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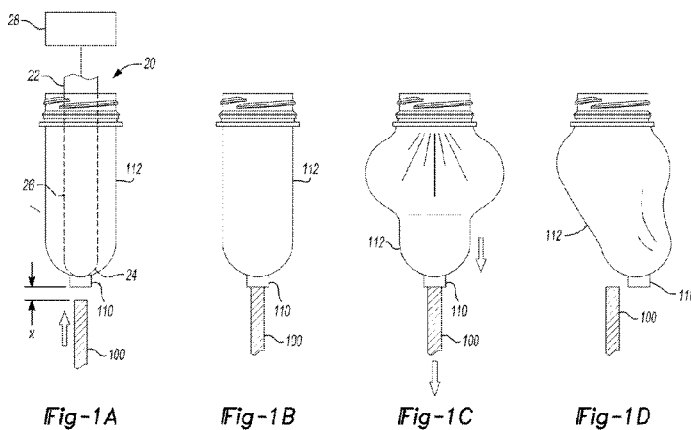
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(54) Title: COUNTER STRETCH CONNECTING ROD AND POSITIVE FILL LEVEL CONTROL ROD



(57) Abstract: A mold device and a method related thereto for forming a plastic container from a preform. The mold device comprises a mold defining a mold cavity, an optional stretch initiation rod system for engaging an interior portion of the preform to define a stretch initiation area, and a centrally disposed pressure source positionable within the preform for introducing a pressurized fluid.

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$$\% \text{ Crystallinity} = \left(\frac{\rho - \rho_a}{\rho_c - \rho_a} \right) \times 100$$

where ρ is the density of the PET material; ρ_a is the density of pure amorphous PET material (1.333 g/cc); and ρ_c is the density of pure crystalline material (1.455 g/cc).

5 **[0006]** Container manufacturers use mechanical processing and thermal processing to increase the PET polymer crystallinity of a container. Mechanical processing involves orienting the amorphous material to achieve strain hardening. This processing commonly involves stretching an injection molded PET preform along a longitudinal axis and expanding the PET preform along a transverse or
10 radial axis to form a PET container. The combination promotes what manufacturers define as biaxial orientation of the molecular structure in the container. Manufacturers of PET containers currently use mechanical processing to produce PET containers having approximately 20% crystallinity in the container's sidewall.

15 **[0007]** However, in some prior art configurations, preforms can become damaged or unsanitized during mechanical processing. That is, in some configurations, it has been found that preforms can become misaligned with the mechanical device during stretching and consequently lead to premature contact with the mold cavity and/or contact with other mechanical devices. This
20 misalignment thus can lead to defects and wastage.

[0008] In some cases, thermal processing is used which involves heating the material (either amorphous or semi-crystalline) to promote crystal growth. On amorphous material, thermal processing of PET material results in a spherulitic morphology that interferes with the transmission of light. In other
25 words, the resulting crystalline material is opaque, and thus, generally undesirable. Used after mechanical processing, however, thermal processing results in higher crystallinity and excellent clarity for those portions of the container having biaxial molecular orientation. The thermal processing of an oriented PET container, which is known as heat setting, typically includes blow
30 molding a PET preform against a mold heated to a temperature of approximately 250°F - 350°F (approximately 121°C - 177°C), and holding the blown container

against the heated mold for approximately two (2) to five (5) seconds. Manufacturers of PET juice bottles, which must be hot-filled at approximately 185°F (85°C), currently use heat setting to produce PET bottles having an overall crystallinity in the range of approximately 25% -35%.

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SUMMARY

[0009] This section provides a general summary of the disclosure, and is not a comprehensive disclosure of its full scope or all of its features.

[0010] According to the principles of the present disclosure, a mold device and a method related thereto for forming a plastic container from a preform is provided. The mold device comprises a mold defining a mold cavity, a stretch initiation rod system for engaging an interior portion of the preform to define a stretch initiation area, and a centrally disposed pressure source positionable within the preform for introducing a pressurized fluid.

[0011] In some embodiments, the present teachings provide an apparatus for forming a plastic container from a preform, the preform having an upper portion with an opening, a body, and an internal volume accessible through the opening. The apparatus comprises: a mold having a mold cavity for expanding the preform, the mold cavity having an upper end, a lower end and a central portion extending from the upper end to the lower end along a longitudinal axis, the mold having a first aperture for accessing the mold cavity through the upper end, the first aperture being adapted for holding the preform at its upper portion while the body of the preform is placed into the central portion of the mold cavity; a liquid supply means for supplying a pressurized liquid through the opening and into the internal volume of the preform; and a centering rod disposed adjacent to the lower end of the mold cavity and telescopically extendable along the longitudinal axis into the central portion of the mold cavity.

[0012] In some embodiments, the centering rod comprises a tip portion at its upper end, the tip portion being adapted to engage with an exterior feature disposed on the outer surface of the body of the preform.

[0013] In some embodiments, the tip portion of the centering rod comprises a protrusion, the protrusion being adapted to engage an indentation disposed on the outer surface of the body of the preform.

[0014] In some embodiments, the tip portion of the centering rod comprises an indentation, the indentation being adapted to engage a protrusion extending from the outer surface of the body of the preform.

5 **[0015]** In some embodiments, the centering rod is telescopically extendable between an extended position and a retracted position, wherein in the retracted position the centering rod does not extend into the central portion of the cavity.

10 **[0016]** In some embodiments, the centering rod is disposed below the lower end of the mold cavity, the centering rod is telescopically extendable into the central portion of the mold cavity through a second aperture in the lower end of the mold cavity.

[0017] In some embodiments, the centering rod is integrated into a bottom portion of the mold.

15 **[0018]** In some embodiments, the apparatus comprises a stretch rod being movable along the longitudinal direction through the first aperture and into the internal volume of the preform.

20 **[0019]** Accordingly, the present teachings provide a method for forming a plastic container from a preform comprising the steps of: heating a preform having an internal volume; placing the preform into a mold cavity of a mold; expanding the preform by introducing a liquid at a pressure into the internal volume of the preform; and holding the preform within a central volume of the mold cavity with a telescopically expandable centering means.

25 **[0020]** In some embodiments, the telescopically expandable centering means extends to a fully extended position when no opposing longitudinal force is applied and retracts when an opposing longitudinal force is applied to the telescopically expandable centering means.

30 **[0021]** In some embodiments, the step of holding the preform within the central volume of the mold cavity comprises the step of engaging a tip portion of the telescopically expandable centering means with an exterior feature disposed on the outer surface of the preform.

[0022] In some embodiments, the step of holding the preform within the central volume commences no later than the step of expanding the preform.

[0023] In some embodiments, the preform is held within the central volume of the mold cavity for at least the first half of the step of expanding the preform by introducing a pressurized liquid into the internal volume of the preform.

[0024] In some embodiments, the method further comprises the step of stretching the preform by applying a stretching force to an internal surface of the preform.

