



(11) **EP 3 302 846 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:
12.02.2020 Bulletin 2020/07

(51) Int Cl.:
B21D 26/049 ^(2011.01) **B21D 26/053** ^(2011.01)

(21) Application number: **16728186.4**

(86) International application number:
PCT/US2016/034214

(22) Date of filing: **26.05.2016**

(87) International publication number:
WO 2016/191513 (01.12.2016 Gazette 2016/48)

(54) **HIGH SPEED BLOW FORMING PROCESS TO SHAPE ALUMINUM CONTAINERS USING 3XXX ALLOYS WITH HIGH RECYCLE CONTENT**

HOCHGESCHWINDIGKEITSBLASFORMVERFAHREN ZUR FORMUNG VON
ALUMINIUMBEHÄLTERN MIT 3XXX-LEGIERUNGEN MIT HOHEM RECYCLINGANTEIL

PROCÉDÉ DE FORMAGE PAR SOUFFLAGE À GRANDE VITESSE POUR METTRE EN FORME
DES RÉCIPIENTS EN ALUMINIUM EN UTILISANT DES ALLIAGES 3XXX AVEC UNE TENEUR
ÉLEVÉE EN PRODUIT RECYCLÉ

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

- **LEHMAN, Robert**
Marietta, GA 30066 (US)
- **MALLORY, Robert, William**
Dallas, GA 30132 (US)
- **GO, Johnson**
Marietta, GA 30068 (US)

(30) Priority: **26.05.2015 US 201562166212 P**

(43) Date of publication of application:
11.04.2018 Bulletin 2018/15

(74) Representative: **Weickmann & Weickmann**
PartmbB
Postfach 860 820
81635 München (DE)

(73) Proprietor: **Novelis, Inc.**
Atlanta, GA 30326 (US)

(72) Inventors:
• **CUTTER, Christopher**
Wesley Chapel, FL 33545 (US)

(56) References cited:
US-A- 3 896 648 US-A1- 2013 167 607
US-B2- 8 683 837

EP 3 302 846 B1

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 62/166,212, filed May 26, 2015.

FIELD

[0002] This disclosure provides a high-speed blow forming process for shaping aluminium containers using 3xxx can body stock alloys with high recycled content.

BACKGROUND

[0003] Metal cans are well known and widely used for beverages. Conventional beverage can bodies generally have simple upright cylindrical side walls. It is sometimes desired, however, for reasons of aesthetics, consumer appeal and/or product identification, to impart a different and more complex shape to the side wall and/or bottom of a metal beverage container, and in particular, to provide a metal container with the shape of a bottle rather than an ordinary cylindrical can shape.

[0004] Methods of pressure forming metal containers from preforms are known in the art as described, for example, in U.S. Patent No. 8,683,837, which discloses a process for shaping aluminium containers comprising the sequential steps of: placing a bottle preform into a mold cavity; injecting gas into the preform to expand the preform into the mold; and applying an axial load to the bottle preform using a backing ram. A further similar process is disclosed by US 3 896 648 A. There is a demand, however, for rapid production of aluminium containers using metal with a high recycled content.

[0005] A method according to claim 1 provides a solution for rapid production of aluminium containers using metal with a high recycled content.

SUMMARY

[0006] The methods described herein provide an efficient, high-speed blow-forming process for shaping aluminium containers using conventional 3xxx can body stock alloys with high recycled content. For example, the methods may be carried out on alloys having recycled content as high as 50 wt. % to 100 wt. %.

[0007] This disclosure provides methods for high-temperature and low-temperature 3xxx series aluminium blow forming of fully or partially annealed aluminium alloy draw-and-iron (D&I) preforms. A preform is a hollow workpiece typically having an open end opposite a closed end and a generally cylindrical wall. A D&I preform is a preform made by a D&I process.

[0008] Preforms used in the methods described herein typically have a diameter of about 63.5 mm (2.5 inches (in)) to about 76.2 mm (3.0 in), a height of about 254.0

mm (10.0 in) to about 317.5 mm (12.5 in), a wall thickness of about 0.1524 mm (0.006 in) to about 0.508 mm (0.020 in), and a dome depth of about 10.16 mm (0.400 in) to about 25.4 mm (1.00 in).

[0009] Preforms used in the methods described herein can be either coated or uncoated depending on the application. For example, a conventional can coating system can be applied on the preforms. A conventional can coating system comprises inside spray, ink and over-varnish.

[0010] This disclosure provides methods for aluminium forming at temperatures ranging from ambient temperature (i.e., between about 18 °C - about 25 °C) up to about 300 °C and provides methods for preform expansion to a diameter up to 40% larger than the original preform diameter. This disclosure provides methods for a low-pressure forming operation that operates up to 420 psi (≈30 bars), with the use of a single segment split mold.

