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This invention refers to assemblies in particular for a wind turbine according to the preambles of independent claims 1 and 4, and relates to notably using a pivoting bearing of a servo-actuator for a
5 blade of such a wind turbine rotor hub.

Document EP-A-1 266 137 describes an assembly comprising such bearings interposed between a rotor hub and a blade of such a wind turbine. The assembly comprises:

10 - first and second bearing rings having different diameters, parallel to a radial direction with respect to the axis of the blade,

- a connection part integrated or embedded in the rotor hub, interposed between the blade and the rings
15 and extending, in a radial direction with respect to the axis of the blade, opposite said first and second rings with which it is connected,

- a third bearing ring located, radially with respect to the axis of the blade, between the first and
20 second bearing rings, which third ring is attached to the rotor hub, and at least one, among said connection part and the first and second bearing rings, is attached to the blade.

In particular on the wind turbines, the bearing
25 rings withstand significant stresses. And the blades withstand not only significant stresses in the axis of each blade (axial stresses), but also very significant stresses exerted radially with respect to the axis of the blade and the rotor hub (radial or centrifugal
30 stresses).

The rotation speeds, the ever-increasing sizes of wind turbines, the stresses imposed by the wind, as well as the stresses associated with the blade angle require an ever-increasing strength of the bearings.

5 With regard to the aforementioned blade angle, it is commonplace for the blades to be capable of pivoting about ten degrees about their axis of extension so as to enhance their efficiency according to the direction of wind.

10 The arrangement of the rings for the roller bearings and the attachments between these rings, the rotor hub and the blade are major elements in the operation of the wind turbine.

15 In this context, an objective of the invention is to improve these points with respect to the existing solutions by improving the mechanical strength of the bearings, the conditions of attachment and the costs.

20 In a proposed solution, on the aforementioned assembly including the blades, the bearings and the rotor hubs, said connection part or portion extends, parallel to said radial direction with respect to the axis of the blade, in front of said first and second bearings which are attached all together on said connection part by means of first fixation means and
25 second fixation means, respectively.

30 In an other alternative or additional approach to the problem raised here, it has also been considered an possible other assembly ready to be used on wind turbine or other big engines (crane...) comprising a pivoting bearing interposed between a first element (or unit) and a second element (or unit). On such an

already known assembly, the aforementioned connection part is replaced by a (independent) connection element interposed between the second element and the first and second bearing rings and extending, in a radial direction with respect to the axis of said second element, opposite (or in front of) said first and second rings with which it is connected. The aforementioned blade is replaced by the second element, the rotor hub by the first one.

10 For solving at least partially the same problems in situations where very high stresses are imposed, it is proposed, according to an aspect of the present invention that at least one of the first and second bearing rings is attached to the (independent) connection element without being attached (no direct attachment) to the second element to which it is, however, connected by means of said connection element.

15 Thus, the second element (blade) will be attached only to the third ring (intermediate) and will not therefore be attached directly to the first and second outer rings.

20 While formulated according to different features, these two solutions, respectively with the connection part and the connection (independent) element, provide a solution to the same problem already stated: to improve the strength under stress of the bearings, in particular radially with respect to the rotation axis of the/each blade, on increasingly powerful wind turbines, which are therefore placed under increasing mechanical stress.

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On the second element/blade side (via said connection element) or the first element/hub side (via said connection part or portion), there is systematically an indirect attachment to them by the
5 first and second rings, with at least one exertion of stress common to the two rings.

In the second case, it is also advantageously recommended that:

- the third bearing ring be attached (therefore
10 directly) to the blade by third attachment means,

- and that the first and second attachment means be arranged, together, on said connection portion and respectively on the first and second rings, at a radial distance with respect to the axis of the blade, which
15 is different from the distance that separates this axis from said third attachment means.

Moreover, it is then favourable, with the rotor hub having an axis parallel to that of the blade, according to a cross-section parallel to the axis of
20 the hub, for said connection portion to define a T-shaped extension integrated with the rotor hub and of which the bar receives the attachments between this connection portion and the first and second bearing rings, respectively.

25 If the solution with the connection element on the blade side is preferred, it is recommended that:

- in a radial plane with respect to the axis of the blade, the first and second rings and the blade be connected by a single connection, through which (all of)
30 the stresses exerted simultaneously on the first and

second rings pass, and which is therefore not specific to any of these rings,

- and/or for each of the first and second rings to be attached directly to the connection element, and not to the blade, which connection independent element is also, in a radial plane with respect to the axis of the blade, is attached to the blade by a single connection, through which (all of) the stresses exerted simultaneously on the first and second rings pass,

- and/or for the first ring, which is radially farthest from the axis of the blade, to be attached directly to the connection element, and not to the blade, then with the second ring, which (in a radial plane with respect to the axis of the blade) will be attached to said connection part and to said blade by a connection through which (all of) the stresses exerted simultaneously on the first and second rings pass,

- and/or for at least one of the first and second rings, in a radial plane with respect to the axis of the blade, the sites of the attachment of the ring concerned with the connection element and of the connection between said ring and said blade, to be located at different radial distances from the axis of the blade.

The features above, and even those in the following more detailed description, improve the reliability of the wind turbines in question, as well as the ergonomics of assembly/disassembly, by providing a technically and financially effective solution.

In this regard, for optimised radial strength of the roller bearings, it is recommended that the bearing

also include a holding element or portion that is mechanically connected to the connection element or to the rotor hub, by being held at least radially with respect to the axis of the blade by one or the other, and which, in a radial direction with respect to this blade axis, borders an external peripheral surface with respect to that among said rings that is radially farthest from the axis of the blade, so as to oppose a radial stress tending to separate at least some of said rings from one another and/or deflect this ring, which is radially farthest from the axis of the blade, when the blade rotates.

According to an alternative, it is also envisaged that the first ring, which is radially farthest from the axis of the blade, can radially have a thickness that is greater toward its end closest to the blade than toward its end closest to the rotor hub, which ring consequently has an external peripheral surface with a generator that is not parallel or not continuously parallel to the axis of the blade.

