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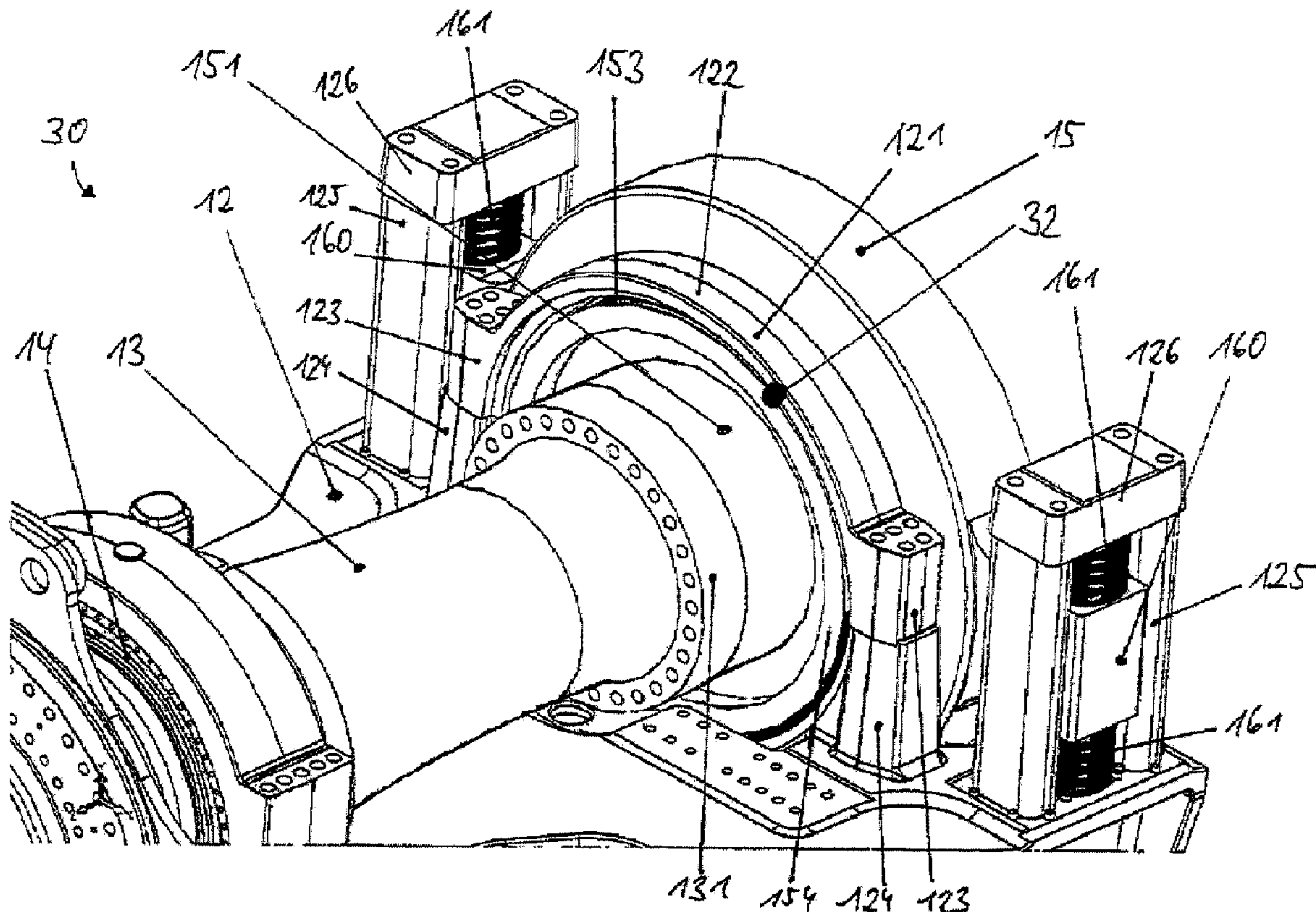
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(54) **Titre : AMENAGEMENT DE PALIER D'ENTRAINEMENT D'UNE EOLIENNE ET EOLIENNE**

