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CRAZE-RESISTANT PLASTIC CLOSURES

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FIG. 1

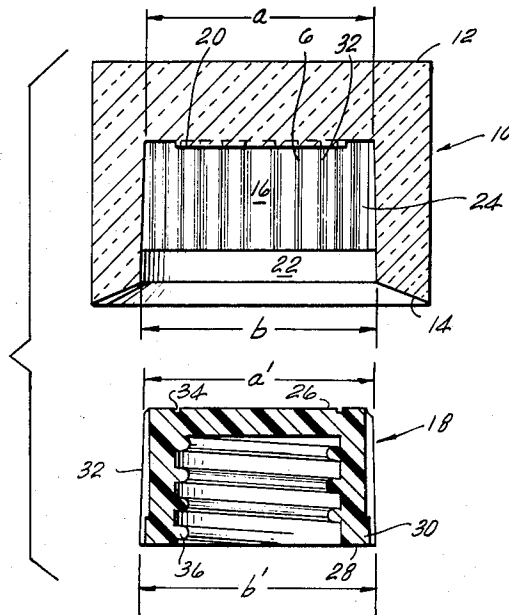


FIG. 2

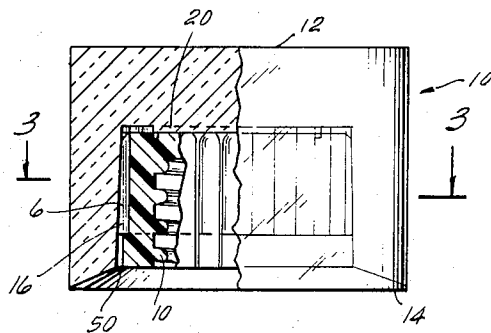
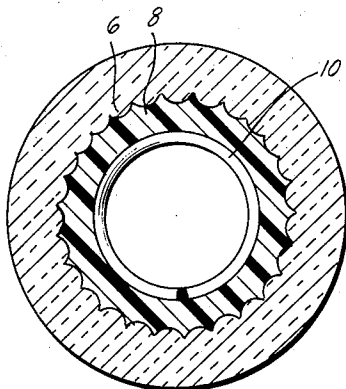


FIG. 3

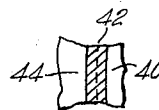


FIG. 4

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CRAZE-RESISTANT PLASTIC CLOSURES

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This invention relates to plastic closures. More particularly, this invention relates to two-piece craze-proof or craze-resistant plastic closures which are particularly suited for bottles containing perfumes and other toiletries.

Frequently, caps of hard, lustrous and clear plastics cannot be used on containers for perfumes or other toiletries due to radial stresses or solvent crazing which mars their appearance. Although the organic liquid of the toiletry may not normally attack the plastic, contact of the liquid or its vapor produces crazing when normal closure stresses are present. Inserts can be used to inhibit solvent crazing by reducing contact between the contained liquid and the plastic and by absorbing the closure stresses required to seal the container. However, in the past, cap inserts have not been entirely satisfactory for this purpose since in many instances they have little effect in preventing crazing and often distract from the closure's appearance.

It is an object of this invention to provide an attractive and craze-resistant bottle closure of a clear and lustrous plastic together with a plastic insert.

It is another object of this invention to provide a closure as above described wherein the cap and insert have certain critical relative dimensions, each fluted to prevent relative rotation, and which are adhesively bonded together to provide the desired function and appearance while effectively preventing solvent crazing.

Broadly, the closures of this invention comprise a hard, plastic cap having a lustrous surface. The cap has a cavity therein for accommodating a plastic insert which is substantially unaffected by toiletries such as perfumes. The mating sides of the cap and insert are within certain tolerances or dimensions. The bottom mating edges of the cap and insert are bonded with an adhesive to prevent axial displacement and to obstruct organic liquids or vapors from penetrating between the cap and insert. The insert seals the mouth of the container and is keyed for common rotation with the cap, preferably by cooperating fluted mating sides of the cap and insert since the fluting gives an attractive and ornamental effect to the closure. In preferred embodiments, the caps are crystal-clear or translucent with a high surface luster, brilliance and clarity. However, the caps can be dyed transparent or semitransparent such as hazy blue caps or marbled black and red caps, which have a high surface luster. Generally the plastic material of the cap is glassy and amorphous. The inserts are preferably opaque.

