United States Patent

[11] 3,582,165

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[45] Patented **June 1, 1971**

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[54] **CAGE-AND-ROLLER COMBINATION**
10 Claims, 16 Drawing Figs.

[52] **U.S. Cl.** **308/217**
[51] **Int. Cl.** **F16c 33/46**
[50] **Field of Search** 308/201, 217, 212, 213

[56] **References Cited**
UNITED STATES PATENTS
3,114,960 12/1963 Einaudi 308/217

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Assistant Examiner—Frank Susko
Attorney—Jackson, Jackson & Chovanes

ABSTRACT: In cage and roller combinations suitable for operation between inner and outer members to form a bearing, a cage guided on its outside diameter is produced by forming a blank having thickened rim portions at the ends, relieved relatively thin portions inwardly of the rim portions, thickened guiding portions and outward retaining portions inwardly of the relieved portions and a relatively thin midlength portion, then punching windows with parallel sides from the midlength portion, the guiding and outward retaining portion and the relieved portion but not entering the rim portions, the windows being relatively wide at the ends and relatively narrow at the middle, and then coining the crossbars desirably simultaneously to form lips at the guiding and outward retaining portions near the outside while retaining parallel sides at the guiding portions near the pitch diameter, and to displace metal from the midlength portions so as to form inwardly converging sidewalls which will clear the rollers and prevent escape of the rollers inwardly. The invention may provide cage-and-roller combinations in which a single roller in a window is guided adjoining the pitch circle near the end, the guiding portion outwardly converges to retain the roller against outward motion, and the window at the end terminates short of the rims.

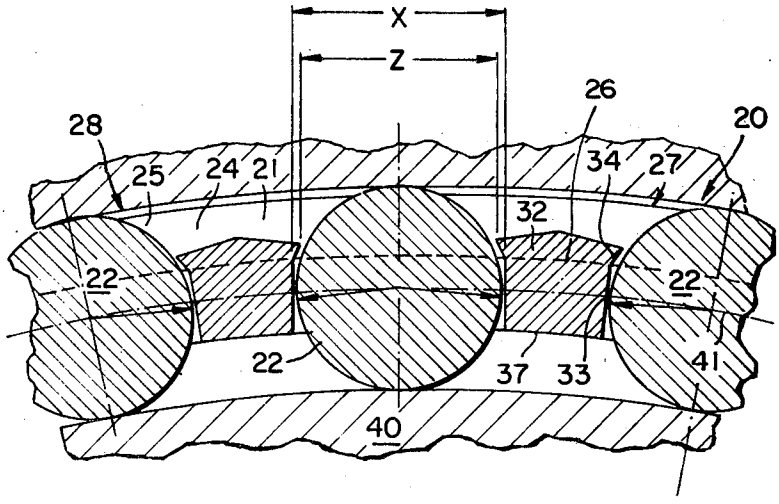
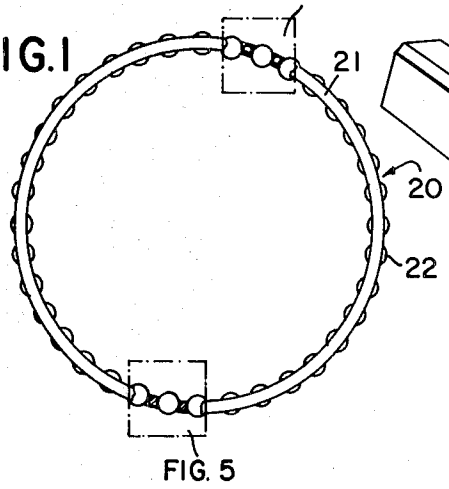


