Title: SELF-CONTAINED, PRESSURE-ACTIVATED COOLING DEVICE

Abstract: A self contained cooling apparatus (60) in a pressurized beverage container (10) includes an outer at least partially compressible housing (62, 103) which contains a liquid and is sealed by a diaphragm (66) and an inner breakable housing (64, 90) which contains a sorbent (29) mixed with a phase change material (29). When the container (10) is opened the pressure falls whereby the diaphragm (66) which was pushed inwardly returns and fractures the shell of the inner housing (64, 90) thereby exposing the sorbent (29) to the liquid which by evaporating cools the beverage. The diaphragm (66) can be kept in its pushed-in state by a torsionally twistable bridge (68), a dissolvable column (111) or a spring (115) held by a dissolvable latch (117).
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
SELF-CONTAINED, PRESSURE-ACTIVATED COOLING DEVICE
BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the mechanical arts. In particular, the present invention relates to self-contained beverage coolers which may be activated upon demand by the use of a pressure responsive valve.

2. Discussion of the Related Art

There are many beverages that may be stored almost indefinitely at average ambient temperatures of 20°-25° C, but require cooling immediately before consumption. In general, the cooling of these beverages is accomplished by electrically-run refrigeration units. The use of these units to cool such beverages is not always practical, because refrigerators generally require a source of electricity, they are not usually portable, and they do not cool the beverage quickly.

An alternative method for providing a cooled material on demand is to use portable insulated containers. However, these containers function merely to maintain the previous temperature of the beverage placed inside them, or they require the use of ice cubes to provide the desired cooling effect. When used in conjunction with ice, insulated containers are much more bulky and heavy than the beverage. Moreover, in many locations, ice may not be readily available when the cooling action is required.

Ice cubes have also been used independently to cool beverages rapidly. However, use of ice independently for cooling is often undesirable because ice may be stored only for limited periods above 0° C. Moreover, ice may not be available when the cooling action is desired.

Most attempts to build a self-contained, miniaturized cooling device have depended on the use of a refrigerant liquid stored at a pressure above atmospheric pressure, so that the refrigerant vapor could be released directly to the atmosphere. Unfortunately, many available refrigerant liquids have serious drawbacks when used to cool beverages. For example, the liquids are either flammable, toxic, harmful to the environment, or exist in liquid form at such high pressures that they represent an explosion hazard in quantities suitable for the intended purpose. Conversely, other available refrigerant liquids acceptable for discharge into the
atmosphere (such as carbon dioxide) have relatively low heat capacities and latent heats of vaporization necessitating larger devices. As a result, cooling devices releasing carbon dioxide are bulkier than is commercially acceptable for a self-contained device.

The prior art discloses numerous disposable beverage containers having various types of self-contained cooling devices therein. However, most cooling devices have thus far been unduly complicated and expensive. One reason for the complexity of each of the devices has been the need to construct a mechanism to activate the cooling process upon demand. To accomplish this task, the prior art utilizes various ways of attaching the cooling device to the flip-top tab portion of the beverage container. Such a construction compromises the effectiveness of the cooling apparatus and seriously limits the type of cooling devices which may be incorporated into beverage containers. Moreover, the mechanisms take up valuable space within the container so that less beverage can fit within it; alternatively, they require the use of an unduly large container.

U.S. Pat. No. 4,911,740 discloses a self-contained cooling device in which a cooling effect is produced by causing a refrigerant liquid to evaporate under reduced pressure in a first sealed chamber and in the process absorb heat from its surroundings. The resulting refrigerant vapor is then adsorbed or absorbed by a desiccant housed in a second, separate chamber. To achieve an effective cooling action, both the evaporative housing and the desiccant or sorbent housing must be maintained at a vacuum pressure level. The desiccant housing, in particular must have a substantial vacuum condition.

However, there remains a definite need for self-contained cooling devices having improved effectiveness. There remains a further need for self-contained cooling devices that take up a minimum amount of space in a beverage container. There remains a still further need for self-contained cooling devices that are simple and inexpensive to manufacturer and to install in beverage containers. The present invention satisfies these and other needs and provides further related advantages.

**SUMMARY OF THE INVENTION**

The present invention is embodied in a self contained cooling device in a pressurized host container comprising (1) a first housing at least partially compressible containing a
vaporizable liquid, (2) a second evacuated housing containing a sorbent for the liquid, the second housing being contained within the first housing and having a breakable shell, and (3) a trigger for breaking the shell of the second housing and exposing the sorbent within the second housing to the vaporizable liquid in the first housing when the pressure within the host container is lowered below a predetermined value.

The present invention is further embodied in a system for cooling a substance comprising (1) a pressurized host container, (2) a self-activated cooling device comprising a first housing at least partially compressible containing a vaporizable liquid, a second evacuated housing containing a sorbent for the liquid, the second housing being contained within the first housing and having a breakable shell; and a trigger for breaking the shell of the second housing and exposing the sorbent within the second housing to the vaporizable liquid in the first housing when the pressure within the host container is lowered below a predetermined value.

