United States Patent [19]

Greenleaf

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[54] **PROCESS FOR MANUFACTURING CURVED CHANNELED MEMBERS**

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[73] Assignee: **General Motors Corporation,** Detroit, Mich.

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[21] Appl. No.: **193,496**

[52] **U.S. Cl.** **29/477,** 29/480, 72/354

[51] **Int. Cl.** **B23k 31/02**

[58] **Field of Search** ..... 29/480, 159 A, 475, 477; 72/354; 113/116 D

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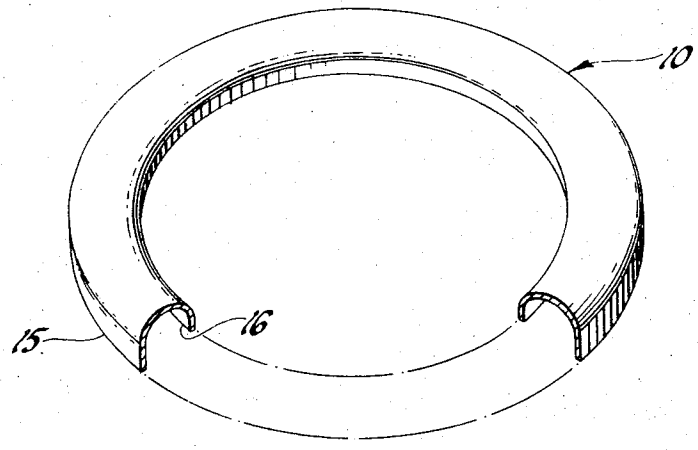
Attorney, Agent, or Firm—W. E. Finken et al.

[57] **ABSTRACT**

Metallic strip stock preferably of rectilinear shape is formed into a cylindrical workpiece by joining its free end portions. The cylindrical workpiece is loaded into a die having a curl ring and a forming post and the die is actuated so that the sides of the cylindrical workpiece are progressively curled over the forming post preferably from the top edge as the die strokes to a stop point whereby the sides of the workpiece are curled into an annular and generally U-shaped configuration with the top and bottom edges of the workpiece coplanar or disposed in adjacent planes that intersect the axis of the cylindrical workpiece.

