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## (54) Plastic closure with premolded deflection.

(57) The premolding of predetermined deflection in the top wall of plastic closures for pressure or vacuum applications is described. The premolded deflection is to compensate for pressure forces, or atmospheric pressure in the case of vacuum, within the sealed container so that the closure, after sealing, will be essentially flat in appearance and better able to maintain a pressure seal from both a short term as well as long term sealing application to a jar or bottle.

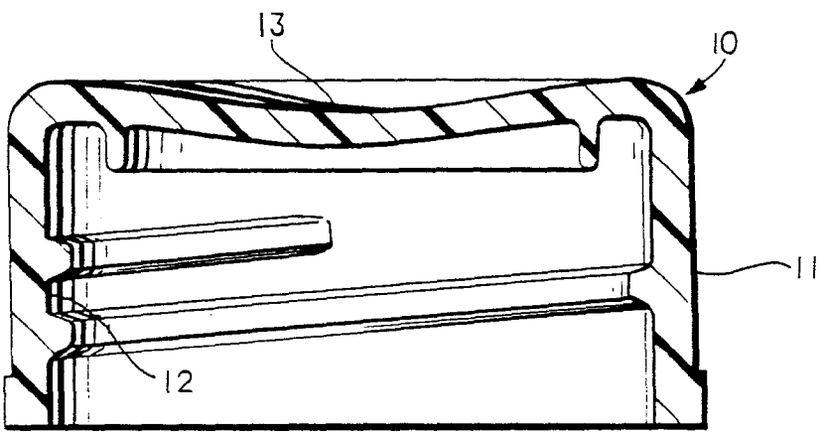


FIG. 1

EP 0 186 277 A2

# PLASTIC CLOSURE WITH PREMOLDED DEFLECTION

## Background of the Invention

Plastic closures are presently made for soft-drink containers, both plastic and glass. When they are threaded onto the container and seal, the internal pressure in the container, which may be in the range of 100-150 psi depending upon the degree of carbonation and temperature, exerts sufficient force on the underside of the closure to cause mechanical deflection or "doming" of the center portion of the cap.

The "doming" of the cap creates problems in maintaining a seal, resulting in loss of carbonation in some instances and when the closure with a dome is disturbed, there is even a greater risk in the closure leaking. The domed closure may be disturbed by the application of the price to the closure by the marking devices in the store, or by the stacking of several containers on top of each other. Doming which occurs in some plastic closures due to internal pressure may become more severe with time due to the tendency for some plastic closure materials to "creep" under stress. As can be seen, when the closure is first applied, it will seal, and while the pressure will immediately deflect the center of the cap to some degree, the constant pressure over a period of time will result in the possible loss of pressure because the seal may be disturbed.

Of course, while internal pressure may cause the plastic closure to "dome", a similar phenomenon will occur when the closure is being used to seal a produce under vacuum, in which case the closure will deflect inwardly of the container to which it is applied. This is a common feature of containers that are packed under heat or with steam, such as baby foods and instant coffee. In the case of containers under vacuum, the diameter of the closure and degree of vacuum will determine the diameter of the closure and degree of vacuum will determine the deflection of the closure due to atmospheric pressure acting on the closure.

To be competitive with metal closures, the plastic closures must not be overly complicated because of the tooling costs for the molds and the resin costs for the plastics.

Obviously, the closure must retain the pressure and therefore cannot be permeable to the gas that is in the head space.

In order to minimize this doming effect, some closures have been formed with internal, radial ribs. While this may be one solution to the "doming" problem, the injection molds for the closures are expensive to make and maintain. Also, it is possible to make the closures very thick in section but of course this also runs up the cost per unit manufactured.

## Summary of the Invention

Plastic closures for pressurized containers are made of the usual material but are molded so as to have a predetermined degree of initial deflection in the top so that when applied to the container the internal pressure stress will render the closure top surface essentially flat. In those situations where the span of the closure is large, such as on a wide mouth jar, a contoured thickness in addition to the premolded shape is provided to the closure.

It is therefore an object of the present invention to form closures of plastic for containers that will be under non-atmospheric internal pressure, where the closure after application will assume a generally horizontal top surface during its useful period of sealing the container.

It is a further object of the present invention to form closures of plastic with a preformed deflection in the closure top to compensate for the deflection that may be caused by the pressure condition to be encountered when in use.

Other and further objects will be apparent from the following description taken in conjunction with the annexed sheets of drawings.

