

Case Studies

Aluminum Beverage Can

Background

- 300 million cans/day (~5 cans/sec) – 100 billion/year
- Totally replaced steel can (30 billion in 1973)
- Can weight 13.6g (0.48 oz) down from 18.7 g (0.66oz) in 1960
- Save 1% wt in can = ~\$20 million in Al
- Al used in can required 2.3 MJ energy to produce (=100W bulb lit for 6hrs)
- Cans now 20% Al production: 1/3 beer, 2/3 soft drink
- Walls ~0.003" = 0.075mm (can take 90 psi)
- Steel cans still widely used in South America, Europe and Asia

Alloys used in aluminum can

Body: AA3004 (Al-1.2%Mg-1.0%Mn) → Formability

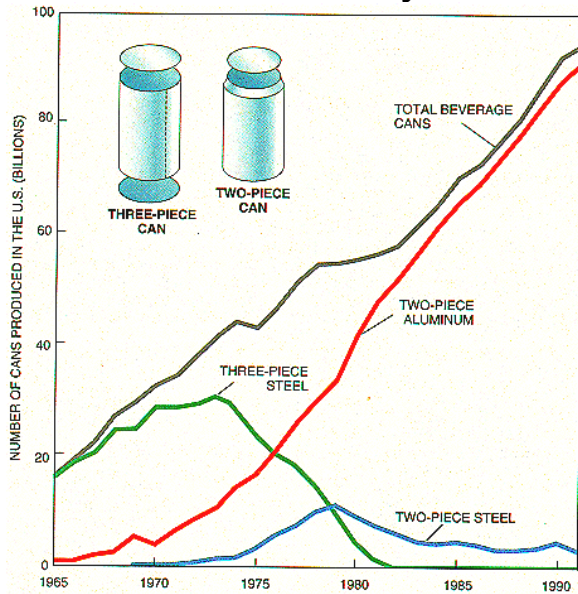
Top: AA5182 (Al-4.5%Mg) → Strength

Tab: AA5052 (Al-2.5%Mg) → Strength

History

- 1935 1st three piece steel beverage can Kreuger Brewing (Richmond, Va)
- 1940's Government shipped quantities of beer in steel cans to servicemen overseas
- 1958 1st aluminum beverage can Adolph Coors - Golden Colorado
- 1963 Reynolds metals pioneers modern method to produce Al cans
- 1996 Al has virtually displaced steel in all beverage cans

History

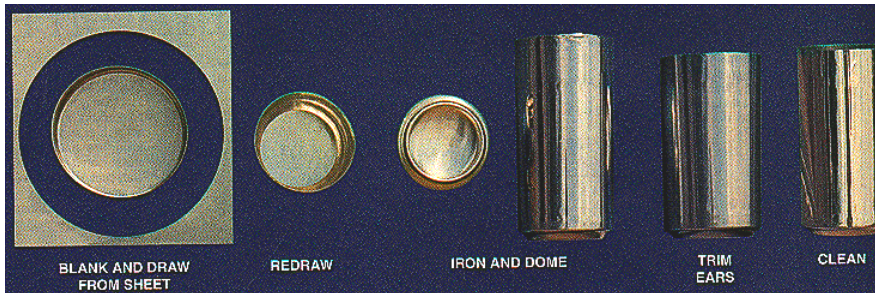


Early advertisement marketing pull-top Al can (~1960's)

