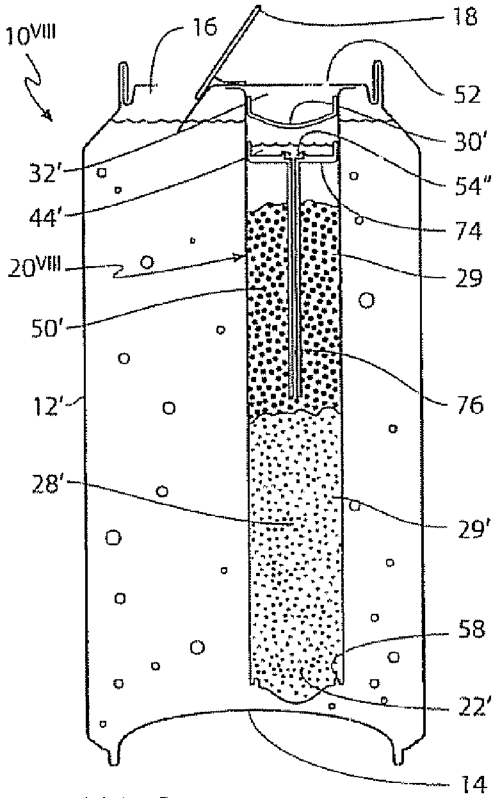

FIG 8B

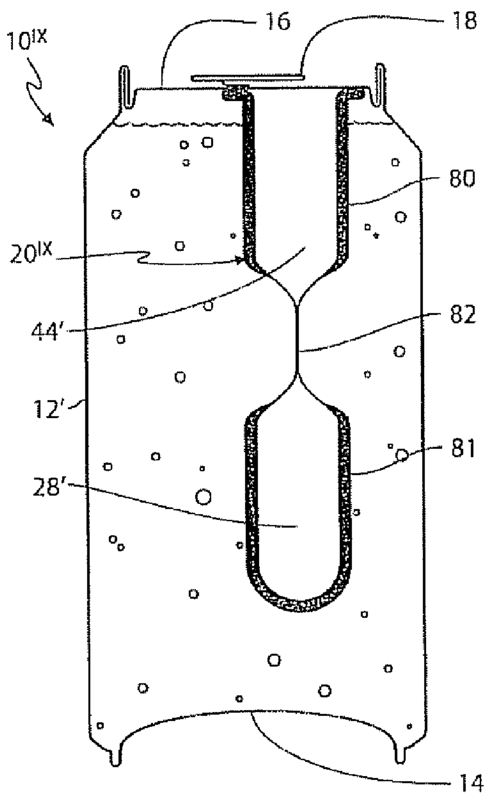

FIG 9A

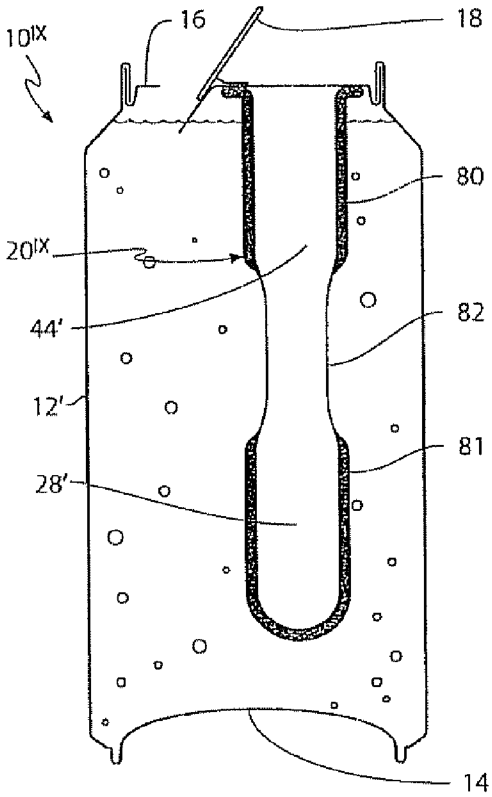

FIG 9B

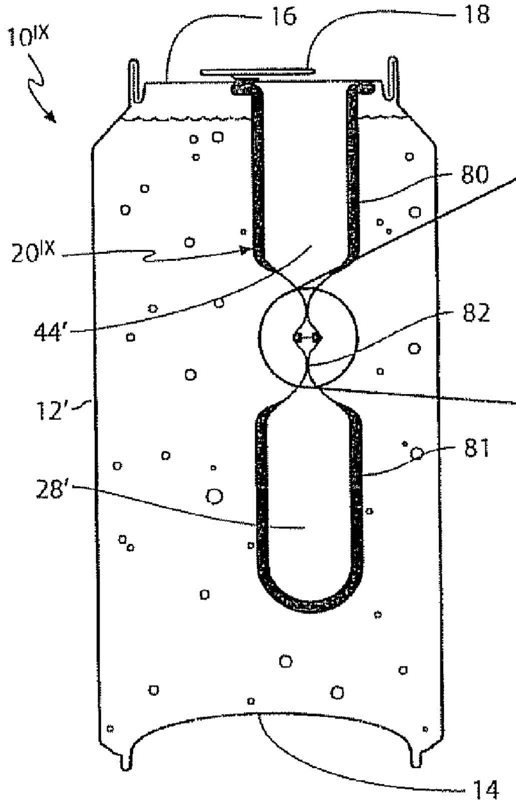

FIG 9C

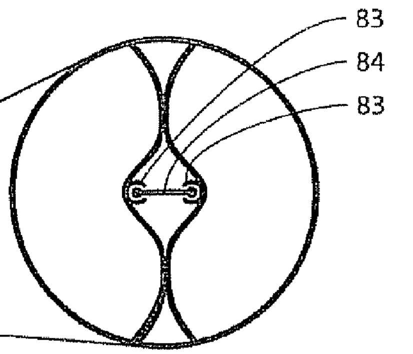

FIG 9D

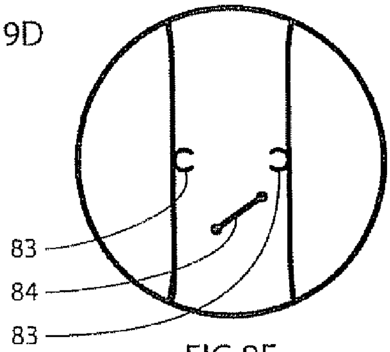

FIG 9E

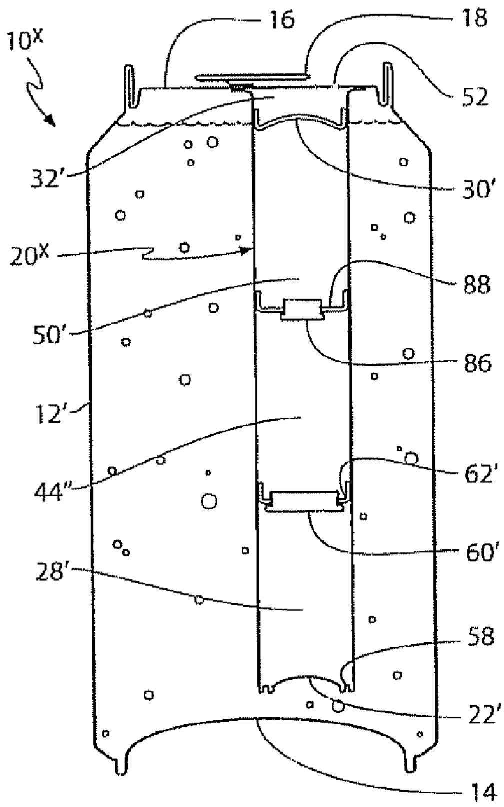

FIG 10A

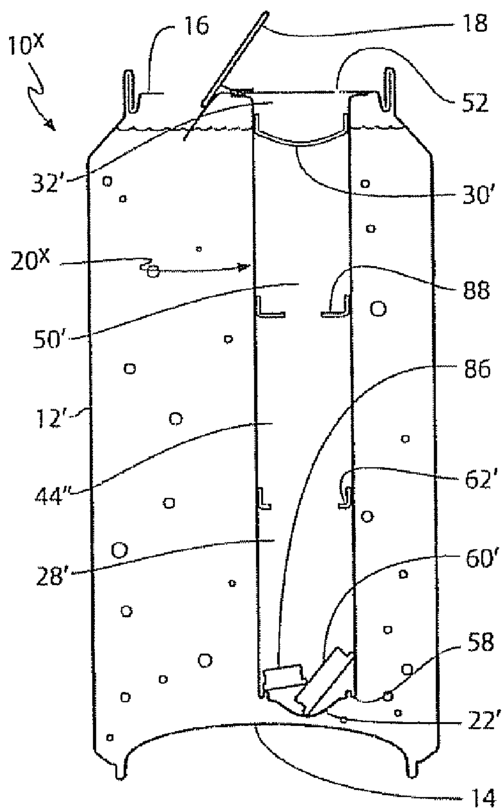

FIG 10B

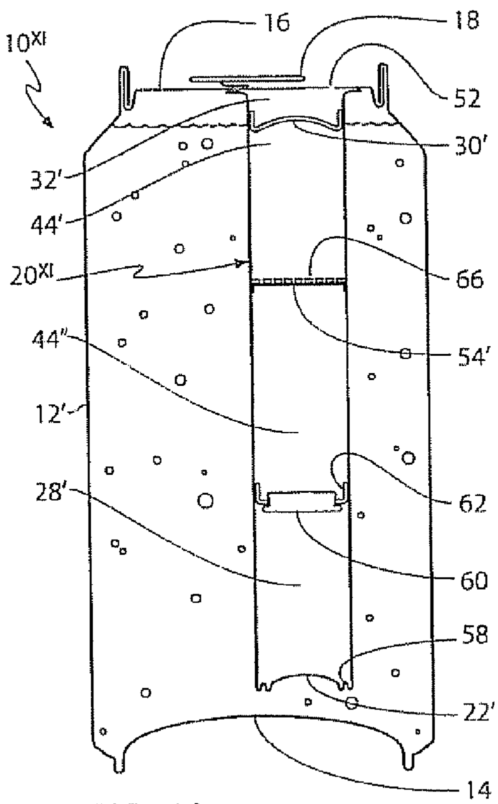

FIG 11A

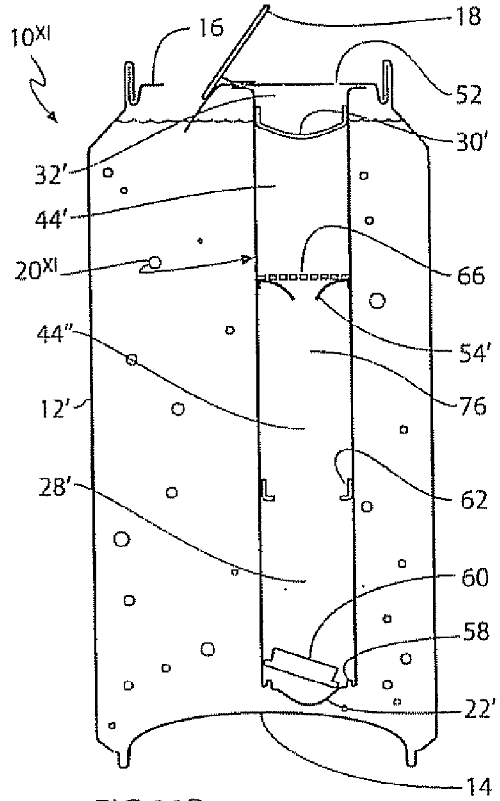

FIG 11B

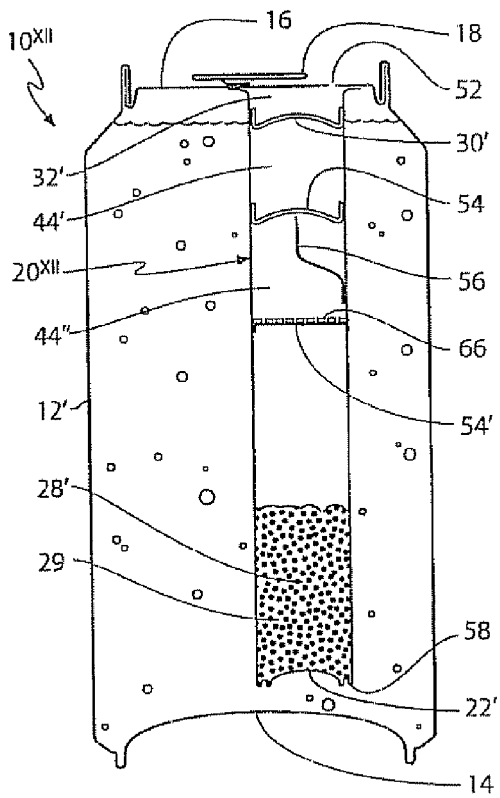

FIG 12A

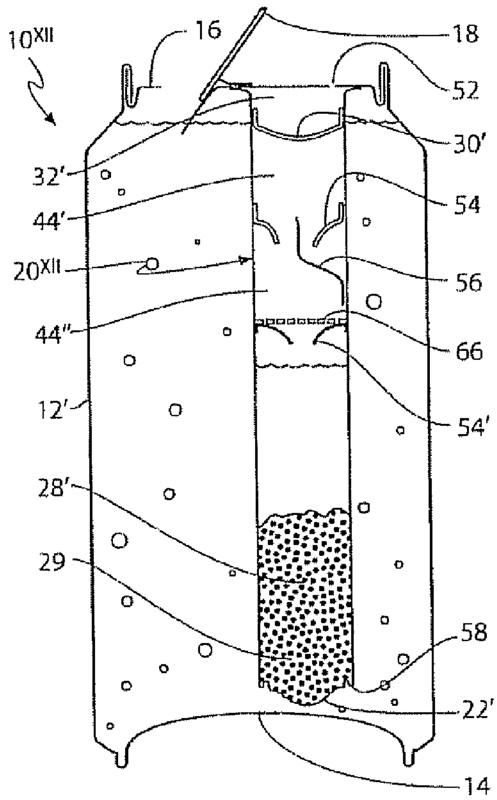

FIG 12B

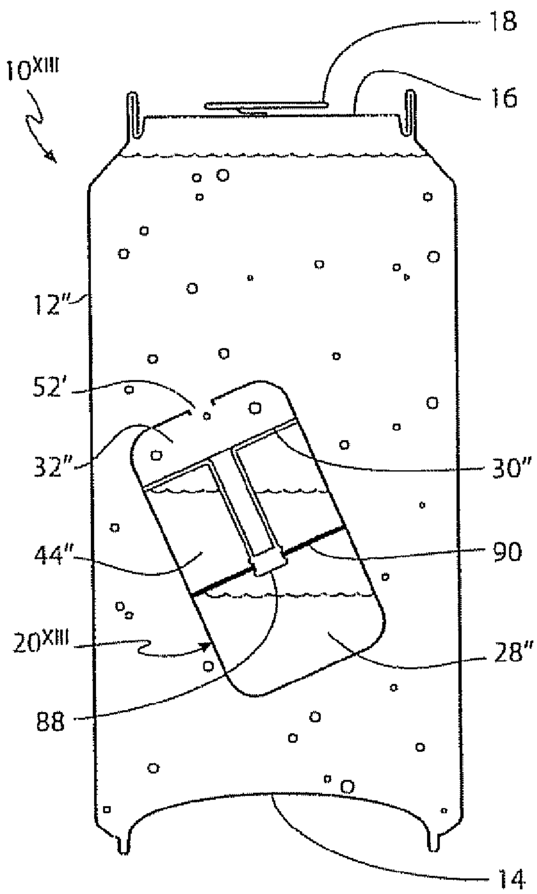

FIG 13A

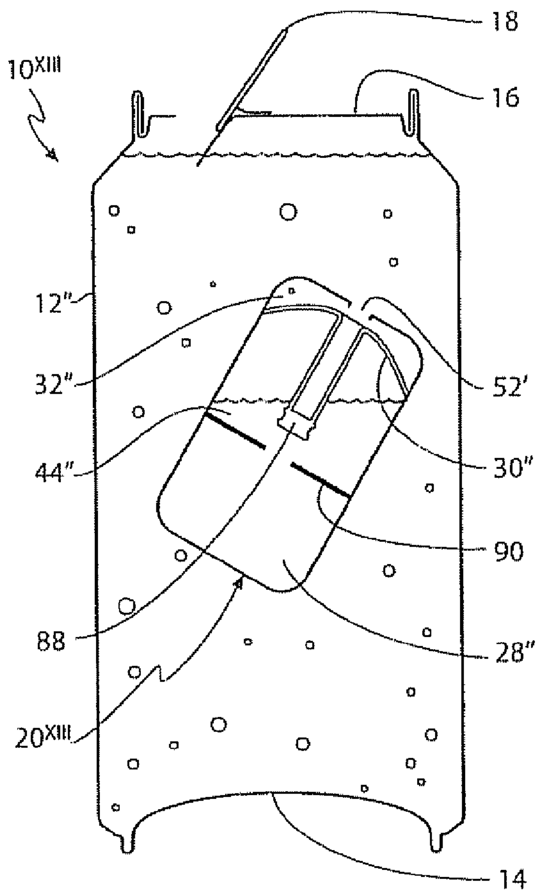

FIG 13B

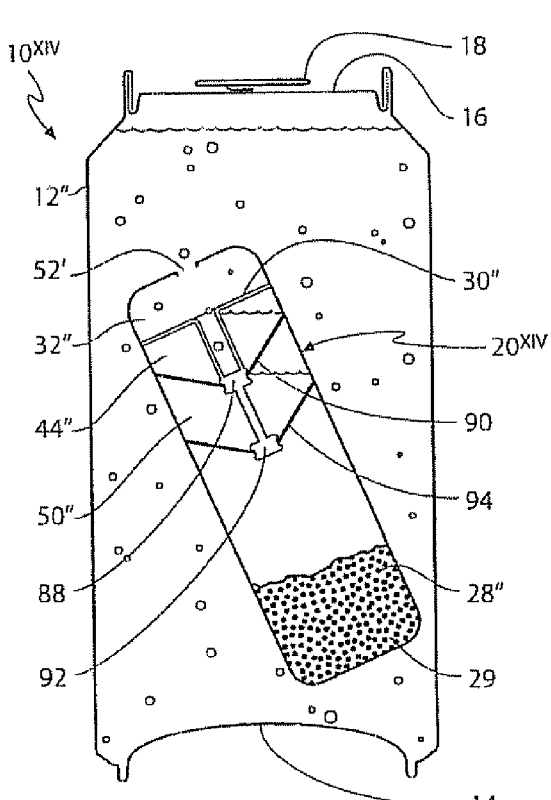

FIG 14A

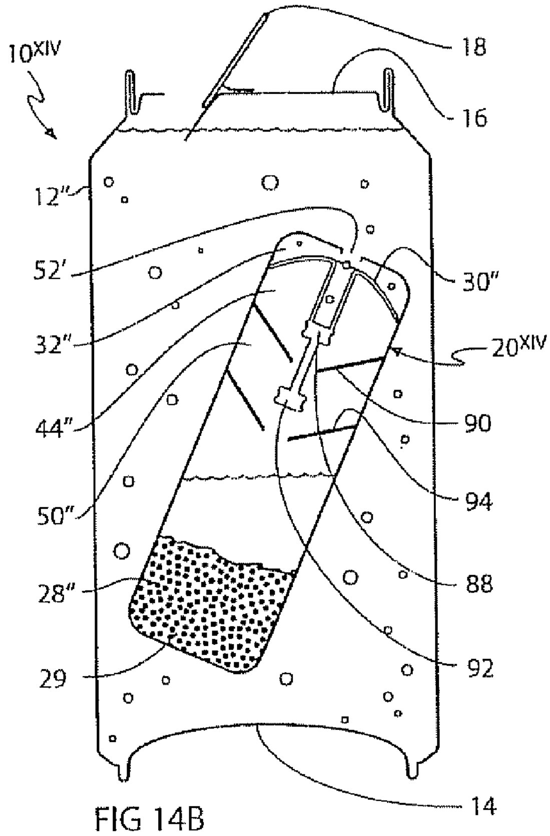

FIG 14B

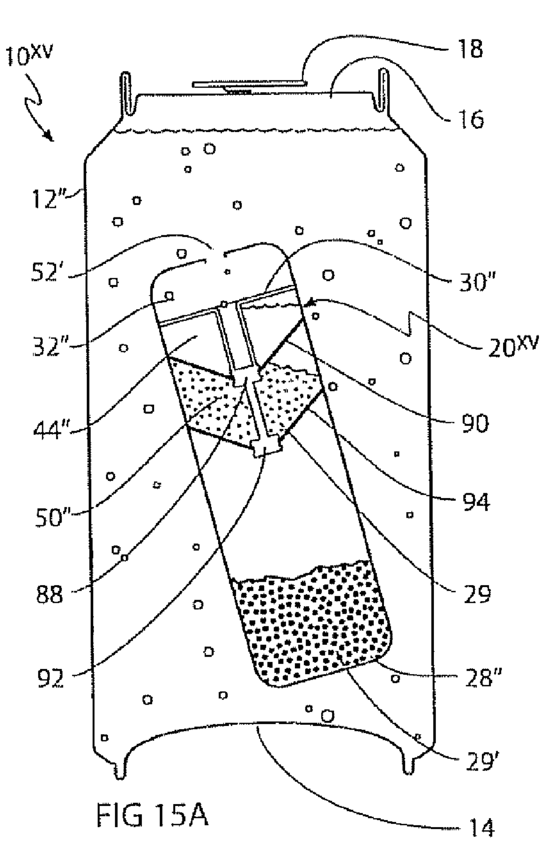

FIG 15A

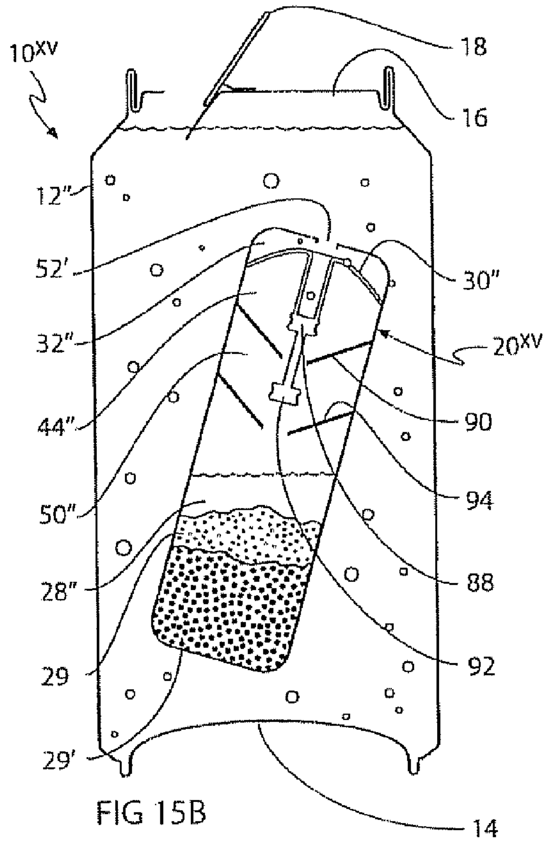

FIG 15B

