United States Patent

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[54] CAN BODY FABRICATION

23 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** 72/83, 72/347, 113/120
[51] **Int. Cl.** **B21d 22/16**
[50] **Field of Search** ..... 72/347, 348, 80, 81, 82—85, 83; 113/120 H

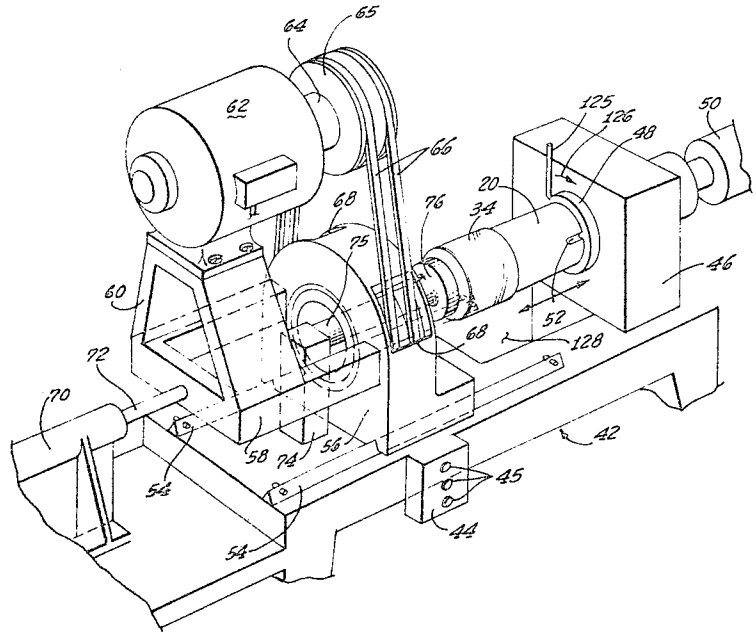
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ABSTRACT: To produce a cylindrical can body, a cup-shaped workpiece having a relatively thick and relatively short cylindrical wall is telescoped over the end of a mandrel and a rotating ring of hard material is advanced axially onto and along the mandrel to cooperate with the mandrel to thin and spread the cylindrical wall.



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SHEET 1 OF 3

Fig. 1

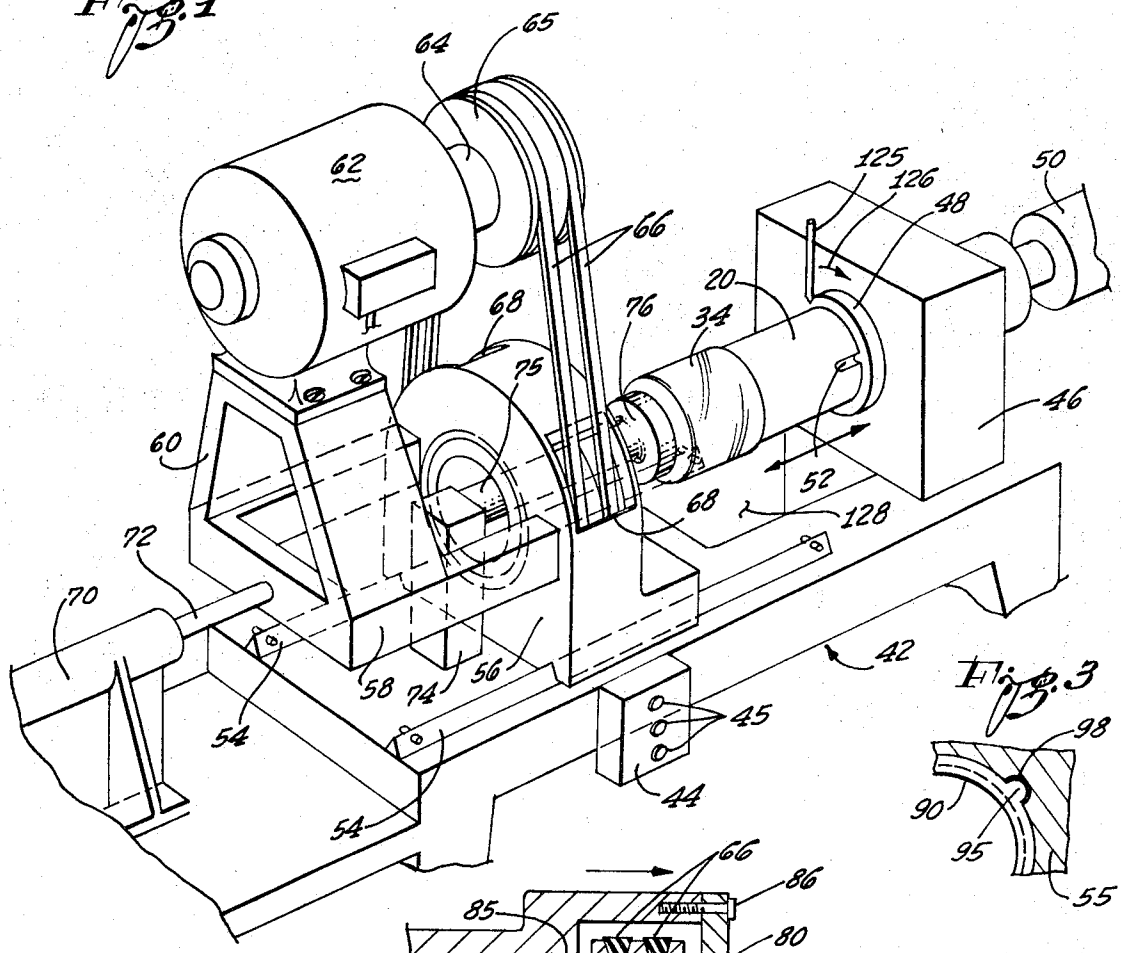
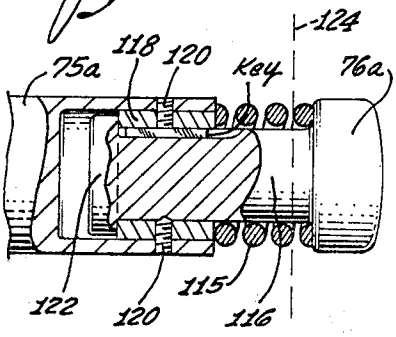


