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(54) **METHOD OF MAKING A RING**

VERFAHREN ZUR HERSTELLUNG EINES RINGS

PROCÉDÉ DE FABRICATION D'UN ANNEAU

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Description

Field of the Invention

[0001] The invention relates to a method of making a ring, and more particularly, to a method of making a ring by expanding the middle of a slit blank while simultaneously applying a compressive force to ends of the blank.

Background of the Invention

[0002] Tubular rings are used for many applications in the industry. Rings can be broached, hobbled, machined, ground, or used as is for many applications. Applications include gears, starter gears, clutch hubs, sprockets, pulleys, crankshaft dampers, and many other products.

[0003] There are many existing arts for manufacturing tubular rings. Some common methods include making a hoop from bar stock and welding the joint; making a tube and cutting it; deep drawing a cup and removing the face of the cup; expanding a blank in ring rolling, forging, casting, or spinning a blank from sheet metal.

[0004] All of these processes are suitable, but the cost or quality of the produced ring is always a problem. For example, welded hoops have problems in the weld area when the ring is flow formed further to make gears, pulleys, splined rings, etc. Further, the welding and cleaning the weld and/or heat treating to normalize the weld area is costly.

[0005] Cut seamless tubes are expensive and making a cup in a press and removing the face creates excessive waste.

[0006] Representative of the art is US patent no. 4,590,780 which discloses a process starting from a pre-heated bar, there is sheared-off first a portion (41) which, in a first forming stage of the machine, is formed into a tier shaped pressed article. In the second forming stage, the pressed article is further formed so that it has an inner ring (J), an outer ring (A) arranged co-axially to this and a radial annular web (s) connecting the two rings (J,A). The sheared-off outer ring (44) is therefore ejected in the next to last stage, while in the last working stage the inner ring (45) separated from the outer ring is subjected to further working. This last working stage involves stamping out a waste piece (35) and shearing-off an annular web (38). It is also possible to carry out a forming operation in this last working stage to upset the remaining inner ring (22a). By means of this process which provides for the elimination of the finished outer ring (44) in the last working stage, the radial annular web (38) can be supported over its full cross-sectional surface during the shearing-off operation. US 1839 530 discloses a method according to the preamble of claim 1.

[0007] What is needed is a method of making a ring by expanding the middle of a slit blank while simultaneously applying a compressive force to ends of the blank. The present invention meets this need.

Summary of the Invention

[0008] The primary aspect of the invention is to provide a method of making a ring by expanding the middle of a slit blank while simultaneously applying a compressive force to ends of the blank.

[0009] Other aspects of the invention will be pointed out or made obvious by the following description of the invention and the accompanying drawings.

[0010] The invention comprises a method of making a ring comprising cutting a raw material stock to a predetermined length, cutting a slit through the raw material stock along its length to form a blank, inserting the blank into a tool, expanding the middle of the slit while simultaneously applying a compressive force to the ends of the blank, and expanding the middle of the slit until the blank is round.

Brief Description of the Drawings

[0011] 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 plan view of a blank.

Fig. 2 is a side view of the blank in the tooling.

Fig. 3 is a side view of the blank in the tooling.

Fig. 4 is a perspective view of the blank at an intermediate step.

Fig. 5 is a side view of the blank in the tooling.

Fig. 6 is a perspective view of the finished ring.

Fig. 7 is a top perspective view of a blank in the tooling.

Fig. 8 is a top perspective view of the tooling.

Fig. 9 is a side perspective view of the tooling.

Detailed Description of the Preferred Embodiment

[0012] The invention comprises a process of manufacturing a tubular ring from bar stock. Although a rectangular bar stock is preferred, any other configuration (round, hexagonal, etc.) may also be used.

[0013] The manufactured ring may be used in making gears, pulleys, sprockets, bearing races, one-way clutch races crankshaft damper inertia rings and similar products.

[0014] Fig. 1 is a plan view of a blank. The process starts with a raw material such as a simple bar stock from which is cut a blank 10 having the desired length (L) and width (W). Raw materials may comprise other than bar stock, including flats, rounds, or any other available form of metal material. For the purpose of this example a rectangular bar stock is used. The four corners 11 at the ends of the cut rectangular blank are rounded using known processes to facilitate the process and to give the blank a uniform thickness.

[0015] The blank is cut to form a slit 12 in the middle extending in the longitudinal direction (along its length). The slit can be cut using a laser or other cutting means which include but not limited to: high pressure water jet, laser, plasma, abrasive cutters, milling, or other means. At each end of the slit is a radius 13 to prevent crack formation in the expansion process and to keep the thickness uniform. The width of the slit is kept to a minimum to reduce waste.

