(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
14 June 2007 (14.06.2007)

PCT

(10) International Publication Number
WO 2007/067303 A2

(51) International Patent Classification:
B21D 22/24 (2006.01) *B21D 53/26* (2006.01)

(21) International Application Number:
PCT/US2006/043869

(22) International Filing Date:
10 November 2006 (10.11.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11/295,802 6 December 2005 (06.12.2005) US

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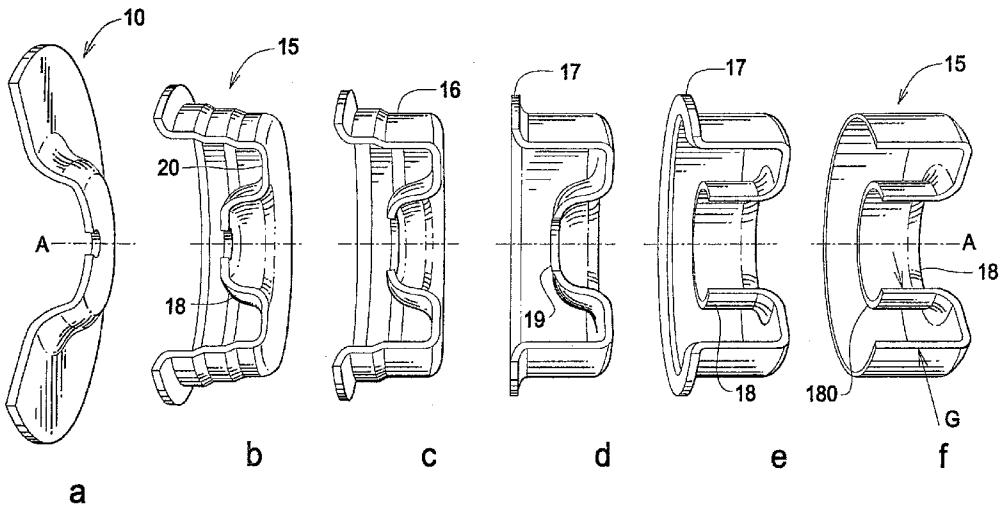
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) **Title:** METHOD OF FORMING A PART



(57) **Abstract:** A method of forming a part comprising the steps of forming a round sheet metal blank, pressing the sheet metal blank through a first forming die to form a blank, the blank having a bearing seat, the bearing seat having a bearing seat edge, pressing the blank through a second forming die using a mandrel applying a pressure to the bearing seat edge, and sequentially reducing the diameter of the blank by a single pass through the second forming die.

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Title

Method of Forming a Part

Field of the Invention

The invention relates to a method of forming a part by using a forming die to sequentially reduce the diameter of the part by pressing the part through a multi-diameter forming die in a single pass while solely pressing an edge in order to urge it through the forming die.

Background of the Invention

Manufacturing of parts, including idler pulleys, from sheet metal for belt drive power transmission applications is a common practice. The easiest way to make these products is using multi-station dies to form the idlers.

One of the challenges in making idlers is when the gap between the bearing seat and the belt contact area becomes too small to form the part in the press. As a rule of thumb, once the gap becomes smaller than 10 mm, it is not practical to make a sheet metal idler. This is due to the fact that the tooling that goes into the gap, commonly referred to as a mandrel, becomes too thin and would break under forming forces in the press. Consequently, rather than using sheet metal idlers that are lighter and less expensive, alternative methods of manufacturing such as machining from solid bar stock, forging, casting, or powder metal (sinter metal) processes are used to manufacture small gap idlers. All these alternative processes produce a much heavier and more expensive product. Powder metal idlers are prone to internal corrosion and have lower strength due to their

inherent porosities. Spinning processes are slower than press forming process and thereby they are costlier.

