(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 October 2003 (23.10.2003)

PCT

(10) International Publication Number
WO 03/086890 A1

(51) International Patent Classification[7]: B65D 41/04

(21) International Application Number: PCT/US03/11096

(22) International Filing Date: 10 April 2003 (10.04.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/371,885 11 April 2002 (11.04.2002) US

(71) Applicant: **E.I. DU PONT DE NEMOURS AND COMPANY** [US/US]; 1007 Market Street, Wilmington, DE 19898 (US).

(72) Inventors: **SCHENCK, Timothy, T.**; 420 Twaddell Mill Road, Centerville, DE 19807 (US). **TOPA, Antonio, J.F.**; 3131 Wilmont Drive, Wilmington, DE 19810 (US).

(74) Agent: **EVANS, Craig, H.**; E.I. Du Pont de Nemours and Company, Legal Patent Records Center, 4417 Lancaster Pike, Wilmington, DE 19805 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW.

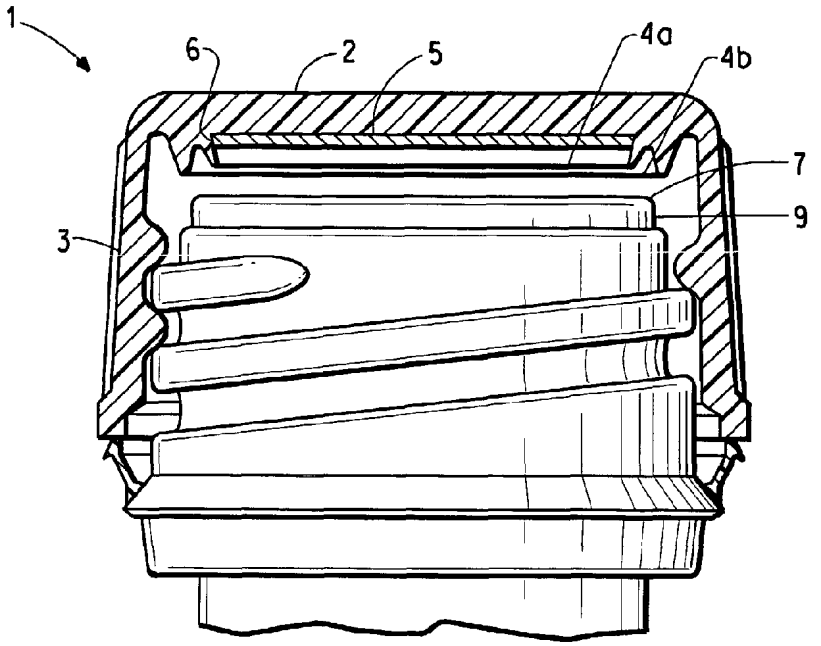
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG,*

[Continued on next page]

(54) Title: PLASTIC BARRIER CLOSURE AND METHOD OF FABRICATION



(57) Abstract: The present invention relates to a plastic barrier closure (or cap) for bottles and the like that has (1) a body having a top wall, a side wall, a securing means and a seal that has at least one concentric sealing member extending from the top wall, and (2) a barrier incorporated into the top wall. The barrier layer may be incorporated into the top wall by (1) depositing a melted mass of barrier polymer in the pre-molded cap body and then molding it into place by mechanical means or (2) forming a barrier layer from the barrier polymer and inserting it into a pre-molded cap body.

WO 03/086890 A1

KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations*

Published:

— *with international search report*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

TITLE
PLASTIC BARRIER CLOSURE AND METHOD OF FABRICATION

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a plastic closure (or cap) for containers such as glass bottles and PET bottles. The closure provides barrier against transmission of gases such as carbon dioxide and oxygen and also exhibits a reduced tendency to "scalp" flavor components from the packaged product. Methods of fabricating such a closure are also described.

Description of Related Art

Plastic closures for packaging containers, including glass and plastic bottles, have been commercially available for a number of years. The most common examples of the plastic caps are internally threaded to allow them to be screwed onto the neck of PET bottles used to package a variety of beverages including carbonated soft drinks. The most common caps for carbonated soft drinks comprise an outer shell of molded polypropylene with a liner material usually made from an ethylene vinyl acetate polymer compound. The shell is fabricated either by injection molding or compression molding. The liner is installed using one of two methods: 1) "pick and place" where a pre-molded disk of material is mechanically placed into the shell and, 2) "in-shell molding" where a small mass of melted material is deposited in the shell and then molded in place by a plunger. The cap liner functions as a mechanical gasket or seal that will prevent the leakage of carbon dioxide gas from the cap. These caps are referred to as "two-piece" caps.