5 Claims, 8 Drawing Figures



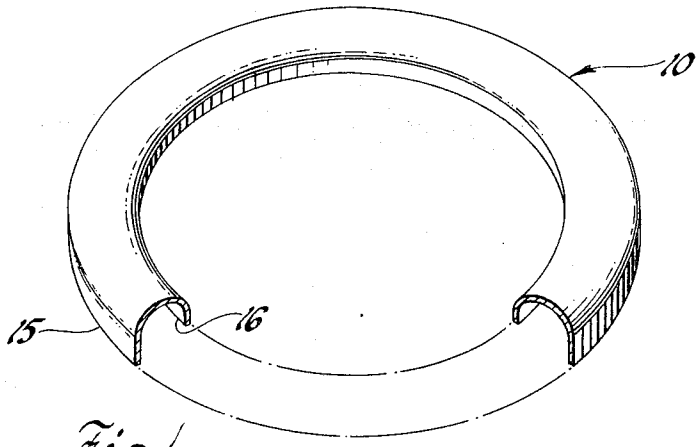


Fig. 1

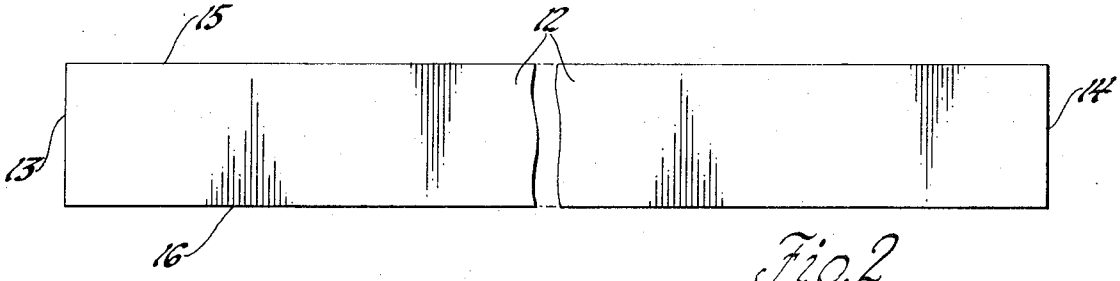


Fig. 2

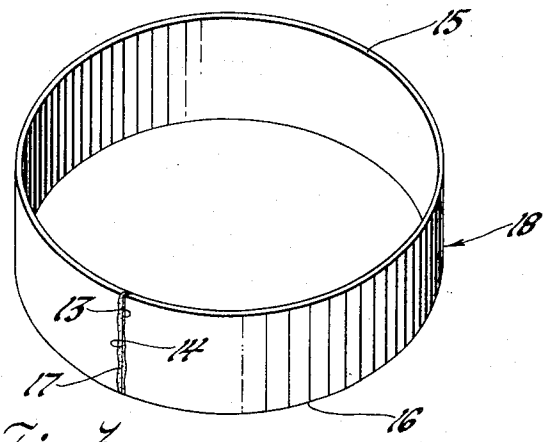


Fig. 3

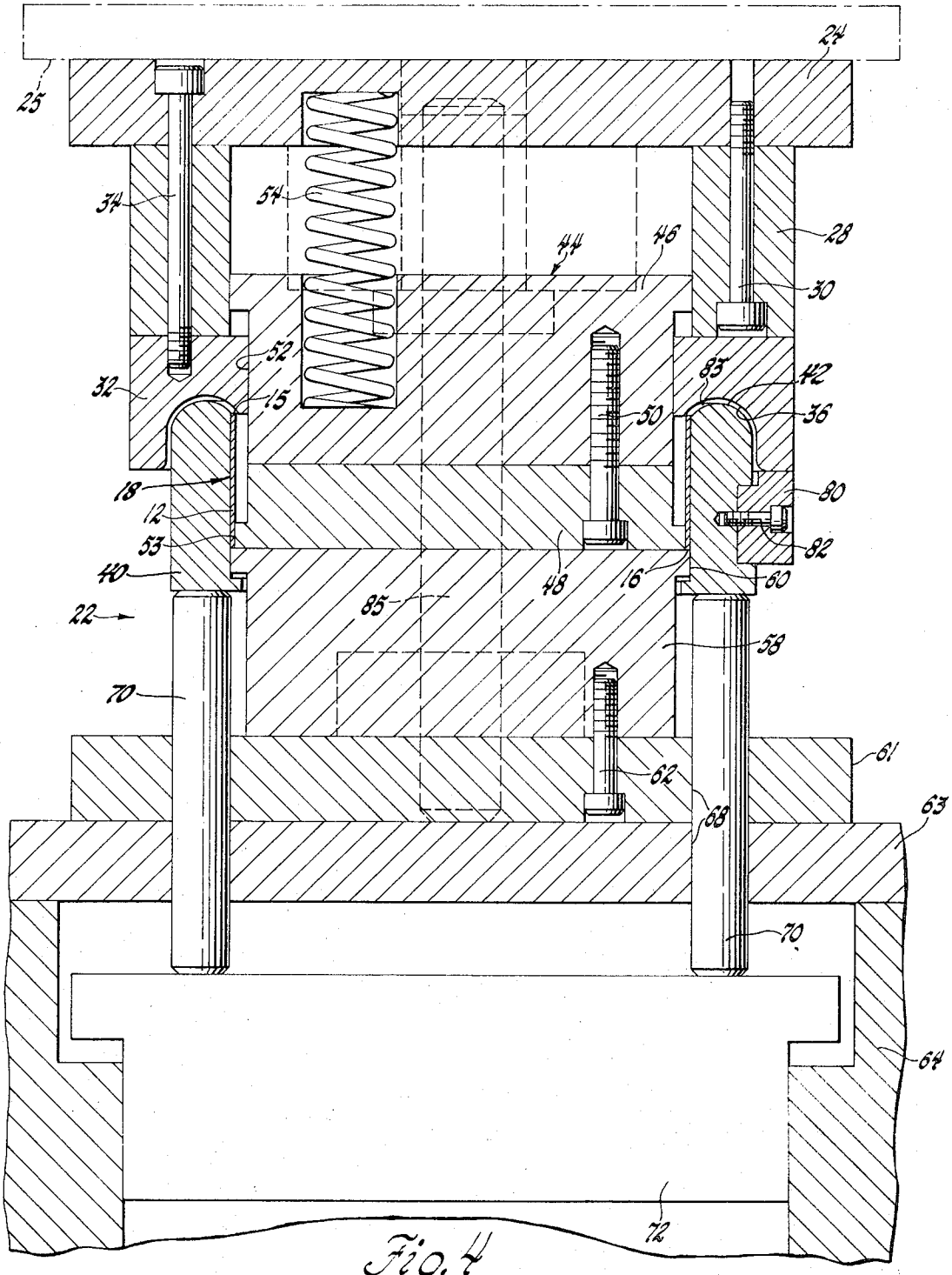

