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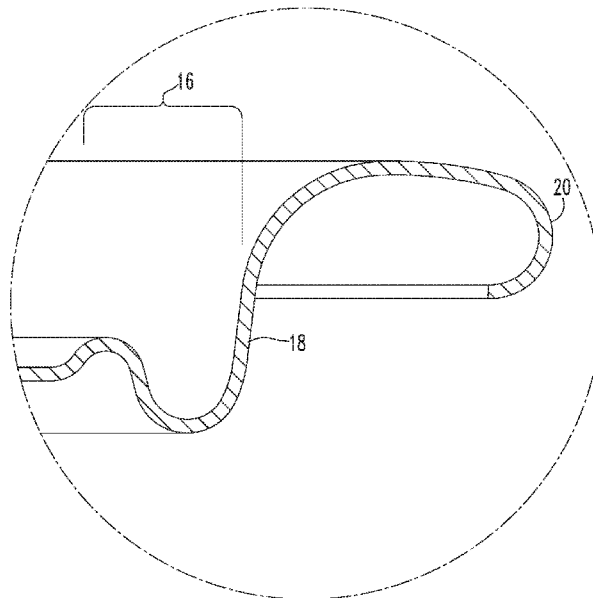


FIG. 4A

(57) **Abstract:** A can end (12) including a center panel (14), an annular portion (16) disposed about the center panel (14), a standard chuck wall (18A) disposed about the annular portion (16), and a curl (20) extending radially outwardly from the standard chuck wall (18A). The annular portion (16) includes an enhanced annular countersink (110).



WO 2019/046109 A1

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PRESSURE CAN END COMPATIBLE WITH STANDARD CAN SEAMER

CROSS REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Patent Application Serial No.
5 15/690,792 filed August 30, 2017, which is incorporated by reference herein.

BACKGROUND OF THE INVENTION

Field of the Invention

The disclosed and claimed concept relates to can ends and, more particularly,
10 to can ends made from a sheet material having a reduced base gage and/or a reduced
final thickness relative to known can ends. The disclosed concept also relates to tooling
and associated methods for providing such can ends.

Background Information

15 Metallic containers (e.g., cans) are structured to hold products such as, but not
limited to, food and beverages. Generally, a metallic container includes a can body and
a can end. The can body, in an exemplary embodiment, includes a base and a depending
sidewall. The can body defines a generally enclosed space that is open at one end. The
can body is filled with product and the can end is then coupled to the can body at the
20 open end. The container is then placed in an oven and heated to cook the product and/or
sterilize the product. The heating and subsequent cooling of the container, and food,
causes pressure changes. That is, as the food is heated, the pressure inside the container
increases. This pressure is identified as an “internal” or “positive” pressure. Containers
are structured to resist deformation due to the internal pressure. In an exemplary
25 embodiment, the heating of the container, and food, is performed by pressurized steam.
The pressurized steam applies pressure to the outer side of the container. Pressure on
the outer side of the container is “external” or “reverse” pressure. Containers are not
always structured to resist deformation due to external pressure. Thus, if the metal of
either, or both, the can body and/or the can end is weak, the can body and/or the can
30 end will deform due to pressure changes and the container will be defective.

A “can end,” as used herein, is the element coupled to a can body to form a
container. The “can end” includes a tab or similar device structured to open the
container. As discussed below, “can end” is, typically, formed from a “shell.” That is,
a shell is formed from a generally planar blank cut from sheet material. The blank is

formed to include an annular countersink, a chuck wall, and other constructs. The concept disclosed and claimed below are discussed as part of a “can end.” It is understood, however, that the disclosed and claimed concept can be formed while the blank is still a “shell” as opposed to a “can end.” That is, while the following discussion uses the term, “can end,” the discussion is also applicable to “shells.”

A container is exposed to pressures during processing. For example, some food items are cooked and/or sterilized while in the container. Such a container is exposed to both internal pressure, also identified herein as “buckle” or “buckle pressure,” as well as external pressure, also identified herein as “reverse buckle” or “reverse buckle pressure.” A container, that is the can body and the can end, must have the strength to resist deformation due to buckle pressure and/or reverse buckle pressure.

Generally, the strength of the container is related to the thickness of the metal from which the can body and the can end is formed, as well as, the shape of these elements. This application primarily addresses the can ends rather than the can bodies. The can ends are either a “sanitary” can end or an “easy open” end. As used herein, a “sanitary” end is a can end that does not have a tab or score profile to open and would have to be opened by use of a can opener or other device. As used herein, an “easy open” can end includes a tear panel and a tab. The tear panel is defined by a score profile, or scoreline, on the exterior surface (identified herein as the “public side”) of the can end. The tab is attached (e.g., without limitation, riveted) adjacent the tear panel. The pull tab is structured to be lifted and/or pulled to sever the scoreline and deflect and/or remove the severable panel, thereby creating an opening for dispensing the contents of the container. The following addresses an “easy open” can end but is also applicable to a “sanitary” can end. That is, a “sanitary” can end is produced in a similar manner, and coupled to a can body in a similar manner. Thus, as used herein, a can end is further defined as including constructs that are used for both “sanitary” can ends and “easy open” ends.

When the can end is made, it originates as a blank, which is cut from a sheet metal product (e.g., without limitation, sheet aluminum; sheet steel). In an exemplary embodiment, the blank is then formed into a “shell” in a shell press. As used herein, a “shell” is a construct that started as a generally planar blank and which has been subjected to forming operations other than rivet forming and tab staking. The shell press includes a number of tool stations where each station performs a forming operation (or which may include a null station that does not perform a forming

operation). The blank moves through successive stations and is formed into the “shell.” A shell is, in an exemplary embodiment, a “sanitary” can end that is structured to be coupled to a can body.

For an “easy open” end, a shell is further conveyed to a conversion press, which
5 also has a number of successive tool stations. As the shell advances from one tool station to the next, conversion operations such as, for example and without limitation, rivet forming, paneling, scoring, embossing, and tab staking, are performed until the shell is fully converted into the desired can end and is discharged from the press. Thus, as used herein, a “can end” includes a “shell” as well as a construct including a tab and
10 a score line.

In the can making industry, large volumes of metal are required in order to manufacture a considerable number of cans. Generally, steel cans are made from sheet material having a base gauge, or an original thickness (as used herein, the terms are equivalent to each other), of between 0.0050 inch to 0.0096 inch. The required original
15 thickness of the material is determined by a variety of factors such as, but not limited to, the dimensions of the finished can, the temperature to which the can (and contents) are exposed during processing, the nature of the contents to be placed in the cans, as well as other factors. The original thickness of the material for each specific type, model, and/or style of can and/or can end is, as used herein, the “established thickness.”

That is, for example, the steel used for a common 18.6 oz. soup can has an
20 established thickness of 0.0090 inch. The can end/container formed from steel with this established thickness is structured to withstand a buckle pressure of 34.8 psi and a reverse buckle pressure of 33.0 psi.

An ongoing objective in the industry is to reduce the amount of metal that is
25 consumed. Efforts are constantly being made, therefore, to reduce the thickness or gauge (sometimes referred to as “down-gauging”) of the stock material from which can ends, tabs, and can bodies are made. Alternatively, the material can be thinned from the base gauge to have a thinner, or partially thinner, final thickness that is less than the base gauge. However, as less material (e.g., thinner gauge) is used, problems arise that
30 require the development of unique solutions. As noted above, a common problem associated with can ends for food cans is that they are subject to pressure changes associated with processing the food product within the can. When the base gauge of the metal is too thin, the can end deforms. This is a problem.

One solution to the problems associated with using thin metal is to provide strengthening constructs in the can end. Strengthening constructs include, but are not limited to, recessed or protruding panels that add rigidity to the generally planar can ends. The strengthening constructs are, in an exemplary embodiment, created by forming the panels in the body of the can end. The can end includes other, similar constructs such as recesses for the tab. As noted above, however, the can end and the strengthening constructs are, in an exemplary embodiment, structured to resist internal pressure.

There is, therefore, a need for a can end having a shape that resists deformation even when the can end is made from a down-gauged, *i.e.*, thinner, metal. There is a further need for a can end having a shape that resists deformation from external or reverse pressure.

SUMMARY OF THE INVENTION

The disclosed and claimed concept provides a can end structured to be coupled to a container, the can end including a down-gauging construct. That is, the can end includes a center panel, an annular portion disposed about said center panel, a standard chuck wall disposed about said annular portion, a curl extending radially outwardly from the chuck wall, and said annular portion including an enhanced annular countersink. The enhanced annular countersink, as well as other down-gauging constructs such as an annular tapered portion, solve the problems stated above and allows the can ends to be made from a material with a decreased original thickness. Further, a can end in the disclosed configuration solves 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 top view of a prior art can end.

Figure 2 is a side elevation sectional view of a prior art can end.

Figure 3 is a top view of a shell.

Figure 4 is a cross-sectional view of a shell. Figure 4A is a detail view of a shell.

Figure 5 is a top view of a can end.

Figure 6 is a cross-sectional view of a can end. Figure 6A is a detail view of a can end.

Figure 7 is a cross-sectional view of a can end identifying selected terms used herein.

5 Figure 8 is a cross-sectional view of a can end coupled (seamed) to a can body.

Figure 9 is a cross-sectional view of a tooling assembly structured to form a can end. Figures 9A-9G show the progression of the tooling assembly as the upper tool assembly moves from the first position to the second position.

Figure 10 is a flow chart for a disclosed method.

10 Figure 11 is a top view of another embodiment of a can end.

Figure 12 is a cross-sectional view of a can end of Figure 11. Figure 12A is a detail view of a can end of Figure 12.

Figure 13 is a partially schematic, detail cross-sectional view comparing an enhanced annular countersink to a prior art annular countersink.

15 Figure 14 is a cross-sectional view of another embodiment of a can end. Figure 14A is a detail view of another embodiment of a can end. Figure 14B is a schematic cross-sectional side view of the can end of Figure 14 engaged by a seamer.

Figure 15 is a flow chart for a disclosed method.

20 DESCRIPTION OF THE PREFERRED EMBODIMENTS

It will be appreciated that the specific elements illustrated in the figures herein and described in the following specification are simply exemplary embodiments of the disclosed concept, which are provided as non-limiting examples solely for the purpose of illustration. Therefore, specific dimensions, orientations, assembly, number of
25 components used, embodiment configurations and other physical characteristics related to the embodiments disclosed herein are not to be considered limiting on the scope of the disclosed concept.

Directional phrases used herein, such as, for example, clockwise, counterclockwise, left, right, top, bottom, upwards, downwards and derivatives thereof,
30 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, 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, 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 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
5 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
10 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, the phrase “removably coupled” or “temporarily coupled” means that one component is coupled with another component in an essentially
15 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
20 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
25 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
30 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, “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 “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.” Further, a “path of travel” or “path” relates to a motion of one identifiable construct as a whole relative to another object. For example, assuming a perfectly smooth road, a rotating wheel (an identifiable construct) on an automobile generally does not move relative to the body (another object) of the automobile. That is, the wheel, as a whole, does not change its position relative to, for example, the adjacent fender. Thus, a rotating wheel does not have a “path of travel” or “path” relative to the body of the automobile. Conversely, the air inlet valve on that wheel (an identifiable construct) does have a “path of travel” or “path” relative to the body of the automobile. That is, while the wheel rotates and is in motion, the air inlet valve as a whole, moves relative to the body of the automobile.

As used herein, the statement that two or more parts or components “engage” one another means 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
5 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.
10 However, when a rotational force is applied to the screwdriver, the screwdriver “operatively engages” the screw and causes the screw to rotate.

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. Further, a “depending”
15 sidewall inherently has a distal end.

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
20 (*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],”
25 *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
30 “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.

5 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
10 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/or near relevant to the term being modified as would be understood by one of ordinary skill in the art.

15 The following discussion and the Figures use a generally cylindrical can end 12, discussed below, as an example. It is understood that the disclosed and claimed concept is operable with can ends 12 of any shape and the cylindrical shape discussed and shown is exemplary only. Figures 1 and 2 show a prior art easy open can end 1, hereinafter
20 “prior can end” 1. The prior can end 1 includes an opener (*e.g.*, without limitation, pull tab 2), which is attached (*e.g.*, without limitation, riveted) to a tear strip or severable panel 3. The severable panel 3 is defined by a scoreline 4 in the exterior surface 5 (*e.g.*, public side) of the prior can end 1. The pull tab 2 is structured to be lifted and/or pulled to sever the scoreline 4 and deflect and/or remove the severable panel 3, thereby creating an opening for dispensing the contents of the can (not shown). As shown, the
25 prior can end 1, when viewed in cross-section as in Figure 2, includes a center panel 6, an annular countersink 7, a chuck wall 8, and a curl 9. It is understood that the prior can end 1 is formed from a generally, or substantially, planar blank 10 (Figure 9A, shown schematically). In an exemplary embodiment, the blank 10 is a generally planar disk, as is known.

30 A blank 10 is initially formed into an improved shell 13, Figures 3-4, which is then further formed into an improved can end 12 (hereinafter, and as used herein, “can end” 12) shown in Figures 5 and 6. As noted above, and as used herein, a “can end” 12 and a shell 13 include common elements and similar reference numbers are used in the Figures to identify these elements including: a center panel 14, an annular portion

16, a chuck wall 18 and a curl 20. Further, the can end 12 has an exterior, or “public,” side 22 and an interior, or “product,” side 24. The public and product sides 22, 24 relate to the configuration of the can end 12 when the can end 12 is coupled to a filled can body 60 (Figure 8). As used herein, the center panel 6, 14 is “generally planar” even if it includes recesses, a rivet, and other formed constructs.

In an exemplary embodiment, the annular portion 16 includes a “down-gauging construct” 11, Figure 6A. As used herein, a “down-gauging construct” means a construct structured to increase the can end 12 resistance to buckling and other deformations that arise after the can end 12 is coupled to a can body 60. Further, as used herein, a “down-gauging construct” means a construct that is disposed only in the annular portion 16 between the center panel 14 and the chuck wall 18. The down-gauging construct 11 is structured to, and does, allow the can end 12 to be made from a material with a “decreased original thickness.”

