Beer Barrels: from Roman times to the Present Day

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Metal beer containers have now almost completely replaced timber ones, stainless steel being the most widely used material. The influences on container design, as well as the manufacture and operation of them, are discussed.

History

The art of brewing, which became highly developed in most English monasteries, can be traced back to Roman times. For two thousand years beers have been produced and stored in wooden vessels which have been lined with a variety of materials such as pitch to help seal them against leakage. Originally, beer was brewed to meet the needs of small communities and was consumed at the production site but, as demand for it grew and beer had to be taken to more distant points-of-sale, transportable casks were required and these, too, were made from wood. The most common size of cask held one "barrel", a brewing unit which, in Medieval times, was a volume of 145.5 liters (32 Imperial gallons) but which is now standardized at 163.7 liters (36 Imperial gallons). This volume naturally gave its name to the cask of that capacity, but was eventually adopted colloquially for all sizes of cask, despite their having their own names; the 4.5-gallon "pin", the 9-gallon "firkin", the 18-gallon "kilderkin" and the 54-gallon "hogshead" (20.5, 40.9, 81.8 and 245.5 liters respectively). Wooden casks were made from vertical strips of oak, or "staves", held tightly together by horizontal steel hoops(6). For this arrangement to be watertight, the staves were not only tapered so that together they created a circular cross-section, but also bowed so that steel hoops could be forced down from the circular end to squeeze them together. This gave rise to the bellied shape of casks, which offered the practical advantages that even the hogshead, which weighed nearly one third of a ton (700 kg) when full, could easily be rolled and steered along the ground with a stick or by gentle kicking. Then, when it needed to be lifted up to, and laid horizontally on, the rack (or, "stillage") in the customer's cellar, the bellied shape allowed the container to be rocked backwards and forwards longitudinally until it could be lifted smoothly onto its end and then swung completely over and onto the stillage [see Figure 1]. There it was stored until the natural conditioning processes were complete and the beer was ready for drinking. The belly also retained the yeast sediment which settled during conditioning such that, even as the level in the cask fell, the beer was constantly drawn off from above the sediment, keeping it clear or, "bright."

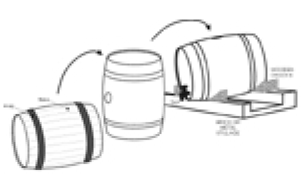

Figure 1: A wooden cask of traditional beer, stillaged and tapped.

LARGER VIEW

Eventually, with the advent of brewing on an industrial scale, metallic materials were introduced for the production vessels, but these were selected essentially for their strength. From the middle of the 19th century (with little recognition of the effects of corrosion and the resultant product contamination) process tanks were made out of soldered copper sheet and massive open fermenting chambers were lined with lead. Vessels were sometimes named after the materials which the industry had begun to use and the ingredients for beer are even today boiled in "coppers". However, until the mid 1900s wood remained the only material commonly used for casks for storage, distribution and dispense, it having the advantage that staves damaged by impact during delivery could be replaced individually by the Cooper.

Although from 1934 Flowers' India Pale Ale was, for a short time, exported from Britain to India in experimental steel casks, it was not for another quarter-century that metals became extensively used for the bulk packaging of beers. Stainless steel was introduced in the late 1950s for the smaller sizes of cask, the dimensions of which mimicked as far as possible those of the traditional oak ones so that they could operate side-by-side with them, and the weights of which were less than those of wooden casks of the same strength. In the early 1960s, aluminum alloys were introduced because they offered the advantage that, for an equivalent size and strength of container, they were approximately 30% lighter even than stainless steel.

■ Terminology

"Beer" is the generic name which encompasses ales, lagers and stouts. "Container" is the generic term including all sizes of both casks and kegs (although all are often colloquially referred to simply as "barrels").

"Traditional ales" complete their conditioning in the containers in which they have been transported to the sales outlet. Typically, they have a low carbon dioxide content and can therefore be packaged into dual-aperture containers which, since at least as far back as 1727 have been called "casks". Originally these were wood, but they are now almost all metallic [see Figure 2] and they are sealed only by tapered wooden (or, latterly, plastic) bungs driven into "shive" (inlet) and "keystone" (outlet) bushes. These bungs are removed when the empty cask returns to the Brewery for washing and they are renewed before the cask is re-used. Figure 3 shows a cross-section through a cask during dispense.