More recently, another kind of cap design has been introduced to the market. Referred to as "one-piece" or "linerless" caps, these are injection-molded or compression-molded caps that are made from a single polymer, most commonly HDPE. Examples of such closures are described in the following patents, which are incorporated by reference:

USP 3,948,405, USP 4,526,284, USP 4,739,893, and USP 5,743,420. Through a proper combination of geometric design and material, these caps can provide adequate mechanical seal against CO_2 leakage, for example, from a carbonated beverage.

Although cap designs as described above can provide good mechanical seal against gas leakage, they are not effective in preventing permeation of gas through the wall of the cap because the polyolefin polymers typically used have relatively poor gas barrier properties. For some packaging applications, a better barrier against gas permeation is desired.

A number of approaches to plastic closures with improved barrier have been described in the prior art. One approach is to replace the liner used in a two-piece cap with a liner formed from a barrier material. EP 62340 teaches the use of a multilayer structure where at least one layer provides a barrier against gas permeation and at least one other layer functions as the mechanical seal layer. JP – 07137754 describes a closure comprising a multilayer liner with a barrier layer and a seal layer, with the closure body molded over the liner. EP 926078 describes a sealing liner consisting essentially of alternating layers of matrix material and barrier material. In both EP 62340 and EP 926078, the liners described function both as a mechanical seal against gas leakage and as a barrier layer against permeation of gas. An alternative approach to a barrier closure as disclosed in EP 233414 is to coat a conventional plastic cap (presumably one-piece or two-piece) with a coating of "vapour impermeable material" which is cured to form a solid and is permanently adhered to the cap.

Another concept for a barrier cap is to produce a cap of linerless design from a material that exhibits good barrier properties rather than from HDPE, which is preferred. Most common barrier polymers, however, tend to be stiff and hard making it difficult to achieve a good mechanical seal against gas leakage.

BRIEF SUMMARY OF THE INVENTION

The present invention provides for a plastic closure (or cap) for a container, particularly a container having an externally threaded neck through which the container can be filled or emptied, such as bottles and the like. The neck of the container or opening of the container is a tubular member connected to the container at one end and open at the opposing end (top edge or rim). The rim has an inner edge and an outer edge. The tubular member has an inside surface and an outside surface. Preferably, there are threads on the outside surface, the threads extending between the top edge and a location between the top edge and the bottom of the member. Preferably, the closure is secured on (or screwed onto) the bottles as treads on the inside of the closure engage threads on the outside of the bottle opening. Other means for securing the closure to the bottle may be employed.

The closure exhibits good barrier against the transmission of gases and reduced tendency to absorb flavor components from the packaged product. The closure comprises a body and a barrier layer.

The body comprises

a A disc-shaped top wall having an inside surface that is disposed so as to contact or nearly contact the rim of the container neck when engaged on the neck,

b A cylindrical side wall attached to and extending from the top wall;

c A means for securing the body with the neck; the means preferably comprising internal threads in the cylindrical side wall that engage corresponding threads on the outside surface of the neck; and

d A seal disposed so as to provide a good mechanical seal against leakage of gas when the closure is installed on the container.

The seal comprises at least one sealing member that is attached to and extends from the inside surface of the top wall, is concentric with the cylindrical side, and is disposed so as to continuously contact the neck of

the container (top of rim, inner or outer edge of rim, or side wall of neck) when the body is engaged with the neck.

Alternatively, the seal may comprise

i An outer sealing member that is attached to and extends from the inside surface of the top wall and is disposed between the inside surface of the cylindrical side wall and the outside edge of the bottle opening so as to continuously contact the top outside edge of rim of the container neck when the body is engaged with the neck; and

ii An inner sealing member concentric with the outer sealing member and extending from the inside surface of the top wall of the body so as to continuously contact the inner edge of the rim when the body is engaged with the neck.

The body is made of molded plastic, most preferably HDPE.

The barrier layer, which is incorporated into the top wall of the body, is selected from materials known to provide a good barrier against permeation of gas and also exhibit a low tendency to absorb flavor components from the packaged product. The barrier material can be any of a number of barrier polymers including EVOH, nylon, and polyester (including 2GT, 3GT and blends of 2GT and 3GT polyester). Amorphous nylon or 3GT polyester is preferred. The barrier layer can also be metallic such as aluminum.

