

## [54] PRESS TYPE CLOSURE

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1.5 B

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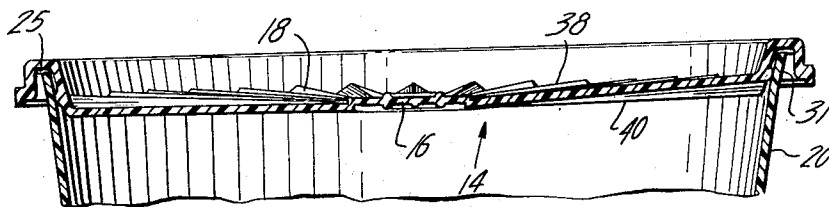
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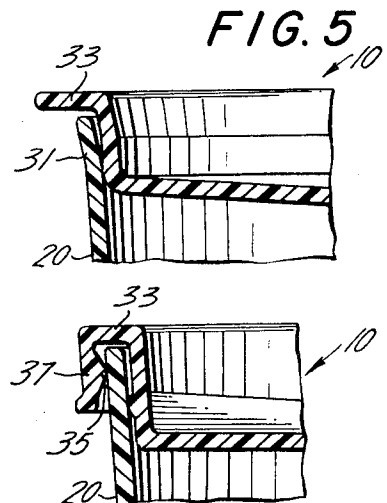
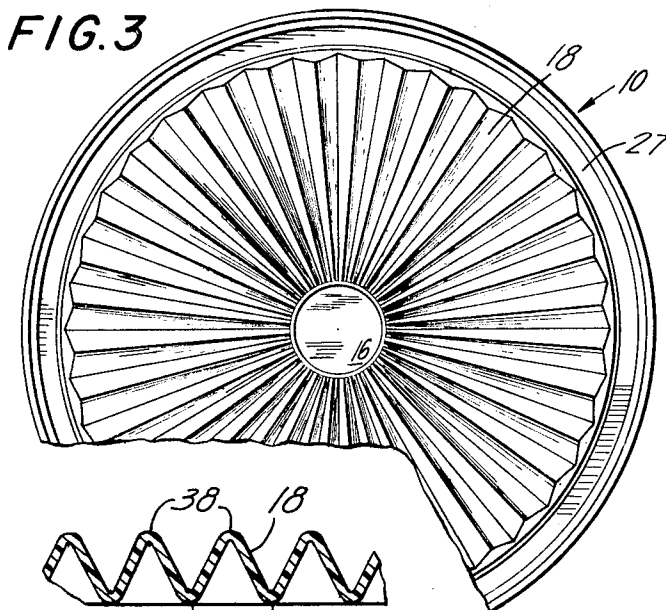
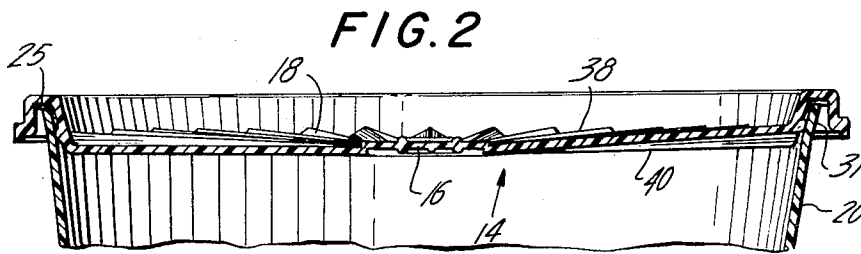
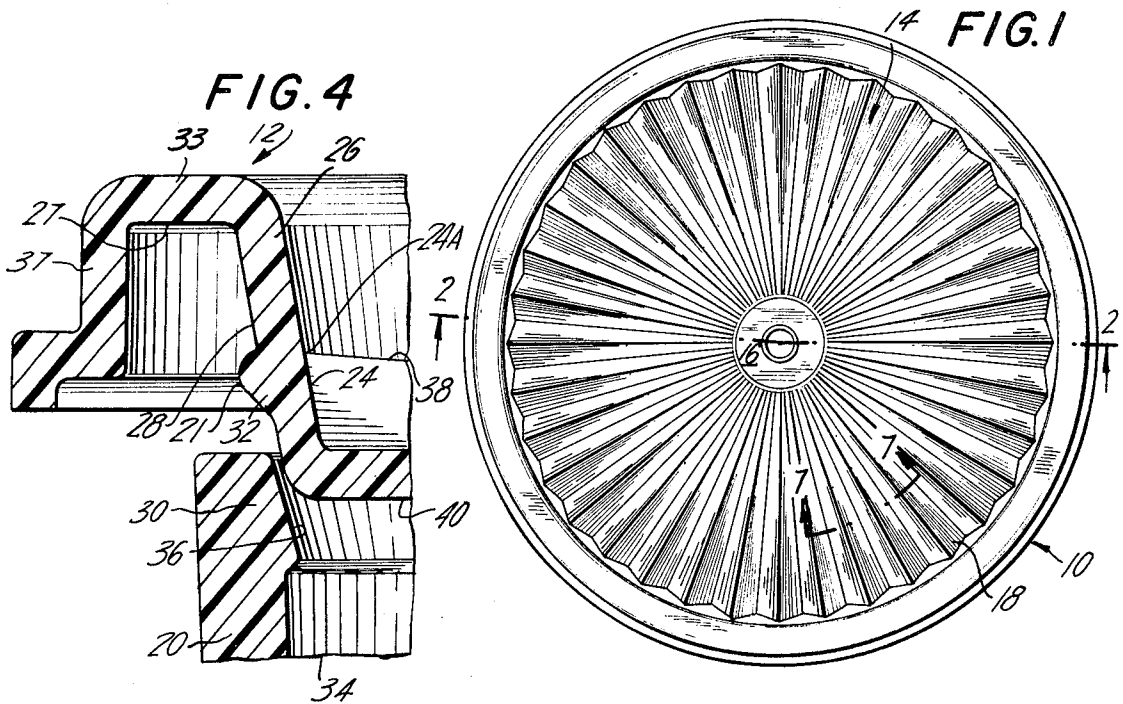
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### ABSTRACT