This invention is illustrated by the attached drawings wherein:

FIG. 1 is a vertical cross section of the cap and insert closure components of this invention in unassembled relationship;

FIG. 2 shows the closure components of FIG. 1 in assembled relationship;

FIG. 3 is a cross section taken on the plane of the line 3-3 of FIG. 2; and

FIG. 4 is an enlarged cut-away bottom view of a segment of the adhesively secured mating surfaces of the closure at a spot 50.

Referring now to the drawings wherein identical numerals refer to identical parts, the numeral 10 represents a cap of a crystal-clear copolymer of alpha-methyl

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styrene and methyl methacrylate (e.g., BAVICK-11, manufactured by the J. T. Baker Chemical Company of Phillipsburg, New Jersey). In place of the particular polymer employed for the cap, other hard, lustrous and clear thermoplastic polymer materials having similar properties can be used such as: various acrylic polymers, e.g., methyl methacrylate; polystyrene; styrene-acrylonitrile copolymers; acrylonitrile-butadienestyrene copolymers; styrene-methylmethacrylate copolymers; polyvinyl-chloride; polycarbonates; and the like.

Cap 10 has a top 12, bottom 14, and a cavity 16 for accommodating insert 18. Cavity 16 is substantially cylindrical with a thin centrally disposed top shoulder 20, a smooth circular bottom ring 22 and inwardly protruding vertical fluting 24 about the sides thereof above ring 22.

Insert 18 is a plastic such as that of a urea-formaldehyde polymer and comprises a top 26, a bottom 28, an outer annular ring 30 at bottom 28, and fluting 32 which mate with fluting 24 of the cap. The annular ring 30 extends outwardly of the valleys of fluting 32 but just short of the ridges of fluting 32. Insert 18 also has a circular indentation design 34 at its top and internal screw threads 36 for securing about the mouth of a container. It will be seen from the drawing that the insert is imperforate and would completely seal the mouth of a container. The fluting of the cap and insert interlock and prevent relative rotation thereof.

The insert 18 can be of any polymeric material which is not affected by organic solvents and which has the strength to seal the liquid in the bottle effectively. The insert 18 can be prepared from a variety of thermoplastic or thermosetting polymers such as those of various phenolics, epoxy resins, polyurethanes, polyethylenes, urea-formaldehyde, Teflon, polypropylene, and the like in either filled or unfilled formulations. The insert can be colored or uncolored and is designed for the type of closure desired, e.g., snap-on, screw-on, etc.

In the assembled condition as shown in FIG. 4, the mating bottom edges of the cap and insert are secured with an adhesive. Also, the adhesive completely seals about the mating rings 22 and 30 of the cap and insert respectively, to obstruct penetration of liquids or vapors therebetween. It should be noted that a tight fit between the cap and insert without an adhesive seal increases rather than decreases the capillary action of liquid contact between the two interfaces.

Epoxy cements are preferred adhesives for use in this invention since they: (1) have low dimensional changes on curing; (2) generally do not contain harmful solvents; (3) provide strong bonds; and (4) can be formulated to give the desired appearance. Illustrative of suitable epoxy adhesives there can be mentioned those of Maraglas, No. 656 resin (89%) together with Maraglas No. 656 hardener (9%) and colloidal silica (2%). The resulting epoxy is cloudy white and provides good appearance when inserted along the annular rings between the lower edges of the cap and insert. The colloidal silica keeps the epoxy in place on the insert during assembly both before the cap is placed over the insert and during the curing period. However, the adhesive is not limited to epoxides or even relative clear materials. Additional suitable adhesives include various cements, polysulfides, etc. Preferably, the cured adhesive has an index of refraction substantially the same as that of the cap.

As stated hereinbefore, the relative dimensions of the mating sides of the cap and insert are critical with regard to the prevention of crazing and for enhancing appearance. In the case of acrylics, the outside dimensions of the insert must be such that the cap is forced to distort by less than 0.2% of its internal diameter. This reduces the stress to less than 1000 p.s.i. The maximum percent

distortion (of the internal diameters) for prevention of crazing for other polymers include: styrene-acrylonitrile polymers, 0.2%; general purpose polystyrene, 0.1%; impact polystyrene, 0.3%; acrylonitrile-butadiene-styrene polymers, 0.2%; polyvinyl chloride, 0.5%; and polycarbonate, 0.8%. Preferably, however, the outside diameter of the insert is equal to the inside diameter of the cap so that no compression of the cap takes place. The outside diameter of the insert can, of course, be smaller than the inside diameter of the cap, e.g., by 0.1% to 3%. However, it is preferred that the diameter of the insert be no smaller than the internal diameter of the cap.