An alternative embodiment comprises a body with a seal that has a single sealing member that is attached to and extends from the inside surface of the top wall and is disposed so as to continuously contact the outside edge of the container rim when the body is engaged with the neck of the container. When only an outer sealing member is employed as the seal, the barrier material preferably contacts the rim of the container with the closure is engaged with the container neck.

The barrier layer is incorporated into the body of the cap by one of two methods:

a. a melted mass of the barrier polymer is deposited in the pre-molded cap body and then molded into place by mechanical means. This method is referred to as "in-shell molding".

b. The barrier layer is formed in a separate step and then installed into the pre-molded cap body. This method is referred to as "pick and place."

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1. is a vertical sectional view showing a closure in accordance with the invention being applied to the neck of a container.

Figure 2. is a vertical sectional view showing a closure in accordance with the invention, installed on a container, where an inner concentric ring provides mechanical seal.

Figure 3. is a vertical sectional view showing a closure in accordance with the invention, installed on a container, where an outer concentric ring provides mechanical seal and the barrier layer functions as a positive stop.

Figure 4. is a vertical sectional view showing a closure in accordance with the invention, installed on a container, with an alternate configuration to Figure 3 where an outer concentric ring provides mechanical seal and the barrier layer functions as a positive stop.

DETAILED DESCRIPTION

The present invention provides for a generally cylindrical plastic closure for sealing the open end of a container neck (or cap) in a way that provides superior barrier to the transmission of gas and a reduced tendency to absorb flavor components from product packaged in the sealed container. Such a closure is especially useful as a cap on glass bottles and PET bottles such as are used for carbonated soft drinks, beer and other beverages. The closure may optionally include a guarantee ring or tamper-evident strip. This closure comprises a body that is bottle-cap shaped (i.e., having a generally disc-shaped top wall with a cylindrical or

tubular side member essentially perpendicular to and extending from the top wall) and a barrier layer incorporated into the top wall of the closure.

The body of the closure, as will be more clearly understood from reference to the figures that are part of the disclosure of this specification, has a means for securing the closure to the container and a means for providing a mechanical seal when the closure is secured to the container.

The means for securing the closure is typically internal threads that engage with external threads on the neck of the container, as is depicted in Figure 1. While the closure of the present invention has been described as utilizing a threaded engagement with the container neck, it is understood that the attendant benefits may be realized with other means for securing such as if a crown or Snap-On type closure design is utilized.

The means for providing a mechanical seal preferably conmprises one or more sealing members attached to the inside top of the closure and extending therefrom so as to contact the neck of the container when the the closure is secured to the container.

Figures 1 and 2 depict a closure in accordance with the invention being applied to the neck of a container. The body **1** of the closure comprises a top wall **2**, an internally threaded sidewall **3**, and a seal **4**. The seal may consist of an inner concentric ring **4a**, an outer concentric ring **4b**, or both. The seal extends downwardly from an inner surface of the top wall and is disposed to engage the neck of the container so as to provide a good mechanical seal against leakage of gas when the closure is screwed onto the bottle. It will be appreciated that the body **1** of the closure may also be of a different configuration. The prior art contains many designs for such plastic closures where a section or sections of the body of the closure are disposed to engage the neck of a container to affect a good mechanical seal against gas leakage. The seal can be disposed to engage the neck of the container on the rim **7** or on the inside wall **8** or on the outside wall **9**. This class of closure is referred to as "one-piece" or "linerless."

The body can be made from any number of plastic materials including polyolefins, such as high-density polyethylene (HDPE), low-

density polyethylene (LDPE) and polypropylene (PP), nylon, polyvinyl chloride, polycarbonate, polystyrene, and polyester. In general, thermoplastic polymers are preferred although thermoset polymers can be used. For many packaging applications, and in particular for packaging carbonated soft drinks, HDPE is the preferred material of construction for the body. HDPE exhibits a combination of mechanical properties (in particular, flexural modulus and hardness) well suited to produce an effective mechanical seal against a container rim. For packaging applications involving a hot-fill or retort process, depending on pressure and temperature, HDPE may not offer adequate thermal resistance as a body material. In these applications, materials exhibiting higher thermal resistance than HDPE, such as polypropylene or nylon, may be preferred. The body can be produced using common thermoplastic processing methods such as compression molding and injection molding.