A closure suitable of insertion over the opening of a tubular or similarly constructed member and adapted to hermetically seal that opening. The closure construction includes a biased center main wall that particularly adapts it for placement upon the tubular member by a light application of finger pressure to the approximate center of the main wall. Also disclosed is the method of application of such a closure upon a tubular member, and a combined snap-on and locking feature for this closure.

**6 Claims, 7 Drawing Figures**





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## PRESS TYPE CLOSURE

This invention relates to containers and container closures which, preferably, are formed from distortable materials of construction. More particularly, the invention concerns reusable, plastic container closures for open-mouthed containers and further contemplates a closure arrangement and sealing method that is quickly and easily effectable and which assures a lasting reliable hermetic seal.

Food storage containers, including those formed of plastic materials, have been available for many years and have generally employed a bowl, cylinder or similarly shaped tubular vessel and a separate closure or lid made of a relatively flexible material. The closures for such vessels have normally been of several types. One of these types includes an inverted peripheral groove that is placed upon the top edge or rim of a container wall and is pressed onto or expanded over that edge to form a hermetic seal between the two parts. The application of such a closure usually requires that the user apply pressure all around the periphery of the closure to effectively seat same upon the container. Another typical closure is the two-position type which may be flexed to either of two stable positions. In one of these positions, the closure may be easily placed over the rim or within the open-mouth of a container, and then may be flexed to the second position. This flexing action either expands or contracts the peripheral portions of the closure and forces it into tight locking contact with the rim or inside container wall. Others, of course, include the cork-like and toggle action closures which loosely fit into the open mouth of a container and which are thereafter expanded into contact with the container inside wall surfaces.

As might be expected, all of the mentioned closures have been quite satisfactory in operation and construction. It should be noted, however, that each is not wholly satisfactory for many reasons. For example, the closure having the inverted peripheral groove has to be stretched over or pressed onto the container rim normally by finger pressure applied at successively adjacent points along the top groove defining wall. This, of course, may be a time-consuming and laborious procedure, especially if the closure is as tight fitting as is required to obtain a lasting hermetic seal. Further, when the closure must be stretched in this manner, stress concentrations are increased to such a degree that stress cracking may result. Similarly, lids of this type are susceptible to warpage due to a lack of structural rigidity and, of course, in a warped condition, placement of the lid on a container is made more difficult and sometimes even impossible.

