A method for manufacturing a rolling-element bearing cage includes clamping a cage blank in the radial direction using a clamping element in a first position where the cage blank is processed. Then, the cage blank is rotated relative to the clamping element to a second position where the cage blank is further processed. A device for manufacturing a rolling-element bearing cage includes the clamping element, which remain stationary together with a tool for processing the cage blank, while only the cage blank is rotated.
METHOD AND DEVICE FOR MANUFACTURING A ROLLER BEARING CAGE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to German patent application no. 10 2013 226 750.9 filed on Dec. 19, 2013, the contents of which are fully incorporated herein by reference.

TECHNICAL FIELD

[0002] Exemplary embodiments relate to a method for manufacturing a rolling-element bearing cage and to a device for manufacturing a rolling-element bearing cage.

BACKGROUND

[0003] Rolling-element bearing cages can be manufactured on conventional devices using a variety of conventional methods. For this purpose cage blanks are usually processed. For rolling-element bearing cages starting from a certain diameter, these methods or the devices required therefor are relatively expensive. In some conventional solutions, the pockets are milled from a tubular cage blank. In other conventional methods, cages are even milled from a solid material. This can be the case, for example, when corresponding devices for manufacturing these cages are very expensive.

[0004] Such devices can be presses, for example. Due to the geometry of the cages, these presses are often custom products. For processing in the press, the cage blank is clamped, for example, by a clamping element. In a first position a first pocket can then be punched-out from the cage blank using a tool of the press. The cage blank is then rotated by the clamping element to a second position with respect to the tool. Subsequently, for example, a further pocket can be punched-out from the cage blank. The press can be, for example, a C-portal press. In order to move the cage blank with the clamping element onward into the different positions, the presses are often equipped with an additional indexing head. As a result the presses can be relatively expensive to manufacture. This can be the case, for example, in the manufacturing or processing of large-bearing cages. Large-bearing cages usually have a diameter of over 250 mm or even over 1000 mm.

[0005] In other cases the pockets can be cut-out from a cage blank using, for example, a laser method. However, this may be possible only up to a plate thickness of 10 mm.

SUMMARY

[0006] A need therefore exists to provide a concept for manufacturing a rolling-element bearing cage, by which the manufacturing of the rolling-element bearing cage can be simplified.

[0007] Exemplary embodiments relate to a method for manufacturing a rolling-element bearing cage. In a rolling-element bearing cage, a cage blank is clamped in the radial direction using a clamping element. Then the cage blank is processed at a first position. The cage blank is rotated with respect to the clamping element. The cage blank is processed at a second position.

[0008] Since the cage blank is rotated with respect to the clamping element for the processing of the second position, in some exemplary embodiments it can be made possible that the clamping element can be configured in a simple manner and need not be rotated with the cage blank.

[0009] Here a cage blank can be any component from which a rolling-element bearing cage can be manufactured. For example, the cage blank can be a tube, the cage pockets can be punched-out of its walls. Furthermore, a cage blank can also be an already-processed component. This can already have, for example, pockets or individual pockets which are to be post-processed. The cage blank or the tube can be formed as a cylinder. Alternatively the cage blank or the tube can also be formed as a truncated cone. The rolling-element bearing cage can be any rolling-element bearing cage. For example, a rolling-element bearing cage can be a cage for a cylindrical roller bearing, a tapered roller bearing, a ball bearing, or the like.

[0010] A first position of the cage blank can be, for example, any to-be-processed position of a cage blank. The first position can be, for example, a position at which a pocket is to be introduced. Furthermore, the first position can be a bridge which is to be embossed. Furthermore, a second position of the cage blank can be any other position of the cage blank than the first position. Here, rotating of the cage blank with respect to the clamping element can take place in a circumferential direction of the cage blank. Here a circumferential direction can be a direction along an outer diameter of the cage blank. For example, the rotating can occur about an axis of rotation of the cage blank. Here a clamping can occur, for example, from radially inside to radially outside. A force acting radially outward can thus be exerted on the cage blank. This can occur, for example, at a plurality of positions. Under certain circumstances these positions can be selectively spaced from one another.

