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(54) **Title**: BLADE PITCHING SYSTEM FOR A HORIZONTAL AXIS WIND TURBINE

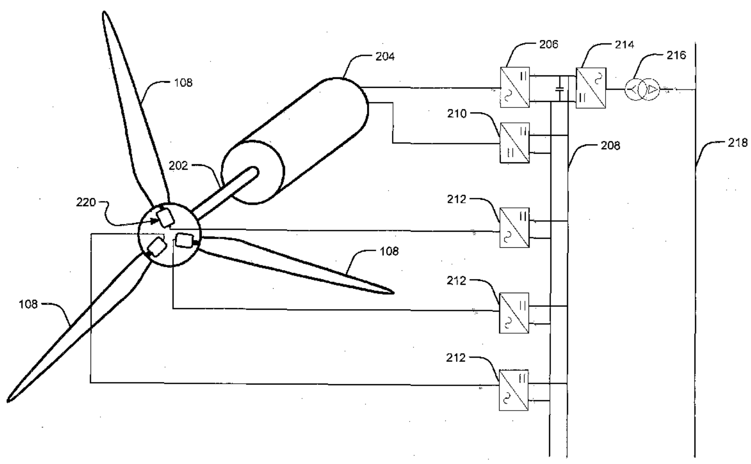

Figure 2

(57) **Abstract**: The present subject matter relates to a pitching system for a blade (108) of a horizontal axis wind turbine (100). The pitching system includes a motor-cum-generator (220) to adjust a pitch of the blade (108) during a pitch-in mode, the blade (108) being adjusted against wind force during the pitch-in mode, and to generate an output power during a pitch-out mode, the blade (108) being pitched by wind force during the pitch-out mode and acting as a prime mover for the motor-cum-generator (220) during the pitch-out mode. The pitching system also includes a power converter (212) provides an input power to the motor-cum-generator (220) to adjust the pitch of the blade (108) during the pitch-in mode from a power source and provides a part of the output power generated by the motor-cum-generator (220) during the pitch-out mode to the power source.

WO 2015/001403 A1

BLADE PITCHING SYSTEM FOR A HORIZONTAL AXIS WIND TURBINE

TECHNICAL FIELD

[0001] The present subject matter is related to a horizontal axis wind turbine in general and, in particular, to a blade pitching system for the horizontal axis wind turbine.

BACKGROUND

[0002] Wind turbines utilize wind energy to produce electrical power. There are many types of the wind turbines, including a horizontal axis type wind turbine. The horizontal axis type wind turbine includes a rotor having a hub mounted on a horizontal drive shaft and multiple blades mounted on the hub via pitch bearings. The blades transform wind energy into rotational motion of the horizontal drive shaft. The horizontal drive shaft in turn drives an electrical generator to produce electrical power to be fed to a power grid. During varying wind speed conditions, each of the multiple blades may be pitched about a pitch axis, via blade pitch drive mechanisms, to increase or decrease the rotational speed of the rotor and hence the electrical power produced by the electrical generator.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] The detailed description is described with reference to the accompanying figures. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The same numbers are used throughout the drawings to reference like features and components.

[0004] Figure 1 illustrates a schematic view of an exemplary configuration of a typical horizontal axis wind turbine.

[0005] Figure 2 illustrates a block diagram of a pitching system for at least one blade of a horizontal axis wind turbine, according to an embodiment of the present subject matter.

[0006] Figure 3 illustrates a block diagram of a pitching system for at least one blade of a horizontal axis wind turbine, according to another embodiment of the present subject matter.

[0007] Those skilled in the art shall appreciate that any block diagrams herein represent conceptual views of illustrative the pitching system embodying the principles of the present subject matter.

DETAILED DESCRIPTION

[0008] Various embodiments described herein, in accordance with the present subject matter, include a pitching system for one or more blades of a horizontal axis wind turbine (HAWT). The pitching system may be implemented for each of the blades independently or as a common pitching system for all the blades of the HAWT.

