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Costanzo

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[45] **Aug. 28, 1973**

[54] **METHOD FOR NECKING-IN CAN BODIES**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 136,958, April 23, 1971.

[52] **U.S. Cl.** **72/105**, 72/111, 72/121

[51] **Int. Cl.** **B21d 19/06**

[58] **Field of Search** 72/102, 103, 104, 72/105, 111, 94, 80–85, 91, 121

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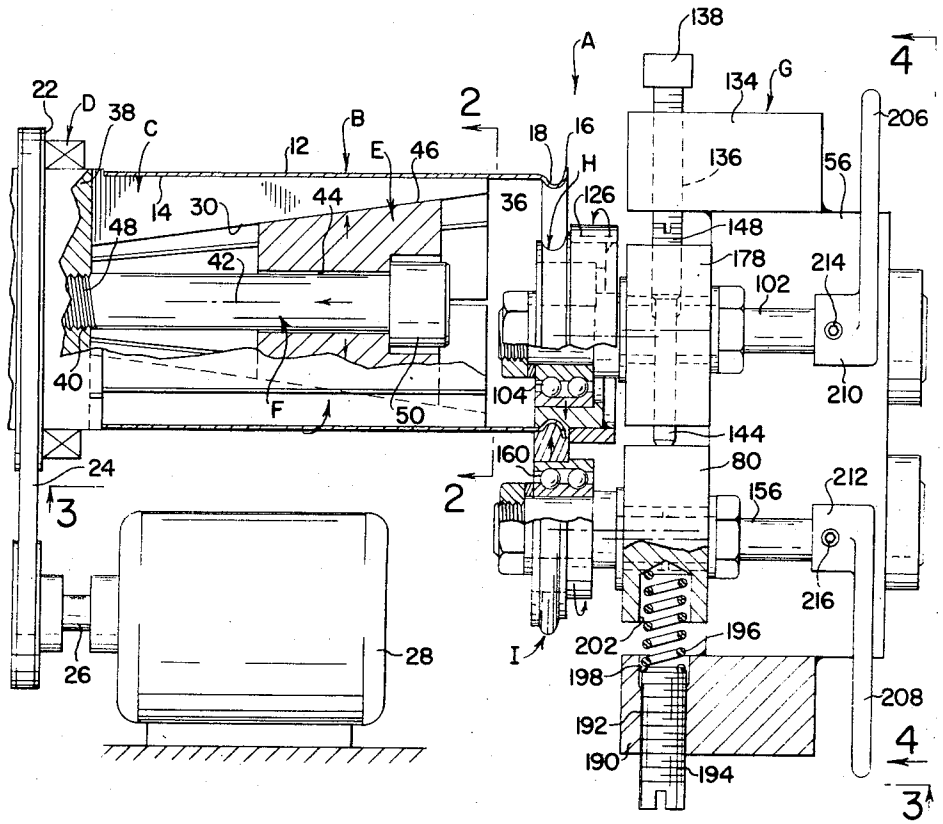
Primary Examiner—Richard J. Herbst
Attorney—Meyer, Tilberry & Body

[57] **ABSTRACT**

Apparatus for necking-in at least one end portion of a substantially cylindrical can body includes expandable and contractable gripping means for positively gripping a peripheral surface of the can body over a major portion of the circumference and length thereof to positively hold the can body in a substantially cylindrical shape. Female and male forming rolls act against a terminal end portion of the can body to deform the terminal end portion inwardly. The female forming roll is positioned within an open end portion of the can body and is moved outwardly into engagement with the terminal end portion of the can body to form an outwardly extending flange thereon for stiffening the end portion of the can body against wrinkling. A male forming roll positioned outside of the can body is moved toward the female forming roll to neck-in the terminal end portion of the can body.

32 Claims, 17 Drawing Figures



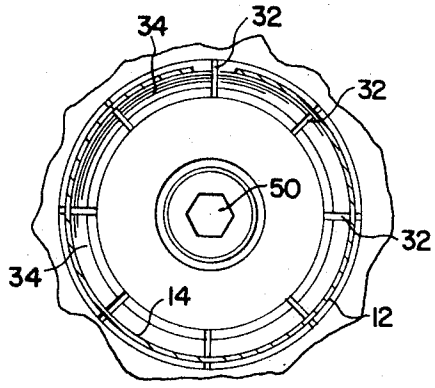

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FIG. 2

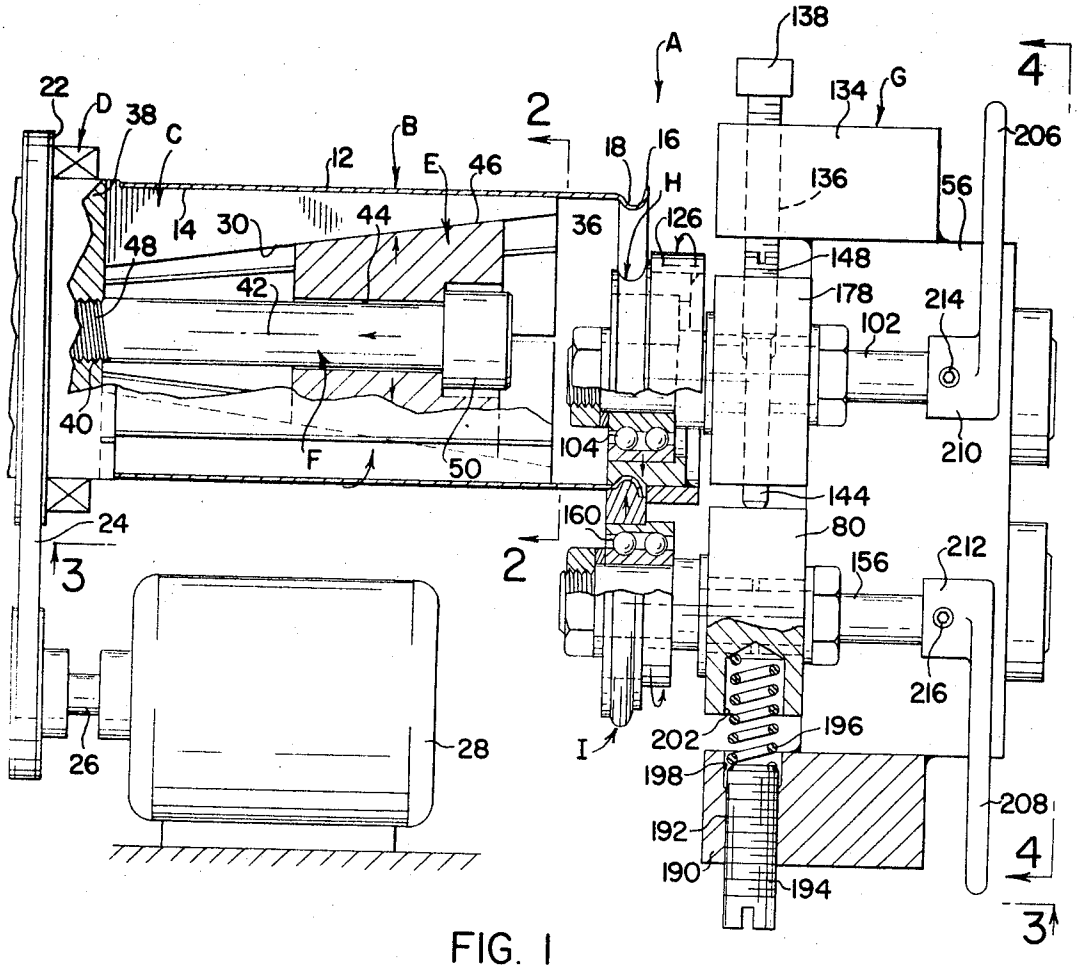
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FIG. 1