Specifically, the present invention comprises a temperature changing device that is immersed in and capable of operating physically unattached to a pressurized liquid filled host container or aluminum can. The temperature changing device is a self-contained unit having at least two separated housings, the first housing containing an evaporant liquid at low pressure to be adsorbed or absorbed by a sorbent or desiccant and the second housing being substantially evacuated and containing that sorbent or desiccant. Thus, when a communication channel is opened between the two housings, there is an associated drop in pressure in the first housing due to the evacuated condition of the second housing. The drop in pressure causes the liquid in the first housing to vaporize, and this liquid-to-gas phase change results in removing heat equal to the latent heat of vaporization of the evaporated liquid from the first housing, thereby cooling the first housing. As a result, the exterior walls of the first housing in contact with the beverage are cooled, thereby cooling the beverage.

Adequacy of the cooling effect, however, requires that the problems referred to above are sufficiently dealt with. To assure that the desiccant housing is adequately evacuated, any desiccant used needs to be thoroughly activated. Alternatively, a suitable phase change material may be included with the desiccant as a heat absorber.

The removal of too great a level of heat from the first housing can cause any liquid contained within the housing to freeze. To avoid this problem and to provide a continuous
stream of water or other liquid to be evaporated, it is desirable to coat the inner wall of the evaporative housing with a sintered heat pipe material or micropore material which will keep a substantial amount of the liquid (water) entrained in the wall.

To activate the cooling process, the user merely opens a flip-top tab, or other opening device which releases the pressure from within the beverage container so that a pressure responsive means allows communication between the two separated housings. The first exemplary embodiment utilizes two sealed housings, one inside the other, with the inside housing containing a desiccant and a phase change material, suitably mixed. The inside housing is evacuated to a hard vacuum and is in the form of an ampule with a knob or projection at each end with glass sidewalls, preferably pre-scored. At the lower end of the inner housing, the knob is secured with clips to the outer housing which is in the form of a cylinder closed on one end. At its upper end, the outer housing containing a refrigerant liquid, is closed via a diaphragm. A clip secured to the inside of the diaphragm is adapted to capture the projection on the inner housing. A bridge member made from an elastic material which spans the outside of diaphragm may be torsionally twisted to displace the diaphragm into a position where the clip captures the upper knob on the ampule. When the cooling device is placed in the host container and the host container is filled and pressurized, the additional pressure further displaces the diaphragm away from the bridge and the bridge is released from its twisted position, allowing the diaphragm to move upward when the pressure applied to it is reduced below a predetermined state. The device remains in this condition until the pressure is released from the host container at which time the diaphragm returns to its normal or unloaded position. In so doing, the movement of the inner housing causes the clip to pull the captured projection upwardly, fracturing the ampule and communicating the contents of the evacuated inside housing with the refrigerant fluid, which may be water. This interaction causes the refrigerant fluid to vaporize, cooling the walls of the outside housing and, hence, the contents of the host container. The resulting vapor flows into the desiccant and is absorbed or adsorbed and the heat absorbed by the phase change material. The sintered heat pipe or micropore material described above may be used to coat the inside and/or outside of the evaporative housing.

In a second exemplary embodiment, the knob and projection of the inner housing are removed for a glass ampule structure with a pre-scored circumferential recess. Replacing the clips securing the knob on the inner housing is a receiving base made up of a plurality of receiving arms with gripping fingers extending vertically upward to secure the inner housing
at the recess. Replacing the clips securing the projection on the inner housing is a locking structure made up of a plurality of grabbing arms with grasping fingers extending vertically downward to secure the inner housing at the recess when the bridge spanning the diaphragm is twisted so as to force the diaphragm downwards. After being placed in the host container and during the host container sealing process, the diaphragm is displaced further downwards by the increased pressure within the container, thus releasing the bridge from its twisted position. The eventual release in pressure due to the opening of the beverage container causes the diaphragm with the secured inner housing, and thus the locking structure, to move upwards while the receiving base remains stationary. The counteracting forces applied to the inner housing causes it to fracture resulting in the cooling of the beverage as previously described.

In a third exemplary embodiment, a column of dissolvable sugar mounted to the bridge replaces the elastic torsional bridge as the device displacing the diaphragm in a downwards position during assembly. After the beverage is introduced into the host container and the host container is sealed, the column dissolves into the beverage allowing for the diaphragm to freely move upwards when the pressure within the container is reduced below a predetermined value so as to fracture the inner housing.

In a fourth exemplary embodiment, a leaf spring secured by a small amount of sugar or salt to the bridge replaces the dissolvable sugar column in displacing the diaphragm in a downwards position during assembly. The leaf spring has a memory such that it tends to straighten out, but is held in a bowed configuration against the diaphragm. After the beverage is introduced into the host container and the host container is sealed, the sugar or salt securing the leaf spring dissolves, whereby the spring straightens out allowing for the diaphragm to freely move upwards when the pressure within the container is reduced below a predetermined value so as to fracture the inner housing.