[0011] The methods disclosed herein are commercially valuable because they use blow-forming to expand preforms made by a D&I process. The D&I process is more efficient than the alternative impact extrusion (IE) process. The D&I process is capable of running at a considerably higher production speed than the IE process, which makes the D&I process an economical option for a high-speed, large-volume production plant. Moreover, the D&I process can be carried out on alloys having a high recycled content. Because of the large amount of deformation required, the IE process requires the use of high-purity 1xxx series aluminium alloys, which are not recycle friendly. Thus, the disclosed methods are advantageous over conventional methods, at least because in those conventional methods aluminium bottles are manufactured by the impact extrusion (IE) process.

[0012] The blow-forming methods described herein use high pressure gas to expand an aluminium preform to fit a negative mold. The disclosed methods also could be applied to a product line employing hydroforming, which uses a liquid in place of the gas used in blow forming.

[0013] In some examples, a process for shaping aluminium containers includes the sequential steps of blanking out a disk from a sheet of a 3xxx series aluminium alloy; forming a bottle preform by drawing, redrawing, ironing, and doming the cup; placing the preform into a mold cavity; applying an axial load to the preform; and injecting an inert gas into the interior of the preform with sufficient pressure until the preform expands to fill the mold cavity. Optionally, the sheet has a thickness in the range of about 0.381 mm (0.0150 in) to about 0.635 mm (0.0250 in). Optionally, the disk has a diameter in the range of about 152.4 mm (6.0 in) to about 241.3 mm (9.5 in).

[0014] In some examples, the preform is heated to a forming temperature prior to injecting the inert gas. In some cases, the forming temperature is about 200 °C to about 300 °C. In some cases, the forming temperature is about 250 °C to about 255 °C, or nominally 250 °C.

When the process includes heating the preform to a forming temperature, the heating may be carried out while the preform is under the axial load. That is, the heating may be carried out while the axial load is applied. The axial load prevents the preform from expanding in the axial direction, but the axial load does not compress (i.e., reduce the length of) the preform.

[0015] The inert gas is injected after a preset axial load is reached. In some examples, the preset axial load is in the range of about 488.243 to 1220.61 kg/m² (100 to 250 lb/ft²). As the preform expands, the axial load decreases, so the injected gas applies pressure to the preform at a controlled rate.

[0016] In some examples, the preform may be annealed before it is placed in a mold cavity. In some cases, the annealing temperature is from about 100 °C to about 400 °C. In some cases, the annealing temperature is from about 300 °C to about 400 °C.

[0017] Also included within the scope of this disclosure are aluminium bottles made by any method disclosed herein.

[0018] The flexibility of the methods disclosed herein allows for production of elaborate designs in the aluminium bottle market, which would be difficult with other aluminium forming methods, for example mechanical shaping.

BRIEF DESCRIPTION OF THE FIGURES

[0019]

Figure 1 is an illustration of a mold cavity according to the methods described herein.

Figure 2 is a schematic of a blow forming process according to the methods described herein.

Figure 3 is a graph of the forming parameters of a D&I preform upon expansion to fill a mold during a high-speed blow-forming process.

DETAILED DESCRIPTION

[0020] The methods described herein provide shaped aluminium bottles from conventional 3xxx can body stock alloys with up to 100% recycled content. In some cases, the methods include manufacturing a preform having a wall, a closed end, and an open end by a D&I process and expanding the preform into a shaped container by high-speed blow forming.

[0021] By way of example, but not limitation, a disk is blanked out of an aluminium sheet. The blank may be formed by any method known in the art, such as by punching or cutting. In one embodiment an outer cutting tool cuts a 3xxx series aluminium sheet having a thickness ranging from about 0.381 mm (0.0150 in) to about 0.635 mm (0.0250 in) (e.g., 0.381 mm (0.0150 in) to 0.508 mm (0.0200 in), 0.4572 mm (0.0180 in) to 0.508 mm (0.0200

in), 0.4572 mm (0.0180 in) to 0.635 mm (0.0250 in), or 0.508 to 0.635 mm (0.0200 to 0.0250 in)), into a disk, and the disk is immediately drawn into a cup. The disk may be drawn into a cup with an inner cup forming tool.

5 The cutting and drawing is carried out by a double action press, where the first action performs disk cutting and the second action performs cup forming in a continuous motion. To provide sufficient material for aluminium bottles, including large format aluminium bottles, the cut-out disk may have a diameter ranging from about 152.4 mm (6.0 in) to about 254.0 mm (10.0 in) (e.g., 152.4 mm (6.0 in), 157.48 mm (6.2 in), 165.1 mm (6.5 in), 170.18 mm (6.7 in), 177.8 mm (7.0 in), 182.88 mm (7.2 in), 190.5 mm (7.5 in), 195.58 mm (7.7 in), 203.2 mm (8.0 in), 208.28 mm (8.2 in), 215.9 mm (8.5 in), 220.98 mm (8.7 in), 228.6 mm (9.0 in), 233.68 mm (9.2 in), 241.3 mm (9.5 in), 246.38 mm (9.7 in), or 254.0 mm (10.0 in).)