[0011] In some further exemplary embodiments, the processing is a punching-out of a pocket. In some exemplary embodiments it can thus be made possible that a cage having side rings disposed in the circumferential direction results from a tube segment. The side rings can be connected, for example, by bridges. Here the pockets can have any shape. For example, the pockets can be shaped as rectangles, as trapezoids, or as circles. The pockets can optionally also be formed as a projection of one of these shapes onto an arched or curved surface. Thus in some exemplary embodiments it can be made possible that the pockets are suited for the holding of the corresponding rolling element, for example a cylindrical roller, a tapered roller, or a ball. For the punching-out, a stamp can be pressed, for example, from a radially-inner-lying region of the cage blank through a wall of the cage blank. A die can be disposed, for example, in a region that lies outside the cage blank in the radial direction. For example, the die can abut on an outer diameter of the cage blank. Rotating of the cage blank with respect to the clamping element can occur, for example, in any manner. For example, a stop can be provided for this purpose. The cage blank can be rotated, for example, up to the stop. For example, with an adjustable stop, the rotating can take place manually using a positioning device, or can be automated using a rotary drive.

[0012] In some further exemplary embodiments the processing is an embossing of cage bridges. The cage blank is then rotated with respect to the clamping element far enough until one of the cage bridges abuts on a stop. Thus in some exemplary embodiments it can be made possible that the cage bridge(s) can be directly positioned for the embossing. For embossing the cage bridge, an embossing stamp can be pressed, for example, from radially inside against the cage.
blank. The embossing stamp can be, for example, a V-shaped stamp. For example, the V-shaped stamp can be positioned in the radial direction over a center axis of a pocket. It can thus be made possible in some exemplary embodiments that edges of the bridge, on which edges rolling elements could rub or jam, are removed.

[0013] In some further exemplary embodiments, for clamping the cage blank, a diameter of the clamping element is enlarged to an inner diameter of the cage blank. It can thus be made possible in some exemplary embodiments that the clamping device can be adapted to a variety of cage blanks.

[0014] In some further exemplary embodiments the clamping device is configured in order to clamp the cage blank in a region that later forms a side ring disposed in the circumferential direction. In some exemplary embodiments it can thus optionally be made possible that the clamping device does not abut in regions of the cage blank which are to be processed or from which material is to be punched-out.

[0015] In some further exemplary embodiments the cage blank is positioned on an abutment surface. Here the cage blank is positioned on an abutment surface such that an axial edge surface of the cage blank abuts at least sectionally on the abutment surface. It can thus be made possible in some exemplary embodiments that the cage blank achieves a positioning in the axial direction due to the abutment surface. This could result in that the clamping element can be formed more simply. This can be possible, for example, because the clamping element optionally need not perform the positioning in the axial direction. For example, the axial edge surface of the cage blank can be an axially-facing edge surface of a future side ring of the cage, which side ring is disposed encircling in the radial direction.

[0016] In some further exemplary embodiments the cage blank is clamped such that an axis of rotation of the cage blank is oriented parallel to an acting weight force of the cage blank. Thus in some exemplary embodiments it can be made possible, for example, that the cage blank achieves a uniform deformation in the direction of the weight force due to its own weight force. The clamping device can thereby be formed more simply. This effect could be increased, for example, by the cage resting on the abutment surface in the direction of its acting weight force. For example, for this purpose the abutment surface can be oriented perpendicular to the acting weight force of the cage blank. Here an orientation of an axis of rotation of the cage blank parallel to the acting weight force of the cage blank can form an angular range. The angular range can include a starting value and an ending value. A starting value and an ending value of the angular range can be, for example, 0°, 1°, 2°, 3°, 4°, 10°, 15°, 20°, 30° or 45°.

[0017] Exemplary embodiments relate to a device for manufacturing a rolling-element bearing. The device comprises a clamping element. The clamping element is configured in order to orient a cage blank in the radial direction and along a circumferential direction with respect to a tool. Here the cage can be rotated with respect to the clamping element.

[0018] Since the cage blank can be rotated with respect to the clamping element, in some exemplary embodiments it can be made possible that the clamping element itself can be configured very simply and in a non-rotatable manner. Thus in some exemplary embodiments the entire device can be formed in a more simple manner, since no means for rotating the clamping element need be provided.

[0019] The tool can be, for example, a punching or embossing device or a punching or embossing stamp. For example, the stamping or embossing device can be hydraulically driven.