[0025] In some embodiment, an apparatus is provided for forming a plastic container from a preform adapted to performing the steps of the aforementioned method.

[0026] Further areas of applicability will become apparent from the description provided herein. The description and specific examples in this summary are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

DRAWINGS

[0027] The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

[0028] FIGS. 1A-1C illustrate a series of schematic side views illustrating a central rod guiding a preform during the forming process (not to scale);

[0029] FIG. 1D illustrates a schematic side view illustrating a slipped condition of a central rod;

[0030] FIGS. 2A-2D illustrate a plurality of locating features according to the principles of the present teachings;

[0031] FIGS. 3A-3B illustrate a stretch initiation rod being withdrawn from a container to create a fluid headspace;

[0032] FIGS. 4A-4B illustrate a stretch initiation rod being inserted into a container to create a fluid pressure spike;

[0033] FIG. 5A illustrates a mold device having a central rod according to the present teachings;

[0034] FIG. 5B illustrates a mold device having a centering feature coupled with the central rod according to the present teachings;

[0035] FIGS. 6A-6F illustrate a series of schematic side views illustrating a central rod guiding a preform during the forming process (not to scale); and

[0036] FIG. 7 is a flow chart of a manufacturing process according to
5 some embodiments of the present teachings.

[0037] Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION

10 **[0038]** Example embodiments will now be described more fully with reference to the accompanying drawings. Example embodiments are provided so that this disclosure will be thorough, and will fully convey the scope to those who are skilled in the art. Numerous specific details are set forth such as examples of
15 specific components, devices, and methods, to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that example embodiments may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure.

[0039] The terminology used herein is for the purpose of describing
20 particular example embodiments only and is not intended to be limiting. As used herein, the singular forms "a", "an" and "the" may be intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms "comprises," "comprising," "including," and "having," are inclusive and therefore specify the presence of stated features, integers, steps, operations, elements,
25 and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. The method steps, processes, and operations described herein are not to be construed as necessarily requiring their performance in the particular order discussed or illustrated, unless specifically identified as an order of performance.
30 It is also to be understood that additional or alternative steps may be employed.

[0040] When an element or layer is referred to as being "on", "engaged to", "connected to" or "coupled to" another element or layer, it may be directly on, engaged, connected or coupled to the other element or layer, or intervening

elements or layers may be present. In contrast, when an element is referred to as being "directly on," "directly engaged to", "directly connected to" or "directly coupled to" another element or layer, there may be no intervening elements or layers present. Other words used to describe the relationship between elements should be interpreted in a like fashion (e.g., "between" versus "directly between," "adjacent" versus "directly adjacent," etc.). As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0041] Although the terms first, second, third, etc. may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms may be only used to distinguish one element, component, region, layer or section from another region, layer or section. Terms such as "first," "second," and other numerical terms when used herein do not imply a sequence or order unless clearly indicated by the context. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the example embodiments.

[0042] Spatially relative terms, such as "inner," "outer," "beneath", "below", "lower", "above", "upper" and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. Spatially relative terms may be intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "below" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, the example term "below" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

[0043] The present teachings provide for a stretch blow molding machine having a centering device operable for engaging a preform container during the molding process and a stretch initiation device operable to create a stretch initiation area on the preform container. The stretch initiation device, unlike

molding machines, can be used to initiate the stretching of the preform and encourage the preform to engage the centering device. The centering device of the present teachings, unlike conventional molding machines, provides improved control for maintaining the preform in a predetermined orientation to minimize
5 contact of the stretch rod to the preform, which could result in contamination of the finished container.

[0044] As will be discussed in greater detail herein, the shape of the container described in connection with the present teachings can be any one of a number of variations. By way of non-limiting example, the container of the present
10 disclosure can be configured to hold any one of a plurality of commodities, such as beverages, food, or other hot-fill type materials.

[0045] It should be appreciated that the size and the exact shape of the centering device are dependent on the size and shape of the container to be formed. Therefore, it should be recognized that variations can exist in the
15 presently described designs.

[0046] The present teachings relate to the forming of one-piece plastic containers. Generally, these containers, after formation, generally define a body that includes an upper portion having a cylindrical sidewall forming a finish. Integrally formed with the finish and extending downward therefrom is a shoulder
20 portion. The shoulder portion merges into and provides a transition between the finish and a sidewall portion. The sidewall portion extends downward from the shoulder portion to a base portion having a base. An upper transition portion, in some embodiments, may be defined at a transition between the shoulder portion and the sidewall portion. A lower transition portion, in some embodiments, may
25 be defined at a transition between the base portion and the sidewall portion.

[0047] The exemplary container may also have a neck. The neck may have an extremely short height, that is, becoming a short extension from the finish, or an elongated height, extending between the finish and the shoulder portion. The upper portion can define an opening. Although the container is
30 shown as a drinking container and a food container, it should be appreciated that containers having different shapes, such as sidewalls and openings, can be made according to the principles of the present teachings.

[0048] The finish of the plastic container may include a threaded region having threads, a lower sealing ridge, and a support ring. The threaded region provides a means for attachment of a similarly threaded closure or cap (not illustrated). Alternatives may include other suitable devices that engage the finish
5 of the plastic container, such as a press-fit or snap-fit cap for example. Accordingly, the closure or cap (not illustrated) engages the finish to preferably provide a hermetical seal of the plastic container. The closure or cap (not illustrated) is preferably of a plastic or metal material conventional to the closure industry and suitable for subsequent thermal processing.

[0049] The container can be formed according to the principles of the present teachings. A preform version of the container can include a support ring, which may be used to carry or orient the preform through and at various stages of manufacture. For example, the preform may be carried by the support ring, the support ring may be used to aid in positioning the preform in a mold cavity, or the
10 support ring may be used to carry an intermediate container once molded. At the outset, the preform may be placed into the mold cavity such that the support ring is captured at an upper end of the mold cavity.

[0050] In general, as illustrated in FIGS. 5A and 5B, the mold 300 can comprise a mold cavity 302 having an interior surface 304 corresponding to a
20 desired outer profile of the blown container. More specifically, the mold cavity according to the present teachings defines a body forming region, an optional moil forming region and an optional opening forming region. Once the resultant structure, hereinafter referred to as an intermediate container, has been formed in some embodiments, any moil created by the moil forming region may be severed
25 and discarded. It should be appreciated that the use of a moil forming region and/or opening forming region are not necessarily in all forming methods or according to all embodiments of the present teachings.

