Oct. 31, 1967 L. A. N. BIJVOET 3,349,600

APPARATUS FOR FORMING A PLURALITY OF AXIALLY SPACED BEADS IN A HOLLOW, SUBSTANTIALLY CYLINDRICAL SHEET METAL BLANK

Filed Sept. 17, 1964 3 Sheets-Sheet 1

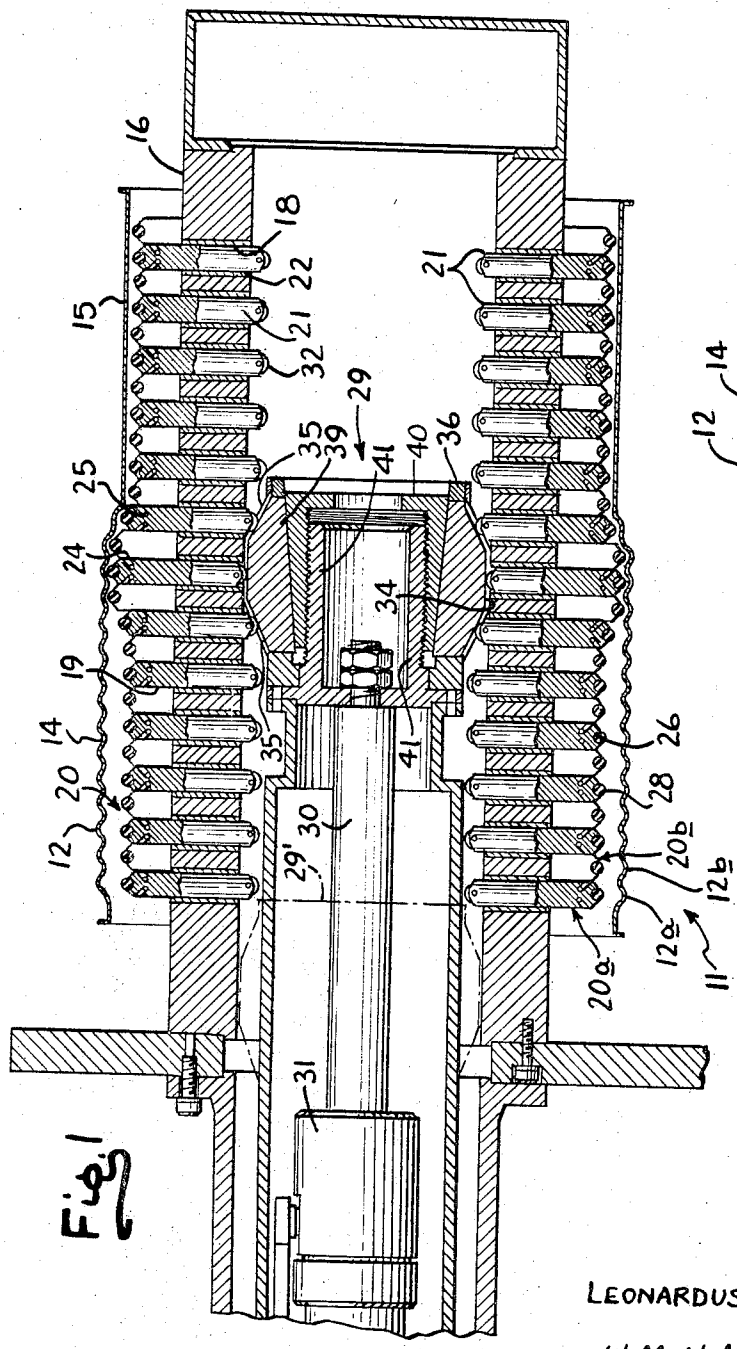


Fig. 1