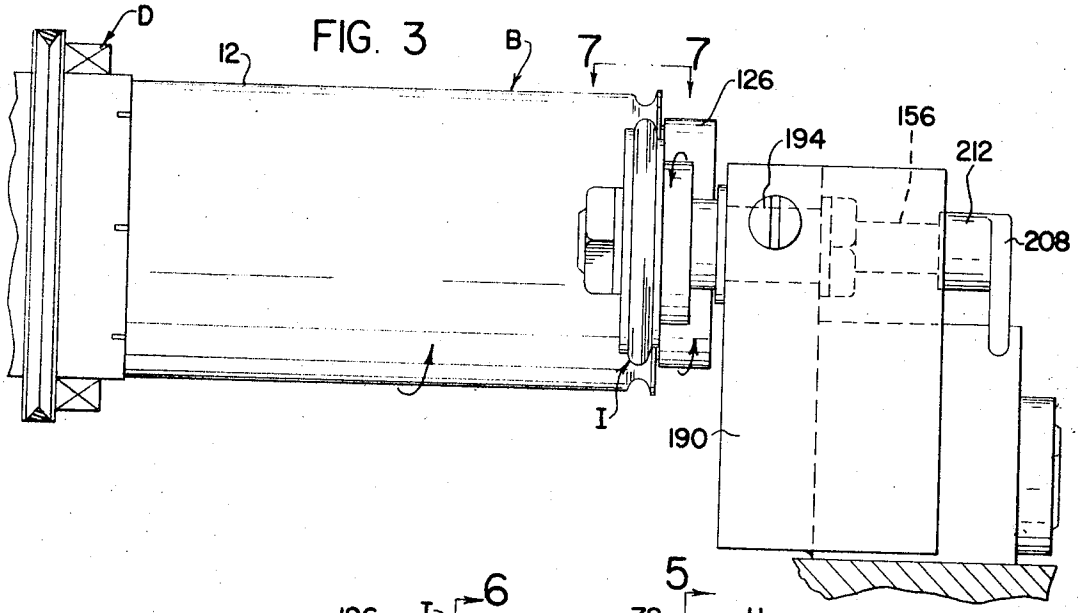
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FIG. 3

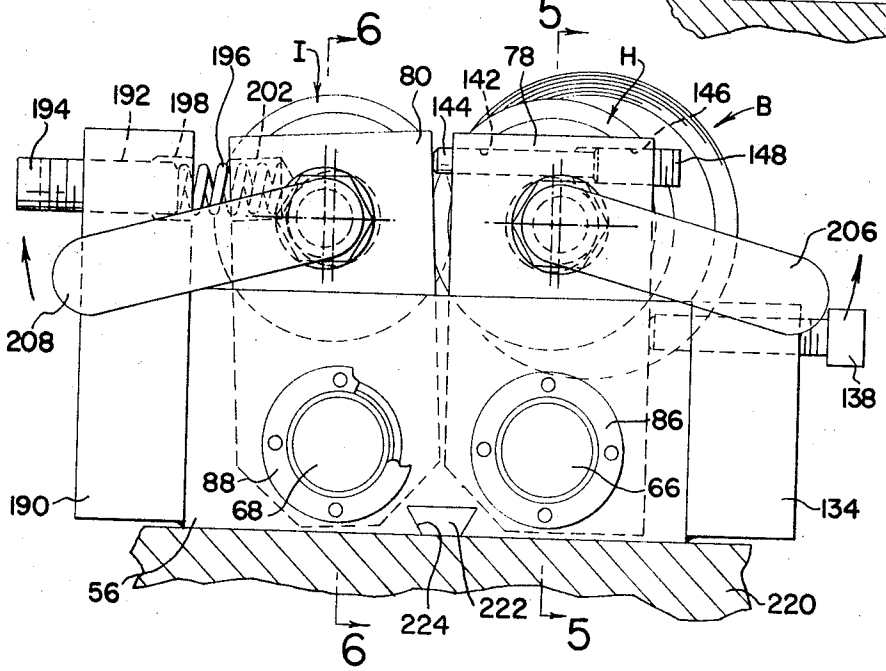
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FIG. 4

FIG. 5

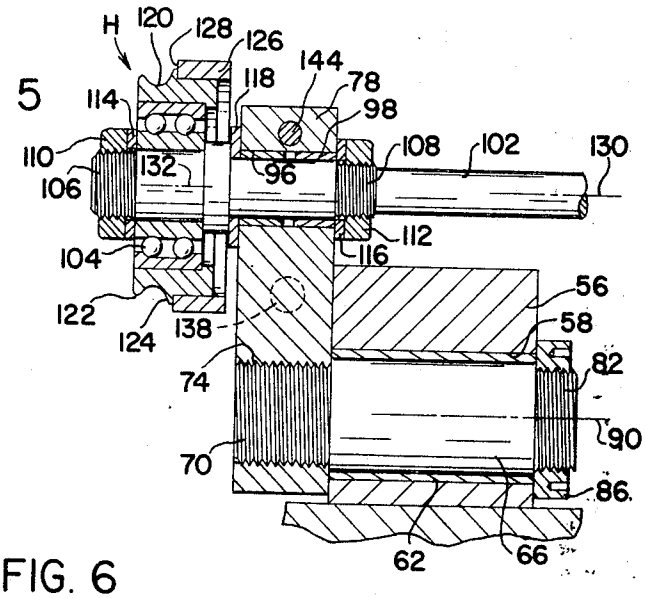
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FIG. 6

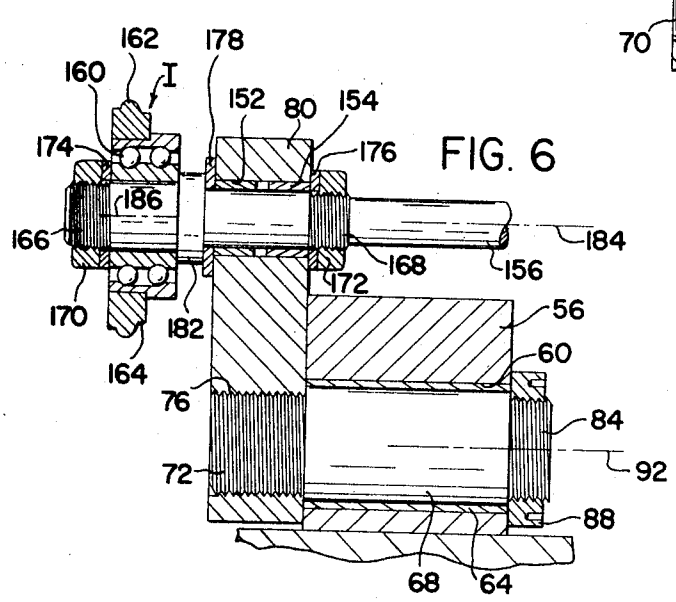
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FIG. 7

