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(73) Patenthaver: **NTN Corporation, 3-17, Kyomachibori 1-chome , Nishi-ku, Osaka-shi, Osaka 550-0003, Japan**

(72) Opfinder: **Omoto, Tatsuya, NTN Corporation, 3066, Aza Oyumida Oaza Higashikata, Kuwana-shi, Mie 511-0811, Japan**
Hioki, Shoichi, NTN Corporation, 3066, Aza Oyumida Oaza Higashikata, Kuwana-shi, Mie 511-0811, Japan
Sasabe, Mitsuo, NTN Corporation, 3066, Aza Oyumida Oaza Higashikata, Kuwana-shi, Mie 511-0811, Japan
Nakamizo, Eiichi, NTN Corporation, 3066, Aza Oyumida Oaza Higashikata, Kuwana-shi, Mie 511-0811, Japan
Sakaguchi, Tomoya, NTN Corporation, 3066, Aza Oyumida Oaza Higashikata, Kuwana-shi, Mie 511-0811, Japan

(74) Fuldmægtig i Danmark: **Chas. Hude A/S, H.C. Andersens Boulevard 33, 1780 København V, Danmark**

(54) Benævnelse: **Rulleleje, bursegment og hovedakselbærekonstruktion til vinddrevet generator**

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DESCRIPTION

TECHNICAL FIELD

[0001] The present invention relates to a roller bearing, a retainer segment, a spacer and a main shaft structure of a wind-power generator, and more particularly to a large roller bearing, a retainer segment and a spacer contained in the large roller bearing, and a main shaft structure of a wind-power generator comprising the large roller bearing.

BACKGROUND ART

[0002] A roller bearing comprises an outer ring, an inner ring, a plurality of rollers arranged between the outer ring and the inner ring, and a retainer retaining the plurality of rollers in general. The retainer retaining the rollers includes various kinds of retainers such as a resin retainer, a pressed retainer, a machined retainer, and a welded retainer based on a difference in material and production method, and they are used depending on their usage and characteristics. In addition, the retainer is an integrated type, that is, it comprises annular one component in general.

[0003] According to a roller bearing for supporting a main shaft of a wind-power generator provided with a blade for receiving the wind, since it needs to receive a high load, the roller bearing becomes also large. It means that each component member constituting the roller bearing such as a roller and a retainer becomes large, so that it becomes difficult to produce and assemble the member. In this case, when each member can be split, its production and assembling become easy.

[0004] Here, a technique regarding a split type retainer in which a retainer contained in the roller bearing is split along a split line extending in a direction along a shaft has been disclosed in European Patent Publication No. 1408248A2. Fig. 36 is a perspective view showing a retainer segment of the split type retainer disclosed in the European Patent Publication No. 1408248A2. Referring to Fig. 36, a retainer segment 101a has column parts 103a, 103b, 103c, 103d and 103e extending in a direction along a shaft so as to form a plurality of pockets 104 to hold rollers, and connection parts 102a and 102b extending in a circumferential direction so as to connect the plurality of column parts 103a to 103e.

[0005] Fig. 37 is a sectional view showing a part of the roller bearing containing the retainer segment 101a shown in Fig. 36. Referring to Figs. 36 and 37, a description will be made of the constitution of a roller bearing 111 containing the retainer segment 101a. The roller bearing 111 has an outer ring 112, an inner ring 113, a plurality of rollers 114, and the plurality of retainer segments 101a, 101b, 101c and the like. The plurality of rollers 114 are held by the plurality of retainer segments 101a and the like in the vicinity of a PCD (Pitch Circle Diameter) in which the rollers roll most stably. The retainer segment 101a holding the plurality of rollers 114 is arranged circumferentially so as to abut on the adjacent retainer segments 101b and 101c having the same configuration at its column parts 103a and 103e positioned on the circumferentially most outer side. The plurality of retainer segments 101a, 101b, 101c and the like are continuously lined with each other and incorporated in the roller bearing 111, whereby one annular retainer contained in the roller bearing 111 is formed.

[0006] The above one annular retainer is formed by lining the plurality of retainer segments continuously in the circumferential direction. When the one annular retainer is formed by lining the plurality of retainer segments in the circumferential direction, a circumferential gap in view of thermal expansion and the like is needed.

[0007] When the gap exists between the retainer segments after the roller bearing is assembled, the adjacent retainer segments collide against each other in the circumferential direction when the roller bearing is operated. In this case, the column part positioned at the end receives the circumferential load from the adjacent retainer segment and it is deformed.

[0008] This will be described with reference to Figs. 36, 37 and 38. Fig. 38 is a view showing the vicinity of the column part 103a positioned at one end of the retainer segment 101a incorporated in the roller bearing, taken from the radial outer side, that is, from a direction shown by an arrow X in Fig. 37. In addition, the deformation of the column part 103a is shown with exaggeration in Fig. 38. Referring to Figs. 36, 37 and 38, the retainer segment 101a receives the load from the circumferential direction, that is, from the direction shown by arrows Y in Figs. 37 and 38 due to the collision against the adjacent retainer segment 101b.

[0009] Here, the load from the retainer segment 101b is applied to the column part 103a positioned at the circumferential end in the retainer segment 101a. Since the column part 103a is not connected in the circumferential direction and vulnerable to the circumferential load, it is deformed to the side of the pocket 104. In this case, the circumferential inner side of the column part

103a, that is, an end face 109 of the pocket 104 enters the pocket 104. As a result, the roller could be locked and the retainer segment 101 could be damaged due to the abrasion of the column part 103a.

DISCLOSURE OF THE INVENTION

[0010] It is an object of the present invention to provide a roller bearing in which rollers can roll appropriately and a retainer segment which is hardly damaged.

[0011] It is another object of the present invention to provide a retainer segment in which rollers can roll appropriately and a retainer segment which is hardly damaged.

[0012] It is still another object of the present invention to provide a main shaft structure of a wind-power generator having a long life.

[0013] According to an aspect of the present invention, a roller bearing comprises an outer ring, an inner ring, a plurality of rollers arranged between the outer ring and the inner ring, and a plurality of retainer segments having a plurality of column parts extending in a direction along a shaft so as to form a pocket for holding the roller, and a connection part extending in a circumferential direction so as to connect the plurality of column parts, and continuously lined with each other in the circumferential direction between the outer ring and the inner ring. The column part is positioned at circumferential each end of the retainer segment, a circumferential outer side of the column part positioned at the end is provided with an expansion part expanding in a circumferential direction and a circumferential inner side thereof is provided with a recess recessed in the circumferential direction.

[0014] According to the above constitution, the expansion part provided on the circumferential outer side of the column part positioned at the end in the retainer segment abuts on the adjacent retainer segment. Thus, the load applied from the adjacent retainer segment in the circumferential direction is applied to the expansion part first. Since the circumferential inner side of the column part is provided with the recess, the load applied to the expansion part is transmitted to the connection part along the configuration of the column part. Therefore, the column part is prevented from being deformed and the roller is prevented from being locked and the column part is prevented from being abraded. Since the connection parts are continuously lined in the circumferential direction, it is resistant to the load in the circumferential direction and can receive a high load. As a result, the retainer segment can be prevented from being damaged.

[0015] Preferably, the expansion part has a roughly arc configuration. Thus, since the load applied from the adjacent retainer segment is received at the roughly arc shaped part, the load can be transmitted to the connection part while the column part is further prevented from being deformed.

[0016] Still preferably, the recess has substantially the same configuration as that of the expansion part. Thus, the load can be transmitted to the connection part along the configuration of the column part more effectively. Here, the term "substantially the same configuration" means that when the expansion part has an arc configuration, the recess has also the arc configuration and when the expansion part comprises a plurality of flat surfaces, the recess also comprises a plurality of flat surfaces.

[0017] Still preferably, the expansion part and the recess are provided at the column part positioned at each end. Thus, since the retainer segments can be arranged to assemble the roller bearing without concerning about directionality, the productivity of the roller bearing is improved.

[0018] Still preferably, the column part having the expansion part and the recess is provided with a guide surface formed at a position in which the recess is not provided. Thus, since the retainer segment can be guided at a part of the column part unaffected by the deformation of the recess, the retainer segment can be stably guided.

[0019] Still preferably, a spacer arranged between the circumferentially arranged first retainer segment and last retainer segment is provided.