FIG. 1



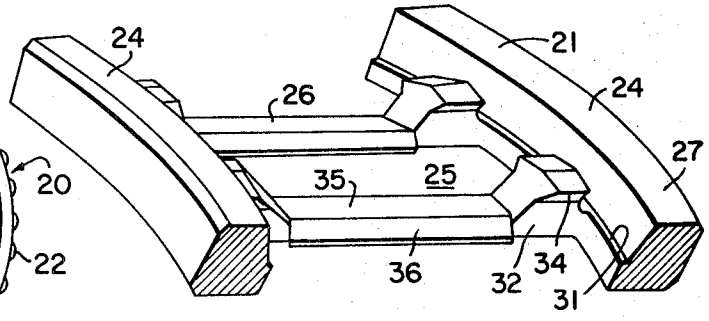


FIG. 3

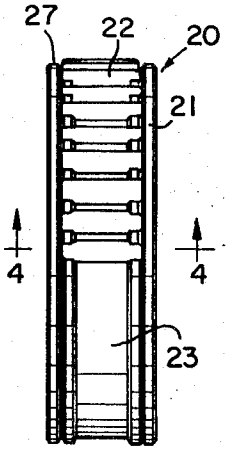
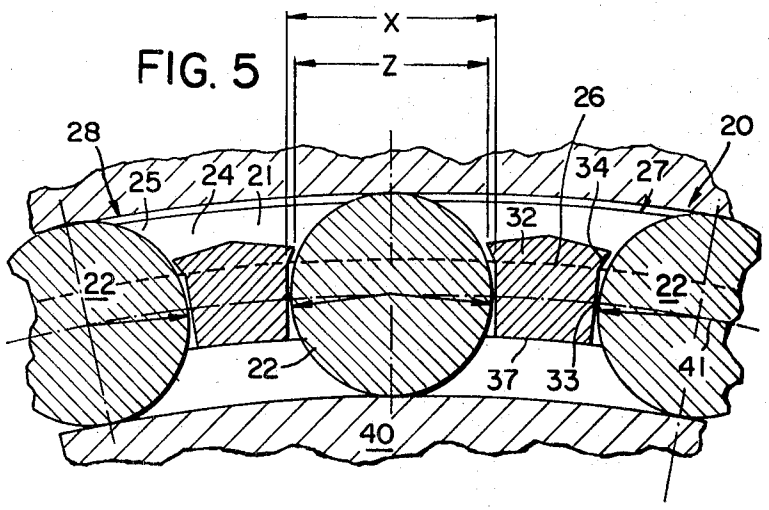


FIG. 2

FIG. 5



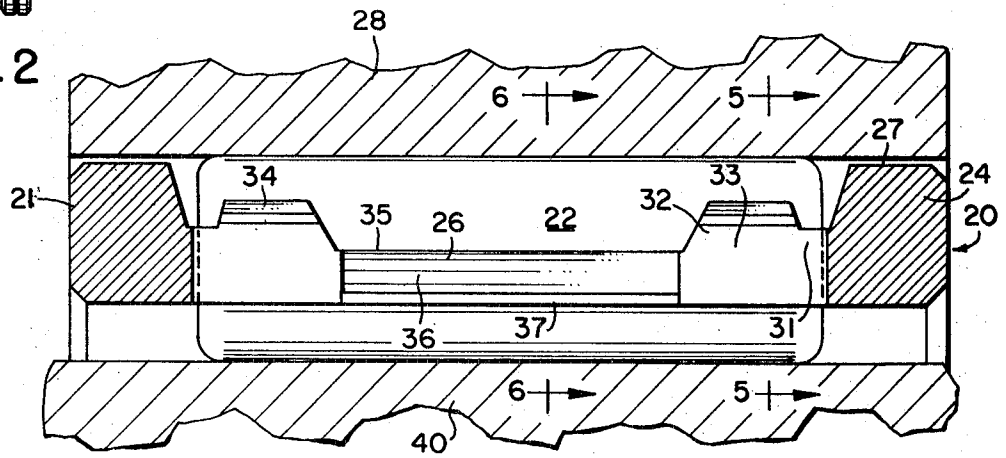


FIG. 4

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FIG. 7

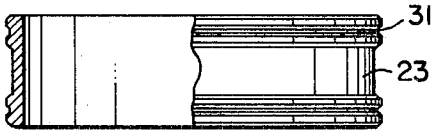
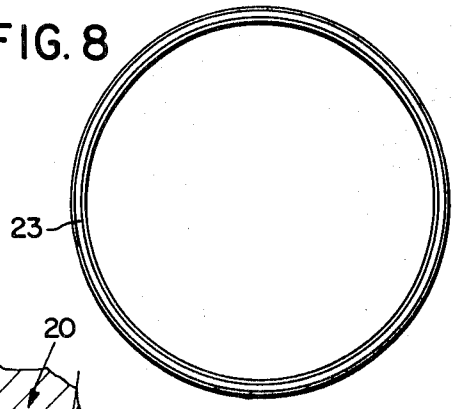