[0020] In some exemplary embodiments the clamping element can be formed to exert a radially-outward-acting force on the cage blank. This force can be, for example, at least 1 N, 5 N, 10 N, 100 N, 500 N, or 10,000 N. In certain circumstances the clamping element can contact the cage blank only from radially inside. In some further exemplary embodiments the clamping element has a slide surface. The slide surface can be a radially-outwardly-directed surface of the clamping element. Thus in some exemplary embodiments it can be made possible that friction can be held as low as possible when the cage is rotated with respect to the clamping element. In certain circumstances the clamping element can include a plurality of slide surfaces, for example at least 2, 3, 4, 5, 6, 7, 8, 9, or more. These can be spaced from one another in the circumferential direction. In certain circumstances the cage blank can spaced from the clamping element in the circumferential direction between the slide surfaces.

[0021] In some further exemplary embodiments the device includes an abutment surface. The abutment surface is configured in order to abut at least sectionally on an axial edge surface of the cage blank. It can thus be made possible in some exemplary embodiments that an axial aligning of the cage blank takes place by the abutment surface. In some exemplary embodiments the clamping element thus need not perform the axial orienting or positioning of the cage blank. As a result, the clamping element could be formed more simply.

[0022] In some further exemplary embodiments the abutment surface is oriented horizontally so that an axis of rotation of the cage blank is oriented parallel to an acting weight force of the cage blank. Thus in some exemplary embodiments it can be made possible that the weight force of the cage blank is supported by the abutment surface. Deformation of the cage blank in the direction of the weight force can thereby be at least reduced or even avoided. For example, deformation of the cage blank in the direction of its weight force can thereby be avoided. For example, an axis of rotation of the cage blank, which is oriented parallel to an acting weight force of the cage blank, can form an angle with the weight force. The angle can fall in an angular range. The angular range can include a starting value and an ending value. A starting- and ending-value of the angular range can be, for example, 0°, 1°, 2°, 10°, 20°, 30° or 45°. In some exemplary embodiments having a smaller angle, it can thus be achieved, for example, that a greater proportion of the weight force of the cage blank can be supported by the abutment surface.

[0023] In some further exemplary embodiments the tool includes a frame. For processing the tool blank this frame is closed on four sides. Thus in some exemplary embodiments a stability of the tool can be increased. The frame can extend in a plane that is oriented parallel to a movement or a stroke of the punch. A die can be attached on one side of the frame; the punch can move into the die. One side of the frame can be removed or opened. Thus in some exemplary embodiments a cage blank can be inserted or removed again therefrom. For example, this side can be an auxiliary yoke. The auxiliary yoke can be oriented parallel to a stroke or a movement of the punch.

[0024] In some further exemplary embodiments the clamping element is adjustable to a plurality of inner diameters of to-be-clamped cage blanks. Thus in some exemplary embodi-
ments it can be made possible that a clamping element can be used for a variety of cage blanks. In certain circumstances the clamping element or at least one segment of the clamping element can be adjusted for this purpose in the radial direction. For example, a position of the at least one slide surface can be changeable in the radial direction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] Further advantageous designs are described in more detail below with reference to exemplary embodiments depicted in the drawings, but are not limited to said exemplary embodiments.

[0026] FIG. 1 shows a flowchart of a method for manufacturing a rolling-element bearing cage according to an exemplary embodiment.

[0027] FIG. 2 shows a schematic depiction of a perspective view of a device for manufacturing a rolling-element bearing cage according to an exemplary embodiment.

[0028] FIG. 3 shows a schematic depiction of a perspective view of a device for manufacturing a rolling-element bearing cage according to FIG. 2.

[0029] FIG. 4 shows a schematic depiction of a plan view of the device for manufacturing a rolling-element bearing cage according to FIG. 2.

[0030] FIG. 5 shows a schematic depiction of a side view of a tool of the device for manufacturing a rolling-element bearing cage according to FIG. 2.

[0031] FIG. 6a shows a schematic depiction of a perspective view of a device for cage-positioning for the tool according to FIG. 5.

[0032] FIG. 6b shows a schematic depiction of a side view of the device for cage-positioning according to FIG. 5.

[0033] FIG. 6c shows a schematic plan view of the device for cage-positioning according to FIGS. 6a and 6b.