(54) **Title: DRIVETRAIN BEARING ARRANGEMENT OF A WIND TURBINE, AND WIND TURBINE**



(57) **Abrégé/Abstract:**

The invention relates to a drivetrain bearing arrangement (30) of a wind turbine (1) that has a rotor, a substantially horizontally aligned rotor shaft (13), a planetary gear set (15) and a mainframe (12), comprising a rotor-side rotor bearing (14) opposite the

(57) Abrégé(suite)/Abstract(continued):

planetary gear set (15), a planet-carrier bearing (152) for a rotor-side planet carrier (151) of the planetary gear set (15), and at least one lateral torque support (160, 160'), which is connected to the planetary gear set (15) on one side of the planetary gear set (15), the rotor bearing (14) being realized as a fixed bearing for absorbing axial loads. The invention further relates to a corresponding wind turbine (1). According to the invention, provided for the purpose of absorbing bending loads of the rotor shaft (13), there is a radial bearing (32), which comprises an annular elastomer (153), and which is disposed in a plane of the planet-carrier bearing (152) and is mounted in a fastening structure (121) of the mainframe (12).

Drivetrain bearing arrangement of a wind turbine, and
wind turbine

Abstract

(in conjunction with Fig. 2)

The invention relates to a drivetrain bearing arrangement (30) of a wind turbine (1) that has a rotor, a substantially horizontally aligned rotor shaft (13), a planetary gear set (15) and a mainframe (12), comprising a rotor-side rotor bearing (14) opposite the planetary gear set (15), a planet-carrier bearing (152) for a rotor-side planet carrier (151) of the planetary gear set (15), and at least one lateral torque support (160, 160'), which is connected to the planetary gear set (15) on one side of the planetary gear set (15), the rotor bearing (14) being realized as a fixed bearing for absorbing axial loads. The invention further relates to a corresponding wind turbine (1).

According to the invention, provided for the purpose of absorbing bending loads of the rotor shaft (13), there is a radial bearing (32), which comprises an annular elastomer (153), and which is disposed in a plane of the planet-carrier bearing (152) and is mounted in a fastening structure (121) of the mainframe (12).

Drivetrain bearing arrangement of a wind turbine, and
wind turbine

Description

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The invention relates to a drivetrain bearing
arrangement of a wind turbine that has a rotor, a
substantially horizontally aligned rotor shaft, a
planetary gear set and a mainframe, comprising a rotor-
10 side rotor bearing opposite the planetary gear set, a
planet-carrier bearing for a rotor-side planet carrier
of the planetary gear set, and at least one lateral
torque support, which is connected to the planetary
gear set on one side of the planetary gear set, the
15 rotor bearing being realized as a fixed bearing for
absorbing axial loads. The invention additionally
relates to a corresponding wind turbine.

Many modern wind turbines of the megawatt and multi-
20 megawatt class, in the present case horizontal-axis
wind turbines having substantially horizontal rotor-
shaft axes, have, in a nacelle or enclosure at the tip
of the tower, a gearbox that connects the rotor to a
generator. In these wind turbines, the rotor shaft is
25 horizontal or slightly inclined relative to the
horizontal, this having the advantage of a greater
distance between the rotor blades and the tower.
Accommodated in the nacelle there is a mainframe, on
which the generator and the gearbox are mounted. Since
30 the mainframe also has to carry the rotor, in such
cases a three-point bearing arrangement or a four-point
bearing arrangement is normally used as a bearing
arrangement for the drivetrain composed of the rotor,
rotor shaft and gearbox. In the context of the present
35 invention, in the following, a drivetrain bearing
arrangement is understood to mean a bearing arrangement
of a rotor and gearbox.

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The three-point bearing arrangement that may be cited by way of example comprises a rolling bearing, as a rotor bearing, by which the rotor shaft is guided and which supports the rotor shaft. The rotor shaft runs
5 into the gearbox. Two further bearing points are disposed laterally on the gearbox, and fasten the gearbox to the mainframe. These lateral bearings absorb the gearbox torque and bending moments of the rotor shaft, and are referred to as supports or gearbox
10 supports.

