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(54) System and method for mechanical closure of container openings

(57) A mechanical lid or a plug (101) interacts with an opening (1036) of a pouch or a container (103), as well as with a rigid ring (102) placed inside the container (103) opening to provide a tight seal of the opening (1036). The mechanical plug (101) compresses both the outside of the opening (1036) and the inner face of the ring (102) placed inside the container opening (1036). The radial edge of the inner face of the mechanical plug (101) has an arch-shaped annular recess (101a) extending around the plug (101) such that the radial edge of the plug (101) is adapted to hug the perimeter of the container opening (1036). In addition, attached to the inner face of the mechanical plug (101) are two or more legs (1011) which extend perpendicular to the inner face of the mechanical plug (101) and engage the bottom of the rigid ring/radial groove combination. The outside surface of the neck region of the container opening (1036) and the interior surface of the annular recess of the mechanical plug (101) each has one or more protrusions (1013,1014,1015) which force the container material displaced by compression to be confined within a defined area, thereby ensuring the tightness of the seal for a prolonged period of time. The lower surface of the mechanical plug (101) is sloped downward in the direction of the centre, to which a plunger (1017) is attached for insertion into the liquid content of the container before the mechanical plug (101) is snapped into the container opening (1036), thereby substantially eliminating the residual air bubbles which may otherwise remain trapped between the surface of the liquid and the lower surface of the mechanical plug (101), which allows airless filling of the container without the need for a vacuum condition.

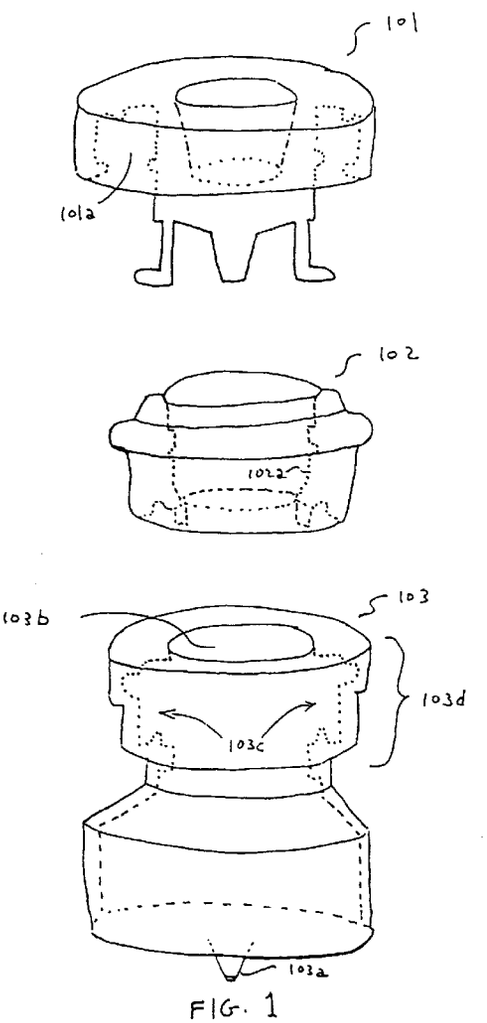

FIG. 1

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Description

This invention relates generally to a system and a method for mechanically closing an opening of a pouch or a container, and relates more particularly to a system and a method for closing an opening of a pouch or a container by using a combination of a plug mechanism and an annular ring mechanism.

Generally, the task of filling a pouch or a container with a liquid content and ensuring that the content is tightly sealed may be achieved by one of two approaches: fill a pouch or a container which has an opening for introducing the liquid content and subsequently seal the opening; or fill a sealed pouch or container using a liquid-introducing needle and subsequently seal the puncture point. Both methods generally require application of external sealing agents, the efficacy of which sealing agents may be subject to the material characteristics of the container, for the purpose of forming tight seals. Material characteristics of the container are usually constant, but should they vary, these characteristics would affect the tightness of the seal.

One alternative approach is, then, to utilize plugs or lids which are formed to mechanically interact with the opening of a pouch or a container to form a tight seal. The main difficulty with this approach is that the allowable mechanical tolerances of the interacting parts are extremely small in order to achieve a tight, substantially hermetic seal. Furthermore, even if the interacting parts initially form a tight seal, the portions of the interacting parts which are under pressure tend to experience a "creep," i.e., deformation of the material, over time. Accordingly, the "creep" phenomenon tends to reduce the tightness of the seal. Thus, there is a need for a mechanical closure system which achieves and maintains hermetic seal of a pouch or a container over a substantial period of time.

Accordingly, it is an object of the present invention to provide a mechanical closure system for achieving a tight, substantially hermetic seal of a pouch or a container having an opening.

It is another object of the present invention to provide a method of mechanically sealing a pouch or a container having an opening to achieve a tight, substantially hermetic seal.

It is yet another object of the present invention to provide a mechanical closure system for a pouch or a container having an opening, which mechanical closure system compensates for deformation of the interacting parts of the mechanical closure system and the pouch or the container.

It is yet another object of the present invention to provide a method of forming a mechanical seal of a pouch or a container having an opening, which mechanical seal compensates for deformation of the interacting parts of the mechanical closure system and the pouch or the container.

It is yet another object of the present invention to provide a mechanical closure system for achieving a tight, substantially hermetic seal of a pouch or a container having an opening, which system does not require extremely small tolerances for the interacting parts.

It is yet another object of the present invention to provide a method of mechanically sealing a pouch or a container having an opening with a mechanical closure system, which method does not require extremely small tolerances for the interacting parts of the mechanical closure system to achieve a tight, substantially hermetic seal.

