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(54) DIGITALLY OPENABLE CONTAINER CLOSURE, AND METHOD AND APPARATUS FOR FORMING SUCH CLOSURE

(71) We, ALUMINUM COMPANY OF AMERICA, a Corporation organised and existing under the laws of the State of Pennsylvania, United States of America of, Alcoa Building, Pittsburgh, State of Pennsylvania, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to metal container closures and more particularly to an improved method and apparatus for forming and construction for a digitally openable container end closure that not only exceeds the stringent and competitively dictated present day commercial economic and performance criteria but also satisfies all ecology based governmental regulations now extant.

The metal container industry and its ever increasing demands for thin sheet metal has been one of the major motivating factors in both the growth and strength of our domestic economy. At the present day, for example, about 40 billion metal cans are fabricated each year alone to contain, preserve and transport beverages, such as soda and beer. Over the past 75 years or more, the ever increasing demands for product integrity backed up by governmental regulations and judicial pressures have, in an environment of continually increasing cost sensitivity, resulted in the development of commercially and competitively dictated interrelated economic and performance criteria of ever increasing stringency for metal containers. In the more recent years the competitive pressures attendant the fabrication of metal containers has been further complicated by the changing habits of the consumer and a marked increase in

the long standing desire for metal containers that could be manually opened at the point of consumption without employment of auxiliary tools or the like. In the beverage field, such demand was recently satisfied, despite the existence of great numbers of suggested expedients therefor in the prior art and attendant unfavorable economic considerations, by the industry-wide fabrication of the pull tab easy open end closure. The widespread utilization of such type of end closures has, apart from the increased costs inherently attendant its fabrication due to increased metal content thereof and required multiple fabricating operations, created a serious ecology problem due to the hazards attendant the relatively sharp-edged removable tab portion thereof and the propensity of consumers to indiscriminately dispose of such tabs immediately following their separation from the container. In part, the problems attendant such indiscriminate tab disposal have resulted in the actual or contemplated banning of such closures in certain jurisdictions with the concomitant creation of problems of major magnitude for the can fabricators.

As noted above, the prior art, and notably the patented art, is replete with hundreds of suggested expedients for achieving the long desired objective of simplified can opening, including many suggested expedients for can closures that can be digitally opened, i.e., manually opened without the use of auxiliary tools or the like. Included in such expedients were the use of container walls and end closures which included weakening lines or score lines defining tear strips or panels which could either be depressed into or pried out of a container to form either a vent or a pouring opening therein. Closures of this type are exemplarily disclosed in a number

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of United States Patents including Newman 1,805,003; Fried 2,176,898; Asbury 3,227,304; Asbury 3,246,791; Asbury 3,355,058; Klein et al 3,334,775; Foss et al 3,401,436; Punte 2,187,433; Punte 2,289,452; Punte 2,312,358; Punte 2,312,359; Fink 2,119,533; and Punte 2,120,186. Such end closures have sometimes required the use of rigid tools, such as a coin or a fork, to rupture the score line around the removable panel in order to form an opening in the end closure. Several of such end closures have included embossments in the removable portion to facilitate opening of the removable portion by pressing or prying against such embossments.

It has also been suggested to form a weakening line in the form of a fracturable web in such a container closure by displacing metal along one side of a line at right angles to the initially undisplaced surface of the container wall in such a way that the edge defining the periphery of the removable wall portion underlaps the corresponding edge of the non-removable wall portion and has an abrupt change in cross-sectional wall thickness as is disclosed in United States Geiger Patent No. 3,362,569. That Patent discloses that the removable wall portion in such a closure has greater resistance against severance of the fracturable web as would be occasioned by internal pressure than it has against severance due to an opening force applied against the exterior surface of the portion. It has been found, however, that displacing metal at right angles to the surface of the sheet in the manner taught and disclosed in Geiger Patent No. 3,362,569 can cause small cracks in, or accidental severance of, the fracturable web that is formed, particularly in hard temper metal. Punte United States Patent No. 2,187,433 suggests another expedient wherein a weakened thinned portion is formed in a container wall by thinning the wall between a rounded corner of a movable die member and a die surface disposed at a 45° angle to the axis of displacement of the movable die member. Other expedients suggested by the art for the formation of particularly shaped weakened areas are embodied in United States Patents in Barrath 540,625; Frazee 3,291,336; Cookson 3,434,623; Cookson 3,698,590 and Baumeyer et al 3,693,827.

Insofar as we are aware, none of these suggested expedients have apparently been able to satisfy the stringent and complementally interrelated economic and performance criteria necessary for widespread use on beverage and like containers. As evidenced by the span of years covered by the above noted Patents, it has long been desired to have a container

end closure or container wall with a removable portion in it which can be inwardly displaced from the end closure or wall without need for a separate tool or a pull tab attached to the removable portion. While the pull tab easy open end closure is, as noted above, presently in wide use despite its additional expense, the current ecology induced pressures make it desirable to utilize the concepts of the Geiger Patent, but to provide a method of forming a fracturable web that is not subject or vulnerable to small cracks or failure therein and which satisfies the current stringent and complementally interrelated economic and performance criteria necessary for widespread commercial use.

Accordingly the present invention provides a sheet metal container component having a wall with at least one inwardly displaceable opening panel therein having an integral rim peripherally terminating in a fracturable junction defining a locus of separation of said opening panel from the adjacent portion of said wall, an integral deflectable portion of said wall projecting outwardly from the general plane of the wall adjacent said junction and terminating in a lip integrally interconnected with the rim of said opening panel and defining therewith the boundaries of said fracturable junction, the rim of said opening panel including an exposed surface terminally intersecting the exposed marginal edge of the lip of said deflectable portion in an exposed corner, said deflectable portion having a portion of the undersurface thereof terminally meeting the undersurface of the outer marginal edge of said rim in predetermined space relation with said exposed corner to define therebetween the extent of said fracturable junction said opening panel being of greater rigidity than said deflectable portion to effect an initiation, in response to digitally applied localized inwardly directed pressure against said deflectable portion in opening panel, of relative displacement of said lip relative to said rim to strain said fracturable junction and induce fracture thereof to permit inward displacement of a separated opening panel.

According to a further aspect of the invention there is provided a method for the formation of a sheet metal container component according to the preceding paragraph which has at least one inwardly displaceable opening panel and an outwardly projecting deflectable portion disposed in integral interconnected relation therewith by a fracturable junction, said method comprising the steps of: introducing a sheet of metal intermediate a

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first die member having a first substantially planar metal extruding surface and a second and substantially frustoconical metal extruding surface defining therewith a corner at the locus of intersection therebetween, and a second die member having a first base surface and a second and substantially frusto-conical metal shaping surface, and with auxiliary die means disposed on the same side of the sheet as said first die member having a metal shaping base surface facing a generally opposed direction from said first base surface of said second die member and in laterally spaced relation therewith in respect of an axis of displacement of said dies, linearly displacing said first die member towards said second die member to selectively move said first and second surfaces of said first die member into operative proximity with said surfaces of said second die member to engage said sheet and laterally displace portions thereof by the conjoint action of said first and second surfaces of said first and second die members to form said fracturable junction, stopping said die member displacement when the apex of said corner on said first die member is disposed in substantial alignment with said first base surface of said second die member, and lineally displacing said auxiliary die means towards said second die member to selectively move said base surface thereof into predetermined longitudinally offset relation with said first base surface of said second die member in the direction of die displacement to form said deflectable portion by the conjoint action thereof.

