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WIND TURBINE COMPRISING AN INTERNAL POWER SUPPLY UNITDescription

- 5 [0001] The invention relates to a wind turbine comprising an internal power supply unit. The wind turbine comprises a wind rotor for driving a generator comprising a converter for generating electrical power and a controller. For the internal power supply, an auxiliaries transformer is provided, which is in turn supplied with power from the converter or the generator via a power link.
- 10 [0002] When assembling wind turbines and in particular when commissioning same, a power supply is required in order to be able to provide the electrical energy required for certain functions of the wind turbine. Such functions are, besides those of controlling the wind turbine itself, also those of controlling certain actuators, for example the azimuth system for swiveling the nacelle depending on the wind direction.
- 15 [0003] For the purposes of setting up and commissioning the wind turbine at the installation site, usually a power unit is provided, which is usually in the form of a diesel generator. Voltages of 230 V and 400 V voltage levels are thus generated for supplying power. Since a higher voltage level (usually 660 V) is required for the azimuth drive, which is usually powerful, the power unit is provided with an additional transformer, which
- 20 makes available the necessary 660 V voltage level from the voltage levels generated by the diesel unit. Such an additional transformer is known for example from WO 2011/014343 A1. Despite the portable design of the additional transformer, a lot of effort is involved in providing and then removing the latter.
- [0004] DE 10 2009 017 244 A1 discloses a wind turbine comprising an auxiliaries grid, with
- 25 an auxiliaries transformer being provided in order to supply power thereto.
- [0005] In principle, this known concept of using a power unit with an additional transformer for generating the higher voltage level is practicable, but it is relatively laborious to use. In addition, a safety problem arises since the direct feeding of the azimuth drive via the higher voltage provided by the additional transformer makes it
- 30 necessary to bypass safety systems in the nacelle of the wind turbine. This further increases the risk of an activity that already tends to be hazardous.

[0006] The object of the invention is to enable an internal power supply for the wind turbine, in particular during set-up and commissioning, in such a way as to avoid the aforementioned disadvantages.

[0007] The solution according to the invention lies in the features of the independent claims. Advantageous developments form the subject matter of the dependent claims.

[0008] In a wind turbine comprising a wind rotor for driving a generator comprising a converter for generating electrical power, a controller and an internal power supply unit, for which an auxiliaries transformer is provided, which is connected at the feed-in connection thereof to the generator and/or converter via a power link and supplies power to the internal power supply unit via the low-voltage connection thereof, according to the invention a switching device for the auxiliaries transformer is provided, which is designed to reverse a power flow through the auxiliaries transformer in a reverse operating mode in such a way that in the reverse operating mode the feed-in connection of the auxiliaries transformer acts as output and is connected to a high-voltage consumer, and an output connection of the auxiliaries transformer acts as input and is fed from the low-voltage connection of the internal power supply unit.

[0009] The invention is based on the concept of making use of the auxiliaries transformer that is already present in any case for commissioning the wind turbine. In the regular operating mode, the auxiliaries transformer reduces the voltage generated by the generator/converter system from a high voltage level (for example 660 V) to such an extent that it is used for the internal power supply at a low voltage level (for example 400 V). In the normal operating mode, therefore, the auxiliaries transformer reduces the voltage. The invention makes use of this transformer, which is already present in any case, by reversing the power flow through it during commissioning and thus inverting the function thereof, namely to create a transformer that increases the voltage. By thus switching over the power flow through the auxiliaries transformer to a reverse operating mode, the auxiliaries transformer can be used to generate the high voltage level required during commissioning, for which a separate additional transformer previously had to be provided.

[0010] The invention has recognized that, by operating the auxiliaries transformer in reverse, there is no need to use a separate additional transformer for the commissioning. Since the required high voltage level is generated internally within the nacelle thanks to the auxiliaries transformer operated in reverse (and is not supplied from outside by means

of a separate additional transformer), it is no longer necessary to switch off safety systems of the nacelle for the purpose of feeding in the high voltage from outside. The safety problems that occur in the prior art are thus avoided.

[0011] The invention thus combines in an astonishingly simple way the advantages of a less complicated solution with those of a solution that is at the same time also safer.