It is yet another object of the present invention to provide a method of mechanically sealing an opening of a pouch or a container after having introduced liquid into the container through the opening, which method eliminates the need to provide vacuum conditions for filling the container and, thereby, substantially reduces the cost of the mechanical system for filling the container.

It is yet another object of the present invention to provide a system of mechanically sealing an opening of a pouch or a container for a liquid, which system provides a mechanical plug that facilitates maximum collapsibility of the container by allowing transverse and longitudinal deformation of the container material without hindrance, which in turn minimizes residue in the container after dispensing the liquid.

In accordance with the above objects, the present invention provides a mechanical lid or a plug which interacts with an opening of a pouch or a container, as well as with a rigid ring placed inside the container opening. The mechanical plug is snapped into the container opening such that the mechanical plug compresses both the outside of the opening and the inner face of the ring placed inside the container opening, thereby forming a tight seal of the opening.

The opening area of the container has an annular recess configured to accommodate the rigid ring, where the rigid ring is snapped into the annular recess. After the rigid ring has been snapped into the annular recess of the opening region of the container, the mechanical plug is snapped both into the rigid ring and around the outside edge of the container opening so that the container opening is compressed between the rigid ring and the mechanical plug. The radial edge of the inner face of the mechanical plug is formed as a an arch-shaped region which extends around the plug such that the radial edge of the plug is adapted to "hug" the perimeter of the container opening. In addition, attached to the inner face of the mechanical plug are two or more legs which extend perpendicular to the lower surface of the mechanical plug. The ends of the legs are hook-shaped to engage the bottom of the rigid ring/radial groove combination. The annular recess and the legs of the mechanical plug facilitate both vertical and radial compression of the opening region of the container and the rigid ring. In this manner, a tight seal of the container opening is ensured.

In addition, the outside surface of the opening re-

gion of the container and the interior surface of the annular recess of the mechanical plug each has one or more protrusions, or "interferences." Once the mechanical plug has been snapped into the container opening, the resulting compression of the container material tends to cause displacement, or "creep," of the compressed material towards areas of lesser compression. The protrusions limit the range of displacement of the compressed container material, i.e., force the container material displaced by compression to remain within a defined area, thereby ensuring the tightness of the seal for a prolonged period of time.

The central inner surface of the mechanical plug may be equipped with an extension or a plunger which is adapted to extend into the liquid content of the container in such a way that the mechanical plug snaps tightly into the container opening after, and only after, the plunger has displaced the surface level of the liquid up to the upper edge of the container opening, thereby obviating the need for a vacuum condition normally utilized for an air-less filling process. In this manner, the plunger substantially reduces the residual air bubbles which may otherwise remain between the surface of the liquid and the inner surface of the mechanical plug.

The mechanical closure system and method according to the present invention may be used for any application in which an opening of a pouch or a container needs to be tightly sealed. For example, the mechanical closure system according to the present invention is particularly well suited for closing medicament containers or pouches containing medicament. Because the mechanical closure system according to the present invention achieves a substantially hermetic seal without the need for caulking materials, glues or other external sealing agents, expensive sealing systems for applying the external sealing agents are not necessary. In addition, because of interaction of the protrusions provided on the exterior surface of the opening region of the container and the interior surface of the annular recess of the mechanical plug, the allowable mechanical tolerances of the interacting components of the mechanical closure system are increased.

The invention will now be described in detail, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 is an exploded view of components of one preferred embodiment of the mechanical closure system according to the present invention.

Fig. 2 is an exploded cross-sectional view of components of the preferred embodiment of the mechanical closure system according to the present invention shown in Fig. 1.

Fig. 3 is a cross-sectional view of assembled components of the preferred embodiment of the mechanical closure system according to the present invention shown in Fig. 1.

Fig. 4 is an exploded cross-sectional view of components of another preferred embodiment of the mechanical closure system according to the present invention.

Fig. 5 is a cross-sectional view of assembled components of the preferred embodiment of the mechanical closure system according to the present invention shown in Fig. 4.

As shown in Fig. 1, which is an exploded view of a first exemplary embodiment of a mechanical closure system according to the present invention, the first embodiment of the present invention includes a mechanical lid or plug 101 and a rigid annular ring 102, both of which interact with a neck region 103d near an opening 103b of a pouch or container 103 to tightly seal the opening 103b. The pouch or container 103 may be made of any one of several materials well known in the art, including butadiene polyethylene styrene (KRATON™), polyethylene, polyurethane or other plastic materials, thermoplastic elastomers or other elastic materials. As shown in Fig. 1, the container 103 may be a medicament dispensing cartridge with a nozzle 103a.

As shown in Fig. 1 and Fig. 2, the latter of which is an exploded cross-sectional view of the first embodiment of the mechanical closure system according to the present invention, the contour of the rigid ring 102 is complementary to the inside contour 103c of the neck region 103d of the container 103 near the opening 103b, thereby allowing the rigid ring 102 to be snapped into the inside contour 103c of the neck region 103d. Similarly, as shown in Figs. 1 and 2, radial edge 101a of the mechanical plug 101 is formed as a U-shaped region which extends around the plug and complements the exterior contour of the combination of the rigid ring 102 and the neck region 103d. After the rigid ring 102 has been snapped into the inside contour 103c of the neck region 103d, the mechanical plug 101 is subsequently snapped into place around the container opening 103b such that the U-shaped region 101a tightly engages the neck region 103d of the pouch 103 and the interior surface of the rigid ring 102.