According to yet a further aspect of the invention there is provided apparatus for forming a sheet metal container component as defined in claim 1 which has at least one inwardly displaceable opening panel and an outwardly projecting deflectable portion disposed in integral inter-connected relation therewith by a fracturable junction comprising: a first die member having a first substantially planar metal extruding surface and a second and substantially frusto-conical metal extruding surface defining with said first surface a corner at the locus of intersection therewith, a second die member having a first base surface and a second and substantially frusto-conical metal shaping surface, and auxiliary die means having a metal shaping base surface facing in a generally opposed direction from said first surface of said second die member and in laterally spaced relation therewith, said first die member and said auxiliary die means being linearly displaceable relative to said second die member with said first and second surfaces of said first member in generally opposed

relation with said first and second surfaces of said second die member, whereby displacement of said die member and said auxiliary die means against a sheet of metal positioned therebetween to a closed die position in which said apex of said corner on said first die member is in substantial alignment with said first base surface of said second die member and said base surface of said auxiliary die means is in longitudinally offset relation with said first base surface of said second die member in the direction of die displacement will laterally displace portions of said sheet through the conjoint action of said first and second surfaces of said first and second die members to form said fracturable junction and will form said deflectable portion by the conjoint action of said first base surface of said second die and said base surface of said auxiliary die means.

Some embodiments of the invention will now be described in greater detail by way of example only, with reference to the accompanying drawings, wherein:

Fig. 1 is plan view of a can end of the invention;

Fig. 2 is an enlarged cross-section through the can end of Fig. 1 taken along line 2—2 of Figure 1;

Fig. 3 is an enlarged cross-sectional view of a can end of the invention seamed on a container and illustrating finger pressure applied to an outwardly domed or bulged panel to initiate rupture of the fracturable junction in the can end;

Fig. 4 is a section view similar to Fig. 3 and showing the can end after opening;

Fig. 5 is a perspective view of an alternative embodiment of a closure of the invention;

Fig. 6 is a cross-section through the closure of Fig. 5;

Fig. 7 is a cross-section illustrating tools for deforming a container wall in accordance with the invention;

Fig. 8 is an enlarged cross-sectional view of a portion of the tools from Fig. 7 illustrating an intermediate stage in the forming of a fracturable junction in a container wall;

Fig. 9 is a cross-sectional view similar to Fig. 7 illustrating further displacement of the die members in the formation of a fracturable junction in a container wall;

Fig. 10 is an enlarged cross-sectional view of a portion of a presently preferred embodiment of a container wall constructed in accordance with principles of the invention;

Fig. 11 is a plan view of another embodiment of the can end of the invention;

Fig. 12 is an enlarged fragmentary cross-

section through the can end of Fig. 11 taken along line 12—12 of Figure 11.

Fig. 13 is a cross-section illustrating tools for forming a weakening line in a container wall as shown in Fig. 11;

Fig. 14 is an enlarged fragmentary cross-section of the tools of Fig. 13; and

Figs. 15, 16 and 17 are enlarged fragmentary cross-sections similar to Fig. 14 showing exemplary alternative tool shapes that can be used in the practice of this invention.

Referring to Figs. 1 and 2, a container wall or can end 10 is shown which includes a substantially planar central panel 12, a peripheral groove 14 around the panel, an upstanding wall 16 outwardly of the groove, a flange 18 extending outwardly from the top of the upstanding wall and a curled edge 20 on the outer end of the flange. Such general construction of a peripherally chimed can end is typical of can ends which are adapted to be sealed on container bodies by conventional double seaming operations.

In order to facilitate understanding of the subject invention and in the interest of clarity, the terms "inwardly" and "outwardly" will be herein employed to delineate directions relative to the interior and exterior respectively of a cylindrical container having the end closure of interest mounted on the end thereof.

In accordance with this invention, can end 10 further includes at least one, and preferably two, inwardly displaceable opening panels 22 of equal size defined by weakening divisions 24 in the form of fracturable junctions in the central panel 12. Panels 22 are designed to be opened by displacing them into a container on which can end 10 is sealed to form a pouring opening and/or a vent in the can end. In the embodiment selected for illustration in Figures 1 through 4, each fracturable junction 24 may be C-shaped with a bridge of metal between the ends of the line providing a hinge 26 which prevents complete separation of the opening panel 22 from container end 10. Hinge 26 between the ends of the fracturable junction 24 may be slightly weakened by a shallow score line or the like, but may also be unweakened for some applications. In case of accidental rupture of the junction 24 due to excessively high internal pressures in a container, hinge 26 will prevent complete separation of a removable panel 22 from can end 10. Hinge 26 also normally prevents the panel 22 from dropping into the container after inward displacement thereof.

It is a feature of a preferred embodiment of a container end constructed in accord with the principles of this invention that at

least a marginal edge portion 28 of opening panel 22 adjacent the fracturable junction 24 be disposed with respect to an adjacent marginal edge portion 30 of central panel 12 on the other side of the junction such that opposite faces of such two marginal edge portions 28 and 30 are disposed in nearly the same plane. In the embodiment selected for illustration in Figs. 1—4, such displacement results in the top surface of the edge portion 28 of the opening panel 22 being disposed in nearly the same plane as is the bottom surface of edge portion 30 of the adjacent portion of central panel 12 disposed on the other side of the fracturable junction.

It is another feature of this invention that the central panel 12 has a bulge or bulges formed in it adjacent the fracturable junction 24 as is best illustrated in Figs. 2 and 9. As will be explained, flexing or other digitally induced displacement of such bulge or bulges, which constitute at least part of a deflectable portion of the container wall, facilitates rupture of the junction 24 by producing relative movement of metal on opposite sides of the junction to strain the residual metal and initiate its failure. In can end 10, a bulge 32 is formed adjacent removable panel 22 and a bulge 33 may be formed within the opening panel 22 as will be described.

Depending on the intended use of a container end e.g., on pressurized or unpressurized cans or on automatically ventable cans; the adjacent portions of metal on opposite sides of the fracturable junction 24 and the flexible deflectable portions 32 and 33 are formed outwardly directed with respect to the initially undisplaced metal in the container wall. In the can end 10 illustrated in Figs. 1—4, which is adapted to be sealed on a container for holding relatively high internal pressures, the marginal edge portion 28 of opening panel 22 has preferably been displaced downward with respect to the adjacent portion 30 of central panel 12 on the opposite side of the fracturable junction so that the junction will have a greater resistance against rupture due to internal pressure in the container than it will have against rupture due to external pressure applied against opening panel 22. The difference in resistance to rupture of a weakening line depending on the direction of force was previously broadly disclosed in the Punte and Geiger United States Patent Nos. 2,187,433 and 3,362,569, and is believed to result from an overlap of metal on opposite sides of a weakening line.