Fig. 3

Fig. 9



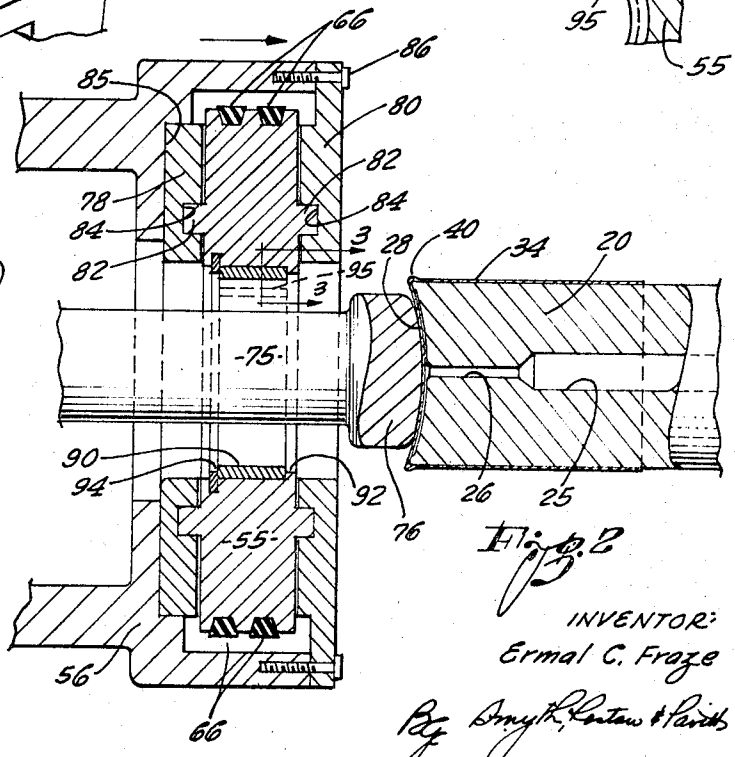


Fig. 2

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Fig. 4

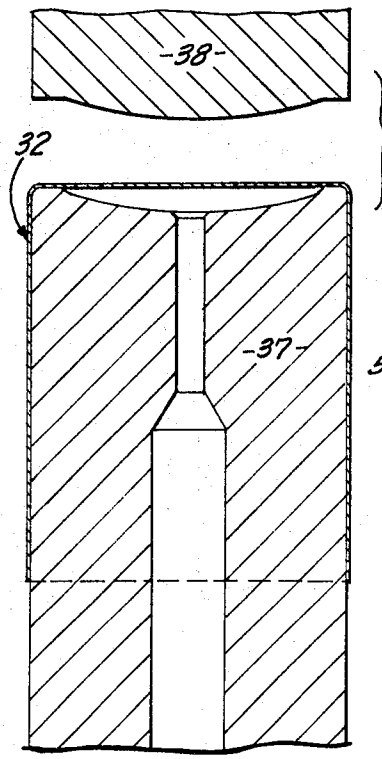


Fig. 6

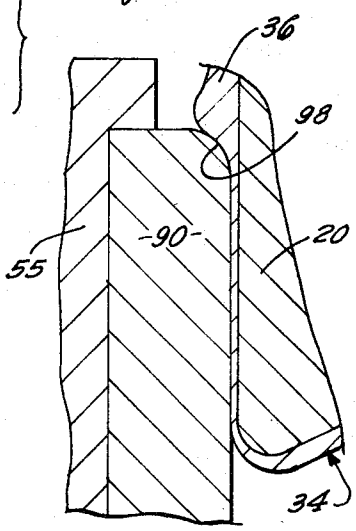


Fig. 7

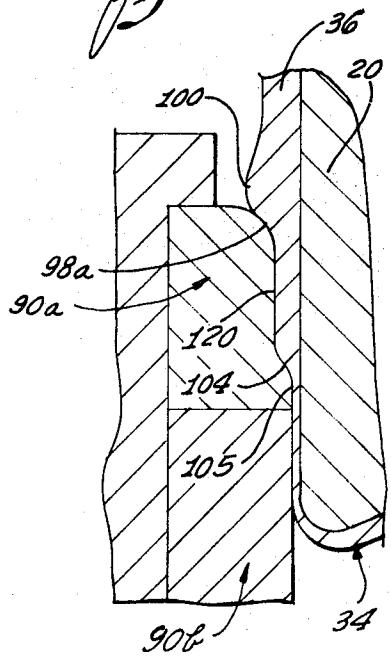
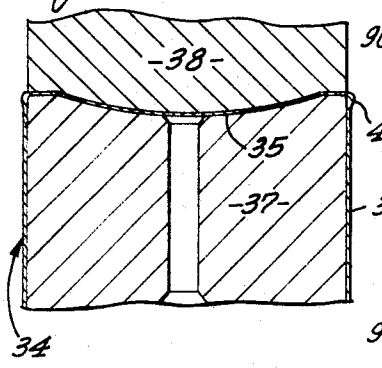