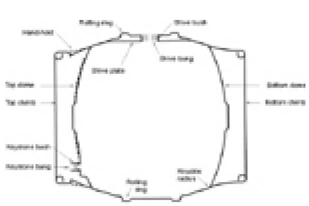

Figure 2: A typical metal cask for traditional beers.

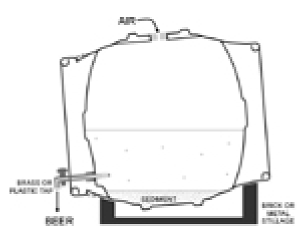

Figure 3: The dispense of beer from a traditional

cask.

LARGER VIEW

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"Pasteurized beers" (both ales and lagers) are conditioned in the brewery and have a relatively-high gas content (which may be carbon dioxide or a mixture of this gas with nitrogen). In the packaging of these beers, the superior ability of metallic containers to contain a gas pressure becomes of paramount importance, as it is essential to maximizing the shelf-life of the product. Such beers are therefore packaged into single-aperture metal "kegs" [see Figure 4], first developed in the UK in the early 1960s, which incorporate a semi-permanent "extractor" (or, "spear" or, "closure" or, "valve"). This is commonly screwed into a "Barnes Neck" (originally called a "Barnes Bush") which is welded to the keg body (and was named after its inventor, Australian Roy Barnes, who was then employed by one of the major UK container manufacturers). The extractor remains in the keg whilst it is being cleaned, filled and subsequently emptied. It seats on a synthetic sealing-gasket in the neck and features two concentric, spring-loaded valves [see Figure 5], through the outer of which a gas pressure can be applied at dispense to force the beer up the downtube and through the inner valve to the dispense point on the bar [see Figure 6]. It is because of this extractor that cleaning and filling can be mechanized and the costs of packaging significantly reduced.

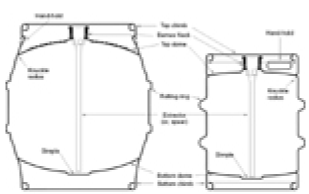

Figure 4: Typical metal kegs for pressurized beers.

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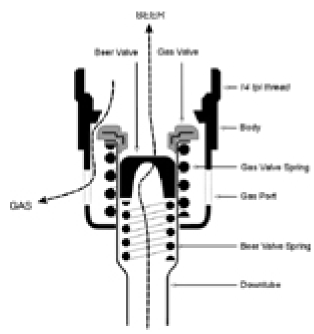

Figure 5: A typical extractor.

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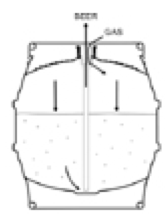

Figure 6: The dispense of beer from a pressurized keg.

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Similar kegs and extractors (with slight design and materials modifications to accommodate the more aggressive environment) are also used to package ciders.

Regulations and Codes of Practice

European legislation(5) stipulates that materials must not "react with, or alter the organoleptic properties of, foods with which they come into contact." This standard has necessitated much research into materials, including the epoxy resins used to line aluminum containers, higher grades of stainless steels and the synthetics used for the gaskets and valves of the extractors.

The British Beer and Pub Association issues the instruction(1) that all pressure kegs "shall be tested at the manufacturer's works to at least 1.5 times their Safe Working Pressure," this SWP being "the maximum gauge pressure to which equipment should be subjected and which must not be exceeded by any planned method of working." It further stipulates that "the maximum test pressure should not subject the material to stresses in excess of 90% of the minimum specified yield for the material [and that it] shall be maintained for a sufficient length of time to permit a thorough examination to be made of all seams and joints." In practice, the industry voluntarily applies these same procedures to the manufacture of traditional casks and, in view of this self-regulation, beer kegs and casks are currently exempt from all EU legislation applicable to the design, manufacture and testing of pressure vessels.

