Description

CUTTING METHOD AND APPARATUS

Technical Field

[0001] The present invention concerns the cutting of the sidewall of a cup-shaped sheet metal can body, closure or similar article. In particular it relates to the cutting of a drawn cup-shaped closure body having an inwardly protruding feature or features at its rim, into a separate ring and shallower cup-shaped article.

Background Art

[0002] Several methods are known by which can bodies are cut (trimmed) to a desired height to produce a separate ring. These methods are used in rotating machinery commonly supplied for example by Belvac Production Machinery and by CarnaudMetalbox Engineering, and are well suited to trimming where the ring is usually discarded, and where the height of the cut ring is usually significantly less than the height of the trimmed can body.

[0003] WO 08053013 A (CROWN PACKAGING TECHNOLOGY, INC.) and un-published patent application EP-08153134.5 describe methods of manufacturing a two-part closure and the resulting two-part closures respectively. To produce such closures requires the cutting of a drawn cup-shaped article close to its end panel, such that the height of the cut ring part is greater than the height of the cut end-part. To manufacture the closures described in these patents, it would be useful for the cup shaped article to have an inwardly protruding curl already formed at the rim before cutting. It would be even better to be able to cut a cup shaped article that also had inwardly protruding lugs.

[0004] Known cutting methods are difficult to use to cut such closures due to the proximity of the closed end of the cup to the cutting tools.

[0005] Most conventional cutting processes use a pair of knives to cut the metal in a rotary scissor-action and may leave undesirable burrs on opposing sides of the cut edge. If similar cutting processes are used on coated metal, then hairs of coating material may be created during cutting and/or subsequent forming of the cut edges.

[0006] Residual stresses in drawn sheet metal parts can result in distortion of the cut parts during cutting. This can cause the cut-edges of the ring and end-parts to deviate from a circular path as cutting progresses around the periphery such that undesirable sharp slivers can be produced.

[0007] The cut edges produced by known rotary cutting methods produce little or no bending inwards or outwards ("flare") of the cut-edge, thus neither increasing nor decreasing the diameter of the wall significantly at the cut-edge. However, if it is desired subsequently to flange or curl either or both the cut-edges inwardly or outwardly, as in the case of producing the closures described in **WO 08053013** A (CROWN PACKAGING TECHNOLOGY, INC.) and EP-08153134, it would be advantageous for the cut-edge already to have a flare in the same direction after cutting.

[0008] Most known cutting apparatus cannot be used to cut a can body having any inwardly protruding rim.

[0009] Other known methods of cutting also have disadvantages. Laser cutting produces vaporised debris, which may contaminate the finished article. Clip trimming as described in **WO 08053013** A (CROWN PACKAGING TECHNOLOGY, INC.) can only be carried out on an article that has no inwardly projecting features on the sidewall.

[0010] The processes of "scoring" and "parting" are known for producing two open-ended cylinders from one open-ended cylinder. This involves firstly producing a linear indentation or "score" on a flat, typically rectangular sheet metal blank. The blank is then rolled into an open-ended cylinder so that the score becomes circumferential part way up the outside of the cylinder, and then the adjacent edges of the blank are joined by welding. The cylinder is then parted by rolling a circular tool around the inside of the cylinder adjacent to the score whilst the outside of the cylinder is supported by a pair of curved rails positioned at either side of the score. However, this method can only be used on a flat sheet metal blank, to produce cylinders which are open at both ends.

Disclosure of Invention

[0011] According to an embodiment~~the present invention~~, there is provided a method of manufacture of a two-part article from a cup formed from a single sheet

metal blank, comprising: inserting a circular cutting ring having a sharp peripheral edge inside the cup; and pressing and rolling an anvil having a curved surface against the outside of the cup, to cause the sharp edge of the cutting ring to penetrate into the wall of the cup to form a "V" shaped groove.

[0012] This cost-effective manufacture of, for example, certain two-part closures or can body and end component combinations from one drawn sheet metal blank thus uses a rotary method (and complementary apparatus) to cut a substantially cylindrical portion of the sidewall of the cup-shaped article ('cup') to an even height. The cutting process according to an embodiment~~of the invention~~ is suitable to cut a cup-shaped article that has an inwardly protruding feature or features already formed on its rim before cutting.