In the case of three-point bearings, all forces arising from pitching and yawing loads, i.e. bending moments arising from the rotor shaft, as well as the torque
15 arising from the rotation of the rotor (torsional load), are transmitted to the mainframe via the supports. A soft bearing-bush design at the lateral supports then, besides resulting in a reduction of the torsional excitation and consequently good decoupling
20 of structure-borne sound, also results in a greater displacement of the gearbox under bending loads. This may result in non-permissible displacements of the generator coupling or even of the main bearing. Transfer of the bending loads into an open mainframe
25 design also represents a challenge in this case.

An alternative to this is represented by four-point bearings, such as those used, for example, in the 5M series and 6M series of the applicant. The latter,
30 besides having usually two lateral supports or torque supports on the gearbox, have two separate bearings for the rotor shaft in front of the gearbox, one of the rotor shaft bearings being realized as a floating bearing and the other as a fixed bearing, which absorbs
35 axial forces acting on the rotor and deflects them into the mainframe, such that the gearbox is no longer subjected to axial loading. The two rotor shaft bearings also absorb the bending loads of the rotor

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shaft, such that the torque supports then only have to absorb torsional loads caused by the rotation of the rotor, and the gearbox no longer undergoes displacement as in the case of the three-point bearings.

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Against this, the present invention is based on the object of making available a simple and effective drivetrain bearing arrangement, and a wind turbine having a corresponding drivetrain bearing arrangement.

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This object is achieved by a drivetrain bearing arrangement of a wind turbine that has a rotor, a substantially horizontally aligned rotor shaft, a planetary gear set and a mainframe, comprising a rotor-side rotor bearing opposite the planetary gear set, a planet-carrier bearing for a rotor-side planet carrier of the planetary gear set, and at least one lateral torque support, which is connected to the planetary gear set on one side of the planetary gear set, the rotor bearing being realized as a fixed bearing for absorbing axial loads, which drivetrain bearing arrangement is developed in that, provided for the purpose of absorbing bending loads of the rotor shaft, there is a radial bearing, which comprises an annular elastomer, and which is disposed in a plane of the planet-carrier bearing and is mounted in a fastening structure of the mainframe.

In the classic case of two torque supports that are disposed symmetrically on both sides of the gearbox, the drivetrain bearing arrangement according to the invention is a four-point bearing arrangement. In the case of a drivetrain having a planetary gear set, the rotor shaft is flange-connected, on the gearbox side, to a central planet carrier of a, in particular first, planetary stage of the planetary gear set, which planet carrier is disposed in the extension of the rotor shaft. The planet carrier is mounted, with respect to

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the housing of the planetary gear set, by means of a planet-carrier bearing, which in most cases is realized as a rolling bearing.

5 According to the invention, the annular elastomer is disposed in the plane of the planet-carrier bearing such that it supports the housing of the planet carrier radially with respect to the mainframe. The planet-carrier bearing, which is present in any case, thus
10 transmits bending moments to the mainframe via the annular elastomer. The latter is disposed in the plane of the planet-carrier bearing, thus at least partially overlapping with the planet-carrier bearing in the axial direction, such that a favourable radial flow of
15 forces is realized without axial offset, i.e. on a most direct path that is correct in respect of flow of forces. Bending moments are thus transferred without loading the toothed parts of the gearbox.

20 An adaptation might possibly be indicated in so far as the planet-carrier bearing is to be designed such that it withstands the transmission, correct in respect of flow of forces, of the bending loads from the rotor shaft to the fastening structure of the mainframe.

25 The drivetrain bearing arrangement according to the invention is comparable with a double rotor bearing arrangement, but without a second rotor bearing. In comparison with the prior art, according to the
30 invention there is no gearbox-side dedicated bearing for the rotor shaft itself that is not at the same time a bearing for the gearbox. Moreover, the bending loads and the torsional loads are introduced into the mainframe structure in a functionally separate manner
35 via differing elements.

According to the invention, the rotor-side rotor bearing serves as a fixed bearing for axial loads,

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while the radial bearing disposed in the gearbox, with the planet-carrier bearing and the annular elastomer, now absorbs the bending loads of the rotor shaft and introduces them into the mainframe, which bending loads were previously absorbed by the gearbox-side rotor bearing, as a result of which the planet-carrier bearing had hitherto been relieved of bending moments. The support according to the invention achieves good support of the rotor shaft, and has the effect that there is little stress, resulting from linear and bending stresses, on the planetary gear set, which in the context of the invention also includes a planetary/spur-gear set. Instead of the planetary gear set, a pure spur-gear set may be mounted correspondingly.