In the examples shown in the appended figures:

- figure 1 is a front diagram of a wind turbine according to the invention,
- figure 2 is a side view,
- figure 3 shows the cross-section III-III, along a plane perpendicular to the axes, in this case coincident, of the rotor hub and the blade in question,
- figures 4, 5 and 6 show three alternatives with the same cross-section,
- figure 7 shows a diagram of the three rings alone of the preceding figures,

- figure 8 is an alternative of figure 4 with another type of roller bearing,

- and figure 9 is an alternative of figure 3 with a larger blade diameter and therefore an attachment of the ring outside this blade through the connection element.

Figures 1 and 2 show a wind turbine 1 including a head mast 3 on which three blades 5a, 5b, 5c rotate about the horizontal axis 7a of a central hub 7.

10 Typically, the hub 7 is itself mounted so as to rotate about a vertical axis 7b with respect to the mast 3, so as to be best oriented with respect to the wind.

Each blade, and in particular blade 5c of figure 2, 15 can pivot several to several dozen degrees about its axis of extension 50c, with respect to the rotor hub 7, so as to be best catch the wind.

Figure 3 shows the axis 50c of the blade 5c and the rotor hub 7.

20 The preferred angular orientation of each blade, such as blade 5c, generates in particular significant radial stresses, as well as high bending moments.

The bearing 9 shown in figure 3 is a double-row roller bearing 11a, 11b.

25 It includes an external ring 13, an internal ring 15 and an intermediate ring 19. The three rings are concentric with respect to the axis 50c and therefore all extend in a general radial plane 21 with respect to the axis 50c.

30 The intermediate ring 19 is attached to the rotor hub 7, while the external 13 and internal 15 rings are

attached to the rotor blade 5c by means of a connection individual, or independent, element 23.

In a general direction parallel to the axis 50c, the connection element 23 provides, in this case with regard to the blade 5c, the direct attachment of the internal ring 15 to said blade, via the attachment means 25, while the attachment of the external ring 13 to the blade is only indirect, since it is attached to the connection element 23 by the attachment means 27.

In figure 3, in plane 21, the radial distance d1 is greater than that of d2.

The first ring 13 is located radially beyond the blade. Thus, its axial attachment means 27, in this case bolts, extend outwardly, at two axial ends opposite the ring, and are in this case easily accessible, either by the clamping head 27a or by the nut 27b.

The attachment means 25, which are therefore located at the internal diameter d1, also each include a threaded rod accessible from its clamping end 250b, which in this case has a nut 25b and which ends opposite the hollow internal volume 31 of the rotor hub 7.

It is noted that this volume 31 communicates axially with the hollow internal volume 500c of the blade shown here, via the intermediate internal volumes successively of the internal ring 15 and the connection element 23 inserted parallel to the axis 50c between the rings 13, 15 and the blade, with which said rings come into contact.

At its other axial end 250a, the threaded rod 25 is screwed into the body of the blade 5c.

Between these ends, the rod 25, on its non-threaded portion, passes through the second ring 15 and
5 the connection element 23.

Thus, the attachments in this case are axial, which is preferable, and these attachments ensure at least one exertion of stresses common to the two rings 13, 15, which are therefore attached with the
10 connection element 23 at two different radial distances from the axis of the blade.

In this case, the first ring 13 is attached directly to the connection element 23, and not to the blade, while the second ring 15 is attached to the
15 blade, with and/or through the connection element 23, thus providing a connection with the blade through which the stresses exerted both on the first and second rings will pass.

Located at the intermediate diameter d_3 are the
20 first ring 19 and its attachment means 29, which lead, at one end, into the volume 31 (nut 29b) and, at the other end (rod head 29a), into an internal chamber 33, limited radially by the cylindrical external and internal walls, respectively, of the two rings 15, 13,
25 and, axially, at one end by the planar wall of the ring 19 in contact with the head 29a, and at the other end by a concave surface 230 of the connection element 23.

The clamping end of the bolt 29, which leads to 33, is locked in rotation by holding protuberances 35
30 attached to the ring 19 or to the connection element 23.

Thus, the ring 19 is attached to the hub 7 and its clamping, in this case parallel to the axis 50c, can take place from the internal volume 31.

In this way, the attachment means of the three
5 rings 13, 15, 19 will be easily accessible and each of the end rings 13, 15 is attached to the intermediate radial connection element 23, and not directly to the blade.

The attachment of this connection element 23 to
10 the blade, therefore by the connections located in a single radius, as shown in figure 3, is such that no connection with the blade 5c is specific to either of the two rings 13, 15.

In figure 3, it is also noted that the external
15 peripheral surface 13a of the external outer ring 13 is held at least radially with respect to the axis 50c of the blade in question, by a holding element 231 mechanically connected to the connection element 23, so as to oppose a radial stress F tending to separate at
20 least some of said rings from one another and/or deflect in particular the ring 13, when the blade rotates or, more generally, when the wind turbine is operating.

In this case, the holding part 231 is closely
25 connected to the connection element 23 with which it is integrated and which it extends as a shoulder with which the peripheral surface 13a of the ring 13 is radially in contact, in the zone 130.

Alternatively, it is possible to imagine a
30 connection by other means, such as attachment means (screwing, welding, etc.), so that the integrated

portion 231 can form a physically distinct element, while being securely and rigidly connected to the connection element 23.

In a possible alternative, it can thus be imagined, in a solution that is in principle fail-soft, that the rotor hub 7 has a radial protuberance 71 provided with a shoulder 700, coming into radial contact with said external surface 13a, but on the side of the opposite end of the ring 13, i.e. toward its end closest to the hub 7, axially.

This shoulder 700 may even be part of a connection element 800 (dotted lines in figure 3) inserted between the hub 7 and the ring 19 and through which the means 29 would pass in order to be attached in the hub.

Between the intermediate ring 19 and said first and second rings 13, 15, respectively, are at least two series of roller bearings.

In this case, they are spherical roller bearings.

In the solution of figure 3, there are two rows of roller bearings, 37a, 37b and 39a, 39b, respectively, therefore arranged in groups of two, axially offset parallel to the axis 50c, at two different radial distances therefore in direction 21.

Figure 4 shows the same constituent elements and the same provisions as in figure 3, except with regard to the attachment of the connection element 23 (in this case, reference 23a) to the blade 5c, and the ball bearings, of which there are now three, as well as a provision with four roller bearings as in figure 3, in two rows of two, which could be entirely suitable.