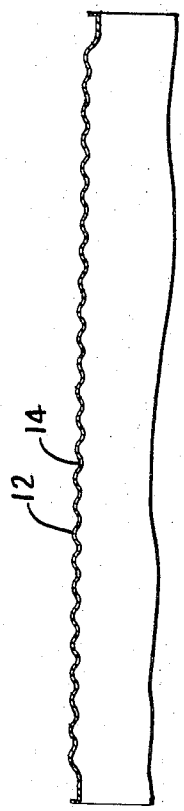


Fig. 9

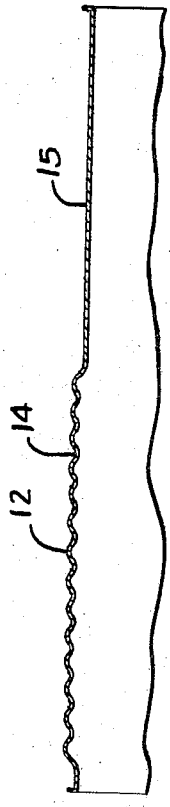


Fig. 10

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Fig. 2

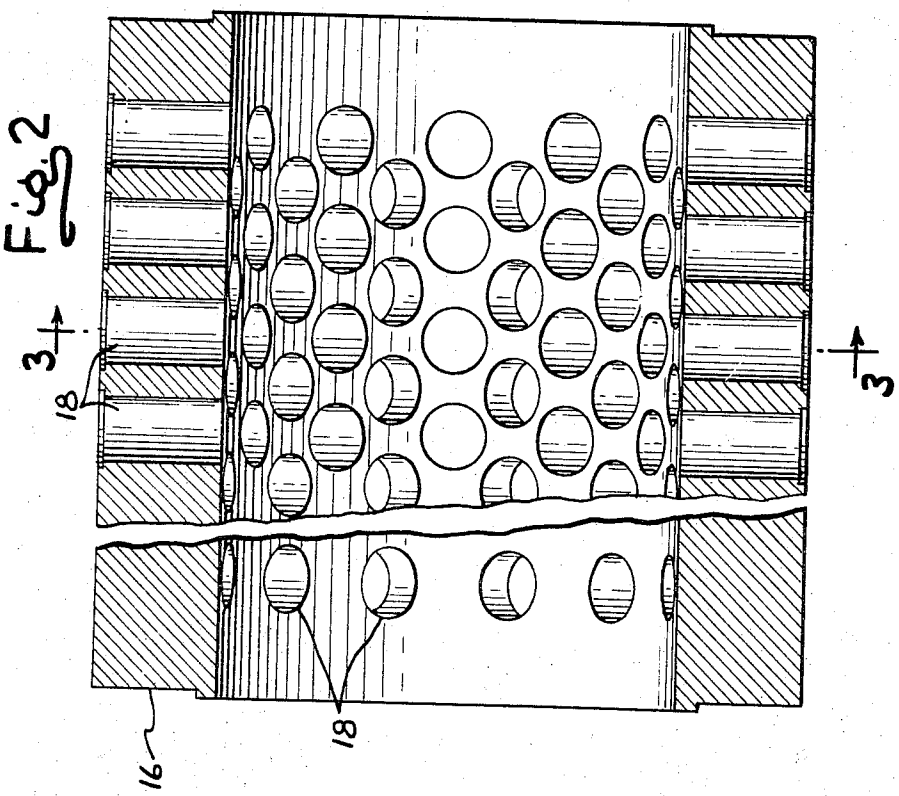
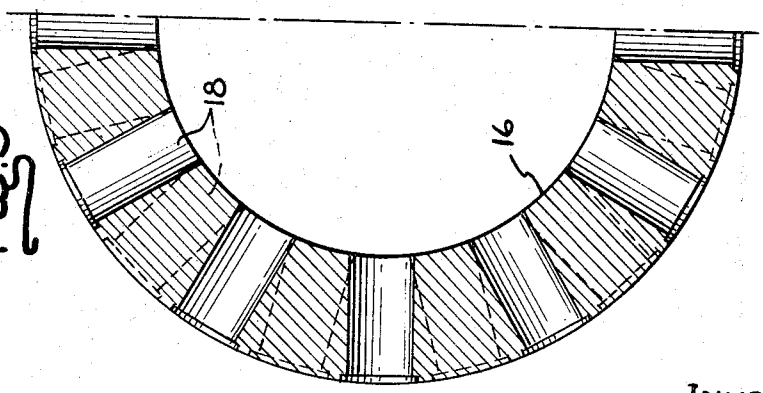