[0009] The HAWT typically receives electric power from a power grid to operate its auxiliary loads, such as blade pitch drive mechanisms, whenever the HAWT is not in service. However, when the HAWT is in service, a part of electrical power generated by the HAWT is consumed to operate the blade pitch drive mechanisms. Such blade pitch drive mechanisms may be either hydraulically or electrically driven pitch systems. In the hydraulically driven pitch systems, there are limitations in terms of speed and accuracy to control individual blade angle unlike the electrically driven pitch systems.

[0010] Further, the electrically driven blade pitch drive mechanisms typically utilize a pitch motor, such as an AC motor and a DC motor. Whenever there is a need to change a pitch angle of a blade, a power converter typically feeds necessary power to the pitch motor to control the speed and direction of rotation of the pitch motor. During a normal operation of the wind turbine, i.e., when change in the pitch angle is not required, the power fed to the pitch motor is either isolated or kept zero. In such a situation, an electromechanical brake holds a pitch position of the blade still to resist wind force. During this time, lots of stresses are developed on various mechanical parts, such as pitch bearings, a pitch gear box, and casting or steel parts. Further, in order to change the pitch angle, the electromechanical brake has to be released and the necessary power, which is consumed during pitching of the blade, has to be fed to the pitch motor.

[0011] According to an embodiment of the present subject matter, a pitching system for a blade of a horizontal axis wind turbine (HAWT) is described. The present pitching system includes a motor-cum-generator, for example, an AC or DC machine having a permanent magnet rotor. The motor-cum-generator may be implemented in a gearless manner, i.e., the motor-cum-generator may be coupled to the blade directly without a gearbox to improve the response and accuracy of the pitching system.

[0012] Further, the motor-cum-generator may operate at least in three operating modes: a braking mode, a pitch-in mode, and a pitch-out mode. In the braking mode, the motor-cum-generator holds the blade still about a pitch axis. In the pitch-in mode, the motor-cum-generator, in a manner similar to that used by the conventional pitch motor, adjusts a pitch of the blade against wind force when wind speed is less than a rated wind speed for the HAWT. However, in the pitch-out mode, the blade is pitched by wind force, i.e., rotated about a pitch axis of the blade, when wind speed is more than or equal to the rated wind speed for the HAWT. Accordingly, the blade, when pitching-out about the pitch axis, acts as a prime mover for the motor-cum-generator that generates an output power in the pitch-out mode.

[0013] The pitching system further includes a power converter that provides an input power to the motor-cum-generator from a power source to adjust the pitch of the blade during the pitch-in mode or to hold the blade still about the pitch axis in the braking mode. Accordingly, the present pitching system may be implemented without conventional electromechanical brakes, and the stresses otherwise developed on the mechanical parts are reduced automatically. Since the motor-cum-generator remains active throughout the operation of the HAWT in all the operating modes, a response time of the present pitching system is, therefore, better than the conventional pitching systems. Further, the power converter may provide the output power generated by the motor-cum-generator during the pitch-out mode back to the power source. The power source may be a power grid or a DC bus of the HAWT that provides an intermediate DC output of the HAWT. Depending upon the power source, such as an AC source or DC source, and a type of motor-cum-generator, such as an AC machine or DC machine, an appropriate power converter may be provided, for example, a DC to AC converter, a DC to DC converter, an AC to DC converter, and an AC to AC converter.

[0014] The pitching system further includes a pitch control system to control the power converter and the motor-cum-generator. The pitch control system may be provided as an in-built control system to the power converter or as a separate control system. In one implementation, the pitch control system may be communicatively coupled to a main control system of the HAWT.

[0015] As compared to conventional pitching systems that consume power during pitch-in and pitch-out as well, the pitching system as described herein consumes power only during the pitch-in mode, and besides not consuming power in the pitch-out mode, it generates output power during the pitch-out mode. Advantageously, the input power consumed by the present pitching system as described herein is not only less as compared to the conventional pitching systems, but the present pitching system can also generate the output power, which may be either fed back to the power source or may be consumed within the pitching system.

