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(71) Applicant: **STOLLE MACHINERY COMPANY, LLC** [US/US]; 6949 South Potomac Street, Centennial, Colorado 80112 (US).

(72) Inventors: **CARSTENS, Aaron E.**; 10696 Meadowfield Court, Centerville, Ohio 45458 (US). **MCCARTY, Patrick K.**; 2112 Moreland Avenue, Dayton, Ohio 45420 (US). **MCCLUNG, James A.**; 1351 Applegrove Street, N.E., Canton, Ohio 44721 (US). **RIPPLE, Paul L.**; 1621 36th Street, N.E., Canton, Ohio 44714 (US). **BUTCHER, Gregory H.**; 1325 Little Bear Heron Court, Naples, Florida 34108 (US).

(74) Agent: **JENKINS, David C.** et al.; Eckert Seamans Cherin & Mellott, LLC, 600 Grant Street, 44th Floor, Pittsburgh, Pennsylvania 15219 (US).

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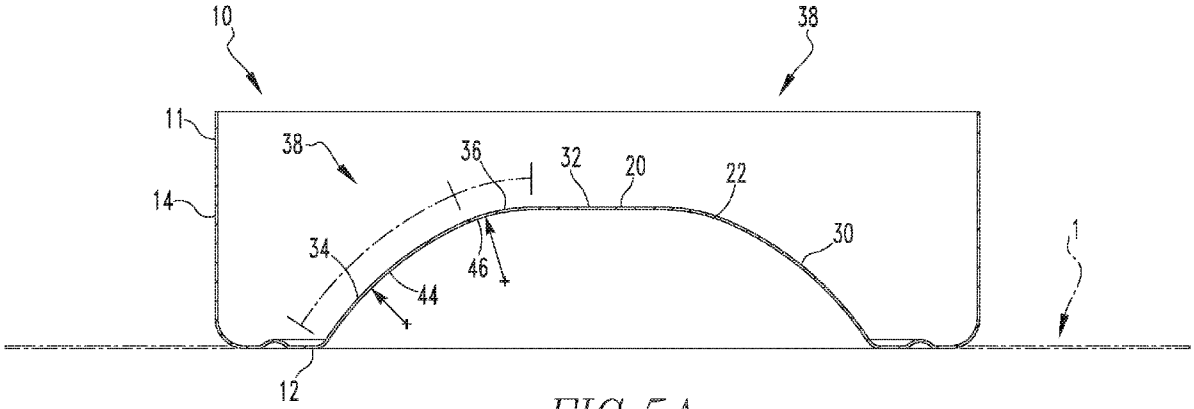

FIG. 5A

(57) Abstract: A formed blank (10) is provided. The formed blank (10) includes a stretched portion (38) and/or a truncated protrusion (20), a tooling assembly (100) structured to form a formed blank (10) including a stretched portion (38) and/or a truncated protrusion (22), and a method of forming (1000) a formed blank (10) including a stretched portion (38) and/or a truncated protrusion (22). The formed blank (10) includes a base (12) and a depending sidewall (14). The stretched portion (38) and/or the truncated protrusion (22) is disposed on the formed blank base (12) and the thickness of the stretched portion (38) and/or the truncated protrusion (22) is less than the sidewall (14). The stretched portion (38) and/or the truncated protrusion (22) utilizes less material relative to an unformed base that has about the same thickness as the sidewall (14).

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TRUNCATED DOME CUP

CROSS REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Patent Application Serial No. 15/382,850, filed December 19, 2016, which is incorporated by reference herein.

BACKGROUND OF THE INVENTION

Field of the Invention

The disclosed concept relates generally to containers and, more particularly, to metal containers such as, for example, beer or beverage cans, as well as food cans. The disclosed concept also relates to cups and blanks for forming cups and containers. The disclosed concept further relates to methods and tooling for selectively forming a cup or bottom portion of a container to reduce the amount of material in the cup or bottom portion.

Background Information

It is generally well known to draw and iron a sheet metal blank to make a thin walled container or can body for packaging beverages (*e.g.*, carbonated beverages; non-carbonated beverages), food or other substances. As is known, many such containers have a generally cylindrical shape and the example discussed herein is assumed to have such a shape. It is understood, however, that the disclosed container (as well as the cup that becomes the container) method for forming such a container/cup is not limited to this specific shape.

One of the initial steps in forming such containers is to form a cup. As shown in Figure 1, the cup begins as a generally planar blank 1 cut from sheet material. The blank 1 is then drawn into a cup 2. The cup 2 is generally shorter and wider than the finished container. Accordingly, the cups 2 are typically subjected to a variety of additional processes that further form the cup into the finished container. The cup includes a base 3 having an upwardly depending sidewall 4. The container body, hereinafter can body 5 (Figure 2), is formed by additional processes such as, but not limited to, drawing, redrawing, and ironing the cup 1. The can body 5 also includes a base 6 and a sidewall 7. The can body base 6 includes a bottom profile. That is, as used herein, a "bottom profile" is the shape of the base 3, 6 after forming. Generally, a beverage can body 5A, the bottom profile slopes inwardly from an annular ridge 8 to form an inwardly projecting,

generally hemispherical dome 9. Conversely, a food can body 5B (shown during formation in Figure 4E) has a generally flat bottom profile. The dome 9 is formed by a "domer" during the forming of the cup 2 and/or a can body 5. The apparatus and tooling structured to form a cup 2 and/or a can body 5 is shown in U.S. Patent Application Serial No. 15/286,954, which is incorporated by reference.

There is a constant desire in the industry to reduce the gauge, and thus the amount of material used to form such containers. However, among other disadvantages associated with the formation of containers from relatively thin gauge material, is the tendency of the container to wrinkle, particularly during redrawing and doming. Prior proposals have, in large part, focused on forming bottom profiles of various shapes that were intended to be strong and, therefore, capable of resisting buckling while enabling metal having a thinner base gauge to be used to make the can body. As used herein, "base gauge" means the initial thickness of the material and is not limited to the thickness of the base portion/element. Thus, the conventional desire has been to maintain the material thickness in the dome and bottom profile to maintain or increase strength in this area of the can body and thereby avoid wrinkling.

Tooling for forming domed cups or can bodies has conventionally included a curved, or arcuate, punch core and a die core with a corresponding curvature, such that a domed can body is formed from material (*e.g.*, without limitation, a sheet metal blank) conveyed between the punch core and the die core. Typically, the punch core extends downwardly into the die core, forming the domed cup or can body. During this forming operation, the material is drawn between the punch core and the die core. That is, in order to maintain the thickness of the domed portion, the material is relatively lightly clamped on either side of the portion to be domed. Thus, the material can move (*e.g.*, slide) or flow toward the dome as it is formed in order to maintain the desired thickness in the bottom profile. Further, as shown in U.S. Patent No. 5,394,727, it is known to form a bottom profile including generally planar (when viewed in cross-section) surfaces instead of a dome. Such protrusions are also formed by drawing the material over a die. The domes and protrusions of the known art are structured to generally maintain the thickness of the material during the formation of a dome.

Further, can bodies formed from a cup with a generally hemispherical dome also have disadvantages. For example, certain beverage can bodies are formed by reversing, or flattening, the dome on the cup and reforming the dome on the can body. The steps to

this process are shown in Figures 3A-3C and include reversing the dome (Figures 3B and 3C) and reforming a can body dome (Figures 3D and 3E). It is noted that a cup's generally arcuate dome, *i.e.*, a generally hemispherical dome is generally arcuate in cross-section as shown in the figures, defines a volume of metal. This volume of metal must be reformed when the cup is formed into a can body. Further, it is noted that a generally arcuate dome includes a greater volume of metal relative to other shapes such as, but not limited to a truncated dome, as shown in Figure 5A, discussed below. This greater volume of metal allows the metal to wrinkle or have other defects during the formation of the can body. This is also true for food can bodies, which typically have a generally planar bottom, when formed from a cup with a generally arcuate dome. That is, the steps of forming a food can body are shown in Figures 4A-4E. As with beverage can bodies, the greater volume of metal in a generally hemispherical dome, *i.e.*, a generally arcuate dome when viewed in cross-section, allows for the formation of defects in the food can body when the cup is reformed.

There is, therefore, room for improvement in containers such as beer/beverage cans and food cans, as well as in selectively formed cups and tooling and methods for providing such cups and containers. That is, the problem in the known art is that the cup, or can body, uses too much material, especially in the base.

SUMMARY OF THE INVENTION

The disclosed and claimed concept provides for a formed blank including a stretched portion and/or a truncated protrusion, a tooling assembly structured to form a formed blank including a stretched portion and/or a truncated protrusion, and a method of forming a formed blank including a stretched portion and/or a truncated protrusion. The formed blank includes a base and a depending sidewall. The stretched portion and/or the truncated protrusion is disposed on the formed blank base and the thickness of the stretched portion and/or the truncated protrusion is less than the sidewall. The stretched portion and/or the truncated protrusion utilizes less material relative to an unformed base that has about the same thickness as the sidewall. As such, the formed blank, the tooling for forming the formed blank, and the method of forming the formed blank solve the problems stated above.

BRIEF DESCRIPTION OF THE DRAWINGS

A full understanding of the invention can be gained from the following description of the preferred embodiments when read in conjunction with the accompanying drawings in which:

Figure 1 is a cross-sectional view of a prior art cup.

Figure 2 is a cross-sectional view of a prior art can body.

Figures 3A-3E show the formation of a prior art beverage can body.

Figures 4A-4E show the formation of a prior art food can body.

Figure 5A is a cross-sectional view of a formed blank in the form of a cup. Figure 5B is a cross-sectional view of a formed blank in the form of a can body.

Figure 6 is a partially schematic, cross-sectional view of a tooling assembly.

Figure 7 is a detail cross-sectional view of a domer structured to form a truncated protrusion.

Figures 8A-8E show the formation of a beverage can body from a cup with a truncated dome.

