(19) DANMARK

(10) DK/EP 3341528 T3

(12) Oversættelse af europæisk patentskrift

Patent- og Varemærkestyrelsen

(51) Int.Cl.: *E 02 D 27/42 (2006.01)* *F 03 D 13/20 (2016.01)*

(45) Oversættelsen bekendtgjort den: **2022-09-05**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2022-08-03**

(86) Europæisk ansøgning nr.: **16757269.2**

(86) Europæisk indleveringsdag: **2016-08-29**

(87) Den europæiske ansøgnings publiceringsdag: **2018-07-04**

(86) International ansøgning nr.: **EP2016070296**

(87) Internationalt publikationsnr.: **WO2017032904**

(30) Prioritet: **2015-08-27 DE 102015216444**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

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(54) Benævnelse: **Vindenergianlæg**

(56) Fremdragne publikationer:
EP-A1- 1 526 278
EP-A1- 2 821 565
DE-U1-202009 013 844

Description

The present invention concerns a wind turbine.

Before a tower of a wind turbine is erected it is necessary to provide a suitable concrete foundation in the ground. The foundation is typically cast with concrete on site (in-situ concrete). After the concrete has set a first segment of the tower of the wind turbine can be placed on the foundation.

WO 2012/035206 A1 shows a wind turbine and a foundation of a wind turbine.

On the German patent application from which priority is claimed the German Patent and Trade Mark Office searched the following documents: DE 10 2007 060 379 B4, DE 10 2013 211 750 A1, DE 20 2009 013 844 U1, EP 2 375 057 A1, EP 2 821 565 A1, WO 2012/035 206 A1, CN 203 924 104 U1 and CN 203924104 U. The above-mentioned document EP 2 821 565 A1, DE 20 2009 013 844 U1 or EP 1 526 278 A1 disclose a wind power installation comprising a foundation, wherein the foundation has a first foundation portion having a top side and a concrete foundation pedestal having a top side, wherein the top side of the concrete foundation pedestal is angular and projects beyond the top side of the first foundation portion, a steel tower having a flange and a plurality of through holes, a plurality of clamping elements, wherein lower ends of the clamping elements are fastened by means of first fixing units in or under the first foundation portion, wherein upper ends of the clamping units project beyond the upper end of the concrete foundation pedestal and extend through the through bores, wherein the upper ends of the clamping elements are braced by means of second fixing units, wherein a plurality of bores for receiving the clamping elements is provided in the foundation pedestal and the foundation portion, wherein the bores in the region of the concrete foundation pedestal are through bores.

An object of the present invention is to provide a wind turbine and a tower of a wind turbine having an improved foundation.

That object is attained by a wind turbine according to claim 1 and by a method for erecting a wind turbine according to claim 3.

Thus there is provided a wind turbine having a foundation. The foundation has a first foundation portion having a top side and a concrete foundation pedestal having a top side. The top side of the concrete foundation pedestal is annular and projects beyond the top side of the first foundation portion. The wind turbine also has a steel tower having a plurality of tower segments, wherein a lower tower segment has a flange having a plurality of through bores. The flange is placed on a top side of the concrete foundation. The wind turbine further has a plurality of clamping elements. A lower end of the clamping elements is fixed by means of a fixing unit in or under the first foundation portion. An upper end of the clamping elements projects beyond an upper end of the concrete foundation pedestal and extends through the through holes. The upper ends of the clamping elements are braced by means of fixing units. The outward side of the concrete foundation pedestal is of a conical configuration. Provided in the concrete pedestal and in the foundation portion is a plurality of bores for receiving the clamping elements. The bores in the region of the concrete pedestal are through bores, through the entire height of the concrete pedestal.

According to an aspect of the present invention the clamping elements are in the form of threaded rods or in the form of stressing wire strands.

According to the present invention the height of the concrete foundation pedestal is greater than 2 m.

Further configurations of the invention are subject-matter of the appendant claims.

Advantages and embodiments by way of example of the invention are described in greater detail hereinafter with reference to the drawing.

Figure 1 shows a diagrammatic view of a wind turbine according to the invention,

Figure 2 shows a diagrammatic sectional view of a wind turbine foundation according to a first embodiment, and

Figure 3 shows a diagrammatic sectional view of a wind turbine foundation according to a second embodiment.

Figure 1 shows a diagrammatic view of a wind turbine according to the invention. The wind turbine 100 has a tower 200 and a pod 104.