[0020] As described above, when the one annular retainer is formed by lining the plurality of retainer segments in the circumferential direction, the gap within an appropriate range is needed in the circumferential direction in view of the thermal expansion and the like. However, since each retainer segment is produced independently, each retainer segment has circumferential dimensional deviation. When such retainer segments are continuously lined with each other in the circumferential

direction, the dimensional deviation are also accumulated. In order to limit the gap dimension to a predetermined range, each retainer segment has to be produced with high accuracy.

[0021] Here, it is not necessary to produce each retainer segment with high accuracy by providing the spacer for adjusting the gap between the adjacent retainer segments when the circumferential gap dimension is adjusted, so that the productivity of the retainer segment is improved. Accordingly, the productivity of the roller bearing is improved.

[0022] According to still another aspect of the present invention, a retainer segment is provided by splitting one annular retainer along a split line extending in a direction along a shaft so as to have at least one pocket for housing a roller. In addition, the retainer segment has a plurality of column parts extending in the direction along the shaft so as to form the pocket for holding the roller, and a connection part extending in a circumferential direction so as to connect the plurality of column parts. The column part is positioned at circumferential each end of the retainer segment. Here, a circumferential outer side of the column part positioned at the end is provided with an expansion part expanding in the circumferential direction and a circumferential inner side thereof is provided with a recess recessed in the circumferential direction.

[0023] According to the above retainer segment, since the circumferential load can be transmitted along the configuration of the column part while the column part is prevented from being deformed, the roller can be prevented from being locked and the retainer segment is prevented from being damaged.

[0024] According to still another aspect of the present invention, a main shaft support structure of a wind-power generator comprises a blade receiving wind power, a main shaft having one end fixed to the blade and rotating together with the blade, and a roller bearing incorporated in a fixing member and supporting the main shaft rotatably. The roller bearing comprises an outer ring, an inner ring, a plurality of rollers arranged between the outer ring and the inner ring, and a plurality of retainer segments having a plurality of column parts extending in a direction along the shaft so as to form a pocket for holding the roller, and a connection part extending in a circumferential direction so as to connect the plurality of column parts, and continuously lined with each other in the circumferential direction between the outer ring and the inner ring. The column part is positioned at circumferential each end of the retainer segment. Here, a circumferential outer side of the column part positioned at the end is provided with an expansion part expanding in a circumferential direction and a circumferential inner side thereof is provided with a recess recessed in the circumferential direction.

[0025] Since the above main shaft structure of the wind-power generator contains the roller bearing in which the roller can roll appropriately and the retainer segment is hardly damaged, it can implement a long life.

[0026] According to the present invention, the expansion part provided on the circumferential outer side of the column part positioned at the end in the retainer segment abuts on the adjacent retainer segment. Thus, the load applied from the adjacent retainer segment in the circumferential direction is applied to the expansion part first. Since the circumferential inner side of the column part is provided with the recess, the load applied to the expansion part is transmitted to the connection part along the configuration of the column part. Therefore, the column part is prevented from being deformed and the roller is prevented from being locked and the column part is prevented from being abraded. Since the connection parts are continuously lined in the circumferential direction, it is resistant to the load in the circumferential direction and can receive a high load. As a result, the retainer segment can be prevented from being damaged.

[0027] According to the above retainer segment, since the circumferential load can be transmitted to the connection part along the configuration of the column part while the column part is prevented from being deformed, the roller can be prevented from being locked and the retainer segment is prevented from being damaged.

[0028] Since the above main shaft structure of the wind-power generator contains the roller bearing in which the roller can roll appropriately and the retainer segment is hardly damaged, it can implement a long life.

[0029] Embodiments of the present invention will be described with reference to the drawings 12-22B and 34-38 hereinafter.

BRIEF DESCRIPTION OF DRAWINGS

[0030]

Fig. 1 is a schematic view showing the vicinity of a column part positioned on the circumferential outer side of a retainer segment, taken from the radial outer side;

Fig. 2 is a perspective view showing the retainer segment contained in a tapered roller bearing

Fig. 3 is a sectional view showing the retainer segment shown in Fig. 2, cut by a plane containing a line inner III-III in Fig. 2 and intersecting with a shaft;

Fig. 4 is a sectional view showing the retainer segment shown in Fig. 2, cut by a plane passing through the center of the column part and intersecting with a circumferential direction;

Fig. 5 is a perspective view showing a spacer contained in the tapered roller bearing;

Fig. 6 is a schematic sectional view showing the tapered roller bearing in which the plurality of retainer segments and the spacer are arranged in the circumferential direction;

Fig. 7 is an enlarged sectional view showing the adjacent retainer segments;

Fig. 8 is a view showing the abutment part between the retainer segments shown in Fig. 7, taken from the radial outer side;

Fig. 9 is an enlarged sectional view in which the spacer is arranged between the first retainer segment and the last retainer segment;

Fig. 10 is a sectional view in which a spacer having a roughly rectangular solid configuration is arranged between the first retainer segment and the last retainer segment;

Fig. 11A is a view showing a retainer segment taken from the radial outer side, in which a recess comprises a plurality of flat surfaces;

Fig. 11B is a view showing a retainer segment taken from the radial outer side, in which two recesses are provided;

Fig. 12 is a schematic view showing the vicinity of a column part positioned on the circumferential outer side of a retainer segment contained in a tapered roller bearing according to an embodiment of the present invention, taken from the radial outer side;

Fig. 13 is a perspective view showing the retainer segment contained in the tapered roller bearing according to still another embodiment of the present invention;

Fig. 14 is a sectional view showing the retainer segment shown in Fig. 13, cut by a plane containing a line XIV-XIV in Fig. 13 and intersecting with a shaft;

Fig. 15 is a sectional view showing the retainer segment shown in Fig. 13, cut by a plane passing through the center of the column part and intersecting with a circumferential direction;

Fig. 16 is a perspective view showing a spacer contained in the tapered roller bearing according to still another embodiment of the present invention;

Fig. 17 is a schematic sectional view showing the tapered roller bearing in which the plurality of retainer segments and the spacer are arranged in the circumferential direction;

Fig. 18 is an enlarged sectional view showing the adjacent retainer segments;

Fig. 19 is a view showing the abutment part between the retainer segments shown in Fig. 18, taken from the radial outer side;

Fig. 20 is an enlarged sectional view in which the spacer is arranged between the first retainer segment and the last retainer segment;

Fig. 21 is a sectional view in which a spacer having a roughly rectangular solid configuration is arranged between the first retainer segment and the last retainer segment;

Fig. 22A is a view showing a retainer segment according to still another embodiment of the present invention, taken from the radial outer side, in which an expansion part and a recess comprise a plurality of flat surfaces;

Fig. 22B is a view showing a retainer segment according to still another embodiment of the present invention, taken from the radial outer side, in which an expansion part comprises a crowning configuration and a recess comprises three curved surfaces;

Fig. 23 is a perspective view showing a retainer segment contained in a tapered roller bearing.

Fig. 24 is a sectional view showing the retainer segment shown in Fig. 23, cut by a plane containing a line XXIV-XXIV in Fig. 23

and intersecting with a shaft;

Fig. 25 is a sectional view showing the retainer segment shown in Fig. 23, cut by a plane passing through the center of the column part and intersecting with a circumferential direction;

Fig. 26A is a view showing a circumferential end face of the retainer segment, taken from the axial direction, in which a full crowning is provided;

Fig. 26B is a view showing a circumferential end face of a retainer segment, taken from the axial direction, in which a cut crowning is provided;

Fig. 26C is a view showing a circumferential end face of a retainer segment, taken from the axial direction, in which an R-chamfer is provided;

Fig. 27A is a view showing the circumferential end face of the retainer segment, taken from the radial direction, in which a full crowning is provided;

Fig. 27B is a view showing the circumferential end face of the retainer segment, taken from the radial direction, in which a cut crowning is provided;

Fig. 27C is a view showing the circumferential end face of the retainer segment, taken from the radial direction, in which a R-chamfer is provided;

Fig. 28 is a perspective view showing a spacer contained in the tapered roller bearing;

Fig. 29 is a schematic sectional view showing the tapered roller bearing in which the plurality of retainer segments and the spacer are arranged in the circumferential direction;

Fig. 30 is an enlarged sectional view showing the adjacent retainer segments;

Fig. 31 is an enlarged sectional view in which the spacer is arranged between the first retainer segment and the last retainer segment;

Fig. 32 is a schematic view showing the part shown in Fig. 31 taken from the radial outer side;

Fig. 33A is a sectional view showing a part of a retainer segment in which a column part comprises a full crowning at an end face:

Fig. 33B is a sectional view showing a part of a retainer segment in which a column part comprises a cut crowning at an end face:

Fig. 34 is a view showing one example of a main shaft structure of a wind-power generator using the tapered roller bearing according to the present invention;

Fig. 35 is a schematic view showing the main shaft support structure of the wind-power generator shown in Fig. 34;

Fig. 36 is a perspective view showing a conventional retainer segment;

Fig. 37 is a sectional view showing the retainer segment shown in Fig. 36, cut by a plane containing a column part and intersecting with a shaft; and

Fig. 38 is a view showing the conventional retainer segment taken from the radial outer side when a load is applied from an adjacent retainer segment in a circumferential direction.

