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(54) **A bearing ring**

(57) In a method of producing a heat treated bearing ring for a linear recirculating-ball bearing having a longitudinally extending slot, a flat strip (16) of metal is bent to form the ring, the ring is heat treated and the edges (17, 18) forming the slot are prevented from buckling or being displaced due to thermal distortion by a projection (19) which fits in a recess (22) without clearance. After heat treatment, the projection (19) is broken off. Projections 20 engage with clearance in recesses 22.

Two or more flat strips (16) may be used to produce the ring (24).

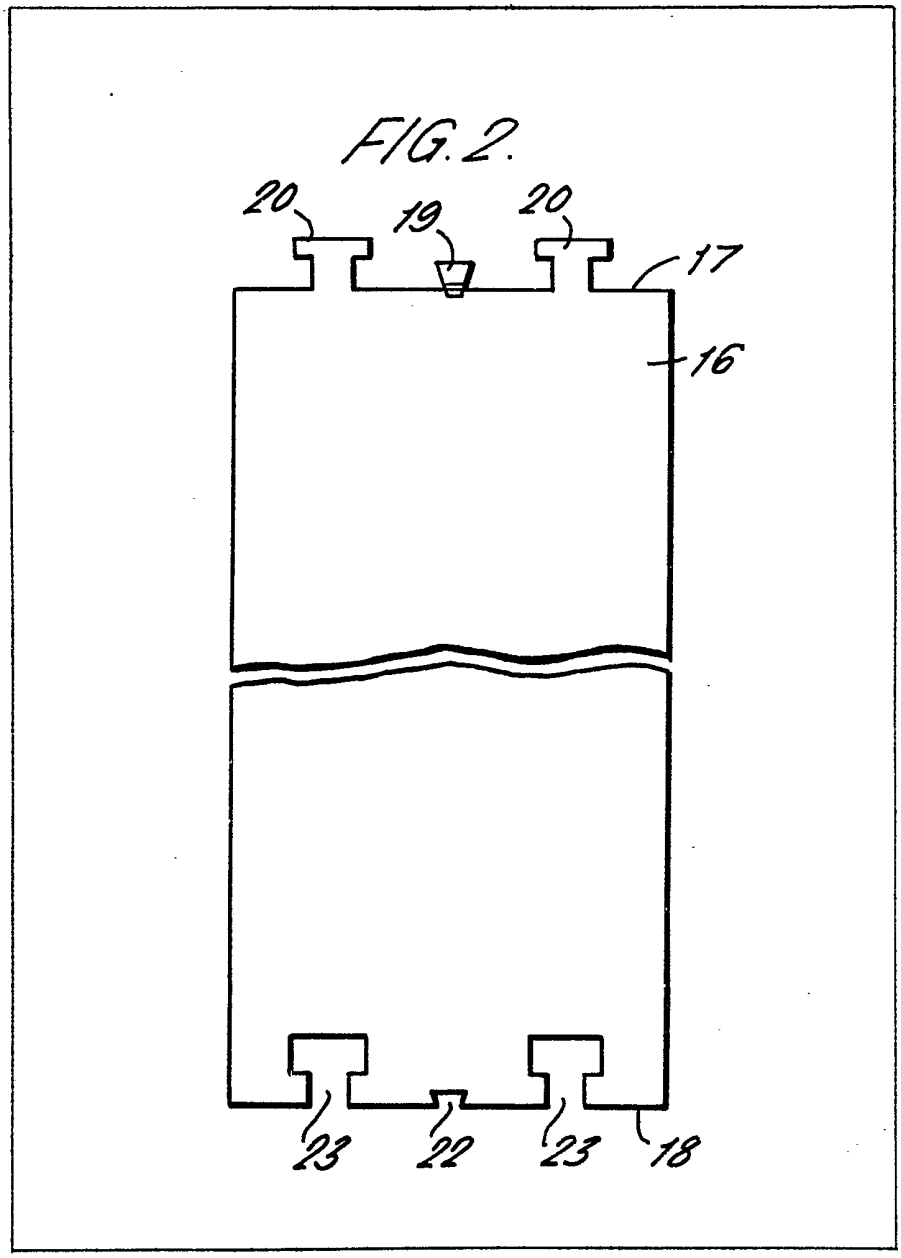

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FIG. 1.