The barrier layer **5** of the closure can be made from any number of common barrier materials including amorphous nylon, semicrystalline nylon, ethylene vinyl alcohol (EVOH), polyvinylidene chloride (PVDC), polyester (PE), including 2GT, 3GT and blends of 2GT and 3GT polyester, and polyacrylonitrile. The barrier layer can also be made of metal, such as aluminum, but, in general, a plastic barrier material is preferred. The barrier layer of the closure functions to prevent permeation of gasses such as carbon dioxide and oxygen through the closure. It also may exhibit a reduced tendency to absorb, or "scalp", flavor components from the packaged product or impart undesired components to the product. A preferred material for the barrier layer is amorphous nylon such as Selar®PA from E. I. du Pont de Nemours and Company. For liquid packaging, among the common barrier materials, amorphous nylon provides the best combination of gas barrier properties and non-scalping performance. Another preferred material is 3GT polyester, which offers good barrier properties and ease of processing. In particular, 3GT can be processed at lower melt temperatures than the other common barrier polymers.

The barrier layer can be incorporated into the closure body by various methods including the following.

1) A melted mass of the barrier material is deposited on the inside surface of the top wall of a pre-formed body and then molded in place by an actuated plunger to form the finished barrier layer. This process is referred to as "in-shell molding." The melted material may be conventional polymer melt or the melted material may be foamed using chemical or physical blowing agents. The amount of barrier material deposited is controlled so that the finished dimensions of the barrier layer are maintained within acceptable limits. The face of the molding plunger is designed to give the desired contour to the exposed surface of the barrier layer.

In Figure 2, the barrier layer **5** is flat. In Figures 3 and 4, the barrier layer **5** is contoured so as to provide a raised area that serves as a stop for the container rim **7**. The plunger diameter is sized slightly smaller than the smallest diameter of the innermost seal ring of the body so that there is minimum clearance between the plunger and the seal ring as the plunger compresses the melted barrier material into the body. Equipment that utilizes this in-shell molding process is commercially available from companies including Sacmi and Oberburg Engineering AG. The barrier layer **5** is retained in the body **1** of the closure by direct adhesion to the body, by mechanical retention, or both. To achieve mechanical retention, the closure body **1** is preferably designed with an undercut **6** at the root of the seal ring **4b** as illustrated in Figures. 3 and 4, such that the barrier layer **5** will have a outer diameter somewhat larger than the inside minimum diameter of the sealing ring **4b**.

2) The barrier layer **5** may be formed in a separate process, and then installed into the preformed body **1** by mechanical means to produce the finished closure. This process is referred to as the "pick and place" process. The barrier layer **5** is retained in the body

1 by mechanical retention.

As illustrated in Figures 3 and 4, the body **1** is designed with an undercut **6** at the root of the seal ring **4b**, thus creating an interference fit between the preformed barrier layer **5** and the body **1**. The preformed barrier layer must be sufficiently flexible to survive the installation process without cracking. This method of installation is especially suited for metallic barrier layers and thermoset plastic barrier layers but can also be used if the barrier layer is formed from a thermoplastic material.

An alternative method for preparing a plastic barrier cap of the present design is by use of a coextrusion injection molding process. In this process, two extruders are used to produce molten material; one extruder for the body material, and a second extruder for the barrier material. The molten materials are introduced either simultaneously or sequentially into a mold cavity to form the finished plastic cap. The equipment and tooling used in this process tend to be more complicated and costly than the equipment and tooling used in either the "in-shell molding" process or the "pick and place" process.

The benefits of the present invention are most attendant if the gas barrier properties of the barrier layer material are at least one order of magnitude higher than the body material, preferable at least two orders of magnitude higher. For example, one preferred embodiment of the invention comprises a HDPE body and an amorphous nylon barrier layer: amorphous nylon exhibits a CO_2 barrier about 100x higher than HDPE.

In one embodiment of this invention, as illustrated in Figure 2, the seal in the body **1** comprises only the inner concentric seal member **4a** extending down from the top wall **2** disposed to engage the inner edge **7a** of the rim of the neck of the container when the closure is installed on the container. Alternatively, the inner concentric seal ring **4a** could be disposed to engage the inside wall **8** of the neck of the container. The inner seal member **4a** provides the mechanical seal against gas leakage

and the barrier layer **5** provides the primary barrier against gas permeation.

