

[54] CONTAINER BODY AND A METHOD OF FORMING THE SAME

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abandoned.

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[51] Int. Cl. **B21d 51/00**

[58] Field of Search..... 113/120 A, 120 H,
113/7 R, 7 A; 220/70; 72/348

[57] **ABSTRACT**

An aluminum container body and a method of forming the same by ironing the side wall of a drawn cup to thin and lengthen it, and reforming the bottom end wall of the ironed cup to form therein an upwardly domed central portion connected through a substantially vertical wall section and an outwardly and upwardly tapered shoulder into the side wall of the can body. The ironed can body may have a protective coating applied to its inner surfaces and cured thereon prior to reforming the end wall.

[56] **References Cited**

UNITED STATES PATENTS

3,406,554 10/1968 Frankenberg..... 113/7 R

6 Claims, 6 Drawing Figures

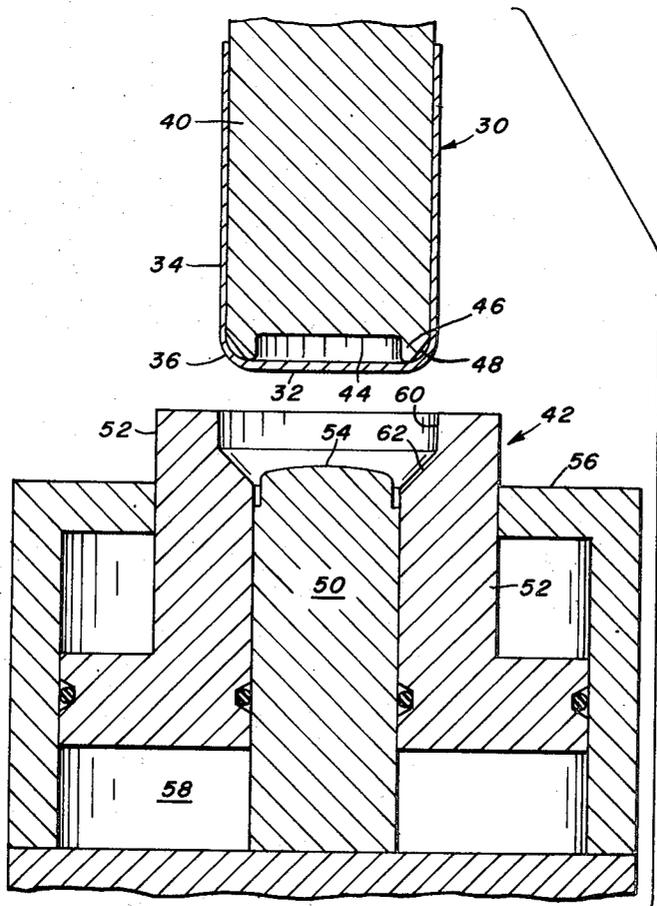


FIG. 2.

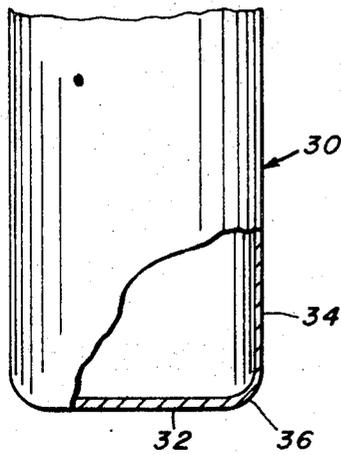


FIG. 1.

