United States Patent [19]

Heinle

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[45] **Sept. 11, 1973**

[54] **APPARATUS FOR NECKING-IN TUBULAR MEMBERS**

[75] Inventor: **Carl William Heinle,** Pompano Beach, Fla.

[73] Assignee: **American Can Company,** Greenwich, Conn.

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Related U.S. Application Data

[62] Division of Ser. No. 231,207, March 2, 1972.

[52] **U.S. Cl.** ..... **72/354,** 113/1 G, 113/120 AA

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

[58] **Field of Search** ..... 72/352, 353, 354, 72/370; 113/1 G, 120 AA, 120 R

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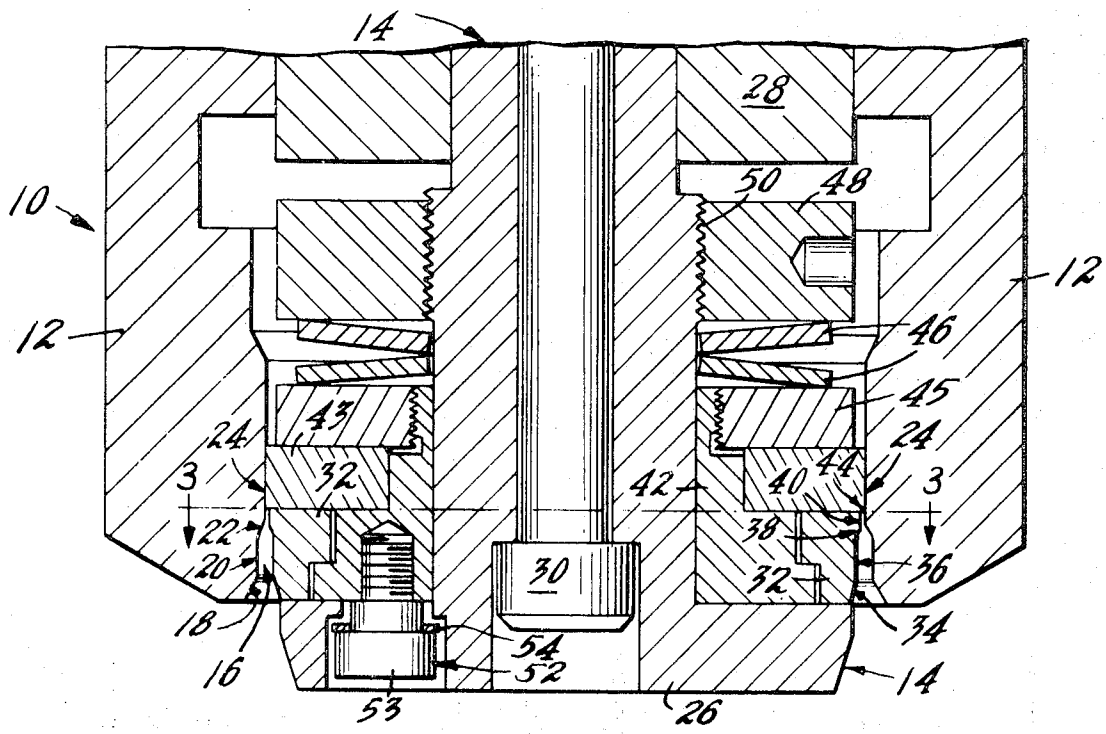
Primary Examiner—Richard J. Herbst

Attorney—Robert P. Auber, George P. Ziehmer et al.

[57] **ABSTRACT**

Method and die assembly for necking-in tubular members wherein the die assembly comprises an outer reducing die and an inner die pilot comprised of a T-shaped holder on which is mounted a pilot ring that floats radially on an also mounted spring biased axially floating retaining ring means. The reducing die has a recessed inwardly angled directing surface on the wall of its inner chamber, and the pilot ring has a wide diameter circumferential step surface and two supporting surfaces of lesser diameter. A clearance is provided between the pilot ring supporting surfaces and the outer reducing die. The outer reducing die is brought into telescoping engagement with the marginal edge portion of the wall of a tubular member. This causes the reducing die directing surface to direct the marginal edge portion inwardly against the pilot ring step whereby the edge portion is directed into a groove formed by the pilot ring, the outer reducing die and a control surface which transversely engages the edge of the wall and controls its axial movement in relation to the die assembly. In the groove, the marginal edge portion is formed into a rim of reduced diameter. As the outer reducing die continues to move axially over the tubular wall, the directing surface directs the flow of tubular wall material into the aforementioned clearance and toward the lesser diameter pilot ring surfaces against and along which it rests to form a neck having a diameter less than that of the rim.