As regards the attachment of the connection element 23a, it now has, opposite the internal volume 150 mentioned above, a solid part 233 provided with axial apertures (parallel to the axis 50c) 41 located at a radial distance d_4 from the axis 50c that is shorter than all of the aforementioned distances d_1 , d_2 , d_3 shown in figure 3. These apertures are each passed through by one of a plurality of fourth attachment means 43 attaching, alone, the connection element 23a (which of course has the shape of a ring, like the element 23), directly to the blade 5c, while the first external ring 13 and the second ring 15 are each attached only to this connection element 23a, at two different radial distances, in this case d_1 and d_5 , respectively.

The attachment means, in this case identical, correspond to the bolts such as 27 and 45, leading, on one side, by their screw head and, on the other side, by the threaded end of their rod equipped with nuts 27b and 45b, to the outside or to the inside of the hub 7, into the volume 31 for the threaded rod corresponding to the bolt 45.

Thus, the stresses passing through the two outer rings 13, 15 will pass into the connection element 23a and be transmitted to the blade 5c by the attachment means 43, with the end of the threaded rod being screwed into this blade and capable of being clamped by the series of nuts 43b at its opposite end, in the place where it ends opposite the volume 150.

For the roller bearings, the third roller bearing 47 is again a spherical roller bearing, but it is larger than the other roller bearings 37a, 37b.

Both radially and axially (parallel to the axis 50c), it is offset with respect to said roller bearings 37a, 37b. Thus, the third roller bearing 47 is located between the two series of roller bearings 37a, 37b of the other line, in an orthogonal projection of the axis 50c.

At the radial distance d_4 from the axis 50c, the connection element 23a is therefore attached to this blade, while at the distances d_1 and d_5 , which are different, the first and second rings 13, 15 are individually attached to this connection element 23a.

In figure 4, the connection of the intermediate ring 19 is therefore identical to that of figure 3.

In the solution of figure 4, it is of course alternatively possible for there to be two double lines of roller bearings 37a, 37b and 39a, 39b of figure 3.

Optionally, in a version in which the diameter of the blades, and in particular of blade 5c, is greater than in the case of figure 3, the attachment to this blade via the connection element 23 can be achieved with the external ring 13, by replacing the internal ring 15; see figure 9.

For an attachment parallel to the axis 50c, it is thus possible in some way to switch the attachment means 25 and 27, so that the internal ring 15 is attached by the bolts 27 that would lead, on one side, to volume 31 and, on the other side, to volume 500c (then radially wider), whereas the external ring 13

would be axially passed through by the attachment means 25, which would lead to the outside (zone 46 of figure 3) and into the actual body of the blade, via the threads 250a.

5 It is noted that in figure 3, the threaded portion 250a screws only into the body of the blade 5c, while the threads 250b, by contrast, engage only with the nut 25b.

10 In this preferred version, the individual element 23 and the rings 13, 15 are not threaded.

Figure 5 shows a rotor hub, in this case referenced 70, as well as the wind turbine blade 5c, which then has a diameter slightly larger than in the case of figures 3 and 4.

15 The bearing still includes a first external ring (radially with respect to the axis 50c) 130, an internal ring 150 and an intermediate ring 190.

20 The diameters, with respect to the axis 50c, where these rings are attached, are different from one another; see d12, d13 and d14 of figure 5, which references also apply to figure 6.

25 Figure 7 shows these attachments: at each pitch P, there is, for each ring, an attachment either to the blade or to the hub, with the same diameter, as shown in figure 3 with a same diameter d2, and with this same pitch P, an attachment of the internal ring 15 to the blade and, similarly, a connection between the ring 15, the connection 23 and the blade. Figure 7 does not show the roller bearings.

30 With respect to the solutions described above, those of figures 5 and 6 show an attachment of the

intermediate ring 190 in the root of the blade 5c, while the two outer rings 130, 150 are attached directly to the hub 70, all parallel in this case to the axis of extension 50c of the blade 5c.

5 More specifically, the attachment means (27, 49 respectively) of these rings are directly attached to the connection portion 51 closely connected to the rotor hub 70 and extending, in the direction 21 already mentioned above, radially with respect to the axis of
10 the blade, until it is opposite the two outer rings 130 and 150, with a locally concave surface 510, opposite the attachment means 53 with which the intermediate ring 190 is attached in the root of the blade 5c.

For this, the attachment means 53 can be identical
15 to the means 25 of figure 3, and in this case include threaded rods of which the clamping head 55 is housed in the closed chamber extending opposite the surface 510, as shown with the chamber 33 of figure 3.

Figure 6 shows the same assembly, except that
20 instead of two rows, each with two series of roller bearings 37a, 37b and 39a, 39b of figure 5, there is a double row 39a, 39b at the smaller diameter d7, while at the larger diameter d8, there is a series of spherical roller bearings having a greater diameter 47,
25 as mentioned above.

Alternatively, the series of roller bearings 47 can be at the diameter d7, and the two series of spherical double roller bearings having a smaller diameter can be at the diameter d8, as shown in figure
30 4.

Therefore, in figures 5 and 6, there is no longer a shoulder provided on a connection element as in figures 3 and 4, for radially holding the external ring 13.

5 As a replacement, the external ring 130 farthest from the axis 50c, radially has a thickness that is greater, such as e1, toward its end 130a closest to the blade, while toward its end 130b closest to the rotor hub 70 this thickness decreases (see thickness e2 of
10 figure 6, with e2 being smaller than e1).

Thus, the ring 130 has an external peripheral surface 130c having a generator 130d that is not parallel, or not continuously parallel, to the axis 50c.

The external peripheral surface 130c in this case
15 corresponds to a slanted wall with respect to the axis 50c. It can be a step or a shoulder close to the end 130a and increasing the thickness from e2 to e1.

This added radial thickness will preferably be at least 20 %.

20 It is noted that figures 5 and 6 show different radial distances for the outer rings 130, 150 attached directly to the connection portion 51 of the rotor hub, and for the third ring 190 attached in the root of the blade 5c.