■ Design Considerations

Existing standards

Few design standards currently exist for beer containers. In the absence of any liaison between brewing companies or container manufacturers in the early days of container production, as many slightly-different designs were created as there were customers. Even with the introduction by a significant number of UK brewers of the European cylindrical 50-litre (11-gallon) stainless steel keg in the late 1980s, there was little industry-wide standardization of dimensions as each brewer's keg had to meet slightly different operational constraints, particularly those of compatibility with his pre-existent packaging, handling, storage and transportation systems. In 1984, however, the major UK brewers came together to form the InterBrewer Technical Liaison Group (INTEL) and this body recommended procedures for materials selection(3) and standards for the performance testing(4) of kegs. In conjunction with INTEL, the UK British Beer and Pub Association (BBPA) issued in the early 1990s detailed specifications(2) for the two most common designs of Barnes Neck.

Compatibility with existing machinery and equipment

In view of the extent to which the operation of both kegs and casks are now mechanized, it is essential that their designs are compatible with the plant on which they will be cleaned and filled (the "washer/racker"), the machinery which will palletize them, the boards or pallets on which they will be stored, the road vehicles on which they will be transported and the dispense environment, including stillages for casks and extractors in kegs.

Strength

Almost all damage to kegs happens in the distribution cycle. Drop tests can simulate a container falling the 1.5 meters (4.5 feet) from the bed of a delivery vehicle onto a concrete pavement, and evaluate the strength of rolling rings and chimbs, particularly when a full container falls at 45º onto its handholds.

Testing the strength of domes can simulate static loads, such as "topping". This is the practice of stacking a small container horizontally on top of a larger container which is vertical (i.e.: standing on one end). Whilst this can save space on a delivery vehicle bed, it can also damage the Barnes Neck or the keystone bush of the lower container.

When a keg is to be cleaned and refilled in the brewery, the washer/racker effects a seal between the washing/filling head and the rim of the Barnes Neck by means of a pneumatically-operated clamp. However, a 75 mm (3 inch) air-ram at 3 bar (50 psig) exerts a force of nearly 0.25 ton (500 lbf) axially onto the keg neck - when applied gently. If the head impacts the neck suddenly the effect can be equivalent to a far higher static force.

If, during the cleaning process, steam injected to purge the detergent is followed by rinse-water, the steam in the keg will condense rapidly to water, creating a vacuum. A hard vacuum applies a force of 300 kgf (700 lbf) to the end-domes of an 50-litre (11-gallon) keg, which may cause them to collapse inwards.

Design features such as impressed stars (or, "cruciforms") spanning most of the diameter of end-domes can significantly increase their resistance to deflection without any increase in weight [see Figure 7].

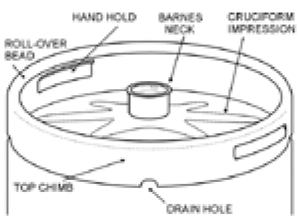

Figure 7: The top dome of a typical cylindrical metal keg.

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Weight

The strength of a container can be improved by increasing the thicknesses of its materials, but this will increase both its tare weight and its cost and it will reduce road-vehicle payloads. The use of superior materials, such as half-hard stainless steels (some chimbs being rolled from sheet of over 1000 N/mm2) and the addition of cruciforms will both permit higher specific strengths. However, it is advantageous for there to be as little variation as possible between different manufacturers' tare-weights because of the weighing-scales at the end of the washer/racker in the Brewery which automatically check for kegs not sufficiently filled.

In addition to consumer demand for a wider choice of beers at the point of sale, European Manual Handling Legislation is resulting in a trend towards a greater number of smaller (and, therefore, lighter) containers. Some aluminum hogsheads and barrels remain in service, but most are being phased out in favor of containers of 100 liters (22 gallons) or less, which remain of an acceptable weight even in stainless steel.

Table 1 shows the weights of typical metal casks. A keg of the same capacity will weigh about 0.5 kg (1lb) more than a cask because of its extractor.

Table 1: Weights and nominal capacities of typical metal beer casks.

CASK	NOMINAL CAPACITY Liters (Imperial Gallons)	MATERIAL	WEIGHT Empty kg (lb)	WEIGHT Full kg (lb)
Firkin	41 (9)	Stainless Steel	11 (25)	54 (119)
Kilderkin	82 (18)	Stainless Steel	23 (51)	107 (236)
Barrel	164 (36)	Aluminum	29 (63)	197 (435)
Hogshead	246 (54)	Aluminum	39 (85)	291 (641)

Volume

Even today, casks are filled manually through the shive bush. It is therefore possible to brim-fill them, and so the content of each cask is the same as its capacity.