Fig. 3



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Fig. 5

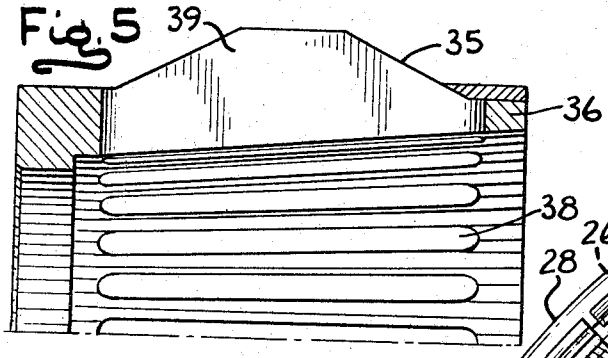


Fig. 4

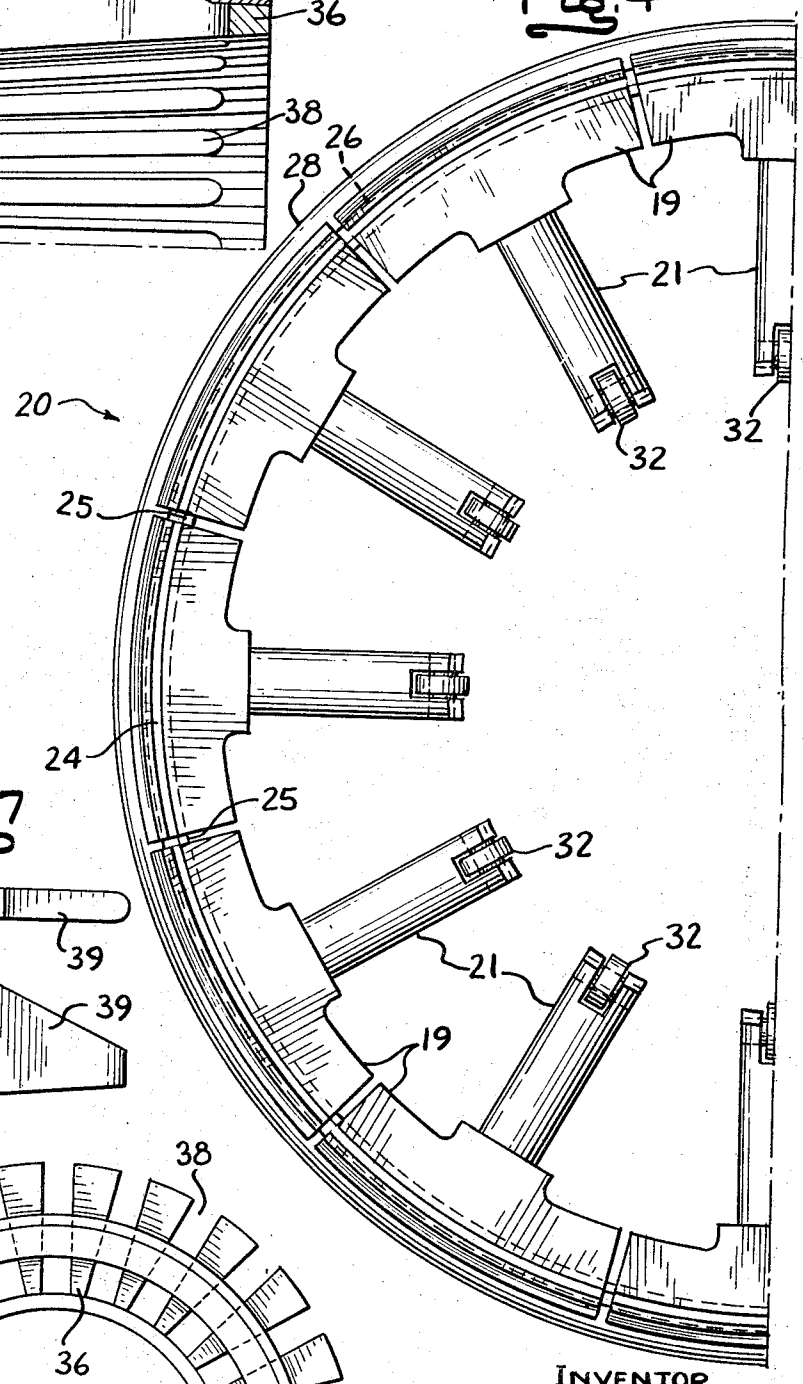


Fig. 7

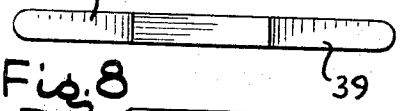


Fig. 8

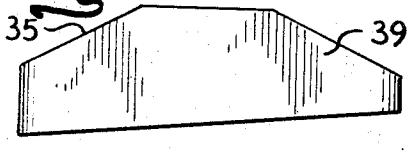
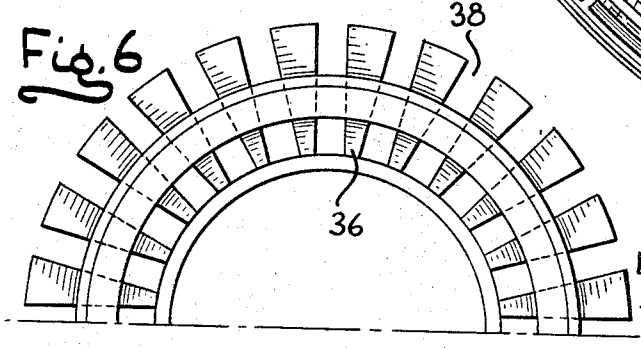


Fig. 6



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3,349,600

APPARATUS FOR FORMING A PLURALITY OF AXIALLY SPACED BEADS IN A HOLLOW, SUBSTANTIALLY CYLINDRICAL SHEET METAL BLANK

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Filed Sept. 17, 1964, Ser. No. 397,205
Claims priority, application Great Britain, Sept. 18, 1963, 36,834/63
6 Claims. (Cl. 72—393)

ABSTRACT OF THE DISCLOSURE

Method and apparatus for individually and successively expanding a plurality of radially extending peripheral beads alternating with a plurality of radially inwardly extending furrows in a cylindrical sheet metal blank wherein the material is stressed primarily in a radial and circumferential direction with the strain in the longitudinal or axial direction being controlled with minimum values. Consecutive individual beads formed successively one after another by radially expanding die units with the blank held in position by one or more beads already formed which are engaged by preceding expanded die units to permit the not yet deformed portion of the blank to freely shift towards the individual bead which is being formed.

