Whitepaper for 1/31/20

Non-CTS Caps

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Continuous thread screw (CTS) caps are the most common cap type. They come in different sizes and styles. A number of different types of capping machines are available to apply them.

In general, closures can be grouped as caps or plugs. Caps are those closures which go over the bottle neck. Plugs are those which go inside. This whitepaper will cover non-CTS caps and their application.

ROPP

Roll On Pilfer Proof (ROPP) caps are sometimes called rolled thread caps. Roll-On because the threads are rolled into the cap during application. Pilfer proof because, on first use, the cap has obviously been opened. In non-skirted caps, the sealing ring remains on the neck providing clear visual evidence.

The customer sees little difference between ROPP and CTS caps. Functionally, they are very different. CTS caps rely on the cap and neck threads to pull the cap valve or pointer tightly against the bottle neck. As the cap is torqued down, the body of the cap and/or the bottle neck stretches slightly. If the cap is lined, there will also be some elasticity from the liner. This elasticity plus friction between threads is what keeps the cap sealed.

There are a couple of problems with this

- It is not a positive lock and the vibration of shipping and temperature changes in storage can work it loose
- If the cap is applied tightly enough not to loosen in shipping and storage, it may be too tight for the end customer to remove easily.
- The threads do not provide a uniform down force. This constant, uneven, stress can cause cracking off plastic caps. Multiple lead threads improve but don't eliminate the stress.

Single lead and Multi-lead Caps

ROPP caps solve these problems.

The first thing to notice about bottles designed for ROPP is that, below the threads, the bottle has a molded sealing ring.

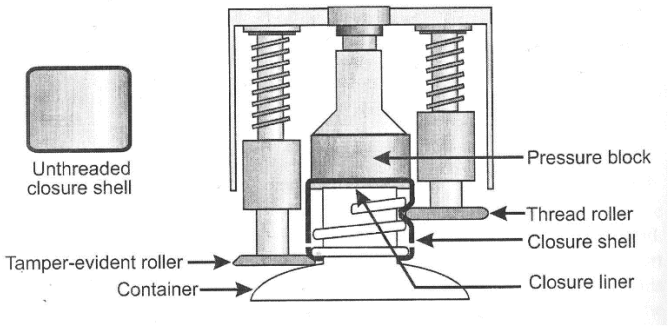
The ROPP cap is supplied as an unthreaded, straight sided aluminum shell with a compressible liner. The bottom portion of the shell is perforated horizontally. In some instances, it will be perforated vertically in several places as well.

ROPP Caps with and without skirt

SOURCE: Maxwelcaps.com

Instead of being turned or screwed onto the bottle, the cap shell is dropped over the neck. A top pressure block pushes the shell down, compressing the liner to force a tight seal.

ROPP Cap Chuck



Source: Fundamentals of Packaging Technology

While the shell is held down a chuck mounted wheel rolls the edge of the shell under the sealing ring. This seals the bottle.

If left like this, it would be difficult to open and could not be reclosed. It needs threads.

A second roller rolls the shell in to conform to the bottle threads. This allows the cap to be twisted open, breaking the sealing ring. The threads allow the user to reclose the bottle.

Crimped caps

Crimped caps are used to permanently fix the cap to the bottle. They are common with liquid pharmaceuticals where they lock the rubber plug in place. They are also common in cosmetics to apply aerosol valves.

The caps are provided as an aluminum shell and placed over the bottle neck. In typical pharmaceutical usage they are applied over a rubber stopper which provides the elasticity and sealing. Aerosols and other closures include an elastomer or gasket in the cap for sealing.

After placing the cap, two methods are commonly used for sealing

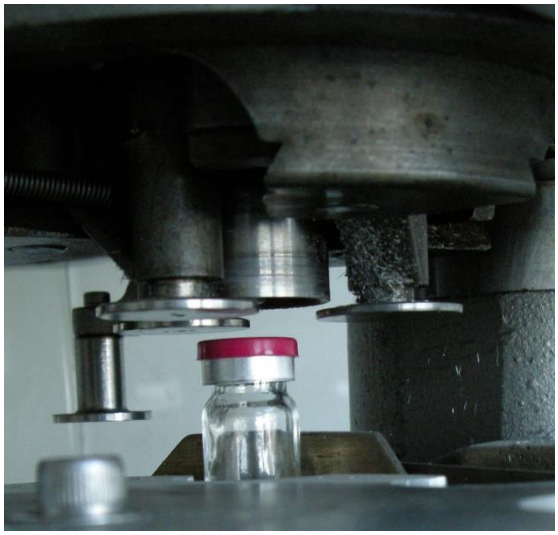
Crimping is the simpler of the two methods. A chuck with segmented jaws is lowered over the cap compressing the plug or elastomer. The jaws then close, forcing the lower edge of the cap under the neck ring of the vial.

Courtesy Chase-Logeman Corp

A variation on the crimp capper is the crown capper popular in bottled beverages. The segmented jaws match the serrations in the cap. As the cap is pressed down on the bottle, the jaw pushes them under the neck ring. Unlike the overcap above, these caps are designed to be removeable. A slight flare is left on the skirt to allow use of a bottle opener to lever it off the bottle. Some bottles include a screw thread that allows the cap to be twisted open. Application is the same in both instances.

A disadvantage of crimping jaws is that they can leave a mark where the segments meet. This is not noticeable on the crown cap but may be on the overcap with the smoother edge.

Rollers provide a smoother finish. This picture shows a a spinning chuck with 3 free-spinning wheels. A starwheel indexes the vial under the chuck and pushes it up against a pressure block, compressing the stopper. The spinning wheels are moved in in folding the lower portion of the overcap under the vial lip.



