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PATENT SPECIFICATION

DRAWINGS ATTACHED

Inventor: LEONARDUS ARNOLDUS NICOLAAS BIJVOET

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COMPLETE SPECIFICATION

An Apparatus for Forming a Plurality of Axially Spaced Beads in a Hollow, substantially Cylindrical Sheet Metal Blank

We, METAL CONTAINERS LIMITED, a British Company, of Seymour House, 17 Waterloo Place, Pall Mall, London, S.W.1, 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:—

The present invention relates to an apparatus for forming a plurality of axially spaced peripheral beads in a hollow, substantially cylindrical sheet metal blank.

In the specification of our prior patent No. 973373 there is described a sheet metal shipping container having a side wall formed with a plurality of radially outwardly extending peripheral beads alternating with a plurality of radially inwardly extending furrows. Furthermore, a method of forming such a side wall is described, the main feature of said method being that during the formation of the peripheral beads the side wall material is stressed only in a radial and circumferential direction and not in a longitudinal or axial direction. Thereby, less stress is created during the formation of the beads and consequently, the material can bear greater further stress and thus can be deformed to a greater extent without bursting or fracturing. According to the invention forming part of the subject matter of our said co-pending patent application this was achieved by locally expanding a cylindrical blank in a radial direction in a plurality of axially spaced points while permitting the blank material at both sides of each bead being formed to move towards said bead.

It has now been found that forming a plurality of beads in a substantially cylindrical sheet metal blank while avoiding stressing the material in two directions at right angles to

one another can also be achieved in an alternative way which, under certain conditions and in various cases, affords advantages over the method according to our previous patent application.

Although primarily intended to provide an apparatus for forming beaded side walls for containers according to our previous invention it should be noted that the application of our present invention is by no means limited thereto. On the contrary, it can advantageously be used in all cases where a plurality of axially spaced peripheral beads are to be formed in a hollow, substantially cylindrical sheet metal blank. The beads need not necessarily have the shape as described and claimed in the specification of our co-pending application nor need they be formed over substantially the entire axial length of the blank. Moreover, the work-piece obtained according to the present invention need not constitute the side wall for a container but it can instead be used for any other purpose.

It has been found that avoiding axial stresses in addition to radial and circumferential stresses can also be achieved if the material is permitted to move towards the bead being formed from one side only, provided that the beads are formed one after another and in the sequence they will have in the ultimate work piece and that the material of the non-deformed blank is allowed to shift to the zone of operation, that is to the bead being formed.

Accordingly, the present invention provides an apparatus for forming a plurality of axially spaced peripheral beads in a hollow, substantially cylindrical sheet metal blank, said apparatus comprising at least two juxtaposed co-axially arranged radially expansible and

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contractable die units each consisting of a set of radially movable die segments, each of said die segments being formed with a radially inwardly extending guide pin slidably mounted in a radially extending bore in the wall of a cylindrical casing, said bore and guide pin being angularly offset in relation to the bore and guide pin of the adjacent die unit or die units, the apparatus also comprising an actuator adapted successively to expand said die units and to hold at least one die unit in expanded position while expanding the next die unit, and means for contracting each of said die units after it has been released by said actuator.

One of the advantages afforded by the present invention is that the problem of holding in place the blank operated upon is solved; this is now automatically achieved, since at least one bead already formed is held until the blank is so tightly engaged for forming the next bead that it is held by the die unit for forming that bead. Moreover, the formation of a work piece which, apart from the beads is a straight cylinder, is warranted. Finally, beads are formed which are equidistantly spaced and which are exactly parallel to one another; this of course is beneficial to the overall appearance of the finished article.

In a preferred embodiment of the invention the apparatus is provided with a number of die units which is equal to the number of beads which it is intended to form in the blank, the axial spacing of said die units being equal to the intended axial spacing of the beads to be formed.

Thus it has been found that the apparatus according to the present invention permits the provision of floating dies to be dispensed with while still avoiding axial stress in the blank material which of course eliminates a complication.