Bead forming apparatus having a plurality of radially expansible internal die units with a single longitudinally shitfable actuator having a raised portion and at least one tapered portion for forcibly and successively expanding the die units as the actuator passes along the axis with the raised portion holding at least one die unit expanded during the expansion of the next succeeding die unit and each of the die units being contracted after passage of the actuator.

A bead forming apparatus including a generally cylindrical frame having a plurality of radially extending bores formed therein to receive die units with radially inwardly extending guide pins slideably received within the bores and where adjacent circumferential rows of bores may be angularly offset and staggered to permit close positioning of adjacent rows of die units.

An actuator reciprocally movable along the central axis of the casing supporting the die units to expand the die units wherein the actuator includes a body portion having a hollow, cage-like casing formed with radially extending slots therein which receive lamellae and provision is made for varying the amount of projection of the lamellae to change the effective diameter of the actuator body thus formed.

The present invention relates generally to metal forming methods and apparatus and more particularly, apparatus for forming a plurality of axially spaced peripheral beads in a hollow, substantially cylindrical, sheet metal blank. In its principal aspect, the invention is concerned with improved apparatus for forming a plurality of axially spaced peripheral beads in a cylindrical metal blank wherein the net axial strain in the blank resulting from the beading or metal deforming operation is minimized thereby producing a finished beaded product that is more resistant to deformation forces.

A peripherally beaded product, in this case, a shipping container of the type that may be advantageously formed by the methods and apparatus of the present invention is described and claimed in the copending application of M. J. M. Coppens, Ser. No. 273,071, filed July 5, 1963,

now abandoned, and copending divisional application thereof of M. J. M. Coppens, Ser. No. 470,983, filed July 12, 1965, now U.S. Patent 3,268,109, all assigned to the assignee of the present invention. Such beaded container comprises a sheet metal sidewall having a plurality of radially extending peripheral beads formed therein alternating with a plurality of radially inwardly extending furrows. The aforesaid copending applications of M. J. M. Coppens further describe and claim a method for forming a beaded sidewall wherein, during the formation of the peripheral beads, the sidewall material (i.e., the cylindrical blanks) is stressed primarily in a radical and circumferential direction with the strains in a longitudinal or axial direction being controlled within minimum values. Thereby, less axal strain is created during the formation of the beads and, consequently, the side wall can sustain greater further strain during a forming operation and can be deformed to a greater extent without bursting or fracturing. Moreover, the finished product can withstand greated deformation forces of the type normally encountered during shipping or handling without bursting or fracturing. These advantageous results are achieved in the Coppens method by locally expanding a cylindrical blank in a radial direction at a plurality of axially spaced points while permitting the blank material at both sides of each bead being formed to move towards the bead.

The present invention relates to alternative apparatus for forming a plurality of axially spaced peripheral beads in a generally cylindrical blank and wherein the net axial strain produced in the blank is minimized and controlled within tolerable limits. In this instance, however, this is accomplished by permitting the material of the blank to move towards the bead being formed from only one side of the bead as contrasted with the methods described in the aforesaid copending applications of M. J. M. Coppens.

Accordingly, it is a general aim of the present invention to provide novel apparatus for expanding a plurality of axially spaced peripheral beads in a hollow, substantially cylindrical sheet metal blank, wherein the internal axial strains created in the blanks as are incident to the beading operation are minimized thereby insuring greater strength in the product being formed. While not so limited in its application, the invention will find especially advantageous use in the formation of beaded sheet metal shipping containers.

Another object of the invention is the provision of apparatus for expanding peripheral beads in a cylindrical metal blank wherein the blank material on one side of each bead being formed is generally constrained while the blank material on the opposite side of the bead being formed in permitted to move axially toward the bead, thus minimizing the internal axial strains created in the blank.

A more specific object of the invention is to provide procedures and apparatus for forming beaded metal blanks and which are characterized by their simplicity and reliability and wherein the products produced thereby are characterized by their strength and durability. A related object of the invention is the provision of apparatus for a plurality of beads in a hollow metal blank one at a time in successive sequential order and wherein the blank material is held or confined in the vicinity of the bead or beads just formed while being maintained free of restraint in the blank area that is as yet unbeaded, thus permitting the material of the unbeaded portion of the blank to move axially towards the bead being formed.

An ancillary object of the invention is the provision of apparatus which permits mass production of beaded blanks on an economical basis. To this end, it is an object of the invention to provide apparatus wherein successive blanks can be beaded during forward and reverse power strokes of the forming equipment and wherein such blanks

can be readily loaded in and removed from such equipment.

