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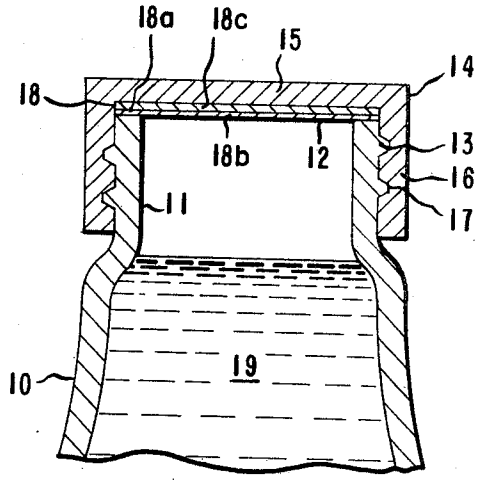

INVENTOR.
ROBERT B. GAINES
JOHN A. HAYES

BY Melville J. Hayes
AGENT

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CLOSURE-CAP HAVING VENTING GASKET

Robert B. Gaines, Wilmington, Del., and John A. Hayes, Philadelphia, Pa., assignors to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

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ABSTRACT OF THE DISCLOSURE

There is disclosed a novel closure-cap, and an article in which said closure-cap is combined with a container to provide improved means for packaging, storing and shipping aqueous bleach compositions and other liquids which, when packaged in conventional containers, tend to develop harmful pressure differentials or leaking of the liquids from the closed containers; the novel closure-cap contains a sealing member such as a disc comprised of a particular nonwoven fibrous sheet of continuous strand material, and preferably also comprised of an upper layer of porous polymer-bonded asbestos fiber sheet material.

BACKGROUND OF THE INVENTION

This invention relates to closure-caps and articles of manufacture formed by combining closure-caps with containers such as bottles and the like.

It is known that the industries which package liquids in bottles often use a glass or plastic bottle having an external screw thread on the neck portion which defines the mouth, and a closure-cap whose skirt portion has an internal screw thread engaging the neck thread. And usually the cap has a liner disc to serve as a liquid-impermeable sealing member in interposed engagement with the top of the cap and the mouth of the bottle. When the cap is suitably tightened, the cap liner prevents the liquid from leaking out when the bottle is tipped or shaken.

The conventional cap liner in the assembled package is not only liquid-impermeable but also gas-impermeable. Thus, when the tightly-capped bottle contains a bleach composition or other liquid which tends to liberate a gas during storage or shipment of the package, the bottle or cap can be damaged by the super-atmospheric pressure developed within the package. Also, when the tightly-capped bottle contains a hot liquid as the result of a hot-filling process, and the liquid is allowed to cool to a substantially lower temperature after the cap is tightened, the bottle can be damaged by the sub-atmospheric pressure developed within the package. For example, many of the lightweight, blow-molded, and flexible plastic bottles now widely used will often undergo unsightly distortion under such conditions. Past attempts to replace the known impervious cap liners with porous liners have had a decided tendency to result in such problems as undue leakage of liquid, harmful attack of the liner by the liquid, or insufficient gas permeability for certain applications.

There is a definite need in the art for a bottle cap which is capable of allowing gas to escape at a satisfactory rate from the tightly-capped bottle (e.g., a bottle containing a gas-liberating bleach composition), or allowing gas to enter the tightly-capped bottle (e.g., a bottle filled with a hot liquid which is allowed to cool after the cap is put on); and which is also capable of preventing liquids from leaking out when the bottle is tipped or shaken.

SUMMARY OF THE INVENTION

Expressed broadly, the present invention provides a closure-cap adapted to provide a gas-permetable liquid-impermeable seal on the mouth of a container for liquids

having a mouth-containing cylinder-like neck with cap-fastening means below the mouth, said cap comprising:

A top panel adapted for sealing engagement with the container mouth,

A depending annular attaching skirt at the periphery of the panel,

Holding means on the skirt adapted for engaging the cap-fastening means of the container neck, and

A sealing member covering at least the peripheral portion of the inside of the top panel and adapted to provide a gas-permeable liquid-impermeable seal when the cap is tightly fastened on the container neck so that the sealing member is in interposed sealing engagement with the top panel and the mouth,

At least the bottom portion of said sealing member being a coherent, flexible, nonwoven fibrous sheet from which there can be removed continuous lengths of plexifilamentary strand material, said strand material being disposed in multidirectional overlapping and intersecting arrangement throughout said sheet, lying generally parallel to the major plane of said sheet, and being self-bonded to provide a sheet density greater than 7 lbs./ft.^{3} and a tensile strength above 0.3 lb./in./oz./yd.^{2}, said strand material further being composed of networks having a surface area greater than 2 m.^{2}/g., comprising a three-dimensional integral plexus of synthetic organic, crystalline polymeric, fibrous elements, said elements being coextensively aligned with the network axis and having the structural configuration of oriented film-fibrils, an average film thickness of less than 4 microns and an average electron diffraction orientation angle of less than 90°.