Figures 9A-9E show the formation of a food can body from a cup with a truncated dome.

Figure 10 is a flow chart for the disclosed method.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Directional phrases used herein, such as, for example, clockwise, counterclockwise, left, right, top, bottom, upwards, downwards and derivatives thereof, relate to the orientation of the elements shown in the drawings and are not limiting upon the claims unless expressly recited therein.

As used herein, the singular form of "a," "an," and "the" include plural references unless the context clearly dictates otherwise.

As used herein, "structured to [verb]" means that the identified element or assembly has a structure that is shaped, sized, disposed, coupled and/or configured to perform the identified verb. For example, a member that is "structured to move" is movably coupled to another element and includes elements that cause the member to move or the member is otherwise configured to move in response to other elements or assemblies. As such, as used herein, "structured to [verb]" recites structure and not function. Further, as used herein, "structured to [verb]" means that the identified element

or assembly is intended to, and is designed to, perform the identified verb. Thus, an element that is merely capable of performing the identified verb but which is not intended to, and is not designed to, perform the identified verb is not "structured to [verb]."

As used herein, "associated" means that the elements are part of the same assembly and/or operate together, or, act upon/with each other in some manner. For example, an automobile has four tires and four hub caps. While all the elements are coupled as part of the automobile, it is understood that each hubcap is "associated" with a specific tire.

As used herein, the statement that two or more parts or components are "coupled" shall mean that the parts are joined or operate together either directly or indirectly, *i.e.*, through one or more intermediate parts or components, so long as a link occurs. As used herein, "directly coupled" means that two elements are directly in contact with each other. As used herein, "fixedly coupled" or "fixed" means that two components are coupled so as to move as one while maintaining a constant orientation relative to each other. Accordingly, when two elements are coupled, all portions of those elements are coupled. A description, however, of a specific portion of a first element being coupled to a second element, *e.g.*, an axle first end being coupled to a first wheel, means that the specific portion of the first element is disposed closer to the second element than the other portions thereof. Further, an object resting on another object held in place only by gravity is not "coupled" to the lower object unless the upper object is otherwise maintained substantially in place. That is, for example, a book on a table is not coupled thereto, but a book glued to a table is coupled thereto.

As used herein, a "fastener" is a separate component structured to couple two or more elements. Thus, for example, a bolt is a "fastener" but a tongue-and-groove coupling is not a "fastener." That is, the tongue-and-groove elements are part of the elements being coupled and are not a separate component.

As used herein, the phrase "removably coupled" or "temporarily coupled" means that one component is coupled with another component in an essentially temporary manner. That is, the two components are coupled in such a way that the joining or separation of the components is easy and would not damage the components. For example, two components secured to each other with a limited number of readily accessible fasteners, *i.e.*, fasteners that are not difficult to access, are "removably coupled" whereas two components that are welded together or joined by difficult to

access fasteners are not "removably coupled." A "difficult to access fastener" is one that requires the removal of one or more other components prior to accessing the fastener wherein the "other component" is not an access device such as, but not limited to, a door.

As used herein, "temporarily disposed" means that a first element(s) or assembly (ies) is resting on a second element(s) or assembly(ies) in a manner that allows the first element/assembly to be moved without having to decouple or otherwise manipulate the first element. For example, a book simply resting on a table, *i.e.*, the book is not glued or fastened to the table, is "temporarily disposed" on the table.

As used herein, "operatively coupled" means that a number of elements or assemblies, each of which is movable between a first position and a second position, or a first configuration and a second configuration, are coupled so that as the first element moves from one position/configuration to the other, the second element moves between positions/configurations as well. It is noted that a first element may be "operatively coupled" to another without the opposite being true.

As used herein, a "coupling assembly" includes two or more couplings or coupling components. The components of a coupling or coupling assembly are generally not part of the same element or other component. As such, the components of a "coupling assembly" may not be described at the same time in the following description.

As used herein, a "coupling" or "coupling component(s)" is one or more component(s) of a coupling assembly. That is, a coupling assembly includes at least two components that are structured to be coupled together. It is understood that the components of a coupling assembly are compatible with each other. For example, in a coupling assembly, if one coupling component is a snap socket, the other coupling component is a snap plug, or, if one coupling component is a bolt, then the other coupling component is a nut.

As used herein, "correspond" indicates that two structural components are sized and shaped to be similar to each other and may be coupled with a minimum amount of friction. Thus, an opening which "corresponds" to a member is sized slightly larger than the member so that the member may pass through the opening with a minimum amount of friction. This definition is modified if the two components are to fit "snugly" together. In that situation, the difference between the size of the components is even smaller whereby the amount of friction increases. If the element defining the opening and/or the component inserted into the opening are made from a deformable or compressible

material, the opening may even be slightly smaller than the component being inserted into the opening. With regard to surfaces, shapes, and lines, two, or more, "corresponding" surfaces, shapes, or lines have generally the same size, shape, and contours.

As used herein, a "planar body" or "planar member" is a generally thin element including opposed, wide, generally parallel surfaces, *i.e.,* the planar surfaces of the planar member, as well as a thinner edge surface extending between the wide parallel surfaces. That is, as used herein, it is inherent that a "planar" element has two opposed planar surfaces. The perimeter, and therefore the edge surface, may include generally straight portions, *e.g.,* as on a rectangular planar member, or be curved, as on a disk, or have any other shape.

As used herein, a "path of travel" or "path," when used in association with an element that moves, includes the space an element moves through when in motion. As such, any element that moves inherently has a "path of travel" or "path."

As used herein, the statement that two or more parts or components "engage" one another shall mean that the elements exert a force or bias against one another either directly or through one or more intermediate elements or components. Further, as used herein with regard to moving parts, a moving part may "engage" another element during the motion from one position to another and/or may "engage" another element once in the described position. Thus, it is understood that the statements, "when element A moves to element A first position, element A engages element B," and "when element A is in element A first position, element A engages element B" are equivalent statements and mean that element A either engages element B while moving to element A first position and/or element A either engages element B while in element A first position.

As used herein, "operatively engage" means "engage and move." That is, "operatively engage" when used in relation to a first component that is structured to move a movable or rotatable second component means that the first component applies a force sufficient to cause the second component to move. For example, a screwdriver may be placed into contact with a screw. When no force is applied to the screwdriver, the screwdriver is merely "coupled" to the screw. If an axial force is applied to the screwdriver, the screwdriver is pressed against the screw and "engages" the screw. However, when a rotational force is applied to the screwdriver, the screwdriver "operatively engages" the screw and causes the screw to rotate. Further, with electronic

components, "operatively engage" means that one component controls another component by a control signal or current.

As used herein, the word "unitary" means a component that is created as a single piece or unit. That is, a component that includes pieces that are created separately and then coupled together as a unit is not a "unitary" component or body.

As used herein, the term "number" shall mean one or an integer greater than one (*i.e.*, a plurality).

As used herein, in the phrase "[x] moves between its first position and second position," or, "[y] is structured to move [x] between its first position and second position," "[x]" is the name of an element or assembly. Further, when [x] is an element or assembly that moves between a number of positions, the pronoun "its" means "[x]," *i.e.*, the named element or assembly that precedes the pronoun "its."

As used herein, "about" in a phrase such as "disposed about [an element, point or axis]" or "extend about [an element, point or axis]" or "[X] degrees about an [an element, point or axis]," means encircle, extend around, or measured around. When used in reference to a measurement or in a similar manner, "about" means "approximately," *i.e.*, in an approximate range relevant to the measurement as would be understood by one of ordinary skill in the art.

As used herein, a "radial side/surface" for a circular or cylindrical body is a side/surface that extends about, or encircles, the center thereof or a height line passing through the center thereof. As used herein, an "axial side/surface" for a circular or cylindrical body is a side that extends in a plane extending generally perpendicular to a height line passing through the center. That is, generally, for a cylindrical soup can, the "radial side/surface" is the generally circular sidewall and the "axial side(s)/surface(s)" are the top and bottom of the soup can.

As employed herein, the terms "can" and "container" are used substantially interchangeably to refer to any known or suitable container, which is structured to contain a substance (*e.g.*, without limitation, liquid; food; any other suitable substance), and expressly includes, but is not limited to, beverage cans, such as beer and soda cans, as well as food cans.

As used herein, a "contour" means the line or surface, that defines an object. That is, for example, when viewed in cross-section, the surface of a three-dimensional object is

reduced to two dimensions; thus, a portion of a three-dimensional surface contour is represented by a two-dimensional line contour.

As used herein, a "perimeter portion" means the area at the outer edge of a defined area, surface, or contour.

As used herein, a "truncated protrusion" is a profile for a cup base or a can body base that includes a "stretched portion" and a generally planar portion at the distal end of the protrusion, *i.e.,* the end of the protrusion located furthest from the base. Thus, as used herein, a "truncated protrusion" inherently includes a stretched portion and a generally planar portion. Further, as used herein, a "generally planar portion" of a "truncated protrusion" includes both substantially planar elements and elements that include beads, corrugations, or similar constructs structured to accommodate additional material in a defined area and relative to a substantially planar element having the same defined area so long as the area including beads, corrugations, or similar constructs has generally planar contour over the defined area. Further, as used herein, a "truncated protrusion" is formed and offset inwardly. That is, a "truncated protrusion" is formed by deforming material into the space partially enclosed by a base and sidewall, such as on a cup of can body. Thus, the formation of an outwardly protruding bead extending about base does not convert the generally planar portion of the base encircled by the bead into a "truncated protrusion" because the generally planar portion of the base encircled by the bead is not formed or offset inwardly.

As used herein, a "truncated protrusion forming profile" is a surface on a forming element, such as, but not limited to, the surface of a die, structured to form a material into a "truncated protrusion" as defined above. As used herein, a "die truncated protrusion forming profile" is a surface on a die, structured to form a material into a "truncated protrusion" as defined above.