The critical dimensions for the closures of this invention are broadly illustrated in FIG. 1 wherein *a* is the internal diameter of the cap at its top; *b* is the internal diameter of the hollow portion of the cap at its bottom; *a'* is the outside diameter of the insert at its top end, and *b* is the outside diameter of the insert at its bottom. Referring to the above values of maximum diameter elongations, it can be seen that for an acrylic cap the insert must have a diameter across its top of less than 0.2% greater than the internal diameter of the cap to prevent crazing of the cap. Thus, in this instant situation, assuming substantially the same diameter for the top and bottom of the mating parts of the closures a cap of 0.725" internal diameter, the outside diameter of the insert should be no greater than 0.7264". Also for a cap having 1.500" internal diameter, the outside diameter of the insert should be no greater than 1.530".

Table I which follows is a tabulation of crazing resistance versus cap and insert dimensions. It can be seen that whenever the caps were within the tolerances provided for hereinabove, crazing did not occur. However, when the differences were greater than provided for above, crazing was evident.

TABLE I

Crazing resistance versus cap and insert dimensions

	Case I	Case II	Case III
I.D. of cap:			
At top.....	0.725"	0.729"	0.739"
At bottom.....	0.742"	0.742"	0.744"
O.D. of insert:			
At top.....	0.741"	0.739"	0.739"
At bottom.....	0.746"	0.744"	0.744"
Required change in relative diameters on inserting:			
At top.....	0.016"	0.010"	0.000"
At bottom.....	0.004"	0.002"	0.000"
Percent elongation in top of cap assuming no deformation of insert.....	2.2%	1.4%	0.0%
Crazing after contact with perfume in short term laboratory tests.....	4 of 4 caps crazed within 1 minute.	4 of 4 caps crazed within 5 minutes.	None of 20 crazed after 4 week test.
Crazing in long term field test.....	With caps and inserts of Cases I and II and no sealing of insert into caps, 5 of 24 failed in 1 week, 14 of 24 failed in 6 weeks.		With Case III type, with sealing, 0 of 13 failed in 6 weeks.

What is claimed is:

1. A craze-resistant closure for a container comprising:
 - (a) a hollow cap insert having a top and sides of a polymeric material resistant to attack by organic liquids, said insert having means for engaging about the mouth of a container;
 - (b) a hollow cap of a hard thermoplastic polymer having a lustrous surface;
 - (c) the insert fitted within said hollow cap with the sides of said insert in close fitting relationship with the corresponding surfaces of said cap wherein the outer diameter of said insert is not more than 0.8% greater than the unstressed inner diameter of said cap;
 - (d) the outer configuration of said insert in assembled relationship keyed to the adjacent configuration of the cap to prevent rotation; and

(e) an adhesive securing the lower mating edges of said cap and insert and obstructing the penetration of liquids therebetween.

2. A closure of claim 1 wherein the cap is of a glassy substantially transparent polymer.

3. A closure of claim 1 wherein the adhesive is an epoxy adhesive.

4. A closure of claim 1 wherein the cap and insert have mating vertical fluting keeping the two together, wherein the insert has a diameter within the range of 0% to 0.8% greater than the unstressed internal diameter of said cap, wherein the cap is of a polymeric material selected from the group consisting of an acrylic polymer, polystyrene, styrene-acrylonitrile copolymers, acrylonitrile-butadiene-styrene polymers and alpha-methyl styrene-methylmethacrylate copolymers, polyvinyl-chloride and a polycarbonate and the insert is a polymeric material selected from the group consisting of a ureaformaldehyde resin, Teflon and polypropylene.

5. A closure of claim 1 wherein the cap is an alpha-methylstyrene-methylmethacrylate copolymer, the insert is a ureaformaldehyde polymer and the external diameter of the insert is not more than 0.2% greater than the unstressed internal diameter of the cap.

6. A craze-resistant closure for a container comprising:

- (a) a hollow cap insert having a top and sides of a polymeric material resistant to crazing by organic liquids and adapted to seal about the mouth of a container;
- (b) a lustrous cap of an acrylic polymer having a cavity therein fitting about said insert, the insert obstructing normal contact of liquids from the mouth of a container with said cap;
- (c) the sides of said insert and cap cavity having fluted mating surfaces to prevent relative rotation, the outer

diameter of the insert being within the range of about 0% to 0.2% greater than the unstressed internal diameter of said cap;

(d) the bottom mating edges of said insert and cap being adhesively secured to obstruct the passage of liquid therebetween.

7. A closure of claim 6 wherein the cap is substantially transparent.

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