Until twenty years ago, kegs were brim-filled in the upright position with the Barnes Neck uppermost and so, again, the contents were always the same as the capacity. It is now, however, almost universal practice that the washer/racker fills kegs in the inverted position, because the beer can be injected faster (and less turbulently) through the gas-ports of the extractor than through the narrow downtube [see Figure 8]. However, an inverted keg cannot be completely filled because of the gap between the tip of the downtube and the dome of the keg. There is always a mushroom-shaped gas space left and this can account for as much as 1/2 pint in a 72-pint firkin, and 3/4 pint in a 288-pint barrel, depending on the shape of the dome and the distance between it and the tip of the downtube.

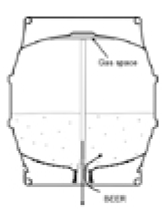

Figure 8: Filling a keg through the gas-ports of the extractor.

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However, UK Trading Standards stipulate that, when a brewery fills a batch of containers all of a nominal capacity of (for instance) 18 gallons and to be sold as "18-gallon casks" or "18-gallon kegs", the actual contents of all of the containers in that batch must average 18 gallons and each individual container must hold at least nominal-less-3% (i.e.: 17.46 gallons) in the case of casks or nominal-less-2% (i.e.: 17.64 gallons) in the case of kegs. Similarly, each individual 50-litre (11-gallon) keg in a production batch must hold at least nominal-less-2% (i.e.: 49 liters). This "Declaration of Contents" regulation has to be allowed for when specifying the capacities of new containers as containers can change in capacity over long periods of service. Aluminum containers with rolling-rings swaged from the body tend to grow in length and capacity with time because the rings flatten out, but stainless steel containers tend to shrink by about one-twentieth of a percent of their original capacity for every year in service because of all the small dents they accumulate in their bodies. The design specification for the lower limit (i.e.: nominal less manufacturing tolerance) of the volume of a container should therefore reflect both filling practice and in-service changes in shape, usually by including an over-measure of approximately 1% of the nominal capacity.

Practicality

The profile of the bottom dome of a container can significantly affect both the volume of beer left in the keg after normal dispense and the effectiveness of the on-line deterging procedures. Too shallow a dome radius may result in too great a volume of beer being unextractable, and for this reason many kegs incorporate in their bottom dome a small sump (or, "dimple") of approximately 75 mm (3 inches) diameter and 6 mm (1/4 inch) depth (equivalent to about one fluid ounce, or 25 ml) into which the tip of the extractor just reaches. On the other hand, if the shape of this sump is not carefully chosen, then the detergents which are lanced into the inverted keg through the extractor downtube during the washing cycle may not spray evenly over all internal surfaces and clean them effectively.

Tight radii, such as at the knuckle or around the rolling rings can create areas inside containers which are difficult to clean.

Top chimbs usually incorporate small drain holes just above the butt-weld which attaches them to the top dome such that extraneous water flows away easily [see figure 7].

■ Materials Selection

Operating environment

The conditions under which casks and kegs must operate will influence the choice of the materials used for the bodies of the containers themselves, any protective interior linings they may have, the synthetics of extractor components and any plastics used for shive or keystone bungs.

Beer has a pH of about 4 when fresh, but this can drop to 3.5 or below if the beer is exposed to oxygen such that it sours, as is inevitable in a traditional cask after dispense. Fresh ciders may have a pH as low as 3.3 and, when oxidized, even below 3. Stainless steel is generally impervious to these levels of acidity, but the oxide layer with which aluminum alloys protect themselves from corrosion is attacked by any pH less than about 4 or over about 9. Aluminum alloy containers are therefore internally lined at manufacture by a sequence of steam-sealing, anodizing and epoxy lacquering. However, if that lacquer lining is broken down (such as may be caused by impact to the keg during handling), then not only can flakes of lacquer get into and jam the extractor valves but also the keg itself can be corrosively attacked. This is most prevalent at exposed welds and can threaten the structural integrity of the container.