The invention also provides a capped bottle (or other container) capable of allowing gas to enter or leave the bottle without allowing liquid to leak out when the bottle is tipped or shaken, the novel cap being tightly fastened on the neck of the bottle.

BRIEF DESCRIPTION OF THE DRAWING

In the single figure of the attached drawing is shown a very useful embodiment of the capped container of this invention; this is a view in central vertical section of the upper portion of a bottle on which is fastened the novel closure-cap.

DESCRIPTION OF PREFERRED EMBODIMENTS

The examples which follow are given for the purpose of illustrating the invention. All quantities shown are on a weight basis unless otherwise indicated.

Example 1

With reference to the drawing, bottle **10** has a cylinder-like neck **11** defining mouth **12**, and an external screw thread **13** on the neck below the mouth. Closure-cap **14** is telescoped over the neck and comprises (a) top panel (or mouth-closing means) **15** adapted to close the mouth, (b) depending annular attaching skirt **16** at the periphery of the panel, (c) internal screw thread **17** engaging the neck thread, and (d) gas-permeable liquid-impermeable sealing disc **18** whose peripheral portion **18***a* is in interposed sealing engagement with panel **15** and mouth **12**. Cap **14** can be a conventional screw cap made of metal, plastic or other suitable material.

The bottom portion **18***b* of disc **18** is a coherent nonwoven fibrous sheet as described above in the summary of the invention and further characterized as follows:

(1) The crystalline fibrous elements of the sheet are made of linear polyethylene;

(2) The networks of the sheet are highly fibrillated and transversely spread networks;

(3) The sheet has a density of about 19 lbs./ft.^{3} and a thickness such that it weighs about 2.2 oz./sq. yd. This kind of nonwoven sheet can be made by the general

method described in column 11, lines 21–58 of U.S. Pat. 3,169,899 (issued to W. Steuber on Feb. 16,1965), the roll pressure being sufficient to provide a sheet density of about 19 lbs./ft.^{3}. The disclosure of the Steuber patent is incorporated herein by reference.

The top portion **18***c* of disc **18** is a porous polymer-bonded asbestos fiber sheet material which (a) contains 82% asbestos fibers and about 18% of a synthetic elastomer binder (butadiene-styrene polymer) based on the total weight of fibers and binder (b) has a thickness of about 37 mils of (0.037 inch), and (c) has a weight of about 84 grams per sq. ft. This kind of asbestos fiber sheet material can be made by the general method described in U.S. Pat. 2,759,813 (issued to D. A. Feigley on Aug. 21, 1956) wherein a latex of the elastomer is added to an aqueous slurry of asbestos fibers while agitating the slurry under conditions which allow the binder to deposit on the fibers, and the resulting elastomer-coated fibers are formed into a dried sheet. The disclosure of the Feigley patent is incorporated herein by reference. Sealing disc **18** can be made by (a) applying to the top surface of the nonwoven sheet **18***b* by means of a roller-coating apparatus a light coat (barely sufficient to wet the surface) of a polyester solution adhesive composition made by the general method described in Example 1 of U.S. Pat. 2,892,747 (issued to J. I. Dye on June 30, 1959), the composition being a 20% solution of the polyester in a mixture of 60 parts toluene, 37.5 parts dioxane and 2.5 parts cyclohexanone, (b) allowing part of the solvent to evaporate by exposing the adhesive coat to air at 21° C. for 2 minutes, (c) placing the asbestos sheet **18***c* in superposed contact with the tacky adhesive-coated nonwoven sheet, (d) subjecting the composite sheet to mild pressure between platens or pressure rolls to insure that the two sheets are in intimate contact with each other, (e) allowing the composite sheet to air-dry at 22° C. for 10 hours and (f) cutting disc **18** from the resulting laminated composite sheet so that it just fits within skirt **16** of the cap.

As is true of most capped containers of this general design, even when cap **14** is screwed tight on neck **11**, narrow channels are present between neck **11** and skirt **16** through which gases and liquids can pass in the absence of a sealing member impermeable to gases and liquids. If a known cap-fastening means is used which prevents suitable gas leakage, the skirt or neck can be provided with one or more small channels to give the desired means for gas to enter or leave through the sealing member.