Deflectable portion 32 is formed outwardly with respect to the initially undisplaced surface of can end 10 so that

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finger pressure applied against said deflectable portion 32 will cause flexing and selective displacement thereof to facilitate initial fracture of the junction 24 as will now be explained. As illustrated in Fig. 3, depressing the illustrated outwardly domed opening panel 22 causes flexing and displacement of at least portions of central panel 12. While not fully understood at the present time, it is believed that this flexing of portions of central panel 12 causes relative movement of adjacent portions of metal on opposite sides of the fractureable junction 24 to thereby stress and fracture the thin residue of metal constituting such junction. Such flexing displacement of portions of container panel 12 is also believed to cause some bending of the thin residue of metal constituting the junction to further contribute to the initiation of fracture thereof. As opening panel 22 is further depressed, the junction 24 around the panel 22 continues to separate so that the panel may be hinged inwardly into the container as illustrated in Fig. 4. When both panels 22 have been so opened, one opening can be used for pouring or drinking from the container, and the other opening will vent air into the container.

Figs. 5 and 6 illustrate another embodiment of a closure incorporating the principles of this invention which is particularly adapted for closing a bottle or other container for food which may be vacuum packed. Closure 34 includes an end wall 36, a peripheral skirt 38 with a curled edge 40 thereon for engaging under a retaining bead or lugs on a container. In accordance with this invention, closure 34 further includes an upwardly domed deflectable button 42 in end wall 36 and two fractureable junctions 44 formed in the button near its top. Fracturable junctions 44 may be arcuate in shape and concave toward the periphery of the closure leaving a bridge 46 of unweakened metal between the fractureable junctions. In this embodiment of the invention, the metal between the fractureable junctions 44 is preferably displaced outwardly with respect to adjacent metal on the opposite sides thereof as illustrated in Fig. 6.

When it is desired to open a container on which closure 34 is sealed, bridge 46 may be inwardly displaced to cause failure of at least one of junctions 44 and thereby release the vacuum in the container. Releasing the vacuum in a container on which closure 34 is sealed will obviously facilitate removal of the closure from the container by freeing the closure to be more easily moved with respect to the container. It is believed that inward displacement of bridge 46 causes relative movement of metal on opposite sides of fractureable junctions 44 to stress

the thin residue of metal in the function and thereby facilitate initiation of its rupture.

Figs. 7, 8 and 9 illustrate exemplary tools and a preferred method for forming the particularly contoured fractureable junction in accordance with the invention. Such exemplary tools comprise an annular top die 48 and an annular bottom die 50 between which a sheet metal container wall 10 is introduced to have the fractureable junction formed therein, an auxiliary outer die means 49 and an optionally employable inner doming tool 51 for controlling the direction in which deflectable portion 32 and domed opening panel 22 are formed in the container wall. Top die 48 has a first substantially planar horizontal bottom face or base surface 52, an inner face 53 inclined upwardly from base surface 52 to permit the formation of an upwardly domed opening panel, and a second and angularly disposed frusto-conical metal extruding surface or face 54 which preferably extends outwardly from the first base surface at approximately a 45° angle, although limited angular departure therefrom may apparently be tolerated. The first base surface 52 and second metal extruding surface 54 of die 58 meet at a relatively sharp corner 56 so that a similar sharp corner will be formed in container wall 10. Preferably the corner 56 between the first and second die surfaces 52 and 54 has a radius of less than 0.001 inch, but may tolerate a radius, as for example as would be occasioned by wear, of up to about 0.005 inch on tools for forming a fractureable junction in rigid aluminum alloy container sheet having a thickness in a range of 0.010 inch to 0.015 inch which is typical of sheet used in the production of can ends.

Bottom die 50 has a first substantially planar base surface or top face 58, a downwardly inclined outer face 59 to permit the formation of a deflectable portion 32 externally adjacent the opening panel 22 and a second and angularly disposed frusto-conical metal extruding surface or inner face 60 extending downwardly from the first base surface 58 at approximately a 45° angle. Base surface 58 and metal extruding surface 60 also preferably meet at a relatively sharp corner 62 as do the die faces in top die 48. Metal extruding surfaces 54 and 60 on top and bottom dies 48 and 50 are preferably substantially parallel, although limited departure therefrom can apparently be tolerated. Inner doming tool 51 may further have an upwardly projecting dome 64 on it to form an outwardly domed opening panel 22 which can be concurrently formed therewith. The auxiliary die means 49 and inner doming tool 51 may be integral parts

of tools 48 and 50 respectively, or for ease of fabrication may be separate parts as illustrated, but are preferably moved as unitary assemblies during practice of the invention. Inner doming tool 51 may be omitted from the tools where the presently preferred inwardly domed opening panel 22 is to be formed.

Auxiliary outer die means 49 is disposed on the same side of container wall 10 as is upper die member 48 and has a metal shaping base surface 49a facing the same general direction as does first base surface 52 of upper die member 48 and is in laterally spaced relation with the first base surface 58 on the lower die member 50.

As tools 48, 49, 50 and 51 (when included) are moved against container wall 10 which has been introduced between the dies, metal from the container wall is first drawn or stretched over dome 64 on inner doming tool 51. As the dies continue to close, the first base surface 52 and the second metal extruding surface 54 of the top die member 48 are lineally displaced toward the second angularly disposed metal extruding surface 60 and first base surface 58 respectively of the second die member 60 and with the corners 56 and 62 being maintained in laterally spaced relationship. Following initial engagement of the top die member 48 with interposed metal sheet, metal from container wall 10 begins to be displaced or moved by the base die surfaces 52 and 58 substantially perpendicular, or at right angles, to the initially undisplaced surface of the container wall. When base die surfaces 52 and 58 have closed to within approximately threefourths to two-thirds of the thickness of container wall 10, metal begins to be extruded from between the angularly offset metal extruding surfaces 54 and 60 on the dies. Up to that point, the metal in container wall 10 is merely reformed around corners 56 and 62 on the dies.

As dies 48 and 50 continue to close with respect to one another, metal in container wall 10 is squeezed between the metal extruding surfaces 54 and 60 of the dies to cause lateral flow or extrusion of metal away from the fracturable junction while metal is also being displaced at substantially right angles to the initially undisplaced surface of the container wall. The described lineal displacement of the top die member 48 toward the lower die member 50 continues until the first base surface 52 thereof is disposed substantially coplanar with the first base surface 58 of lower die member 50. It is believed that this lateral flow or extrusion of metal away from the fracturable junction which is being formed is important in preventing cracks from forming in, and premature severance of the

junction. In the absence of such extrusion, metal may be sheared or cut by the tools as is done in typical blanking or punching operations in which the metal is separated or sheared along the line of the tools before the dies have completely penetrated the metal. The present invention substantially eliminates the formation of cracks or failures in the fracturable junction because metal is extruded laterally away from the junction during the right angle displacement of metal to cause lateral flow of metal approximately as fast as the metal is being displaced at right angles so that the metal is not sheared or separated by such right angle displacement. Experience to date indicates that in the practice of this invention, container ends of the type disclosed can be formed at high rates of press operation to produce 300 or more ends per minute per die set up with few or no defective can ends.