As noted above, the “established thickness” for a specific can end is determined by many factors such as, but not limited to, the geometry and configuration of the finished container. As such, this application is not limiting a “decreased original thickness” to a specific thickness or range of thicknesses. Instead, as used herein, a “decreased original thickness” means a thickness that is less than the “established thickness.” Thus, the “decreased original thickness” varies depending upon the geometry and configuration, as well as other factors, of the finished container. Stated alternately, as used herein, a “decreased original thickness” means that the material has an original thickness that is thinner than the “established thickness” for a specific type, model, and/or style of can end. The “established thickness” for a specific can end is well known in the art.

The following discussion relates to an exemplary can end 12 which is a steel shell/can end 12 used for a common 18.6 oz. soup can which is the same container discussed above in the Background Information. When the can end 12 includes a down-gauging construct 11, the sheet material, *i.e.*, the sheet steel, has an original thickness of about 0.0079 inch. Thus, compared to the established thickness of 0.0090 inch for this exemplary can end, the can end 12 has a “decreased original thickness.” Further, use of the down-gauging construct 11 allows the can end to withstand a buckle pressure of 34.6 psi and a reverse buckle pressure of 30.0 psi, see, Figure 6A and/or 12A. The pressure resistance of the can end 12 with the down-gauging construct 11 is generally the same as the known can end and the can end 12 with the down-gauging construct 11

can be used in place of the known can end.

That is, a can end 12 made from a material with a decreased original thickness and that includes the concept disclosed herein is usable with the same can body as a can end with the established thickness. This solves the problems stated above. Further, a
5 can end 12 that includes the concept disclosed herein and which is made from material having a “decreased original thickness” is, as used herein, a “decreased original thickness can end” 12.

To provide a reference, the plane of the blank 10 defines, as used herein, the “original plane” of the blank 10 and the resulting can end 12. As discussed below, the
10 “original plane” is also the plane of the center panel 6, 14 immediately adjacent and inside, *i.e.*, toward the center of the can end 12, the annular portion 16. It is noted that, prior can end 1 (Figure 2) includes an annular countersink 7 that extends toward the product side 24 from the periphery of the center panel 6. That is, the prior can end 1 does not include an annular ridge 50, as defined below.

As shown in Figure 7, and as noted above, a can end 12 includes a center panel
15 14, an annular portion 16, a chuck wall 18 and a curl 20. The following terms are used to describe characteristics of a can end’s 12 components. As used herein, the curl 20 has a “curl height” which means the vertical distance between the top of the curl 20 and the distal end of the curl 20. As used herein, the “countersink depth” means the vertical
20 distance between the top of the curl 20 and the bottom of an annular countersink 52, discussed below. As used herein, the “panel depth” means the vertical distance between the bottom of the annular countersink 52 and the bottom of the center panel 14. As used herein, the “reverse panel depth” means the vertical distance between the top of an annular ridge 50, discussed below, and the top of the center panel 14. It is noted that
25 the prior can ends did not have a “reverse panel depth,” Figure 7, because the prior can ends 1 did not have an annular ridge 50. Further, the can end 12 has, as used herein, an “exterior,” or “public,” side 22 and an “interior,” or “product,” side 24. The “exterior,” or “public,” side 22 is the side that, when the can end 12 is coupled to a can body 60, is exposed to the atmosphere. The “interior,” or “product,” side 24 is the side that, when
30 the can end 12 is coupled to a can body 60, is not exposed to the atmosphere.

The center panel 14 is generally planar. As shown in Figure 6A, the center panel 14 includes a scoreline 30 on the public side 22. The scoreline 30 defines a tear strip or severable panel 32. In the embodiment shown, the severable panel 32 occupies the majority of the center panel 14 as is common with, but not limited to, a can end 12

for a food container. In this configuration, the center panel 14 includes a peripheral portion 34 and the severable panel 32. It is understood that to open a container including the can end 12, the severable panel 32 is removed (or displaced) relative to the peripheral portion 34.

5 The annular portion 16 is disposed about the center panel 14 and is unitary therewith. In one exemplary embodiment, the down-gauging construct 11 includes an annular ridge 50. That is, the annular portion 16 includes an annular ridge 50 and an annular countersink 52. As used herein, a “ridge” begins and ends in the same general plane (hereinafter the ridge plane, shown as “RP” in Figure 7) and includes a peak, *i.e.*,
10 a vertex when viewed as a cross-section with the cross-sectional plane generally perpendicular to the plane of the center panel 14. At the ridge plane, a “ridge” has a maximum width of about 0.100 inch. The width of a ridge is the distance between an upward slope (shown as “U” in Figure 7) and a downward slope (shown as “D” in Figure 7) measured at the ridge plane and shown as “W” in Figure 7. Further, as used
15 herein, an “annular ridge” extends about, or substantially extends about, a severable panel 32. Thus, features on a shell or can end such as wide tiers (such as, but not limited to, tier “T” in Figures 1 and 2), localized protrusions or recesses do not define an “annular ridge” as used herein. For example, the “panel formation” (reference number 118) in U.S. Patent Number 9,616,483 is not, and does not include, an “annular ridge”
20 because the “panel formation 118” does not extend about the severable panel defined by a scoreline.

 In an exemplary embodiment, the annular ridge 50 has a height, as measured at the top of the ridge plane to the top of the center panel 14 of between about 0.010 inch and 0.050 inch, or about 0.040 inch. This offset also defines the “reverse panel depth”
25 of the center panel 14. That is, as shown, the ridge plane is substantially the same as the plane of the center panel 14. Thus, as shown in Figures 7 and 8, the annular ridge 50 extends upwardly from the center panel 14. In an exemplary embodiment, annular ridge 50 curves upwardly from the center panel 14 (when viewed in cross-section, as shown in Figure 8) wherein the curve has a radius (R_1) of between about 0.010 inch and
30 0.030 inch, or about 0.015 inch. Further, in an exemplary embodiment, the annular ridge 50 is generally curvilinear or generally arcuate. When the annular ridge 50 is generally arcuate, the annular ridge 50 has an internal radius (R_2), *i.e.*, the radius of the curve between and including the upward slope and the downward slope, of between about 0.010 inch and 0.030 inch, or about 0.015 inch. The annular ridge 50 is the portion

disposed about, and immediately adjacent, the center panel 14. An annular ridge 50 in any of the configurations and with the characteristics described above solves the problems stated above.

In an exemplary embodiment, the annular portion 16 includes a generally planar portion 54 (when viewed in cross-section as shown in Figure 7), hereinafter “annular planar portion” 54. It is noted that the plane of the annular planar portion 54 is not in the same plane as, or parallel to, the plane of the center panel 14. That is, the plane of the annular planar portion 54 is angled relative to the plane of the center panel 14. In an exemplary embodiment, the annular planar portion 54 has a length between about 0.015 inch and 0.050 inch, or about 0.035 inch, wherein the “length” is measured from the annular ridge 50 to the annular countersink 52. If included, the annular planar portion 54 is disposed about, and immediately adjacent, the annular ridge 50.

In one embodiment, the annular countersink 52 is disposed about, and immediately adjacent, the annular ridge 50. In another embodiment, the annular countersink 52 is disposed about, and immediately adjacent, the annular planar portion 54. As used herein, the “annular countersink” 52 begins and ends in the same general plane (hereinafter the countersink plane, shown as “CP” in Figure 7) and includes a nadir, *i.e.*, a bottom vertex when viewed as a cross-section with the cross-sectional plane generally perpendicular to the plane of the center panel 14, as shown in Figure 7. At the countersink plane, the “annular countersink” 52 has a maximum width of about 0.120 inch. The width of the annular countersink 52 is the distance between the downward slope (not identified in the Figures) and the upward slope (not identified in the Figures) measured at the countersink plane. Further, in an exemplary embodiment, the annular countersink 52 is generally curvilinear or generally arcuate. When the annular countersink 52 is generally arcuate, the annular countersink 52 has an internal radius, *i.e.*, the radius of the curve between and including the upward slope and the downward slope, of between about 0.015 inch and 0.050 inch, or about 0.020 inch.

As shown in Figure 6A, the chuck wall 18 is disposed about, and immediately adjacent, the annular countersink 52. The curl 20 is disposed about, and immediately adjacent, the chuck wall 18. That is, the curl 20 extends radially outwardly from the chuck wall 18. As is known, and as shown in Figure 8, the can end 12 is coupled, directly coupled, fixed, or “seamed” (as discussed below) to a can body 60 thereby forming a container 70. A can body 60 includes a base 62 and an upwardly depending sidewall 64. The can body 60 defines a generally enclosed space 66.

As noted above, a can end 12 including an annular portion 16 with an annular ridge 50 and an annular countersink 52 allows for the use of thinner materials, or materials that have been thinned, relative to a prior can end 1. In an exemplary embodiment, the blank 10 or the material from which the blank 10 is formed, has an original thickness. During the forming process of a can end 12, as discussed below, the original thickness is, in one exemplary embodiment, maintained. In another exemplary embodiment, during the forming process of a can end 12, the original thickness is generally reduced, or, the thickness of selected portions thereof are reduced. Whether the same as the original thickness or reduced from the original thickness, the elements of the can end 12 begin with a material with a decreased original thickness, as defined above, and end with a final thickness. That is, in an exemplary embodiment, each of the center panel 14, the annular portion 16, the chuck wall 18, and the curl 20 have originally have a decreased original thickness and end with a final thickness. In an exemplary embodiment, *i.e.*, for the decreased original thickness, and/or final thickness, is between about 0.0050 inch or 0.0096 inch, or is about 0.0079 inch. Using a can end 12, *i.e.*, a decreased original thickness can end 12, solves the problems noted above.

The can end 12 described above is formed in a tooling 100, or tooling assembly 100, as shown in Figure 9. The tooling 100 includes an upper tool assembly 102 and a lower tool assembly 104. The upper tool assembly 102 and the lower tool assembly 104 cooperate to form material disposed therebetween into a can end 12 as described above. That is, the upper tool assembly 102 and the lower tool assembly 104 cooperate to form the annular portion 16 with an annular ridge 50 and an annular countersink 52, as described above. That is, the upper tool assembly 102 and the lower tool assembly 104 cooperate to form the annular ridge 50 substantially disposed above the original plane, and to form the annular countersink 52 substantially disposed below the original plane. In an exemplary embodiment, the upper tool assembly 102 and the lower tool assembly 104 cooperate to form the annular ridge with a generally arcuate cross-section, and, to form the annular countersink 52 with a generally arcuate cross-section.

In an exemplary embodiment, as shown in Figure 9, the upper tool assembly 102 includes an upper die shoe 200, an upper tooling retainer 202, a die center riser 204, a “blank and draw” die punch 206, that is, element 206 is a single element that both cuts the blank from the sheet material and draws the blank, an upper piston 208, a die center punch, 210 and, for the embodiment with a reverse panel, an upper reverse panel insert 212. In the same exemplary embodiment, the lower tool assembly 104

includes a lower die shoe 220, a lower tooling retainer 222, a die core ring 224, a panel punch piston 226, a lower piston 228, a panel punch 230, a cutting ring 232 with a cut edge 234, and a lower reverse panel insert 236. The interaction of these elements are shown sequentially in Figures 9A-9G. It is noted that, for clarity, a blank 10 is not shown in Figures 9B-9G, but is shown schematically in Figure 9A. The motion of these elements are generally disclosed in U.S. Patent No. 5,857,374 and the discussion associated with Figures 2-13 of that patent are incorporated by reference with the understanding that the upper reverse panel insert 212 moves with the die center punch, 210 (die center 52 in U.S. Patent No. 5,857,374) and the lower reverse panel insert 236 moves with the panel punch 230 (element 125 in U.S. Patent No. 5,857,374).

Accordingly, as shown in Figure 10, a method of making a can end 12 with an annular ridge 50 and an annular countersink 52 includes: providing 1000 a sheet material defining an original plane, providing 1002 a tooling 100 with an upper tool assembly 102 and a lower tool assembly 104, introducing 1004 material between the upper tool assembly 102 and the lower tool assembly 104, cutting 1005 a blank 10 from the sheet material, forming 1006 the material, or the blank 10, to include a center panel 14, an annular portion 16 disposed about the center panel 14, a chuck wall 18 disposed about the annular portion 16, and a curl 20 extending radially outwardly from the chuck wall 18 (hereinafter "forming 1006 the material"), and, forming 1008 the annular portion 16 to include an annular ridge 50 and an annular countersink 52. In an exemplary embodiment, forming 1008 the annular portion 16 to include an annular ridge 50 and an annular countersink 52 includes forming 1020 the annular countersink 52 so as to be substantially disposed below the original plane, and, forming 1022 the annular ridge 50 so as to be substantially disposed above the original plane. Further, in an exemplary embodiment, forming 1008 the annular portion 16 to include an annular ridge 50 and an annular countersink 52 includes forming 1030 the annular countersink 52 with a single center and extending over an arc of between about 140° and 180°, forming 1032 the annular countersink 52 with a radius of between about 0.015 inch and 0.050 inch or about 0.020 inch, forming 1034 the annular ridge 50 with a single center and extending over an arc of between about 140° and 180°, or in one embodiment an arc of about 150°, or, in another embodiment, and arc of about 160° and forming 1036 the annular ridge 50 with a radius of between about 0.010 inch and 0.030 inch, or about 0.015 inch.

In another exemplary embodiment, providing 1000 a sheet material defining an original plane includes providing 1040 the material with an decreased original thickness, wherein the decreased original thickness is between about .0055 inch and 0.0110 inch, between about 0.0050 inch and 0.0096 inch, or about 0.0079 inch, wherein
5 after forming 1006 the material to include a center panel 14, an annular portion 16, a chuck wall 18, and a curl 20, each of the center panel 14, the annular portion 16, the chuck wall 18, and the curl 20 have a final thickness, and wherein, the final thickness is substantially the same as the decreased original thickness, *i.e.*, between about .0055 inch and 0.0110 inch, between about 0.0050 inch and 0.0096 inch, or about 0.0079 inch.

10 In another exemplary embodiment, shown in Figures 11 and 12, the down-gauging construct 11 includes an enhanced annular countersink 110 and/or an annular tapered portion 112. That is, in this embodiment, the annular portion 16 includes an enhanced annular countersink 110 and/or an annular tapered portion 112. As used herein, an “enhanced annular countersink” means a countersink that is part of a can end
15 12 wherein the panel depth is between about eight and nine times the center panel 14 final thickness. Further, an “enhanced annular countersink” means that the countersink does not begin and end in the same general plane. Instead, an “enhanced annular countersink” 110 includes a curvilinear portion 122 (discussed below), or arcuate portion, of between about 115° and 160°, or about 135° (shown by line “EAC” in Figure
20 12A). Further, as used herein, an “enhanced annular countersink” is radially wider than a standard seam chuck 502, discussed below. That is, as shown in Figure 13, a prior art annular countersink 7 (in ghost) has generally the same radial width as a standard seam chuck 502. The enhanced annular countersink 110, however, has a radial width that is substantially wider than a standard seam chuck 502.