In a fifth exemplary embodiment, the outer housing is fully compressible with a series of bellows to form an accordion-like structure. When one of the previously described ampule configurations is placed within the outer housing during assembly, it is secured by the receiving base while the locking structure is placed on top to a point where the grasping fingers do not sit in the recess. When the beverage is introduced and during the sealing process of the host container, the outer housing compresses such that the grasping fingers on the locking structure slide within the circumferential recess. The eventual release in pressure within the host
container due to its opening causes the outer housing with the glass ampule to move upwards and fracture the ampule resulting in the cooling of the beverage as previously described.

Though the temperature changing devices herein are disclosed in conjunction with a beverage container, it will be understood that they can be applied to any container whose contents are under a pressure different from atmospheric pressure, including evacuated housings.

Other features and advantages of the present invention will become apparent from the following description of the preferred embodiments, taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of the invention.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a pressurized host container with a pressure activated temperature changing device shown in phantom;

FIG. 2 is an enlarged vertical cross-sectional view showing details of the temperature changing device of FIG. 1;

FIG. 3A is a top plan view of the device of FIG. 2;

FIG. 3B is a fragmentary section view of the device of FIG. 2, partly in phantom, as seen from the side in an alternate operating position;

FIG. 4 is a fragmentary sectional view of the device of FIG. 2 take along line 4-4 from FIG. 3B;

FIG. 5 is a sectional view of the device of FIG. 2 shown in an alternate operating position;

FIG. 6 is a fragmentary sectional view of the device of FIGS. 2-5 as it appears as a result of pressure from the host container;
FIG. 7 is a sectional view of the device of FIGS. 2-6 within the host container as it appears following the release of pressure from the host container;

FIG. 8 is an enlarged vertical cross-sectional view showing details of a second exemplary embodiment of a temperature changing device;

FIG. 9 is a fragmentary sectional view of a third exemplary embodiment of a temperature changing device before placement within the host container of FIG. 1;

FIG. 10 is a fragmentary sectional view of a fourth exemplary embodiment of a temperature changing device before placement within the host container of FIG. 1; and

FIG. 11 is an enlarged vertical cross-sectional view showing details of a fifth exemplary embodiment of a temperature device before placement within the host container.

**DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS**

To exemplify the device in accordance with the invention, the following description may concentrate primarily on a self-contained cooling device for use in a soda can or a beer can. It should be readily apparent to the skilled artisan that the description, with little modification, might also apply to any other pressurized system wherein cooling is desired. Further, there can be modifications in the equipment used to accommodate other systems.

FIG. 1 shows a typical pressurized beverage host container 10 commonly made from aluminum or steel that is used to contain a beverage such as beer, soda, seltzer water, or other carbonated or pressurized drinks. Typically, the pressure within such containers when sealed ranges from 35 psi to 95 psi. The standard 12 ounce soda and beer can is 4 3/4 inches high with a diameter of 2 5/8 inches at its widest point and the standard 16 ounce beer can is 6 1/2 inches high with a diameter of 2 5/8 inches at its widest point.

The host container 10 is opened by means of a flip-top or releasable tab (not shown) which is flipped or pulled off to provide an opening. When the container is opened as described, the pressure from within the container is released.
A self-contained, pressure-activated cooling device in accordance with the invention, generally at numeral 60, is shown within host container 10. Although the device shown is generally cylindrical, it may be any suitable shape so long as its contact with the beverage is substantial.

FIG. 2 illustrates a cross-sectional view of the pressure-activated cooling device 60 shown inside the host container 10. Cooling device 60 consists of an inner housing 64 and an outer housing 62. Both housings 62, 64 are cylindrical in shape and the opposing ends of both cylinders are sealed so that they are impermeable, such that their respective contents are not in communication with each other or the contents of the host container 10.

The inner housing 64 is formed as a sealed ampule made of glass such as soda lime or boro silicate, or any other non-permeable, frangible material. In some embodiments, the sides of housing 64 are substantially thinner (0.010 inches to 0.030 inches) than the ends (0.050 inches to 0.060 inches). The ampule is sealed at one end as a result of a vacuum formation process which leaves the glass smooth and bulbous. The other end is later sealed to permit the filling of ingredients and evacuation to take place in a single operation.

The side of inner housing 64 is pre-scored as at line 74 such that when a predetermined level of tension is applied to the glass, it fractures at or near line 74. The pre-scoring is a general surface abrasion that is created either through blasting using sand or other suitable abrasive or through a deliberate and linear surface deformation. In the embodiment shown in FIG. 2, the inner housing 64 has a single, annular score line positioned substantially mid-way along the length of the housing 64. However, this score line may be positioned elsewhere along the length of the housing such that an adequate amount of desiccant 28 remains in the bottom portion of the fractured housing 64.