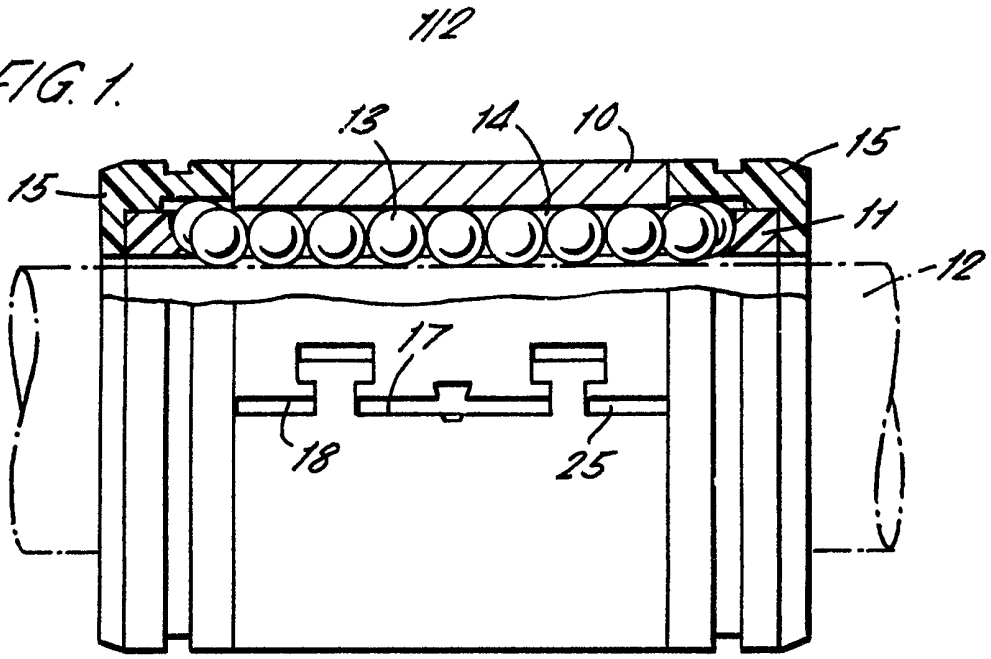


FIG. 2.

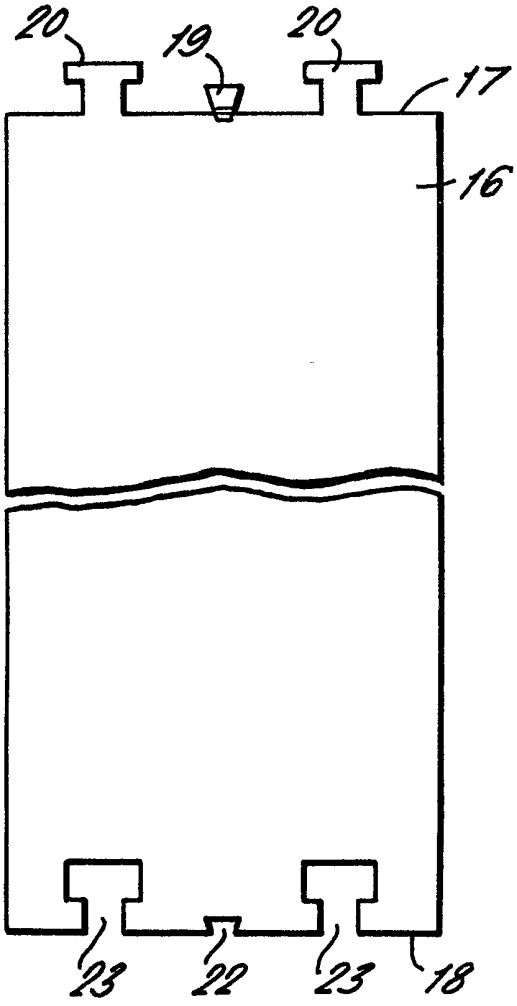


FIG. 3.

