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(54) Tamper-indicating closure.

(57) A thermoplastic closure (10) for fitment to a container for packaging a product capable of producing internal container pressure, e.g., a carbonated beverage, is disclosed. The closure (10) comprises a top wall (12) and an annular sidewall (14). A closure thread (20) is provided on the inside surface of the sidewall (14) and is preferably extended to require the user to make two turning motions to achieve removal. Thread (20) cooperates with the container neck thread (42) to achieve fitment of the closure (10) to the container neck (40). A sealing system (22) adjacent the top wall of the closure provides sealing of the closure to the container. One or more gas venting grooves (26) are provided on the closure for venting of pressurized gas from the container upon loss of the seal when the closure is rotated to remove it from the container. In order to strengthen the closure (10) where it is crossed by the groove(s) (26), a rigidifying structure (34) is provided at each point of traverse by the vent groove(s) (26) of the closure thread (20). The height of the rigidifying structure (34) is less than that of the thread (20). Stand-off protuberances (32) are preferably provided about the lower inside surface (28) of sidewall (14). A heat-shrinkable tamper-indicating means (16) is attached to the lowermost edge of the sidewall of the closure (10). Application of heat to the tamper-indicating means (16) causes it to shrink towards the container and to a point of interference with a container flange (48).

The combination of tamper-indication means (16) and venting structure (26) enables a closure to be formed with tamperproof properties and compatible resistance to premature release from a pressurized container.

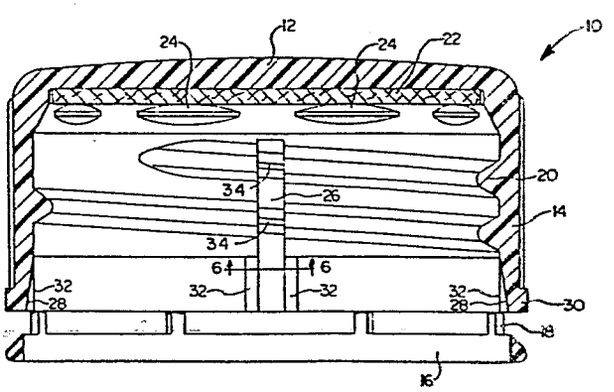

FIG. 2.

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TAMPER-INDICATING CLOSURE

This invention relates to a tamper-indicating closure suitable for use in packaging carbonated beverages.

Due to the economy of manufacture and availability of raw material, the utilization of thermoplastic closures in packaging carbonated beverages is becoming more popular. To be commercially acceptable, the closure must have tamperproof qualities. As understood in the closure art, the term "tamperproof" also has the meaning of tamper-indicating qualities. A highly successful tamperproof system for use on thermoplastic closures is the one disclosed in U.S. Patent Specification 4,206,851. This system utilizes a fracturable band which can be heat shrunk into an interfering fit with a container flange. The fracturable band is carried by a plurality of non-fracturable ribs attached to the lowermost end of the closure sidewall. Attempted removal of the closure from the container results in fracture of the band as it attempts to override the container flange. There are

other tamperproof systems, such as the ones shown in U.S. Patent Specification 4,033,472 and British Patent Specification 1,384,370, which also utilizes a tamperproof band which needs to be heated so that it can achieve a position of interfering with a container flange.

In designing the total package, either the container and/or the closure must be designed to prevent premature release of the closure from the container. This premature release phenomenon is most often experienced as the user turns the closure to begin its removal from the container. As the closure is turned, it moves axially upward thus breaking the seal between the top of the closure and the top of the container. Upon loss of the seal, pressurized gas from the container enters between the sidewall of the closure and the container, tending to bulge the closure sidewall outwardly. As the closure of the sidewall bulges outwardly, the closure threads are pulled away from engagement with the container threads and the connection between the container and closure is tenuous at best. If the gas is under sufficient pressure, the closure will be released from the container since the container-closure thread engagement is insufficient to contain the pressurized gas. This release is oftentimes with great force thereby presenting danger to the user.