The ends of glass housing 64 are each formed of relatively heavy glass. Each end terminates in an engageable portion. For example, the lower end terminates in a knob 76, while the top end terminates in a protuberance 78 having a barbed or mushroom-like configuration.

Before sealing, the inner housing 64 is filled with appropriate materials including a sorbent or desiccant 28, preferably commingled with a heat-removing material. The sorbent material preferably absorbs or adsorbs all the vapor produced by the liquid, while complying
with all applicable government safety standards for use in an environment. Suitable sorbents include but not limited to: barium oxide, magnesium perchlorate, calcium sulfate, calcium oxide, activated carbon, calcium chloride, glycerine silica gel, alumina gel, calcium hydride, phosphoric anhydride, phosphoric acid, potassium hydroxide, and sodium sulfate.

The heat-removing material is one of three types: (1) a material that undergoes a change of phase when heat is applied; (2) a material that has a heat capacity greater than the sorbent; or (3) a material that undergoes an endothermic reaction when brought in contact with the liquid refrigerant. Suitable phase change materials include but not limited to: paraffin, naphthalene sulphur, hydrated calcium chloride, bromocamphor, cetyl alcohol, cyanamide, eleudic acid, lauric acid, hydrated calcium silicate, sodium thiosulfate pentahydrate, disodium phosphate, hydrated sodium carbonate, hydrated calcium nitrate, Glauber's salt, potassium, neopentyl glycol, sodium and magnesium acetate.

The phase change materials remove some of the heat from the sorbent material simply through storage of sensible heat because the phase change materials heat up as the sorbent heats up, removing heat from the sorbent. However, the most effective function of the phase change materials is in the phase change itself. An extremely large quantity of heat is absorbed in connection with the phase change (i.e. change from a solid phase to a liquid phase, or change from a liquid phase to a vapor phase). During the phase change, there is typically little change in the temperature of the phase change materials, despite the relatively substantial amount of heat required to effect the change, which heat is absorbed during the change.

Another requirement of any of utilized phase change materials is that it change phase at a temperature greater than the expected ambient temperature of the material to be cooled, but less than the temperature achieved by the sorbent material upon absorption of a substantial fraction (i.e. one-third or one-quarter) of the refrigerant liquid. Thus, for example, in the cooling devices according to the present invention, the phase change should take place at a temperature above about 30°C, preferably above about 35°C but preferably below about 70°C, and most preferably below about 60°C.

Turning to the details of the construction of the outer housing 62, the outer housing is formed as a deep drawn cylinder, with one end closed and the opposing end having a peripheral flange 70. The lower surface of the peripheral flange forms a roll seal with a corresponding
flange 72 to secure a dish diaphragm 66 and effectively seal the outer housing 62. Diaphragm 66 flexibility is enhanced by a single fold bellows, the bottom of which is formed away from and parallel to the plane of the diaphragm 66 to form the corresponding flange 72.

Extending down from the center of the inner surface of the diaphragm 66 is attached a clip 82 for engaging the protuberance 78. Because of diaphragm 66 flexibility, the diaphragm 66 can move a predetermined amount along the longitudinal axis of housing 64, without causing the ampule to shatter.

The diaphragm 66 is made of the same material or different material as the outer housing 62. Preferably both are made of an aluminum alloy.

Centered over the diaphragm 66 and extending axially from the periphery of the outer housing 62, is a metal bridge 68. The bridge is attached on to the lower surface of peripheral flange 70. The bridge 68 is formed from a strip of elastic metal, such as phosphor bronze, with two right angles overlaying the outer housing 62 as illustrated in FIG. 3A.

As best seen in FIG. 3A, the bridge 68 is a strip of metal extending across the diameter of the diaphragm 66. As shown in FIG. 4, during assembly, the diaphragm 66 is manually depressed while the portion of the bridge 68 extending over the top of diaphragm 66 is manually twisted approximately 90 degrees so that it contacts the diaphragm and is retained between a pair of spaced apart projections 86. As long as the bridge remains in this twisted position it prevents upward movement of the diaphragm 66 (see FIG. 3B).

FIG. 5 is a sectional view of the cooling device further illustrating the bridge in its twisted position. In this position, the bridge 68 contacts the top of diaphragm 66 deforming it somewhat and pushing clip 82 downwardly such that it engages the protuberance 78. It should be understood that the diaphragm 66 and bridge seek the position shown in FIG. 2 and are only held in the position shown FIG. 5 because the bridge is in a locked position between the protrusions 78. The bridge 68 remains in the locked position during storage and when initially placed in the unpressurized host container 10. However, once the contents of the container are sealed, under pressure, the cooling device is subjected to a substantial pressure loading. The pressure loading against diaphragm 66 displaces the diaphragm away from the bridge 68 releasing the bridge from its locked position and causing the bridge to return to a position as
shown in FIG. 6.

Secured to the inside surface of the lower end of outside housing 62 are a pair of spring clips 80 which snap into a constricted part of knob 76 so as to engage the knob and secure the lower end of housing 64 to the bottom of the outer housing.