The tower 200 comprises a plurality of tower segments 201 – 206. The tower segments 201 – 206 are produced in particular from steel. Provided on the pod 104 is a rotor 106 having (three) rotor blades 108 and a spinner 110. In operation of the wind turbine the rotor 106 is caused to rotate by the wind and thus also rotates a rotor or rotor member of an electric generator in the pod 104. The pitch angles of the rotor blades 108 can be varied by pitch motors at the rotor blade roots of the respective rotor blades 108.

Figure 2 shows a diagrammatic sectional view of a wind turbine foundation according to a first embodiment. A lower tower segment 201 of steel is placed on a foundation 300. The lower tower segment 201 has a flange 200a having a plurality of through bores 200b.

The foundation 300 can represent for example a foundation made of in-situ concrete. As an alternative thereto it is also possible to use a prefabricated concrete foundation. The foundation 300 has a foundation portion 310 and a concrete foundation pedestal 330. The foundation portion 310 has an upper edge or an upper end 311. The concrete foundation pedestal 330 projects beyond the upper edge 311. The flange 200a of the lower tower segment 201 is placed at a top side 331 of the concrete foundation pedestal 330. The concrete foundation pedestal 330 can be annular. The concrete foundation pedestal 330 can be concreted on to the upper edge 311 of the foundation portion 310. That concrete foundation pedestal 330 can also replace a lower tower portion.

The concrete pedestal 310 is of a conical configuration at its outward side 332 and is of a height 333 above the upper edge 311. An inward side 334 of the concrete pedestal 330 can be straight. The concrete foundation pedestal 300 has a plurality of through holes or bores 335 for receiving clamping elements 320. The pedestal 330 projects beyond a ground level 10 of the ground 11 in the region of the foundation (that is to say around the foundation).

The through bores 335 extend along the entire height of the concrete foundation pedestal 330.

A plurality of threaded rods 320 can be provided in the concrete foundation 300, wherein a lower end 320a of the threaded rod 320 is fixed by means of a plate 323, a washer 334 and a (hexagonal) nut 325.

The other or upper end 320b of the threaded rod 320 projects beyond the upper end 331 of the concrete pedestal 330. The flange 200a has a plurality of through bores 200b. The through holes 200b are placed over the upper ends 320b of the threaded rods 320 and the flange 200a can be fixed for example by means of a plurality of washers 321 and nuts 322.

The concrete pedestal 330 and the flange 200a can be of an annular configuration.

Figure 3 shows a sectional view of a wind turbine foundation according to a second embodiment. A concrete foundation 300 has a first concrete foundation portion 310 having an upper end 311. The foundation 300 further has a concrete pedestal 330 which extends above the upper end 311 and has an upper end 331. The upper end 331 of the pedestal 330 can be in particular of a circular or annular configuration. A plate 323 or a ring 323 can be provided beneath the first foundation portion 310. Provided in the foundation is a plurality of clamping units like stressing wire strands 302, the lower ends 302a of which are held by means of a fixed anchor 325a. A tensioning anchor 322a can be provided at the upper end 302b of the stressing wire strand 302. The lower flange 200a of the lower tower segment 201 can be fixed to the foundation by means of the stressing wire strand 320a, the fixed anchor 325a and the tensioning anchor 322a.

The concrete pedestal 310 is of a conical configuration at its outward side 332 and is of a height 333 above the upper edge 311. An inward side 334 of the concrete pedestal 330 can be straight. The concrete foundation pedestal 300 has a plurality of through holes 335 for receiving clamping elements 320. The through bores 335 extend along the overall height of the concrete foundation pedestal 330. The pedestal 330 projects beyond a ground level 10 of the ground 11 in the region of the foundation (that is to say around the foundation).

The concrete foundation portion 310 can be in the form of in-situ concrete or in the form of a precast (concrete) foundation. The concrete foundation pedestal 310 is of a conical configuration, that is to say the outside diameter of the lower end 334 is larger than the outside diameter of the upper end 331. The transmission of load of the tower 200 to

the foundation 300 can be improved or optimised by virtue of the larger outside diameter at the lower end while the outside diameter of the lower tower portion can be reduced, which is advantageous in regard to transport.

The height 333 of the foundation pedestal 310 can correspond to a height of a lower tower segment (that is to say for example > 3m) so that the lower tower segment 201 can be at least partially replaced by a higher foundation pedestal 310.

The conical configuration of the concrete foundation pedestal 330 means that it is possible to increase a diameter, that is structurally and/or statically necessary, in respect of the transition between the pedestal and the foundation portion. Nonetheless the diameter of the upper end of the pedestal (and thus the diameter of the lower tower segment) can be reduced, more specifically to a degree less than the maximum width for on-land transport operations.

