ABSTRACT
The invention contemplates a bottle and closure-cap construction wherein locking formations hold the parts to secure a liquid-seal closure of the bottle. The nature of the liquid-seal engagement is one of circular line contact, involving a cylinder within a conical concavity, specifically between a relatively thin-walled outwardly flaring upper end of the bottle and the lower limit of a cylindrical seal projection on the closure wall of the cap. An axially compliant generally radially extending annular portion connects the lower end of the flared neck part to the rest of the neck and is axially stressed to resiliently load the seal engagement.

8 Claims, 3 Drawing Figures
The invention relates to a plastic bottle construction and closure cap and is particularly applicable to such bottles produced by extrusion blow-molding. It is an object of the invention to provide an improved construction of the character indicated.

Another object is to provide superior seal capabilities in a construction of the character indicated.

A further object is to provide axially compliant features in the neck of a bottle, of the character indicated, whereby compliant deformation in the neck, in the course of setting and locking the cap, is utilized to generate reactive forces for resiliently loading, and thus enhancing, the locked and sealed relationship.

Other objects and various further features of novelty and invention will be pointed out or will occur to those skilled in the art from a reading of the following specification in conjunction with the accompanying drawings.

In said drawings, which show, for illustrative purposes only, a preferred embodiment of the invention:

FIG. 1 is a fragmentary exploded view in side elevation, partly broken-away and in longitudinal section, showing cooperating bottle and cap parts of the invention;

FIG. 2 is a plan view of the neck end of the bottle part of FIG. 1; and

FIG. 3 is a diagrammatic presentation of locking parts of the bottle neck, shown in flattened development, and centered on the central line of the aspect 3-3 in FIG. 2.

The invention is shown in application to a plastic bottle 10 having a body 11 and upwardly directed a neck 12, providing discharge access to bottle contents, and to be selectively closed and sealed by a cap 13. The neck 12 comprises a lower cylindrical portion 14 having locking formations engageable with coacting formations in the bore 15 of the outer wall 16 of cap 13. The neck also includes an upper, generally outwardly flaring seal portion 17 having circular line-contact engagement with the seal edge 18 of a internal projecting cylinder on skirt 19, carried by the closure wall 20 of the cap. Skirt 19, of maximum diameter D1 greater than the small-end diameter D2 of surface 17, and at least no greater than the maximum diameter D3 thereof, is connected to the relatively rigid outer cap body 16 by an integral axially compliant annular portion 21, shown downwardly dished, at the angle B1. As shown, the locking formations 22-23-24 (22'-23'-24') on neck portion 14 are of the bayonet variety, at equal angular spacings, and they co-act with suitable locking lugs 25 at similar spacings in the cap bore 15.

In accordance with the invention an axially compliant, generally radial annular portion 26 integrally connects the neck portions 14-17, and the lower limit (or sealed line) 18 of the maximum-diameter extent of projection 19 is so positioned with respect to the axial relation of parts in locked condition that said generally radially extending annular portions 21-26 are oppositely axially stressed when in locked condition. Thus, an upwardly dished orientation B2 characterized the unstressed condition of annular portion 26. Also, a short cylindrical lip extension 27 terminates the flared seal portion 17, to protect the neck mouth and to provide hoop retention of the outer limit of flare 17; the outer diameter D2 of the flared portion 17 (and also of lip 27) is at least no greater than substantially the diameter of the lower cylindrical portion 14, so that lip 27 (rather than a sharp truncation of the conical portion 17) can serve to align and pilot the cap 13 in the course of bottle-closure assembly. Preferably, the portions 17-26 are relatively thin-walled, the radial offset at 26 exceeding neck-wall thickness; and when the cylindrical lower portion is also thin-walled, as shown, the locking formations 22-23-24 extend close to the radial level of portion 26. Similarly, the closure wall 20 and projection 19 are preferably of the relatively thin-walled nature of the compliant portion 21, and a bottom lip extension 28 is of similar thickness. In order that lip 28 will not interfere with the desired line contact at 18, the lip 28 is inwardly converged at an angle α2, materially exceeding the divergent flare angle α1 of the seal portion 17. Generally, the angle α2 is in the range 15 to 25 degrees, preferably substantially 20°, α1 being at least 5° greater, for example 30° for an angle α2 of 20°.

The described bottle construction will be seen as lending itself particularly to extrusion blow-molding of suitable plastic, for example, high-density polyethylene. The relatively uniformly thin neck portions having smooth contours which are not required to build up to greater thickness at the lip end. End flashing is cut-off and trimmed to leave the short cylindrical lip 27, and the design affords reliable fluid flow of material to the locking formations 22-23-24, etc.