10 Claims, 9 Drawing Figures



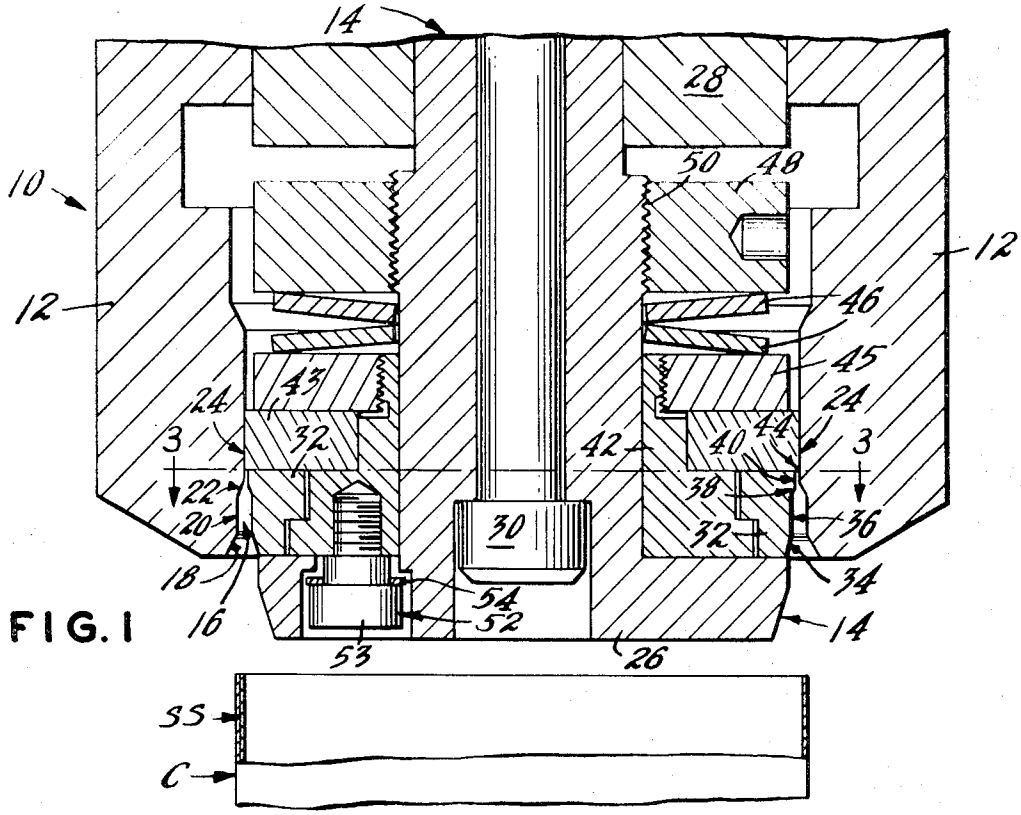


FIG. 1

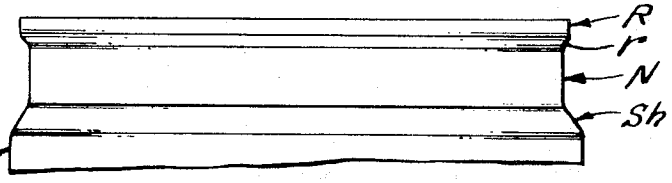


FIG. 2

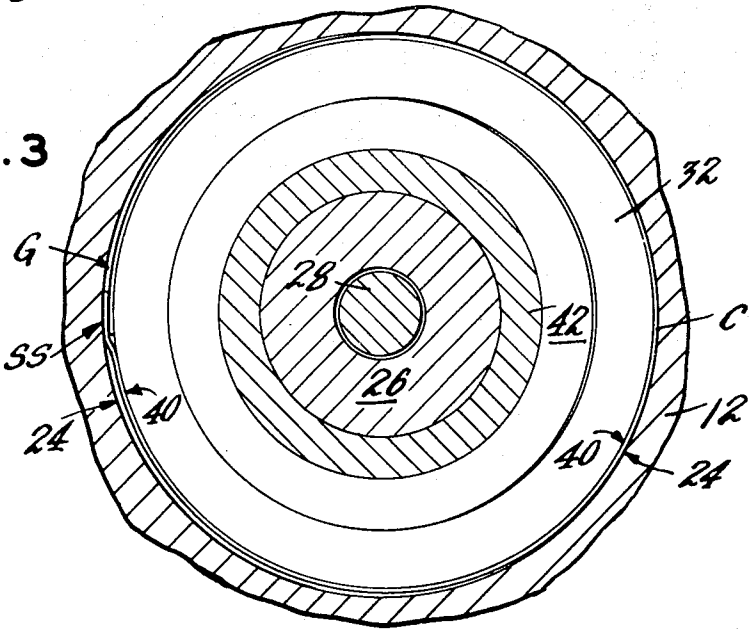


FIG. 3

FIG. 6

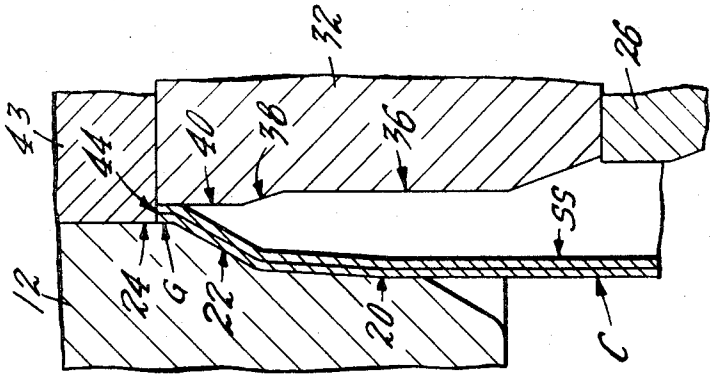


FIG. 5

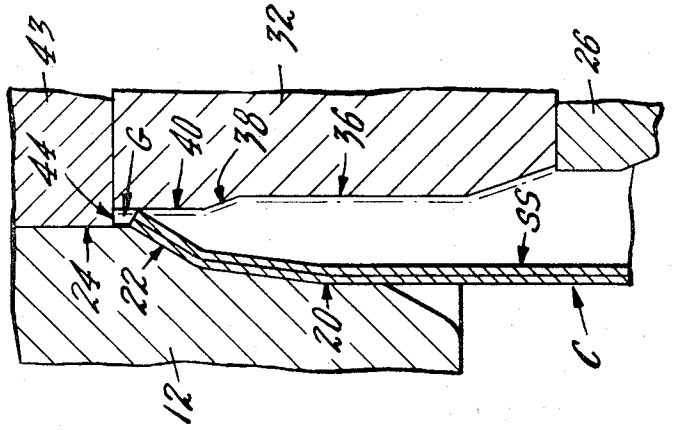


FIG. 4