Typically, beer contains chlorides at up to 350 mg/l (ppm) and sulphates at up to 300 mg/l. This environment might only be corrosive to stainless steels if combined with an abnormally-high temperature (over about 55ºC), which would itself be deleterious to the beer, and might affect areas such as rolling-rings, which retain high stresses from the manufacturing processes. However, for this reason, stainless steel containers should not be exposed to hot, salty conditions such as exist at the seaside in summer, even when empty.

Even during filling and dispense using mixtures of carbon dioxide and nitrogen, the pressures in kegs should rarely exceed 3 bar (50 psig). All containers made in Europe (whether kegs or casks) are designed for a working pressure of 4 bar (60 psig) and every one is tested at manufacture and after repair to 6 bar (90 psig). In practice, aluminum containers rarely fail at less than 20 bar (300 psig) and stainless steel ones will commonly withstand 70 bar (1000 psig).

During the washing and re-filling processes, steam at up to 145ºC is used to sanitize kegs and this has generally proved to be too high a temperature for synthetics to be used as a material of construction for beer kegs. If steaming is immediately followed by a charge of inert gas to remove all oxygen before the new beer is added, the material of the container can suffer thermal shock from approximately 120ºC down to 0ºC. If steaming follows a cold-water rinse the thermal shock can be from 20ºC to 140ºC. Such sudden changes in temperature can crack the epoxy linings of aluminum kegs, exposing the substrate to subsequent corrosion by the beer.

Commonly, hot 1% phosphoric acid is used to remove process soils from the interiors of metallic kegs and warm 4% phosphoric solution to remove normal dirt from their exteriors. Alternatively, a hot 2% caustic soda solution with EDTA may be used to clean both the interior and exterior of stainless steel containers (but not aluminum ones as it is highly corrosive).

Some lubricants used on conveyors may embrittle synthetics.

Storage temperatures will normally range between 0ºC and 25ºC. However, they may fall to -20ºC if the container is left outside during winter, under which circumstances the 9% expansion of the water content of the beer as it turns to ice can create internal pressures in excess of 27 bar (400 psig); high enough to distend outwards the end domes of stainless containers or burst most aluminum ones (especially at sites of corrosion) and all wooden casks. Such pressures in traditional casks may be relieved by the shive or keystone bungs being blown out, but this cannot be guaranteed to happen, particularly if an ice-plug has formed beneath them first. The temperature of a container may rise to 60ºC if it is left exposed to strong sunshine for extended periods in the summer and this can cause synthetics to soften.

In the event of a fire, the materials of containers should neither ignite easily nor support a flame.

When a container is damaged irreparably or its design becomes obsolete, the material from which it is made must satisfy the European Packaging and Packaging Waste Directive requirements for recyclability.

Materials Selected

During the 1950s, attempts were made in the UK to develop containers which were stronger, cheaper to maintain and more hygienic than timber alone. A number of materials combinations were tried, some more successfully than others:

- A thin stainless steel liner was encased in a wooden cask. This presented to the beer a more hygienic surface than timber alone, but the wood still broke during handling and the stainless steel liner could easily be dented.
- A stainless steel vessel was complete encased in a mild steel jacket. This was known as a "Brown Bomber" and was strong but very heavy. External rusting of the jacket also presented a poor image of the contents.
- A thin stainless steel body had a pair of mild steel chimbs longitudinally bolted together to entrap the vessel. This was quite strong but, again, unacceptably heavy.
- A cylindrical stainless steel body had interference-fit galvanized mild steel chimbs with integral rolling-rings pressed onto each end. This "Sunbrite" design, developed by GKN-Sankey in the UK, is still in service today.

  In the 80s and 90s synthetic materials were introduced:
- Polyurethane was used to jacket thin-walled stainless steel kegs, thereby benefiting from both the advantages of having stainless steel in contact with the beer - but at a thinner, cheaper gauge than would be strong enough to withstand everyday handling on its own - and a synthetic exterior material which could not only be decorative and promotional but also supported the stainless lining whilst making the keg very much quieter to roll around than an all-stainless one. However, these kegs were not only as expensive overall as all-stainless steel ones, but they were also very difficult to repair, particularly if an impact dented them and de-laminated the thin stainless skin from the plastic.
- Under development are all-synthetic kegs made from plastics which can withstand the high stresses imposed during manual handling and the high steam temperatures required to sterilize beer kegs before they are re-filled, but which do not taint the flavor of the beer.