It is a further object to provide a novel apparatus for successively forming peripheral beads in a blank while simultaneously minimizing the axial strain created in the blank as an incident to the beading operation and wherein the beads are maintained equidistantly spaced and exactly parallel to one another thus enhancing not only the strength, but also the appearance of the blank.

Yet another object of the invention is the provision of expanding apparatus which is characterized by its versatility and which can be readily adapted for forming beads of various dimensions in cylindrical blanks by the simple expedient of replacing a single set of actuator elements.

Other objects and advantages of the invention will become apparent as the following description proceeds, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a vertical cross-sectional view of an exemplary bead forming apparatus embodying the features of the present invention, here depicting the apparatus during a blank expanding operation;

FIG. 2 is a fragmentary enlarged longitudinal cross-sectional view of the casing of the apparatus shown in FIG. 1;

FIG. 3 is a cross-sectional view of the casing taken substantially along the line 3—3 of FIG. 2;

FIG. 4 is an enlarged end view of one half of a die unit forming part of the apparatus shown in FIG. 1;

FIG. 5 is an enlarged fragmentary longitudinal cross-sectional view of the frame of the actuator of the apparatus shown in FIG. 1;

FIG. 6 is an end elevation of the frame shown in FIG. 5;

FIGS. 7 and 8 are a top plan view and a side elevation respectively, of one of the actuator camming elements adapted to be removably mounted in the actuator frame shown in FIGS. 5 and 6;

FIG. 9 is a fragmentary sectional view of a completed product made in accordance with the present invention; and

FIG. 10 is a similar view of the product shown in FIG. 9 during its formation.

While the invention is susceptible of various modifications and alternative forms, a specific embodiment thereof has been shown by way of example and will herein be described in detail. It should be understood, however, that it is not intended to limit the invention to the particular form disclosed, but, on the contrary, the intention is to cover all modifications, equivalents and alternatives that fall within the spirit and scope of the invention as expressed in the appended claims.

Referring now to the drawings, there is illustrated in FIG. 1, an exemplary expanding apparatus, generally indicated at **11**, which is particularly suited for forming beads **12** and furrows **14** in a blank **15**, in accordance with the present invention. In the illustrative form of the invention, the expanding apparatus **11** includes a generally hollow cylindrical frame **16** having a plurality of radially extending bores **18** formed therein for slidable reception of a plurality of die segments **19** which form part of a plurality of expandable and retractable die units, generally indicated at **20**. As best shown in FIG. 4, end die unit **20** comprises a plurality of die segments **19** which are disposed about the periphery of the frame **16** (FIG. 1) and which when expanded are adapted to form one continuous peripheral bead in the metal blank **15**. Thus there are preferably as many die units **20** as there are beads **12** to be formed in the blank **15**—in the exemplary form of the invention, twenty-six such die units are provided and, therefore, the finished product (FIG. 9) has twenty-six beads **12** formed therein.

In carrying out the present invention, the die segments **19** are provided with radially inwardly extending guide pins **21** (FIGS. 1 and 4) which are adapted to be slidably received within the bores **18** formed in the frame **16**

(FIGS. 1–3). The diameter of the guide pins **21** 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 **12**, and hence the axial spacing of the die units **20** and the die segments **19**, is a predetermined value, this spacing may well be too small to provide sufficient room for all of the guide pins **21** to be positioned on the frame **16**. Indeed, in the exemplary apparatus **11** shown in the drawings, such is actually the case. In order to overcome this difficulty and to solve the problems presented thereby, the bores **18** for the guide pins **21** of one die unit **20** are angularly offset in relation to the bores **18** for the guide pins **21** of the adjacent die unit or die units **20**, as best shown in FIGS. 4 and 5 of the drawings. By staggering the bores **18** and guide pins **21** in this manner, sufficient room is provided to accommodate the guide pins of adjacent die units while still maintaining the predetermined desired spacing of the die units. As shown in the drawings, and particularly FIG. 1 thereof, the bores **18** in the frame **16** may be lined with sleeves **22** made of an anti-friction material.

In order to insure that the die segments **19** of each die unit **20** are maintained in place relative to the frame **16** of the expanding apparatus **11**, and for the additional purpose of automatically contracting the segments of each die unit following an expanding operation, the segments are provided with arcuate grooves **24** (FIGS. 1 and 4) which are located in the opposed faces of the segments and which define a pair of circumferential disposed grooves adapted to respectively receive a pair of annular contracting springs such, for example, as helically wound springs **25**. Thus, the arrangement is such that during an expanding operation, the die segments **19** in each die unit **20** are moved uniformly outward in a radial direction (by means to be described below) against the biasing effect of the springs. Upon completion of an expanding operation, the radially inwardly directed force exerted by the springs **25** tends to contract the die segments.