In an advantageous development, the radial bearing is realized as a floating bearing for the rotor shaft in respect of axial loads of the rotor shaft. This simplifies the design of the radial bearing and is possible since the rotor-side rotor bearing is already realized as a fixed bearing.

Preferably, the annular elastomer has a Shore hardness (A) of more than 70, in particular more than 90, in particular more than 120. It is therefore designed so as to be relatively hard, and it minimizes radial displacements of the gearbox under bending load, with the effect of also being easy on the gearbox itself.

Advantageously, the annular elastomer is mounted in segments of the mainframe by means of a bolted or boltable clamp, or in a full-circumference structure.

The at least one lateral torque support is realized, advantageously, to absorb torsional loads. For this purpose, preferably one or more elastomer bodies of the at least one lateral torque supports is or are realized

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so as to be soft in the direction of compression, in particular having a Shore hardness (A) of between 30 and 80, in particular between 35 and 65. This comparatively low hardness allows effective decoupling
5 of structure-borne sound, which is particularly important in respect of the torsional excitations. The choice of such low hardnesses is enabled by the absorption of the bending loads in the radial bearing because, owing to the functional separation of the
10 various elements for absorbing bending loads, or torsional loads, the gearbox can have a very soft mounting in respect of torsion without non-permissible displacement occurring under bending moments.

15 The torque support or torque supports is or are preferably designed without preload. This is possible because an operating preload ensues automatically as a result of the torque of the rotor always having the same direction when the wind turbine is in production
20 operation. As an alternative or in addition to this, advantageously, there is a stop buffer for the purpose of resilience.

In an advantageous development, the torque support
25 comprises elastomer bodies placed in the shape of a roof and/or sleeve-shaped elastomer bodies.

Preferably two torque supports are comprised, disposed symmetrically on both sides of the planetary gear set.
30 This arrangement enables torsional forces to be transferred in a uniform manner into the mainframe, with less local stress than in the case of a single torque support.

35 The object on which the invention is based is further achieved by a wind turbine that has a rotor, a substantially horizontally aligned rotor shaft, a planetary gear set and a mainframe, comprising a

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previously described drivetrain bearing arrangement according to the invention. The wind turbine shares with the drivetrain bearing arrangement according to the invention the previously described features,
5 properties and advantages of the latter.

Further advantages of the invention become evident from the description of embodiments according to the invention, together with the claims and the appended
10 drawings. Embodiments according to the invention may fulfil individual features or a combination of a plurality of features.

The invention is described in the following, without
15 limitation of the general concept of the invention, on the basis of exemplary embodiments, with reference to the drawings, and reference is expressly made to the drawings in respect of all details according to the invention not explained in greater detail in the text.
20 There are shown in:

Fig. 1 a schematic cross section through the nacelle of a known wind turbine,

25 Fig. 2 a schematic perspective representation of a drivetrain bearing arrangement according to the invention, and

Fig. 3 a schematic cross-sectional and perspective
30 representation of a radial bearing according to the invention.

In the drawings, elements and/or parts that are the same or of the same type are in each case denoted by
35 the same reference numerals, such that presentation in each case is not repeated.

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Fig. 1 shows a cross-sectional representation through a nacelle of a known wind turbine, for example the wind turbine MD70 of the applicant. The nacelle 3 sits on a tower 2, of which the portion near the nacelle is represented. Represented on the left in Fig. 1 is a rotor, having a rotor hub 4, and rotor blades 5, which are represented only in the region of the rotor-blade roots. In the region of the rotor-blade roots, the rotor blades 5 each have a rotor-blade bearing 6, acting upon which is a pitch drive 7. The pitch drive 7 is operated by a controller 8 and alters the pitch angle of the respective rotor blade 5 when the wind turbine 1 is in operation.