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Fig. 4

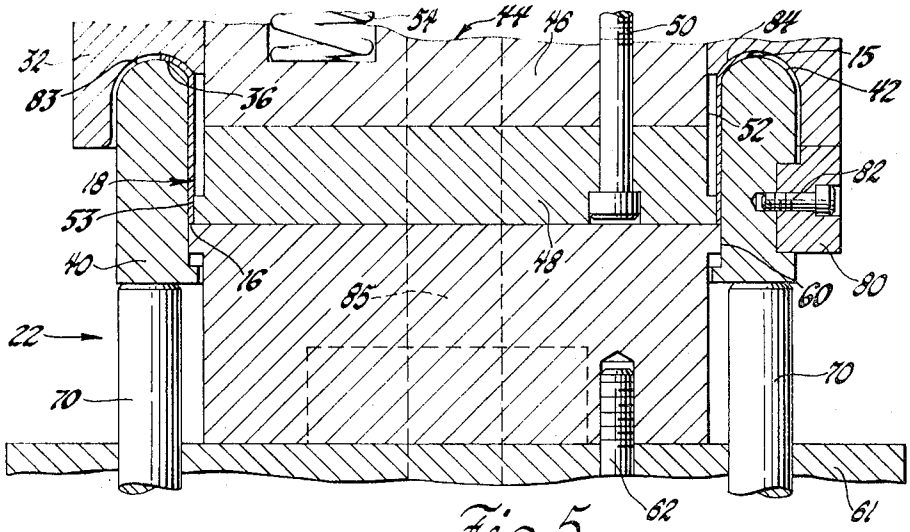
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Fig. 5

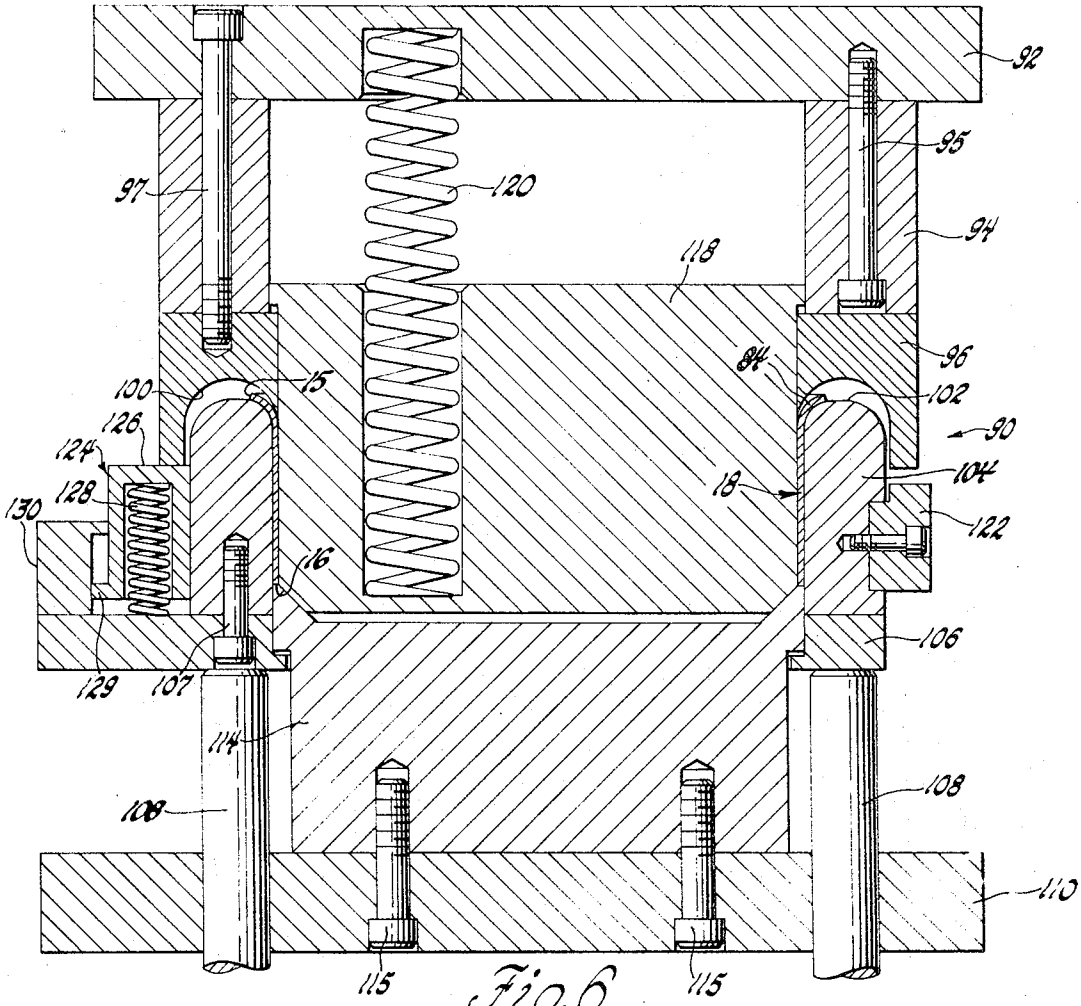
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Fig. 6

