Title of the Invention: Attachment of can ends
Abstract Title: Attachment of can ends

A can end 2 and can body 3 are joined by a seaming process, that folds a peripheral curl 5 of the can end 2 around the flange of the can body 3. Additionally an ultrasonic weld 18 is performed extending around the circumference of the can, joining the can end 2 and body 3 along the chuck 1 wall, within or below the seam. This ultrasonic weld 18 provides the end panel stiffness normally provided by the can end countersink 11. Thus the countersink may be reduced or deleted from the end design, thereby saving material. The seam may be a single lap-over seam or a double interlocking seam.
Title
Attachment of Can Ends

Field of Invention
The present invention concerns a material and manufacturing energy saving change to state of the art beverage can manufacture. In particular it relates to a novel addition to the current seaming process which allows a change to the end and body design such that material use is reduced in comparison with present designs. The invention has particular application in the manufacturing of cans for containing carbonated drinks, but it may be used to seal cans containing other contents whether pressurised or not.

Prior Art
Can body manufacturing techniques are described in the patent literature. Representative patents include U.S. Pat. Nos. 6,305,210; 6,132,155; 6,079,244; 5,984,604, and 5,934,127.

In current practice, after the body is formed in the body maker, it is sent to a separate necking and flanging station, where neck and flange features are formed. The flange is a geometric feature, used in the sealing process to create a hermetic seam. The component with the neck feature is referred to as the "can body" and the lid is referred to as the "can end" in this document. All of the figures included are cross sectional views showing the corresponding interface between the can end and the can body, the remaining can geometry is not depicted, but is referred to. Can ends are subject to a separate manufacturing process. U.S. Pat. No. 6,533,518 and references cited therein describe several press designs used to form a can end from sheet material.

FIGS. 1A to 1C show the construction of a current state-of-art can design and how stiffness and strength is provided in order to meet specific distortion and ruggedness requirements. Common practice defines the method of sealing as follows:
At the time of filling the can body 3 with product, the end 2 is placed over the can body 3 and then attached to the can using a process known as seaming. **FIGS. 1A to 1C** are cross-sections showing a can end 2, can body 3, seam tooling comprising chuck 1 and seaming rollers 6 and 7. The figures show the flange 4 of the can body 3 and the curl 5 of the can end 2 before **(FIG. 1A)** and after **(FIG. 1C)** a double seaming operation, in accordance with a prior art double seam joint 8. The can end 2 has a peripheral curl 5, which is rolled against a peripheral flange 4 in the can body 3. The can end 2 is placed on top of the can body 3 and a seaming chuck 1 is inserted into the can end 2. A first roller 6 is moved laterally (x-axis as labeled) into engagement with the curl 5 and presses the curl 5 against the flange 4 in a first seaming operation, as shown in **FIG. 1B**. In a second seaming operation, as shown in **FIG. 1C**, a second seaming roller 7 continues the seaming operation and presses the flange 4 and curl 5 together against the seaming chuck 1 to form a tight double seam joint 8 between the can end 2 and the can body 3. The double interlocking seam joint 8 created is hermetic due to the application of “compound” within the peripheral curl 2 prior to the seaming operations.

A published PCT application of Williamson, publication no. WO 02/42196, defines an alternative means of achieving a hermetic seal otherwise obtained from the current state-of-the-art double seam joint. The publication demonstrates the potential materials savings due to the incorporation of an alternative means of can sealing to current industry techniques. See also U.S. Pat. Nos. 5,186,592; 5,125,780 and 4,854,467 to Budenbender; U.S. Pat. No. 4,738,560 to Brussow; U.S. Pat. No. 4,758,704 to Kogel, and U.S. Pat. No. 2006/0186127 A1 to Gopalswamy. There is always a demand to improve the efficiency of can manufacture, for example by reducing the quantity or the quality of the materials used, while maintaining sufficient rigidity of the can end and a strength of the seal that will allow cans to be pressurised to 90 PSI (620kPa) or greater, which is currently a design standard for can designs in the beverage industry.