FIG. 8



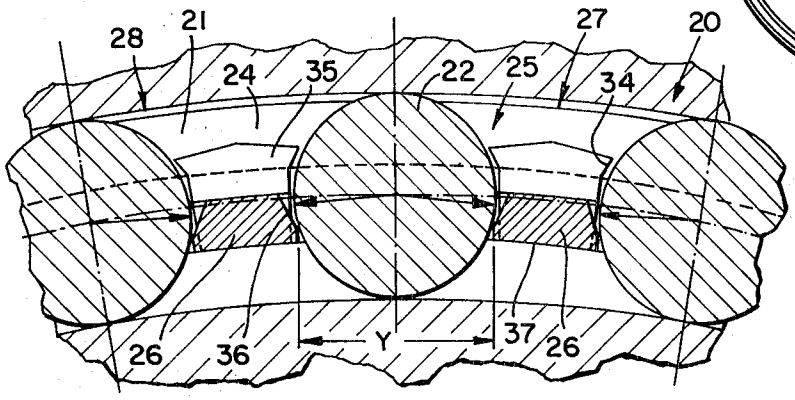


FIG. 6

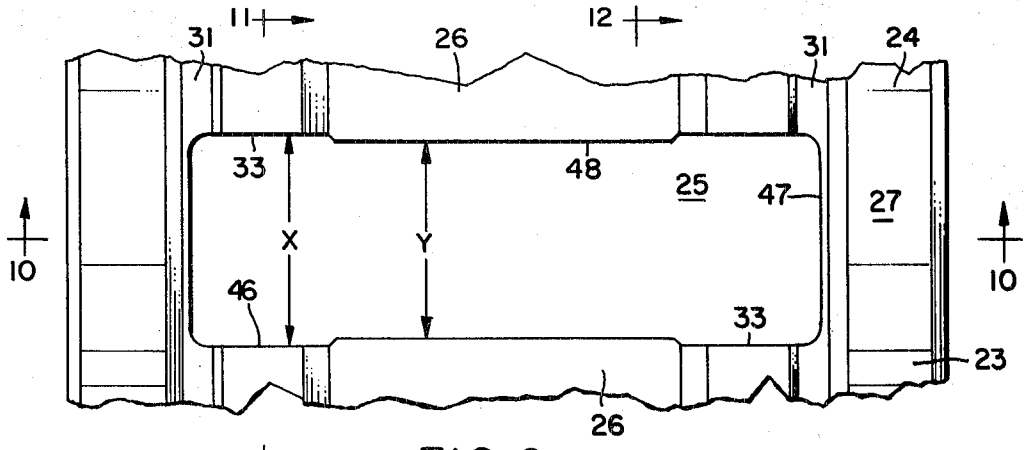


FIG. 9

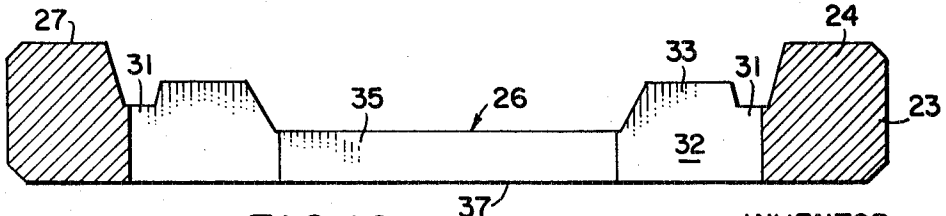


FIG. 10

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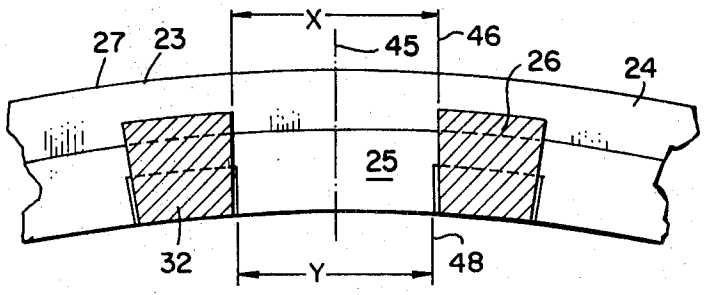