US Patent 6,505,490 by Hodjat and Roes which discloses a method of forming a sheet metal cup without using a mandrel. A cup shaped blank is first produced having a relief on a rim or outer circumference. The blank is clamped in the spinning machine. The relief controls and facilitates the bending process, creating a uniform curve at a predetermined bending point. During the rolling process, a forming roller is engaged with rim, and is moved progressively parallel with an axis of rotation. As the forming roller moves, the rim is progressively bent from an orientation normal to an axis of rotation to a position parallel to the axis of rotation. The fully formed rim can then be punched to accommodate a bearing or shaft. This allows a small radius pulley to be formed without use of a mandrel.

What is needed is a method of forming a part by using a forming die to sequentially reduce the diameter of the part by pressing the part through a multi-diameter forming die in a single pass while solely pressing the edge of the part in order to urge it through the forming die. The present invention meets this need.

Summary of the Invention

The primary aspect of the invention is to provide a method of forming a part by using a forming die to sequentially reduce the diameter of the part by pressing the part through a multi-diameter forming die in a single pass while solely pressing the edge of the part to urge it through the forming die.

Other aspects of the invention will be pointed out or made obvious by the following description of the invention and the accompanying drawings.

The invention comprises a method of forming a part comprising the steps of forming a round sheet metal blank, pressing the sheet metal blank through a first forming die to form a blank, the blank having a bearing seat, the bearing seat having a bearing seat edge, pressing the blank through a second forming die using a mandrel applying a pressure to the bearing seat edge, and sequentially reducing the diameter of the blank by a single pass through the second forming die.

Brief Description of the Drawings

The accompanying drawings, which are incorporated in and form a part of the specification, illustrate preferred embodiments of the present invention, and together with a description, serve to explain the principles of the invention.

Fig. 1 is a cross-sectional view showing press formation of an idler blank.

Fig. 2 is a cross-sectional view of the sizing die.

Fig. 3 is detail 2 from Fig. 2.

Detailed Description of the Preferred Embodiment

The invention comprises a method of manufacturing a part by press forming. The inventive process can be accomplished in one or two operations, but for simplicity, a two step operation is described here. The two step press operations can be combined into one if so desired.

The first step is to manufacture a part, such as an idler, with the required bearing seat design but having a larger belt bearing surface diameter which is large enough to allow a minimum mandrel diameter, for instance 10 mm to be used.

In Fig. 1(a) a round sheet metal blank 10 is manufactured using methods known in the art, for example, by stamping. Figures 1(b) thru 1(d) depict the formation of an idler blank by pressing the blank 15 through a first forming die using methods known in the art. Pressing blank 15 through a forming die creates a belt bearing surface 16 having an interim stepped shape due to the progressive reduction in diameter, see Fig. 3. Excess material forms a flange 17 around an outer edge of the blank 15. Also formed is bearing seat 18. Bearing seat 18 and belt bearing surface 16 are substantially parallel. They are also parallel to the axis of rotation of the idler A-A. Bearing seat 18 engages an outer race of a bearing such as a ball bearing. The ball bearing is pressed into the bearing seat 18.

In Fig. 1(e) excess material 19 formed in Fig. 1(d) has been removed by a cutting operation known in the art. Flange 17 is removed by a known cutting operation. Finished blank 15 is shown in Fig. 1(f) with the final form of the bearing seat 18 and belt bearing surface 16. The radial distance, or gap, between the bearing seat 18 and the belt bearing surface 16 is denoted "G". The width of gap (G) is a function of the thickness of the mandrel used to press the blank 15 though the forming die.

The second step is sequentially reducing the belt bearing surface diameter in a sizing die. Fig. 2 is a cross-sectional view of the sizing die apparatus. Sizing die apparatus 100 comprises in part a mandrel 101 and a forming die 102.

Blank 15 is first put onto die 103 and pressed by the mandrel 101 to fully engage die 103 with bearing seat 18. For the purpose of the forming operation die 103 is disposed in the position that will be later occupied by a

ball bearing. Mandrel 101 comes into contact with die 103. Mandrel 101 presses blank 15 which causes spring 107 to compress. Blank 15 is then pressed further until belt bearing surface 16 engages forming die 102.