One of the most popular threaded closures used

in packaging carbonated products is the nearly ubiquitous metal cap. To aid in preventing premature release of this type of closure, the art has suggested providing a vent slot through the container threads. The slot provides a path for the pressurized gas to vent to the atmosphere, thus preventing closure bulge. Reference is made to U.S. Patent Specification 4,007,848. In U.S. Patent Specification 4,007,851 another venting method for metal closures is shown. The closure is constructed to have, at a point adjacent the intersection of the sidewall and the top wall, at least one vent through which the pressurized gas may pass. Another type of system, one which uses circumferential venting, is shown in U.S. Patent Specification 1,739,659. These systems, while they may work in theory, are not particularly desirable as either they require modification in the design of the container threaded neck portion, they have dirt trapping openings in the closure itself, or they do not provide a sufficient amount of venting.

The use of thermoplastics materials enables the solution of these problems. Thermoplastic closures can be designed so that a vent groove is cut on the inside surface of the closure sidewall across the closure threads. See U.S. Patent Specification 3,888,347. The width of the vent groove and the number of vent grooves utilized can be

varied to provide the necessary venting rate for the conditions expected. Further, with this type of system, there will be no dirt entrapping openings exposed to the outside of the closure. (The use of such a groove on a metal closure is not practical as the metal closures used in packaging carbonated beverages are almost all roll formed on the container from a blank.)

EP-A-0060218 describes a screw cap for bottles of carbonated beverage. The thread of the cap and/or the thread of the bottle have one or more spacers on one or both sides of the flanks of the thread to form a ventilation channel which runs approximately vertically between the flanks of the thread.

GB-A-2062593 discloses a container cap having heat-shrinkable tamper-indicating means comprising an annular band attached to the sidewall of the cap by a plurality of spaced-apart ribs. The band is so structured that when heat is applied after the cap is fitted to the container at least one region of reduced cross-sectional area is produced in the band as it is shrunk around the container neck.

Combining a tamperproof system which utilizes heat application with a venting system, such as the one described above, can present a problem in the fact that application of heat to the tamperproof band cannot be

done very precisely and that, oftentimes, heat intended for the band also reaches the lower closure sidewall. Heating of the sidewall can cause it to shrink inwardly and make intimate contact with the container flange or container neck. When this occurs, the function of the venting system is compromised as the shrunken portion of the sidewall which is in contact with the container interferes with gas escapement.

The degree and incidence of shrinkage is increased when the lower portion of the sidewall is thinned out so that it flares outwardly from the container flange. The flare configuration is desirable since it aids in placement of the cap on the container as it goes through the capping line. The flaring is also desirable as it provdes a space between the closure sidewall and the container flange. Of course, by thinning out the lower portion of the closure sidewall, this thinned sidewall portion will more likely reach its heat shrinking temperature if it receives stray heat from the source used to apply heat to the tamperproof band.

The problems of the prior art are overcome by providing a thermoplastics material closure having a heat-shrinkable tamperproof band and a pressurized gas venting system which are compatible with each other.

Thus, the invention provides a thermoplastic closure for fitment to a container and comprising

a top wall, an annular sidewall downwardly depending from the top wall and with a closure thread about the inside surface thereof, sealing means above the closure thread adapted, in use, to achieve a gas-tight seal with the container, a vent groove extending from a point above the closure thread to a lower portion of the sidewall below the thread for venting gas from the container to the atmosphere subsequent to loss of a gas-tight seal upon loosening of the closure from fitment to the container, at each point of traverse by the vent groove of the closure thread a rigidifying means which has a perpendicular height measured from the sidewall less than the perpendicular height of the closure thread measured from the sidewall, and heat-shrinkable tamper-indicating means attached to the bottom of the closure sidewall.

Desirable as it may be, the location of the vent groove in the closure presents problems itself. The use of the vent groove requires a recessed cut in the closure sidewall across the closure thread, with the result being that the closure sidewall is thinner at the vent slot and unsupported by a continuous thread. Upon tightening the closure to the container, the weakened sidewall will expand outwardly as, in its weakened configuration, it cannot support the forces applied on it by the engagement of the container and closure threads. Also, when the closure is loosened from its seal position, the pressurized gas can cause the weakened closure sidewall to expand. Both the closure expansion realized upon tightening and the closure expansion caused by the pressurized gas jeopardize the closure-container thread engagement. When the thread engagement is compromised to the extent that the pressure inside the closure cannot be held by the threads, then premature release of the closure occurs. Using a closure with thickened sidewalls is not an answer as such a closure uses more thermoplastics material per closure and could not compete economically in the marketplace.