  The two most prevalent materials now, however, are aluminum alloy and stainless steel:

- Aluminum alloys, borrowed from the aircraft industry for their lightness and strength, were introduced in the early 1960s. Initially, container bodies were cast, but these were found over time to deteriorate to the point where they could suffer fast fracture at normal working pressures and so the BBPA's Code of Practice now prohibits the use of cast aluminum for pressure kegs. It may be used for the chimbs welded to the ends of the beer-containing section, but the bodies themselves are manufactured from sheet HE30, a 1% Silicon, 0.7% Magnesium, 0.6% Manganese heat-treatable aluminum alloy. Any welded-on rolling-rings are manufactured from an extruded version of this alloy. Aluminum alloy containers have the advantage of a high specific strength but the disadvantages of high purchase and operating costs. The material requires heat-treatment before and after both manufacture and repair and, to minimize its corrosion by the beer, a series of expensive processes including internal steam-sealing, anodizing, epoxy-lacquer spraying and stoving to provide a barrier between the alloy and the beer. However, this protection is still very susceptible to crazing as a result of impact-damage during handling and delivery of the container. Furthermore, in the case of pressure kegs [see Figure 4], a special design of Barnes Neck is required to insulate the aluminum body of the keg from the stainless steel of the extractor components. It comprises an outer, aluminum bolster welded to the keg body and an interference-fit stainless steel insert (which carries in its bore a female thread for the extractor), the two being separated by an electrically-insulating nylon sleeve. Failure of this sleeve, as is common in service, results in the creation of a galvanic cell, the beer acting as an electrolyte between the stainless steel and the aluminum, and this can increase the rate of general corrosion of the aluminum alloy some thirty times. There is also a significant trade in stolen aluminum beer containers as the material is easily smelted. For these reasons, aluminum containers are almost exclusive to the UK and, indeed, up to the 100-litre (22-gallon) size are being superseded by stainless steel ones.

- Stainless steels are readily formed and welded, robust, totally inert in normal usage, impervious to the most effective internal and external detergents, simple and economic to repair and very safe. Deep-drawing of the bodies now offers higher strength for the same weight and at about half the cost per unit volume which was possible until the 1990s. The most common sheet material used is EN: X5CrNi18/10 (1.4301; AISI 304 - 17 to 19.5% chromium, 8 to 10.5% nickel) and there are now approximately ten million stainless steel beer kegs and casks in service in the UK made from this grade. With its higher resistance to general pitting corrosion EN: X5CrNiMo17/10/2 (1.4436; AISI 316 - 16.5 to 18.5% chromium, 10.5 to 13.0% nickel, 2.5 to 3.0% molybdenum) has been used where the environment was particularly aggressive, such as for ciders to which metabisulphite preservatives had to be added. The 1.4301 series is also used to make the Barnes Necks but here it is important to ensure its compatibility with the materials of the extractors as two such stainless steel components, connected by fine (14 tpi) threads, may gall (or, cold-weld) themselves together unless their individual chemical compositions and their surface topographies and finishes are specified correctly.

■ Manufacture and Repair

Processes and Practices

Aluminum alloys must be solution-treated at over 600ºC before manipulation.

Both stainless steel and aluminum alloy containers were originally manufactured with five major components [see Figure 9], to which the "fittings" (Barnes Necks, shive bushes and keystone bushes as appropriate) were attached. The centre section of the body was formed from rolled sheet, longitudinally welded into a cylinder and then profiled. Two pressed domes were then circumferentially welded on and, to these, the two chimbs were also circumferentially welded. In the 1980s deep-drawing was introduced for both materials, discs being drawn into half-shells to form the centre section, to which the two chimbs were attached, all three welds being circumferential [see Figure 10]. For both materials, deep-drawing reduced the amount of welding necessary, but in the case of stainless steel it had the added advantage that the material was significantly work-hardened between the two knuckles, enhancing the strength of the cylindrical body.

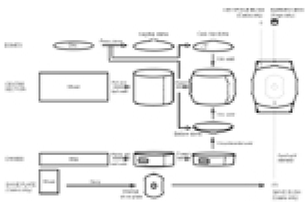

Figure 9: The manufacture of 5-piece metal beer containers.