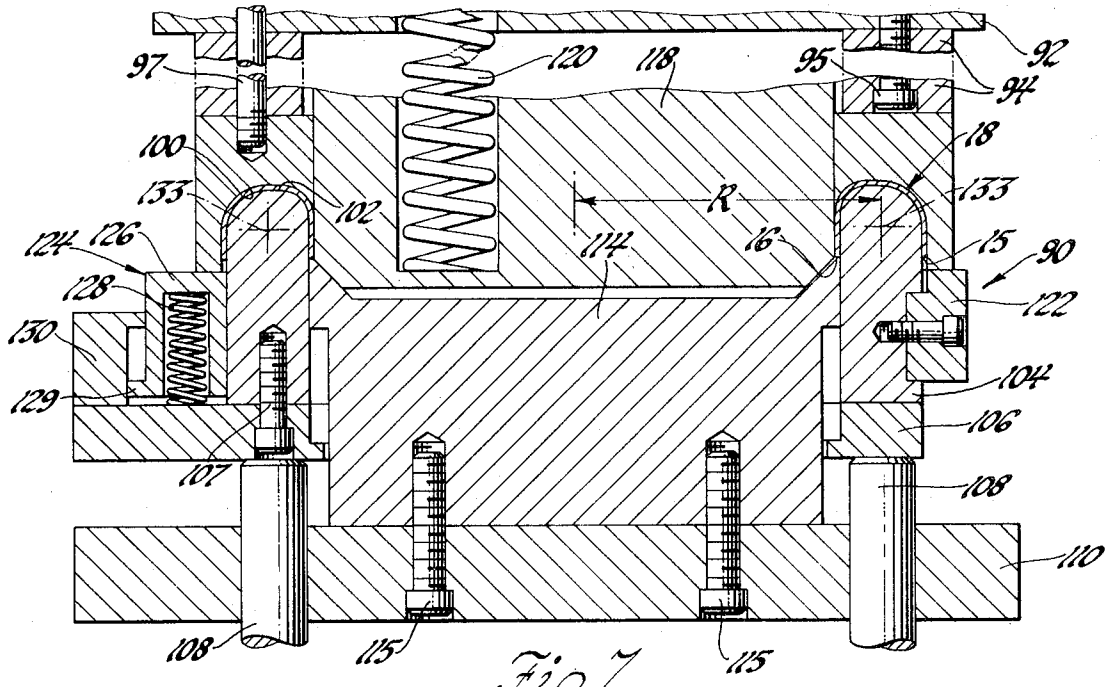
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Fig. 7

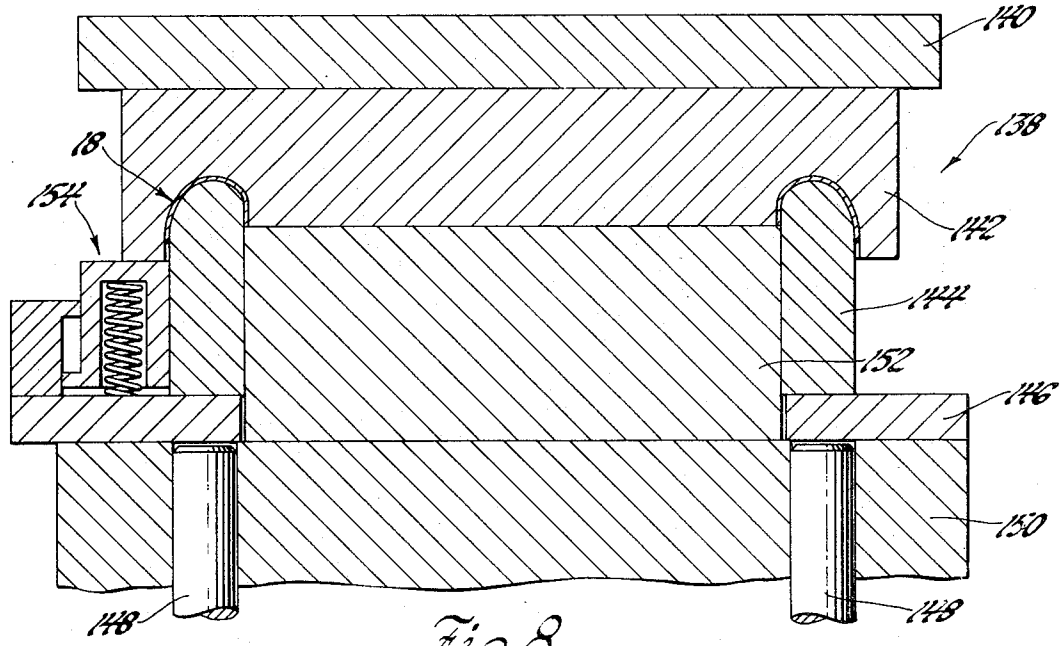
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Fig. 8

PROCESS FOR MANUFACTURING CURVED CHANNELED MEMBERS

This invention relates to a process for making curved, channeled shells and more particularly for curling thin walled curved shell members from straight strip stock leaving substantially no scrap.