In keeping with the present invention, provision is made for insuring that the beads **12** formed in the blank **15** have a smoothly curved, continuous, convex outer periphery even in the region between adjacent segments **19** of any given die unit **20**. To accomplish this, the die segments **19** are all provided with circumferentially disposed concave grooves **26**, with the grooves in the segments of each die unit defining a continuous circumferential groove adapted to receive a ring **28** of stretchable resiliently deformable material such as rubber (FIG. 1). As here shown, the ring **28** has a smoothly curved convex outer periphery which assists in forming beads having the desired configuration. Thus, the ring **28** may simply take the form of an O-ring having a circular cross section (FIG. 1).

In order to expand the die units **20**, thus urging the segments **19** radially outward and pressing the O-rings **28** into engagement with the inner periphery of the blank **15** so as to deform the latter and form beads **12** therein, provision is made for camming the inner ends of the guide pins **21** outwardly. To this end, an actuator assembly, generally indicated at **29** in FIG. 1, is mounted coaxially within the frame **16** of the expanding apparatus with freedom for controlled axial movement relative to the die units **20**. The particular means employed for mounting the actuator assembly and effecting such controlled relative movement, are not critical to the present invention and may take any of numerous, conventional forms well known to those skilled in the art. However, to facilitate an understanding of the present invention, the actuator assembly **29** is here shown as mounted on the outer end of a piston rod **30**, the inner end of the latter being received within a fluid actuated cylinder **31**. Thus, pressurized fluid (which may, for example, be either hydraulic or gaseous fluid such as compressed air) is

selectively routed through suitable conduits (not shown) to one end or the other of the cylinder **31**, the opposite end thereof being selectively coupled to the fluid source through a conventional bleed line (not shown), thereby driving the piston rod **30** and the actuator assembly **29** along the axis of the frame **16** in the desired direction. To facilitate movement of the actuator assembly **29** through the frame **16**, and to minimize the amount of friction generated as the assembly successively contacts the die units **20**, suitable rollers **32** or the like are preferably journaled within the bifurcated inner ends of the guide pins **21**, as best shown by reference to FIGS. 1 and 4 conjointly.

Those skilled in the art will appreciate that prior to an expanding operation, an unbeaded cylindrical blank **15** is first positioned about the forming apparatus **11**. In order to accommodate the blank **15**, the actuator assembly is first moved to one of its limit positions (e.g., to the extreme lefthand side of the apparatus **11** shown in FIG. 1), thus permitting contraction of all of the die units **20** under the influence of their associated springs **25**. Under these conditions, the blank **15** is positioned about the contacted die units **20** and shifted axially relative thereto until the blank is properly positioned so that the region thereof to receive the first bead **12***a* (FIG. 1) is adjacent to and surrounding the first die unit **20***a* (FIG. 1). The equipment is now ready for a bead forming operation.

In accordance with one of the important aspects of the present invention, provision is made for successively forming a plurality of outwardly extending, peripherally continuous beads **12** in a blank **15**, such beads alternating with a plurality of inwardly extending furrows **14**, in such a manner that the unformed portion of the blank on one side of each bead being formed is maintained free of any confining or restraining forces, thereby permitting the unformed blank material to move axially towards the bead being formed and thus minimizing the axial strain created in the deformed or beaded portion of the blank. To this end, provision is made for insuring that the blank **15** is held or restrained from axial movement only in the vicinity of the previously formed beads and, more particularly, in the vicinity of the last formed bead or beads, thus, not only insuring that the unformed blank material is free for axial movement but moreover, insuring that the material of the blank in the formed or beaded portion thereof is precluded from moving towards the bead being formed. In this manner, the previously formed beads are not distorted by the formation of successive beads.

In order to permit attainment of the foregoing objectives, the actuator assembly **29** comprises a body having a subsantially cylindrical portion **34** and a tapered end portion **35** at both ends of the cylindrical portion, as best shown in FIG. 1. It will, of course, be appreciated that when the actuator body is provided with two tapered end portions **35** as shown in FIG. 1, preferably both strokes of the piston rod **30** are power strokes—that is, one blank may be beaded during an outward stroke of the actuator assembly **29** and a second blank beaded during the inward or return stroke of the assembly **29**. Alternatively, the actuator body may have only one tapered end portion **35** and, in that case, at least the stroke of the assembly in which the tapered end portion **35** is the leading end is a power stroke, thus permitting the tapered end portion **35** to cam or forcibly expand the die units **20** successively during the power stroke.

