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Description

The invention relates to a rolling-element bearing having at least one inner ring and at least one outer ring, wherein a plurality of rolling bodies are arranged between the bearing rings, wherein the rolling bodies are retained by a cage, wherein the cage consists of a plurality of cage segments, wherein each cage segment consists of a frame-like structure, in which a plurality of lateral partition walls form a receiving pocket for a rolling body, wherein at least one fastening element is arranged on each cage segment, wherein the cage segments can be connected at least temporarily via a coupling element, to which end the coupling element is brought into engagement with the fastening elements, and wherein the fastening elements are configured at least partially, preferably completely, as closed eyelets, through which the coupling element can be threaded.

A rolling-element bearing such as this is disclosed in **WO 2012/092107 A2**. Similar and other solutions emerge from **GB 2 104 600 A**, from **DE 100 49 578 A1**, from **DE 10 2011 089 078 A1**, from **DE 10 2011 080 167 A1**, from **DE 10 2007 002 359 A1**, from **DE 10 2006 045 436 A1**, from **DE 199 37 660 A1**, from **DE 89 14 085 U1**, from **DE 42 29 136 C1**, from **DE 40 15 303 C2** and from **DE 10 2011 004 374 A1**.

A different rolling-element bearing is known from document **WO 2012/076583 A2**. Instead of a classic integral bearing cage, the cage here is formed by a plurality of cage segments. This offers the advantage that there is especially good suitability for large tapered roller bearings, and the stresses that arise here can be absorbed especially well. Furthermore, the individual cage segments can be well installed; at the same time, a low cage weight can be achieved. The configuration of the cage segments permits a secure accommodation of the rolling body and a reliable guidance of the cage segment on the rolling body. When used as intended, the cage segments do not come into contact; they are not connected to one another.

After the assembly of the bearing, however, it must be handled as a unit, since the outer bearing ring and the inner bearing ring cannot be separated without the bearing falling apart. This results from the conceptual lack of an interconnection of the individual cage segments. Thus the bearing must be transported and installed as a complete unit. This is disadvantageous under particular circumstances and limits the advantages of the cage segment design.

The invention addresses the problem of developing a bearing of the type in question in such a way that the aforementioned disadvantage can be eliminated. Accordingly, the handling of the bearing, particularly during its assembly, is intended to be improved and/or facilitated in a simple way. A further essential aspect is that the cage should also be held stable in its intended working position in the case of vibrations during operation. Accordingly, bearing vibrations in particular should not have such a disruptive effect.

The solution to this problem by the invention is characterized in that a cage segment receives a rolling body by means of its receiving pocket, and the rolling bodies that adjoin said rolling body in the circumferential direction are kept clear by a cage segment, wherein retaining sections that protrude in the circumferential direction are arranged on the cage segment and form a thrust surface for the rolling bodies which, in the circumferential direction, adjoin the rolling body that is retained by the cage segment and which limit the radial mobility of the rolling bodies.

The coupling element is preferably a component which transmits tensile forces but is largely flexurally slack. Specifically, a cable is intended here.

The fastening elements can be integrally formed on the cage segment.

The lateral partition walls of the cage segment can form a

closed, substantially rectangular (or conical) frame, wherein two partition walls run in the circumferential direction of the rolling-element bearing, wherein two partition walls connect the partition walls that run in the circumferential direction, and wherein one fastening element is arranged on each of the two partition walls that run in the circumferential direction.

The partition walls, which connect the partition walls that run in the circumferential direction, can be provided with concave thrust surfaces that limit the radial mobility of the rolling body situated in the receiving pocket.

Preferably, the cage segments consist of a material whose coefficient of thermal expansion has a value which lies in a tolerance range of +/-15% compared with the coefficient of thermal expansion of steel. In particular, cast iron has proven to be a material that has this property and is employed advantageously.

One development provides that at least one spacer element is arranged against or on the coupling element. By means of said spacer element, relative mobility between the coupling element and at least one fastening element can be limited in the circumferential direction. Additionally or alternatively, the spacer element also serves to keep the distance between two adjacent cage segments constant. Accordingly, spacer elements are thus provided which are wound up on the cable and arranged between two cage segments in order to keep the cage segments in the circumferential direction at a defined distance. The capacity for movement of the individual cage segments relative to one another and in the circumferential direction can be defined and/or set in this way.