The two-position closure may also require some dexterity if it is to be accurately locked in position. For example, the peripheral edge of such a closure must be maintained in close association with the top edge of the container as the top wall of the closure is flexed to its locking position. As might be expected, this, in some instances, necessitates that the closure be simultaneously held at the edges and flexed at the center.

Similarly, the toggle-action and roll type toggle action closures may also require dexterity in their proper assemblage with suitable closures. In addition, however, the toggle action lids include hinged areas that necessarily have been weakened and are therefore more susceptible to failure. This type of construction also presents numerous molding difficulties which tend to limit the materials of construction from which such closures may be manufactured. And, of course, like the tightly stretched closure mentioned above, extreme stresses are created in the sealed position which tends to accelerate stress cracking of the closure. Further, when a roll-type toggle is employed, it is not uncommon for the seal between the closure and container to be lost when items are placed on top of the closure. The weight of such items will depress the dome-like central area and because of its inherent tendency to continue any such change in position, the dome-like area will simply roll into its second or released position. It should also be apparent that such closures also have a tendency to turn inside-out, thus requiring that the user reinvert the closure before any further attempt is made to seal the container. Such addi-

tional working, besides being bothersome, also shortens the life of the closure.

Closures of the above-mentioned types also somewhat restrict the manufacturer in his material selection and the overall dimensional characteristics of the closure, i.e., wall thicknesses, etc. In most instances, the utmost in flexibility is needed and therefore thinner constructions are required. This in turn results in an end product or closure that is highly susceptible to heat distortion.

Expandable cork-like closures are also deficient in several respects, especially where large open-mouthed containers are concerned. For example, the construction of such closures besides employing complicated mechanical manipulative devices also necessarily, because of their bulk, decrease the usable volume in any container where they are used.

This invention provides a sealing closure that is, in all respects, a compromise between the known prior art closures and incorporates the best features of those mentioned above. In addition, however, it is more simple in its operation, gives a lasting hermetic seal, and is of a construction that reduces stress concentrations and susceptibility to heat distortion. In particular, the construction enables the user to apply a closure to a container simply by applying pressure at the approximate center of the closure top wall.

This new closure further includes several distinctive constructional features which enhance its applicability for use in the food storage container area and in other related fields. Among these is a biased or conical center wall arrangement which preferably includes a corrugated, fluted or similarly pleated construction that effectively and easily enables the contraction of the center wall peripheral edge and the recovery thereof toward or to its extended position with minimum development of internal stresses. This edge, of course, includes as an integral part a sealing wall portion which in its sealed relationship with a container retains the contained materials out of contact with those parts of the closure that lie above the portion or overlie the container edge or rim. Thus, because of this internal sealing arrangement, the hygienic features of this closure are considerably improved over those where sealing was obtained on the outside wall of the container.

The invention also encompasses variable construction parameters affecting the efficient operability of such closures. Therefore, the construction described in detail below has as its principle objectives to minimize both internal stresses within the container closure, as well as the force required to properly assemble a closure and container. At the same time, it is an objective to maximize the sealing pressure between the closure and container and the lateral contraction of the closure sealing wall portion per unit of applied force.

Further objectives of the invention are to provide: an improved closure that is easily applicable to a container and yet will effectively hermetically seal that container; a closure construction which may be molded by compression or injection techniques and which will be economical to manufacture and durable in operation.

Other objectives and advantages will become more apparent upon further reference to the specification, drawing and claims which describe the invention in more detail and wherein:

FIG. 1 is a top view of a closure construction incorporating the concepts of this invention;

FIG. 2 is a cross-section of the closure taken along line 2—2 in FIG. 1 and a partial cross-section of a container showing the closure in sealing relationship with the container;

FIG. 3 is a partial bottom view of the closure as is depicted in FIG. 1;

FIG. 4 is an enlarged partial cross-section of the peripheral edge of a typical closure and another container shown in disassembled relationship;

FIG. 5 is a partial cross-section of another embodiment of a closure member and container embodying the concepts of this invention;

FIG. 6 is a partial cross-section of another embodiment of a closure member and container embodying the concepts of this invention; and,

FIG. 7 is a partial cross-section of a closure of this invention taken along line A—A of FIG. 1.