DETAILED DESCRIPTION

[0034] In the following description of the accompanying Figures, like reference numerals refer to like or comparable components. Furthermore, summarizing reference numerals are used for components and objects that appear multiple times in an exemplary embodiment or in an illustration, but that are described together in terms of one or more common features. Components or objects that are described with the same or summarizing reference numbers can be embodied identically, but also optionally differently, in terms of individual, multiple, or all features, their dimensions, for example, as long as the description does not explicitly or implicitly indicate otherwise.

[0035] FIG. 1 shows a flowchart of a method for manufacturing a rolling-element bearing cage according to an exemplary embodiment.

[0036] In a method 1 for manufacturing a rolling-element bearing cage, a cage blank is clamped in the radial direction using a clamping element in a step 2. Then in a step 3 the cage blank is processed at a first position. After the processing, the cage blank is rotated relative to the clamping element in a further step 4. Subsequently the cage blank is processed at a second position.

[0037] FIG. 2 shows a schematic depiction of a perspective view of a device for manufacturing a rolling-element bearing cage according to an exemplary embodiment.

[0038] As shown in FIG. 2, a device 5 for manufacturing a rolling-element bearing cage comprises a clamping element 6. The clamping element 6 is configured in order to orient a cage blank 7 in the radial direction and along its circumferential direction of the cage blank 7 relative to a tool 8. Furthermore the clamping element 6 is configured to clamp the cage blank 7 such that the cage blank 7 can be rotated relative to the clamping element 6.

[0039] In the exemplary embodiment of FIG. 2, the device 1 also comprises an abutment surface 9 in addition to the clamping element 6 and the tool 8. The clamping element 6 is attached to the abutment surface 9. The abutment surface 9 can be moved in a plane relative to the tool 8. This plane lies parallel to a side ring 10 of the cage blank 7 or to a future cage. The side ring 10 extends is disposed in a circumferential direction of the cage. For moving the abutment surface 9, the device 5 has a linear guide 11. A rail 12 of the linear guide 11 is disposed for this purpose on a substructure 13 of the device 5.

[0040] FIG. 3 shows a schematic depiction of a cut, side view of the device for manufacturing a rolling-element bearing cage according to FIG. 2.

[0041] As depicted in FIG. 3, the linear guide 11 comprises a sled 14. This sled 14 is attached to an underside 15 of the abutment surface 9. Furthermore the sled 14 is also movably disposed on the rail 12 of the linear guide 11. The abutment surface 9 has a cutout 16. The tool 8 is disposed in the cutout 16 of the abutment surface 9. The cutout 16 thus projects from an edge surface 17 of the abutment surface 9 into the abutment surface 9. The clamping element 6 is disposed on the abutment surface 9. The cutout 16 extends up to beyond a center point of the clamping element 6. The cutout 16 thus projects at least so far into the abutment surface 9 that the tool 8 can be positioned at the position at which the cage blank 7 is to be processed. Since the tool 8 is disposed in the cutout 16, in some exemplary embodiments it can be made possible that the cage blank 7 can be held by the abutment surface 9 using a large part of its edge surface. The edge surface of the cage blank 7 can be directed in an axial direction M of the cage blank 7. For example, the cutout 16 has a width for this purpose that corresponds at most to w/6, w/5, w/4, w/3, w/2 or w/1 of a length of a circumference of the cage blank 7.

[0042] FIG. 4 shows a schematic depiction of a plan view of the device for manufacturing a rolling-element bearing cage according to FIG. 2.

[0043] As depicted in FIG. 4, the clamping element 6 comprises a plurality of variable cage-clamping segments 18. In the exemplary embodiment of FIG. 4, the cage-clamping segments 18 are each formed as a rail. The cage-clamping segments 18 are disposed such that their length extends in a radial direction of the cage blank 7 in the exemplary embodiment of FIG. 4, the clamping element 6 comprises seven cage-clamping segments 18. The seven cage-clamping segments 18 and the tool 8 are disposed at a uniform distance to each other so that they divide a circle into eight parts.

[0044] In further, not-depicted exemplary embodiments, the clamping element can include any other number of cage-clamping segments.