25 In these figures, the connection portion or part 51 is integrated in a single piece with the rotor hub 70 that it extends, in a cross-section, in the shape of a T of which the stem axially extends the body of the rotor hub and of which the bar receives, on one side
30 51a the clamped attachment of the attachment means 27 and, on the other side 51b, the clamped attachment of

the attachment means 49, which therefore lead on one side into the hollow internal volume 310 of the rotor hub 70 and, at the opposite axial end, opposite the internal volume 500d of the blade 5c of which the internal diameter d9 is slightly greater than that d10 of the blade of figure 3, which was greater than the diameter d11 of the blade of figure 4.

In figures 5 and 6, the internal volume 500d communicates with the internal volume 310 by the internal volume of the intermediate ring 190, those of the internal ring 150 and the end forming the connection portion 51.

It is possible to use only two rings. It is possible to remove the internal ring 15 or 150 and therefore the roller bearings between it and the ring 19 or 190.

However, this solution appears to be unsuitable for large wind turbines. Possible applications of the solutions proposed in this case can be envisaged in particular for large cranes.

It should also be noted that, radially with respect to the axis of the blade, instead of a provision as in figure 4 of the fourth 43, third 45 then first 27 attachment means located in succession, with an increasing distance with respect to this axis, it is possible to provide the following order: third 45, first 27, then fourth 43 attachment means. Instead of being radially internal, the blade would have a larger diameter than the hub 7. In figure 3, it is also possible to attach the internal ring 15 only to the connection element 23 and the external ring 13 to a

blade with a larger diameter, through this connection element, thus causing the stresses of the ring 15 and its connection to the blade to pass through it.

Figure 8 is of course intended to show that a solution with at least four spherical roller bearings 37a, 37b, 39a, 39b could be used, as an alternative to the three roller bearings of figure 4.

Patentkrav

1. Indretning til et vindkraftanlæg med et vindmøllerotornav, et vindmølleblad og et drejeligt leje til en servomotor, der er anbragt mellem nævnte vindmøllerotornav (7, 70) og nævnte vindmølleblad (5c), hvor dette blad og lejet har en akse, hvor nævnte indretning yderligere omfatter:
 - en første og anden kuglekrans (130, 150), der har forskellige diametre, parallelt med en til bladaksen (50c) radial retning (21),
 - en forbindelsesdel (51), der strækker sig parallelt med nævnte til akse af bladet (5c) aksiale retning over for første og anden kran, hvortil den er fastgjort med henholdsvis første og andre fastgørelsesmidler (27, 49),
 - en tredje kuglekrans (190), der er anbragt radialt til bladaksen mellem den første og anden kuglekrans,**kendetegnet ved, at:**
 - nævnte forbindelsesdel (51), der er tæt forbundet med rotornavet (7, 70), er anbragt mellem dette og den første og anden kuglekrans,
 - den tredje kuglekrans er fastgjort til bladet,
 - den første og anden kran (130, 150) er sammen fastgjort på nævnte forbindelsesdel (51).

2. Indretning ifølge krav 1, **kendetegnet ved, at:**
 - bladet (5c) har en enkelt vingerod, og
 - den tredje kuglekrans (190) er fastgjort på denne enkelte vingerod med tredje fastgørelsesmidler (53).

3. Indretning ifølge krav 1 eller 2, **kendetegnet ved, at:**
 - rotornavet (70) har en akse, der er parallel med bladets akse,
 - og nævnte forbindelsesdel (51) ifølge et med rotornavets akse parallelt afsnit definerer en T-formet forlængelse, der er en integreret del af nævnte rotornav og hvis stang (51a, 51b) optager befæstelserne mellem denne forbindelsesdel og henholdsvis den første og anden kuglekrans (130, 150).

4. Indretning til et vindkraftanlæg med et vindmøllerotornav (7, 70), et vindmølleblad (5c) og et drejeligt leje til en servomotor, der er anbragt mellem nævnte vindmøllerotornav (7, 70) og nævnte vindmølleblad (5c), hvor dette blad og lejet har en akse, hvor nævnte indretning yderligere omfatter:
 - en første og anden kuglekrans (13, 15), der har forskellige diametre, parallelt med en til akse (50c) af bladet (5c) radial retning,
 - en forbindelsesdel (23, 23a), der er anbragt mellem bladet og den første og anden krans (13, 15) og strækker sig i en til akse af nævnte blad radial retning over for første og anden krans, hvortil den er forbundet,
 - en tredje kuglekrans (19), der er anbragt radially til bladaksen mellem den første og anden kuglekrans, hvor denne tredje krans er fastgjort til totornavet (7), og hvor mindst én blandt nævnte forbindelsesdel og den første og anden kuglekrans er forbundet med bladet,

kendetegnet ved, at mindst én af den første og anden krans (13, 15) er fastgjort direkte på forbindelsesdelen (23, 23a) uden at være det på bladet (5c), til hvilken den imidlertid er forbundet ved hjælp af denne forbindelsesdel.
5. Indretning ifølge krav 4, **kendetegnet ved, at** den første og anden krans (13, 15) og bladet (5c) langs et radially plan til bladaksen er indbyrdes forbundet med en enkelt forbindelse (25, 43), hvorigennem alle kræfter, der udøves på både den første og anden krans, passerer og som således ikke er specifik til nogen af kransene.
6. Indretning ifølge krav 4 eller 5, **kendetegnet ved, at** enhver af den første og anden krans (13, 15) er fastgjort direkte og udelukkende på forbindelsesdelen (23a), og således ikke på bladet (5c), og hvor denne forbindelsesdel ifølge et til nævnte bladakse radially plan desuden er fastgjort til dette blad med en enkelt forbindelse (43), hvorigennem kræfter, der udøves på både den første og anden krans (13, 15), passerer.

7. Indretning ifølge krav 4 eller 5, **kendetegnet ved, at:**
 - den første krans (13), som er radialt længst væk fra akse af bladet (5c), er fastgjort direkte og udelukkende på forbindelsesdelen (23), og altså ikke på dette blad, og
 - den anden krans (15) langs et til nævnte bladakse radialt plan er fastgjort til nævnte forbindelsesdel og til bladet (5c) med en forbindelse (25), hvorigennem de kræfter, som udøves på både den første og den anden krans, passerer.