Accordingly, a rigidifying structure is also provided to enhance the hoop strength of the closure sidewall at the vent groove(s). The structure is located

at each point of traverse by the venting groove with the closure thread. This structure is dimensioned so that its perpendicular height, measured from the sidewall, is less than the perpendicular height of the closure thread, also measured from the inside surface of the sidewall. By having the rigidifying structure with this smaller dimension, the pressurized gas is able to find sufficient escapement cross sectional area in the venting groove. Location of the rigidifying structure at the point(s) of intersection of the vent groove and the closure thread insures that no threading interference will occur between the structure and the cooperation of the closure and container threads. The vent groove(s) width and depth will be dependent upon the pressures expected to be encountered as the closure is removed from the container.

In addition, although the venting can be accomplished by using a vertical vent groove on the container or closure because with the vent groove the gas is not trapped between the closure sidewall and the container neck, there is still a chance for blow-off if the thread engagement is lessened too quickly as sufficient time will not have passed for the pressurized gas to complete its venting. For some closures, complete unscrewing of the closure from the container can take as little as one-half of a second. Clearly, in this amount

of time, venting has only started and pressure in the container is still high. Thus, preferably, on the inside surface of the annular sidewall is a helical extended closure thread traversing from 400 to 500 degress and dimensioned for cooperation with a similar container thread for fitment of the closure to the container neck.

In the present closure, the lower portion of the inside surface of the closure sidewall is preferably flared slightly outward.

Connected to the lowermost edge or bottom of the closure sidewall is tamper-indicating means, preferably a fracturable, heat-shrinkable, tamperproof band which is attached to the closure sidewall by means of a plurality of non-fracturable ribs. To give the lower portion of the closure sidewall resistance to achieving a temperature conducive to its shrinkage, there is preferably provided on the outside surface of this sidewall portion an annular bead which operates as a heat sink.

To help prevent contact between the inside surface of the closure sidewall and the container, a plurality of stand-off protuberances are preferably positioned about the inside surface of the closure sidewall. Preferably, these protuberances will take the form of vertical ribs, a rib being located adjacent each side of the lowermost extent of the vent groove(s) 26.

Our copending application published under No 0067650 from which the present application is divided is also directed towards a tamper-indicating closure and claims a thermoplastics material closure for fitment to a container and comprising a top wall, an annular sidewall downwardly depending from said top wall and with a closure thread about the inside surface thereof and stand-off protuberances about the lower inside surface of said sidewall adapted, in use, to aid in keeping said sidewall from making contact with the container, sealing means above said closure thread adapted, in use, to achieve a gas-tight seal with the container, gas venting means for venting gas from the container to atmosphere subsequent to loss of a gas-tight seal upon loosening of said closure from fitment to the container, and heat-shrinkable tamper-indicating means attached to the bottom of said sidewall.

The invention will now be further described and illustrated by way of the following description of

preferred embodiments with reference to the accompanying drawings, in which identical numerals refer to identical parts, and in which:

FIGURE 1 is a front elevational view of a closure of this invention;

FIGURE 2 is a sectional view taken through section line 2-2 of Figure 1;

FIGURE 3 is a vertical sectional view of the closure shown in Figure 1 fitted to a container;

FIGURE 4 is a vertical sectional view of a closure not in accordance with this invention;

FIGURE 5 is an enlarged sectional view showing the path of escapement for the pressurized gas as the closure shown in Figures 1,2 and 3 is removed from a container; and

FIGURE 6 is a partial sectional view taken through section line 6-6 of Figure 2.

Referring now to Figures 1-2, the closure of this invention, generally designated by the numeral 10, has a

top wall 12 and a downwardly depending annular sidewall 14. Nested against the inside surface of top wall 12 is a liner 22. Liner keepers 24 are utilized to hold liner 22 in a position adjacent the inside surface of top wall 12. Liner 22 is utilized to effect a gas-tight seal with the top lip of the container neck. Other sealing systems may be utilized with the closure of this invention. The systems utilized, whether they be liner systems or linerless systems, must fulfill the requirement that they be capable of effecting a gas-tight seal under the pressure expected in the package. About the inside surface of sidewall 14 there is provided a helical thread 20. Helical thread 20 is dimensioned to cooperate with container helical thread 42, shown in Figure 3, to effect fitment of closure 10 to the container.