FIG. 11

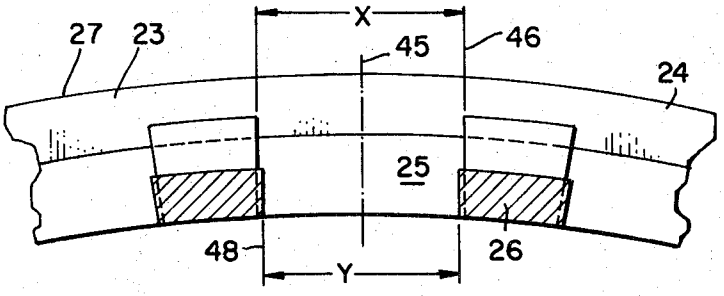


FIG. 12

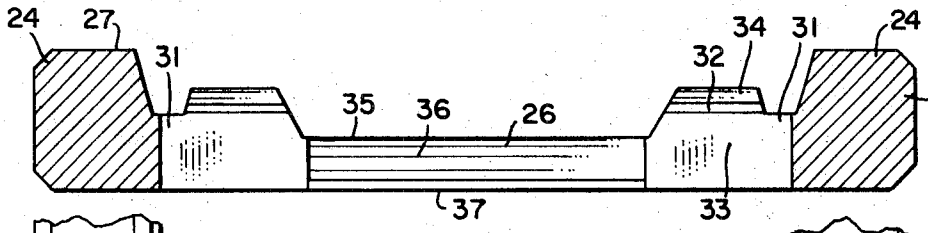


FIG. 14

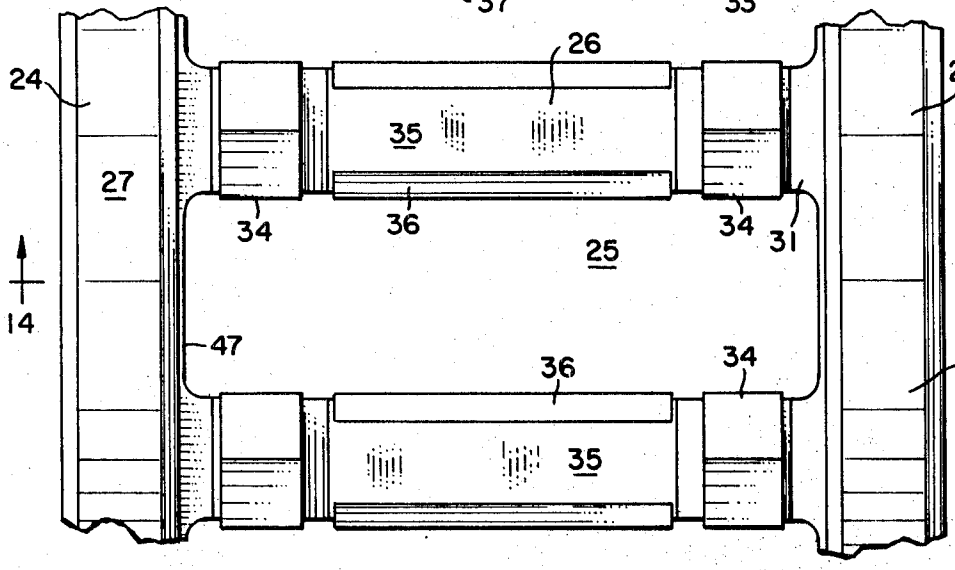


FIG. 13

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FIG. 15

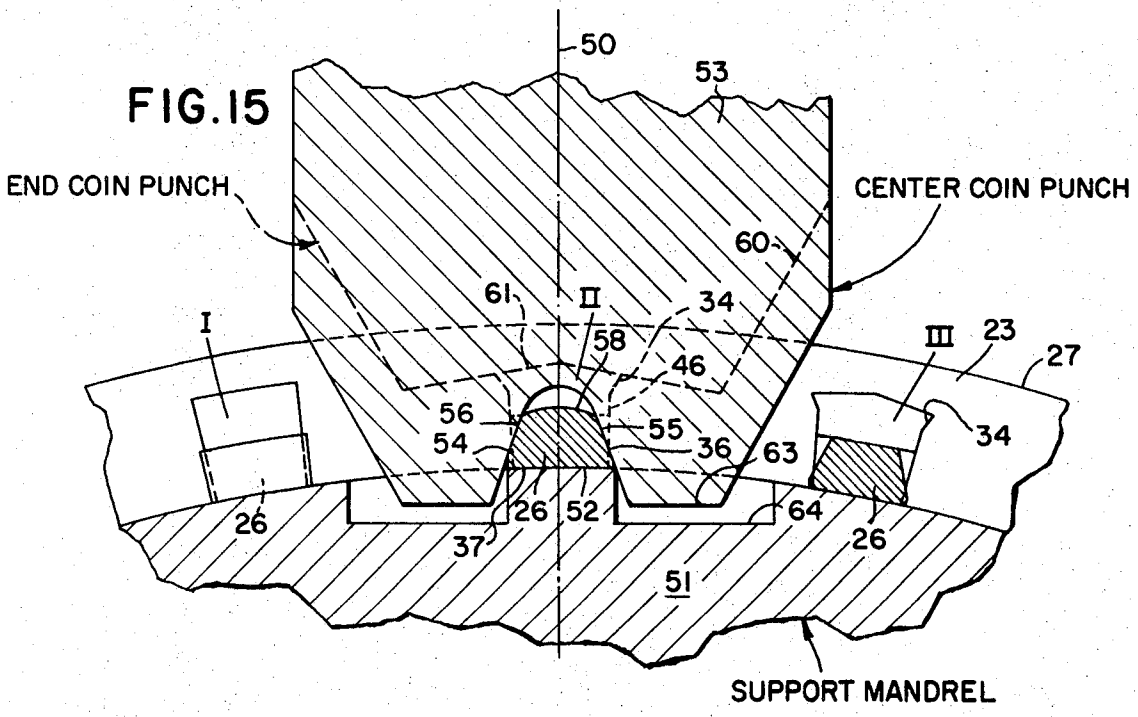
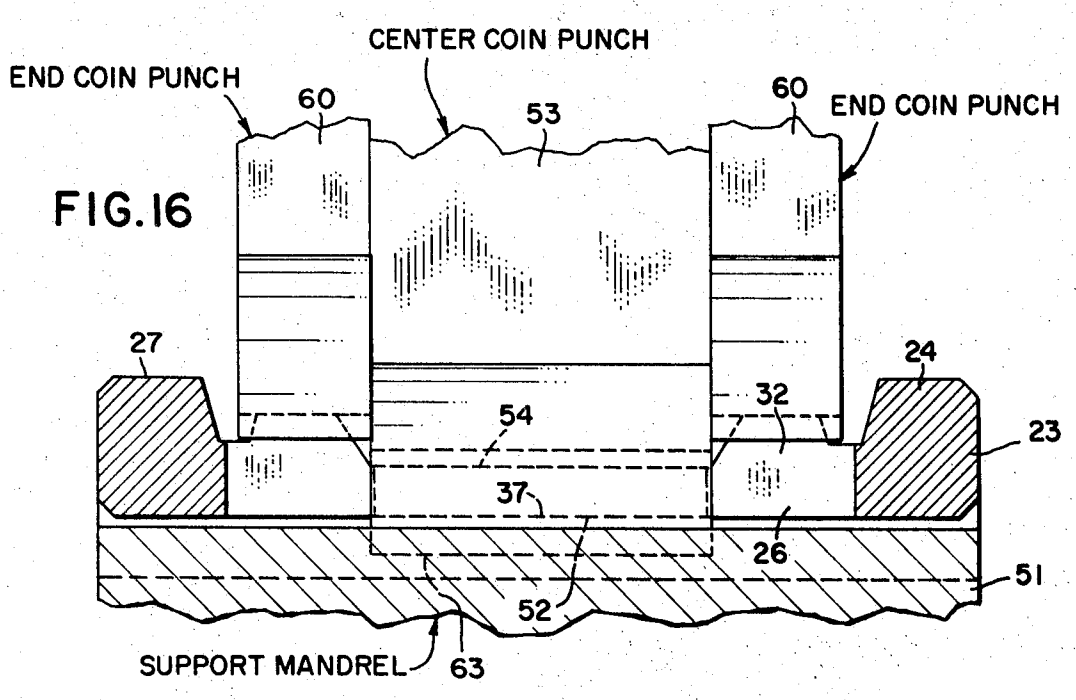