As used herein, a "truncated dome" is a "truncated protrusion" having a generally curvilinear (or arcuate) portion and a generally planar portion when viewed in a lateral cross-section; that is, a truncated dome is a dome wherein a generally planar portion is disposed where the vertex of the dome would be, *i.e.*, a dome with a generally flat top. Further, the "stretched portion" and the "generally planar portion" are one configuration selected from the group consisting of coextensive (*i.e.,* fully overlapping), partially coextensive (*i.e.,* partially overlapping), or separate (*i.e.,* no overlap).

As used herein, a "truncated dome forming profile" is a surface on a forming

element, such as, but not limited to, the surface of a die, structured to form a material into a "truncated dome" as defined above. As used herein, a "die truncated dome forming profile" is a surface on a die, structured to form a material into a "truncated dome" as defined above.

As used herein a "stretched portion" is a portion of a material formed by stretching the material. Further, as used herein, a "stretched portion" is not an unstretched portion that is capable of being stretched but rather one that has been stretched. Thus, an unstretched portion that is capable of being stretched is specifically excluded from the definition of a "stretched portion." A "truncated protrusion" or a "truncated dome," in an exemplary embodiment, includes an unstretched portion as well as the required "stretched portion." That is, a protrusion/dome with only an unstretched portion, *i.e.,* lacking a "stretched portion," is specifically excluded from the definition of a "truncated protrusion" or a "truncated dome." Further, due to the absence of a "stretched portion," a protrusion formed exclusively by drawing, such as the protrusion(s) disclosed in U.S. Patent No. 5,394,727, are specifically excluded from the definition of a "truncated protrusion" and a "truncated dome."

As used herein, a "formed blank" means a cup as well as a can body that has been formed from a cup.

As used herein, "depending" means to extend at an angle other than zero (0°) from another element without regard to direction. That is, for example, a "depending" sidewall may extend generally upwardly from a base.

As used herein, "generally curvilinear" includes elements having multiple curved portions, combinations of curved portions and planar portions, and a plurality of planar portions or segments disposed at angles relative to each other thereby forming a curve.

As used herein, "generally" means "in a general manner" relevant to the term being modified as would be understood by one of ordinary skill in the art.

As used herein, "substantially" means "for the most part" relevant to the term being modified as would be understood by one of ordinary skill in the art.

As used herein, "at" means on and near relevant to the term being modified as would be understood by one of ordinary skill in the art.

Generally, and as shown in Figures 5A and 5B, a formed blank 10, *i.e.,* a cup 2 or a can body 5, is formed from a blank 1. That is, blank 1 is formed by a tooling assembly 100, shown partially schematically in Figure 6. As is known, the tooling assembly 100

includes a first tool assembly 102 and a second tool assembly 104. At least one of the first tool assembly 102 and the second tool assembly 104 is movable and is coupled to a press 106 or similar device. In an exemplary embodiment, the first tool assembly 102 includes a forming punch 108 and the second tool assembly 104 includes a forming die 110. The press 106 is structured to, and does, move the first tool assembly 102 between a first position, wherein the first tool assembly 102 is spaced from the second tool assembly 104, and a second position, wherein the first tool assembly 102 is immediately adjacent and minimally spaced from the second tool assembly 104. That is, as the first tool assembly 102 moves from the first position to the second position, the forming punch 108 engages and deforms blank 1 and forms the blank into a formed blank 10. As is known, the tooling assembly 100, in one embodiment, is supplied with pre-cut blanks 1 to be formed into cups 2. In another embodiment, the tooling assembly 100 is supplied with a sheet of material (not shown) and cuts blanks 1 from the sheet as part of the forming operation.

The following disclosure details the formation of a cup 2 which is then formed into a can body 5, as is generally known. The cup 2, and the subsequent can body 5, hereinafter and collectively the formed blank 10, includes a truncated protrusion 20, as shown in Figures 5A and 5B. Initially, however, the following disclosure details the configuration of the finished formed blank 10. That is, the formed blank 10 includes a body 11 having a base 12 and a depending sidewall 14. Further, as is known, a can body base 12 includes a ridge 16 extending about the base 12. In an exemplary embodiment, the base 12 is generally circular and, as such, the depending sidewall 14 is generally cylindrical and the ridge 16 is an annular ridge 16'. Further, in an exemplary embodiment, the truncated protrusion 20 is a truncated dome 22. That is, the base 12 includes a truncated protrusion 20 including a number of generally curvilinear portion(s) 30 and a generally planar portion 32. It is noted that the cup 2 shown in Figure 5A has a single bead (not numbered) and is a cup 2 for a beverage can body 5A. Conversely, the cup shown in Figure 9A (not numbered) has two beads and is for a food can body 5B. Generally, a cup 2 for a food can body 5B has a greater diameter than a cup 2 for a beverage can body 5A and, as such, can accommodate another bead.

Further, compared to a generally hemispherical dome, *i.e.*, a generally arcuate dome when viewed in cross-section, a truncated dome 22 has a "reduced volume." As used herein, a "reduced volume" means a protrusion formed in the bottom of a cup, such

as, but not limited to, a truncated dome that has a reduced volume of metal compared to a generally hemispherical dome, *i.e.*, a generally arcuate dome when viewed in cross-section. It is noted that the length of the bottom profile (when viewed in cross-section as shown in Figure 5A) of a truncated dome 22, *i.e.*, the length from the outer edge of the truncated dome 22 to the center of the truncated dome 22 is shorter than the length of a generally hemispherical dome because the generally planar portion 32 of a truncated dome 22 has a shorter length relative to an arc on a generally hemispherical dome. Stated alternately, when an arc within and confined by a perimeter, *e.g.*, sidewalls 14 (when viewed in cross-section), is flattened to a generally straight line, the length of the now flattened line is shorter relative to the previously existing arc. Thus, as this distance is shorter, the volume of the truncated dome 22 is less than a generally hemispherical dome having the same diameter.

In one exemplary embodiment, not shown, there is a single curvilinear portion 30 that extends between the annular ridge 16' and the generally planar portion 32. Further, the single curvilinear portion 30 is, in an exemplary embodiment, an arcuate portion 40. As used herein, the term "arcuate portion" refers to the shape of the truncated protrusion 20 when viewed in cross-section, as shown in Figure 5A; it is understood that the curvilinear portion 30 (or arcuate portion 40) when rotated about an axis in three dimensions forms a dome, or dome-like, shape. In the embodiment shown, the number of generally curvilinear portion(s) 30 includes a first generally curvilinear portion 34 and a second generally curvilinear portion 36. The truncated dome first generally curvilinear portion 34 has a first center, and, the truncated dome second generally curvilinear portion 36 has a second center. As used herein, the "center" of a curvilinear line means a point that is disposed generally an equal distance from all points on the curvilinear line; for an arcuate line, the "center" means a point that is disposed substantially an equal distance from all points on the arcuate line. In an exemplary embodiment, the first generally curvilinear portion 34 and the second generally curvilinear portion 36 are a first generally arcuate portion 44 and a second generally arcuate portion 46, respectively.

Further, as discussed in more detail below, a portion of the truncated protrusion 20 (or truncated dome 22) is stretched (hereinafter the "stretched portion" 38) during the forming process so that the material forming the truncated protrusion 20, or a portion of the truncated protrusion 20, is thinner than the base gauge of the original material, *i.e.*, the base gauge of the blank 1 which, in an exemplary embodiment, is also the thickness of the

sidewall 14. In an exemplary embodiment, substantially all of the truncated protrusion 20 (or truncated dome 22) has a uniform thickness. That is, in one exemplary embodiment, the stretched portion 38 extends over substantially all of the curvilinear portion(s) 30 (34, 36) as well as the planar portion 32. In other embodiments, the stretched portion 38 extends over only a portion of the curvilinear portion(s) 30 (34, 36) and/or the planar portion 32. Further, in an exemplary embodiment, the truncated protrusion 20 (or truncated dome 22) has a thickness that is between about 0.0003 inch and 0.002 inch thinner than the base gauge of the original material and/or the sidewall 14.

Generally, the tooling and method of forming a cup 2 or can body 5 with a stretched dome is disclosed in U.S. Patent Application Serial No. 15/286,954. The following disclosure addresses the details of the tooling assembly 100, shown in Figure 6, and method (Figure 10) for forming a truncated protrusion 20 (or truncated dome 22). As noted above, the tooling assembly 100 includes a first tool assembly 102 and a second tool assembly 104 structured to form a blank 1 into formed blank 10, *i.e.*, a cup 2 or a can body 5. It is noted that the blank 1 has a base gauge (thickness) and that, after the initial formation of the formed blank 10, the base 12 and the sidewall 14 have substantially the same thickness as the base gauge. Further, in an exemplary embodiment, the tooling assembly 100 is structured to, and does, maintain the thickness of the sidewall 14 substantially at the base gauge.

The first tool assembly 102 and second tool assembly 104 are further structured to, and do, clamp the blank 1 of material at the periphery of the base 12. In an exemplary embodiment, the periphery of the base 12 is defined by the ridge 16; thus, the first tool assembly 102 and second tool assembly 104 are further structured to, and do, clamp the blank 1 of material at the ridge 16. The first tool assembly 102 and the second tool assembly 104 are structured to, and do, stretch a portion of the base 12 and thereby thin the base stretched portion 38 relative to the base gauge of the material and/or the sidewall 14. As discussed above, the stretched portion 38, in an exemplary embodiment, has a generally uniform thickness. Further, in an exemplary embodiment, the stretched portion 38 is coextensive with the entire base 12. To accomplish this, the formed blank 10 is moved by the forming punch 108 to the forming die 110. The forming punch 108, in this embodiment, is an elongated, generally cylindrical body 112 with a cavity 114 at the distal end. The cavity 114, in one embodiment, is generally concave and contoured to correspond to the shape of a forming surface 120, discussed below. In another

embodiment, the cavity 114 is generally cylindrical; that is, the forming punch 108 is generally hollow.