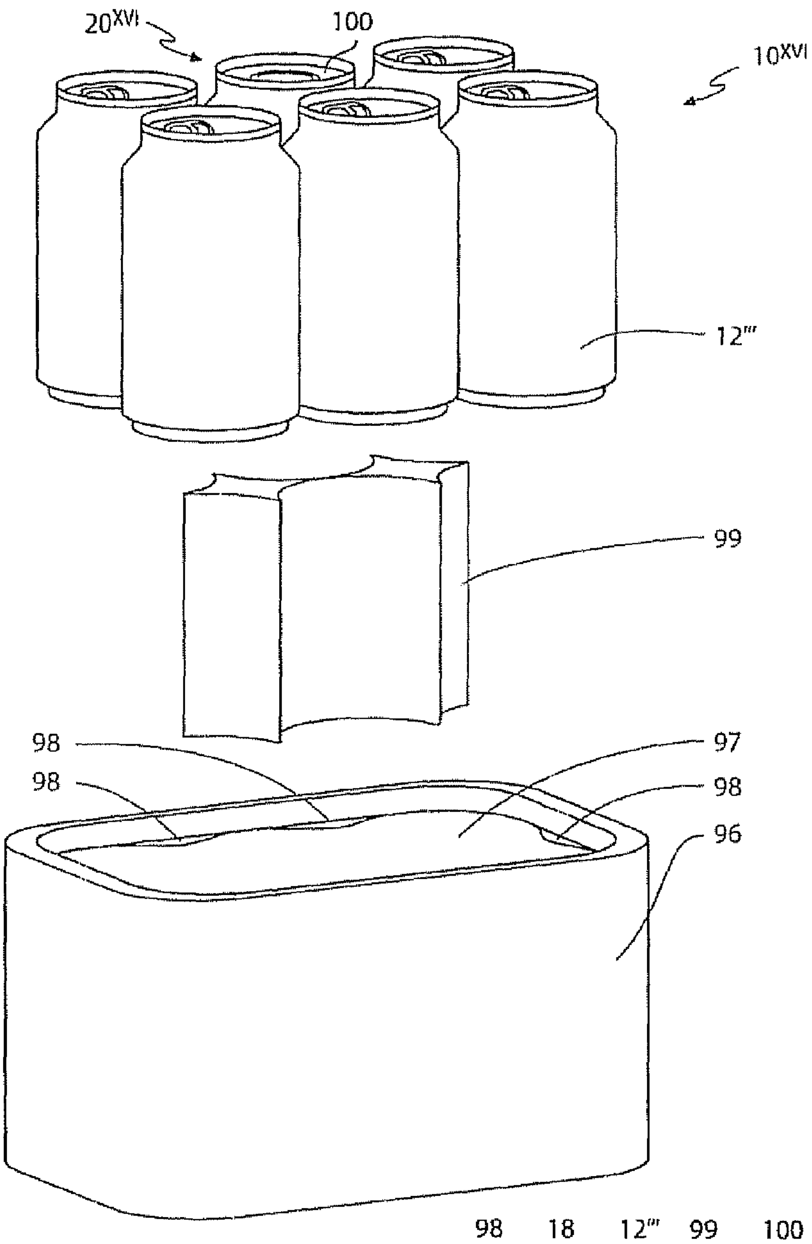

FIG 16A

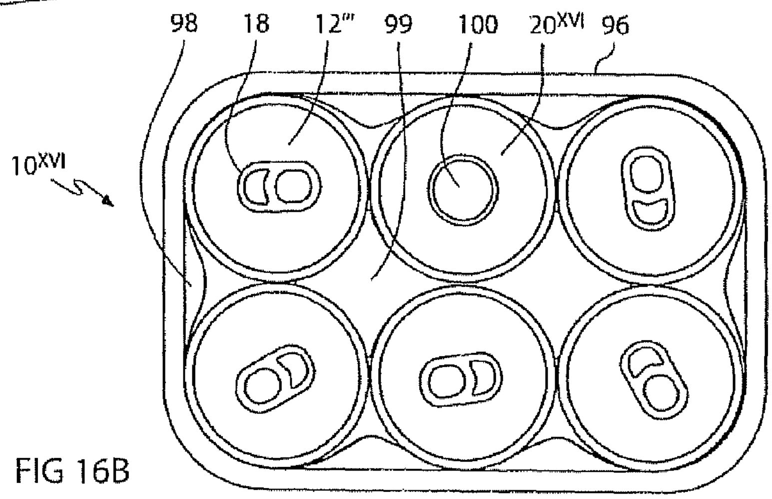

FIG 16B

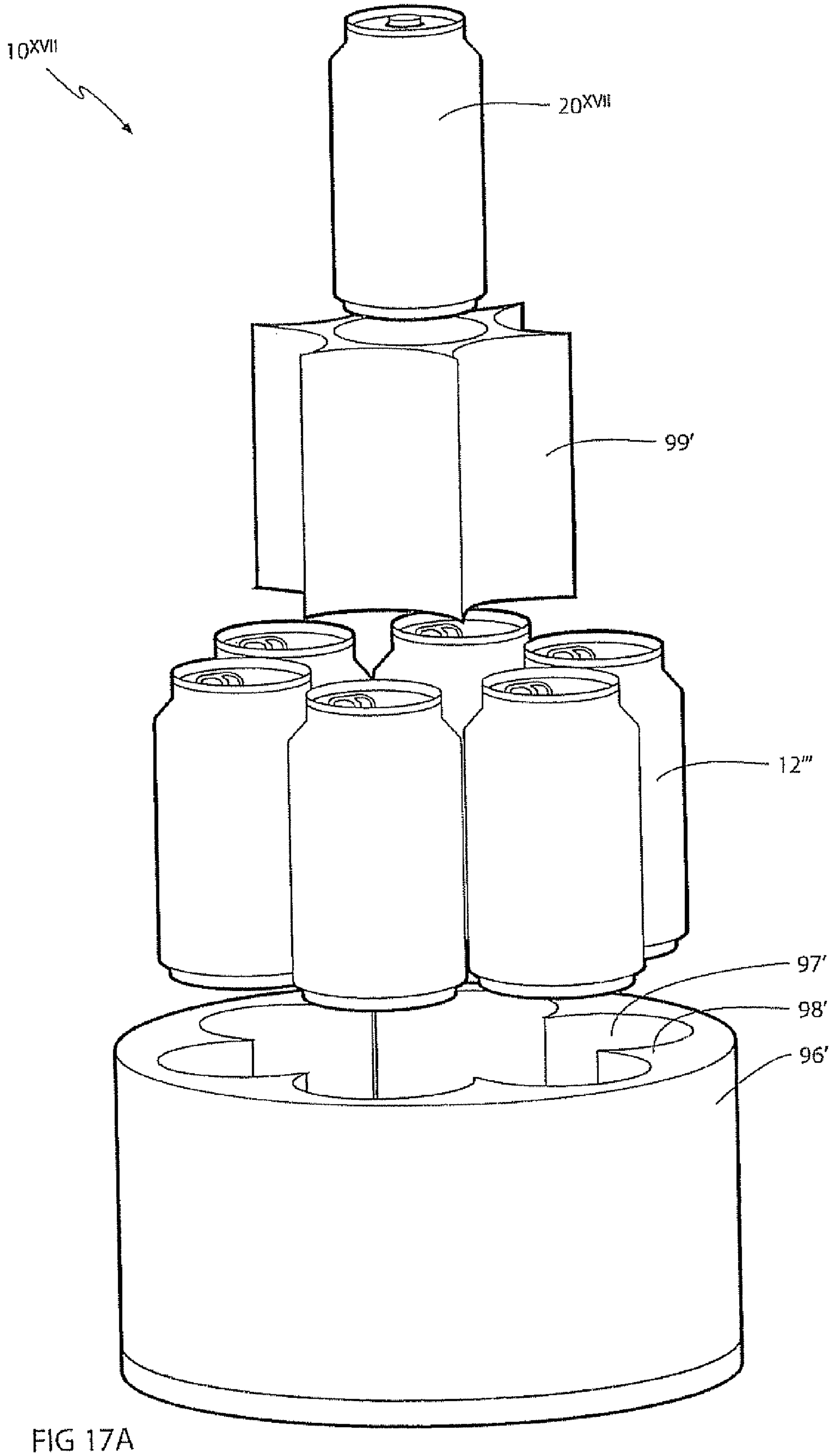

FIG 17A

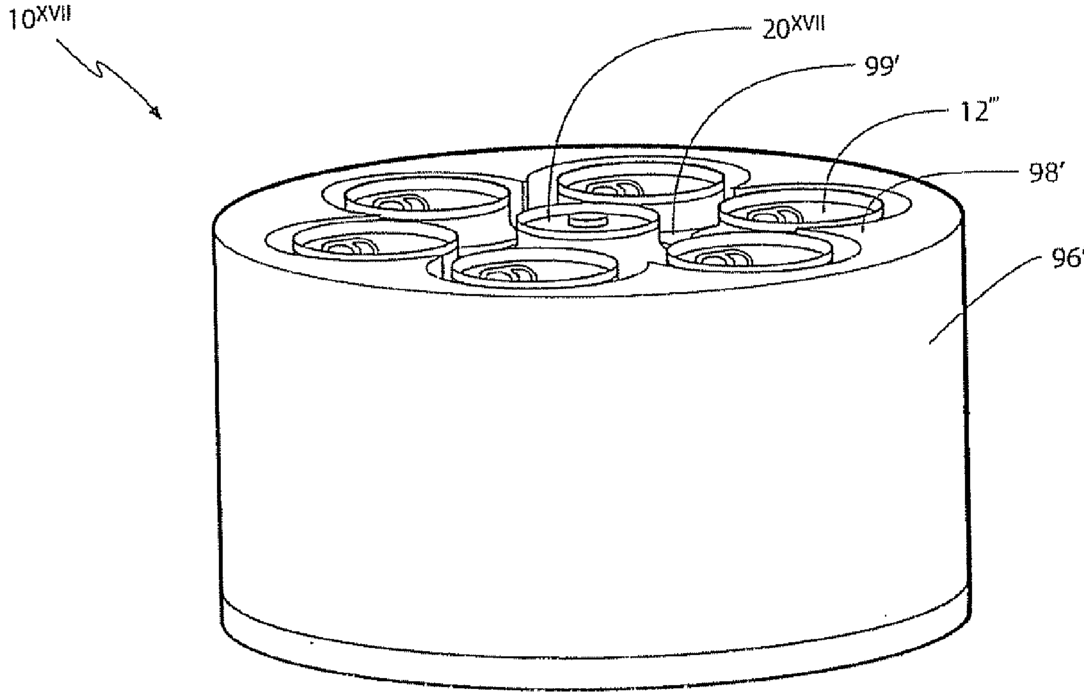

FIG 17B

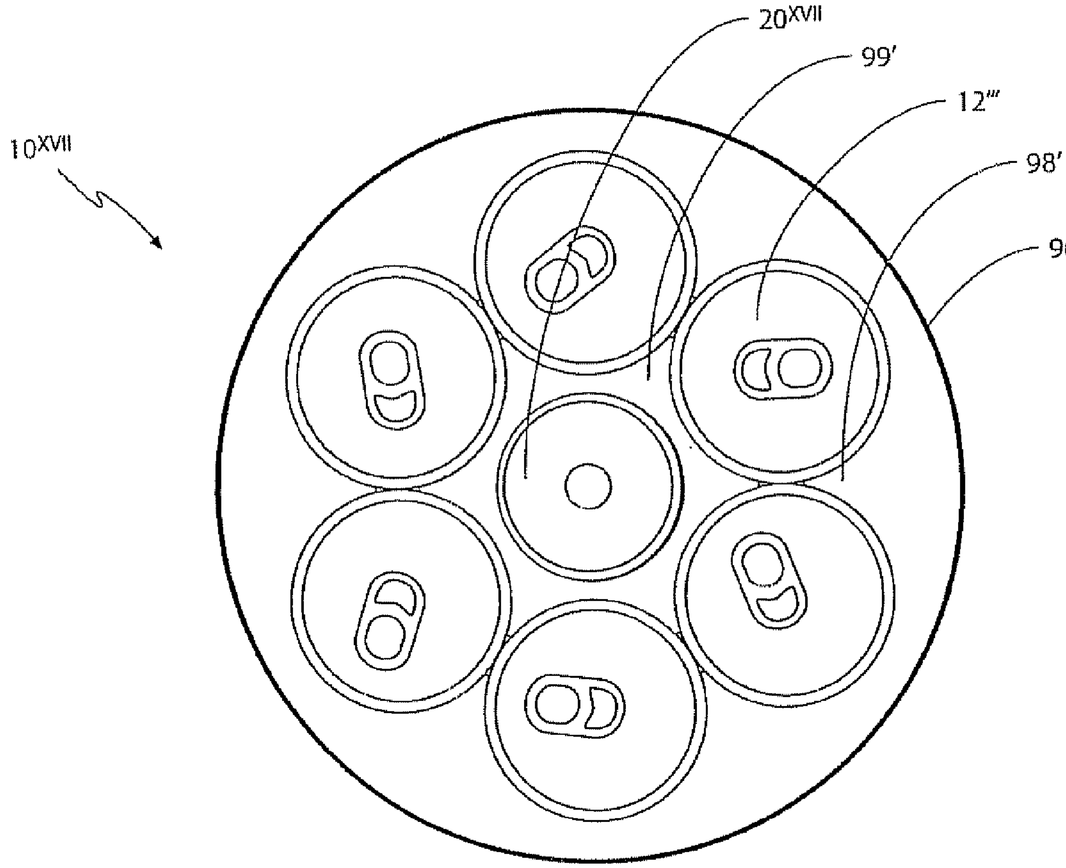

FIG 17C

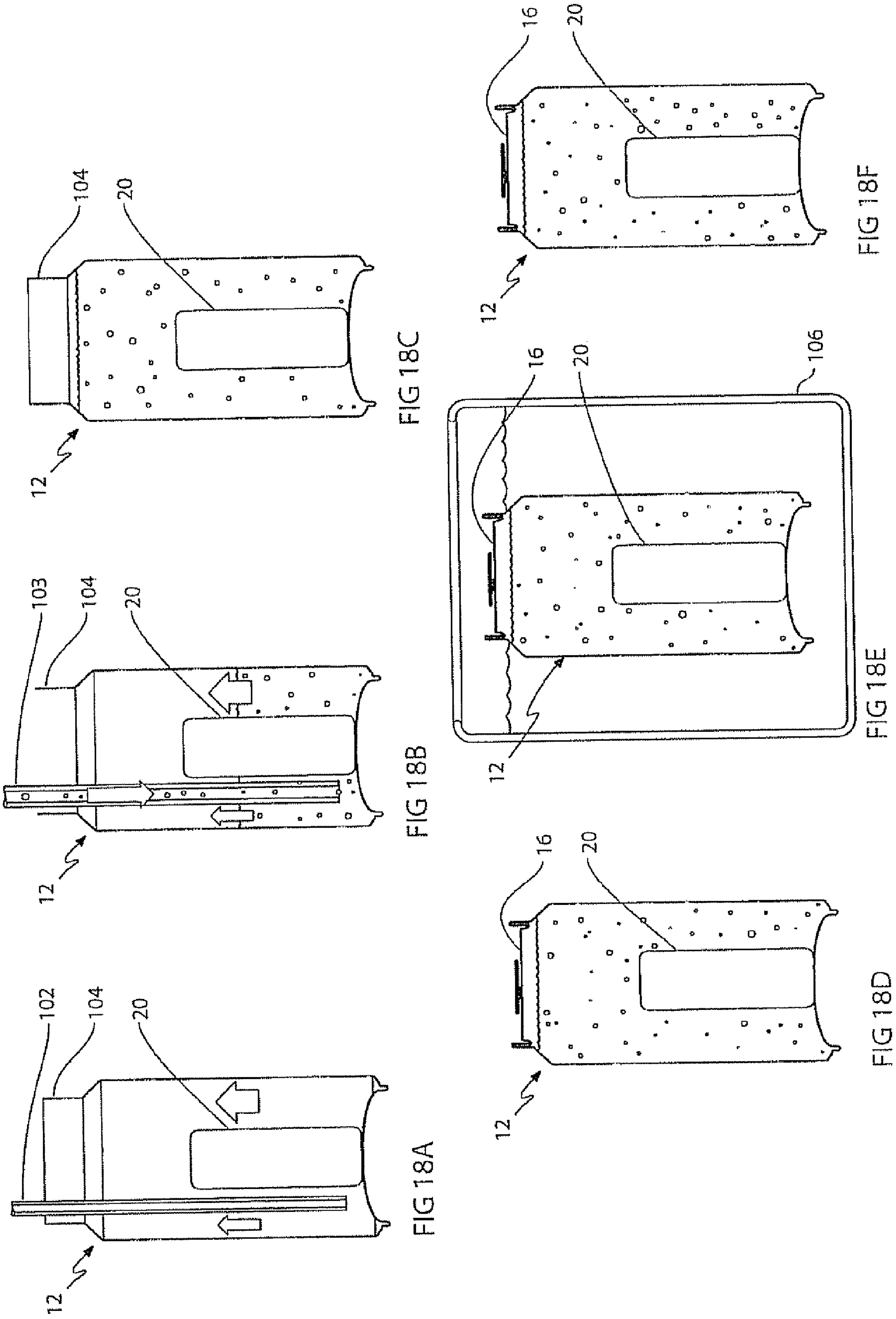

FIG 18A
FIG 18B
FIG 18C
FIG 18D
FIG 18E
FIG 18F

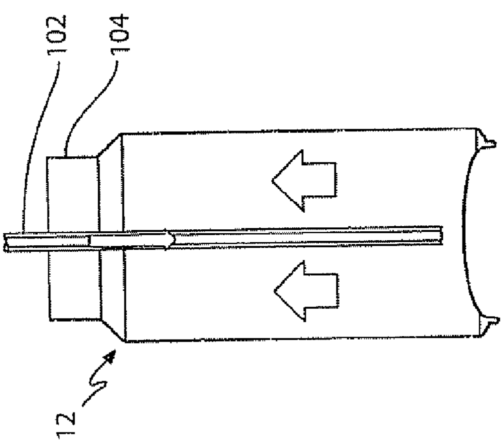

FIG 19A

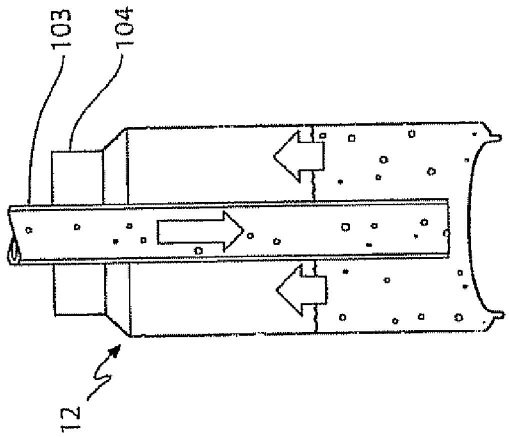

FIG 19B

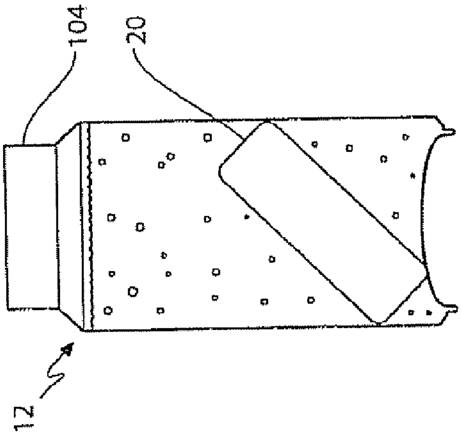

FIG 19C

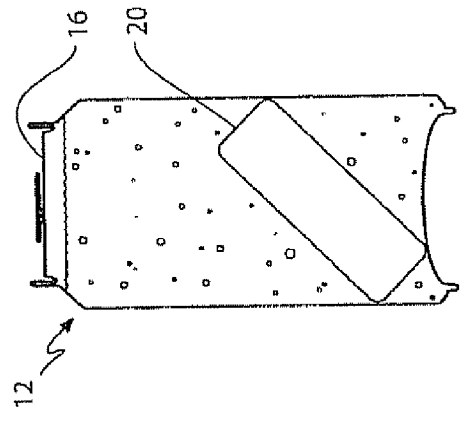

FIG 19D

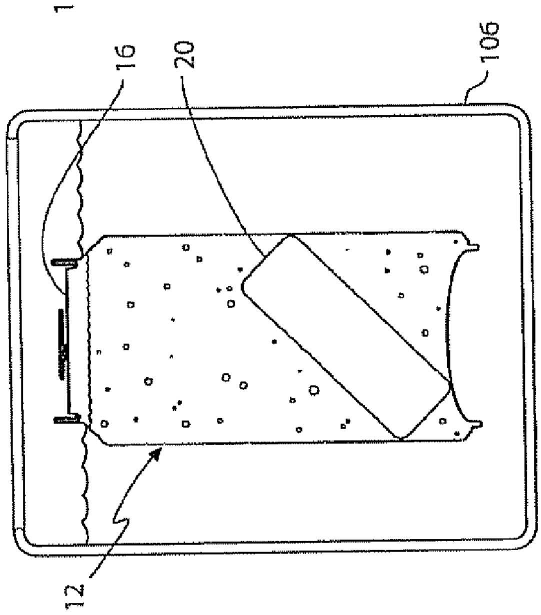

FIG 19E

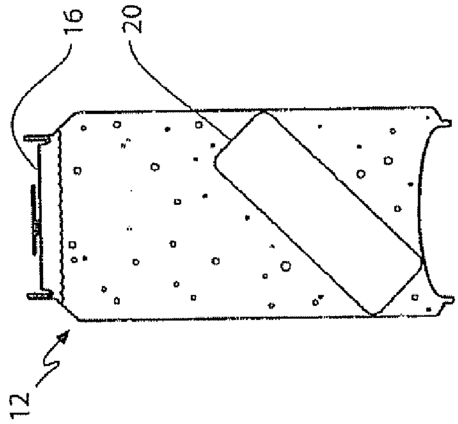

FIG 19F

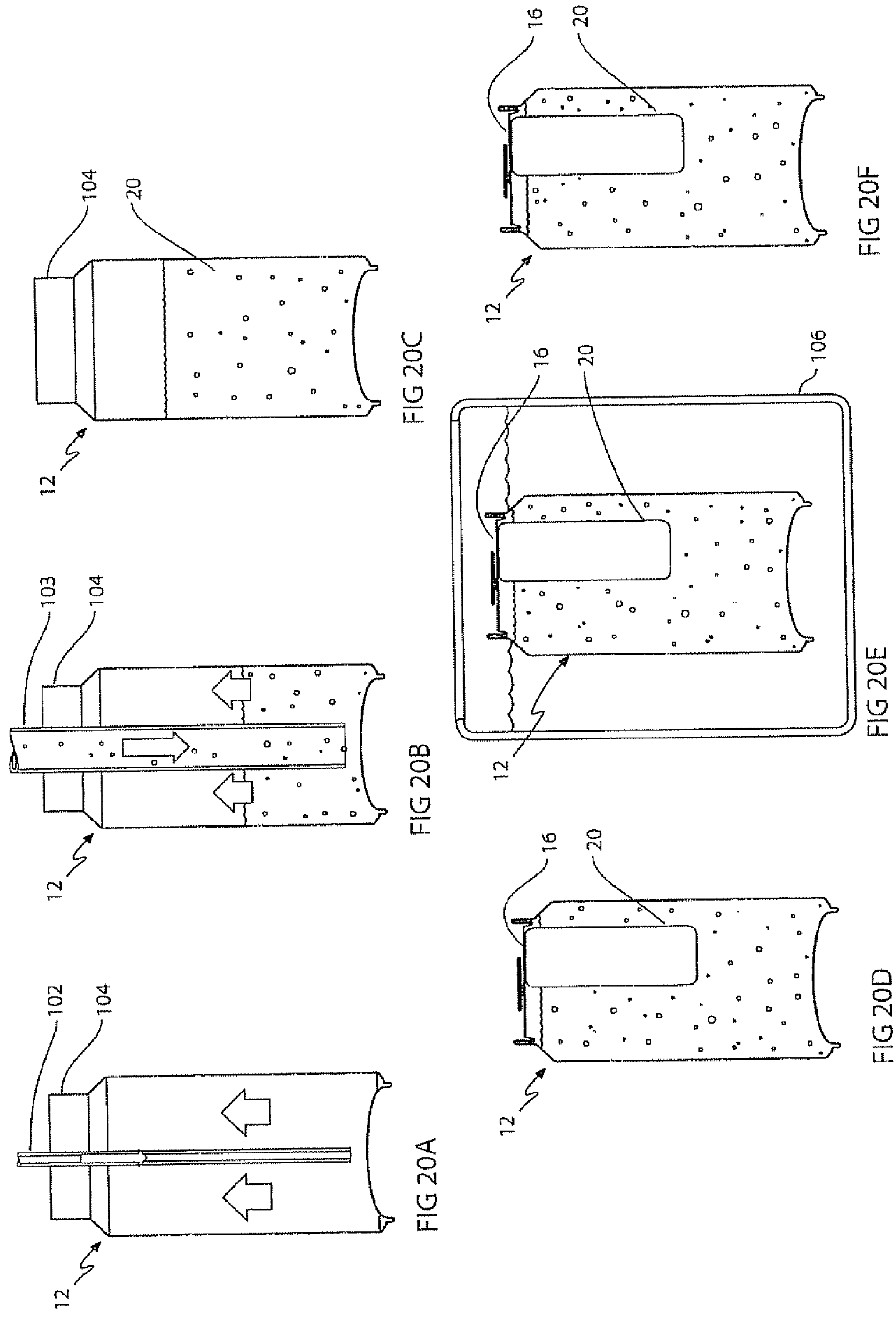

FIG 20A

FIG 20B

FIG 20C

FIG 20D

FIG 20E

FIG 20F

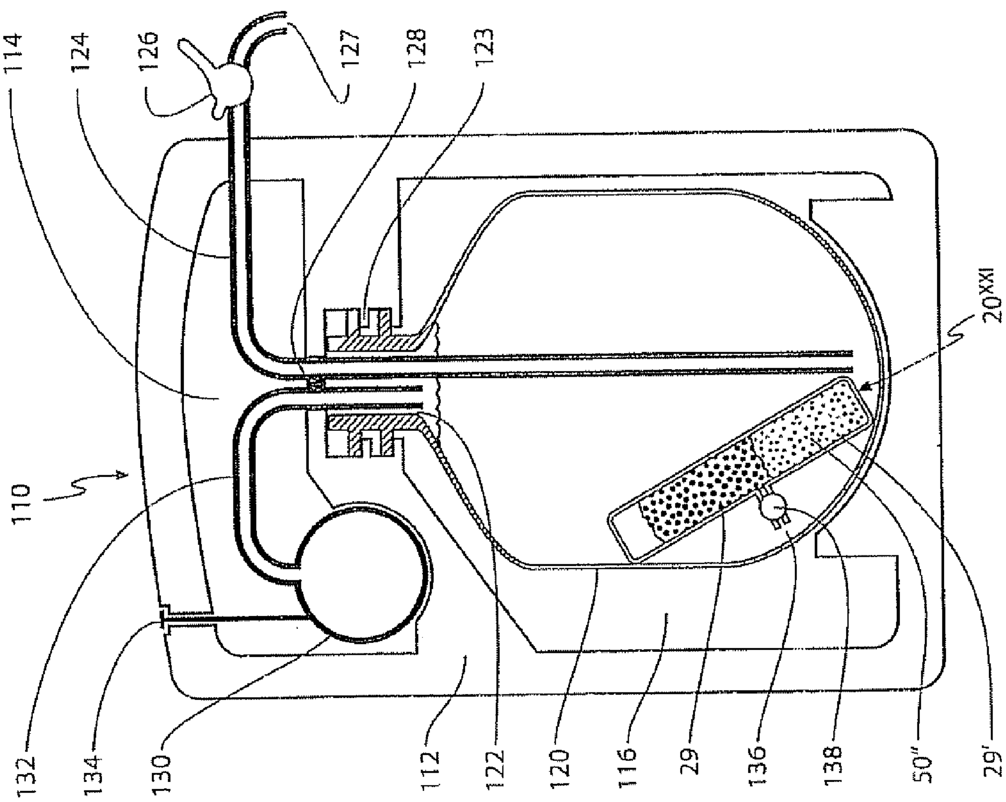

FIG 21 B

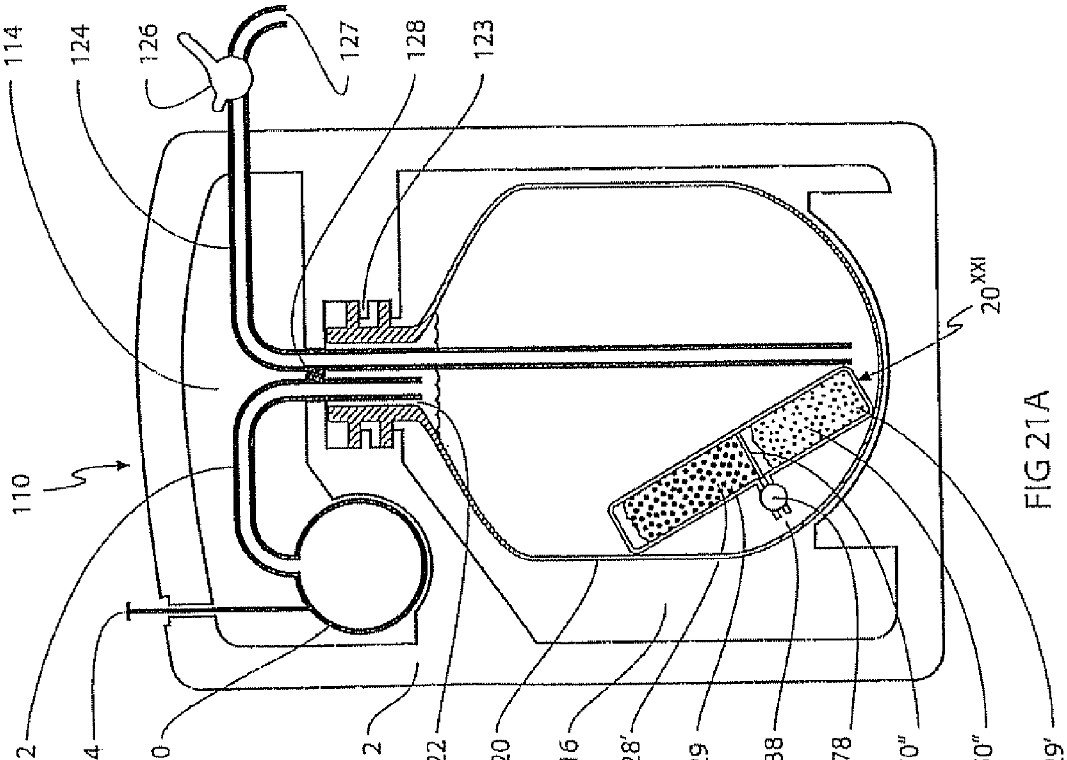

FIG 21 A

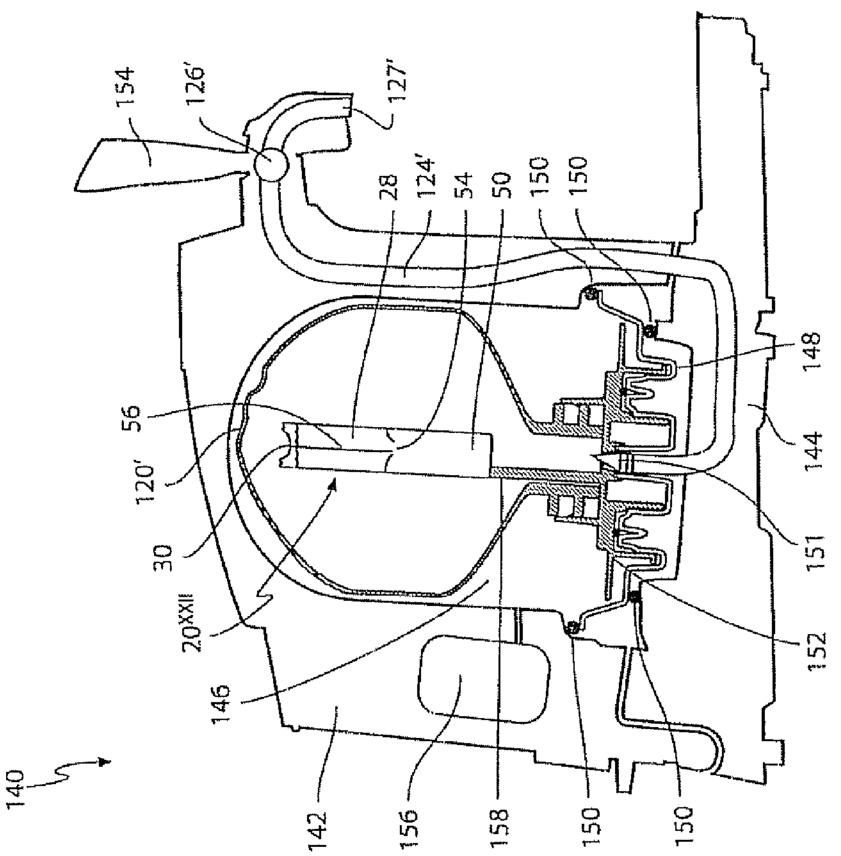

FIG 22B

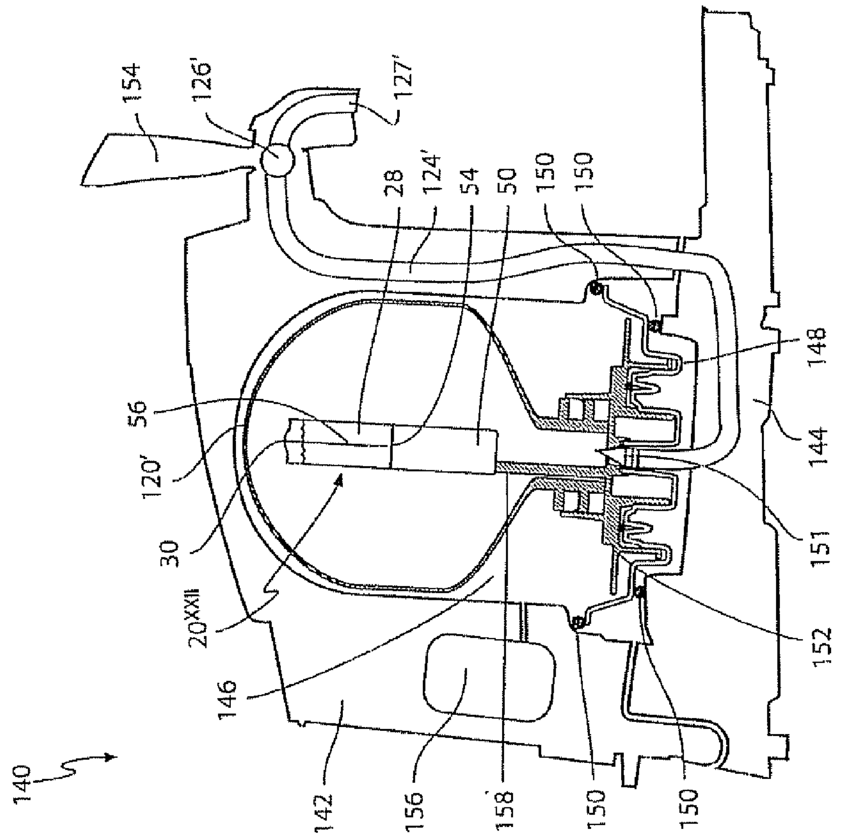