[0045] In the exemplary embodiment of the Figures, all cage-clamping segments 18 are formed identically. In further, not-depicted exemplary embodiments, individual cage segments can differ from one another in their design.

[0046] Only the configuration of the cage-clamping segment 18-a will be described in a representative manner. The cage-clamping segment 18-a has a slide surface 19. The slide surface 19 is the part of the cage-clamping element 18-a that
comes in contact with the cage blank 7. In the present exemplary embodiment the slide surface 19 has an upper surface that is curved radially outward. For example, a radius of the curvature can be smaller than an inner diameter of the cage blank 7. In some exemplary embodiments it can thus be made possible, for example, that the cage blank 7 and the slide surface 19 have only a small contact surface with each other. Only a smallest-possible friction between the cage blank 7 and clamping element 19 could thereby be generated when the cage blank 7 displaces relative to the clamping element 6 and thus also relative to the slide surface 19. The slide surface 19 abuts on a surface 20 of the cage blank 7, which surface 20 faces radially inward and extends in the circumferential direction. Expressed in other words, the slide surface 19 abuts on an inner diameter of the cage blank 7.

A position of the cage-clamping element 18-a can be changed in the radial direction R of the cage blank 7 with respect to a center axis M. In the present exemplary embodiment the cage-clamping segment 18-a is movably guided for this purpose in a recess 21. The recess 21 is introduced in a base plate 22 of the clamping element 6. The base plate 22 can, for example, be fixedly connected to the abutment surface 9. The recess 21 also extends in a radial direction of the cage blank 7. The cage-clamping segment 18-a can be fixed at a certain diameter via an attachment means 23. This can be, for example, the inner diameter of the cage blank 7 to be processed. The fixing or a fitting can take place, for example, such that the slide surface 17 is positioned on an inner diameter of the cage blank 7 to be clamped. For example, the cage-clamping segment 18-a can be fixed for this purpose in the recess 21. For this purpose the base plate 22 can include a not-depicted attachment structure. This can work together with the attachment means 23. For example, a slot or a plurality of slots can be introduced into the cage-clamping segment 18-a as the attachment means 23.

In some further, not-depicted exemplary embodiments the cage-clamping segment can have any shape. For example, the cage-clamping segment can have the shape of a circle segment. In some further exemplary embodiments any attachment structure and a corresponding counterstructure on the abutment surface can be provided as the attachment means. For example, a clamping device, a latching device, or similar can be provided for this purpose. For example, in some exemplary embodiments the individual cage-clamping segments can be connected to one another, so that a conjoint adjustment of the cage-clamping segments can be possible.

The abutment surface 9 comprises a plurality of rollers 24. The rollers 24 are configured in order to support the cage blank 7. Seventeen rollers are present in the exemplary embodiment of the Figures. The rollers 24 serve to reduce friction between the cage blank 7 and the abutment surface 9. This can possibly be important when the cage blank 7 is rotated with respect to the clamping element 6. In the exemplary embodiment the rollers 24 or their axes of rotation are disposed parallel to the radial direction of the cage blank 7. For example, the upper surface of the rollers 24 can each lie in the same plane as the upper surface of the abutment surface 9. Alternatively the rollers 24 can be disposed such that they protrude from the abutment surface 9. In some exemplary embodiments this can result in that the cage blank 7 abuts on the abutment surface 9 only on the rollers 24. The rollers 24 are each disposed in an upper surface of the abutment surface 9. The rollers 24 have a length L. Here the length L of the rollers 24 is chosen such that the rollers 24 lie in a range of a smallest possible and a largest possible diameter of possible cage blanks that are to be processed on the device 5. The rollers 24 are disposed in different sections to one another. The three rollers 24-a, 24-b, and 24-c are disposed adjacent to the tool 8 or the cutout 16. These rollers have a smaller distance to one another than the rollers 24-d and 24-e which are disposed adjacent to the rollers 24-f, 24-g, 24-h, and 24-i. In an analogous manner to the three rollers 24-a, 24-b, and 24-c, three rollers 24-j, 24-k, 24-l, which have a smaller distance to each other than the rollers 24-m and 24-n, are disposed on the other side of the cutout 16 or of the tool 8.