BEST MODE FOR CARRYING OUT THE INVENTION

[0031] A tapered roller bearing according to the present invention will be described. Fig. 13 is a perspective view showing a retainer segment 11i contained in a tapered roller bearing according to the present invention. Fig. 12 is a view showing the vicinity of a column part 14i positioned on circumferential one end in the retainer segment 11i, taken from the radial outer side, that is, from a direction shown by an arrow XII in Fig. 13. Fig. 14 is a sectional view showing the retainer segment 11i shown in Fig. 13, cut along arrows XIV-XIV in Fig. 13 in the radial direction. In addition, Fig. 15 is a sectional view showing the retainer segment 11i cut along the section containing the column part 14i in the axial direction. In addition, in view of easy understanding, a plurality of tapered rollers 12i, 12j and 12k held by the retainer segment 11i are shown by dotted lines in Figs. 14 and 15. In addition, a

PCD 22i is shown by a dashed line.

[0032] With reference to Figs. 12, 13, 14 and 15, the constitution of the retainer segment 11i contained in the tapered roller bearing will be described first. The retainer segment 11i is provided by splitting one annular retainer along a split line extending in an axial direction so as to have at least one pocket for holding the roller. The retainer segment 11i contains four column parts 14i, 14j, 14k and 141 extending in the axial direction so as to form pockets 13i, 13j and 13k for holding the tapered rollers 12i, 12j and 12k, and a pair of connection parts 15i and 15j extending in the circumferential direction so as to connect the four column parts 14i to 141.

[0033] The pair of connection parts 15i and 15j has predetermined curvature radiuses in the circumferential direction so as to form the one annular retainer in the circumferential direction when the plurality of retainer segments 11i are incorporated in the tapered roller bearing. The curvature radius of the connection part 15i positioned on the small diameter side of the tapered rollers 12i to 12k is designed to be smaller than the curvature radius of the connection part 15j positioned on the large diameter side of the tapered rollers 12i to 12k, between the connection parts 15i and 15j.

[0034] Oil grooves 19i and 20i are provided at the axial center of the column parts 14i to 141 such that they are recessed from the outer diameter side and the inner diameter side toward the radial inner side and outer side, respectively and penetrate in the circumferential direction. The oil grooves 19i and 20i implement the preferable circulation of a lubricant agent.

[0035] Guide surfaces 17i, 17j, 17k, 171, 18j, 18k for guiding the rollers are provided on the inner diameter side and the outer diameter side of the column parts 14i to 141 positioned on circumferential both sides of the pockets 13i to 13k. According to the above constitution, the retainer segment 11i is guided by the rollers and the radial movement of the retainer segment 11i can be regulated and the arrangement thereof can be stabilized.

[0036] Here, an expansion part 23i expanding in the circumferential direction is provided on the circumferential outer side of the column part 14i positioned at circumferential one end. In addition, a recess 23j recessed from a circumferential inner side end face 25i in the circumferential direction is provided on the circumferential inner side of the column part 14i, that is, on the pocket 13i side (refer to Fig. 12). The expansion part 23i and the recess 23j comprise curved surfaces 24i and 24j having smooth arc shapes, respectively. In addition, the recess 23j has the substantially the same configuration as that of the expansion part 23i. In addition, the recess 23j is provided at the axial center of the column part 14i.

[0037] In addition, regarding the column part 14i having the expansion part 23i and the recess 23j, a guide surface 17i for guiding the roller is provided at a position of the end face 25i of the column part 14i in which the recess 23j is not provided. According to such constitution, the guide surface 17i is not affected by the deformation of the recess 23j. Therefore, the retainer segment 11i can be stably guided by the tapered roller 12i held in the pocket 13i.

[0038] In addition, although the expansion part 23i and the recess 23j are also provided in the column part 141 positioned at the circumferential other end, since their constitutions are the same as the expansion part 23i and the recess 23j provided in the column part 14i, their description will be omitted.

[0039] Then, a description will be made of a spacer contained in the tapered roller bearing according to still another embodiment of the present invention to adjust the dimension of a circumferential gap between the circumferentially lined retainer segments 11i and the like. Fig. 16 is a perspective view showing a spacer 26i contained in the tapered roller bearing. Referring to Fig. 16, the constitution of the spacer 26i will be described. The spacer 26i includes end parts 27i and 27j positioned at axial both ends, and a center part 28i positioned between the end parts 27i and 27j. The axial distance between the end parts 27i and 27j is the same as the axial distance between the pair of connection parts 15i and 15j contained in the above retainer segment 11i. In addition, oil grooves 30i and 30j penetrating in the circumferential direction are provided on the inner diameter surface side and the outer diameter surface side of the center part 28i.

[0040] Next, a description will be made of the constitution of the tapered roller bearing containing the retainer segment 11i and the spacer 26i. Fig. 17 is a schematic sectional view showing a tapered roller bearing 31i in which the plurality of retainer segments 11i, 11j, 11k and 111 and the spacer 26i are circumferentially arranged, taken from the axial direction. In addition, Fig. 18 is an enlarged sectional view showing a part XVIII in Fig. 17. Here, since the retainer segments 11j, 11k and 111 have the same configuration as that of the retainer segment 11i, their description will be omitted. In addition, a tapered roller 34i retained in the retainer segment 11a is omitted in Fig. 17. Furthermore, here, it is assumed that the retainer segment that is arranged first is the retainer segment 11i and the retainer segment arranged last is the retainer segment 111 among the retainer segments 11i to 111.

[0041] Referring to Figs. 17 and 18, the tapered roller bearing 31i comprises an outer ring 32i, an inner ring 33i, the plurality of retainer segments 11i to 111, and the spacer 26i. The retainer segments 11i to 111 are arranged continuously in the circumferential direction. Here, the retainer segment 11i is arranged first, and then the retainer segment 11j is arranged so as to abut on the retainer segment 11i. Then, the retainer segment 11k is arranged so as to abut on the retainer segment 11j, and the retainer segment is arranged continuously, and finally the retainer segment 111 is arranged.

[0042] A description will be made of a case where a circumferential load is applied from the adjacent retainer segment among the retainer segments 11i to 111 arranged as described above. Fig. 19 is a schematic view showing the abutment part between the adjacent retainer segments 11i and 11j, taken from the radial outer side, that is, from a direction shown by an arrow XIX in Fig. 18. In addition, the tapered rollers held by the pockets 13i and 13m in the retainer segments 11i and 11j are not shown in Fig. 19.

[0043] Referring to Figs. 18 and 19, the expansion part 23i of the column part 14i of the retainer segment 11i abuts on an expansion part 23k of a column part 14m of the retainer segment 11j. While the tapered roller bearing 31i is operated, a load is applied from the adjacent retainer segment 11j in the circumferential direction, that is, in a direction shown by an arrow C in Figs. 18 and 19. In this case, the load is applied to the column part 14i positioned at the circumferential end in the retainer segment 11i.

[0044] Here, the recess 23j having substantially the same configuration as that of the expansion part 23i is provided on the side of the pocket 13i of the column part 14i. Therefore, the load applied from the adjacent retainer segment 11j is transferred to the connection parts 15i and 15j along the configuration of the column part 14i as shown by an arrow D in Fig. 19. Thus, the deformation of the column part 14i due to the circumferential load can be suppressed, and the tapered roller 34i held in the pocket 13i can be prevented from being locked and the column part 14i is prevented from being abraded. In addition, since the connection parts 15i and 15j are continuously lined in the circumferential direction, they are resistant to the circumferential load and they can receive a high load. As a result, the retainer segment 11i can be prevented from being damaged.