Recessed in the inside surface of sidewall 14 is vent groove 26. As can be seen in Figure 2, vent groove 26 intersects closure thread 20. For the embodiments shown in the drawings, a single vent groove is utilized. However, it is to be understood that more than one vent groove may be used. The width and depth of vent groove 26 should be such that sufficient passageway is provided for the pressurized gas so that it may be vented safely to the atmosphere within a period of time that is shorter than the time necessary for removal of closure 10 from the

container by the user.

Traversing vent groove 26 at each point of its intersection with closure thread 20 is rigidifying structure 34. For the embodiment shown in Figures 2 and 6, rigidifying structure 34 has a cross sectional shape resembling a truncated pyramid. Whatever the form of rigidifying structure 34, it cannot have a height, measured from the inside surface of sidewall 14, greater than the height of closure thread 20, also measured from the inside surface of sidewall 14. However, the height of rigidifying structure 34 should not be so small that it is not able to achieve its required enhancement of sidewall hoop strength. Determination of the height of rigidifying structure 34 will be dependent on several factors, i.e. the pressures expected to be encountered, the material of construction for the closure, the width and depth venting groove(s) 26, the length of closure thread 20 and the degree of engagement between closure thread 20 and container thread 42. An example of a useful closure is one made of polypropylene having a vent groove width of about 1/16 inch (1.6 mm) and depth of .005 to .015 inches (0.13-0.38 mm), a sidewall thickness of .035 to .040 inches (0.89-1.02 mm), a closure thread traversing approximately 480 degrees having conventional thread engagement and a rigidifying structure height of about 2/3 of thread height. For other materials

and other venting channel depths and sidewall thicknesses, the sizing of rigidifying structure 34 is empirically determined by observation and experimentation, both of which are well within the ability of those skilled in the art having the disclosure of this invention before them.

The inside surface of sidewall 14, at its lowermost end, is preferably provided with a flared profile when viewed in cross section. Such flaring is beneficial for the reasons stated previously. About the lowermost outside surface of sidewall 14 an annular boss 30 is desirably provided. As mentioned previously, annular boss 30 serves the function of providing a heat sink for absorption of "stray heat" from the heat shrinking operation of band 16. Thus, the configuration and size of annular boss 30 is not critical so long as the heat sink function is achieved and thus the lowermost portion of sidewall 14 does not reach a temperature which would cause its shrinkage.

To further discourage contact of the lower inside surface 28 of sidewall 14 with the container, stand-off protuberances 32 are provided. These protuberances prevent any tendency of the lower portion of sidewall 14 to move towards the container. For the embodiment shown, these protuberances are vertical ribs grouped in pairs and spaced each pair every ninety degrees. In fact, it

has been found desirable to dimension ribs 32 so that when the closure is fitted to the container, sidewall 14 is slightly deformed outwardly from the container. It is to be understood that other forms of protuberances may be utilized such as beads and the like.

Extending downwardly from the lowermost edge of sidewall 14 are a plurality of non-fracturable ribs 18. These ribs are for carrying heat shrinkable tamper-indicating band 16. Band 16 is provided with at least one weakened portion so that this portion can fracture upon stress applied to the band. This fracture of the band is a clear indication to the user that the closure has been tampered with.

In Figure 3, closure 10 is shown fitted to a container. As can be seen in this figure, container neck 40 has closure 10 fitted thereto by the cooperation of container threads 42 and closure threads 20. Note that heat shrinkable band 16 has been heat shrunken so that it has moved to a position of interference with container flange 48. As can be appreciated, unscrewing of closure 10 results in upward axial movement of the closure, which movement forces the fracture of band 16 as it is not able to follow this axial movement without fracturing due to its interference with container flange 48. Also, it is to be seen from Figure 3 that the spacing 50 between the

lowermost edge of sidewall 14 and container flange 48 has been maintained since no shrinkage of sidewall 14 at its lowermost portion has occurred. Also, as pointed out previously, ribs 32 will act to accomplish this function.

In Figure 4, the results of utilizing closure 10 without annular boss 30 and ribs 32 is depicted. As can be seen, the lowermost portion of sidewall 14 has shrunk inwardly and is in intimate contact with container flange 48. As mentioned previously, this contact often results in restriction of the passage of pressurized gas to the atmosphere so that premature release of the closure occurs.