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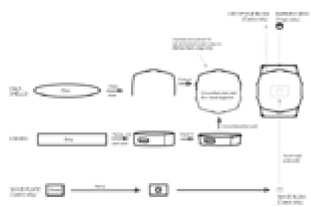

Figure 10: The manufacture of deep-drawn metal beer containers.

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After assembly, aluminum alloy containers are internally steam-sealed, anodized and sprayed with an epoxy-resin lining. They are then heat-treated at approximately 190ºC both to cure that lining and to precipitation-harden the alloy. Stainless steel containers do not require lining, but must be pickled in a 3% hydrofluoric/10% nitric acid to de-scale the welds.

After manufacture, all containers are immersed in water and leak-tested to 40 psig with air, and then pressure-tested to 90 psig hydraulically.

Welding Standards

All welding of aluminum alloy containers is by Gas Metal Arc Welding (sometimes known as 'Metal Inert Gas' welding) which involves a filler wire. All stainless steel welding is Gas Tungsten Arc Welding (sometimes known as 'Tungsten Inert Gas' welding) which does not. Welding standards should control:

- The alignment of components (particularly at butt welds) and the maximum projection of the weld-bead into the beer (both to maximize cleanability);
- Weld penetration (to preclude crevices which could be hygiene hazards);
- Porosity (to maximize strength); and
- Straightness of circumferential weld runs.

Performance in Service

Damage repair

Although stainless steel does suffer more bending and indentation in service than aluminum alloy, it can be straightened again relatively easily and repeatedly. A Cooperage (often sited beside the brewery washer/racker) can hydraulically pull a depressed keg top-dome back up and re-round badly damaged chimbs. However, repairs involving capacity correction, pressure-testing, welding or fitting of new parts are generally carried out by specialist companies external to the brewery.

All repairs to aluminum containers have to be carried out by specialist companies, as the alloy requires re-solution-treatment to soften it before reshaping it, and then re-precipitation hardening.

Corrosion

Once the protective internal lining of an aluminum alloy container is flawed (such as can result from impact damage during handling, or thermal shock, or physical damage when fragments of the wooden shive or keystone bungs are spiked from inside casks), the material will suffer corrosion by the beer. Attack is particularly prevalent at exposed welds (these effectively comprising cast material and therefore having a lower corrosion resistance than the parent plate) and this can ultimately threaten the structural integrity of the keg.

In normal service, stainless steel kegs exhibit no corrosion.

The Future

To meet the continuing demand for traditional ales most UK brewing companies still maintain large stocks of casks, these generally being of 4.5, 9 or 18 gallons capacity. However, existing 36-gallon and 54-gallon casks are generally being replaced by smaller ones, both because of their weight and because of the shorter shelf-life of traditional beers once stillaged and tapped in the cellar which necessitates high sales volumes.

Existing 9- and 18-gallon stainless steel kegs remain in common use, but are being supplemented by deep-drawn 30-litre, 50-litre (11-gallon) and 100-litre (22-gallon) stainless steel kegs.

Glossary

BBPA -- British Beer and Pub Association, the trade association of the UK brewing industry, formerly known as the Brewer's and Licensed Retailer's Association and the Brewer's Society.

Barnes Neck -- A bush welded to the top dome of a metal keg to accept the extractor, which commonly screws into this neck with a 7 tpi or 14 tpi, 2" diameter thread [see Figure 4]. Between the extractor and the neck is a synthetic sealing gasket to hold the gas in the keg.

Barrel -- A volume of 36 Imperial gallons (163.7 liters) which gives its name to a wooden or metal container holding that nominal volume of beer. However, the name "barrel" is often applied colloquially to other sizes of beer or cider container.

Board -- An abbreviation of "Locator Board".

Cask -- A re-usable, dual-aperture storage and transportation container for traditional beers which are not ready to drink when they leave the brewery but must complete their conditioning both in these containers and at the sales outlet [see Figure 1]. Traditional beers (sometimes referred to as "real ales") typically have a low gas-content and can therefore be packaged into such containers which are sealed only by tapered bungs driven into their shive and keystone bushes.

Chimb -- An end-ring formed in a wooden cask by the tips of the staves and in a metallic container usually by a separate component welded to the body [see Figures 2 and 4]. Chimbs provide stability when the container is stood upright and also protect the Barnes Necks of kegs.

