6 AEROSOL COVER CAPS

AEROSOL COVER CAPS came into existence about 1951, as a necessary adjunct to the new one-inch (25.4 mm) valve. The protective covers used before this, such as the flat 211-diameter (65 mm) dust lids, "Derby Domes" and small metal clips or shrink-set plastic valve wraps, are not usually thought of as cover caps.

Aerosol cover caps have a number of functions, such as:

a. They physically protect the spray head from possible damage if the dispenser is dropped.

b. They prevent the actuator from discharging the contents during storage, due to the pressure of overlying cases.

c. They prevent cases from becoming bulged or split during storage, due to the pressure of overlying cases.

d. They avoid the accumulation of dust or dirt on the valve and (often) on the dome of the can.

e. They provide tamper-proof or child-resistant attributes, if desired or needed.

f. They enhance the general appearence of the container, sometimes adding height and volume, covering double seam constructions, or assisting in the development of color and decoration schemes.

g. They can be imprinted with short but important messages, such as "Shake Before Use."

h. Full-diameter plastic cover caps are thought to provide a degree of thermal insulation to the dome area of cans if they become involved in a warehouse fire, thus reducing the hazard slightly by delaying rupture and release of possible flammable materials.

In some instances cover caps have added a substantial degree of novelty or utility to the package. Some

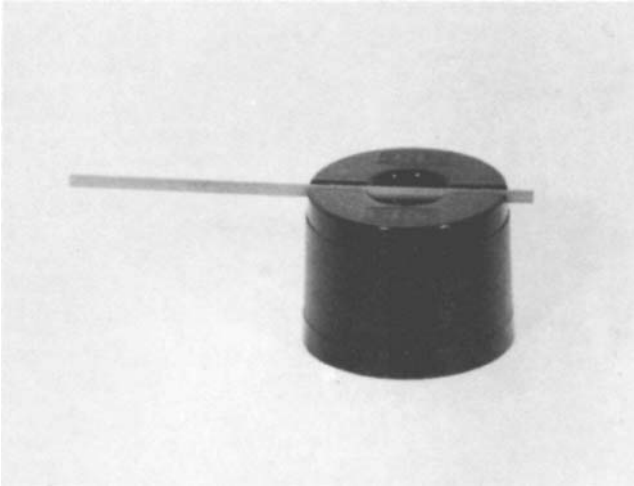


Figure 1. Slotted Cover Cap with Extension Tube
Top-slotted cover cap with friction-fitted extension tube (patent pending). Saves labor cost of applying side wall of dispenser using either a rubber band or Scotch Tape.

aerosol fire extinguishers use caps in the shape of a fireman's helmet. One used with an absorbant silica product is molded with plastic bristles on the top surface for removing the spent powder. The now obsolete "Sunbrella" suntan lotion product used a yellow cap in the shape of an umbrella for quick identification and interest at the point of purchase. A similar sunscreening product of Japanese origin carried a yellow cap in the shape of a delicate parasol. Finally, an interesting cap is sometimes used for products requiring valve button extension tubes, such as lubricants, car lock de-icers, adhesives and similar specialty items. The top of the cap is slotted to hold the tube on a friction fit basis. If the units are hand-packed, extension tubes having lengths of up to twice the can diameter can be accommodated readily in regular shippers. A typical slotted cap and extension tube is shown in Figure 1.

A special form of the cover cap is the actuator cap, where the actuating pad is recessed in the plastic cap to prevent accidental operation. At the same time it provides a convenient way of discharging the contents without the need for first removing the protective cover. The actuator itself may be a large or small button, or a lever hinged to the cap. These special caps have an advantage of being highly directional, so that customer mishaps caused by misdirecting the spray are rarely encountered. These dual-purpose fitments have become very popular in recent years. They do increase packaging costs in most cases and cannot be used for certain aerosol products, such as paints and coatings.

The first aerosol cover caps were rather small, designed to snap over the outer edge of the one-inch (25.4 mm) valve mounting cup. They quickly became known as one-inch caps. Actually, the term is a misnomer, since these caps have outside diameters of about 1.45" (36.8 mm). They were made in enameled tinplate, polyethylene, polypropylene, polystyrene and other materials. One fancy cologne product even had a cap made of polished wood.

The one-inch caps are now rather uncommon, although they do represent the practical ultimate of packaging economy. They have been replaced largely by plastic full-diameter caps and actuator caps, since marketers discovered that these larger versions had advantages of aesthetics, functionality and apparent package size enhancement that far outweighed the modest price increase. The one-inch cap is compared with several full-diameter cover cap designs in Figures 2, 3, 4 and 5.

Aerosol cover caps and their spray-cap counterparts represent a business volume of about 2.2 billion units per year and a dollar volume of about $4 million (1981 and 1982 basis).

Today, nearly all the caps are of plastic, due to economics. They are made by a relatively small group of plastics molding companies, but also by a few marketer-fillers and contract fillers.

Considering aerosol cans with one-inch valves, there are technically four areas where the cap can be locked into position on the dispenser.

a. The outermost cut edge of the valve mounting cap.

   This applies to all one-inch metal and plastic cover caps, to full-diameter double shell plastic cover caps and to two-piece fabricated metal caps of a similar shape.

b. A "snap-lok" ring around the can dome, just inside the countersink area.

   This applies to single shell plastic cover caps of a particular set of designs, where the base is thickened so that lugs can hold the fitment onto the dome contour, while still allowing the cap to sit upon the top double seam for both stability and appearence.

   A ring of four dome dimples has been used in the past for the same purpose, but the dome became rather ugly as a result and the design was discontinued about 1971.

c. The top double seam of the can.

Two cap designs are available in this case, but both snap over the double seam and are held firmly in place with lugs.

The first of these caps was produced about 1958 with the design shown in Figure 4. When attached, it produced a final dispenser shape consisting of a cylinder with an annular ring around it. The necked-in can became available in a limited way about 1967, and for these units a full-diameter, straight wall, internally ribbed cover cap was made to fit over a double necked-in top seam construction to give the package a perfectly cylindrical profile.

d. The crimping indentations in the valve cap. (Obsolete)

This full diameter cover cap style had a double shell construction. The inner shell was either straight or vee split, for flexibility, and had lugs to fit within the crimping indentations. It was phased out because the valve button was often pushed to one side rather severely when the cap was removed in the normal way. Several full diameter valve actuators still use this method of attachment.

In the foreseeable future the necked-in can will undoubtedly become more important, due to simple economics, and with it the straight wall, single shell, over-the-rim plastic cover cap. In North America, as of 1982, this can design had not yet become a production item of major significance. As a consequence, the cover cap is thought to be produced by only one U.S.A. supplier: Risdon Corporation's Dispensing Systems Division, as their Models #82-02-1 (202- or 52 mm diameter) and #82-11-1 (211- or 65 mm diameter), although Southern Can Company may elect to act as a distributor of these caps for cans of all diameters. In Europe, where necked-in cans were pioneered by the Metal Box Limited firm and are now fairly commonplace, Metal Box and several other firms now produce a range of these caps for use with tinplate cans from 114- (45 mm) diameter to the 211- (65 mm) diameter.

One of the more critical appraisals for a cover cap is the firmness of its attachment to the rest of the package. The fit must be snug and tight, but not so tight that it cannot be taken off except by the application of brute force. Many persons seem to have a preference for picking aerosols up by the cover cap or spray cap. In this

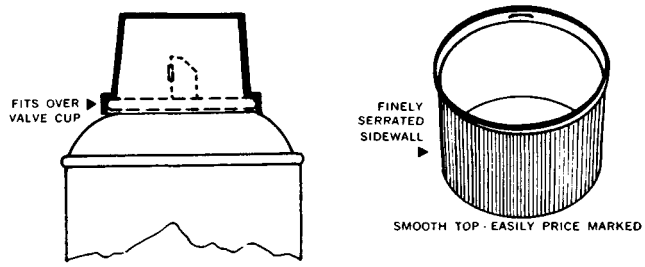


Figure 2. Drawing of Old Style One-Inch Cap
The old style one-inch caps are gripped by the outer edge of the valve mounting cup.

