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DESCRIPTION

[0001] The present invention relates to improvements of wind energy turbines and, in particular, to a device for driving a first part of a wind energy turbine with respect to a second part of the wind energy turbine or vice versa.

[0002] Modern wind energy turbines are provided with pitch and yaw drives. By means of the yaw drive it is possible to azimuthally drive the nacelle of a wind energy turbine with respect to its tower rotatably supporting the nacelle. A pitch drive is used to adjust the rotor blade of a wind energy turbine rotor. For each rotor blade usually one separate pitch drive is provided.

[0003] Both pitch and yaw drives of wind energy turbines have brakes on the motion generating means which normally includes a electrical motor. Moreover, the electrical motor often includes the brake system. Additionally or alternatively brakes may be built on the bearing structure between the first and second part. The brakes of the pitch and yaw drives of a wind energy turbine are operable to prevent unallowed relative rotation of the one part (rotor blade or nacelle) with respect to the other part (hub or tower, respectively). However, it may happen that wind forces act on the rotor blade and nacelle which wind forces result in torques acting on the blade or on the nacelle which are higher than the break-loose torques. Since the inertia of the elements of the pitch and yaw drives are significant, the torques on the elements of the drives can rise to levels higher than the break-loose torque which may damage the drives.

[0004] It is known to provide the connection of the housing of a yaw drive to the nacelle with a slip coupling. If this coupling slips due to high wind forces acting on the nacelle, the complete housing of the yaw drive rotates with respect to the nacelle so that the electrical cables and, if provided, hydraulic conduits have to be designed accordingly to compensate for the rotation. This complicates the construction of the yaw drive.

[0005] Various conventional mechanical drives, including several that may be used for wind turbines, are discussed in the following documents: US 2004/151577, WO 96/04488, DE 103 07 929, WO 2005/012763, CA 2 343 876, EP 1 286 049 and DE 42 21 783.

[0006] The present invention is defined by the appended claims.

[0007] Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic view illustrating a yaw drive of a wind energy turbine for azimuthally rotating the nacelle of the wind energy turbine with respect to its tower.

[0008] Prior art yaw systems of wind energy turbines may undesirably be loaded to torques higher than the yaw drive can withstand. This may overload components in the drive or in the support structure. By not letting the yaw slip, the loads on components may be higher and thus require additional efforts to withstand the higher torques. The solution to this problem is the provision of a slip coupling limiting the maximum torques which the elements of the drive and its support structures are subjected to.

[0009] As shown in Figure 1, a yaw drive 10 for rotating a nacelle 12 relative to a tower 14 of a wind energy turbine is provided with a device 16 provided with a driving element 18 arranged in driving engagement with tower 14. In this embodiment driving element 18 includes a gear engaged with a ring gear 20 arranged at tower 14. Within nacelle 12 there is arranged a driving unit 22 of device 16 having a housing 24 fixedly connected to a frame 26 of nacelle 12. A planetary plus two stage gear box 28 is arranged within housing 24 although other reduction concepts are also possible to realize. Gear box 28 is a motion transferring means for transferring the motion of an input shaft 30 to an output shaft 32 to which driving element 18 is coupled. In one embodiment, input shaft 30 is a motive element which, is rotated by a motion generation means 34 which in this embodiment, an electrical motor having a brake system 36.

[0010] In Figure 1, reference numeral 38 indicates possible locations for a slip coupling to be arranged in order to prevent elements of device 16 and its support structures from being overloaded. For example, in one embodiment, the slip coupling is arranged at one of input shaft 30 and at the output shaft 32. Both can be located inside or outside the gearbox housing. An alternative location for the slip coupling is within gear box 28. In this example one of the gear box stages is designed as a planetary gear within which the slip coupling is arranged between outer ring gear 40 and one of housing 42, output shaft 32, and

input shaft 44 of the planetary gear.

[0011] Depending on the requirements and the design of the drive the slip coupling is arranged in either the high speed stage or the low speed stage of the drive. Alternatively, the slip coupling is arranged between the stages. The closer the slip coupling is arranged to the electrical motor 34 (motive generation means), the less mass moment of inertia will be isolated from the nacelle yaw movement.

[0012] Yaw drive 10 also includes a sensor means 46 for sensing relative movement of two elements of the driving unit 22 between which the slip coupling is arranged. By means of sensor means 46 it is possible to detect any slippage of the slip coupling so that it can be indicated that during the next maintenance stop of the wind energy turbine, maintenance work has to be performed on the slip coupling, too.

[0013] The device includes a driving element for driving engagement with the first part. The driving element is driven by a driving unit including a housing to be fixedly connected to the second part. The housing also includes a motion generation means (e.g. an electrical motor) for generating motion of a motive element (i.e. a shaft) and a motion transferring means for transferring the motion of the motive element to the driving element. At least one slip coupling is provided between two engaging elements of the driving unit and the slip coupling is adjusted to slip if a torque acting on the slip coupling due to a movement force acting on the driving element exceeds a predetermined maximum torque. This maximum torque is higher than the torque to be transferred by the slip coupling for actively driving the one part with respect to the other part of the wind energy turbine. The slip coupling prevents the elements of the driving unit arranged between its housing and the slip coupling from being subjected to unallowed loads which may occur due to large wind forces acting on the parts of the wind energy turbine to be driven relative to each other by the device.

[0014] The at least one slip coupling is arranged within the housing or between adjacent engaging elements of the driving unit and the driven element, respectively. In other words, the housing of the driving unit is fixedly connected to the first or second part of the wind energy turbine, respectively. Therefore, the housing of the driving unit cannot slip relative to that part of the wind energy turbine to which the housing is fixedly connected.