**Statement of the Invention**

This invention meets the aforesaid. It provides improvements in seam designs that are particularly useful in combination with ultrasonic welding of the components to
increase can strength. Specifically, the invention defines the means in which the can end 2 and can body 3 are hermetically sealed, although, the means also allows for design modifications to be made to both can end 2 and can body 3. The use of the suggested joining process enables material reductions in terms of countersink, panel depth and seaming panel geometries, due to the replacement of the current standard double interlocking seam with the ultrasonic weld. FIG. 3A shows a potential can seaming design which doesn’t include the countersink feature 11 found in current standard can design. Alternatively, the modification of the chuck wall angle in relation with the countersink radius, allows for the control of chuck wall length, meaning that a greater material saving can be achieved. This modification to the chuck wall angle effects the integration of the two components in terms of initial can end positioning as well as their proximity within the weld zone, i.e. the distance between the two interfaces. A suitable interfacial -therefore chuck- angle is defined as being of a magnitude to allow for an accordingly sized weld for the creation of a hermetic seal.

FIG. 3F illustrates how the combination of countersink removal and chuck wall reduction can save significant proportions of material within the can end 2. The reduction of seaming panel length, due to single seam 19, allows for additional savings in material used, effectively reducing the material cost associated per beverage can manufactured, without compromise to the physical requirements of the complete can.

According to a first aspect of the present invention, a can sealing process comprises a combination of a rolling action and an ultrasonic process which welds the can end 2 and can body 3 together in the area of the chuck wall interface 9, 10, either within or directly below the peripheral curl 5 and flange 4. The weld preferably forms a seal between the can body and the can end around the circumference of the can. The ultrasonic weld increases the rigidity of the can end, allowing significant material and energy savings to be made in other areas.

The ultrasonic weld may be produced whilst keeping changes to all other aspects of the can manufacturing and seaming process to a minimum. For significant material savings such as the elimination of countersink, reductions in geometric features and alternative seam types, the design of the can end and body require revision and potential redesign, resulting in necessary modification of required manufacture and processing tooling.
The ultrasonic weld may be formed between the seam and the panel of the can end but preferably the ultrasonic weld is formed in the region of the seam. This allows improvements in seam design that are particularly useful in combination with ultrasonic welding of the components to increase can strength and stiffness. For example, the seam may be a single lap-over seam rather than a double interlocking seam. Further material reduction may be achieved by omitting a countersink from the end camp and/or reduction of panel depth.

Preferably, the chuck wall is of suitable angle to allow for the ultrasonic process, taking into consideration interfacial proximity and available weld zone. This angle is specific to the application of the ultrasonic process and the sonotrode would need to be positioned such that, it suitably contacts the interfacial area. The modification of the chuck wall angle allows for the reduction in chuck wall length, meaning that a greater material saving can be achieved; effectively reducing the material cost per beverage can manufactured. According to a further aspect of the present invention, a method of manufacturing a can comprises the step of ultrasonically welding the can body to the can end.

**Brief Description of the Drawings**

**FIGS. 1A, 1B and 1C** – Cross-sections of part of a can end 2 and body 3 and seam tooling; illustrating steps in the process of double seaming the flange 4 and curl 5, according to the prior art. Figures illustrate the can before the first operation roll (**FIG. 1A**); after completion of the first operation roll (**FIG. 1B**) and after completion of the first and second operation rolls (**FIG. 1C**).

**FIGS. 1D, 1E and 1F** – Cross-sections corresponding to **FIGS. 1A, 1B and 1C** and illustrating schematically a basic arrangement of the welding means to weld the can end 2 to the can body 3 along the length of the angled chuck wall 9 in accordance with the present invention.

**FIGS. 2A, 2B and 2C** – Cross-sections corresponding to **FIGS. 1A, 1B and 1C** of a can end 2 and body 3 but incorporating a vertical or near-vertical chuck wall 10 in accordance with a preferred embodiment of the present invention.
FIG. 2D – Cross-section corresponding to FIG. 2B showing the area suitable for an ultrasonic weld to be located along the vertical or near-vertical chuck wall 10.

FIGS. 3A, 3B and 3C – Cross-sections corresponding to FIGS. 1A, 1B and 1C but illustrating the potential material saving by removal of the countersink 11 feature by use of the present invention.

FIG. 3D – Cross-sections corresponding to FIG. 3A showing the area suitable for an ultrasonic weld to be located along the vertical or near-vertical chuck wall 10.