Fig. 5



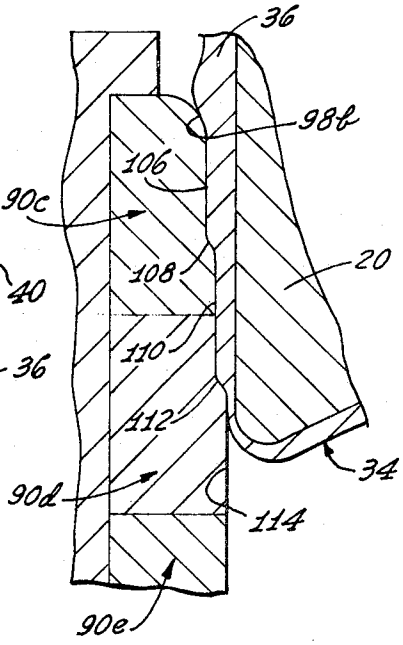


Fig. 8

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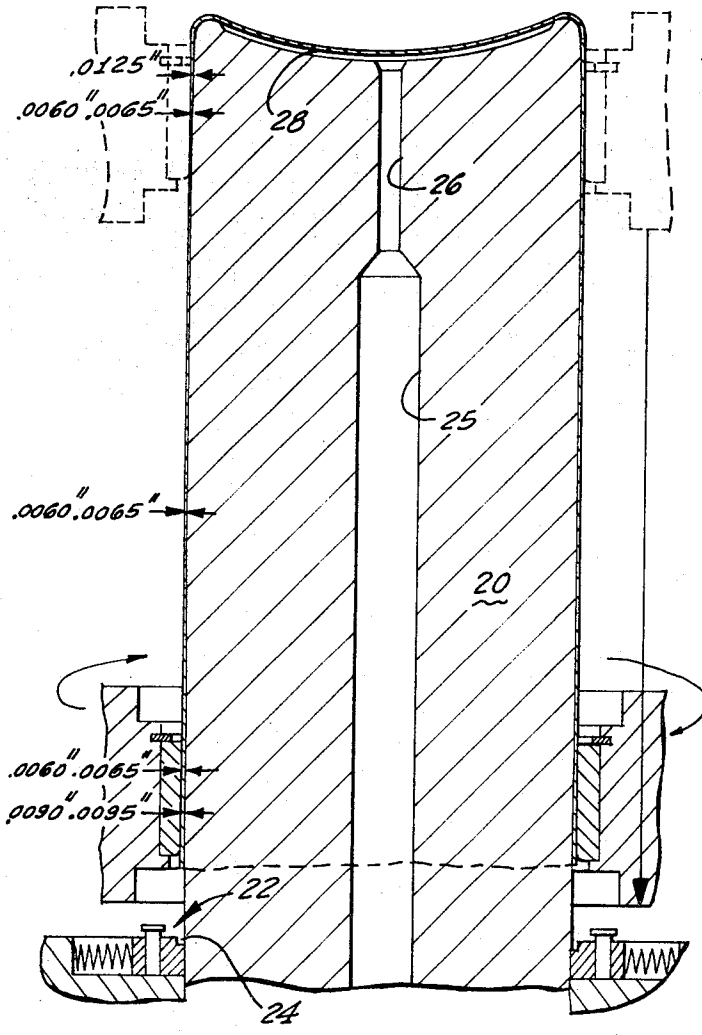
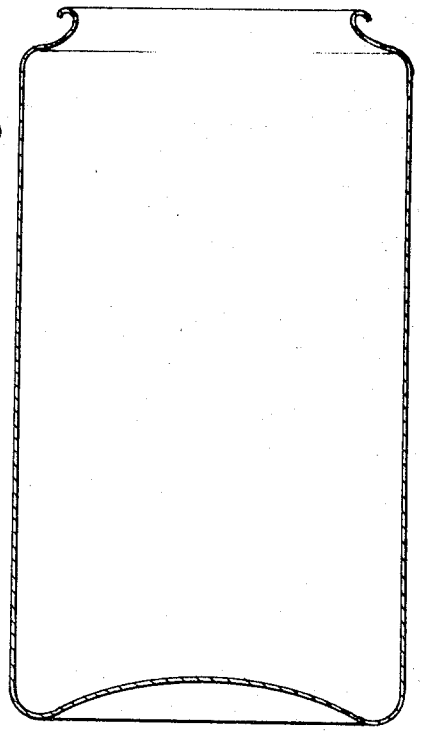


Fig. 10

Fig. 11



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CAN BODY FABRICATION

BACKGROUND OF THE INVENTION

Various fabrication procedures have been employed heretofore for the production of cans of the general type commonly used for beverages and food products. In the conventional fabrication of a tin-coated steel can, for example, a cylindrical shell is first formed out of sheet metal and then a stamped sheet metal bottom is assembled to one end of the shell.

To avoid the necessity of separately fabricating a cylindrical shell and a bottom wall, it is highly desirable to form a can body with an integral bottom wall and such one-piece can bodies made of aluminum alloy have been produced heretofore.

One prior art method of producing a one-piece aluminum can body is to use progressive drawing dies to produce a cup-shaped aluminum body of somewhat less than the desired axial dimension and then to place the cup-shaped body on a mandrel for the purpose of "ironing" the cylindrical wall of the body by means of a hard metal or carbide ring to thin the cylindrical wall and to elongate the cylindrical wall to the desired axial dimension.

Another prior art method of producing a one-piece aluminum can body employs impact extrusion to produce an intermediate cup-shaped workpiece. It is not practical to extrude such an intermediate workpiece in a single-impact stroke because it would be too severe on the dies and because slight defects in the metal and the presence of minute bodies of lubricant would result in too many rejects, and therefore repeated extrusion is employed. The product of the repeated extrusion is placed on a mandrel and is finished to the desired final dimension by using a hard metal ring for a simple ironing operation.

All of these prior art techniques result in a can body in which the thickness of the metal is greater than necessary in some parts of the can and therefore there is a pressing need for a method of fabricating a one-piece can body with greater economy of material. This need may be appreciated by setting forth ideal dimensions for a one-piece can body made of an aluminum alloy.