8. Indretning ifølge et hvilket som helst af kravene 4 til 7, **kendetegnet ved, at** der til mindst én af første og anden krans (13, 15) og langs et til nævnte bladakse radialt plan er anbragt anbringelsessteder til fastgørelse af den pågældende krans (13, 15) på forbindelsesdelen (23, 23a) og forbindelse mellem nævnte krans og bladet (5c) med forskellige radiale afstande af akse af dette blad.

9. Indretning ifølge et hvilket som helst af kravene 4 til 7, **kendetegnet ved, at** forbindelsesdelen (23, 23a) ved en første radial afstand (d_2 , d_6) af nævnte bladakse gennemskæres af et middel (25, 43) til fastgørelse til dette blad, og den første krans (13) ved en anden radial afstand (d_1) af akse af nævnte blad, der er forskellig fra den første radiale afstand, er fastgjort på forbindelsesdelen.

10. Indretning ifølge et hvilket som helst af kravene 4 til 9, **kendetegnet ved, at** den yderligere omfatter et fastholdelselement eller – afsnit (231, 700), som er mekanisk forbundet til forbindelsesdelen (23, 23a, 51, 800) eller til rotnavet (7, 70) ved at være fastholdt i det mindste radialt til nævnte akse af bladet af den ene eller den anden, og som ifølge en til denne akse radial retning grænser op til en udvendig omkredsflade (13a) af den af nævnte krans, der er radialt længst væk fra nævnte akse af bladet for at modvirke en radial kræft, der har tendens til at fjerne i det mindste nogle af nævnte krans og/eller aflede den krans (13), der er radialt længst væk fra bladaksen, under en rotation af dette blad.

11. Indretning ifølge et hvilket som helst af kravene 1 til 3, **kendetegnet ved, at** den første krans (130), som er radialt længst væk fra bladaksen, radialt har en tykkelse (e1), der er større mod den ende, der er nærmest nævnte blad, der er monteret drejeligt omkring nævnte akse (50c), end mod den ende, der er nærmest rotornavet, hvor denne krans derfor har en udvendig omkredsflade (130c) med en generator (130d), der ikke er parallel eller gennemgående parallel med aksens af nævnte blad.
12. Indretning ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at:**
- lejet omfatter første, andre og tredje kuglerækker (37a, 37b; 39a, 39b; 47), hvor mindst én af disse rækker strækker sig mellem den første og tredje krans (13, 15, 19; 130, 150, 190), og den eller de resterende rækker strækker sig mellem den tredje og anden krans,
 - og at der mellem enten den første og tredje krans, eller den tredje og anden krans strækker sig en enkelt kuglerække med kugler (47):
 - som er større end kuglerne (37a, 37b, 39a, 39b) af de to andre rækker,
 - og som er anbragt mellem kuglerne af disse to andre kuglerækker ifølge en retvinklet projektion på nævnte akse (50c).
13. Indretning ifølge krav 4 eller 5, **kendetegnet ved, at:**
- den første krans (13), som er radialt længst væk fra aksens af bladet (5c), er fastgjort til nævnte forbindelsesdel (23) og til bladet (5c) med en forbindelse (25), hvorigennem de kræfter, der udøves på både den første og anden krans, og
 - den anden krans (15) er fastgjort direkte og udelukkende på forbindelsesdelen (23), og altså ikke på dette blad.
14. Indretning ifølge et hvilket som helst af kravene 4 til 10, 12 eller 13 afhængig af et af dem, **kendetegnet ved, at** bladet (5c) har en enkelt vingerod, og forbindelsesdelen (23, 23a) er fastgjort på denne enkelte vingerod af bladet (5c).