Referring now to FIGS. 1-4, it can be seen that in this preferred embodiment, the closure member 10 includes essentially three functional parts, a peripheral inverted U-shaped groove in lip 12, a conical or radially biased center main wall 14 and a centrally positioned substantially planar area 16 in the center surface wall. Specifically, the conical or biased area is preferably formed of a plurality of upstanding tapered ridges 18, that produce a corrugated, fluted or pleated construction which is more fully described hereinafter. These corrugations (FIG. 7) emanate from the substantially planar area 16 and terminate at or closely adjacent the peripheral edge 24 of the center main wall 14. The lip 12 is integrally attached to edge 24 and portions of this lip effect the seal between the closure 10 and container 20.

It can be seen that at the peripheral edge 24 of the center main wall, there is an integral upwardly extended side wall 26. Further, as indicated, the side wall 26 normally extends above the radially biased, corrugated center main wall 14 and forms the inside wall of the inverted peripherally disposed groove of lip 12 in closure member 10. This lip and groove are completed by an outer downwardly directed wall 37 and an interconnecting substantially horizontally disposed top wall 33. The outer portion 28 of wall 26 is adapted for mating engagement with the inner wall area of the projecting wall 30 which forms the open mouth in container 20. This engagement, of course, creates the hermetic seal spoken of and thus produces a highly desirable storage container especially suited for the storage of foodstuffs. Likewise, the outer and top walls 37 and 33, respectively, function to properly position the closure on the container 20 and to provide a suitable means for grasping the closure 10 to effect its removal from the container.

The biased or conical center main wall 14 includes, therefore, in the preferred embodiment a corrugated or fluted structure such as is exemplified by the plurality of upwardly and outwardly tapered ridges 18. As can be readily seen in FIGS. 1 and 2, the upper portion 38 of these ridges are angularly directed with respect to planar area 16 and therefore the respective peripheral edges 24A thereof lie in a plane removed from that of planar area 16. Similarly, the bottom portions 40 of these corrugations lie in a substantially parallel plane approximate to that of area 16 when the closure is in a relaxed or as molded condition. However, when the closure is in place upon a container, even the bottom portion 40 will be angled toward the container center.

The corrugation height at its peripheral terminus 24, i.e., the point of connection to the integral upwardly extended side wall 26, is dependent upon the size of the closure as well as the other parameters mentioned above. Similarly, it is preferable that the uppermost flute portion 38 is approximately opposite principal sealing point or the protruding bead 32, which is more fully discussed below. Thus, even though the lateral dimensions of the outer portion 28 at bead 32 are slightly greater than that of the inside diameter of the container, the application of pressure to the centrally positioned substantially planar area 16 will cause sufficient inward lateral displacement of the side wall 26 such that the closure slips easily onto the container.

With continued reference to FIGS. 1 and 4, in particular, one will recognize that in operation the locally distortable closure member is contractably and distensibly constructed so that the wall 26 will be displaceable with the peripheral edge 24 of biased center main wall 14. In accomplishing this, the resiliency and elastic memory of the particular materials of construction must be considered and, in particular, the center main wall shape should be carefully constructed to take advantage of these inherent physical characteristics of the materials employed. Therefore, the radially extending biased center main wall 14 which extends between the center portion

or substantially planar area 16 to the peripheral edge 24 is of considerable importance to the invention. In essence, the center main wall 14, because of its biased construction, tends to collapse upon itself upon the application of light finger pressure to area 16. This collapse substantially uniformly displaces the peripheral edge 24 inwardly and thus draws the side wall 26 inwardly with it. Seemingly, the entire center main wall 14 would continue to collapse with an umbrella-like result if it were not for the reinforcing and stiffening effect of the side wall 26. Despite this restraining effect, the corrugated wall 14 continues to function as described and, in fact, the resilient return of the closure to its approximate as molded size and shape after each distortion is presumably aided by the noted side wall 26.

As indicated above, the closure embodiments depicted in FIGS. 2, 4 and 6 further include an outwardly protruding bead 32 which extends around the periphery of outer portion 28 of side wall 26. FIG. 4 further shows an undercut or inverted ledge 34 below which the bead 32 is adapted to seal against the inner wall are of projecting wall 30 of the container. As is readily apparent, the undercut is produced by downwardly directed inwardly sloping portion 36 of this inner wall area which terminates with undercut 34. At this point, which is adjacent the upper edge of projecting wall 30, the normal inner wall contour is resumed.