To move the cage blank 7 with respect to the clamping element 6 and thus also with respect to the tool 8, a not-depicted, integrated positioning device can be provided. Furthermore, for this purpose the device 5 can also include a not-depicted rotary drive. For this purpose, for example, an angular interval can be sensed using a displacement measuring system. In cases wherein cages are to be manufactured only in small quantities, the cage or the cage blank 7 can also be moved by hand from the first position to the second position. An also not-depicted stop can be provided for this purpose, for example. Expressed in other words, the forward indexing from pocket to pocket or between processing positions can take place manually, for example using an adjustable stop.

In the exemplary embodiment of the Figures, the tool 8 can be used for different processing procedures. For one, the tool can be used for punching the pockets. For this purpose the tool 8 is equipped with a window punch 25 and a die 26, into which the window punch moves. As depicted in FIG. 3, the window punch 25 is connected to a press cylinder 27. The press cylinder 27 is disposed radially inside the cage blank 7. For the punching, the window punch 25 is pressed from a radially inwardly oriented circumferential surface 20 of the cage blank 7 to radially outward into the die 26. Any cylinder can be used as the press cylinder 27. For example, a hydraulic cylinder is used as the press cylinder 27. For example, in some exemplary embodiments a linear actuator (e.g. an “Ultra Power” cylinder (“HPF”)) can be used as the press cylinder 27. The linear actuator can have a length, for example, of approximately 400 mm and can be extended to a maximum length, for example, of 8000 mm. Furthermore, the cylinder or linear actuator can have a diameter, for example, between 140 mm and 160 mm. For example, using the cylinder or linear actuator, a static force of 7182 kN and a dynamic force of 1600 kN can be exerted.

For example, the cage blank 7 can have a diameter of over 250 mm, 500 mm, 1000 mm, 1500 mm, 2000 mm, or 2500 mm. For example, the cage blank 7 can have a thickness of 10 mm to 12 mm.

The tool 8 has a scraper 28 to take off the material punched-out from the pocket. The tool 8 comprises a main yoke 29. The main yoke 29 serves to hold the press cylinder 27. The die 26 is held in a frame 30. The frame 30 is connected to the main yoke 29 via an auxiliary yoke 31. Furthermore, the main yoke 29 is connected to the frame 30 via a guide column 32. A further guide column 33 protrudes from the main yoke 29 into an interior of the tool 8 towards the frame 30. The window punch 25 is guided along the guide columns 32 and 33. The frame 30 and the main yoke 29 are connected to a top side of the tool 8 via the auxiliary yoke 31. The auxiliary yoke 31 is configured to be removable. Thus the cage blank 7 can be inserted into the tool 8 or removed again therefrom.
Expressed in other words, the cage blank 7 to be processed or the finished cage can be exchanged due to the removable auxiliary yoke 31.

[0054] The auxiliary yoke 31 and also the guide column 33 and optionally the guide column 32 are removable. Then the main yoke 29 can be pivoted away. Thus in some exemplary embodiments, the tool 8 or the window punch 25 and/or the die 26 can be more simply exchanged or replaced. For example, the window punch 25 can be replaced by another window punch in another size or shape. For example, the window punch 25 can be replaced when worn. Furthermore, the die 26 can be selected or exchanged to match the window punch 26. Furthermore, the tool 8 can also be retrofitted for another processing operation, namely an embossing.

[0055] FIG. 5 shows a schematic depiction of a side view of a tool of the device for manufacturing a rolling-element bearing cage according to FIG. 1.

[0056] As depicted in FIG. 5, an embossing stamp 34 can also be attached to the press cylinder 27. The embossing stamp 34 can serve to correspondingly process the cage bridges in a cage blank 7 from which the pockets have already been punched-out. When the tool 8 includes the embossing stamp 34 or if this is mounted in the tool, the tool 8 also includes a cage positioner 35. Using the cage positioner 35, the cage blank 7 from which pockets have already been punched can be positioned with respect to the tool for the embossing of the bridges. The cage positioner 35 is disposed on the frame 30 of the tool 8. The cage positioner 35 is disposed radially outside the cage blank 7.

[0057] FIGS. 6a to 6c show enlarged detail views of the cage positioner 35.