[0022] The formed cup has a fairly large diameter that requires further operation to reduce its size to a smaller diameter to facilitate subsequent operations. This is accomplished by a redraw process. A suitable redraw process for the methods described herein includes, for example, the direct redraw process wherein the cup is drawn from inside of the cup base by using similar cup forming tools to reduce its diameter and displace the material to form a taller cup wall. Another suitable redraw process for use in the methods described herein is the reverse redraw process wherein the cup is drawn from the bottom of the cup and metal is folded in an opposite direction to form the taller cup wall. The methods disclosed herein may include either of these preform redraw processes, but are not limited to these redraw processes. Depending on machine requirements, limitations, and process requirements, there may be multiple redraw processes or combinations of redraw processes.

[0023] Once the cup is drawn to a final bottle preform diameter, an ironing tool will stretch and thin the cup wall to achieve the final preform wall thickness and length. At the end of the D&I process, a doming operation is performed wherein the bottom of the preform, i.e., the dome profile, is formed. For use in the blow forming process described herein, the final preform may have a diameter ranging from about 50.8 mm (2.0 in) to about 88.9 mm (3.5 in) (e.g., 50.8 mm (2.0 in) to 76.2 mm (3.0 in), or 63.5 mm (2.5 in) to 88.9 mm (3.5 in)) and may be as tall as about 254.0 mm (10.0 in) to about 317.5 mm (12.5 in) (e.g., 254.0 mm (10.0 in), 266.7 mm (10.5 in), 279.4 mm (11.0 in), 292.1 mm (11.5 in), 304.8 mm (12.0 in), or 317.5 mm (12.5 in)). The preform wall has a thickness ranging from about 0.1524 mm (0.006 in) to about 0.508 mm (0.020 in) (e.g., 0.1524 mm (0.006 in), 0.1778 mm (0.007 in), 0.2032 mm (0.008 in), 0.2286 mm (0.009 in), 0.254 mm (0.010 in), 0.3048 mm (0.012 in), 0.3556 mm (0.014 in), 0.4064 mm (0.016 in), 0.4572 mm (0.018 in), or 0.508 mm (0.020 in)). In some cases, the preform may have a constant wall thickness of about 0.254 mm (0.010 in) to about 0.508 mm (0.020 in) (e.g., 0.3048 mm (0.012 in), 0.3556 mm (0.014 in), 0.4064 mm (0.016 in), or 0.4572

mm (0.018 in)). In other cases, the bottle preform may have a variable wall thickness with a thicker portion at the top of about 0.254 mm (0.010 in) to about 0.508 mm (0.020 in) (e.g., 0.254 mm (0.010 in), 0.3048 mm (0.012 in), 0.3556 mm (0.014 in), 0.4064 mm (0.016 in), 0.4572 mm (0.018 in), or 0.508 mm (0.020 in)) and a thinner portion in the middle of about 0.1524 mm (0.006 in) to about 0.3048 mm (0.012 in) (e.g., 0.1524 mm (0.006 in), 0.1778 mm (0.007 in), 0.2032 mm (0.008 in), 0.2286 mm (0.009 in), 0.254 mm (0.010 in), or 0.3048 mm (0.012 in)). The preform dome has a depth from about 10.16 mm (0.400 in) to about 25.4 mm (1.00 in) (e.g., 10.16 mm (0.400 in), 12.7 mm (0.500 in), 15.24 mm (0.600 in), 17.78 mm (0.700 in), 20.32 mm (0.800 in), 22.86 mm (0.900 in), or 25.4 mm (1.00 in)).

[0024] During the preform forming process, the preform may be subjected to an optional annealing operation with a temperature ranging from about 100 °C to about 400 °C (e.g., 100 °C - 300 °C, 100 °C - 200 °C, 200 °C - 400 °C, 200 °C - 300 °C, or 300 °C - 400 °C for a duration ranging from about 1 minute to about 3 hours (e.g., 1 minute - 1 hour, 1 minute - 30 minutes, 5 minutes - 20 minutes, 1 hour - 3 hours, 2 hours - 3 hours, or 1 hour - 2 hours). The annealing process may be performed to improve metal formability. In certain cases, the annealing process may have a duration ranging from about 1 hour to about 3 hours. In other cases, the annealing process may range from about 1 minute up to about 30 minutes. The annealing operation may be added during aluminium sheet production or during one or more preform production steps. The annealing process may be applied locally to a specific portion of the preform. For example, the annealing process may be applied to the neck portion of the bottle, to the body portion of the bottle, to the base portion of the bottle, or any combination thereof. The annealing process may also be applied to selective portions of the aluminium sheet before it is processed into a preform. Consequently, a gradient of mechanical properties is induced along the height of the sidewall of the preforms. Alternatively, the annealing step may be applied as an intermediate step in the necking and shaping progression operations.

[0025] In some examples, the methods provide high-speed blow forming processes for shaping D&I preforms of conventional 3xxx can body stock alloys with high recycled content. The recycled content may be present in an amount of up to 100 wt. % of the alloy. In some cases, the recycled content may be present from 50 wt. % to 100 wt. % of the alloy (e.g., 50 wt. %, 55 wt. %, 60 wt. %, 65 wt. %, 70 wt. %, 75 wt. %, 80 wt. %, 85 wt. %, 90 wt. %, 95 wt. %, or 100 wt. %).