In Figure 5, the venting of pressurized gas from the package is shown. Note that as closure 10 is rotated about container neck 40, closure 10 moves axially upward. This axial upward movement results in liner 22 being removed from its nesting position on the top 44 of container neck 40. Pressurized gas in the interior of the container begins movement through vent groove 26 as indicated by the arrows. As can be seen, the utilization of rigidifying structure 34 does not interfere with passage of the pressurized gas while at the same time the aforementioned enhancement in hoop strength provided by rigidifying structure 34 is realized. As closure 10 continues its removal rotation, pressurized gas is

continuously vented until the interior package pressure is equal to ambient pressure. Since there has been no loss of container thread to closure thread cooperation, removal of closure 10 is done without fear of premature closure release.

A particularly useful closure of this invention is one made of polypropylene. However, it is to be understood that other materials may be utilized such as polyethylene terephthalate, polyvinyl chloride, high density polyethylene, and the like. The closure of this invention may be made by any well known injection molding techniques.

Illustrative of the benefits realised when utilizing an annular boss 30 in this invention is the fact that a polypropylene closure with the features of this invention and such a boss can be passed through a 52 inch (132 cm) long slotted forced-air heater utilizing 404°C. air with a passage time of two seconds and a package rotation of 3-1/4 revolutions per pass without shrinkage of the lower portion of sidewall 14. To accomplish this passage through this slotted oven, annular boss 30 had a thickness measured from the inside wall to the outside wall of 0.037 inches (0.94 mm). Without annular boss 30, the thickness would normally be 0.028 inches (0.71 mm) for this portion of sidewall 14.

CLAIMS:

1. A thermoplastic closure for fitment to a container and comprising a top wall (12), an annular sidewall (14) downwardly depending from the top wall (12) and with a closure thread (20) about the inside surface thereof, sealing means (22) above the closure thread (20) adapted, in use, to achieve a gas-tight seal with the container, a vent groove (26) extending from a point above the closure thread (20) to a lower portion of the sidewall (14) below the thread (20) for venting gas from the container to the atmosphere subsequent to loss of a gas-tight seal upon loosening of the closure (10) from fitment to the container, at each point of traverse by the vent groove (26) of the closure thread (20) a rigidifying means (34) which has a perpendicular height measured from the sidewall (14) less than the perpendicular height of the closure thread (20) measured from the sidewall (14), and heat-shrinkable tamper-indicating means attached to the bottom of the closure sidewall (14).

2. A closure as claimed in claim 1 further comprising stand-off protuberances (32) about the lower inside surface of the sidewall (14) adapted, in use, to

aid in keeping the sidewall (14) from making contact with the container.

3. A closure as claimed in claim 2 wherein the stand-off protuberances (32) comprise a vertically extending rib adjacent each side of the lowermost extent of the vent groove(s) (26).

4. A closure as claimed in any one of the preceding claims further comprising heat sink means (30) adjacent the bottom of the sidewall (14).

5. A closure as claimed in claim 4 wherein the heat sink means is an annular bead (30) extending outwardly from the outer lowermost surface of the sidewall (14).

6. A closure as claimed in any one of the preceding claims wherein the closure thread (20) traverses from about 400 to 500 degrees of rotation about the inside surface of the sidewall (14).

7. A closure as claimed in any one of the preceding claims further comprising retaining means (24) about the inside surface of the sidewall (14) positioned below

the sealing means (22) but above the closure thread (20) for preventing the sealing means (22) from moving down to the closure thread (20).

8. A closure as claimed in any one of the preceding claims wherein the tamper-indicating means is a fracturable heat-shrinkable bead (16) attached to the bottom of the sidewall (14) by a plurality of non-fracturable ribs (18).

9. A closure as claimed in any one of the preceding claims wherein the closure (10) is made from polypropylene.

10. A closure as claimed in any one of the preceding claims wherein the lower inside surface of the sidewall (14) is flared outwardly by thinning of said lower portion from its uppermost extent to its lowermost extent.

11. A closure as claimed in any one of the preceding claims wherein the rigidifying means (34) when viewed in cross section has the shape of a truncated pyramid.