FIG. 16



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CAGE-AND-ROLLER COMBINATION

DISCLOSURE OF INVENTION

This application is being divided, and the divisional application relating to the method will be embodied in Ser. No. 88,373 filed Nov. 10, 1970.

The present invention relates to roller-and-cage combinations of the character which are intended to operate between a hardened shaft on the inside, and the interior or bell portion of a hardened shaft at the outside, or in a bearing outer race or recess at the outside. The cage-and-roller combinations of the character under discussion are extensively used in vehicle transmissions and as connecting-rod bearings in internal combustion engines. It will be understood that the cage may be interrupted as for insertion around a crankshaft.

A purpose of the invention is to greatly improve the tool life in making steel cages for roller-and-cage combinations by eliminating offcenter shaving operations which have formerly been necessary.

A further purpose is to make it possible to produce roller-and-cage combinations having thick machined cages using metals which are stronger and more wear resistant than aluminum and particularly to permit the production of such cages from steel. By this technique the tendency of windows to open up and release rollers which has been encountered in aluminum cages is prevented.

A further purpose is to permit the manufacture of a cage for a roller-and-cage combination by greatly reducing the amount of metal thickness through which punching must occur, particularly adjacent the ends of the punches, and thus greatly reducing wear on the punch curved end portions.

A further purpose is to avoid the tendency which has previously existed to twist the cage crossbars by conducting punching and shaving operations in a direction other than along the radial direction with respect to the cage.

A further purpose is to accomplish guiding at the pitch circle and avoid any tendency to cam the rollers out of the cage by virtue of the guiding on a coined surface.

A further purpose is to form a window with parallel sides, wide at the ends and narrow toward the midlength area, and to coin the crossbars between the windows near the ends in the radial direction from the center of the crossbars so as to form outer retaining lips at the ends and so as to displace metal a the midlength portion to permit the roller to seat and be retained.

A further purpose is to avoid a tendency to rock the crossbar under the shaving action so as to make the roller tend to bind in the window at one side of the crossbar and tend to be loose in the window at the other side of the crossbar, and to make the retention inside and outside by the crossbars more uniform on all windows.

Further purposes appear in the specification and in the claims.

In the drawings I have chosen to illustrate one only of the numerous embodiments in which the invention may appear, selecting the forms shown from the standpoints of convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

FIG. **1** is an end elevation partly in section transverse to the bearing axis, illustrating a roller-and-cage combination of the invention.

FIG. **2** is a side elevation of the roller-and-cage combination of FIG. **1**, showing half of the cage completely finished and the other half of the cage prior to punching of the windows.

FIG. **3** is a sectional perspective showing a portion of the finished cage of the invention.

FIG. **4** is an enlarged section through a bearing employing the roller-and-cage combination of the invention, the section being taken on the line **4–4** of FIG. **2**.

FIG. **5** is a section on the line **5–5** of FIG. **4**.

FIG. **6** is a section on the line **6–6** of FIG. **4**.

FIG. **7** is a partially sectioned side elevation of the blank from which the cage has been manufactured in accordance with the invention.

FIG. **8** is an end elevation of the blank of FIG. **7**.

FIG. **9** is a fragmentary outside view of the blank after punching the window and before coining.

FIG. **10** is a section on the line **10–10** of FIG. **9**.

FIG. **11** is a section on the line **11–11** of FIG. **9**.