Further objects, features and advantages of the invention will become apparent from the following description of an apparatus according to the invention which is shown by way of example only in the accompanying drawings, and of its operation. In these drawings:

Figure 1 is a longitudinal cross-sectional view of a completed workpiece made in accordance with the present invention;

Figure 2 is a similar view of the workpiece during its formation;

Figure 3 is a longitudinal cross-sectional view of an apparatus according to the invention;

Figure 4 is a longitudinal cross-sectional view of the casing of the apparatus shown in Figure 3;

Figure 5 is a radial cross-sectional view of said casing;

Figure 6 is a side elevation of one half of

a die unit forming part of the apparatus shown in Figure 3;

Figure 7 is a longitudinal cross-sectional view of part of the actuator of the apparatus according to the invention, and

Figure 8 is an end elevation of this part.

Figure 9 is a top plan view of one of a plurality of other parts of the actuator, and Figure 10 is a side elevation of this part.

Referring to Figures 1 and 2 of the drawings, there is shown in Figure 1 a completed workpiece produced by the method according to the invention, whilst Figure 2 illustrates the workpiece at a stage of operation thereon. The invention provides means for forming a plurality of axially spaced peripheral beads 11 in a hollow, substantially cylindrical sheet metal blank 12, said means operating so as successively to form consecutive beads one after the other. The blank is held in place by means (not shown in Figures 1 and 2) engaging one or more of the beads already formed, at least until the blank 12 is so tightly engaged for forming the next bead that it is held by friction; thus, at least the extreme right hand bead 11 in Figure 2 is held until the portion of the blank 12 adjacent said bead is engaged by the bead forming means. While each bead is being formed the not yet deformed portion of the blank 12 is permitted freely to shift or float towards the bead being formed. Thus, referring to Figure 2, the material of the blank 12 is permitted to move from the right towards the left.

Referring to Figure 3, the apparatus according to the invention includes a plurality of juxtaposed co-axially arranged radially expandable and contractable die units generally indicated at 13. Each of the die units consists of a set of radially movable die segments 14. The apparatus further includes an actuator generally indicated at 15 which, in a manner hereinafter to be described, is adapted forcibly and successively to expand said die units 13 and to hold at least one die unit in expanded condition while expanding the next die unit 13. Finally, the apparatus includes means for contracting each of the die units 13 after it has been released by the actuator 15. In the embodiment shown in Figure 3 these contracting means comprise a pair of annular contracting springs, for instance helically wound springs 16, accommodated in circumferential grooves 17 formed in the die segments 14.

The apparatus comprises a number of die units 13 equal to the number of beads 11 which it is the intention to form in the blank 12, the axial spacing of the die units being equal to the intended axial spacing of the beads to be formed. In the embodiment of the invention shown in Figures 1-3 of the drawings the number of beads, and thus the number of die units, amounts to 26.

Each of the die segments 14 of all die units 13 is formed with a radially inwardly extended guide pin 18 carrying at its inner extremity a rotatably mounted roller 19 to be engaged by the actuator 15. The guide pins 18 are slidably mounted in radially extending bores 20 in the wall of a cylindrical casing 21. The diameter of the guide pins 18 must conform to certain minimum requirements in order to impart sufficient strength to the die segments and the die units constituted thereby to stand the loads imposed upon them during the expanding operation. Inasmuch as the axial spacing of the beads, and hence the axial spacing of the die units and the die segments, is a predetermined value, this spacing may well be too small to provide sufficient room for the guide pins which in fact is the case with the embodiment of apparatus shown in the drawings. In order to overcome this difficulty and to solve the problem presented thereby, the bores 20 for the guide pins 18 of one die unit are angularly offset in relation to the bores 20 for the guide pins 18 of the adjacent die unit or die units 13, as shown in the drawings, particularly in Figures 4 and 5 thereof. In that way sufficient room is provided to accommodate the guide pins of adjacent die units whilst still adhering to the predetermined spacing of the die units.

As shown in the drawings, and particularly Figure 3 thereof, the bores 20 in the casing 21 may be lined with sleeves 22 made of an anti-friction material.