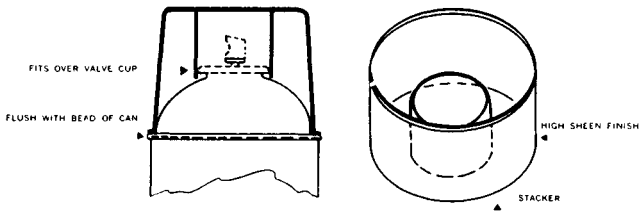


Figure 3. Drawing of Double Shell Cap
It is the inner shell of the double shell cap that grips the container, fitting around the outer edge of the mounting cup.

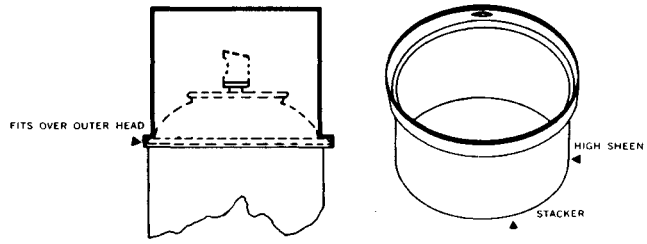


Figure 4. Drawing of Rim Snap Cap
Rim snap caps are of single shell construction. The outer rim of the cap snaps over the chime to hold the cap in place.

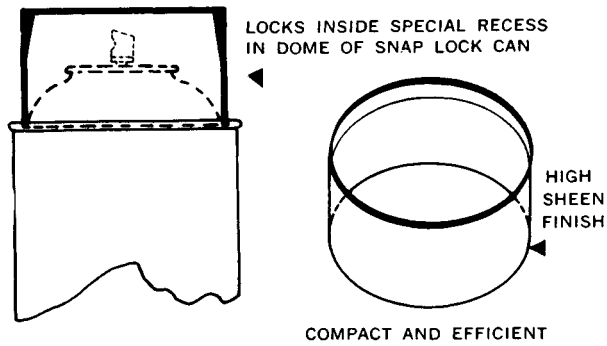


Figure 5. Drawing of Snap Lock Cap
The snap lock cap locks into position by being pressed into a ringlike depression in the countersink area of the dome.

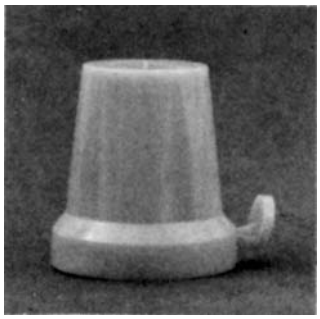


Figure 6. "Lift-Up" Cap
Unique "lift-up" cap used on some food products on a Mira-flo aerosol can. The lever provides easy removal.

case a relatively loose cover cap may come free of the can, causing it to fall. At least a few lawsuits have resulted from foot injuries sustained in retail outlets because of loose-fitting caps.

During the mid-1960s a CSMA Committee took a hard look at the problem of loose cover caps and eventually suggested the use of a simple "go/no-go" testing device developed by Gilbert Plastics, Inc., as a standard for measuring the gripping force between the one-inch cap and the valve cup. The Aerosol Cover Cap Fitment Gauge or Cap Gauge, as it came to be called, consists of a solid mass of hardened steel, weighing 1 lb. 7 oz. (652 g) and having the dimensions shown in Figure 8.

The A, B, C and D dimensions are critical and should be machined accurately. The A dimension is the most critical of the set. In the event metal caps are tested, this diameter should be checked periodically for possible wear, using a micrometer.

To perform a fitment test, the cap is assembled over the rim of the simulated valve cup portion of the gauge block. The unit is then lifted carefully by the cap and slowly tilted to an angle of 30° with the vertical. The cap should remain in place.

This method, while certainly useful, applies only to separating loose caps from others. It does not detect extra tight-fitting caps, nor can it be used with any caps that attach at the snap-lok or around the top double seam. Since the preponderance of cover caps are of these last two varieties, some additional method had to be found.

During the late 1970s, at least one marketer developed a rather interesting method for assessing the holding quality of these full diameter cover caps. In this case, a small hole is bored through the top of the cap, exactly one inch (25.4 mm) from the axis. A thin string is knotted and inserted through the hole, after which the cap is snapped onto the test can. The test can should previously have been measured with a micrometer, so that it is known to have a representative average diameter for that dimension needed for a good cover cap fit. The can is fixed in a testing jig and the string led upward at an angle of 30° with the vertical, then through an eyelet (to maintain the angle), after which it is attached to a spring gauge. By slowly pulling upward on the spring gauge the tension (actually torque) needed to dislodge the cap can be determined readily.

The acceptable force range can be derived from panel or consumer tests. If the cap manufacturer concurs and agrees to the test and applied benchmark as a valid measurement of the fit quality, then the method can be applied as part of the incoming inspection process.

Without an unwieldy degree of sophistication and inspection time, the methods cannot be applied to "worst case" cover cap retentions. These would occur at the maximum can diameter and minimum cap diameter, for the tightest fit, and the reverse for the loosest fit. By using a test can from the lot to be actually mated with the cover caps during production, a satisfactory test result and prognosis can almost always be obtained.

Overly loose and tight cover caps are still an occasional problem, and have resulted in both in-plant rejections and field problems. Although cover caps are produced in steel molds of precise dimensions, the shrinkage of the molded article can vary according to (1) plastic composition (including plasticizer type and amount) (2) the type and loading level of pigments, and (3) the molding temperature. In one memorable case, a marketer changed his full-diameter cap color from a pastel blue to a dark blue and had to reject the lot because the new caps were almost impossible to apply and remove from the cans.

Cover cap manufacturers use a still more sophisticated method for measuring cap retention. The cap is attached, either to a standard aerosol can or to a machined and hardened steel dummy, with ideal dome and valve cup dimensions. The assembly is then fixed in a horizontal position and a dial-reading force gauge is positioned on a vertical column so that the force bar is directly over the top end of the cap, where the side wall joins the top. Using a hand lever, pressure is applied increasingly until the cap is dislodged. In the case of child-resistant caps, grip retention is monitored by physically pulling caps off the cans.

In the case of actuator caps, the very strong attachment of cap to can is deliberate. They are not meant to be removed. The shape and size of the hold-down lugs

are adjusted so that these caps require such drastic removal methods that they are often stripped of their lugs, deformed or destroyed in the process.

A similar very strong attachment is used for tamperproof caps. This type of cover cap is used for paints, coatings and other products to prevent capricious or malicious actuation. A tamperproof cap is also child resistant. It must be pried open by inserting a screwdriver through a slot and using it as either a torsion bar or as a lever, depending upon cap design. The smaller versions are shaped to fit inside the valve cup, and the attachment is made by means of a lower skirt shaped to snap into the crimp indentations. A typical version is the Snap-Lox Model 910 by Newman-Green, Inc. Other models include full-diameter varieties, where the connection is made around the outer cut edge of the valve cup, using a rather heavy flange. The double shell Gilbert Model No. 306-SD is typical of these designs. These caps are generally made from high-density polyethylene (HDPE).