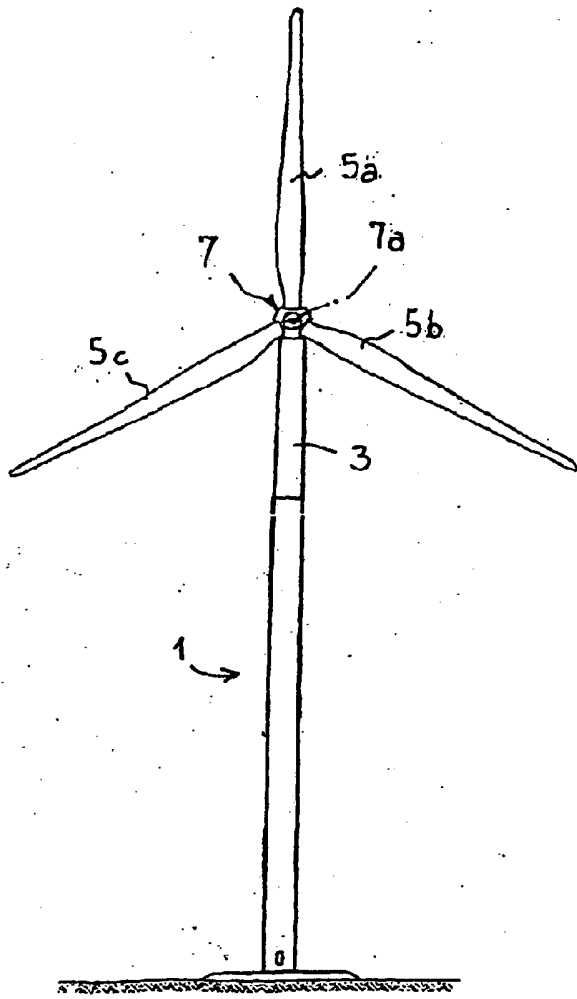


FIG. 1

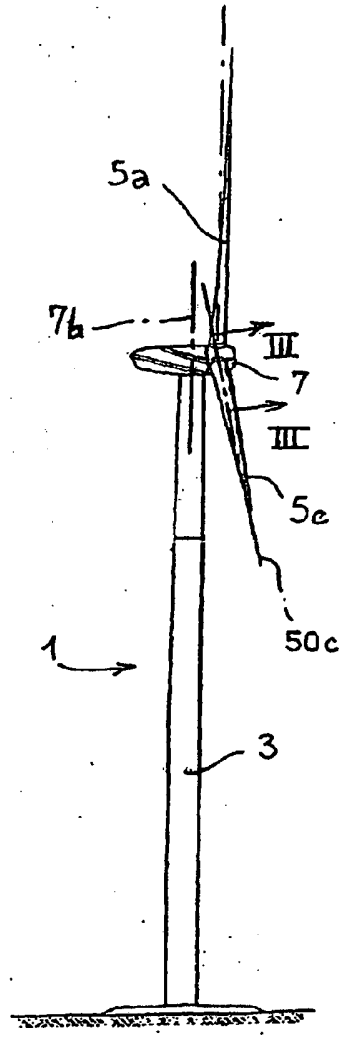


FIG. 2

FIG. 3

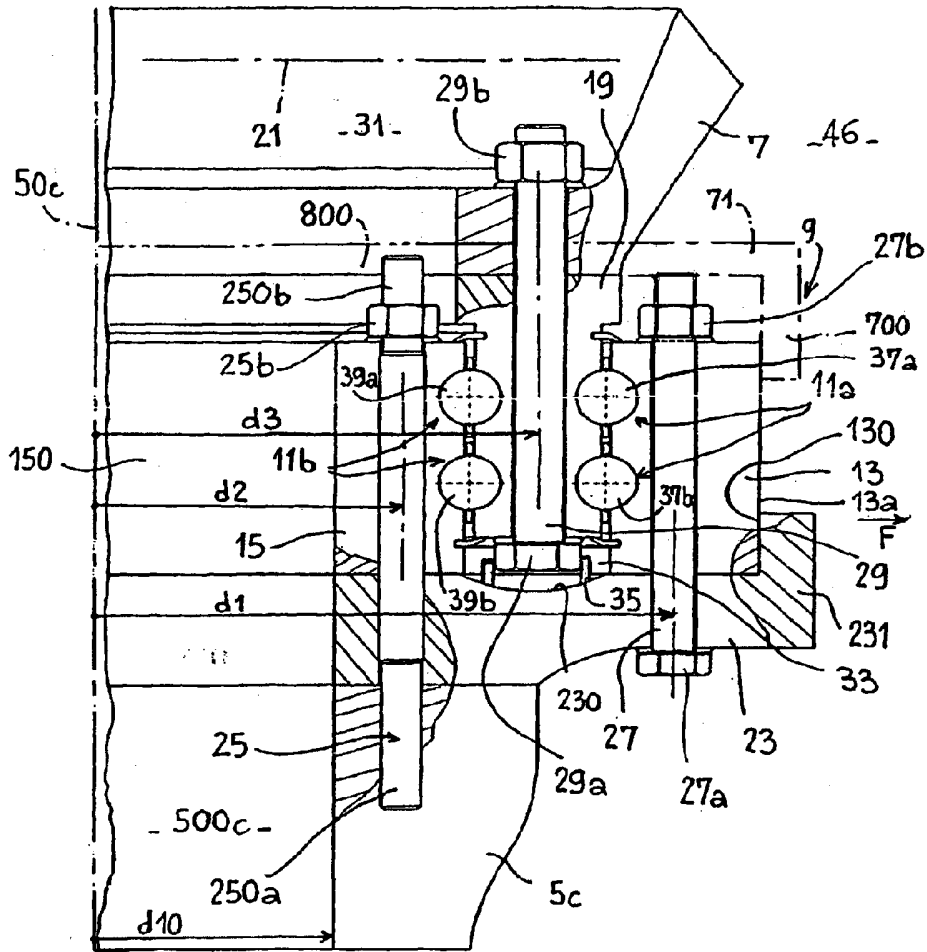
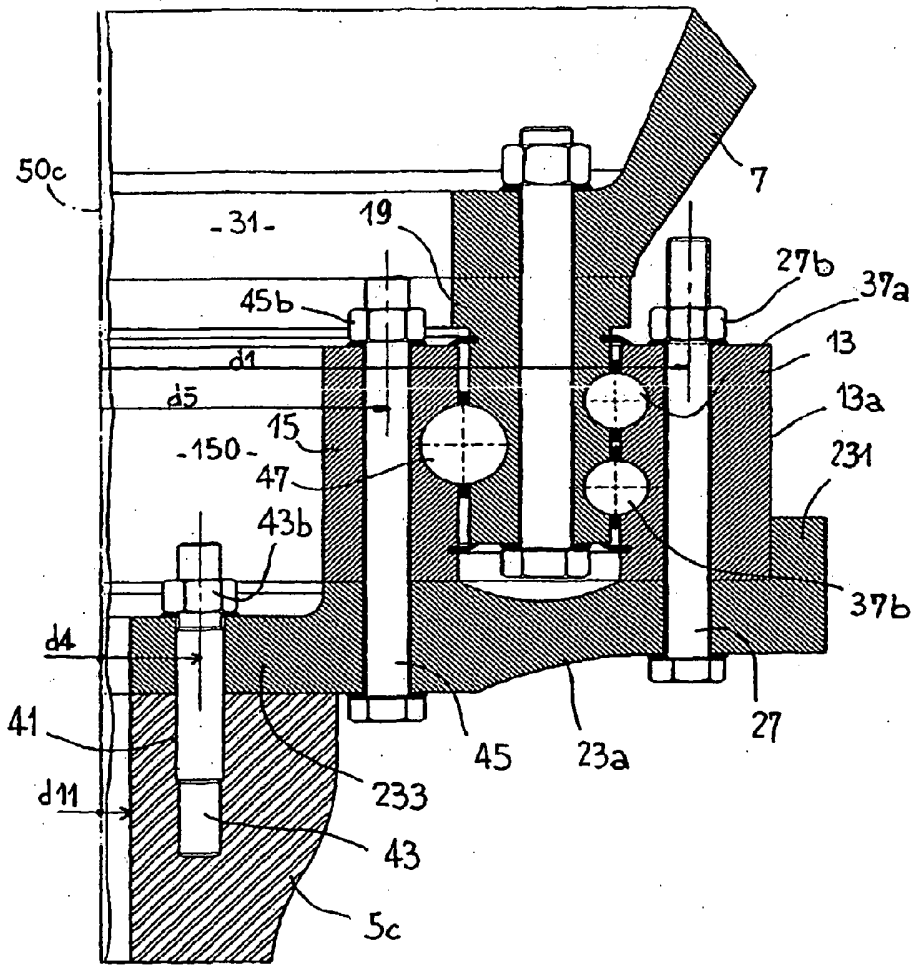