As shown in Figure 6, the forming surface 120 is disposed on the forming die 110 of the second tool assembly 104. In an exemplary embodiment, the forming die 110 remains substantially stationary relative to the forming punch 108. That is, the forming punch 108 reciprocates in a generally vertical direction and the upper surface of the forming die 110 has a convex protrusion 111 that defines the forming surface 120. The forming surface 120 includes a truncated protrusion forming profile 122. Thus, the forming punch 108 is structured to, and does, move the blank 1 of material into contact with the truncated protrusion forming profile 122. In an exemplary embodiment, the truncated protrusion forming profile 122 is a truncated dome forming profile 122'.

The truncated dome forming profile 122' includes a number of generally curvilinear portions 126 and a planar portion forming construct 128. To form a truncated dome 22 as described above, the truncated dome forming profile number of generally curvilinear portions 126 includes a first generally curvilinear portion 130 and a second generally curvilinear portion 132. The truncated dome forming profile first generally curvilinear portion 130 has a first center 134 and the truncated dome forming profile second generally curvilinear portion 132 has a second center 136. Further, in an exemplary embodiment, the truncated dome forming profile first generally curvilinear portion 130 is a first generally arcuate portion 140, and, the truncated dome forming profile second generally curvilinear portion 132 is a second generally arcuate portion 142.

The truncated dome forming profile planar portion forming construct 128 is in one exemplary embodiment, not shown, a generally planar surface. That is, the truncated dome forming profile 122' is generally flat at the vertex. In the embodiment shown, the truncated dome forming profile planar portion forming construct 128 is a cavity 150. That is, the truncated dome forming profile 122' is defined by the number of generally curvilinear portions 126. The truncated dome forming profile planar portion forming construct is the cavity 150 in the die. Stated alternately, the number of generally curvilinear portions 126 extend generally concentrically about a cavity 150.

In this configuration, the formed blank 10, and more specifically the base 12, is clamped between the first tool assembly 102 and the second tool assembly 104 as it is moved into the forming die 110. As the forming punch 108 moves the base 12 over the truncated dome forming profile 122', the material of the base 12 is stretched and thinned.

Further, the material of the base 12 is formed to the contour of the truncated dome forming profile 122'. That is, a portion of the base 12 is formed to the truncated dome forming profile first generally curvilinear portion 130 and the truncated dome forming profile second generally curvilinear portion 132. Further, as the center of the forming die 110 is hollow (and as the forming punch 108 is also hollow) the center of the base 12 remains generally planar while being thinned. In an exemplary embodiment, the first tool assembly 102 and the second tool assembly 104 are structured to form the formed blank sidewall 14 with a thickness about the same as the base gauge. The first tool assembly 102 and the second tool assembly 104 are also structured to form the formed blank truncated protrusion with a thickness that is less than the formed blank sidewall 14. In an exemplary embodiment, the first tool assembly 102 and the second tool assembly 104 are structured to form the formed blank truncated protrusion 20 with a thickness that is between about 0.0003 inch and 0.002 inch thinner than the formed blank sidewall 14.

Thus, as shown in Figure 10, a method of forming a formed blank within a tooling assembly 100, as described above, includes forming 1000 a blank 1 of material to include a base 12 and a depending sidewall 14, clamping 1002 the blank 1 between the first tool assembly 102 and the second tool assembly 104 at the periphery of the base 12, and stretching 1004 the base 12, thereby thinning a portion of the base 12 relative to the sidewall 14 to form a stretched portion 38. In an exemplary embodiment, stretching 1004 the base 12, thereby thinning a portion of the base 12 relative to the sidewall 14 to form a stretched portion 38 includes stretching 1006 the base stretched portion so as to have a generally uniform thickness. Further, stretching 1004 the base 12, thereby thinning a portion of the base 12 relative to the sidewall 14 to form a stretched portion 38 includes forming 1010 a truncated protrusion 20. In an exemplary embodiment, forming 1010 a truncated protrusion 20 includes forming 1012 a truncated dome 22.

To form the truncated dome 22 described above, forming 1012 a truncated dome includes: forming 1020 a dome with a first generally curvilinear portion and a second generally curvilinear portion, forming 1022 the first generally curvilinear portion about a first center, and forming 1024 the second generally curvilinear portion about a second center. Further, to form the truncated dome 22 described above forming 1000 the blank 1 of material to include a base 12 and a depending sidewall 14 includes forming 1030 the sidewall 14 with a thickness generally corresponding to the base gauge of the material. Further, stretching 1004 the base 12, thereby thinning a portion of the base 12 relative to

the sidewall 14 includes forming 1032 the stretched portion 38 with a thickness that is less than the formed blank sidewall 14. Further, in an exemplary embodiment, stretching 1004 the base 12, thereby thinning a portion of the base 12 relative to the sidewall 14 includes forming 1036 the stretched portion 38 with a thickness that is between about 0.0003 inch and 0.002 inch thinner than the sidewall 14.

The process described above discloses forming a blank 1 into a cup 2 having a truncated protrusion 20. It is understood that such a cup 1 is then formed into a can body 5 either in the same device or the cup 2 is transported to a bodymaker, as is known. The can body 5 made from such a cup 2 also includes the truncated protrusion 20. Alternatively, when forming the cup 1 into a can body 5, the thinned portion is reformed into a traditional dome that is generally concave; *i.e.,* the dome 9 does not have a generally planar portion. As used herein, a can body 5 made from a cup 2 having a truncated protrusion 20 is also a formed blank 10 having a truncated protrusion 20 regardless of whether the truncated protrusion 20 is reformed at a later stage of processing.

That is, as shown in Figures 8A-8E, cup 2 with a truncated protrusion 20 is formed into a beverage can body 5'. That is, as shown in Figures 8A-8C, the cup 2 is reformed by inverting the truncated protrusion 20. During this forming process, the bottom of the cup 2 is reformed so as to be substantially planar. Thus, as shown in Figures 8D and 8E, when the can beverage can body 5' is reformed with a dome, the bottom of the cup 2 forms over the domer 180 with no loose metal as in the prior art.

Similarly, Figures 9A-9E show the formation of a food can body 5''. In this process, the cup 2 and the truncated protrusion 20 are reformed as substantially planar elements. Because the generally planar portion 32 is already generally planar, the reformed can body does not include an offset portion which is a remnant of the dome.

While specific embodiments of the invention have been described in detail, it will be appreciated by those skilled in the art that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. Accordingly, the particular arrangements disclosed are meant to be illustrative only and not limiting as to the scope of invention which is to be given the full breadth of the claims appended and any and all equivalents thereof.

What is Claimed is:

1. A formed blank (10) comprising:

a body (11) including a base (12); and

the base (12) including a truncated protrusion (20).

2. The formed blank (10) of Claim 1 wherein the truncated protrusion (20) is a truncated dome (22).

3. The formed blank (10) of Claim 2 wherein:

the truncated dome (22) includes a first generally curvilinear portion (130) and a second generally curvilinear portion (132);

the truncated dome first generally curvilinear portion (130) having a first center (134); and

the truncated dome second generally curvilinear portion (132) having a second center (136).

4. The formed blank (10) of Claim 3 wherein:

the truncated dome first generally curvilinear portion (130) is a first generally arcuate portion (140); and

the truncated dome second generally curvilinear portion (132) is a second generally arcuate portion (142).

5. The formed blank (10) of Claim 1 wherein the stretched portion (38) of the truncated protrusion (20) has a generally uniform thickness.

6. The formed blank (10) of Claim 1 wherein the formed blank (10) has a base gauge and wherein;

the body (11) includes a sidewall (14) depending from the base (12):

the sidewall (14) has a thickness generally corresponding to the base gauge; and

the truncated protrusion (20) has a thickness that is less than the sidewall (14).

7. The formed blank (10) of Claim 6 wherein the truncated protrusion (20) has a thickness that is between about 0.0003 inch and 0.002 inch thinner than the sidewall (14).

8. Tooling assembly (100) for forming a blank of material (1) into a formed blank (10), the formed blank (10) including a base (12) and a depending sidewall (14), the tooling assembly (100) comprising:

a first tool assembly (102);

a second tool assembly (104);

the first tool assembly (102) and the second tool assembly (104) structured clamp the blank of material (1) at the periphery of the base (12);

the first tool assembly (102) and the second tool assembly (104) structured to stretch a portion of the base (12) and thereby thin the base stretched portion (38) relative to the sidewall (14); and

wherein the base stretched portion (38) is generally uniform in thickness.

9. The formed blank of Claim 1 wherein the formed blank has a reduced volume.

10. The tooling assembly (100) of Claim 9 wherein:

the first tool assembly (102) includes a forming punch (108);

the second tool assembly (104) includes a forming surface (120);

wherein the forming surface (120) includes a truncated protrusion forming profile (122); and

wherein the forming punch (108) moves the blank of material (1) into contact with the truncated protrusion forming profile (122).

11. The tooling assembly (100) of Claim 10 wherein the forming surface (120) includes a truncated dome forming profile (122').

12. The tooling assembly (100) of Claim 11 wherein:

the truncated dome forming profile (122') includes a first generally curvilinear portion (130) and a second generally curvilinear portion (132);

the truncated dome forming profile first generally curvilinear portion (130) having a first center (134); and

the truncated dome forming profile second generally curvilinear portion (132) having a second center (136).

13. The tooling assembly (100) of Claim 12 wherein:

the truncated dome forming profile first generally curvilinear portion (130) is a first generally arcuate portion (140); and

the truncated dome forming profile second generally curvilinear portion (132) is a second generally arcuate portion (142).