[0045] Here, since the expansion part 23i and the recess 23a comprise the curved surfaces 24i and 24j having the arc shapes, respectively, they do not contain a corner part. Therefore, the column part 14i can be further prevented from being deformed. In addition, the radiuses of the arcs constituting the curved surfaces 24i and 24j are preferably as small as possible. Thus, the load can be transmitted to the connection parts 15i and 15j effectively. However, when the radius of the arc of the curved surface 24j is too small, it could be damaged by a crack. Therefore, the radius of the arc of the curved surface 24j is large to some extent to prevent the above.

[0046] In addition, similarly, according to the retainer segments 11j and 11k, an expansion part 231 of a column part 14n of the retainer segment 11j abuts on an expansion part 23m of a column part 14o of the adjacent retainer segment 11k, and even when a load is applied in the circumferential direction, since the load can be transmitted to the connection parts 15k and 151, the retainer segments 11j and 11k can be prevented from being damaged.

[0047] In addition, in the retainer segment 11i, since the expansion part 23i and the recess 23j are provided at each of the column parts 14i and 141 positioned at the circumferential both ends, the retainer segments 11i to 11k can be arranged continuously in the circumferential direction without concerning about the directionality. Therefore, the productivity of the tapered roller bearing 31i can be improved.

[0048] Next, a description will be made of the arranged state of the spacer 26i arranged between the first retainer segment 11i and the last retainer segment 111. Fig. 20 is an enlarged sectional view showing a part XX in Fig. 17. Referring to Figs. 16, 17 and 20, the retainer segments 11i and the like are continuously arranged so as to abut on each other, and the spacer 26i is arranged between a gap 39i between the retainer segment 11i and the retainer segment 111 such that an expansion part 23n of a column part 14p positioned at the circumferential end of the retainer segment 11l abuts on one end faces 29i and 29j of the end parts 27i and 27j of the spacer 26i. Thus, the dimension of a circumferential last gap 40i generated between the retainer segment 11i and the spacer 26i can fall within a set range easily. The last gap means a maximum gap between the first retainer segment 11i, and the spacer 26i arranged between the first retainer segment 11i and the last retainer segment 111 when the retainer segments 11i to 111 are arranged circumferentially without leaving any gap, and the last retainer segment 111 and the spacer 26i are arranged without leaving any gap.

[0049] Here, although the end faces 29i and 29j of the circumferential end parts 27i and 27j of the spacer 26i abut on the circumferential outer side expansion part 23n of the retainer segment 11l in this embodiment, it may be such that the spacer 26i is formed into a roughly rectangular solid and abuts on the expansion part 23n of the column part 14p of the adjacent retainer segment 111. Fig. 21 is a view showing the arranged state between the retainer segment 111 and a spacer 41i, taken from the

radial outer side, in this case. In addition, the guide surfaces provided in the retainer segments 11i and 111 are omitted in Fig. 21. Referring to Fig. 21, the spacer 41i having the roughly rectangular solid is arranged between the retainer segments 11i and 111 such that its circumferential end face 42i abuts on the expansion part 23n of the column part 14p of the adjacent retainer segment 111. Here, the circumferential load is applied from the adjacent spacer 41i to the column part 14p of the retainer segment 111. However, since the load applied to the column part 14p is transmitted to the connection parts 15m and 15n along the configuration of the column part 14p due to the expansion part 23n and the recess 23o, the retainer segment 111 can be prevented from being damaged.

[0050] In addition, although the expansion part and the recess comprise the curved surfaces having the arc shapes in the above embodiment, the present invention is not limited to this, and an expansion part and a recess may comprise a plurality of flat surfaces. Fig.22A is a view showing a part of a retainer segment in which an expansion part and a recess comprising a plurality of flat surfaces are provided in a column part at a circumferential end. Referring to Fig. 22A, an expansion part 53i provided in a column part 52i of a retainer segment 51i comprises a plurality of flat surfaces 54i, 54j and 54k. In addition, a recess 53j comprises a plurality of flat surfaces 55i 55j and 55k. According to the constitution of the expansion part 53i and the recess 53j, the retainer segment 51i can be prevented from being damaged.

[0051] In addition, as shown in Fig. 22B, according to an expansion part 58i and a recess 58j provided in a column part 57i of a retainer segment 56i, the recess 58j may comprise a plurality of curved surfaces 60i, 60j and 60k. In addition, a curved surface 59i constituting the expansion part 58i may have a crowning shape.

[0052] In addition, although the expansion part and the recess are provided in each of the column parts at the circumferential both ends of the retainer segment in the above embodiment, the present invention is not limited to this and the expansion part and the recess may be provided only in the column part at one end. In this case, the retainer segment can be effectively prevented from being damaged by aligning the arrangements of the column parts in which the expansion part and the recess are provided when the retainer segments are arranged in the circumferential direction continuously.

[0053] Figs. 34 and 35 show one example of a main shaft support structure of a wind-power generator in which the roller bearing according to one embodiment of the present invention is used as a main shaft support bearing 75. A casing 73 of a nacelle 72 for supporting the main part of the main shaft support structure is put on a support table 70 through a slewing bearing 71 at a high position so as to be horizontally turned. A blade 77 receiving wind power is fixed to one end of a main shaft 76. The main shaft 76 is rotatably supported in the casing 73 of the nacelle 72 through the main shaft support bearing 75 incorporated in a bearing housing 74, and the other end of the main shaft 76 is connected to a speed-up gear 78, and an output shaft of the speed-up gear 78 is coupled to a rotor shaft of a generator 79. The nacelle 72 is turned at any angle by a rotation motor 80 through a speed-down gear 81.

[0054] The main shaft support bearing 75 incorporated in the bearing housing 74 is the roller bearing according to one embodiment of the present invention comprising the outer ring, the inner ring, the plurality of rollers arranged between the outer ring and the inner ring, and the plurality of retainer segments having the plurality of column parts extending in a direction along the shaft so as to form a pocket for holding the roller, and the plurality of connection parts extending in the circumferential direction so as to connect the plurality of column parts, and continuously lined with each other in the circumferential direction between the outer ring and the inner ring. The column part is positioned at circumferential each end of the retainer segment. Here, the circumferential outer side end face of the column part positioned at each end is flat, and the circumferential inner side end face of the column part positioned at the end is provided with the recess recessed in the circumferential direction so as to reduce the thickness of the column part.

[0055] Since the main shaft support bearing 75 supports the main shaft 76 whose one end is fixed to the blade 77 receiving great wind power, it receives a high load. Here, according to the above constitution, even when a circumferential high load is applied from the adjacent retainer segment to the retainer segment in the roller bearing, the roller can be prevented from being locked and the column part can be prevented from being damaged. Thus, the roller bearing has a long life and the main shaft support structure of the wind-power generator implements long life.

[0056] The main shaft support bearing 75 incorporated in the bearing housing 74 is the roller bearing according to still another embodiment of the present invention comprising the outer ring, the inner ring, the plurality of rollers arranged between the outer ring and the inner ring, and the plurality of retainer segments having the plurality of column parts extending in the direction along the shaft so as to form the pocket for holding the roller and the plurality of connection parts extending in the circumferential direction so as to connect the plurality of column parts and continuously lined with each other in the circumferential direction between the outer ring and the inner ring. The column part is positioned at circumferential each end of the retainer segment. Here, the expansion part expanding in the circumferential direction is provided on the circumferential outer side of the column part

positioned at the end, and the recess recessed in the circumferential direction so as to reduce the thickness of the column part is provided on the circumferential inner side thereof.

[0057] Since the main shaft support bearing 75 supports the main shaft 76 whose one end is fixed to the blade 77 receiving great wind power, it receives a high load. Here, according to the above constitution, even when a circumferential high load is applied from the adjacent retainer segment to the retainer segment in the roller bearing, the retainer segment can be prevented from being damaged. Thus, the roller bearing has a long life and the main shaft support structure of the wind-power generator implements long life.

[0058] The main shaft support bearing 75 incorporated in the bearing housing 74 is the roller bearing according to still another embodiment of the present invention, and the roller bearing comprises the outer ring, the inner ring, the plurality of rollers arranged between the outer ring and the inner ring, and the plurality of retainer segments having the plurality of column parts extending in the direction along the shaft so as to form the pocket for holding the roller and the plurality of connection parts extending in the circumferential direction so as to connect the plurality of column parts and continuously lined with each other in the circumferential direction between the outer ring and the inner ring, in which the corner of the circumferential end face is chamfered.