[0051] In one example, a machine places the preform heated to a temperature between approximately 190°F to 250°F (approximately 88°C to
30 121°C) into the mold cavity. The mold cavity may be heated to a temperature between approximately 250°F to 350°F (approximately 121°C to 177°C). An internal stretch rod apparatus can stretch or extend the heated preform within the mold cavity to a length approximately that of the intermediate container thereby

molecularly orienting the polyester material in an axial direction generally corresponding with the central longitudinal axis of the container. While the stretch rod extends the preform, fluid (e.g. liquid, such as the final liquid commodity; air; and the like) from a centrally disposed pressure source, having a pressure
5 between 300 PSI to 600 PSI (2.07 MPa to 4.14 MPa), assists in extending the preform in the axial direction and in expanding the preform in a circumferential or hoop direction thereby substantially conforming the polyester material to the shape of the mold cavity and further molecularly orienting the polyester material in a direction generally perpendicular to the axial direction, thus establishing the
10 biaxial molecular orientation of the polyester material in most of the intermediate container. The pressurized fluid holds the mostly biaxial molecularly oriented polyester material against the mold cavity for a period of approximately two (2) to five (5) seconds before removal of the intermediate container from the mold cavity. This process is known as heat setting and results in a heat-resistant
15 container suitable for filling with a product at high temperatures.

[0052] With particular reference to FIGS. 1A-4B, stretch blow molding systems can employ a central interior stretch initiation rod system 20 that can engage an interior feature or surface of a preform 112 and/or a central exterior rod system 100 that can engage an exterior feature 110, or other portion, of the
20 preform 112. It should be appreciated that according to the principles of the present teachings, central interior stretch initiation rod system 20 and central exterior rod system 100 can be used separately or in combination. Moreover, central interior stretch initiation rod system 20 and central exterior rod system 100 can be used independently and/or simultaneously.

[0053] With particular reference to FIGS. 1A, 3A, 3B, 4A, and 4B, in some embodiments, stretch initiation rod system 20 can be raised and lowered relative to preform 112 to provide a mechanical urging force against an interior surface of preform 112. Stretch initiation rod system 20 can comprise a rod member 22 having a distal tip 24, an elongated shaft 26, and a drive system 28
25 coupled to the elongated shaft 26 to actuate distal tip 24 between a retracted (see FIGS. 3B and 4A) and an extended (see FIGS. 1A, 3A, and 4B) position. Drive system 28 can comprise a pneumatic drive system, a servo drive system, or other known system for creating motion of rod member 22. In some embodiments,
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drive system 28 includes a servo or positive stop to provide positioning information. Moreover, in some embodiments, drive system 28 can be used for real-time tracking a position and/or drive speed of rod member 22 to provide real-time control. Still further, it should be appreciated that although rod member 22 is described and illustrated as being cylindrical with a rounded tip, other shapes and tips are envisioned, including but not limited to conical, non-uniform, tapered, pointed, flattened, and the like or can be varied to define a predetermined volume.

[0054] It should be noted, however, that stretch initiation rod system 20 can be separate from or joined with a typical central rod of a blow molding system. That is, a stretch initiation rod system 20 can be separately formed or integrally formed with the central rod. Stretch initiation rod system 20 can, however, employ distal tip 24 to engage or otherwise contact preform 112 to define the stretch initiation area and/or prestretch. By way of non-limiting example, prestretches of about 40 mm have been found to be beneficial, however other prestretch lengths, such as the distance X of FIG. 1A, may be appropriate. This insures a known stretching response and material distribution during molding, rather than the unpredictable stretching response common with conventional molding systems. This material distribution can include non-uniform distribution for predetermined design criteria.

[0055] With reference to FIGS. 1A-1D, central exterior rod system 100 can be used, ideally, to maintain preform 112 in a predetermined orientation during the stretch blow forming process as illustrated in FIGS. 1A-1C. Central interior stretch initiation rod 20 can be used, ideally, to initiate the forming process. In this way, the preform 112 is initially stretched to achieve a predetermined molding response using stretch initiation rod system 20 and then centrally maintained by central exterior rod system 100 relative to the stretch rod and/or stretch initiation rod system 20 extending therein, thereby ensuring that the stretch rod(s) does not contact the inside of the preform. Such contact of the stretch rod within the preform can cause contamination of the resultant container, thereby requiring the resultant container to be discarded or sanitized.

[0056] In some embodiments, stretch initiation rod system 20 can be used to achieve a precise headspace within the final filled container. Specifically, as seen in FIGS. 3A-3B, stretch initiation rod system 20 can be actuated and/or

sized such that following formation of the preform 112 into the final container (which is done with the final fill commodity), retraction of rod member 22 can represent a precise volume (that is, the volume of rod member 22 disposed within the final fill commodity) that when retracted provides the desired headspace for packaging and shipment. Such precise headspace is achieved without complex valve systems and the like.

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[0057] Moreover, in some embodiments, stretch initiation rod system 20 can be used to achieve a fluid pressure spike to aid in the shaping of preform 112 or container. Specifically, as seen in FIGS. 4A-4B, stretch initiation rod system 20 can be actuated such that the fluid volume displaced by rod member 22 is greater than a headspace within the preform 112 or finished bottle, such that insertion of rod member 22 into the preform 112 or container, having a contained and generally fixed volume, causes a pressure spike within the preform 112 or container. Such pressure spikes can be used to define final details within the preform 112 or container.

[0058] Turning now to FIG. 1D, in some embodiments, preform 112 may form in such a way as to slip off or become disengaged from the central exterior rod system 100. This can often lead to damage to the preform by contact with the central exterior rod system 100 and/or contamination with the internal stretch rod.

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[0059] To overcome this issue, with reference to FIGS. 2A-2D, in some embodiments, central exterior rod system 100 can comprise a locating feature 120 for engaging or otherwise contacting the preform 112. Locating feature 120 can comprise, in some embodiments, a protruding portion 122 defining a first shape. A corresponding depression 124, having a complementary shape to the first shape, can be formed as part of preform 112. In this way, protruding portion 122 can be positively received within depression 124 to define a reliable connection therebetween. In some embodiments, protruding portion 122 is sized and shaped to closely conform to depression 124 to minimize lateral movement (that is, movement in a hoop direction). The shape of protruding portion 122, and consequently depression 124, can be cylindrical (FIGS. 2A and 2B), tapered (FIGS. 2C and 2D), wide (FIG. 2C), narrow (FIGS. 2B and 2D), or any other shape/size that provides a reliable connection between central exterior rod system 100 and preform 112. It should be appreciated that locating feature 120 can

define a reverse orientation (indicated with similar primed reference numbers) to those already described in that the locating feature 120 can comprise a protruding portion extending from the preform (FIGS. 2C and 2D) for engaging a depression formed in the central exterior rod system 100.

5 **[0060]** Still further, in some embodiments as illustrated in FIGS. 5A-5B, central exterior rod system 100 can extend from mold device 200 as a generally cylindrical member (FIG. 5A) or can include a centering feature 210 located along a portion of central exterior rod system 100. In some embodiments, centering feature 210 can be an oversized head member 211 disposed on distal end 212 of
10 central exterior rod system 100. In some embodiments, the oversized member can include a tapered portion 214, such as conical portion, that is sized to be received and/or captured within a conical depression 216 formed in the mold device 200. In this way, upon retraction of central exterior rod system 100, tapered portion 214 can be centrally received within conical depression 216 to
15 ensure proper aligned of the now-expand preform 112 or resultant container. It should also be recognized that in some embodiments, oversized head member 211 can be shaped to form part of the mold device and, at least in part, impart a shape upon preform 112 during formation of the resultant container.