[0013] Advantageously, the cutting process may produce a slight inward (or outward) bend or "flare" to assist subsequent forming of features such as curls to hide or protect the cut-edge. The method according to an embodiment~~of the invention~~ also ensures that the end of the cut coincides with the start of the cut to avoid the formation of slivers. Ideally, the cutting process positions any burrs or weakened coatings that are formed during the cutting process so as to avoid being dislodged by subsequent forming operations.

[0014] The diameter of the cutting ring is smaller than the inside diameter of any curl or the distance between any inwardly protruding lugs or other features below the position of the cut, to allow the cup to be placed over the cutting ring and to allow the cut ring to be removed.

[0015] In a rotating-type machine, one or more circular cutting or profiled rings may be arranged such that their individual axes rotate around a central axis, with the surface of the anvil or parting tool concentric to that central axis.

[0016] In a manually fed or an indexing-type machine, the axis of the circular cutting or profiled ring may be stationary, and the anvil or parting tool may rotate. In this case the anvil or parting tool would have a portion of constant radius, which would contact the cup and a portion of reduced radius to allow space for the cup to be placed over and removed from the cutting disc.

[0017] In either type of machine, the entire cup may be held axially to slide between two close-fitting flat (guiding) surfaces, or the closed end of the cup may be held to slide between an external guiding surface and a guiding surface on top of the cutting ring. Alternatively or additionally, either or both sides of the closed end of the cup may be urged to slide against a flat surface by the application of compressed air, vacuum or magnets. One of the guiding surfaces may be held against the cup by a spring mechanism.

[0018] The angles of the "V" shaped cutting ring may be equal, or may be unequal so as to urge the cup to slide against one of the guiding surfaces in preference to the other. Unequal angles of the cutting ring may also be used to preferentially compress and / or work-harden material on one side of the "V" shaped groove, or to produce a groove or cut shape to suit subsequent manufacturing processes.

[0019] In one embodiment, there ~~invention~~ is provided a single stage process, in which the depth of the groove created by the cutting ring (typically greater than two-thirds of the wall thickness) and the forces created by the penetration angle (the total angle between each side of the cutting ring which is typically between 45 degrees and 90 degrees, and preferably between 50 degrees and 75 degrees) are sufficient to cause the material at the bottom of the groove to split. Splitting will occur because the shape of the cutting ring acts as a wedge.

[0020] A complete circumferential cut is created when the anvil has rolled around the entire periphery of the cup. The single stage process will produce little or no flare.

[0021] The sharp edge of the cutting ring may be prevented from accidentally contacting the anvil during cutting and the depth of the groove may be closely controlled by providing a second ring portion of a slightly smaller diameter than the sharp edge adjacent to it.

[0022] The cut may be kept in one plane and slivers may thus be avoided by limiting the axial movement of the cup. Provided that the axial movement of the cup is limited to less than half the width of the "V" shaped groove, then the end of the cut should meet the start of the cut and slivers should

be avoided.

[0023] Distortion of the cup and the risk of forming slivers may be further avoided if the anvil surface rotates the cup more than once, such that the groove is progressively formed before splitting occurs.

[0024] A flare may be produced at the cut edges if a groove is provided around the anvil to bend the wall during cutting.

[0025] In other preferred embodiments ~~of the invention~~, the method is a two-stage process to cut a ring from a cup-shaped article. In the two stage process, the first stage is the same as the one-stage process, except that the depth of the groove (typically between half and three quarters of the wall thickness) and the forces created by the penetration angle (typically between 45 degrees and 90 degrees, and preferably between 50 degrees and 75 degrees) are not sufficient to cause the material at the bottom of the groove to split. The penetration angle may be reduced from these angles, if it is desired to use a cutting ring with unequal angles. In this process, the reduced thickness of the sidewall at the bottom of the groove is described as the "score-residual".