As shown in Fig. 2, the U-shaped region 101a of the mechanical plug 101 has protrusions 1013, 1014 and 1015, and at least one recess 1016. Similarly, the exterior surface of the neck region 103d of the mechanical plug has protrusions 1031 and 1033, and the interior surface of the neck region has a protrusion 1035. In addition, the rigid ring 102 has recesses 1021 and 1022 at the vertical interior surface 102a and the bottom surface, respectively. The recess 1022 of the rigid ring 102 accommodates the protrusion 1035 of the neck region 103d, thereby securely engaging the rigid ring to the neck region of the container 103 once the rigid ring has been snapped into place. The protrusions 1013, 1014 and 1015, as well as a portion 1018, of the U-shaped region 101a of the mechanical plug engage the recess 1021 of the rigid ring and portions 1034, 1036 and 1037 of the exterior surface of the neck region 103d, respectively. In addition, the protrusions 1031 and 1033 of the exterior surface of the neck region 103d engage a por-

tion 1017 and the recess 1016 of the U-shaped region 101a of the mechanical plug.

In addition to the above-described combinations of interlocking protrusions and recesses, attached to the lower surface of the mechanical plug 101 are at least two legs 1011 which extend perpendicularly to the lower surface of the mechanical plug, as shown in Fig. 2. Each of the legs 1011 has a hook-shaped end portion 1012 adapted to engage a recess region 1032 at the bottom interior of the assembled combination of the rigid ring 102 and the neck region 103d of the mechanical plug. The legs 1011 are flexible enough such that, during assembly of the mechanical closure system according to the present invention, the legs 1011 slide down the vertical interior surface 102a of the rigid ring and snap into place at the recess region 1032, against a portion 1038 of the neck region 103d of the container.

The combination of the U-shaped region 101a and the legs 1011 of the mechanical plug 101 facilitates both vertical and radial compression of the neck region 103d of the container and the rigid ring against the mechanical plug. For example, as shown in Fig. 2, the portion 1012 of the legs 1011 interact with the portion 1023 of the rigid ring and the portion 1038 of the neck region 103d of the container, and portions 1014 and 1018 of the mechanical plug interact with portions 1034 and 1037 of the neck region 103d of the container, respectively, to vertically compress the neck region between the mechanical plug 101 and the rigid ring 102. Similarly, the portions 1013, 1015 and 1017 of the U-shaped region 101a of the mechanical plug 101 interact with the portions 1021, 1036 and 1031, respectively, to radially compress the neck region 103d between the mechanical plug and the rigid ring 102. In this manner, a substantially hermetic seal of the container opening 103b is achieved, as shown in Fig. 3.

As can be understood from the above description and Figs. 2 and 3, the first embodiment of the mechanical closure system according to the present invention achieves two types of mechanical seals. First, a seal extending along the horizontal direction of the neck region, e.g., the area extending between the portions 1034 and 1037, as well as the interface of the regions 1022 and 1035, is achieved by the vertical compression of the neck region 103d by the mechanical plug against the rigid ring 102. Second, a seal extending along the vertical direction, e.g., the area extending between the portions 1036 and 1034, as well as the interface of the regions 1021 and 1013, is achieved by the horizontal compression of the neck region 103d by the mechanical plug against the rigid ring 102.

Once the mechanical plug has been snapped into the container opening, the resulting compression of the container material tends to cause displacement, or "creep," of the compressed material towards areas of lesser compression. The protrusions force the container material displaced by compression to be confined within a restricted area, thereby ensuring the tightness of the seal for a prolonged period of time. For example, the protrusions 1014 and 1015 of the mechanical plug 101 delimits the protrusion 1031 on the exterior surface of the neck region 103d of the container. Accordingly, when the material of the protrusion 1031 is initially compressed by the portions 1015 and 1017, the displaced material of the protrusion 1031 is forced towards the protrusion 1014, which limits any further movement of the displaced material, thereby maintaining a tight seal.

As shown in Figs. 2 and 3, the central portion of a lower surface 1019 of the mechanical plug 101 is preferably equipped with an extension or a plunger 1017 which is adapted to extend into the liquid content of the container before the mechanical plug 101 has been snapped into place around the container opening 103b. The inserted plunger 1017 forces the liquid level to rise, hence allowing air or gas bubbles to rise along with the liquid level and escape through the container opening 103b which is not yet sealed by the mechanical plug 101. In this manner, the plunger 1017 substantially reduces the residual air bubbles which may otherwise remain between the surface of the liquid and the lower surface of the mechanical plug. The configuration and dimensions of the mechanical plug 101, the neck region 103d and the rigid ring 102 are such that the U-shaped region 101a and the legs 1011 of the mechanical plug interact with the neck region 103d and the rigid ring 102 to form a tight seal only after the plunger 1017 has forced the liquid level to rise to approximately the upper edge of the neck region 103d, thereby obviating the need for a vacuum condition normally utilized for an air-less filling process.

The lower surface 1019 of the mechanical plug 101 is sloped in order to ensure that the air or gas bubbles which have been forced up to the surface level of the liquid by the insertion of the plunger 1017 are not trapped between the liquid level and the lower surface of the mechanical plug. The sloped surface 1019 facilitates radially upward movement of the air bubbles which eventually escape through the opening 103b of the container, via the area between the two legs 1011.