A further development provides that at least one supporting element is arranged on the cage segment; said supporting element is preferably made from the material of the cage segment itself, i.e. it is moulded on. In the event that the cage segment tilts, this supporting element permits it to be supported on a shoulder

of the bearing ring.

The proposed rolling-element bearing is especially preferably a tapered roller bearing.

The embodiment according to the invention offers the possibility of dismantling the bearing for installation, i.e. in the case of tapered roller bearings, separating the inner ring and the roller set from the outer ring without the bearing components falling apart. The cage segments are thus self-retaining. The invention thus provides that a one-pocket cage segment is provided with an additional retaining device, which serves to connect the individual segments together and thereby prevents the roller-cage composite in the assembled state from being able to detach from the inner ring.

Preferably, only every other rolling element (roller) is completely enclosed by a cage segment, i.e. only half as many cage segments as rollers are present in the bearing. Alternatively, every roller can also be equipped with a cage segment.

The rollers situated in the cage segment receiving pockets are retained in the pocket by the aforementioned geometric configuration by the snap-fit principle. In this context, express reference is made to the above-cited document WO 2012/076583 A2 by the applicant, in which details thereof are described. The rollers, which are not encircled by a cage segment, are preferably prevented from falling out, i.e. prevented from free movement in the radial direction, by two additional projections that extend in the circumferential direction.

As has been explained, retaining devices, to which e.g. a cable can be attached, are preferably installed on the end faces of the cage segments in order to connect the individual cage segments together. The roller-cage composite is established by this connection of individual cage segments, and so the roller

set including the cage segments rests on the inner bearing ring such that it is secured against falling apart.

The cable can remain installed just until the final assembly of the bearing has been carried out; it can then be removed because it is not needed for the operation of the bearing. However, it is equally possible that the cable remains permanently installed.

The cable is preferred as the coupling element, but other solutions are also plausible, such as a screw connection that is operatively positioned between two adjacent cage segments.

Therefore, by affixing the coupling element (cable) to the fastening elements, the cage, which consists of segments, and the rollers can be captively connected to the inner bearing ring and integrated into the application separately from the outer ring in an advantageous way.

Since the coefficients of thermal expansion of steel and plastic - of which the cage segments can fundamentally be manufactured - typically differ, the end play between the cage segments must be greater, which can have a disadvantageous effect on a maximum load rating. Therefore, a further aspect of the present invention relates to the choice of material for the cage segments. It is preferably selected such that the material of the cage segment has a coefficient of thermal expansion similar to that of steel. The selected material of the cage segment in this instance should have a coefficient of thermal expansion from 10×10^{-6} to 13×10^{-6} 1/K (it is 11.5×10^{-6} 1/K for steel). As is explained above, cast iron is proven as a material for the cage segments; this material satisfies the stated condition. This makes it possible to permit narrower distances in the design of the roller end play and the snap measurement, since the thermal expansion of rings and cage segments is similar. This supports secure handling of the inner ring with an installed roller set, but without an outer ring. The use of this type of material, the thermal expansion of which is similar to that of

steel, thus permits less end play within the roller-cage composite, which is advantageous both for the retention of the rollers on the inner ring and for the performance of the bearing.

An exemplary embodiment of the invention is illustrated in the drawing. The following is shown:

Fig. 1 shows a part of a tapered roller bearing, viewed in the axial direction,

Fig. 2 shows the inner ring of a tapered roller bearing with the roller set and the cage, and

Fig. 3 shows a cage segment of the cage of a tapered roller bearing, viewed in the radial direction.

The concept according to the invention for the use in a tapered roller bearing is illustrated in the figures.

It can be seen in Fig. 1 that the rolling-element bearing 1 comprises an inner ring 2 and an outer ring 3, which can rotate relative to each other about the axial direction a, wherein rolling bodies 4, 4’ - tapered rollers in the present case - are arranged between the rings. The rolling bodies 4, 4’ are retained by a cage.