25 In an exemplary embodiment, the annular planar portion 54 is an “enhanced annular planar portion” 120 disposed between the center panel 14 and the annular countersink 52. As used herein, an “enhanced annular planar portion” means that the annular planar portion 54 has a height (as shown in Figure 12A, *i.e.*, a distance measured normal to the plane of the center panel 14) of between about eight and nine
30 times the center panel 14 final thickness. In this configuration, the annular countersink 52 has a depth, as measured from the bottom of the annular countersink 52 to the bottom of the center panel 14, that is greater than the depth of an annular countersink on a prior art can end 12. This solves the problems stated above. Further, in an exemplary

embodiment, the enhanced annular planar portion 120 extends generally perpendicular to the plane of the center panel 14.

In an exemplary embodiment, the enhanced annular planar portion 120 is disposed immediately adjacent the center panel 14 and extends about the center panel 14. Further, the enhanced annular countersink 110 is disposed immediately adjacent the enhanced annular planar portion 120 and extends about the enhanced annular planar portion 120. The enhanced annular countersink 110 is generally curvilinear, or generally arcuate, when viewed in cross-section, as shown in Figure 12A and is identified hereinafter as a generally curvilinear portion 122. The enhanced annular countersink 110, or stated alternately the generally curvilinear portion 122, extends between about 115° and 160°, or about 135°. In an exemplary embodiment, the generally curvilinear portion 122 is generally arcuate. Further, the generally curvilinear portion 122 has a radius or between about 0.015 inch and 0.050 inch, or about 0.020 inch.

In an exemplary embodiment, the enhanced annular countersink 110 is encircled, or surrounded by the annular tapered portion 112. That is, the annular tapered portion 112 is disposed immediately adjacent, and extends about, the enhanced annular countersink 110. As used herein, an “annular tapered portion” is angled, *i.e.*, is not generally perpendicular or generally parallel to the plane of the center panel 14. As shown, the annular tapered portion 112 is angled (as shown by angle α) between about 25° and 50° relative to the plane of the center panel 14 (which is also the original plane or parallel to the original plane). As used herein, an angle of between about 25° and 50° is not generally perpendicular or generally parallel to a reference plane. In this embodiment, the annular tapered portion 112 is generally straight (when viewed in cross-section as shown) and is, as used herein, a “straight annular tapered portion” 112. That is, as used herein, a “straight annular tapered portion” 112 means an annular tapered portion 112 that does not include a “step,” as defined below, or a similar variation, *e.g.*, a double step, in the annular tapered portion 112.

Further, as used herein, an “annular tapered portion” is angled upwardly and outwardly. That is, the end of the annular tapered portion 112 adjacent the enhanced annular countersink 110 has a smaller radius relative to the end of the annular tapered portion 112 adjacent the chuck wall 18, and, the end of the annular tapered portion 112 adjacent the enhanced annular countersink 110 has a greater offset (*i.e.*, distance normal to the plane of the center panel 14) relative to the end of the annular tapered portion

112 adjacent the chuck wall 18. In an exemplary embodiment, the annular tapered portion 112 has a radial width of between about six and eight times the center panel final thickness. As used herein, a “radial width” means the distance measured generally parallel to the plane of the center panel 14.

5 In another exemplary embodiment, as shown in Figures 14, 14A and 14B, an annular tapered portion 112A includes a first section 130 and a second section 132. The annular tapered portion first section 130 is disposed about, and immediately adjacent to, the enhanced annular countersink 110. The annular tapered portion second section 132 is disposed about, and immediately adjacent to, the annular tapered portion first section 130. The annular tapered portion first section 130 is angled between about 35° and 65°, or about 55°, to the plane of the center panel 14. The annular tapered portion second section 132 is angled between about 15° and 30°, or about 20°, to the plane of the center panel 14. In this configuration, an interface 134 between the annular tapered portion first section 130 and the annular tapered portion second section 132 defines a
10 “step” 136 as viewed in cross-section. As used herein, a “step” is an area of transition between two planes. In this embodiment, the annular tapered portion 112A is, as used herein, a “stepped annular tapered portion” 112A. That is, as used herein, a “stepped annular tapered portion” 112A means an annular tapered portion 112, as described above, that also includes a “step.”
15

20 The step 136, as well as a “standard chuck wall” 18A above the step 136, is structured to be, and is, engaged by a standard seam chuck 502, as shown in Figure 14B. As used herein, a “standard chuck wall” is a chuck wall 18 structured to be engaged by a seam chuck structured to seam prior art can ends and is the same, or substantially the same, as the prior art chuck wall 18A (Figure 2). Further, in an
25 exemplary embodiment, the annular tapered portion first section 130 has a height of between about 0.040 inch and 0.085 inch, and, the annular tapered portion second section 132 has a height of between about 0.010 inch and 0.030 inch.

30 In an exemplary embodiment, the chuck wall 18 is a “standard” chuck wall 18A. As used herein, a “standard” chuck wall 18A is structured to be engaged by a standard seam chuck 502. That is, containers 70 generally have a standard size such as, but not limited to, a 12 oz. beverage container (not shown). Food and beverage producers obtain can ends 12 and can bodies 60 from different manufacturers that are processed in a seaming press 500, discussed below. For the can ends 12 and can bodies 60 to be processed, they must be a standard size. Thus, as used herein, a “standard” chuck wall

18A means a chuck wall that is structured to be, and is, engaged by a standard seam chuck 502 for a common container size known in the art. Further, a “standard seam chuck” means a seam chuck structured to seam a common prior art shell or can end 1. It is understood that different size containers are associated with different sized seam chucks; thus, a “standard seam chuck” means a seam chuck that is associated with a specific size container. Stated alternately, and as example only, a 12 ounce beverage container has a “standard seam chuck” of one size but a 3.5 ounce sardine container has a “standard seam chuck” of a different size.

As before, the standard chuck wall 18A is disposed about, and immediately adjacent, the annular countersink 52. The curl 20 is disposed about, and immediately adjacent, the standard chuck wall 18A. That is, the curl 20 extends radially outwardly from the standard chuck wall 18A. As is known, the can end 12 is coupled, directly coupled, or fixed to a can body 60 thereby forming a container 70.

In another exemplary embodiment, the annular portion 16 includes each, or any combination of, an annular ridge 50, an enhanced annular countersink 110 and annular tapered portion 112, each as described above. Stated alternately, a can end 12 down-gauging construct 11 includes an annular ridge 50, an enhanced annular countersink 110 and annular tapered portion 112. The use of these down-gauging construct(s) 11 solve the problems noted above whereby the original, as well as the final thickness, of the can end 12 is reduced relative to the known art.

A can end 12 having an enhanced annular countersink 110 and/or an annular tapered portion 112 is formed in a tooling 100 as generally described above. It is additionally noted that to form the enhanced annular countersink 110 and/or annular tapered portion 112 the upper tool assembly 102 and the lower tool assembly 104 are structured to cooperate to form material disposed therebetween into a can end 12, the can end 12 including a center panel 14, an annular portion 16 disposed about the center panel 14, a standard chuck wall 18A disposed about the annular portion 18, and a curl 20 extending radially outwardly from the standard chuck wall 18A;

In an exemplary embodiment, the upper tool assembly 102 and the lower tool assembly 104 are substantially similar to the tooling assembly of U.S. Patent No. 5,857,374 except that the contour of the outer periphery of the die center (element 52 of U.S. Patent No. 5,857,374) is shaped to substantially correspond to the enhanced annular countersink 110 as described above as well as either the straight annular tapered portion 112 or the stepped annular tapered portion 112A. That is, the upper tool

assembly 102 includes a punch structured to form an enhanced annular countersink as defined above.

In an exemplary embodiment, the upper tool assembly 102 and the lower tool assembly 104 are structured to form an enhanced annular planar portion 120 extending generally perpendicular to the plane of the center panel 14. Further, the upper tool assembly 102 and the lower tool assembly 104 are structured to form, and do form, the annular tapered portion 112 to be angled between about 25° and 50° to the plane of the center panel 14, and, the upper tool assembly 102 and the lower tool assembly 104 are structured to form, and do form, the annular tapered portion 112 with a radial width of between about six and eight times the center panel final thickness. The can ends 12 are subsequently processed by a seaming assembly which includes a standard seam chuck 502 as is known.

Accordingly, as shown in Figure 15, a method of making a can end 12 with an enhanced annular countersink 110 and/or an annular tapered portion 112 includes, providing 1000 a sheet material defining an original plane, providing 1002 a tooling 100 with an upper tool assembly 102 and a lower tool assembly 104, introducing 1004 material between the upper tool assembly 102 and the lower tool assembly 104 (as described above), cutting 1005 a blank 10 from the sheet material, as well as, forming 1006 the material to include a center panel 14, an annular portion 16 disposed about the center panel 14, a standard chuck wall 18A disposed about the annular portion 16, and a curl 20 extending radially outwardly from the standard chuck wall 18A, forming 2008 the annular portion 16 to include an enhanced annular countersink 110 and an annular tapered portion 112 wherein the annular tapered portion 112 is disposed about the enhanced annular countersink 110.

Further, forming 2008 the annular portion 16 to include an enhanced annular countersink 110 and an annular tapered portion 112 includes, forming 2010 the enhanced annular countersink 110 with a single center and extending over an arc of between about 115° and 160°, or about 135°, forming 2012 the enhanced annular countersink 110 with a radius of between about 0.015 inch and 0.050 inch, or about 0.020 inch, forming a straight annular tapered portion 112 with an angle of between about 25° and 50° relative to the original plane. Further, forming 2008 the annular portion 16 to include an enhanced annular countersink 110 and a stepped annular tapered portion 112A includes, forming 2020 the annular tapered portion 112 with a first section 130 and a second section 132, the annular tapered portion first section 130

disposed about the enhanced annular countersink 110, the annular tapered portion second section 132 disposed about the annular tapered portion first section 130, the annular tapered portion first section 130 angled between about 35° and 65° to the plane of the center panel 14, the annular tapered portion second section 132 angled between
5 about 15° and 30° to the plane of the center panel 14.

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
10 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 can end (12) structured to be coupled to a can body (60), the can end (12) comprising:
 - a center panel (14);
 - 5 an annular portion (16) disposed about said center panel (14);
 - a standard chuck wall (18) disposed about said annular portion (16);
 - a curl (20) extending radially outwardly from the chuck wall (18); and
 - said annular portion (16) including an enhanced annular countersink (110).

- 10 2. The can end (12) of Claim 1 wherein:
 - said center panel (14) is generally planar and has a final thickness;
 - said annular portion (16) includes an enhanced annular planar portion (120);
 - and
 - said enhanced annular planar portion (120) extending generally perpendicular
 - 15 to the plane of said center panel (14).

3. The can end (12) of Claim 1 wherein:
 - said annular portion (16) includes an annular tapered portion (112);
 - said annular tapered portion (112) disposed about said enhanced annular
 - 20 countersink (110);
 - said center panel (14) is generally planar and has a final thickness;
 - said annular tapered portion (112) is angled between about 25° and 50° to the plane of said center panel (14); and
 - said annular tapered portion (112) has a radial width of between about six and
 - 25 eight times the center panel (14) final thickness.

4. The can end (12) of Claim 3 wherein:
 - said enhanced annular countersink (110) includes an annular curvilinear portion
 - (122);
 - 30 said annular curvilinear portion (122) extending over an arc of between about 115° degrees and 160° degrees.

5. The can end (12) of Claim 3 wherein:

said annular tapered portion (112) includes a first section (130) and a second section (132);

said annular tapered portion first section (130) disposed about said enhanced annular countersink (110);

5 said annular tapered portion second section (132) disposed about said annular tapered portion first section (130);

said annular tapered portion first section (130) angled between about 35° and 65° to the plane of said center panel (14); and

said annular tapered portion second section (132) angled between about 15° and
10 30° to the plane of said center panel (14).

6. The can end (12) of Claim 5 wherein:

said annular tapered portion first section (130) has a height of between about 0.040 inch and 0.085 inch; and

15 said annular tapered portion second section (132) has a height of between about 0.010 inch and 0.030 inch.

7. The can end (12) of Claim 1 wherein:

said center panel (14), said annular portion (16), said chuck wall (18) and said
20 curl (20) are structured to be coupled to a food can body; and

said annular portion (16) includes an annular ridge (50).

8. A container (70) comprising:

a can body (60) including a base (62) and a depending sidewall (64), said can
25 body (60) defining a generally enclosed space (66);

a can end (12) including a center panel (14), an annular portion (16) disposed about said center panel (14), a standard chuck wall (18) disposed about said annular portion (16), a curl (20) extending radially outwardly from the chuck wall (18); and
said annular portion (16) including an enhanced annular countersink (110).

30

9. The container (70) of Claim 8 wherein:

said center panel (14) is generally planar and has a final thickness;

said annular portion (16) includes an enhanced annular planar portion (120);

and

said enhanced annular planar portion (120) extending generally perpendicular to the plane of said center panel (14).

10. The container (70) of Claim 8 wherein:
5 said annular portion (16) including an annular tapered portion (112);
said annular tapered portion (112) disposed about said enhanced annular countersink (110);
said center panel (14) is generally planar and has a final thickness;
said annular tapered portion (112) is angled between about 25° and 50° to the
10 plane of said center panel (14); and
said annular tapered portion (112) has a radial width of between about six and eight times the center panel (14) final thickness.

11. The container (70) of Claim 8 wherein said annular portion (16) includes
15 an annular ridge (50).

12. A tooling (100) for forming a can end (12), said tooling (100) comprising:
an upper tool assembly (102);
20 a lower tool assembly (104);
said upper tool assembly (102) and said lower tool assembly (104) are structured to cooperate to form material disposed therebetween into a can end (12), said can end (12) including a center panel (14), an annular portion (16) disposed about said center panel (14), a standard chuck wall (18A) disposed about said annular portion (16), a curl
25 (20) extending radially outwardly from said standard chuck wall (18A); and
wherein said upper tool assembly (102) and said lower tool assembly (104) further cooperate to form said annular portion with an annular ridge (50) and an annular countersink (52).