[0026] In one example, standard AA3104 can body stock alloys are used. Other non-limiting alloys that may be used in the methods disclosed herein are AA3003, AA3004, AA3105, and AA3204.

[0027] In one non-limiting example, a preform optionally is annealed in a box furnace prior to blow-forming. After optional annealing, the preform is placed in a mold

cavity for blow forming. The mold cavity typically has a long axis. The preform also has a long axis and is disposed substantially coaxially within the mold cavity. Optionally, the mold cavity is part of a split mold, i.e., a mold made up of two or more mating segments around the periphery of the mold cavity, separable for removal of the formed container. With a split mold, the defined shape may be asymmetric about the long axis of the cavity.

[0028] In one example, a high-speed blow forming process uses an ambient or heated mold cavity. In the case of the heated mold cavity, a controlled temperature gradient may be used, such that the temperature of the mold cavity varies about 5 °C to 10 °C (e.g., 5 °C, 6 °C, 7 °C, 8 °C, 9 °C, or 10 °C) from the top to the bottom of the preform. In practice, the top and bottom of the mold cavity are heated to temperatures from about 200 °C to 300 °C (e.g., 200 °C, 220 °C, 240 °C, 260 °C, 280 °C, or 300 °C), with the bottom being 5 °C to 10 °C higher than the top. In some examples, a mold apparatus includes a split mold having two halves (left and right), a backing ram (bottom), and a preform seal (top). In addition to the mold cavity being heated, the backing ram and preform seal may also be heated. When the backing ram and seal are heated, the backing ram is generally heated to a temperature from about 215 °C to about 335 °C (215 °C, 225 °C, 235 °C, 245 °C, 255 °C, 265 °C, 275 °C, 285 °C, 295 °C, 305 °C, 315 °C, 325 °C, or 335 °C), and the preform seal is generally heated to a temperature similar to the upper portion of the mold cavity, for example, to about 180 °C to 320 °C (e.g., 180 °C, 200 °C, 220 °C, 240 °C, 260 °C, 280 °C, 300 °C, or 320 °C). Figure 1 is a schematic of a mold cavity showing one half of a split mold 110 and a backing ram 120.

[0029] Figure 2 is a schematic of a blow-forming process. During a blow-forming process, a mold cavity 210, a backing ram 220, and a preform seal 230 enclose a preform 240 as shown in Fig. 2, panel A. The backing ram 220 places an axial load indicated by arrow 250 on the preform 240 while the preform 240 is heated to its forming temperature, as shown in Fig. 2, panel B. The axial load typically is in the range of 488.243 kg/m² (100 lb/ft²) to 1220.61 kg/m² (250 lb/ft²) (e.g., 488.243 kg/m² (100 lb/ft²), 610.303 kg/m² (125 lb/ft²), 732.364 kg/m² (150 lb/ft²), 854.425 kg/m² (175 lb/ft²), 976.486 kg/m² (200 lb/ft²), 1098.55 kg/m² (225 lb/ft²), or 1220.61 kg/m² (250 lb/ft²)). Although the backing ram 220 exerts a load on the preform 240, there is no significant compression, or reduction in length, of the preform. The displacement of the backing ram 220 is about 0 mm (0 in) to about 1.27 mm (0.050 in) (e.g., 0.635 mm (0.025 in) - 1.27 mm (0.05 in)). The backing ram 220 is essentially stationary once in place in contact with the preform dome and during the molding process.

[0030] Once the forming temperature is reached, the preform 240 is pressurized with an inert gas 260, such as nitrogen, until the preform 240 expands to completely fill the mold cavity 210, as shown in Fig. 2, panels C and D. The blowing pressure is applied to the preform at a

controlled rate. As the preform 240 expands, the axial load decreases.

[0031] In one non-limiting example, for a preform nominal temperature of 250 °C, the upper portion of the mold cavity is heated to 250 °C and the bottom portion of the mold cavity is heated to 255 °C. The seal is heated to 250 °C and the backing ram is heated to 275 °C. During the forming process, the four parts (i.e., the two halves of the mold, the backing ram, and the seal) enclose the preform. An axial load of about 297.683 kg/m (200 lb/foot) is placed on the preform while the preform is heated to its forming temperature. Once the forming temperature is reached, the preform is pressurized with nitrogen until the mold cavity is filled.

[0032] Optionally, a blow forming method may be carried out at ambient temperatures, i.e., without heating the mold apparatus. When forming under ambient temperature conditions, for example 23 °C, the preform is immediately pressurized with an inert gas once the preset axial load is reached. The pressurization rate is approximately 1 second and the pressure is held until the blow formed preform completely fills the mold cavity.

[0033] The split mold expansions increase in diameter up to 40% larger than the original diameter (e.g., 15 %, 20%, 25%, 30%, 35%, or 40%). The forming temperature ranges from ambient temperature, for example about 23 °C, to about 300 °C (e.g., 23 °C - 100 °C, 23 °C - 200 °C, 100 °C - 300 °C, or 200 °C - 300 °C).