It has been found that the bottom wall of an aluminum alloy can may be relatively thin and yet be of adequate strength by a liberal margin if the bottom wall is shaped to nonplanar configuration, for example, an inwardly bulged configuration. Thus an aluminum alloy can body of a common size of 2 11/16 inch inside diameter may have a shaped bottom wall of a thickness of only 0.0125 inch. It is further possible to make the cylindrical wall of a can relatively thin in the intermediate region between the ends of the can without reducing the strength of the can below a safe margin. Thus the cylindrical wall of an aluminum alloy can may abruptly taper in thickness from approximately 0.0125 inch near its bottom end to a minimum thickness of 0.006—0.0065 inch. It has also been found that if the upper end of such an aluminum alloy can body is necked down to reduced diameter to permit the use of a top wall of reduced diameter, the necking down locally reinforces the cylindrical wall to permit the local thickness of the cylindrical wall to be reduced. Thus, with the open end of the aluminum can body strengthened in this manner, the thickness of the cylindrical wall may be of a thickness of only 0.00600—0.0065 inch throughout the major intermediate portion of its length with a thickness of approximately 0.0125 near the bottom end and a thickness of 0.0090—0.0095 inch near the open end.

If an aluminum alloy can body were fabricated with the above specified thickness dimensions, only 28 to 30 pounds of metal would be required to produce 1,000 can bodies with integral bottom walls. Unfortunately, however, progressive drawing alone, progressive drawing combined with an ironing operation, and repeated extrusion combined with ironing are all inherently incapable of producing such an ideally dimensioning aluminum alloy can body. The aluminum alloy required in each instance is approximately 38 to 40 pounds for 1,000 can bodies with integral bottom walls. Theoretically, then, it is possible to save from 8 to 12 pounds of aluminum alloy per thousand can bodies which means a saving in metal of 15 to 30 percent.

The economic significance of this fact may be appreciated when it is considered that with aluminum alloy can bodies produced by automatic machinery at rates as high as 600—700 cans per minute, 80 percent of the cost of the cans is in the aluminum alloy, only 20 percent of the cost being labor, overhead and profit. Thus 15 to 30 percent saving in the amount of aluminum alloy means a saving of 16 to 24 percent of the total cost for the can bodies. At the high rate of production made possible by automatic machinery, a saving of only 5 percent would pile up rapidly and the possibility of obtaining such a saving by some new fabrication technique would warrant investment of a large sum of money in a development program.

The present invention is directed to the problem of providing a fabrication technique for producing one-piece can bodies of highly economical thickness dimensions. The economical thickness dimensions specified above for aluminum alloy are by way of example only, it being understood that other thickness dimensions would be specified for other metals such as steel and for other materials such as ductile plastics.

SUMMARY OF THE INVENTION

By way of example, the invention is described herein as applied to the production of aluminum alloy can bodies. The fabrication of an aluminum alloy can starts with an aluminum alloy sheet blank having initial nominal thickness substantially in excess of the maximum thickness dimension desired in the cylindrical wall of the finished can body. For example, to produce an aluminum alloy can body with an inside diameter of 2 11/16 inch and with an axial dimension of approximately 4 ¾inch and with a maximum wall thickness of approximately 0.0125 inch, the initial thickness of the sheet metal bland may be approximately 0.020—0.025 inch.

The first step is to form the sheet metal blank to an intermediate configuration of a cup of approximately the desired final inside diameter and of an axial dimension substantially less than the final axial dimension of the can body. For example, the axial dimension of the cylindrical wall of the cup may be approximately 2 ¾inch which is approximately 60 percent of the desired final axial dimension.

Preferably the bottom wall of the cup-shaped receptacle is of reduced thickness, say a thickness of approximately 0.0125 inch, and for this purpose the bottom wall of the cup-shaped receptacle may be subjected to a suitable impact operation or pressure operation to squeeze the material and thus cause a portion of the material of the bottom wall to flow radially outward and form an outer circumferential bead.

The next step is to telescope the cup-shaped receptacle over a nonrotating mandrel in a fixed manner and to spread the metal of the circumferential wall including the metal of the circumferential bead. For this purpose, a ring of hard material is rotated on its axis and at the same time is advanced coaxially of the mandrel to telescope over the mandrel and to advance lengthwise of the mandrel. With the inside diameter of the rotating ring equal to the desired outside diameter of the final can body, the advancing rotating ring displaces surplus metal of the cylindrical wall of the receptacle axially and thus not only thins the cylindrical wall to the desired length. Such a metal ring may, for example, have a working surface of tungsten carbide.

In the presently preferred embodiment of the apparatus for carrying out the invention, the rotary processing ring is suitably journaled on a carriage and a motor for rotating the ring is also mounted on the carriage. With the rotating ring positioned coaxially of the mandrel and retracted from the

end of the mandrel, suitable means is employed to advance the carriage and thus advance the rotating ring axially to the extent required to finish the cylindrical wall of the workpiece.

The preferred practice of the invention is characterized by the employment of a mandrel that varies in diameter along its length to vary the thickness of the cylindrical wall to save material without unduly weakening the cylindrical wall. In the presently preferred practice of the invention the mandrel cooperates with the rotary ring to cause the cylindrical wall of the can body to be relatively thin in its midregion.

The features and advantages of the invention may be understood from the following detailed description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, which are to be regarded as merely illustrative:

FIG 1 is a perspective view of the presently preferred apparatus for processing what may be termed a second intermediate cup-shaped receptacle;

FIG. 2 is a longitudinal cross section of a portion of FIG. 1 showing the relation of the rotary ring to the mandrel at the start of the processing of the second intermediate cup-shaped receptacle;

FIG. 3 is a fragmentary section taken along the line 3—3 of FIG. 2 showing how a tungsten carbide liner for the ring may be keyed to the ring;

FIG. 4 is a sectional view showing how a first intermediate cup-shaped receptacle may be placed on a lower of two dies for the purpose of shaping and simultaneously thinning the bottom wall of the receptacle to produce the second intermediate cup-shaped receptacle;

FIG. 5 is a similar view showing how the two dies close to thin the bottom wall of the receptacle to displace surplus metal radially to produce the second intermediate cup-shaped receptacle;

FIG. 6 is an enlarged sectional view showing how the advancing rotary ring thins the cylindrical wall of the second intermediate cup-shaped receptacle;

FIG. 7 is a view similar to FIG. 6 showing how the inner circumference of the ring may be shaped to thin the circumferential wall of the second intermediate receptacle in two stages;

FIG. 8 is a similar view showing how the ring may be shaped to thin the wall of the second intermediate receptacle in three stages;

FIG. 9 shows how the apparatus may be modified to employ spring pressure to keep the cup-shaped receptacle from rotating relative to the mandrel on which it is mounted;

FIG. 10 is an enlarged longitudinal sectional view of the mandrel showing how the rotary ring processes a can body; and

FIG. 11 is a longitudinal sectional view showing how the resulting can body may be flanged and at the same time reduced in diameter in a well-known manner to receive a can top of reduced diameter.