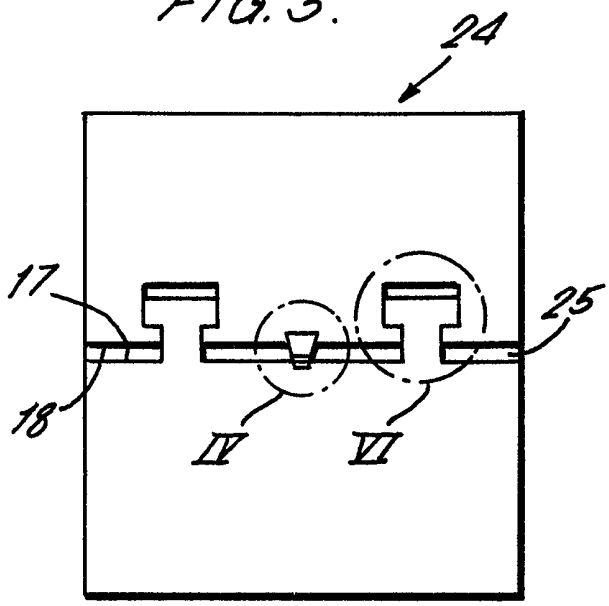


FIG. 4.

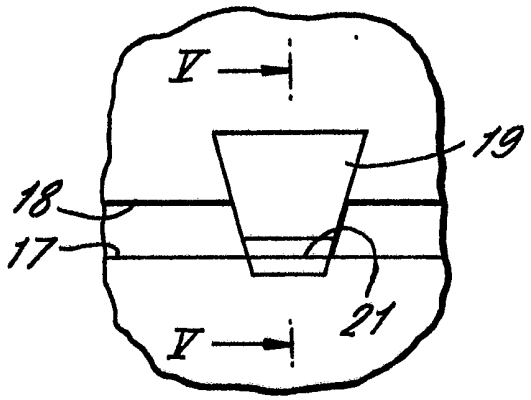


FIG. 5.

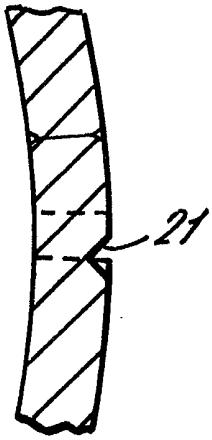
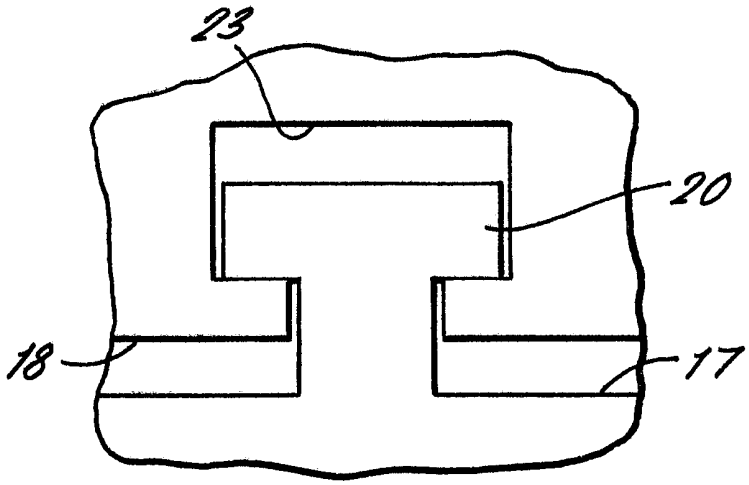


FIG. 6.



SPECIFICATION

A bearing ring

This invention concerns a method of producing a heat treated bearing ring having one or more longitudinally extending slots and a bearing ring produced by the method.

Specification GB 2026103 (corresponding to DE 2830400) discloses a linear recirculating rolling bearing including a sleeve, a method of producing a sleeve for a rolling bearing and a sleeve when formed by such a method. The method comprises providing a flat strip, shaping the edge at one end of the strip to provide a lug, shaping the edge at the other end of the strip to provide a recess suitable for accommodating the lug, bending the strip about an axis extending transversely of the length of the strip and fitting the lug in the recess so that the strip has the shape of a sleeve, and the said edges are opposed to each other and are held in position relative to each other against movement in a circumferential direction. The edge at one end of the strip is shaped preferably to provide T-shaped lugs while the edge at the other end is shaped to provide T-shaped recesses suitable for accommodating the lugs. The cross-pieces of each T-shaped lug are cut narrower than the recess so allowing limited circumferential relative movement of the opposed edges.