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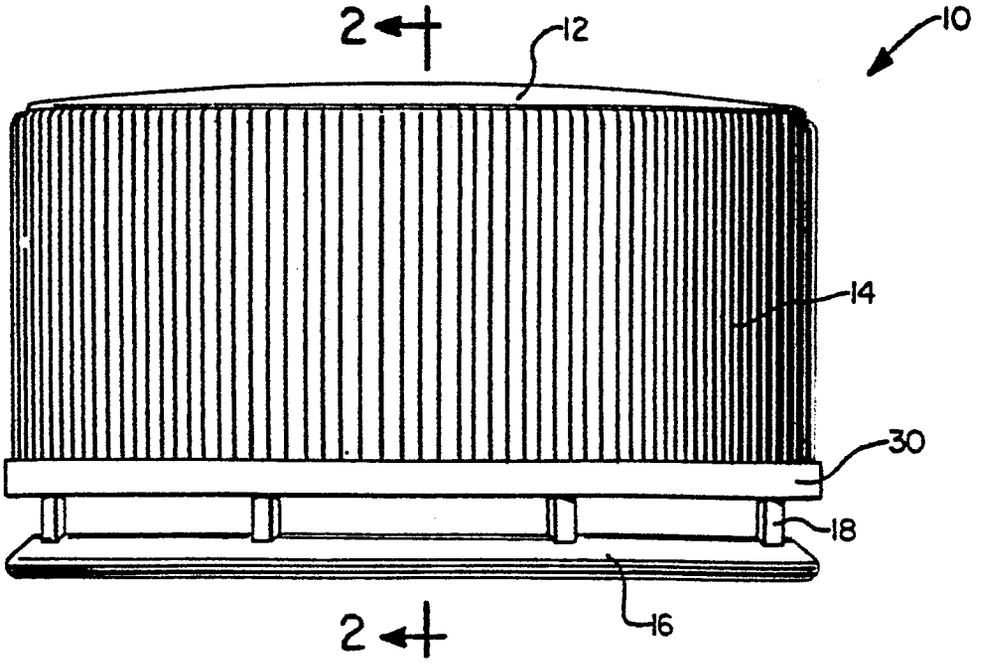

FIG. 1.

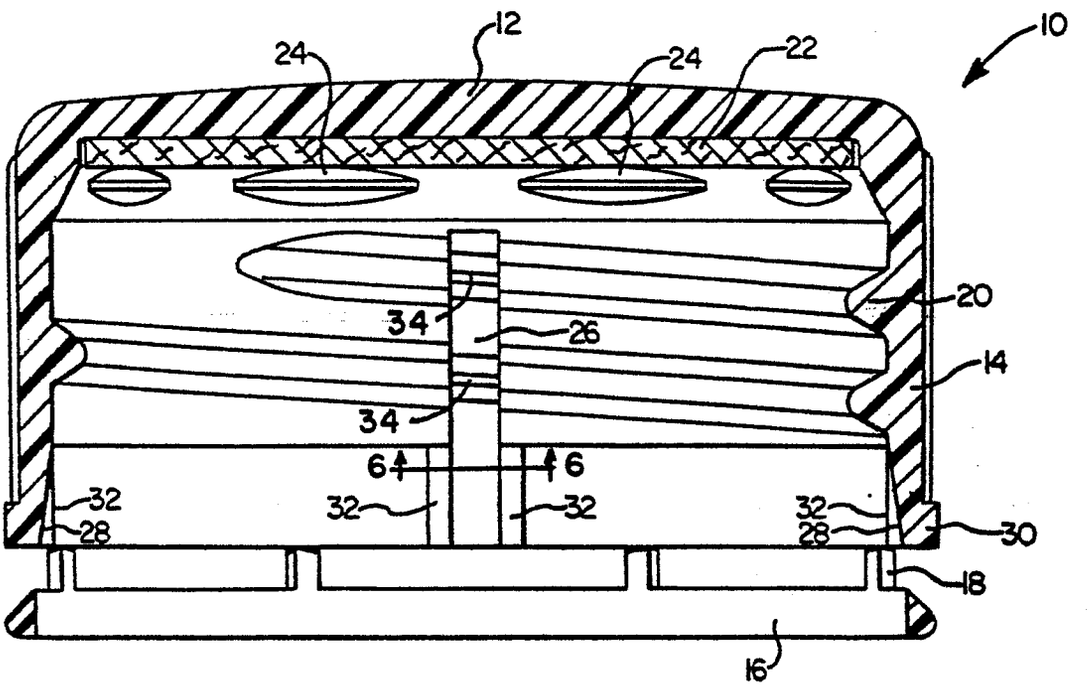

FIG. 2.