As shown in Fig. 4, which is an exploded cross-sectional view of a second exemplary embodiment of a mechanical closure system according to the present invention, the second embodiment of the present invention is substantially similar to the first embodiment and includes a mechanical plug or plug 401 and a rigid annular ring 402, both of which interact with a neck region 403d of a pouch or container 403. As in the first embodiment described in conjunction with Figs. 1-3, the contour of the rigid ring 402 is complementary to the inside contour of the neck region 403d of the container 403, thereby allowing the rigid ring 402 to be snapped into the inside contour of the neck region 403d. In addition, radial edge 401a of the mechanical plug 401 is formed as an arch-shaped region which extends around the plug and complements the exterior contour of the combination of the rigid ring 402 and the neck region 403d. After the rigid

ring 402 has been snapped into the inside contour of the neck region 403d, the mechanical plug 401 is subsequently snapped into place around the container opening 403b defined by the neck region 403d such that the arch-shaped region 401a tightly engages the neck region 403d of the pouch 403 and the rigid ring 402, as shown in Fig. 5.

As with the first embodiment of the mechanical closure system, the lower surface 4019 of the mechanical plug 401 of the second embodiment is sloped, or tapered, in order to ensure that the air or gas bubbles which have been forced up to the surface level of the liquid by the insertion of the plunger 4017 are directed radially upward and eventually escape through the opening 403b of the container, via the area between the two legs 4011.

In addition, similar to the first embodiment of the mechanical closure system, the second embodiment shown in Figs. 4 and 5 preferably have at least two legs 4011 attached to the lower surface of the mechanical plug 401, each of the legs having a hook-shaped region 4012 at the end. The hook-shaped region 4012 is adapted to engage a region 4023 at the bottom surface of the rigid annular ring 402. In addition, attached to the central lower surface of the mechanical plug 401 is an extension or a plunger 4017 which is adapted to extend into the liquid content of the container before the mechanical plug 401 is snapped into place around the container opening 403b, thereby substantially reducing the residual air bubbles which may otherwise remain between the surface of the liquid and the lower surface of the mechanical plug.

The second embodiment of the mechanical closure system according to the present invention utilizes fewer protrusions on the surfaces of the mechanical plug 401 and the neck region 403d than the number of protrusions found on the corresponding parts of the first embodiment. However, the unique arrangement of the interacting components, i.e., the mechanical plug 401, the rigid ring 402 and the neck region 403d, ensures a substantially hermetic seal of the pouch 403. As shown in Figs. 4 and 5, a protrusion 4015 and a region 4017 of the mechanical plug interact with a region 4031 of the neck region 403d, which region 4031 includes a protrusion from the regular contour of the exterior surface of the neck region 403d, and a portion 4016 of the mechanical plug interacts with the region 4022 of the rigid ring 402, thereby achieving radial compression of the rigid ring 402 and the neck region 403d. In addition, portions 4016 and 4012 of the mechanical plug interact with regions 4022 and 4023 of the rigid ring 402 to vertically compress the neck region 403d and the rigid ring 402.

In order to ensure that the displacement or creep of the container material around the points of compression does not result in reduced tightness of the seal, the second embodiment of the mechanical closure system provides the protrusion 4015 at the radial edge of the mechanical plug 401. As shown in Figs. 4 and 5, the protrusion 4015 forces the container material of region 4031 displaced by compression to be channeled upwards, towards a space 4018 delimited by the annular rigid ring 402. Accordingly, the protrusion 4015 and the rigid ring 402 confine the displaced material of the region 4031 of the container 403, thereby maintaining a tight seal for a prolonged period of time.

While specific, preferred embodiments have been described above, it should be readily apparent to those of ordinary skill in the art that the above-described preferred embodiments are exemplary in nature since certain changes may be made thereto without departing from the teachings of the invention, and the preferred embodiments should not to be construed as limiting the scope of protection for the invention as set forth in the appended claims. For example, while the exemplary embodiments of the mechanical closure system according to the present invention have been described as being adapted for containers or pouches having circular openings, the mechanical closure system according to the present invention may be adapted for openings of other shapes, e.g., square or rectangle.

Claims

1. A system for mechanically sealing an opening of a container defined by a neck region of said container, which comprises:

   a rigid ring for operatively engaging an interior surface of said neck region of said container; and

   a mechanical plug for operatively and simultaneously engaging an exterior surface of said neck region of said container and said interior annular surface of said rigid ring, said mechanical plug having a leg extending substantially perpendicular to a bottom surface of the mechanical plug for operatively engaging a bottom surface of said rigid ring;

   whereby said mechanical plug and said rigid ring provide a mechanical seal of said container opening by simultaneously engaging at least a portion of said neck region of said container.

2. The system according to claim 1, wherein said mechanical plug and said rigid ring provide a horizontal compression of said neck region of said container to achieve a seal along the vertical dimension of the neck region.

3. The system according to claim 2, wherein said mechanical plug and said rigid ring provide a vertical compression of said neck region of said container to achieve a seal along the horizontal dimension of the neck region.

4. The system according to claim 3, wherein said mechanical plug has an arch-shaped annular region at the radial edge, and wherein an interior surface of said arch-shaped annular region has a protrusion which operatively interacts with said exterior surface of said neck region to delimit displacement of material of said exterior surface of said neck region.

5. The system according to claim 4, wherein said exterior surface of said neck region of said container has a protrusion, and wherein said protrusion of said interior surface of said arch-shaped annular region delimits displacement of said protrusion of said exterior surface of said neck region.

6. The system according to claim 5, wherein said mechanical plug has a plunger extending substantially perpendicular to the bottom surface of the mechanical plug for displacing liquid contained in said container.

7. The system according to claim 6, wherein said bottom surface of the mechanical plug is sloped radially upwards from the plunger for directing gas displaced along with the displaced liquid in radially upward direction.

8. The system according to claim 7, wherein said mechanical plug is securely engaged with said container after substantially all of the gas within the container has been displaced out of the container by the plunger.