13. The tooling (100) of Claim 12 wherein said upper tool assembly (102) is structured to form an enhanced annular countersink (110) with an annular tapered portion.

14. The tooling (100) of Claim 11 wherein said center panel (14) is generally planar with a final thickness, said enhanced annular countersink (110) includes an enhanced annular planar portion (120), and, wherein said upper tool assembly (102) and said lower tool assembly (104) are structured to form said enhanced annular planar portion (120) extending generally perpendicular to the plane of said center panel (14).

15. The tooling (100) of Claim 11 wherein said center panel (14) is generally planar with a final thickness, and wherein:
said upper tool assembly (102) and said lower tool assembly (104) are structured to form said annular tapered portion (112) to be angled between about 25° and 50° to the plane of said center panel (14); and
said upper tool assembly (102) and said lower tool assembly (104) are structured to form said annular tapered portion (112) with a radial width of between about six and eight times the center panel (14) final thickness.

15

16. A method of forming a can end (12) comprising:
providing (1000) a sheet material defining an original plane;
providing (1002) a tooling (100) with an upper tool assembly (102) and a lower tool assembly (104);
introducing (1004) material between said upper tool assembly (102) and said lower tool assembly (104);
forming (2006) said material to include a center panel (14), an annular portion (16) disposed about said center panel (14), a standard chuck wall (18A) disposed about said annular portion (16), and a curl (20) extending radially outwardly from said standard chuck wall (18A); and
forming (2008) said annular portion (16) to include an enhanced annular countersink (110) and an annular tapered portion (112) wherein said annular tapered portion (112) is disposed about said enhanced annular countersink (110).

17. The method of Claim 16 wherein forming (2008) said annular portion (16) to include an enhanced annular countersink (110) and an annular tapered portion (112) includes:

forming (2010) said enhanced annular countersink (110) with a single center and extending over an arc of between about 115° and 160°;

forming (2012) said enhanced annular countersink (110) with a radius of between about 0.015 inch and 0.050 inch; and

forming said annular tapered portion (112) with an angle of between about 25° and 50° relative to said original plane.

5

18. The method of Claim 16 wherein forming (2008) said annular portion (16) to include an enhanced annular countersink (110) and an annular tapered portion (112) includes:

forming (2020) said annular tapered portion (112) with a first section (130) and
10 a second section (132);

said annular tapered portion first section (130) disposed about said enhanced annular countersink (110);

said annular tapered portion second section (132) disposed about said annular tapered portion first section (130);

15 said annular tapered portion first section (130) angled between about 35° and 65° to the plane of said center panel (14); and

said annular tapered portion second section (132) angled between about 15° and 30° to the plane of said center panel (14).

1/16

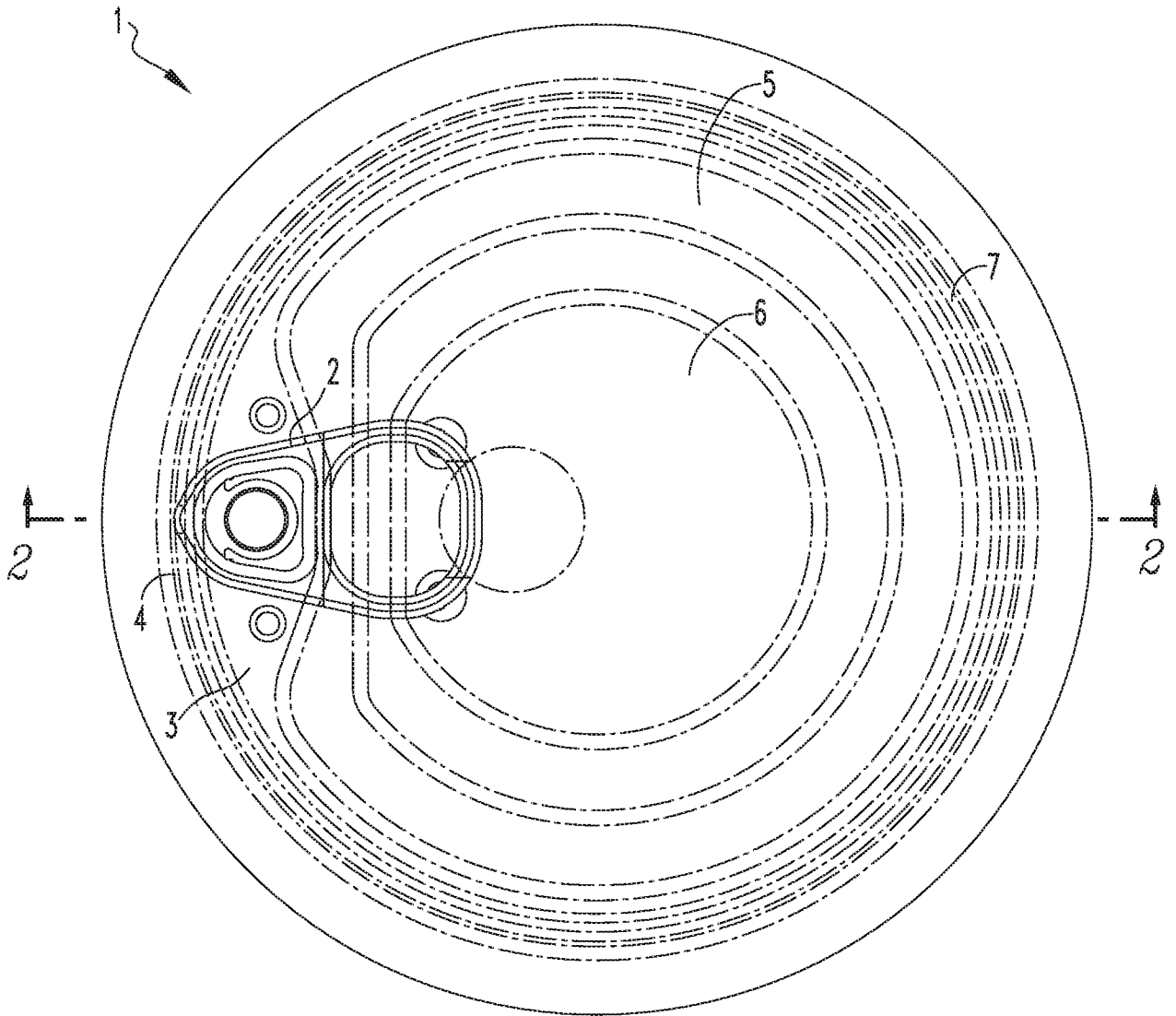


FIG. 1
(PRIOR ART)

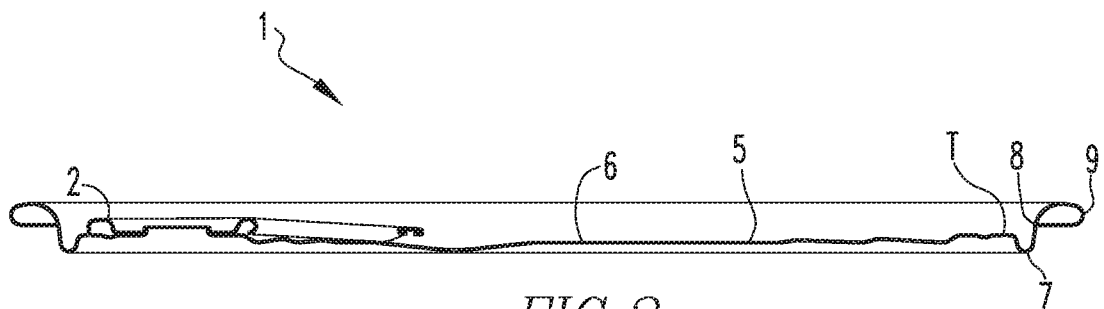


FIG. 2
(PRIOR ART)

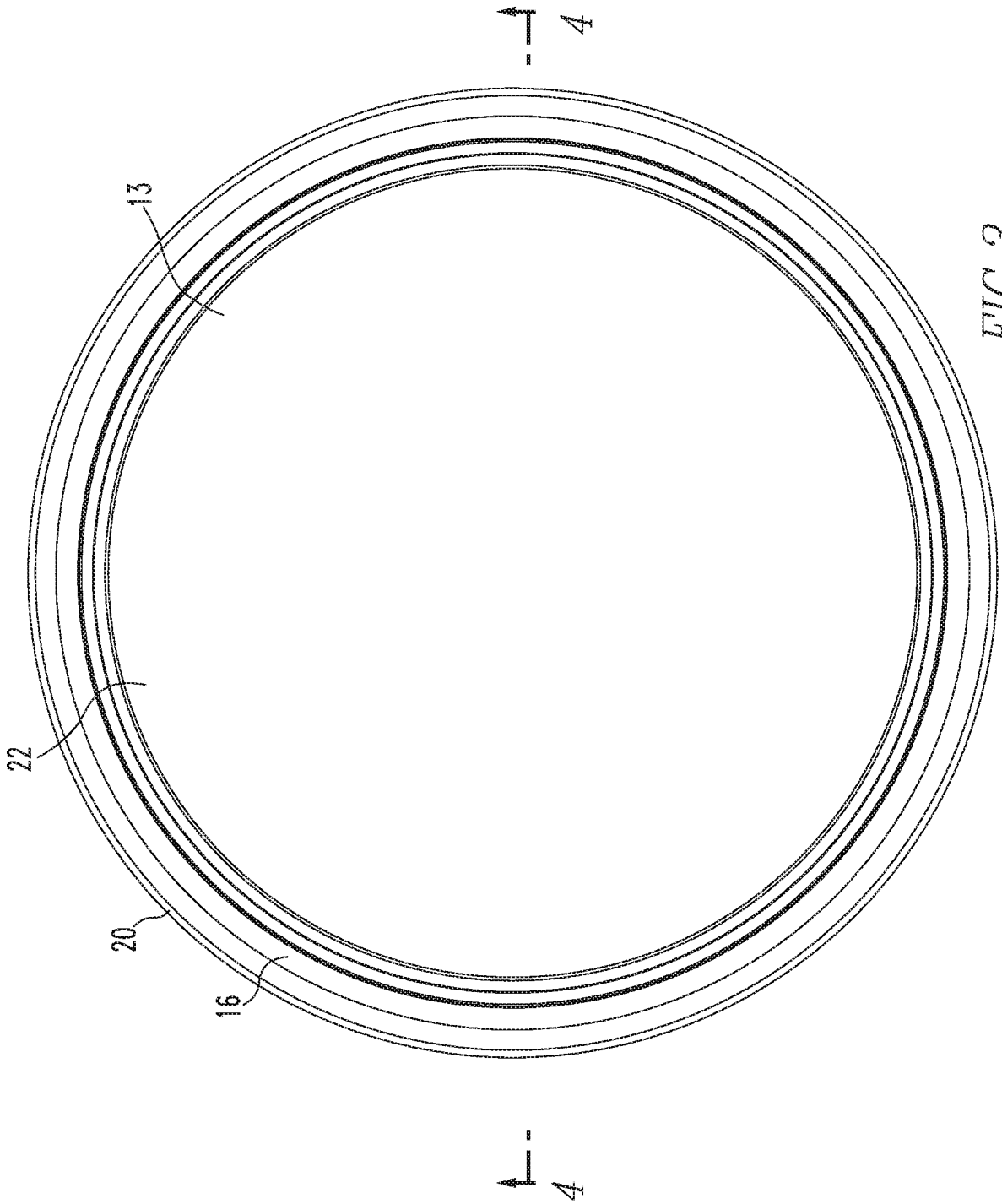
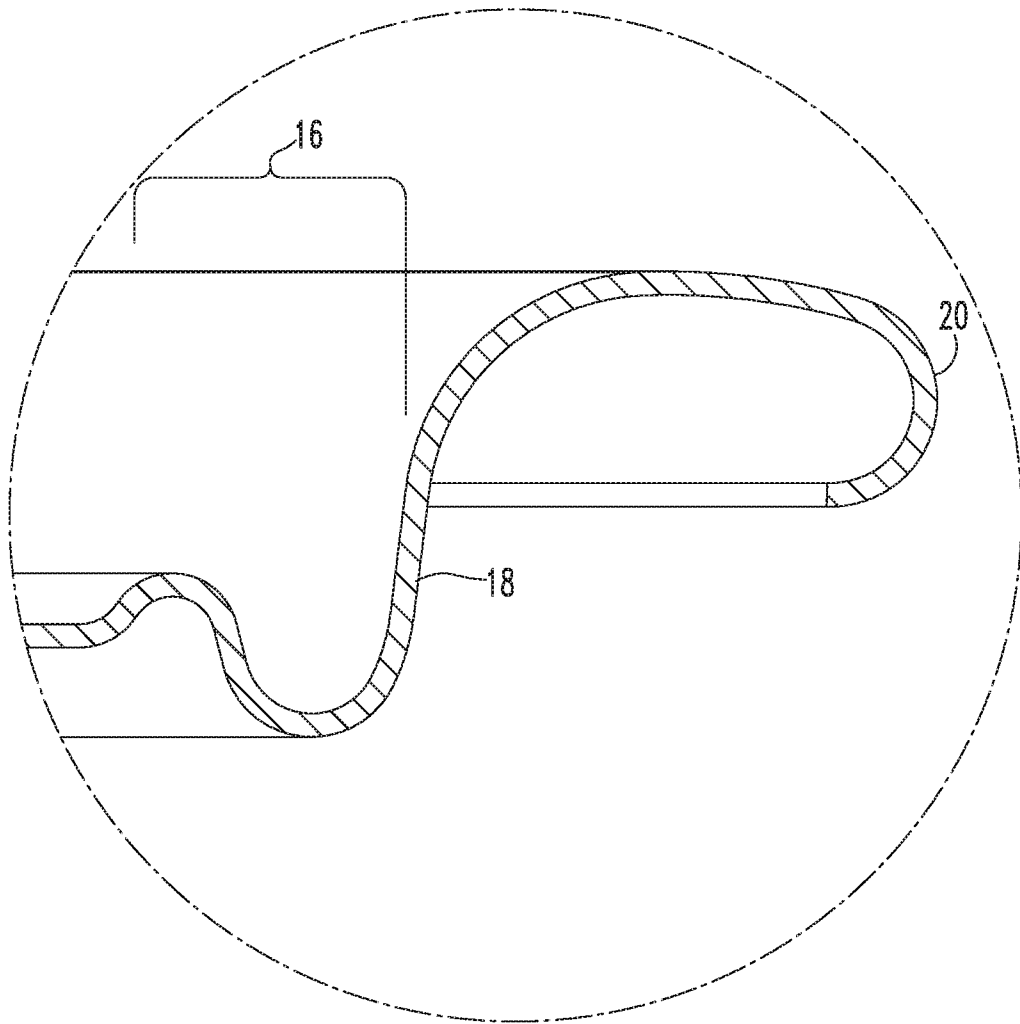
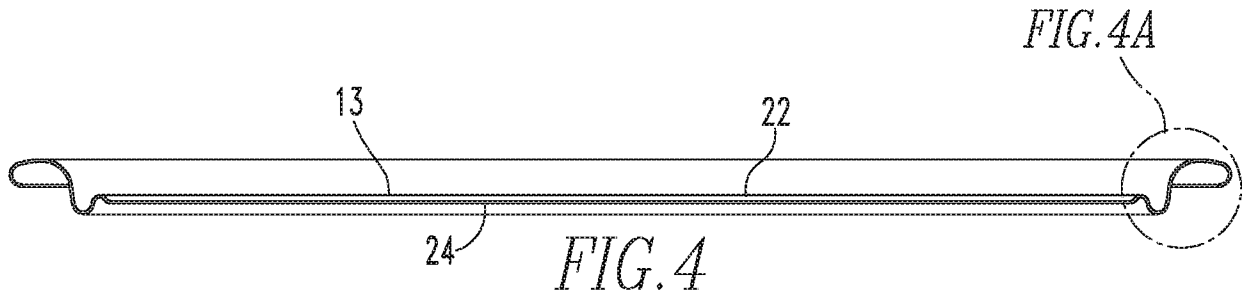