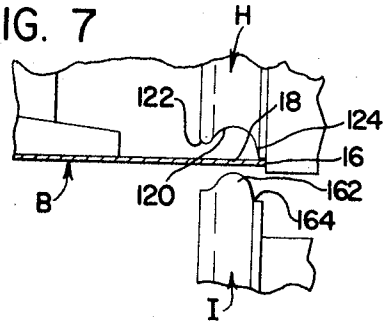


FIG. 8

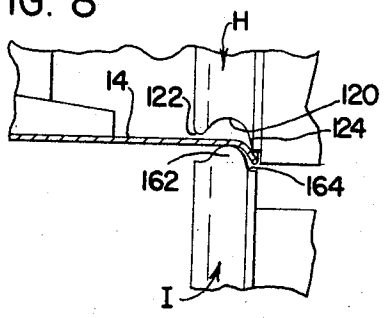


FIG. 11

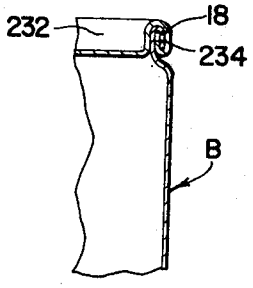


FIG. 9

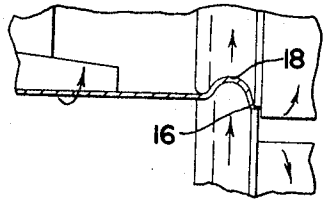


FIG. 10

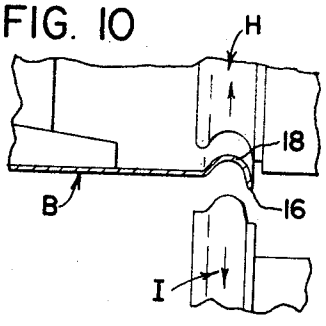


FIG. 12

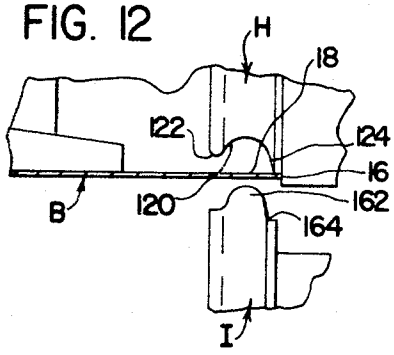


FIG. 13

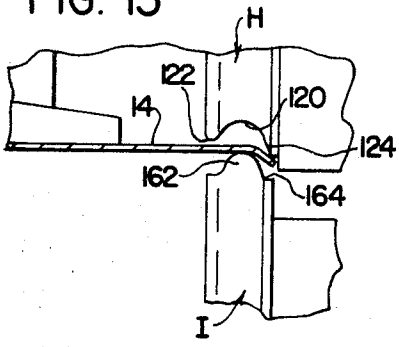


FIG. 14

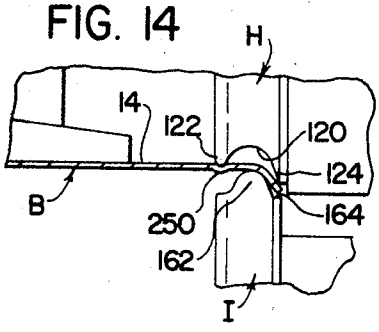


FIG. 15

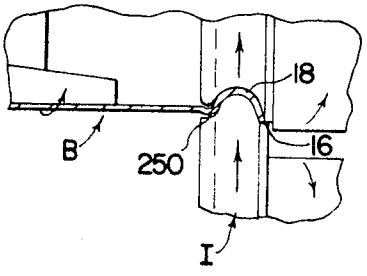


FIG. 16

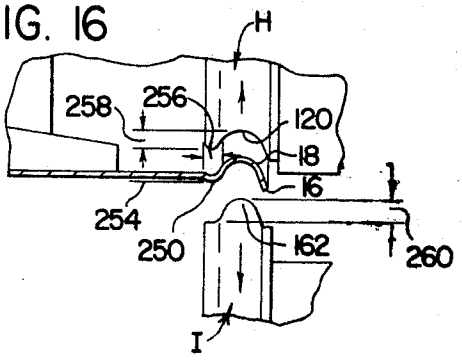
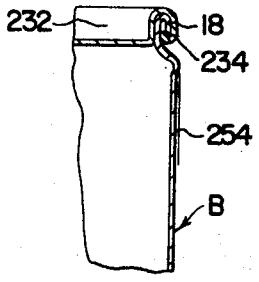


FIG. 17



METHOD FOR NECKING-IN CAN BODIES

This application is a continuation-in-part of U.S. patent application Ser. No. 136,958, filed Apr. 23, 1971.

BACKGROUND OF THE INVENTION

This application pertains to the art of can manufacture and more particularly to an apparatus and method for necking-in terminal end portions of can bodies. The invention is particularly applicable to can bodies and will be described with particular reference thereto although it will be appreciated that the invention has broader applications and may be used for necking-in pipes or the like.

Open end portions of cylindrical metal can bodies are commonly reduced in diameter or neckin-in to save expenses on end closures for the can body. Reducing the diameter on end portions of a can body still allows the can to hold substantially the same capacity. Reducing the end portions allows the use of a smaller diameter end closure in order to save on material. The smaller area and circumference of the end closure also allows the use of less tin plate, enamel and sealant so that the total cost of a completed can is substantially reduced due to the savings in materials.

Cylindrical metal pails and other containers manufactured from relatively soft steel have previously had the end portions thereof reduced by utilizing female and male deforming rolls. When using relatively soft steel, the steel can flow rather easily during deformation of the end portions of the container and wrinkling is not always a serious problem. In current practice, metal containers are frequently manufactured from double reduced steel plate in order to save expenses on materials used. Regular steel for use in making can bodies is generally around ten thousandths of an inch thick. In current practice, such steel is double reduced by rolling it to a thickness of around six and one-half thousandths of an inch thick. Rolling the steel to a reduced thickness work hardens the steel and it does not flow readily under further deformation such as that which takes place during reduction of the terminal end portions of a cylindrical can body.

Conventional apparatus for reducing the end portion of a cylindrical can body formed from work hardened steel have been found to be inadequate because longitudinal wrinkles or fractures would form in the can body during deformation of the end portions thereof.

SUMMARY OF THE INVENTION

An apparatus and method for necking-in an end portion of a cylindrical can body includes an expandable and contractable gripping means for positively gripping the inner or outer peripheral surface of the can body over a major portion of the circumference and length thereof to positively hold the can body in a substantially cylindrical shape. The positive holding action of the gripping means prevents formation of wrinkles or fractures in the can body during the necking-in operation.

In accordance with one arrangement, a rotatably mounted female forming roll has a circumferential arcuate groove therein. The female forming roll is positionable within an open end portion of a cylindrical can body for deforming the terminal end portion thereof. A rotatably mounted male forming roll has a circumferential arcuate peripheral surface defining a rib which is receivable in the groove of the female forming roll. The male forming roll is positionable outside of the can body adjacent the terminal end portion thereof and with the rib on the male forming roll aligned with the groove on the female forming roll transversely of the longitudinal axis of the can body.

Power means is provided for rotating either the can body about its own longitudinal axis, or for rotating the female and male forming rolls in a circular path in order to pass the entire periphery of the terminal end portion of the can body between the female and male forming rolls.

Mounting means is provided for independently mounting each of the female and male forming rolls for movement toward and away from the longitudinal axis of the can body. A first operating means is provided for moving the female forming roll away from the longitudinal axis of the can body into engagement with the inner peripheral surface of the can body at the terminal end portion thereof. The power means then operates to move the entire periphery of the termial end portion of the can body between the forming rolls, and the female forming roll deforms the terminal end portion of the can body into an outwardly extending flange so that the terminal end edge of the can body increases in diameter. Formation of the outwardly extending flange on the terminal end portion of the can body reinforces the terminal end portion against bending and assists in prevention of wrinkles under further deformation during the necking-in operation. Second operating means is provided for moving the male forming roll toward the longitudinal axis of the can body and into engagement with the outer peripheral surface thereof at the terminal end portion to deform the terminal end portion into the arcuate groove in the female forming roll.

It has been found that positive gripping over a major portion of the circumference and length of the can body positively holds the can body in a substantially cylindrical shape and prevents the terminal end portion of the can body from becoming eccentric so that wrinkles or fractures cannot form therein during the necking-in operation. Formation of the outwardly extending flange prior to the necking-in operation is also very important in order to prevent wrinkles or fractures because the flange also reinforces the terminal end portion of the can body and holds it in a substantially true cylindrical shape. The pre-flanging operation also works the metal at the extreme terminal end of the can body to elongate the metal and relieve some of the stress which was placed therein by work hardening when reducing the thickness thereof.