As it presses blank 15 into forming die 102, mandrel 101 bears upon and applies pressure in direction M+ to the bearing seat edge 180 of the bearing seat 18. In a preferred embodiment mandrel 101 bears solely upon and applies pressure to the bearing seat edge 180. Bearing seat edge 180 comprises the bearing seat edge of blank 15 which is formed by the process described in Fig. 1. By pressing on bearing seat edge 180 instead of on inner surface 20 as in the prior art, the final dimension of gap G is not limited by the thickness of a mandrel that would otherwise be engaged with the inner surface 20, thereby occupying the gap G between the belt bearing surface 16 and the bearing seat 18. Hence, the width of gap G is then only limited by the diameter of the rings as described in Fig. 3. This process allows a small gap idler to be fabricated having reduced weight and cost.

During the pressing operation, the inside of the bearing seat 18 is supported by die 103 to prevent crushing or compression failure of bearing seat 18. Die 103 is seated against moveable member 104. During the pressing operation mandrel 101 and die 103 are fully engaged and move as a unit in conjunction with moveable member 104.

Moveable member 104 is slidingly engaged with cavity 106 in base 105. Spring 107 resists movement of moveable member 104 in direction M+. Once the idler is fully formed spring 107 has a spring rate sufficient to force member 104, die 103 and fully formed idler blank 15 in direction M-, whereby fully formed idler 15 is ejected from forming die 102. Once idler 15 and die 103 are

ejected from forming die 102, die 103 is pressed from the bearing seat 18 using known means.

Depending on the desired reduction of diameter of the blank 15, one or more sizing diameters for forming die 102 are used. Fig. 3 depicts the various diameters D1, D2, D3. D3 is less than D2, which is less than D1. Each diameter, or ring, sequentially reduces the diameter of the blank 15 by roughly about 1 mm. The amount of reduction depends on many factors including the thickness of the metal and the finished diameter of the blank as compared to the initial diameter of the idler blank. The diameters or rings can be stacked up one on top of one another to form as many sequential stages of reduction as required. Consequently with one pressing movement of mandrel 101 the idler diameter (and consequently the gap width) can be sequentially reduced to the desired value by choosing the proper number of rings to accommodate the interim reduction steps. To assure a smooth sizing operation, it is preferred to have a generous radius R on the idler, namely, that portion disposed between the bearing seat and the belt track.

The final diameter D3 results in blank 15 having a gap G2. Gap G2 is significantly less than gap G. Gap G2 is significantly less than a gap created using the prior art mandrel method, namely, because it eliminates the need for pressing blank 15 through forming die 102 with a mandrel that is engaged with the inner surface 20 of the blank as shown in Fig. 1.

This new invention reduces the cost, process complexity, and capital equipment requirements comparing with the prior art. The inventive method reduces the weight in comparison with prior art processes of machining idlers from solid, powder metal, forged, or cast parts.

Although a form of the invention has been described herein, it will be obvious to those skilled in the art that variations may be made in the construction and relation of parts without departing from the spirit and scope of the invention described herein.

Claims

I claim:

1. A method of forming a part comprising the steps of:

forming a round sheet metal blank;

pressing the sheet metal blank through a first forming die to form a blank, the blank having a bearing seat, the bearing seat having a bearing seat edge;

pressing the blank through a second forming die using a mandrel applying a pressure to the bearing seat edge; and

sequentially reducing the diameter of the blank by a single pass through the second forming die.

2. The method as in claim 1 wherein forming the round sheet metal blank comprises stamping.

3. The method as in claim 1 further comprising the step of ejecting the formed blank from the second die by spring force.