The cage is not configured in one piece, but rather is formed by a plurality of cage segments 5. A cage segment 5 of this type is illustrated in Fig. 3 - viewed in the radial direction r. According to this, each cage segment 5 consists of a frame-like structure, which is formed by four partition walls 6, 7, 8 and 9. The four walls form a substantially rectangular (strictly speaking: conically shaped) receiving pocket 10, in which a rolling body 4 is placed.

As is apparent when Figures 1 and 3 are considered in combination, thrust surfaces 14 are formed on the sides of partition walls 7 and 9, which face the receiving pocket 10, in

such a way that an indentation for a rolling body 4 in the installed state is created in the radial direction r, i.e. the rolling body 4 is retained in the receiving pocket 10 of the cage segment in the manner of a snap-fit connection. For details in this regard, express reference is made to WO 2012/076583 A2 by the applicant.

As can also be seen from Fig. 1, only every other rolling body 4 is retained by a cage segment 5. In each case, one rolling body 4' that is not surrounded by a cage segment 5 is arranged between two such rolling bodies 4 that have a cage segment 5. However, retaining sections 15 extend laterally away from the cage segment 5 in the circumferential direction U, and so - as can best be seen from Fig. 1 - the adjacent rolling bodies 4' are held in position by thrust surfaces 16 that are formed on the retaining section 15. Accordingly, it is ensured that the rolling bodies 4' that are not arranged in a receiving pocket 10 of the cage segment 5 are also prevented from falling radially outwardly, since they are held back by the thrust surfaces 16.

In order for the rolling bodies 4', 4' in the cage arrangement, which consists of the individual cage segments 5, to form a captive composite together with the inner ring 2 even when the outer ring 3 is uninstalled, fastening elements 11 and 12, which in the exemplary embodiment are configured as eyelet-like mouldings on the partition walls 6, 7, is formed on the partition walls 6 and 8 - as can best be seen from Fig. 2 in combination with Fig. 1. A coupling element 13 in the form of a cable is drawn through the eyelet-like fastening elements 11, 12 (illustrated with dashed lines in Fig. 1). After the tensioning of the cable, a composite of the individual cage segments 5 is formed, and so the captive composite of cage elements 5 is established with the rolling bodies 4, 4' and the inner ring 2 even if the outer ring 3 is removed.

For the purposes of illustration, the fastening element 12 described above is shown as a complete eyelet in Fig. 2. The fastening element 11 shown near the bottom is represented as an

interrupted eyelet, i.e. the fastening element is configured here in the manner of two interacting hook sections that grip the cable 13. The cable 13 can thus advantageously be hooked here from the side.

Not necessarily but preferably, however, all eyelet-like fastening elements 11, 12 are configured as closed eyelets - i.e. ring-like. As was explained, it can be seen in Fig. 2 that only the radially outer fastening elements 12 are configured as closed eyelets. The radially inner fastening elements 11 are slotted in this case, i.e. they are not closed.

The individual cage segments 5’ are guided by rollers. In the event of a tilting of a cage segment 5, it can be guided on one end face on the shoulder 17 of the inner ring 2 and on the other end face on a thrust surface 18 (see Fig. 2). To this end, supporting elements 19 are moulded onto the cage segment.

This is intended to prevent a run-up from occurring on the track 21 of the inner ring 2. To achieve this, a distance x between the supporting element 19 on the end face of the cage segment 5 and the shoulder 17 must be smaller than the distance y between a web projection 20 and the inner ring track 21.

The following can also be recognized in Fig. 1: It is exemplified in a sketch for only one single circumferential location of the cage that spacer elements 22 can be provided. In the exemplary embodiment, these spacer elements 22 are configured in the manner of an O ring, slid onto the cable 13 and cause a relative displaceability in the circumferential direction U between the cable 13 and the fastening element 11, 12 to be impeded. Likewise, the spacer element can be configured, for example, as a sheath that is slid onto the cable 13; the longitudinal extension of said sheath is selected such that the fastening elements 11, 12 of two adjacent cage segments 5 are retained at a defined distance. Accordingly, the cage segments cannot “push together” in the circumferential direction.

