

INVERTED DOME TO SUPPLY DOSE

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BACKGROUND OF THE INVENTION

5 FIELD OF THE INVENTION

This invention relates generally to the field of packages and containers, and in particular, pertains to containers having two compartments and that may be used to keep two components separate until use and dispense of one component into the other at the point of use.

10 RELATED ART

It is desirable to fit a device to the top of a beverage or other like product that can dose or supply a second product thereto.

Twist to open technology provides limited opening port increased operational forces and a steep learning curve for use by the end user. Ingredients
15 housed are often compromised when the mating components are not properly aligned. This failure breaches the seal integrity for the ingredients and may not be readily known by the manufacturer or the end user. These devices may also contain multiple parts to achieve the actions needed to house product and twist to dispense. Other products require a great deal of force to open the closure and is
20 commonly opened by slamming the head of the closure down onto a hard surface in order to breach the sealed portion of the closure thereby allowing access to ingredients. There remains a need for a storing and dispensing closure device that can store a product separately from a second product so as to retain its ingredient integrity over time and to dose or supply the product at a predetermined dose or
25 supply into a receptacle, vessel or container for consumption without contamination or spilling, that is easily assembled, filled and operated.

SUMMARY OF THE INVENTION

A first aspect of the invention provides a dispensing closure device capable of storing and dispensing at the point of use one or more ingredients, formulations
30 or products. The dispensing closure devices of the present invention are attached

to a receptacle, container or vessel capable of receiving the one or more ingredients, formulations or products dispensed from the closure apparatus. The dispensing closure devices of the invention comprise a press part, like a convex dome or a frustum cone, that when pressed it becomes inverted forming a concave configuration thereby activating dispensation of one or more ingredient, formulations, or products.

In one embodiment of the invention there is an inverted press part dispensing closure comprising a housing having a press part, a septum, and an end plate seal; a receiving vessel attached to the inverted dome dispensing closure; and a user-actuated means for dispensing from said inverted press part dispensing closure one or more ingredients. In some embodiments, the housing of the inverted press part dispensing closure further comprises an end cap or a septum end attachment. In some embodiments, the press part is a frustum cone capable of being pressed into a concave configuration. In some embodiments, the user actuated means for dispensing comprises application of a pressing force against the press part to cause the convex press part to be in a concave configuration.

In another embodiment there is a dispensing closure device comprising (a) a housing wherein the housing comprises a press part at the proximal top end, an end plate seal at the distal base, a septum in axial alignment within the housing depending from the apex of the press part toward the base of the housing; and (b) a means for attaching the dispensing closure device to a receiving vessel comprising a closure radial skirt attached to the outer diameter of the housing, having a greater outer diameter than the housing, and capable of attaching to a receiving vessel for dispensing one or more ingredient therein.

In another embodiment there is an dispensing closure device comprising (a) a housing wherein the housing comprises a press part at the proximal top end, an end plate seal at the distal base, a septum in axial alignment within the housing depending from the apex of the press part toward the base of the housing, an end cap in mating engagement with the base of the septum; and (b) a means for attaching the dispensing closure device to a receiving vessel comprising a closure radial skirt attached to the outer diameter of the housing, having a greater outer diameter than the housing, and capable of attaching to a receiving vessel for

dispensing one or more ingredient therein.

In another embodiment there is an dispensing closure device comprising (a) a housing; and (b) an attachment means for attaching, removing and reattaching the dispensing closure device to a receiving vessel; (c) the housing comprises a press point at the proximal top end, an end cap at the distal base, a septum in axial alignment within the housing depending from the apex of the press part toward the base of the housing; and (d) the attachment means comprising a closure radial skirt attached to the outer diameter of the housing, having a greater outer diameter than the housing, and capable of attaching to a receiving vessel for dispensing one or more ingredient therein. In some embodiments the housing further comprises ingredients contained therein a dose chamber. In some embodiments the housing further comprises an end plate seal at the distal base of the housing.

In another embodiment there is an inverted press part storage and dispensing closure device comprising: (a) a housing having a dose chamber and a user-actuated means for dispensing one or more ingredients; and (b) an attachment means for attaching the device to a receiving vessel comprising a closure radial skirt attached to outer diameter of the housing in axial alignment with the housing, having a greater outer diameter then the housing, and capable of attaching to a receiving vessel for dispensing the one or more ingredient therein. In some embodiments the user-actuated means for dispensing comprises a convex dome, a septum, an end cap. In some embodiments the user-actuated means for dispensing comprises a frustum cone, a septum, and an end cap. In other embodiments the user-actuated means for dispensing further comprises an end plate seal. In some embodiments the user-actuated means for dispensing comprises a convex dome, a septum, septum end attachment and end plate seal. In some embodiments the user-actuated means for dispensing comprises a frustum cone, a septum, septum end attachment and end plate seal.

It is another aspect of the invention to provide a point of use dispensing device that retains the integrity and freshness of ingredients until dispensation, and that minimizes exposure of contained ingredients from UV light and moisture. In some embodiments the dispensing closure device comprises an end plate seal. In one embodiment the foil end plate seal is comprised of foil. In another

embodiment the foil end plate seal is lined with plastic to reinforce the seal for purposes of ingredient freshness and product integrity. In another embodiment the dispensing closure device is made with materials that block UV light. In some embodiments there is an end cap in interfering sealing engagement with the
5 internal side walls of the housing using highly polished mating surfaces which when in intimate contact provide a superior seal integrity against moisture and maintain product integrity.

It is another aspect of the invention to provide a point of use dispensing device that indicates to the end user whether inadvertent dispensation or tampering
10 with the product has occurred. In one embodiment there are tamper evident (TE) components to the inverted press part dispensing closure that indicate premature dispensing and/or tampering. In one embodiment there are radial hinges on the inner surface of the convex dome to maintain the inverted concave configuration of the dome after being pressed, thereby indicating actuation of the dispensing means.
15 In another embodiment there is a tamper evident skirt attached to the distal radial edge of the closure radial skirt by a break-away attachment. The dispensing closure cannot be removed from a receiving vessel without breaking the break-away attachment. Removal of the break-away attachment from the tamper evident skirts is an indication that tampering with the device has occurred. In another
20 embodiment there is a fold away tab or truss attached to the outer diameter of the press part by a break-away tab. A detached break-away tab is an indication that tampering with the device has occurred.