FIG 22A

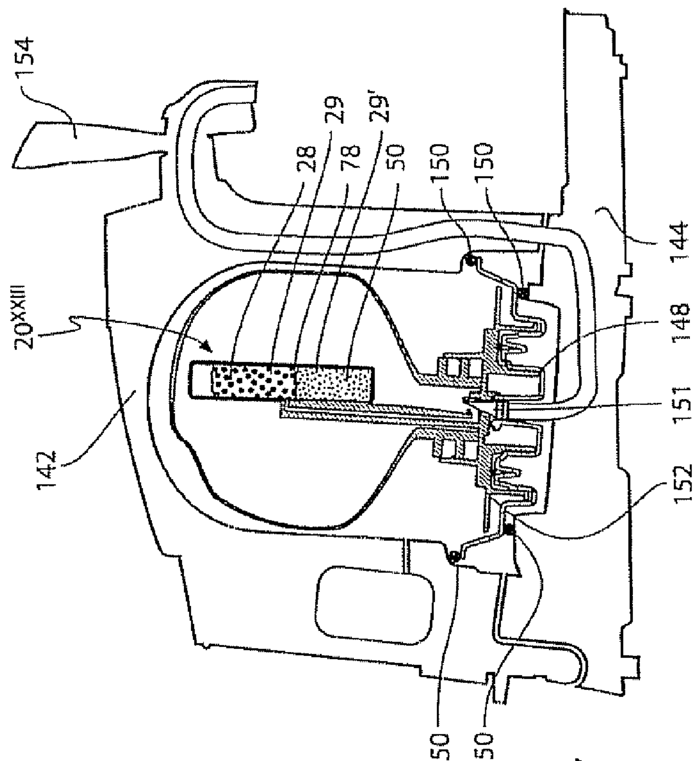

FIG 23B

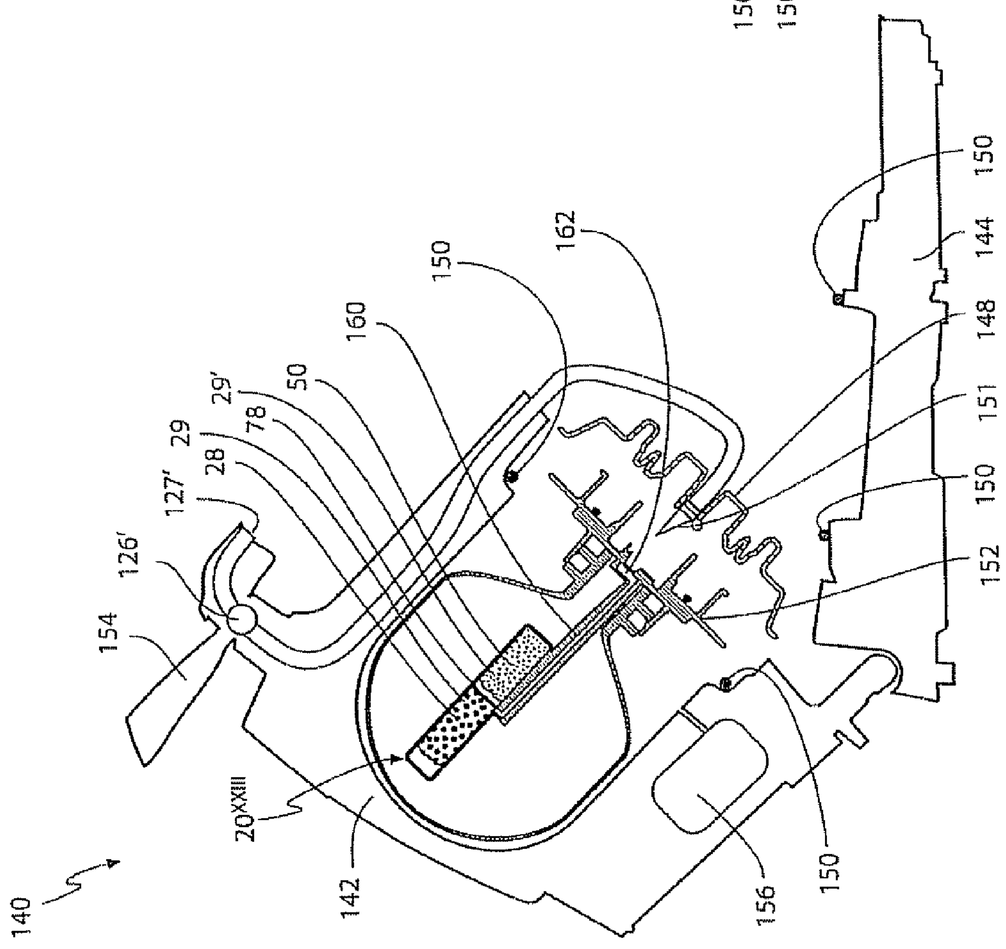

FIG 23A

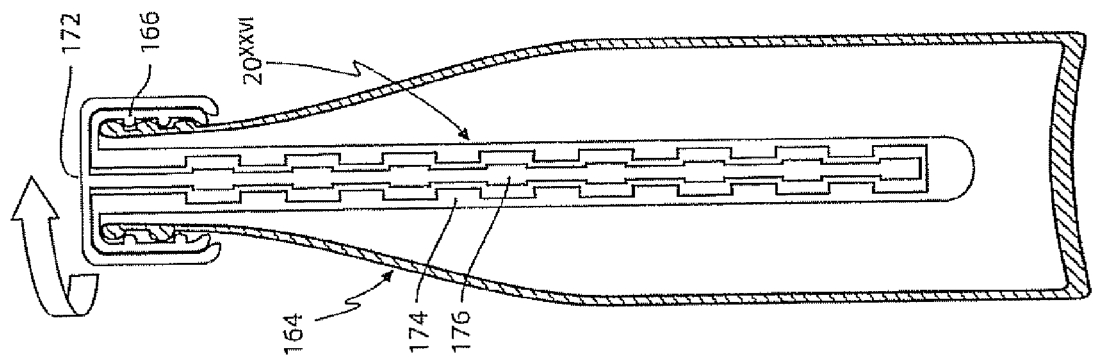

FIG 26 B

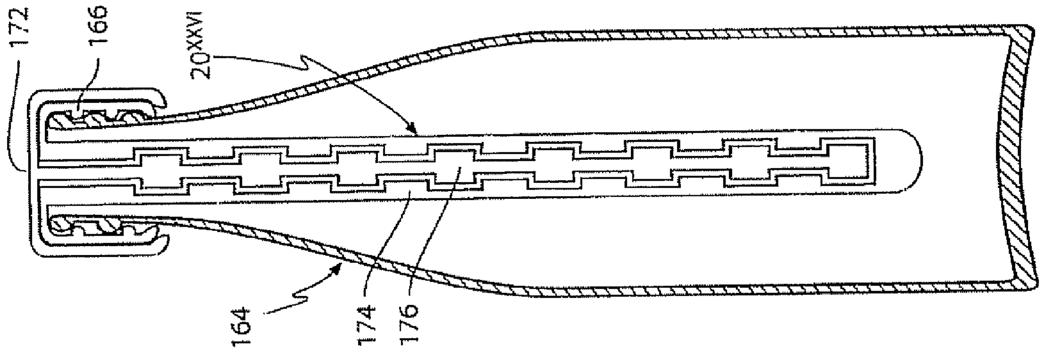

FIG 26A

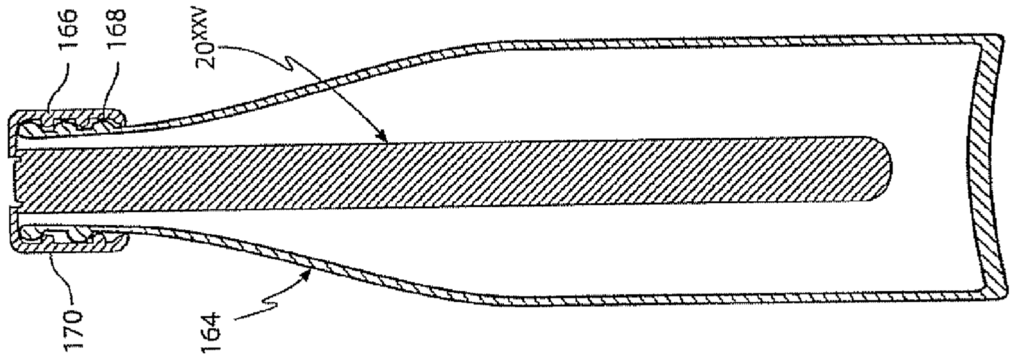

FIG 25

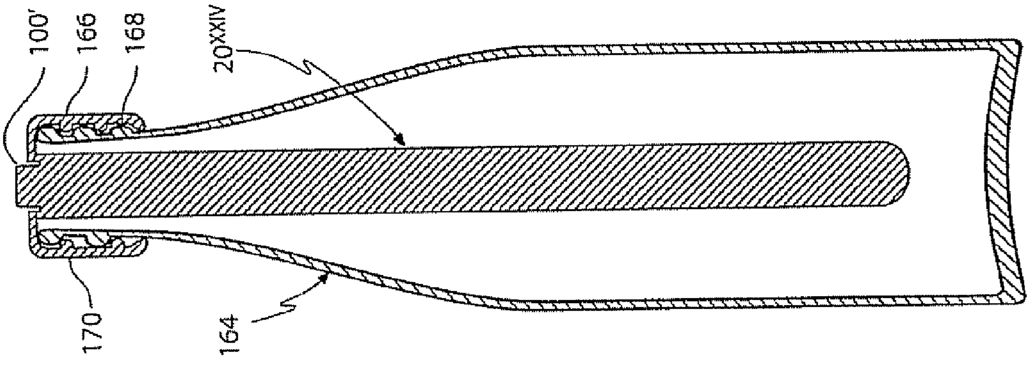

FIG 24

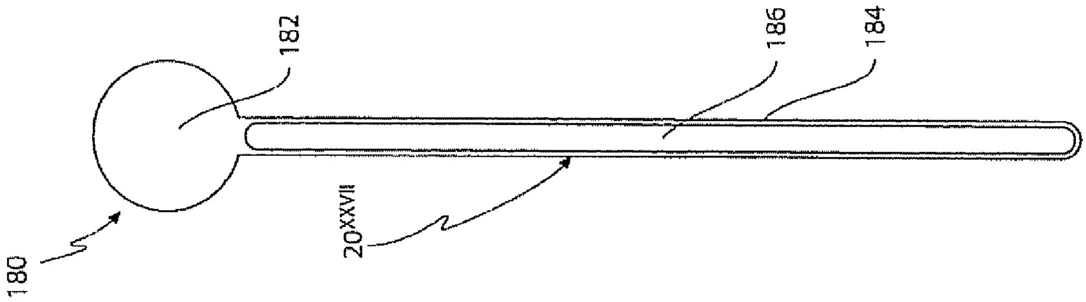

FIG 27A

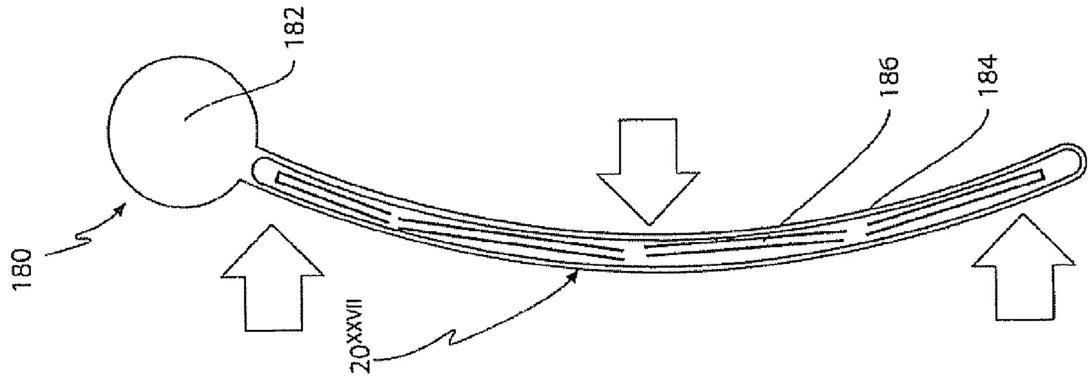

FIG 27B

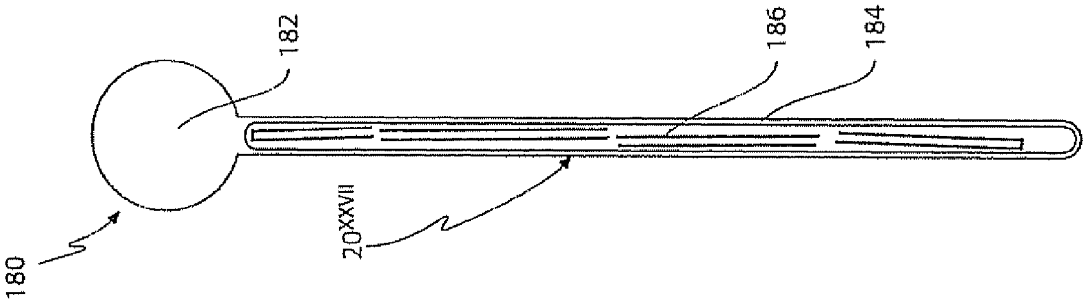

FIG 27C

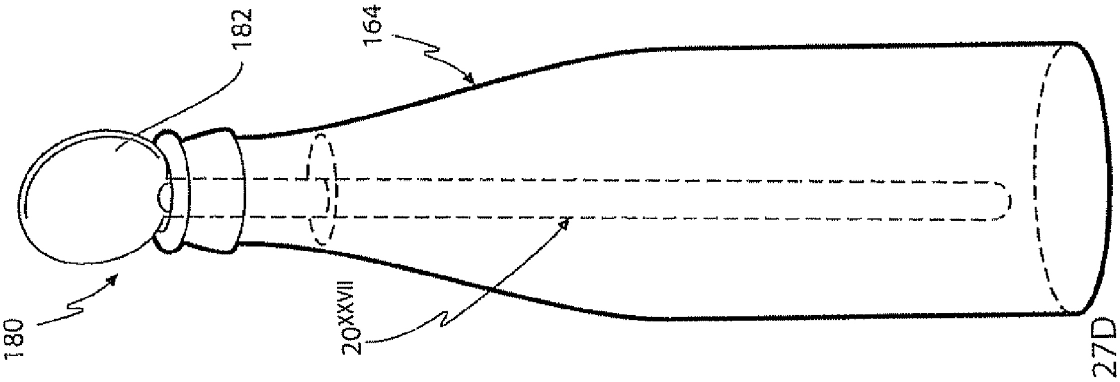

FIG 27D

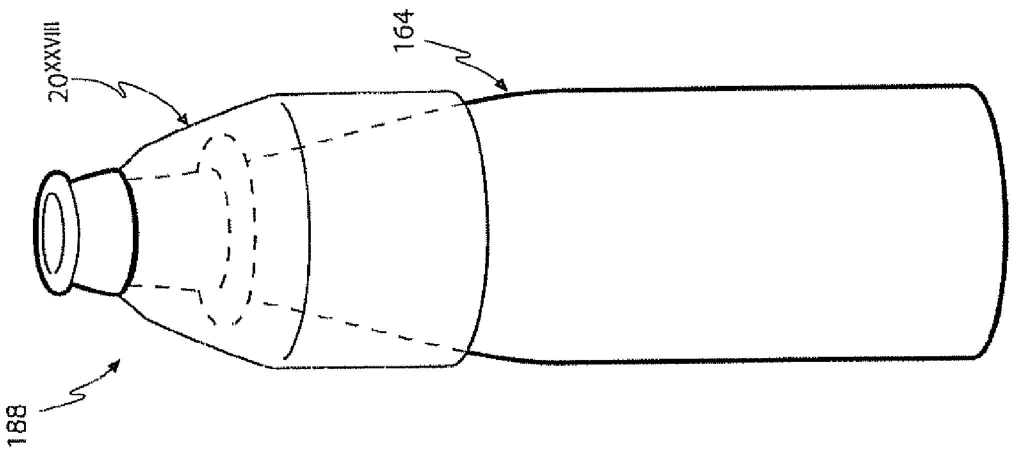

FIG 28C

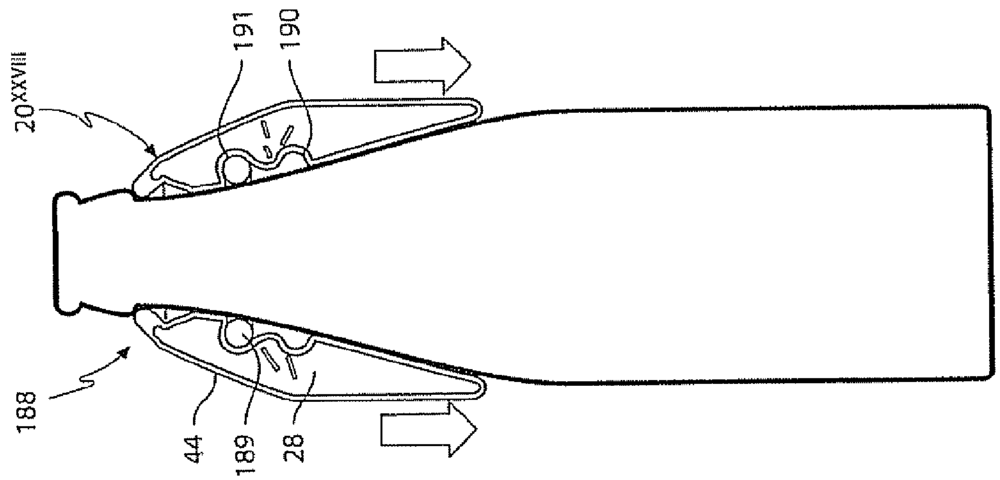

FIG 28B

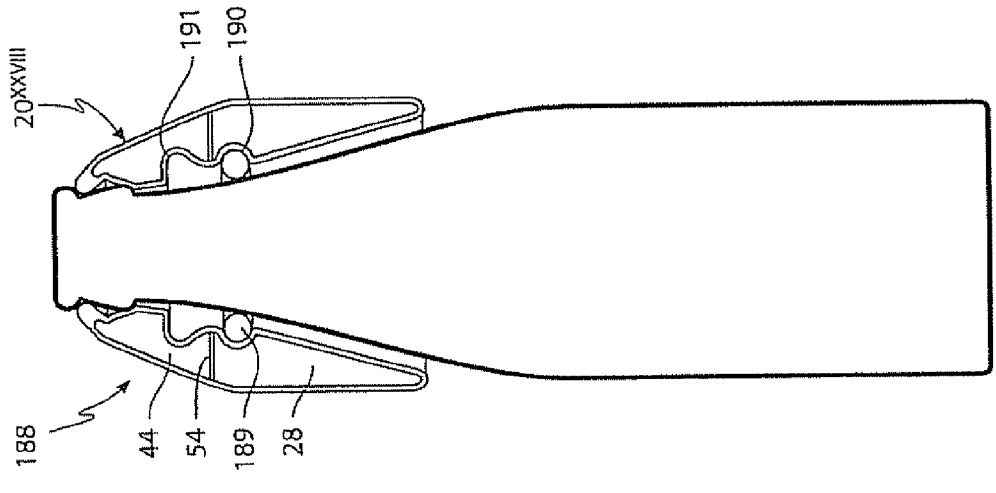

FIG 28A

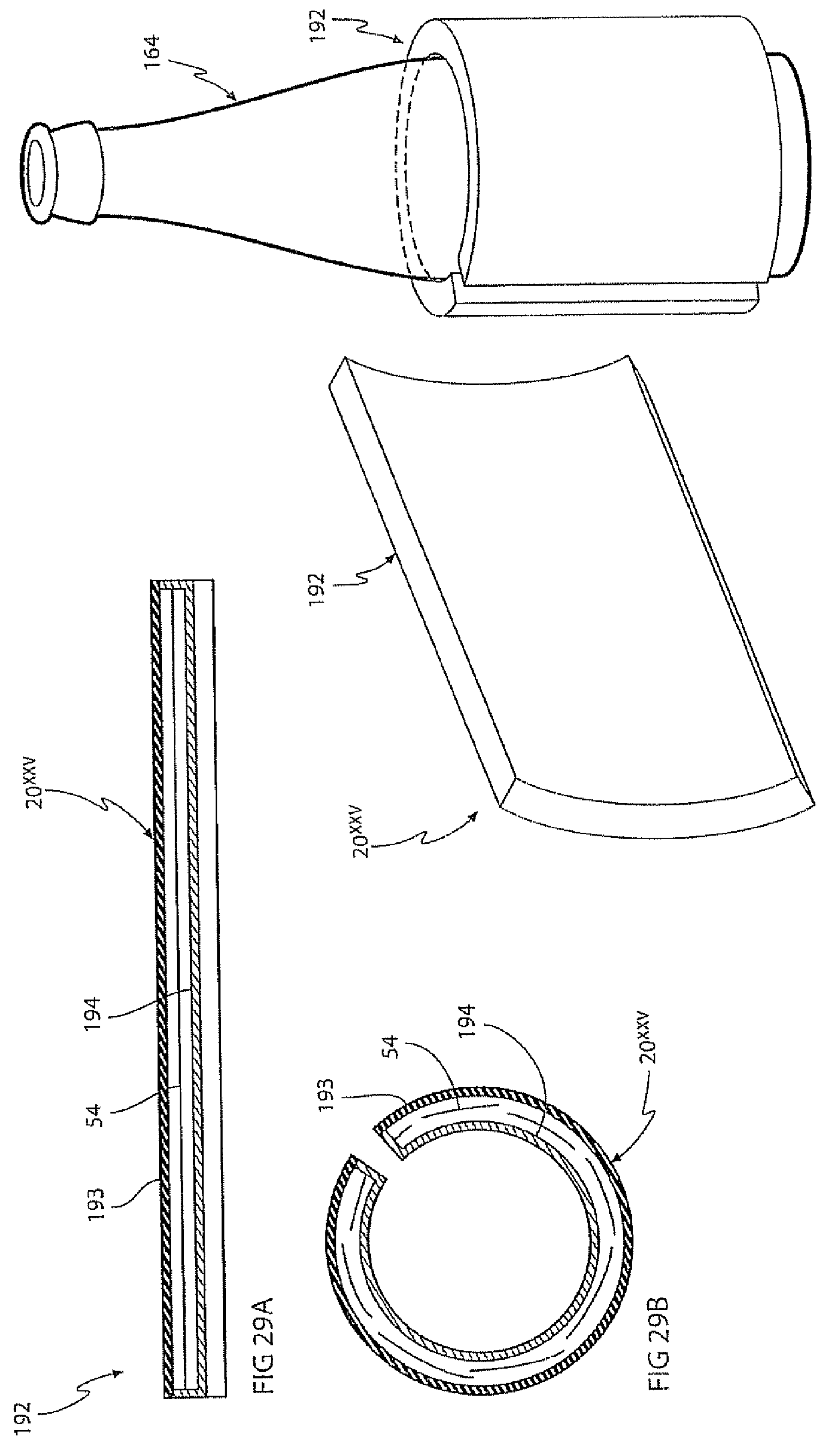

FIG 29A

FIG 29B

FIG 29C

FIG 29D

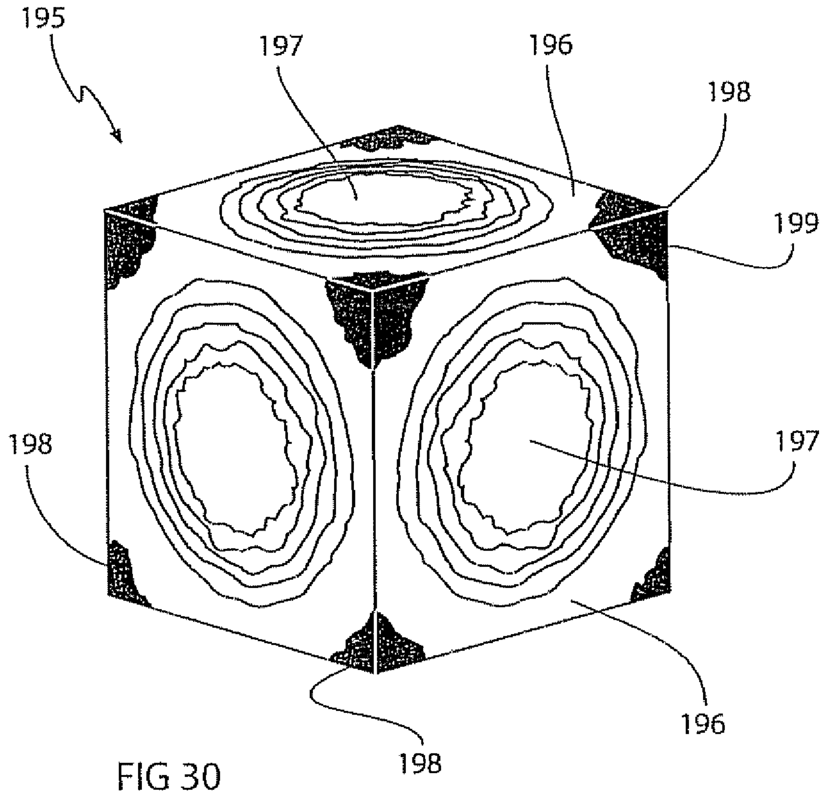

FIG 30

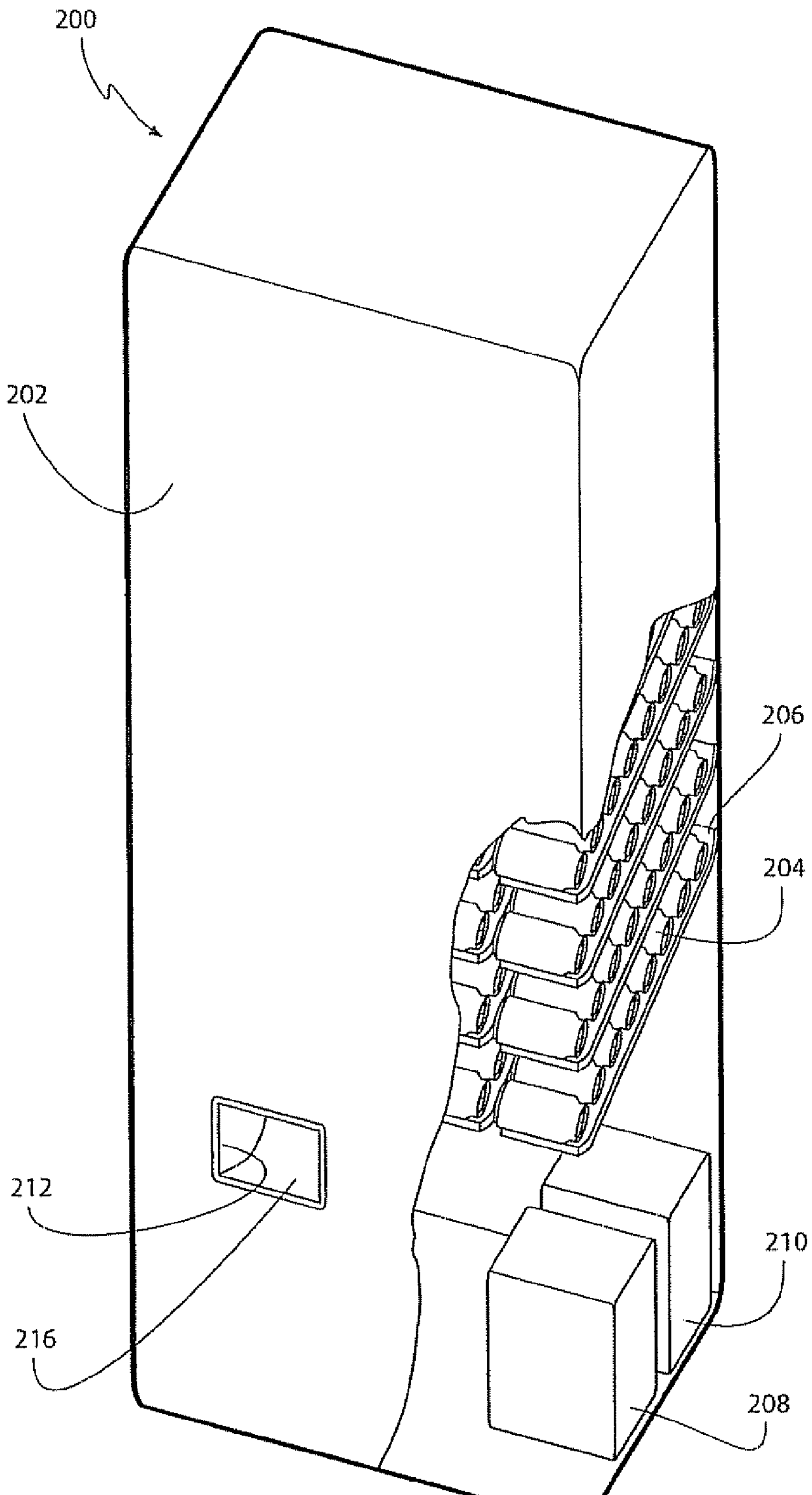

FIG 31

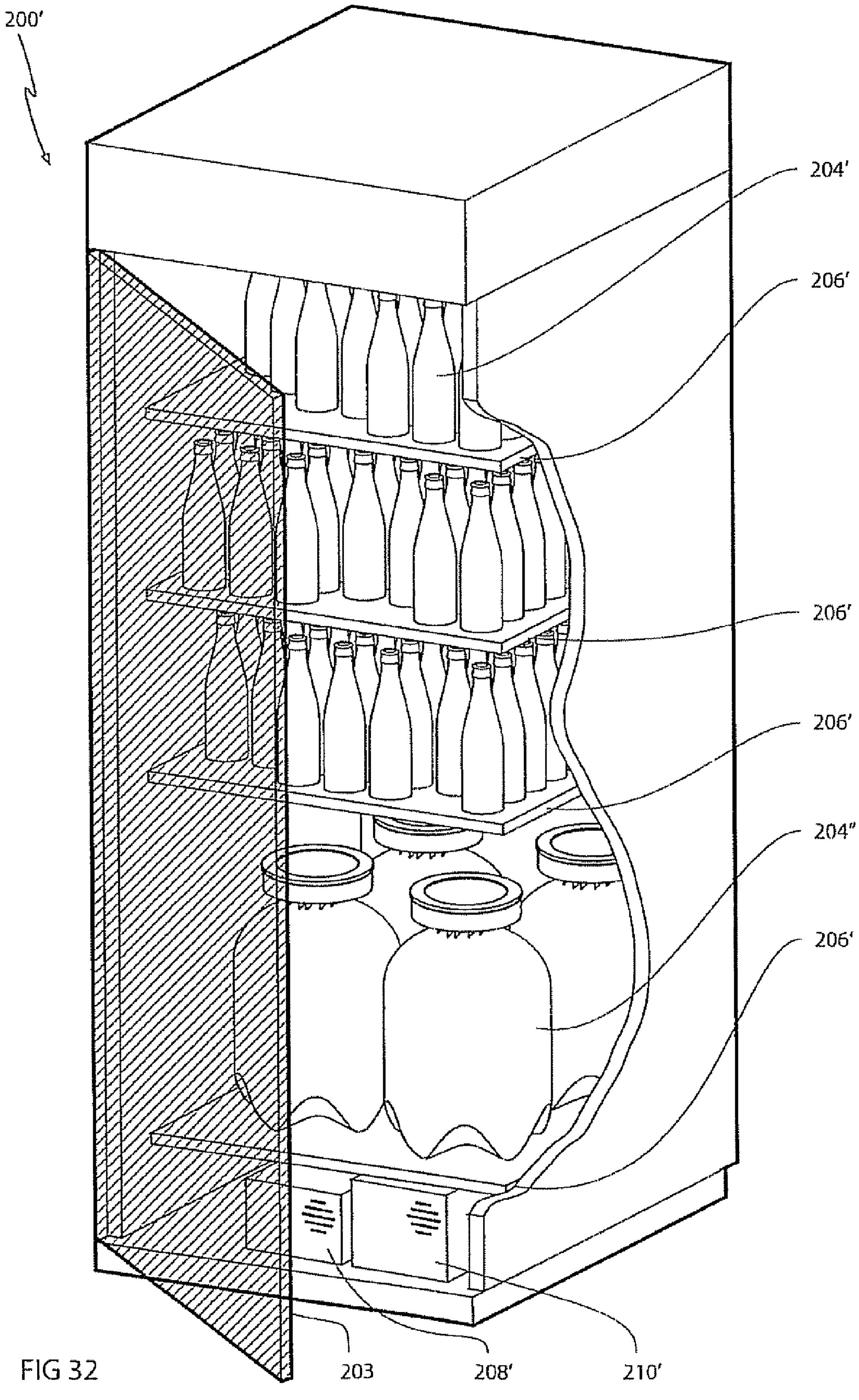

FIG 32