Cover Cap Dimensions

Plastic cover caps are available for the 114-, 202-, 207.5-, 211- and 300-diameter tinplate cans, plus 20 mm valve containers, various aluminum tubes and special collared fittings. They come in various heights. One of the tallest is the Gilbert Model 301-EH, with a height of 2.641" (67.1 mm), designed to fit over the Clayton and Super Whip type valves characterized by their tall dispensing stems. Conversely, cover caps can be quite small indeed; one of the smallest fits over the actuator pad of foam valves. A typical protective cover of this variety measures about 1.19" x 0.31" high (30.2 x 0.79 mm) and may be ordered optionally already fitted onto the foam spout by the supplier, so that the filler has only one assembly step on the production line instead of two.

A listing of 70 cover caps is provided in Table I, showing most of the sizes provided by six major cap suppliers.

TABLE I

Aerosol Plastic Cover Cap Identification Chart

Container Diameter	General Description	Total Height	Aerosol Cover Cap Manufacturer's Stock Number					
			Gilbert	Imperial	Sunbeam	Atco	Pharmaplastics	Paragon Plastics
5/8"	Straight wall - to fit over 5/8" diameter tube	1.125"				0.625		
(20 mm)	Straight wall - to fit over 20 mm valve ferrule	1.250"	901			90-A		
(20 mm)	Serrated, curved wall - to fit over 20 mm valve ferr.	1.250"	902					
(20 mm)	Serrated, curved wall - to fit over 20 mm valve ferr.	1.375"				90-T		
(20 mm)	Serrated, curved wall - to fit over 20 mm valve ferr.	1.875"						
(20 mm)	Inside ribbed, curved wall, 1.250" o.d. - fits on ferrule	1.469"					Series 160	
(20 mm)	Plain reverse taper - to fit over 20 mm valve ferrule	1.656"					Series 110	
(20 mm)	Plain reverse taper - to fit 1010 collar for use with the Wheaton bottle No. RS-1668	1.656"					Series 100	
(20 mm)	Plain reverse taper - to fit 1500 collar for use with the Carr-Lowry bottle No. 4303	1.469"					Series 150	

TABLE I (Continued)

Aerosol Plastic Cover Cap Identification Chart

Container Diameter	General Description	Total Height	Aerosol Cover Cap Manufacturer's Stock Number: Gilbert	Imperial	Sunbeam	Atco	Pharmaplastics	Paragon Plastics
(20 mm)	Fine ribbed, dome-top, banded cap with short internal ribs	1.906″					Series 200	
(20 mm)	Fine ribbed, dome-top, banded cap with short internal ribs	1.906″					Series 210	
(20 mm)	Ribbed, flat top, banded cap with short internal ribs	1.906″					Series 220	
(20 mm)	Ribbed, flat top, banded cap with long internal ribs	1.906″					Series 230	
(20 mm or one-inch)	Double ribbed overcap to fit bottles or one-inch valve cups	1.625″					Series 400	
(One-inch)	Double ribbed "Stacker" cap	1.000″	405	100SC		40B	Series 450	
(1.5″ tube)	Cap for 1.50″ aluminum tube	1.500″	1100			1.5F	Series 550-560	
114-diam.-necked-in	Single shell rim-snap, by Metal Box Ltd. and Southern Can Co. (only)	1.750″						
202-diam. Spra-tainer	Smooth, straight wall.	1.516″	100			10D	Series 950-951	
202-diam. (52 mm)	Double-shell.	1.219″	209	202-DD	202-DS	20D		
	,,	1.313″					Series 940	
	,,	1.375″					Series 960	
	,,	1.969″	209T					
2.089″ diam. (52 mm)	Double-shell for Peerless Tube aluminum monobloc	1.719″					Series 930	
202-diam. necked-in	Single-shell, rim snap. By Metal Box Ltd. & Risdon	1.500″						
202-diam. (52 mm)	Single-shell, rim snap	1.313″		202-RS	202-RS	20A		
	,,	1.375″					Series 800	2020R
	,,	1.391″	201					
	,,	1.437″						
	,,	1.516″	201T					
	,,	1.969″	201XT					
	,,	2.020″						XT2020R
202-diam. (52 mm)	Single shell, snap-lock	1.250″			202-S			
	,,	1.346″						202 IR
	,,	1.469″	1202					
	,,	1.485″						T202IR
202-diam. (52 mm)	Spra Guide (Directional Spray)	1.375″			202-SG			
202-diam. (52 mm)	Tamperproof Cap. Double shell.	1.375″		202-CR	TP-202-DS			
202-diam. (52 mm)	Spra Mate (Directional Spray)	1.625″			202-SM			
202-diam. (52 mm)	Single shell, rim snap with polyethylene brush on top	2.000″		202-RB	2260-RB			

TABLE I

Aerosol Plastic Cover Cap Identification Chart (Continued)

Container Diameter	General Description	Total Height	Aerosol Cover Cap Manufacturer's Stock Number: Gilbert	Imperial	Sunbeam	Atco	Pharmaplastics	Paragon Plastics
207.5-diam. (60 mm)	Double-shell	1.656″	809	207-DS				
	”	1.688″			207.5-DS	80D		
		1.719″					Series 970	
207.5-diam. (60 mm)	Single-shell, rim snap	1.844″	801					
	”	1.825″			207.5-RS			
207.5-diam. (60 mm)	Single-shell, snap-lock	1.750″	1801					T207.5IR
		1.875″						
207.5-diam. (60 mm)	Spra Guide (Directional Spray)	1.688″			207.5-SG			
207.5-diam. (60 mm)	Spra Mate (Directional Spray)	1.688″			207.5-SM			
211-diam.	Double-shell dome-top	1.625″		211DD				
211-diam. (65 mm)	Double-shell	1.625″	309	211DS	211-DS	30D		211DW
	”	1.688″	305					
		1.969″	309T					
211-diam. (65 mm)	Single-shell, rim snap	1.688″		211-RS				
	”	1.844″					Series 910	
	”	1.859″	301T		211-RS	30T		T211OR
	”	2.031″	301XT					XT211OR
	”	2.641″	301EH					
211-diam. (65 mm)	Single-shell, snap-lock	1.688″			211-ST			
	”	1.813″	1301					
	”	1.930″						XT211IR
211-diam. (65 mm)	Spra Guide (Directional Spray	1.750″			211-SG			
211-diam. (65 mm)	Tamperproof Cap	1.656″	306	211-CR				
	”	2.000″			TP-211			
211-diam.	Tamperproof Cap - Flat finish	1.656″		211-CRF				
211-diam. necked-in	Single-shell, rim snap. Made by Metal Box Ltd. & Risdon.	2.088″						
300-diam. (76 mm)	Double-shell	1.656″	509		300-DS	50D		
	”	1.672″						
	”	1.688″		300-DS				
	”	1.766″						
300-diam. (76 mm)	Single-shell, rim snap	2.125″	501T					
300-diam. (76 mm)	Single-shell, snap-lock (Not made; weakens dome.)							
300-diam. (76 mm)	Spra Guide (Directional Spray)	1.875″				300-SG		

Notes:

a. All height dimensions are approximate (±0.031″). Manufacturers tolerance for height is usually ±0.015″.

b. Cover caps are often available in polypropylene as well as polyethylene.

c. The tabulation is not represented as complete. Current data should always be obtained from the suppliers.

d. A single-shell, rim snap cover cap for 300-diameter necked-in cans is experimental at this time and available from the Southern Can Company.

e. Lines of plastic cover caps are available from most valve companies and from several other firms. They are not included here only because of lack of space.

f. As an example of the terminology used by cap suppliers, Imperial caps are designated DS for double shell and flat top, DD for double shell with domed top (center area), RS for single shell and flat (matte finish) top and CR for child-resistant (with domed top- center area).