Referring to FIG. 1, it will be observed that the arrangement is such that as the actuator assembly **29** is driven through a power stroke by the piston **30** and cylinder **21** assembly, and assuming that it starts in the extreme lefthand position shown by the phantom lines **29'**, the tapered leading edge **35** of the actuator body engages all of the rollers **32** associated with the first die unit **20***a*. Continued axial movement causes such rollers to ride up the leading edge **35** of the actuator body, thus driving the die segments **19** in die unit **20***a* outwardly and pressing the O-ring **28** into the blank **15** to form the bead **12***a*. When the actuator assembly has proceeded axially a sufficient distance so that the rollers **32** associated with die unit **20***a* are riding on the cylindrical portion **34** of the actuator body, bead **12***a* is completely formed.

Continued axial movement of the actuator assembly will now cause the rollers **32** associated with the second die unit **20***b* to start riding up the leading edge **35** of the assembly, thus starting to deform the blank material to form bead **12***b*. A this time, the blank material to the right of bead **12***b* is not restrained and is free to move towards the bead. However, the die unit **20***a* is still expanded into engagement with bead **12***a*, thus inhibiting movement of the blank material in the formed bead. The foregoing operation is continued so as to successively and sequentially form all of the beads **12** as the actuator assembly proceeds from, in this instance, left to right as viewed in FIG. 1. Moreover, it will be observed that the axial length of the cylindrical portion **34** of the actuator assembly **29** is sufficiently great to hold three die units **20** in expanded position while it expands the next die unit, thereby insuring that the previously formed beads are not distored.

In accordance with another of the important aspects of the invention, the effective diameter of the actuaor assembly is made variable, thus permitting accurate control of the diameter of the formed beads. To this end, the actuator assembly **29** 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 trunco-conical, the apex angle of both cones being equal to one another, and means being provided to move the inner portion axially in relation to the outer portion.

More particularly, and as best shown by reference to FIGS. 1, 5, 6, 7 and 8 conjointly, the outer annular expansible actuator portion includes a hollow cage-like casing **36** formed with radially extending angularly spaced slots **38** in its wall, and a plurality of lamellae **39** each of which is slidably mounted in a radial direction in each of the slots **38**. The inner portion of the actuator body is constituted by a truncated conical core member **40** which is accommodated in the cage-like casing **36** and which radially supports the inner edges of the lamellae. The angle of inclination of the inner edges of the lamellae **39** 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.

In order to adjust the effective diameter of t heactuator body, the conical core member **40** is mounted on the piston rod **30** by means of a sleeve **41** secured to the end of the piston rod **30**; the sleeve **41** is formed with external screw threads engaging and cooperating with internal screw threads formed in the truncated conical core member **40** as indicated at **41**. By rotating the piston rod **30** with the sleeve **41** in relation to the core member **40**, or vice versa, the latter may be drawn further into the cage-like casing **36** (to the left in FIG. 1) or withdrawn therefrom (to the right in FIG. 1). Thereby also the radius of the circle defined by the projecting central portions of the lamellae **39** can be varied.

This construction of actuator body not only permits adjustment 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, but it also allows easy replacement of worn out lamellae.

Another advantage of the present construction 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 cooperation with the rollers **32** mounted on the die segments.

In accordance with the operation of the apparatus of the present invention the blank **15** placed about the die units **20** by sliding it on from the right as shown in FIG.

1 and one of the die units (e.g., the lefthand die unit **20***b*) is expanded forming a peripheral bead; consecutive beads are then formed successively one after another by the adjacent and following die units being expanded by the axially moving actuator. During the operation the blank is held in place and correct position by one or more of the beads already formed which are engaged by preceding die units frictionally held in expanded position thereby permitting the not yet deformed portion of the blank to freely shift towards the bead which is being formed.

The apparatus in accordance with the present invention produces a drum body or sidewall formed over substantially its entire length with a plurality of radially outwardly extending peripheral beads **12** separated by a plurality of radially inwardly extending peripheral furrows **14**, with the alternate beads and furrows being so interrelated and associated with one another as to form a container sidewall construction which exhibits optimum performance characteristics in terms of "balanced strength" and resistance to deformation forces. In the exemplary sidewall construction shown in FIG. 9, twenty-six such beads **12** are formed in the sidewall, the beads being respectively spaced apart by twenty-five furrows **14**.

Of course, while twenty-six beads **12** and twenty-five furrows **14** have been shown, it will be understood that the particular number of beads and furrows may be varied without departing from the invention. It is important, however, that the beads and furrows be interrelated and associated with one another in accordance with particular criteria which are set forth in the aforementioned copending Coppens applications. The apparatus in accordance with the present invention enables the production of such peripherally beaded products wherein the strains in the formed sidewall are primarily limited to circumferential strains, whiel axial strains are substantially minimized and the beaded product is characterized by its high resistance to loads, shocks and similar forces which tend to deform or otherwise damage containers during transportation or storage. Therefore, in the appended claims it is intended that the term "plurality" connote at least the formation of three beads.