FIG. 3



4/16

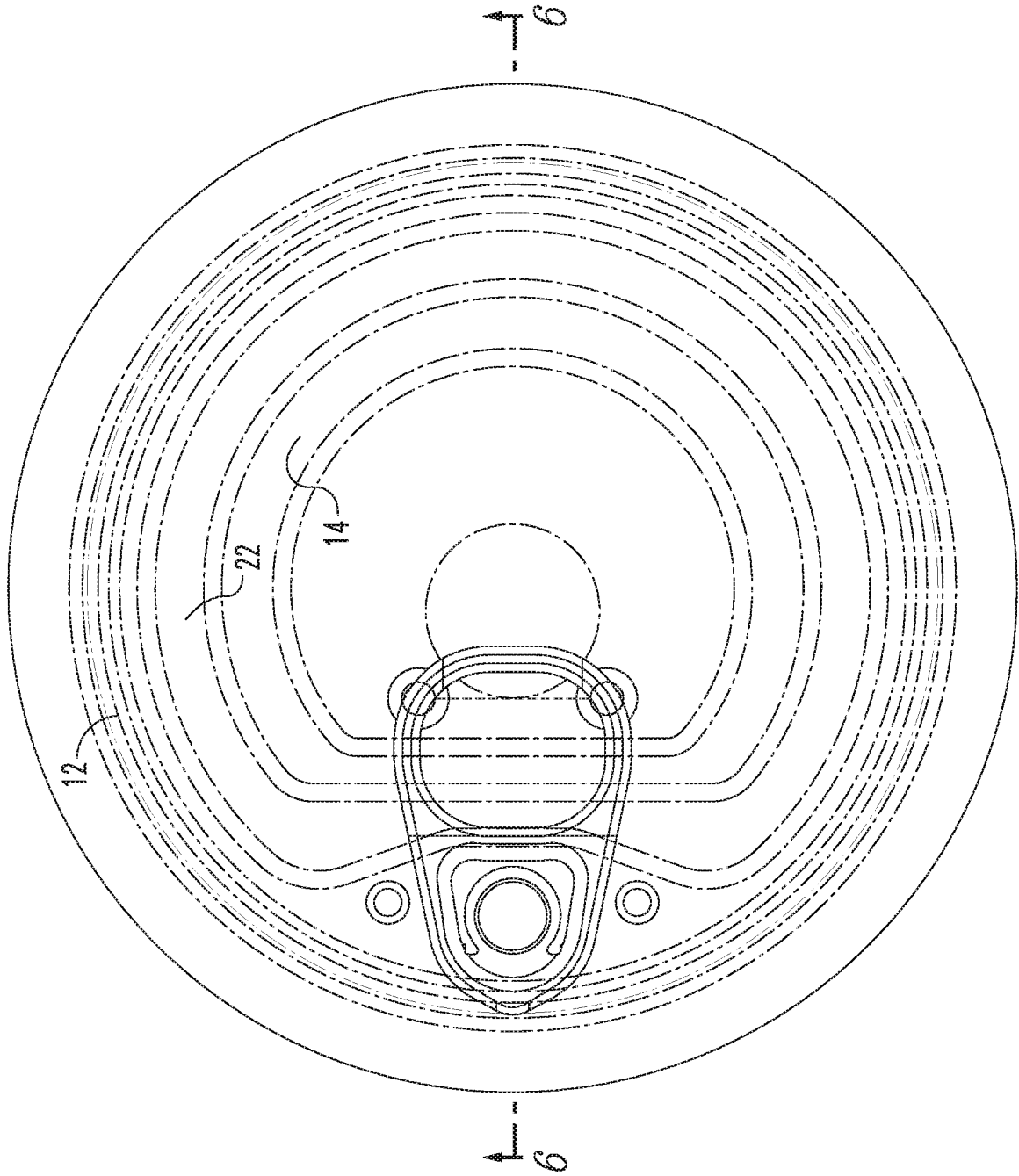
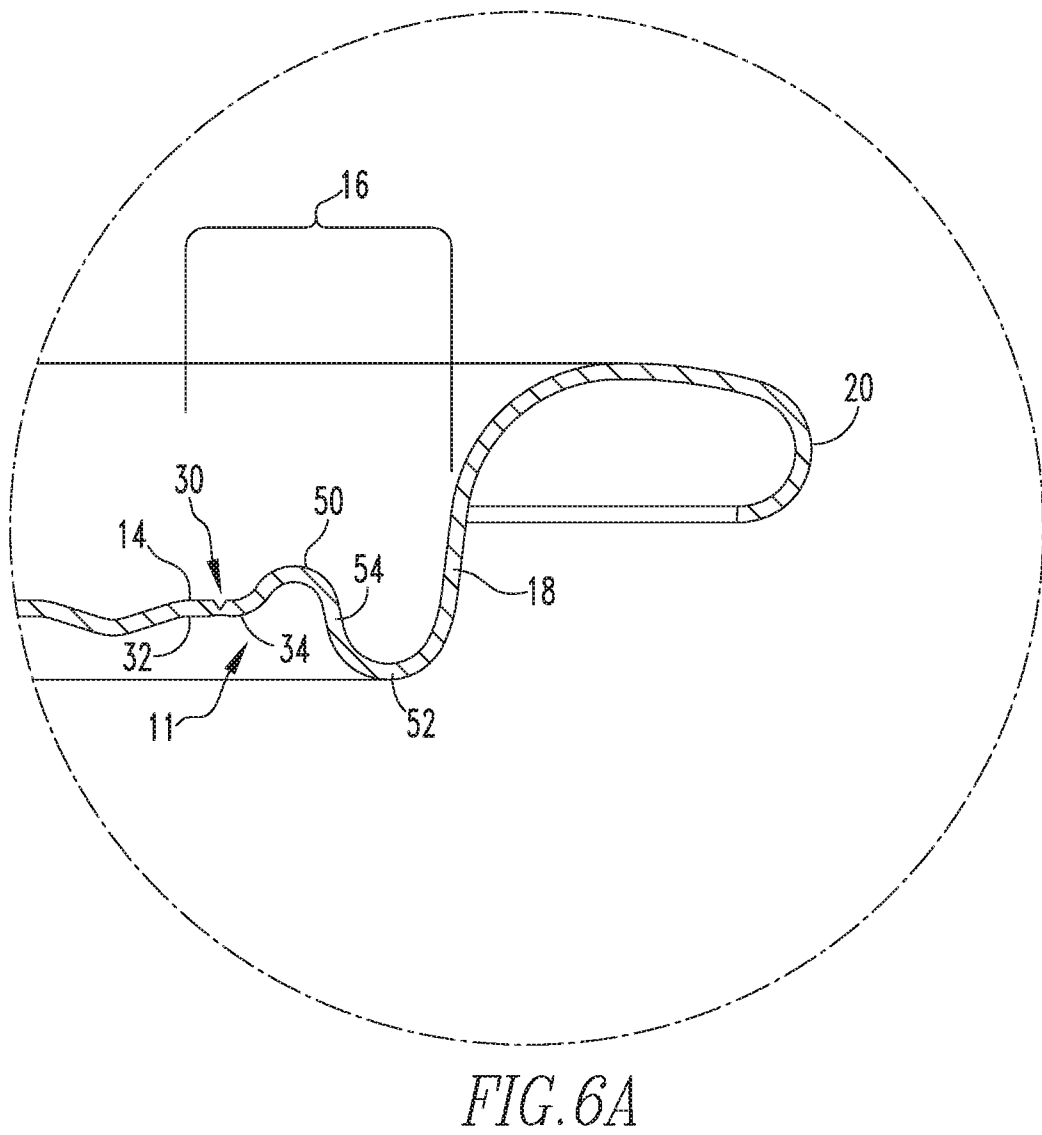
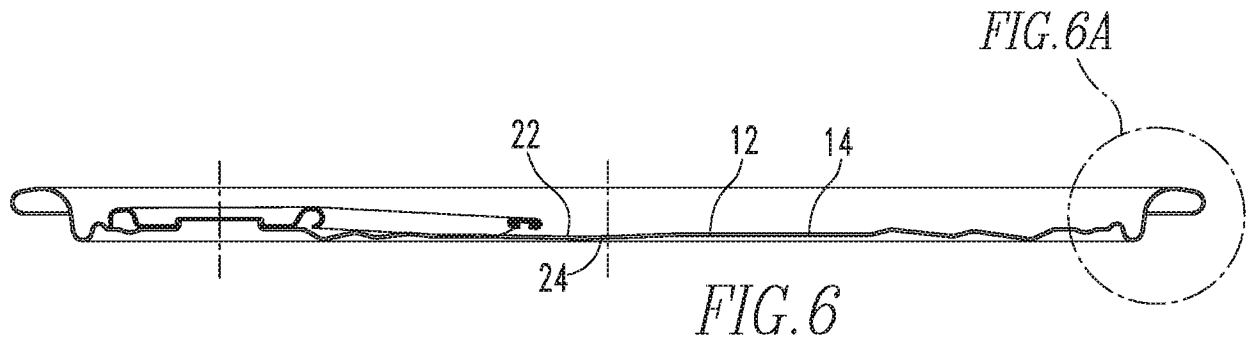