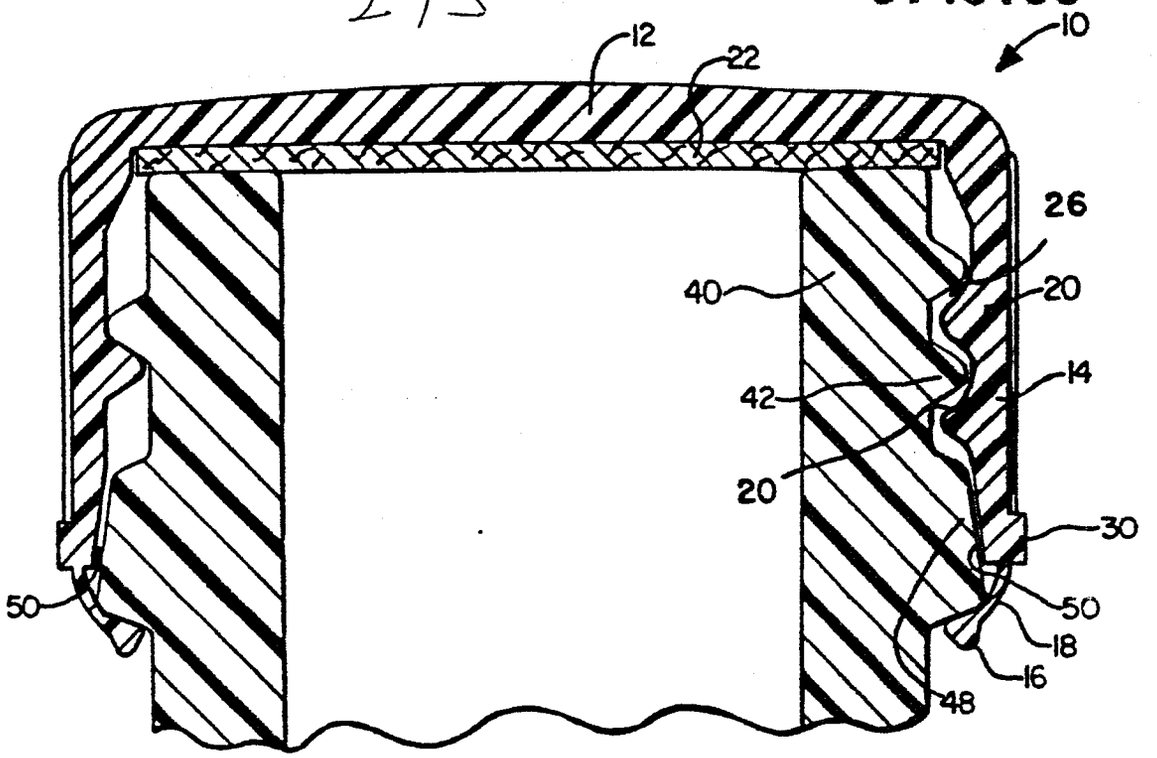
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FIG. 3.