FIG. 3E – Cross-section of part of a can end 2 and body 3 illustrating a single lap-over seam in accordance with one embodiment of the present invention.

FIG. 3F – Cross-section of part of a can end 2 and body 3 illustrating the potential material saving between FIG. 2C and FIG. 3C by use of the present invention.

Specific Description

The present invention concerns the introduction of an ultrasonically welded joint in such a way and in such a location as to provide the necessary stiffness and strength which requires less material and hence less manufacturing energy than cans known in the art. An embodiment of such a seam is shown in FIG. 3F, illustrating potential material savings by the dashed lines 11 and 12.

An embodiment of the present invention would involve the ultrasonic seam welding of minimally but suitably modified can components with less material preferably as part of an otherwise unmodified can manufacturing process preferably where operating costs are unchanged or reduced with respect to the present state-of-the-art.

The example of an ultrasonically welded seam shown by FIG. 3F may be produced by an arrangement of ultrasonic welding equipment, preferably integrated into otherwise unmodified canning machinery, such as that illustrated by FIGS. 1D, 1E, 1F, 2D and 3D.

The chuck, 1 may also act as the anvil, 15 for the ultrasonic welding equipment. After filling of the can and assembly of can end 2 to can body 3, there is potential for the application of the sonotrode (or horn) 14 and anvil 15 before, during or after the
described seaming operations for the ultrasonic welding means to weld the angled or near-vertical interfaces 9, 10 (respectively). Ultrasonic welding means does not require simultaneous seaming and welding processes as shown in FIG. 1D. The angled chuck wall interface 9 or angle of chuck wall local to specified weld area is a fundamental geometric variable which requires consideration in the incorporation of the ultrasonic welding means; the greater the geometric complexities of the chuck wall interface 9, 10 as a result of can end 2 and body 3 design, the greater the complexity of the ultrasonic welding means, specifically relating to the design of the sonotrode 14. FIGS. 1E and 1F show the potential inclusion of modified operation rolls 16 and chuck anvil 15 for simultaneous first and second operation seaming means during ultrasonic welding, where weld dimensions are predefined by can end 2 and body 3 design that ultimately define modified operation roll 16 and anvil 15 geometries such as length 17.

FIGS. 2A, 2B and 2C illustrate the same can end 2 and can body 3 with the significant reduction of chuck wall angle relative to the axis of the can i.e. the vertical (y) direction as illustrated in the drawings; therefore resulting in a near-vertical chuck wall interface 10 and a greater angle of radial sweep in the countersink 11. The reduction in chuck wall angle, increases the cross-sectional area of the can end 2 and body 3 assuming a constant outside curl diameter, meaning the largest diameter of the complete and un-seamed can end 2. However, the elongation of the peripheral curl 5 and body flange 4 allows for potential metal reduction in the length of the chuck wall as shown in 12 (FIG. 3F). It is acknowledged that a reduction in the chuck wall angle, may reduce the ease of the can end/body mating operation and this must be done in such a way as not to compromise the speed of the seaming operation.

The potential for using an ultrasonic weld, in conjunction with a roller seam, offers the potential for a can end 2 and can body 3 to be constructed using less metal for the same contained volume (FIGS. 3A, 3D and 3E) than that used in current practice. FIG. 3A illustrates the potential removal of the countersink, and replacement with a round of predefined radius 13 dependent on design. The deletion of the countersink significantly reduces the quantity of metal used in the manufacture of the can end 2. Additionally, the ultrasonic seam approach may permit the can end 2 to be joined to the can body 3 in a single seam 19 (FIG. 3E), which requires less metal in the peripheral curl 5 of the can end 2 and in the flange 4 of the can body 3, whereas the current approach using a double seam 8 requires more metal in the peripheral curl 5
of the can end 2 and in the flange 4 of the can body 3. The prospect of ultrasonic seaming also has the potential for removal of the application of a seam compound to the peripheral channel 20 (FIG. 3F) in the end, which seals the can when the double seam 8 is formed within the second operation roll 7. This is possible when the ultrasonic weld provides the required hermeticity otherwise provided by the inclusion of the compound.