If the sleeve is hardened by heat treatment to increase its load carrying capacity, there is the danger that the two opposed edges will be so distorted that the bearing surface will buckle and therefore lose its accuracy of shape. In this case the lugs may be jammed and bent in their recesses.

Specification GB 2026624 (corresponding to DE 2832744) also discloses a linear recirculating rolling bearing having such a sleeve formed by such a method.

Specification US 3262185 discloses a method of making a race ring for a ball or roller bearing comprising shaping two half rings, clamping the two half rings together, welding the half rings together at localised positions at their annular edges, machining, heat treating and grinding the race, and finally cutting out the weld metal by sawing or grinding. With this method the accuracy of shape of the race ring leaves much to be desired because heat is generated during welding and grinding which distorts the race ring. Also the race ring produced by this method is relatively expensive because complicated additional machinery has to be carried out to remove the weld metal and produce a longitudinally extending slot.

The subject of the present invention is a method of producing a heat treated bearing ring which is relatively simple and economical and provides a ring which has an extremely high accuracy of shape.

The invention provides a method of producing a heat treated bearing ring having one or more pairs of longitudinally extending and circumferentially spaced edges, the or each pair of edges forming a longitudinally extending slot, the method comprising the steps of:

(a) stamping from sheet metal one or more elongate flat strips, the or each strip having at one end a first projection extending longitudinally from that end and lying in the plane of the strip and having at the other end a first recess extending in longitudinally from that other end and corresponding in size and shape with the or one of the first projection;

(b) bending the or each strip around an axis extending across the length of the strip and radially engaging the or each first projection in the or one of the corresponding first recesses so that the strip or strips form a ring and the ends of the strip or strips provide one or more pairs of longitudinally extending and circumferentially spaced edges, the or each pair of edges forming a longitudinally extending slot, the or each first projection engaging in its corresponding first recess without clearance, and the or each first projection and the first recess in which it engages being so shaped that relative longitudinal and circumferential movement of the edges is prevented;

(c) heat treating the ring; and

(d) severing the or each projection from the main body of the or each strip.

Step (a) may include providing the or each strip with more than one first projection and recess.

As soon as the or each strip is bent around and the or each first projection is engaged in the or one of the corresponding first recesses, the opposed longitudinally extending edges forming the or each longitudinal slot are fixed both axially and circumferentially with respect to each other. The or each first projection is readily engaged radially in the or one of the corresponding first recesses since the or each first projection has not yet been heat treated, for example, hardened. The opposed longitudinally edges of the or each longitudinal slot are prevented from being displaced with respect to each other, due to thermal distortion, during the heat treatment. After the heat treatment, for example, hardening, of the ring the or each first projection can be severed from the main body of the or each strip and removed from the corresponding first recess by a punch arranged to act radially on the or each first projection. A finished bearing ring is thus produced of which the or each longitudinal slot, despite heat treatment of the ring, is accurate in size and shape.

When the ring is produced from two or more strips, the first projection of one strip will engage in the first recess of another strip, each strip being bent to form, in cross-section, a part of a ring.

Step (a) may include providing a second projection at one end of the or each strip and a second recess at the other end of the or each strip, the or each second projection extending longitudinally from that one end and lying in the plane of the strip, and the or each second recess extending in longitudinally from that other end and

corresponding in size and shape to the or one of the second projections; and

step (b) may include radially engaging the or each second projection in the or one of the corresponding second recesses, the or each second projection engaging with clearance in its corresponding second recess.

Step (c) may include providing the or each strip with more than one second projection and recess.