The actuator 15 comprises a body having a substantially cylindrical portion and a tapered end portion at both ends of the cylindrical portion, as shown in Figure 3. The apparatus further includes means for reciprocating the actuator body axially of the die units 13. In the embodiment shown this means comprises a piston rod 23 secured to a piston slidable in a cylinder 24; the driving medium for the piston may be a hydraulic or a gaseous fluid, such as compressed air. When the actuator body is provided with two tapered end portions as shown in Figure 3, preferably both strokes of the piston rod 23 are power strokes so that a blank may be beaded both during an outward and during an inward or return stroke. Alternatively, the actuator body may have only one tapered end portion, and in that case at least the stroke of the reciprocating means in which the tapered end portion is the leading end is a power stroke so as to permit the tapered end portion forcibly to expand the die units successively during the power stroke.

As shown in Figure 3 the axial length of the cylindrical portion of the actuator is sufficiently great to hold three die units in fully expanded position while it expands the next die unit.

In a preferred embodiment of the apparatus according to the invention the effective

diameter of the actuator is variable. Thus the actuator 15 may include an outer annular portion which is expansible and an inner portion, the inner surface of the outer portion and the outer surface of the inner portion being frusto-conical form, the apex angle of both cones being equal to one another, the inner portion being movable axially in relation to the outer portion.

More particularly, as shown in Figures 3, 7, 8, 9 and 10 of the drawings, the outer annular expansible actuator portion includes a hollow cage-like casing 25 formed with radially extending angularly spaced slots 26 in its wall, and a plurality of lamellae 27 each of which is slidably mounted in a radial direction in each of the slots 26. The inner portion of the actuator body is constituted by a truncated conical core member 28 which is accommodated in the cage-like casing 25 and which radially supports the inner edges of the lamellae 27. The angle of inclination of the inner edges of the lamellae 27 is equal to one half of the apex angle of the truncated cone, or in other words, the apex angles of the conical core member and of the conical body defined by the inner edges of the lamellae are equal to one another. This construction of actuator body permits adjustments in the effective diameter of the actuator body, and thus of the outer diameter of the ultimate beads, to be made in a simple way by merely replacing the lamellae with other ones having a different overall height. It also allows easy replacement of worn lamellae.

Another advantage is that the lamellae can be made of a harder material than that of the cage-like casing so that the lamellae may have a greater resistance to wear and tear by their co-operation with the rollers 19 mounted on the die segments.

The conical core member 28 is mounted on the piston rod 23 by means of a sleeve 29 secured to the end of the piston rod 23. The sleeve 29 is formed with external screw threads engaging and co-operating with internal screw threads formed in the truncated conical core member 28 as indicated at 30. By rotating the piston rod 23 with the sleeve 29 in relation to the core member 28, or vice versa, the latter may be drawn further into the cage-like casing 25 (to the left in Figure 3) or withdrawn therefrom (to the right in Figure 3). Thereby also the radius of the circle defined by the projecting central portions of the lamellae 27 can be varied.

As shown in Figure 3 of the drawings, the radial dimensions of the cage-like casing 25 are slightly larger than the corresponding dimensions of the lamellae 27 in their most protruded position; thereby, the dams or bridges between the slots 26 may serve to guide the actuator body along the inner surface of the casing 21.

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In a preferred embodiment of apparatus according to the invention a ring 31 of stretchable resiliently deformable material, such as rubber, is provided around the die segments 14 of each of the die units 13, as shown in Figure 3 of the drawings. The ring has a smoothly curved convex outer periphery so as to assist in forming the blank with smoothly curved beads. This may simply be accomplished by forming the ring 31 as an O-ring having a circular cross-section.