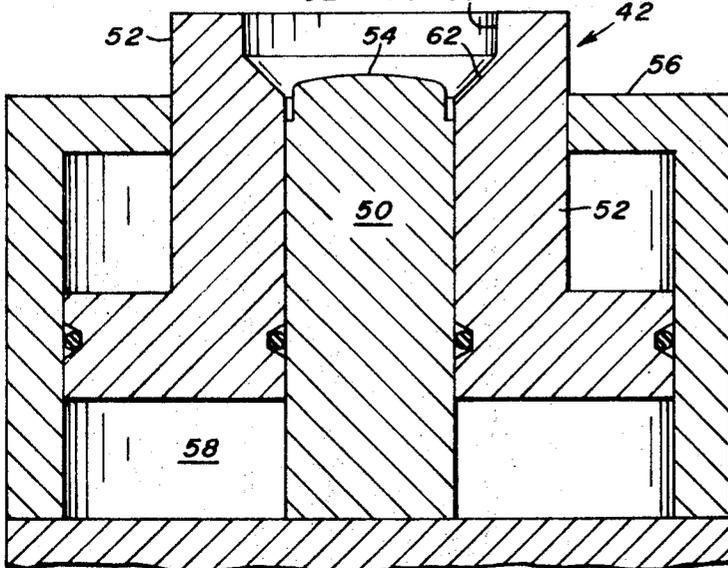
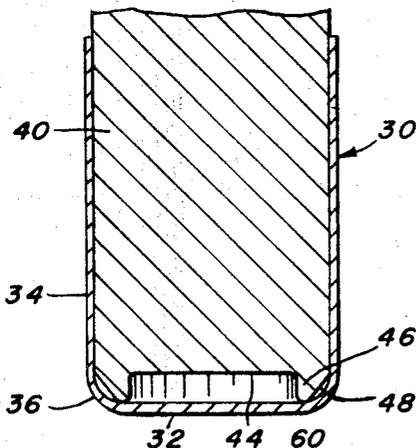
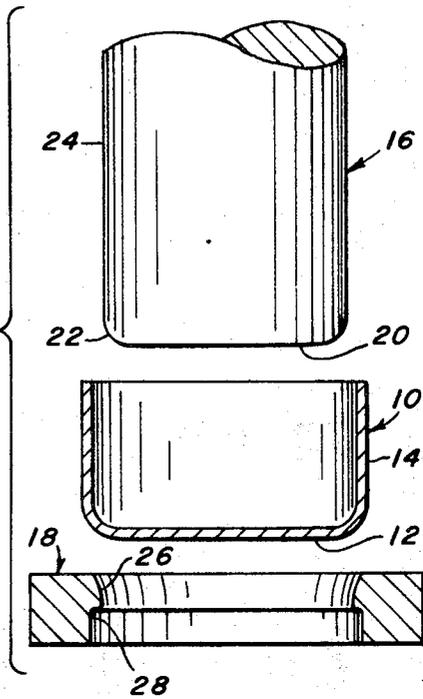


FIG. 3.

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CONTAINER BODY AND A METHOD OF FORMING THE SAME

This is a continuation of application Ser. No. 856,331, filed Sept. 9, 1969, now abandoned.

BACKGROUND OF THE INVENTION

As shown in U.S. Pat. No. 3,402,554, it is well known to iron the side wall of a drawn cup to thin it and thereby extend the length of the cup, and to reform the end wall of the ironed container to improve its resistance to outward bulging which may result from high pressures in the container. By ironing the side wall of the container and forming a pressure resistant end wall thereon, the formed container may be of a relatively thin gauge and light in weight. It is desirable, however, to further reduce the weight of drawn and ironed containers without sacrificing the strength of such containers.

SUMMARY OF THE INVENTION

The invention provides a method of forming a light weight container by ironing the side wall of a drawn aluminum cup and thereafter reforming the bottom end wall of the ironed cup to form an upwardly domed central portion therein connected through a substantially vertical wall section to a rim or shoulder which tapers into the side wall of the can body. Small radii may be provided in the end profile to connect the vertical wall section with the central domed portion and with the tapered shoulder. The drawn cup may be made of a hard temper aluminum alloy, and an interior protective coating, an exterior decorative ink and an overvarnish may be applied and cured on the ironed cup prior to forming the end profile thereon. By this method, a very light weight container body may be formed which has substantial resistance to outward bulging of the end wall of the container.

Accordingly, an object of the invention is to provide a method of forming a light weight, high strength container body.

Another object of the invention is to provide an improved light weight container body.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects and advantages of the invention will be more fully understood and appreciated with reference to the following description and drawings appended thereto in which:

FIG. 1 is a sectional elevation view of an ironing punch, drawn aluminum cup and ironing ring;

FIG. 2 is an elevation view in partial section showing an ironed container body;

FIG. 3 is a sectional elevation view of the ironed container body of FIG. 2 positioned on a punch prior to reforming the end wall of the container against a reforming die;

FIG. 4 is an enlarged sectional elevation view similar to FIG. 3 showing a container body in the dies during reforming of the container's end wall;

FIG. 5 is a view similar to FIG. 4 showing completion of reforming of the container's end wall; and

FIG. 6 is an elevation view in partial section showing a container body with an end profile formed thereon.