Another aspect of the invention is to provide a point of use dispensing device that protects against accidental dispensation. In some embodiments of the
25 dispensing closure there are dispensation-preventative components that provide protection from inadvertent, accidental or premature dispensing. In one embodiment there is a fold away tab or truss that straddles the outer surface diameter of the press part to prevent inadvertent activation and dispensation. In another embodiment there is a standing radial rim connected to the proximal top of
30 the housing and surrounding the press part beyond the proximal top of the press part to prevent inadvertent activation and dispensation. In another embodiment there is a protective overcap covering the press part.

Another aspect of the invention provides a method for supplying a dosage. In one embodiment there is a method of supplying a dosage of one or more ingredients to another set of one or more ingredients comprising the steps of: (a) providing an inverted press part dispensing closure attached to a receiving vessel wherein the inverted dome dispensing closure comprises a housing having a septum, a convex dome, an end plate seal, and one or more ingredients stored within; and (b) dispensing from the inverted dome dispensing closure by a user-actuated means the one or more ingredients into the receiving vessel. In some embodiments the housing further comprises an end cap or a septum end attachment. In one embodiment the user-actuated means comprises applying a pressing force against the convex dome.

In another embodiment there is a method for supplying a dosage of one or more ingredients to another set of one or more ingredients comprising the steps of: (a) providing an inverted press point dispensing closure capable of being attached to a receiving vessel wherein the inverted press point dispensing closure comprises a housing having a press point, a septum, end plate seal, and one or more ingredients stored within; and (b) attaching the inverted press point dispensing closure to a receiving vessel; and (c) dispensing from the inverted dome dispensing closure by a user-actuated means the one or more ingredients into the receiving vessel. In some embodiments the housing further comprises an end cap or a septum end attachment. In one embodiment the user-actuated means is application of a pressing force against the press part. . In some embodiments the inverted press point dispensing closure further comprises a closure radial skirt for attachment of the inverted dome dispensing closure to the receiving vessel.

In another embodiment of the invention, there is a method for supplying a dosage of one or more products to another product comprising the steps of: (a) providing an inverted dome dispensing closure having a housing capable of holding one or more products, wherein the housing comprises a septum, a convex dome, an end plate seal, and a user-actuated means for dispensing one or more products; (b) providing a receiving vessel having another set of one or more products and capable of receiving the one or more products from the inverted dome dispensing closure; (c) attaching the inverted dome dispensing closure to the

receiving vessel; and (d) dispensing by the user-actuated means one or more products into the receiving vessel. In some embodiments the housing further comprises an end cap. In other embodiments the housing further comprises a septum end attachment. In one embodiment the user-actuated means comprises
5 applying a pressing force against the convex causing inversion of the convex dome into a concave configuration. In some embodiments there is a dose chamber capable of containing the one or more products in the housing until dispensation. In one embodiment the inverted dome dispensing closure is attached to a receiving vessel by a manufacturer. In another embodiment the inverted dome dispensing
10 closure is attached to the receiving vessel at the point of use by an end user. The inverted dome dispensing closure is removable and capable of being reattached from the receiving vessel by the end user.

Other aspects and advantages of the present invention will become apparent from the following descriptions, taken in connection with the accompanying
15 drawings, wherein, by way of illustration and example, an embodiment of the present invention is disclosed.

BRIEF DESCRIPTION OF THE FIGURES

The drawings constitute a part of this specification and include exemplary embodiments to the invention, which may be embodied in various forms. It is to
20 be understood that in some instances various aspects of the invention may be shown exaggerated or enlarged to facilitate an understanding of the invention.

FIG. 1: Perspective view of an inverted dome dispensing closure with protective overcap applied.

FIG. 2: Top view of an inverted dome dispensing closure with the protective
25 overcap applied.

FIG. 3: Cross section view of an inverted dome dispensing closure in assembly identifying the dome, septum, end plate seal position and a threaded portion of the closure radial skirt and illustrating the protective overcap in a closed position and a hinge attachment area for the protective overcap.

FIG. 4: Perspective view of an inverted dome dispensing closure with a
30 removable standing radial rim with a tear-away pull tab.

FIG. 5: Top view of an inverted dome dispensing closure showing with a removable standing radial rim with a tear-away pull tab.

FIG. 6: Cross section view of the inverted dome dispensing closure with a tear away protective means surround the dome, identifies the dose chamber, the deck of the radial closure skirt, a threaded portion of the closure radial skirt, and illustrates a
5 septum end attachment, and one or more radial beads.

FIG. 7: Top view of a tamper evident dosing closure with a fold away truss or tab feature.

FIG. 8: Cross section assembly view of a tamper evident dosing closure with
10 fold away truss feature having radial hinges at the septum and tube. Figure 8 further illustrates an end cap, a foil liner, and a plug seal.

FIG. 9: Front view of the tamper evident dosing closure with a fold away truss or tab feature showing the break-away attachment to, and a hinge portion for, the fold away truss or tab. Figure 9 also illustrates a closure radial skirt having finger recess
15 elements and a tamper evident skirt with a pull tab.

FIG. 10: Perspective view of tamper evident dosing closure with fold away truss or tab feature.

FIG. 11: Perspective view of tamper evident dosing closure with a standing radial rim.

FIG. 12: Top view of a flexible dome closure with integral protective over cap
20 in open position

FIG. 13: Side view of a flexible dome closure with integral protective overcap in the open position.

FIG. 14: Cross section view of a flexible dome closure with integral protective
25 overcap in open position.

FIG. 15: Cross section view through hinge area of a flexible dome closure with integral protective overcap in open position. Figure 15 also identifies a flexible dome, septum and end cap.

FIG. 16: Top view of a flexible dome in the inverted concave position with
30 fold away truss in the folded position.

FIG. 17: Cross section view of the inverted dome dispensing closure in an open or activated position for dispensing ingredients.

FIG. 18: Side view of an inverted dome dispensing closure in the activated position with the end cap in the down position below the distal base of the housing.

FIG. 19: Cross section view of an inverted dome dispensing closure in the activated position with the dome in the inverted concave configuration and the end cap in down position below the distal base of the housing.

FIG. 20: Perspective view of the underside an inverted dome dispensing device (with threads removed from closure radial skirt) in the activated position with end cap in down position below the distal base of the housing.

FIG. 21: Side view of an inverted frustum cone dispensing closure.

FIG. 22: Top view of an inverted frustum cone dispensing closure.