TABLE II

Variation of Cap Wall Thickness With Diameter

Can Diameter (in.)	(mm)	Typical Cap Wall Thickness (in)	(mm)
114	45	0.032	0.813
202	52	0.033	0.838
207.5	60	0.035	0.889
211	65	0.042	1.067
300	76	0.048	1.219

Thicker constructions provide more deformation resistance, greater load-bearing ability and more crush resistance if the aerosol is dropped.

There are two general groupings in terms of cap diameter, the various "full-diameter" caps and those which are much smaller and fit directly over 13 mm, 20 mm and one-inch (25.4 mm) valves. The full-diameter types are slightly less than the maximum can diameter if they fit on snap-lock can domes, and slightly larger if they fit over the top double seam, as in the rim snap varieties. Where the can is double necked-in at the top, then caps that fit over the double seam are truly the same diameter as the can; but this is the only case.

For 20 mm closures full-diameter cover caps are often vaned inside, so that three or possibly four radially situated vanes fit snugly against the outer wall of the valve ferrule and allow the cap to be made in any desired diameter, up to the diameter of the bottle or aluminum tube as a practical limit. A problem sometimes experienced with these caps is that the consumer may attempt to remove them by pulling them upward at an angle. If one of the vanes then forces the valve button to one side there probably will not be any damage, but the actuator will take on an unsightly appearence, unless it is straightened.

Most plastic cover caps are engineered to provide a wall angle of about 1° to 1.5° with the vertical. This is to facilitate removal from the mold after injection. Wall thicknesses vary with can diameter, and typical values are about as shown in Table II.

Although the steel molds used commonly to make 8, 16 or even more caps in each operation are machined to very precise dimensions, the finished cap dimensions are less exact because of shrinkage. Plastic shrinkage

TABLE III

Dimensional Comparison of 21 Typical Aerosol Cover Caps

General Type	Can Size	Model No.	Overall Height (in.)	(mm)	Overall Diameter (in.)	(mm)	I.D. at Contact Surface (in.)	(mm)	Number of Tangs
Over valve cup	(All)	401	1.438	36.52	0.969	24.61	1.265 ± 0.012	32.13 ± 0.30	—
Over valve cup	(All)	405	1.438	36.52	0.969	24.61	1.265 ± 0.012	32.13 ± 0.30	4
Over valve cup	(All)	411	1.438	36.52	1.078	27.38	1.265 ± 0.012	32.13 ± 0.30	4
Over rim	202	201	1.391	35.33	2.066	52.48	2.185 ± 0.008	55.50 ± 0.20	4
Over rim	202	202-T	1.516	38.51	2.066	52.48	2.185 ± 0.008	55.50 ± 0.20	4
Over rim	202	202-XT	1.969	50.01	2.066	52.48	2.185 ± 0.008	55.50 ± 0.20	4
Over can chime	202	201-CC	1.391	35.33	2.250	57.15	2.175 ± 0.015	55.24 ± 0.38	4
Double shell	202-Sp*	100	1.516	38.51	2.066	52.48	1.269 ± 0.006	32.23 ± 0.15	3
Double shell	202	209	1.219	30.96	2.000	50.80	1.269 ± 0.006	32.23 ± 0.15	3
Double shell	202	209-T	1.469	37.31	2.000	50.80	1.269 ± 0.006	32.23 ± 0.15	3
Over rim	207.5	801	1.844	46.84	2.555	64.90	2.485 ± 0.015	63.12 ± 0.38	4
Double shell	207.5	809	1.656	42.06	2.266	57.56	1.269 ± 0.006	32.23 ± 0.15	3
Over rim	211	301-T	1.859	47.22	2.766	70.26	2.701 ± 0.006	68.61 ± 0.15	4
Over rim	211	301-XT	2.031	51.59	2.766	70.26	2.701 ± 0.006	68.61 ± 0.15	4
Over rim	211	301-EH	2.641	67.08	2.766	70.26	2.701 ± 0.006	68.61 ± 0.15	4
Double shell	211	309	1.656	42.06	2.469	62.71	1.268 ± 0.006	32.21 ± 0.15	3
Double shell	211	305	2.688	42.88	2.469	62.71	1.268 ± 0.006	32.21 ± 0.15	3
Double shell	211	309-T	1.969	50.01	2.469	62.71	1.268 ± 0.006	32.21 ± 0.15	3
Double shell	211	306-SD**	1.688	42.88	2.469	62.71	1.216 ± 0.006	30.89 ± 0.15***	—
Over rim	300	501-T	2.125	53.98	3.101	78.77	3.005 ± 0.015	76.33 ± 0.38	4
Double shell	300	509	1.656	42.06	2.750	69.85	1.269 ± 0.006	32.23 ± 0.15	3

*For 6-ounce Spra-tainer can.
**Tamper-proof - Screwdriver release - slotted cover cap.
***Measured to inner edge of continuous hold-down flange.
Models and dimensions are those of Gilbert Plastics, Inc.

after separation from the mold will vary according to the cycle speed composition, temperature and other factors. For polyethylenes, it will average about 0.012"/inch (0.012 mm/mm) or 1.2%. If the mold temperature increases, shrinkage will increase.

Non-critical dimensions for cover caps generally have tolerances in the range of ±0.31" (±0.38 to ±0.79 mm) and are often noted as inches plus fractions on drawings. As a rule, the only really critical dimension is the inside diameter at the contact surface, where the snap-on to the aerosol container is made. Tolerances of about ±0.006"(±0.15 mm) are applied to this dimension. Wall thickness is important from an economic standpoint, since a reduction of as little as 0.001" (0.025 mm) can save 2 to 3% of the plastic weight, depending on cap diameter. Decreased wall thickness invites warping in the cases, crushing if the can is dropped on the cover, a reduction of load-bearing strength in warehouse storage (especially important during hot, moist summer days, when corrugate is weakened considerably) and some reduction of holding power in the connection to the can. Wall thicknesses are generally held to a tolerance of less than ±0.002" (0.051 mm).

Table III provides the overall height, overall diameter and the critical i.d. at the contact area for a group of 21 cover caps made by Gilbert Plastics, Inc., stipulating that the selection of this firm does not imply any recommendation as to dimensions, quality or other attribute.

Dimensional development can be more complex than is generally recognized. Cover caps are often engineered rather intricately to provide optimum strength, fit and aesthetics. A case in point is the snap-lock cover cap. As shown in Figure 9, the undertuck dimension on the snap-lock can dome is only 0.003" (0.076 mm) as a minimum, and the cap must fit snugly to this tiny protrusive ring of metal.

The detail of a typical snap-lock cap in this area is provided in Figure 10, in the case of a 207.5-diameter (60 mm) size. The design is further complicated by the inclusion of about two air vents. In some cases, up to twelve or sixteen lugs are used instead of a regular undercut band. Either high density polyethylene (HDPE) or polypropylene (PP) are the preferred plastics for snap-lock cover caps.

Air vents are included in nearly all full-diameter caps. This is because residual moisture from the hot tank water may be trapped below the valve cup or on other top areas of the dispenser. If the cover cap acts to seal it in, then eventual rusting may result. In the U.S.A., the air vents are simple channels cut inside the cover cap, where it contacts the dispenser. In Europe, a very small breather hole is pin molded through the top surface, near the edge. Both work equally well. A European cap by Metal Box Limited is shown in Figure 9 on the next page.