DESCRIPTION OF A PREFERRED MODE

Referring to the drawings, FIG. 1 illustrates a drawn cup 10, preferably formed from hard temper aluminum

alloy, having an end wall 12 and a side wall 14. Preferably, cup 10 is made of an aluminum base alloy in a state resulting from cold reduction, e.g. rolling, of approximately 80 percent of the thickness of fully recrystallized, e.g. annealed, stock known as H19 temper. An ironing punch 16 for moving cup 10 through at least one ironing ring 18 has a forward end 20 for pushing against end wall 12 of the cup 10, and has a rounded corner 22 between its forward end 20 and its side 24. Punch 16 may be hollow to receive a mandrel, not shown, and the end 20 thereof may be centrally recessed to receive means such as a nut, also not shown, for securing the punch to the mandrel and to an ironing press. The radius of rounded corner 22 of punch 16 is large enough to distribute the force of punch 16 against cup 10 around the corner of the cup and thereby avoid high stress concentration at the corner which could tear or rupture the metal along such corner during ironing, but is also small enough to effect ironing of a maximum length of side wall 14. With an excessively large radius at corner 22, an excessive amount of metal in cup 10 would be formed around the radius and not be disposed far enough outwardly to bear against the working surfaces of ironing ring 18 to be thinned during ironing. An excessively large radius at corner 22 may also cause wrinkling around the corner of the container bottom when the end profile is formed. For a two and one-half inch diameter can, a corner radius of approximately one-quarter inch has been found to work well.

Ironing ring 18, selected for illustration, has an ironing face 26 and a relief portion 28 therebelow, but may be of a variety of other configurations known in the art. Preferably, ironing ring 18 is made of carbide or high carbon steel, is set in a reinforcing ring, not shown, and has an inside diameter a few thousandths of an inch less than the diameter of punch 16 plus the double thickness of side wall 14 of cup 10 to squeeze or iron side wall 14 as cup 10 is moved through ring 18. Cup 10 has an inner diameter slightly larger than the outer diameter of punch 16 so that the punch can be readily moved into cup 10 and the air in the cup be exhausted therefrom. A difference of approximately 0.025 inch in such diameters has been found to be adequate for such purposes. A redraw ring, not shown, may be provided anterior to the ironing ring or rings to redraw cup 10 against punch 16 prior to moving through the ironing ring. FIG. 2 shows a container body 30 after ironing. Container 30 has a substantially flat end wall 32 and a side wall 34 having a thickness less than the thickness of end wall 32, and a rounded corner 36 at the junction of the end wall and side wall.

After the side wall of cup 10 has been ironed, an interior protective coating and exterior decoration in the form of ink and an overvarnish may be applied on the ironed cup and cured thereon. The interior coating is adapted to protect the contents of container 30 against reaction with the metal of the container, and may be applied to the interior surfaces of the ironed container, by spraying or the like as is well known in the art. Coatings for such product protection may be any of a variety of known thermosetting compositions including the epoxy, vinyl and acrylic resins, among others. The decoration for the exterior surfaces of the container may be applied by means of rollers, and an overvarnish sprayed, brushed or rolled thereover. It is noted that such decoration can be applied to substantially the full

length of the side wall of the ironed container body to the top of rounded corner 36 thereon. The protective coating and overvarnish can be cured on a container by controlled heating of the same, for example, by controlled heating in an oven, not shown, or by other means and methods well known in the art. Such curing may be effected at a temperature in the range of 300° to 600°F or greater, maintained for 2 to 30 or more minutes. Controlled heating of a container 30 reduces the temper of, or partially anneals, the metal in the container, with the higher temperatures and longer curing times effecting greater reductions in the temper of the metal container. Generally speaking, a harder temper alloy before curing, will also usually result in a harder final temper alloy after heating at a particular temperature for a specified time. Different alloy will, of course, react differently to heat. Commencing with a typical aluminum alloy in a full hard condition, it has been found that curing of a protective coating thereon by heating it to approximately 400°F for 20 minutes will reduce the temper and yield strength of the alloy by approximately 15 percent with corresponding increase in the workability of the metal. With more rapid curing, the reduction in temper may be in the range of 5 percent or less.