Prior to the present invention curved channeled shell members such as the thin walled and toroidal shells of torque converter rotors were made by stamping large washer-like blanks from flat sheets. These blanks were then pressed into an annular channeled member to form the inner or outer shell of a torque converter rotor. However, when stamping these blanks from the sheets, annular discs were produced to form the center holes in the blanks. These discs and the other portions of the stock sheets outside of the outer circumference of the circular blanks resulted in a waste or scrap accumulation. While this prior process provided for the successful mass production of channeled annular shells the recovery, handling and recycling of the scrap added substantially to the shell cost.

This invention provides a more economical and advantageous process for making such annular toroidal or other curved channeled members. In the preferred process of this invention, rectilinear strip stock of a predetermined width and length with straight top and bottom edges is curved and securely joined at the free ends to make a cylindrical workpiece. Using tooling devices such as a die, the cylindrical workpiece is preformed by curling or turning the top edge on a radius. In a subsequent operation the sides of the cylinder are curled by a die set or other device to form an annular toroidal channeled member generally U-shaped in cross section. If needed, the channeled member manufactured can be restruck with a die set to finish form the part.

It is an object and feature of this invention to provide a new and improved process for making curved channel members from strip stock.

It is an object and feature of this invention to provide a new and improved process for making a curved channel from rectilinear strip stock by bending the strip stock into a curved wall and subsequently curling the wall from its extremity around a curved member to form a smooth wall channel without fractures, folds or galling.

It is another object and feature of this invention to provide a new and improved process for making a circular channel member in the general form of a laterally bisected torus by joining the ends of rectilinear strip stock to form a cylinder with top and bottom circular edges and subsequently curling the sides of the cylinder leading from one of the edges until the edges are in planes adjacent to each other to form the channel member.

Another object and feature of this invention is to provide a new and improved process for making an annular channel member by using strip stock, joining the strip stock at its ends to make a cylindrical member, preforming the cylindrical member by turning an edge portion of one end thereof radially and subsequently simultaneously curling the side wall of the cylindrical member into an annulus having a generally U-shaped cross section.

Another object and feature of this invention is to provide a new and improved process of forming an annular thin walled channel member from a substantially flat

sheet of metal having top and bottom edges and having end portions which are joined by means such as welding to form a cylindrical workpiece having a central axis and subsequently employing a curl ring and a forming post to curl the side wall of the workpiece leading from one of its edges over the post to a position whereby said top and bottom edges are disposed in planes closely adjacent to each other which intersect the central axis.

These and other advantages, objects and features of this invention will become more apparent from the following detailed description and drawing in which:

FIG. 1 is a perspective view of a portion of an annular channeled member formed by the process of this invention.

FIG. 2 is a top view of a rectangular piece of metallic strip stock.

FIG. 3 is a perspective view showing the strip stock of FIG. 2 joined at its ends to form a cylindrical member.

FIG. 4 is a view partly in cross section showing the cylindrical member of FIG. 3 in a preform die set before closing.

FIG. 5 is a view partly in cross section showing the cylindrical member in the preform die set after closing.

FIG. 6 is a view partly in cross section showing the cylindrical member in a curling die set before closing.

FIG. 7 is a view partly in cross section showing the curling die set of FIG. 6 in a closed position with the side walls of the cylinder curled into an annular channeled member.

FIG. 8 is a view partly in cross section of the workpiece in a finished form in a closed restrike die set.

Turning now to FIG. 1, there is shown an annular channeled shell 10 for a hydrodynamic coupling or converter to which series of blades can be affixed to form a rotor. This shell is made from strip stock such as the rectangular metallic strip 12 shown in FIG. 2 having square ends 13 and 14 and top and bottom edges 15 and 16. In the preferred process the ends 13 and 14 of the strip 12 are secured together preferably by welding as at 17 to form a circular cylindrical workpiece 18 such as shown in FIG. 3. The welded area 17 is preferably planished and smoothed to a degree whereby there is no substantial irregularity in the annular cylinder as a result of the welding. The cylindrical workpiece 18 is then curled into shape without fractures, folds or galls by initially stretching and subsequently compressing the material of the cylinder as it is forced over a forming ring of a die set.