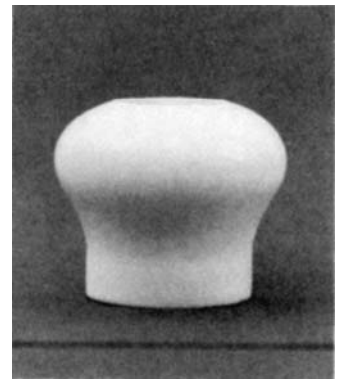
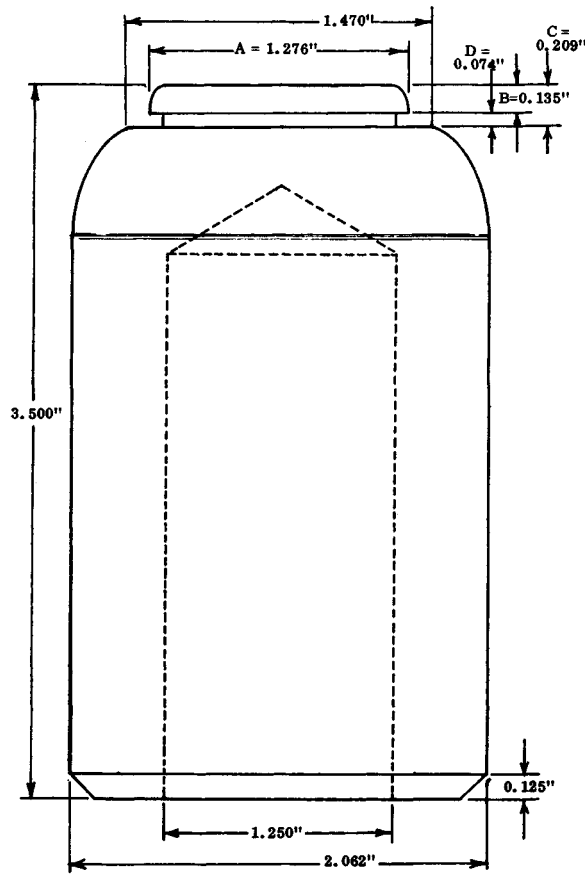


Figure 7. European Cap
A unique European polyethylene cap, designed to fit around the one-inch valve cup.

Figure 8. Aerosol Cover Cap Fitment Gauge



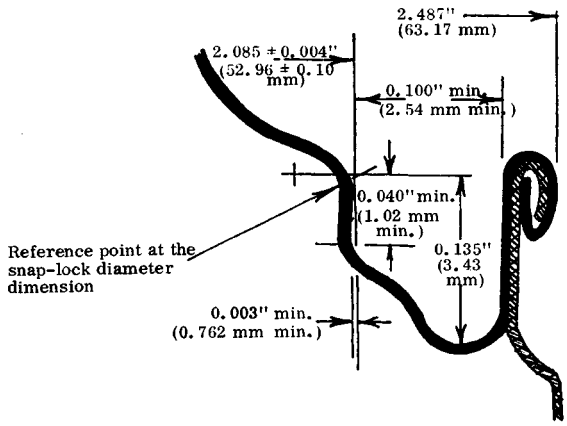
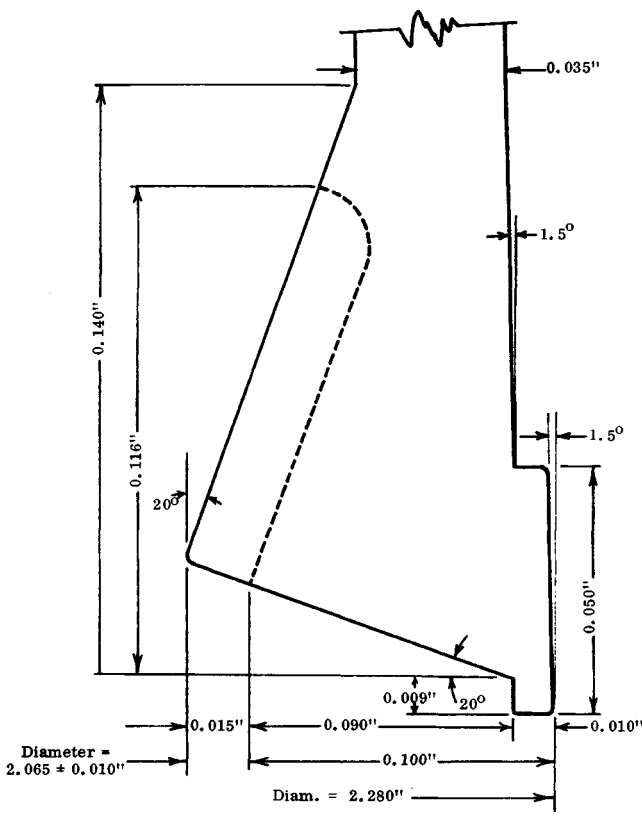


Figure 9. Fitment on a Necked-In Can
Recommended voluntary industry standard cover cap fitment on a 207.5/211-diameter necked-in aerosol can with snap-lock cap.

2.487" (63.17 mm) is the diameter over the double seam, excluding cross-over area.

2.085 ± 0.004" (52.96 ± 0.10 mm) is the snap-lock diameter.

0.040" min. (1.02 mm, min.) is the length of the snap-lock wall -- measured vertically from the maximum snap-lock dimension to the point where the maximum undercut is obtained.



(Dotted line: One of two vents inside on undercut.)

Figure 10. Detail on 207.5 Diameter Snap Lock Cap

Plastic cover caps that fit tightly around the valve cup often inhibit the evaporation of moisture. When they are to be used, extra attention should be given to air drying the actuator, stem and inside of the valve cup as effectively as possible to prevent possible staining or rusting. Epon lining the cup may help delay or reduce corrosion, but it rarely prevents it.

In the past, other plastics besides HDPE and PP were used, and a few suppliers still offer them. They often present problems. For instance, polystyrene is very sensitive to traces of methylene chloride vapors, tending to soften or even "melt" under conditions of seepage rate often found with formulations containing this strong solvent. Polypropylene (PP) is a good, all-around resin for caps, but tends to become very brittle at temperatures of about 0°F (- 17.8°C) or less. Conversely, HDPE is useful down to at least -40°F (-40°C) without becoming more than slightly brittle. When changing plastics, keep in mind the different coefficients of expansion/contraction with temperature. Otherwise, caps that are too large or too small may result.

Metal cover caps are available, but are generally used with "low aesthetic" tinplate aerosol products, or else, in the case of highly polished, lacquered, anodysed, alodysed or enameled aluminum caps, with high quality aerosols packaged in aluminum or glass. The steel utility cap is manufactured by the Sterling Seal Co. and several other firms. Sterling's "No. 7 Outer Protection Cap" is one of the most popular. It is made of tinplate about 0.0156" (0.40 mm) thick and has a curled bottom edge that rests against the can "flat" just below the valve cap. The sealing area has anominal i.d. of 1.288", but the connection to the valve cup depends upon three flats or indentations, which make the effective i.d. 1.257 ± 0.005" (31.93 ± 0.13 mm). The side wall is decorated with vertical knurled bar-like depressions and the top has a low ridge around the periphery that can fit into a mating-type indentation on stacker-type can bottoms for stacking in store displays and similar purposes.

Thin wall aluminum cover caps are produced by such firms as the Dispensing Systems Division of Risdon Corp. and Neotechnic Engineering Ltd. These particular companies have made both valves and caps for aerosol products since the 1950's. They have specialized in deep drawn presswork.

Ferrule type aerosol valves are produced in 13, 15, 18, 20 and even 32 mm diameters, and aluminum

cover caps are available for all of these sizes. In addition, pressed-fitted aluminum collars are made for both glass and aluminum aerosol packs, and these too can be outfitted with aluminum caps. A typical composite can be cited as the Risdon No. 73-20-4 (inverted teardrop) or No. 72-20-4 (swirl design) two-ounce glass bottles, which can be sealed with a 20 mm ferrule valve and then press-fitted with a No. 61-20-3 polished and dye lacquered aluminum collar. The No. 51-20-3 polished and dye lacquered aluminum cap is then fitted over the collar and held snugly in place by means of several small vertical ribs. As an alternate, plastic collars are also available.