DETAILED DESCRIPTION OF THE INVENTION

Detailed descriptions of embodiments of the invention are provided herein. It is to be understood, however, that the present invention may be embodied in various forms. Therefore, specific details disclosed herein are not to be interpreted as limiting, but rather as a basis for the claims and as a representative basis for teaching one skilled in the art to employ the present invention in virtually any appropriately detailed system, structure or manner.

INVERTED PRESS PART DISPENSING CLOSURE

In one aspect the present invention relates to novel inverted press part dispensing closure devices. The press part may be a convex dome or frustum cone that becomes inverted when pressed or activated. The inverted press part dispensing closure may be used to separately house, store or carry a dose or supply of a product or one or more ingredients to maintain freshness and integrity of the ingredients until dispensed into a separate receiving vessel. When activated the inverted press part dispensing closures of the present invention deliver the dose to the receiving vessel and allows the end user to dispense the dose or supply of product without the removal of the dispensing closure from a bottle or container thereby eliminating spills and contamination. The combined contents of the receiving vessel can be dispensed for consumption by removing the dispensing closure from the receiving vessel.

In some embodiments the inverted dome dispensing closure comprises a

housing and an attachment means for attaching the inverted press part dispensing closure to a receiving vessel. In other embodiments the inverted dome dispensing closure comprises a housing, an attachment means for attaching the inverted press part dispensing closure to a receiving vessel, and a receiving vessel.

5 Housing

The housing of the inverted dome dispensing disclosure has a proximal top, a distal base, side walls and an internal volume. In one embodiment the side walls of the housing are curved to give the housing a tubular shape. The housing is also referred to herein as the tube or housing tube. The tubular shape of the housing may be conical including any tapered tubular form or cylindrical including an elliptic cylinder shape, parabolic cylinder shape, hyperbolic cylinder shape, circular cylinder shape and generalized cylinder (in which the cross-section may be any curve) shape. In another embodiment the side walls of the housing are flat having three or more side walls forming an angular tube shape. The angular tube shape of the housing includes a triangular shaped tube, square shaped tube, rectangular shaped tube, polygon shaped tube. The proximal top of the housing comprises a press part described in greater detail below. The distal base of the housing comprises an end cap and/or end plate seal as described in greater detail below. In some embodiments the internal volume of the housing is predetermined for dosing and supplying methods.

As shown in Figure 6, the housing further comprises internal hollow dose chamber. The hollow dose chamber is used to house the one or more ingredients, formulations or products. The distal base of the housing further comprises a dispensing port when the closure device is activated. Upon actuation, there is provided a spaced opening at the distal end of the housing allowing one or more ingredients to exit the dose chamber and be dispensed. Ingredients

The type and form of one or more ingredients, formulations or products stored in the dose chamber is unlimited. In some embodiments there is a single ingredient, formulation or product and in other embodiments there is a combination of ingredients, formulations and/or products. Non-limiting exemplary forms of ingredients, formulations or products include powders, dehydrated constituents, liquids, liquid concentrate and suspensions. Non-limiting examples

of the types of ingredients, formulations or products that can be stored and dispensed from the dispensing closure include dietary supplements (e.g., fiber and vitamins), sport nutrition ingredients (e.g., amino acids, fat burning agents, muscle builders), diet nutrition ingredients (e.g., appetite suppressants, fat burning agents, ingredients causing a feeling satiety), ingredients with anti-aging benefits, immune supporting ingredients (e.g., prebiotics, probiotics), energy boosting agents, stimulants, anti-oxidants.

The ingredients capable of being stored and dispensed from the dispensing closure device can also include medicaments, drugs and pharmaceuticals. It is desirable to formulate a point of use form of delivering medicine that avoids the need to swallow hard tablets, capsules, avoids bad taste associated with more traditional forms of medicines and maintains the product integrity.

Any of the one or more ingredients or products stored and dispensed by the dispensing closure device of the present invention may be store independently or in combination with other ingredients, flavoring, sweetening, acidulants, excipients, preservatives and/or coloring agents.

The housing further comprises a user-actuated means for dispensing the one or more ingredients. In another embodiment the dispensing means comprises a press part, a septum and an end cap. In another embodiment further comprises an end plate seal. In another embodiment the dispensing means comprises a press part, a septum, a septum end attachment and end plate seal. In some embodiments the dispensing means comprises a press part having a convex dome shape. In some embodiments the press part is a frustum cone shape. The dispensing means is intended to be actuated at the point of use by an end user. The end user activates dispensation by applying a force to the convex press part. The end user applies a pressing force to the convex dome or frustum cone causing inversion into a concave configuration. In one embodiment, movement of the press part into a concave configuration applies a force on to the septum causing the septum to move in a distal direction and press upon the end plate seal, end cap or septum end attachment. In one embodiment, the force of the septum pressing upon the end plate seal causes the end plate seal to shear, break or fracture. In another embodiment, the force of the septum pressing upon the end cap causes the end cap

to shear, break or fracture the end plate seal and move beyond the distal end of the housing. In another embodiment, the force of the septum pressing upon the septum end attachment causes the septum end attachment to shear, break or fracture the end plate seal and hold the flexible end plate seal within the radial beads positioned to the inside of the cupped end of the septum end attachment. In all embodiments, there is created a spaced opening in the distal end of the housing allowing one or more ingredients to exit the dose chamber and be dispensed.

Closure Radial Skirt

The housing is attached to a closure radial skirt. The closure radial skirt serves to attach the inverted dome dispensing closure device to a receiving vessel capable of receiving the one or more ingredients dispensed from the housing. The closure radial skirt has a greater diameter than the housing. The closure radial skirt has a proximal upper deck, peripheral side walls, and a distal annular edge. As shown in Figures 3 and 6, in one embodiment there are longitudinal finger recess elements on the outer side walls of the closure radial skirt for better grasping by the end user. In one embodiment, the closure radial skirt has threads on the internal side walls capable of being rotatably coupled to a receiving vessel opening. In another embodiment the closure radial skirt is non-threaded. In some embodiments, the closure comprises a depending radial flexible member that fits to the inner diameter of a receiving vessel opening. The depending radial member is designed to have interfering engagement with the inner diameter of the opening of a receiving vessel such that it seals the contents of the receiving vessel from leaking out and still allows sufficiently low application and removal forces to be readily applied and removed by the end user. As shown in Figure 8, in one embodiment there is a flexible depending radial member referred to as the plug seal capable of plugging the opening of a receiving vessel. This seal protrudes inside the opening of a receiving vessel keeping its contents secure from leakage.