[0026] The second stage of the two-stage process may comprise inserting a profiled ring having a grooved profile is inserted inside the cup with the centre of the grooved profile opposite the "V" shaped groove in the cup, and pressing and rolling a parting tool having a sharp edge or small edge radius against the outside of the cup opposite the "V" shaped groove in the cup. The penetration of the parting tool into the wall of the cup causes the material at the bottom of the groove to split, and the material either side of the split or "cut-edge" to bend or "flare" inwards.

[0027] The diameter of the profiled ring is smaller than the inside diameter of any curl or the distance between any inwardly protruding lugs or other features below the position of the cut, to allow the cup to be placed over the profiled ring and to allow the cut ring to be removed.

[0028] The length of wall that is bent inwards and the distance it is bent may be optimised to suit subsequent processes by varying any combination of the grooved profile of the profiled ring, the edge radius of the parting tool, the penetration depth of the cutting ring in the first stage to alter the

"score-residual", or the penetration of the parting tool into the profiled ring in the second stage.

[0029] A complete circumferential cut is created when the parting tool has rolled around the entire periphery of the cup. The amount of "flare" may be kept even around the periphery of each cut part by limiting the axial movement of the cup.

[0030] The amount of flare may be further kept even if the parting tool rotates the cup more than once, such that the flare is progressively formed before splitting occurs.

[0031] Each side of the groove in the profiled ring may be symmetrical, or may be asymmetrical so as to urge the cup to slide against one of the guiding surfaces in preference to the other or to create a different flare on the cut ring to the flare on the cut end-part. Similarly the groove in the profiled ring may be positioned centrally or offset in relation to the "V" shaped groove in the cup. The profile of the parting tool may also be symmetrical or asymmetrical.

[0032] In an alternative second stage process, the cup may be progressively rolled and "pinched" between two rails or between a rail and a circular disc each having a penetrating sharp edge or small radius edge. The penetration of the edges into the wall of the cup causes the material at the bottom of the groove to split, and the material either side of the split or "cut-edge" to bend or "flare" inwards.

[0033] In another embodiment, a ring is inserted inside the cup to one side of the "V" shaped groove, and a parting tool is pressed or rolled against the outside of the cup to the other side of the "V" shaped groove. The penetration of the parting tool into the wall of the cup causes the material at the bottom of the groove to split, and the material to one or both sides of the split or "cut-edge" to bend or "flare" inwards.

[0034] The diameter of the ring is smaller than the inside diameter of any curl or the distance between any inwardly protruding lugs or other features below the position of the cut, to allow the cup to be placed over the ring and to allow the cut ring to be removed.

[0035] The length of wall that is bent inwards and the distance it is bent may be

optimised to suit subsequent processes by varying any combination of the profile of the ring, the profile of the parting tool, the penetration depth of the cutting ring in the first stage to alter the "score-residual", the penetration of the parting tool into the ring in the second stage or the axial distances of the ring and the parting tool from the "V" shaped groove.

[0036] A complete circumferential cut is created when the parting tool has rolled around the entire periphery of the cup. The amount of "flare" may be kept even around the periphery of each cut part by limiting the axial movement of the cup.

[0037] The amount of flare may be further kept even if the parting tool rotates the cup more than once, such that the flare is progressively formed before splitting occurs.

[0038] In yet another embodiment, the second stage is a repetition of the first stage, but with a cutting ring or anvil of a different profile to complete the cut.

[0039] In any of the two-stage embodiments, it is not necessary to carry out the second stage immediately after the first stage, and other manufacturing steps may be carried out between each stage if desired.

[0040] Other features such as curls, beads or embossing may be rolled or formed on, or materials such as lubricants or corrosion-resistant materials may be applied to the cup at the same time as the first stage or second stage is being carried out.

[0041] Lubricants or other materials may be delivered or applied to parts of the apparatus and transferred to the cup during operation of the apparatus. Lubricants or other materials may be applied to the "V" shaped groove between the first and second stage.