## Brief Description of the Drawings

FIG. 1 is a cross-sectional view through a plastic closure of the invention for application to a pressurized container;

FIG. 2 is a vertical cross-section through a plastic closure for an evacuated container;

FIG. 3 is a vertical cross-section through the closures of Figs. 1 and 2 after being sealed to the container finish;

FIG. 4 is a vertical sectional view through a plastic closure adapted for sealing an evacuated wide mouth container; and,

FIG. 5 is a vertical sectional view through a plastic closure to the invention adapted for sealing a wide mouth jar under internal pressure.

## Detailed description of the Drawings

With particular reference to the appended drawings, and in particular Fig. 1, there is shown a closure 10 formed of a plastic such as polypropylene which has an annular skirt portion 11 with internal threads 12. The closure 10 is formed with a circular top 13 joined to the skirt 11 with the central portion formed in a downwardly concave configuration. The degree of concavity with respect to edges of the closure top is selected on the basis of the bending modulus of the top panel 13 of the closure, the thickness of the closure top and the degree of internal pressure within the container to which the closure will be applied. The closure of Fig. 1 is formed with the curvature shown, and upon application to a container finish and sealing thereon, the top of the closure will assume a generally horizontal or flat configuration as shown in Fig. 3.

Turning now to Fig. 2, there is shown a closure 20 similar to that shown in Fig. 1, except this closure 20 is formed with its central top portion 21 in a "domed" upward fashion, as shown. The closure 20 has an internally threaded skirt portion 22 to which the top 21 is joined and is adapted to be applied to a container which is intended to hold a vacuum or pressure less than atmospheric. Here again, when the closure is sealed onto a container whose contents are under vacuum, the center 21 of the closure will assume a generally horizontal configuration as illustrated in Fig. 3. The thickness of the closure top, the degree of premolded "doming" will be based upon the anticipated degree of vacuum which will be present in the container to which the closure is to be sealed.

As can be seen, when either the Fig. 1 or Fig. 2 closure is applied to the container with the appropriate internal pressure condition, the closure will assume the shape shown in Fig. 3, at which time the tendency of the plastic of the closure to "creep" under stress is greatly reduced and the possible loss of pressure due to the closure unsealing because of top loading is greatly reduced.

Furthermore, there is virtually no possibility that the top of the closure will experience cracking due to "doming" or sinking as has been experienced in the past with closures that are not non-premolded with a deflection therein. While the "doming" of present closures does not always result in cracks, the top loading of the "domed" closure will usually disturb the seal causing the package to vent or for carbonation leakage to occur. With the preformed closures of the invention, no "doming" will be present after sealing and thus nodisturbance of the seal will occur with top loading of the package as will occur when the sealed bottles, for example, are stacked in cases on top of each other for shipment or for display in the market.

The precise amount of premolded deflection in the closures can be specified for different sizes, pressure, resins and top thicknesses using theoretical formulae and/or finite element stress analysis techniques so that stresses resulting from internal pressure conditions of the package are within safe limits.

Turning to Figures 4 and 5, there are disclosed two examples, 40 and 50 respectively, of the configurations for wide mouth container closures pre-molded for pressure and vacuum conditions. As shown in Fig. 4, the central portion 41 of the top 42 of the closure 40 is formed with a significantly thicker section than the outer portions. This is so take care of the fact that with a wide mouth container the closure will be subjected to greater overall internal force because the area that will be exposed to the interior of the container will be significantly larger than in the case of the closure shown in Fig. 1. The closure of Fig. 4 may be in the range 1.5 to 3 inches in diameter. In this case the center portion is made thicker so as to be able to withstand the increased forces without "doming" when applied to a pressurized container but assume a generally flat, top surface configuration.

In Fig. 5 there is shown a premolded wide mouth closure 50 having a top wall 51 with a thicker cross-section at the center 52 than at the edges. This closure would, for example, be suited for application to a baby food jar where the contents will be under vacuum. Here again, the closure top 51 will assume a generally flat configuration when applied to a container with internal vacuum conditions of the type experienced with baby food packages.

It may also be noted that with the closure as shown in Fig. 5 applied to a baby food containing jar under vacuum, the flat configuration of the closure top provides an indication that the package is still sealed. In the event the seal were lost and leakage may have occurred, the plastic closure will appear "domed" as in Fig. 5 and thus become a readily apparent tell-tale that the seal has been lost and the contents may not be sterile. Obviously, in the case where the contents may have spoiled, the center of the closure may even be "domed" to a greater extent due to the possibility that pressures will have built up beneath the closure.