Press Part

The press part is located at the proximal top of the housing and is the component actuated by the end user. In one embodiment, the press part is a convex dome, as shown in Figures 3, 6, 8-11, and 13-15. In one embodiment the press part is a frustum cone as shown in Figures 21 and 22. The press part is made

of a thin uniform wall of material that can be readily deformed into an inverted concave configuration when sufficient force is applied to it. Applying a force against the press part to cause a concave configuration initiates the dispensing. In some embodiments the end user actuates the dispensing by applying a force against
5 the press part causing the press part to depress into an inverted concave configuration.

In some embodiments the convex dome press part is configured with a plurality of radial hinge members that are spaced apart throughout the arc of the dome. In some embodiments there are radial hinge elements placed at the upper
10 radial edge of the tube, at the upper radial edge of the septum and combinations thereof, as shown in Figure 8. The radial hinges are configured in a manner to allow the convex dome to flex to a maximum inverted position. When the convex dome is molded in anything but white colored material, the flexing portion of the dome creates a crease at the areas where the dome bends. The whitening is a
15 function of the material or resin used to mold the press point. The crease is also influenced by the design of fillet radii in that flexing area. One skilled in the art will know the specific geometry needed to make sure these areas bend or flex without shearing as the material is stressed beyond its natural elastic limits at the outer and inner portions of the dome.

20 In some embodiments the underside of the convex dome has supporting axial ribs, radial ribs or combinations thereof. The supporting dome ribs provide actuation feel for the end user.

In other embodiments, the frustum cone press part having a general convex shape and capable of being pressed into a concave configuration is configured with
25 radial hinges, axial ribs, radial ribs or combinations thereof.

Septum

At the apex of the press part there is a depending septum extending towards the distal base of the housing as exemplified in Figures 3, 8 and 15. In some embodiments the septum is integrally molded to the underside of the press part. In
30 some other embodiments the septum is interferingly engaged with the underside of the press part. The septum is actuated by the inverted press part pressing on its proximal end and moving it toward the distal base of the housing. In some

embodiments, the distal end of the septum is configured to receive an end cap in mating engagement. In other embodiments, the distal end of the septum is attached to a septum end attachment. The septum is configured to be in axial alignment with the housing in an non-activated state and maintains axial alignment during
5 actuation of the dispensing means and accepting of the end cap.

The septum is substantially rigid and not intended to bend or flex to a deformable position. The rigidity of the septum aids assembly so that it can readily accept the end cap as there is interfering engagement in between the septum and the end cap. The end cap is intended to remain engaged in the septum and not
10 readily removed from the septum. As the press part is inverted the septum forces the end cap in a downward direction beyond the distal base of the dose chamber and housing. The strength of the septum needs to be structurally sound enough to forcibly remove the end cap from the product chamber where there is diametrical interference.

15 End Cap

The end cap is located at the distal base of the housing and is mating engagement with the distal end of the septum as exemplified in Figures 8 and 15. In some embodiments the end cap is configured to receive the distal end of the septum in a recess to maintain axial alignment within the housing. In other
20 embodiments the septum is configured to receive the proximal end of the end cap. The end cap is in interfering engagement with the internal side walls of the housing sufficient to provide sealing integrity alone and maintain the one or more ingredients in the dose chamber of the housing tube. In some embodiments, the end cap is comprised of propylene and ethylene materials. In some embodiments
25 the end cap and internal side walls of the housing tube are made of a highly polished mating surfaces. These highly polished faces when in intimate contact provide superior seal integrity against moisture and maintain product integrity. Such polishing methods are known to one of skill in the art.

The end cap can be configured to include a liner in between the end of the
30 septum and the bottom portion of the end cap to provide sealing interface and added removal resistance. A small foil disc with materials coated on the outside is cut and placed into the bottom of the recess formed to accept the septum. The liner

welds to both portions the end cap and the septum using an RF (radio frequency) sealing process common in the foil liner applications. This process is very similar to the foil liner found on catsup bottles only the liner can be configured to seal both portions. When other portions are welded with this type of liner the strength of the weld is very strong and the end cap cannot be readily separated from the septum. The advantage is this avoids spin welding which would weld the outer portion of the end cap to the product chamber. Sonic welding and heat stake welding processes are not directional enough to avoid heating the adjacent areas of the product chamber and end cap thus adhering them together.

10 End Plate Seal

In some embodiments an end plate seal is used to provide a protective seal at the distal base of the housing. The end plate seal extends across the distal base of the housing tube as exemplified in Figures 3 and 8. The end plate seal may be made from a variety material that are thin and frangible in nature to fracture when the press part is inverted to a concave shape causing the engaged septum to apply a force against the end cap causing force against the end plate seal. In some embodiments a foil liner is applied at the distal base of the end cap and distal base of the housing tube to seal the interior of the housing tube. The closure created by the end plate seal is used to add to product efficacy and provide tamper evidence if prematurely breached.

In other embodiments the foil end plate seal is supported by plastic across the entire face of the foil to provide sufficient mechanical support to pass common shipping, filing and drop tests and to maintain product integrity. Use of a supporting plastic also allows for a majority of the foil to be intimately attached to both the polypropylene (PP) and high density polyethylene (HDPE) polymers used to mold the inverted dome dispensing closure device components thereby reducing the amount of foil particulates falling into the receiving vessel upon dispensation.

Septum End Attachment

In some embodiments the inverted dome dispensing closure further comprises a septum end attachment as exemplified in Figure 6. This separate attachment is used to capture a foil type of an end plate seal. The septum end attachment is configured in a manner to apply uneven pressure on the end plate to

reduce the force required to fracture or open the end plate. The septum end attachment is generally reduced in diameter from the dose chamber to allow free movement of the septum and dome inversion. The septum end attachment is configured to include one or more radial beads and is largely cupped in configuration. Once the dome is inverted the septum end attachment acts against the end plate in sufficient force to break-away the end plate seal. The end plate seal being flexible enough to accept the cup shaped septum end attachment and hold the flexible seal within the radial beads positioned to the inside of the cupped end of the septum end attachment.