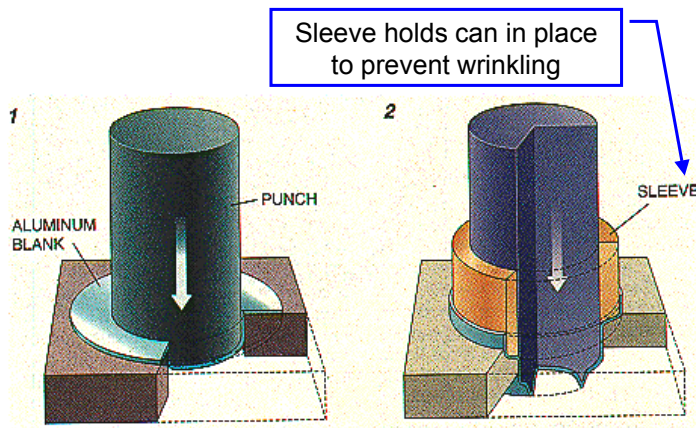


Production of aluminum cans

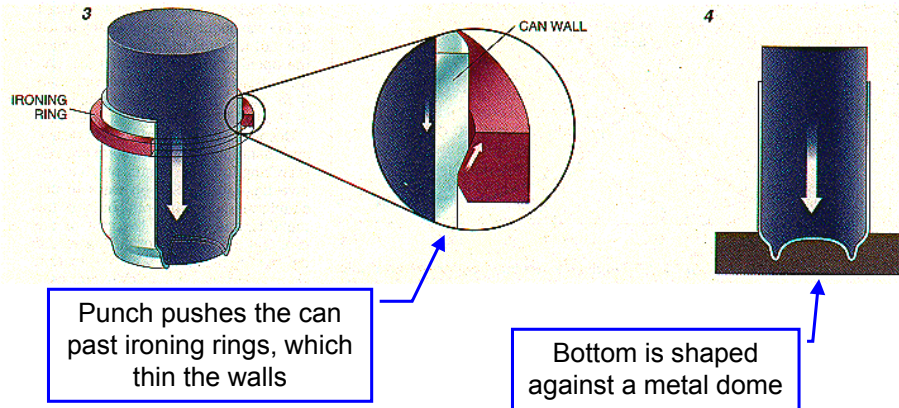
- 2 piece drawing and ironing
 - Starts with sheet in the H19 condition
- Process
 - Cut circular blanks (5.5" dia.)
 - Draw into 3.5" dia. Cup (with punch)
 - Drawing and ironing operation
 - Base formed against metal dome: **all in ~0.2 seconds!**



Drawing



Ironing



Labelling



After the "ears" at the top of the walls are trimmed, the can is cleaned, decorated and then "necked" to accommodate the smaller lid. The top is flanged to secure the lid. Once filled and seamed shut, the can is ready for sale.

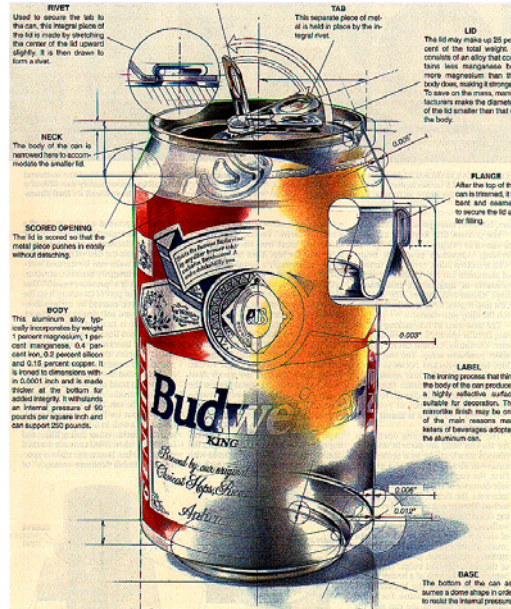
Properties

- Body thickness: $0.3\text{mm} \pm 0.005\text{ mm}$
 - (~2 sheets of paper)
- Can weight: 11 grams
- Pressure in can: $>620\text{ KPa}$
 - (~3x Pressure in car tyre)
- Body can support 100 Kg (column strength)