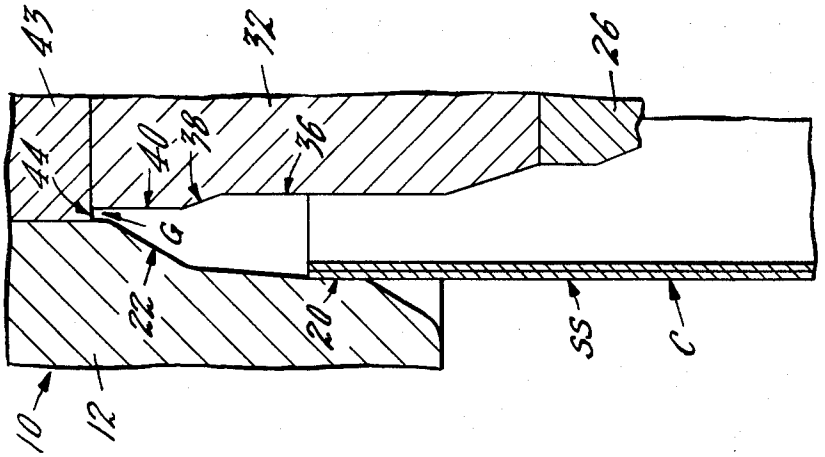


FIG. 9

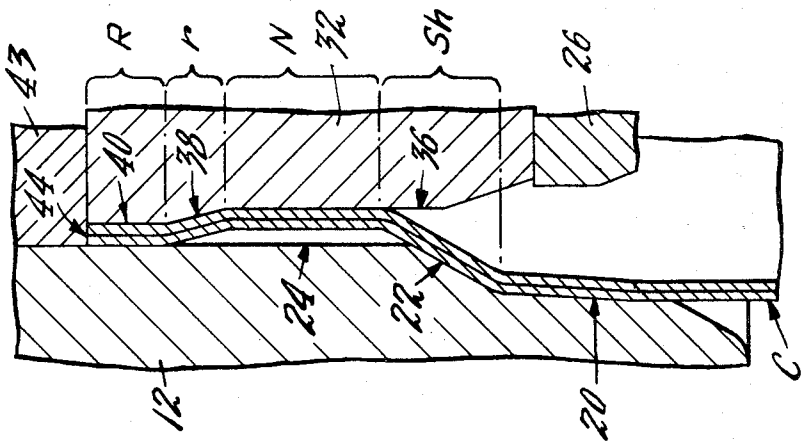


FIG. 8

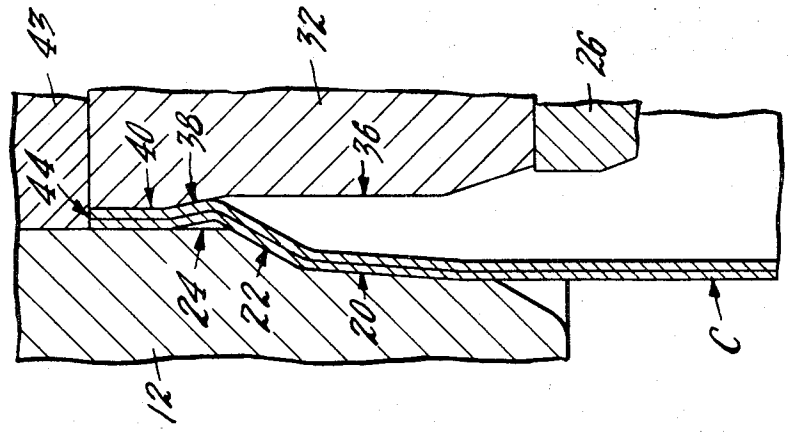
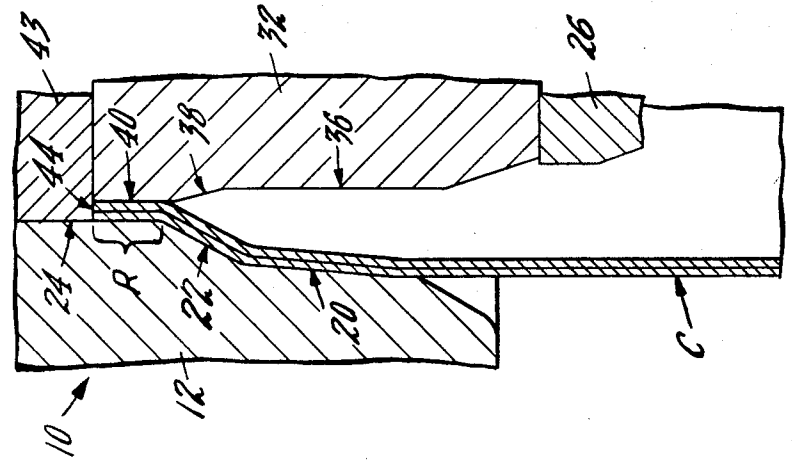


FIG. 7



APPARATUS FOR NECKING-IN TUBULAR MEMBERS

This is a division, of application Ser. No. 231,207, filed Mar. 2, 1972.