Lateral metal flow away from the fracturable junction that is being formed also produces an increased surface area of metal in a can end for forming the desired deflectable portion in the metal adjacent the junction. As explained above, such deflectable portion 32 is believed to facilitate rupture of the fracturable junction. In the tools illustrated in Figs. 7-9, the auxiliary die means 49 and the inner doming tool 51 respectively control the direction in which the increased area of metal is formed so that deflectable portion 32 and domed opening panel 22 project outwardly with respect to the original undisplaced surface of the can end.

After inner doming tool 51 has initiated outward doming of opening panel 22, lateral extrusion of metal produced by the formation of fracturable junction 24 further domes the opening panel so that the metal in the panel is spaced above dome 64 on the doming tool 51 as is illustrated in Fig. 9. Auxiliary die means 49 controls the formation of the preferred outwardly projecting deflectable portion 32 adjacent the fracturable junction 24 by restraining the metal outside the fracturable junction so that the metal bows upward over bottom die 50 as is also illustrated in Fig. 9. In forming the deflectable portion 32, the auxiliary die means 49 is lineally displaced to selectively move the base surface 49a thereof into predetermined longitudinally offset relations with the first base surface 58 of lower die member 50 in the direction of die displacement.

It is believed that lateral extrusion of metal during formation of the particularly contoured fracturable junction 24 in accordance with the principles of this invention results in the formation of complex residual stresses in the junction

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probably having a substantial component thereof in shear which may interact with the stresses produced by inward displacement of the deflectable portions to contribute in initiating rupture of the fracturable junction. Such residual stresses apparently act within the fracturable junction 24 to make it easier to initiate its rupture.

In the practice of this invention, the amount of lateral spacing "x" between the corners 56 and 62 in the horizontal direction may vary depending upon the alloy, temper and thickness of the metal in container wall, the angle of the metal extruding surfaces 54 and 60, and the residual thickness of metal to be left in the fracturable junction among other factors. Such lateral spacing is preferably in the range of 1/4 to 1/6 of the thickness of the container wall in which the fracturable junction is formed, but may be from 5% to 50% of the metal thickness for some applications. In the exemplary practice of the invention, spacing "x" of die surfaces 54 and 60 of approximately 0.0032 inch has been found to work well in forming a fracturable junction in a container wall made from a sheet of hard temper aluminum base alloy 0.013 inch thick. In that example, the dies were moved toward one another until base surfaces 52 and 58 were within approximately 0.001 inch of coplanar orientation. This produced a fracturable junction with a thin remanance of metal approximately 0.004 inch thick with no cracks therein.

Fig. 10 illustrates a presently preferred configuration of a metal and closure incorporating the principles of this invention. There is provided a central panel 12 having at least one circular and relatively rigid opening panel 22 contoured to include an inwardly domed center portion 33 bounded by a rim 28 peripherally terminating in a fracturable junction 24. The junction 24 interconnects the rim 28 with a lip 30 of an integral outwardly projecting deflectable portion 32 of generally frusto-conical configuration surrounding the opening panel 22 in the adjacent portion of the container wall. Preferably, rim 28 has a substantially planar upper surface 70 which terminally intersects an angularly inclined surface 72 defining the inner marginal edge of lip 30 of deflectable portion 32 in an exposed corner 74. Lip 30 has a substantially planar undersurface 76 disposed in substantially coplanar relation with the upper surface 70 of rim 28 and which terminally intersects an angularly inclined surface 78 defining the outer marginal edge of the rim 28 of the panel 22 in a second corner 80. The corners 74 and 80 are disposed in predetermined

laterally spaced relation and define therebetween the lateral extent of the fracturable junction 24.

Deflectable portion 32 in container end 10 is adapted to effect, in response to inwardly directed digitally applied pressure, a relative displacement of lip 30 with respect to rim 28 to strain fracturable junction 24 and initiate fracture thereof to permit inward displacement of a separated opening panel of greater rim size than the size of the opening which is formed in the end. Such inwardly directed digital pressure is best applied against the end 10 adjacent junction 24 and preferably against the raised lip 30 of the deflectable portion 32 as is illustrated in Fig. 10. Such inward pressure against the deflectable portion 32 appears to move the lip 30 relative to the rim 28 of the relatively rigid opening panel 22 to strain the fracturable junction 24 and initiate fracture thereof. As pointed out above, the opening panel 22 is of relatively rigid character to resist bending thereof and thereby insure that the displacement of the deflectable portion 32 will create sufficient relative displacement of the lip 30 thereof with respect to the rim 28 of the opening panel 22 to initiate junction fracture. The lateral spacing corners of 74 and 80 are selected to define a junction of at least a predetermined minimal extent sufficient to maintain its structural integrity during exposure to variations in the magnitude of the residual stress therein occasioned by normal container handling and usage and less than a predetermined maximum extent that would preclude said displacement induced fracture thereof in response to said digitally applied inwardly directed pressure.

While the mechanics underlying the mode of operation of the subject construction are not well understood at the present time, it is believed that complex residual stresses are introduced into the particularly contoured fracturable junction by the metal displacement effected during the formation thereof. It is further believed that the relative displacement of the deflectable portion induced by the inwardly directed digitally applied pressure introduces a further complex stress pattern of varying character into said junction and that localized junction fracture is initiated by selectively located and probably localized interactions thereof with the formation-created residual stresses extant therein.

It is therefore seen that a container wall and a method of forming the same are provided which offer improved opening characteristics and improved resistance to the formation of cracks in the fracturable junction in the container wall. Metal is moved substantially at right angles to the

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initially undisplaced surface of the container wall along the fracturable junction while metal is extruded laterally away therefrom. The extrusion of metal causes lateral metal flow which is approximately as fast as the right angle displacement of metal during at least the latter part of the forming operation to thereby avoid shearing the metal, and further forms a deflectable portion in the container wall whose digitally induced displacement initiates junction fracture.

The invention is particularly well suited for use with container walls made of work hardened aluminum base alloy sheet material in the thickness range of 0.010 inch to 0.015 inch and which is at least quarter hard, and preferably at least three-quarter hard temper or is of extra hard temper alloy which has been partially annealed as a result of heating it to cure a protective coating thereon. Quarter hard aluminum alloy sheet will generally have a yield strength which is at least one-half the yield strength for the same alloy in a full hard condition, and two or more times the yield strength for the product in a fully annealed or recrystallized condition. It is believed that such work hardened alloy sheet material is particularly well suited to practice of the invention because material of the specified hardness is required to assure conversion of the inwardly directed digitally applied pressures into selectively directed displacement of the lip of the deflectable portion relative to the rim of the relatively rigid opening panel. It is further believed that work hardened aluminum alloy will also result in the presence of greater residual stresses in the metal, both as to those introduced in the initial formation of the fracturable junction and those introduced by relative metal displacement as described above.

Experience to date has indicated that opening panels having diameters in the range of about one-eighth inch to three-quarters inch provide adequate pour and venting rates and also result in adequate lateral metal extrusion during forming to produce deflectable portions of desired size and configuration. With respect to such deflectable portions, it is believed that an angle inclination in a range of about 5 to 15 degrees to the general plane of an end closure provides an adequate toggle-like action to effect the necessary displacement of the lip portion relative to the opening panel rim portion to initiate junction fracture.