DESCRIPTION OF THE PREFERRED PRACTICE OF THE INVENTION

FIG. 11 shows a preferred configuration of a can body that is the end result of the process taught by the invention. It is to be noted that the can body is necked down to a reduced diameter near its open end to permit the can body to be closed by a can end of reduced diameter, this configuration strengthening the can body near its open end to permit the corresponding portion of the circumferential wall to be reduced in thickness. It is contemplated that the can body shown in FIG. 11 will at least approximate most of the ideal thickness dimensions heretofore set forth. Thus, the bottom wall of the can body may have a thickness of approximately 0.0125 inch; the cylindrical wall of the can body may be of the same thickness of 0.0125 inch near the bottom end and may be of a thickness of approximately 0.0090—0.0095 inch near the open end of the can body, the intermediate major portion of the length of the cylindrical wall being of 0.0060—0.0065 inch in thickness.

Since the employment of a ring to process the cylindrical wall of a cup-shaped workpiece results in a cylindrical wall of uniform outside diameter, the desired variation of the wall thickness may be accomplished by varying the outside diameter of the mandrel. Accordingly, the mandrel that cooperates with the ring varies in diameter along its length inversely with the desired variations in the thickness of the cylindrical wall of the finished can body.

In accordance with this concept, in FIG. 10 the radial dimension of the portion of the mandrel 20 near its outer end is smaller than the inside radius of the rotary ring by a difference of 0.0125 inch to cause this portion of the cylindrical wall of the can body to be of this thickness. At the base end of the mandrel the difference is 0.009—0.0095 inch. The major portion of the length of the mandrel between these two extremes is of a radius that is smaller than the inside diameter of the rotary ring by a difference of only 0.006—0.0065 inch.

Referring again to FIG. 10, preferably a suitable stripper 22 is provided at the base end of the mandrel. The inner circumference of the stripper 22 is formed with an annular recess 24 to engage the rim of the can body at the end of the thinning operation.

It is further preferred that the stripping of a semifinished can body from the mandrel 20 at the end of the wall-thinning operation be facilitated by a burst of compressed air. For this purpose the mandrel 20 is provided with an axial air passage 25 which has a reduced end portion 26 and the concave end of the mandrel is formed with radial grooves 28 to provide radial distribution of the compressed air. The compressed air in combination with the stripper 22 is highly effective to overcome the resistance to removal of the can body that arises from the fact that the mandrel 20 is of maximum diameter in its mid region, it being necessary for the metal of the circumferential wall of the can body near its open end to stretch circumferentially slightly to pass over the mid region of the mandrel.

Blank sheet stock employed to fabricate the can body may have a thickness of 0.020—0.025 inch and is first processed by suitable drawing dies (not shown) to produce what may be termed a preliminary cup-shaped receptacle, generally designated 32 in FIG. 4, which has a cylindrical wall of substantially the starting thickness of 0.020—0.025 inch and which has a flat bottom wall of substantially the same thickness. The cylindrical wall 36 is slightly flared to conform to the taper of the leading end of the mandrel 20. FIGS. 4 and 5 illustrate the operation by means of which the preliminary cup-shaped receptacle 32 is converted into what may be termed an intermediate cup-shaped receptacle 34 having a shaped bottom wall 35 and a cylindrical wall 36.

In FIG. 4 the preliminary cup-shaped receptacle 32 is telescoped over a lower die 37 which cooperates with an upper die 38. The upper end of the lower die 37 is concave to conform to the desired shape of the bottom wall of the finished can body and the upper die 38 has a lower end of complementary configuration. The two dies 37 and 38 cooperate to thin the bottom wall by a squeezing operation and preferably the two dies close together with relatively high-impact force. The surplus metal of the bottom wall is extruded radially in all directions to result in the formation an outer circumferential bead. Thus, when the two dies 37 and 38 close together to thin the bottom wall of the primary receptacle 32 to a thickness of approximately 0.0125 inch, the intermediate cup-shaped receptacle 34 is formed and has an outer circumferential bead 40.

FIG. 2 shows how in preparation for the metal-thinning operation, by a rotary ring the intermediate cup-shaped receptacle 34 is telescoped over the leading end of the mandrel 20. The intermediate cup-shaped receptacle 34 is of approximately the inside diameter of the desired can body but is only

somewhat more than half as long. In this example, the intermediate cuprshaped receptacle **34** has an inside diameter of approximately 2 11/16 inches and has an axial dimension of approximately 2 ¾ inches which is approximately 58 percent of the desired axial dimension of 4 ¾ inches of the final can body. Thus, the cylindrical wall of the intermediate cup-shaped receptacle **34** is to be increased in axial dimension by approximately 73 ⅔ percent to produce the desired end product. If a cylindrical wall of any given thickness if lengthened by 73 percent, its thickness is reduced to 58 percent of its starting thickness. Thus the reduction in thickness is 42 percent and the starting thickness is 73 percent greater than the final thickness.