10 Receiving Vessel

The receiving vessel may be any container, receptacle, vessel of varying size and shape capable of being attached to the dispensing closure devices of the present application. It may be constructed from glass, plastic or other similar material. In some embodiments the receiving vessel has a threaded neck for attachment thereto. In some embodiments the receiving vessel is attached to a dispensing closure of the present invention by a manufacturer. In other embodiments the receiving vessel is attached to a dispensing closure device of the present invention at the point of use by an end user. In some embodiments the receiving vessel has a pliable seal at the land of the vessel opening that can be removed by an end user at point of use before attachment. The pliable seal at the land of the vessel opening is used to maintain product integrity of the receiving vessel. In other embodiments the receiving vessel has a removable screw cap or such other removable top that once removed it is capable of attaching to the dispensing closure devices.

25 Non-limiting exemplary receiving vessels include bottles, other beverage containers, cartons, canteens, stand-up pouches, cans, flasks, glass bottles, and the like.

The type and form of one or more ingredients of the receiving vessel is unlimited. Non-limiting exemplary forms of ingredients of the receiving vessel includes beverages, drinks, infusions, liquids, shots, suspensions, syrups and swills. Non-limiting examples of the one or more ingredients of the receiving vessel include water, sports drinks, meal replacement beverages, diet beverages,

energy drinks. The receiving vessel may also contain excipients, acidulants, sweeteners, flavoring agents and coloring agents for easier consumption by the end-user of a medicament, drug or pharmaceutical dispensed therein.

Materials

5 In some embodiments, the materials of the inverted dome dispensing closure device are primarily comprised of propylene and ethylene materials or combinations thereof. In some embodiments the material is polypropylene (PP) and/or polyethylene (PE) materials. In some embodiments the material is a high density polyethylene (HDPE). Alternate materials of flexible nature can also be
10 employed like thermoplastic elastomers and others of a lower modulus sufficient to provide flexibility.

TAMPER EVIDENT AND PROTECTIVE COMPONENTS

It is another aspect of the invention to provide a point of use dispensing closure device that indicates to the end user whether inadvertent dispensation or
15 tampering with the product has occurred and that protects from accidental, inadvertent or premature dispensation.

Inverted Dome Configuration

The convex dome itself is configured to indicate tampering. The convex dome is designed in such a manner as to not be readily re-inverted, or moved from
20 a concaved activated position back to a convex armed and ready for use position. The dome once activated, does not return to the pre-flexed position on its own accord. The radial hinges act to maintain the inverted concave position of the activated dome. Once it is inverted, the dome then in a concave configuration resides below the proximal upper edge of the housing tube sufficient to not allow
25 re-inversion. Inversion of the dome prior to the point of use is indicative of tampering and/or premature dispensation.

Fold Away Tab

As seen in Figures 7-10, in some embodiments there are a fold away tab or truss added to the convex dome to protect against inadvertent activation and
30 dispensation. The fold away attachment can be configured to extend from the housing tube to which the dome is attached or from the deck of the closure radial skirt. The truss has an outboard hinged attachment to the housing tube or the deck

of the closure radial skirt. In some embodiments the truss also has a break-away attachment centered to the dome and truss between the outer dome and the truss. A broken break-away attachment such that it no longer connects the underside of the truss to the outer diameter of the convex dome indicates that tampering has occurred. A space is provided between the truss configuration and tube of the closure and the convex dome for ease of customer use. The truss and break-away attachment are also used to prevent the dome from premature inversion in the event a vacuum is formed on the end of the closure inside a vessel.

The inverted dome dispensing closure is activated by pressing on the truss in a manner to fold it away from the dome top. The folding motion shears the break-away attachment and is hingedly pivoted beyond the outer edge of the dome toward the radial edge of the tube. The truss is configured to have interfering engagement with the radial edge of the housing tube to prevent the truss from moving back over the dome.

A fold away truss or tab as described herein may also be employed with a frustum cone press part to protect from inadvertent activation and dispensation of product and for use as an indicator of tampering.

Radial Rim

As seen in Figures 4-6 and 11, in some embodiments, the convex dome can be configured to have a surrounding structure around the dome, a standing radial rim, to prevent inadvertent actuation. In some embodiments the standing radial rim may be configured with one or more ports or openings to allow easier user access or to drain water after washing. In another embodiment, the standing radial rim is removable. A removable standing radial rim further comprises a pull tab to remove the rim from the housing to provide easier access to the convex dome for actuation at point of use. Removal of the radial rim before actuation by the end user is indicative of tampering. A radial rim as disclosed herein may also be employed to protect a frustum cone shaped press part from inadvertent activation and dispensation of product and as an indicator of tampering.

Protective Overcap

As seen in Figures 12-15, some embodiments of the inverted press part dispensing closure further comprise a removable protective overcap to protect

against inadvertent inversion of the convex dome or the frustum cone into a concaved position. The protective overcap surrounds the press part leaving a space between the cap and the press part such that a reasonable force against the protective overcap does not invert the dome. In some embodiments there is a hinge connecting the protective overcap to the inverted dome disclosure device
5 allowing removal and reattachment of the cap. The hinge may connect the protective overcap to the radial closure skirt or the outer diameter of the housing. In other embodiments once the protective overcap is removed it cannot be reattached. A pull tab may be used to remove the protective overcap. The pull tab
10 if actuated can be indicative of tampering if removed prior to the point of use.

Tamper Evident Skirt

In some embodiments as shown in Figure 9, the closure radial skirt has a frangible tamper evident (TE) skirt that interferingly engages with the neck of an attached receiving vessel to prevent removal of the inverted press part dispensing
15 closure. In one embodiment, there is a pull tab that when pulled breaks the TE skirt away from its engagement with the closure radial skirt. In another embodiment, the TE skirt is attached by one or more break away tabs such that application of a twisting motion to the closure radial skirt in a counter clock wise direction breaks the TE skirt away. A TE skirt that is not in interfering
20 engagement with the receiving vessel at point of use is indicative of tampering. The closure radial skirt can be used with or without the depending tamper evident skirt band.

MECHANISM OF ACTION

The one or more ingredients stored inside the dose chamber of the housing
25 tube are released by applying a force against the press part. In some embodiments the end user presses the press part. An embodiment of the mechanism of action is illustrated in Figures 16 through 20. The convex dome is pressed downwardly or inwardly until it inverts and remains in a now concaved configuration. This action directly acts on the depending septum which is attached to the end cap. The
30 septum moves vertically downward pressing the end cap from its inactivated position within the diameter of the housing to its activated position below the distal end of the housing. This motion also causes the end cap to breach the end plate

seal lining allowing the one or more ingredients inside the dose chamber of the housing tube a path way out of the tube. The pathway out of the tube is a spaced opening or port for maximum dispensation about the entire area of the distal base of the housing except for the area of the distal base of the septum.