A further embodiment of the invention is shown in Fig. 11 wherein a container wall such as a closure or a can end 110 which is made of deformable material preferably hard temper aluminum alloy, may include

at least one, preferably two, depressible panels 112 which are defined by fracturable junctions 114 in the can end. Panels 112 are designed to be opened by pressing them into a container on which can end 110 is sealed to form a pouring opening and/or a vent in the can end. Fracturable junctions 114 around panels 112 are formed by displacing metal at right angles to the initially undisplaced surface of the metal and squeezing a narrow zone of metal along the fracturable junction. Each fracturable junction 114 in the can end may be C-shaped and may have a bridge of metal 118 between the ends of the line providing a hinge which will prevent complete separation of panels 112 from container end 110. Hinge 118 between the ends of each fracturable junction 114 may be slightly weakened by a shallow scoreline or the like, but may also be unweakened for some applications.

Referring to Fig. 12, it is seen that in this embodiment of this invention top surface 116 of panel 112 adjacent fracturable junction 114 is in approximately the same plane or line-on-line with bottom surface 117 of metal adjacent the scoreline outside the panel. It is further seen in Fig. 12 that a flexible bulge 124 is formed in the can end adjacent each fracturable junction. As will be explained later, bulge 124 facilitates depressing of panel 112 into a can on which end 110 is secured.

The depressible panels 112 are preferably downwardly domed as is illustrated in Fig. 12. Such downwardly domed panels 112 provide maximum resistance to rupture of fracturable junction 114 by high internal pressure in container 120 on which the end is secured, and also provide maximum ease of rupture of the fracturable junctions by force applied externally against the can end. Pressure in container 110 will produce primarily compressive stresses in the residual metal in fracturable junction 114 around downwardly domed panel 112, and the metal can withstand relatively high compressive stresses without failure. But, when external force is applied against container wall 110 in the area of fracturable junction 114, a combination of stresses, including at least some shear stress, will be produced in the residual metal and this combination of stresses, and in particular the shear stress, will rupture the fracturable junction even when the stresses are relatively low in magnitude. Bulge 124 adjacent fracturable junction 114 will flex downward under such externally applied force to cause metal on opposite sides of the fracturable junction to move relative to one another in a plane substantially parallel to the sheet to produce shear force in the residual metal in the fracturable junction.

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Figs. 13 and 14 illustrate a preferred form of tools for producing the further embodiment of the invention. Such tools comprise a vertically movable annular top die 128 and an annular bottom die 130 between which a metal sheet or container wall 132 can be positioned to have a fracturable junction formed in it. The tools further include a vertically movable outer annular doming and coining tool 134 for coining the container wall adjacent the fracturable junction and controlling the direction in which a bulge is formed in the container wall. Although die 134 is illustrated as being separate from die 128, the two dies may be an integral unit. Referring to Fig. 14, which is an enlargement of the dies 128, 130 and 134 at completion of the forming operation, top die 128 has a substantially horizontal bottom surface or face 136, an inner face 138 which is inclined upwardly from face 136 at approximately a 15° angle, an outer face 140 inclined upwardly from the bottom face at approximately a 45° angle, a vertical face 142 extending upwardly from the outer edge of face 140, and a substantially horizontal face 144 extending outwardly from the top of face 142. Bottom die 130 includes a substantially horizontal top surface or face 146, an outer face 148 which is inclined downwardly and away from top face 146 at approximately a 15° angle, an inner face 150 inclined downwardly from the top face at approximately a 45° angle, a vertical face 152 extending downwardly from the outer edge of face 150, and a substantially horizontal face 154 extending from the bottom of face 152.

Faces 140 and 150 on dies 128 and 130 respectively are substantially parallel and overlap each other in a horizontal plane to cause a relatively narrow zone of metal to be squeezed or extruded laterally from between such faces when the dies are closed against sheet 132. Preferably, such lateral flow or extrusion of metal occurs at approximately a 45° angle to the original undisplaced surface of metal sheet 132, and the horizontal overlap of surfaces 140 and 150 is preferably approximately 1/6 to 1/4 of the thickness of the metal sheet 132. Dies 128 and 130 which have been selected for illustration are so dimensioned that in the closed position of the dies faces 136 and 144 on die 128 which oppose faces 154 and 146 on die 130 are vertically spaced a distance of approximately the thickness of sheet 132 to provide a band or zone of relief between the scoring means and the coining means on the dies. The exact spacing of such opposed die surfaces is not considered to be critical to proper functioning of the dies as long as the dies permit the metal in the area between bead 156 on die 134 and side

surface 140 on die 128 to flow with little or no restraint. It is believed that face 144 on die 128 and face 158 on die 134 could be spaced a substantial distance above face 136 on die 128, or could be non-existent, and have little if any effect on the functioning of the dies.

It is a feature of this embodiment that face 140 on die 128 and face 150 on die 130 each have a height in a vertical plane approximately equal to one-half the thickness of the sheet of metal in which the fracturable junction is formed. Limiting the height of each face 140 and 150 to approximately one-half the thickness of the sheet, in combination with relief or lack of restraint against the metal in the area between face 140 and bead 156 is believed to minimize the stresses which are produced in the metal during the weakening process, and thereby facilitate the formation of fracturable junctions in sheet metal which varies in thickness within commercially acceptable ranges.

It is a further feature of this embodiment that die 134 includes means such as coining bead or rib 156 for coining sheet 132 adjacent the fracturable junction which is formed by tools 128 and 130. Rib 156 may be arcuate in cross section as illustrated in Fig. 14, or may also have other configurations which will squeeze metal against bottom die 130. Although it is not fully understood, it is believed that coining metal between rib 156 and face 148 on die 130 causes metal to flow laterally from between the rib and die surface to control the stresses which are produced by dies 128 and 130 in forming a fracturable junction in sheet 132. The height of rib 156 as measured perpendicular to surface 158 on die 134 is preferably in a range of approximately one-quarter to three-quarters of the thickness of sheet 132. Additionally, radii of 0.005 inch, 0.0075 inch and 0.010 inch have been found to work well for rib 156 when forming a weakening line in a hard temper aluminum alloy sheet 0.012 inch thick. Rib 156 is preferably spaced from the fracturable junction which is formed a distance of approximately one to three times the thickness of sheet 132.

In the operation of dies 128, 130 and 134 to form a fracturable junction in a container wall or sheet of metal in accordance with this invention, sheet 132 is positioned between the dies as illustrated in Fig. 13, and dies 128 and 134 are closed or moved as a unit toward die 130 to deform the metal sheet therebetween. Faces 136 and 146 on dies 128 and 130 displace or move metal in sheet 132 at substantially right angles to the original undisplaced surface of the sheet to form a line of

reduced metal thickness in the sheet. When die surfaces 136 and 146 have closed to within approximately 2/3 to 3/4 of the thickness of sheet 132, metal begins to be extruded or squeezed laterally from between faces 140 and 150 on the dies. This lateral extrusion of metal away from the fracturable junction which is being formed occurs substantially simultaneously with completion of the displacement of metal at substantially right angles to the original surface of the sheet, and prevents shearing the sheet between the dies. Such lateral flow of metal is preferably approximately at the same rate as the metal is being displaced at right angles to minimize the chances of such metal being sheared or severed by such right angle displacement.