The preferred embodiment of the apparatus for carrying out the method taught by the invention is illustrated by FIGS. **1**—**3** wherein the moving parts of the apparatus are mounted on a base **42** which is provided with a control panel **44** having push-buttons **45** for electrical and hydraulic control of the operation. Mounted on the base **42** is a fixed upright block **48** in which the previously mentioned mandrel **20** is slidingly mounted in a fixed sleeve **48**. The mandrel **20** is moved axially by a hydraulic power cylinder **50** under the control of a suitable four-way valve (not shown) and is prevented from rotation by a spline (not shown) which extends radially inward from the sleeve **48** into a longitudinal groove **52** of the mandrel.

The base **42** further carries a pair of guide rails **54** on which is slidingly mounted a suitable carriage that carries the required rotary ring **55** which is shown in cross section in FIG. **2**. The carriage includes a housing **56** in which the rotary ring **55** is journaled and further includes a U-shaped yoke **58** with a pedestal **60** extending upward from the yoke to support a motor **62** for actuating the rotary ring. The motor carries a drive shaft **64** on which is mounted a drive pulley **65** that actuates the rotary ring by means of a pair of V-belts **66**, the V-belts extending through windows **68** in the housing **56**. Reciprocation of the carriage on the guide rails **54** is accomplished by a hydraulic power cylinder **70** having a piston rod **72** connected to the yoke **58**.

Also mounted on the base **42** is a fixed upright block **74** which fixedly carries a horizontally extending shank **75**, which, as best shown in FIG. **2**, terminates in a pressure head **76**. When the intermediate cup-shaped receptacle **36** is mounted on the mandrel **20** in the manner shown in FIG. **2** and the hydraulic power cylinder **50** is activated, the power cylinder presses the leading end of the mandrel towards the pressure head **76** and thereby clamps the intermediate cup-shaped receptacle against rotation on the mandrel **20**.

The rotary ring **55** may be journaled in the housing **56** in any suitable manner. In the construction shown, the rotary ring **55**, which may be made of steel, is journaled between two bronze bearing rings **78** and **80** and for this purpose the steel ring has opposite cylindrical flanges **82** that extend into corresponding circular grooves **84** in the two bearing rings. The bearing ring **78** fits into an annular seat **85** in the housing **56** and the bearing ring **80** is releasably mounted on the housing by suitable screws **86**. The periphery of the rotary ring **55** is formed with a pair of circumferential grooves as shown for engagement by the two V-belts **66**.

In the preferred embodiment of the invention, the rotary ring **55** has an inner circumferential liner **90** that spreads the metal of the cylindrical wall of the cup-shaped member **30** and for this purpose the liner may be made of any suitable hard material such as tungsten carbide. The liner **90** may be removably mounted inside the rotary ring **55** in any suitable manner. In the construction shown in FIG. **2** one end of the liner **90** abuts a radial shoulder **92** of the rotary ring **55**, the liner being confined between the shoulder **92** and a snap ring **94**. To prevent relative rotation between the liner **90** and the rotary ring **55**, the liner may be formed with one or more longitudinal ribs **95** as indicated in FIG. **3** that fit into corresponding longitudinal grooves **96** in the rotary ring.

The manner in which the apparatus functions for its purpose may be understood from the foregoing description. With the mandrel **20** axially retracted by the hydraulic power cylinder **50**, an intermediate cup-shaped receptacle **34** is telescoped onto the leading end of the mandrel and then the hydraulic power cylinder is activated to thrust the mandrel towards the pressure head **76** to clamp the cup-shaped receptacle between the mandrel and the pressure head and thus effectively anchor the cup-shaped receptacle against rotation relative to the mandrel. At this point in the operation, the parts are positioned as shown in FIGS. **1** and **2**, the carriage being retracted to retract the rotary ring from the leading end of the mandrel **20**.

With the ring **55** rotated at a suitable speed by the motor **62**, for example 570 r.p.m., hydraulic power cylinder **70** is activated to advance the carriage and thereby advance the rotating ring axially onto and over the cup-shaped receptacle **34** on the mandrel **20**. FIG. **6** indicates how the advancing rotating liner **90** displaces metal of the cylindrical wall **36** of the cup-shaped receptacle **34** to thin the cylindrical wall. Preferably the liner **90** has a smoothly curved inner rim **98** on its leading end which acts on the metal in the manner indicated, the rotating liner displacing a bead **100** of surplus metal as it advances and thins the cylindrical wall **36** of the cup-shaped member **34**.

At the end of the axial advance of the rotary ring **55** the cylindrical wall **36** of the cup-shaped member **34** is thinned to the desired degree and at the same time the cylindrical wall is extended to the length desired for the can body. The carriage is then retracted to retract the rotary ring **55** from the finished can body and then a suitable cutting means **125** is advanced to the can body on the mandrel **20** to penetrate the cylindrical wall of the can body. The cutting means is then rotated as indicated by the arrow **126** to trim the can body to the desired length, the trimming operation leaving a ring of sheet metal on the mandrel. The hydraulic power cylinder **50** is then activated to retract the mandrel **20** from the pressure head **76** thereby to terminate the clamping of the can body to the mandrel. The final retraction movement of the mandrel brings the severed ring of sheet metal against the stripper **22** and simultaneously a burst of compressed air is delivered to the air passage **25** to dislodge the can body from the mandrel. The can body and the severed ring of sheet material drop through an opening **128** in the base **42**. Thereafter the can body is both necked down and flanged by suitable dies to result in the final product shown in FIG. **11**.

The present process has a number of advantages over a conventional ironing operation wherein a hard metal ring cooperates with a mandrel to thin a cylindrical wall without rotation of the ring. In the first place, if the ironing ring is not floatingly supported with a certain freedom for lateral movement, the metal may pile up excessively at one point of the ring to result in rupture of the workpiece and, on the other hand, if the ironing ring is floatingly supported, localized resistance, for example a local thick spot in the metal, causes the mandrel and/or ring to shift laterally to result in a nonuniform cylindrical wall. In contrast the rotating ring of the present invention instead of merely pushing the surplus metal axially of the mandrel by brute force acts on the metal helically with a circumferential component of motion that tends to spread a thick spot laterally to eliminate the thick spot. Because of the ease with which the rotating ring overcomes thick spots without tearing the metal, the rotating ring may be closely controlled to conform accurately to a straight axis for close control of the thickness of the finished cylindrical wall and therefore the finished cylindrical wall may be made as thin as desired.