[0059] Since the main shaft support bearing 75 supports the main shaft 76 whose one end is fixed to the blade 77 receiving great wind power, it receives a high load. Thus, the main shaft support bearing 75 has to be large itself. Here, when the retainer segment is provided by dividing the one annular retainer to improve the productivity, since each retainer segment is an independent member, it is likely that the retainer segment is inclined and it is in contact with the adjacent retainer segment at their edges. Thus, according to the above constitution, even when the retainer segment is inclined, since it is in contact with the chamfered part, edge hitting can be prevented. Therefore, the retainer segment is prevented from being damaged, and the main shaft support structure of the wind-power generator implements a long life.

[0060] In addition, although the retainer segment has three pockets for holding the rollers in the figures, the present invention is not limited to this and a retainer segment may have four or more pockets. According to such retainer segment, since it has many pockets provided with the guide surface, it can be arranged in the radial direction more stably.

[0061] In addition, although the tapered roller is used as the roller provided in the roller bearing in the above embodiment, the present invention is not limited to this, a cylindrical roller, a needle roller, and a long roller may be used.

[0062] Furthermore, although the tapered roller bearing comprises the spacer in the above embodiment, the present invention is not limited to this and it can be applied to a tapered roller bearing having no spacer. In addition, the configuration of the spacer may be a roughly rectangular solid or a configuration in which the center is expanded in the circumferential direction. Furthermore, the roller may not be arranged between the adjacent retainer segments, or the roller may be arranged between the spacer and the retainer segment.

[0063] Although the embodiments of the present invention have been described with reference to the drawings in the above, the present invention is not limited to the above-illustrated embodiments. Various kinds of modifications and variations may be added to the illustrated embodiments within the same or equal scope of the present invention.

INDUSTRIAL APPLICABILITY

[0064] According to the roller bearing and the retainer segment in the present invention, since the roller can be prevented from being locked and the column part can be prevented from being damaged, they can be effectively applied to a roller bearing in which smooth roller rolling is required.

[0065] In addition, according to the roller bearing, the retainer segment and the spacer in the present invention, since the retainer segment can be prevented from being damaged, they can be effectively applied to a roller bearing in which a long life is required and a retainer segment and a spacer used in such roller bearing.

[0066] In addition, according to the main shaft support structure of the wind-power generator in the present invention, it can be effectively applied to a main shaft support structure of a wind-power generator in which a long life is required.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP1408248A2 [0004] [0004]

Patentkrav

1. Rulleleje omfattende:

en ydre ring,
en indre ring,
et antal ruller (13i-13k), som er anbragt imellem den ydre ring og den indre ring, og
et antal holdesegmenter (11i-1, 51i, 56i), som har et antal søjledele (14i-p, 52i, 57i), som strækker sig i en retning langs en aksel, således at de danner i det mindste en lomme til optagelse af rullerne og i det mindste en forbindelsesdel (15i-m), som strækker sig i en rundtgående retning, således at antallet af søjledele forbindes og er kontinuerligt opstillet med hinanden i den rundtgående retning imellem den ydre ring og den indre ring, hvorved en af søjledelene (14i, l-p, 52i, 57i) er placeret ved hver ende af holdesegmentet i rundtgående retning,
en rundtgående ydre side af søjledelen, placeret ved den nævnte ende, er forsynet med en ekspansionsdel (23i, k-m, 53i, 58i), som udvider sig i rundtgående retning, og en rundtgående inderside (25i) heraf er forsynet med en udsparing (23j, o, 53j, 58j), som er udskåret i den rundtgående retning.

2. Rulleleje ifølge krav 1, hvorved
ekspansionsdelen har en grov bueformet form, når den ses fra den radialt udvendige side.

3. Rulleleje ifølge krav 1, hvorved
udsparingen har i alt væsentligt sammen konfiguration som ekspansionsdelens udsparing.

4. Rulleleje ifølge krav 1, hvorved
søjledelen, som har ekspansionsdelen, og udsparingen er forsynet med en rulleføringsflade (17i, l) ved en position, hvori udsparingen ikke er tilvejebragt.

5. Rulleleje ifølge krav 1, og som yderligere omfatter:

et afstandsorgan (26i, q, 41i), som er anbragt imellem det i rundtgående retning anbragte første holdesegment og sidste holdesegment.

6. Holdesegment forsynet ved aksial spaltning med en ringformet rulleholder, således at det har i det mindste en lomme til optagelse af en rulle, hvilket holdesegment har:

et antal søjledele (14i-p, 52i, 57i), som strækker sig i retningen langs akslen, således at lommen til optagelse af rullen dannes, og
i det mindste en forbindelsesdel (15i-m), som strækker sig i en rundtgående retning, således at antallet af søjledele forbindes, hvorved
en af søjledelene er placeret ved hver rundtgående ende af holdesegmentet, og en rundtgående ydre side af søjledelen, som er placeret ved den nævnte ende, er forsynet med en ekspansionsdel (23i, k-m, 53i, 58i), som udvider sig i en rundtgående retning, og en rundtgående indre side (25i) heraf er forsynet med en udsparing (23j, o, 53j, 58j), som er udskåret i den rundtgående retning.

7. Hovedakselbærekonstruktion til en vindkraftgenerator omfattende:

et blad (77), som optager vindkraft,
en hovedaksel (76), som har en ende fastgjort til bladet og roterer sammen med dette, og
et rulleleje (75), som er inkorporeret i en fast del og bærer hovedakselen roterbart, idet rullelejet er et rulleleje ifølge krav 1.