[0012] The switching device is advantageously designed as part of a feedback distribution system, which can be assembled and disassembled in a modular manner. This not only enables a compact construction, but also makes it possible for the feedback distribution system to be preassembled with the switching device in the factory. In terms of assembly, therefore, everything is thus prepared for commissioning, so that it is no longer necessary for any work in this regard to be carried out at the installation site itself. Commissioning can take place simply by using the feedback distribution system. Once commissioning has taken place, even the feedback distribution system, which is no longer required, can be removed in a modular manner and reused to install other wind turbines.

[0013] The feedback distribution system is advantageously designed in such a way that it is connected to the high-voltage consumer of the internal power supply unit and is attached to the feed-in connection of the auxiliaries transformer. This ensures that a power supply with the required high voltage level (660 V) is achieved by the modularly assembled feedback distribution system. The high-voltage consumer may in particular be a high-voltage connection of the internal power supply unit.

[0014] The modular design of the feedback distribution system is particularly advantageous when the feedback distribution system is already preassembled in the wind turbine. One particularly simple possible embodiment of the switching device consists in a reversible cable link. Preferably, the power link of the auxiliaries transformer is isolated from the auxiliaries transformer when the switching device is actuated.

[0015] The feedback distribution system is advantageously formed in a housing, through which each of the phases is conducted by means of a fuse and which preferably has, at least on one side, flexible connection lines for mobile operation. Once commissioning has taken place, disassembly can thus easily be carried out, and the feedback distribution system is ready for reuse without any problem. The internally arranged fuses also provide sufficient intrinsic safety, so that no additional external safety measures need to be taken for commissioning.

[0016] The invention further extends to a retrofitted energy supply system for wind turbines, which have a wind rotor for driving a generator comprising a converter for generating electrical power and a controller, comprising an auxiliaries transformer for the power supply, which is connected at the feed-in connection thereof to the generator and/or to the converter via a power link and supplies power to the energy supply unit via the low-voltage connection thereof, it being provided according to the invention that the retrofitted energy supply system has a switching device for the auxiliaries transformer, which is designed to reverse a power flow through the auxiliaries transformer in a reverse operating mode in such a way that in the reverse operating mode the feed-in connection of the auxiliaries transformer acts as output and is connected to a high-voltage consumer, and an output connection of the auxiliaries transformer acts as input and is fed from the low-voltage connection of the internal power supply unit.

[0017] The invention further extends to a method for constructing and commissioning a wind turbine, which has a wind rotor for driving a generator comprising a converter for generating electrical power and a controller, wherein an internal power supply unit and an auxiliaries transformer are provided for internal power supply, wherein the invention provides for switching over the auxiliaries transformer in a reverse operating mode with reversed power flow direction, wherein the auxiliaries transformer generates an increased voltage, and for using the feed-in connection of the auxiliaries transformer as output with a reconnection from a power source to a high-voltage connection of the internal power supply unit.

[0018] For a more detailed explanation of these further aspects of the invention, reference is made to the above description.

[0019] The invention will be explained in greater detail below with reference to the accompanying drawing, in which an advantageous exemplary embodiment is shown. In the drawing:

Fig. 1: shows a schematic view of a wind turbine according to an exemplary embodiment of the invention;

Fig. 2: shows a detail view of a feedback module of the exemplary embodiment according to Fig. 1;

Fig. 3: shows a functional diagram of an internal power supply without feedback; and

Fig. 4: shows a functional diagram of the internal power supply with feedback according to the exemplary embodiment of the invention.

[0020] A wind turbine according to an exemplary embodiment of the invention is designated as a whole by reference sign 1. It comprises a tower 10, at the upper end of which a nacelle 11 is arranged such as to be able to swivel. The ability to swivel is given in the horizontal plane, so that the nacelle 11 rotates about the central axis of the tower 10. As the actuator for this, a swivel drive 12 is provided, which swivels the nacelle 11 by means of a pinion and a gearwheel that is fixedly arranged on the tower.

[0021] A wind rotor 13 is rotatably arranged on an end face of the nacelle 11 and, via a rotor shaft, drives a generator 14 arranged within the nacelle 11. The generator 14 generates electrical power, which it outputs, by way of the converter 15 connected thereto via cabling 18 in the tower 10, to a system transformer 19 at the base of the tower 10. Via the latter, the electrical power is output to a grid (not shown).