Modifications to can ends are possible although with extensive constraints of specific dimensions within the can end geometry. A potential mode of material saving to the can end is the reduction of the thickness of the material. However, can performance may be a concern due to the greater likelihood of can end displacement due to buckling and may ultimately result in “tab over chime” failure, in which the detachable tab of a beverage can protrudes above the level of the rim of the can and becomes vulnerable to damage during transit.

The ultrasonic weld is to feature as an alternative means of hermetic seal to current practice. Considering the combined use of the current practice and the invention, allows for the current practice to be modified such that, the can end can be modified; for example modification through material change (manufacture of a can end made from a material of lesser physical property requirements and cost) or modification to the gauge thickness of the material used, therefore using less material in can end manufacture.

Additional savings can be made to the can body due to reinforcement of the can end by means of an ultrasonic weld. Panel height 12 for example can be reduced; a direct effect of this geometric reduction would be an additional material saving in the can body. A necessary volume is required within the can itself between the panel 2 and the product. This volume is known as “head space” in the art. The open volume is a fundamental factor in the relationship between internal pressures of the can with variation to temperature, therefore can performance. Alternative modes of material savings exist due to the deletion of the countersink 11 in relation to the allowable head space. The reduction of the countersink increases the head space in the beverage can, therefore altering can performance and potentially allowing for the use of a lower grade or gauge of material used in the manufacture of the can end 2 as the relationship between pressure and temperature would have been modified.
Alternatively reductions in can body 3 height can be utilised to maintain the head space prior to the reduction of the countersink from the can end 2 profile.

Instead of forming the ultrasonic weld as a single, broad band, the weld could be formed as multiple narrow bands using a sonotrode consisting of one or more thin-point horns. The formation of narrow welds would lead to savings due to a quicker weld time and/or lower energy usage.
Claims

1. A method of joining a can end to a can body, comprising:
   a. Placing the can end on the can body;
   b. Performing a seaming operation so as to form a seam joining the can end to the can body; and
   c. Ultrasonically welding the can end to the can body.
2. The method of claim 1, wherein the welding operation (c) occurs before the seaming operation (b).
3. The method of claim 1, wherein the welding operation (c) occurs during the seaming operation (b).
4. The method of claim 1, wherein the welding operation (c) occurs after the seaming operation (b).
5. The method of any of claims 1 to 4, wherein the ultrasonic weld forms a hermetic seal between the can end and the can body around the circumference of the can.
6. The method of claim 5, wherein the ultrasonic welding operation comprises forming multiple welds around the circumference of the can.
7. The method of any of claims 1 to 6, wherein the can body comprises a flange and wherein the can end comprises a peripheral curl; wherein during the seaming operation of step (b), the peripheral curl is folded about an edge of the flange to form a single seam.
8. The method of claim 7, wherein the ultrasonic weld is below the folded seam.
9. The method of claim 7, wherein the ultrasonic weld is at least partly covered by the folded seam.
10. A can comprising a can end and a can body, the can end being joined to the can body by a seam and by an ultrasonic weld.
11. A can according to claim 10, wherein the ultrasonic weld forms a hermetic seal between the can end and the can body around the circumference of the can.
12. A can according to claim 10 or claim 11, comprising multiple ultrasonic welds around the circumference of the can.
13. A can according to any of claims 10 to 12, wherein the seam is a single, lap-over seam.
14. A can according to any of claims 10 to 12, wherein the seam is a double, interlocking seam.
15. A can according to any of claims 10 to 14, wherein the ultrasonic weld is below the seam.

16. A can according to any of claims 10 to 14, wherein the ultrasonic weld is at least partly covered by the seam.

17. A can according to any of claims 10 to 16, wherein in the region of the ultrasonic weld, the can end and the can body abut along a surface that tapers outwards at an angle from 0° to 30°, to the vertical axis (y).

18. A can according to any claim 10 to 17, wherein the can end comprises an end panel and an annular wall with countersink therebetween of radius 10 millimeters or less.

19. A can according to any claim 10 to 17, wherein the can end comprises an end panel and an annular wall with no countersink therebetween.

20. A can according to any of claims 10 to 19 which contains no sealing compound within the seam.
Application No: GB0917832.8
Claims searched: All Claims

Examiner: Tony Martin
Date of search: 26 November 2009

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

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The following online and other databases have been used in the preparation of this search report
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