List of Reference Signs

1	Rolling-element bearing
2	Inner ring
3	Outer ring
4	Rolling body
4'	Rolling body
5	Cage segment
6	Partition wall
7	Partition wall
8	Partition wall
9	Partition wall
10	Receiving pocket
11	Fastening element
12	Fastening element
13	Coupling element (cable)
14	Thrust surface
15	Retaining section
16	Thrust surface
17	Shoulder
18	Thrust surface
19	Supporting element
20	Web projection
21	Inner ring track
22	Spacer element
U	Circumferential direction
a	Axial direction
r	Radial direction
x	Distance
y	Distance

Patentkrav

1. Rulningsleje (1) med i det mindste en inderring (2) og i det mindste en yderring (3), hvor der mellem lejeringene (2, 3) er anbragt et antal rullelegemer (4), hvor rullelegemerne (4) holdes ved hjælp af et bur, hvor buret består af et antal bursegmenter (5), hvor hvert bursegment (5) består af en rammeformet struktur, ved hvilken flere sideværts begrænsningsvægge (6, 7, 8, 9) danner en optagelomme (10) for et rullelegeme (4), hvor der på hvert bursegment (5) er anbragt i det mindste et fastgørelseselement (11, 12), hvor bursegmenterne (5) via et koblingselement (13) i det mindste midlertidigt kan forbindes, hvortil koblingselementet (13) bringes i indgreb med fastgørelseselementerne (11, 12), og hvor fastgørelseselementerne (11, 12) i det mindste delvist, fortrinsvist fuldstændigt, er udformet som lukkede øjer, gennem hvilke koblingselementet (13) kan føres igennem,
kendetegnet ved, at
et bursegment (5) med sin optagelomme (10) optager et rullelegeme (4), og de rullelegemer (4'), der slutter sig til dette rullelegeme (4) i omkredsretningen (U), er friholdt fra et bursegment (5), hvor der på bursegmentet (5) er anbragt i omkredsretningen (U) udragende holdeafsnit (15), som for de rullelegemer (4'), som i omkredsretningen (U) slutter sig til det af bursegmentet (5) holdte rullelegeme (4), danner en anløbsflade (16), der begrænser rullelegemerne (4') i deres radiale bevægelighed.

2. Rulningsleje ifølge krav 1, kendetegnet ved, at koblingselementet (13) er en komponent, som overfører trækkræfter, men i vid udstrækning er bøjningsslapt.

3. Rulningsleje ifølge krav 2, kendetegnet ved, at koblingselementet (13) er en line.

4. Rulningsleje ifølge et af kravene 1 til 3, kendetegnet ved, at fastgørelseselementerne (11, 12) er tildannet i ét stykke på bursegmentet (5).

5. Rulningsleje ifølge et af kravene 1 til 4, kendetegnet ved, at de sideværts begrænsningsvægge (6, 7, 8, 9) danner en lukket i det væsentlige rektangulær ramme, hvor to begrænsningsvægge (6, 8) forløber i rulningslejets omkredsretning (U), hvor to begrænsningsvægge (7, 9) forbinder de i omkredsretningen (U) forløbende begrænsningsvægge (6, 8), og hvor der på de to i omkredsretningen (U) forløbende begrænsningsvæggen (6, 8) hver gang er anbragt et fastgørelseselement (11, 12).

6. Rulningsleje ifølge krav 5, kendetegnet ved, at de begrænsningsvægge (7, 9), der forbinder de i omkredsretningen (U) forløbende begrænsningsvægge (6, 8), er forsynet med konkave anløbsflader (14), som begrænser det rullelegeme (4), der befinder sig i optagelommen (10), i sin radiale bevægelighed.

7. Rulningsleje ifølge et af kravene 1 til 6, kendetegnet ved, at bursegmenterne (5) består af et materiale, hvis varmeudvidelseskoefficient har en værdi, der ligger i et tolerancebånd på +/- 15 % sammenlignet med varmeudvidelsskoefficienten for stål, hvor bursegmenterne (5) især består af støbejern.