FIG. 5



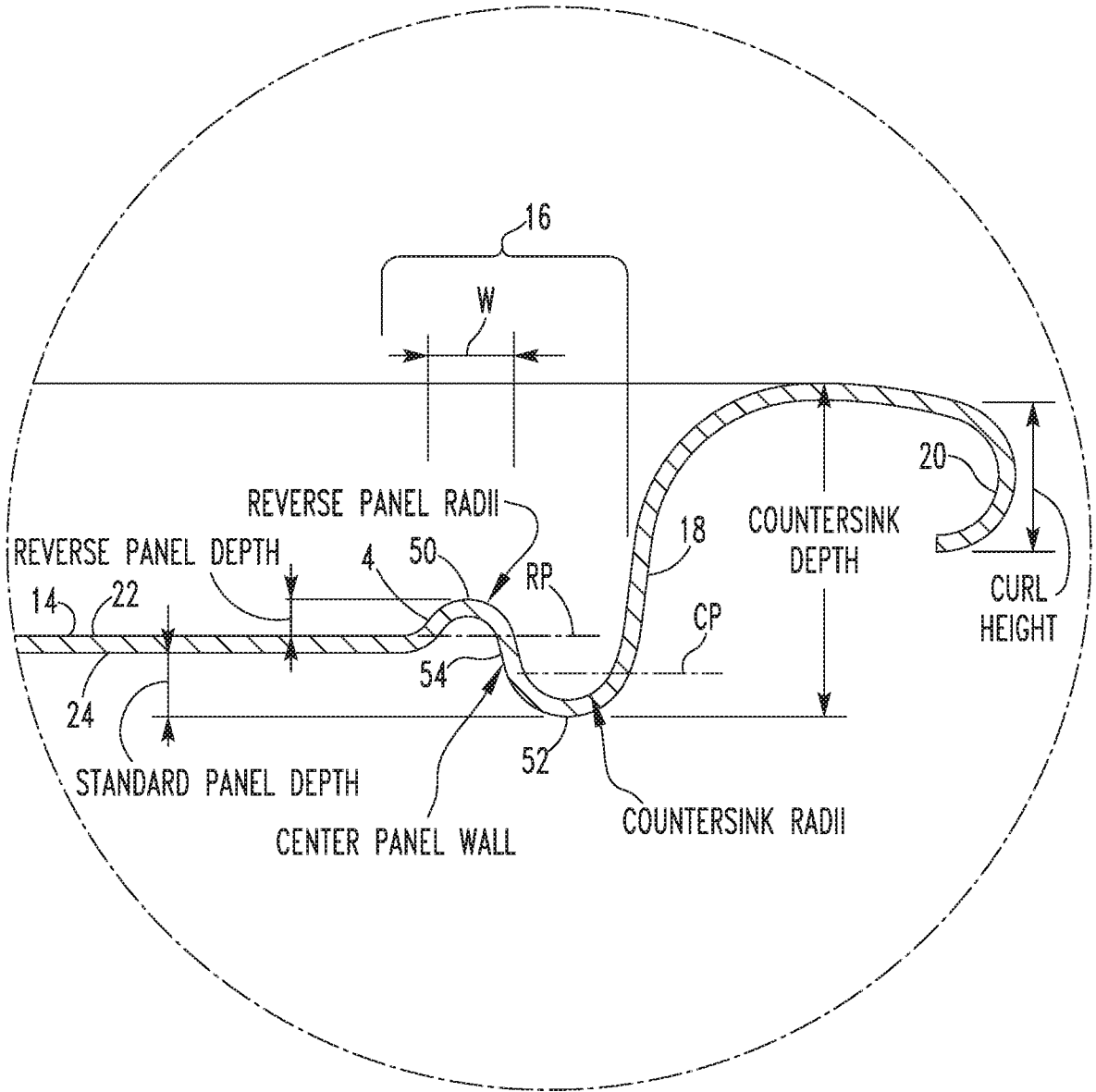
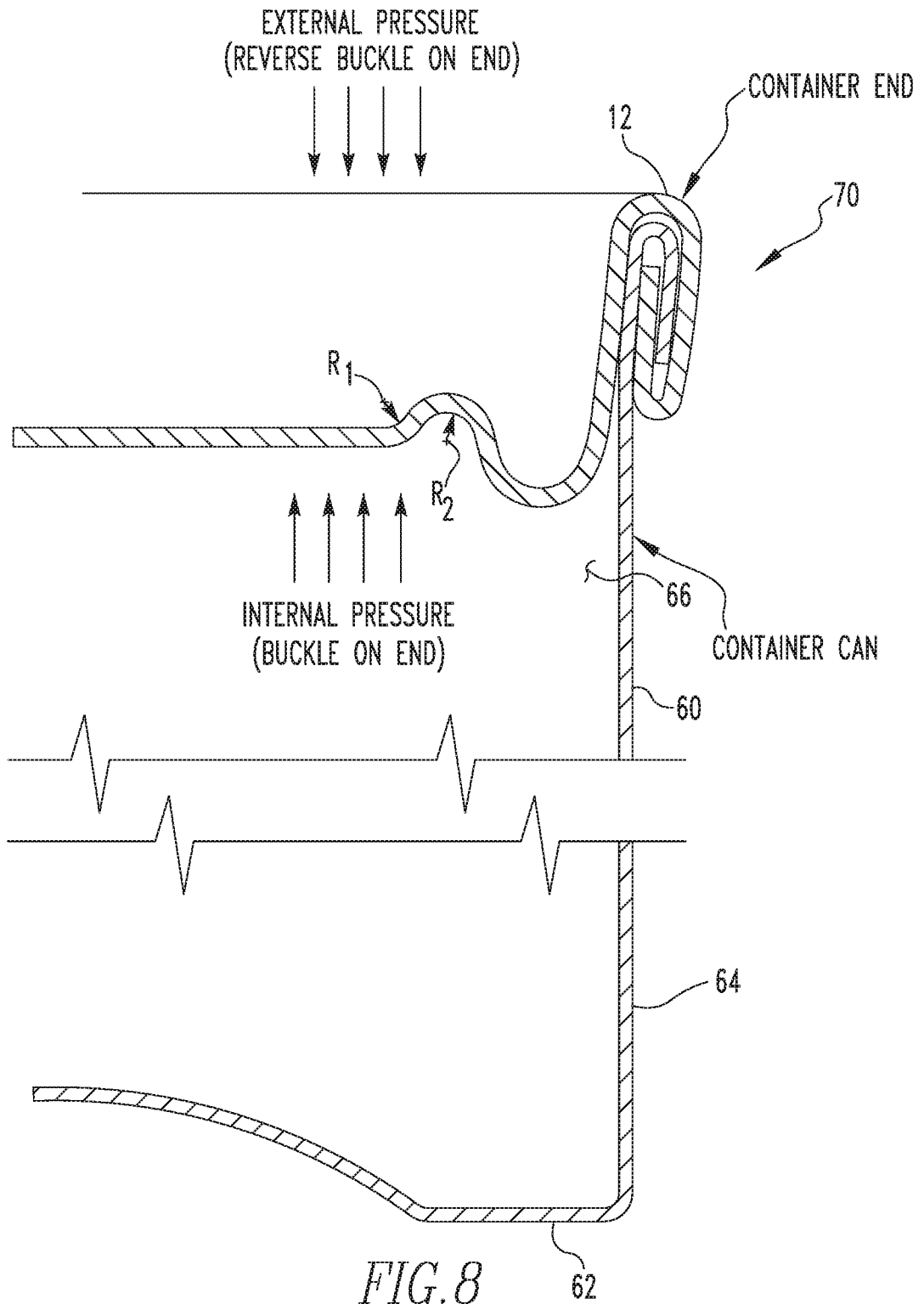