The comparative distances between the inside upper surface 27 of the U-shaped groove and the bead 32 and between the top edge projecting wall 30 and undercut 34 are preferred to be such that the entirety of the bead will lie below and out of contact with the undercut when the container and closure are in sealed relationship. This then assures that actual sealing occurs between the bead 32 or the wall 26 and the container side wall and not against the undercut 34. In addition, it may be desirable to provide a small land 21 on the outermost area of bead 32 to effect an even better seal between the closure 10 and container 20.

The noted disparity in the respective dimensions between surface 27 and bead 32, and the top edge of wall 30 and undercut 34, tends to negate the necessity to retain exacting tolerances on them. For example, if a lasting seal were to be maintained between the bead and undercut, one would have to be assured that a virtual line contact was kept between these elements because of their respective contoured features. In this disclosed arrangement, however, it is only necessary to maintain the bead 32 below the undercut 34 in a manner so that sealing occurs against a virtually flat wall surface.

The undercut 34 therefore functions to produce an audible indication of when the closure slips into proper sealing engagement with the container, and further tends to restrain the closure upon the open mouth of the container. In this respect, it should be noted that the undercut 34 may be either continuous or discontinuous to produce the desired effect, and that the undercut and bead may be reversed in their placement on the container and closure respectively if desired.

In addition and as is evident from FIGS. 2, 5 and 6, the undercut 34 need not be employed as shown in the preferred embodiment. For example, the uppermost part of projecting walls 30 of a typical tubular member or container 20, when utilizing this invention, may be flared as is depicted in FIGS. 2 and 5. Further, the lip 12 need not extend downwardly over the container rim but instead may terminate with top wall 33 (FIG. 5) extending substantially horizontally out beyond projecting edge 30. Likewise, bead 32 may be eliminated in certain instances without impairing the operability of the inventive closure.

In the embodiment shown in FIG. 6, an inwardly protruding peripherally extending integral ridge 35 resides on the inside surface of the outer wall 37. In this instance, a dual seal is effected, thus further improving the tightness and integrity of the overall seal that is produced. Also, as is evident from FIG. 2 ribs 25 may be employed at spaced intervals on the underside of wall 33 so that air can be easily expelled from the container 20 as the closure 10 is applied. In this respect, it should

be apparent that as the closure member 10 is applied to the open end of an otherwise closed container, air will be expelled or displaced therefrom. This, therefore, will create a slight pressure differential across the closure further tending to assist its being retained on the container.

As was mentioned above, one principle objective of this invention is to optimize forces for applying such closures, sealing pressures, and the stresses in the closures. Ideally, a high sealing pressure, a small push-down force and a low stress level in the described structure are desirable. Therefore, it becomes significant to analyze the relationship between the applied axial force (push-down pressure), the lateral contraction or displacement of the side wall 26, the stresses within the closure, and the sealing pressure.

While applicants do not want to be bound by theory, seemingly the material properties of the majority of materials from which closure members 10 might be produced, particularly the plastics, have no directional preference and are thus isotropic in nature. However, the biased construction illustrated and the introduction of corrugations make the stretching and bending stiffness in the peripheral or circumferential direction weaker than those in the radial direction. This difference in stiffness in two perpendicular directions, which is referred to as orthotropy, is thought to be a principle contributory factor in the operation of the closure as is described above.

Computer analyses of closure member 10 is accomplished treating the member as a shallow orthotropic thin elastic conical shell of revolution with the side wall 26 acting as an edge stiffener. Thus, it was found that the peak stresses in this closure member 10 occur during the push-down phase as the closure is applied to the container. Further, the dominant stresses occur at the edge of the planar area 16 and are radially and circumferentially directed. Shear stresses are found to be of secondary importance. Similarly, by varying the structural parameters, one learns that the radial contraction per unit push-down force for a corrugated closure is much larger than that for a flat closure even if the latter is determined by a non-linear plate analysis. The radial contraction for a smooth conical closure, an isotropic shell, whose meridional slope is about one-half of the uppermost flute portion 38, approximates that of a corrugated closure but only if the side wall construction is very stiff. If, however, the side wall is relatively flexible, the radial contraction of a smooth conical closure will be theoretically only about one-third that of a corrugated closure. Further, the smooth conical arrangement has at least one other disadvantage in that the peak stresses produced therein are about twice as high as those created in a corrugated closure member.