BACKGROUND OF THE INVENTION

This invention relates to the necking-in of tubular members. More particularly, the invention relates to necking-in, i.e., reducing the diameter of or forming a neck in, one or both ends of metal can bodies often having side seams of double metal thickness, and coatings of enamels, inks and other materials on their respective internal and external surfaces. Still more particularly, the invention relates to an improved method and die assembly apparatus for necking-in can bodies which can accomodate side seams and minimize scratches in the aforementioned surfaces, and coatings, as well as folds cracks and other irregularities in the overall necked-in areas of can bodies.

Currently, when can bodies are necked-in by use of die assemblies which consist of an outer reducing die and an inner die pilot, relative movement is effected between the die assembly and can body to bring the substantially straight wall of the can body into the die assembly necking-in area between the reducing die and the inner pilot. The marginal edge portion of the can body is movingly frictionally compressed between the respective die surfaces and has its diameter reduced by an inwardly angled shoulder-forming surface on the interior of the outer die.

This type of necking-in operation is problematical for several reasons. When the edge portion of the can is subjected to the friction and compressive forces exerted by outer and/or inner die surfaces, scratches and scores are obtained in interior enamel and in exterior enamel and decorative coatings. Inner scratches can result in metal pickup by and consequent deterioration of container contents. Another problem is that when the diameter of a can body is reduced, metal in the reduced area is pressed into folds, puckers and other irregularities which often form cracks during subsequent flanging and double seaming operations.

Still other problems involved in current necking-in operations are that the die assemblies do not accomodate changes in length of can body walls when their diameters are reduced. Extra length accentuates the aforementioned scratching and cracking problems. Further, current die assemblies are not adaptable for working can bodies made of various metals of various strengths, or those of various types, e.g., those having or not having side seams of various types. For example, the assemblies cannot control or vary in the amount of pressure or force exerted lengthwise on can body walls as would be required to work say both steel and thin light gauge aluminum bodies with the same die assembly. Further, some die assemblies require orientation of can body side seams in order to compensate for the double metal thickness of the can side seam. Still further, because inner pilots usually are inserted quite deeply and are held quite tightly by the can bodies during the necking-in operation, considerable pressure is required to strip the can bodies from the pilots.

SUMMARY OF THE INVENTION

In view of the aforementioned problems encountered in current die necking-in operations, it is an object of this invention to provide a method and a die assembly

for necking-in tubular members which provides and utilizes a clearance between the outer die and inner die of the die assembly to greatly reduce the friction and compressive forces exerted by the die surfaces on tubular walls being worked and thereby greatly minimize the amount of scratches, scores and other defects which usually appear in the necked-in wall surfaces.

It is another object of this invention to provide a method and a die assembly for necking-in tubular members which greatly reduces the amount of folds, cracks and other irregularities which usually appear adjacent the necked-in areas and reduced diameter areas of the walls of tubular members.

It is another object of the invention to provide a die assembly that is suitable for necking-in tubular members made of different materials of different strength, and can bodies of varying type diameter, length and thickness.

It is another object of this invention to provide a die assembly for necking-in tubular members wherein compressive forces exerted by the die assembly on the walls of the tubular members can be controlled and adjusted to compensate for the aforementioned differences and variations.

It is still another object of this invention to provide a die assembly for necking-in tubular members having side seams, which does not require orientation of the side seam therewith.

It is yet another object of this invention to provide a die assembly for necking-in tubular members whose pilot is not tightly held by the tubular member and which requires little pressure to remove the tubular members therefrom.

The manner in which there and other objects and advantages are achieved will become more apparent and more fully understood from the following description which when read in conjunction with the accompanying drawings, discloses a preferred embodiment of the invention.

IN THE DRAWINGS

FIG. 1 is an enlarged fragmentary vertical section taken through an outer reducing die and an inner die pilot of a die assembly, and through the top of a straight-walled tubular can body aligned for entry into the forming area of the die assembly.

FIG. 2 is an enlarged fragmentary side view of the top of the can body of FIG. 1 after it has been necked-in with the die assembly of FIG. 1.

FIG. 3 is a sectional plan view taken through line 3—3 of FIG. 1 showing the pilot ring after floating radially to compensate for the side seam of a can body, were the can body of FIG. 1 located in the forming area of the die assembly of that Figure.

FIGS. 4–9 are enlarged fragmentary sectional views showing successive stages wherein one wall of the can body of FIG. 1 is being necked-in by a corresponding sectioned side of the die assembly of that Figure. FIG. 4 shows the can body after entering the mouth of the outer reducing die.

FIG. 5 shows the marginal edge portion of the can body directed inwardly by the outer reducing die and engaging the step of the inner pilot ring.

FIG. 6 shows a portion of the marginal edge of the can body in groove G and transversely engaging the control surface of the retaining ring means.

FIG. 7 shows a rim of reduced diameter formed between the outer reducing die, control surface and pilot ring step.

FIG. 8 shows the can body wall being directed to lay against the smaller diameter portions of the inner die pilot ring.

FIG. 9 shows the can body wall after it has been necked-in.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring to the drawings in detail, FIG. 1 shows a die assembly generally designated **10** and, aligned therewith, a tubular can body generally designated C. Die assembly **10** is comprised of an outer reducing die **12**, often called a punch, and to the interior thereof, an inner die pilot generally designated **14**. Outer reducing die **12** has a chamber **6** having at its mouth an inwardly angled orienting surface **18**, a guiding surface **20** which can be substantially vertical and/or slightly inwardly angled, a recessed, more inwardly angled directing surface **22** and a rim-forming surface **24**.