According to an aspect of the invention an underside of the flange 200a of the lower tower segment is placed directly on a top side 331 of the concrete foundation pedestal 330, which projects beyond an upper side of a first foundation portion 310.

According to the invention a single-row screw means or stressing means for the lower tower segment 201 is provided. According to the invention the through holes 200b in the flange 200a are provided within the wall of the lower tower segment so that the screw means or stressing means is provided within the wall of the lower tower segment and the stressing means is thus protected from the influences of the weather. As an alternative thereto a dual-row screw means is also possible. In that case the lower flange could be in the form of a T-flange.

Optionally the top side 311 of the foundation portion can correspond to a ground level so that the pedestal 330 projects above the ground level.

Patentkrav

1. Vindenergianlæg (100) med
et fundament (300), hvor fundamentet (300) har et første fundamentafsnit (310) med en overside (311) og en betonfundamentsokkel (330) med en overside (331),
hvor oversiden (331) af betonfundamentsoklen (330) er udformet ringformet og rager ud over oversiden (311) af det første fundamentafsnit (310),
et ståltårn (200) med en flerhed af tårnsegmenter (201 - 206), hvor et nedre tårnsegment (201) omfatter en flange (200a) med en flerhed af gennemgangsboringer (200b),
hvor flangen (200a) er anbragt på en overside (331) af betonfundamentsoklen (330),
en flerhed af spændeelementer, hvor nedre ender (320a, 302a) af spændeelementerne (320, 302) er fastgjort i eller under det første fundamentafsnit (310) ved hjælp af første fastgørelsesenheder (325, 325a),
hvor øvre ender (320b, 302b) af spændeelementerne (320, 302) rager ud over den øvre ende (331) af betonfundamentsoklen og strækker sig gennem gennemgangsboringerne (200b),
hvor de øvre ender (320b, 302b) af spændeelementerne (320b, 302b) er spændt ved hjælp af andre fastgørelsesenheder (321, 321a, 322),
hvor ydersiden (332) af betonfundamentsoklen (330) er udformet konisk,
hvor der i betonfundamentsoklen (330) og i fundamentafsnittet (310) er tilvejebragt en flerhed af boringer (335) til optagelse af spændeelementerne,
hvor boringerne (335) i betonfundamentsoklens (330) område er gennemgangsboringer (335),
hvor en højde (333) af betonfundamentsoklen (330) er større end 2 m.

2. Vindenergianlæg ifølge krav 1, hvor
spændeelementerne (320, 320a) er udformet som gevindstænger (320) eller som spændekabler (320a).

3. Fremgangsmåde til opførelse af et vindenergianlæg med trinnene:

at tilvejebringe et fundament (300), der har et første fundamentafsnit (310) med en overside (311) og en betonfundamentsokkel (330) med en overside (311),

hvor oversiden (311) af betonfundamentsoklen (330) er udformet ringformet og rager ud over oversiden (311) af det første fundamentafsnit (310),

at anbringe et ståltårn (200) med en flerhed af tårnsegmenter (211-206) på fundamentet,

hvor et nedre tårnsegment (201) omfatter en flange (200a) med en flerhed af gennemgangsboringer (200b),

at anbringe flangen (200a) på oversiden (331) af betonfundamentsoklen (330),

at fastgøre nedre ender (320a, 302a) af en flerhed af spændeelementer i eller under det første fundamentafsnit (310) ved hjælp af første fastgørelsesenheder (325, 325a),

hvor de øvre ender (320b, 302b) af flerheden af spændeelementer (320, 302) rager ud over den øvre ende (331) af betonfundamentsoklen (330) og strækker sig gennem gennemgangsboringerne (200b) i flangen (200a),

at spænde de øvre ender (320b, 302b) af flerheden af spændeelementer (320b, 302b) ved hjælp af andre fastgørelsesenheder (321, 321a, 322),

hvor ydersiden (332) af betonfundamentsoklen (330) er udformet konisk,

hvor der i betonfundamentsoklen og i fundamentafsnittet (310) er tilvejebragt en flerhed af boringer (335) til optagelse af spændeelementerne,

hvor boringerne (335) i betonfundamentsoklens (330) område er gennemgangsboringer (335),

hvor en højde (333) af betonfundamentsoklen (330) er større end 2 m.