In a preferred embodiment of this invention, as illustrated in Figures. 3 and 4, the seal in the body **1** comprises only the outer concentric sealing member **4b** extending down from the top wall **2** disposed to engage the outer edge **7b** of the rim of the neck of the container when the cap is screwed unto the container. Alternatively, the outer concentric sealing member **4b** could be disposed to engage the outer wall **9** of the neck of the container. The barrier layer **5** is incorporated in the body **1** of the cap and preferably is designed to contact the rim top edge **7** (Figure 3) of the bottle or the rim inner edge **7a** (Figure 4) when the cap is secured to the neck preferably by being screwed on using the proscribed installation torque, typically 14 to 18 inch-pounds for a 28-mm cap. The design of the barrier layer may have a bead **7c** (Figure 3) that contacts the rim top edge **7** or may have a taper (Figure 4) so that the barrier contacts only the inner edge **7a.** In this embodiment, the barrier layer **5** functions as a positive stop as the closure is installed on the container. The outer seal member **4b** of the body **1** provides the primary mechanical seal against gas leakage and the barrier layer **5** provides secondary mechanical seal and functions as the primary barrier against gas permeation. In this preferred embodiment, when the closure is properly installed on the container, the packaged product will have no direct contact with the body material, and the optimum gas barrier and non-scalping performance will be achieved.

It is recognized that the materials used in the fabrication of both the body and the barrier liner may optionally be modified with other materials as are commonly used in the caps and closures industry. These modifiers may include pigments, slip agents, and oxygen scavengers, among others.

While a common utility of the present invention is for closures for PET bottles, it is recognized these closures may be used on any kind of container having a generally cylindrical neck, e.g., bottles or cans made from glass, plastic, or metal.

WHAT IS CLAIMED IS:

1. A closure for a container having a cylindrical neck having an outer wall, an inner wall, and an opening rim with an inner edge and an outer edge comprising a body and a barrier layer wherein

a. the body comprises

(i) A disc-shaped top wall having an inside surface that is disposed so as to contact or nearly contact the rim of the container neck when engaged on the container neck,

(ii) A cylindrical side wall having an inside surface to contact or nearly contact the neck of the container when engaged on the neck attached to and extending essentially perpendicular from the top wall;

(iii) A means for securing the body with the container neck; and

(iv) A seal, wherein the seal comprises at least one sealing member that is attached to and extends from the inside surface of the top wall, is concentric with the cylindrical side, and is disposed so as to continuously contact the container neck when the body is engaged with the container neck; and

b the barrier layer is incorporated into the top wall of the body and is made from a barrier material selected to provide barrier against permeation of gas and absorption of flavor components of container contents when the body is secured to the neck of the container.

2 The closure or Claim 1 wherein the seal comprises an inner sealing member and an outer sealing member,

a the outer sealing member that is attached to and extends from the inside surface of the top wall, is concentric with the cylindrical side, and is disposed so as to continuously contact the outside top edge of the container neck when the body is engaged with the container neck;

b the inner sealing member that is attached to and extends from the inside surface of the top wall of the body, is concentric with the outer sealing means, and is disposed so as to continuously contact the inner edge of the container neck when the body is engaged with the container neck.

3 The closure of Claim 1 or Claim 2 wherein the securing means comprises internal threads in the cylindrical side wall that engage corresponding threads on the outside surface of the container neck.

4 The closure of Claim 1 wherein the seal comprises an outer sealing member disposed to engage the outer edge or the outer wall of the neck of the container, and where the barrier layer is disposed to engage the top edge or inside edge of the neck of the container, when the closure is installed on the container.

5 The closure of Claim 1 or 2 where the body is made from thermoplastic materials selected from the group consisting of polyolefins, nylon, polyvinyl chloride, polycarbonate, polystyrene, and polyester.

6 The closure of Claim 5 wherein the polyolefins are selected from the group consisting of high-density polyethylene, low-density polyethylene, linear low-density polyethylene and polypropylene.

7 The closure of Claim 1 where the barrier layer is incorporated into the top wall of the closure body using the in-shell molding process or the pick-and-place process.

8 The closure of Claim 1 or Claim 2 where the barrier is made from materials selected from the group consisting of amorphous nylon, semicrystalline nylon, ethylene vinyl alcohol, polyvinylidene chloride, polyester, and polyacrylonitrile.