[0016] Fig. 2 is a side view of the blank in the tooling. The blank 10 is then introduced into a press. A contoured thickening and rounding post 20 is pressed into the blank at the slit which opens and expands the slit. The post initially contacts the slit in the middle.

[0017] End 22 of post 20 comprises a blade which engages the slit 12. Post 20 is pressed through blank 10 into a receiving female die 21 using a known hydraulic ram 200.

[0018] Use of a lower support die 21 that is as large as the final size of the ID of the ring, the blank will expand to a certain extent, about 50%, but it tends to bend and does not continue to expand in a single plane. Therefore, in order to have proper support for the blank as it is being expanded and to prevent it from bending during forming, either an expandable (sliding) lower tooling support tooling or a multi station tooling with gradually larger lower tooling opening and thicker and rounder post may be used as described herein.

[0019] The maximum outside diameter of the post 20 substantially matches the desired inner diameter of the finished ring, see Fig. 6, minus any machining that may be required.

[0020] Fig. 3 is a side view of the blank in the tooling. Since tensile forces are not desirable in metal forming and compressive forces are desirable, in order to prevent pulling the ends apart and causing failure the instant process pushes, that is, applies a compressive force simultaneously to the ends of the blank as it is also being expanded by the post 20.

[0021] Applying compressive forces to ends 101, 102 of blank 10 while driving the post 20 into the slit gradually forms the blank into a round ring. The compressive force is applied to ends 101, 102 of the blank through shoes 23, 24. Shoes 23, 24 are pressed by known hydraulic rams 201 and 202 in a manner known in the art.

[0022] Fig. 4 is a perspective view of the blank at an intermediate step. Slit 12 is shown partially opened. The full diameter of post 20 has not yet engaged the blank 10 and so it is not yet fully rounded. Shoes 23, 24 engage ends 101, 102 of the blank.

[0023] Fig. 5 is a side view of the blank in the tooling. The full outside diameter of post 20 is shown fully engaged with the blank 10. Blank 10 is therefore fully round. Shoes 23, 24 are pressed about blank 10 in order to control the forming and to avoid "squaring" of the blank.

[0024] Fig. 6 is a perspective view of the finished ring. The ID of ring 10 substantially matches the OD of the post 20.

[0025] Once the ring is formed on the post, it is ejected and it is ready to use. If desired and required it is ready for final operations, for example, machining, rolling, spinning, forging, sizing, grinding, etc. The formed ring can then be sized in an ironing die in a press to obtain a very accurate size and/or a very fine surface finish.

[0026] Yet another version of the method shows that the blank can be expanded to the somewhat square shape and then rounded in a simple rotary forging operation. Other embodiments include taking the square blank and spinning it into a round ring, or using a ring rolling process to achieve a round ring.

[0027] Further, the ring can either be formed to a round final shape, or it can be introduced to the press tooling again for a final sizing and rounding operation. The need for these additional operations increases as harder material is used, e.g., alloy steels or high carbon steels. Harder steels can be formed with the described press tooling, but, they may require larger diameters at the end of the inner slit to prevent cracking. They may also require hot forming (usually 600 to 1100 degrees Celsius), or warm forming (up to 600 degrees Celsius).

[0028] The geometrical aspects of the parent bar stock, namely the length, radii around the outer edges, the diameter of the rounded radii at the ends of the slit and the slit thickness are all relevant variables which can be easily selected to optimize accuracy with minimum offal.

[0029] The design of the tooling is also relevant to reduce complexity. The tooling can comprise one long post with an expandable lower tooling or a few press stations with gradually expanding lower tooling and gradually thickening and rounding upper tooling. Furthermore, to prevent failure at the ends of the slit for very hard material, the pre-form blank may be made in a "dog bone" shape, where very large diameters at the ends of the slit will allow an easy forming process at the ends of the slit area.

[0030] Fig. 7 is a top perspective view of a blank in the tooling. Blank 10 is shown staged in collar 25. Collar 25 controls the position of the blank prior to and during the forming process. Shoes 23, 24 are each shown withdrawn in order to allow blank 10 to be inserted between. Members 27, 26 support the blank between shoes 23, 24.

[0031] Shoes 23, 24 in Figs. 7, 8, 9 are the same as those shown in Figs. 2, 3, 5.