5 In another embodiment as illustrated in Figure 3 (in the ready or inactivated form), the septum acts directly on the end plate seal in sufficient force to break-away the end plate seal.

 In another embodiment as illustrated in Figure 6 (in the ready or inactivated form), the septum acts directly on a septum end attachment. In turn the septum end
10 attachment acts against the end plate seal in sufficient force to break-away the end plate seal. The one or more radial beads in the cupped end of the septum end attachment retain the broken end plate seal.

 The user-actuated dispensing means of the present invention maximizes the size of the dispensing port from which one or more ingredients are dispensed. The
15 disclosed user-actuated dispensing means provide a spaced opening at the distal end of the housing allowing one or more ingredients to exit the dose chamber and be dispensed. This created spaced opening is the dispensing port. The one or more ingredients are able to flow directly from the dose chamber of the housing into the receiving vessel. In some embodiments, the dispensing port is substantially the
20 same in diameter as the housing. In some embodiments, the dispensing port has an area substantially the area of the distal base of the housing excluding the area of the distal base of the septum.

 The inverted press part dispensing closure device is a one-piece single action delivery method to supply a dose or supply of product into a vessel to which
25 it is attached. The design is intuitive to use and entails a one-touch easy operation by an end user. There is no twisting motion needed for dispensing and no long sleeves or other interfering extensions in the housing tube thereby avoiding or alleviating product interference with the mode of operation for dispensing.

 The dispensing closure of this invention minimizes components and
30 materials which simplifies assembly. It is constructed with fewer parts than other closures on the market. Because there are fewer components to manufacture and the components are manufactured to minimize the amount of materials used, the

dispensing closures of this invention use less material to improve manufacture-ability and reduce environmental impact. Fewer components of the present invention also simplify assembly and filing.

5 The dose chamber is filled from the distal base of the housing with the housing in an inverted position. In some embodiments, the distal base of the housing is open or not yet sealed by an end cap, septum end attachment and/or end plate seal. The open distal end of the housing tube provides a target for easily filling the dose chamber with automated and semi-automated filling equipment of various sophistications. The relatively large target allows for automated assembly
10 to readily locate, index, fill and sense the proper fill has been achieved.

METHODS OF DISPENSING A DOSE

In another aspect of the invention there are methods of supplying or dispensing a dose or one or more ingredients or products comprising providing a dispensing closure device of the present invention, and dispensing the product
15 therefrom. In some embodiments the dispensing disclosure device is provided attached to a receiving vessel. In other embodiments, attachment of the receiving vessel to a dispensing closure device is required.

In one embodiment there is a method for supplying a dosage of one or more ingredients to another set of one or more ingredients comprising the steps of: (a)
20 providing an inverted dome dispensing closure having a housing, wherein the housing comprises a septum, a convex dome, and an end plate seal, and one or more ingredients stored within; (b) providing a receiving vessel having another set of one or more ingredients and capable of receiving the one or more ingredients from the inverted dome dispensing closure; (c) attaching the inverted dome
25 dispensing closure to the receiving vessel; and (d) dispensing by a user actuate means from the inverted dome dispensing closure the one or more ingredients into the receiving vessel. In some embodiments the housing further comprises an end cap. In other embodiments the housing further comprises a septum end attachment.

30 In another embodiment there is a method for supplying a dosage of one or more ingredients to another set of one or more ingredients comprising the steps of: (a) providing an inverted press point dispensing closure attached to a receiving

vessel wherein the inverted press point dispensing closure comprises a housing having a press point, a septum, an end plate seal, and one or more ingredients stored within; and (b) dispensing from the inverted press point dispensing closure by user-actuated means the one or more ingredients into the receiving vessel. In
5 some embodiments the housing further comprises an end cap. In other embodiments the housing further comprises a septum end attachment.

In another embodiment there is a method for supplying a dosage of one or more ingredients to another set of one or more ingredients comprising the steps of:
(a) providing an inverted press point dispensing closure attached to a receiving
10 vessel wherein the inverted press point dispensing closure comprises a housing comprising a user-actuated dispensing means and dose chamber having one or more ingredients stored within; and (b) dispensing from the inverted press point dispensing closure by user-actuated means the one or more ingredients into the receiving vessel. In some embodiments the user-actuated dispensing means
15 comprises a press part and a septum. In some embodiments the user-actuated dispensing means comprises a press part, a septum and end cap. In other embodiments the user-actuated dispensing means comprises a press part, septum and septum end attachment. In one embodiment user-actuated means comprises applying a pressing force against the press part.

20 In another embodiment there is a method for supplying a dosage of one or more ingredients to another set of one or more ingredients comprising the steps of:
(a) providing an inverted press point dispensing closure capable of being attached to a receiving vessel wherein the inverted press point dispensing closure comprises a housing having a press point, a septum, and, an end plate seal, and one or more
25 ingredients stored within; (b) attaching the inverted press point dispensing closure to the receiving vessel; and (c) dispensing from the inverted dome dispensing closure by a user-actuated means the one or more ingredients into the receiving vessel. In some embodiments the housing further comprises an end cap. In other embodiments the housing further comprises a septum end attachment.

30 EXAMPLES

EXAMPLE 1

The POWERCAP® in one form comprises: a housing and a closure radial

skirt; the housing comprising a dose chamber and a user-actuated means for dispensing one or more product and an end plate seal; the user-actuated means comprising a convex dome, septum and end cap; the convex dome further comprising a standing radial rim; the closure radial skirt further comprising a
5 tamper evident skirt.