4. The method as in claim 1 wherein sequentially reducing the diameter of the blank comprises movement in one direction.

5. The method as in claim 1 wherein the mandrel applies pressure solely to the bearing seat edge.

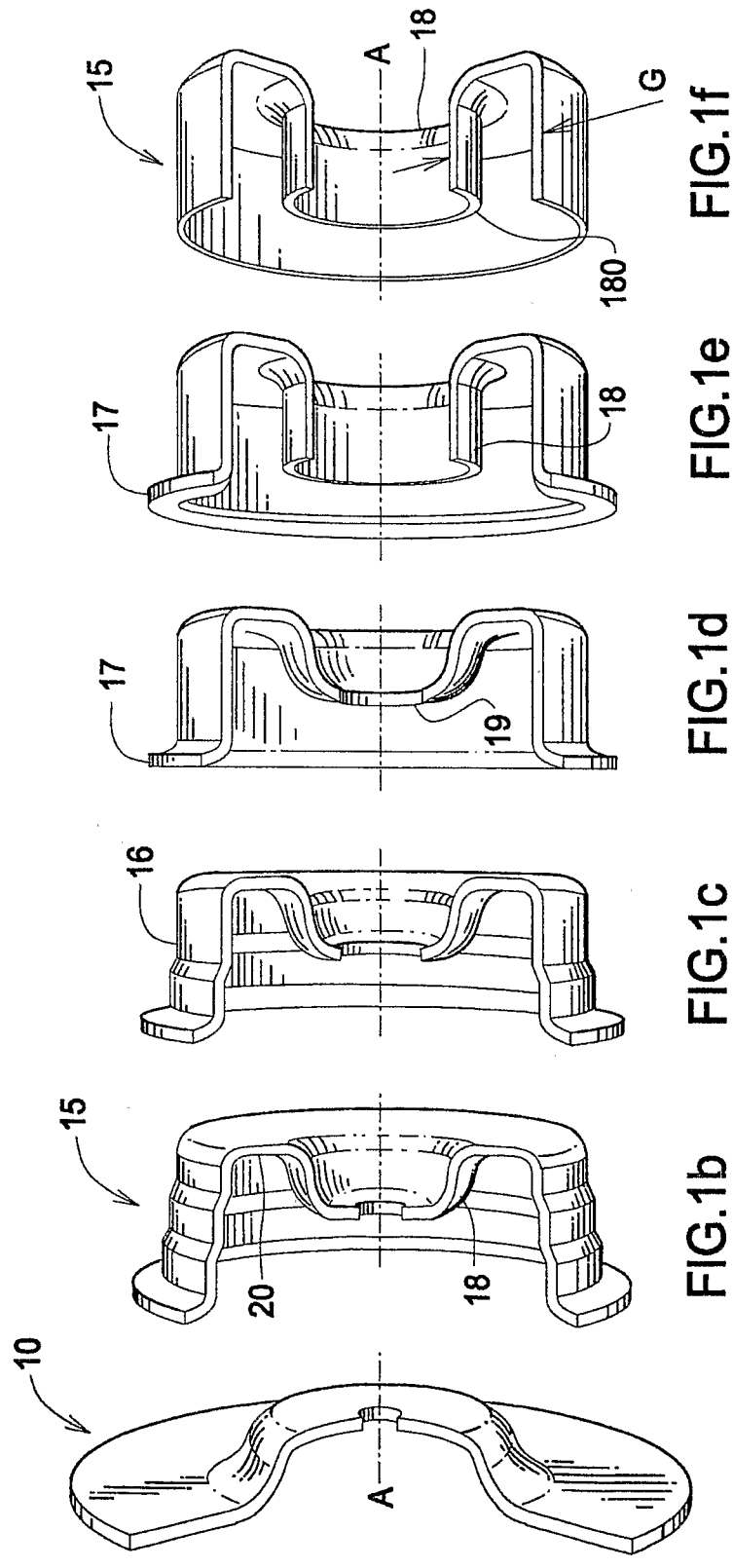