FIGS. 4 through 8 disclose the die sets and die operations preferably employed to make the channeled shell 10 from the cylinder 18. In FIG. 4 there is a pre-form die set 22 employed in a suitable press to initially turn or flare the top edge 15 of cylindrical work piece 18 outwardly. This die set comprises a vertically movable upper punch shoe 24 which is operatively connected to an actuator such as the press ram 25 connected by a wrist pin to a motor driven eccentric not shown. The punch shoe and the connected portions of the die described below are moved by the motor mechanism between a fully open position for workpiece loading and a fully closed position for workpiece curling. A cylindrical riser 28, fastened to the punch shoe 24 by screws 30, carries an annular curl ring 32. This ring is secured to the riser 28 by screws 34 which extend through the punch shoe and riser as shown. The curl ring has an an-

nular concave surface **36** which curls or flares the upper edge **15** of the annular cylinder **18** outwardly in a pre-form operation as will be further explained below. Aligned with this curl ring is a cylindrical form post **40** that has an annular and convex upper surface **42** which cooperates with the concave surface **36** of the curl ring to establish the curvature of the upper portion of cylindrical member **18.**

To provide for the locating, positioning and supporting of cylinder **18,** a spring pad assembly **44** is employed. This assembly has upper and lower sections **46** and **48** secured together by screws **50.** The upper section has a cylindrical guide surface **52** which slidably fits within the curl ring **32** to assist in the guidance of the curl ring during a pre-form operation. The lower section of the spring pad assembly has a cylindrical surface **53** which contacts and supports a portion of the side wall of cylindrical workpiece **18.** The spring pad assembly **44** is yieldably connected to the punch shoe **24** by a plurality of helical springs **54** which are disposed and securely anchored in aligned spring pockets in the spring pad assembly and in the punch shoe.

Immediately below the spring pad assembly **44** is a center post **58** which has an annular shoulder **60** that slidably fits in the curl ring **32** during pre-form operation and provides a support for the cylindrical workpiece **18.** The center post **58** is fastened to a stationary pre-form die shoe **61** by screws **62.** The pre-form die shoe **61** is fastened to a bolster plate **63** mounted on the bed **64** of the press. The pre-form die shoe **61** and bolster plate **63** have a plurality of openings **68** formed on a circular path each of which receives one of the vertically movable pressure pins **70** extending upwardly from a conventional air cushion **72** of the press. As shown each of these pins projects upwardly from air cushion **72** into supporting engagement with the bottom of the form post **40** to yieldably support this die member in position. The air cushion supports in conjunction with the forming post, the cylindrical workpiece on the downward stroke of the press as the cylindrical workpiece curls around the top of the forming post. On the upward stroke it returns the forming post and the curled workpiece to its unloading position.

To properly space the curl ring **32** relative to the form post **40,** a spacer block **80** is employed. This spacer block is secured by screws **82** to the outer periphery of the form post as shown in FIG. **4.** When the lower edge of the curl ring contacts the top of the spacer block **80** a predetermined clearance **83** between the curl ring and the form post is established.

The punch shoe and die shoe are guided in line by conventional guide pins **85.** In a loading position the punch shoe with the attached curl ring **32** and spring pad assembly are moved by the motor operated press ram **25** to an upper position to provide sufficient clearance to allow the cylindrical workpiece **18** to be placed on the center post and within the form post **40.** The punch shoe and the attached spring pad assembly and curl ring are then lowered to the open position shown in FIG. **4.** The ram **25** then lowers and applies a force to the punch shoe which is transferred to the curl ring **32,** spacer block **80** and form post **40,** overcoming the upward force of the air cushion **72.**

With the punch shoe and connected elements moving downwardly and with cylindrical workpiece **18** being held on center post, the upper edge **15** of the cylindrical workpiece **18** enters into the annular clearance **83** between the curl ring and the form post by an amount as determined by travel of the curl ring and the form post relative to the cylindrical workpiece **18.** The downward travel is controlled by a preset stop within the press. FIG. **5** shows the outer rim of cylindrical workpiece **18** annularly flanged at **84** after the completion of the preform operation.

After pre-forming, the workpiece **18** is curled into an annular channeled member in a curl die set **90** shown in FIG. **6.** This die set is similar to die set **22** and therefore only briefly described. The press used with this die set has a punch shoe **92** moved vertically between loading, open, and curling positions by a press ram such as that previously disclosed. A riser **94** is connected to the punch shoe **92** by screws **95** and a curl ring **96** is fastened to the connector member by screws **97.** The curl ring **96** has an annular concave surface **100** which is aligned with and which receives the convex surface **102** of the cylindrical form post **104.** The form post **104** is connected to a base **106** by screws **107** and this base is supported on the pressure pins **108.** These pressure pins are supported on a press air cushion such as described in connection with the pre-form die. The pins **108** extend through a stationary die shoe **110** that is secured to the press bolster plate not shown. The stationary die shoe has a cylindrical center post **114** fixed thereto by screws **115.** The center post extends upwardly from the die shoe **110** through an annular opening formed in the base **106.** As shown the center post supports the cylindrical workpiece **18.** This die set also has a spring pad assembly **118** disposed above the center post which is connected by helical springs **120** to the punch shoe, so that the spring pad moves with the punch shoe. In addition to the above there is a spacer block **122** fixed to the form post that limits the travel of the curl ring relative to the form post.