[0034] Figure 3 is a graph showing change in forming parameters over time as a D&I preform was expanded to a straight wall mold in a high-speed blow forming process. The fully formed bottle had a 40% expansion (to 2.933 in final diameter). This bottle was formed at a nominal temperature of 250 °C with a 5 °C temperature gradient from the top to the bottom of the preform, i.e., the temperature at the top of the preform was 250 °C and the temperature at the bottom of the preform was 255 °C. As shown in Figure 3, the entire forming process for making the straight wall container took approximately 5 seconds.

[0035] The shaped aluminium containers described herein may be used for beverages including, but not limited to, soft drinks, water, beer, wine, energy drinks, and other beverages.

Claims

1. A process for shaping aluminium containers comprising the sequential steps of:

blanking out a disk from a sheet of a 3xxx series aluminium alloy;
forming a bottle preform (240) by drawing, re-drawing, ironing, and doming the disk;
placing the bottle preform (240) into a mold cavity (110; 210);
applying an axial load (250) to the bottle preform

(240) using a backing ram (120; 220), wherein application of the axial load (250) does not reduce the length of the preform (240), and wherein the backing ram (120; 220) is held essentially stationary while applying the axial load (250), undergoing a displacement of between about 0 mm (0 inches) and about 1.27 mm (0.05 inches); and
injecting an inert gas (260) into an interior of the bottle preform (240) with pressure until the bottle preform (240) expands to fill the mold cavity (110; 210).

2. The process of claim 1, wherein the sheet has a thickness ranging from about 0.381 mm (0.0150 in) to about 0.635 mm (0.0250 in), preferably from about 0.4572 mm (0.0180 in) to about 0.635 mm (0.025 in), more preferably from about 0.508 mm (0.0200 in) to about 0.635 mm (0.025 in).
3. The process of claim 1 or claim 2, wherein the disk has a diameter ranging from about 152.4 mm (6.0 in) to about 254.0 mm (10.00 in), preferably from about 152.4 mm (6.0 in) to about 177.8 mm (7.0 in) or from about 203.2 mm (8.0 in) to about 241.3 mm (9.50 in).
4. The process of any of claims 1-3, further comprising heating the bottle preform (240) to a forming temperature prior to injecting the inert gas (260).
5. The process of claim 4, wherein the forming temperature is from about 200 °C to about 300 °C, preferably from about 250 °C to about 255 °C.
6. The process of claim 4, wherein the bottle preform (240) has a top and a bottom, wherein the forming temperature comprises a temperature gradient from the top to the bottom of the preform (240), and wherein the forming temperature at the bottom of the preform (240) is from 5 °C to 10 °C higher than the forming temperature at the top of the preform (240).
7. The process of any of claims 4-6, wherein the heating is carried out while the axial load (250) is applied.
8. The process of any of claims 1-7, wherein the inert gas (260) is injected after a preset axial load (250) is reached.
9. The process of any of claims 1-8, wherein the 3xxx alloy is selected from the group consisting of AA3104, AA3003, AA3004, and AA3105.
10. The process of any of claims 1-9, wherein the 3xxx alloy includes at least 50 wt. % recycled material.
11. The process of any of claims 1-10, further comprising

fully or partially annealing the bottle preform (240) prior to placing the bottle preform (240) in the mold cavity (110; 210).

12. The process of claim 11, wherein the annealing temperature is from about 100 °C to about 400 °C, preferably from about 300 °C to about 400 °C.

13. The process of any of claims 1-12, wherein the bottle preform (240) has:

a diameter of about 63.5 mm (2.5 in) to about 76.2 mm (3.0 in);
a height of about 254.0 mm (10.0 in) to about 317.5 mm (12.5 in);
a wall thickness of about 0.1524 mm (0.006 in) to about 0.508 mm (0.020 in); and
a depth of dome from about 10.16 mm (0.400 in) to about 25.4 mm (1.00 in).

Patentansprüche

1. Verfahren zum Ausformen von Aluminiumbehältern, umfassend die folgenden aufeinanderfolgenden Schritte:

Ausstanzen einer Scheibe aus einem Blech aus einer 3xxx-Serie-Aluminiumlegierung;
Formen einer Flaschenvorform (240) durch Ziehen, erneut Ziehen, Tiefziehen und Wölben der Scheibe;
Platzieren der Flaschenvorform (240) in einem Formhohlraum (110; 210);
Aufbringen einer axialen Last (250) auf die Flaschenvorform (240) unter Verwendung eines Stützstößels (120; 220), wobei das Aufbringen der axialen Last (250) die Länge der Vorform (240) nicht verringert und wobei der Stützstößel (120; 220) im Wesentlichen stationär gehalten wird, während die axiale Last (250) aufgebracht wird, und dabei einer Verschiebung zwischen etwa 0 mm (0 Inch) und etwa 1,27 mm (0,05 Inch) unterzogen wird; und
Injizieren eines Inertgases (260) in ein Inneres der Flaschenvorform (240) mit Druck, bis sich die Flaschenvorform (240) derart ausdehnt, dass sie den Formhohlraum (110; 210) ausfüllt.