The nacelle 3 accommodates a mainframe 12, which is connected to the tower 2 via a nacelle slewing ring 9. Acting on the nacelle slewing ring 9 there are wind direction alignment motors 10 of a yaw control system, which align the nacelle, or rotor, in the direction of the prevailing wind. For this purpose there are four wind direction alignment motors 10, of which two are disposed on the side represented and two are concealed behind it, on the other side of the mainframe 12. Also acting on the nacelle slewing ring 9 are yaw brakes 11, which serve to lock the yaw setting of the rotor.

The rotor drives a rotor shaft 13, which is rotatably mounted in a rotor bearing 14 realized as a rolling bearing. The rotor shaft 13 drives a planetary gear set 15, which converts the slow rotational motion of the rotor shaft into a fast rotational motion of a generator shaft 19, which is represented with couplings, which shaft, in turn, drives a generator 20, equipped with a heat exchanger 21, for the purpose of generating electricity.

In the case of the MD70 wind turbine of the applicant shown in Fig. 1, the drivetrain bearing arrangement is

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realized as a three-point bearing. The rotor bearing 14 in this case is realized as a fixed bearing, which permits only a few millimetres of play in the axial direction of the rotor shaft 13. Two further bearing
5 points consist in the elastic gearbox suspensions, or supports 16, of which one is represented in Fig. 1, while the other is located symmetrically on the other side of the planetary gear set 15 and is therefore concealed by the planetary gear set 15. These bearing
10 points are designed such that they absorb both torsional loads and bending loads of the rotor shaft 13 that are transmitted, via the planetary gear set 15, to the supports 16 and further to the mainframe 12.

15 The support 16, or the elastic gearbox suspension, is of a conventional design, and consists of hollow-cylinder elastomer bodies composed of two half-cylinder partial bodies, which are disposed around a cylindrical pin. With its cylindrical bearings, the cylinder axis
20 of which is aligned parallel to the rotor shaft 13, the support 16 is a floating bearing, since, owing to its softness in this direction, it absorbs only a small amount of rotor thrust in the direction of the rotor shaft axis.

25 By contrast, the sleeve-shaped elastomer bodies in the supports 16 are designed so as to be comparatively stiff in the radial direction. The planetary gear set 15 additionally has a rotor brake 17 and a slip ring
30 transmitter 18.

A perspective view of an exemplary embodiment of a drivetrain bearing arrangement 30 according to the invention is shown in Fig. 2. Shown at bottom left is
35 a portion of a rotor bearing 14, which is realized as a fixed bearing for supporting the rotor shaft 13 axially and radially. The latter is flange-connected, by means of a rotor-shaft flange 131, to a planet carrier 151,

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which is part of a first planetary stage of a planetary gear set 15. The planet carrier 151 is mounted in respect of a housing 154 of the planetary gear set 15 by means of a planet-carrier bearing 152, which is not visible in Fig. 2. A radial bearing 32 is constituted in that, by means of an annular elastomer 153, the housing 154 of the planetary gear set 15 is additionally tensioned and mounted in respect of a fastening structure 121, which is bolted to the mainframe 12. For this purpose, the fastening structure 121 has a semicircular clamp 122, which terminates in two clamp bolt-connection flanges that are bolted to corresponding bolt-connection flanges 124 of the mainframe 12. This radial bearing 32, with the relatively hard annular elastomer, is designed so as to be relatively hard.

The combination of the rotor bearing 14 and the radial bearing 32 absorbs all bending loads of the rotor, or of the rotor shaft 13, and deflects them into the mainframe without loading the teeth of the planetary gear set 15.

The housing 154 of the planetary gear set 15 has, on both sides, a respective torque support 160, which are mounted in a respective frame 125 between elastomer bodies 161. The latter may be of a soft design, since they only have to absorb torsional loads, but not bending loads of the rotor shaft 13. The frames 125 are bolted on their underside to the mainframe 12, and each have a cover 126 on their top side.

The inner structure of the radial bearing 32 from Fig. 2 is shown in a partially perspective cross section in Fig. 3. In addition to the details that can be seen in Fig. 2, Fig. 3 shows how the rotor shaft 13 is flange-connected to the planet carrier 151 by means of the rotor-shaft flange 131. Also shown is the planet-

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carrier bearing 152 between the planet carrier 151 and the housing 154 of the planetary gear set. The housing 154 has a projection in the direction of the rotor shaft 13, the outside of which is opposite the inside of the clamp 122 of the fastening structure 121, with a gap remaining. This gap is partially filled by the annular elastomer 153.