While it is desirable to have a coated container having a hard temper, the present invention takes advantage of the reduction in temper of the metal during curing of coatings thereon, regardless of the degree of such reduction in temper, by forming the end profile on the can after such curing. By forming the end profile after heating the container to cure a coating thereon, the softer or partially annealed metal is more easily formed into a rigid, pressure resistant profile having small radii in its configuration, without fracture or rupture of the metal in the profile. Coating the interior surfaces of the can prior to forming the end profile also assures complete coating of the surfaces since the surfaces are all well exposed, with no sharp corners or vertical interior walls as exist in a formed profile. Furthermore, the interior and exterior coatings act as lubricants for forming the end profile and may reduce or eliminate the need for additional lubricants which would have to be removed after forming of the profile. The coatings also reduce or eliminate metal build-up on the reforming tools.

After the coating or coatings have been cured on the surfaces of container 30, the end of the ironed container body 30 is reformed by means of a reforming punch 40 which is moved into container body 30 and the body moved against a reforming die 42 as illustrated in FIGS. 3 through 5. Reforming punch 40 preferably has a diameter slightly less than the inside diameter of container body 30 so that the punch can be readily moved into the container body. In the practice of the invention, it has been found that a difference of approximately 0.010 to 0.020 inch in the diameters of the punch 40 and container body 30 is sufficient for insertion of the punch into the container body without difficulty. Punch 40 has a recessed end 44 with an annular rim 46 therearound which tapers into the side of the punch at 48. Reforming die 42 comprises a central seat portion 50 and an annular ring 52 therearound. Seat portion 50 is in the form of a cylinder having an upwardly domed end 54 for forming end wall 32 of container 30 inwardly into recess 44 in punch 40, and is rigidly supported. Annular ring 52 is positioned in an

enclosure 56 around its base which forms an air chamber 58 under ring 52. Air chamber 58 is sealed and has sufficient air pressure therein, approximately 40 pounds per square inch gauge for a ring 52 having the bottom surface area of the preferred embodiment, to resiliently support ring 52. Springs or other resilient means could be used in lieu of the air support for ring 52. As illustrated, ring 52 has a throat portion 60 for containing or restraining side wall 34 of container 30 during forming of an end profile, and an inwardly tapered shoulder 62 for forming the end wall of container 30 against punch 40. Tapered shoulders 62 on ring 52 and 48 on punch 40 are parallel, and in the preferred embodiment form an angle A of 53° with the horizontal (FIG. 5). Inasmuch as throat 60 does not work or form side wall 34 of container 30, but only restrains it from bulging, the throat has a diameter slightly larger than the diameter of punch 40 plus the double thickness of the side wall of container 30 to assure a small clearance therebetween.

When punch 40 with container body 30 thereon is moved against reforming die 42, end wall 32 is drawn upward into recess 44 by seat 50 before rounded corner 36 on container body 30 is completely flattened between tapered shoulders 48 and 62. As shown in FIG. 4, this permits the slack metal over tapered shoulder 48 on punch 40 to be drawn inwardly by seat 50 into the center of the end profile on container 30. Utilizing the slack or extra metal around corner 36 in forming the upwardly domed central portion of the end profile facilitates the formation of a vertical wall section and sharp radii in the end profile as will be hereinafter described. If rounded corner 36 were completely flattened and squeezed between die shoulders 48 and 62 prior to at least partial drawing of end wall 32 into recess 44, the slack metal at this corner would be driven or forced up the side of punch 40 and could not be drawn into the center of the end profile by seat 50. Drawing of such slack metal into the upwardly domed central portion of the end profile is assured by positioning the domed end 54 of seat 50 by means of die stops and controls, not shown, so that it contacts end wall 32 either approximately simultaneously with, or prior to, contact of tapered die shoulder 62 against corner 36 on can body 30.

After the slack metal in corner 36 is drawn into the center of the container end, further travel of punch 40 completely flattens and squeezes corner 36 between tapered die shoulders 48 and 62 to form a tapered shoulder 64 on the container. Thereafter, with tapered shoulder 64 tightly held and restrained between die surfaces 48 and 62, annular ring 52 moves downward with punch 40. The final travel of punch 40 draws the metal in the end wall tightly around domed end 54 of the punch and forms an upwardly domed central portion 66 and a vertical wall section 68 in the end profile. Two small radii 70 and 72 at the ends of wall section 68, connect such section with shoulder 64 and central domed portion 66 (FIG. 6). Wall section 68 may be of varying lengths but it is always relatively short and only a few thousands of an inch long to minimize loss of container volume. A third small radius 74 is also formed between shoulder 64 and side wall 34 of container 30.