[0058] As depicted in FIG. 6a, the cage positioner 35 includes four rollers 36. The rollers 36 are disposed such that a cage bridge can respectively be held between two opposing rollers 36. Here the rollers 36 are disposed such that two rollers 36 lie on one side of the cage bridge. The rollers 36 are each disposed such that their axes of rotation extend substantially parallel to a cage bridge or its extension between the side rings of the cage, which side rings are disposed in the circumferential direction. Each of the rollers 36 is held in an attachment element 37. Here each of the attachment elements 37 has a C-shaped profile. The roller 36 is disposed in the C-shaped cutout. The attachment elements 37 are attached to not-depicted rails on a base plate 38.

[0059] As is recognizable in FIG. 6b, each of the attachment elements 37 is movably connected to the base plate 38 via a spring 40. In order to limit a movement of the attachment elements 37 towards a region 43 wherein the cage bridge is to be positioned and held, a stop 41 is disposed between the attachment elements 37. The stop 41 is fixedly connected to the base plate 38. Using the base plate 38, the cage positioner 35 can be adapted to different angles of the cage blank 7 and possibly also to different pocket sizes. For example, the cage positioner 35 can thus be adapted to a cylindrical or truncated-cone-shaped cage blank 7. For this purpose the base plate 38 has a surface 42. The surface 42 is formed on a side of the base plate 38 which is facing away from the region 43, in which the cage bridge can be held. The surface 42 that is disposed at an angle to the region 43 for the cage bridge.

[0060] When a cage blank 7 having punched-out pockets is positioned on the tool 8, one of the cage bridges is centered between the opposing rollers 37, parallel to the axes of rotation of the rollers. The stop 40 guides the roller attachment elements 37. The stop 40 prevents the attachment elements 37 from being able to move too far towards the cage bridge held between them. The springs 40 press the attachment elements 37 and the rollers 36 against the cage blank 7 until they snap onto the bridge.

[0061] For the assembly, in some exemplary embodiments the movable components and the springs can be used and the cage positioner 35 can be screw fastened to the holder, i.e. to the frame 30 of the tool 8.

[0062] As depicted in FIG. 5, the tool 8 can be adjusted to different shapes of different cage blanks 7. This can occur independently of the tooling of the tool 8, i.e. with a stamping punch or window punch or an embossing stamp. For this purpose the tool 8 has a height adjuster 44. Using the height adjuster 44 the tool 8 can be positioned at different heights parallel to an axial direction M of the cage. Using the height adjuster 44, a tool base plate 45, on which the frame 30 is rotatably attached, can be moved in the axial direction M.

[0063] For example, the frame 30 can be pivotally connected to the base plate 45 at a corner via a hinge 46. In the exemplary embodiment of FIG. 5 the frame 30 of the tool 8 is rotatably connected to the base plate 45 at the corner, which connects a side of the frame 30, at which the die 26 or the cage positioner 35, and at a side which opposes the auxiliary yoke. The tool 8 or a frame of the tool 8 having the punch can thus be pivoted with respect to the center axis M of the cage blank 7 in a plane that is oriented perpendicular to the abutment surface 9. Thus the punch or the tool can be adapted to a shape of the cage blank 7, cylindrical or truncated-cone-shaped. In order to lock a position of the punch and of the frame 30, the tool 8 comprises an adjustment element 49. The adjustment element 49 produces an operative connection between the frame 30 of the tool 8 and the base plate 45. Using the adjustment element 49 the frame 30 can be pivoted about the hinge 46 and then locked. For this purpose the adjustment element 49 is attached to a frame part 48 which is disposed opposite the auxiliary yoke 31. The adjustment element 49 is attached via a hinge 47 that includes the frame part 47.

[0064] Expressed in other words, an advantageous method for cage-punching and/or embossing can be performed with a device in some exemplary embodiments. This can optionally be possible without acquisition of an expensive custom apparatus. With some exemplary embodiments, an expensive custom press having an indexing or clamping device can be omitted. Instead, using the device 5 according to some exemplary embodiments, an adjustable, variable holder for the cage or cage blank 7 can be provided without expensive clamping tools. With some exemplary embodiments, existing tools can be readily adapted and held, for example, in the frame 30.

[0065] The device of the exemplary embodiment is a hydraulic punching- and embossing-device for steel-plate cages. For example, the force can be applied onto the punch by any other cylinder.