FIG. **12** is a section on the line **12–12** of FIG. **9**.

FIG. **13** is a fragmentary outside elevation showing the completed cage of the invention after coining.

FIG. **14** is a section on the line **14–14** of FIG. **13**.

FIG. **15** is a diagrammatic progressive stepwise view, partly in section transverse to the bearing axis at the middle, illustrating in position I the blank prior to coining, showing in position II the coining operation with the tools engaging the blank and in position III showing the completed coined bar.

FIG. **16** is a section through the middle of the window showing a side view of the tools used in coining.

Describing in illustration but not in limitation and referring to the drawings;

Many self-contained roller-and-cage units have been produced in the art.

Some of them use relatively soft materials in the form of die castings or the like and do not provide strong cages.

In some of the roller-and-cage units, the cage is made from strip stock which has a thickness of only approximately 20 percent of the roller diameter so that the cage is lacking in strength and rigidity.

Other roller-and-cage units employ tubing which is pierced and coined by pressure rolling it to make the outside retention, leaving the crossbar toward the middle untouched with a relatively thin and inadequate thickness.

In other cage units which are pierced and coined from a machined blank, the coining leads to a guiding portion which is relatively far inward of the pitch circle, and either leads to roller guiding of the cage without guiding of the cage on the outside or cam action against the guiding surfaces tending to jam the roller or both difficulties.

In other self-contained cages which are made by piercing a machined blank, it is necessary to go through elaborate supplemental machining operations such as milling, broaching, shaving, or even grinding, which are both time consuming and uneconomical.

One procedure for making a self-contained cage for a roller-and-cage unit is to first pierce a machined blank and then shave it at an offset angle to the radial direction. This leads to rocking the crossbar at its transverse axis so that the window is open at one side of the bar and constricted at the other side of the bar, thus encouraging loss of retention at one side and binding at the other side, Heinrich Schmidt U.S. Pat. No. 3,163,447. Also the tool wear in producing this cage from steel is excessive, due to the heavy wall thickness needed and the offset direction of shaving.

Other efforts to solve this problem appear in Schaeffler U.S. Pat. No. 3,110,529 which has guidance provided near the interior of the crossbars by lips which tend to cam the roller outwardly when the cage leads and lags with respect to the motion of the roller. A further effort has been made to solve this problem in Einaudi U.S. Pat. No. 3,114,960 which has an extremely thin midlength portion which permits one rim to twist with respect to the other. In this Einaudi cage the window is pierced through the thick section of the rim, thus drastically reducing tool life.

The present invention is designed to overcome these difficulties, making it possible to obtain a roller-and-cage combination with a steel cage, while obtaining long tool life.

In accordance with the invention, a suitably curved blank is employed, which has a thick section at the rims, a relieved portion immediately inside the rims at which the end of the pierced window is to be located, a thick section toward the middle at each side which is to provide guidance and outer retention, and a thin midsection which is to provide inner retention.

The windows are punched by indexing the blank and forming parallel sides which are wide at the ends and relatively narrow at the midlength portion. Subsequent to forming the win-

dows, the crossbars are coined, preferably simultaneously at both the center and the ends, to form lips on the thickened guiding portions which will retain the roller at the outside when the cage is removed from the assembly, and to form inwardly converging walls at the midlength portion which will retain the roller in the cage when the cage is outside the assembly.

In FIG. 1 I illustrate a roller-and-cage combination 20 consisting of a cage 21 and rollers 22 supported in the cage. The cage is capable of holding the rollers in position during transport, sale and installation, and also during removal for subsequent repair.

In FIG. 2 I illustrate a portion of the cage 21 provided with rollers 22 and also a portion of blank 23 from which the cage has been made.

The construction of the cage will be better understood by reference to FIG. 3. At the opposite ends the cage 21 has rims 24, which may extend continuously where the bearing can be inserted endwise, or may be divided or interrupted for insertion around a shaft or the like as in the case of a connecting-rod bearing. Toward the midlength portion of the cage there are a plurality of windows 25, each of which is adapted to receive and retain one roller, and between the windows there are crossbars 26.

Each of the rims has a radially outward surface 27 which is intended to guide on a suitably hardened land of an outer tubular member 28, normally not supplied by the bearing manufacturer, as shown in FIG. 4.

Toward the midlength portion at each end of the crossbar 26 there is an external recess opposite a reduced section 31, at which the window terminates endwise.

Further inward, toward the midlength portion of the cage, there is a thickened guiding portion 32 at each end which is adapted to guide the rollers approximately opposite the pitch diameter as shown at 33. Radially outside of the pitch circle, at each side of the guiding portion 32 there are lips 34, protruding toward the opposite side of the window, which serve to retain the roller in place when the roller-and-cage combination is outside the assembled bearing.

Toward the midlength portion of the crossbar 26, there is a relatively thin inner retaining portion 35 of the crossbar which has at the two sides outwardly converging sidewalls 36 which allow clearance for the roller when it is in operation and at the same time retain the roller in the cage when the combination is removed from the assembly.