[0032] Fig. 8 is a top perspective view of the tooling. Blank 10 is removed to give a better view of the members 26, 27. Members 26, 27 apply a force in a vector direction normal to the compressive force vector of shoes 23, 24 and simultaneously withdraw, or move apart from each other in concert with post 20 as post 20 is pressed through the slit in blank 10. This provides the necessary support for blank 10 as it is formed. Put another way, members 26, 27 support the blank to prevent an axial deformation that is normal to the direction of expansion of the slit. This prevents the blank from deforming in the direction of movement of post 20. The movement of post 20 is characterized as movement in an axial direction.

[0033] Fig. 9 is a side perspective view of the tooling. Post 20 is shown at the beginning of insertion into slit 12. Blade 22 is shown engaged with slit 12. Post 20 is pressed into slit 12, thereby expanding the middle of the slit while shoes 23, 24 simultaneously compress the ends of the blank. Post 20 is pressed into the blank 10, thereby continuing to expand the middle of the slit until the blank is round. Post 20 is then withdrawn and the formed ring is ejected.

[0034] Although forms of the invention have 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 scope of the invention as defined by the appended claims

Claims

1. A method of making a ring comprising:

cutting a raw material stock to a predetermined length;
cutting a slit (12) through the raw material stock along its length to form a blanks (10)
inserting the blank (10) into a tool; and
expanding the middle of the slit (12) until the blank (10) is round; and **characterised by** :
expanding the middle of the slit (12) while simultaneously applying a compressive force to the ends of the blank (10)

2. The method as in claim 1 further comprising supporting the blank (10) in a direction that is normal to the simultaneously applied compressive force.

3. The method as in claim 1 further comprising cutting a radius (13) at each end of the slit (12).

4. The method as in claim 1 further comprising:

ejecting the formed blank (10) from the tool; and
finishing the formed blank (10) to a final size and form.

5. The method as in claim 1 further comprising supporting the blank (10) to prevent an axial deformation that is normal to the direction of expansion of the slit (12).

Patentansprüche

1. Verfahren zur Herstellung eines Rings, umfassend:

Schneiden eines Rohmaterials auf eine vorbestimmte Länge;
Schneiden eines Schlitzes (12) durch das Rohmaterial entlang seiner Länge zur Ausbildung

eines Rohlings (10);

Einsetzen des Rohlings (10) in ein Werkzeug; und

Aufweiten der Mitte des Schlitzes (12), bis der Rohling (10) rund ist; **gekennzeichnet durch**:

Aufweiten der Mitte des Schlitzes (12) bei gleichzeitigem Anlegen einer Druckkraft an die Enden des Rohlings (10).

2. Verfahren nach Anspruch 1, das weiterhin Stützen des Rohlings (10) in einer Richtung, die normal zu der gleichzeitig angelegten Druckkraft verläuft, umfasst.

3. Verfahren nach Anspruch 1, das weiterhin Schneiden eines Radius (13) an jedem Ende des Schlitzes (12) umfasst.

4. Verfahren nach Anspruch 1, das weiterhin Ausstoßen des geformten Rohlings (10) aus dem Werkzeug; und Endbearbeiten des geformten Rohlings (10) auf eine Endgröße und -form umfasst.

5. Verfahren nach Anspruch 1, das weiterhin Stützen des Rohlings (10) zum Verhindern einer axialen Verformung, die normal zur Aufweitungsrichtung des Schlitzes (12) verläuft, umfasst.

Revendications

1. Procédé de fabrication d'un anneau, comprenant les étapes suivantes:

couper une barre de matière brute à une longueur prédéterminée;
découper une fente (12) à travers la barre de matière brute le long de sa longueur de manière à former une ébauche (10);
insérer l'ébauche (10) dans un outil; et
expanser le milieu de la fente (12) jusqu'à ce que l'ébauche (10) soit ronde;

caractérisé par l'étape suivante:

expanser le milieu de la fente (12) tout en appliquant simultanément une force de compression aux extrémités de l'ébauche (10).

2. Procédé selon la revendication 1, comprenant en outre le support de l'ébauche (10) dans une direction qui est normale à la force de compression appliquée simultanément.

3. Procédé selon la revendication 1, comprenant en outre la coupe d'un rayon (13) à chaque extrémité

de la fente (12).