DRAWINGS

FIG. 1

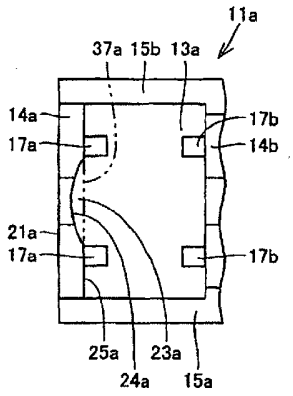

FIG. 2

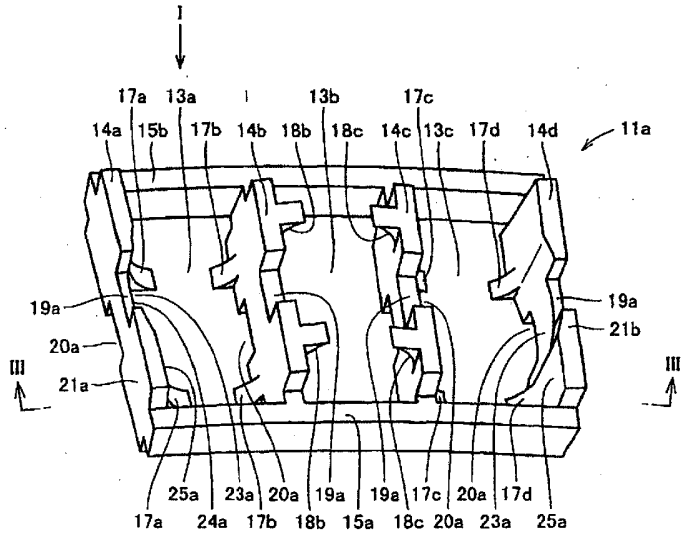

FIG. 3

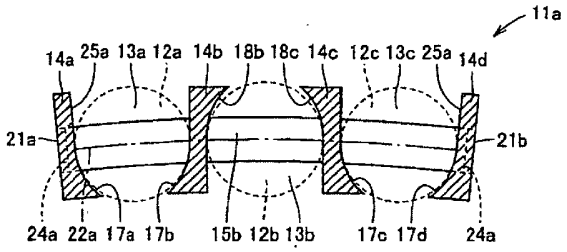

FIG. 4

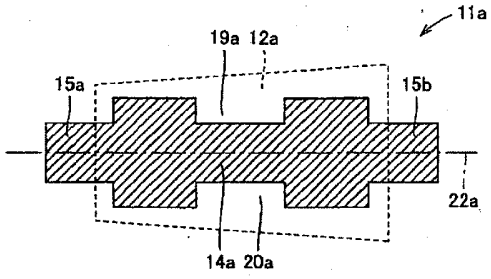

FIG. 5

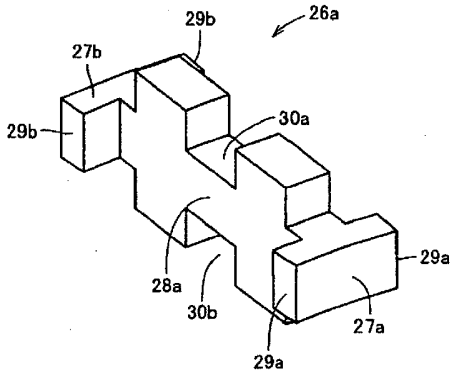

FIG. 6

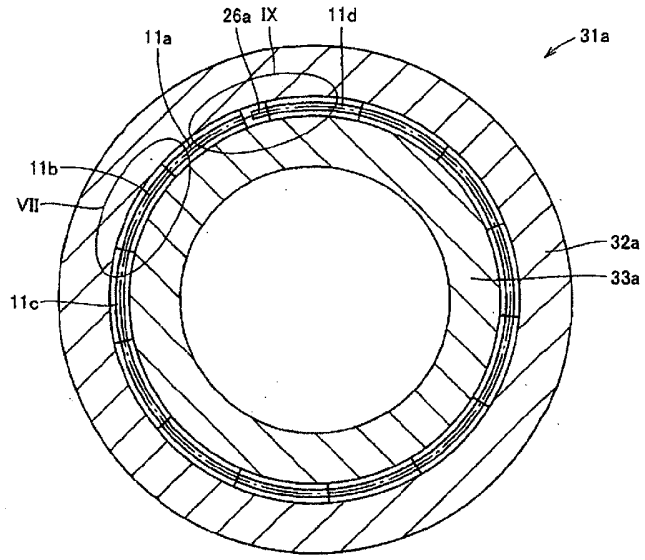
26a
IX
11d
11a
31a
11b
VII
32a
33a
11c

FIG. 7

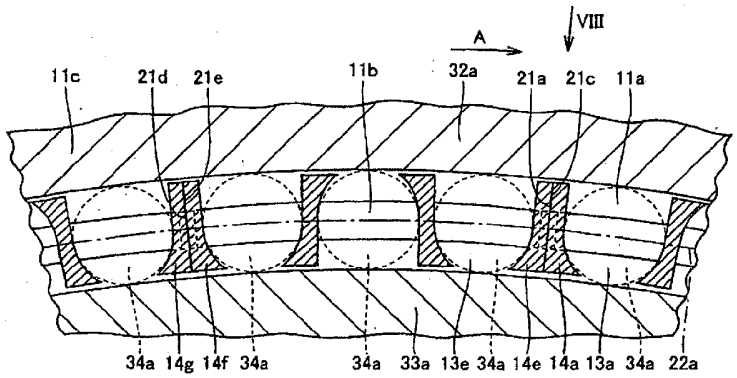
VIII
A
11c
21d
21e
11b
32a
21a
21c
11a
34a
14g
14f
34a
34a
33a
13e
34a
14e
14a
13a
34a
22a

FIG. 8

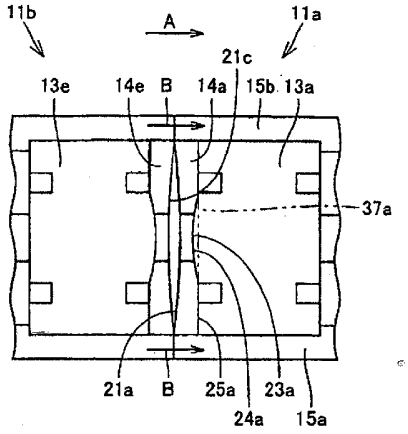
11b
A
11a
21c
13e
14e
B
14a
15b
13a
37a
21a
B
25a
24a
23a
15a

FIG. 9

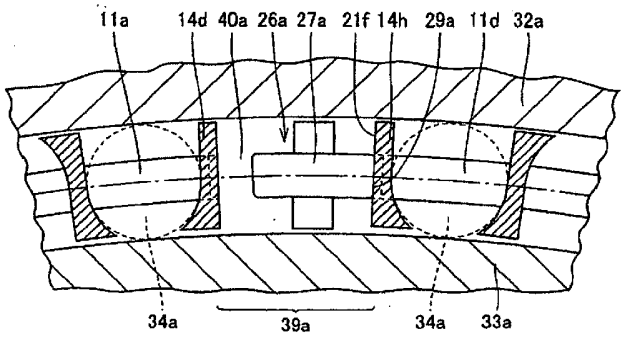
11a
14d
40a
26a
27a
21f
14h
29a
11d
32a
34a
39a
34a
33a

FIG. 10

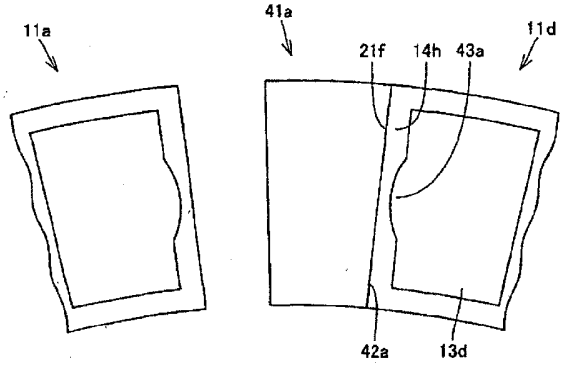

FIG. 11A

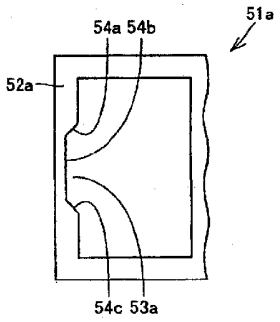

FIG. 11B

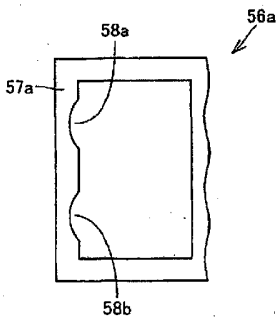

FIG. 12

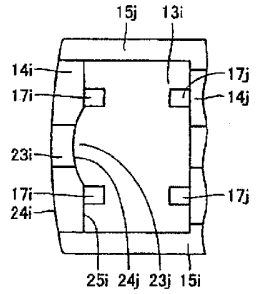

FIG. 13

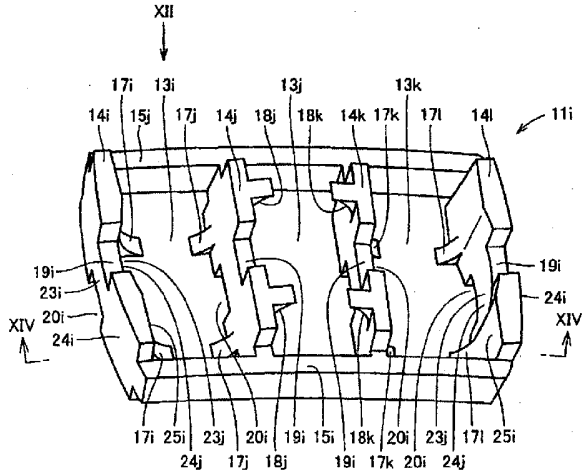

FIG. 14

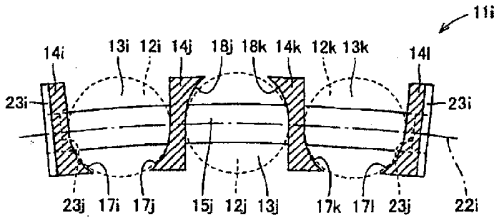

FIG. 15

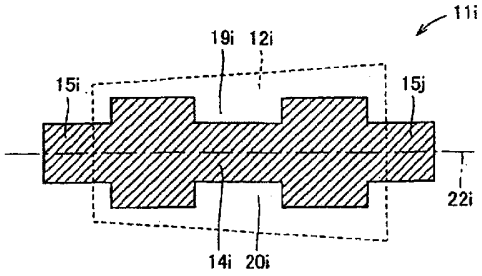
11i
19i
12i
15i
15j
22i
14i
20i

FIG. 16

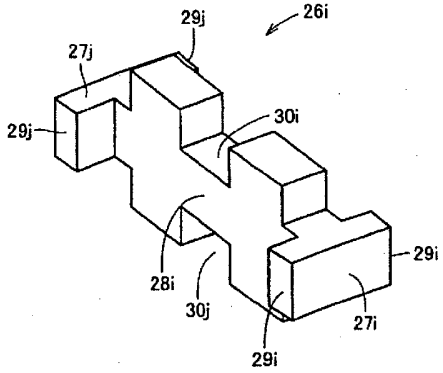
26i
29j
27j
29j
30i
28i
30j
29i
27i
29i

FIG.17

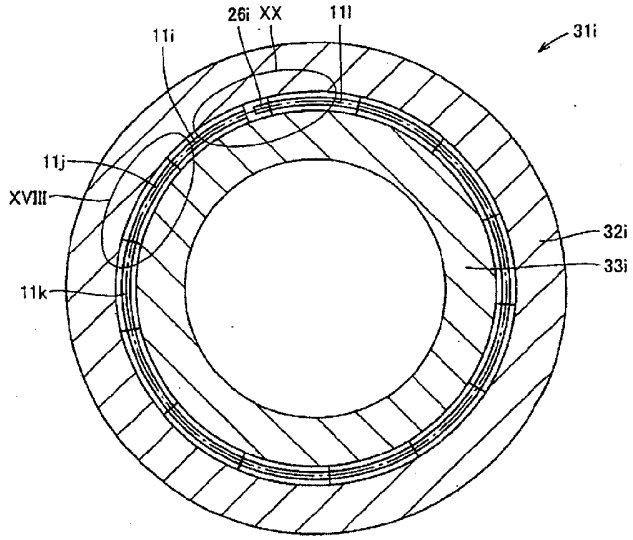
26i
XX
11l
11i
31i
11j
XVIII
32i
33i
11k