In accordance with a preferred arrangement, the male forming roll has an end portion positioned adjacent the terminal edge of the can body. The end portion of the male roll has a circumferential shoulder thereon which is engageable with the terminal end edge of the can body during the necking-in operation. The circumferential shoulder on the male roll controls the length of the outwardly extending flange on the terminal end portion of the can body during the necking-in operation. Controlling the length of the flange results in a substantially precise outer peripheral edge on the deformed end portion of the can body so that no trimming operation is necessary prior to application of a closure to the end portion of the can body.

In accordance with another aspect of the invention, yieldable biasing means is provided for yieldably biasing the male forming roll toward the can body. Defor-

mation of can bodies having welded or soldered seams then allows the male forming roll to yield away from the can body against the force of the yieldable biasing means when the seam passes between the forming rolls. The yieldable biasing means also firmly holds the male forming roll against the terminal end portion of the can body to prevent bouncing of the male role when a seam passes between the rolls.

In a preferred arrangement, the can body to be deformed has a predetermined diameter, and each of the female and male forming rolls have a maximum diameter which is substantially less than the predetermined diameter of the can body. This allows positioning of the rolls for rotation on axes off the longitudinal center line of the can body which also assists in necking-in the end portion of the can body without formation of wrinkles or fractures, and without damage to enamel or laquer on the can body. In the preferred arrangement, the female forming roll has a minimum diameter across the groove therein and the male forming roll has a greatest diameter across its rib. These minimum and greatest diameters are substantially the same. This arrangement allows both the male and female forming rolls to rotate at substantially the same speed and to rotate substantially the same number of revolutions during passage of the terminal end portion of the can body therebetween.

In another arrangement, an adjustable stop is provided for the mounting means of the male forming roll for adjustably positioning the male forming roll adjacent the outer peripheral surface of the can body. In one arrangement, the mounting means for the female and male forming rolls comprises a pair of pivotally mounted bearing blocks which are movable toward and away from the longitudinal axis of the can body. A shaft is rotatably mounted on each of the bearing blocks for rotation about a shaft axis. The female forming roll is rotatably mounted on one of the shafts for rotation about a female roll is rotatably mounted on the other of the shafts for rotation about a male roll axis which is eccentric to the shaft axis. The operating means is connected to the shafts so that rotation of the shafts selectively moves the rolls toward and away from the can body due to the eccentricity of the roll axes to the axes of the shafts.

In accordance with another aspect of the invention, a stop collar is provided on the female roll for positioning the female roll within the open end portion of the can body. The stop collar is engageable with the terminal end edge of the can body for locating the female forming roll within the open end portion of the can body in predetermined relationship to the terminal end portion thereof.

In accordance with another aspect of the invention, the terminal end portion of a can body is deformed inwardly into an inwardly directed smoothly curved circumferential bead. The can body merges into the bead over a merging area. In a preferred arrangement, the male and female rolls have outer surfaces dimensioned and shaped for squeezing at least a portion of the terminal end portion of the can body during formation of the bead. These surfaces are shaped and dimensioned for maintaining the merging area free of squeezing engagement action between the surfaces of the roles during formation of the bead. This allows an outwardly directed circumferential hump to form in the merging area for relieving stress and preventing wrinkles in the terminal end portion of the can body.

In accordance with the invention, an improved necked-in can body is formed having a smoothly curved circumferential hump therein spaced inwardly from the terminal edge of the body. The terminal end portion is smoothly curved inward between the hump and the terminal end edge of the can body to form a circumferential bead extending inwardly. The hump allows the metal of the can body to relieve stresses so that wrinkles are not formed during formation of the bead.

It is a principal object of the present invention to provide an improved apparatus for necking-in terminal end portions of cylindrical metal can bodies.

It is also a principal object of the present invention to provide an improved method for necking-in terminal end portions of cylindrical metal can bodies.

It is a further object of the present invention to provide an improved apparatus and method for necking-in terminal end portions of can bodies without fracturing or wrinkling the metal, and without damaging enamel or laquer on the can body.

It is also an object of the present invention to provide an economical and efficient apparatus and method for necking-in terminal end portions of can bodies.

It is an additional object of the present invention to provide an improved substantially cylindrical body having at least one end portion thereof necked-in and free of wrinkles.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may take physical form in certain parts and arrangements of parts, a preferred embodiment of which will be described in detail in this specification and illustrated in the accompanying drawings which form a part hereof.

FIG. 1 is a top plan view of one form of apparatus constructed in accordance with the present invention and with portions in section for clarity of illustration;

FIG. 2 is a cross-sectional elevational looking in the direction of arrows 2—2 of FIG. 1;

FIG. 3 is a side elevational view looking in the direction of arrows 3—3 of FIG. 1;

FIG. 4 is an end elevational view looking in the direction of arrows 4—4 of FIG. 1;

FIG. 5 is a cross-sectional elevational view looking in the direction of arrows 5—5 of FIG. 4;

FIG. 6 is a cross-sectional elevational view looking in the direction of arrows 6—6 of FIG. 4;

FIG. 7 is a plan view looking generally in the direction of arrows 7—7 of FIG. 3, with portions cut away from clarity of illustration, and showing the arrangement of the rolls immediately after the terminal end portion of a can body has been positioned therebetween;

FIG. 8 is a view similar to FIG. 7 and showing the arrangement of the rolls and the terminal end portion of the can body after the inner female roll has been moved outwardly;

FIG. 9 is a view similar to FIGS. 7 and 8, and showing the arrangement of the rolls and the terminal end portion of the can body after the outer male forming roll has been moved into engagement with the terminal end portion of the can body;

FIG. 10 is a view similar to FIGS. 7–9, and showing the position of the rolls and the shape of the terminal end portion of the can body after the necking-in operation has been completed;

FIG. 11 is a partial cross-sectional elevational view of a can body which has been necked-in in accordance with the present invention and after an end closure has been applied thereto;

FIG. 12 is a view like FIG. 7 showing the initial position of the forming rolls prior to formation of the inwardly directed circumferential bead in the terminal end portion of a can body;

FIG. 13 is a view like FIG. 8 showing the forming roles in a further position for deforming the terminal end portion of a can body;

FIG. 14 is a view similar to view 12 and 13 showing a further position of the forming rolls;

FIG. 15 is a view similar to views 12–14 showing the position of the rolls after full movement thereof to deform the terminal end portion of the can body;

FIG. 16 is a view similar to FIG. 10 but showing a different shape for the terminal end portion of the can body; and

FIG. 17 is a view similar to FIG. 11 but showing a slightly different shape for the terminal end portion of the can body.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, wherein the showings are for purposes of illustrating a preferred embodiment of the invention only and not for purposes of limiting same, FIG. 1 shows an apparatus A for necking-in terminal end portions of cylindrical metal can bodies as shown at B. Can body B has a substantially cylindrical outer peripheral surface 12 and a substantially cylindrical inner peripheral surface 14. Can body B has at least one open end portion and a terminal end edge 16 at the open end portion thereof. Can body B further includes a terminal end portion 18 adjacent terminal end edge 16. It should be recognized that the apparatus and method of the present invention can be used with cylindrical can bodies which are open at both ends thereof or with drawn cylindrical can bodies having integral closed bottoms. It should also be recognized that the apparatus of the present invention can be used with can bodies which are formed of aluminum steel, and which may be seamless, or have welded or soldered seams. In the arrangement shown in FIG. 1 for purposes of illustration, can body B is open at both ends thereof.

In the arrangement shown, a rotatable mandrel C defines a gripping means for positively gripping can body B to hold can body B in a substantially true cylindrical shape. Mandrel S is rotatably mounted as in bearing D and has a pulley 22 attached thereto.