4. Procédé selon la revendication 1, comprenant en outre l'éjection de l'ébauche formée (10) hors de l'outil; et la finition de l'ébauche formée (10) pour lui donner une taille et une forme finales. 5
5. Procédé selon la revendication 1, comprenant en outre le support de l'ébauche (10) de manière à empêcher une déformation axiale qui est normale à la direction d'expansion de la fente (12). 10

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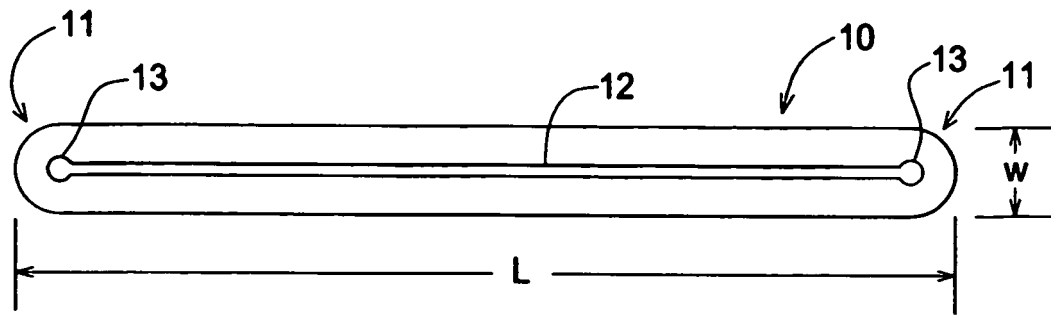