EXAMPLE 2

Many nutrients and vitamins that can be used to create functional beverages are sensitive to the conditions most often utilized to manufacture and store such products (i.e. heat, light, water). The POWERCAP® dosing closure is a beverage
10 technology that can protect ingredients in an enclosed chamber with a friction fit seal that can be engaged to dispense stored materials into liquid to create a functional beverage at the time of use. This experiment investigated the ability of the POWERCAP® dosing closure to retain the chemical integrity of vitamin C (ascorbic acid) and caffeine as compared to subjecting those nutrients to the
15 conditions typical of hot fill beverage manufacturing. A standard formulation, containing known quantities of both vitamin C and caffeine, was distributed among four experimental conditions: 1) within the POWERCAP® chamber and stored without attachment to a bottle; 2) within the POWERCAP® chamber and stored fully threaded onto a standard form threaded bottle filled with water; 3) dispensed
20 into a water volume and stored in a capped bottle; and 4) dispensed into a water volume, heated to 80°C for 30 minutes, and stored in a capped bottle. Each of the test samples was stored in an oven at 37°C for 30 days. At periodic interim time points, replicates were pulled from their storage conditions and evaluated by high performance liquid chromatography coupled to photodiode array and mass
25 detectors to determine the quantity of vitamin C and caffeine retained in each. This process was repeated at the end of the 30 day experiment. Caffeine displayed strong stability under all experimental conditions. Vitamin C stability was dependant on the storage experimental conditions. Steep degradation was observed for vitamin C when mixed with water and exposed to hot fill conditions and also in
30 extended liquid storage without hot fill temperatures. However excellent chemical stability of vitamin C was obtained when the mix was kept dry stored in POWERCAP®, off the bottle or attached to a water filled bottle. Our results

demonstrate that vitamin C, a very labile nutrient easily degraded in solution, can stay stable in the dry form, even if subjected to temperature stress conditions (37°C).

EXAMPLE 3

5 The dispensing closure of the present invention is useful for the creation of alternative form or variants of existing brand beverages. Such variants include by non-limiting examples convenience forms, travel forms, dehydrated forms requiring only the addition of water, variants with an extended shelf-life, sugar-free forms, and variants with attributes of freshness, efficacy, potency, stability and
10 consistency.

EXAMPLE 4

 Another embodiment of the dispensing closure device of the present invention is the dispensing closure device marketed and sold separately and unattached from a receiving vessel needed to form a finished product. This
15 has benefits in lowering shipping costs by avoiding shipping costs associated with shipping water or other liquids while also providing attributes such as freshness, convenience, efficacy, potency, consistency, for example.

EXAMPLE 5

 Another embodiment of the dispensing closure device of the present
20 invention is a storage and delivery system for ingredients that exhibit stability, solubility, and efficacy challenges when exposed to water or other liquids. Non-limiting examples of such ingredients include Glisodin (poor solubility and stability over time in water), probiotics (poor shelf life when exposed to water activity, CoQ10 (poor stability and solubility over time in water).

25 EXAMPLE 6

 Another embodiment of the dispensing closure device of the present invention is a storage and delivery system for a hangover protection beverage comprising glucarate other forms of glucaric acid, and/or b vitamins, and/or caffeine (and other energy drink ingredients), and/or electrolytes independently or
30 in combination with flavoring, sweetening, acidulants, and/or coloring agents.

EXAMPLE 7

 Another embodiment of the dispensing closure device of the present

invention is storage and delivery system to create a fiber enhanced water using either soluble or insoluble fibers (i.e. arabinogalactan, arabinoxylan, and others) independently or in combination with other ingredients, flavoring, sweetening, acidulants, and/or coloring agents.

5 EXAMPLE 8

Another embodiment of the dispensing closure device of the present invention is a storage and delivery system to create an immune supporting beverage using probiotics independently or in combination with other ingredients, flavoring, sweetening, acidulants, and/or coloring agents.

10 EXAMPLE 9

Another embodiment of the dispensing closure device of the present invention is a storage and delivery system to create 'beauty from within' beverages using ingredients that can provide anti-aging benefits by ingestion of them within the created beverage independently or in combination with other ingredients, 15 flavoring, sweetening, acidulants, and/or coloring agents.

EXAMPLE 10

Another embodiment of the dispensing closure device of the present invention is a storage and delivery system to create sports nutrition beverages targeting benefit areas such as recovery, stamina, strength, muscle building, etc. 20 Ingredients that can be utilized for such benefits are branched chain amino acids, L-carnitine, creatine, glutamine, proteins, hydrolyzed proteins, free amino acids, and other such ingredients independently or in combination with other ingredients, flavoring, sweetening, acidulants, and/or coloring agents.

While the invention has been described in connection with the disclosed 25 embodiments, it is not intended to limit the scope of the invention to the particular form set forth, but on the contrary, it is intended to cover such alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

WHAT IS CLAIMED IS:

1. A closure device for point-of-use dosing comprising:
 - a. an inverted press part dispensing closure having a housing;
 - b. the housing having a septum, a press part, and an end plate seal;
 - c. a receiving vessel attached to the inverted press part dispensing closure; and
 - d. a user-actuated means for dispensing from the inverted press part dispensing closure into the receiving vessel.
2. The device of claim 2 wherein the housing comprises a proximal top, a distal base and side walls.
3. The device of claim 2 wherein the press part comprises the proximal top of the housing.
4. The device of claim 2 wherein the end plate seal comprises the distal base of the housing.
5. The device of claim 2 wherein the housing is tubular in shape.
6. The device of claim 1 wherein the housing further comprises a dose chamber capable of storing one or more ingredients.
7. The device of claim 1 wherein the press part is capable of flexing to a concaved configuration when force is applied.
8. The device of claim 1 wherein the press part further comprises a plurality of hinge members at the upper radial edge of the dose chamber, one or more hinge at the upper radial edge of the septum, or combinations thereof.
9. The device of claim 1 wherein the press part further comprises one or more radial ribs, one or more axial ribs or combinations thereof.

10. The device of claim 1 wherein the press part comprises a convex dome or a frustum cone.
11. The device of claim 2 wherein the septum depends from the apex of the convex dome toward the base of the housing.
12. The device of claim 1 wherein the septum maintains axial alignment within the housing.
13. The device of claim 1 wherein the housing further comprises an end cap in mating engagement with the base of the septum.
14. The device of claim 13 wherein the end cap is in interfering engagement with the inner diameter of the housing.
15. The device of claim 1 wherein the septum further comprises a septum end attachment of a reduced diameter from the internal diameter of the housing attached to the distal end of the septum and having one or more radial beads.
16. The device of claim 1 wherein the end plate seal comprises a foil liner.
17. The device of claim 16 wherein the foil liner is supported across its face by plastic lining.
18. The device of claim 6 wherein the receiving vessel contains another set of one or more ingredients.
19. The device of claim 17 wherein the receiving vessel is sealed by a plug seal.
20. The device of claim 18 wherein the receiving vessel is a bottle.
21. The device of claim 1 wherein a user-actuated means for dispensing one or more ingredients comprises applying a force to the press part causing it to invert and remain in a concave configuration.
22. The device of claim 1 wherein the inverted press part dispensing closure

further comprises a closure radial skirt attached to the outer diameter of the housing of the inverted press part dispensing closure, in axial alignment with the housing and having a greater outer diameter than the housing, a proximal deck, and distal radial edge.