To remove the work from the form post after being formed or curled a workpiece stripper **124** is employed. This stripper has a vertically movable outer housing **126** which is located adjacent to the form post and has a biasing spring **128** therein which urges the housing **126** upwardly. The housing **126** has a flange **129** disposed in a vertical slot in retainer **130** to limit the stroke of the stripper housing **126.** The punch shoe and die shoe are guided in line by conventional guide pins and bushings as in the pre-form die.

In operation, the die is opened so that cylinder **18** with the flared edge **84** can be inserted within the confines of the form post. The punch shoe with the spring pad and the curl ring are moved by the press ram to the ready position of FIG. **6.** Subsequently th punch shoe is then moved downwardly; the curl die **96** engages the spacer block which sets the predetermined clearance between the curl ring and the form post. The form post and the curl ring then moved downwardly as a unit overcoming the opposing force of spring pins **108.** The cylindrical workpiece **18** cannot move downwardly being supported by the center post. The side wall of this workpiece is then progressively curled by the downwardly moving dies over on the form post to reversely curve the side wall with respect to a circular axis **133** having a radius R from the central axis of the workpiece. In the preferred process the radius R is greater than the radius of the circular cylinder. The edges **15** and **16** are coplanar or are disposed in closely adjacent planes which intersect the central axis of the workpiece. The downward stroke of the punch shoe is

stopped by stroke limiting mechanism within the press. As the punch shoe **92** is raised the stripper housing **126** is biased upwardly by the spring **128** and engages the lower edge **16** of the workpiece and unloads it from the form post.

In the event that additional forming is desired an optional restrike die set **138** can be employed. This die set is similar to the pre-form and curl die sets previously described. The press ram operated punch shoe **140** is vertically movable as described in connection with the pre-form and curl die and is secured to the punch steel **142.** This punch steel has an annular, concave forming surface that matches the convex and annular surface of the form post **144.** The form post is secured to annular base **146** that is mounted on the pressure pins **148** extending upwardly from the press air cushion not shown. The restrike die **150** is secured to the press bolster plate not shown and supports the center post **152.** The center post supports the workpiece as in the previously described die sets.

The workpiece stripper mechanism **154** is the same construction and operation as described in connection with the curl die set. as shown by FIG. **8,** the closed position of the restrike die set, the punch steel and the cooperating form post has further curled the workpiece into a finished form as shown in FIG. **1.** In this form the top edge **15** has been curled so that it is in a plane below the plane of the bottom edge **16.**

The detailed description and drawings are illustrative of but the preferred process of this invention which may be modified in accordance with specific needs and circumstances. The scope of this invention is therefore not to be limited by the particular description and drawings of the preferred process but by the claims appended hereto.

I claim:

1. A process of forming a toroidal member with spaced cylindrical side walls defining the inner and outer radial limits of said member and with a convexly curved end wall connecting the side walls comprising the steps of providing a substantially flat sheet of metal having side edges and having free end portions, welding the free end portions of said sheet of metal to form a cylindrical workpiece having contiguous ends and an intermediate cylindrical portion disposed around a central fixed line axis, positioning said cylindrical workpiece on a stationary base and adjacent to one side of a toroidal forming post having cylindrical inner and outer radial sides and a convexly curved top, said positioning forming an imaginary plane defined by the contact of one of said ends of the cylindrical workpiece and the stationary base, positioning an annular concave curling ring a predetermined distance from the top of said forming post thereby providing a space into which at least a portion of the workpiece is to be fed, initially linearly moving the forming post and curling ring as a unit relative to the base from a starting position toward a terminal position to thereby progressively feed the other of said ends of said cylindrical workpiece into said space between said top of said forming post and said concave curling ring, continuing linearly moving said forming post and said curling ring as a unit relative to said base to said terminal position to progressively feed said intermediate portion of said workpiece into said space to thereby curl said intermediate portion into conformity with the curvatures of said top of said forming post and said curling ring and to force the said other of said ends of said cylindrical workpiece downwardly a predetermined distance alongside the other side of said forming post to form a continuous side wall and to move said other of said ends of said cylindrical workpiece through said plane thereby completing the formation of said toroidal member.