Aluminum cover caps are usually straight walled and flat-topped; however, they can be obtained with slightly domed tops, ballooned tops, flared bases (Europe only), and flared tops. It is not unusual for major toiletry marketers to have thier corporate name or logo embossed or debossed on the top of these caps for an added touch of elegance.

These caps fit onto the appropriate valve ferrule because of a forming process known as cap triangulation. They are made out-of-round in the lower wall area, actually pressed into the shape of a very rounded triangle form. The degree of out-of-roundness is almost unnoticeable, actually, but when the cap is slipped over the ferrule, the inner walls provide a friction fit against it in three equidistant points around the circumference. A second option is to provide ribbing for the cap, but generally the aesthetics have caused marketers to shy away from this alternate. Ferrule ribs have been used, but nearly always for the long-skirt ferrules found so commonly with pump-action sprayers.

Custom Caps

Customized cover caps are available in any size, in both metal and plastic. For example, a major marketer in the U.S.A. currently makes most of his plastic caps and actuator caps. The cost of multi-cavity molds of 16 or more units can easily run into the $60,000 to $100,000 area, so decisions to make special cover caps cannot be made lightly, or for products with sales of less than about 5 to 10 million units per year. Single unit soft or hard molds can be made in a few weeks at a cost of about $10,000 or less, and can be used to turn out perhaps as many as 100,000 special caps for test marketing and other purposes. From this point on the stakes get considerably higher in terms of both capital and waiting time. Nevertheless, marketers in the U.S.A., Europe and Japan have developed uniquely styled cover caps that have undoubtedly assisted them in getting on-the-shelf recognition and in expanding their sales.

Each marketer must decide if the added cost of a custom closure is worthwhile for his particular product, weighing at the same time the limitations placed on the flexibility of his operations by the adoption of custom rather than stock parts. For example, if he does his own filling at a single location and has his custom caps made internally or nearby, then his transportation problems are minimized. On the other hand, if he has his product filled at widely separated points for national distribution, then there will be an added cost for shipping his custom closures to the remote filling locations. This is not a large factor, since large cover caps and actuator caps can be packed 500 to 1000 per box and from about 275,000 to 600,000 per truckload. Then too, only about 15% of U.S.A. aerosol production is done west of the Mississippi River, where distances are greatest.

The marketer who decides to work with stock closures is not particularly inconvenienced. Special colors and printing offer a considerable degree of brand identi-

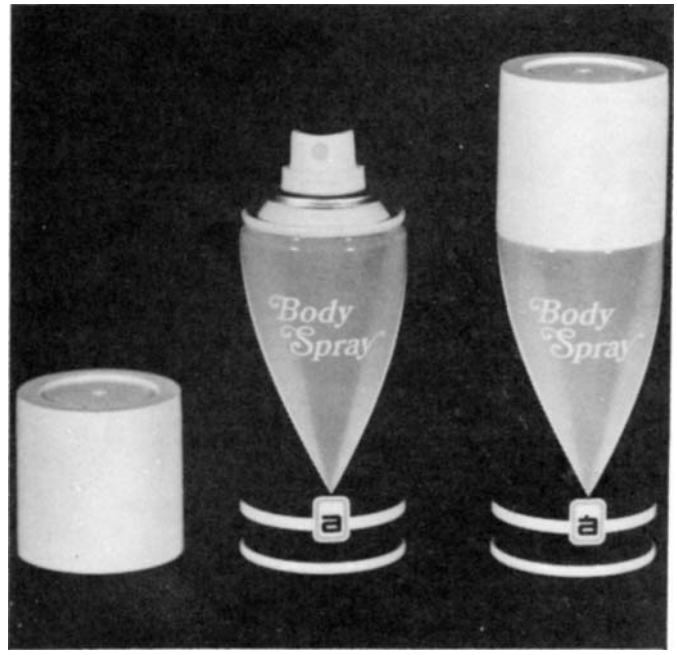


Figure 11. 114-Diameter Can Necked-In to a 112 Can
A 114-diameter (45mm) aerosol can, necked-in to a 112-diameter (42mm) and fitted with a single shell overcap. The can and cap are made by Metal Box Limited. Like most European caps, this one has a small air vent hole in the top to release possible moisture from the hot tanking operation. The hole is near the decorative recessed ring.

fication. Cap colors can be matched to dominant colors on the can label or lithography. Cap printing can be handled in up to three colors, although this is rarely called for. In some cases, heavy paper hoops are fitted over full-diameter caps to provide the consumer with special information, redemption coupons and other offers. In a few cases the plastic cap is printed with various offers, with directions that the cap be cut with scissors to isolate the coupon, after the can is used up.

Actuator Caps

The actuator cap was introduced at least as early as 1954, in conjunction with the first productions of RAID insecticide, in Danville, IL. The Schrader Valve Division was responsible for some very early actuator caps, and National Laboratories used them on three of their disinfectant/deodorant sprays back in the fifties. Several difficulties slowed the growth of this packaging adjunct, such as splitting, warping and fitting difficulties, as well as the relatively high costs.

About 1961 both "Raid" and "Glade" products (by S.C. Johnson & Son, Inc.) were converted to water-based forms, and presented in very attractive dispensers with well-designed VCA actuator caps. Their many competitors responded, and among other things, this put the actuator cap into the aerosol business in a very big way. Now, some twenty years later, most of the cap makers and valve companies offer one or more designs, some of them quite unique, and the actuator cap is used on a large percentage of all aerosol products.

The actuator cap cannot be used on a number of products. For instance, it is contraindicated for paints and coatings, for extension tube items and for viscous products. In some cases, the added cost may not be supportable. But in general it has had a very good reception. A number of distinct advantages have led to this degree of success:

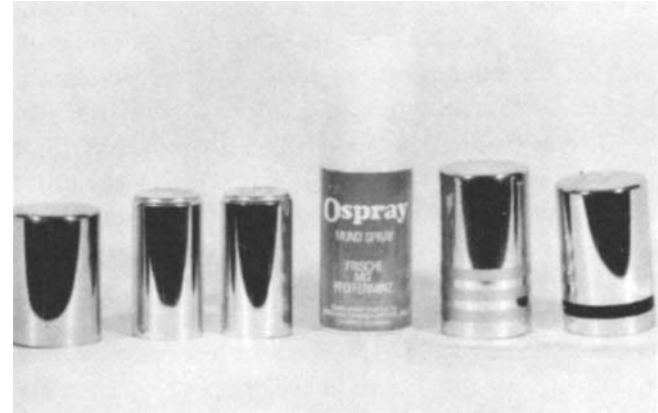


Figure 12. Selection of Anodysed Aluminum Caps
These caps are for 13 and 20 mm ferrules. Shown also is an aluminum cap of breath freshener under the OSPRAY brand, sold in Europe by Beecham Markenartikel AG (Switzerland) with the label printed in English and German. The bottle cap is a 20 mm polyethylene type.

a. The package is easier to hold and operate.
b. The rather unsightly can dome is not exposed—in the case of full-diameter caps.
c. Directionality, and thus consumer safety, is markedly enhanced for spray products.
d. No overcap need be removed and replaced.
e. Considerably more aesthetic appeal is possible.
f. A sense of larger proportions is achieved.
g. Special actuating features can be obtained, such as a brush top used for certain upholstery cleaners, where the product is actuated into the brush area.
h. Replaces the standard actuator and overcap, so that the cost of these components can rightfully be subtracted from that of the actuator cap.