FIG.1f FIG.1e FIG.1d FIG.1c FIG.1b FIG.1a

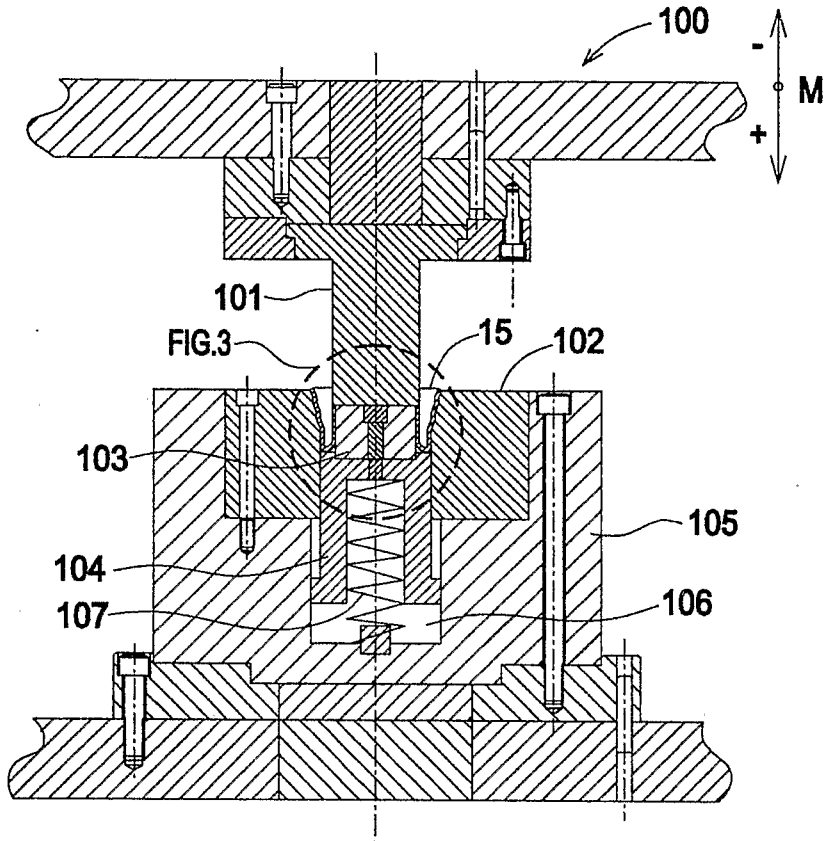
100
-
M
+
101
FIG.3
15
102
103
105
104
106
107

FIG.2

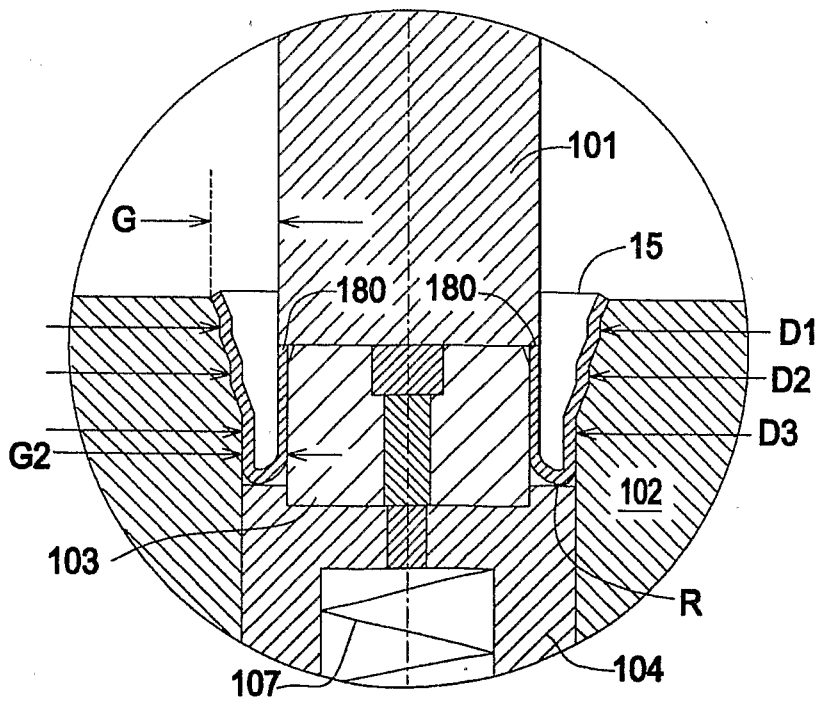
101
G
15
180
180
D1
D2
D3
G2
102
103
R
104
107

FIG.3