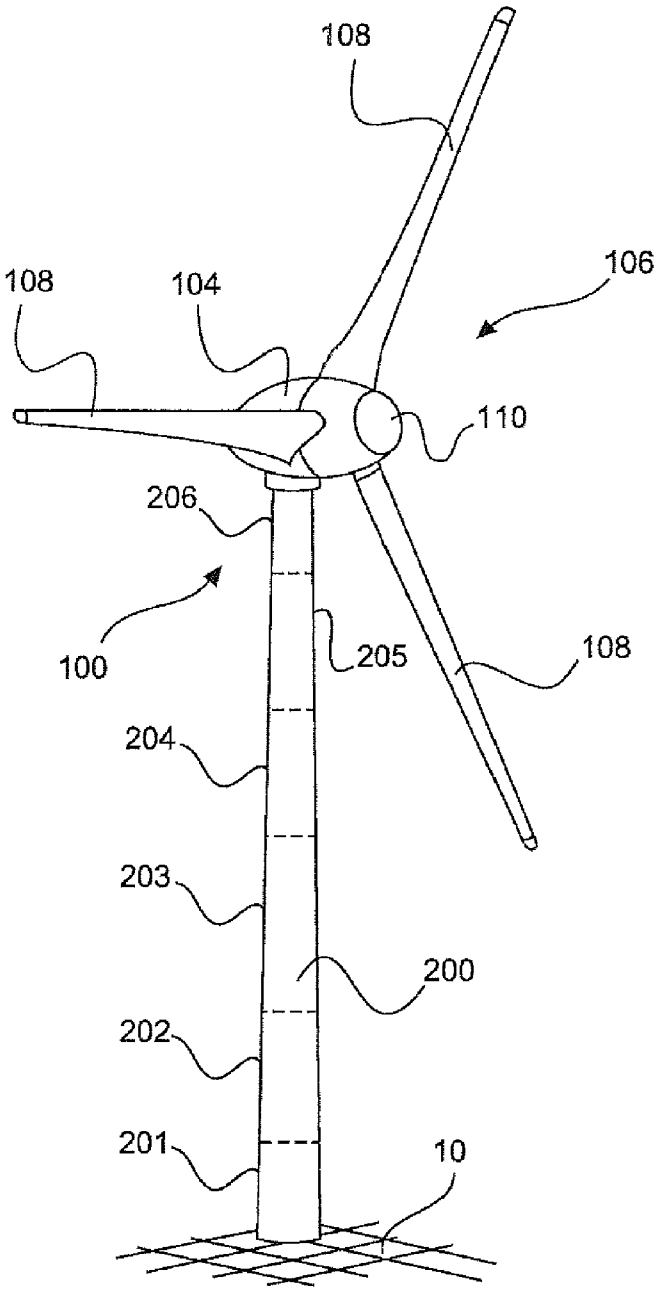

Fig. 1

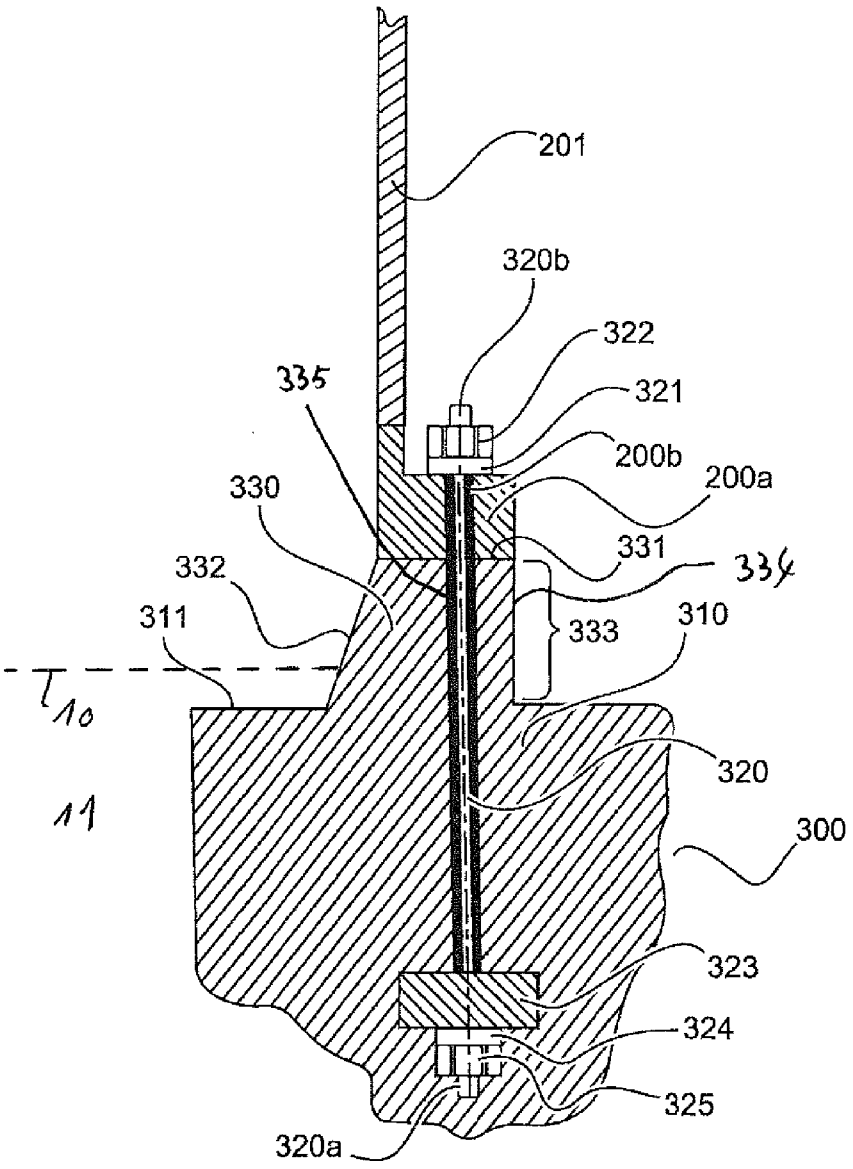
201
320b
322
321
335
200b
200a
330
331
332
334
311
333
310
T10
11
320
300
323
324
325
320a