[0022] Also arranged in the nacelle 11 are a controller 2, which acts as an operational controller for the wind turbine, and an auxiliaries transformer 3, which provides the electrical energy required to operate the components within the nacelle, in particular the controller 2 and the internal power supply unit 4 thereof. Furthermore, an uninterruptible power supply (UPS) 7 is provided in the nacelle 2, it being possible, as an alternative or in addition, for an emergency power unit 8 to be arranged in the tower 10.

[0023] In the regular operating mode (see Fig. 3) of the wind turbine 1, electrical power is supplied to the controller 2 and the internal power supply unit 4 thereof via an auxiliaries transformer 3. The latter is connected at the feed-in connection 31 thereof to the converter 15 via a power link 17 and in this way is supplied with electrical power from the generator 14. The power flow direction through the auxiliaries transformer 3 is shown by an arrow in Fig. 3. The electrical power is stepped down by the auxiliaries transformer from the voltage of the converter 15, which is usually 660 V, to a voltage of around 400 V, which corresponds to the usual mains voltage in the three-phase system, and is output at the output connection 32 thereof for delivery to a 400 V low-voltage connection 41 of the internal power supply unit 4, to which the controller 2 is also connected. To supply power in an emergency, the UPS 7 is connected to the low-voltage connection 41 of the power supply unit 4, as is possibly also the emergency power unit 8. These also form the power source for the commissioning.

[0024] In the exemplary embodiment of the invention described here, a switching device 6 is provided (see Fig. 4), which for commissioning purposes reverses the power flow direction of the auxiliaries transformer 3. The switching device 6 is integrated with a feedback distribution system 5 and is looped into the connection line for the feed-in connection 31 of the auxiliaries transformer 3. The feedback distribution system 5 is integrated in a housing 50, in which a fuse 51 is provided for each phase. A flexible phase line 45 is connected to each fuse via a respective screw connector 52. Thanks to the flexible phase line 45, the feedback distribution system 5 can easily be assembled in the nacelle 11 in a modular manner during manufacture and can be disassembled again once commissioning of the wind turbine 1 has taken place.

[0025] When the switching device 6 is actuated for commissioning, the feed-in connection 31 is reversed from the lower position (solid line) shown in Fig. 4 to the upper position (dashed line) for operation during commissioning. In doing so, the feed-in connection 31 of the auxiliaries transformer 3 is no longer connected to the converter 15 as power source, but instead is connected to a high-voltage connection 40 of the internal power supply unit 4. At the high-voltage connection 40, a voltage of around 660 V is expected in order to supply power to high-voltage consumers, in particular the swivel drive 12. The output connection 32 of the auxiliaries transformer 3 is connected to the low-voltage connection 41 of the internal power supply unit 4 and is now supplied with the 400 V low voltage via the latter and the UPS 7 connected thereto. The UPS 7 may optionally be bolstered by the emergency power unit 8, which is preferably arranged at the base of the tower 10 and is connected via a low-voltage line 48. Therefore, when the switching device 6 is actuated, the auxiliaries transformer 3 is now fed with a low voltage at a level of 400 V via its actual output connection 32, and outputs a higher voltage, namely at a level of 660 V, at its actual feed-in connection 31. The power flow direction through the auxiliaries transformer 3 is thus reversed (see arrow shown in dashed line) in relation to the originally intended power flow direction (arrow shown in solid line). This switching-over of the auxiliaries transformer 3 means that the voltage required for operating high-power components, such as the swivel drive 12, can be generated from the 400 V voltage of the internal power supply unit 4, namely without an additional separate transformer being required for this purpose.

[0026] The switching device 6 with the feedback distribution system 5 is of modular design so that it can be removed once commissioning has taken place. The auxiliaries

transformer 3 is then permanently connected to the converter 15 via the power link 17. The feedback distribution system 5 with the switching device 6 thus becomes free and can be reused to commission another wind turbine.