[0042] The embodiments have~~invention has~~ been described as currently preferred to manufacture a two-part metal closure, having a groove formed on the inside of the cup wall and the cup wall being penetrated by a parting tool or rails from the outside. However, it is also possible to form the groove on the outside of the wall and to break the material at the bottom of the groove by penetration from either the inside or the outside in order to suit subsequent forming processes for other products.

[0043] Other products that may be manufactured using the methods described include but are not limited to drawn can and end combinations, drawn can and ring combinations and drawn end and ring combinations. Can bodies may also be trimmed using the methods described.

[0044] The apparatus described for any of the embodiments may include means of driving the working surfaces of the cutting ring and anvil, or of the ring and parting tool, at specific relative speeds.

[0045] Alternatively or additionally, the apparatus may include means of sucking and / or blowing any debris from the cut edges. This is particularly useful in the case of cups made from coated material, where hair-like pieces of coating may detach during cutting or forming of the "V"-shaped groove.

[0046] The quality of products manufactured using the cutting methods described is improved because the subsequent forming operations can be carried out with fewer defects, and the ability to use thinner and more cost-effective materials without causing defects is increased.

[0046a] According to a first aspect, there is provided a method of manufacture of a two-part article from a cup having a sidewall and integral base, formed from a single sheet metal blank, the method comprising: placing the cup over a circular cutting ring having a sharp peripheral edge; and pressing and rolling an anvil having a curved surface against and around the outside of the cup, to cause the cup to rotate and to cause the edge of the cutting ring to penetrate into the sidewall of the cup to form a continuous circumferential "V" shaped groove.

[0046b] According to a second aspect, there is provided an apparatus for carrying out the method according to the first aspect, in which one or more cutting rings are arranged for rotation about a central axis and the anvil is concentric to that axis.

[0046c] According to a third aspect, there is provided an apparatus for carrying out the method according to the first aspect, in which the axis of a central cutting ring is stationary and the anvil rotates, the anvil having a portion of constant radius for contacting the cup and a portion of reduced radius to allow space for the cup to be placed over and removed from the cutting ring.

Brief Description of Figures in the Drawings

[0047] Preferred embodiments of the invention will now be described by way of example only, with reference to the drawings, in which:

[0048] Figures 1a, 1b, 1c and 1d are side, top, sectional and perspective views of a cup;

Figures 2a, 2b, 2c and 2d are a sectional view of a cut end-piece, a sectional view of a cut ring and enlarged detailed partial sectional views of their respective cut edges;

Figures 3a and 3b are a sectional view and an enlarged detailed partial sectional view of a scored cup;

Figures 4a, 4b, 4c, and 4d are a sectional view of a parted end-piece, a sectional view of a parted ring and enlarged detailed partial sectional views of their respective parted edges;

Figures 5a and 5b are perspective and side views of a manually operated apparatus used to score a cup;

Figures 6a, 6b, 6c and 6d are a sectional view of a manually operated apparatus being used to score a cup, enlarged detailed partial sectional views of the scoring tools and a sectional view of a manually operated

apparatus being used to score a cup, sectioned in the plane of the score;
Figures 7a, 7b and 7c are a sectional view of a manually operated apparatus being used to part a cup and enlarged detailed partial sectional views of the parting tools;
Figure 8 is a schematic view of an alternative arrangement to score cups;
Figure 9a, 9b, 9c, and 9d are perspective, top, sectional and enlarged detailed sectional views of an alternative arrangement to part cups;
Figures 10a, 10b, and 10c are a sectional view of a manually operated apparatus being used to score a cup, and enlarged detailed partial sectional views of the scoring tools; and
Figures 11a, 11b and 11c are a sectional view of a manually operated apparatus being used to part a cup and enlarged detailed partial sectional views of the parting tools.

Mode(s) for Carrying Out the Invention

[0049] Figures 1a to 1d show a cup 1 comprising an end 2 and integral sidewall 3. The end 2 is profiled into beads 4 and centre panel 5 during the cupping process (see figure 1b and section through A-A in figure 1c). The sidewall 3 terminates with an inward curl 6 which is best seen in figure 1c.