These behaviors are all due to an important property of the corrugated construction, i.e., its relatively low bending and stretching stiffness in the circumferential direction. This property is also characterized by the fact that the radial or lateral displacement per unit push-down force increases with flute height and with the number of flutes. It follows that for a given lateral displacement, a seal with a larger number of flutes will require a smaller push-down force and therefore the peak stresses will be reduced.

A reduction in peak stresses may also be effected by increasing the radius or area of planar area 16. The reason for this seems to be that the reduced effects of stress concentration gained by making the area larger, overcomes corresponding losses due to a higher stretching stiffness. Additional reductions in stresses may be accomplished by making the seal lip 12 more flexible, or by increasing the ratio of the flute height at the side wall to the flute thickness at the side wall. It should be noted, however, that such reduction of peak stresses are not without limit and that at some point, the peak stresses will no longer occur at the edge of the planar area 16.

Peak stresses may also be reduced significantly by reducing the lateral displacement in effecting placement of the closure on a container. However, this also reduces the sealing pressure between the two and therefore somewhat modifies the extent that this approach may be employed.

Additional analysis reveals that a measure of the sealing pressure of the closure is the radial stress at the outer edge of the corrugated seal after the closure is fitted with the container and the push-down force is removed and it becomes apparent that the sealing pressure will increase as the ratio between the flute height at the side wall and the flute base width at the side wall increases. The same effect may also be obtained by increasing the ratio between the radius of planar area 16 and the radius at the side wall 26.

Having learned how the push-down force, the lateral displacement, peak stresses and sealing pressure vary with the structural design, the various design parameters may then be chosen to achieve the appropriate desired results.

Also, as is discussed briefly above, the closure member 10 is presently preferably formed from a distortable thermoplastic, for example, low density polyethylene; however, high density polyethylene, polypropylene, polyolefin blends or similar materials may be suitably employed in effectuation of the inventive concept. Likewise, the open-mouthed containers 20 (FIGS. 2, 4, 5 and 6) with which these closures are primarily intended for use, are also generally formed from the same or similar materials. It should be pointed out, however, that such closures may well be adapted for use with containers including a diversified types of materials.

In this new method of operation, closures of this invention tend to experience a lateral displacement within the conical, corrugated or fluted area 18 as pressure is applied to the planar area 16 in the approximate center of the main wall 14. The biased construction accentuates this displacement as the center main wall 14 folds upon itself in an accordion-like fashion. This then similarly tends to enable the side wall 26 to draw inwardly, thereby facilitating entry of the central surface wall area 14 into the open-mouth end of the container or tubular member 20. After insertion and upon release of the applied pressure, the resilient closure material due to its elastic memory, attempts to assume its relaxed or as molded orientation and thus expands the side wall 26 against the inner portion of the container wall to hermetically seal the container. To remove the closure, it is only necessary to apply an upward pressure against the U-shaped seal lip 12 thus prying the closure off from projecting edge 30 of the container.

From the foregoing description, it should be apparent that the invention encompasses an advantageous advance in the art. Further, it should be clear that the invention may be embodied in other specific forms without departing from the spirit of the essential characteristics thereof. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

We claim:

1. A locally distortable integrally molded thermoplastic closure contractably and distensibly constructed and having an elastic memory such that it is adapted to hermetically seal an open-mouthed member and comprising:

a. a center main wall being substantially formed of a plurality of corrugations emanating from a center portion thereof and tapering upwardly and outwardly from the plane of said center portion to a terminal peripheral edge, said center main wall being adapted for the application of downward pressure to said center portion in such manner that said corrugations tend to collapse upon one another and substantially uniformly displace said peripheral edge until the closure is easily positionable on an open-mouthed member; and,

b. an integral substantially uniform smooth surfaced upwardly outwardly sloping means positioned around said peripheral edge of the center main wall at a position proximate the uppermost portion of said corrugations said means being displaceable in like manner with said peripheral edge such that at least a portion of said means is closely engageable with and sealable against the walls of an open-mouthed member due to the resiliency and elastic memory of said closure upon the discontinuance of applied downward pressure to said center main wall.