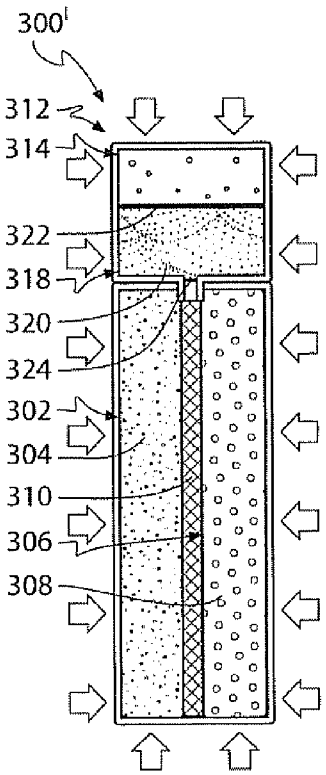

FIG. 33A

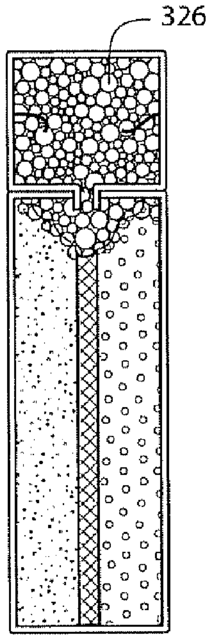

FIG. 33B

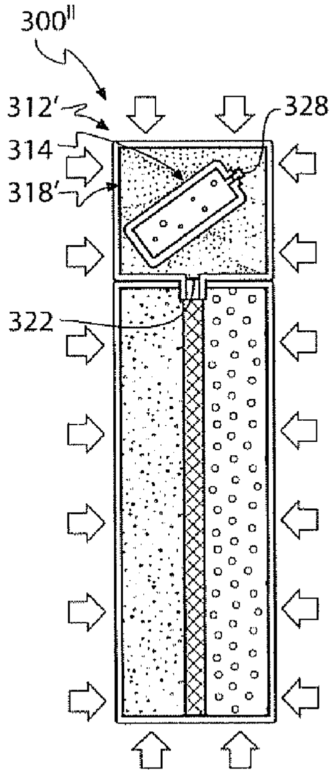

FIG. 34A

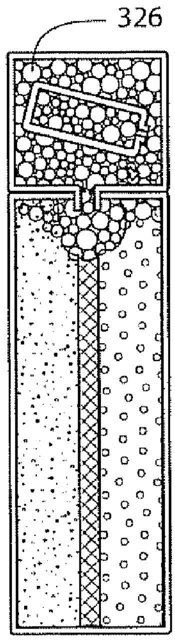

FIG. 34B

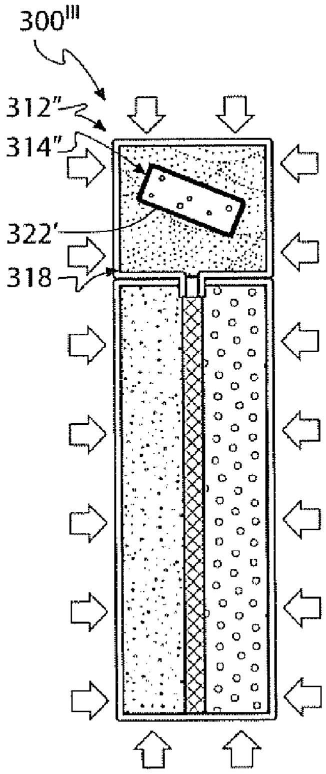

FIG. 35A

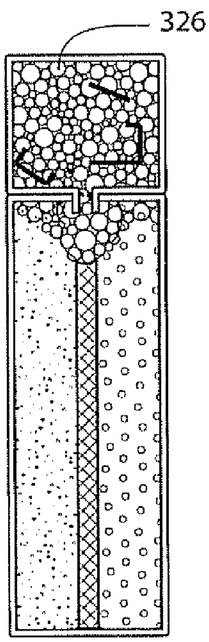

FIG. 35B

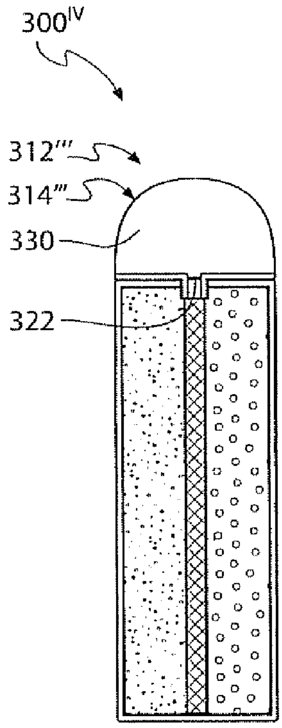

FIG. 36A

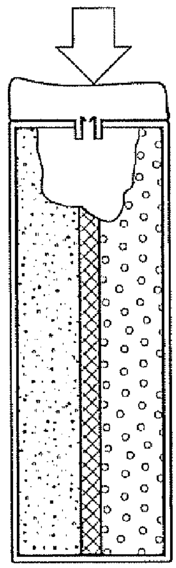

FIG. 36B

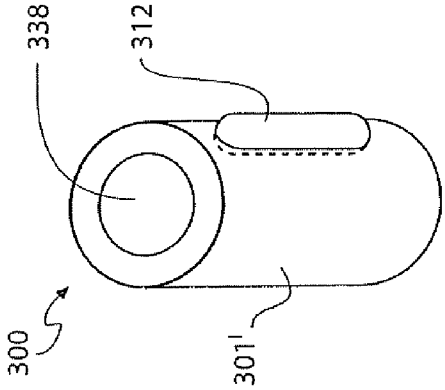

FIG.38A

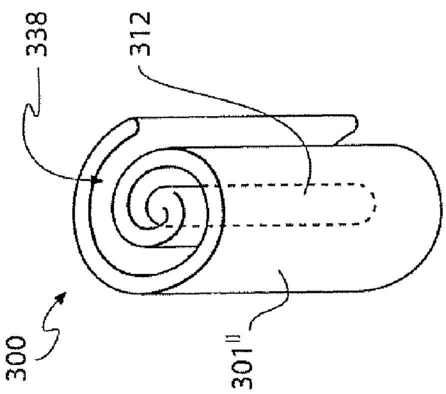

FIG.38B

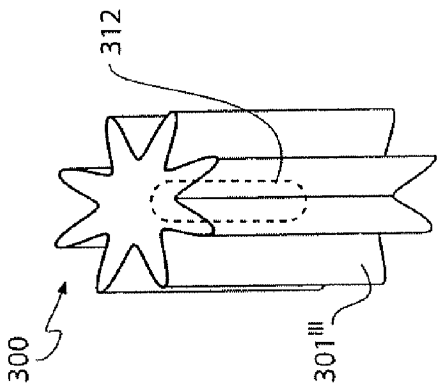

FIG.38C

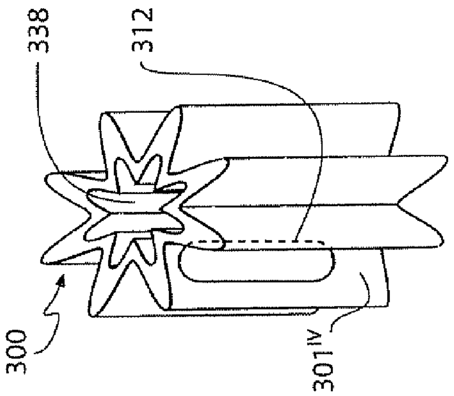

FIG.38D

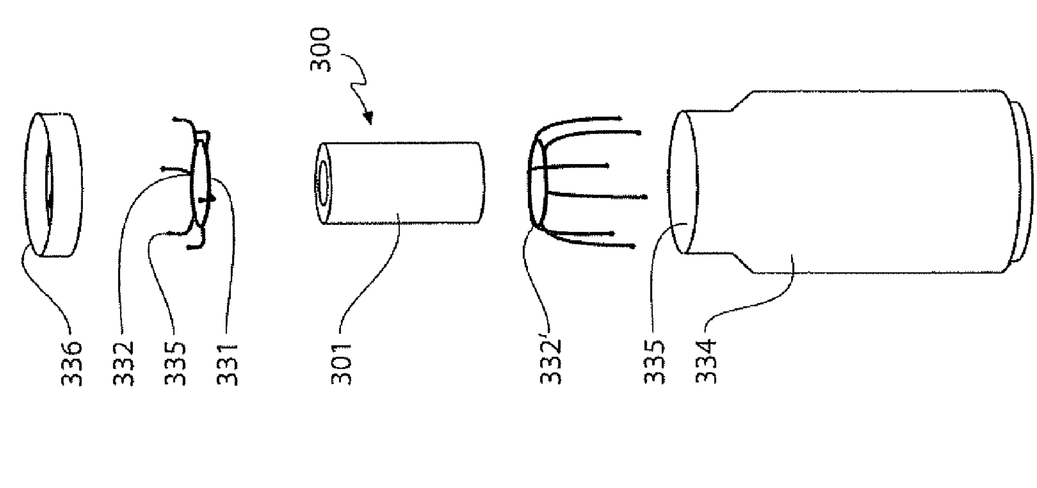

FIG.37A

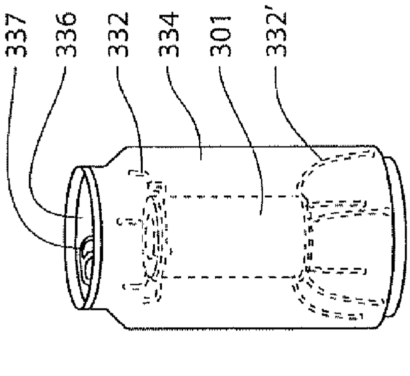

FIG.37B

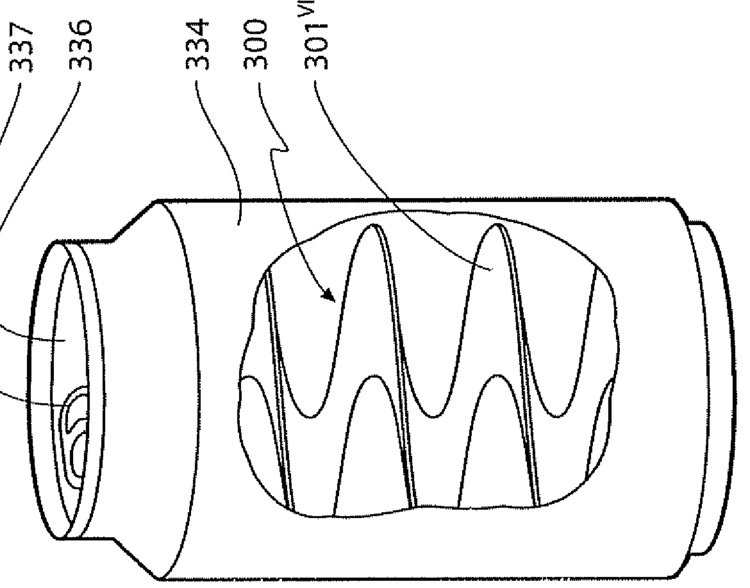

FIG. 40

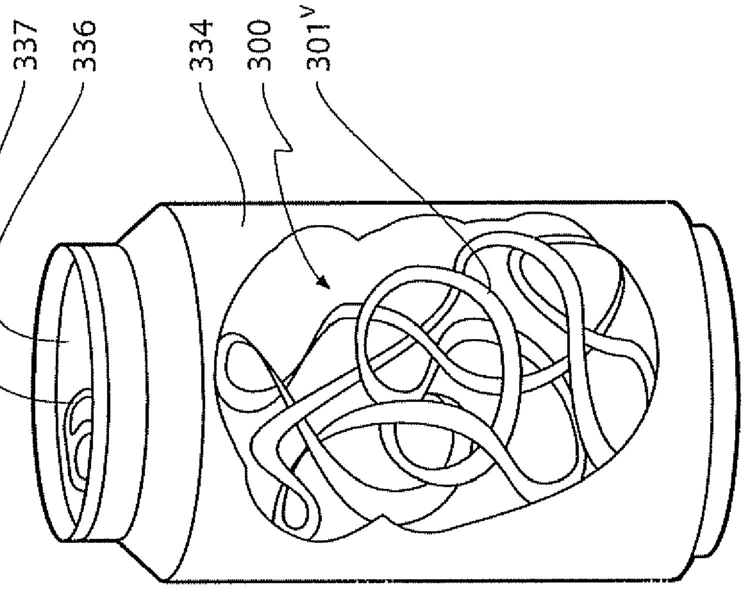

FIG. 39

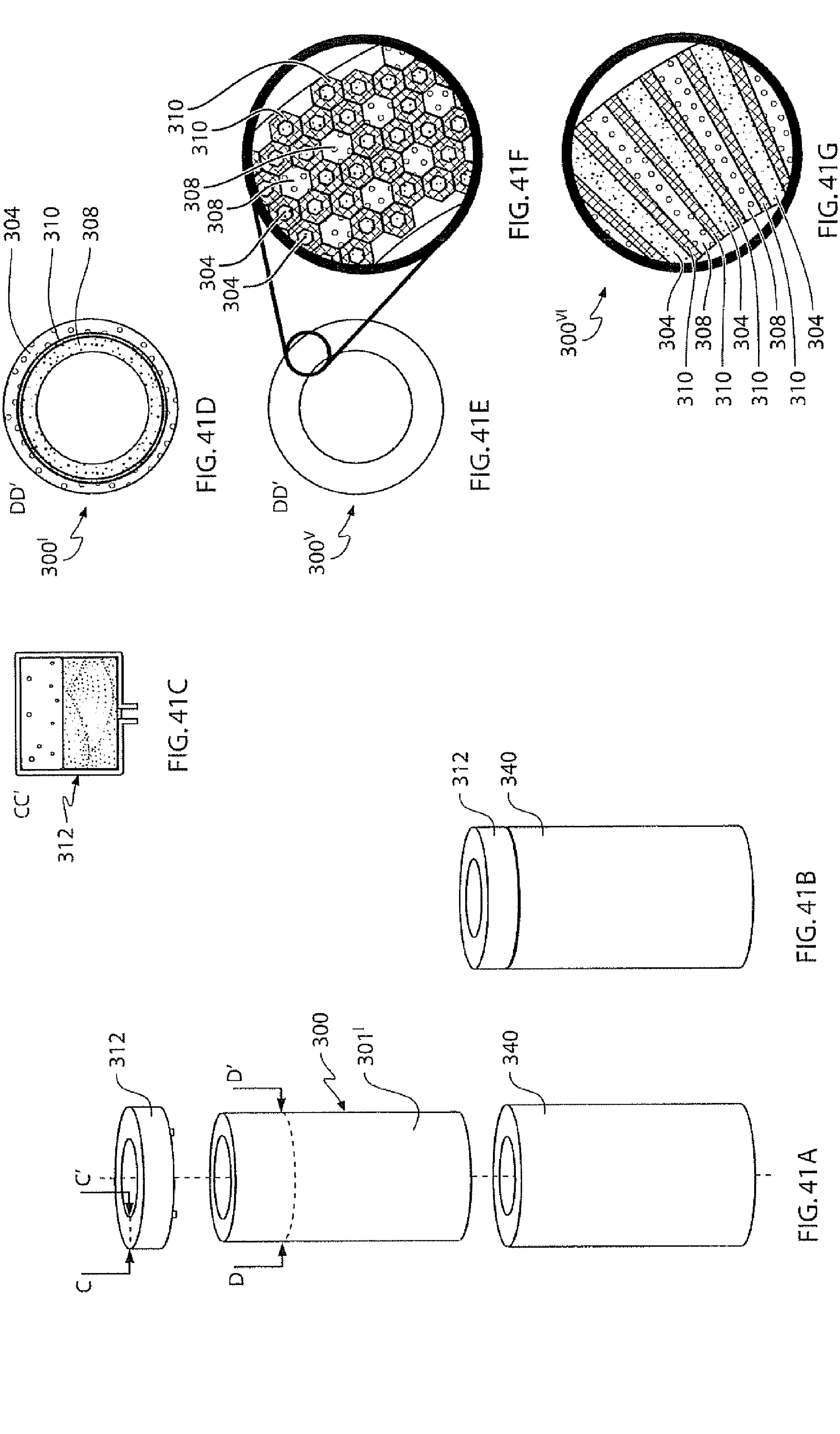

FIG. 41A

FIG. 41B

FIG. 41C

FIG. 41D

FIG. 41E

FIG. 41F

FIG. 41G