[0050] Figure 2 shows the cut end piece 10 (figure 2a) and cut ring 11 (figure 2b) from a single stage process. Their respective cut edges 12 and 13 are shown in figures 2c and 2d.

[0051] The two stage option of figures 3 and 4 first forms a score 15 in sidewall 3 towards the end 2 with a 'V'-shaped cut between half and three quarters of the wall thickness having a total internal angle 16 of about 60° (degrees). When the end piece 2 of figure 4a is parted from sidewall (ring) 3, the parted edges 17 and 18 are flared inwardly

[0052] A manual cutting or scoring apparatus 20 is shown in perspective and side views respectively in figures 5a and 5b. The apparatus comprises a cutting ring 21 positioned below a cut-out of top plate 22. Beneath the top plate 22, an anvil 25 can be seen in the side view of figure 5b.

[0053] The shape of the anvil 25 can be better seen in figure 6d. The anvil 25 has a portion of constant radius and also a portion of reduced radius coincident with the cut-out of top plate 22. The length of the constant radius portion of

the anvil 25 is greater than the circumference of the cup 30. Handle 26 is connected by bolts to the rotating anvil 25 and top plate 22.

[0054] In the sectional view of the scoring apparatus in figures 6a, 6b and 6c, a cup 30 has been placed over a lower guide surface 23 and an upper guide surface of top plate 22 traps the cup 30 in position over cutting ring 21. As the handle is rotated, the anvil 25 turns until it pushes cup 30 against the edge 24 of cutting ring 21. The cutting ring edge has an angle of 60°-70° (degrees), which forms a corresponding groove in the cup 30. The rotation of the constant radius portion of the anvil 25 rotates the cup 30 and cutting ring 21 about their respective axes, such that the cup 30 revolves at least one full turn.

[0055] Whilst the top plate 22 is connected to and rotates with the anvil 22 for convenience of loading the cup through the cut-out, an upper guide surface 22 may be provided by any flat surfaced part attached to the apparatus adjacent to the cup in the position shown in figure 6b.

[0056] The depth of the groove may be controlled by adjusting the distance between the shafts 27 and 27', to which the cutting ring and anvil are mounted. In the apparatus of fig 6a, these shafts run in bearings 28 which are mounted in housings 29 either or both of which may have inside diameters that are eccentric to their outside diameters. Rotating such an eccentric housing will alter the distance between the shafts.

[0057] The depth of the groove may be further controlled by the radius of the depth-setting ring 27 in relation to the radius of the cutting ring 21. If the depth of the groove is sufficient, the bottom of the groove will be split by the cutting ring edge 24, and the cutting will be complete in a single stage. If the depth of the groove is shallow and there is a sufficient residual thickness of metal, then cutting is completed using the parting apparatus 40 of figure 7.

[0058] In another version of this embodiment the anvil may have two portions of constant radius, each having sufficient chordal length to drive the cup through at least one revolution. The first portion to contact the cup would have a slightly smaller radius than the second, such that a shallow groove would be formed by the first portion and would be deepened by the second

portion. In this version, the distortion of the cup during forming of the shallow groove would be reduced, and this groove would then provide guidance for the cup to the cutting ring during deepening by the second portion. Such an apparatus might also be used to complete the cutting of the cup if the second portion of the anvil deepened the cut so as to cause it to split.

[0059] This scoring stage produces a groove which is then parted by the apparatus of figure 7. The cutting edge 24 of figure 6c produces a circumferential groove on the inner sidewall 32 of cup 30. In the parting apparatus 40, parting tool 42 pushes and enters the outside sidewall 34 of cup 30 adjacent the groove 15 to split the bottom of the groove and produce a slight inward bend or flare 36.

[0060] The penetration distance of the parting tool 42 into the cup wall may be controlled by adjusting the distance between the shafts 68, 68', to which the supporting annuli 44 and parting tool 42 are mounted. In the apparatus of fig 7a, these shafts run in bearings 68 which are mounted in housings 69 either or both of which may have inside diameters that are eccentric to their outside diameters. Rotating such an eccentric housing will alter the distance between the shafts.