8. Rulningsleje ifølge et af kravene 1 til 7, kendetegnet ved, at der ved eller på koblingselementet (13) er anbragt i det mindste et afstandselement (22).

9. Rulningsleje ifølge et af kravene 1 til 8, kendetegnet ved, at der på bursegmentet (5) er anbragt, især tildannet, i det mindste et støtteelement (19).

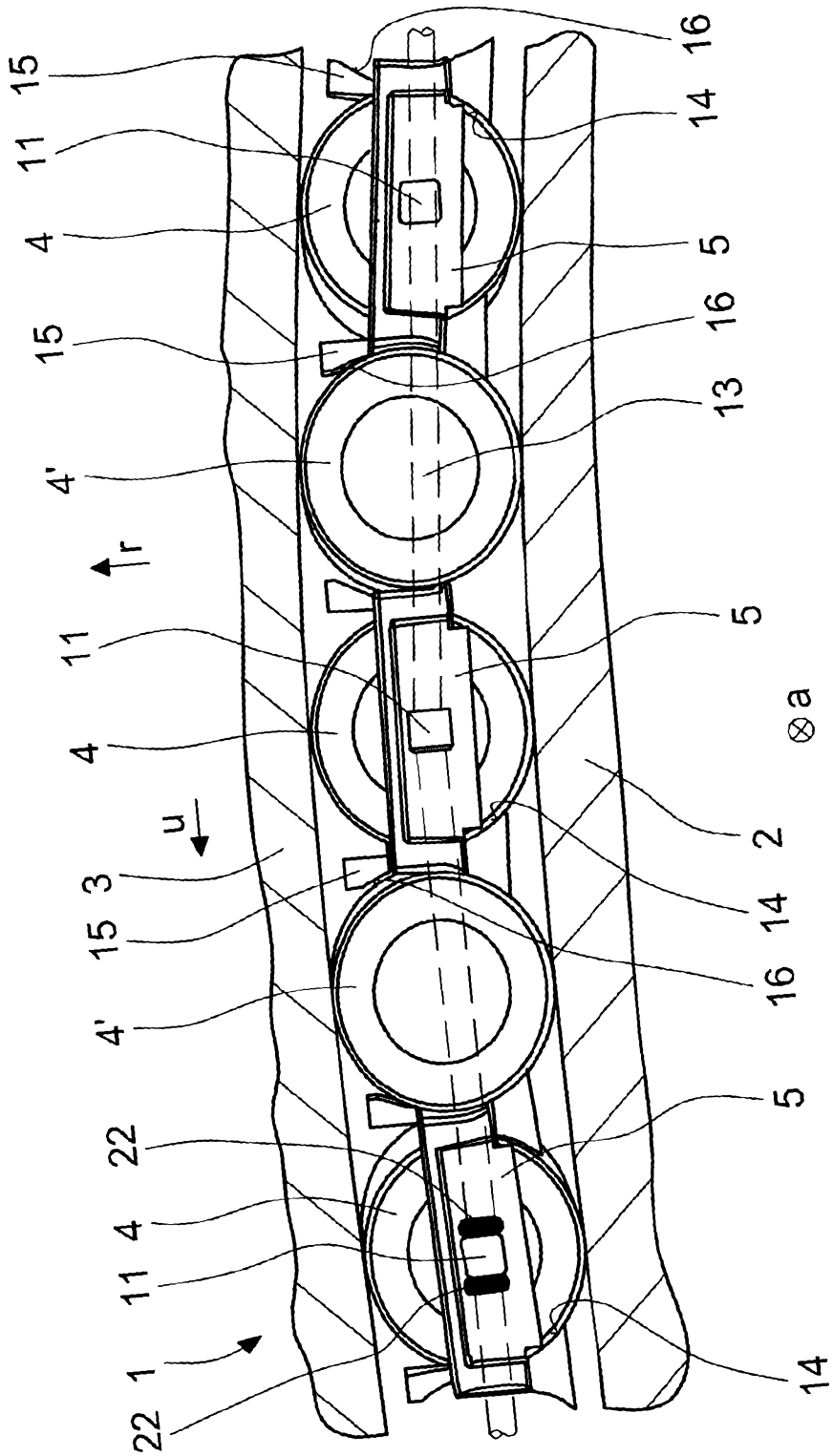

Fig.1

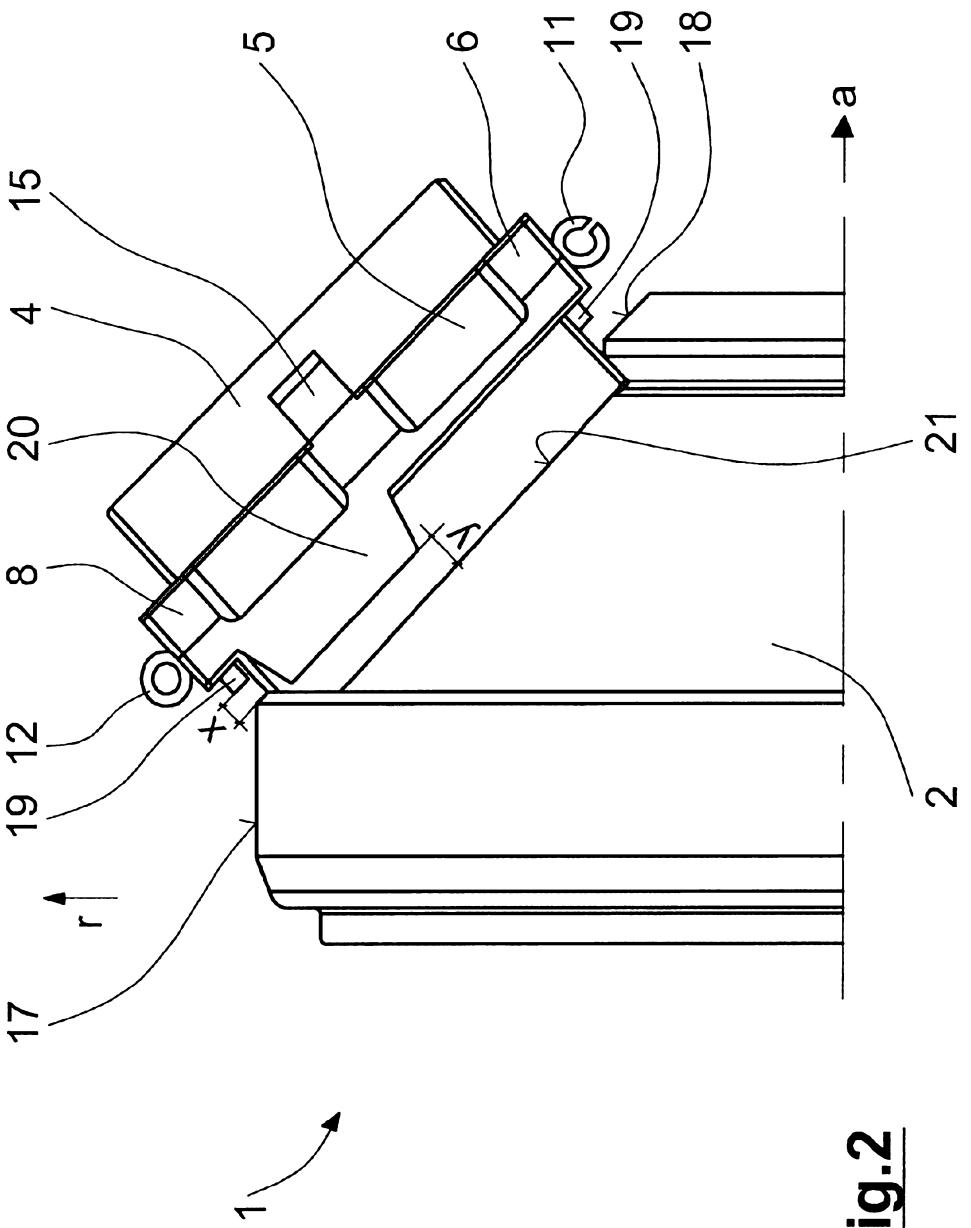

Fig.2

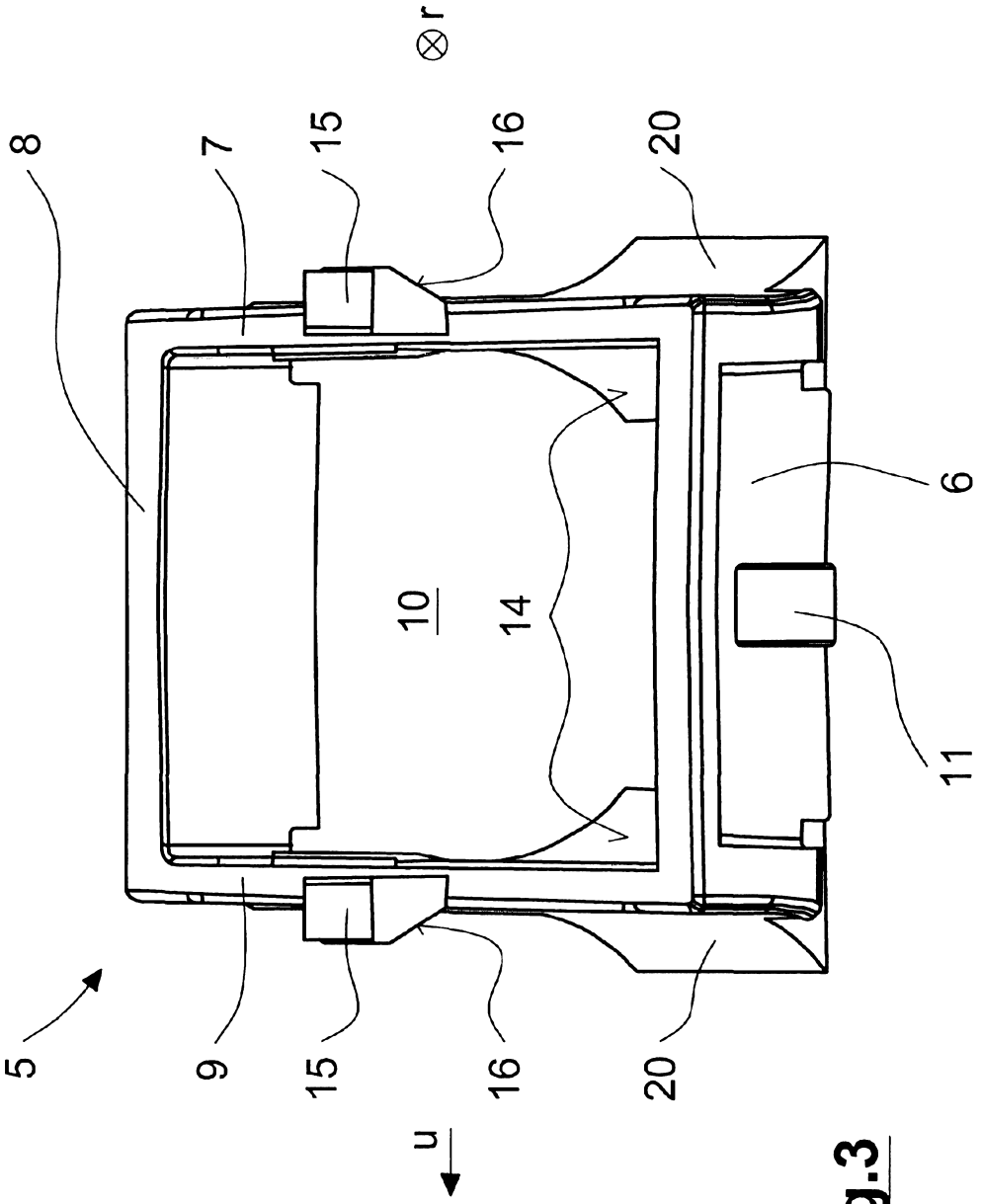

Fig.3