[0016] In case, the pitching system is implemented separately for each blade of the HAWT, the output power generated by a pitching system of one blade can be utilized by a pitching system of another blade as it is common that, due to the huge size of modern wind turbines, the pitch angles at a time for different blades are different due to different local wind conditions at each blade. For example, in a three blade HAWT, it is quite possible that one blade is in the pitch-in mode, while other two blades are in the pitch-out mode. In such a case, the power generated by the other two blades in the pitch-out mode may be utilized by the blade in the pitch-in mode, thereby reducing electricity costs for the pitching system.

[0017] The aspects defined above and further aspects of the present subject matter are apparent from the examples of embodiment to be described hereinafter and are explained with reference to the examples of embodiment. The present subject matter will be described in more detail hereinafter with reference to examples of embodiment but to which the present subject matter is not limited.

[0018] Figure 1 illustrates a schematic view of an exemplary configuration of a typical HAWT 100. In some configurations, the HAWT 100 includes a nacelle 102 housing a generator (not shown in Figure 1). The nacelle 102 is mounted on the top of a tower 104, only a portion of which is shown in Figure 1. The HAWT 100 also includes a rotor 106 that has one or more blades 108 attached to a hub 110 via pitch bearings (not shown in Figure 1). The blades 108 may be pitched about a pitch axis or a longitudinal axis of the blades 108 as and when required. Although the HAWT 100 illustrated in Figure 1 includes three blades 108, there are no specific limits on the number of blades 108 required by various embodiments of the present subject matter.

[0019] Figure 2 illustrates a block diagram of a pitching system for a blade(s), such as blade 108, of a HAWT, such as the HAWT 100, according to an embodiment of the present subject matter. The blade 108 is coupled, via a shaft 202, to a generator 204. When the blade 108 rotates due to wind force, the generator 204 generates electrical power. The generator 204 feeds the electrical power to a rectifier 206, which is connected downstream to the generator 204, and which converts the electrical power into an intermediate DC output. The intermediate DC output can be made available, via a DC bus 208, for various auxiliary loads, for example, an excitation circuit 210, a power converter(s) 212, a back-up supply for the pitching system like a battery box or capacitor box, a lighting system, and any system in the HAWT 100 that consumes electricity. The intermediate DC output can also be fed to an inverter 214, which is connected downstream to the rectifier 206, and which converts the intermediate DC output into a standard AC output. The inverter 214 can feed the standard AC output, via a transformer 216, into a power line 218, for example, 33KV, 50Hz power line, of a power grid or utility grid (not shown in Figure 2). The present pitching system described herein for the blade 108 includes the power converter 212 and a motor-cum-generator(s) 220.

[0020] The motor-cum-generator 220 may be an AC machine or a DC machine coupled to the blade 108. In one implementation, one motor-cum-generator 220 may be coupled to all the blades 108 of the HAWT 100 to form a common pitching system for the blades 108 of the HAWT 100. In said implementation, all the blades 108 may be pitched together. In another advantageous implementation, one motor-cum-generator 220 may be coupled to one blade 108 of the HAWT 100 to form an independent pitch system. In said advantageous implementation, each of the blades 108 may be pitched independent of each other considering different local wind conditions at each of the blades 108.

[0021] In one implementation, a power source for the motor-cum-generator 220 may be the intermediate DC output available via the DC bus 208, or any other suitable DC power source, such as a battery or emergency power supply for pitching the blade 108. In another implementation, the power source may be the power grid or the utility grid, or any other suitable AC power source.

[0022] The power converter 212 connects the motor-cum-generator 220 to the power source. The power converter 212 may be selected from amongst an AC to DC converter (e.g., a controlled active rectifier), a DC to DC converter (e.g., an electronic switch-mode DC to DC converter), a DC to AC converter (e.g., an inverter), and an AC to AC converter (e.g., combination of a controlled active rectifier and an inverter) depending upon a type of the power source and the motor-cum-generator 220. For example, if the power source is a DC power source and the motor-cum-generator 220 is an AC machine, then the DC to AC power converter may be selected. In one example, the power converter 212 may be a Metal Oxide Semiconductor Field Effect Transistor (MOSFET) based power converter, a fully regenerative Insulated Gate Bipolar Transistor (IGBT) based power converter, or the like.