FIG.18

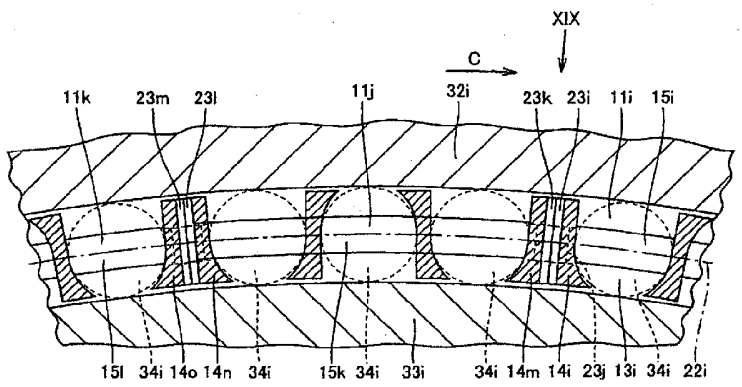
XIX
C
11k
23m
23l
11j
32i
23k
23i
11i
15i
15l
34i
14o
14n
34i
15k
34i
33i
34i
14m
14i
23j
13i
34i
22i

FIG.19

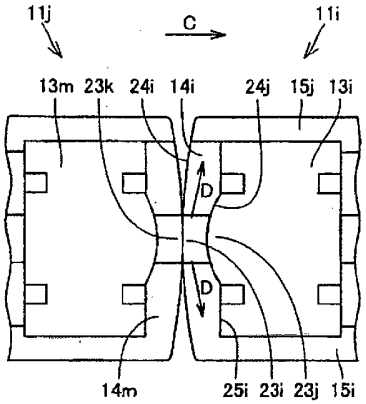
11j
C
11i
13m 23k 24i 14i 24j 15j 13i
D
D
14m
25i 23i 23j 15i

FIG. 20

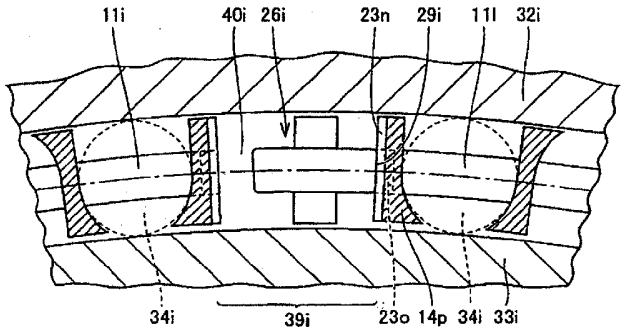
11i
40i 26i
23n 29i 11l 32i
34i
39i
23o 14p 34i 33i

FIG.21

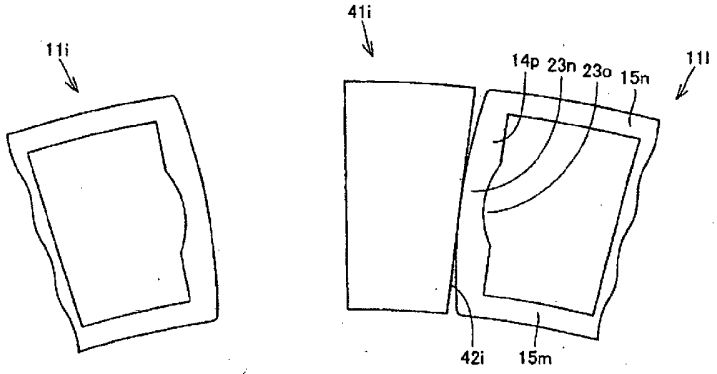

FIG. 22A

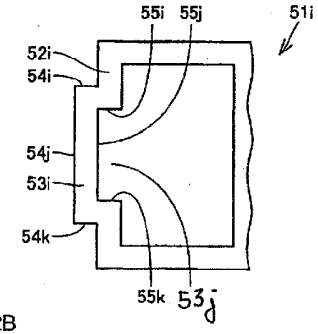

FIG. 22B

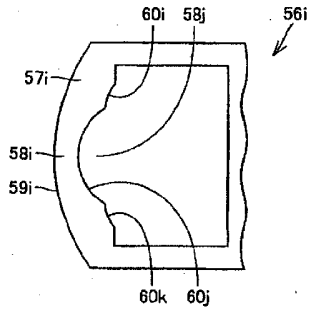

FIG. 23

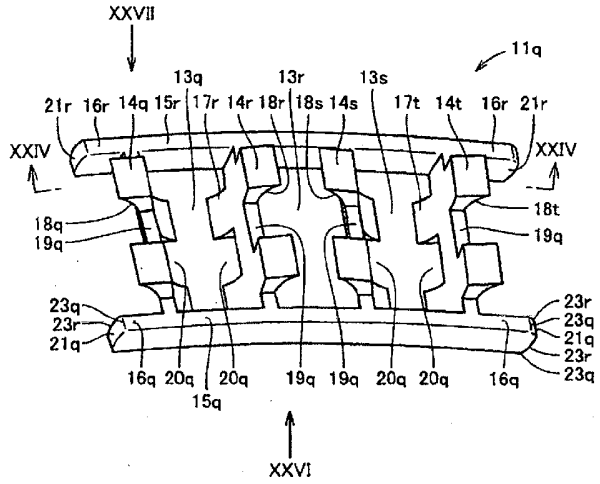

FIG. 24

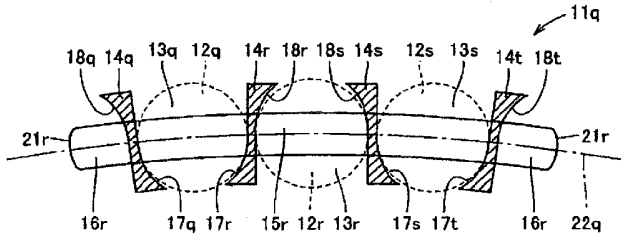

FIG. 25

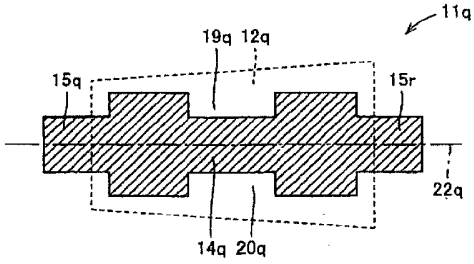

FIG. 26A

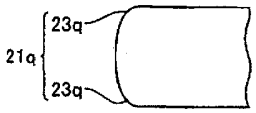

FIG. 26B

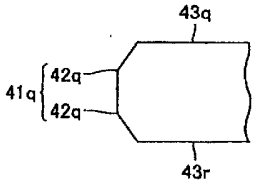

FIG. 26C

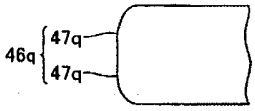

FIG. 27A

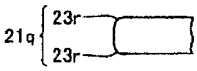

FIG. 27B

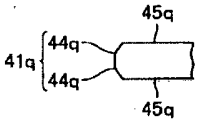

FIG. 27C

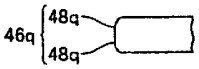

FIG. 28

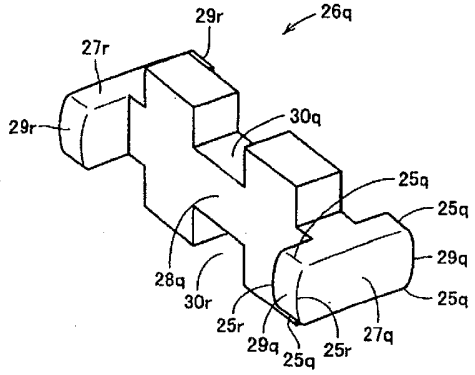
29r
26q
27r
29r
30q
25q
25q
29q
25q
28q
30r
25r
29q
25q
25r
27q