Specific deflections of polypropylene closures for application to containers which will be under 28 inches of Mercury vacuum are as follows:

70 mm.size with top thickness of .050 in. the deflection will be .200 in.: and,

53 mm. size with top thickness of .050 in. the deflection will be .080 in.

In addition to the advantages of the closure with premolded deflection to offset pressure within the container, it should be pointed out that when doming occurs in the prior art closures, it is necessary that the closure be labeled before application to the container, thus requiring an inventory of closures for each customer.

With the closure of the invention, it is possible to make a stock closure which may be labeled after application without fear of disturbing the seal or the labeling may occur as part of the filling and sealing. Obviously, a stock closure may result in manufacturing costs and thus make the sealed package, such as soft drink, less expensive.

While the foregoing description sets forth the best mode of carrying out the invention, as presently contemplated, obvious modifications of the concepts may be resorted to within the scope of the appended claims.

## Claims

1. A plastic closure for a container having a non-atmospheric pressure therein in which the closure is molded with internal threads in a cylindrical, depending skirt portion joined to a top with sealing means formed therein, the improvement in the closure comprising, molding the top with a predetermined wall thickness and non-linear contour to compensate for the deflection of the closure when subjected to the prevailing atmosphere in the container.

2. The closure of Claim 1 wherein the top of the closure is molded with a concave curvature, whereby a pressurized product in the container will raise the closure top to a substantially horizontal level.

3. The closure of Claim 1 wherein the top of the closure is molded with a convex curvature of an amount such than when applied to a container with a vacuum therein the top will become essentially flat.

4. A plastic closure for a container that is to contain a product under pressure comprising, a cylindrical skirt, container attaching means formed internally of said skirt, sealing means within said closure for sealing cooperation with the finish of the container, a premolded top on said closure being formed with a concave contour to the outside top thereof and a thicker wall section at the center than at the edges which join the skirt, whereby the deflection of the closure is such that virtually no "doming" takes place.

5. The closure of Claim 4 wherein the center of said top is joined to the side thereof by a straight taper.

6. The closure of Claim 4 wherein the wall thickness of said top is conical in configuration with the height of the downwardly extending cone being determined by the degree of resistance to deflection desired.

7. A method of forming a premolded plastic closure for a pressurized container, comprising the steps of molding the top of the closure with a concave contour and having a thickness such that it assumes a generally horizontal attitude when applied to the container under pressure.

8. The method of Claim 7 further including determining the bending modulus of the closure material and adjusting the thickness of the closure top panel in accordance with the pressure to be contained.