Outer housing 62 contains a refrigerant liquid 40 and is substantially evacuated. The liquid and the sorbent must be complimentary (i.e. the sorbent must be capable of absorbing or adsorbing the vapor produced by the liquid), and suitable choices for these components are any combination that provides for rapid beverage cooling, is compact, and meets all applicable government safety standards.

Suitable refrigerant liquids used in the present invention have a high vapor pressure at ambient temperature so that a reduction of pressure will produce a high vapor production rate. The vapor pressure of the liquid at 20°C is preferably at least about 9 mm Hg, and more preferably is at least about 15 or 20 mm Hg. Suitable refrigerant liquids include: various alcohols, such as methyl alcohol or ethyl alcohol; ketones or aldehydes such as acetone and acetaldehyde; water and freons such as freon C318, 114, 21, 11, 114B2, 113 and 112. The preferred liquid is water.

In some embodiments, the refrigerant liquid is mixed with an effective quantity of a miscible nucleating agent having a greater vapor pressure than the liquid to promote ebullition so that the liquid evaporates even more quickly and smoothly, while preventing the liquid from super-cooling. Suitable nucleating agents include ethyl alcohol, acetone, methyl alcohol, propyl alcohol and isobutyl alcohol, all of which are miscible with water. For example, a combination of a nucleating agent with a compatible liquid might be a combination of 5% ethyl alcohol in water or 5% acetone in methyl alcohol. The nucleating agent preferably has a vapor pressure at 25°C of at least about 25 mm Hg and, more preferably, at least about 35 mm Hg. Alternatively, solid nucleating agents may be used, such as conventional boiling stones used in chemical laboratory applications.

Outer housing 62 further includes an inner coating of wicking material 73 (see FIG. 1) for drawing and maintaining a desired amount of water or other suitable refrigerant liquid 40 in contact with the interior surface of the housing 62. Preferred wicking materials include
microporous metals or other hygroscopic materials, such as sintered heat pipe material or glass paper.

The refrigerant liquid 40 collects in very thin layers among the interstices of the microporous or sintered heat pipe wicking material 73. This arrangement spreads much of the refrigerant liquid 40 over a comparatively large area where it is substantially instantly exposed to the substantial drop in pressure when the two housings 62, 64 are in communication causing it to flash into vapor. After the initial drop in pressure, the refrigerant liquid 40 continues to migrate into the wicking material 73 resulting in further vaporization, thereby producing a cooling effect on the outside of the outer housing 62.

The non-permeable structure of the glass inner housing 64 prevents refrigerant liquid 40 in the outer housing 62 from reaching the evacuated inner housing 64 containing the sorbent or desiccant 28. Thus, it is a distinct advantage of the cooling device 60 that, once assembled, it can be stored indefinitely until it is installed in the container 10. Installation preferably takes place just prior to filling container 10 with a beverage under pressure and sealing the beverage container with a lid having a flip-top or releasable tab.

Housing 62 is evacuated to a pressure close to the vapor pressure of the refrigerant liquid 40 such that all non-condensable gases are removed. With reference to FIG. 7, when it is desired to consume the beverage in container 10, the flip top or releasable tab 69 is activated and the pressure in container 10 is released and simultaneously the pressure applied to the outer housing 62 and thus, the diaphragm 66, is lessened. Once the pressure within the host container 10 is below a predetermined value, diaphragm 66 moves upward amplifying the stress on the glass housing 64 to the point that a fracture propagates along pre-scored line 74.

The fracture of the inner housing 64 opens up fluid communication between housings 62 and 64 causing a drop in pressure in housing 62 because of the evacuated condition of housing 64. The drop in pressure in housing 62 upon opening the container 10 causes the refrigerant liquid 40 to boil at ambient temperature. The resultant vapor is absorbed or adsorbed by the desiccant 28. This process causes the desiccant 28 to heat appreciably where said heat is at least partially removed by the heat removing material. Because the glass of housing 64 is a superior insulator, the heat generated by the adsorption reaction remains contained for the time required for the consumer to finish drinking the beverage. This liquid-to-
gas phase change can occur only if the refrigerant liquid 40 removes heat equal to the latent heat of vaporization of the evaporated refrigerant liquid 40 from housing 62. If this condition is met, housing 62 is cooled. The cooled housing 62, in turn, removes heat from its surrounding material including the outside wall of housing 62 which is in contact with the beverage in container 10. The beverage is thereby cooled and ready for consumption. One of ordinary skill in the art realizes that a heat removing material 29 (not shown) which is thermally coupled to the sorbent 28 and which is preferably mixed with the sorbent 28 may optionally be used to remove heat from the sorbent 28, preventing or slowing a rise in temperature in sorbent 28 and in inner housing 64 that adversely affects the cooling effect provided by the outer housing 62.