Another disadvantage of ironing the metal with a nonrotating ring is that a minor defect such as a crack in the sheet metal usually results in a reject whereas the circumferential component of motion of a rotating ring actually tends to heal defects in the material of the cylindrical wall.

It is to be further noted that the rate of movement of a nonrotating ironing ring relative to the cylindrical wall of a workpiece is limited to the rate of axial movement of the ring

whereas the rate of movement of the working surface of a rotating ring relative to the cylindrical wall of a workpiece depends on the helix angle of the relative motion. If the ratio between the circumferential speed of the inner periphery of the rotating ring relative to the speed of axial travel is only 1:1 the motion of the inner surface of the ring relative to the workpiece is only approximately 40 percent greater than the rate of axial travel of the ring, but if the ring rotates at a relatively high speed and is moved axially at a relatively slow speed, the motion of the inner circumferential surface of the ring relative to the workpiece approaches the circumferential speed of the inner surface of the ring and is a great many times more than the axial speed of the ring. A special advantage of such a high relative speed is the great amount of heat generated by friction to soften the displaced metal and thus facilitate displacement flow of the metal to reduce the resistance to axial movement of the ring.

Since the described liner **9** is of uniform inside diameter, it reduces the thickness of the cylindrical wall **32** of the cup-shaped receptacle **30** in a single stage. FIG. **7** shows how a liner **90***a* and a separate abutting liner **90***b* may be employed to thin the cylindrical wall **32** in two stages. The liner **90***a* has the usual rounded inner rim **98***a* on its leading end and the end portion **102** of the liner immediately behind the rounded rim is of a diameter to only partially reduce the thickness of the cylinder **32** to the desired ultimate thickness. The end portion **92** of the liner terminates at a sloping shoulder **104** which provides a smooth transition to the remaining portion **105** of the liner which completes the thinning of the cylindrical wall to the desired degree. Thus the first stage of reduction in thickness of the cylindrical wall **32** is carried out by the leading rounded rim **98***a* and the adjacent leading end portion **102** of the liner while the second stage is carried out by the sloping shoulder **104** and the adjacent remaining portion **105** of the liner.

FIG. **8** shows a set of abutting liners **90***c*, **90***d* and **90***e* which reduce the thickness of the cylindrical wall **32** of the workpiece in three stages. The first stage in reduction of thickness is carried out by the rounded inner rim **98***b* and an adjacent end portion **106** of the liner **90***c;* the second stage is carried out by a sloping shoulder **108** and an adjacent portion **110** of the same liner **90***c;* and finally, the third stage is carried out by a sloping shoulder **112** of the liner **90***d* and the remaining portion **114** of the liner **90***d*.

In the described apparatus, the clamping pressure between the pressure head **76** and the mandrel **20** that immobilizes a cup-shaped workpiece on the mandrel is created solely by the hydraulic power cylinder **50**. FIG. **9** shows how the clamping pressure may be determined solely by a coil spring **115**. In FIG. **9** the pressure head **76***a* is mounted on a stem **116** that telescopes into the tubular end of a shank **75***a* that fixedly extends from the previously mentioned rigid block **74**. In the construction shown, the stem **116** of the pressure head is keyed against rotation and is surrounded by a sleeve **118** that is secured by radial screws **120**. An enlargement **122** on the inner end of the stem **116** cooperates with the inner end of the sleeve **118** to limit axial outward movement of the pressure head **76***a*.

In this modification of the invention the hydraulic power cylinder **50** advances the leading end of the mandrel **20** to a limit position which is indicated by the dotted line **124** in FIG. **9**. At this predetermined limit of advance of the mandrel, the coil spring **115** is compressed to a predetermined extent to provide a predetermined force for clamping the cup-shaped workpiece against rotation relative to the mandrel **20**.

My description in specific detail of the selected process of the invention will suggest various changes, substitutions and other departures from my disclosure.

I claim:

1. A method of fabricating from ductile sheet material a cylindrical can body with an integral bottom wall, characterized by the steps of:

forming the ductile sheet material into a cup-shaped receptacle having a cylindrical wall of substantially the desired inside diameter of the can body and having an axial dimension substantially less than the desired axial dimension of the can body with the cylindrical wall of the receptacle substantially thicker than the thickness desired in the finished can body;

telescoping the cup-shaped receptacle over the end of a mandrel having a cross section corresponding to the desired internal configuration of the finished can body;

providing a hard ring of an inside diameter exceeding the outside diameter of the mandrel by substantially twice the thickness desired for the cylindrical wall of the finished can body; and

advancing the ring axially over the mandrel from the end thereof while simultaneously causing relative coaxial rotation between the ring and the mandrel to cause the inner circumferential surface of the ring to advance helically of the mandrel to thin the cylindrical wall of the receptacle to the desired final thickness and to spread the material of the cylindrical wall to increase the axial dimension of the receptacle to at least the desired final axial dimension of the can body.

2. A method of fabricating from ductile sheet material a cylindrical can body with an integral bottom wall, characterized by the steps of:

forming the ductile sheet material into a cup-shaped receptacle having a cylindrical wall of substantially the desired inside diameter of the can body and having an axial dimension substantially less than 75 percent of the desired axial dimension of the can body with the average thickness of the cylindrical wall of the receptacle at least 35 percent thicker than the average thickness desired in the finished can body;

telescoping the cup-shaped receptacle over the end of a mandrel having a cross section corresponding to the desired internal configuration of the finished can body;

providing a hard ring of an inside diameter exceeding the outside diameter of the mandrel by substantially twice the thickness desired for the cylindrical wall of the finished can body; and

advancing the ring axially over the telescoped receptacle from the bottom end thereof while simultaneously causing relative coaxial rotation between the ring and the mandrel to cause the inner circumferential surface of the ring to advance helically of the mandrel to thin the cylindrical wall of the receptacle to the desired final thickness and to spread the material of the cylindrical wall to increase the axial dimension of the receptacle to at least the desired final axial dimension of the can body.