FIG. 7



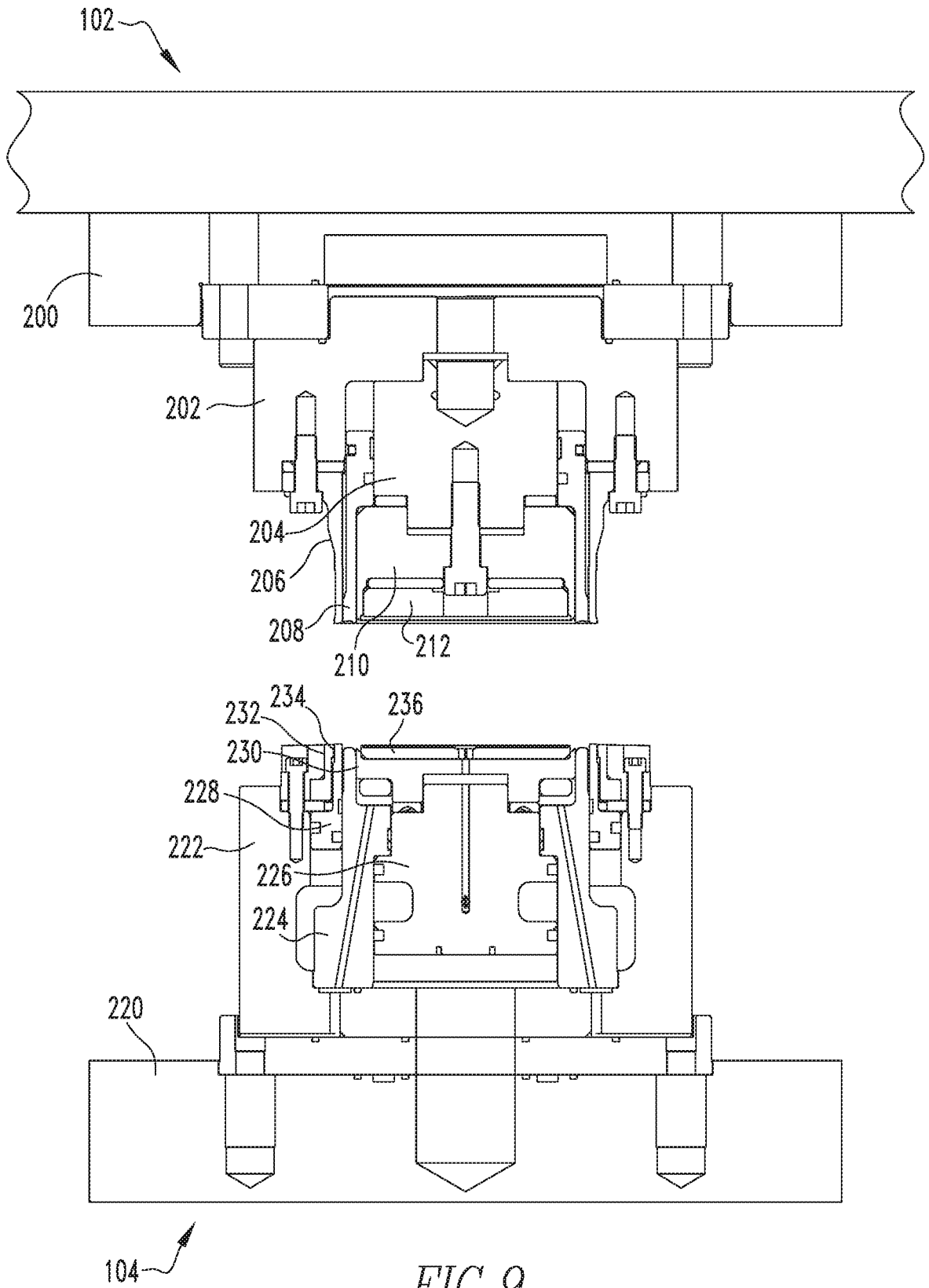


FIG. 9

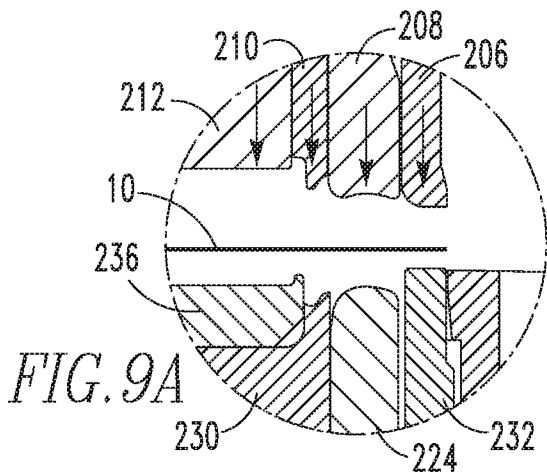


FIG. 9A

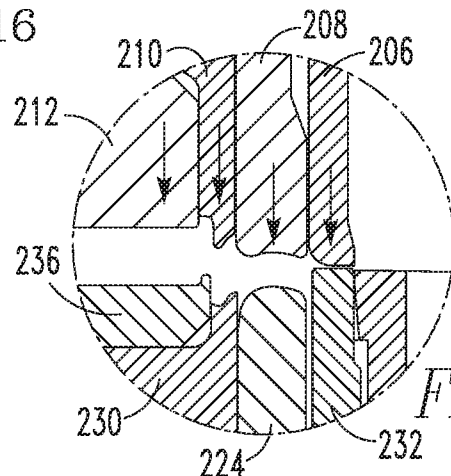


FIG. 9B

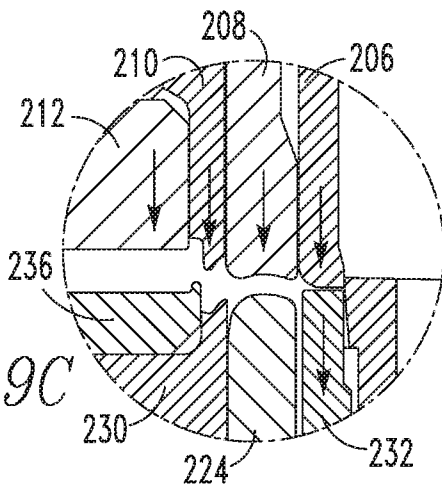


FIG. 9C

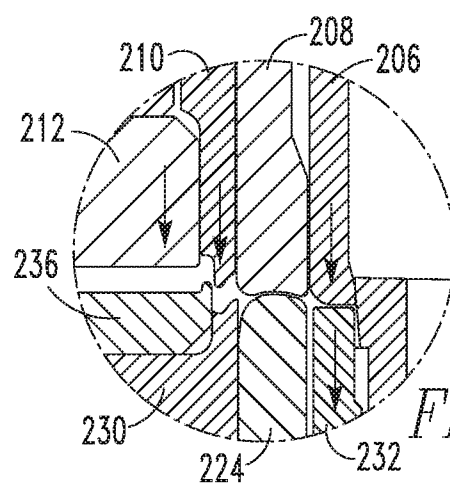


FIG. 9D

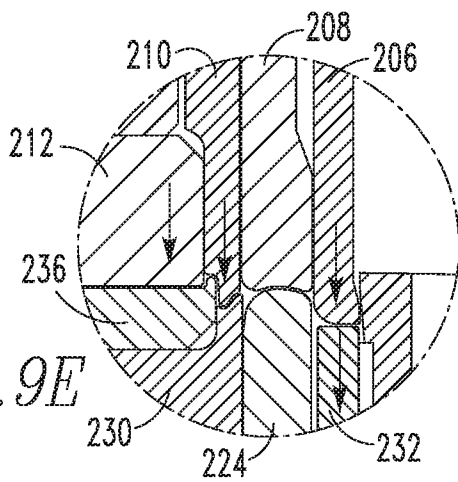


FIG. 9E

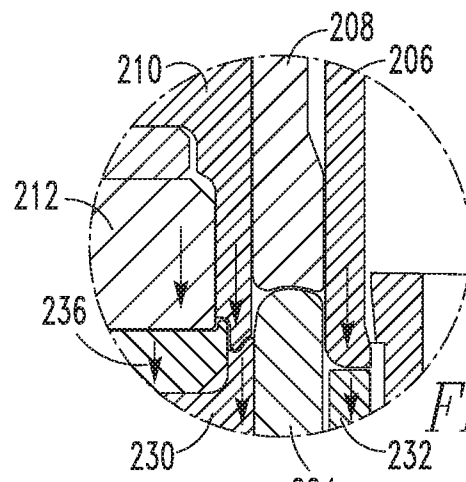


FIG. 9F

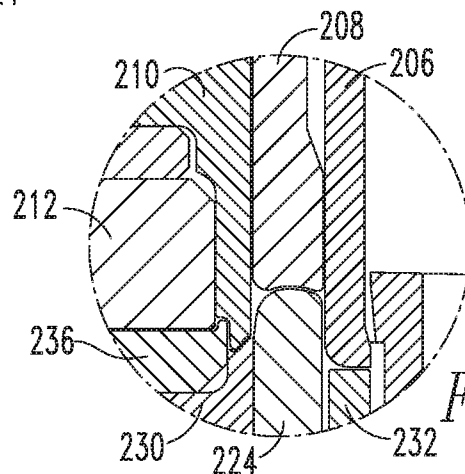


FIG. 9G

10/16

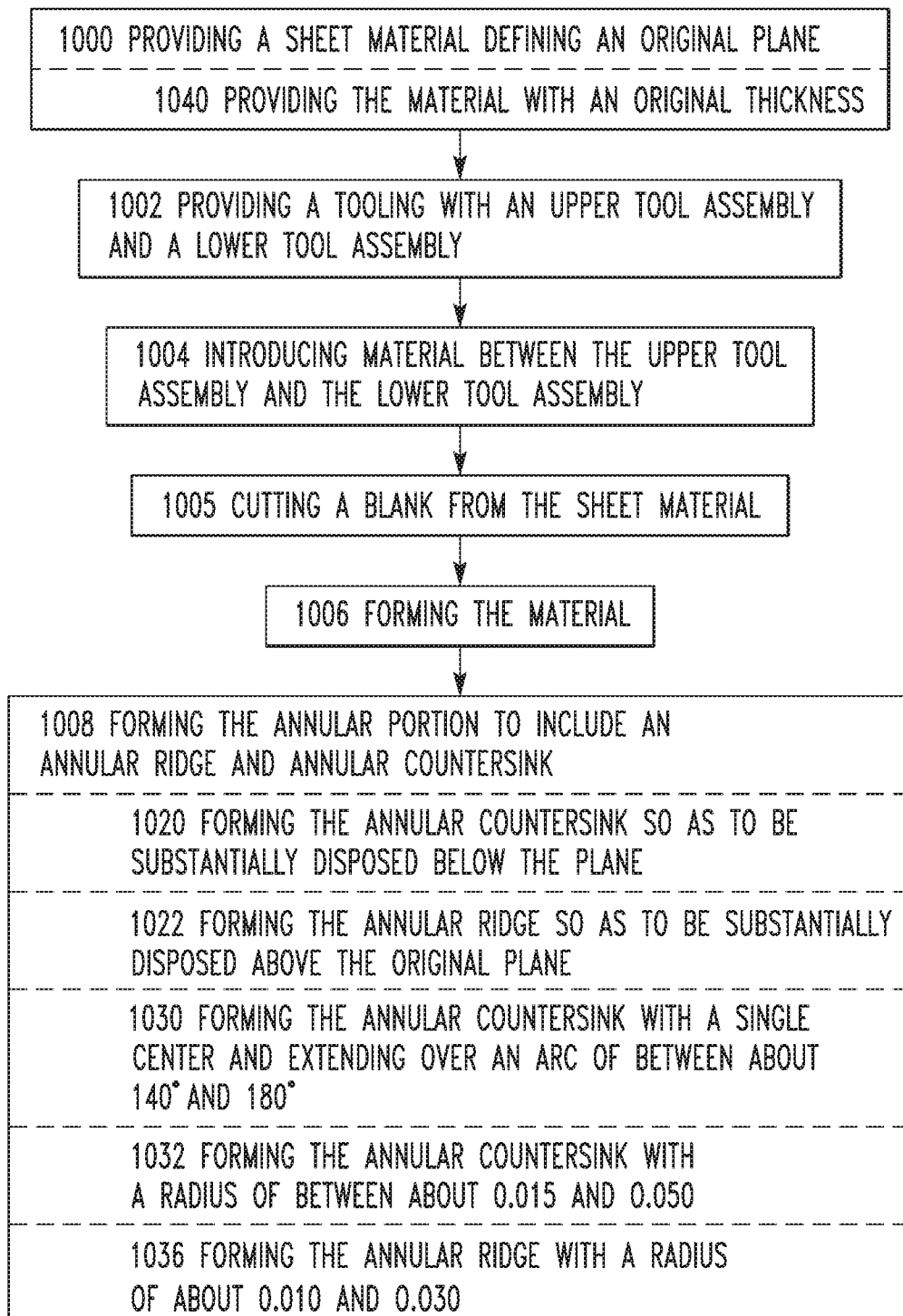
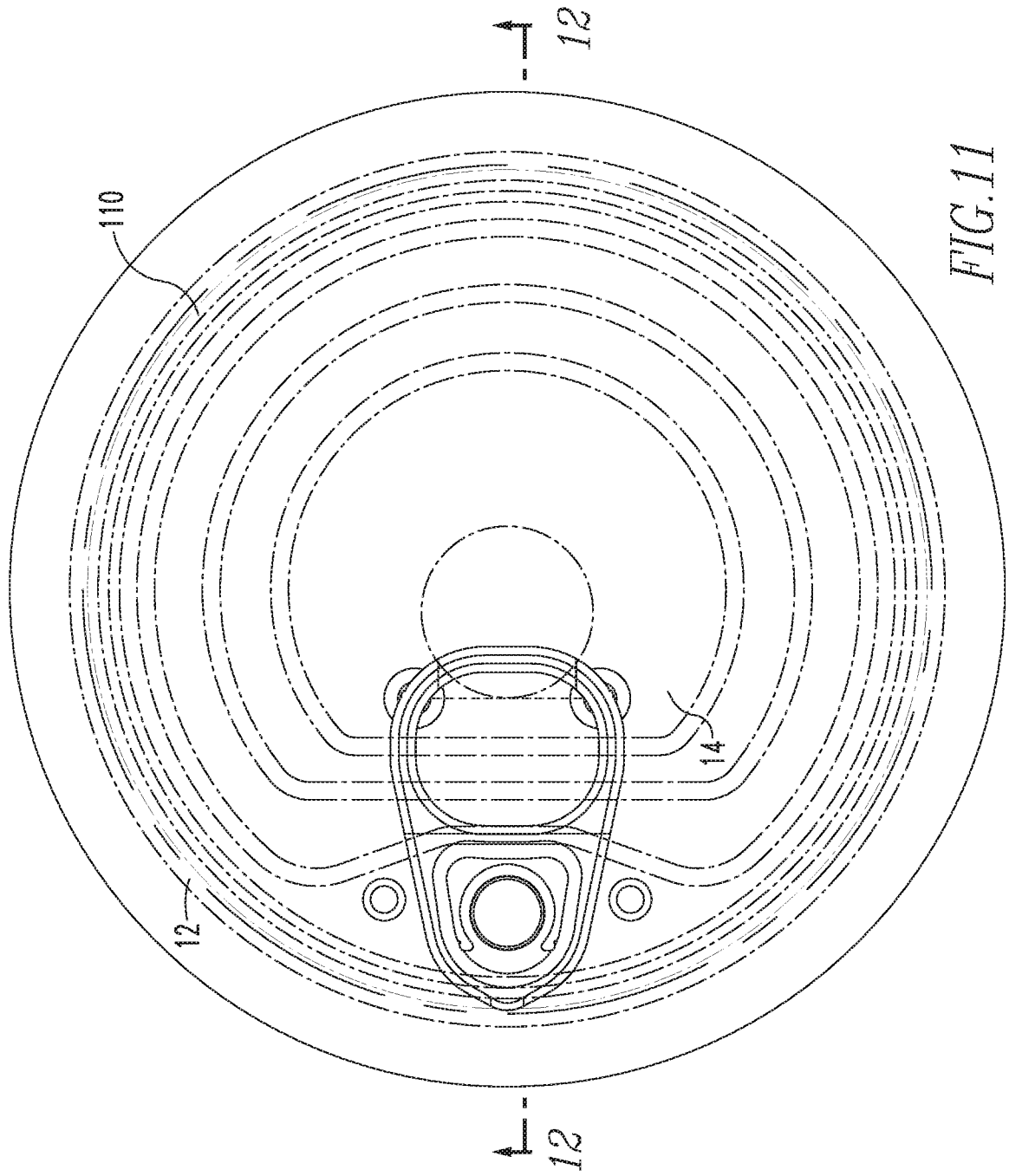
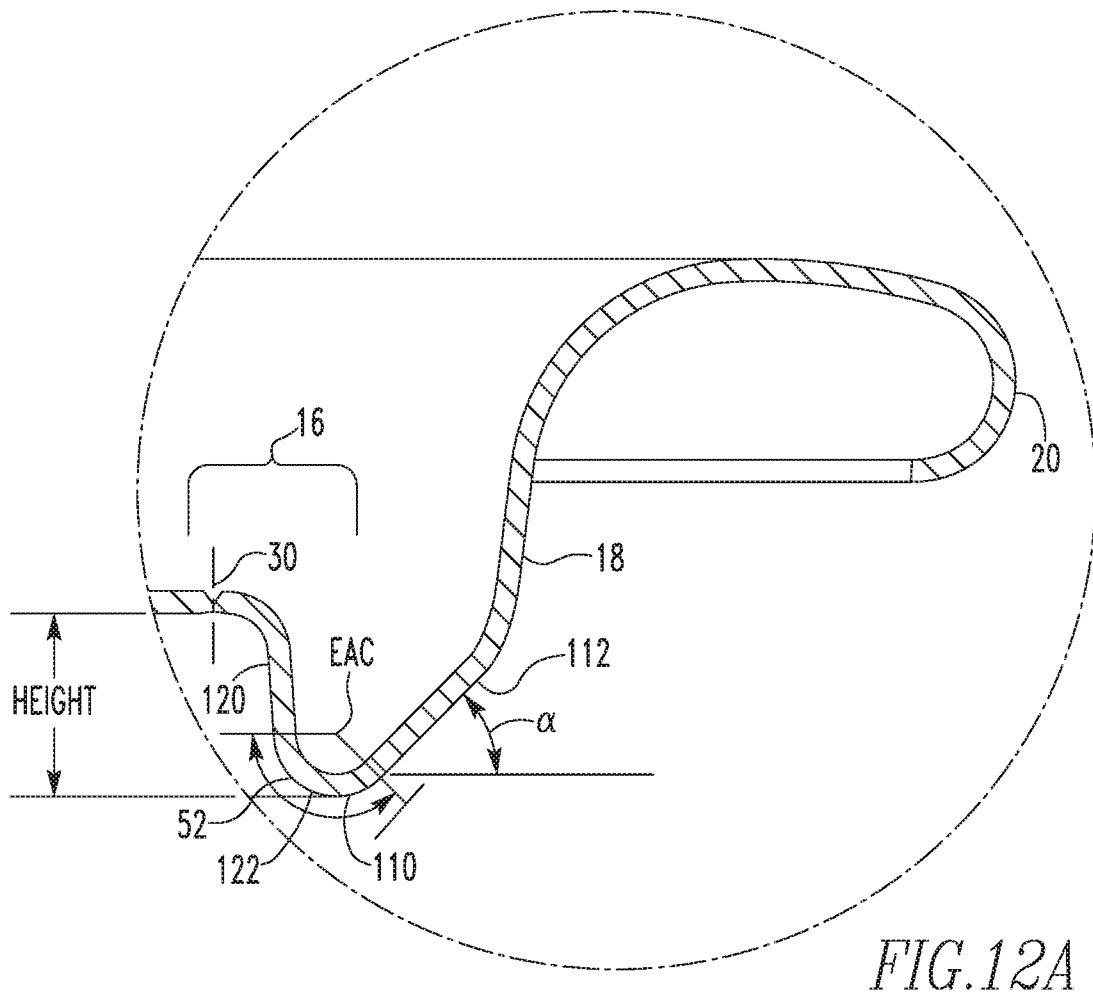
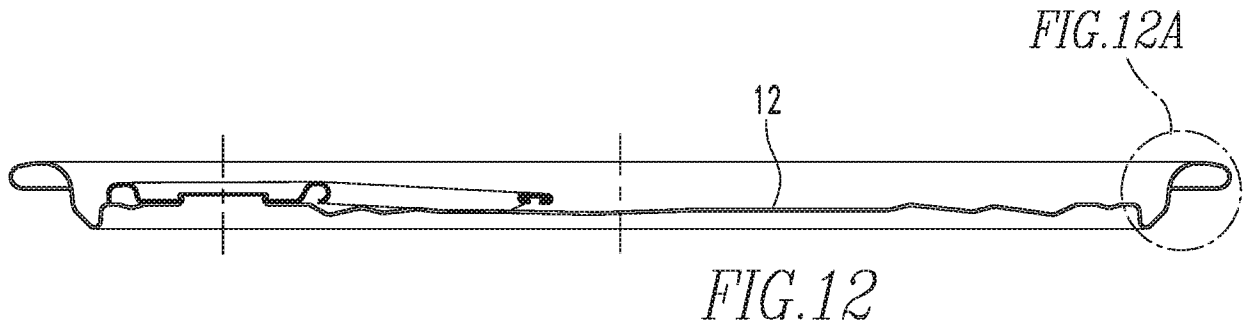