FIG.1

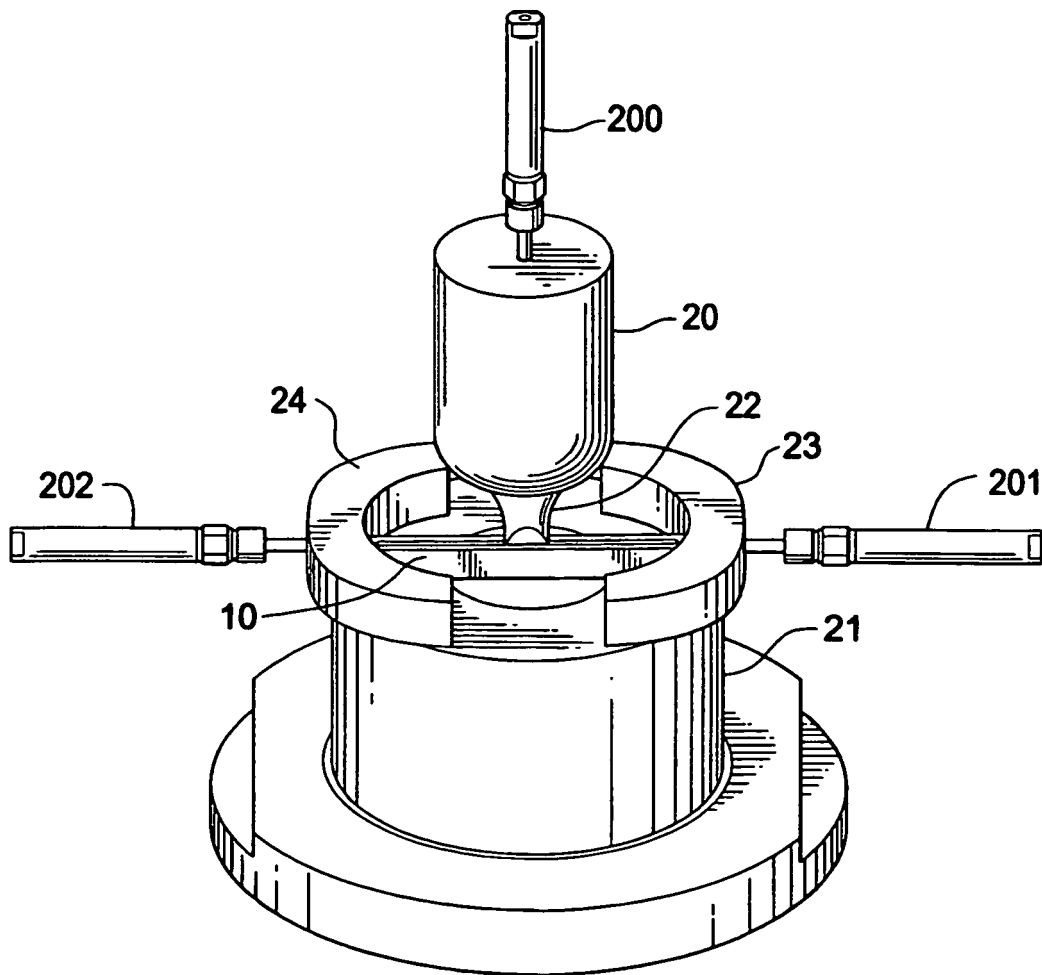


FIG.2

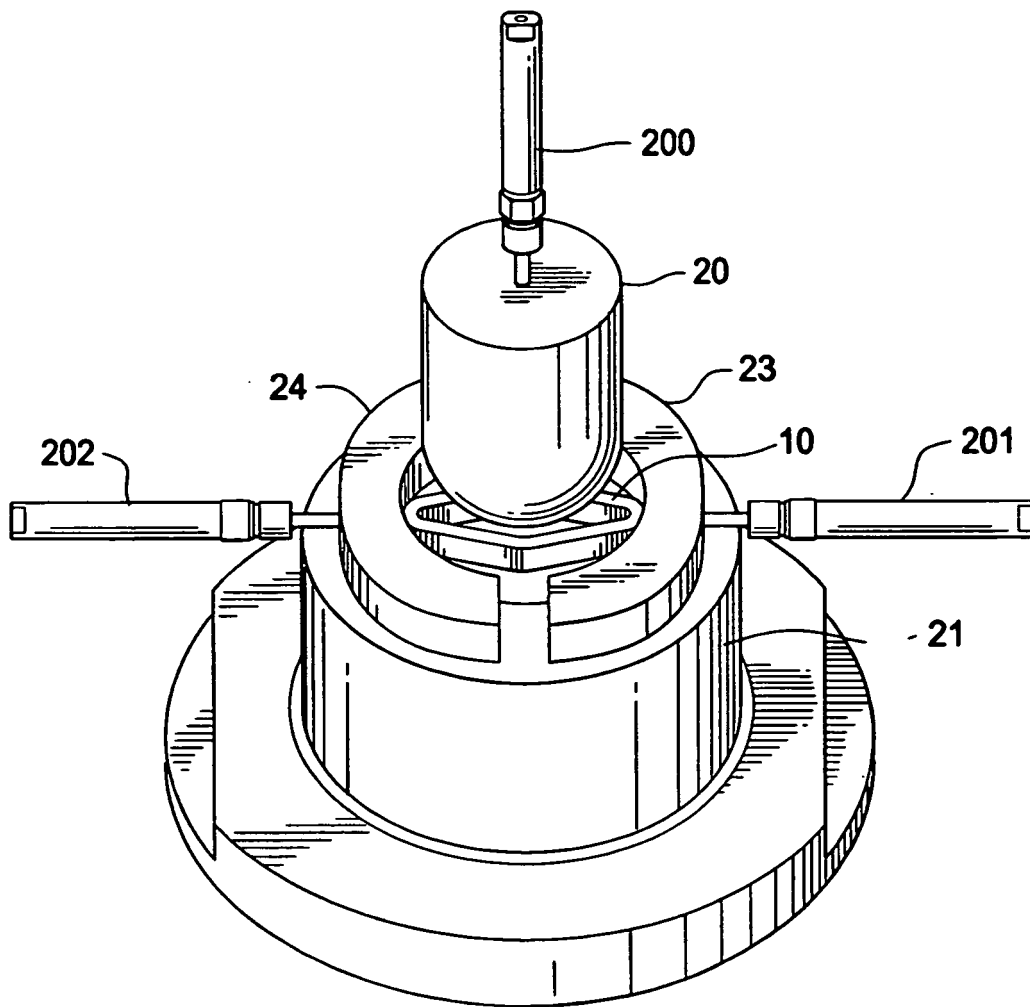


FIG.3