9. The system according to claim 1, wherein said mechanical plug has an arch-shaped annular region at the radial edge, and wherein an interior surface of said arch-shaped annular region has a protrusion which operatively interacts with said exterior surface of said neck region to delimit displacement of material of said exterior surface of said neck region.

10. The system according to claim 9, wherein said exterior surface of said neck region of said container has a protrusion, and wherein said protrusion of said interior surface of said arch-shaped annular region delimits displacement of said protrusion of said exterior surface of said neck region.

11. The system according to claim 10, wherein said mechanical plug has a plunger extending substantially perpendicular to the bottom surface of the mechanical plug for displacing liquid contained in said container.

12. The system according to claim 11, wherein said bottom surface of the mechanical plug is sloped radially upwards from the plunger for directing gas displaced along with the displaced liquid in radially upward direction.

13. The system according to claim 12, wherein said mechanical plug is securely engaged with said container after substantially all of the gas within the container has been displaced out of the container by the plunger.

14. A method for mechanically sealing an opening of a container defined by a neck region of said container with a rigid ring and a mechanical plug having an arch-shaped annular region at the radial edge and a leg extending substantially perpendicular to a bottom surface of the mechanical plug, which comprises:

operatively engaging a rigid annular ring with an interior surface of said neck region, an exterior surface of said annular ring and said interior surface of said neck region having substantially complementary contours;
operatively and simultaneously engaging said arch-shaped annular region of said mechanical plug with an exterior surface of said neck region of said container and an interior surface of said rigid ring; and
operatively engaging said leg of said mechanical plug with a bottom surface of said rigid ring.

15. The method according to claim 14, wherein an interior surface of said arch-shaped annular region has a protrusion, and wherein said step of operatively engaging said arch-shaped annular region of said mechanical plug with an exterior surface of said neck region of said container comprises operatively engaging said protrusion of said arch-shaped annular region of said mechanical plug with said exterior surface of said neck region to delimit displacement of material of said exterior surface of said neck region.

16. The method according to claim 14, wherein said mechanical plug has a plunger extending substantially perpendicular to the bottom surface of the mechanical plug for displacing liquid and gas contained in said container, further comprising, prior to said step of operatively and simultaneously engaging said arch-shaped annular region of said mechanical plug with an exterior surface of said neck region of said container, the step of:

displacing substantially all of the gas within the container to a region outside the container by placing said plunger into the liquid.

17. A system for mechanically sealing an opening of a container defined by a neck region of said container, which comprises:

a rigid ring for operatively engaging an interior surface of said neck region of said container; and

a mechanical plug for operatively and simultaneously engaging an exterior surface of said neck region of said container and said interior annular surface of said rigid ring, said mechanical plug having a leg extending substantially perpendicular to a bottom surface of the mechanical plug for operatively engaging a bottom surface of said rigid ring, and said mechanical plug also having a plunger extending substantially perpendicular to the bottom surface of the mechanical plug for displacing liquid and gas contained in said container;

wherein said mechanical plug and said rigid ring provide a mechanical seal of said container opening by simultaneously engaging at least a portion of said neck region of said container, said mechanical plug being securely engaged with said container after substantially all of the gas within the container has been displaced out of the container by the plunger, whereby said system facilitates air-less filling of the container.