Nonwoven sheet **18***b* has a vapor permeability value (VPV) of 10,800; asbestos sheet **18***c* has a VPV of 10,500; and the laminated composite sealing disc **18** has a VPV of 3000. These vapor permeability value figures are in terms of grams of water vapor passed per hour through 100 square meters of material when the product is tested at 21° C. and 90% relative humidity for three hours by the general method described by Kanagy and Vickers in the Journal of American Leather Chemists Association, 45, 211–242 (Apr. 19, 1950). The sample is sealed on top of a container of calcium chloride, and the weight increase of the container due to water vapor passing through the sample is used to circulate the vapor permeability value.

For the purpose of illustrating the invention further, and still referring to the drawing, bottle **10** is a one quart bottle made by blow-molding high density polyethylene. With cap **14** removed, the bottle is filled 90% full with liquid **19**, a bleach composition which tends to liberate a gas when stored at commonly encountered storage temperatures. Liquid **19** is prepared by the method described in Example 6 of U.S. patent application Ser. No. 768,165, filed by Golton and Rutkiewic on Oct. 16, 1968; said method comprises adding a mixture of 462.2 parts water, 35.0 parts sulfamic acid and 21.6 parts acetic acid to 530.8 parts of a 14% sodium hypochlorite solution having an active oxygen content of 2.67%; then 50.0 parts sodium sesquicarbonate are added and dissolved by stirring the mixture. The resulting liquid **19** bleach has an active oxygen content of 1.15% and a pH of 9.2.

After filling bottle **10** with the bleach, cap **14** is put on the bottle of bleach and tightened at 15 in./lbs. of torque. The capped bottle of bleach is stored at 38° C. and inspected daily. After 120 days all parts of the capped bottle are still in satisfactory condition; there is no noticeable damage to the bottle, cap **14** or disc **18**. There is no noticeable bulging or distortion of the bottle. Apparently the gas liberated by bleach **19** passes harmlessly out of the bottle through disc **18** and narrow channels (not shown) present between neck **11** and skirt **16**. None of the liquid leaks out when the capped bottle is shaken, or when it is allowed to lie on its side or upside down.

It is quite unexpected that the capped bottle of Example 1 has this beneficial ability to leak gas without leaking liquid and without other harmful results. When the nonwoven layer of continuous strand material of the sealing member is replaced with various known cap liner materials (for example porous and nonporous plastic films, heat-bonded filament sheet material, and fibrous sheets containing polymeric binders), the capped bottle either has unsatisfactory resistance to liquid leakage, or resistance to harmful attack by the liquid, or insufficient ability to leak gas.

Example 2

The test procedure described in Example 1 is repeated except the bottle of bleach is stored at 49° C. After 120 days, all parts of the capped bottle are still in satisfactory condition; and the capped bottle is highly resistant to leakage of the liquid.

The same test procedure is repeated with a bottle of the bleach stored at 60° C. The capped bottle remained free of cracks and leakage for more than 50 days at this high temperature.

Example 2A

For comparison, the same test procedure used in the above examples is repeated with (a) a bottle of the bleach stored at 38° C. (b) a bottle of the bleach stored at 49° C. and (c) a bottle of the bleach stored at 60° C., except for one difference: disc **18** is replaced with a sealing member outside the present invention, namely, a 50-mil thick disc of a resilient plasticized polyvinyl chloride sheet material of a type commonly used as a cap-sealing member in the manufacture of bottled liquids. Within 34 days, the bottle stored at 38° C. developed one or more cracks or ruptures through which the bleach can leak out; the bottle stored at 49° C. developed cracks within seven days; and the bottle stored at 60° C. developed cracks in less than 24 hours. In each of the tests, the bottle readily developed objectionable bulging of the bottle walls.

The container employed in this invention can be selected from the known containers made of glass, metal, plastic and the like, and designed to have the required strength, chemical resistance and other properties for the particular application.

Regarding the essential gas-permeable nonwoven fibrous sheet, preferably about 50–100% by weight of the crystalline fibrous elements are composed of linear polyethylene; these elements can be made of a blend of linear polyethylene and branched polyethylene. The nonwoven sheet can be made according to the teaching of the above-mentioned U.S. Pat. 3,169,899. The networks of the nonwoven sheet are preferably transversely spread and highly fibrillated. Especially useful are the nonwoven sheets having a density of about 17–21 lbs./ft.^{3}; and these sheets preferably are of such a thickness that they weigh about 1.6–2.8 oz./yd.^{2}.