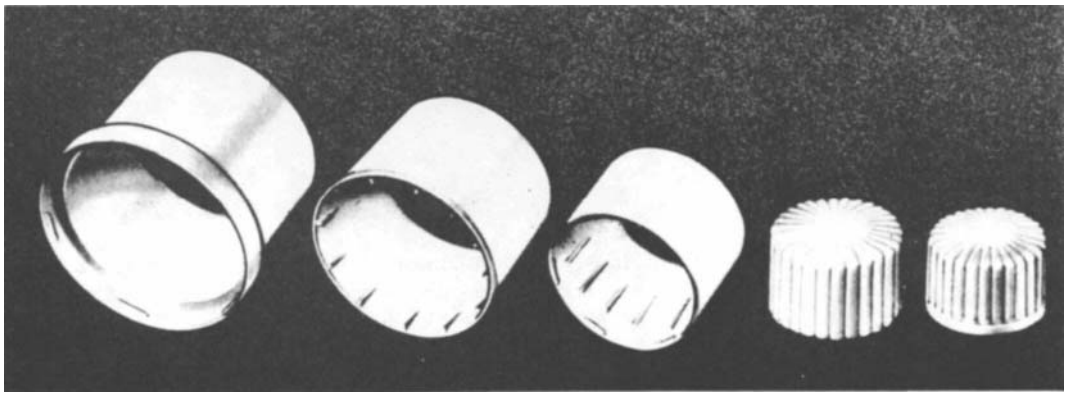


Figure 13. Mark Series Caps by Metal Box Ltd.
The first three styles (l to r) are full diameter, for regular and necked-in 114 (45 mm), 202 (52 mm), 207.5 (60 mm) and 211 (65 mm) ETP cans. The last two styles fit over the valve mounting cup.
The middle cap style is also made by Plasticum, bv (Tilburg, Holland) for the 112/114 and other necked-in cans.

i. The dispenser can be dropped to the floor in any position, probably with no damage.
j. Diptube orientation is more reliable.
k. The large actuator pad reduces finger fatigue during extended spray periods.
l. The unit is instantly available for use.
m. Certain designs qualify as "Child Resistant" and "Tamper-proof". A "Pressure-release" version is under development in California.

Child Resistant Caps

Under the Poison Prevention Act of Dec. 30, 1970, the Consumer Product Safety Commission (CPSC) has the authority to develop and enforce regulations governing the child-resistant packaging of dangerous consumer products. Since their purvue is confined mainly to household products (although the Consumer Product Safety Act appears to give them much broader authority in the field of safe packaging), the Environmental Protection Agency (EPA) moved to require child-resistant packaging in the case of economic poisons as well.

Under these almost identical regulations, "special packaging" is designed to protect children from serious injury or illness that might otherwise result from the handling, using or ingestion of harmful substances. Acceptable packages must be sufficiently difficult for children under the age of five to open, or to obtain a toxic or harmful amount of the substance from the package, but not difficult for the normal adult to use properly.

The test protocol for evaluating the child-resistant properties of a closure requires that 200 children be used. They must be about equally divided as to sex, and distributed in age between 42 and 51 months, inclusive. They are dispersed into groups of two each, and placed in comfortable surroundings. A "specially packaged" commodity, which has already been opened and closed ten times or more, is given to each of the paired children with a request for them to open it. For those children unable to open the package after five minutes, a silent, visual demonstration is given for opening the closure. The reclosed package is then given to each child for an additional five minutes.

In the second phase of the testing protocol, a panel of 100 adults, aged 18 to 45 years inclusive, 70% of whom are female, is then tested, individually. Each person is given five minutes to open the package. Standard opening instructions, if any, are to be read prior to testing. The percentage effectiveness of all three testing cycles is recorded and compared against specific standards stated in the regulations; e.g.

a. Child-resistant effectiveness without demonstration: 85% minimum
b. Child-resistant effectiveness with demonstration: 80% minimum.
c. Adult-use effectiveness: 90% minimum.

The cost of these elaborate testing programs runs between $6,000 and $12,500, depending upon the firm selected.

The regulations still permit marketers of hazardous products to sell one can size in ordinary packaging forms, designed for those homes where children are not present, and where the adults may have an infirmity of arthritis, poor eyesight or other problem that limits their ability to remove the child-resistant closure. Aerosol caustic-type oven cleaners, furniture polishes, engine cleaners high in petroleum distillate content and other somewhat hazardous products are often sold in a single package size, thus avoiding the need for onerous special packaging closures.

The first aerosol child-resistant closure was introduced by Stem Industries, Inc. in 1969. It was a two-piece assembly of polypropylene. The top segment has an internal thread that was placed over a mate collar held in place by lugs that extended under the rim of the valve cup and allowed it to rotate freely. To open, the collar must be held firmly to keep it from rotating, while the top portion is turned counterclockwise. Like most of its successors, the key to success was that two separate manual operations had to be done, simultaneously, to open the unit. The Stem Industries product looked rather cumbersome, the lower section sometimes impinged the spray, and it was fairly expensive. It was never used to any extent and may now be obsolete.

Figure 14. Full Diameter Cover Cap
Unique polyethylene full-diameter cover for 202-diameter (42 mm) tinplate cans containing various underarm spray products—marketed in England.

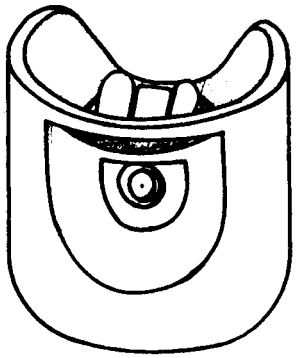


Figure 15. KinderGuard™
Child-resistant actuator. Kinder-Guard is a registered trademark of the Seaquist Valve Company, Cary, IL

A unique design for a child-resistant cap was developed by Seaquist Valve Co. about 1972 and is known as the Kinder-Guard™ system. The unit consists of a full-diameter actuator cap, where the actuator has a more-or-less rectangular pad on top. At each side of the actuator are small mounds, or rounded "ears" of plastic which must be spread outward in order to allow the actuator to be depressed. A child's finger is sufficiently narrow that pressing down on the actuator pad will not serve to spread both "ears", although this can be done rather easily by an adult. The closure is the only child resistant system that provides automatic re-engagement of the child resistant position after each use. By doing so, it avoids perhaps the greatest problem with child-resistant hardware: failure of the adult to replace the cap or otherwise reseal the unit after using it. See Figure 15.

About 1976, a major marketer launched an ill-fated product line characterized by a rather unique full-diameter, dome-like, child-resistant actuator cap with a vertical protuberance along one side. To operate, a person inserted the index finger all the way into the tubular cavity formed by the protuberance. At the end was the hidden actuator, which could then be depressed and operated. The child-resistant attribute was satisfied on the basis that a child's finger was simply not long enough to extend up through the hole and reach the sprayhead. In the marketplace the huge plastic dome was said to have had a negative effect upon sales from both an appearence and functional standpoint. Apparently a few people were injured when they had their finger up into the hole at a moment when someone else spontaneously grabbed the unit to take a better look at it. Fingers were sometimes broken in this fashion. The actuator now seems to have disappeared from the market.

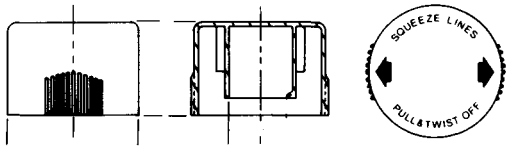
Excellent child-resistant caps are now supplied by several firms. The 26 active cap models sold by Gilbert Plastics now include 3 child-resistant versions. Imperial Plastics offers 10 active models of cover caps, including two child-resistant sizes. The Knight Engineering and Molding Co. produces 11 caps, of which three are child resistant. The child resistant type locks to the valve cup when attached, and can be removed only by squeezing the sides at designated (serrated) areas while twisting and pulling off. Removal instructions are normally embossed on the top surface of all child resistant caps. Figure 16 is an illustration of the Knight Engineering child resistant cover caps.