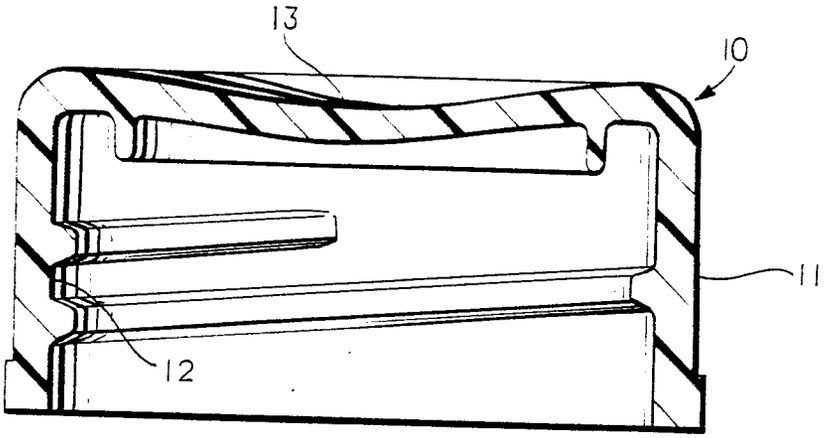


FIG. 1

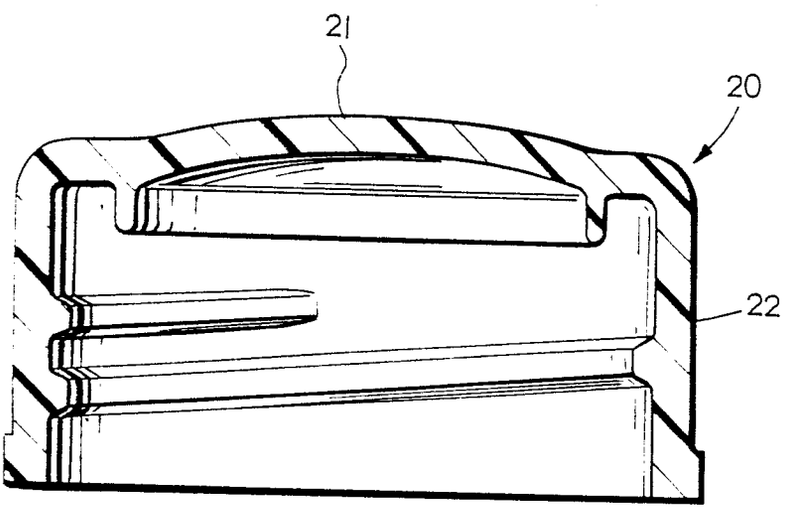


FIG. 2

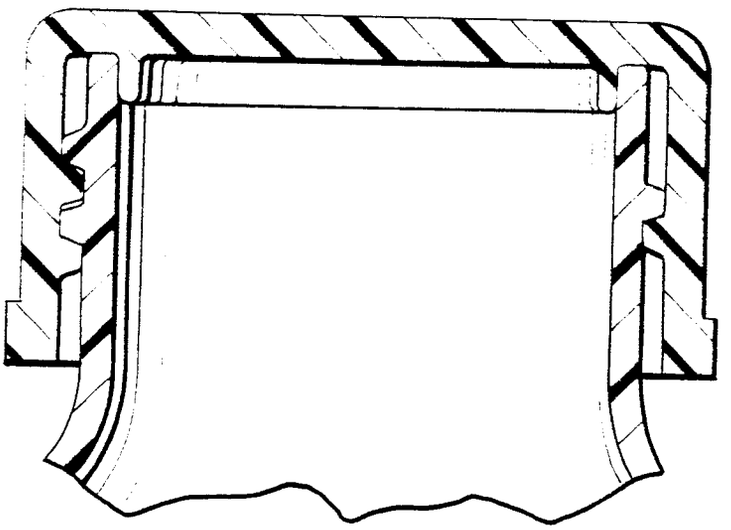

FIG. 3

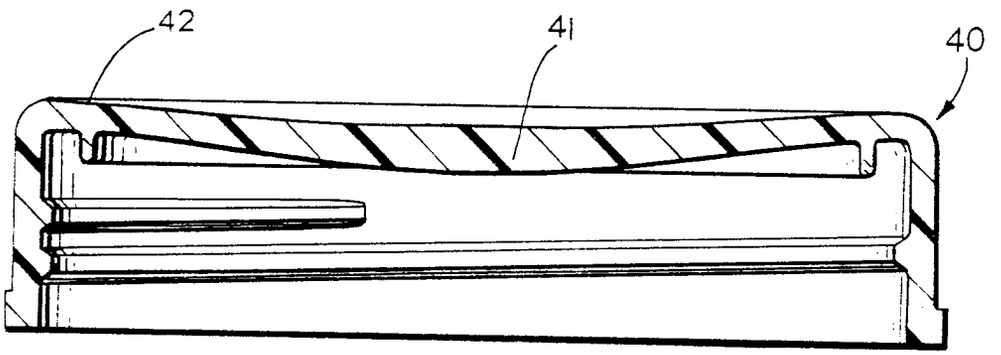


FIG. 4

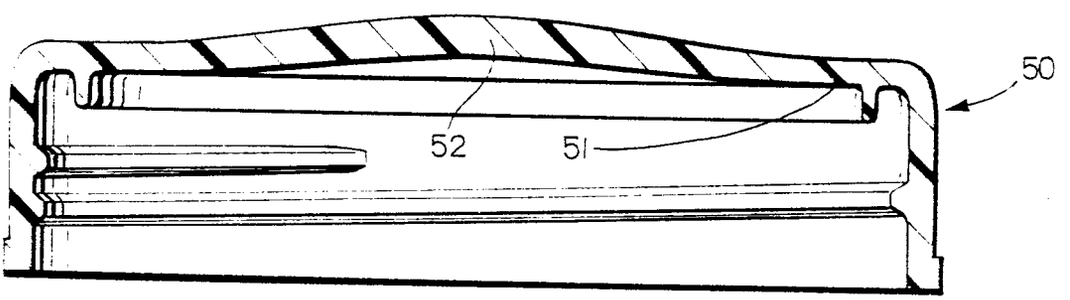


FIG. 5