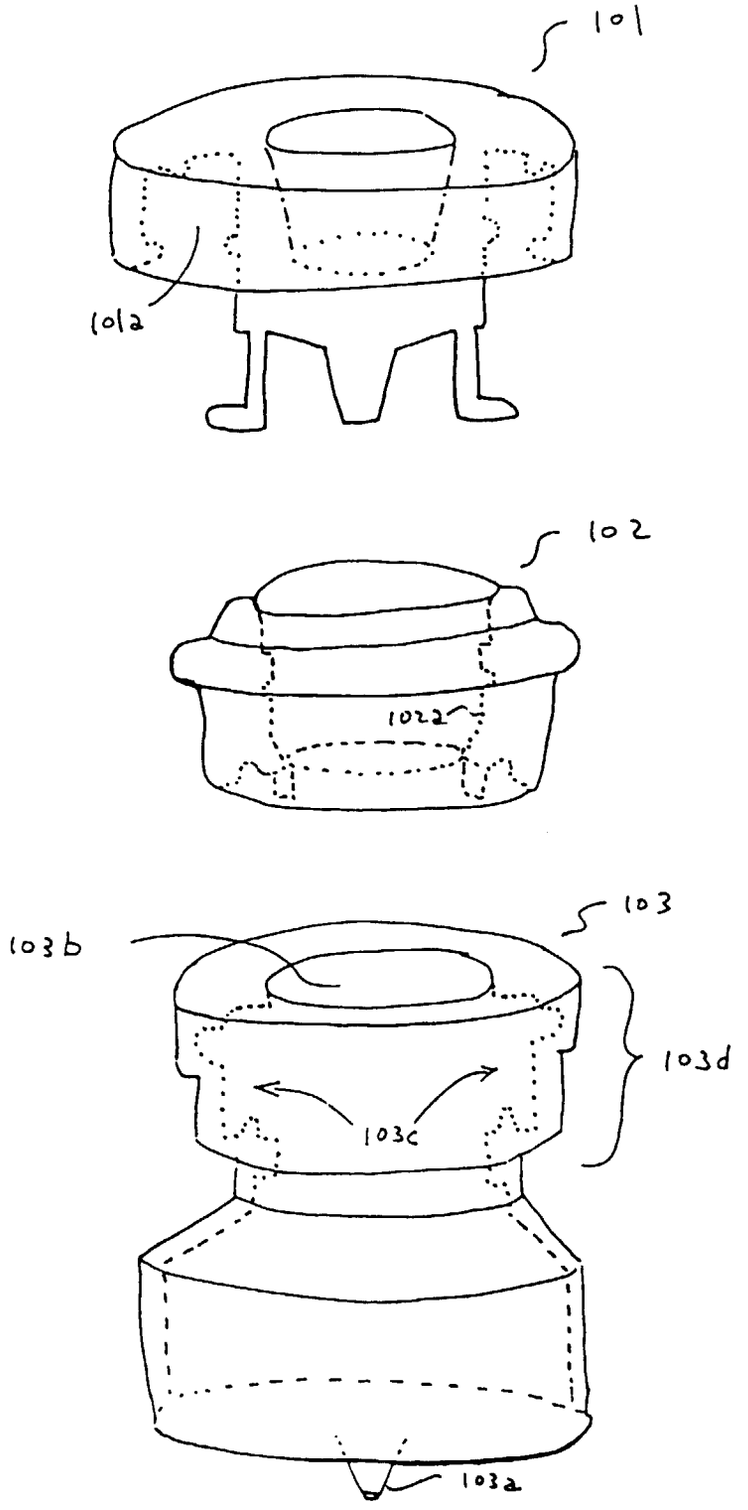

FIG. 1

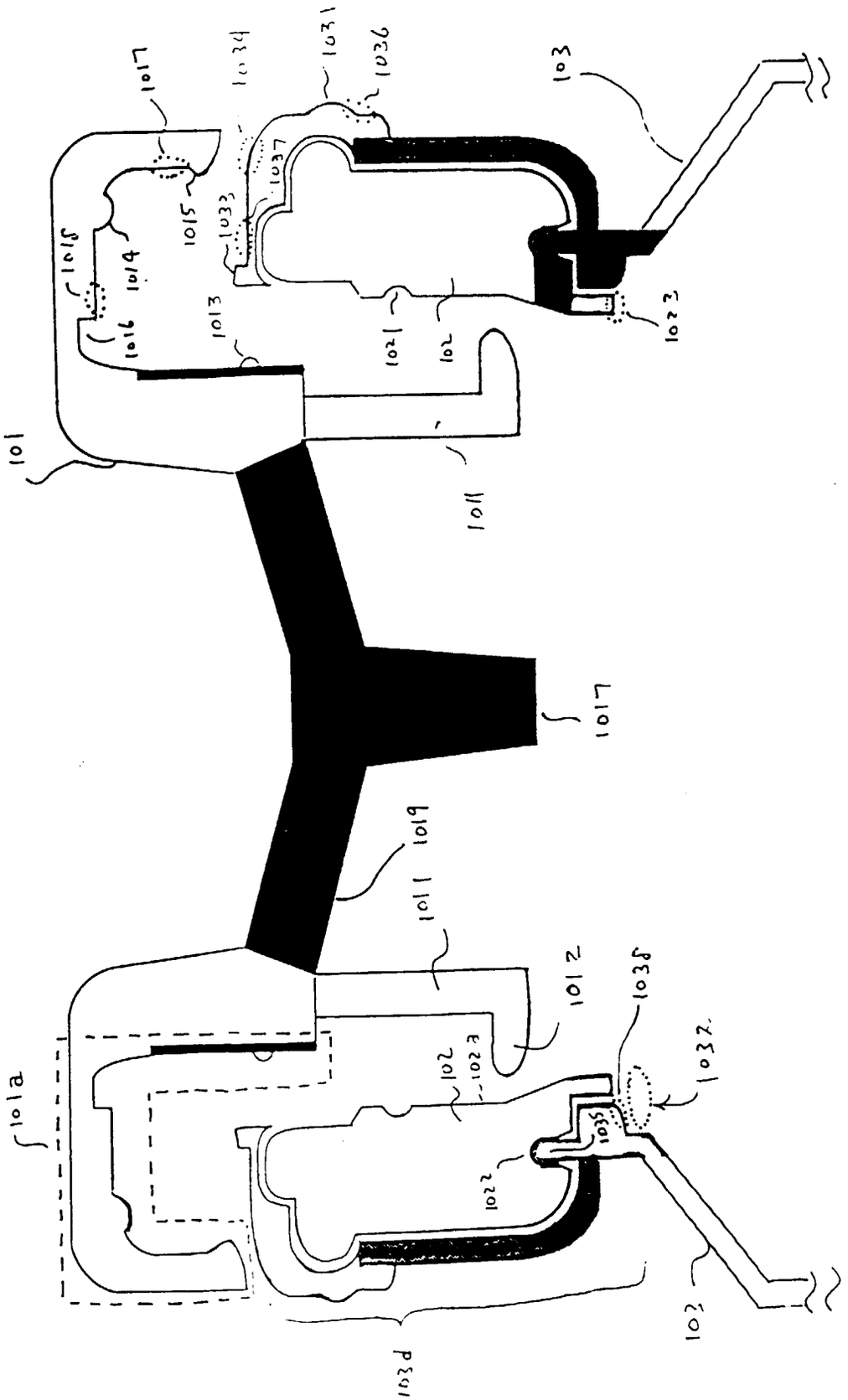
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FIG. 2