FIG. 10

11/16





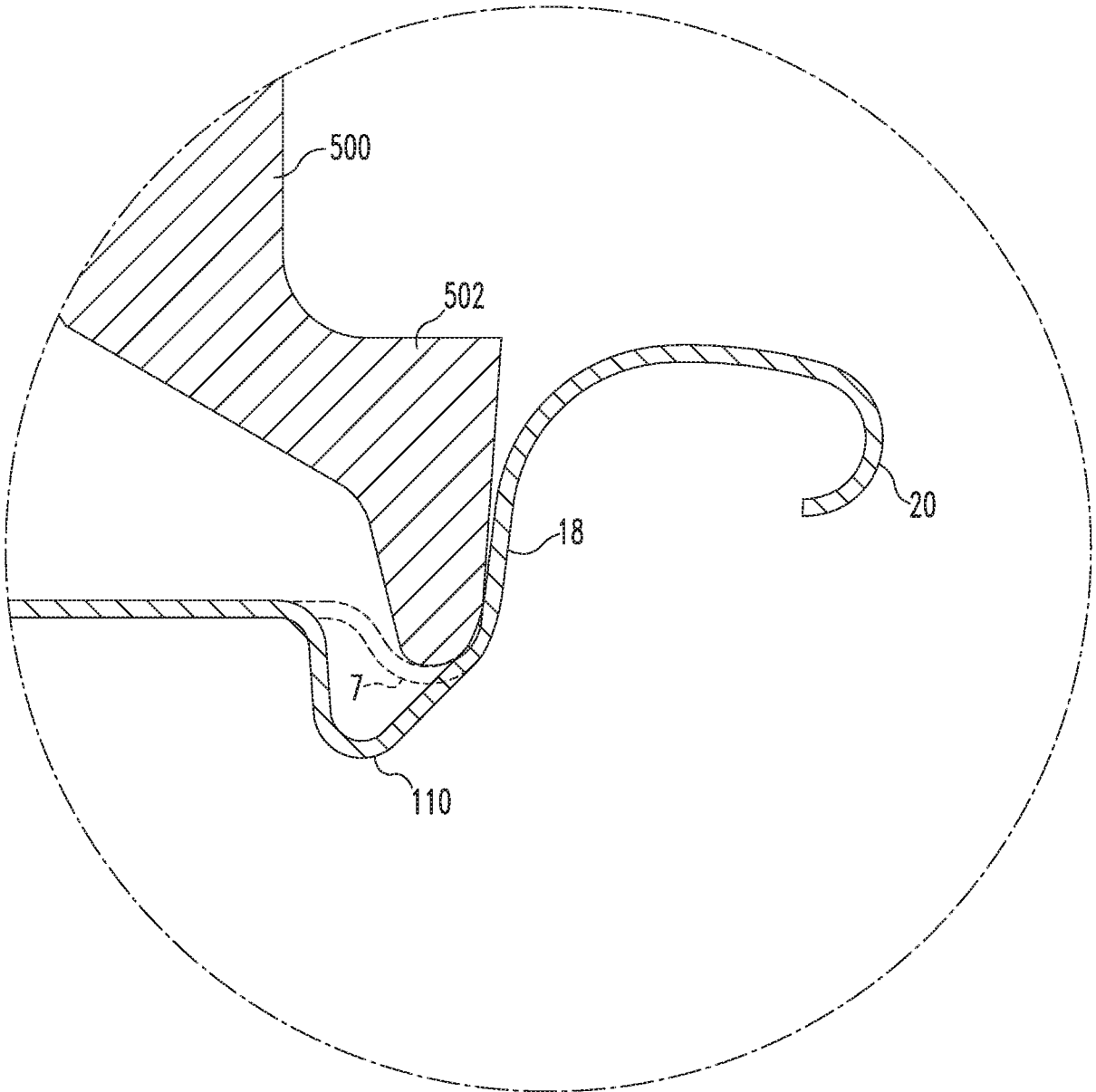
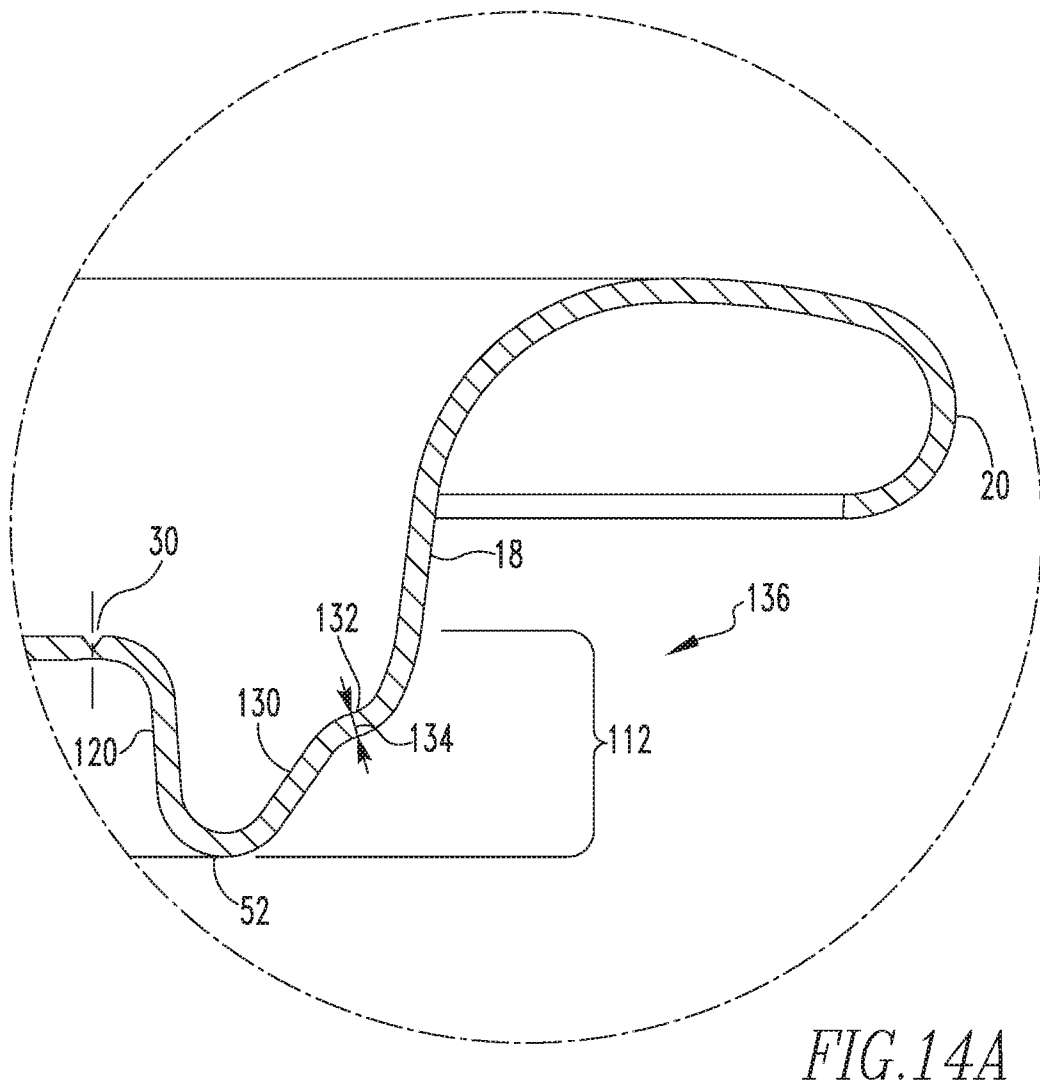
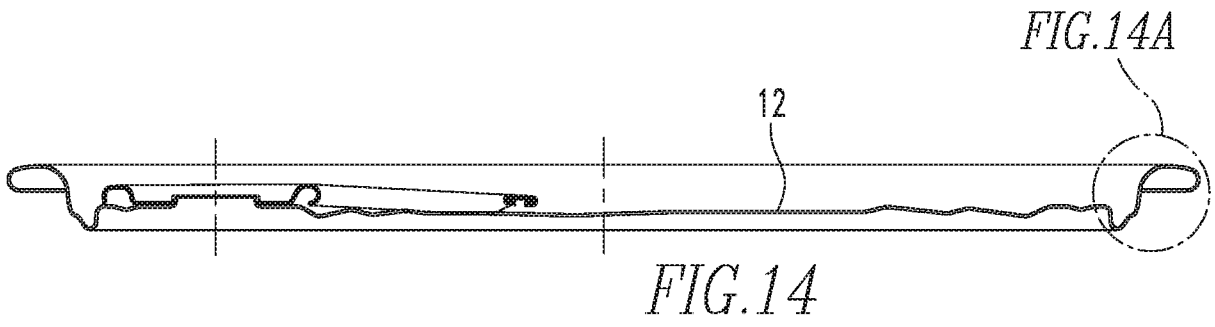


FIG. 13



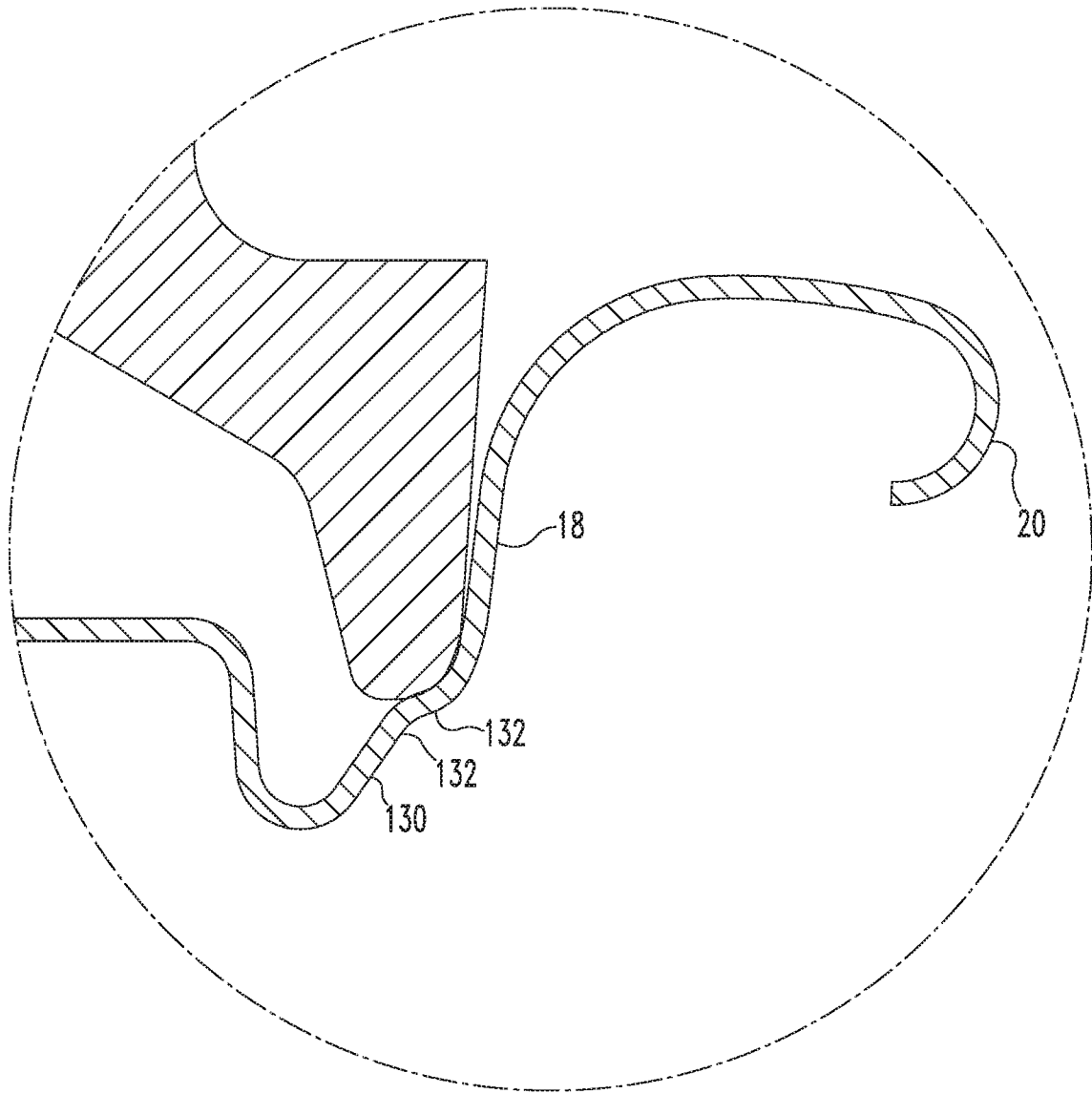
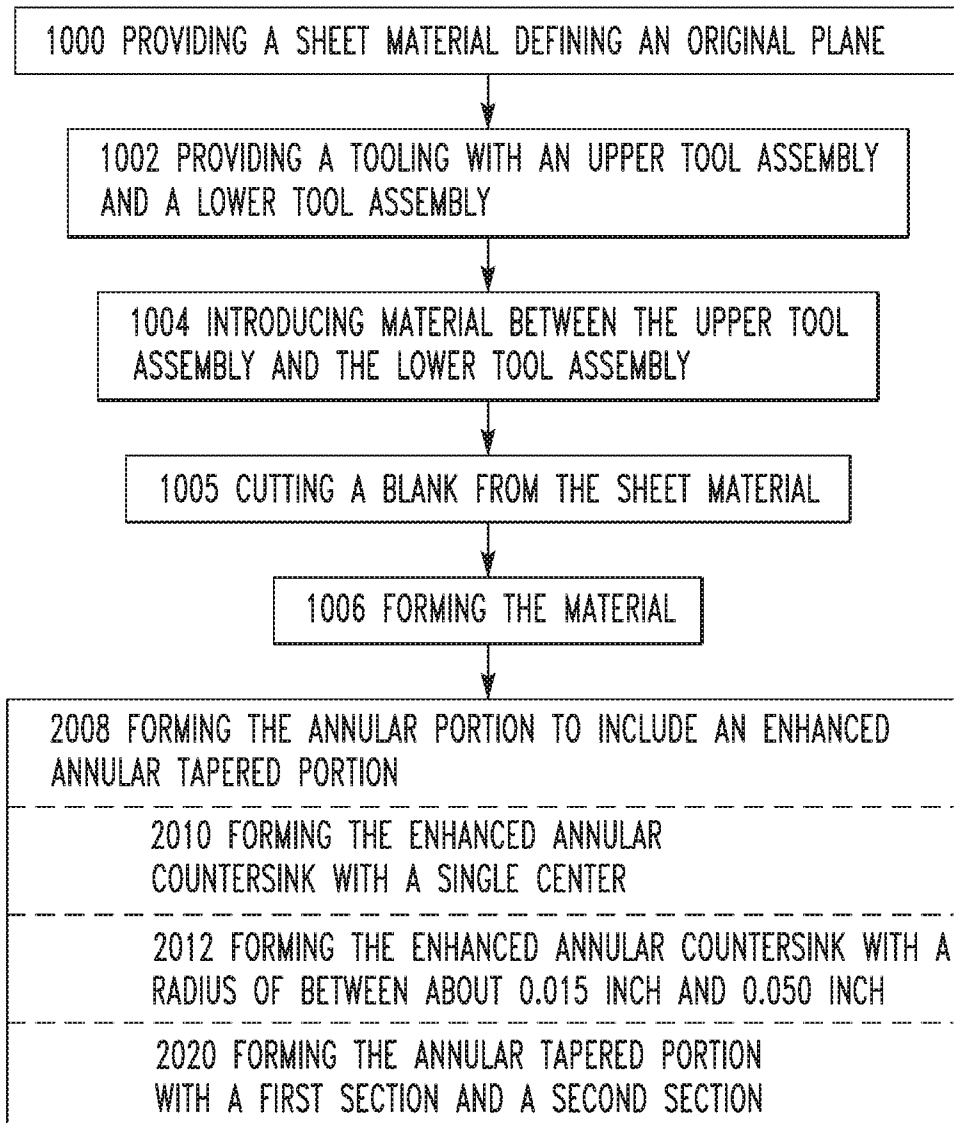


FIG.14B

16/16

*FIG. 15*

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US18/47838

A. CLASSIFICATION OF SUBJECT MATTER
 IPC - B21D 37/10, 51/38, 51/44; B65D 17/00, 17/06, 17/08 (2018.01)
 CPC - B21D 37/10, 51/38, 51/44; B65D 17/00, 17/06, 17/08

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
 See Search History document

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 ---- Y	US 2002/0134788 A1 (NGUYEN, T., et al.); 26 September 2002; figure 5; figure 7; paragraph [0069]	1-2, 8-9, 16 ----- 3-7, 10-15, 17-18
Y	US 4,213,324 A (KELLEY, J., et al.); 22 July 1980; figures 2, 3; abstract; claim 9	7, 11-15

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

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Date of the actual completion of the international search
 08 October 2018 (08.10.2018)

Date of mailing of the international search report
18 OCT 2018

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