Inner die pilot **14**, telescoped within outer reducing die **12**, is comprised of suitable mounting means, which can include means such as T-shaped holder **26**, shaft **28** and means such as an Allen head cap screw **30** for fastening holder **26** to shaft **28**.

Mounted on T-shaped holder **26** for axial movement thereon is pilot ring **32**, axially floating retaining ring means **42**, spring means **46** and spring support means **48**. Pilot ring **32** is in turn mounted for radial floatation upon and within retaining ring means **42** biased from the interior of inner die pilot **14** by spring means **46**. Spring means **46** preferably is comprised of conical washers but can also be other suitable spring means such as coil springs. Spring support means **48** preferably is adjustingly secured to holder **26** as by threads **50**, but can also be a solid extension of T-shaped holder **26**.

Pilot ring **32** has an orienting surface **34**, a substantially vertical supporting surface **36**, an inwardly angled step-joining supporting surface **38** and a wide diameter step **40**. Pilot ring **32** is constructed of a dimension that leaves a gap between it and retaining ring means **42**, and a gap between pilot step **40** and outer reducing die rim-forming surface **24**, the area of the two gaps being sufficient to allow the marginal edge portion of can body C to fit fairly snugly and restrainingly between pilot step **40** and reducing die rim-forming surface **24**. The total width of the gap allows pilot ring **32** to float radially and thereby compensate for and accomodate the double metal thickness of can side seam SS.

The gap between pilot ring supporting surfaces **38** and **36** and outer reducing die **12** provides enough clearance for a can body wall which has been directed inwardly off of inwardly angled reducing die directing surface **22**, to flow inwardly and rest or lay against pilot ring surfaces **38** and **36** in a manner to be more fully explained later.

Retaining ring means **42** can be one piece but preferably is comprised of several pieces tied together and axially moveable as a unit as shown in FIG. **1**. Shown therein is retaining ring means **42** which can be moderately L-shaped so that its lower leg extends to the vertical plane of and has a configuration similar to that of pilot ring support surface **36** and orienting surface **34**. Retaining ring means **42** can include control ring **43** having a control surface **44** positioned adjacent to and protruding slightly beyond pilot ring step **40**, and means such as nut **45** for adjustably holding control ring **43** in place and for maintaining a suitable uniform radial gap between control ring **43** and pilot ring **32** which will allow the pilot ring to float radially.

The distance that control surface **44** protrudes beyond step **40** is a distance that will enable surface **44** to transversely engage the edge of a can body wall brought into groove G formed by pilot ring step **40**, control surface **44** and reducing die rim-forming surface **24**. As will be more fully explained later, control surface **44** is utilized to essentially prevent relative movement between the can body and the surfaces of pilot ring **32** by transversely engaging the can body edge and causing pilot ring **32** and retaining ring means **42** to move as a unit as the can body moves and to float axially against or with the bias of spring means **46**.

The distance that retaining ring means **42** and pilot ring **32** float axially and the amount of compressive force exerted on the can body all can be controlled by controlling the amount of tension or pressure exerted by spring means **42**. Less axial movement and greater pressure can be obtained by lowering spring support means **48** toward retaining ring means **42**.

Another means by which the aforementioned axial floatation and compressive force can be controlled is by use of suitable retaining ring control means such as shoulder screws **52** (only one shown) which can, for one thing, prevent inward axial movement beyond a certain preset distance. Shoulder screws **51** have threaded ends which engage retaining ring means **42** on an interior side of a portion of a T-shaped holder leg, and screw heads **53** which have undersurfaces parallel to but removed or gapped from opposing stopping surfaces on the exterior side of the aforementioned portion of holder **26**. When the total distance of axial floatation desired to be set is less than the gap between the aforementioned surfaces, a shim **54** of a thickness which establishes the desired distance can be employed.

FIG. **2** is a side view of tubular can body C of FIG. **1**, here designated C', after it has be necked-in with the die assembly of FIG. **1**. Neck-in can body C' is shown having a rim R, an intermediary surface *r*, a neck N and a shoulder Sh respectively having the configuration of pilot ring step **40**, step-joining supporting surface **38** and supporting surface **36**.

FIG. **3** is a top sectional view as would be taken along line 3—3 of FIG. **1** were straight-walled can body C of FIG. **1** to have entered groove G of die assembly **10**. FIG. **3** shows that when can body C, having double seam SS, enters groove G, pilot ring **32** floats radially (to the right in FIG. **3**) to compensate for the double metal thickness of the side seam. It can be seen that whereas on the left side of die assembly **10** reducing die rim-forming surface **24** engages side seam SS but not the adjacent single wall portions, and whereas on the left the adjoining surfaces of retaining ring means **42** and pilot ring **32** abut one another, on the right side of die assembly **10** rim-forming surface **24** and step **40** engage the single wall, and the adjoining surfaces of retaining ring means **42** and pilot ring **32** do not abut one another.

FIGS. **4** through **9** show the manner in which straight-walled can body C is necked-in with die assembly **10**. The Figures show what is occurring at various stages during the necking-in operation and does not necessarily show that the operation stops at each stage. Prefera-

bly the operation is continuous. It is to be noted that according to this invention, the can body, the outer reducing die, the inner die pilot or any combination or combinations thereof may be moved to effect the relative movement between die assembly **10** and can body C that is required to neck-in the can body. However, FIGS. 4–9 show the preferred method of effecting the necking-in operation, that is, wherein relative movement is effected by holding can body C stationary and moving die assembly **10** telescopingly into engagement with can body C.