The annular elastomer 153 and the planet-carrier bearing 152 overlap in a plane perpendicular to the central axis of the rotor shaft 13, such that a direct radial flow of forces is realized from the planet carrier 151 via the planet-carrier bearing 152, the housing 154 and the annular elastomer, to the circumferential fastening structure 121, and thus to the mainframe 12.

All stated features, also the features given only by the drawings and also individual features that have been disclosed in combination with other features, are regarded as material to the invention. Embodiments according to the invention may be fulfilled by individual features or by a combination of a plurality of features. Features that are characterized with "in particular" or "preferably" are to be understood as optional features in the context of the invention.

List of references

	1	wind turbine
	2	tower
5	3	nacelle
	4	rotor hub
	5	rotor blade
	6	rotor-blade bearing
	7	pitch drive
10	8	controller of the pitch control
	9	nacelle slewing ring
	10	wind direction alignment motors
	11	yaw brakes
	12	mainframe
15	13	rotor shaft
	14	rotor bearing
	15	planetary gear set
	16	elastic gearbox suspension
	17	rotor brake
20	18	slip ring transmitter
	19	generator shaft with couplings
	20	generator
	21	heat exchanger
	30	drivetrain bearing arrangement
25	32	radial bearing
	121	fastening structure
	122	clamp
	123	clamp bolt-connection flange
	124	bolt-connection flange
30	125	frame
	126	cover
	131	rotor-shaft flange
	151	planet carrier
	152	planet-carrier bearing
35	153	annular elastomer
	154	housing
	160	torque support
	161	elastomer body

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Drivetrain bearing arrangement of a wind turbine, and
wind turbine

Claims

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1. Drivetrain bearing arrangement (30) of a wind turbine (1) that has a rotor, a substantially horizontally aligned rotor shaft (13), a planetary gear set (15) and a mainframe (12), comprising a rotor-side rotor bearing (14) opposite the planetary gear set (15), a planet-carrier bearing (152) for a rotor-side planet carrier (151) of the planetary gear set (15), and at least one lateral torque support (160, 160'), which is connected to the planetary gear set (15) on one side of the planetary gear set (15), the rotor bearing (14) being realized as a fixed bearing for absorbing axial loads, characterized in that, provided for the purpose of absorbing bending loads of the rotor shaft (13), there is a radial bearing (32), which comprises an annular elastomer (153), and which is disposed in a plane of the planet-carrier bearing (152) and is mounted in a fastening structure (121) of the mainframe (12).

25

2. Drivetrain bearing arrangement (30) according to Claim 1, characterized in that the radial bearing (32) is realized as a floating bearing for the rotor shaft (13) in respect of axial loads of the rotor shaft (13).

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3. Drivetrain bearing arrangement (30) according to Claim 1 or 2, characterized in that the annular elastomer (153) has a Shore hardness (A) of more than 70, in particular more than 90, in particular more than 120.

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4. Drivetrain bearing arrangement (30) according to any one of Claims 1 to 3, characterized in that the annular elastomer (153) is mounted in a plane of the rotor-side planet-carrier bearing (152) and in a fastening structure (121) of the mainframe (12), in particular in segments of the mainframe (12) by means of a bolted or boltable clamp (122), or in a full-circumference structure.
5. Drivetrain bearing arrangement (30) according to any one of Claims 1 to 4, characterized in that the at least one lateral torque support (160) is realized to absorb torsional loads.
6. Drivetrain bearing arrangement (30) according to any one of Claims 1 to 5, characterized in that one or more elastomer bodies (161) of the at least one lateral torque support (160) is or are realized so as to be soft in the direction of compression, in particular having a Shore hardness (A) of between 30 and 80, in particular between 35 and 65.
7. Drivetrain bearing arrangement (30) according to any one of Claims 1 to 6, characterized in that the torque support (160) or torque supports (160) is or are designed without preload and/or there is a stop buffer for the purpose of resilience.
8. Drivetrain bearing arrangement (30) according to any one of Claims 1 to 7, characterized in that the torque support (160) comprises elastomer bodies placed in the shape of a roof and/or sleeve-shaped elastomer bodies.
9. Drivetrain bearing arrangement (30) according to any one of Claims 1 to 8, characterized in that two torque supports (160) are comprised, disposed

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symmetrically on both sides of the planetary gear set (15).