[0061] Supporting annuli 44 enable metal to be formed around radii at each apex 45 as parting tool 42 moves radially inwardly. This assists any subsequent forming operations which are to be carried out on the cut cup or ring, such as curls, seams or flanges. By using this apparatus, the cut is formed completely circumferential, with the end of the cut accurately positioned so as to coincide with the start of the cut. This ensures that the formation of slivers of metal is avoided.

[0062] In another version of this embodiment, the parting tool 42 may have two portions of constant radius, each having sufficient chordal length to drive the cup through at least one revolution. The first portion to contact the cup would have a slightly smaller radius than the second, such that a shallow indentation would be formed by the first portion and would be deepened by the second portion to cause the bottom of the groove to split. In this version, the flare would be formed more evenly around the periphery of the

cut edges, especially where the split starts and finishes.

[0063] An alternative scoring arrangement for rotary movement of the cup 1 could carry a series of cups supported by scoring or cutting mandrel 46 rolling the cups along a curved rail 47, which acts as the anvil. This arrangement is shown in figure 8. A similar arrangement may be used for parting.

[0064] The alternative parting apparatus 50 of figure 9 comprises a bottom plate 51 and guide rail 52, a fixed outer parting rail 53 having an edge 54 and a rotating parting wheel 55 having an edge 56. The cup 30 is introduced between the rail 53 and wheel 55. The cup is held in one plane by the close fit of bottom plate 51 and guide rail 52. The diameter of the cup 30 is slightly less than the difference between the radii of the edges 54 and 56, and thus the cup is both driven around the apparatus as indicated by the arrow, and the sidewall is progressively indented to form a flare 36 and is split to form a cut end piece 10 and cut ring 11.

[0065] An additional supporting ring or rings may be attached to either or both sides of the parting wheel, and additional supporting rails may be attached to either or both sides of the outer parting rail, to contact and help drive the cup around the apparatus during parting

[0066] The scoring apparatus of figures 10a, 10b and 10c shows additional and alternative features to the scoring apparatus of figures 6a, 6b and 6c. In figure 10, the rim (70) of the cup (30) is held against a planar surface (71), by applying suction to the inside of the cup through the channel (72). Rotation of the handle (26) drives both shafts (27 and 27') via wheels (73 and 73'). This arrangement avoids skidding of the cup, and ensures complete formation of the "V" shaped groove around the cup.

[0067] Application of a lubricant to the cutting rings of either figure 6 or figure 10, before the cup is placed in the apparatus may improve the life of the cutting ring and assist subsequent performance in manufacturing and use.

[0068] The parting apparatus of figures 11a, 11b and 11c shows additional and alternative features to the scoring apparatus of figures 7a, 7b and 7c. In figure 11, the scored cup (30) is able to rotate and slide between planar surfaces (81and 82). Suction is applied via interconnecting channels (85, 86), which pulls the rim of the cup (30) against planar surface (81).

[0069] Rotation of the handle (26) brings the parting tool (83) into contact with the outer sidewall of the cup, just above the "V" shaped groove, and pushes the inner sidewall of the cup against the ring (84) just below the "V" shaped groove. The shearing action of the parting tool and ring splits the cup (30) into a cut end piece (10) and a cut ring (11). Rotation of the handle (26) rotates the parting tool (83) and rotates the ring (84), cup (30), and surface (81) via the shafts (27 and 27') and wheels (73 and 73'). This arrangement avoids skidding of the cup, and ensures complete cutting around the cup. Air that is sucked through the gap that is formed between the cut end piece (10) and the cut ring (11) carries away any debris released during cutting through the interconnecting channels (85, 86). Whilst figure 11 shows a ring inside a cup below a parting tool outside a cup, it is equally possible to position a ring inside a cup above a parting tool outside a cup.

[0070] The apparatus of figure 6 or figure 10 could be used twice in any combination – firstly to form a groove using one cutting ring, and secondly to complete the cut by splitting along the groove using another cutting ring.

[0071] Further methods of achieving even cutting without risk of tearing material are possible within the scope of the invention, including for example combinations of any of the methods and apparatus described.