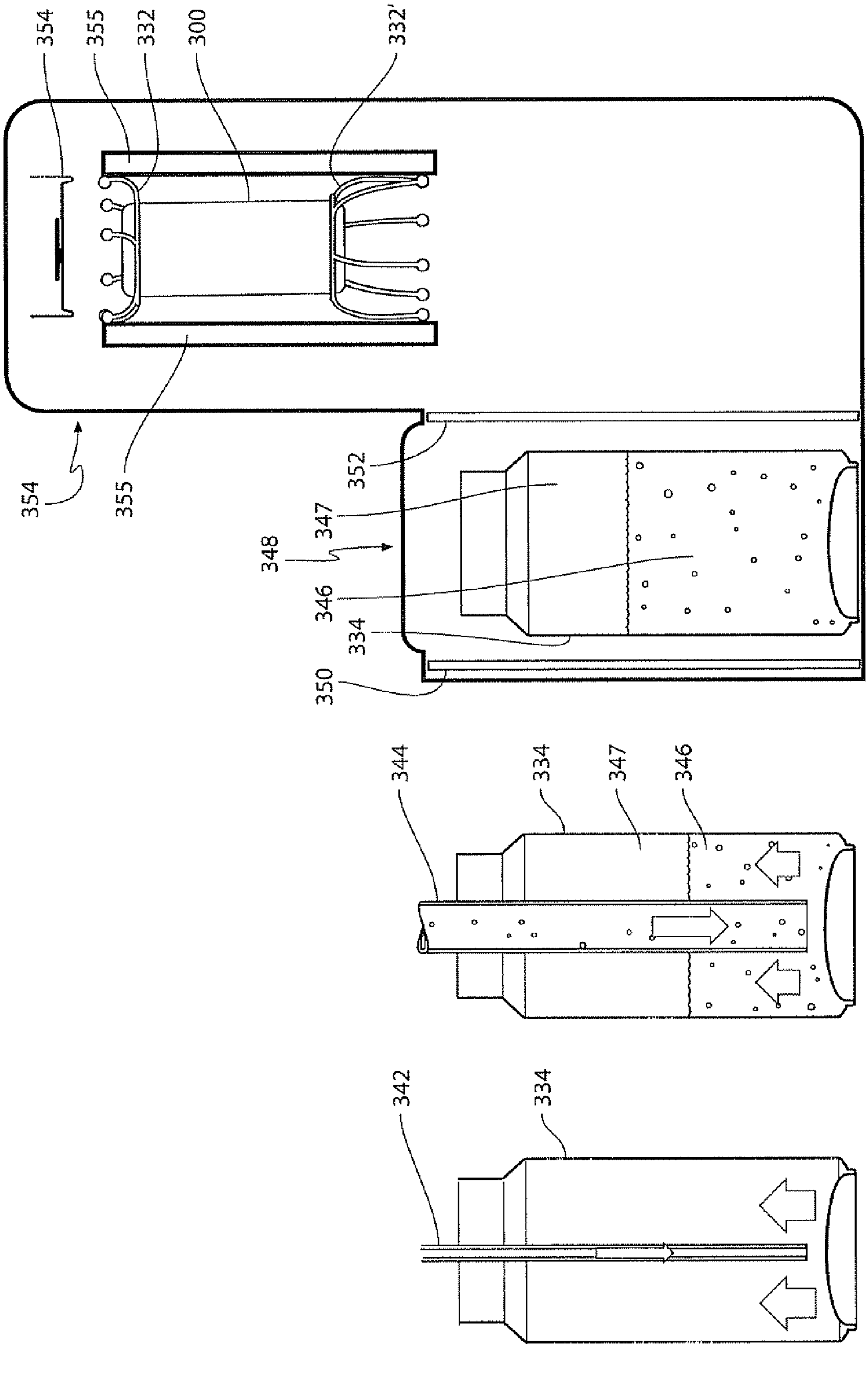

FIG 42C

FIG 42B

FIG 42A

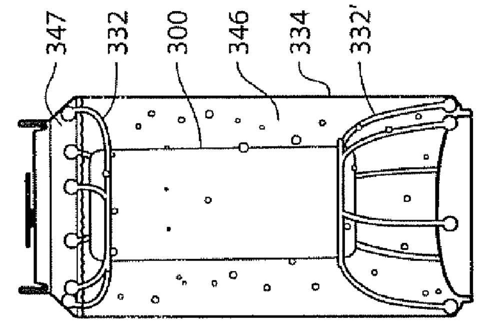

FIG 42F

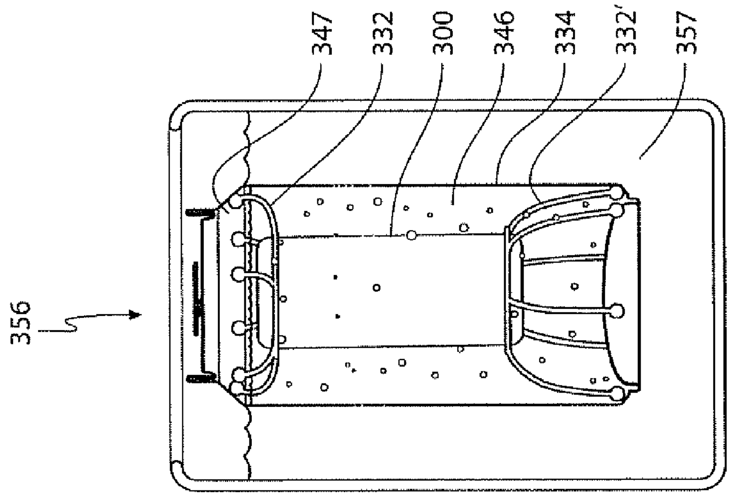

FIG 42E

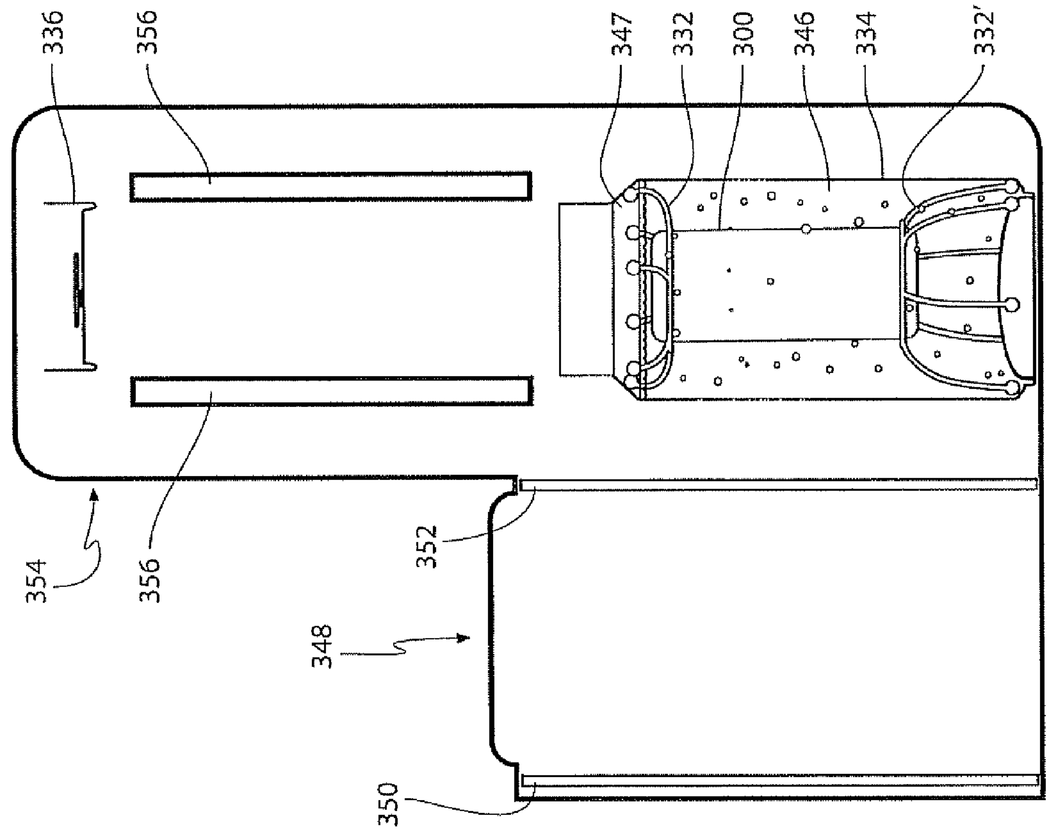

FIG 42D

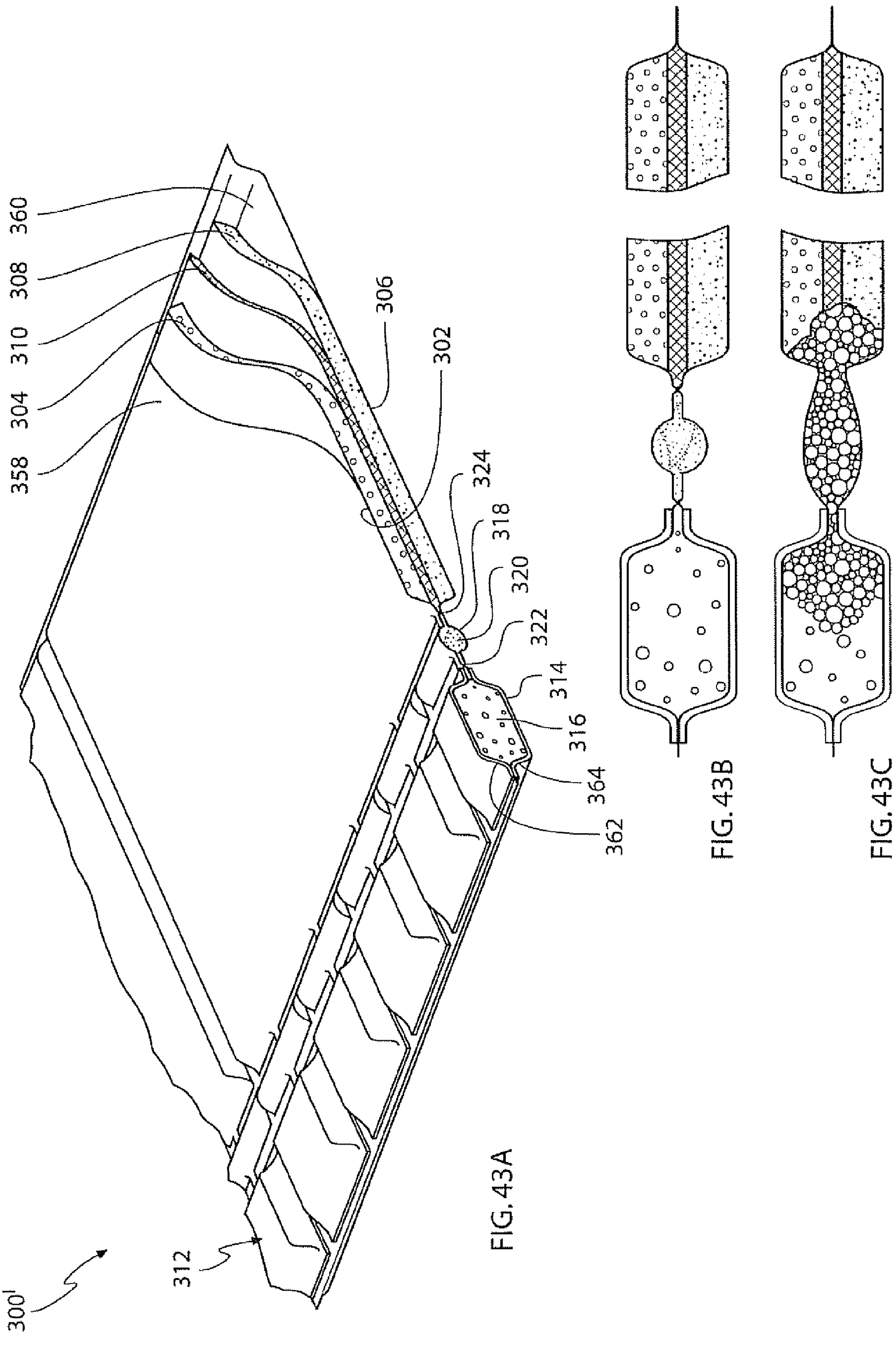

FIG.43A

FIG.43B

FIG.43C

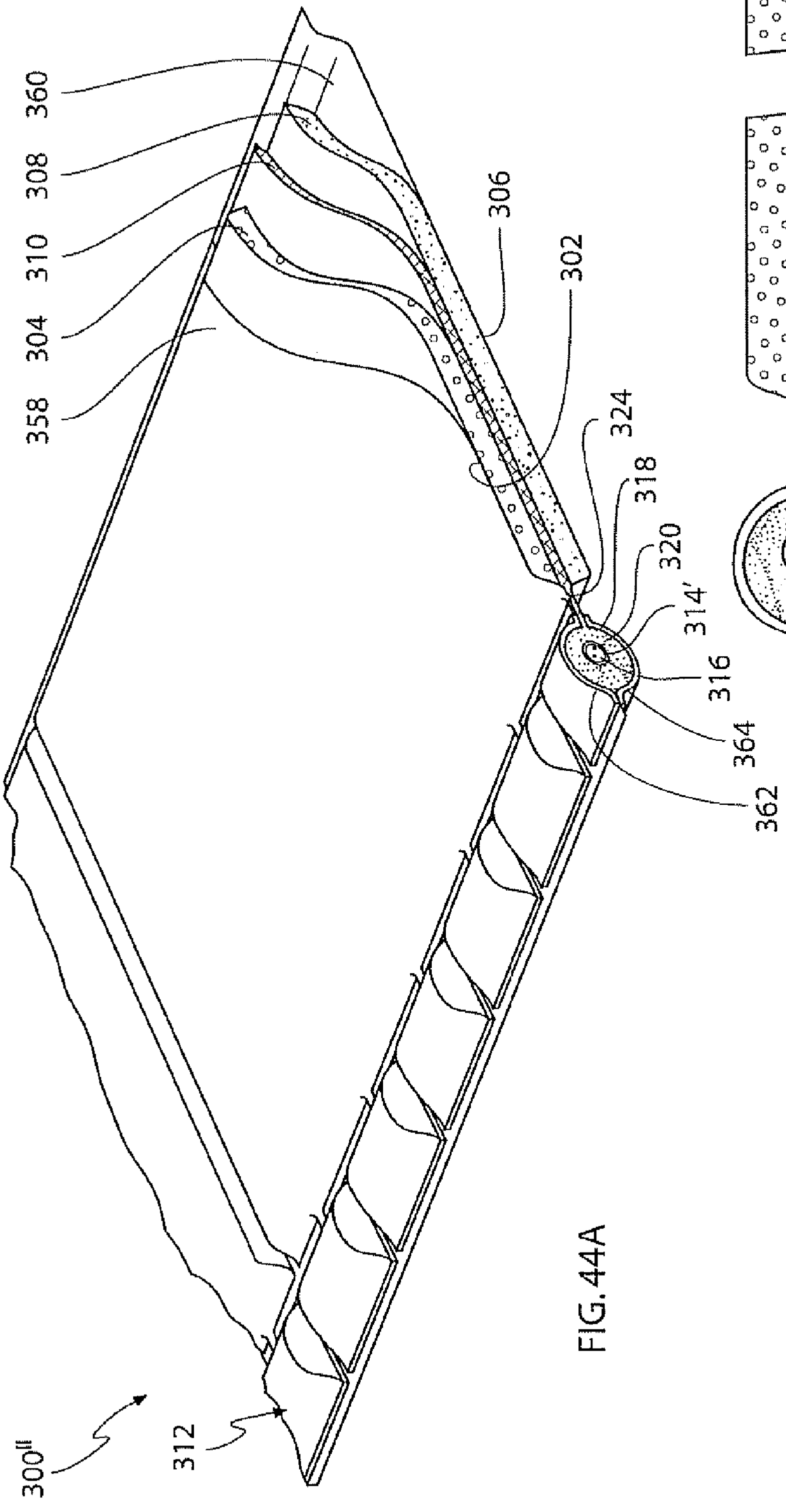

FIG. 44A

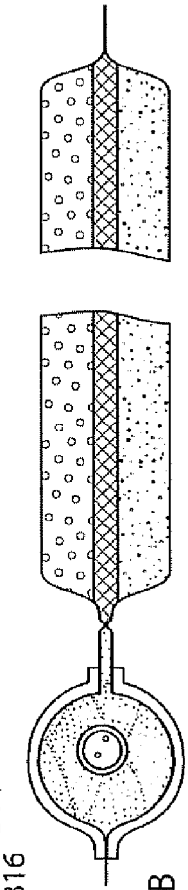
FIG. 44B

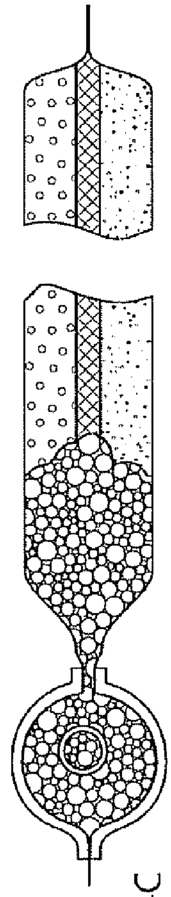
FIG. 44C

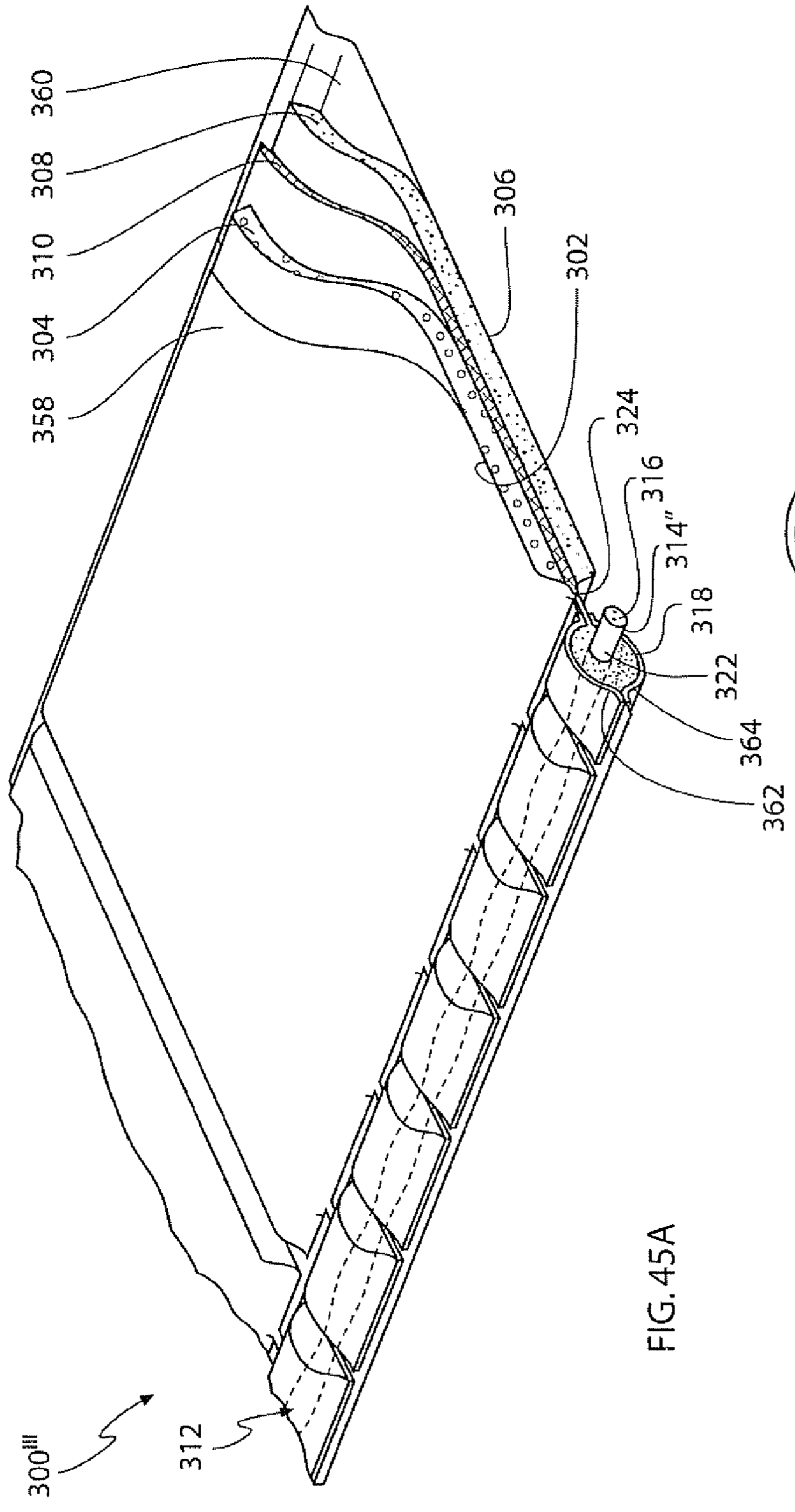

FIG. 45A

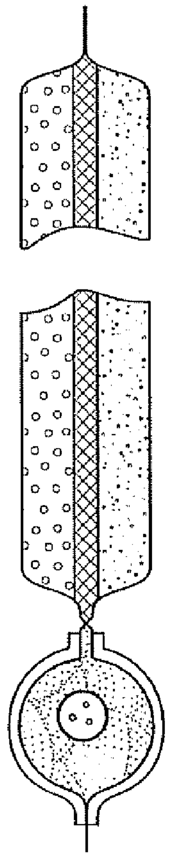

FIG. 45B

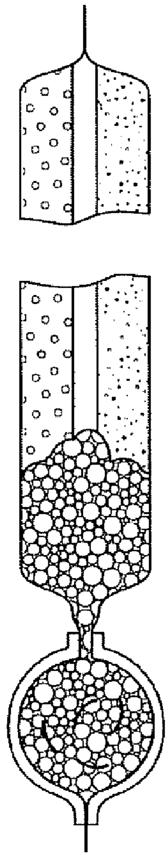

FIG. 45C

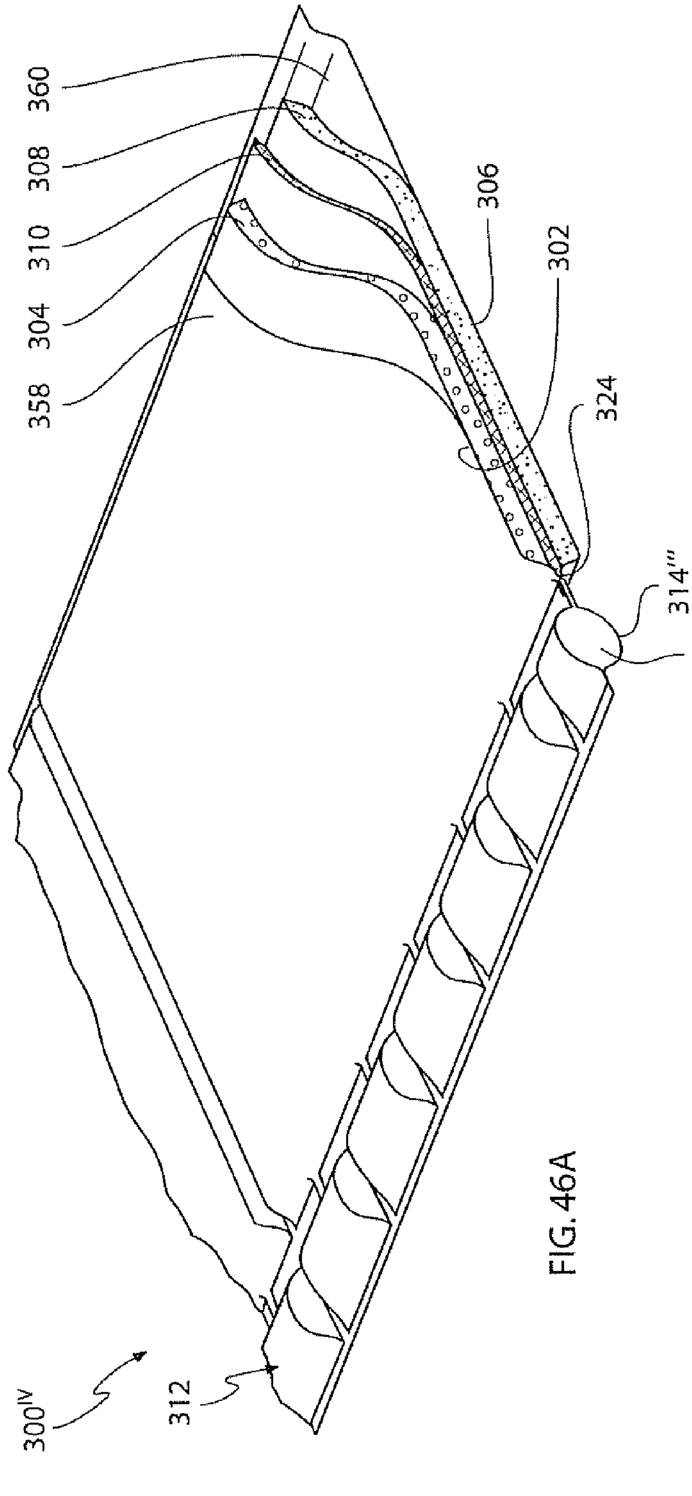

FIG. 46A

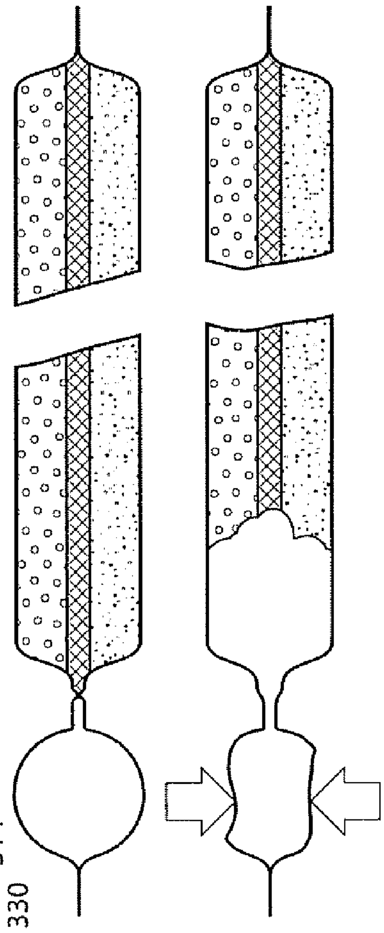

FIG. 46B

FIG. 46C

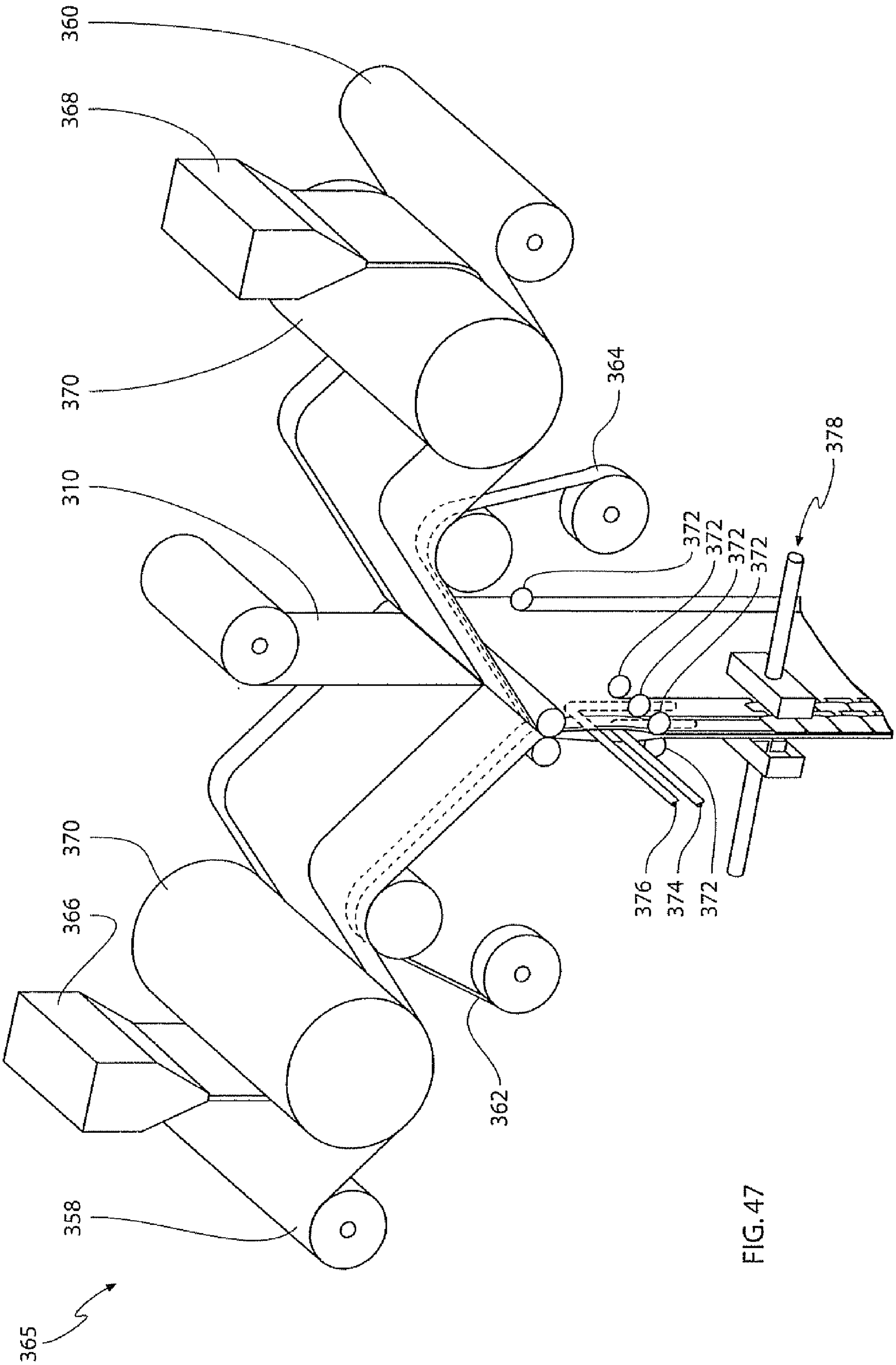
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FIG. 47

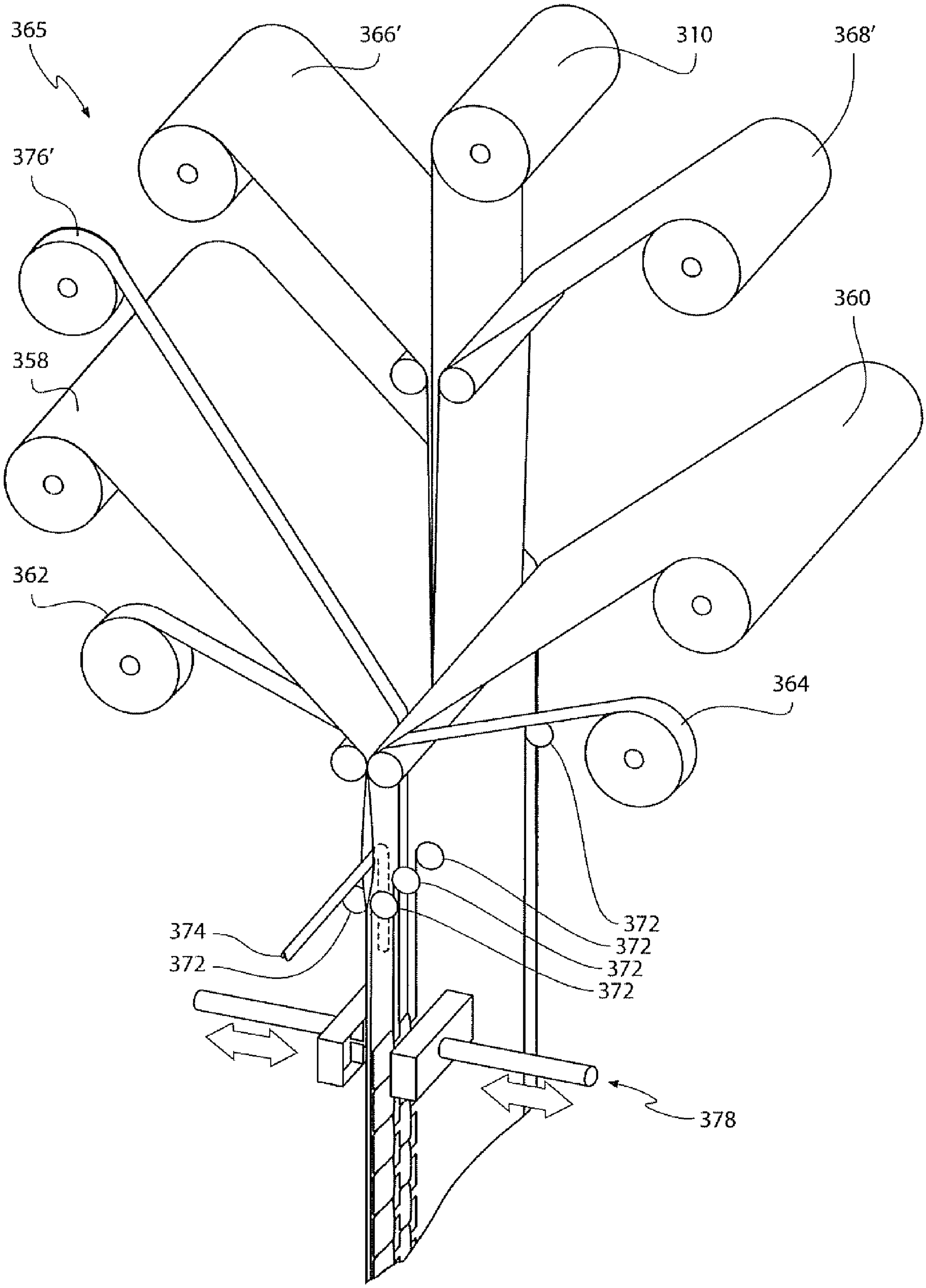

FIG. 48

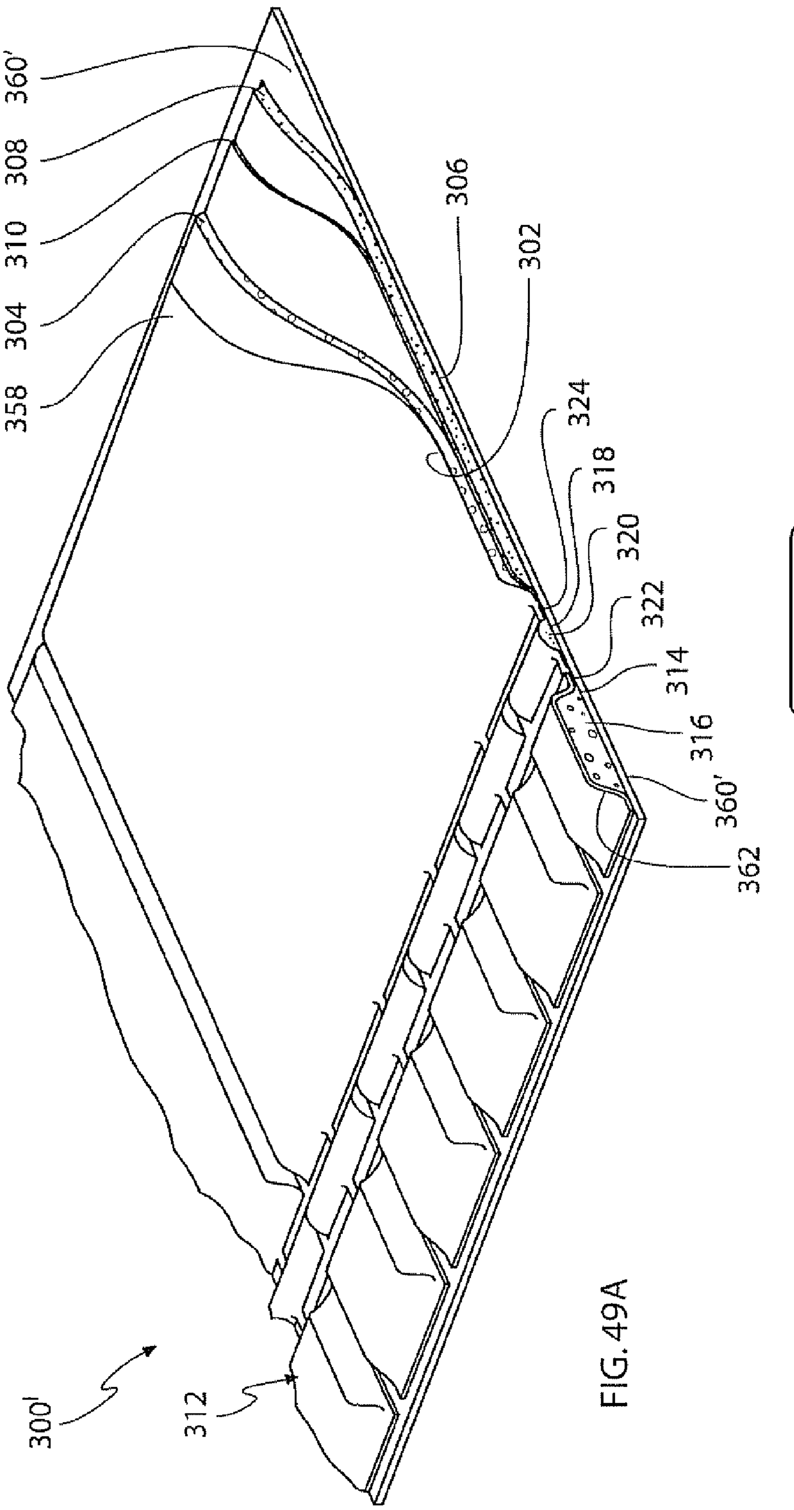

FIG.49A