[0066] The exemplary embodiments and their individual features disclosed in the above description, the following claims, and the accompanying Figures can be meaningful and implemented both individually and in any combination for the realization of an exemplary embodiment in its various designs.

[0067] Representative, non-limiting examples of the present invention were described above in detail with reference to the attached drawings. This detailed description is merely intended to teach a person of skill in the art further details for practicing preferred aspects of the present teachings and is not intended to limit the scope of the invention.
Moreover, combinations of features and steps disclosed in the above detailed description may not be necessary to practice the invention in the broadest sense, and are instead taught merely to particularly describe representative examples of the invention. Furthermore, various features of the above-described representative examples, as well as the various independent and dependent claims below, may be combined in ways that are not specifically and explicitly enumerated in order to provide additional useful embodiments of the present teachings.

All features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original written disclosure, as well as for the purpose of restricting the claimed subject matter, independent of the compositions of the features in the embodiments and/or the claims. In addition, all value ranges or indications of groups of entities are intended to disclose every possible intermediate value or intermediate entity for the purpose of original written disclosure, as well as for the purpose of restricting the claimed subject matter.

REFERENCE NUMBER LIST

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<td>0068</td>
<td>Moreover, combinations of features and steps disclosed in the above detailed description may not be necessary to practice the invention in the broadest sense, and are instead taught merely to particularly describe representative examples of the invention. Furthermore, various features of the above-described representative examples, as well as the various independent and dependent claims below, may be combined in ways that are not specifically and explicitly enumerated in order to provide additional useful embodiments of the present teachings. All features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original written disclosure, as well as for the purpose of restricting the claimed subject matter, independent of the compositions of the features in the embodiments and/or the claims. In addition, all value ranges or indications of groups of entities are intended to disclose every possible intermediate value or intermediate entity for the purpose of original written disclosure, as well as for the purpose of restricting the claimed subject matter.</td>
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</tbody>
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41 Stop
42 Surface
43 Region
44 Height adjuster
45 Tool base plate
46 Hinge
47 Hinge
48 Frame component
49 Adjustment element
50 Cage axial direction
50 Roller length

We claim:
1. A method (1) for manufacturing a rolling-element bearing cage, comprising:
   - clamping (2) of a cage blank (7) in the radial direction using a clamping element (6);
   - processing (3) of the cage blank (7) at a first position;
   - rotating (4) of the cage blank (7) with respect to the clamping element (6); and
   - processing (5) of the cage blank (7) at a second position.
2. The method according to claim 1, wherein the processing (3, 5) is a punching-out of a pocket.
3. The method (1) according to one of the preceding claims, wherein, when an embossing of cage bridges occurs in the processing (3, 5), the cage blank (7) is rotated with respect to the clamping element (6) far enough until one of the cage bridges abuts on a stop (35).
4. The method (1) according to claim 1, further comprising:
   - fitting of a clamping element (6) to an inner diameter of the cage blank (7) for clamping (2) the cage blank (7).
5. The method (1) according to one of the preceding claims, comprising:
   - positioning of the cage blank (7) on an abutment surface (9) such that an axial edge surface of the cage blank (7) at least sectionally abuts on the abutment surface (9).
6. The method (1) according to one of the preceding claims, wherein the cage blank (7) is clamped such that an axis of rotation (M) of the cage blank (7) is oriented parallel to an acting weight force of the cage blank (7).
7. A device (5) for manufacturing a rolling-element bearing cage, comprising:
   - a clamping element (6) which is configured in order to orient a cage blank (7) in a radial direction and along its circumferential direction with respect to a tool (8) such that the cage blank (7) can be rotated with respect to the clamping element (6).
8. The device (5) according to claim 7, comprising an abutment surface (9) which is configured in order to abut at least sectionally on an axial edge surface of the cage blank (7) and/or an abutment surface (9) is oriented horizontally so that an axis of rotation (M) of the cage blank (7) is oriented parallel to an acting weight force of the cage blank (7).
9. The device (5) according to one of claim 7 or 8, wherein the tool (8) includes a frame, which is closed on at least four sides for processing the cage blank (7), wherein a side (31) can be opened for insertion of the cage blank (7).
10. The device (5) according to one of claims 7 to 9, wherein the clamping element (6) is adjustable to a plurality of inner diameters of to-be-clamped cage blanks (7).