Patentkrav

1. Vindturbine, der omfatter en vindrotor (13) til at drive en generator (14), som omfatter en
5 konverter (15) til frembringelse af elektrisk strøm, en styreenhed (2) og en intern
strømforsyningsenhed (4), til hvilken en hjælpetransformator (3) er tilvejebragt, som er sluttet
via indgangsforbindelsen (31) derpå til generatoren (14) og/eller konverteren (15) via et
strømuttag (17) og leverer strøm til den interne strømforsyningsenhed (4) via
lavspændingsforbindelsen (41) derpå,
10 **kendetegnet ved, at**
der er tilvejebragt en skifteanordning (6) til hjælpetransformatoren (3), som er designet til at
vende et strømgennemløb gennem hjælpetransformatoren (3) i en omvendt driftstilstand på
en sådan måde, at i den omvendte driftstilstand fungerer indgangsforbindelsen (31) på
hjælpetransformatoren (3) som udgang og er forbundet med en højspændingsforbruger, og en
15 udgangsforbindelse (32) på hjælpetransformatoren (3) fungerer som indgang og fødes fra
lavspændingsforbindelsen (41) på den interne strømforsyningsenhed (4).
2. Vindturbinen ifølge krav 1,
kendetegnet ved, at
20 skifteanordningen (6) er del af et feedbackdistributionssystem (5), der fortrinsvis kan samles
og adskilles på en modulopbygget måde.
3. Vindturbinen ifølge krav 2,
kendetegnet ved, at
25 feedbackdistributionssystemet (5) er sluttet til højspændingsforbrugeren og er forbundet med
indgangsforbindelsen (31) på hjælpetransformatoren (3).
4. Vindturbinen ifølge krav 2 eller 3,
kendetegnet ved, at
30 feedbackdistributionssystemet (5) er forudsamlet i vindturbinen.
5. Vindturbinen ifølge ethvert af de foregående krav,

kendetegnet ved, at

højspændingsforbrugeren er en højspændingsforbindelse (40) på den interne strømforsyningsenhed (4).

- 5 6. Vindturbinen ifølge ethvert af de foregående krav,

kendetegnet ved, at

skifteanordningen (6) omfatter en reversibel kabelforbindelse (45).

7. Vindturbinen ifølge ethvert af de foregående krav,

- 10 **kendetegnet ved, at**

strømforbindelsen (17) er isoleret fra hjælpetransformatoren (3), når skifteanordningen (6) aktiveres.

8. Vindturbinen ifølge ethvert af kravene 2 til 4,

- 15 **kendetegnet ved, at**

feedbackdistributionssystemet (5) er arrangeret i et hus (50), og en sikring (51) fortrinsvis er tilvejebragt til hver fase, og fleksible forbindelseslinjer (45) til den mobile betjening af feedbackdistributionssystemet (5) desuden fortrinsvis er tilvejebragt i mindst én side.

- 20 9. Eftermonteret energiforsyningssystem til vindturbiner, som omfatter en vindrotor (13) til at drive en generator (14), som omfatter en konverter (15) til frembringelse af elektrisk strøm og en styreenhed (2), der omfatter en strømforsyningsenhed (4) og en hjælpetransformator (3), som er sluttet ved indgangsforbindelsen (31) derpå til generatoren (14) og/eller til konverteren (15) via et strømuttag (17) og leverer strøm til strømforsyningsenheden (4) via
25 lavspændingsforbindelsen (41) derpå,

kendetegnet ved, at

- der er tilvejebragt en skifteanordning (6) til hjælpetransformatoren (3), som er designet til at vende et strømgennemløb gennem hjælpetransformatoren (3) i en omvendt driftstilstand på en sådan måde, at i den omvendte driftstilstand fungerer indgangsforbindelsen (31) på
30 hjælpetransformatoren (3) som udgang og er forbundet med en højspændingsforbruger, og en udgangsforbindelse (32) på hjælpetransformatoren (3) fungerer som indgang og fødes fra lavspændingsforbindelsen (41) på den interne strømforsyningsenhed (4).

10. Eftermonteret energiforsyningssystem ifølge krav 9,

kendetegnet ved, at

det er forbedret ifølge et af kravene 2 til 8.