The operation of the apparatus shown and described is as follows:

A blank 12 is placed around the die units of the apparatus by sliding it on from the right as shown in Figure 3. Assuming that the actuator 15 is in its retracted, that is its extreme left hand position, the blank is so adjusted axially (by means not shown in the drawings) that the extreme left hand die unit is opposite the position where the first bead is to be formed. The actuator 15 is then moved to the right by admitting pressure fluid to the left side of the piston in the cylinder 24. Thereby the extreme left hand die unit is expanded and firstly a bead is formed adjacent the left hand end of the blank, consecutive beads being formed successively one after the other by the adjacent and following die units being successively expanded by the axially moving actuator. During this operation the blank is held in place and correct position by one or more of the beads 11 already formed being engaged by the die unit or units concerned being held in expanded position. At first only one, that is the first, bead is thus held, this number increasing by two to three and as shown in Figure 3 three beads are always held during the further operation. The right hand portion of the blank 12 is not held in any way and thus this not yet deformed portion of the blank is permitted freely to shift towards the bead which is being formed. When the die segments of any die unit are released by the actuator they are contracted by means of the contracting springs 16 in the grooves 17. At the end of the outward stroke to the right the actuator enters into the chamber 32 at the right hand extremity of the casing 21. All die units now being released are all contracted and thus permit the beaded workpiece to be withdrawn to the right from the apparatus. A fresh blank may then be placed on the apparatus and it may be beaded by moving the actuator 15 to the left. When placing the blank on the apparatus for the left hand or return stroke of the actuator it should be so adjusted axially (by means not shown) that the annular zone where the extreme right hand bead is to be formed is opposite to the extreme right hand die unit. Thus it will be clear to the man skilled in the art that when beading a blank in a left

hand or return stroke the blank is placed more to the left on the apparatus than when beading one in a right hand or outward stroke, since the material of the non-deformed portion of the blank flows or shifts towards the place of operation in a direction opposite to that of the movement of the actuator.

WHAT WE CLAIM IS:—

1. An apparatus for forming a plurality of axially spaced peripheral beads in a hollow, substantially cylindrical sheet metal blank, said apparatus comprising at least two juxtaposed co-axially arranged radially expansible and contractable die units each consisting of a set of radially movable die segments, each of said die segments being formed in a radially inwardly extending guide pin slidably mounted in a radially extending bore in the wall of a cylindrical casing, said bore and guide pin being angularly offset in relation to the bore and guide pin of the adjacent die unit or die units, the apparatus also comprising an actuator adapted successively to expand said die units and to hold at least one die unit in expanded position while expanding the next die unit, and means for contracting each of said die units after it has been released by said actuator.

2. An apparatus as claimed in claim 1, wherein there is provided a number of die units equal to the number of beads which are to be formed in the blank, the axial spacing of said die units being equal to the intended axial spacing of the beads to be formed.

3. An apparatus as claimed in any of claims 1 or 2, wherein said actuator includes a body having a substantially cylindrical portion and a tapered portion at least at one end of said cylindrical portion, said apparatus further including means for reciprocating said body axially of said die units, at least the stroke of said reciprocating means in which the tapered end of said body is the leading end being a power stroke.

4. An apparatus as claimed in claim 3, wherein the effective diameter of said actuator body is variable.

5. An apparatus as claimed in claim 4, wherein said actuator body includes an outer annular portion which is expansible and an inner portion, the inner surface of said outer portion and the outer surface of said inner portion being frusto-conical, the apex angle of both cones being equal to one another, said inner portion being movable axially in relation to said outer portion.

6. An apparatus as claimed in claim 5, wherein said outer annular expansible actuator portion includes a hollow cage-like casing being formed with radially extending angularly spaced slots in its wall, and a plurality of lamellae each of which is slidably mounted in a radial direction in each of said slots, the



In a preferred embodiment of apparatus according to the invention a ring 31 of stretchable resiliently deformable material, such as rubber, is provided around the die segments 14 of each of the die units 13, as shown in Figure 3 of the drawings. The ring has a smoothly curved convex outer periphery so as to assist in forming the blank with smoothly curved beads. This may simply be accomplished by forming the ring 31 as an O-ring having a circular cross-section.