2. Verfahren nach Anspruch 1, wobei das Blech eine Dicke aufweist, welche von etwa 0,381 mm (0,0150 Inch) bis etwa 0,635 mm (0,0250 Inch), vorzugsweise von etwa 0,4572 mm (0,0180 Inch) bis etwa 0,635 mm (0,025 Inch), noch bevorzugter von etwa 0,508 mm (0,0200 Inch) bis etwa 0,635 mm (0,025 Inch), reicht.

3. Verfahren nach Anspruch 1 oder 2, wobei die Schei-

be einen Durchmesser aufweist, welcher von etwa 152,4 mm (6,0 Inch) bis etwa 254,0 mm (10,00 Inch), vorzugsweise von etwa 152,4 mm (6,0 Inch) bis etwa 177,8 mm (7,0 Inch) oder von etwa 203,2 mm (8,0 Inch) bis etwa 241,3 mm (9,5 Inch), reicht.

4. Verfahren nach einem der Ansprüche 1-3, ferner umfassend ein Erwärmen der Flaschenvorform (240) bis zu einer Formungstemperatur vor dem Injizieren des Inertgases (260).

5. Verfahren nach Anspruch 4, wobei die Formungstemperatur etwa 200 °C bis etwa 300 °C, vorzugsweise etwa 250 °C bis etwa 255 °C, beträgt.

6. Verfahren nach Anspruch 4, wobei die Flaschenvorform (240) ein oberes Ende und ein unteres Ende aufweist, wobei die Formungstemperatur von dem oberen Ende zu dem unteren Ende der Vorform (240) einen Temperaturgradienten umfasst und wobei die Formungstemperatur an dem unteren Ende der Vorform (240) 5 °C bis 10 °C höher als die Formungstemperatur an dem oberen Ende der Vorform (240) ist.

7. Verfahren nach einem der Ansprüche 4-6, wobei das Erwärmen durchgeführt wird, während die axiale Last (250) aufgebracht wird.

8. Verfahren nach einem der Ansprüche 1-7, wobei das Inertgas (260) injiziert wird, nachdem eine vorbestimmte axiale Last (250) erreicht worden ist.

9. Verfahren nach einem der Ansprüche 1-8, wobei die 3xxx-Legierung aus der Gruppe, bestehend aus AA3104, AA3003, AA3004 und AA3105, ausgewählt wird.

10. Verfahren nach einem der Ansprüche 1-9, wobei die 3xxx-Legierung wenigstens 50 Gew.-% recyceltes Material umfasst.

11. Verfahren nach einem der Ansprüche 1-10, ferner umfassend ein vollständiges oder teilweises Anlassen der Flaschenvorform (240) vor dem Platzieren der Flaschenvorform (240) in dem Formhohlraum (110; 210).

12. Verfahren nach Anspruch 11, wobei die Anlasstemperatur etwa 100 °C bis etwa 400 °C, vorzugsweise etwa 300 °C bis etwa 400 °C, beträgt.

13. Verfahren nach einem der Ansprüche 1-12, wobei die Flaschenvorform (240) aufweist:

einen Durchmesser von etwa 63,5 mm (2,5 Inch) bis etwa 76,2 mm (3,0 Inch);
eine Höhe von etwa 254,0 mm (10,0 Inch) bis

etwa 317,5 mm (12,5 Inch);
eine Wanddicke von etwa 0,1524 mm (0,006 Inch) bis etwa 0,508 mm (0,020 Inch); und
eine Wölbungstiefe von etwa 10,16 mm (0,400 Inch) bis etwa 25,4 mm (1,00 Inch).

Revendications

1. Processus pour mettre en forme des contenants en aluminium comprenant les étapes séquentielles consistant à :

découper un disque à partir d'une tôle d'un alliage d'aluminium de série 3xxx ;
former une préforme de bouteille (240) par étirage, ré-étirage, emboutissage, et bombement du disque ;
placer la préforme de bouteille (240) dans une cavité de moule (110 ; 210) ;
appliquer une charge axiale (250) à la préforme de bouteille (240) à l'aide d'un vérin de renfort (120 ; 220), dans lequel l'application de la charge axiale (250) ne réduit pas la longueur de la préforme (240), et dans lequel le vérin de renfort (120 ; 220) est maintenu essentiellement statique pendant l'application de la charge axiale (250), subissant un déplacement compris entre environ 0 mm (0 pouce) et environ 1,27 mm (0,05 pouce) ; et
injecter un gaz inerte (260) dans un intérieur de la préforme de bouteille (240) avec pression jusqu'à dilatation de la préforme de bouteille (240) pour remplir la cavité de moule (110 ; 210).

2. Processus selon la revendication 1, dans lequel la tôle a une épaisseur dans une plage d'environ 0,381 mm (0,0150 pce) à environ 0,635 mm (0,0250 pce), de préférence d'environ 0,4572 mm (0,0180 pce) à environ 0,635 mm (0,025 pce), de manière davantage préférée d'environ 0,508 mm (0,0200 pce) à environ 0,635 mm (0,025 pce).