10. Wind turbine (1) that has a rotor, a substantially
5 horizontally aligned rotor shaft (13), a planetary gear set (15) and a mainframe (12), comprising a drivetrain bearing arrangement (30) according to any one of Claims 1 to 9.

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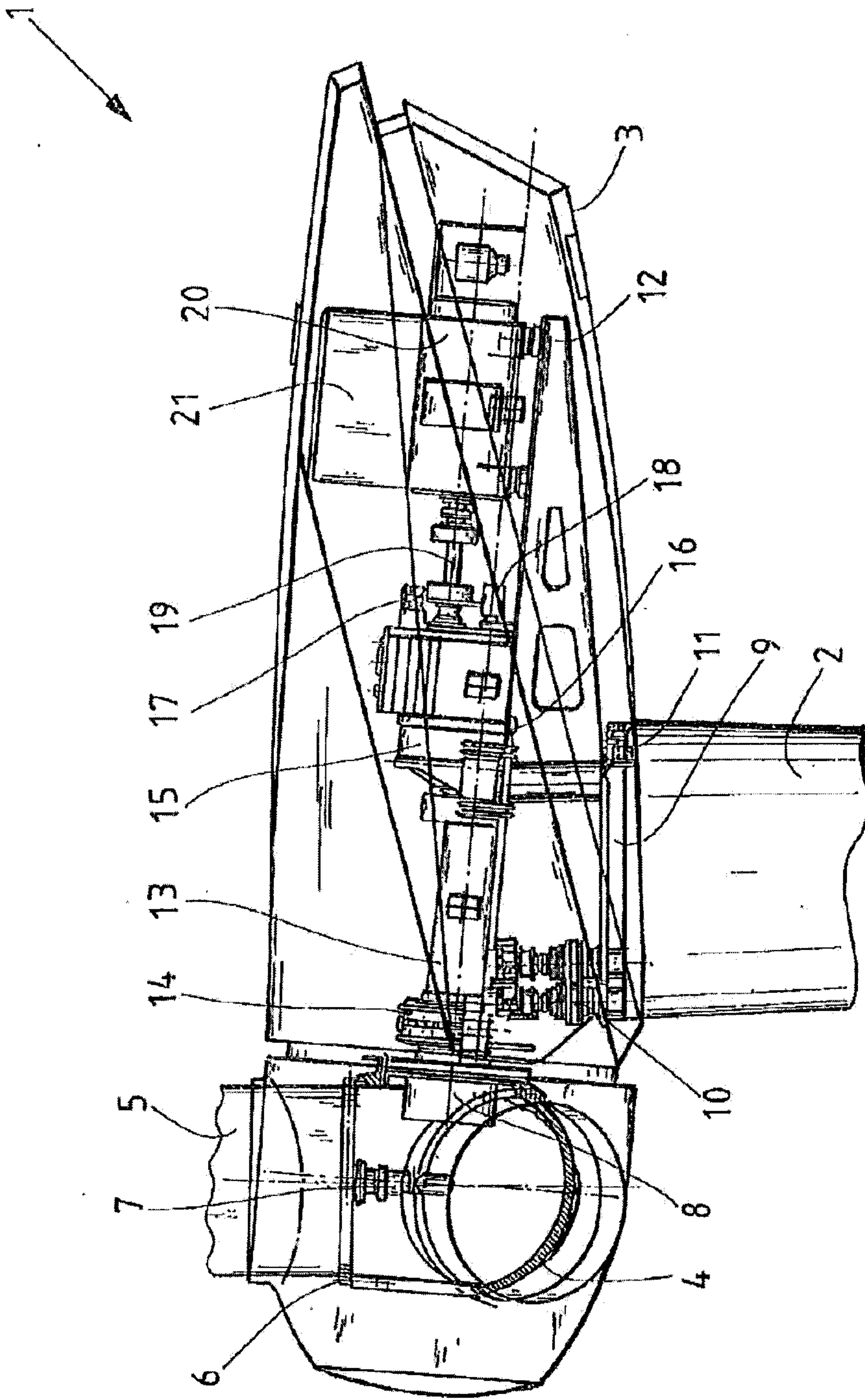