3. A method as set forth in claim **1** which includes the step of pressing the bottom wall of the receptacle against the end of the mandrel to anchor the receptacle against rotation relative to the mandrel.

4. A method as set forth in claim **1** in which the mandrel is held against rotation and the ring is rotated as it is advanced.

5. A method of fabricating from ductile sheet material a cylindrical can body with an integral bottom wall, characterized by the steps of:

providing a blank of ductile sheet material of a thickness greater than any wall thickness desired in the finished can body;

forming the blank sheet into a cup-shaped receptacle having a cylindrical wall of substantially the desired inside diameter of the can body and having an axial dimension substantially less than the desired axial dimension of the can body with the cylindrical wall of the receptacle substantially thicker than the thickness desired in the finished can body;

squeezing the bottom wall of the cup-shaped receptacle to reduce the thickness of the bottom wall to the desired final thickness and to spread material of the bottom wall radially to form a circumferential bead on the receptacle;

telescoping the cup-shaped receptacle over the end of a mandrel having a cross section corresponding to the desired internal configuration of the finished can body;

providing a hard ring of an inside diameter exceeding the outside diameter of the mandrel by substantially twice the thickness desired for the cylindrical wall of the finished can body; and

advancing the ring axially over the telescoped receptacle from the bottom end thereof while simultaneously causing relative coaxial rotation between the ring and the mandrel to cause the inner circumferential surface of the ring to advance helically of the mandrel to thin the cylindrical wall of the receptacle to the desired final thickness and to spread the material of the cylindrical wall including said bead to increase the axial dimension of the receptacle to at least the desired final axial dimension of the can body.

6. A method as set forth in claim **1** in which the leading inner circumferential rim of the ring is of rounded cross-sectional configuration.

7. A method as set forth in claim **1** in which the inner circumference of the ring is of stepped configuration to thin the cylindrical wall of the receptacle by stages.

8. A method as set forth in claim **1** in which the inside diameter of the leading end portion of the ring is less than the outside diameter of the receptacle but greater than the desired outside diameter of the finished can body; and

in which the ring is formed with an inner circumferential shoulder spaced from the leading end portion of the ring, the inside diameter of the ring being stepped down at the shoulder to substantially the desired outside diameter of the finished can body.

9. A method as set forth in claim **1** in which the inside diameter of the leading end portion of the ring is less than the outside diameter of the receptacle but greater than the desired outside diameter of the finished can body; and

in which the ring is formed with a plurality of inner circumferential shoulders at each of which the inside diameter of the ring steps down, the last shoulder stepping the inside diameter down to the desired outside diameter of the finished can body.

10. A method as set forth in claim **1** in which the mandrel tapers in diameter towards its opposite ends for maximum thinning of the material in the intermediate region of the length of the cylindrical wall of the finished can body.

11. A method as set forth in claim **1** which includes the step of trimming the cylindrical wall of the receptacle to length while the receptacle is on the mandrel after the receptacle is processed by the ring.

12. An apparatus for spreading the material of the cylindrical wall of a cup-shaped receptacle for the dual purpose of thinning the cylindrical wall to a predetermined thickness and of increasing the axial dimension of the cylindrical wall, comprising:

a mandrel dimensioned to fit into the receptacle to support the receptacle from inside, said mandrel tapering in diameter towards its opposite ends for maximum thinning of the material in the intermediate region of the length of the cylindrical wall of the finished can body;

a ring having an inner circumferential surface of material substantially harder than the material of the receptacle and having an inside diameter exceeding the diameter of the mandrel by substantially twice said predetermined thickness;

means to create relative axial movement between the ring and the mandrel to advance the ring coaxially of the mandrel over the end of the mandrel and along the length of the mandrel; and

means to cause relative coaxial rotation between the ring and the mandrel as the mandrel advances.

13. An apparatus as set forth in claim **12** which includes means to hold the receptacle against rotation relative to the mandrel.

14. An apparatus as set forth in claim **12** which includes means to press the bottom wall of the receptacle against the end of the mandrel to anchor the receptacle against rotation relative to the mandrel.

15. An apparatus as set forth in claim **12** which includes:

a carriage on which the ring is rotatably mounted;

means on the carriage to rotate the ring; and

means to shift the carriage axially of the mandrel.

16. An apparatus as set forth in claim **12** in which the inner rim of the leading end of the ring is of rounded cross-sectional configuration.

17. An apparatus as set forth in claim **12** in which the inner circumference of the ring is of stepped configuration to thin the cylindrical wall of the receptacle by stages.

18. An apparatus as set forth in claim **12** in which the inside diameter of the leading end portion of the ring is less than the outside diameter of the receptacle but greater than the desired outside diameter of the finished can body; and

in which the ring is formed with an inner circumferential shoulder spaced from the leading end of the ring, the inside diameter of the ring being stepped down at the shoulder to substantially the desired outside diameter of the finished can body.

19. An apparatus as set forth in claim **12** in which the inside diameter of the leading end portion of the ring is less than the outside diameter of the receptacle but greater than the desired outside diameter of the finished can body; and

in which the ring is formed with a plurality of inner circumferential shoulders at each of which the inside diameter of the ring steps down, the last shoulder stepping the inside diameter down to the desired outside diameter of the finished can body.

20. An apparatus as set forth in claim **12** in which said ring has a replaceable liner of tungsten carbide providing said inner circumferential surface of the ring.

21. An apparatus as set forth in claim **12** which includes means to trim the thinned cylindrical wall of the receptacle to length while the receptacle is on the mandrel.

22. An apparatus as set forth in claim **12** in which the ring has at least one replaceable liner.

23. An apparatus as set forth in claim **22** in which the ring has a plurality of liners positioned end to end.