3. Processus selon la revendication 1 ou la revendication 2, dans lequel le disque a un diamètre dans une plage d'environ 152,4 mm (6,0 pce) à environ 254,0 mm (10,00 pce), de préférence d'environ 152,4 mm (6,0 pce) à environ 177,8 mm (7,0 pce) ou d'environ 203,2 mm (8,0 pce) à environ 241,3 mm (9,50 pce).

4. Processus selon l'une quelconque des revendications 1 à 3, comprenant en outre le chauffage de la préforme de bouteille (240) jusqu'à une température de formage avant l'injection du gaz inerte (260).

5. Processus selon la revendication 4, dans lequel la température de formage est d'environ 200 °C à environ 300 °C, de préférence d'environ 250 °C à en-

viron 255 °C.

6. Processus selon la revendication 4, dans lequel la préforme de bouteille (240) a un sommet et un fond, dans lequel la température de formage comprend un gradient de température du sommet au fond de la préforme (240), et dans lequel la température de formage au niveau du fond de la préforme (240) est de 5 °C à 10 °C plus élevée que la température de formage au niveau du sommet de la préforme (240).

7. Processus selon l'une quelconque des revendications 4 à 6, dans lequel le chauffage est réalisé pendant que la charge axiale (250) est appliquée.

8. Processus selon l'une quelconque des revendications 1 à 7, dans lequel le gaz inerte (260) est injecté après qu'une charge axiale (250) préétablie est atteinte.

9. Processus selon l'une quelconque des revendications 1 à 8, dans lequel l'alliage 3xxx est sélectionné dans le groupe constitué par AA3104, AA3003, AA3004, et AA3105.

10. Processus selon l'une quelconque des revendications 1 à 9, dans lequel l'alliage 3xxx comprend au moins 50 % en poids de matériau recyclé.

11. Processus selon l'une quelconque des revendications 1 à 10, comprenant en outre le recuit total ou partiel de la préforme de bouteille (240) avant le placement de la préforme de bouteille (240) dans la cavité de moule (110 ; 210).

12. Processus selon la revendication 11, dans lequel la température de recuit est d'environ 100 °C à environ 400 °C, de préférence d'environ 300 °C à environ 400 °C.

13. Processus selon l'une quelconque des revendications 1 à 12, dans lequel la préforme de bouteille (240) a :

un diamètre d'environ 63,5 mm (2,5 pce) à environ 76,2 mm (3,0 pce) ;
une hauteur d'environ 254,0 mm (10,0 pce) à environ 317,5 mm (12,5 pce) ;
une épaisseur de paroi d'environ 0,1524 mm (0,006 pce) à environ 0,508 mm (0,020 pce) ; et
une profondeur de bombement d'environ 10,16 mm (0,400 pce) à environ 25,4 mm (1,00 pce).