Fig. 1
(Prior art)

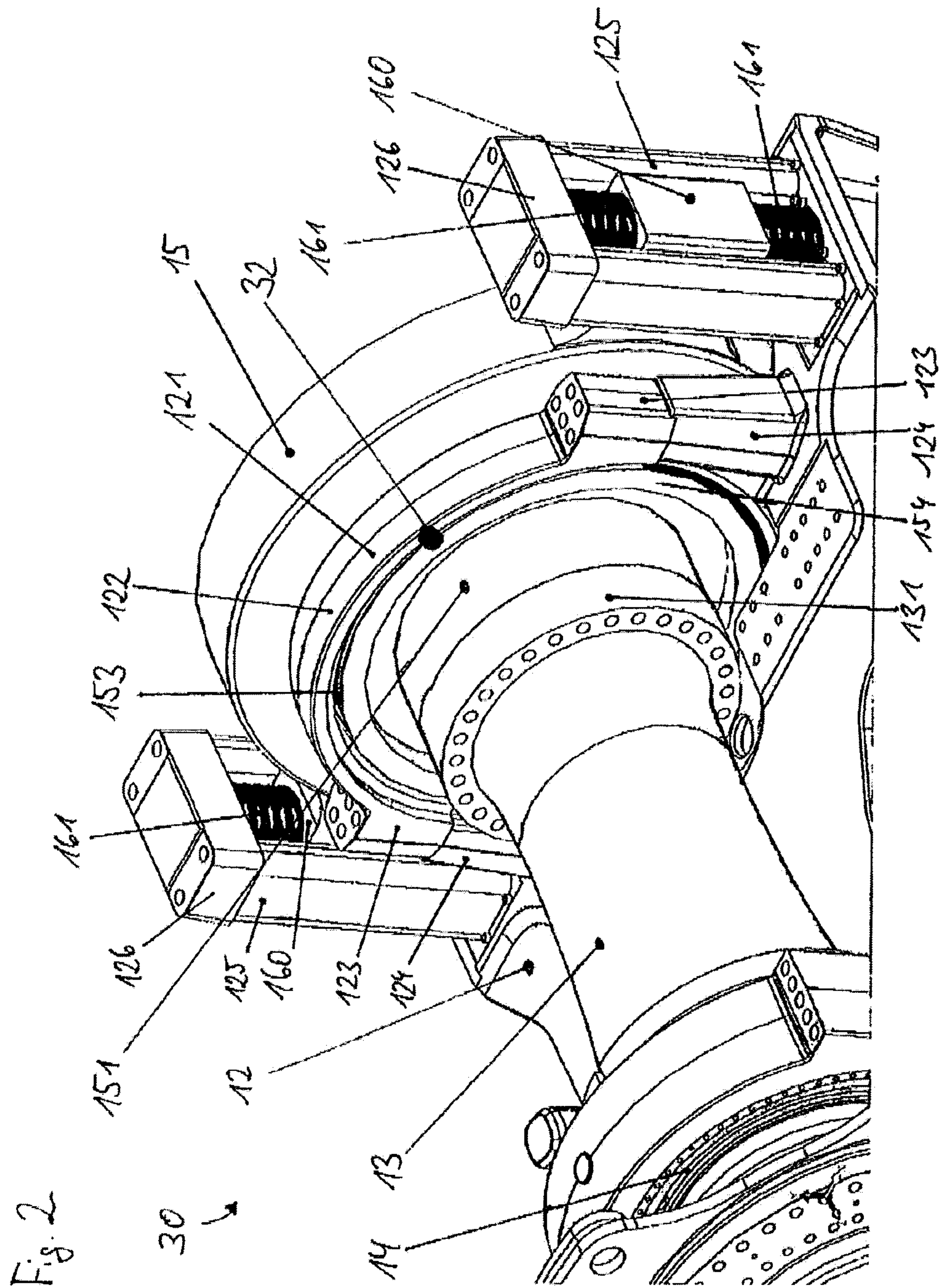


Fig. 3