14. The tooling assembly (100) of claim 9 wherein the blank of material (1) has a base gauge prior to being formed and wherein:

the first tool assembly (102) and the second tool assembly (104) are structured to form the blank of material (1) into a formed blank (10) including a base (12) and a sidewall (14);

the first tool assembly (102) and the second tool assembly (104) are structured to form the formed blank base (12) with a truncated protrusion (20); and

the first tool assembly (102) and the second tool assembly (104) are structured to form the formed blank sidewall (14) with a thickness about the same as the base gauge; and

the first tool assembly (102) and the second tool assembly (104) are structured to form the formed blank truncated protrusion (20) with a thickness that is less than the formed blank sidewall (14).

15. The tooling assembly (100) of claim 14 wherein the first tool assembly (102) and the second tool assembly (104) are structured to form the formed blank truncated protrusion (20) with a thickness that is between about 0.0003 inch and 0.002 inch thinner than the formed blank sidewall (14).

16. A method of forming a formed blank (10) within a tooling assembly (100), the tooling assembly (100) including a first tool assembly (102) and a second tool assembly (104), the method comprising:

forming (1000) a blank of material (1) to include a base (12) and a depending sidewall (14);

clamping (1002) the blank (10) between the first tool assembly (102) and the second tool assembly (104) at the periphery of the base (12); and

stretching (1004) the base (12) thereby thinning a portion of the base (12) relative to the sidewall (14) to form a stretched portion (38).

17. The method of Claim 16 stretching (1004) the base (12) thereby thinning a portion of the base (12) relative to the sidewall (14) to form a stretched portion (38) includes stretching (1006) the base stretched portion (38) so as to have a generally uniform thickness.

18. The method of Claim 16 wherein stretching (1004) and thereby thinning a portion of the base (12) relative to the sidewall (14) to form a stretched portion (38) includes forming (1010) a truncated protrusion (20).

19. The method of Claim 18 wherein forming (1010) a truncated protrusion (20) includes forming (1012) a truncated dome (22).

20. The method of Claim 18 wherein forming (1012) a truncated dome (22) includes:

forming (1020) a dome (20) with a first generally curvilinear portion (130) and a second generally curvilinear portion (132);

forming (1022) the first generally curvilinear portion (130) about a first center; and

forming (1024) the second generally curvilinear portion (32) about a second center.

21. The method of Claim 16 wherein the blank (10) has a base gauge and wherein forming (1000) the blank of material (1) to include a base (12) and a depending sidewall (14) and stretching and thereby thinning a portion of the base (12) relative to the sidewall (14) to form a stretched portion (38) include:

forming (1030) the sidewall (14) with a thickness generally corresponding to the base gauge; and

forming (1032) the stretched portion (38) with a thickness that is less than the formed blank sidewall (14).

22. The method of Claim 21wherein forming (1032) the stretched portion (38) with a thickness that is less than the formed blank sidewall (14) includes forming (1036) the stretched portion with a thickness that is between about 0.0003 inch and 0.002 inch thinner than the sidewall (14).