It will be evident that in the preferred embodiment the interior of the crossbar and the rim forms a straight line axially as shown at 37, for example as shown in FIG. 10, the indentations in the contour being provided at the outside of the cage.

The rim itself is relatively quite thick, and should have a thickness of between 60 and 95 percent of the roller diameter.

The reduced section 31 between the rim 24 and the guiding portion 32 which protects against excessive wear on the fillets at the ends of the punches, may be as thin as 35 percent of the roller diameter and as thick as 20 percent less than the thickness of the guiding portion 32.

The guiding portion 32 will have a thickness of between 55 and 95 percent of the roller diameter. The midlength portion 35 should have a thickness of between 30 and 50 percent of the roller diameter.

In FIG. 4 the assembled roller-and-cage combination is operating between an outer member 28 and an inner shaft or the like 40, the intention being that the cage will guide on its outside diameter.

In FIG. 5 it will be evident that rollers 22 are illustrated in guiding relation at pitch circle 41 with the guiding surfaces 33 of the guiding portions 32, while the outer retaining lips 34 are extending inward to restrict the width of the window to somewhat less than the diameter of the roller, by a difference suitable to press the roller into position, which may be of the order of 0.004 to 0.015 inch (the total interference of the window) with a roller diameter of one-fourth inch.

In normal operation of the roller-and-cage combination, the lips 34 should never contact the rollers, but if the roller-and-cage combination must be removed after assembly, then the lips 34 function to hold the rollers in place.

As shown in FIG. 6, which illustrates the shape of the midlength portion 26 of the crossbar, the sides of the crossbar are relieved at 36 so that no contact should occur with the rollers during normal operation, but when the roller and cage combination are removed from the bearing, then there will be sufficient interference, suitably of the order of 0.004 to 0.015 of an inch (the total interference of the window) in a bearing having ¼-inch roller diameter.

FIGS. 7 and 8 illustrate the blank 23 from which the cage is to be made. While the blank will in many cases preferably be made of steel, which may be used without heat treatment, or may for example be carburized after completion of the cage and before insertion of the rollers, the cage may be of a suitable nonferrous metal, including one of the copper base alloys, or, if the stresses are low enough, it may be made of aluminum or plastic.

The cage is indexed to bring the middle of a window opening opposite the center radial line of punching, and the punch is operated as best shown by FIG. 9 to 12 inclusive, moving it radially inward along center line 45 producing parallel sides of the window as suggested by lines 46 and 48. It will be noted that unlike the Schmidt process, previously described, no shaving in an angular direction is contemplated but merely radial punching or piercing.

To suggest that different dimensions are used at the two critical portions of the window, X in FIG. 9, 11 and 12 suggests punching a wide window opening which begins at the end of the window in the reduced portion 31, thus conserving on the wear on the fillets at the ends of the punch, and Y suggests a somewhat narrower winding opening opposite the midlength section 26. It will be noted that unlike the Einaudi patent above referred to, the punching does not extend into the thick rim.

Thus, as shown in FIG. 9, a window 25 is produced which ends at 47 inwardly of the rim and in the reduced section 31, then there are relatively wide guiding walls 33 produced in the relatively thick guiding portion 32 near each end, and an initially straight-sided relatively narrow portion 48 is produced in the midlength portion 26.

The pierced sidewalls of the window are parallel to one another as shown in FIGS. 11 and 12.

The coining operation of the crossbar of the cage is shown in FIGS. 15 and 16, and the completed crossbar as coined prior to insertion of the rollers is shown in FIGS. 13 and 14. While it is most convenient to coin both parts of the crossbar at the same time, it will be evident of course that separate coining operations for the outside retaining lips and for the inner retaining portion can be used if desired. In any case, the crossbars are coined with the center of the crossbar at the tool axis.

FIG. 15 shows the radial axis of the coining punch, which is directly and centrally aligned with a backup mandrel or anvil 51 which has a crossbar-supporting portion 52 which is immediately beneath the straight portion 37 at the inside of the crossbar and rim.

In full line in FIG. 15, a center coining punch 53 extends inwardly straddling the crossbar by a V-shaped recess 54 and having on either side of this recess diverging forming surfaces 55 which cause plastic deformation of metal at 56 which would otherwise interfere with the roller so that it forms an inclined surface 36 and moves some of the metal upward into a thickened portion 58. Thus the roller-retention feature of the midlength portion 26 of the crossbar with the roller at the two sides is retained and the midlength section of the crossbar has increased depth of section and stiffness.

There is an end coining punch 60, preferably part of the punch 53, at each end, which has symmetrically placed at its forward end oppositely sloping forming portions 61 which encounter at the midline the outer end of the guiding and outside

retaining portion **32**, to spread the metal outward at the outside, forming retaining lips **34**, while at the same time leaving unimpaired the clearance along the punched or pierced walls **46** which engage the sides of the roller at approximately the pitch circle. The clearance between the lips **34** is shown at Z in FIG. **5**.