FIG. 4



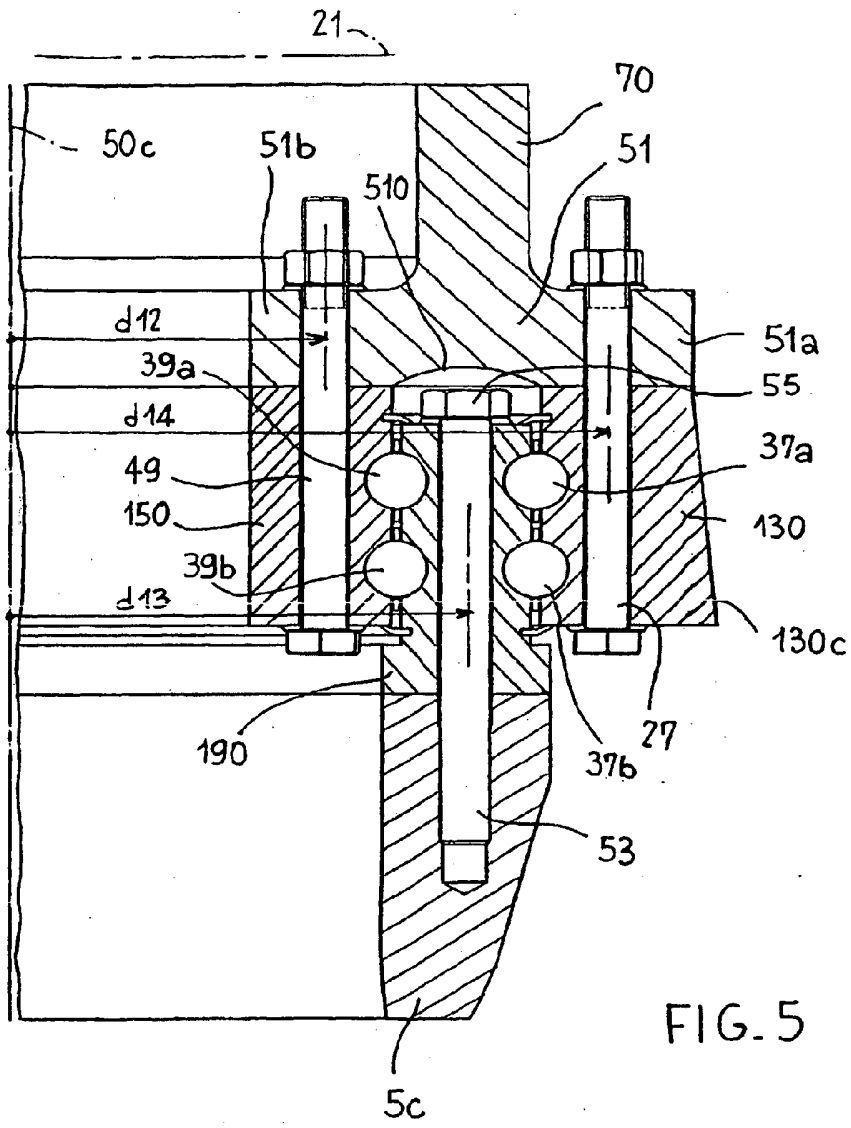


FIG. 5

FIG. 6

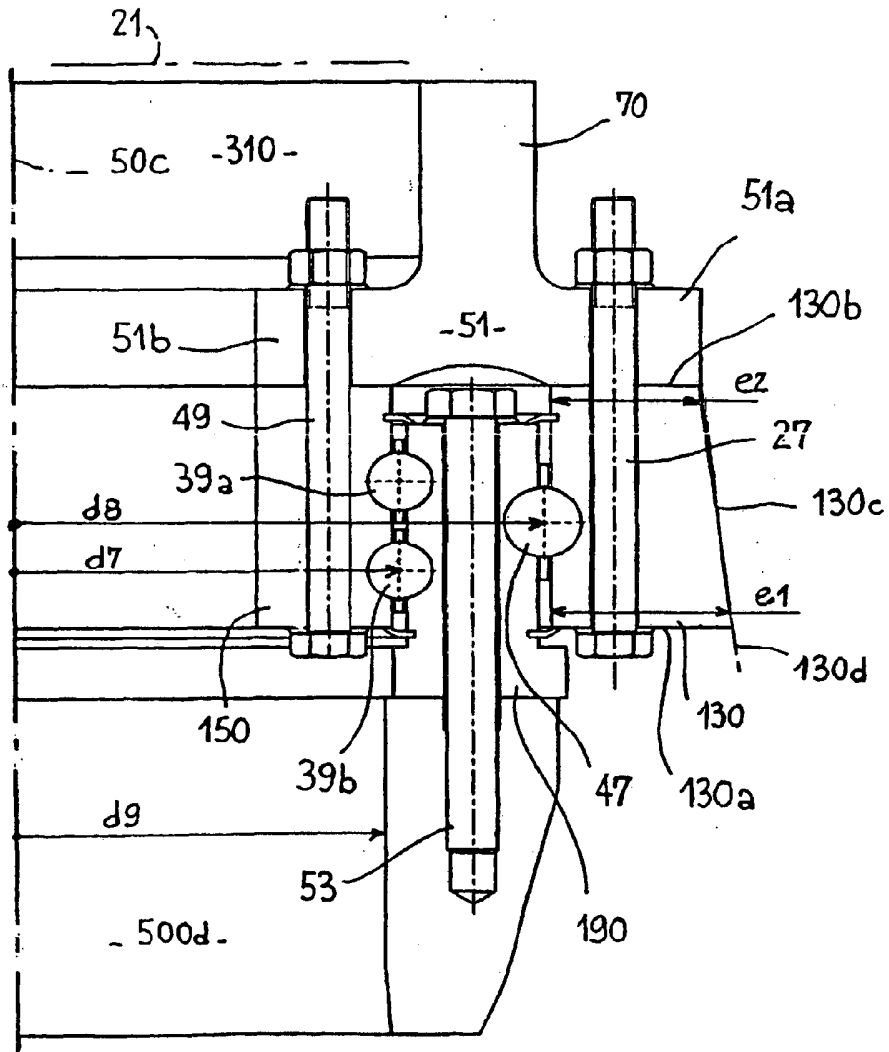