FIG. 29

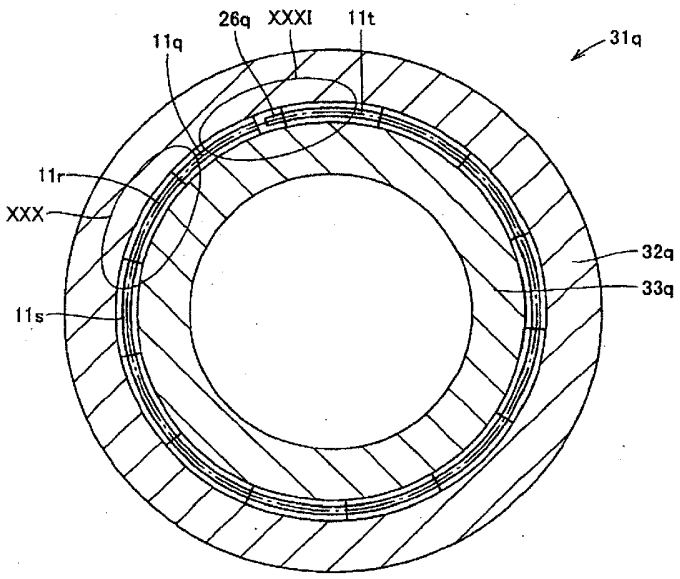
26q
XXXI
11t
11q
31q
11r
XXX
32q
33q
11s

FIG. 30

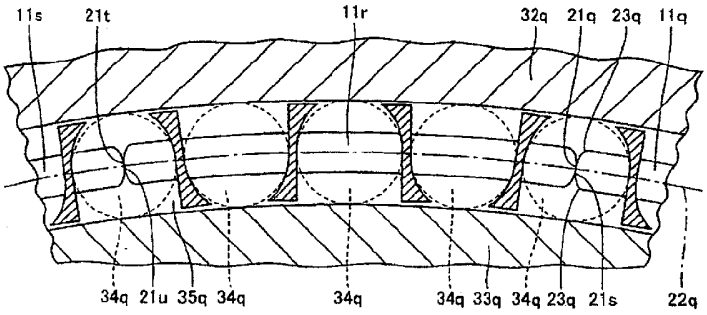
11s
21t
11r
32q
21q
23q
11q
34q
21u
35q
34q
34q
34q
33q
34q
23q
21s
22q

FIG. 31

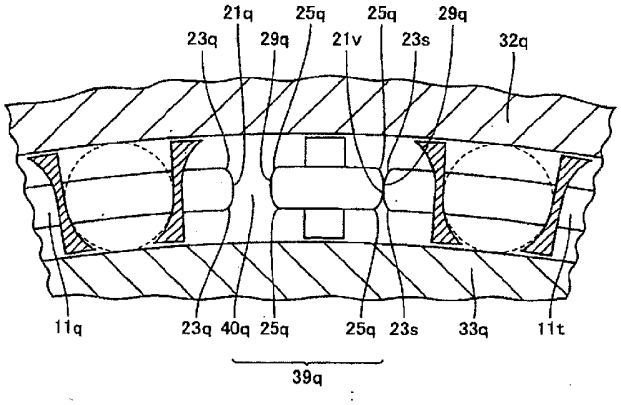
21q
25q
25q
29q
23q
29q
21v
23s
32q
11q
23q
40q
25q
25q
23s
33q
11t
39q

FIG. 32

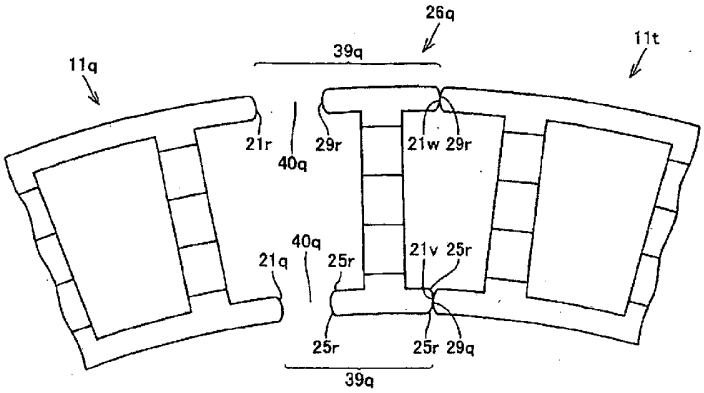

FIG. 33A

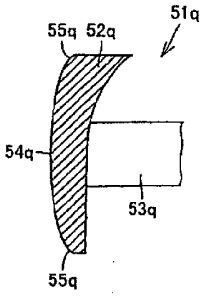

FIG. 33B

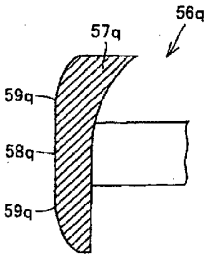

FIG. 34

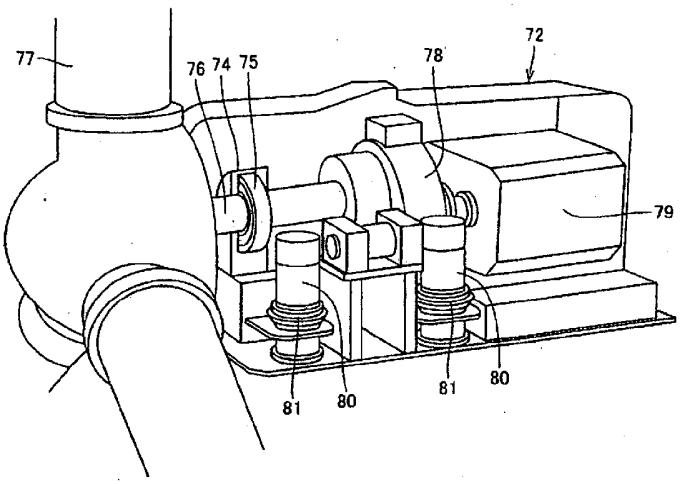

FIG. 35

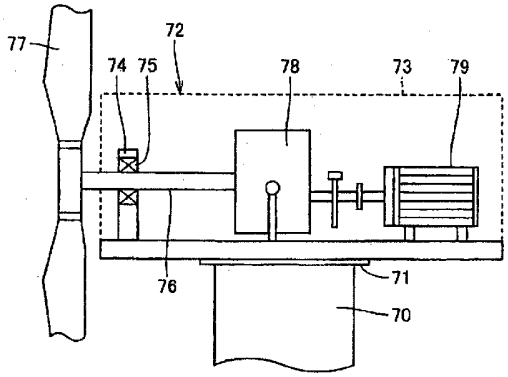

FIG. 36

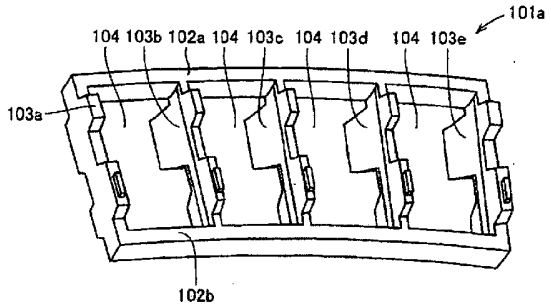

FIG. 37

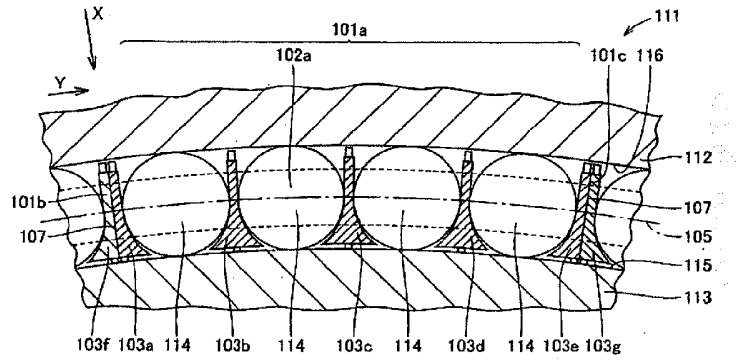

FIG. 38