FIGS. 2 and 3 illustrate parting-line considerations in the design of the respective locking formations, the parting line between mold halves being indicated by legend. Each of these formations provides an axial retention surface for one of the cap lugs 25, at 31 for lug 22, at 32 for lug 23, and at 33 for lug 24, all said surfaces being in the same radial plane. The lugs 25 include cam faces 34 to engage and ride up coacting cam surfaces at corresponding ends of all formations 22-2-3-4, an axial snap to the locked position being achieved over the shoulders 35-36 of formations 22-23 (22'-23'), and rotational limiting abutment being provided at stems 37-38 of the four formations 22-24 (22'-24'). All contours of formations 22-23-24 (22'-23'-24') are precisely formed and are not subject to degradation in the course of mold parting, as will be understood.

In the process of securing the cap 13 to neck 12, lugs 25 are positioned between formations 22-23-24 (22'-23'-24'), and cap 13 is twisted clockwise. As cams 34 ride up the surfaces 35-36, cap 13 is drawn downwardly, causing axial stress and deformation of both annular portions 21-26, in opposite directions. The dished shapes are thus considerably flattened in the course of such rotation, to a maximum extent just prior to snapping off surfaces 35-36, to home all lugs 25, at the respective surfaces 31-32-33; preferably, a substantial residuum of axially stressed compliant action remains after snapping to such home position, so that the line contact at 17-18 tends to spread slightly to a narrow band of axially and radially stressed liquid-sealing engagement, and the seal line is axially and rotationally wiped with attendant seal-cleansive action, in the course of securing the cap. To remove the cap, it must first be pushed axially to the bottle, against further stiffening compliant reaction, before counterclockwise twisting to cause lugs 25 to clear their trapped positions.
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The invention will be seen to have achieved all stated objects with a simple and economic bottle construction which is able to lend axially compliant deformation as a contribution to that provided at 21 for skirt 19. The divergent flare 17 is formed in a single operation, and it is possible to avoid the reaming step, previously necessary in the formation of an accurately flared concavity, for developing a line-contact seal.

While the invention has been described in detail for the preferred form shown, it will be understood that modifications may be made without departing from the invention.

What is claimed is:

1. In combination, a bottle of yieldable plastic material and having an opening at a neck, and a closure cap for selectively closing the opening, interengageable locking means on said cap and neck for selectively securing the closed condition, said neck being of substantially uniform thickness and comprising a lower generally cylindrical locking portion, an upper outwardly flaring generally conical sealing portion, and an annular generally radially inwardly projecting portion connecting said cylindrical and conical portions, the radial extent of said annular portion exceeding the thickness of said portions, whereby said annular generally radial portion provides an axially compliant connection of said upper and lower portions; said closure cap including a relatively rigid outer annular wall having a bore with locking formations engageable with those of said cylindrical locking portion, said cap further having an integral axially yieldable generally radially extending annular closure-wall portion, an integral internal cylindrical seal projection radially inwardly spaced from said bore and extending axially downward for engagement with said conical portion, whereby said closure-wall portion provides an axially compliant connection of said rigid annular wall to said internal seal projection; the maximum diameter of said seal projection being greater than the minimum diameter of said inwardly projecting neck portion and at least no greater than the maximum diameter of said upper conical portion, whereby an essentially circular line-contact circumferential interference will occur for cap-to-neck assembly; and the lower limit of the cylindrical portion of said cylindrical projection being so positioned with respect to the axial relation of parts in locked condition that both said axially compliant connections are oppositely axially stressed to axially preload said interference when said cap and neck are in locked condition.

2. The combination of claim 1, in which the downwardly projecting end of said seal projection has a convergent inwardly tapered region adjacent said lower limit, the angle of convergence of said tapered region exceeding the angle of outward flare of said seal portion.

3. The combination of claim 2, in which the angle of outward flare of said seal portion is in the range of 15° to 25°.

4. The combination of claim 2, in which the angle of outward flare of said seal portion is substantially 20°.

5. The combination of claim 1, which the upper end of said neck integrally includes a short cylindrical portion.

6. The combination of claim 1, in which said interengageable locking means is of the bayonet variety.

7. The combination of claim 1, in which said annular radially extending portion of said neck is upwardly dished.

8. The combination of claim 1, in which said annular radially extending portion of said cap is downwardly dished.

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