When the cap is tightly attached to the mouth of the container, the sealing member must be gas-permeable enough to allow a gas to enter or leave the container; and it must be liquid-impermeable enough so that the capped container has satisfactory resistance to leakage of

liquid when tipped enough to put the liquid in contact with the sealing member. It is not intended to say that a liquid can never pass through the sealing member when it is removed from the capped container and subjected to different test conditions; or even when it is left in place and subjected to extreme pressure or temperature conditions.

Although the sealing member can consist of the nonwoven sheet by itself (e.g., in a thickness to make it resilient), or in combination with a superposed layer of impermeable sheet material, usually the best results are obtained when there is another kind of gas-permeable sheet material, preferably a resilient material, in superposed contact with the nonwoven sheet. For example, a sheet material selected from plain and polymeric binder-containing water-laid fibrous sheets, and woven and nonwoven fabrics; also leather, manmade leather-like sheet materials, and porous polymeric sheet materials, including porous sheet materials prepared as described in U.S. Pats. 3,391,049, 3,364,098, 3,284,274, 3,100,733, 3,067,-483, 3,056,717, 3,056,714, 2,940,983, 2,940,892, 2,868,-641, 2,786,759, 2,773,286, and 2,772,970. In some applications the superposed layer (liner backing) can be a low density resilient cork composition or resilient water-laid sheets of cellulosic fibers (including those often referred to in the liner-backing art as felt, pulpboard and newsboard). Especially useful as the superposed gas-permeable layer is a porous polymer-bonded asbestos fiber sheet material, with particular preference for such a sheet material containing about 50–98% asbestos fibers and about 2–50% of a flexible polymeric binder based on the total weight of fibers and binder present. This kind of sheet material is particularly useful when there is a gas-liberating bleach composition (e.g., an aqueous dichlorosulfamate, hypochlorous acid or peroxide composition) in the container since it provides the desired combination of properties including gas-permeability, resistance to liquid leakage, and resistance to harmful attack or decomposition by the bleach composition. Best results are often obtained when sheet materials of this type have an asbestos fiber content of about 60–92% and a synthetic elastomer binder content of about 8–40%; also, when the sheet has a thickness of about 30–44 mils and a weight of about 77–90 grams per ft.^{2}.

One can prepare these polymer-bonded asbestos fiber sheet materials by adding to an aqueous slurry of asbestos fibers a latex of a suitable polymer while agitating the slurry and allowing the polymer to deposit on the fibers, and forming the resulting polymer-coated fibers into a dried sheet. Useful known procedures of this type are described in U.S. Pats. 2,759,813, 2,772,970, 2,786,-759, 2,868,641, 2,948,092, 2,948,093, 3,056,714 and 3,056,717.

In certain preferred embodiments of the product of this invention, the container contains a liquid which tends to liberate a gas when stored at a temperature of about 15–60° C., for example a liquid bleach composition. Especially preferred embodiments employ as the bleach composition an aqueous solution of sodium hypochlorite containing a buffering compound and an amine-containing compound having at least one NH or NH_2 group reactive with the hypochlorite. Such a bleach composition can be prepared in the manner described in the copending Golton and Rutkiewic application mentioned in Example 1.

One skilled in the art will be able to replace the internal screw thread of the cap and the external screw thread of the container with other known means for attaching caps to container mouths; for example by using caps equipped with means to snap on or clamp on the neck while tightly sealing the mouth. Some general concepts of other known attaching means are illustrated in U.S. Pats. 3,367,524, 3,371,812, 3,371,813, 3,372,834, 3,374,913 and 3,376,996.

The closure-cap of this invention is useful for capping any container wherein it is desired to have a capped container capable of allowing a gas to enter or to leave the closed container. Beneficial utility can be realized even when the container is intended to hold a nonliquid material, for example, a powdered material which tends to liberate a gas. The novel cap is especially useful for capping containers filled with gas-liberating liquids, and containers filled with hot liquids which are allowed to cool after the caps are put on.

We claim:

1. An article comprising

a container adapted to hold a liquid and having a cylinder-like neck defining a mouth, and cap-fastening means on the neck below the mouth, and

a closure-cap telescoped over the neck and comprising a top panel adapted to close said mouth, a depending annular attaching skirt at the periphery of the panel, holding means on the skirt adapted for engaging said cap-fastening means, and a gas-permeable liquid-impermeable sealing member in interposed sealing engagement with the top panel and mouth,

at least the bottom portion of said sealing member being a coherent, flexible, nonwoven fibrous sheet from which there can be removed continuous lengths of plexifilamentary strand material, said strand material being disposed in multidirectional overlapping and intersecting arrangement throughout said sheet, lying generally parallel to the major plane of said sheet, and being self-bonded to provide a sheet density greater than 7 lbs./ft.^{3} and a tensile strength above 0.3 lb./in./oz./yd.^{2}, said strand material further being composed of networks having a surface area greater than 2 m.^{2}/g., comprising a three-dimensional integral plexus of synthetic organic, crystalline polymeric, fibrous elements, said elements being coextensively aligned with the network axis and having the structural configuration of oriented film-fibrils, an average film thickness of less than 4 microns and an average electron diffraction orientation angle of less than 90°.