- 5 **11.** Fremgangsmåde til konstruktion og ibrugtagning af en vindturbine, der har en vindrotor (13) til at drive en generator (14), som omfatter en konverter (15) til frembringelse af elektrisk strøm og en styreenhed (2), hvori en indbygget strømforsyningsenhed (4) og en hjælpetransformer (3) er tilvejebragt til intern strømforsyning, og hvori styreenheden (2) er forsynet med elektrisk strøm til idriftsættelse,

kendetegnet ved

- 10 skifte over hjælpetransformatoren (3) i en omvendt driftstilstand med vendt strømgennemløbsretning, hvor hjælpetransformatoren (3) frembringer en øget spænding, som omfatter brugen af indgangsforbindelsen (31) på hjælpetransformatoren som udgang og gentilslutningen deraf fra en strømkilde til en højspændingsforbindelse (40) på den interne strømforsyningsenhed (4).

15

- 12.** Fremgangsmåden ifølge krav 11,

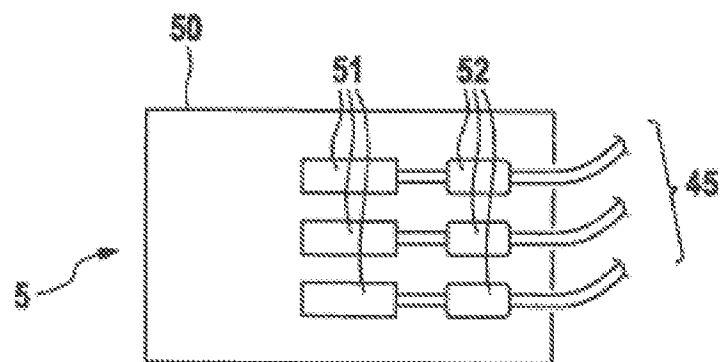
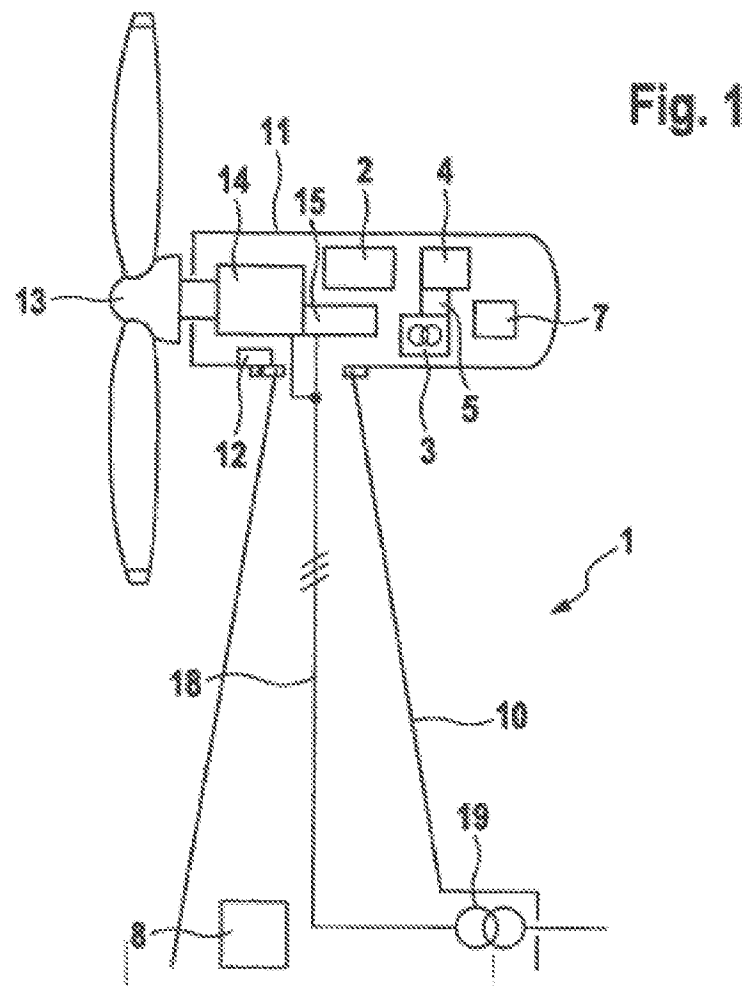
kendetegnet ved

brug af den omvendte driftstilstand ved idriftsættelse af vindturbinen.