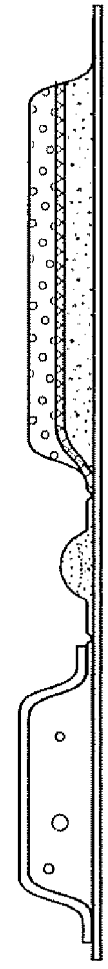

FIG.49B

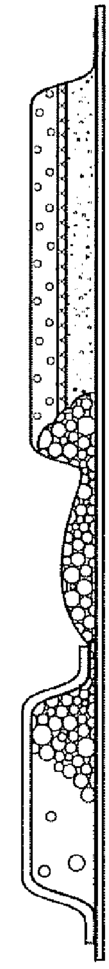

FIG.49C

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EUROPEAN SEARCH REPORT

Application Number
EP 10 16 6014

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 21 50 305 A1 (HOEHNE REINHARD F DR) 12 April 1973 (1973-04-12) * the whole document * -----	1-15	INV. F25D5/02
A	US 2008/016882 A1 (NEUWEILER JEFFREY C [US]) 24 January 2008 (2008-01-24) * the whole document * -----	1-15	
A	"5.1 Endothermic Reactions -- Ba(OH)2 H2O+NH4SCN", INTERNET CITATION, 29 November 2007 (2007-11-29), 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 * -----	1-15	
A	DE 299 11 156 U1 (RECKLEBEN TORSTEN [DE]) 16 September 1999 (1999-09-16) * the whole document * -----	1-15	TECHNICAL FIELDS SEARCHED (IPC) F25D
A	US 3 369 369 A (WEISS JOSEPH F) 20 February 1968 (1968-02-20) * the whole document * -----	1-15	