A race ring formed with these method steps has one more second projections engaging in corresponding second recesses and so maintaining a longitudinal slot or slots between certain limits of size. A race ring of this type is particularly applicable to a linear recirculating rolling bearing. Even if the race ring is relatively long, it can be produced so that the or each second projection engages centrally in the or one of the second recesses and the or each longitudinal slot is of a specific size and shape so as to result in a uniform resilient seating pressure of the race ring in a housing. During heat treatment of the race ring, the or each second projection does not become jammed and buckled since the or each second projection engages with a clearance or slight play in the or each corresponding second recess. Any thermal expansion stresses in the race ring are taken up only by the or each first projection engaging in the or one of the first recesses.

Step (a) may include reducing the thickness of the or each strip at the location where the first projection joins the main body of the or each strip to facilitate severing the or each first projection from the main body of the or each bent strip.

Only relatively small forces are thus required to break off the or each first projection out from its corresponding first recess. Also the actual break location is predetermined so making the operation simple.

Step (a) may include providing the or each first projection with a shape which is wider at its free end than at the end where it adjoins the main body of the or each strip. The shape may be a wedge shape for example.

Step (a) may include providing the or each second projection with a shape in the form of a T.

Preferably after the heat treatment of step (c) and before the or each first projection is severed in step (d), the ring is first machined, for example, ground.

The invention also includes a ring produced by a method according to the invention and includes a bearing, such as a linear recirculating rolling bearing, having such a ring.

An embodiment of the invention will now be described by way of example, reference being made to the accompanying drawings, of which:

Figure 1 is a radial view, partly in longitudinal section, of a linear recirculating rolling bearing;

Figure 2 is a plan view of a flat strip, produced by stamping, and ready for bending to a ring;

Figure 3 is a radial view of the ring produced by bending the flat strip of Figure 2;

Figure 4 is an enlarged view of the encircled portion IV of Figure 3;

Figure 5 is a section on V—V of Figure 4; and

Figure 6 is an enlarged view of the encircled portion VI of Figure 3.

The linear recirculating rolling bearing shown in Figure 1 comprises a sleeve or ring 10, a plastics cage 11 disposed in the bore of the sleeve, a shaft 12 extending through the bore of the cage and a plurality of endless paths of which the main parts are formed by the sleeve and the cage. Each path accommodates a plurality of balls 13 for recirculation between a first longitudinally extending portion 14 of the path, in which, in use of the bearing, the balls transmit loads radially between the shaft 12 and the sleeve 10, and a second longitudinally extending portion (not shown) in which, in use of the bearing, the balls do not transmit those loads.

The two longitudinally extending portions of each path are connected at their ends by reversing portions, usually semi-circular in shape. The cage 11 projects from each end of the sleeve 10 and two rings 15, one at each end, surround the projecting portions of the cage. The reversing portions of the endless paths are formed by the end rings 15 and the cage 11.

In use of the bearing, the balls 13 in the first portion 14 of each path protrude radially inwardly through longitudinal slots in the cage 11, roll on the outer surface of the cylindrical shaft 12 and on the bore surface of the sleeve 10. The bearing is usually disposed in a housing and the sleeve 10 transmits loads radially between the housing and the balls 13.

The sleeve or race ring 10 is a heat treated (hardened) ring produced by the following method: firstly a flat elongate strip 16 (see Figure 2) is stamped from sheet metal, for example, sheet steel. The strip 16 has opposed end edges 17 and 18 and extending from end edge 17 are a first projection 19 and two second projections 20 one on each side of the first projection 19. Each projection 19, 20 extends longitudinally from that end edge 17 and lies in the plane of the strip 16.

First projection 19 has a dove tail or wedge shape which is wider at its free end than at the end where it adjoins the main body of the strip 16. At the location where the projection 19 adjoins the main body of the strip 16, the thickness of the strip is reduced by a notch 21 — this is shown clearly in Figures 4 and 5.

Each second projection 20 has a shape in the form of a T.

At the other end of the strip 16 there is a first recess 22 and two second recesses 23, each extending in longitudinally from the end edge 18 and corresponding in size and shape with the first projection 19 and second projections 20 respectively.