2. A locally distortable integrally molded thermoplastic closure contractably and distensibly constructed and having an elastic memory such that it is adapted to hermetically seal an open-mouthed member and comprising

- a. a center main wall including a plurality of contiguous flutes radially emanating from a center portion thereof and tapering upwardly and outwardly from the plane of said center portion to a terminal peripheral edge, said center main wall being further characterized in that said center portion and at least portions of the peripheral edge lie in different but substantially parallel planes of reference adapting said center main wall for the application of downward pressure to the center portion thereof in such manner that said flutes tend to collapse upon themselves and substantially uniformly displace said peripheral edge until said closure is easily positionable on an open-mouthed member; and,
  - b. integral, substantially uniform and upwardly outwardly sloping side wall means positioned around said peripheral edge of the center main wall, said side wall means being displaceable in like manner with said peripheral edge such that at least a portion of said side wall means is closely engageable with and sealable against the walls of an open-mouthed member due to the resiliency and elastic memory of said closure upon the discontinuance of applied downward pressure to said center main wall.
3. A contractable and distensible closure member having an elastic memory such that it is adapted to hermetically seal an open-mouthed container and comprising:
- a. a center main wall including laterally extending corrugated portions tapering upwardly and outwardly from the plane of a centralmost area to a terminal peripheral edge, at least segments of said edge lying in a different plane than that of the central-most area of said central main wall; and,
  - b. an upstanding outwardly sloping substantially uniformly disposed smooth surfaced sealing member positioned around said peripheral edge, which member is distortably responsive to a substantially centrally and downwardly applied force on the center main wall enabling placement of said closure upon an open-mouthed container, and which is distensibly responsive to any reduction in said force.
4. A contractable and distensible closure member having an elastic memory such that it is adapted to hermetically seal an open-mouthed container and comprising:
- a. a center main wall being formed substantially of laterally extending corrugated portions which are sectorially oriented and dimensionally increase in size as they extend toward and terminate in a peripheral edge, at least segments of said edge lying in a different plane than that of the central-most area of said central main wall; and,
  - b. a substantially uniform upwardly outwardly sloping integral sealing member positioned around said peripheral edge, which member is distortably responsive to a sub-

stantially centrally applied downward force on the center main wall enabling placement of said closure upon an open-mouthed container, and which is distensibly responsive to any reduction in said force.

5. In combination an open-mouthed container and a locally distortable, contractably and distensibly constructed plastic closure having an elastic memory such that it is adapted to hermetically seal said container and comprising:

- a. a container including a projecting wall construction forming the open mouth thereof and in which at least parts of said projecting walls are undercut adjacent the upper edge thereof;
  - b. a closure having a center main wall being substantially formed of a plurality of corrugations emanating from a center portion thereof and tapering upwardly and outwardly from the plane of said center portion to a terminal peripheral edge, said center wall being adapted for the application of downward pressure to said center portion in such manner that said corrugations tend to collapse upon one another and substantially uniformly displace said peripheral edge until the closure is easily positionable on said container; and,
  - c. an integral substantially uniformly disposed upwardly sloping means positioned around said peripheral edge of the center main wall at a position proximate the uppermost portion of said corrugations, said means being displaceable in like manner with said peripheral edge, such that at least a portion of said means is closely engageable with and sealable against the walls of said container below said undercut due to the resiliency and elastic memory of said closure upon the discontinuance of downwardly applied pressure to said center main wall.
6. In combination an open-mouthed container and contractable and distensible closure member having an elastic memory such that it is adapted to hermetically seal said open-mouthed container and comprising:
- a. a container including a projecting wall construction forming the open mouth thereof and in which at least parts of said projecting walls are undercut adjacent the upper edge thereof;
  - b. a closure having a center main wall including laterally extending corrugated portions tapering upwardly and outwardly from the plane of a central-most area to a terminal peripheral edge, at least segments of said edge lying in a different plane than that of the central-most area of said central main wall; and,
  - c. an integral substantially uniform upwardly outwardly sloping sealing member positioned around said peripheral edge, which member is distortably responsive to a substantially centrally applied downward force on the center main wall enabling placement of said closure upon the open-mouthed container and which is distensibly responsive to any reduction in said force, such that it seals against said projecting walls below said undercut.

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