A	WO 2008/000274 A1 (CARLSBERG BREWERIES AS [DK]; VESBORG STEEN [DK]; RASMUSSEN JAN NOERAGE) 3 January 2008 (2008-01-03) * the whole document * -----	1-15	

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	17 November 2010	Jessen, Flemming

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17-11-2010

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 2150305 A1	12-04-1973	NONE	
US 2008016882 A1	24-01-2008	NONE	
DE 29911156 U1	16-09-1999	NONE	
US 3369369 A	20-02-1968	NONE	
WO 2008000274 A1	03-01-2008	CN 101479541 A	08-07-2009
		EA 200970077 A1	30-06-2009
		EP 2038593 A1	25-03-2009

EPO FORM P0459

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Patent documents cited in the description

- US 44013567 B **[0004]**
- US 7117684 B **[0004]**
- EP 0498428 A **[0004]**
- US 2882691 A **[0004]**
- GB 2384846 A **[0004]**
- WO 2008000271 A **[0004]**
- GB 2261501 A **[0004]**
- US 4209413 A **[0004]**
- US 4273667 A **[0004]**
- US 4303121 A **[0004]**
- US 4470917 A **[0004]**
- US 4689164 A **[0004]**
- US 20080178865 A **[0004]**
- JP 2003207243 B **[0004]**
- JP 2000265165 B **[0004]**
- US 3309890 A **[0004]**
- WO 8502009 A **[0004]**
- US 3229478 A **[0004]**
- US 4599872 A **[0004]**
- US 4669273 A **[0004]**
- WO 2000077463 A **[0004]**
- EP 87859 A **[0004]**
- US 4277357 A **[0004]**
- DE 3024856 **[0004]**
- US 5261241 A **[0004]**
- GB 1596076 A **[0004]**
- US 6558434 B **[0004]**
- WO 02085748 A **[0004]**
- US 4993239 A **[0004]**
- US 4759191 A **[0004]**
- US 4752310 A **[0004]**
- WO 0110738 A **[0004]**
- EP 1746365 A **[0004]**
- US 4784678 A **[0004]**
- US 2746265 A **[0004]**
- US 1897723 A **[0004]**
- US 4802343 A **[0004]**
- US 4993237 A **[0004]**
- DE 2150305 A1 **[0012] [0019]**
- DE 29911156 U1 **[0013]**
- US 20080016882 A **[0019]**
- EP 083880419 A **[0147]**
- WO 2007019853 W **[0149]**