[0061] In some embodiments of the present teachings, as illustrated in
20 FIGS. 6A- 6F, rod member 22, such as a counter stretch rod, and central exterior rod system 100 can be actuated concurrently and independently to effect a predetermined stretch and/or forming process. In this way, central exterior rod system 100 can be actuated from the base of mold cavity 302 and can be initially activated to physically touch or contact the preform 112 prior to blowing, or it can
25 stop prior to contacting the preform (see FIGS. 1 and 6A). The central exterior rod system 100 can function correctly up to about 20mm from the preform 112; however, in many embodiments the central exterior rod system 100 improves quality and insures that the center of the preform engages the center of central exterior rod system 100 and is maintained appropriately positioned within mold
30 cavity 302.

[0062] In some embodiments where additional length of central exterior rod system 100 is required in order to contact preform 112 and/or where space limitations below mold 300 prevent use of a unitarily-formed central exterior rod

system 100 having sufficient length to contact preform 112, a telescoping version of central exterior rod system 100 can be used. That is, in some embodiments, a telescoping counter stretch rod 102 can be employed having a first section 104 slidably receiving within a second section 106. It should be recognized, however, that additional telescoping sections can be used.

[0063] During manufacturing, according to the flow chart of FIG. 7, the central exterior rod system 100 (also known as counter stretch rod in FIG. 7) can engage preform 112 at any time prior to or immediately following initiation of the container inflation; however, if central exterior rod system 100 is intended to engage preform 112 prior to inflation, it is best to load preform 112, then engage or actuate the central exterior rod system 100 (as illustrated in sequence in FIG. 7). The rod member 22 (also known as the counter stretch connecting rod in FIG. 7) can be actuated next, and can firmly engage preform 112 with central exterior rod system 100. Once preform is fully engaged with central exterior rod system 100, the container inflation can begin. The container can be inflated with the use of high pressure air or liquid, or two steps of low pressure air or liquid, which is followed by high pressure air or liquid. Preform 112 can begin to inflate away from the rod member 22, and the rod member 22 can remain in place, or retract from the container. Once the fill cycle is complete and the container is fully formed, the rod member 22 can be set to the desired depth in the container such that once the seal pin is closed, the fill level will be at the desired height within the container as discussed herein. The central exterior rod system 100 will then be removed from the container, the nozzle raised, and the container removed from the mold, fully formed and filled, with the correct amount of product remaining inside the container.

[0064] Alternatively, other manufacturing methods, such as for example, extrusion blow molding, one step injection stretch blow molding and injection blow molding, using other conventional materials including, for example, thermoplastic, high density polyethylene, polypropylene, polyethylene naphthalate (PEN), a PET/PEN blend or copolymer, and various multilayer structures may be suitable for the manufacture of plastic containers and used in connection with the principles of the present teachings.

[0065] The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the invention, and all such modifications are intended to be included within the scope of the invention.

CLAIMS

What is claimed is:

1. An apparatus for forming a plastic container from a preform, the
5 preform having an upper portion with an opening, a body, and an internal volume
accessible through the opening, the apparatus comprising:
a mold having a mold cavity for expanding the preform, the mold cavity
having an upper end, a lower end and a central portion extending from the upper
end to the lower end along a longitudinal axis, the mold having a first aperture for
10 accessing the mold cavity through the upper end, the first aperture being adapted
for holding the preform at its upper portion while the body of the preform is placed
into the central portion of the mold cavity;
a liquid supply means for supplying a pressurized liquid through the
opening and into the internal volume of the preform; and
15 a centering rod disposed adjacent to the lower end of the mold cavity and
telescopically extendable along the longitudinal axis into the central portion of the
mold cavity.
2. The apparatus for forming a plastic container from a preform
20 according to Claim 1 wherein the centering rod comprises a tip portion at its upper
end, the tip portion being adapted to engage with an exterior feature disposed on
the outer surface of the body of the preform.
3. The apparatus for forming a plastic container from a preform
25 according to Claim 2 wherein the tip portion of the centering rod comprises a
protrusion, the protrusion being adapted to engage an indentation disposed on the
outer surface of the body of the preform.
4. The apparatus for forming a plastic container from a preform
30 according to Claim 2 wherein the tip portion of the centering rod comprises an
indentation, the indentation being adapted to engage a protrusion extending from
the outer surface of the body of the preform.

5. The apparatus for forming a plastic container from a preform according to Claim 1 wherein the centering rod is telescopically extendable between an extended position and a retracted position, wherein in the retracted position the centering rod does not extend into the central portion of the cavity.

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6. The apparatus for forming a plastic container from a preform according to Claim 1 wherein the centering rod is disposed below the lower end of the mold cavity, the centering rod is telescopically extendable into the central portion of the mold cavity through a second aperture in the lower end of the mold cavity.

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7. The apparatus for forming a plastic container from a preform according to Claim 1 wherein the centering rod is integrated into a bottom portion of the mold.

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8. The apparatus for forming a plastic container from a preform according to Claim 1, further comprises a stretch rod being movable along the longitudinal direction through the first aperture and into the internal volume of the preform.

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9. A method for forming a plastic container from a preform comprising the steps of:

heating a preform having an internal volume;

placing the preform into a mold cavity of a mold;

expanding the preform by introducing a liquid at a pressure into the internal volume of the preform; and

25

holding the preform within a central volume of the mold cavity with a telescopically expandable centering means.

30

10. A method for forming a plastic container from a preform according to Claim 9 wherein the telescopically expandable centering means extends to a fully extended position when no opposing longitudinal force is applied and retracts

when an opposing longitudinal force is applied to the telescopically expandable centering means.

11. A method for forming a plastic container from a preform according to
5 Claim 9 wherein the step of holding the preform within the central volume of the mold cavity comprises the step of engaging a tip portion of the telescopically expandable centering means with an exterior feature disposed on the outer surface of the preform.

10 12. A method for forming a plastic container from a preform according to Claim 9 wherein the step of holding the preform within the central volume commences no later than the step of expanding the preform.

15 13. A method for forming a plastic container from a preform according to Claim 11 wherein the preform is held within the central volume of the mold cavity for at least the first half of the step of expanding the preform by introducing a pressurized liquid into the internal volume of the preform.

20 14. A method for forming a plastic container from a preform according to Claim 11, further comprising the step of stretching the preform by applying a stretching force to an internal surface of the preform.

25 15. An apparatus for forming a plastic container from a preform adapted to performing the steps of the method of Claim 9.