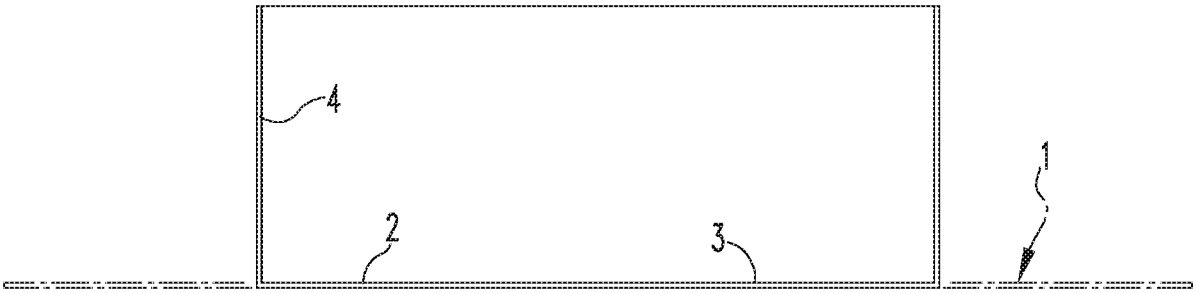

FIG.1
PRIOR ART

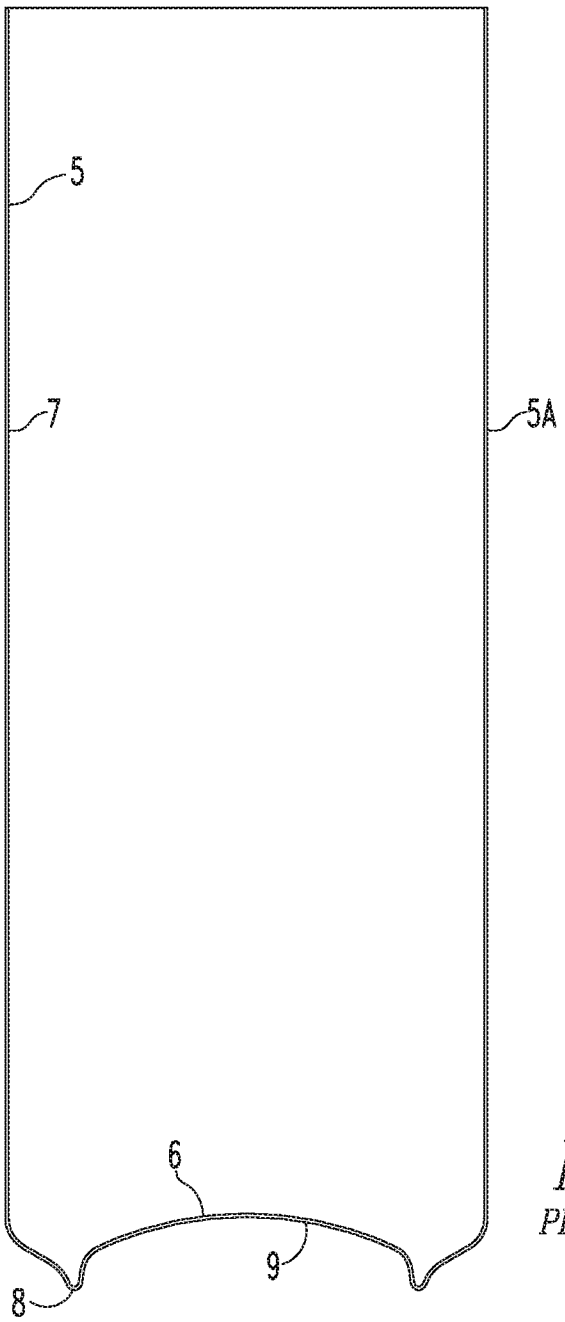

FIG.2
PRIOR ART

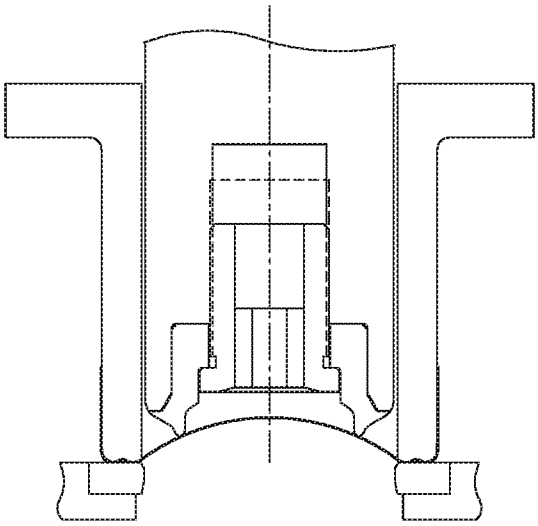

FIG.3A

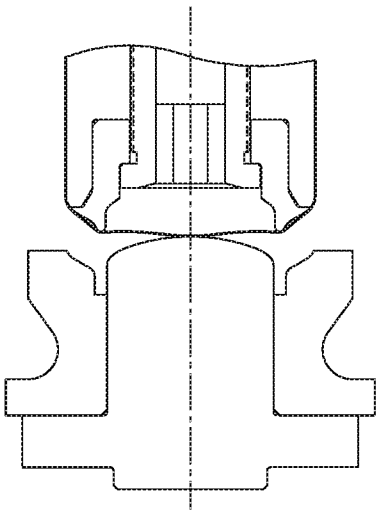

FIG.3D

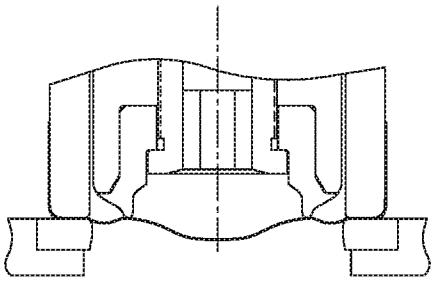

FIG.3B

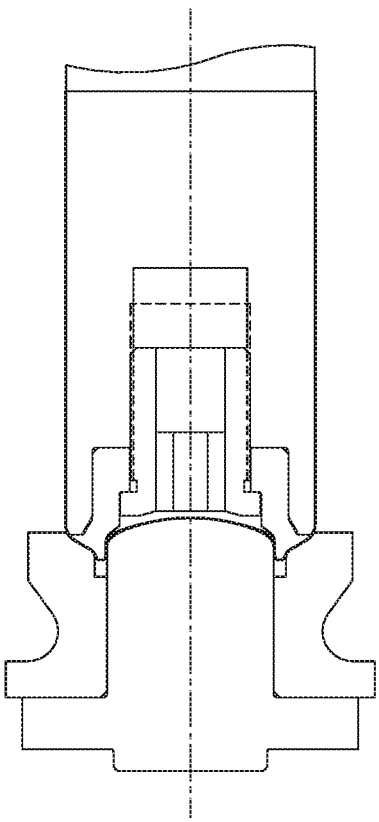

FIG.3E

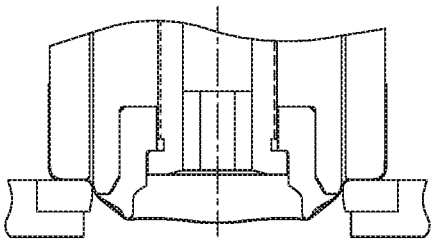

FIG.3C

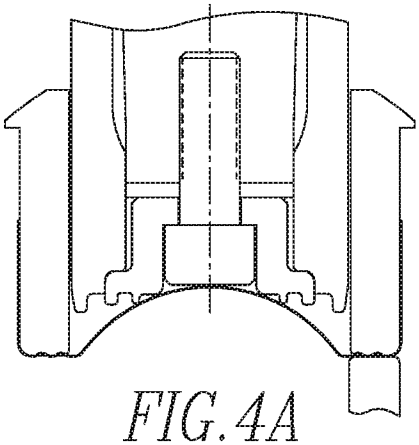

FIG.4A

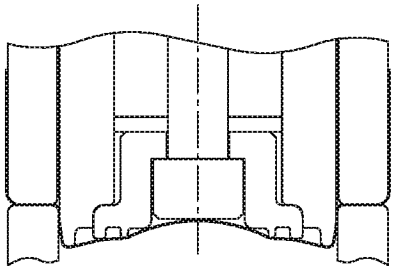

FIG.4D

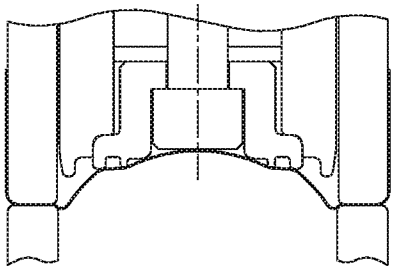

FIG.4B

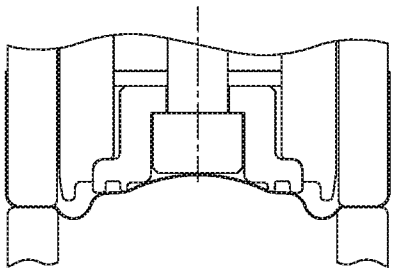

FIG.4C

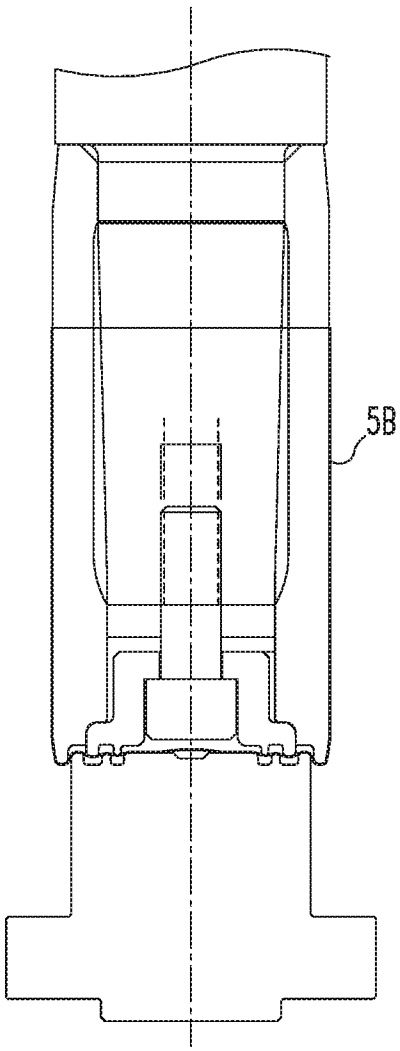

FIG.4E

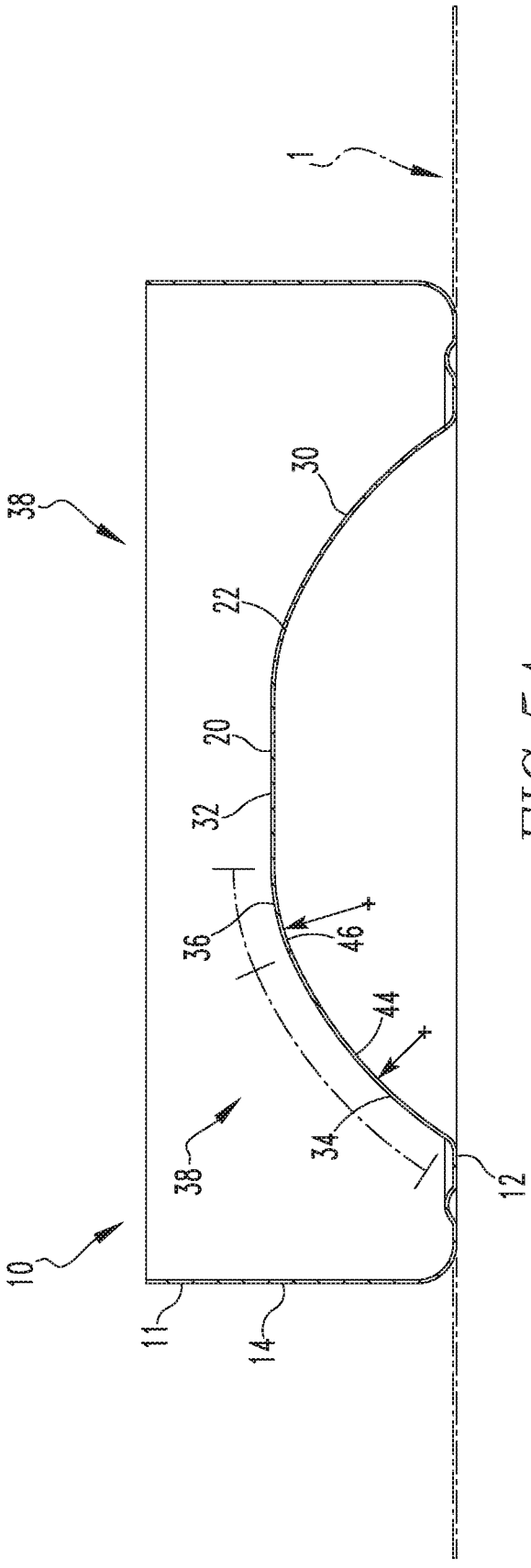

FIG. 5A

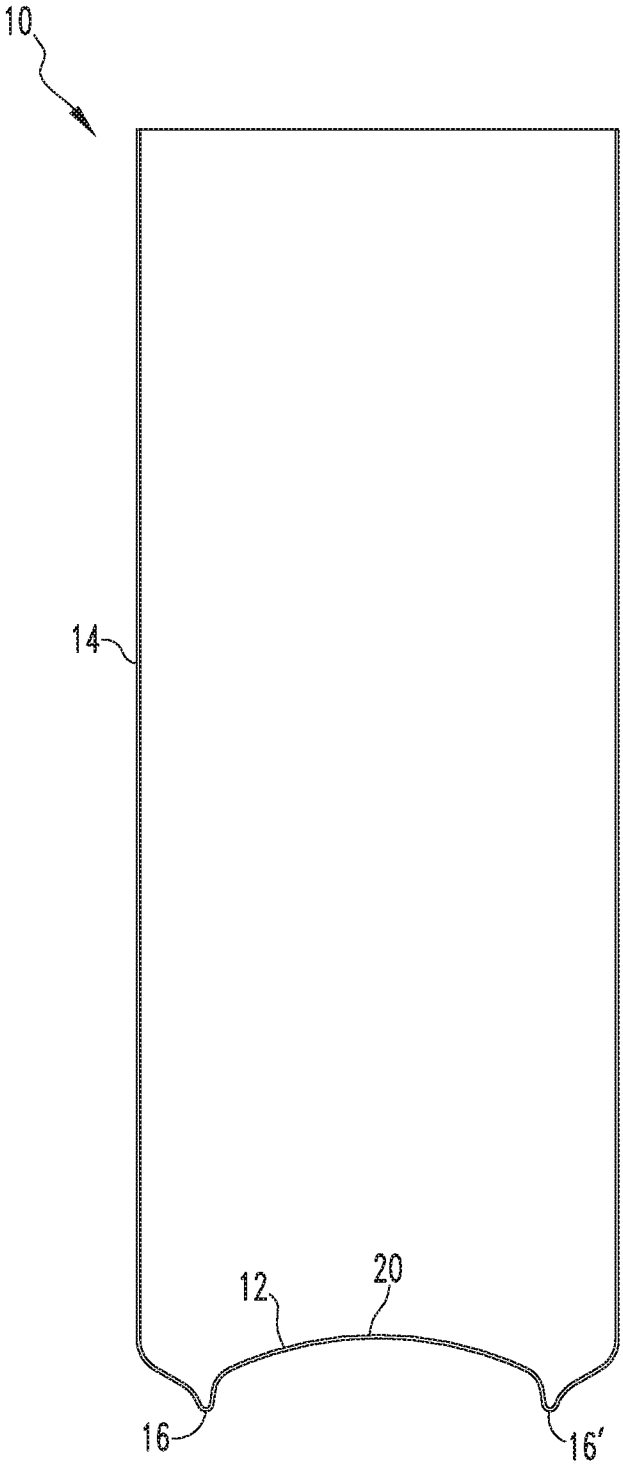

FIG.5B

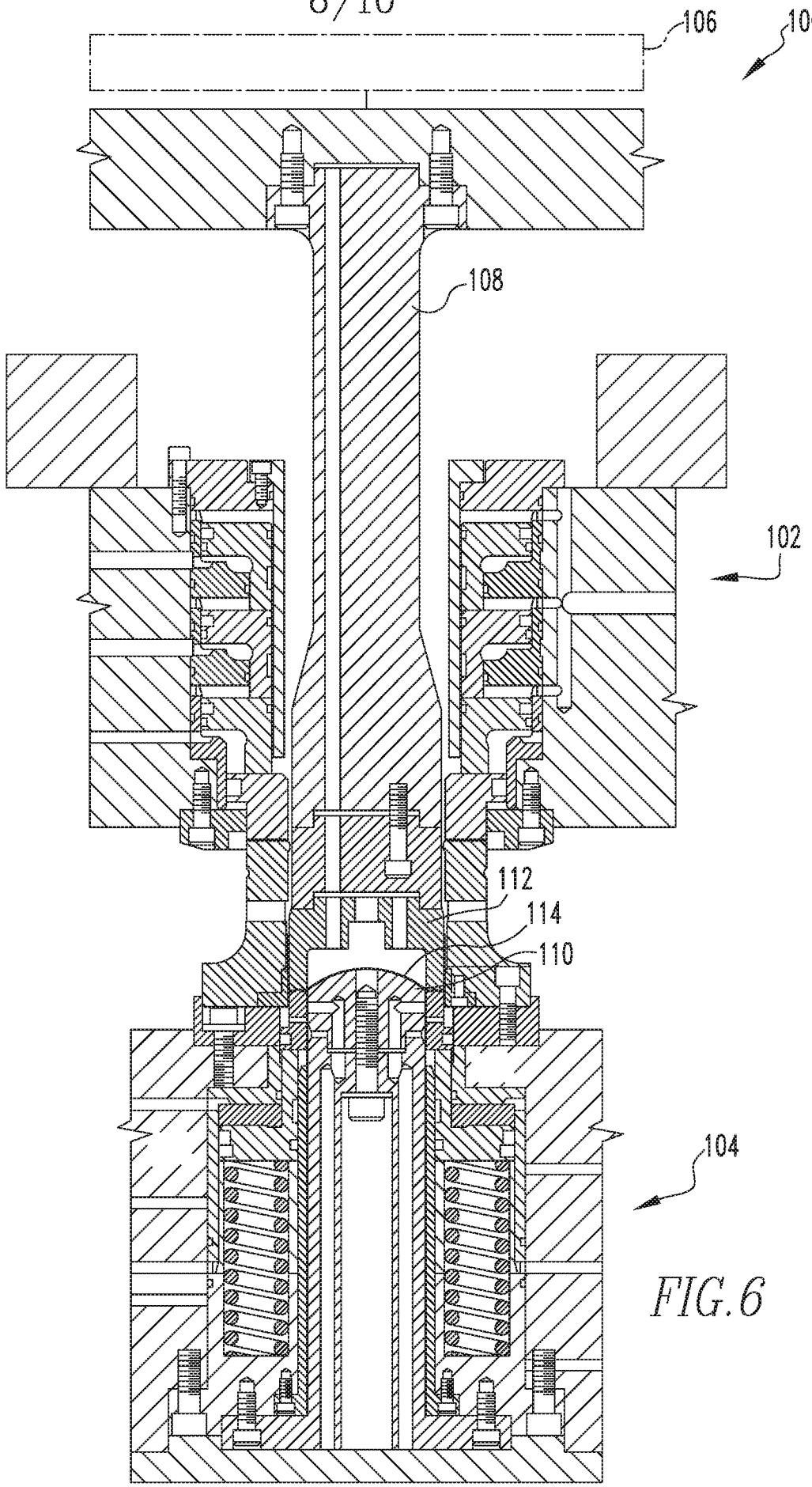

FIG.6

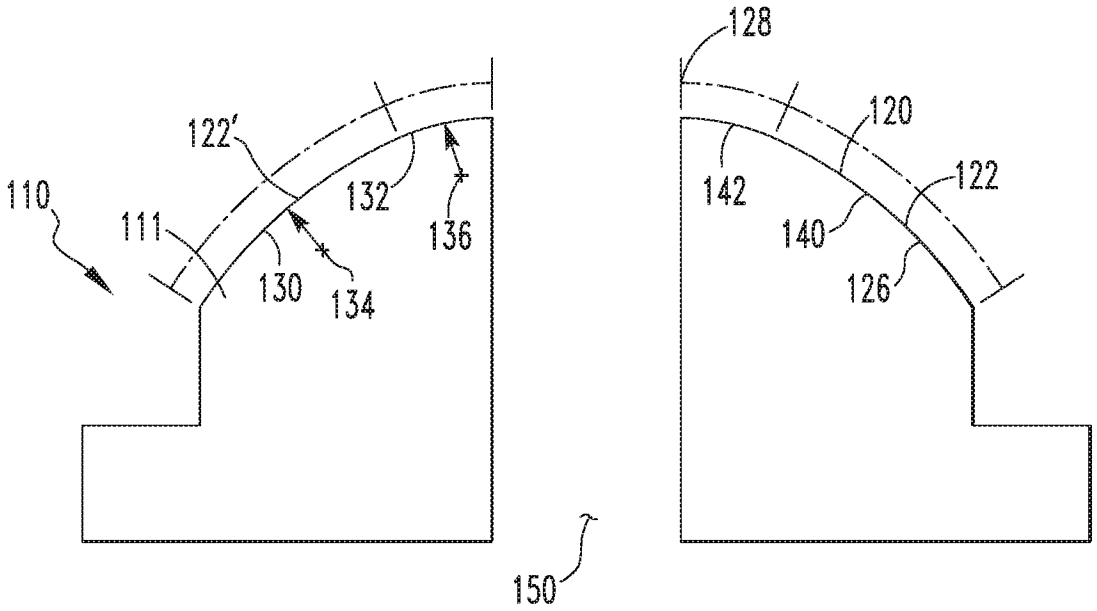

FIG. 7

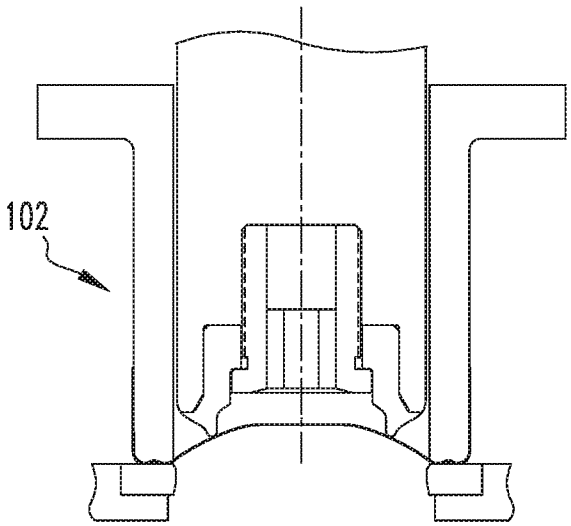

FIG.8A

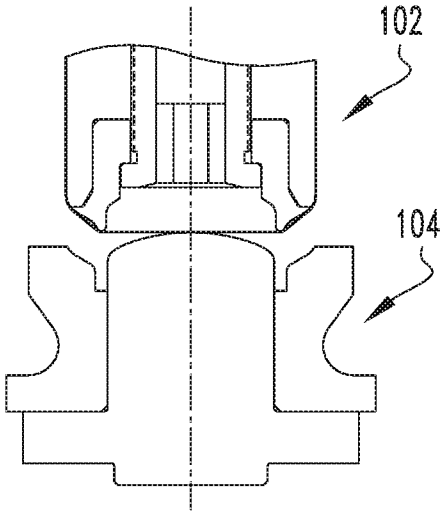

FIG.8D

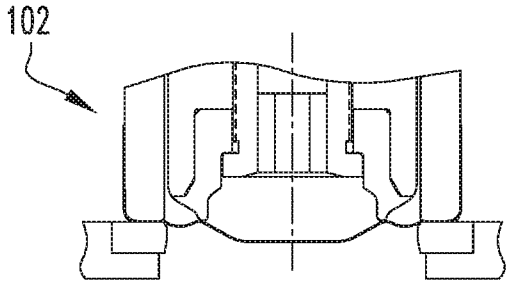

FIG.8B

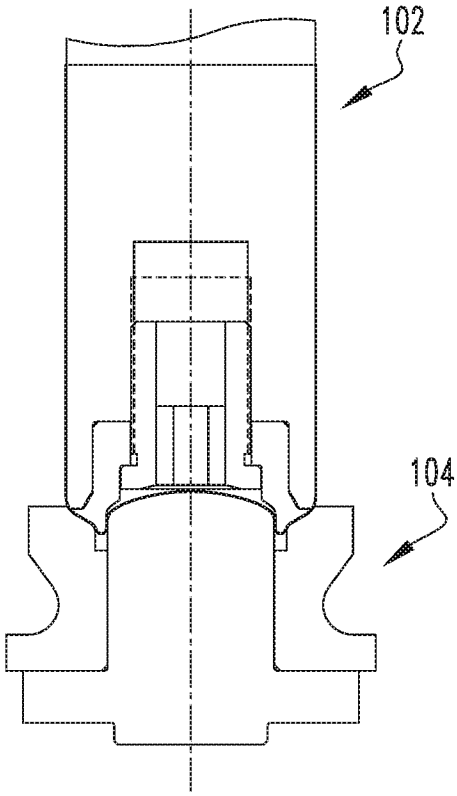

FIG.E

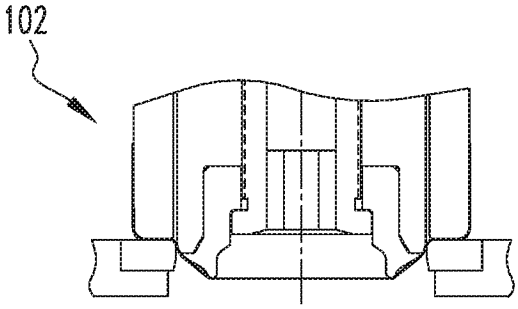

FIG.8C

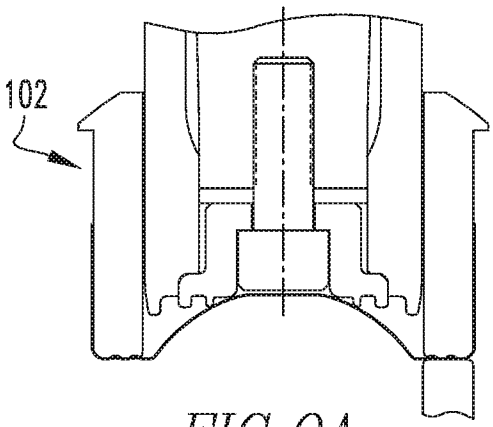

FIG.9A

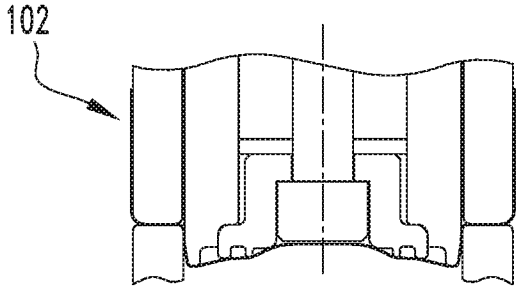

FIG.9A

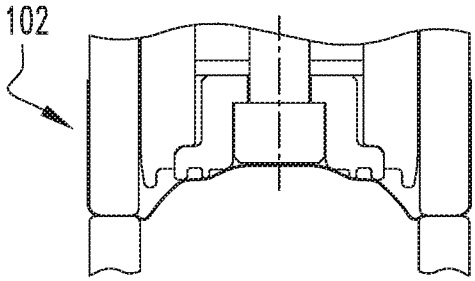