I claim as my invention:

1. In an apparatus for expanding a plurality of axially spaced radially outwardly extending peripheral beads separated by radially inwardly extending peripheral furrows in a hollow, substantially cylindrical sheet metal blank wherein the average net axial strain produced in the blank during bead formation is minimized, the combination comprising a plurality of juxtaposed co-axially arranged radially expansible and contractible die units corresponding in number to the beads to be formed, each of said die units comprising a set of radially movable die segments, a single longitudinally shiftable actuator completely movable through each of said die units during a power stroke, said actuator including means for forcibly expanding said die units in succession and holding at least one already expanded die unit in expanding position while expanding the next adjacent die unit, and means for contracting each of asid die units after it has been released by said actuator.

2. In an apparatus for expanding a plurality of spaced peripheral beads separated by a plurality of peripheral furrows, said beads and furrows blending smoothly into one another in a hollow, substantially cylindrical sheet metal blank wherein the average net axial strain produced in the blank during bead formation is minimized, the combination comprising a substantially cylindrical casing having radially extending bores therein, a plurality of juxtaposed co-axially disposed die units about the periphery of said casing corresponding in number to the beads to be formed, each of said die units comprising a plurality of radially expansible and contractible die segments, said die segments having inwardly extending guide pins slidably mounted in said bores, an actuator longitudinally movable along the axis of said casing, means for moving said actuator longitudinally through said casing, said actuator having a raised portion and a tapered portion, said tapered portion forcibly and sucessively expanding said die units to form beads in said blank as said actuator is drawn along the axis of said casing, means for contracting said die units after passage of said actuator and said raised portion holding at least one preceding die unit in expansion during expansion of the next succeeding die unit so that the non-deformed portion of said blank freely shifts toward the bead being formed.

3. In an apparatus for forming a plurality of equidistantly spaced peripheral beads separated by a plurality of peripheral furrows, said beads and furrows blending smoothly into one another in a hollow, substantially cylindrical sheet metal blank wherein the average net axial strain produced in the blank during bead formation is minimized, the combination comprising a substantially cylindrical casing having radially extending rows of bores in the wall thereof, each row of bores being angularly offset in relation to the adjacent row of bores, a plurality of juxtaposed coaxially disposed die units about the periphery of said casing, each of said die units comprising a plurality of radially expansible and contractible die segments, said die segments having inwardly extending guide pins slidably disposed in said bores, an actuator longitudinally movable along the axis of said casing, means for moving said actuator longitudinally through said casing, said actuator having a raised portion and a tapered portion, said tapered portion forcibly and successively expanding said die units to form beads in said blank as said actuator is drawn along the axis of said casing, and said raised portion holding at least one preceding die unit in expansion during expansion of the next succeeding die unit so that the nondeformed portion of the blank freely shifts toward the bead being formed.

4. In an apparatus for forming a plurality of spaced peripheral beads separated by a plurality of peripheral furrows, said beads and furrows blending smoothly into one another in a hollow, substantially cylindrical sheet metal blank wherein the average net axial strain produced in the blank during bead formation is minimized, the combination comprisingly a substantially cylindrical casing having radially extending bores therein, a plurality of coaxially disposed die units about the periphery of said casing, each of said die units comprising a plurality of radially movable die segments slidably disposed in said bores, an actuator reciprocally movable along the axis of said casing, means for reciprocating said actuator axially of said die units and casing, said actuator including a body having a cylindrical portion, first and second tapered portions adjoining respective sides of said cylindrical portion, said first tapered portion forcibly and successively expanding said die units to form beads in a blank on the outstroke of said actuator along the axis of said casing, means for contracting said die units after passage of said actuator, said cylindrical portion holding at least one preceding die unit in expansion during the expansion of the next succeeding die unit and said second tapered portion forcibly and successively expanding said die units to form beads in a blank on the return stroke of said actuator.

5. An apparatus as claimed in claim **4** in which 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 trunco-conical, the apex angle of both cones being equal to one another, and means for moving said inner portion axially in relation to said outer portion to alter the amount of expansion of said die units.

6. In an apparatus for forming a plurality of spaced peripheral beads in a hollow, substantially cylindrical sheet metal blank, the combination comprising a substantially cylindrical casing having radially extending bores therein, a plurality of juxtaposed coaxially dis-

posed die units about the periphery of said casing, each of said die units comprising segmented radially expansible and contractible dies having inwardly extending guide pins disposed in said bores, an actuator longitudinally movable along the axis of said casing, means for moving said actuator longitudinally through said casing for forcibly and successively expanding said die units, said actuator having an expansible body portion including a hollow, cage-like casing being formed with radially extending angularly spaced slots therein, a plurality of lamellae each of which is slidably mounted in a radial direction in each of said slots, a truncated conical core member disposed in said cage-like casing with the inner edges of said lamellae being radially supported thereon,

and means for moving said core member within said casing to vary the amount of projection of said lamellae and change the effective diameter of said actuator body.

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