16. A mold device for forming a plastic container from a preform, said mold device comprising:

a mold defining a mold cavity for receiving the preform;
a pressure source fluidly coupled to said mold cavity, said pressure source
30 positionable within the preform for introducing a pressurized fluid; and
a telescopically-extending central exterior rod having a locating feature formed therewith, said locating feature engaging an exterior feature of the preform for maintaining a central orientation of the preform during forming.

17. The mold device according to Claim 16, further comprising:

a stretch initiation rod system operably coupled with said mold cavity, said stretch initiation rod system engaging an interior portion of the preform to define a stretch initiation area.

5

18. The mold device according to Claim 17 wherein said stretch initiation rod system comprises an elongated member and a tip portion, said tip portion contacting said interior portion of the preform.

10

19. The mold device according to Claim 18 wherein said stretch initiation rod system comprises a drive system actuating said elongated member and said tip portion between an extended position in contact with the preform and a retracted position.

15

20. The mold device according to Claim 19 wherein said actuation of said elongated member and said tip portion result in a fluid pressure change within the preform or filled plastic container.

20

21. The mold device according to Claim 19 wherein said actuation of said elongated member and said tip portion results in creation of a fluid headspace within the plastic container.

25

22. The mold device according to Claim 16 wherein said locating feature of said central exterior rod comprises a protrusion extending therefrom, said protrusion being sized and shaped to closely conform to the exterior feature of the preform.

30

23. The mold device according to Claim 22 wherein said protrusion is cylindrically shaped.

24. The mold device according to Claim 22 wherein said protrusion is tapered.

25. The mold device according to Claim 16 wherein said locating feature of said central exterior rod comprises a depression formed therein, said depression being sized and shaped to closely receive the exterior feature of the preform therein.

5 26. The mold device according to Claim 25 wherein said depression is cylindrically shaped.

27. The mold device according to Claim 25 wherein said depression is tapered.

10

28. The mold device according to Claim 16, further comprising:

a centering feature being disposed on a portion of said central exterior rod, said centering feature being engageable with said mold to align said central exterior rod with said mold in at least a retracted position.

15

29. The mold device according to Claim 28 wherein said centering feature is conically shaped.

30. A method of forming a plastic container from a preform, said method comprising:

20

heating a preform to a temperature between 190 °F and 250 °F;

heating a mold cavity to a temperature between 250 °F and 350 °F;

inserting said preform within said mold cavity;

actuating a stretch initiation rod system to engage an interior portion of the preform to define a stretch initiation area;

25

introducing a pressurized fluid into said preform to expand said preform to closely conform to said mold cavity; and

actuating a telescopically-extending central exterior rod such that a locating feature formed on said central exterior rod engages an exterior feature of said preform to generally maintain a predetermined orientation of said preform during at least a portion of said introducing said pressurized fluid.

30

31. The method according to Claim 30, further comprising:
actuating said stretch initiation rod system following at least a portion of
said introducing said pressurized fluid to create a headspace within the container.

5 32. The method according to Claim 30, further comprising:
actuating said stretch initiation rod system following at least a portion of
said introducing said pressurized fluid to create a fluid pressure spike within the
container.

10 33. The method according to Claim 30, further comprising:
maintaining a predetermined pressure within said preform following said
introducing said pressurized fluid such that said preform is held against said mold
cavity for a predetermined duration.

15 34. The method according to Claim 33 wherein said predetermined
duration is between 0.1 seconds and 1.5 seconds.

35. The method according to Claim 30 wherein said pressurized fluid
comprises a liquid commodity that remains in the plastic container.

20

36. The method according to Claim 30 wherein said preform is made
from a thermoplastic, a high density polyethylene, a polypropylene, a polyethylene
naphthalate (PEN), a PET/PEN blend, a copolymer, various multilayer structures,
and any combination or blend thereof.

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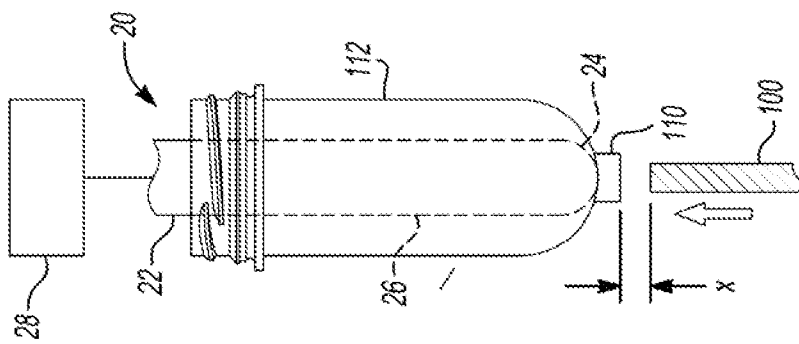