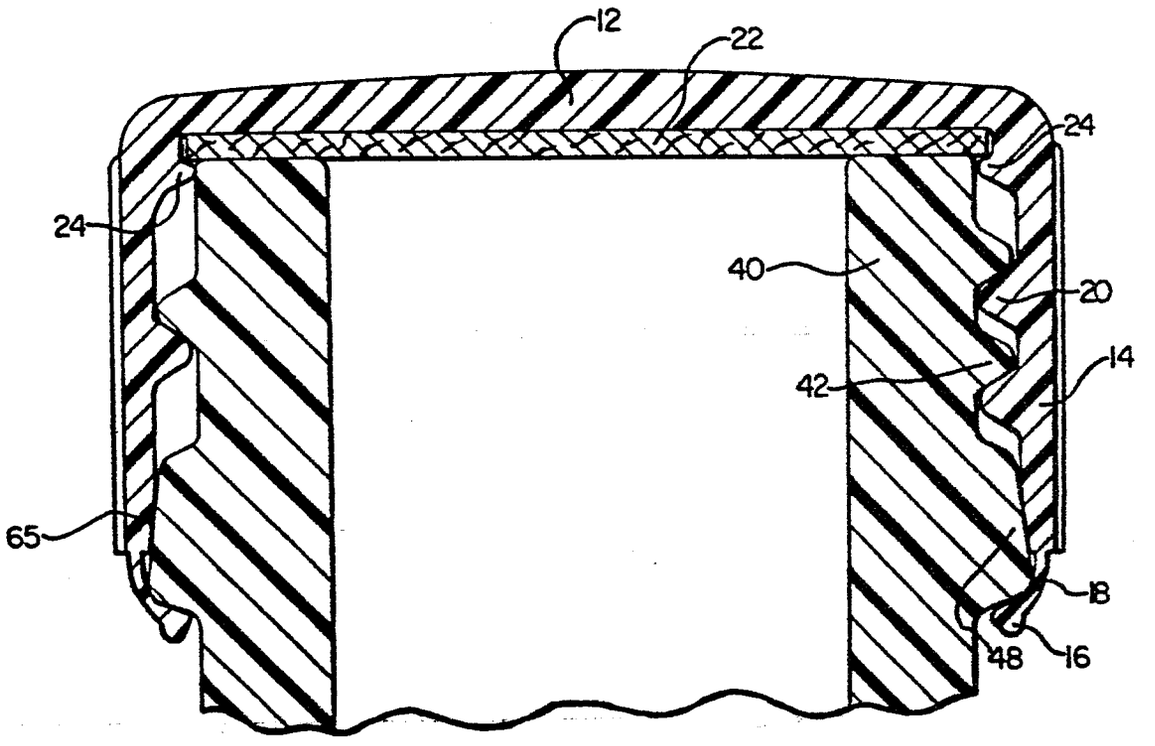
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FIG. 4.

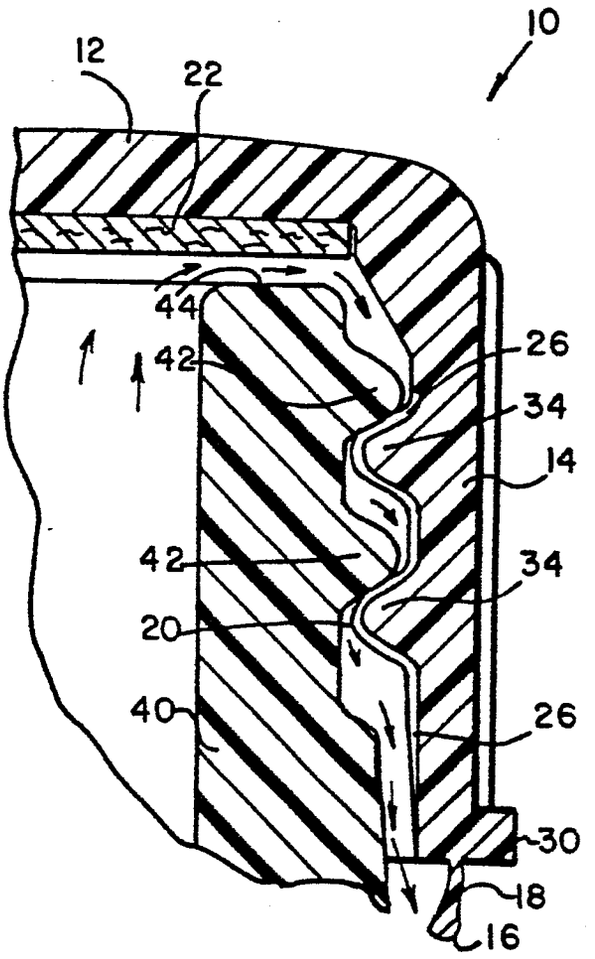

FIG.5

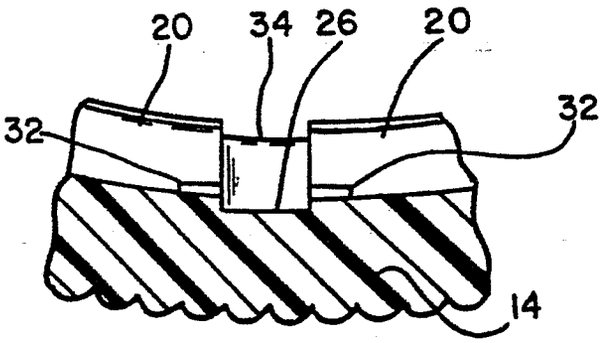

FIG.6