There is little, if any, thinning of the end wall of the container during drawing of the metal over seat 50. The additional metal required for forming upwardly domed central portion 66 comes from the slack metal in cor-

ner 36 as shown in FIG. 3 prior to reforming of the end wall. Referring to FIG. 6, the thinner gauge of container side wall 34 begins at least contiguous container shoulder 64, and preferably extends into such shoulder 64. This is achieved through the use of a reasonably small radius on ironing punch 16 to form a similar radius on container corner 36 during ironing, and drawing of slack metal around corner 36 into the center of the end profile rather than pushing such metal up the side of the punch during reforming. Maximum Maximum of the metal is thereby effected to strengthen the end profile of the container body. Moreover, since the side wall of container body 30 was decorated to the top of corner 36 on cup 30 prior to forming the end profile thereon, such decoration will extend at least to the top of tapered shoulder 64 of the formed profile, and preferably extends around radius 74 and into shoulder 64 to give such a container an aesthetically pleasing appearance. After the end wall of the container body is reformed, punch 40 is moved upward and the container body is removed therefrom. Container body 30 is then ready for necking, flanging, and other operations to be performed before final use.

In reforming the end of container body by the present invention, tapered shoulder 64 effectively reduces the area of end wall which must withstand the internal pressures of the container. The smaller the area of the end wall that faces upwardly against such internal pressures, the less will be the total force against such end wall which could cause the end wall to dome outwardly. If, however, the can end tapers too far inwardly, the can may not have satisfactory stability inasmuch as a can having too small a diameter for the rim on which it sits may fall over when tilted on a relatively small angle. Accordingly, a base diameter has been selected which will provide both stability and strength.

Among the advantages of the present invention, it is believed that straight angular section or leg 68 with relatively small radii 70 and 72 connecting the section with shoulder 64 and domed portion 66 provide rigidity to the end wall to prevent flexing or bulging thereof. Inwardly domed portion 66 acts as an arch to resist outward bulging. As an example of a container body formed by the present invention, cans for containing 12 ounces of liquid, 4.812 inches in height and 2.675 inches in diameter were formed from a hard temper aluminum alloy 0.012 inch thick, and end profiles were formed on the cans having a base angle A on taper 64 as shown in FIG. 4 of 53°, radii 70 and 72 of 0.04 inch and a base diameter of 2.03 inches. Side wall 34 of these cans was approximately 0.0045 inch thick, starting approximately 0.125 inch below radius 74 on side wall 34. These can bodies had good stability when filled with liquid and withstood internal pressures in the range of 90 to 95 p.s.i.g. without outward bulging of the end profile.

As presently appreciated, the biggest advantage of this development is that it facilitates the production of very light weight can bodies having substantial end wall strength against outward bulging or doming. The light weight of the can bodies is primarily a result of the ability to use a thinner gauge metal for forming the drawn cup from which the can bodies are formed. Using a thinner gauge metal results in a thinner gauge in the bottom of the container body produced therefrom, as well as a thinner gauge in the side wall of the container body. Prior to this invention, drawn cups for aluminum

cans were formed from sheet aluminum of 0.016 inch gauge or thicker in order to produce strong enough end walls on the cans as provided by the relatively thick gauge of metal in the end walls, whereas the present invention permits the use of aluminum sheet in the range of 0.0012 to 0.0014 inch, depending on the alloy and temper, for producing cans having a high resistance to bulging of the end walls thereof. Thicker sheet can also obviously be used, but such thicker sheet is not necessary for producing a can body of the desired strength. The present invention makes the use of thinner sheet metal possible by ironing the can body using a first punch, and then forming an end profile on the can body using a second forming punch. By using two separate punches, the punch which forms the end profile can have much sharper radii and form a much stronger profile structurally than it could if it were to be employed both in the ironing operation and the forming operation. By using two separate punches, the slack metal around the corner on the ironed can body on the first punch can also be reformed into the final end profile which is formed on the second punch as discussed above. The increase in the structural strength of the profile produced by such forming permits the use of a thinner gauge of metal in the end wall and therefore a thinner gauge for the sheet from which the containers are formed.