[0015] The at least one slip coupling is arranged within a gear box of the motion transferring means of the driving unit or is arranged within at least one driven shaft of the driving unit in order to couple two parts of the driven shaft. The at least one slip coupling prevents both elements of the driving unit from being overloaded, which element when viewed in the direction of the site of force application to the respective part of the wind energy turbine are arranged behind the slip coupling.

[0016] In order to detect slipping of the slip coupling, a sensor means is included for sensing relative movement of the two elements of the driving unit between which the slip coupling is arranged.

[0017] For maintaining the slip coupling, a monitoring means is provided for monitoring the operation of the slip coupling by applying a torque to the slip coupling up to which the slip coupling is not allowed to slip, and by applying a torque to the slip coupling at which the slip coupling has to slip. The intended function of the device is thus enabled when driving the one part with respect to the other as well as the safety feature of the device according to the invention in order to prevent elements of the driving unit from being overloaded. In one embodiment, these checking torques are introduced by using the driving unit in an overtorque mode or (in case of n driving units per bearing) by using the n-1 driving units to apply the test torques of 1 driving unit, in sequence n times.

[0018] The device is used for pitch and yaw drives of a wind energy turbine. In a pitch drive the first part is a rotor blade of a rotor of the wind energy turbine and the second part is a hub of the rotor of the wind energy turbine rotatably supporting the rotor blade. Alternatively, the parts can be switched. The rotor may comprise several rotor blades each being provided with a pitch drive provided with a slip coupling. As an alternative or in addition, a rotor blade includes the device according to the invention for rotor blade tip adjustment purposes.

[0019] In the case of a yaw drive, the second part is a nacelle of the wind energy turbine and the first part is a tower of the wind energy turbine rotatably supporting the nacelle.

[0020] In the case of a main gearbox, the first part is a rotor of the wind energy turbine and the second part is the stationary part of the gearbox and generator combination of the wind energy turbine rotatably supporting the rotor.

PARTS LIST

10	yaw drive
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12	nacelle
14	tower
16	device
18	driving element
20	ring gear
22	driving unit
24	housing
26	frame
28	gear box
30	input shaft
32	output shaft
34	electrical motor
36	brake system
38	reference numeral
40	outer ring gear
42	housing
44	input shaft
46	sensor means

REFERENCES CITED IN THE DESCRIPTION

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- [US2004151577A \[0005\]](#)
- [WO9604488A \[0005\]](#)
- [DE10307929 \[0005\]](#)
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- [CA2343876 \[0005\]](#)
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Patentkrav

1. Indretning (16) indrettet til at drive en første del af en vindmølle i forhold til en anden del af vindmøllen, hvor indretningen omfatter:

- 5 et drivelement (18) til drivende indgreb med den første del;
en drivenhed (22) omfattende et hus (24) til at blive fast forbundet til den anden del, et bevægelsesgenereringsorgan (34) til at generere bevægelse af bevægelseselementet (30), og et bevægelsesoverføringsorgan (28) til at overføre bevægelsen af bevægelseselementet (30) til drivelementet (18);
- 10 mindst en glidekobling (38) anbragt mellem mindst et af bevægelseselementet (30) af drivenheden (22) og bevægelsesoverføringsorganet, (28) bevægelsesoverføringsorganet (28) og drivelementet, (18) og inden i bevægelsesoverføringsorganet (28);
- 15 hvor glidekoblingen (38) er justeret til at glide, hvis et vridningsmoment, som virker på glidekoblingen (38) på grund af en bevægelseskraft som virker på drivelementet (18), overskrider et forudbestemt maksimalt vridningsmoment for at forhindre elementer af drivenheden (16) anbragt mellem huset (24) og glidekoblingen (38) i at blive udsat for ikke-tilladte belastninger, **kendetegnet ved at** glidekoblingen (38) endvidere omfatter
- 20 sensororgan (46) til at detektere relativ bevægelse af to elementer af drivenheden (16) mellem hvilke glidekoblingen (38) er anbragt; og endvidere omfatter et organ som driver glidekoblingen (38) ved at anvende et første vridningsmoment til glidekoblingen (38) op til hvilket glidekoblingen (38) ikke er tilladt at glide, og derefter, at påføre et andet
- 25 vridningsmoment til glidekoblingen (38) fra hvilket glidekoblingen (38) glider som indikeret af den relative bevægelse af de to elementer af drivenheden (16) som detekteret af sensororganet (46).

- 2.** Indretningen (16) ifølge krav 1, hvor bevægelsesoverføringsorganet (28)
- 30 omfatter en gearkasse og hvor den mindst ene glidekobling (38) er anbragt inden i eller ved gearkassen.

3. Indretningen (16) ifølge krav 1 eller krav 2, hvor bevægelsesoverføringsorganet (28) omfatter mindst en drevet aksel (30,32) og

hvor glidekoblingen (38) er anbragt mellem den første og anden del af den drevne aksel (30,32).

4. Indretningen (16) ifølge et hvilket som helst foregående krav, hvor den anden
5 del er en nacelle (12) af vindmøllen og den første del er et tårn (14) af vindmøllen
som roterbart bærer nacellen (12).

5. Indretningen (16) ifølge et hvilket som helst af kravene 1 til 3, hvor den første
del er en rotorvinge af en rotor af vindmøllen og den anden del er et nav af
10 rotoren af vindmøllen som roterbart bærer rotorvingen.

6. Indretningen (16) ifølge et hvilket som helst af kravene 1 til 3, hvor den første
del er en rotor af vindmøllen og den anden del er en gearkasse-generator-
kombination af vindmøllen som roterbart bærer rotoren.

DRAWINGS