FIG.9A

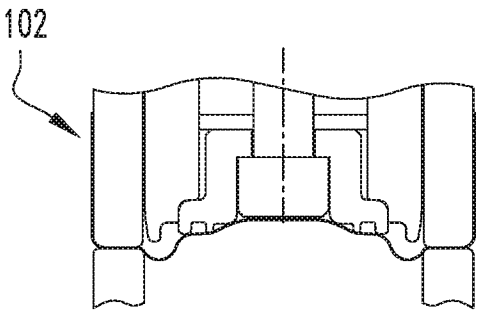

FIG.9A

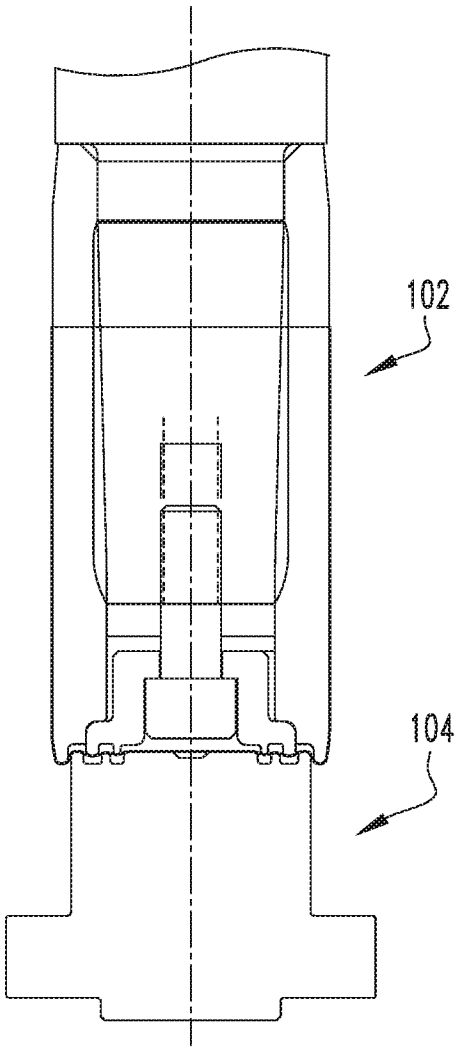

FIG.9A

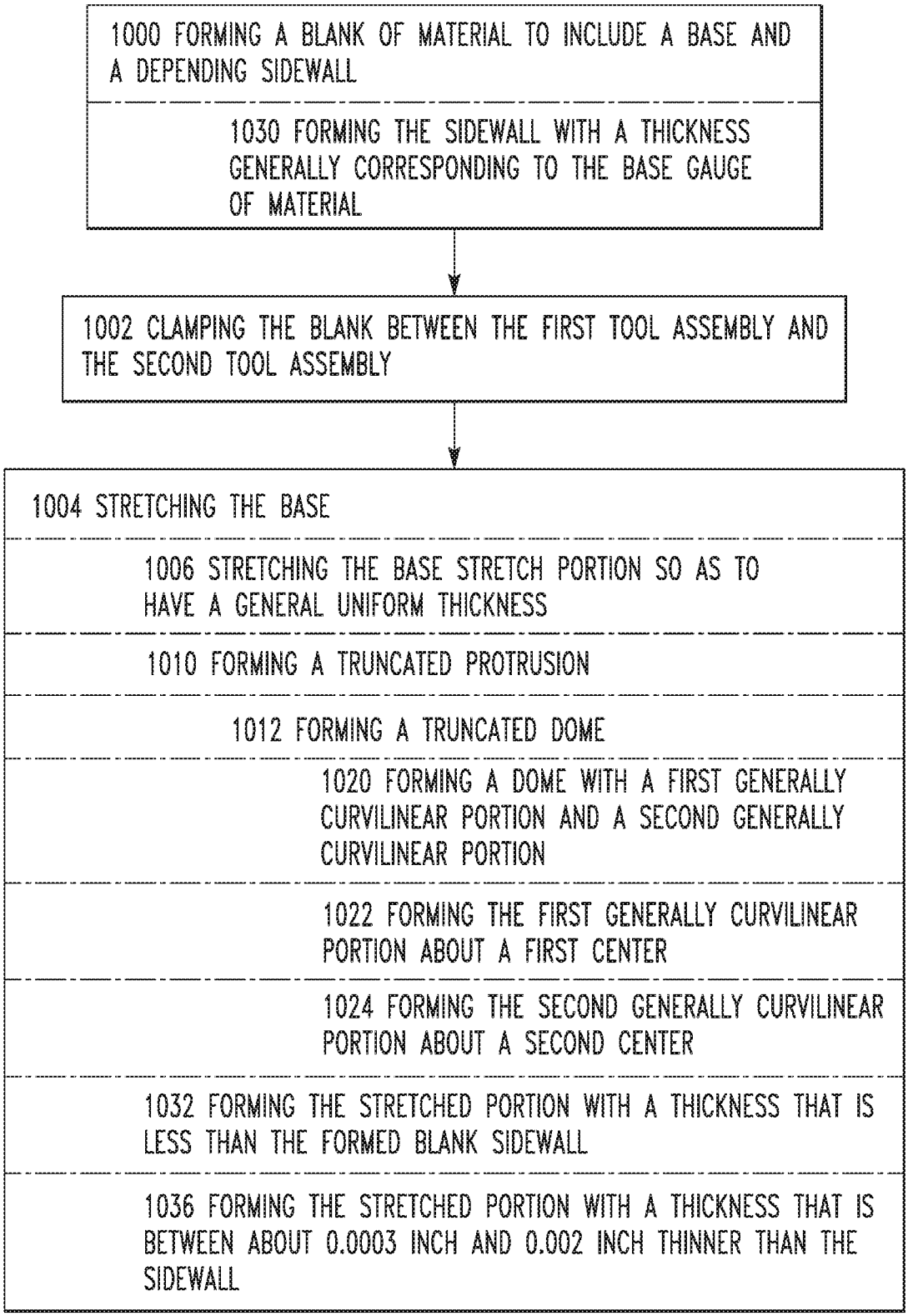
1000 FORMING A BLANK OF MATERIAL TO INCLUDE A BASE AND A DEPENDING SIDEWALL
1030 FORMING THE SIDEWALL WITH A THICKNESS GENERALLY CORRESPONDING TO THE BASE GAUGE OF MATERIAL
1002 CLAMPING THE BLANK BETWEEN THE FIRST TOOL ASSEMBLY AND THE SECOND TOOL ASSEMBLY
1004 STRETCHING THE BASE
1006 STRETCHING THE BASE STRETCH PORTION SO AS TO HAVE A GENERAL UNIFORM THICKNESS
1010 FORMING A TRUNCATED PROTRUSION
1012 FORMING A TRUNCATED DOME
1020 FORMING A DOME WITH A FIRST GENERALLY CURVILINEAR PORTION AND A SECOND GENERALLY CURVILINEAR PORTION
1022 FORMING THE FIRST GENERALLY CURVILINEAR PORTION ABOUT A FIRST CENTER
1024 FORMING THE SECOND GENERALLY CURVILINEAR PORTION ABOUT A SECOND CENTER
1032 FORMING THE STRETCHED PORTION WITH A THICKNESS THAT IS LESS THAN THE FORMED BLANK SIDEWALL
1036 FORMING THE STRETCHED PORTION WITH A THICKNESS THAT IS BETWEEN ABOUT 0.0003 INCH AND 0.002 INCH THINNER THAN THE SIDEWALL

FIG.10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/065671

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B21D 22/26; B21D 22/20; B21D 22/22; B21D 22/24; B21D 22/28; B21D 22/30 (2018.01)

CPC - B21D 22/26; B21D 22/20; B21D 22/22; B21D 22/225; B21D 22/24; B21D 22/28; B21D 22/283; B21D 22/30 (2018.01)

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)

See Search History document

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

USPC - 72/347; 72/348; 72/349; 72/350; 72/379.4; 220/606; 220/608 (keyword delimited)

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

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2001/0009107 A1 (CHENG et al) 26 July 2001 (26.07.2001) entire document	1-7, 8a, 8b, 10-22
X	US 2016/0114371 A1 (BALL CORPORATION) 28 April 2016 (28.04.2016) entire document	1, 8b
A	US 3,855,862 A (MOLLER) 24 December 1974 (24.12.1974) entire document	1-7, 8a, 8b, 10-22
A	US 3,904,069 A (TOUKMANIAN) 09 September 1975 (09.09.1975) entire document	1-7, 8a, 8b, 10-22
A	US 2003/0071044 A1 (WERTH et al) 17 April 2003 (17.04.2003) entire document	1-7, 8a, 8b, 10-22

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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	Date of mailing of the international search report
29 January 2018	14 FEB 2018
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774