Thus, the tolerance on the width of the window which is the roller diameter plus the clearance between the window and the roller, as established by the initial punching or piercing, is retained unimpaired by the cooling, the lip **34** merely being relied upon to retain the rollers in the cage when the cage is not functioning in the assembly.

It will be evident that the forward ends **63** of the center coining punch **53** at either side of the crossbar enter relieved portions **64** in the mandrel **51**.

Thus by reference to FIG. **15**, it will be seen that at position I the crossbar is shown prior to coining, at position II the crossbar is shown at the completion of the simultaneous coining operations, while in position III the crossbar is shown after coining and removal of the coining punch.

As a consequence the finished cage, as shown in FIGS. **13** and **14**, has lips **34** which can be elastically deflected to press in the roller from the outside and then will hold the roller against the escape from the outside and has inwardly converging walls **36** whose total clearance is sufficiently less than the roller diameter so that the roller will not escape radially inwardly.

It will be evident that the invention provides a self-containing unit consisting of a cage and its rollers which can be sold and installed as such, economizing on radial space as compared to a bearing having inner and outer races, and allowing the machinery manufacturer to incorporate the inner and outer race functions in components which will be used also for other purposes.

It will be evident that the dimension which was created by piercing and which is unchanged and provides the guiding contact near the pitch line, must allow for the space occupied by the roller and sufficient clearance for proper operation of the cage with respect to the roller in circumferential and radial motion of the cage and roller.

It will be evident that the design of the crossbar is such that the cage is capable of functioning under heavy duty, and yet flexible enough to permit insertion or if necessary removal of individual rollers as required. The thickness is adequate to provide suitable strength, but still is reduced where practical so as to minimize the wear on the tools. This would be especially a problem if one were to pierce into the rim of a heavy-walled cage. The ends of the window terminate in the relief groove and not in the rim of the cage.

In view of my invention and disclosure, variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the structure shown, and I therefore claim all such insofar as they fall within the reasonable spirit and scope of my claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A roller-and-cage combination for use in a bearing, the cage comprising rims and crossbars extending between the rims and separating the cage into windows, and rollers guided by the cage and positioned with a single roller in each window, the rims being relatively thick with respect to the roller diameter and having guiding surfaces adapted to guide at the outside, the windows terminating short of the rims at each end, the crossbars having at their ends areas of reduced thickness, toward the midlength area from the end, guiding and outward retaining areas, and at the middle, inner retaining areas, the guiding and outward retaining areas providing guidance for the rollers adjacent the pitch diameter and the guiding and outward retaining areas outside the pitch diameter having relatively converging lips which prevent the roller from escaping from the window outwardly, the crossbar at the midlength area having a spacing from the adjoining crossbar at the opposite side of the window which is too small to permit escape of the roller inwardly, and having a diverging shape in the inward direction adjoining the adjacent rollers.

2. A roller-and-cage combination of claim **1**, in which the crossbars and the rims extend straight in the axial direction at the inside.

3. A roller-and-cage combination of claim **1**, in which the thickness of the rim is between 60 and 95 percent of the roller diameter.

4. A roller-and-cage combination in claim **1**, in which the guiding and outward retaining areas of the crossbar have a thickness between 55 and 95 percent of the roller diameter and the areas of reduced thickness at the ends of the crossbar adjoining the rim have a thickness at least 20 percent of the roller diameter less than the thickness of the guiding and outward retaining areas.

5. A roller and cage combination of claim **1**, in which the midlength area of the crossbar has a thickness of between 30 and 50 percent of the roller diameter.

6. A cage for use in a roller and cage combination, comprising relatively thick rims at the opposite ends which are guiding surfaces adapted to guide on the outside diameter, crossbars connecting the rims and providing intervening windows adapted to guide and retain a single roller in each window, each crossbar having adjacent its ends and interposed between the crossbar and the rim a section of reduced thickness, then toward the midlength area at each end a guiding section of increased thickness, and then in the midlength inner retaining area of reduced thickness, the guiding portions at each side of the window having parallel sides adapted to guide the roller adjacent the pitch diameter and outwardly thereof having converging lips which retain the roller against escape outwardly, the area at the midlength having less distance across the window than the guiding portion and having at opposite sides of the window converging sides which retain the roller against escaping inwardly.

7. A cage of claim **6**, in which is straight in the axial direction across the inside of each crossbar and the adjoining rims.

8 A cage of claim **6**, in which the rims have a thickness of between 60 and 95 percent of the roller diameter.

9. A cage of claim **6**, in which the guiding portions have a thickness of between 55 and 95 percent of the roller diameter and the reduced portions at the ends of the crossbars have a thickness which is at least 20 percent of the intended roller diameter less than the thickness of the guiding portion.

10. A cage of claim **6**, in which the crossbar at the midlength portion has a thickness of between 30 and 50 percent of the roller diameter.