Illustrated in FIG. 8 is a second exemplary embodiment of the pressure-activated cooling device 60 to be placed within a host container 10. In this drawing, identical parts are given the same numerals as in the previous FIGS. 1-7. Cooling device 60 consists of an outer housing 62 and an inner housing 90.

The inner housing 90 is made from glass or other impermeable, frangible material and is formed as a sealed ampule. The interior housing 90 is cylindrical shaped with a circumferential recess 92 around its perimeter approximately halfway up the body of the interior housing 90. Similar to the inner housing 64 illustrated in FIGS. 2-7, the sides of the interior housing 90 are substantially thinner than the ends and are pre-scored as at the recess 92 such that the ampule fractures at or near the recess 92 when subjected to a predetermined stress.

The outer housing 62 includes a receiving base 94 from which a plurality of vertical receiving arms 98 extend upwards. The receiving arms 98 are generally straight and end in a substantially ninety degree angle bend forming a plurality of engaging fingers 99. The fingers 99 are spaced apart slightly less than the diameter of the interior housing 90.

At the center of the diaphragm a locking structure 95 is attached using a spot weld or rivet. The locking structure includes a plurality of vertical receiving arms 96 extending downwards. The receiving arms 96 are generally straight and end in a substantially ninety degree angle bend to form an engaging finger 101 on each end. These engaging fingers 99 are also spaced apart slightly less than the diameter of the interior housing 90.

During assembly, as the inner housing 90 is lowered into the outer housing 62, the inner
housing 90 is inwardly biased and centered by the engaging fingers 99 on the receiving arms 98. When the inner housing 90 is lowered such that the engaging fingers 99 of the receiving base are level with the recess 92, the engaging fingers 99 move inwards and secure the inner housing 90 preventing upward movement.

Once the inner housing 90 is secured in the receiving base 94, the diaphragm 66 with the receiving arms 96 is lowered onto the inner housing 90. The receiving arms 96 pinch the inner housing 90 until it is lowered such that the engaging fingers 101 are positioned slightly above the recess 92 prior to the introduction of the beverage into the host container 10. Then the increased pressure associated with the sealing of the beverage container 10 pushes the diaphragm 66 downwards resulting in the engaging fingers 101 locking into the recess 92. In this stage of assembly, the engaging fingers 99 on the receiving base 94 and the engaging fingers 101 on the grabbing arms 96 are inwardly biased so as to secure the inner housing 90.

The operation of the second embodiment is identical to that of the first embodiment after the inner housing 90 is installed. After the cooling device 60 is installed in the host container 10 and is subjected to the substantial pressure loading caused by the pressurized beverage, the diaphragm is forced away from the torsionally biased bridge 68 unloading the force on the bridge and permitting the bridge to return to a position similar to that shown in FIG. 3A. Absent a release of pressure in container 10, the cooling device 60 would remain in this condition indefinitely.

When container 10 is opened, the pressure escapes causing diaphragm 66 to return to its original upwardly biased position. The resulting upwards movement of the diaphragm 66 amplifies the stress on the glass housing 64 so that a fracture propagates along the pre-scored recess 92.

A third exemplary embodiment of the cooling device is shown in FIG. 9. In this drawing, identical parts are given the same numerals as in the previous FIGS. 1-8. In accordance with the third embodiment, a column 111 is attached to the bridge 68. The column is made of an ingestible substance, such as sugar or salt, that dissolves over time, in the beverage and is generally cylindrical. During assembly of the dual housing cooling device, the diaphragm is mechanically pushed downwards and the column 111 is mounted to the bridge 68.
without fracturing the inner housing 90. The diaphragm 66 is then released resulting in its upward movement such that it contacts the column 111. In this position, the cooling device may be stored and installed into the host beverage container 10.

Upon exposure to the beverage, the column 111 dissolves, but the diaphragm 66 remains in its downward position because pressure load created by the pressurized beverage in the container. When the container 10 is opened and the pressure drops, the diaphragm 66 returns to its normal position, forcing the inner housing 64 upwards, and resulting in its fracture.

A fourth exemplary embodiment of the dual housing cooling device is shown in FIG. 10. In this drawing, identical parts are given the same numerals as in the previous FIGS. 1-8. In FIG. 10, a single leaf spring 115 is secured to the underside of bridge 66 in a bowed position. Alternatively, the spring may be cut out of the same piece of material as the bridge 66 with one end still affixed. The other end is secured by a latch 117 made of an ingestible material, such as sugar or salt. The latch 117 must be large enough to withstand shear forces from spring 115 over a period of time such as those presented by rough handling during manufacture, storage, and installation of the cooling device.

During assembly of the cooling device, the diaphragm is mechanically pushed downwards. The diaphragm 66 is then released resulting in its upward movement, until it contacts and rests against the spring 115 without fracturing the inner housing 90. In this position, the cooling device may be transported and installed into the host beverage container 10. After being exposed to the beverage, the latch 117 dissolves and the leaf spring 115 straightens out, but the diaphragm 66 remains in its downward position because of the pressure load exerted by the pressurized beverage. When the container 10 is opened and the pressure drops, the diaphragm 66 returns to its normal position and carries the inner housing 64 upwards resulting in its fracture.