The present invention further permits the use of a thinner gauge sheet from which container bodies are formed by taking advantage of the reduction in the temper of the hard temper alloy during curing of the coating on the container body. By forming the end profile after such curing, the end profile can be formed with a vertical wall section therein and small radii which increase the strength of the end profile against outward doming. If the end profile were formed prior to curing, the harder uncoated metal could not be formed into as strong a profile, and the metal would have to be thicker in order to resist pressures in the container without bulging. Forming after curing also effects an increase in, or recovery of, temper of the metal. For example, a can body originally in a full hard condition which is heated during curing, with an attendant reduction in the temper of the metal by approximately 15 percent, will have the metal in the critical areas which are worked, such as around radii 70 and 72, hardened or re-tempered to approximately 90-95 percent of the original full hard condition when the can end profile is formed after such curing. Consequently, with the stronger profile and recovery of part of the metal strength which was lost during curing, a thinner end wall will have as much resistance to outward bulging as did many previously formed end walls of substantially greater thickness. By way of comparison, the twelve ounce cans described above which were formed by the method of present invention using 0.012 inch thick sheet weight approximately 26 pounds per 1,000 cans and have side wall thicknesses averaging 0.0045 inch, whereas 12 ounce aluminum cans presently on the market with the same performance with regard to internal pressures, weigh 34 pounds or more per 1,000 cans and have side wall thicknesses of 0.006 inch or more. Twelve ounce cans formed in accordance with the invention from 0.014 inch aluminum sheet weigh approximately 28.5 pounds per 1,000 cans and have side wall thicknesses averaging 0.0047 inch.

While the invention has been described and several practices for the employment thereof have been set forth, it will be obvious to those skilled in the art that many modifications of the invention are possible without departing from the scope thereof. For example, the invention includes within its scope ironing the side wall of a drawn cup using a first punch having a rounded corner around its forward end, and then forming the end profile on the ironed cup without heating the cup between such operations. It is also contemplated as being within the scope of the invention to heat the container, either generally or locally in the area of its wall, even in the absence of any coating to reduce the temper of the metal so that the sharp radii and straight wall section can be formed in the profile. Such heating could be effected either before ironing or after ironing and before the profile is formed.

Having thus described my invention and certain embodiments thereof, I claim:

1. A method of forming a light weight can body comprising in sequence the steps of thinning and lengthening, without heat treatment, the side wall of a drawn cup made of at least full hard temper aluminum alloy by moving the cup through at least one ironing ring by means of an ironing punch having a rounded corner around its forward end to form a can body having a substantially flat bottom end wall with a rounded corner therearound leading into the side wall of the can body, withdrawing the ironing punch from the ironed can body, heating at least the bottom end wall of the can body to reduce its temper, introducing a reforming punch into the can body, and reforming the bottom end wall of the can body between the reforming punch and a reforming die to form an upwardly domed central portion therein connected to the side wall of the can body by an outwardly and upwardly flared shoulder.

2. A method as set forth in claim 1 in which metal from said rounded corner of the can body is drawn into said upwardly domed central portion during said reforming of the bottom end wall of the can body.

3. A method as set forth in claim 1 in which a substantially vertical wall section is formed in the bottom end wall of the can body extending downward from the periphery of the central domed portion to the inner edge of the flared shoulder.

4. A method as set forth in claim 1 in which small radii are formed on the top and bottom of the vertical wall section connecting such wall section with the central domed portion and with the flared shoulder.

5. A method of forming a light weight can body comprising in sequence the steps of ironing, without heat treatment, the side wall of a cup made of at least full hard temper aluminum alloy by moving the cup through at least one ironing ring by means of a punch having a rounded corner on its forward end leading into the side wall of the punch to thin and lengthen the side wall of the cup to form a can body, withdrawing the ironing punch from the ironed can body, coating at least part of the surface of the can body, heating the can body to cure the coating thereon, and introducing a reforming punch into the can body, and reforming the bottom end wall of the can body between the reforming punch and a reforming die to form an upwardly domed central portion therein with a substantially vertical wall section extending downward from its periphery to an outwardly and upwardly flared shoulder leading into the side wall of the can body.

6. A method as set forth in claim 5 in which small radii are formed on the top and bottom of the vertical wall section connecting such wall section with the central domed portion and with the flared shoulder.

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