A belt 24 connects pulley 22 with output shaft 26 of motor 28. Mandrel C is a one-piece cylindrical metal member having a substantially cylindrical outer periphery and a tapered central conical bore 30 therethrough. A plurality of circumferentially spaced axially extending slots 32 are formed in mandrel C to define a plurality of gripping members 34. Slots 32 extend from end 36 of mandrel C toward pulley 22 over a major portion of the length of mandrel C. End portion 38 of mandrel C has a threaded bore 40 therein. A conical wedge member E is positionable within bore 30 for expanding gripping members 34 radially outward from longitudinal axis 42 of mandrel C. Wedge member E has a circular hole 44 therethrough and a conical outer surface 46 which is tapered at the same slope as bore 30. A bolt F having a threaded end 48 and an enlarged head 50 is receivable through hole 44. Threaded end 48 threads into threaded bore 40 and tightening of bolt F moves wedge member E axially inward into tapered bore 30 to apply an outward expanding force on gripping members 34. Gripping members 34 then expand radially outward from longitudinal axis 42 to tightly and positively grip inner peripheral surface 14 of can body B. In the preferred arrangement, gripping members 34 grip inner peripheral surface 14 over substantially the entire circumference and length thereof. It is desirable that the gripping means positively engages the peripheral surface of can body B over at least a major portion of the circumference and length thereof to positively hold can body B in a cylindrical configuration. Motor 28 may be energized to rotate mandrel C and can body B for purposes of necking-in terminal end portion 18 of can body B.

It should be recognized that many other gripping arrangements may be used to positively hold can body B. For example, a pair of arcuate wing members may positively grip outer peripheral surface 12 of can body B so that an outside gripping means is used instead of an inner mandrel as shown at C. It should be recognized that it is also possible to grip either the inner or outer peripheral surface of can body B in such a manner that it is possible to reduce the diameter of both terminal end portions of can body B simultaneously.

In a preferred arrangement, end 36 of gripping means C is positioned as close to terminal end portion 18 of can body B as is practical. The expandable and contractable gripping means defined by mandrel C and gripping members 34 positively holds can body B in a substantially true cylindrical shape during necking-in of end portion 18 so that wrinkles cannot form in can body B. Bolt F may be loosened to allow gripping members 34 to move radially inward toward longitudinal axis 42 for removing can body B from mandrel C. It will be recognized that many other types of expandable and contractable gripping means may be utilized for gripping a can body B during deformation thereof. Longitudinal axis 42 of mandrel C also defines the longitudinal central axis of can body B. For purposes of description, can body B may be considered as defining a first structure.

Necking-in apparatus A includes a mounting structure G for rolls which are utilized to deform terminal end portion 18 of can body B. Mounting structure G includes a block member 56 having a pair of spaced-apart holes 58 and 60 therethrough. Sleeve bearings 62 and 64 are received in holes 58 and 60. Shafts 66 and 68 are rotatably received in sleeve bearings 62 and 64. Shafts 66 and 68 have threaded end portions 70 and 72 threaded into threaded bores 74 and 76 in bearing blocks 78 and 80. Shafts 66 and 68 have opposite threaded ends 82 and 84 on which lock nuts 86 and 88 are threaded. It will be recognized that many other arrangements may be used for mounting shafts 66 and 68 in block 56 and for attaching bearing blocks 78 and 80 thereto. Bearing blocks 78 and 80 are rotatable with shafts 66 and 68 about longitudinal axes 90 and 92.

In accordance with one arrangement, bearing block 78 has a hole 96 therethrough receiving a sleeve bearing 98. A shaft 102 extends through sleeve bearing 98 and has a female forming roll H rotatably mounted thereon by means of bearing 104. Shaft 102 has threaded portions 106 and 108 for receiving lock nuts 110 and 112 to hold roll bearing 104 on shaft 102 and

to hold shaft 102 in sleeve bearing 98. Bearing washers 114 and 116 may be positioned respectively between nut 110 and bearing 104, and between nut 112 and bearing block 78. An additional bearing washer 118 may be positioned between female forming roll H and bearing block 78.

Female forming roll H has a circumferential arcuate groove 120 therein to define a concave arcuate outer surface on the outer periphery thereof. Female forming roll H further has a first end portion 122 of a first diameter, and a second end portion 124 of a second diameter which is greater than the first diameter of first end portion 122. A cylindrical member 126 may be positioned on female forming roll H adjacent second end portion 124 thereof to serve as a stop collar. Stop collar 126 has a radially extending circumferential surface 128 which extends outwardly beyond the outer peripheral surface of female forming roll H.

Shaft 102 is eccentric so as to rotate in sleeve bearing 98 about longitudinal axis 130, while female forming roll H rotates about a longitudinal axis 132 which is offset from longitudinal axis 130. A block member 134 may be welded or otherwise secured to mounting block 56. Block member 134 has a threaded hole 136 therethrough threadedly receiving adjustment bolt 138 which strikes against bearing block 78, as best shown in FIG. 4, to adjustably rotate bearing block 78 about longitudinal axis 90. Bearing block 78 has another hole 142 therethrough slidably receiving a pin 144. An enlarged threaded bore 146 is coaxial with bore 142 and receives a set screw 148 which bears against pin 144 to adjustably position pin 144 with the end portion thereof extending out of bore 142 and bearing against bearing block 80 to adjustably hold bearing block 80 in a predetermined spaced position relative to bearing block 78.

Bearing block 80 has a hole 152 therethrough receiving sleeve bearing 154. A shaft 156 is rotatably received through sleeve bearing 154 and has a male forming roll I rotatably mounted thereon by means of bearing 160. Male forming roll I has a circumferential arcuate convex peripheral surface defining a rib 162 which is receivable in groove 120 of female forming roll H. Male forming roll I also has an end portion defining a flat cylindrical shoulder 164. Shaft 156 has threaded portions 166 and 168 for receiving lock nuts 170 and 172 to hold bearing 160 thereon and to hold shaft 156 in sleeve bearing 154. Bearing washers 174 and 176 may be positioned beneath nuts 170 and 172. A bearing washer 178 may also be positioned between bearing block 80 and an enlarged portion 182 of shaft 156. Shaft 156 is eccentric so that it rotates in sleeve bearing 154 about a longitudinal axis 184, while male forming roll I rotates about a longitudinal axis 186 which is offset from axis 184.

In accordance with a preferred arrangement, bearing block 80 is yieldably biased toward bearing block 78. In one arrangement, a block member 190 is welded or otherwise suitably secured to the opposite side of mounting block 56. Block member 190 has a threaded bore 192 receiving an adjustment set screw 194. A coil spring 196 has one end positioned in an enlarged bore 198 which is coincidental with hole 192, and its other end received in a recess 202 in bearing block 80. Coil spring 196 defines a yieldable biasing means which biases against bearing block 80 to rotate bearing block 80 about a longitudinal axis 92 to move male forming roll I toward female forming roll H. The force with which spring 196 biases against bearing block 80 may be adjusted by means of set screw 194. Pin 144 adjustably holds bearing block 80 in spaced relation to bearing block 78 so that rolls H and I are normally spaced-apart and terminal end portion 18 of can body B may be positioned therebetween.

In one arrangement, first and second operating means defined by levers 206 and 208 are secured to shafts 102 and 156. Levers 206 and 208 have socket head portions 210 and 212 receiving the end portions of shafts 102 and 156. Set screws 214 and 216 may be threaded through suitable holes in socket head portions 210 and 212 for locking levers 206 and 208 on shafts 102 and 156. The eccentric or offset relationship of longitudinal axis 130 for shaft 102, and longitudinal axis 132 about which female forming roll H rotates, is such that movement of lever 206 in a counterclockwise direction as viewed in FIG. 4 rotates shaft 102 within bearing 98 to move female forming roll H to the left as viewed in FIG. 4. Clockwise rotation of lever 206 and shaft 102, as viewed in FIG. 4, will move female forming roll H to the right as viewed in FIG. 4.

Clockwise rotation of lever 208, as viewed in FIG. 4, rotates shaft 156 clockwise as viewed in FIG. 4. The eccentric relationship between longitudinal axis 184 of shaft 156, and longitudinal axis 186 about which male forming roll I rotates, is such that male forming roll I moves to the right as viewed in FIG. 4. Counterclockwise rotation of lever 208 and shaft 156, as viewed in FIG. 4, will move male forming roll I to the left.