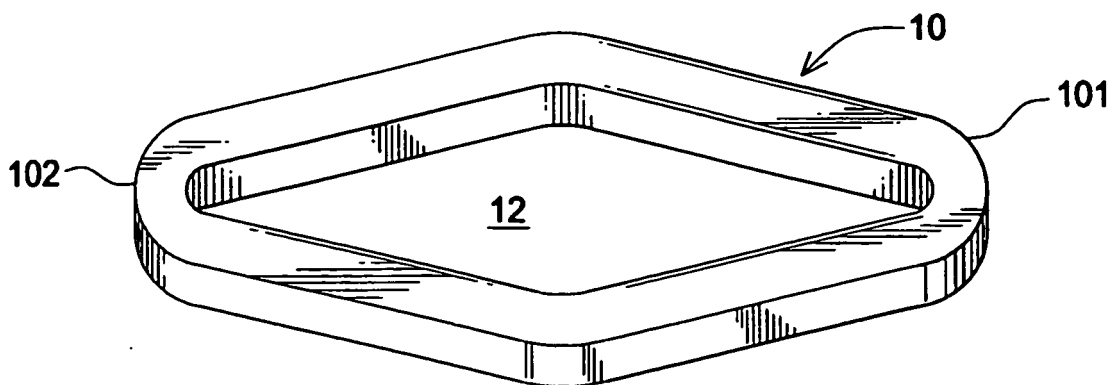


FIG.4

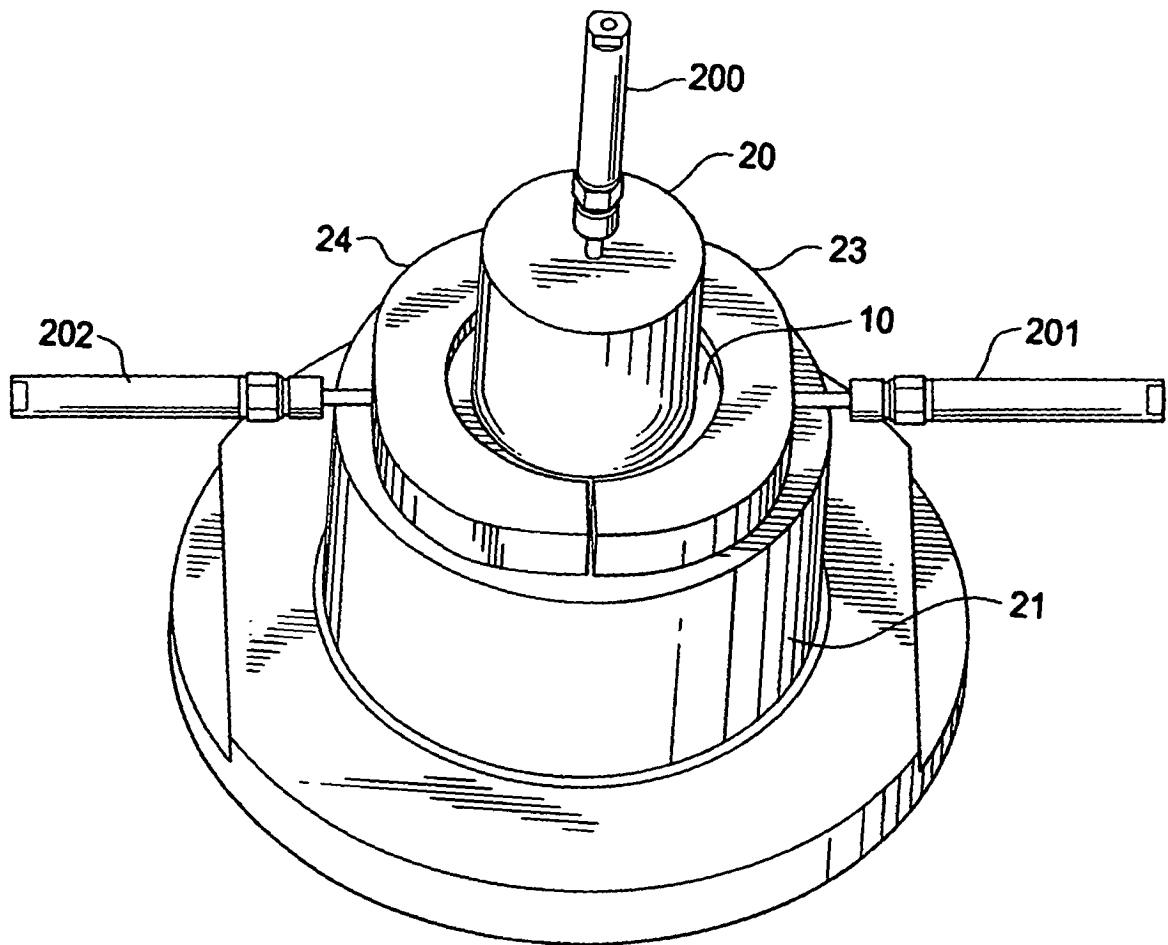


FIG.5

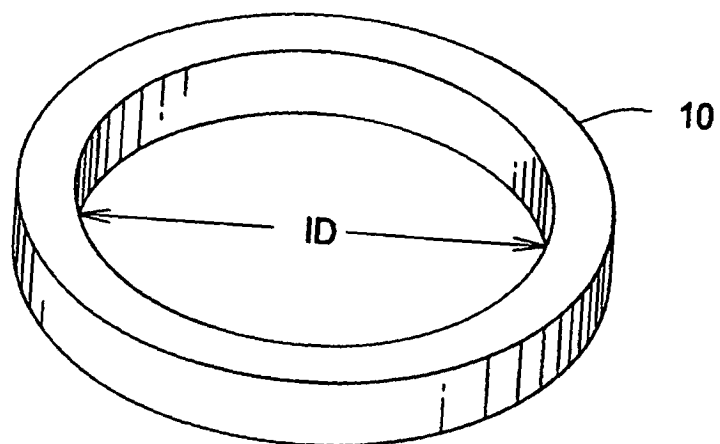