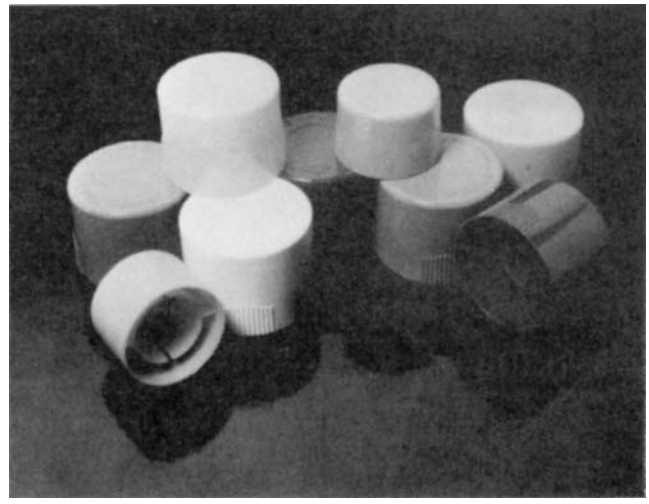
Specialty Caps

In addition to tamperproof and child resistant cover caps, several other specially designed caps are available to help the marketer dispense or use his product more effectively. Powder brush and foam brush caps have

Figure 16. Overcaps by Knight Engineering & Molding Company, Arlington Heights, IL (Photo at right)

Figure 16 A. Shown below is a line detail of the Knight child resistant overcaps.





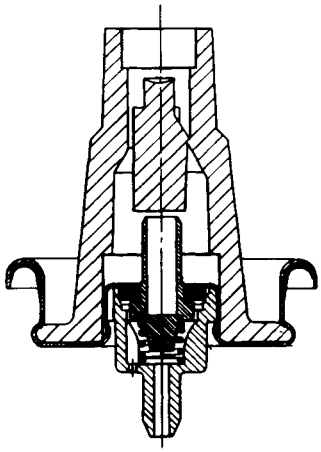


Figure 17. Modified Summit S-63 Valve and Heavy Duty Actuator/Overcap Used for Tire Inflation

been mentioned. A rather unique reversible 202-diameter spray cap is made by the Seaquist Valve Co. for indoor foggers. By removing the cap, turning it upside down and then snapping it down on the valve cup the valve stem is jammed into a centerline hole that ends in a spray orifice. The geometry is such that the stem is depressed far enough to actuate the valve.

Other ideas that have been used include the custom gluing of a plastic scrubber pad onto the top of full-diameter caps for hard surface cleaners and paint stripper products. In a similar approach, an emery cloth was attached to the top of caps for paint touch-up products, but the cost was apparently excessive compared with the benefit, and the idea was never marketed. The modified S-63 transfer valve by Summit Packaging Systems Inc. is fitted with a special heavy duty actuator/overcap that can be used for tire inflation or for refrigerant transfers. It is illustrated in Figure 17.

Precision Valve Corp. (U.S.A.) makes two distinct series of spray domes: the 03-0560/03-0750 Series, and Saturn 03-42 Series. The first of these, developed in the early 1960s, is designed specifically to spray water--based insecticides and air fresheners upward at a 45° angle. Otherwise these products would have to be sprayed by holding the can at an awkward angle to treat the air in the upper third of a room. Because nearly all water-based products must be shaken prior to use to assure a reasonably uniform composition of the spray, the five spray domes are embossed on the top with the words "Shake Before Using." Examples of each series are shown as Figure 18.

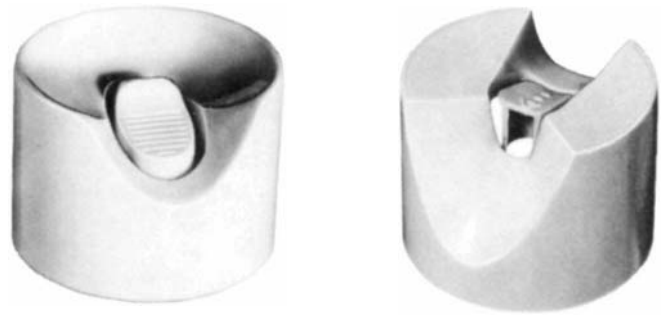


Figure 18. Precision Valve Actuator Caps
(Left: 03-560 Series Right: 03-42 Saturn Series)

Decoration Techniques

Cover caps can be made in any desired color. As a rule, if the customer desires a particular color he will submit a swatch or coupon to the cap maker, where it is compared against standard color chips in a light box. Plastic prills are provided and molded to that color, with sample caps compared with each other and to the master chip for statistical color control during production.

Cap printing is usually done on fully automatic silk-screening equipment, using the customer's camera-ready art. Inks must be formulated to match color specifications. They must resist ultraviolet induced fading and also adhere firmly to the plastic. Copolymer, polypropylene, polyallomer, polyethylenes, K-resin, SAN, ABS and other plastics have all been silkscreened with excellent results. Polyolefins are surface treated to alter the surface and make it more receptive to inks, paints and lacquers. These treatments may include chemical, flame or electronic methods.

Hot stamping is sometimes used for special effects. It is a dry process where a flexible foil or other coating is

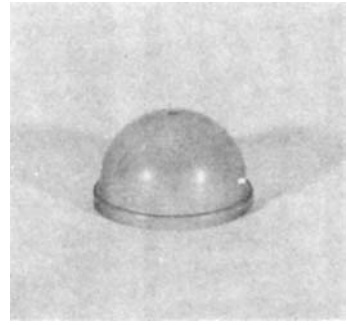


Figure 19. Hemispherical Cover Cap Design
The hemispherical plastic cover cap is used on some 202-diameter cans of anti-perspirants and a few other products. The cap is sometimes anodyzed in gold or silver for extra elegance

Figure 20. Customized Cover Caps and Actuator Cap on Aluminum Cans — European Market

Figure 21. Ordinary Tinplate Can and Cap, Compared with Brushed Aluminum Can and Cap

transferred to the plastic surface by pressure and heat. The impression is made by a metal or silicone die. In the similar heat transfer process preprinted images on the foil are applied to the plastic. This multicolor decoration is a one-step process. Vacuum metalizing and other techniques are available if needed.

Figure 22. Blendax Aerosol Toothpaste in Composite Aluminum Tube. Custom Cap, Spout and Base in Shadow-Box, Sold in West Germany

Metal cover caps may be decorated in a variety of ways. An anodized finish is commonly used for aluminum caps to give a brilliant gold or silvered surface. The process involves an anodic treatment to form an oxide film of controlled properties. The brushed surface often seen on aluminum caps results from a so-called Butler finishing technique, where the metal is micro-scored with a myriad of more-or-less parallel lines, using rotating wire brushes or cloth wheels with applied abrasives. (This technique is also used for the finishing of aluminum aerosol cans in Europe, but is not yet done in the U.S.A.)

Aluminum caps are also treated by matte dipping, electroplating and vacuum metalizing. In the last process a very thin film of metal (generally aluminum) is deposited on the substrate by means of evaporation under high vacuum. After metalizing, a top coat of clear or colored lacquer is applied to protect the delicate metal film. The process can be applied to most plastics and to glass.

Aluminum and enameled steel caps may be decorated by silkscreen printing. Steel discs are silkscreened or enameled prior to deep drawing into cover caps. The printed matter may become slightly wavy due to the uneven stretching of the metal as it is worked, but this is almost never a cause for concern.