Fig. 2

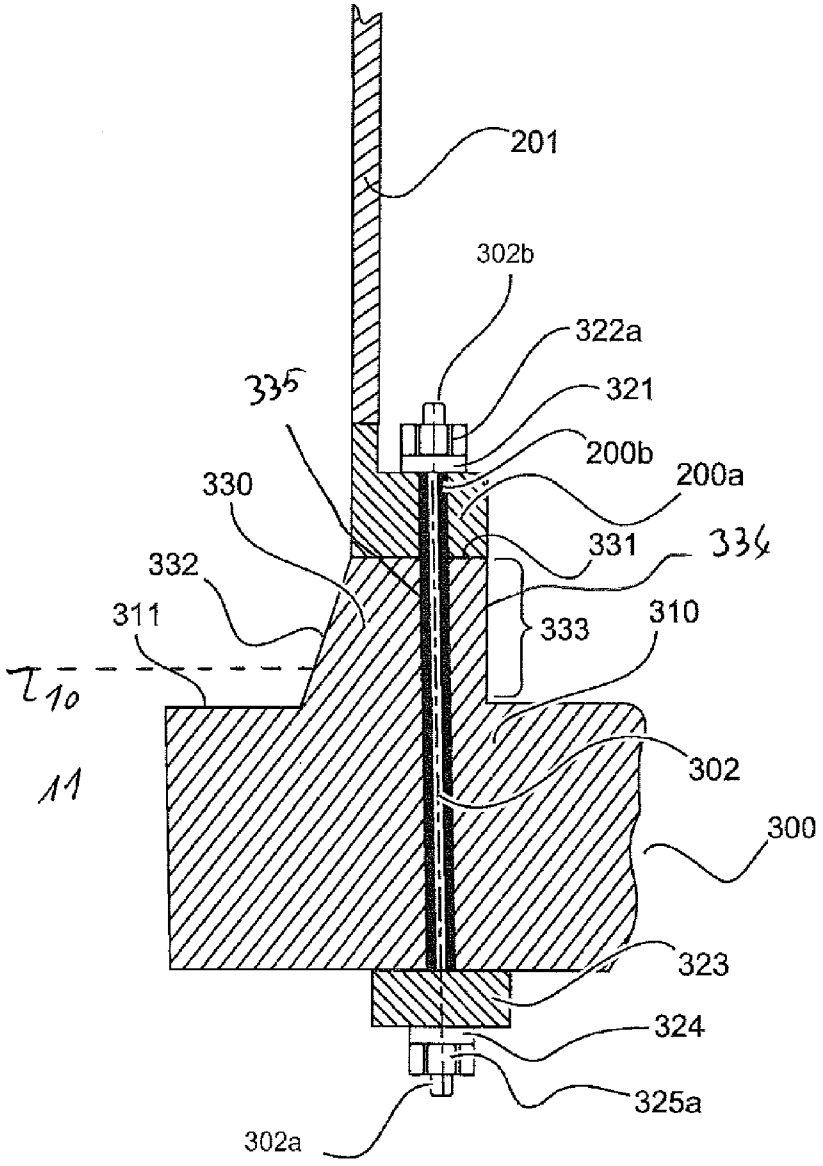
201
302b
322a
321
335
200b
200a
330
331
336
332
333
311
310
l_{10}
11
302
300
323
324
325a
302a

Fig. 3