FIG.6

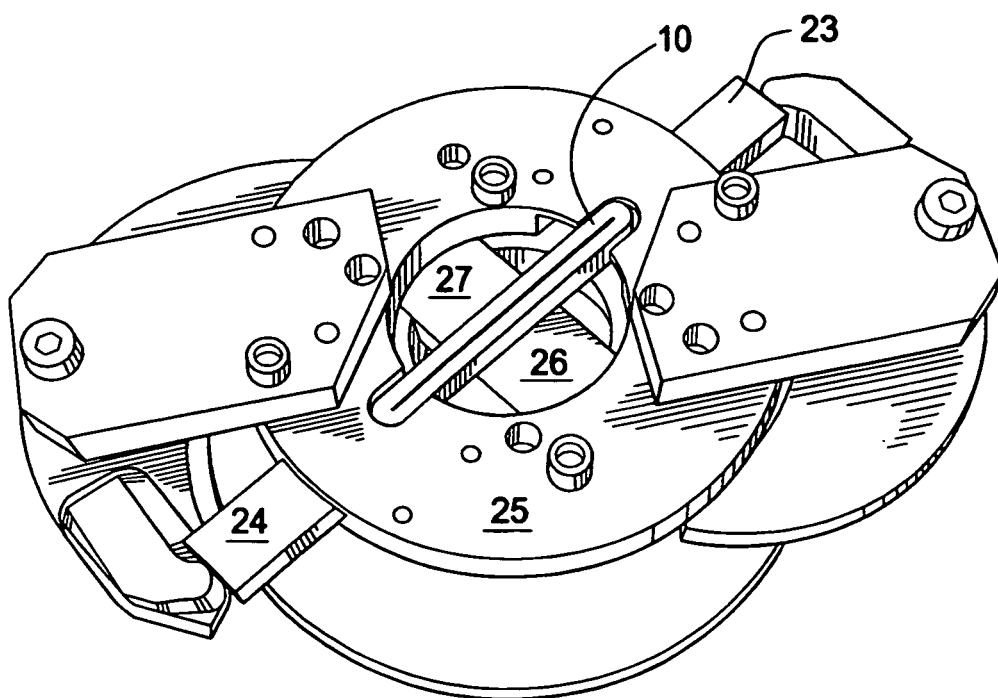


FIG.7

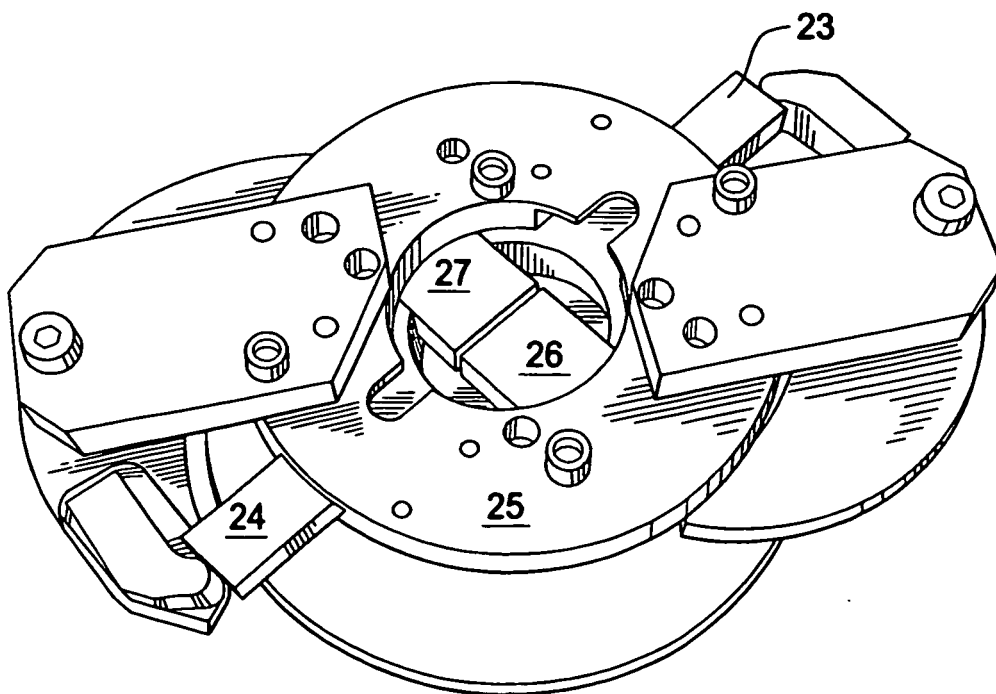


FIG.8