During the formation of a fracturable junction in sheet 132, rib 156 on die 134 coins metal in a zone adjacent to the fracturable junction to facilitate forming of such a fracturable junction in metal sheets which vary from nominal gauge thicknesses. Coining of sheet 132 between rib 156 and die face 148 squeezes or compresses the metal in the sheet causing lateral metal flow away from coining rib 156. Approximately one-half of such metal flow is toward the fracturable junction which is being formed. It is believed that this lateral flow of metal toward the fracturable junction in some way controls the stresses in the fracturable junction which could cause premature or accidental rupture of a fracturable junction in a sheet which varies from nominal gauge thickness. Coining the sheet along the fracturable junction permits closing of dies 128 and 130 to a position where faces 136 and 146 are approximately line-on-line with a very thin remanance of metal between the dies without forming cracks in the fracturable junction, even when sheet 132 is thinner than nominal gauge. In the absence of such coining, closing dies of this type to line-on-line of the opposing top and bottom surfaces of the dies could cause undesirable cracks or failures in the fracturable junctions which are formed.

It is noted that Fig. 14 illustrates coining on one side only of the fracturable junction which is being formed. It will be apparent to those skilled in the art that such coining could also be effected on both sides of the fracturable junction or on the side of the fracturable junction opposite to that illustrated in Fig. 14. It will also be appreciated by those skilled in the art that the coining rib could be provided on bottom die 130 instead of top die 34 and could be of various cross sectional shapes.

In forming a fracturable junction in sheet 132 with dies 128 and 130, the clearance or relief between faces 142 and 144 on upper

die 128 and faces 152 and 154 on bottom die 130 provides space in which metal from sheet 132 can flow as a result of working the metal on either side of such die relief. This further minimizes the stresses which are produced in the sheet during forming of a fracturable junction in the sheet. Prior to this invention, dies for displacing metal at right angles and extruding metal laterally includes side faces similar to faces 140 and 150 of dies 128 and 130, but the faces of the dies extended at approximately a 45° angle for at least the full thickness of the material in which the fracturable junction was formed. The relief which is provided in dies 128 and 130 in accordance with this invention is believed to reduce the amount of metal flow which is effected by such dies and therefore reduces the stresses which are produced in the metal in the area of the fracturable junction or score. Reduction in the stresses in such metal is believed to permit the formation of fracturable junctions having a minimum of residual metal therein for maximum ease of rupture.

In operation of dies 128, 130 and 134, the depressible panel which is formed will be domed downwardly. Forming a fracturable junction between the dies increases the surface area of metal in the sheet due to the thinning of metal in the area of the fracturable junction, and the increased surface area of metal in the panel defined by the fracturable junction produces the downward dome on the panel. As stated above, such downward dome is preferred for container ends which are to be secured on containers which may have higher-than-atmospheric pressures in them because it provides substantial resistance to rupture of the fracturable junction by such internal pressures and greatest ease of rupture by external force applied against the can end. It will be apparent to those skilled in the art that an upward dome could also be provided on such depressible panel in container ends for other applications.

Figs. 15 and 16 illustrate alternative embodiments of dies which can be used to form a fracturable junction or score in a sheet of metal or other plastically deformable material. Coining dies such as the one illustrated in Figs. 13 and 14 are used with the dies illustrated in Figs. 15 and 16, but are not illustrated. Dies 160 and 162 which are illustrated in Fig. 15 include faces 163, 164, 165 and 166 which are similar to like faces of the dies in Figs. 13 and 14. The dies further include faces 167 and 168 which are disposed at approximately a 10° angle to vertical, and a face 169 on die 160 which is disposed at approximately a 45° angle to a horizontal plane. Face 169 is spaced a substantial distance above faces 163 on die 160 and permits free flow of

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metal in the area between the fracturable junction and the zone of coining.

Dies 170 and 172 illustrated in Fig. 16 include faces 174 and 176 which are curved away from faces 178 and 180. It will be appreciated by those skilled in the art that various other die shapes could also be employed for forming fracturable junctions in accordance with this invention. For example, small radii could be provided on corners 182 and 184 on dies 170 and 172, or on like corners of the dies illustrated in Figs. 14 and 15.

Fig. 17 illustrates another alternative form of tools which can be used, including top and bottom dies 186 and 188 for forming a fracturable junction in a metal sheet and a shaping die 190 for working metal adjacent the fracturable junction which is formed. Die 190 has a substantially flat bottom face 194 which is parallel to face 192 on die 188. Faces 192 and 194 are disposed at approximately a 15° angle to the horizontal plane of the initially undisplaced surface of a sheet metal so that the metal therebetween will be formed at a similar angle. Dies 186 and 190 are shown as two separate dies, but they may also be made as a unit. In the closed position of die 186, 188 and 190, die surface 192 and 194 are preferably spaced a distance approximately equal to the thickness of the sheet being scored. However, dies 188 and 190 may also be closed against the sheet to squeeze the metal between faces 192 and 194. Further, die surfaces 192 and 194 may be more closely spaced outside fracturable junction which is to be formed so that when the dies are closed, the sheet will be squeezed or extruded between such die surfaces toward the fracturable junction. Such squeezing or coining of the metal is believed to control the stresses which are produced in the metal so that a fracturable junction can be formed in metal sheet material having thicknesses which vary from nominal gauge.

Although preferred embodiments of this invention have been illustrated and described, it will be apparent to those skilled in the art that various modifications could be made in the container wall, method and tools without departing from the invention or the scope of the claims appended hereto. For example, the die used for coining or squeezing the metal along the weakening line need not be moved as a unit with the die used to form the fracturable junction. Instead, it is believed that the coining die could be closed against a can end and held against the metal as the scoring dies are moved against the can end. It will also be appreciated by those skilled in the art that this invention can be employed to form

fracturable junctions of a variety of configurations in a variety of container components of deformable sheet material such as closures, can ends and the like.

WHAT WE CLAIM IS:—

1. A sheet metal container component having a wall with at least one inwardly displaceable opening panel therein having an integral rim peripherally terminating in a fracturable junction defining a locus of separation of said opening panel from the adjacent portion of said wall, an integral deflectable portion of said wall projecting outwardly from the general plane of the wall adjacent said junction and terminating in a lip integrally interconnected with the rim of said opening panel and defining therewith the boundaries of said fracturable junction, the rim of said opening panel including an exposed surface terminally intersecting the exposed marginal edge of the lip of said deflectable portion in an exposed corner, said deflectable portion having a portion of the undersurface thereof terminally meeting the undersurface of the outer marginal edge of said rim in predetermined spaced relation with said exposed corner to define therebetween the extent of said fracturable junction, said opening panel being of greater rigidity than said deflectable portion to effect an initiation, in response to digitally applied localized inwardly directed pressure against said deflectable portion or opening panel, of relative displacement of said lip relative to said rim to strain said fracturable junction and induce fracture thereof to permit inward displacement of a separated opening panel.