It will be recognized that many other arrangements may be provided for moving rolls H and I, and cams may be provided for automatically moving rolls H and I. Mounting block 56 may be slidable on a base 220 for movement toward and away from mandrel C. A key 222 on base 220 may be slidably received in a key way 224 in the bottom of mounting block 56. Many other arrangements may be provided for moving rolls H and I toward mandrel C and it is also possible to have rolls H and I fixed against such movement, and with mandrel C movable toward and away from rolls H and I.

In operation of the device, a cylindrical can body B is mounted on mandrel C. The gripping means is then adjusted so that gripping members 34 positively grip inner peripheral surface 14 of can body B over a major portion of the circumference and length thereof. Rolls H and I are normally in spaced-apart relationship as shown in FIG. 7. Mounting block 56 is then moved toward mandrel C to position terminal end portion 18 of can body B between rolls H and I. Female forming roll H is positioned within the open end portion of can body B, and mounting block 56 is moved toward mandrel C until surface 128 on stop collar 126 strikes against terminal end edge 16 of can body B. This accurately locates female forming roll H within the open end portion of can body B with second end portion 124 thereof located adjacent terminal end edge 16, and with first end portion 122 thereof spaced axially inward of can body B from terminal end edge 16. Motor 28 is then energized to rotate mandrel C and can body B. While can body B is rotating, lever 206 is moved counterclockwise, as viewed in FIG. 4, to move female forming roll H in a direction away from longitudinal axis 42 and into engagement with inner peripheral surface 14 at terminal end portion 18. Female forming roll H is moved outwardly until first end portion 122 is positioned sub-

stantially against inner peripheral surface **14** of can body B adjacent terminal end portion **18** thereof. Second end portion **124** of female forming roll H engages inner peripheral surface **14** of can body B at terminal end portion **18** thereof to increase the diameter of can body B at terminal end edge **16** and deform terminal end portion **18** into an outwardly extending flange as shown in FIG. **8.** Formation of the outwardly extending flange reinforces the terminal end portion of can body B against wrinkling and also relieves some of the work hardened stress in the metal of can body B. Subsequent to formation of an outwardly extending flange on terminal end portion **18** of can body B, male forming roll I is moved toward longitudinal axis **42** and can body B by rotating lever **208** clockwise as viewed in FIG. **4.** Rib **162** of male forming roll I engages outer peripheral surface **12** of can body B at terminal end portion **18** and moves into groove **120** in female forming roll H to reduce the diameter of can body B at terminal end portion **18.** During the necking-in operation, terminal end edge **16** of can body B engages shoulder **164** on male forming roll I in order to control the length of the outwardly extending flange on can body B. Circumferential shoulder **164** on male forming roll I has a width greater than the thickness of can body B at the terminal end edge thereof so that second end portion **124** of female forming roll H may engage shoulder **164** outwardly of terminal end edge **16** as shown in FIG. **9.** Subsequent to the necking-in operation, levers **206** and **208** are moved back to the original positions to move rolls H and I away from one another to the positions shown in FIG. **10.** The necking-in operation results in a can body having a terminal end portion which curves arcuately inward and then arcuately outward to terminate in a terminal end edge which extends slightly radially outward beyond the outer peripheral cylindrical surface of can body B. A closure **232** may then be applied to the necked-in end portion of can body B as shown in FIG. **11.** The necked-in end portion of can body B is reversely folded and interdigitated with a reversely bent end portion **234** of closure **232.**

It will be recognized that other arrangements may be provided for achieving relative movement between terminal end portion **18** of can body B and the forming rolls in order to pass the entire periphery of terminal end portion **18** between the two forming rolls. For example, can body B may be held stationary while rolls H and I are mounted on a traversing device which will move the two forming rolls in a circular path around terminal end portion **18** of can body B. It is also possible to drive forming rolls H and I while can body B is simply mounted on a rotatable gripping device. Yieldably biasing bearing block **80** toward longitudinal axis **42** allows male forming roll I to move away from longitudinal axis **42** when a welded or soldered seam passes between rolls H and I.

In accordance with another aspect of the invention, with reference to FIGS. **12–16,** rolls H and I may be manipulated, and are dimensioned and shaped, for producing an outwardly directed circumferential hump in the terminal end portion of can body B spaced inwardly from terminal end edge **16.** In one arrangement, female forming roll H is moved outwardly into engagement with the terminal end portion of can body B. First end portion **124** of female forming roll H forms an outwardly directed flange on the very terminal end portion of can body B. First end portion **122** of female forming roll H contacts the inner surface **14** of can body B at a position spaced inwardly from terminal end edge **16** for forming an outwardly directed circumferential hump **250** therein. Male forming roll I is then moved inwardly for forming an inwardly directed and smoothly curved circumferential bead between hump **250** and terminal end edge **16.** While the terminal end portion of can body B is squeezed between the outer surfaces of rolls H and I, the metal must have some place to flow and hump **250** provides such a place where the metal can relieve itself of stress so that the inwardly directed circumferential bead will be formed in can body B without any wrinkling. The arrangement described produces a can body shown in FIG. **16** having a slight and smoothly curved circumferential hump **250** projecting outwardly slightly from the outer surface of can body B as shown by shadow line **254.**

It will be recognized that can body B merges into the inwardly directed circumferential bead over a circumferential area identified by numeral **256** and which may be termed a merging area. In the preferred arrangement, rolls H and I have the mating outer surfaces thereof shaped and dimensioned for maintaining merging area **256** free of squeezing action between rolls H and I during deformation of the terminal end portion of the can body. This allows hump **250** to form in the can body and it is not squeezed down because the rolls do not engage the can body over that area. It will be recognized that it is possible to have female forming roll H engaging inner surface **14** of can body B over merging area **256** but outer male roll I is shaped and dimensioned so that it is spaced from outer surface **12** of can body B so that hump **250** can form therein. In one arrangement, the width of groove **120** is greater than the width of rib **162** on male roll I. In addition, the depth of groove **120** as measured from its bottom and the outer periphery of first end portion **122** is represented by numeral **258.** The height of rib **162** on male roll I is represented by numeral **260.** Distance **260** is preferably slightly greater than the sum of distance **258** plus the thickness of can body B.

Although it is possible to positively form hump **250** as described with reference to FIG. **14,** it has also been found that it is possible to move female roll H outwardly so that first end portion **122** thereof is simply very near inner surface **14** of can body B while the terminal end edge of can body B is deformed outwardly into a flange. Male forming roll I is then moved inwardly to form the inwardly directed circumferential bead as shown in FIG. **15.** Even without first end portion **122** of roll H projecting outwardly far enough to positively form hump **250,** it has been found that hump **250** will form as the inwardly directed circumferential bead is formed. This is believed to be due to the metal stress relieving itself over merging area **256** where can body B merges into the circumferential bead. To allow formation of circumferential hump **250** in this manner, it will be recognized that it is necessary that the outer mating surfaces of rolls H and I be dimensioned and shaped for maintaining merging area **256** free of squeezing action between those surfaces during formation of the inwardly directed circumferential bead.