The next step in the method is bending the strip 16 around an axis extending across the length of the strip and radially engaging the first projection 19 in the first recess 22 and radially engaging the second projections 20 in the second recesses 23

so that the strip forms a ring (see Figure 3). The first projection 19 engages with no clearance or play in the first recess 22 and the dove tail shape or wedge shape of the projection and recess ensures that relative longitudinal and circumferential movement of the edges 17 and 18 is prevented. The two second projections 20 engage centrally with clearance or play in the second recesses 23 as shown clearly in Figure 6. The two longitudinally extending and circumferentially spaced edges 17 and 18 of the ring form a longitudinally extending slot 25 interrupted by the projections 19 and 20.

The following step is to heat-treat the ring 24 by, for example, case-hardening.

After that any necessary finish machining can be carried out, such as lateral and/or cylindrical grinding of the ring 24.

Finally the projection 19 is severed from the main body of the bent strip by being broken off at the notch 21 by, for example, a punch acting radially, so that it comes out of the recess 22.

Thus the bearing ring 24 or sleeve 10 is produced having a pair of longitudinally extending and circumferentially spaced edges 17 and 18 forming a longitudinally extending slot 25. The ring 24 or sleeve 10 has smooth cylindrical outer and bore surfaces. The second T-shaped projections 20 engage in their corresponding recesses 23 and allow only limited axial and circumferential relative movement of the opposed edges 17 and 18, thus keeping the slot 25 to within certain limits of size.

The invention also includes using two or more flat strips 16 to form a bearing ring or sleeve. In this case, each strip is bent to form a part of the ring and the projections of one bent strip are engaged with the recesses of the other. For any one strip its projection may be shaped to only engage with the recess of one other strip and not with the recess of another strip nor correspond to the recess at its other end. This may be useful with more than two strips if the strips have to be engaged with one another, after bending, in a particular order.

CLAIMS

1. A method of producing a heat treated bearing ring having one or more pairs of longitudinally extending and circumferentially spaced edges, the or each pair of edges forming a longitudinally extending slot, the method comprising the steps of:

(a) stamping from sheet metal one or more elongate flat strips, the or each strip having at one end a first projection extending longitudinally from that end and lying in the plane of the strip and having at the other end a first recess extending in longitudinally from that other end and corresponding in size and shape with the or one of the first projection;

(b) bending the or each strip around an axis extending across the length of the strip and radially engaging the or each first projection in the or one of the corresponding first recesses so that the strip or strips form a ring and the ends of the strip or strips provide one or more pairs of longitudinally extending and circumferentially spaced edges, the or each pair of edges forming a longitudinally extending slot, the or each first projection engaging in its corresponding first recess without clearance, and the or each first projection and the first recess in which it engages being so shaped that relative longitudinal and circumferential movement of the edges is prevented;

(c) heat treating the ring; and

(d) severing the or each projection from the main body of the or each strip.

2. A method as claimed in claim 1, wherein step (a) includes providing the or each strip with more than one first projection and recess.

3. A method as claimed in claim 1 or 2, wherein step (a) includes providing a second projection at one end of the or each strip and a second recess at the other end of the or each strip, the or each second projection extending longitudinally from that one end and lying in the plane of the strip, and the or each second recess extending in longitudinally from that other end and corresponding in size and shape to the or one of the second projections; and step (b) includes radially engaging the or each second projection in the or one of the corresponding second recesses, the or each second projection engaging with clearance in its corresponding second recess.

4. A method as claimed in claim 3, wherein step (a) includes providing the or each strip with more than one second projection and recess.

5. A method as claimed in any preceding claims, wherein step (a) includes reducing the thickness of the or each strip at the location where the first projection joins the main body of the or each strip to facilitate severing the or each first projection from the main body of the or each bent strip.

6. A method as claimed in any preceding claim, wherein step (a) includes providing the or each first projection with a shape which is wider at its free end than at the end where it adjoins the main body of the or each strip.

7. A method as claimed in claim 3, wherein step (a) includes providing the or each second projection with a shape in the form of a T.

8. A method as claimed in any preceding claim, wherein after step (c) and before step (d) the ring is finish machined.

9. A method of producing a heat treated bearing ring substantially as herein described with reference to and as shown in the accompanying drawings.

10. A heat treated bearing ring produced

according to the method as claimed in any preceding claim.

11. A bearing having a ring as claimed in claim 10.

12. A bearing as claimed in claim 11, wherein the bearing is a linear recirculating rolling bearing.

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