Any conventional means can be used for holding the can body steady. When only one end of the can is being necked-in, the die assembly is brought into telescoping relationship with that end while for example a cup-shaped base applies an axially and radially restraining force on the opposite end of the can body. When both ends are being necked-in, the die assembly is brought into telescoping relationship with each end while the can is held for example by magnets lining the arcuate surface of can body-shaped cutouts or pockets in for example the flanges of a starwheel or turret.

Any suitable conventional means for insertingly and retractingly moving the die assembly outer reducing die **12** and inner die pilot **14** in independent cooperating relationship can be used, such means being well known in the industry.

FIG. 4 shows outer reducing die **12** and inner die pilot ring **32** in telescoped relationship and together moved into telescoping relationship with stationary can body C whereby outer reducing die **12** has moved over the mouth of body C and has thereby caused the marginal edge portion thereof to be movingly engaged with the lower substantially vertical portion of rim-forming surface **20**. FIG. 4 also shows the previously mentioned groove G.

In FIG. **5**, reducing die **12** and inner die pilot ring **32**, in the same telescoped relationship as in FIG. 4, have together moved further downwardly over stationary can body C thereby causing its can body wall to progressively engagingly travel along and flowingly adopt the contour first of the lower substantially vertical and then the upper slightly inwardly angled portion of guiding surface **20**, and then that of the more inwardly angled directing surface **22**, the latter of which reduces the diameter of the can body and directs the flow of can body metal toward and against the large diameter of pilot ring step **40**. As the inner edge of the can body wall strikes step **40**, pilot ring **40** floats from the phantom line radially to the right where it is shown in FIG. **5**, to compensate for the double thickness of side seam SS. Although the can body edge can be directed to initially strike any portion of step **40**, it is desirable that it strike an upper portion thereof. Preferably, the upper portion is sufficiently removed from control surface **44** to allow for elongation of the can body when its diameter is reduced by inwardly directing surface **22**.

At this point, it should be noted that before and during the stage represented by FIG. **5**, the wall of can body C engages inwardly angled reducing die directing surface **22** before pilot ring **32** is fully inserted into can body C.

As shown in FIG. **6**, as reducing die **12** and inner die pilot ring **32** continue moving in telescoped relationship downwardly over can body C, the can body wall is directed into groove G (see FIG. 4) made up of a portion of reducing die rim-forming surface **24**, retaining ring means control surface **44** and pilot ring step **40**. When the edge of the can body wall engages control surface **44**, inner die pilot **14** essentially stops its movement into can body C. At this point reducing die **12** can dwell, but preferably it continues moving downward over the can body. As will be explained later, it is believed that as the edge of can body strikes pilot step **40**, travels into groove G and transversely engages control surface **44**, pilot ring **32** and retaining ring means **42** move axially upwardly as a unit to load, i.e., compress, conical washer spring means **46** (shown in FIG. **1**).

As shown in FIG. **7**, as outer reducing die **12** continues to move telescopingly downwardly over both can body C and over pilot ring **32**, groove G elongates and more of the marginal edge portion of the can body is brought into and is abuttingly engaged with rim-forming surface **24**, control surface **44** and wide diameter step **40**. As this occurs and as FIG. **7** shows, the marginal edge portion has been formed into a rim R having a reduced diameter, the rim being contained or restrained in and by the surfaces making up groove G.

As seen in FIG. **8**, reducing die **12** continues to move downwardly over stationary can body C. As it does, inwardly angled directing surface **22** continues to direct the flow of can body wall metal progressively inwardly and downwardly against and along the perimeter of pilot ring **32** below the wide diameter of step **40**, namely, along the reduced diameters of inwardly angled step-joining supporting surface **38**. This action further reduces the diameter of and thereby gradually necks in the can body. It is to be noted that reducing the diameter of the lower portions of pilot ring **32** provides a clearance for and allows the inwardly directed metal to continue flowing on its path away from reducing die rim-forming surface **24** so that surface **24** does not rub against or in any way having the outside can body wall portions that form the neck in the can body. It is also to be Figure, that the inwardly flowing metal is not compressed against but is merely gradually directed to gently rest of lay against the lower reduced diameter portions of pilot ring **32**.

As shown in FIG. **9**, the continued downward movement of reducing die **12** in relation to the stationary can body C of previous Figures has caused directing surface **22** to continue to progressively direct the inwardly flowing metal away from reducing die **12** and to lay it against the length of stationary pilot ring supporting surfaces **38** and **36**. FIG. **9** shows the finished necked-in can body C′ having neck N, no part of its outer surface having come into contact with or being in contact with the length of reducing die rim-forming surface **24**. In this FIG., reducing die **12** has approximately completed its downward stroke and has formed a shoulder Sh in can body C′.

After completion of its downward stroke, inner die pilot **14** preferably remains stationary while reducing die **12** is retracted from telescoping engagement with can body C′ leaving its rim R fitting fairly snugly around wide diameter pilot ring step **40**, and its intermediary portion *r* and neck N resting fairly loosely around the lower portions of pilot ring **32**. Because the narrow rim R is the only portion that has been frictionally compressed into fairly snug engagement, very little pressure is required to strip a necked-in can form inner die pilot **14**. Usually, pressure from one finger of the hand is sufficient when only one end has been necked-in. When both ends are necked-in about 4 lbs maxi-

mum per end is required. This is to be compared with conventional die assemblies which often require up to 40 lbs per end when both ends are necked-in.