Fig-1A

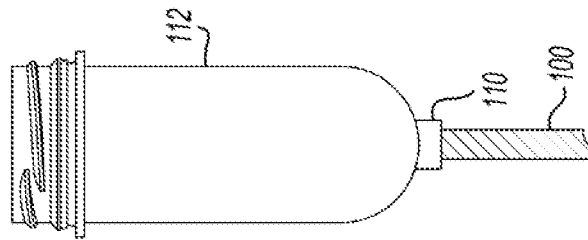


Fig-1B

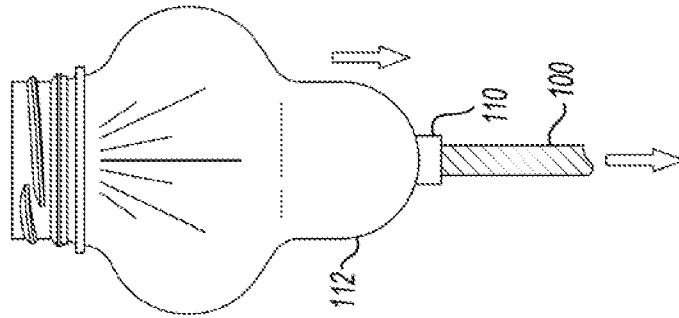


Fig-1C

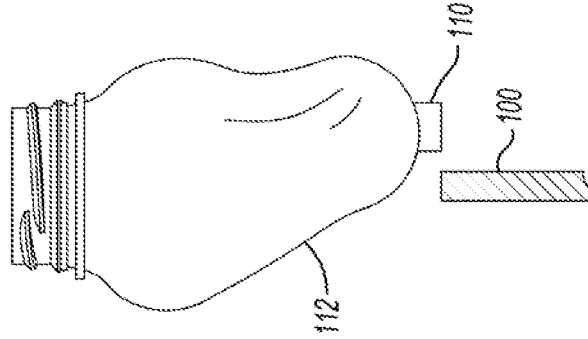


Fig-1D



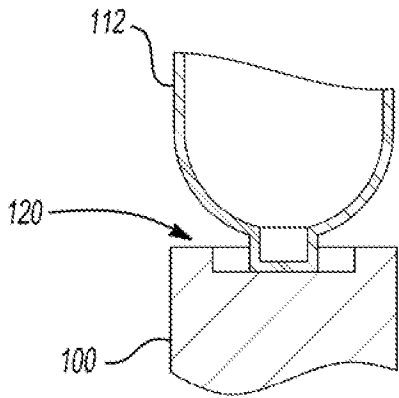


Fig-2A

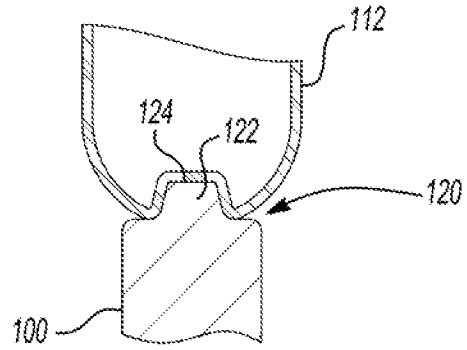


Fig-2B

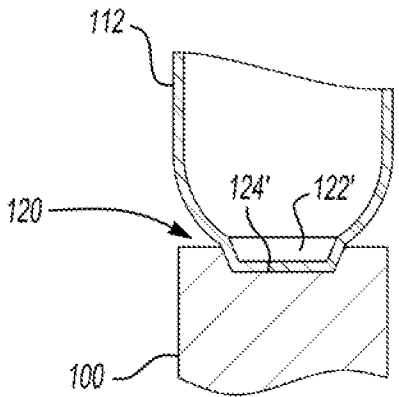


Fig-2C

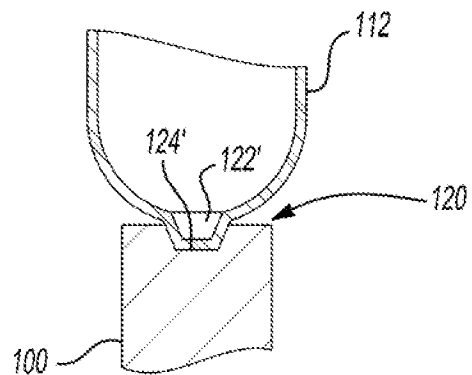


Fig-2D



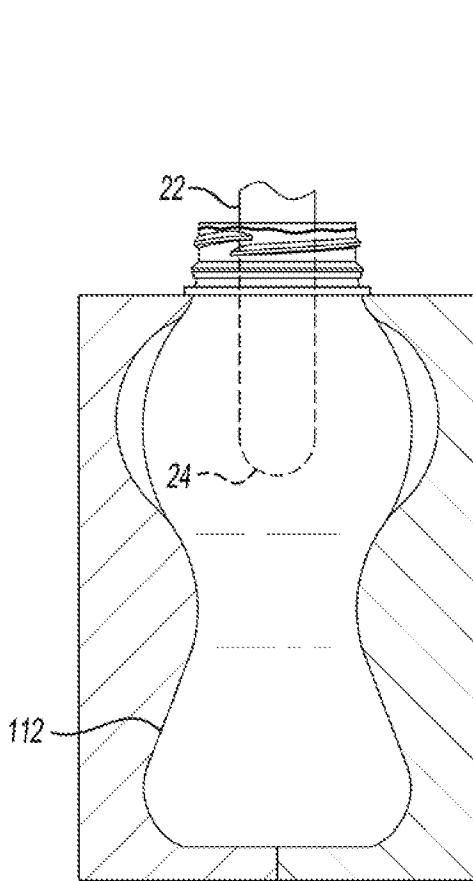


Fig-3A

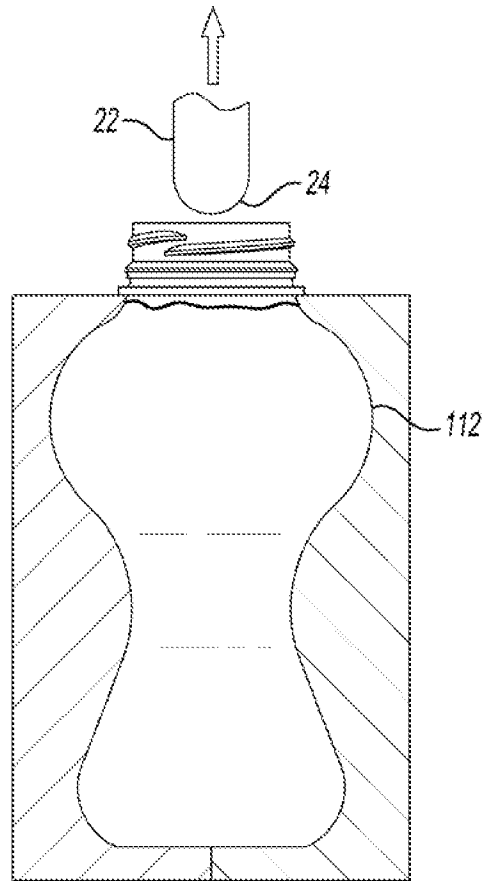


Fig-3B

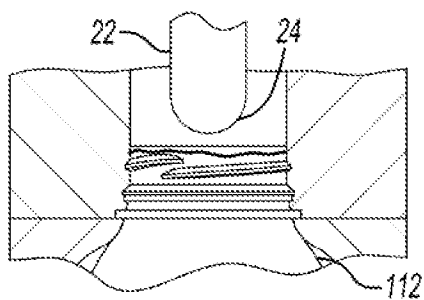


Fig-4A

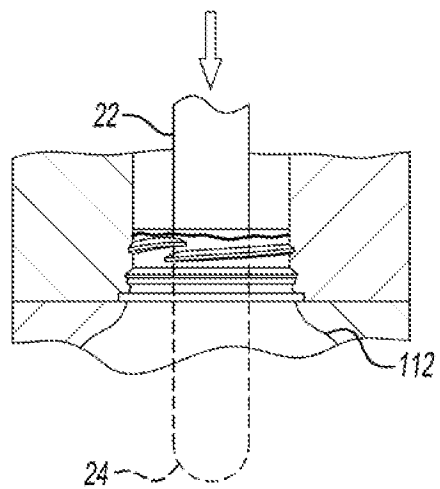


Fig-4B



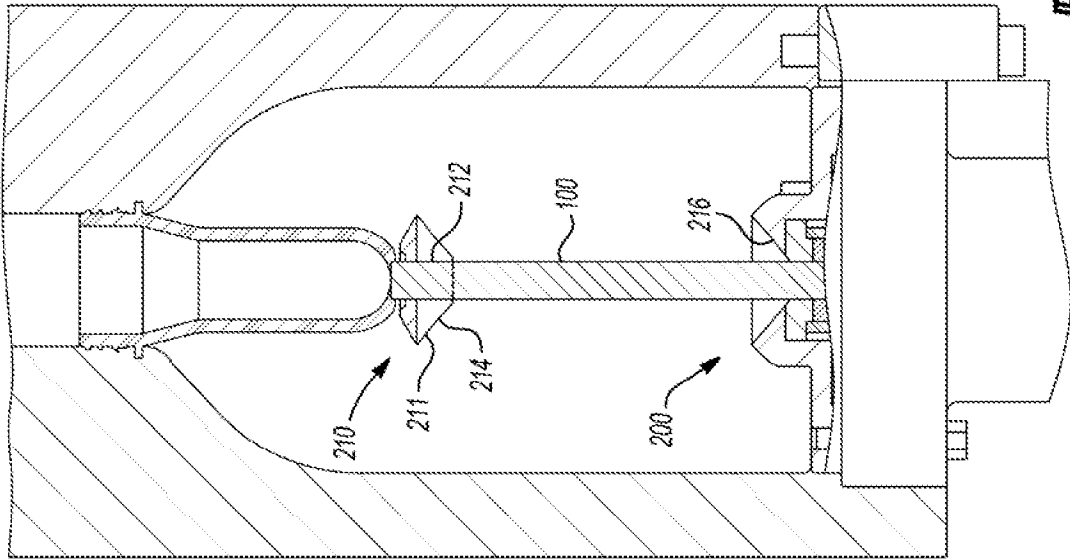


Fig-5B

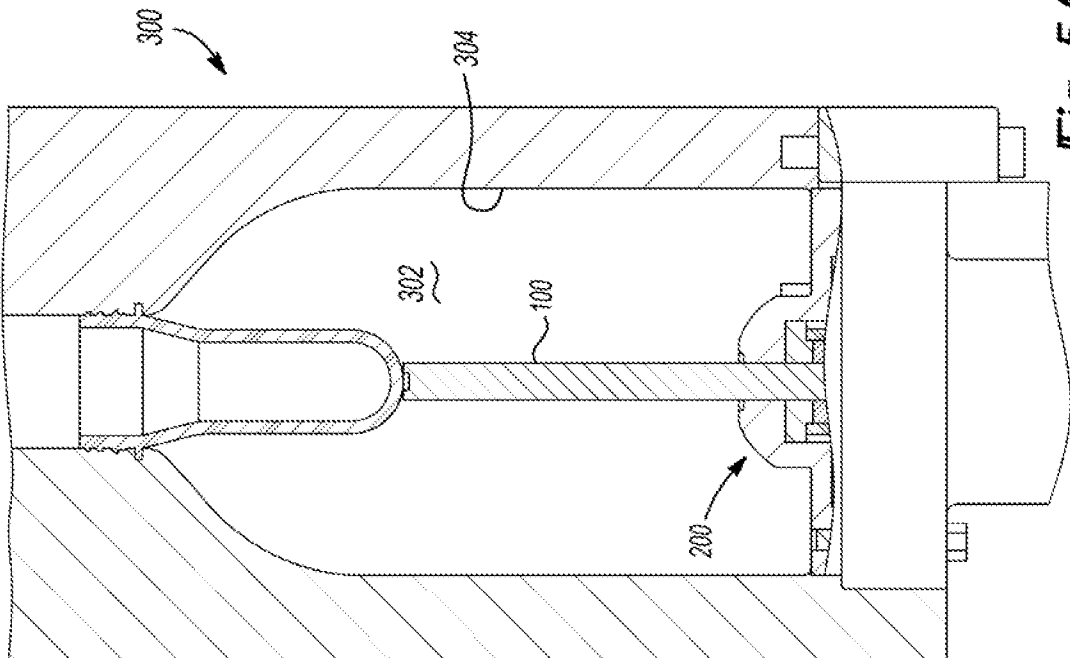


Fig-5A



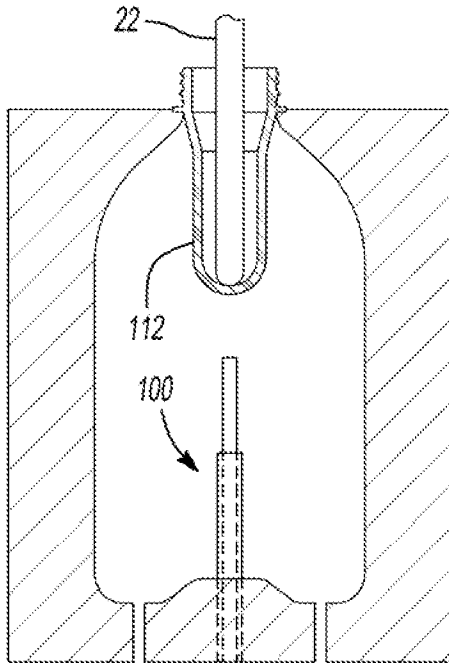


Fig-6A

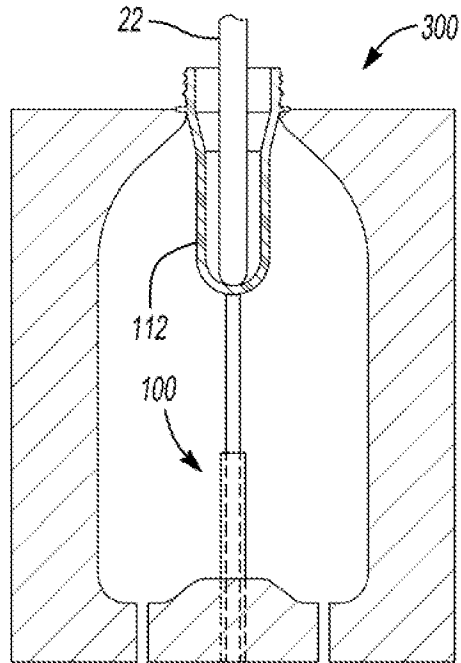


Fig-6B

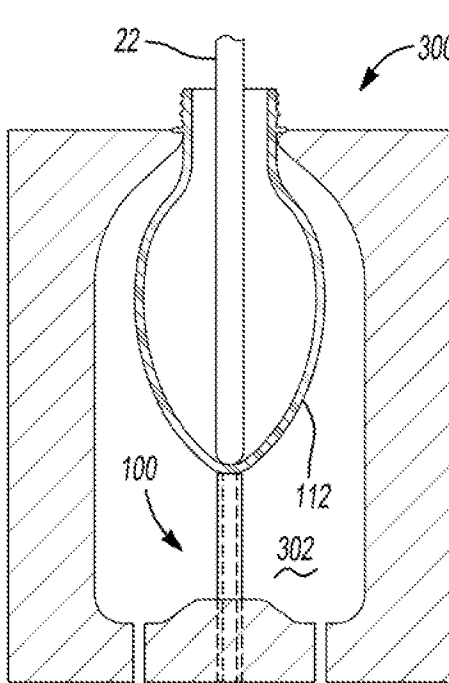


Fig-6C

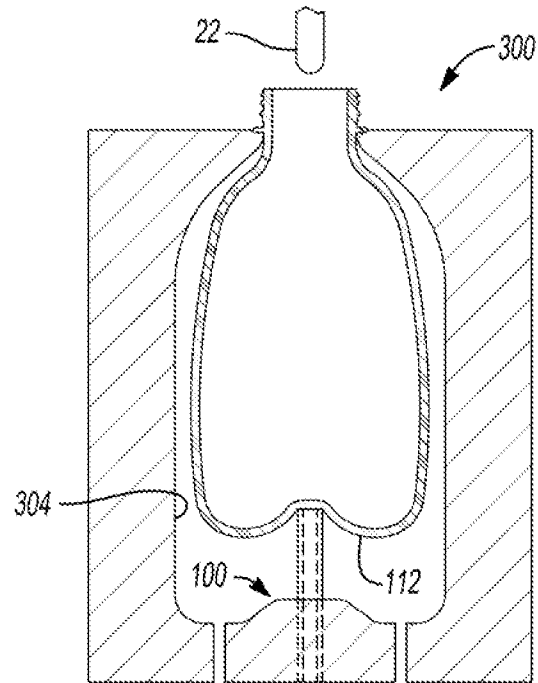


Fig-6D



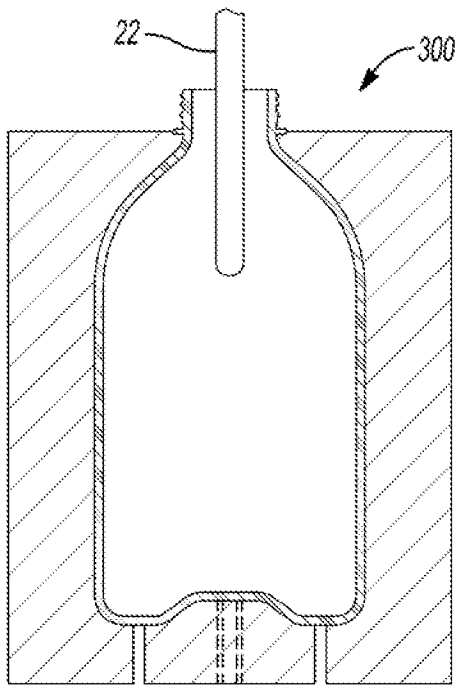