2. An article according to claim **1** wherein said cap-fastening means is an external screw thread on the neck, and said holding means on the skirt is an internal screw thread.

3. An article according to claim **1** wherein about 50–100% by weight of the crystalline fibrous elements of said nonwoven sheet are composed of linear polyethylene.

4. An article according to claim **3** wherein said networks of the nonwoven sheet are highly fibrillated and transversely spread networks.

5. An article according to claim **4** wherein said nonwoven sheet has a density of about 17–21 pounds per cubic foot and a thickness such that a weight about 1.6–2.8 ounces per square yard.

6. An article according to claim **4** wherein said sealing member consists essentially of said nonwoven sheet.

7. An article according to claim **1** wherein the sealing member has another kind of gas-permeable sheet material in superposed contact with said nonwoven sheet.

8. An article according to claim **7** wherein said other kind of gas-permeable sheet material is a porous polymer-bonded asbestos fiber sheet material.

9. An article according to claim **8** wherein said asbestos fiber sheet material contains about 50–98% asbestos fibers and about 2–50% of a flexible polymeric binder based on the total weight of fibers and binder present.

10. An article according to claim **9** wherein said asbestos fiber sheet material contains about 60–92% asbestos fibers and about 8–40% of a synthetic elastomer binder based on the total weight of fibers and binder.

11. An article according to claim **9** wherein said asbestos fiber sheet material has a thickness of about 30–44 mils and a weight of about 77–90 grams per square foot.

12. An article according to claim **9** wherein said as-

bestos fiber sheet material is the product of a process which comprises adding to an aqueous slurry of asbestos fibers a latex of a flexible polymer while agitating the slurry and allowing the polymer to deposit on the fibers, and forming the resulting polymer-coated fibers into a dried sheet.

13. An article according to claim **8** wherein said sealing member is a disk of a laminated composite sheet material having a layer of said polymer-bonded asbestos fiber sheet material in superposed adherence with a layer of said nonwoven sheet.

14. An article according to claim **1** wherein the container contains a liquid which tends to liberate a gas when stored at a temperature of about 15–60° C.

15. An article according to claim **8** wherein the container contains a liquid bleach composition which tends to liberate a gas when stored at a temperature of about 15–60° C.

16. An article according to claim **15** wherein said bleach composition comprises an aqueous solution of sodium hypochlorite, a buffering compound and an amine-containing compound having at least one NH or NH_2 group reactive with the hypochlorite.

17. A closure-cap adapted to provide a gas-permeable liquid-impermeable seal on the mouth of a container for liquids having a mouth-containing cylinder-like neck with cap-fastening means below the mouth, said cap comprising

a top panel adapted for sealing engagement with the container mouth,

a depending annular attaching skirt at the periphery of the panel,

holding means on the skirt adapted for engaging the cap-fastening means of the container neck, and

a sealing member covering at least the peripheral portion of the inside of the top panel and adapted to provide a gas-permeable liquid-impermeable seal when the cap is tightly fastened on the container

neck so that the sealing member is in interposed sealing engagement with the top panel and the mouth, at least the bottom portion of said sealing member being a coherent, flexible, nonwoven fibrous sheet from which there can be removed continuous lengths of plexifilamentary strand material, said strand material being disposed in multidirectional overlapping and intersecting arrangement throughout said sheet, lying generally parallel to the major plane of said sheet, and being self-bonded to provide a sheet density greater than 7 lbs./ft.^{3} and a tensile strength above 0.3 lb./in./oz./yd.^{2}, said strand material further being composed of networks having a surface area greater than 2 m.^{2}/g., comprising a three-dimensional integral plexus of synthetic organic, crystalline polymeric, fibrous elements, said elements being coextensively aligned with the network axis and having the structural configuration of oriented film-fibrils, an average film thickness of less than 4 microns and an average electron diffraction orientation angle of less than 90°.

18. A closure-cap according to claim **17** wherein the holding means on the skirt is an internal screw thread adapted to fit an external screw thread provided as cap-fastening means on the neck of the container.

19. A closure-cap according to claim **17** wherein the sealing member has another kind of gas-permeable sheet material in superposed contact with said nonwoven sheet.

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GEORGE T. HALL, Primary Examiner

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