2. A process of forming a toroidal channel member U-shaped in cross section having spaced inner and outer side walls defining inner and outer limits of said member comprising the steps of providing a substantially flat sheet of metal having side edges and having free end portions, welding the free ends portions of said sheet to form a cylindrical workpiece having ends and an intermediate portion disposed around a central fixed line axis, providing a linearly movable toroidal forming post having cylindrical inner and outer radial side walls and a convexly curved top, providing a stationary base within the confines of said forming post, supporting said cylindrical workpiece adjacent to the inner side wall of said forming post on a plane defined by the contact of one end of said cylindrical workpiece and said stationary base, providing a linearly moveable annular concave curling ring, positioning said curling ring a predetermined distance from said forming post thereby providing a convexly curved space into which at least a portion of said workpiece is to be fed, initially linearly moving the forming post and the curling ring as a unit relative to said base from a starting position toward a terminal position to thereby progressively feed the other end of the cylindrical workpiece into said space between the top of said forming post and said curling ring, continuing the linear movement of said forming post and said curling ring together relative to said base to said terminal position to thereby progressively feed said intermediate portion of said cylindrical workpiece into said space completely over the top of said forming post and thereby move said other end of said workpiece downwardly alongside the outside of said forming post through said plane to form a continuous cylindrical outer side wall which provides the outer side wall of said channel member.

3. A process for making an annular toroidal shell having a central opening and a generally U-shaped cross section comprising the steps of providing an elongated sheet of strip stock with substantially straight side edges and with free end portions, curling the sheet of strip stock about an axis of revolution, welding the free end portions of said strip stock to form a circular cylinder having ends and an intermediate cylindrical portion, providing a stationary base for supporting said cylinder, providing a toroidal forming post having inner and outer cylindrical radial side walls and having a convexly curved annular top connecting said inner and outer cylindrical side walls, providing an annular curl ring with a concave curling wall therein, supporting said cylinder on said base in a plane defined by the contact of one of said ends of the cylindrical workpiece and said stationary base and within said forming post so that said wall of said cylinder is adajcent to the inner side wall of said forming post, positioning said curl ring a predetermined distance from said forming post to form a curved passage into which a portion of the workpiece is to be fed and that terminates at a point along the outer sidewall of said curl ring, initially moving said forming post and said curling ring relative to said base with a press from a start position toward a terminal position so that the other end of said cylinder is progres-

sively displaced in said passage, further moving said curling ring and said forming post relative to said base to said terminal position with a press thereby forcing said intermediate portion of said cylinder into said space to resultantly move said other end of said cylinder further into said space and through said plane to thereby complete formation of said toroidal shell.

4. A process of forming a toroidal thin walled channel member from a substantially flat sheet of metal having side edges and free end portions comprising the steps of welding the free end portions of said sheet to form a circular cylindrical workpiece having ends and an intermediate portion disposed around a fixed line axis, providing a toroidal forming post having radial inner and outer walls and a convexly curved top wall, providing a curling ring with an annular concave curling surface therein, providing a stationary base, loading said cylindrical workpiece in said cylindrical forming post, supporting said cylindrical workpiece on said base and in a plane defined by the contact of one end of the workpiece and the stationary base, spacing said curling ring a predetermined distance from said forming post to form a fixed curved passage therebetween thereby providing a space into which a portion of the workpiece is to be fed, initially moving said forming post and curling ring as a unit relative to said cylindrical workpiece from a first position toward a terminal position thereby to progressively feed the other end of said workpiece into said space, further moving said forming post and said curling ring as a unit relative to said cylindrical workpiece to said terminal position to feed said intermediate portion of said workpiece into said fixed passage between said forming post and curling ring until said intermediate portion of said workpiece is curved onto the top of said forming post and said other end of said workpiece is moved through said plane to form a continuous outer wall of said channeled member having a radius greater than the radius of said cylindrical workpiece.

5. A process of making a toroidal channel member having spaced inner and outer cylindrical side walls as radial inner and outer limits thereof and having a convexly curved end wall connecting said side walls comprising the steps of providing a flat sheet of metal with side edges with free end portions, hooping said sheet about an axis until said free end portions abut, welding said free end portions together to form a cylindrical blank of a predetermined radius having contiguous ends and an intermediate cylindrical portion supporting said cylindrical blank so that one of said ends thereof is disposed in a plane, progressively curving said cylindrical blank starting with the other end thereof in a fixed path convexly curved with respect to a circular line having a radius greater than said radius of said cylindrical blank, subsequently progressively curving said intermediate portion of said cylindrical blank in said fixed convexly curved path and thereby moving said other end at least to a position aligned with said plane to thereby form said outer side wall and complete the formation of said toroidal channel member.

* * * * *