2. A container component according to claim 1, wherein said separated opening panel is of greater rim size than the size of the opening formed in said wall portion as defined by the inner marginal edge of the lip of said deflectable portion.

3. A container component according to claim 1 or 2, wherein said deflectable portion is inclined from the general plane of said wall portion toward said lip at an angle in the range of 5 to 15 degrees.

4. A container component according to any one of claims 1 to 3, wherein said opening panel is of generally circular configuration and said deflectable portion is annularly disposed in surrounding relation therewith.

5. A container component according to any one of the preceding claims, wherein said opening panel has a center portion which is domed.

6. A container component according to any one of the preceding claims, wherein said wall includes at least two circular opening panels of equal diameter.



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metal in the area between the fracturable junction and the zone of coining.

Dies 170 and 172 illustrated in Fig. 16 include faces 174 and 176 which are curved away from faces 178 and 180. It will be appreciated by those skilled in the art that various other die shapes could also be employed for forming fracturable junctions in accordance with this invention. For example, small radii could be provided on corners 182 and 184 on dies 170 and 172, or on like corners of the dies illustrated in Figs. 14 and 15.

Fig. 17 illustrates another alternative form of tools which can be used, including top and bottom dies 186 and 188 for forming a fracturable junction in a metal sheet and a shaping die 190 for working metal adjacent the fracturable junction which is formed. Die 190 has a substantially flat bottom face 194 which is parallel to face 192 on die 188. Faces 192 and 194 are disposed at approximately a 15° angle to the horizontal plane of the initially undisplaced surface of a sheet metal so that the metal therebetween will be formed at a similar angle. Dies 186 and 190 are shown as two separate dies, but they may also be made as a unit. In the closed position of die 186, 188 and 190, die surface 192 and 194 are preferably spaced a distance approximately equal to the thickness of the sheet being scored. However, dies 188 and 190 may also be closed against the sheet to squeeze the metal between faces 192 and 194. Further, die surfaces 192 and 194 may be more closely spaced outside fracturable junction which is to be formed so that when the dies are closed, the sheet will be squeezed or extruded between such die surfaces toward the fracturable junction. Such squeezing or coining of the metal is believed to control the stresses which are produced in the metal so that a fracturable junction can be formed in metal sheet material having thicknesses which vary from nominal gauge.

Although preferred embodiments of this invention have been illustrated and described, it will be apparent to those skilled in the art that various modifications could be made in the container wall, method and tools without departing from the invention or the scope of the claims appended hereto. For example, the die used for coining or squeezing the metal along the weakening line need not be moved as a unit with the die used to form the fracturable junction. Instead, it is believed that the coining die could be closed against a can end and held against the metal as the scoring dies are moved against the can end. It will also be appreciated by those skilled in the art that this invention can be employed to form

fracturable junctions of a variety of configurations in a variety of container components of deformable sheet material such as closures, can ends and the like.

WHAT WE CLAIM IS:—

1. A sheet metal container component having a wall with at least one inwardly displaceable opening panel therein having an integral rim peripherally terminating in a fracturable junction defining a locus of separation of said opening panel from the adjacent portion of said wall, an integral deflectable portion of said wall projecting outwardly from the general plane of the wall adjacent said junction and terminating in a lip integrally interconnected with the rim of said opening panel and defining therewith the boundaries of said fracturable junction, the rim of said opening panel including an exposed surface terminally intersecting the exposed marginal edge of the lip of said deflectable portion in an exposed corner, said deflectable portion having a portion of the undersurface thereof terminally meeting the undersurface of the outer marginal edge of said rim in predetermined spaced relation with said exposed corner to define therebetween the extent of said fracturable junction, said opening panel being of greater rigidity than said deflectable portion to effect an initiation, in response to digitally applied localized inwardly directed pressure against said deflectable portion or opening panel, of relative displacement of said lip relative to said rim to strain said fracturable junction and induce fracture thereof to permit inward displacement of a separated opening panel.

2. A container component according to claim 1, wherein said separated opening panel is of greater rim size than the size of the opening formed in said wall portion as defined by the inner marginal edge of the lip of said deflectable portion.

3. A container component according to claim 1 or 2, wherein said deflectable portion is inclined from the general plane of said wall portion toward said lip at an angle in the range of 5 to 15 degrees.

4. A container component according to any one of claims 1 to 3, wherein said opening panel is of generally circular configuration and said deflectable portion is annularly disposed in surrounding relation therewith.

5. A container component according to any one of the preceding claims, wherein said opening panel has a center portion which is domed.

6. A container component according to any one of the preceding claims, wherein said wall includes at least two circular opening panels of equal diameter.



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5 7. A container component according to any one of the preceding claims, wherein the upper surface of the rim of said opening panel is in substantially coplanar relation with the undersurface of the lip of said deflectable portion.

10 8. A container component according to any one of the preceding claims, wherein said wall comprises work hardened aluminum alloy which is at least three-quarter hard.

15 9. A container component according to any one of the preceding claims, wherein said opening panel is circular in shape and has a diameter in the range of 1/8 inch to 3/4 inch.

20 10. A container component according to any one of the preceding claims, wherein said fracturable junction interconnects the rim of said opening panel and the lip of said deflectable portion outwardly of the general plane of said wall portion.

25 11. A container component according to claim 1, wherein the rim of said opening panel includes an upper planar surface terminally intersecting a frusto-conical, surface defining the inner marginal edge of the lip of said deflectable portion in the first exposed corner, said lip of said deflectable portion including a planar undersurface disposed substantially coplanar with the upper surface of said rim of said opening panel and terminally intersecting a frusto-conical surface defining the outer marginal edge of the rim of said opening panel in the second corner disposed in predetermined spaced relationship, with said first corner to define, by the overlap therebetween, the extent of said fracturable junction.

40 12. A container component according to claim 11, wherein said planar wall portion includes two displaceable opening panels of circular configuration, each surrounded by a deflectable portion of annular configuration.

45 13. A container component according to claim 11 or 12, wherein said opening panel is inwardly domed.

50 14. A container component according to any one of claims 11 to 13, wherein said frusto-conical surface of the lip of the deflectable portion is disposed substantially parallel to the frusto-conical surface of the rim of said opening panel.

55 15. A container component according to claim 14, wherein each of said frusto-conical surfaces is disposed at an angle of about 45° to the planar surface associated therewith.

60 16. A container component according to any one of claims 11 to 15, wherein said fracturable junction is interrupted to form a hinge element of greater thickness than the fracturable junction.

65 17. A container component according to

any one of claims 11 to 16, wherein the work hardened aluminum alloy forming said planar wall portion has a thickness in the range of 0.010 inch to 0.015 inch.

18. A container component according to any one of claims 11 to 17, wherein said first and second corners have a permitted difference in elevation no greater than 0.001 inch.

19. A container component according to any one of claims 11 to 18, wherein said opening panel is of generally circular configuration and said deflectable portion disposed thereabout is of frustoconical configuration.

20. A container component according to any one of the preceding claims, wherein it has a zone of coining along at least one side of said fracturable junction.

21. A container component according to claim 20, wherein said zone of coining is spaced from the fracturable junction a distance approximately equal to 1 to 3 times the thickness of the metal in the container component.