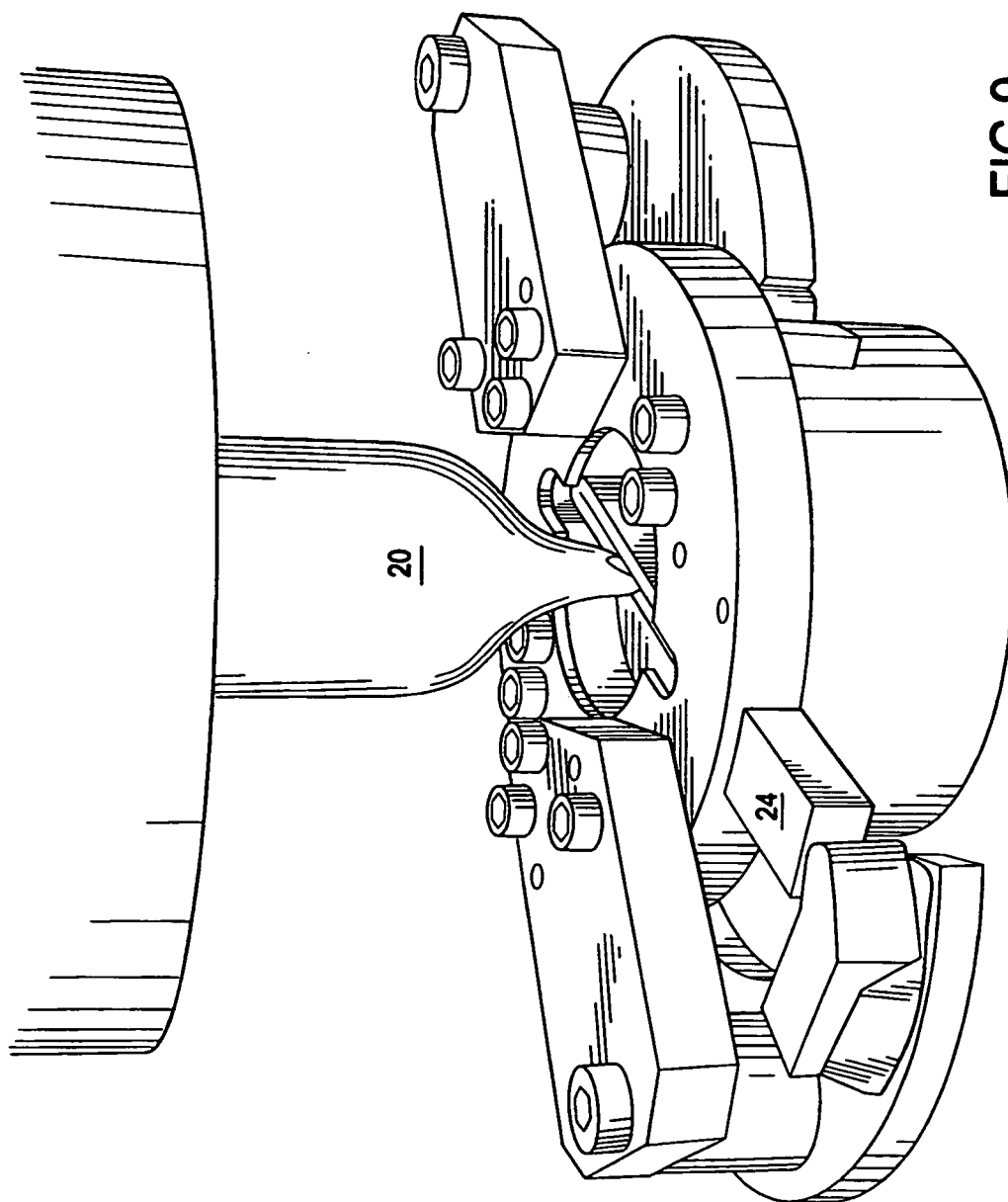


FIG.9

REFERENCES CITED IN THE DESCRIPTION

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