Fig-6E

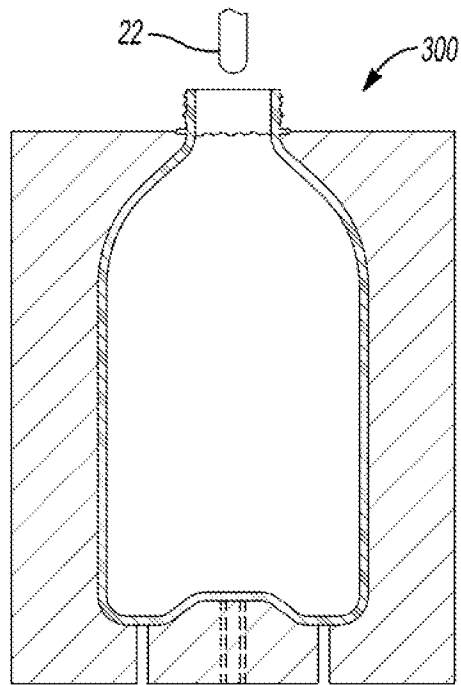
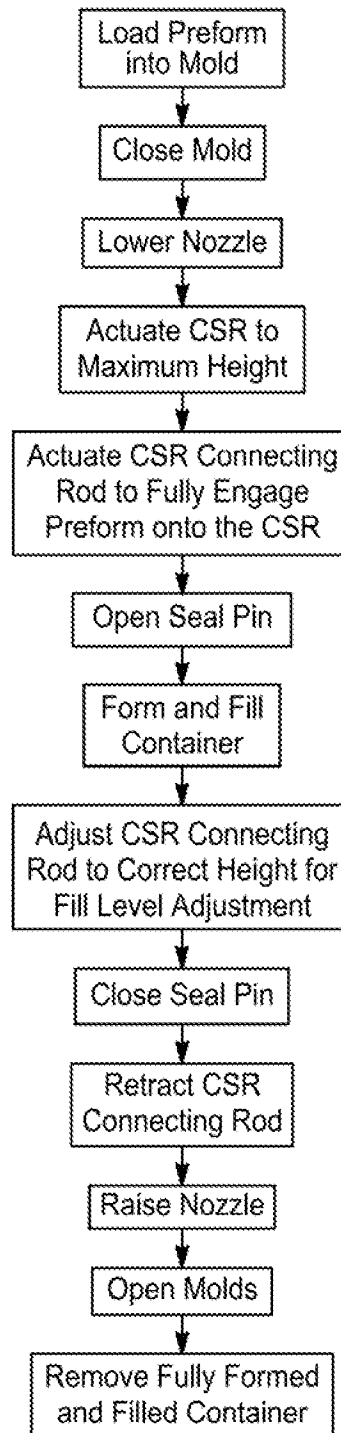


Fig-6F



Fig-7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/062210**A. CLASSIFICATION OF SUBJECT MATTER****B29C 49/28(2006.01)i, B29C 49/42(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B29C 49/28; B29C 53/32; B29C 49/06; B29C 43/52; B29C 43/02; B29C 49/64; B29C 49/16; B29C 45/00; B29C 49/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: preform, plastic container, mold, liquid, extend, centering rod, telescopically-extend

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2002-067131 A (AOKI TECHNICAL LABORATORY INC.) 05 March 2002 See abstract; paragraphs [0011]-[0020],[0024-0026]; figures 1-5	1-27, 30-36 28, 29
A	US 2004-0070119 A1 (FIBBIA, MAURO et al.) 15 April 2004 See abstract; paragraphs [0039],[0041],[0042]; claims 1,11; figures 10-12	1-36
A	US 4952134 A (BARTLEY, HAROLD et al.) 28 August 1990 See abstract; column 4, lines 7-14; claim 1; figures 6-8	1-36
A	US 2005-0189681 A1 (GIANNI, MINGANTI) 01 September 2005 See abstract; claims 1,7,30	1-36
A	US 2008-0029928 A1 (ANDISON, DAVID et al.) 7 February 2008 See abstract; claim 1	1-36
PX	US 2012-0091635 A1 (EBERLE, THEODORE F.) 19 April 2012 See the whole document.	1-36

 Further documents are listed in the continuation of Box C. See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

22 MARCH 2013 (22.03.2013)

Date of mailing of the international search report

25 MARCH 2013 (25.03.2013)

Name and mailing address of the ISA/KR

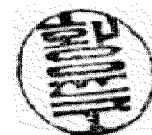
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Authorized officer

HWANG, Yun Koo

Telephone No. 82-42-481-5715



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2012/062210

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