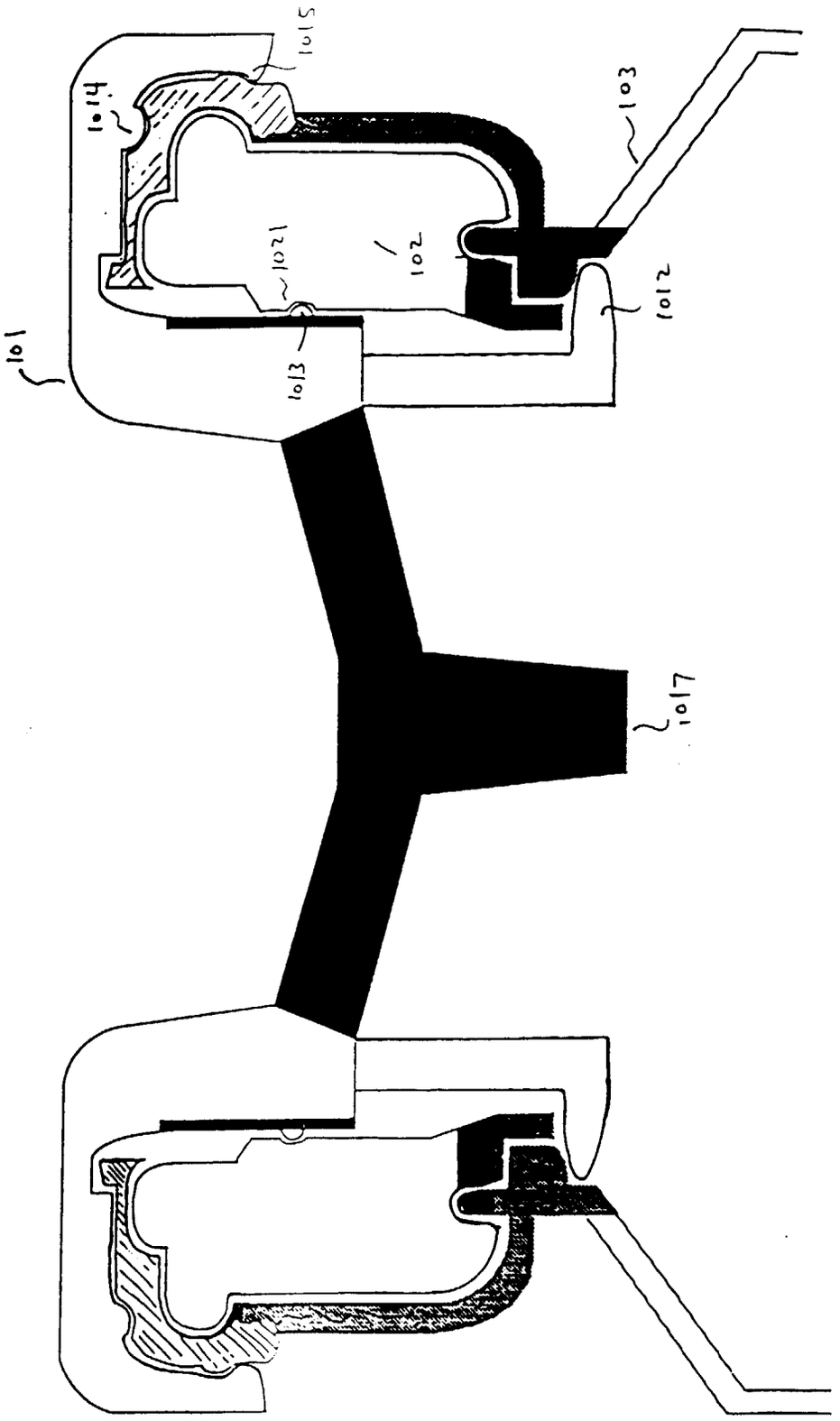

FIG. 3

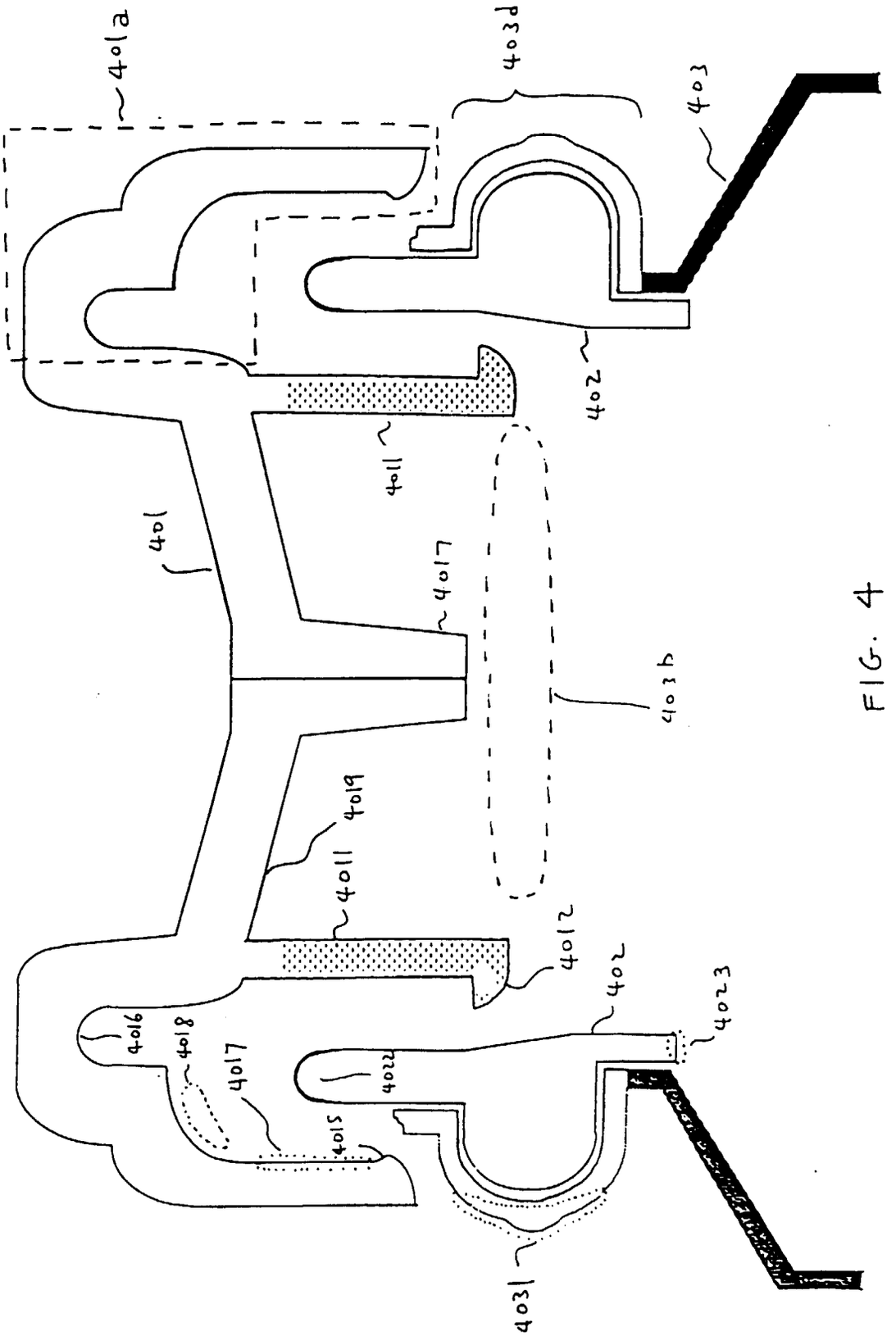
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FIG. 4