In the fifth exemplary embodiment, shown in FIG. 11, the cooling device includes a compressible outer housing 103. In these drawing, identical parts are given the same numerals as in the previous FIGS. 1-8. The compressible housing 103 has both a detachable top portion 105 and a fixed bottom portion 107.

The compressible housing 103 is accordion-like in that it has series of bellow-like folds
permitting it to expand and compress depending on the pressure applied to the top portion 105. Affixed to the bottom portion 107 is a receiving base 94. Mounted on the top portion 105 is a locking structure 95.

During assembly, while the top portion 105 is removed, the inner housing 90 is lowered into the compressible housing 103 and onto the receiving base 94 until the inner housing is secured by the base. The top portion 105, with the locking structure 95, is then lowered onto the inner housing 90 until a point just prior to where the engaging fingers would fixedly grab the recess 92 of the inner housing 90. The top portion 105, after the refrigerant liquid 40 (not shown) is added, is sealed to the compressible housing 103. The compressible housing is then ready to be placed within container 10. Preferably, the compressible housing 103 can only extend to a height corresponding to the height of the compressible housing 103 when the inner housing 90 was initially placed within.

After the container 10 is sealed, the cooling device is subject to a substantial pressure loading causing the bellows of the compressible housing 103 to move the locking structure 95 downwards so it is securely attaches to the inner housing 90 at recess 92. When the container 10 is opened, the pressure escapes causing the compressible housing 103 to return to its original position. The resulting upward movement of the compressible housing 103 amplifies the stress on the glass inner housing 90 to the point that a fracture propagates along the pre-scored recess 92. It is an additional benefit of the compressible housing that the increased surface area presented by the accordion like structure further increases and amplifies the cooling effect on the liquid contained within the host container 10 (not shown).

Preferably, the cooling device displaces no more than three ounces which would result in an outer housing approximately three inches high and one inch in diameter. The inner housing is approximately 1/4 inch smaller in diameter and 3/8 inch shorter in height. The size of the inner housing may also be adjusted when the thickness of the glass utilized requires a different size.

Although the invention has been described in detail with reference only to the preferred embodiments, those having ordinary skill in the art will appreciate that various modifications can be made without departing from the invention. Accordingly, the invention is defined with reference to the following claims.
CLAIMS

1. A self contained cooling device in a pressurized host container comprising:
   a first housing at least partially compressible containing a vaporizable liquid;
   a second evacuated housing containing a sorbent for said liquid, said second housing
   being contained within said first housing and having a breakable shell; and
   a trigger for breaking the shell of said second housing and exposing the sorbent
   within said second housing to the vaporizable liquid in said first housing when the
   pressure within the host container is lowered below a predetermined value.

2. The cooling device as claimed in claim 1 wherein said vaporizable liquid is water.

3. The cooling device as claimed in claim 1 wherein said first housing is made from a
   series of bellows.

4. The cooling device of claim 1 wherein said first housing further comprises a diaphragm
   on one end thereof able to be displaced into a second position and is returnable to a first
   position.

5. The cooling device of claim 4 wherein said trigger further comprises a stationary
   member adjacent said diaphragm, said member able to be torsionally twisted so as to
   displace said diaphragm away from the first position and into the second position.

6. The cooling device of claim 4 wherein said trigger further comprises a stationary
   member adjacent said diaphragm, and a dissolvable column placed between said
   member and said diaphragm displacing said diaphragm away from the first position into
   the second position.

7. The cooling device of claim 4 wherein said trigger further comprises a stationary
   member adjacent said diaphragm, and a spring at least partially secured to said bridge
   by a dissolvable latch thereby displacing said diaphragm away from the first position
   into the second position.
8. The cooling device of claim 1 wherein said second chamber further contains a phase change material.

9. A system for cooling a substance comprising:
   a pressurized host container;
   a self-activated cooling device comprising:
   a first housing at least partially compressible containing a vaporizable liquid;
   a second evacuated housing containing a sorbent for said liquid, said second housing being contained within said first housing and having a breakable shell; and
   a trigger for breaking the shell of said second housing and exposing the sorbent within said second housing to the vaporizable liquid in said first housing when the pressure within the host container is lowered below a predetermined value.

10. The system for cooling a substance of claim 9 wherein said vaporizable liquid is water.

11. The system for cooling a substance of claim 9 wherein said first housing is made from a series of bellows.

12. The system for cooling a substance of claim 9 wherein said first housing further comprises a diaphragm on one end thereof able to be displaced into a second position and is returnable to a first position.

13. The system for cooling a substance of claim 12 wherein said trigger further comprises a stationary member adjacent said diaphragm, said member able to be torsionally twisted so as to displace said diaphragm away from the first position and into the second position.