The operation of the apparatus shown and described is as follows:

A blank 12 is placed around the die units of the apparatus by sliding it on from the right as shown in Figure 3. Assuming that the actuator 15 is in its retracted, that is its extreme left hand position, the blank is so adjusted axially (by means not shown in the drawings) that the extreme left hand die unit is opposite the position where the first bead is to be formed. The actuator 15 is then moved to the right by admitting pressure fluid to the left side of the piston in the cylinder 24. Thereby the extreme left hand die unit is expanded and firstly a bead is formed adjacent the left hand end of the blank, consecutive beads being formed successively one after the other by the adjacent and following die units being successively expanded by the axially moving actuator. During this operation the blank is held in place and correct position by one or more of the beads 11 already formed being engaged by the die unit or units concerned being held in expanded position. At first only one, that is the first, bead is thus held, this number increasing by two to three and as shown in Figure 3 three beads are always held during the further operation. The right hand portion of the blank 12 is not held in any way and thus this not yet deformed portion of the blank is permitted freely to shift towards the bead which is being formed. When the die segments of any die unit are released by the actuator they are contracted by means of the contracting springs 16 in the grooves 17. At the end of the outward stroke to the right the actuator enters into the chamber 32 at the right hand extremity of the casing 21. All die units now being released are all contracted and thus permit the beaded workpiece to be withdrawn to the right from the apparatus. A fresh blank may then be placed on the apparatus and it may be beaded by moving the actuator 15 to the left. When placing the blank on the apparatus for the left hand or return stroke of the actuator it should be so adjusted axially (by means not shown) that the annular zone where the extreme right hand bead is to be formed is opposite to the extreme right hand die unit. Thus it will be clear to the man skilled in the art that when beading a blank in a left

hand or return stroke the blank is placed more to the left on the apparatus than when beading one in a right hand or outward stroke, since the material of the non-deformed portion of the blank flows or shifts towards the place of operation in a direction opposite to that of the movement of the actuator.

WHAT WE CLAIM IS:—

1. An apparatus for forming a plurality of axially spaced peripheral beads in a hollow, substantially cylindrical sheet metal blank, said apparatus comprising at least two juxtaposed co-axially arranged radially expansible and contractable die units each consisting of a set of radially movable die segments, each of said die segments being formed in a radially inwardly extending guide pin slidably mounted in a radially extending bore in the wall of a cylindrical casing, said bore and guide pin being angularly offset in relation to the bore and guide pin of the adjacent die unit or die units, the apparatus also comprising an actuator adapted successively to expand said die units and to hold at least one die unit in expanded position while expanding the next die unit, and means for contracting each of said die units after it has been released by said actuator.

2. An apparatus as claimed in claim 1, wherein there is provided a number of die units equal to the number of beads which are to be formed in the blank, the axial spacing of said die units being equal to the intended axial spacing of the beads to be formed.

3. An apparatus as claimed in any of claims 1 or 2, wherein said actuator includes a body having a substantially cylindrical portion and a tapered portion at least at one end of said cylindrical portion, said apparatus further including means for reciprocating said body axially of said die units, at least the stroke of said reciprocating means in which the tapered end of said body is the leading end being a power stroke.

4. An apparatus as claimed in claim 3, wherein the effective diameter of said actuator body is variable.

5. An apparatus as claimed in claim 4, wherein said actuator body includes an outer annular portion which is expansible and an inner portion, the inner surface of said outer portion and the outer surface of said inner portion being frusto-conical, the apex angle of both cones being equal to one another, said inner portion being movable axially in relation to said outer portion.

6. An apparatus as claimed in claim 5, wherein said outer annular expansible actuator portion includes a hollow cage-like casing being formed with radially extending angularly spaced slots in its wall, and a plurality of lamellae each of which is slidably mounted in a radial direction in each of said slots, the

inner edges of said lamellae being radially supported by a truncated conical core member accommodated in said cage-like casing.

- 5 7. An apparatus as claimed in any one of the preceding claims, wherein a ring of stretchable resiliently deformable material is mounted around the die segments of each of said die units, said ring having a smoothly curved convex outer periphery.

- 10 8. An apparatus for forming a plurality of

axially spaced peripheral beads in a hollow substantially cylindrical blank substantially as herein described with reference to the accompanying drawings.

A. A. THORNTON & CO.,
Chartered Patent Agents,
Northumberland House,
303—306 High Holborn, London, W.C.1,
For the Applicants.

B.K.

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