Closure -- See "Extractor".

Containers -- The generic term for casks and kegs.

Cooper -- A craftsman who manufactures and repairs wooden beer containers essentially using hand tools.

Cruciform -- A star-shape impressed into each dome of a metal keg to enhance its strength; particularly its resistance to end-loads such as those caused by "topping" or those applied by the "washer/racker" [see Figure 7].

Dimple -- An indentation in the bottom dome of a keg to minimize the volume of beer or cider which cannot be extracted. May also be referred to as a "sump".

Extractor -- A bi-directional valve unit which is fitted into the Barnes Neck of a keg and which remains in place whilst the keg is being cleaned, filled and subsequently emptied [see Figure 4] It features two concentric, spring-loaded valves [see Figure 5], through the outer of which a gas pressure can be applied at dispense to force the beer up the downtube and through the inner valve to the dispense point on the bar [see Figure 6]. May also be referred to as a "spear" or "closure" or "valve".

Firkin -- A beer or cider container with a nominal capacity of 9 Imperial gallons (40.9 liters).

Handhold -- An aperture pierced through the chimb of a container to facilitate its being manhandled [see Figures 2 and 4].

Hogshead -- A beer container with a nominal capacity of 54 Imperial gallons (245.5 liters).

Hoop -- A steel band forced down from the end of a wooden cask towards its belly in order to contain and compress the staves and ensure their water-tightness [see Figure 1].

Keg -- A metallic single-aperture storage and transportation container for Brewery-conditioned beers or ciders which are ready to drink immediately upon arrival at the sales outlet [see Figure 4]. Because such beers and ciders typically have a higher gas-content than traditional ales, they depend upon the pressure-integrity of a metal container to maintain their condition.

Keystone -- A wooden bung driven into the outlet bush of a cask [see Figure 2]. It is replaced each time the cask returns to the Brewery for washing and re-filling.

Kilderkin -- A beer container with a nominal capacity of 18 Imperial gallons (81.8 liters).

Knuckle -- The radius between the dome and the wall of a metallic container.

Locator Board -- A pallet-like component made of timber or plastic on which four or six containers are stacked on end in a rectangular array. Another board is placed on top of the containers and another array of containers on top of that, and so on. Two or three layers of containers at a time (according to their size) may be moved by a fork-lift truck which is fitted with special tines which clamp the sides of the containers with a horizontal pincer-action. In the warehouse, stacks of containers will comprise at least six layers.

psig -- Pounds force per square inch (gauge) - i.e.: above atmospheric pressure.

Pin -- A beer container with a nominal capacity of 4.5 Imperial gallons (20.5 liters).

Rolling rings -- Rings around the belly of a container transverse to its longitudinal axis to provide integral 'wheels' to facilitate its being rolled in a straight line. They are formed either by swaging them out from the material of the wall of the container or by welding on separate components [see Figures 2 and 4].

Roll-over bead -- The curling-over of the extremity of the chimb of a metallic container to form a bead which provides a comfortable and safe area to grasp the container, add strength to the chimb and offer a firm ring on which the container can be stood [see Figure 7].

Shive -- A wooden (or, latterly, plastic) bung driven into the inlet bush of a cask [see Figure 2]. It is replaced each time the cask returns to the Brewery for washing and re-filling.

Spear -- See "Extractor".

Staves -- Shaped strips of oak, longitudinal to the axis of a cask and held tightly together by horizontal steel hoops [see Figure 1].

Stillage -- A wooden, brick or concrete cradle in the cellar of a public house on which casks are laid essentially horizontally while the conditioning process is completed and the sediment of their traditional ale settles into the belly of the cask, leaving the beer clear and ready to drink [see Figures 1 and 3].

tpi -- Threads per inch.

Topping -- The practice of stacking a small container which is horizontal on top of a larger container which is vertical (i.e.: standing on one end) in order to save space on a delivery vehicle bed.

Washer/racker -- The item of plant in a Brewery which automatically cleans and re-fills metallic beer kegs. It manipulates the kegs and locates emptying- and filling-heads onto their Barnes Necks by means of pneumatic rams.

Valve -- See "Extractor".

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