To remove inner die pilot **14** from can body C', it has been found that it is only necessary to merely retract die pilot **14** enough to retract step **40** from within the can body rim R. Commercially, it is preferable to utilize some conventional means for holding the can in say its turret pocket location as the finished can is passed out of the necking-in working stations to other stations or machines for flanging and later for double seaming of container end closures to one or both ends of the can body.

It is important to note the manner in which spring means **46** functions throughout the necking-in operation. Although its full function is perhaps not clearly understood, it is believed to be as stated herein. Before can body C strikes some portion of pilot ring **32** and thereafter transversely engages control ring surface **44**, retaining ring means **42** and pilot ring **32** move axially upward against and thereby compress conical washers **46**. Any elongation of the can body wall due to reduction in diameter by inwardly directing surface **22** and possibly due to the pressing of metal in groove G, also aids in the compression of conical washers **46**. As outer reducing die **12** continues downward over the can body wall and stationary die pilot **32**, the can body wall metal is directed to lay against the smaller diameters of pilot support surfaces **38** and **36**. As this occurs the can body wall shortens and conical washers **46** decompress to compensate for the shortening of the body wall. As more fully explained later, this decompression is also believed to aid in the initial bending and in the directing and the laying of the can body metal inwardly against and along pilot ring supporting surfaces **38** and **36**. As outer reducing die **12** continues further downwardly, somewhere between the stages of FIGS. **5** and **6** the can body wall lengthens again and conical washers **46** compress to accomodate the change in length. This compression remains until it follows the can when the can is removed from die pilot **14**. Thus, it can be seen that conical washer spring means **46** are actively compressing and decompressing throughout most if not all of the necking-in operation. By doing so, they enable the die pilot to accomodate and compensate for changes in body length occurring during the necking-in operation as well as for cans of irregular length.

There are several factors which are believed to account for the fact the metal of can body C initially bends inwardly below pilot ring step **40** and flows along and against the reduced diameter supporting surfaces **38** and **36** of pilot ring **32**. The factors are not necessarily listed in their order of importance as it is believed that they all cooperate to achieve the result. The most obvious factor is that the metal is forced to go inwardly by the downward movement of and the inward-angle of directing surface **22**. Another factor is that the directed metal tends to continue on its directed path. Reducing the diameter of pilot ring surfaces below step **40** provides a clearance and a path of less resistance to the flow than did step **40** and thereby permits the metal to proceed further and as far as it can on its path. Other factors are the forces exerted on the edges of the can body wall due to elongation of the can body wall and the de-compressive force exerted by conical washers **46** at both ends when both ends are being necked-in, and at one end when one end is being necked-in and the other is being held steady by some conventional resistive means. These forces are believed to tend to aid the wall metal to initially bend inwardly toward support surface **38** and to continue on its inwardly directed path toward along support surface **36**.

Because the method and die-pilot apparatus of this invention are based on employing an induced natural flow of metal to greatly reduce the amount of pressure and/or friction imposed upon the necked-in surfaces of the can body by the die members, several advantages are obtained. The necked-in can bodies are essentially scratch and score free in their overall necked-in surface areas, especially those surfaces not double seamed to an end closure. (The overall necked-in can surface area just referred to is intended to include rim-adjoining surface *r*, neck N and shoulder Sh). This is because the overall necked-in wall surface area is not compressed into a snug, approximately wall-thick area between two die surfaces and because there is no rubbing of moving metal over or friction occurring on the outer surface, and very little if any on the inner surface of the overall necked-in wall area. There is little if any relative movement or friction on the inside of the necked-in wall surface because the metal is merely directed toward and laid against and along the reduced diameter surfaces of the pilot ring **32**. Relative movement between pilot ring **32** and the can body is minimized because axial movement of the can body also moves control surface **44** and pilot ring **32** tied thereto. Any friction during removal of the necked-in can from the pilot is minimal since the necked-in area fits loosely around the pilot ring. An additional advantage of little compression and friction is increased operating life of the die assembly.

Another advantage is that the length of the marginal edge portion of can body C diameter that is initially reduced (see directing surface **22** of FIG. **5**) is shorter or less than that reduced in conventional die necking-in operations. The length reduced is only that which extends up to the opposing wide diameter surface of pilot ring step **40**. This means that the initial reduction in can mouth circumference is also less than conventionally. Both of these facts mean less bunching of metal around and adjacent the circumference of the open end of the can body. Less compression means less wrinkles when the cans are necked-in. It also means substantially less wrinkles and cracks than usually occur during flanging operations because the metal of the large diameter rim R need not be bent and stretched as far outwardly as usual to form a satisfactory flange. Less wrinkles and cracks result in a lower incidence of can leakage.

The construction and operation of die assembly **10** compensates for irregularities in can bodies that are to be necked-in. For example, its spring means, allows it to accomodate irregularities in can length due to a mislap of a side seam, and the clearance provided between its rim-forming surface **24** and pilot ring supporting surface **38** and **36** permits scratch-free necking-in despite portions of can body walls being irregularly thick due to accumulations of for example solder or enamel.