In considering the finished can body, diameters may be measured either from the inner surface thereof, the outer surface thereof or by using nominal diameters. With the arrangement described, it will be recognized that the can body B has a substantially uniform diame-

ter throughout its length. Hump **250** has a diameter slightly greater than the uniform diameter. The inwardly directed circumferential bead between hump **250** and terminal end edge **16** has a diameter which is less than the defined uniform diameter. The difference between the inwardly directed bead diameter and the uniform diameter is preferably substantially greater than the difference between the hump diameter and the uniform diameter. By way of further example, a can body having an outer uniform diameter of two and five-eighths inches is deformed in such a manner that the outer diameter thereof at hump **250** is **2 21/32** inches while the outer diameter thereof at the inwardly directed circumferential bead is 2 ½ inches. This provides a difference between the hump diameter and the uniform diameter of only one-thirty-secondths of an inch while the difference between the bead diameter and the uniform diameter is five-thirty-secondths of an inch. Thus, the difference between the bead diameter and the uniform diameter is five times the difference between the hump diameter and the uniform diameter. Hump **250** is also smoothly curved outward from the longitudinal axis of can body B in a direction toward terminal end edge **16** and is then reversely curved inward toward the longitudinal axis of can body B in a direction toward terminal end edge **16.** Where it reverses its curvature, hump **250** also merges directly into the inwardly directed circumferential bead. Hump **250** also has a width measured parallel to the longitudinal axis of can body B which is substantially less than the width of the inwardly directed circumferential bead.

Shaping and dimensioning the outer surfaces of groove **120** and rib **162** on rolls H and I so that they will not squeeze can body B in merging area **256** during formation of the inwardly directed bead has been found to be very important for preventing wrinkling of the terminal end portion of can body B. This shaping and dimensioning allows hump **250** to form of its own accord in order to stress relieve the metal in the terminal end portion of can body B. It is theorized that the reduction in diameter of can body B in the area where the inwardly directed circumferential bead is formed tends to increase the thickness of the metal so that wrinkles would not develop but some of this tendency for the metal to thicken is taken up by the expansion of metal and formation of hump **250.**

For purposes of description and definition, the can body may be considered a first structure, while the female and male forming rolls together define a second structure. At least one of these structures is rotatable for moving the entire periphery of the terminal end portion of the can body past the forming rolls.

While the invention has been shown and described with respect to a preferred embodiment, it is obvious that equivalent alterations and modifications will occur to others skilled in the art upon the reading and understanding of this specification. The present invention includes all such equivalent alterations and modifications and is limited only by the scope of the claims.

Having thus described my invention, I claim:

1. Apparatus for necking-in at least one end portion of a substantially cylindrical can body having inner and outer peripheral surfaces and at least one open end portion, said can body having a terminal end edge at said open end portion and a terminal end portion adjacent said terminal end edge, said can body defining a first structure and having a longitudinal axis, comprising; expandable and contractible gripping means for positively gripping one of said peripheral surfaces over a major portion of the circumference thereof and over a major portion of the length of said can body to positively hold said can body in a substantially cylindrical shape, rotatably mounted female forming roll means having a circumferential arcuate groove therein defining a concave arcuate surface terminating at spaced-apart first and second end portions, said first end portion having a first diameter and said second end portion having a second diameter greater than said first diameter, said female forming roll means being positionable within said open end portion of said can body with said second end portion thereof located adjacent said terminal end edge for deforming said terminal end portion, rotatably mounted male forming roll means having a circumferential arcuate convex peripheral surface defining a rib receivable in said groove, said male forming roll means being positionable outside of said can body adjacent said terminal end portion with said rib aligned with said groove, said female and male forming roll means together defining a second structure, power means for rotating at least one of said first and second structures to pass the entire periphery of said terminal end portion of said can body between said female and male forming roll means, mounting means for independently mounting each of said female and male forming roll means for movement toward and away from said longitudinal axis of said can body, first operating means for moving said female forming roll means away from said longitudinal axis to engage said second end portion thereof with said inner peripheral surface adjacent said terminal end edge to deform said terminal end edge outwardly and provide an outwardly extending flange on said terminal end portion, and second operating means operable subsequent to said first operating means for moving said male forming roll means toward said longitudinal axis into engagement with said outer peripheral surface at said terminal end portion inwardly of said terminal end edge to deform said terminal end portion into said arcuate groove in said female forming roll means and squeeze said flange between portions of said groove and rib.

2. The device of claim **1** wherein said male forming roll means has an end portion aligned with said second end portion of said female forming roll means transversely of said longitudinal axis of said can body, said end portion of said male forming roll means having a circumferential shoulder engageable with said terminal end edge of said can body during deformation of said terminal end portion.

3. The device of claim **2** and further including yieldable biasing means for biasing said male forming roll means toward said longitudinal axis of said can body.

4. The device of claim **3** wherein said can body has a predetermined diameter and each of said female and male forming roll means has a maximum diameter substantially less than said predetermined diameter.

5. The device of claim **4** wherein said female forming roll means has a minimum diameter across said groove and said male forming roll means has a greatest diameter across said rib, said minimum and greatest diameters being substantially the same.

6. The device of claim **5** and further including adjustable stop means for said mounting means of said male forming roll means for adjustably positioning said male

forming roll means adjacent said outer peripheral surface of said can body.

7. The device of claim **6** wherein said mounting means for said female and male forming roll means comprises a pair of pivotally mounted bearing block means movable toward and away from said longitudinal axis of said can body, a shaft rotatably mounted on each of said bearing blocks for rotation about a shaft axis, said female forming roll means being rotatably mounted on one of said shafts for rotation about female roll axis eccentric to said shaft axis, said male forming roll means being rotatably mounted on the other of said shafts for rotation about a male roll axis eccentric to said shaft axis.

8. The device of claim **7** and further including stop collar means on said female forming roll means for positioning said female forming roll means within said open end portion of said can body, said stop collar means being engageable with said terminal end edge of said can body for locating said female forming roll means within said open end portion in predetermined relationship to said terminal end portion.

9. The device of claim **8** wherein said gripping means is positionable within said can body for gripping said inner peripheral surface.

10. The device of claim **1** wherein said male forming roll means has an end portion aligned with said terminal end edge transversely of said longitudinal axis of said can body, said end portion of said male forming roll means having a circumferential shoulder engageable with said terminal end edge of said can body during deformation of said terminal end portion.

11. The device of claim **1** and further including yieldable biasing means for biasing said male forming roll means toward said longitudinal axis of said can body.

12. The device of claim **1** wherein said can body has a predetermined diameter and each of said female and male forming roll means has a maximum diameter substantially less than said predetermined diameter.

13. The device of claim **1** wherein said female forming roll means has a minimum diameter across said groove and said male forming roll means has a greatest diameter across said rib, said minimum and greatest diameters being substantially the same.

14. The device of claim **1** and further including adjustable stop means for said mounting means of said male forming roll means for adjustably positioning said male forming roll means adjacent said outer peripheral surface of said can body.

15. The device of claim **1** wherein said mounting means for said female and male forming roll means comprises a pair of pivotally mounted bearing block means movable toward and away from said longitudinal axis of said can body, a shaft rotatably mounted on each of said bearing blocks for rotation about a shaft axis, said female forming roll means being rotatably mounted on one of said shafts for rotation about female roll axis eccentric to said shaft axis, said male forming roll means being rotatably mounted on the other of said shafts for rotation about a male roll axis eccentric to said shaft axis.

16. The device of claim **15** and further including yieldable biasing means for biasing said bearing block for said male forming roll means toward said longitudinal axis of said can body.

17. The device of claim **1** and further including stop collar means on said female forming roll means for positioning said female forming roll means within said open end portion of said can body, said stop collar means being engageable with said terminal end edge of said can body for locating said female forming roll means within said open end portion in predetermined relationship to said terminal end portion.

18. The device of claim **1** wherein said gripping means is positionable within said can body for gripping said inner peripheral surface.

19. The device of claim **1** wherein said one structure rotated by said power means is defined by said can body.

20. The device of claim **1** wherein said rib and groove have outer surfaces between which said terminal end portion of said can body is squeezed and said can body merges into said bead in a merging area, said rib and groove being shaped and dimensioned for maintaining said merging area free of squeezing action between said outer surfaces of said rib and groove when said rib is received in said groove during formation of said groove so that said merging area is free to develop an outwardly directed circumferential hump therein.