22. A container component according to claim 20 or 21, wherein the metal between said zone of coining and said fracturable junction has a thickness equal to or greater than the thickness of the initially undeformed container component.

23. A method for the formation of a sheet metal container component according to claim 1 which has at least one inwardly displaceable opening panel and an outwardly projecting deflectable portion disposed in integral interconnected relation therewith by a fracturable junction, said method comprising the steps of: introducing a sheet of metal intermediate a first die member having a first substantially planar metal extruding surface and a second and substantially frusto-conical metal extruding surface defining therewith a corner at the locus of intersection therebetween, and a second die member having a first base surface and a second and substantially frusto-conical, metal shaping surface, and with auxiliary die means disposed on the same side of the sheet as said first die member having a metal shaping base surface facing a generally opposed direction from said first base surface of said second die member and in laterally spaced relation therewith in respect of an axis of displacement of said dies, lineally displacing said first die member towards said second die member to selectively move said first and second surfaces of said first die member into operative proximity with said surfaces of said second die member to engage said sheet and laterally displace portions thereof by the conjoint action of said first and second surfaces of said

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in the forming process in which, according to said first die member, the portion of said sheet metal extruding surface of said first die member is in generally opposed relation with said second die member, and with said first and second corners of said die members laterally spaced from each other, whereby displacement of said die members and said auxiliary die means against a sheet of metal positioned therebetween to a closed die position in which said apex of said corner on said first die member is in substantial alignment with said first base surface of said second die member and said base surface of said auxiliary die means is in longitudinally offset relation with said first base surface of said second die member in the direction of die displacement will displace portions of the surface of said sheet at substantially right angles to the initially undisplaced surface thereof by action of

first and second die members to form said fracturable junction, stopping said die member displacement when the apex of said corner on said first die member is disposed in substantial alignment with said first base, surface of said second die member, and linearly displacing said auxiliary die means towards said second die member to selectively move said base surface thereof into predetermined longitudinally offset relation with said first base surface of said second die member in the direction of die displacement to form said deflectable portion by the conjoint action thereof.

24. A method as set forth in claim 23 wherein said first die member and said auxiliary die means are linearly displaced against the upper surface of said container component to form a substantially planar upper surface on the rim of said opening panel which is substantially coplanar with a substantially planar undersurface on the inner lip of said deflectable portion.

25. A method according to claim 23 or 24, wherein said container component is compressed or coined in a zone along at least one side of the fracturable junction which is formed in the container component.

26. A method according to any one of claims 23 to 25, wherein said container component is compressed or coined outwardly of the opening panel defined by the fracturable junction.

27. A method according to any one of claims 23 to 26, wherein the container component is substantially unrestrained in the dies between said metal extruding surfaces and the zone along which the container component is compressed or coined.

28. Apparatus for forming a sheet metal container component as defined in claim 1 which has at least one inwardly displaceable opening panel and an outwardly projecting deflectable portion disposed in integral interconnected relation therewith by a fracturable junction, comprising: a first die member having a first substantially planar metal extruding surface and a second and substantially frusto-conical metal extruding surface defining with said first surface a corner at the locus of intersection therewith, a second die member having a first base surface and a second and substantially frusto-conical metal shaping surface, and auxiliary die means having a metal shaping base surface facing in a generally opposed direction from said first surface of said second die member and in laterally spaced relation therewith, said first die member and said auxiliary die means being linearly displaceable relative to said second die

member with said first and second surfaces of said first die member in generally opposed relation with said first and second surfaces of said second die member, whereby displacement of said die member and said auxiliary die means against a sheet of metal positioned therebetween to a closed die position in which said apex of said corner on said first die member is in substantial alignment with said first base surface of said second die member and said base surface of said auxiliary die means is in longitudinally offset relation with said first base surface of said second die member in the direction of die displacement will laterally displace portions of said sheet through the conjoint action of said first and second surfaces of said first and second die members to form said fracturable junction, and will form said deflectable portion by the conjoint action of said first base surface of said second die and said base surface of said auxiliary die means.

29. Apparatus according to claim 28, wherein said first die member has a first substantially planar base surface and a second frusto-conical metal extruding surface defining therewith a first obtuse corner at the locus of intersection therebetween, said second and correspondingly shaped die member having a first substantially planar base surface and a second frusto-conical metal extruding surface defining therewith a second obtuse corner at the locus of intersection therebetween, said auxiliary die means having a metal shaping base surface facing in the same general direction as the first base surface of said first die member and disposed in laterally spaced relation with said first base surface of said second die member, said first die member and said auxiliary die means being linearly displaceable relative to said second die member with said first and second surfaces of said first die member in generally opposed relation with said second and first base surfaces respectively of said second die member, and with said first and second corners of said die members laterally spaced from each other, whereby displacement of said die members and said auxiliary die means against a sheet of metal positioned therebetween to a closed die position in which said first planar surface of said first die member is substantially coplanar with said first planar surface of said second die member and said base surface of said auxiliary die means is in longitudinally offset relation with said first surface of said second die member in the direction of die displacement will displace portions of the surface of said sheet at substantially right angles to the initially undisplaced surface thereof by action of



5 said first planar surfaces of said first and second die members, and will laterally extrude portions of said sheet within the locus of displacement thereof through the conjoint action of said first and second surfaces of said first and second die members to form said fracturable junction, and will form said deflectable portion by the conjoint action of said first surface of said second die and said base surface of said auxiliary die means.

10 30. Apparatus according to claim 29, wherein said die members and die means are of generally circular configurations in concentric relation with one another.

15 31. Apparatus according to claim 29, wherein at least one of said first or second corners of said die members is interrupted at a location on the perimeter of the die members to form a hinge element on said displaceable panel having greater thickness than said fracturable junction.

20 32. Apparatus according to claim 29, wherein each of said second surfaces of said first and second die members is disposed at an angle of about 45° to said first surfaces of said dies to extrude metal between said second surfaces at about a 45° angle to the initially undisplaced surface of said sheet of metal.

30 33. Apparatus according to claim 29, wherein said first and second corners of said die members are laterally spaced less than 0.004 inch.

35 34. Apparatus according to claim 28, wherein said metal extruding surfaces of said first and second die members have a height of approximately 1/2 the thickness of the container component to be formed in

40 which the opening panel is provided and each of said die members further having a substantially vertical face extending from the outer edge of said metal extruding surface in a direction away from the container component.

45 35. Apparatus according to claim 34, wherein said apparatus includes means for coining a container component along at least one side of said metal extruding surfaces.

50 36. Apparatus according to claim 35, wherein said coining means comprises a bead having a substantially arcuate cross section.

55 37. Apparatus according to claim 34 or 35, wherein said coining means is provided between said first die member and said auxiliary die means.

60 38. A sheet metal container component, substantially as hereinbefore described with reference to the accompanying drawings.

65 39. A method for the formation of a sheet metal container component according to claim 1, substantially as hereinbefore described with reference to the accompanying drawings.

70 40. Apparatus for forming a sheet metal container component according to claim 1, substantially as hereinbefore described with reference to the accompanying drawings.

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