A variation on this, for higher speeds (up to 600vpm) applies the cap and times the vials into the capping turret. A top hold down is lowered to compress the stopper, and pedestal, vial, cap and hold down are rotated. As the turret rotates, it rolls the overcap against a stationary rail that folds it under the vial lip.

Lug caps

Lug caps are non-continuous threaded caps. They are threaded onto the bottle or jar but only need a quarter turn or less to tighten. Cap torque is not a serious issue on lug caps. Lug caps are commonly used with vacuum packing. The vacuum provides almost all of the sealing force. The lugs allow for reclosure and seal the cap while the vacuum seal is formed.

Lug caps are applied similarly to CTS caps. Just before placing, a shot of steam is injected into the bottle. After cap tightening, the steam condenses, forming a vacuum.

This vacuum pulls the cap down against the neck forming a tight seal and high friction to prevent accidental cap loosening.

One problem with lug caps is that if they are turned too far, the cap threads will run off the bottle threads leaving an unsealed cap. It is critical that lug caps not be overtorqued to avoid this problem. Some bottle lugs have a hard stop to help make this easier to control.

A vacuum sealing variation on lug caps can be found on baby food and other jars. Instead of having threads, the cap has a heavy internal plastic coating and is heated with steam as it is applied. The jar has a series of fine threads. As the cap is applied, it is forced over the threads. As the plastic cools, it conforms to the jar threads. Steam applied just prior to capping forms a vacuum tightly sealing the cap.

Snap caps

Of all caps, snap on caps or snap caps are the simplest to apply. They are also usually easiest for the end user to remove. Some snap caps, especially those having fitments or pumps, are designed so that, once snapped in place they cannot be removed except by destroying the cap.

The bottle or jar incorporates a protruding ring, the cap incorporates a similar ring. The cap is placed on the bottle then pressed down until the cap ring stretches over the bottle ring and they snap in place. Elasticity of the cap, bottle and cap liner hold everything tight. One issue is that if the bottle shrinks over time or the cap stretches too much, the cap will become loose. Not, generally, loose enough to fall off but loose enough that it no longer provides a hermetic seal. Most bottles with snap on caps will have a foil or paper sealed to the bottle. The purpose of the cap, then, becomes not so much sealing the bottle as providing protection to the foil seal.

One exception to this is the twist-snap cap used on some plastic milk and similar bottles. Bottle and cap are both threaded with fine threads. The cap is pressed onto the

bottle and it's threads ride over the neck threads. As it is pressed on, the flat chuck rotates. As the cap bottoms out, the threads pull the cap down tight. The ratcheted tamper evidence ring prevents it from backing off until removed by the end user.

Foil seals

Many people see the foil liner inside an unapplied cap and think that it is just a part of the cap. It is, but it is more. The foil liner is applied with the cap and is the actual closure. The cap is there as an overcap to protect the foil and to provide a means of reclosing the container.

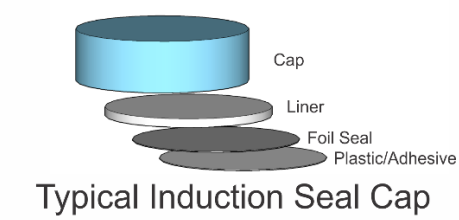
In some instances, the foil becomes the primary closure as shown here.

In the past, several types of glue seals that were common but most modern seals are applied using heat.

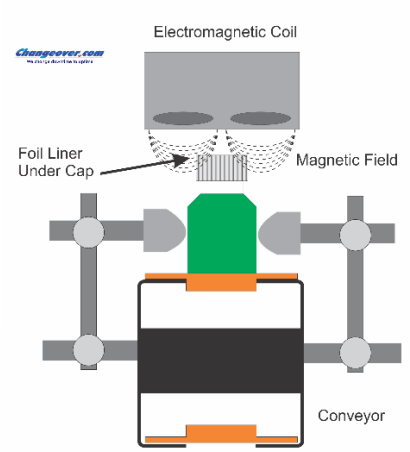
The most common method is induction sealing. It is simple, non-contact and has no moving parts. It is economical and fast, with some applications more than 1,000ppm.

The seal itself is generally a plastic coated foil. Some seals may incorporate a paper layer as well but this is not necessary.

The seal is applied with the cap which clamps it firmly against the bottle neck. The bottle passes under an induction coil, similar to an electromagnet. As it passes, the coil "induces" a current in the foil. This causes the foil to heat, melting the plastic adhesive layer to the bottle.



Typical Induction Seal Cap



Induction Sealer
Source: Packaging Machinery Handbook

Direct heat

The other alternative is direct compression heating.

This yogurt bottle cap is supplied in roll form. As the bottle enters the capping machine, a foil disk is diecut, placed onto the bottle and wiped down, forming a loose cup. The bottle then passes under a chuck with a heated element. As the chuck clamps the foil in place vertically, it also heats it sealing the cap's plastic layer to the bottle.

Another type of direct compression heating is used with these pudding cups. The cups are formed from roll-fed plastic sheet. Pudding is filled into the cup and a flat sheet is placed on top. This sheet can be foil, plastic or paper. As it is laid onto the thermoform, it passes under a roller that provides heat and pressure to seal them together. Some intermittent motion machines, instead of using heated rollers, use heated flat platens instead.

There are lots of ways to seal your product besides screw caps. This paper has discussed the most common and provided an overview of application and usage. When you need closing and sealing machinery, call Frain at (630) 283-8980 or visit them online at www.fraingroup.com. Their knowledgeable engineers will help you find the right solution for your product.