21. Apparatus for necking-in at least one end portion of a substantially cylindrical can body having inner and outer peripheral surfaces and at least one open end portion, said can body having a terminal end edge at said open end portion and a terminal end portion adjacent said terminal end edge, said can body defining a first structure and having a longitudinal axis, comprising; expandable and contractible gripping means for positively gripping at least one of said peripheral surfaces over a major portion of the circumference thereof adjacent said terminal end portion to positively hold said terminal end portion in a substantially cylindrical shape, rotatably mounted female forming roll means having a first end portion of a first diameter and a second end portion of a second diameter greater than said first diameter, said female forming roll having a circumferential arcuate groove therein defining a concave arcuate surface extending between said first and second ends thereof, said female forming roll means being positionable within said open end portion of said can body with said second end portion thereof positioned adjacent said terminal end edge and with said first end spaced inward axially of said can body from said terminal end edge for deforming said terminal end portion, rotatably mounted male forming roll means having a circumferential arcuate convex peripheral surface defining a rib receivable in said groove, said male forming roll means being positionable outside of said can body adjacent said terminal end portion with said rib aligned with said groove transversely of said longitudinal axis, said female and male forming roll means defining a second structure, power means for rotating at least one of said first and second structures to pass the entire periphery of said terminal end portion of said can body between said female and male forming roll means, mounting means for independently mounting each of said female and male forming roll means for movement toward and away from said longitudinal axis of said can body, first operating means for moving said female forming roll means away from said longitudinal axis to position said first end portion thereof substantially against said inner peripheral surface and to engage said second end portion thereof with said terminal end portion to increase the diameter of said can body at said terminal end edge and deform said terminal end por-

tion into an outwardly extending flange during operation of said power means, and second operating means for moving said male forming roll means toward said longitudinal axis into engagement with said outer peripheral surface at said terminal end portion and for positioning said rib within said groove to deform said terminal end portion inwardly.

22. The device of claim **21** wherein said male forming roll means has an end portion positioned adjacent said terminal end edge, said end portion of said male forming roll means having a circumferential shoulder thereon engageable with said terminal end edge of said can body during deformation of said terminal end portion.

23. The device of claim **22** wherein said circumferential shoulder has a width greater than the thickness of said can body at said terminal end edge and said second end portion of said female forming roll means engages said shoulder outwardly of said terminal end edge during deformation of said terminal end portion.

24. The device of claim **21** wherein said can body has a longitudinal seam and further including yieldable biasing means for biasing said male forming roll means toward said longitudinal axis whereby said seam acts against said male forming roll means to move said male forming roll means away from said longitudinal axis against biasing force of said yieldable biasing means.

25. The device of claim **21** and further including stop collar means on said female forming roll means adjacent said second end portion thereof for positioning said female forming roll means within said open end portion of said can body, said stop collar means being engageable with said terminal end edge of said can body for locating said female forming roll means within said open end portion in predetermined relationship to said terminal end portion.

26. The device of claim **21** wherein said rib and groove have outer surfaces between which said terminal end portion of said can body is squeezed and said can body merges into said bead in a merging area, said rib and groove being shaped and dimensioned for maintaining said merging area free of squeezing action between said outer surfaces of said rib and groove when said rib is received in said groove during formation of said groove so that said merging area is free to deveop an outwardly directed circumferential hump therein.

27. A method of necking-in at least one end portion of a substantially cylindrical can body having inner and outer peripheral surfaces and at least one open end portion, said can body having a terminal end edge at said open end portion and a terminal end portion adjacent said terminal end edge, said can body having a longitudinal axis, comprising the steps of; positioning a rotatable female forming roll having a circumferential groove therein within said open end portion, relatively moving said terminal end portion and said female forming roll past one another, moving said female forming roll away from said longitudinal axis into engagement with said inner peripheral surface at said terminal end portion and deforming said terminal end portion outwardly into an outwardly extending flange while increasing the diameter of said can body at said terminal end edge, moving a male forming roll having a peripheral rib into engagement with said outer peripheral surface at said terminal end portion inwardly of said flange, and moving said male forming roll toward said longitudinal axis to position said rib within said groove and deform said terminal end portion inwardly therebetween while squeezing said flange.

28. The method of claim **27** and further including the step of positively gripping one of said inner and outer peripheral surfaces over a major portion of the circumference thereof and over a major portion of the length of said can body to positively hold said can body in a substantially cylindrical shape prior to said step of positioning said female forming roll within said open end portion.

29. The method of claim **27** wherein said female forming roll includes a stop collar and further including the step of engaging said terminal end edge against said stop collar during said step of positioning said female forming roll within said open end portion to locate said female forming roll within said open end portion in predetermined relationship to said terminal end portion.

30. The method of claim **27** wherein said male forming roll includes an end portion having a circumferential shoulder thereon and further including the step of engaging said terminal end edge with said circumferential shoulder during said step of deforming said terminal end portion between said groove and rib.

31. Apparatus for necking-in at least one end portion of a substantially cylindrical can body having inner and outer peripheral surfaces and at least one open end portion, said can body having a terminal end edge at said open end portion and a terminal end portion adjacent said terminal end edge, said can body defining a first structure and having a longitudinal axis, comprising; expandable and contractible gripping means for positively gripping at least one of said peripheral surfaces over a major portion of the circumference thereof adjacent said terminal end portion to positively hold said terminal end portion in a substantially cylindrical shape, rotatably mounted female forming roll means having a first end portion of a first diameter and a second end portion of a second diameter greater than said first diameter, said female forming roll having a circumferential arcuate groove therein defining a concave arcuate surface extending between said first and second ends thereof, said female forming roll means being positionable within said open end portion of said can body with said second end portion thereof positioned adjacent said terminal end edge and with said first end spaced inward axially of said can body from said terminal end edge for deforming said terminal end portion, rotatably mounted male forming roll means having a circumferential arcuate convex peripheral surface defining a rib receivable in said groove, said male forming roll means being positionable outside of said can body adjacent said terminal end portion with said rib aligned with said groove transversely of said longitudinal axis, said female and male forming roll means defining a second structure, power means for rotating at least one of said first and second structures to pass the entire periphery of said terminal end portion of said can body between said female and male forming roll means, mounting means for independently mounting each of said female and male forming roll means for movement toward and away from said longitudinal axis of said can body, first operating means for moving said female forming roll means away from said longitudinal axis to engage said second end portion thereof with said terminal end portion for deforming said terminal end portion into and outwardly extending flange and increasing the diameter of said can body at said terminal end edge and

to engage said first end portion thereof with said inner peripheral surface at a position spaced inwardly from said terminal end edge for forming an outwardly extending circumferential hump in said can body and second operating means for moving said male forming roll means toward said longitudinal axis into engagement with said outer peripheral surface at said terminal end portion and for positioning said rib within said groove to deform said terminal end portion inwardly between said hump and said terminal end edge.

32. A method for necking-in at least one end portion of a substantially cylindrical can body having inner and outer peripheral surfaces and at least one open end portion, said can body having a terminal end edge at said open end portion and a terminal end portion adjacent said terminal end edge, said can body having a longitudinal axis, comprising the steps of; positioning within said open end portion a rotatable female forming roll having a circumferential groove therein between spaced-apart first and second end portions, relatively moving said terminal end portion and said female forming roll past one another, moving said female forming roll away from said longitudinal axis to engage said first and second end portions thereof with said inner peripheral surface at said terminal end portion for deforming said terminal end portion into an outwardly extending flange by increasing the diameter of said can body at said terminal end edge with said second end portion of said female forming roll and for forming an outwardly extending circumferential hump in said can body with said first end portion of said female forming roll at a position spaced inwardly from said terminal end edge, moving a male forming roll having a peripheral rib into engagement with said outer peripheral surface at said terminal end portion between said terminal end edge and said hump, and moving said male forming roll toward said longitudinal axis to position said rib within said groove and deform said terminal end portion inwardly between said terminal end edge and said hump.

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