- 20 **13.** Fremgangsmåde ifølge krav 11 eller 12,

kendetegnet ved, at

der er tilvejebragt et feedbackdistributionssystem (5), der fortrinsvis er udviklet ifølge ét af kravene 2 til 8.



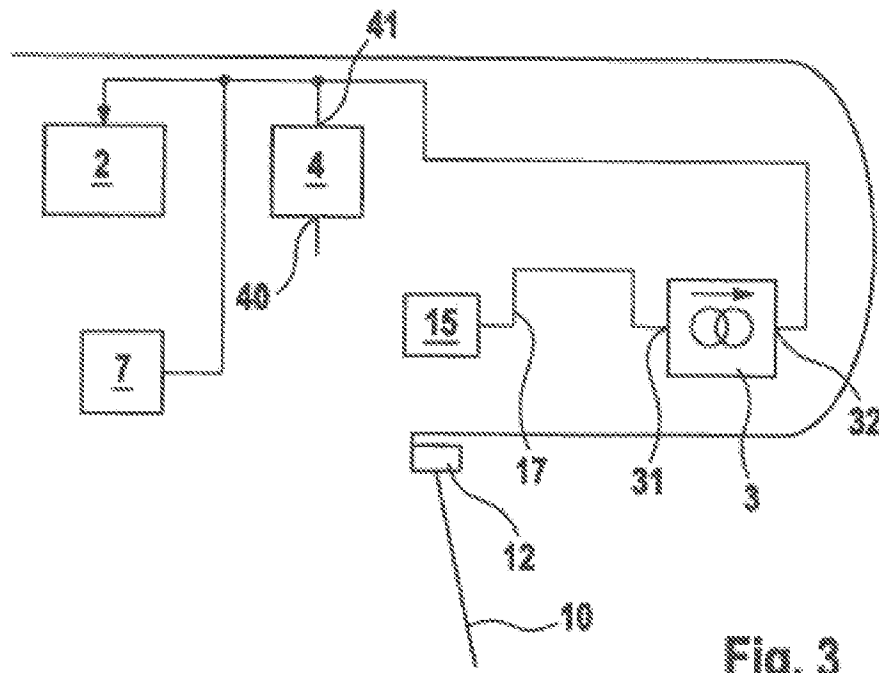


Fig. 3

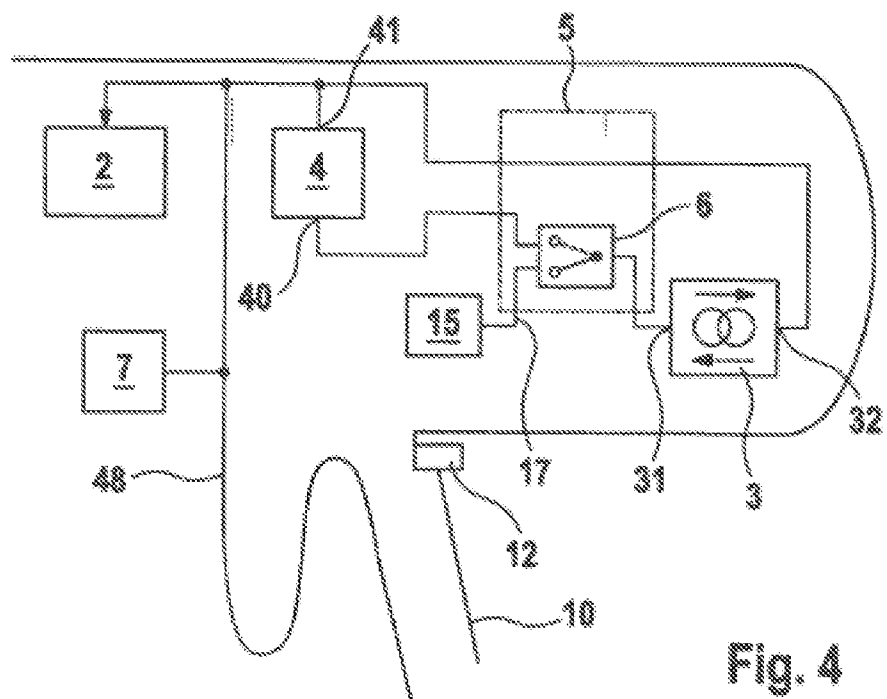


Fig. 4