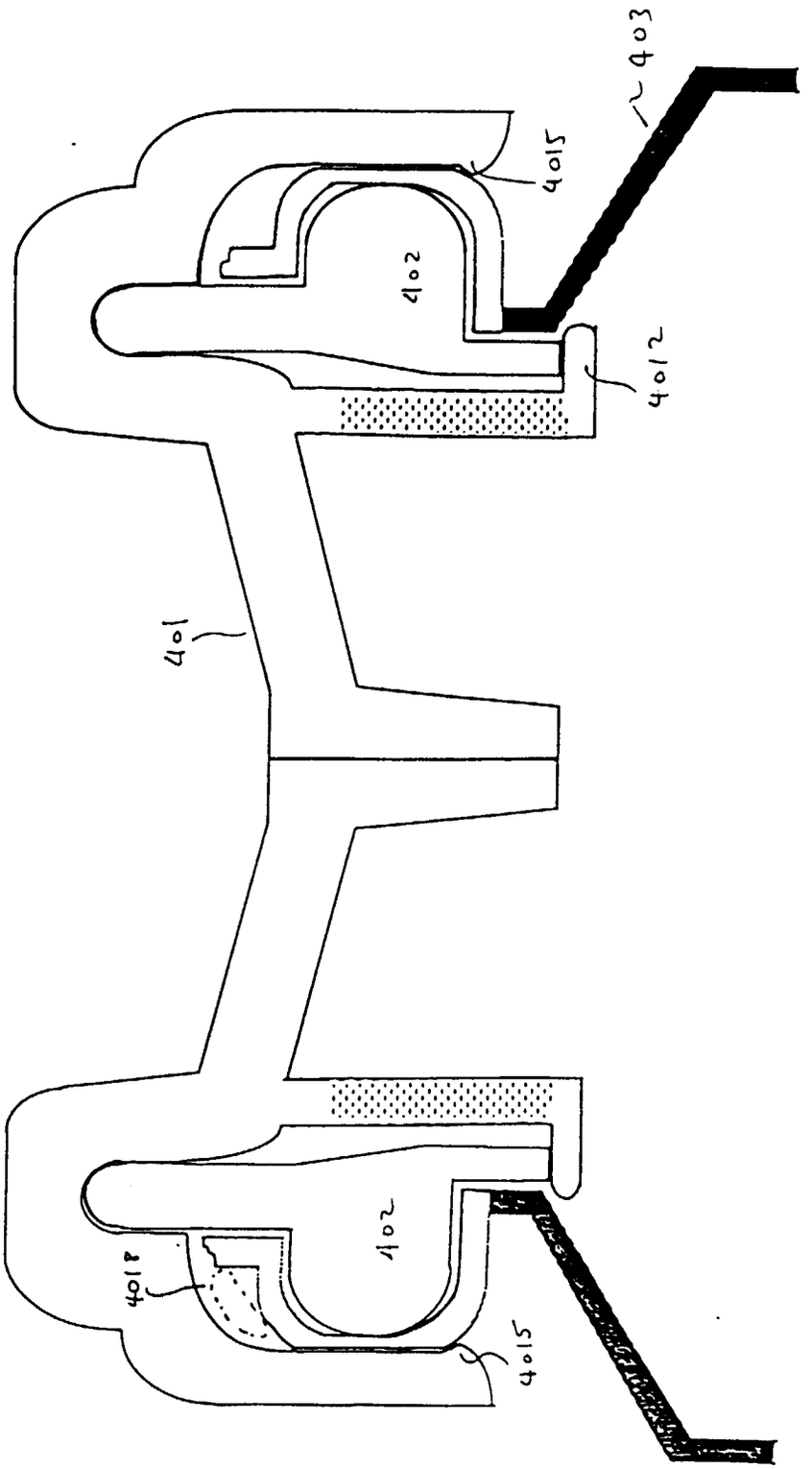

FIG. 5