9 The closure of Claim 5 where the body is made from high density polyethylene.

10 The closure of Claim 8 where the barrier is made from amorphous nylon or 3GT polyester.

11 The closure of Claim 1 where the container is a PET bottle.

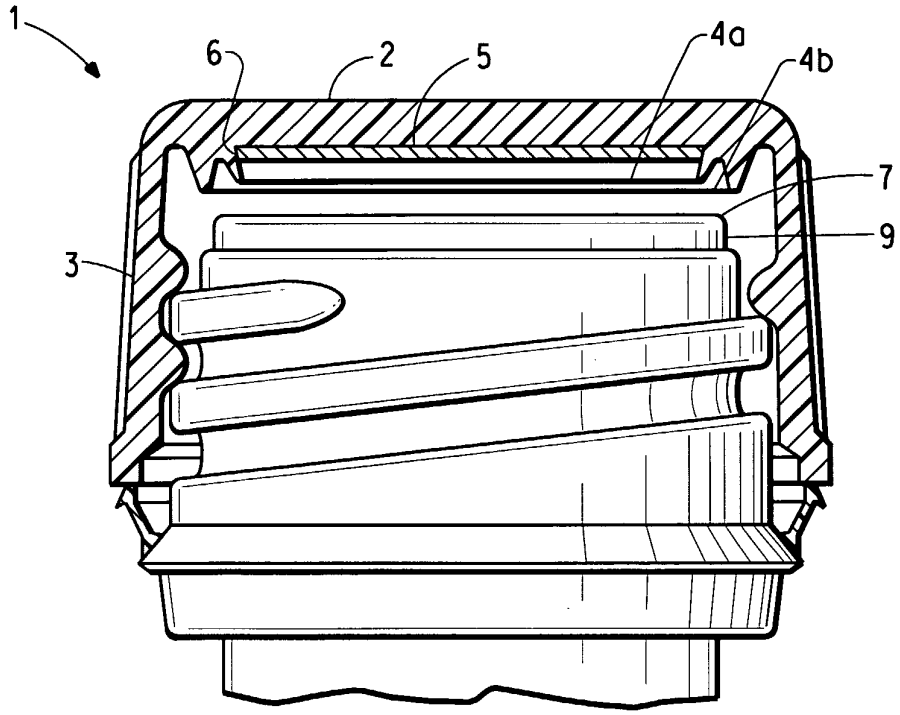


FIG. 1

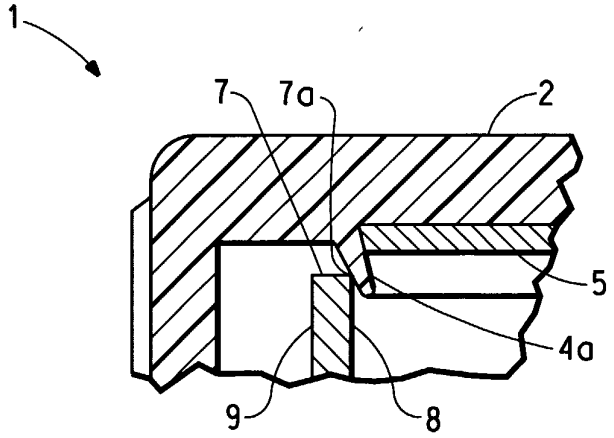


FIG. 2

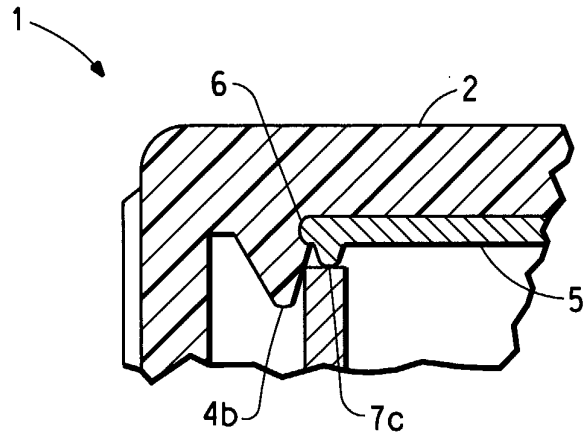


FIG. 3

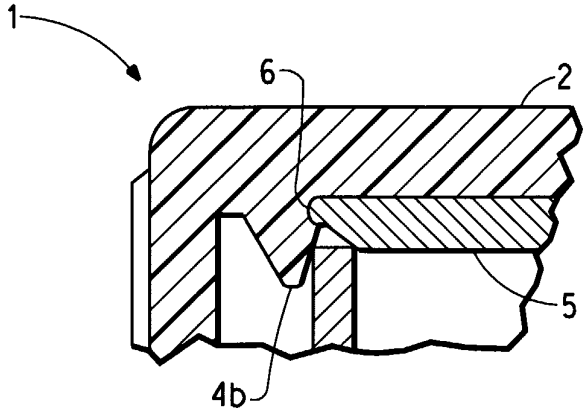


FIG. 4