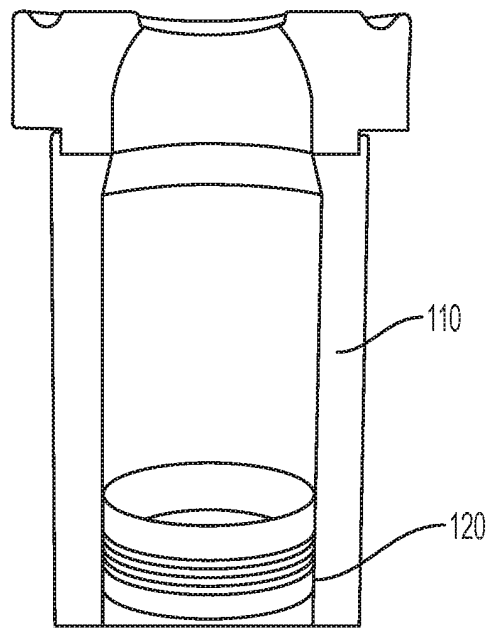


FIG. 1

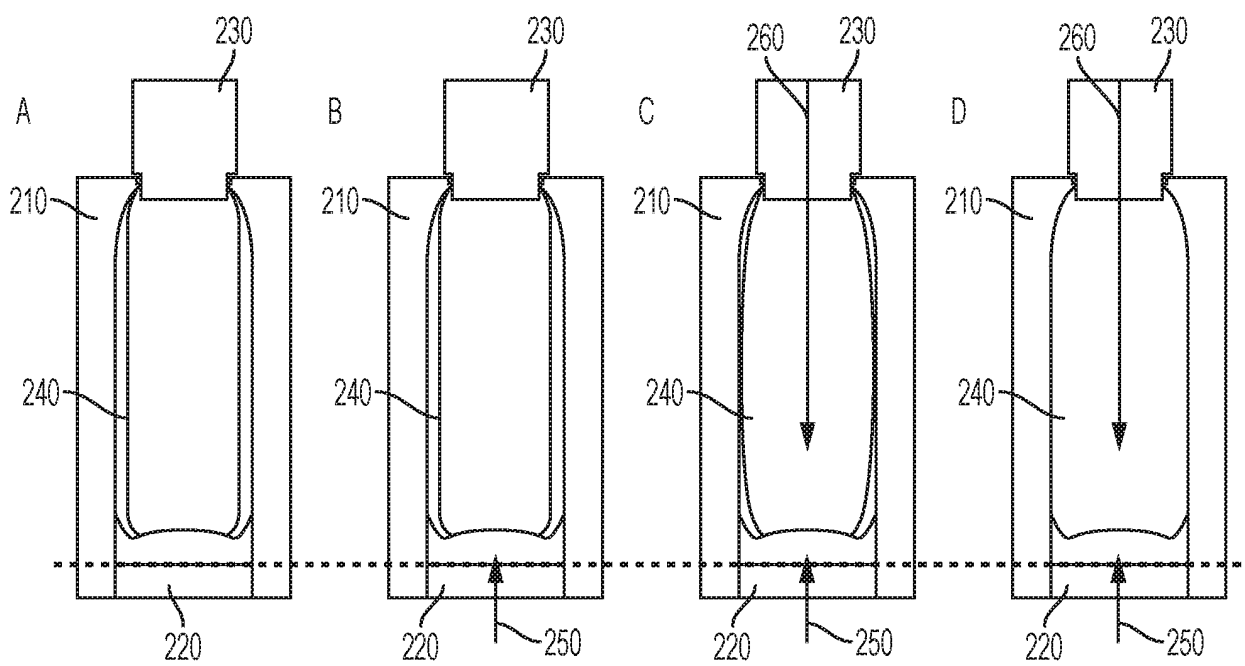


FIG. 2

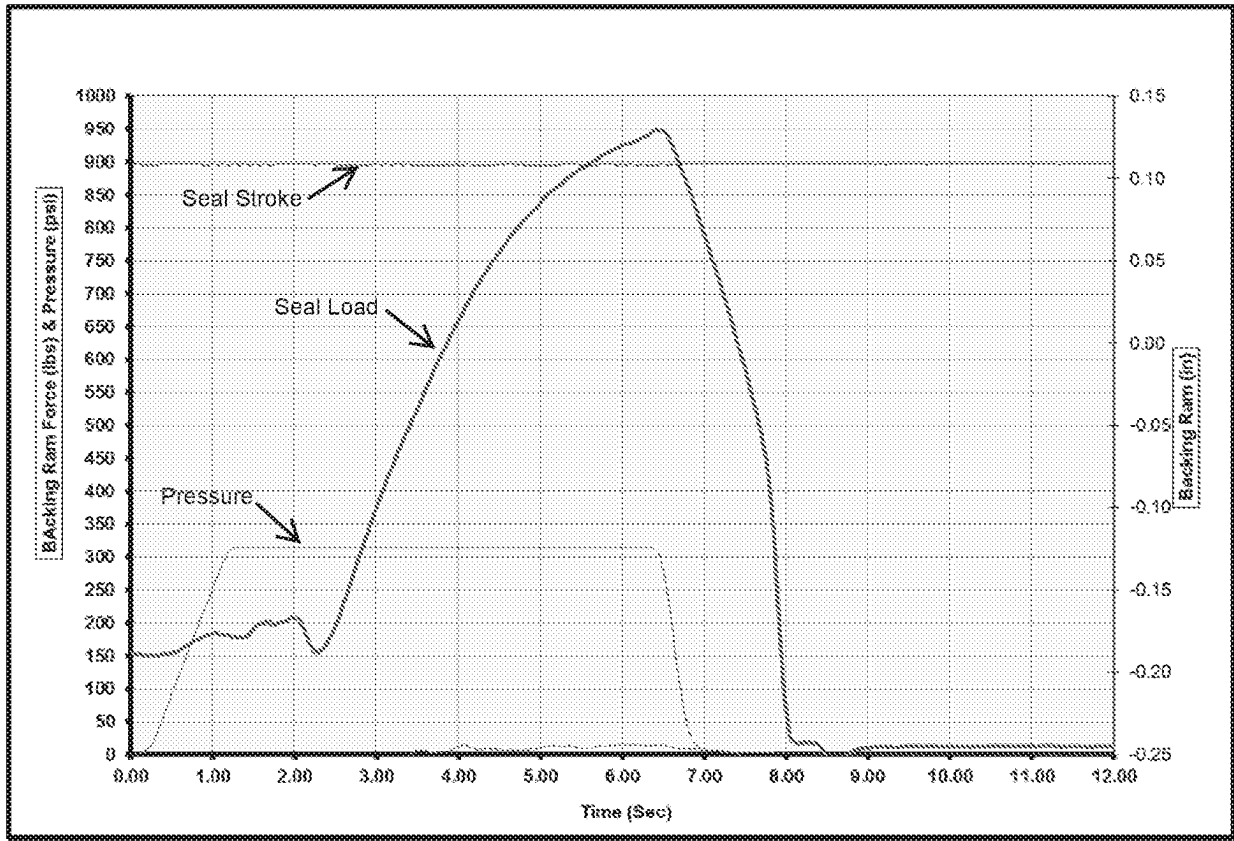


FIG. 3

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 62166212 [0001]
- US 8683837 B [0004]
- US 3896648 A [0004]