Design considerations

- Lid must be stiffer than the body
 - Thicker and stronger alloy (~25% of the weight)
 - Decrease diameter of lid
- Need strong yet formable sheet alloys
 - a) Mn + Mg solid solution hardening: 3104, 3004
 - b) Intermetallics Fe+Mn compounds harder than alloy therefore strengthening dispersion hardening → galling
 - c) Cold rolling of sheet (strain hardening)
- Base of can must resist internal pressure:
 - Base and bottom sidewalls are made thicker than any other part of the wall
 - Bottom given a dome shape to resist internal pressure

Design consideration



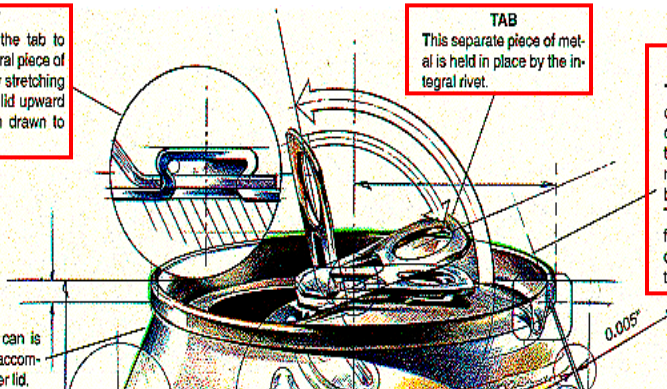
Top

RIVET
Used to secure the tab to the can, this integral piece of the lid is made by stretching the center of the lid upward slightly. It is then drawn to form a rivet.

TAB
This separate piece of metal is held in place by the integral rivet.

LID
The lid may make up 25 percent of the total weight. It consists of an alloy that contains less manganese but more magnesium than the body does, making it stronger. To save on the mass, manufacturers make the diameter of the lid smaller than that of the body.

NECK
The body of the can is narrowed here to accommodate the smaller lid.



Neck flange and opening

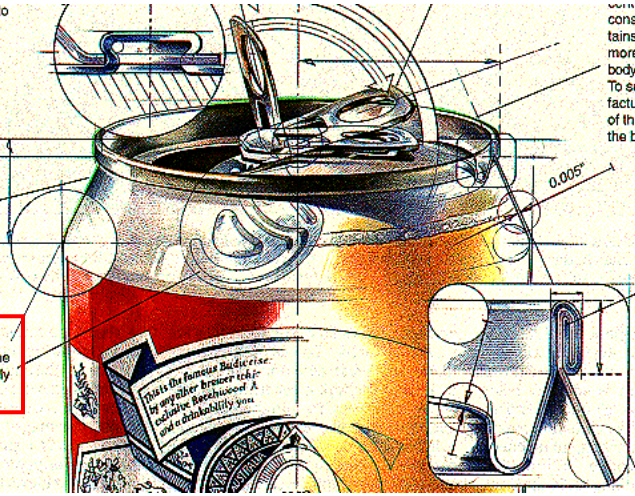
slightly. It is then drawn to form a rivet.

Both the neck and flange consist of an alloy that contains less manganese but more magnesium than the body does, making it stronger. To save on the mass, manufacturers make the diameter of the lid smaller than that of the body.

NECK
The body of the can is narrowed here to accommodate the smaller lid.

SCORED OPENING
The lid is scored so that the metal piece pushes in easily without detaching.

FLANGE
After the top of the can is trimmed, it is bent and seamed to secure the lid after filling.



Body, base and label

BODY
This aluminum alloy typically incorporates by weight 1 percent magnesium, 1 percent manganese, 0.4 percent iron, 0.2 percent silicon and 0.15 percent copper. It is ironed to dimensions within 0.0001 inch and is made thicker at the bottom for added integrity. It withstands an internal pressure of 90 pounds per square inch and can support 250 pounds.

LABEL
The ironing process that thins the body of the can produces a highly reflective surface suitable for decoration. The mirrorlike finish may be one of the main reasons marketers of beverages adopted the aluminum can.

BASE
The bottom of the can assumes a dome shape in order to resist the internal pressure.