14. The system for cooling a substance of claim 12 wherein said trigger further comprises a stationary member adjacent said diaphragm, and a dissolvable column placed between said member and said diaphragm urging said diaphragm away from the first position into the second position.

15. The system for cooling a substance of claim 12 wherein said trigger further comprises
a stationary member adjacent said diaphragm, and a spring at least partially secured to
said bridge by a dissolvable latch thereby displacing said diaphragm away from the first
position into the second position.

16. The system for cooling a substance of claim 12 wherein said second chamber further
contains a phase change material.

17. The system for cooling a substance of claim 9 wherein pressurized host container
is a soda can.

18. The system for cooling a substance of claim 9 wherein pressurized host container
is a beer can.

19. A self-contained cooling device in a pressurized host container comprising:
a first housing containing vaporizable liquid and a diaphragm closing one end thereof;
a second evacuated housing containing a sorbent for said liquid, said second housing
being contained within said first housing, said second housing being of glass having a pre-
scored sidewall and a projection on at least one end;
a bridge secured to the sidewall of said first housing extending across and spaced from
said diaphragm, said bridge made from an elastic material with a memory;
a first spring clip on the inside of said diaphragm adapted to capture said projection;
a second spring clip on a side within said first housing opposite said diaphragm adapted
to further secure the second evacuated housing;
said bridge being twistable against said diaphragm to displace said diaphragm and move
said first spring clip into a position where it captures said projection, such that pressurizing said
apparatus in said host container further displaces said diaphragm, releasing said bridge from
said diaphragm and subsequently depressurizing of said host container causes said diaphragm
to return to its normal position, carrying said spring clip and said projection and fracturing said
pre-scored sidewall thereby permitting said liquid to vaporize and pass into said sorbent
whereby the evaporation of said liquid serves to cool said first housing.
A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F25B17/08 F25D31/00

According to international Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F25B F25D A47J B65D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Relevant to claim No.</th>
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<tr>
<td>A</td>
<td>WO 92 02770 A (INT THERMAL PACKAGING INC) 20 February 1992 (1992-02-20) page 6, line 18 -page 19, line 14; figures 1-9</td>
<td>1, 2, 4, 7-10, 12, 15, 16, 19</td>
</tr>
<tr>
<td>A</td>
<td>US 4 911 740 A (SCHIEDER HANS B) 27 March 1990 (1990-03-27) cited in the application column 3, line 60 -column 9, line 66; figures 1-4</td>
<td>1, 2, 8-10, 16-19</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

Date of the actual completion of the international search

25 February 2000

Date of mailing of the international search report

03/03/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel: (+31-70) 340-2040, Tx: 31 651 epo nl, Fax: (+31-70) 340-3018

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Boets, A

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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>GB 2 329 459 A (BASS PLC) 24 March 1999 (1999-03-24) page 3, line 9 - page 4, line 20 page 8, line 6 - line 19 page 15, line 26 - page 29, line 30; figures 1-32</td>
<td>1-3, 9-11, 17-19</td>
</tr>
<tr>
<td>A</td>
<td>WO 82 02483 A (OSTERRATH HANS) 5 August 1982 (1982-08-05) page 6, line 20 - page 10, line 12; figures 1-4</td>
<td>1,9,19</td>
</tr>
<tr>
<td>A</td>
<td>US 1 897 723 A (FREE WALTER H) 14 February 1933 (1933-02-14) page 2, line 9 - page 4, line 93; figures 1-6</td>
<td>1,9,19</td>
</tr>
<tr>
<td>A</td>
<td>US 4 928 495 A (SIEGEL ISRAEL) 29 May 1990 (1990-05-29)</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>US 5 609 038 A (HALIMI EDWARD M) 11 March 1997 (1997-03-11)</td>
<td></td>
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<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
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<tr>
<td>WO 9202770 A</td>
<td>20-02-1992</td>
<td>AU 8712591 A</td>
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<tr>
<td>US 4911740 A</td>
<td>27-03-1990</td>
<td>AU 622214 B</td>
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<tr>
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<td>AU 4046889 A</td>
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<td>JP 4501306 T</td>
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<td></td>
<td>WO 9001660 A</td>
</tr>
<tr>
<td>GB 2329459 A</td>
<td>24-03-1999</td>
<td>GB 2329461 A</td>
</tr>
<tr>
<td>WO 8202483 A</td>
<td>05-08-1982</td>
<td>DE 3102599 A</td>
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<tr>
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<td>AU 8002082 A</td>
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<td>EP 0070283 A</td>
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<td>IN 154489 A</td>
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<td>ZA 8200156 A</td>
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<tr>
<td>US 1897723 A</td>
<td>14-02-1933</td>
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<td>WO 9015961 A</td>
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<td>JP 62073062 A</td>
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<td>FR 2587608 A</td>
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<td>GB 2183017 A,B</td>
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<td>AU 1424197 A</td>
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<td>EP 0948447 A</td>
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<td>AU 689144 B</td>
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<td>AU 7960394 A</td>
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<td>WO 9509118 A</td>
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