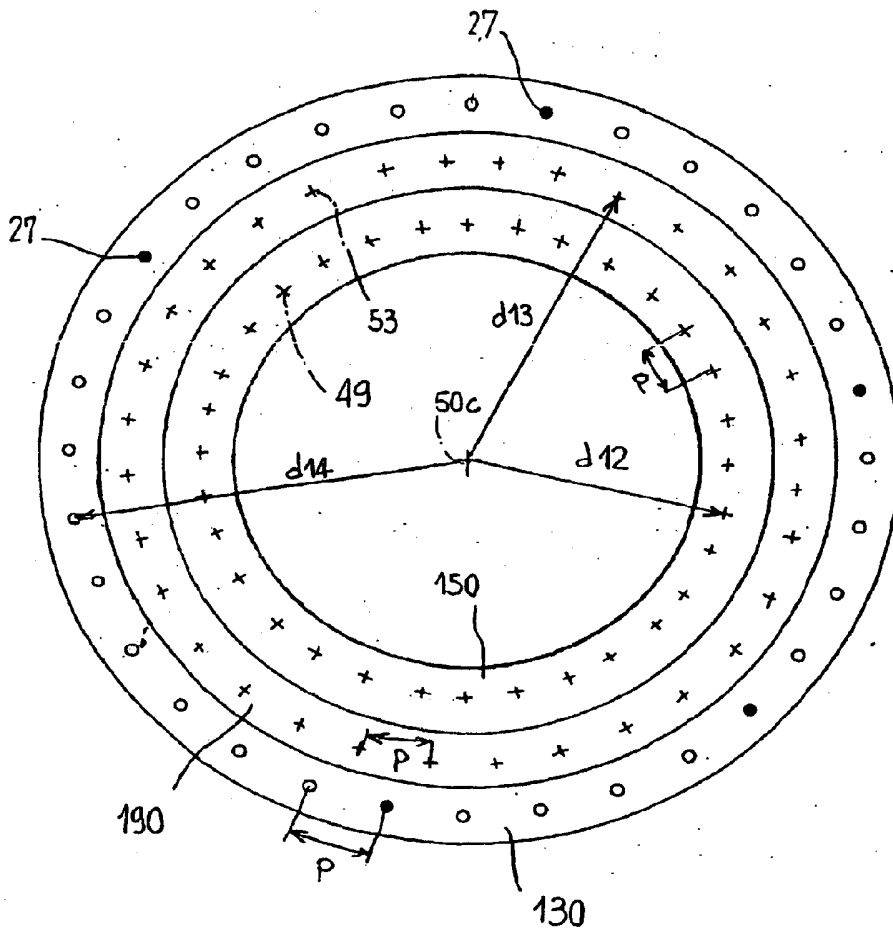


FIG. 7



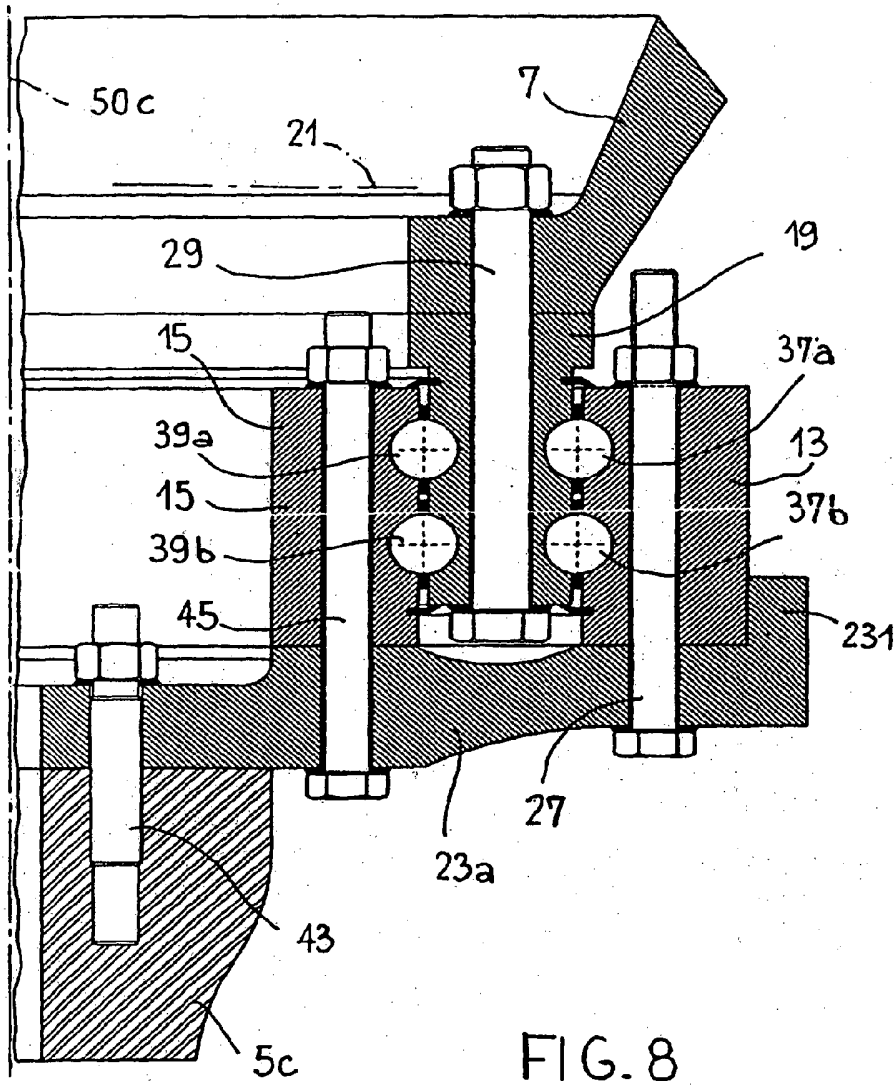


FIG. 9