23. The device of claim 22 wherein the closure radial skirt further comprises threads on its inner diameter for attaching to the receiving vessel.
24. The device of claim 22 wherein the closure radial skirt further comprises finger recesses on the outer diameter.
25. The device of claim 22 further comprising a tamper evident skirt attached to the distal radial edge of the closure radial skirt by a break-away attachment.
26. The device of claim 1 wherein the inverted press part dispensing closure further comprises a fold away truss straddling the convex dome to prevent inadvertent user actuation means of dispensing.
27. The device of claim 26 wherein the fold away truss folds out of the way pivoting on two hinged members connected to the outer diameter of the housing.
28. The device of claim 26 wherein the fold away truss has an inner radius such that when tab is in a folded position the tab interferes with the outer diameter of the housing.
29. The device of claim 26 wherein the fold away truss has a break-away attachment connecting the underside of the truss to the distal edge of the convex dome.
30. The device of claim 27 wherein the break-away attachment connects at the apex of the convex dome.

31. The device of claim 1 wherein the inverted press part dispensing closure further comprises a removable protective overcap.
32. The device of claim 31 wherein the removable protective overcap is connected to the device by a hinge attachment.
33. The device of claim 1 wherein the inverted press part dispensing closure further comprises a standing radial rim attached to the housing and extending beyond the proximal end of the convex dome.
34. The device of claim 33 wherein the standing radial rim comprises a pull tab to remove the standing radial rim before actuation.
35. An inverted press part storage and dispensing closure device comprising:
 - a. a housing wherein the housing comprises a press point at the proximal top, an end plate seal at the distal base, a septum in axial alignment within the housing depending from the apex of the convex dome toward the base of the housing, an end cap in mating engagement with the base of the septum, and a dose chamber capable of storing one or more ingredients; and
 - b. a closure radial skirt attached to the outer diameter of the housing, in axial alignment with the housing, having a greater outer diameter than the housing, and capable of attaching to a receiving vessel for dispensing one or more ingredient therein.
36. An inverted press part storage and dispensing closure device comprising:
 - a. a housing wherein the housing comprises a press point at the proximal top, an end plate seal at the distal base, a septum in axial alignment within the housing depending from the apex of the press point toward the base of the housing, a septum end attachment of a reduced diameter from the internal diameter

of the housing attached to the distal end of the septum and having one or more radial beads, and a dose chamber capable of storing one or more ingredients; and

b. a closure radial skirt attached to the outer diameter of the housing, in axial alignment with the housing, having a greater outer diameter than the housing, and capable of attaching to a receiving vessel for dispensing one or more ingredient therein.

37. A storage and dispensing closure device comprising:

a. a housing comprising a dose chamber and a user-actuated means for dispensing one or more ingredients; and

b. a closure radial skirt attached to outer diameter of the housing in axial alignment with the housing, having a greater outer diameter then the housing, and capable of attaching to a receiving vessel for dispensing one or more ingredient therein.

38. The storage and dispensing closure device of claim 37 wherein the user-actuated means for dispensing comprises a press point, a septum, an end cap and end plate seal.

39. The storage and dispensing closure device of claim 37 wherein the user-actuated means for dispensing comprises a press point, a septum, a septum end attachment and end plate seal.

40. A method for supplying a dosage of one or more ingredients to another set of one or more ingredients comprising the steps of:

a. providing an inverted dome dispensing closure having a housing, wherein the housing comprises a septum, a convex dome, an end plate seal, and one or more ingredients stored within;

- b. providing a receiving vessel having another set of one or more ingredients and capable of receiving the one or more ingredients from the inverted dome dispensing closure;
 - c. attaching the inverted dome dispensing closure to the receiving vessel; and
 - d. dispensing by a user-actuated means from the inverted dome dispensing closure the one or more ingredients into the receiving vessel.
41. The method of claim 40 wherein the housing further comprises an end cap or a septum end attachment.
42. A method for supplying a dosage of one or more ingredients to another set of one or more ingredients comprising the steps of:
- a. providing an inverted press point dispensing closure attached to a receiving vessel wherein the inverted press point dispensing closure comprises a housing having a press point, a septum, an end plate seal, and one or more ingredients stored within; and
 - b. dispensing from the inverted press point dispensing closure by user-actuated dispensing means the one or more ingredients into the receiving vessel.
43. The method of claim 42 wherein the housing further comprises an end cap or a septum end attachment.
44. The method of claim 42 wherein the inverted press point dispensing closure further comprises a closure radial skirt for attachment of the inverted dome dispensing closure to the receiving vessel.
45. The method of claim 42 wherein the receiving vessel having another set of one or more ingredients is capable of receiving the one or more ingredients

from the inverted dome dispensing closure.

46. The method of claim 42 wherein the press point is selected from a convex dome and a frustum cone.
47. A method for supplying a dosage of one or more ingredients to another set of one or more ingredients comprising the steps of:
- a. providing an inverted press point dispensing closure attached to a receiving vessel wherein the inverted press point dispensing closure comprises a housing having a press point, a septum, an end cap, and one or more ingredients stored within; and
 - b. dispensing from the inverted press point dispensing closure by user-actuated dispensing means the one or more ingredients into the receiving vessel.
48. The method of claim 42 wherein the housing further comprises an end cap seal.
49. A method for supplying a dosage of one or more ingredients to another set of one or more ingredients comprising the steps of:
- a. providing an inverted press point dispensing closure capable of being attached to a receiving vessel wherein the inverted press point dispensing closure comprises a housing having a dose chamber having one or more ingredients stored within and a user-actuated dispensing means comprising a press point and a septum;
 - b. attaching the inverted press point dispensing closure to the receiving vessel; and
 - c. dispensing from the inverted dome dispensing closure by a user-actuated means the one or more ingredients into the receiving vessel.
50. The method of claim 49 wherein the user-actuated dispensing means further

comprises an end cap or septum end attachment.

51. The method of claim 50 wherein the housing further comprises an end plate seal.