Tubular members constructed of any material which can be directed to flow in the manner required of this invention, can be necked-in in accordance with this invention. For example, metal cans can for example be made of tin plate, tin free steel or aluminum, and may have or not have any of the various hooked, soldered or thermoplastically adhered or other type side seams. Materials and can bodies of varying strengths can be

necked-in by controlling pressure, for example by varying the amount of pressure exerted by conical washers **46.** This can be done by raising or lowering adjustable spring support means **48** and thereby respectively applying less or more pressure upon the conical washers. Cans made of hard materials such as steel require more tension than those made of soft materials such as aluminum, and cans having side seams, especially soldered or mira-seamed, i.e., thermo-plastically adhered side seams require more than cans not having side seams. The die assembly of this invention has been found especially suitable for necking-in cans made of light weight low strength materials such as aluminum because die assembly **10** does not tend to cause such materials to collapse. Whereas conventional outer reducing dies usually operate on an amount of pressure required to force metal to bend around forming surfaces and to compress and rub metal into and along narrow snug areas, reducing die **10** for the most part only requires pressure sufficient to direct already flowing material which flows through a clearance and rests on the supporting surfaces of pilot ring **32.** Also, little pressure is required with die assembly **10** because, as previously mentioned, little compression and friction of metal takes place.

From the foregoing description, it can be seen that the method of necking-in a tubular member in accordance with this invention basically involves bending the marginal edge portion of the tubular member inwardly to initially reduce its diameter to a first diameter, applying a restraining force to an end portion of the inwardly bent marginal edge portion to form a rim out of the restrained end portion, applying an exterior force to the initially inwardly bent marginal edge portion, the force being sufficient to direct the wall of the tubular member to flow further inwardly than the diameter of the rim to obtain a wall having a second diameter shorter than the initial diameter, and moving the exterior force axially along and through a length of the tubular wall so that the directing of the wall inwardly continues to occur throughout that length and thereby forms a neck having the second diameter. Desirably, an axial force is applied to both ends of the tubular member to hold the tubular member steady while the rest of the aforementioned steps are being carried out.

Thus it can be seen from the above description, and from the appended claims, taken in conjunction with the drawings, that the present invention provides a new and useful die necking assembly and method for tubular can manufacture having a number of novel advantages and characteristics, including those hereinbefore pointed out and others which are inherent therein. It is contemplated that certain changes and variations may be made by those skilled in the art without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. A die assembly for necking-in an end portion of a tubular member comprising:

an outer reducing die having a recessed inwardly angled directing surface, and a rim-forming surface adjoining and interior of said forming surface,

a die interior of and telescoped within said reducing die, a pilot ring mounted on said pilot and having an upper circumferential step of greater diameter than the rest of said pilot ring,

an axially moveable retaining ring means contiguous to said pilot ring for retaining said pilot ring in position on said pilot, said retaining ring means including a control surface adjacent to and protruding slightly beyond said pilot step, said control surface being for transversely engaging the edge of and essentially stopping the movement of a tubular member brought thereagainst,

spring means contiguous with said retaining ring means and providing biasing pressure against said retaining ring means,

spring support means contiguous with said spring means for rigidly supporting said spring means,

mounting means for mounting said die pilot, pilot ring, retaining ring means, spring means and spring support means thereon and for carrying said pilot and each of said means axially in and out of said reducing die,

means for independently advancing and retracting said reducing die and said pilot such that they cooperate and that

said directing surface and the marginal edge portion of said tubular member are movingly engaged before said pilot is fully positioned within an open end of said tubular member,

said directing surface directs said marginal edge portion inwardly against said pilot step,

a portion of said marginal edge portion is brought into abutting engagement with at least a portion of a groove formed by said control surface, said retaining ring means and said pilot step to thereby form a rim of a reduced diameter out of said marginal edge portion, and

said directing surface is moved axially and engagingly through and along wall portions of said tubular member to progressively direct said wall portions inwardly against the rest of said pilot without engaging said rim-forming surface with said inwardly-directed wall portions, to thereby form a neck in said tubular member, said neck having a diameter less than that of said rim.

2. The die assembly of claim **1** wherein there is also included retaining ring control means engaging said retaining ring means, for preventing inward axial movement thereof beyond a certain preset distance.

3. The die assembly of claim **1** wherein said pilot ring floats radially in relation to said retaining ring means to compensate for an extra thickness in the marginal edge portion of said tubular member.

4. The die assembly of claim **2** wherein said pilot ring floats radially in relation to said retaining ring means to compensate for an extra thickness in the marginal edge portion of said tubular member.

5. The die assembly of claim **4** wherein said retaining ring means includes a control ring having said control surface thereon and being in abutting engagement with said retaining ring means and said pilot ring, and means tied to said retaining ring means for adjustably holding said control ring in place and for maintaining a gap between said control ring and said pilot ring which will allow said pilot ring to float radially.

6. The die assembly of claim **3** wherein said retaining ring means includes a control ring having said control surface thereon and being in abutting engagement with said retaining ring means and said pilot ring, and means tied to said retaining ring means for adjustingly holding said control ring in place and for maintaining a gap be-

tween said control ring and said pilot ring which will allow said pilot ring to float radially.

7. The die assembly of claim **6** wherein said reducing die has a slightly inwardly tapered initial guiding surface adjoining and exterior of said directing surface.

8. The die assembly of claim **5** wherein said reducing die has a slightly inwardly tapered initial guiding surface adjoining and exterior of said directing surface.

9. The die assembly of claim **1** wherein said reducing die has a slightly inwardly tapered initial guiding surface adjoining and exterior of said directing surface.

10. The die assembly of claim **1** wherein said reducing die has a slightly inwardly tapered initial guiding surface adjoining and exterior of said directing surface, and wherein said retaining ring means includes a control ring having said control surface thereon and being in abutting engagement with said retaining ring means and said pilot ring, and means tied to said retaining ring means for adjustably holding said control ring in place and for maintaining a gap between said control ring and said pilot ring which allow said pilot ring to float radially.

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