[0023] The present pitching system described herein utilizes the motor-cum-generator 220 that can generate electrical power apart from consuming the electrical power unlike a conventional pitch motor that can only consume electrical power. The motor-cum-generator

220 generates the electrical power when wind energy drives, via the blade 108, a shaft of the motor-cum-generator 220. To keep the motor-cum-generator 220 under control, excess energy must be dealt with and, if possible, may be used to power other electrical parts. The energy or power generated by the motor-cum-generator 220 may be dissipated as heat through a dynamic braking resistor, or it can be advantageously returned to an incoming power line, thus forming a line regenerative drive.

[0024] The motor-cum-generator 220 may operate in at least three operating modes, i.e., a braking mode, a pitch-in mode, and a pitch-out mode.

[0025] In the braking mode, the motor-cum-generator 220 receives an input power from the power source via, for example, the power converter 212 to hold the blade 108 still about a longitudinal axis or a pitch axis. In one example, the input power may be in form of or is similar to back e.m.f. that resists unwanted pitching of the blade 108 by wind force. In another example, the input power may be in form of DC to apply an electrical brake on the motor-cum-generator 220 that is an AC machine. In one implementation, the motor-cum-generator 220 includes a permanent magnet rotor. In said implementation, the permanent magnet rotor induces back e.m.f. in an armature winding of the motor-cum-generator to avoid unwanted pitching of the blade 108. In said implementation, the stator terminals of the motor-cum-generator 220 may be short-circuited together such that the motor-cum-generator 220 holds the blade still in the braking mode. To short circuit the stator terminals in a controlled manner, the stator terminals can be connected via a controlled semiconductor device of the power converter 212. Furthermore, unlike conventional pitching systems, the present pitching system described herein eliminates a need of an electromechanical brake. The electromechanical brake typically causes lot of stresses in the mechanical parts of the conventional pitching systems. In the present pitching system described herein, the motor-cum-generator 220 does the braking under the control of the power converter 212, but not the electromechanical brake. Therefore, the stresses on the mechanical parts and response time of the pitching system are reduced.

[0026] In the pitch-in mode, the motor-cum-generator 220 receives an input power from the power source via, for example, the power converter 212 and acts as a motor to adjust the pitch of the blade 108 against wind force when wind speed is less than or equal to a rated wind speed for the HAWT 100. In the pitch-in mode, the motor-cum-generator 220, therefore, acts as a conventional pitch motor. In situation of wind speed below the rated wind speed, torque control for the generator 204 may be kept active, while a pitch of the blade 108 may be held fairly flat to wind force and at a constant pitch angle to capture maximum wind power.

[0027] In the pitch-out mode, the pitch of the blade 108 is automatically pitched by wind force when the wind speed is more than the rated speed of the HAWT 100, for example, wind speed of 6 to 7 m/s can adjust the blade 108 when the rated speed is 5 m/s. The blade 108 rotating about the pitch axis in the pitch-out mode acts as a prime mover for the motor-cum-generator 220, which acts as a generator in the pitch-out mode. The prime mover is basically a mechanical device that converts some form of energy into motive power. In case of HAWT 100, the blade 108 rotating about main horizontal axis or the shaft 202 act as a prime mover for driving the generator 204, whereas the blade 108 rotating about their longitudinal axis or a pitch axis, while pitching-out by the wind force, act as a prime mover for the motor-cum-generator 220. The motor-cum-generator 220, therefore, acts as a generator and generates an output power. The motor-cum-generator 220 feeds the generated output power back to the power converter 212, hence to the power source.

[0028] In one implementation, the motor-cum-generator 220 may be implemented in a gearless or direct drive manner, i.e., the motor-cum-generator 220 may be coupled to a root portion of the blade 108 directly without a pitch gearbox to improve the response time and accuracy of the pitching system. The said implementation allows the blade 108 to efficiently drive the motor-cum-generator 220 in the pitch-out mode, i.e., when wind speed is greater than the rated wind speed of the HAWT 100, and hence the motor-cum-generator 220 acts as a generator to generate the output power.

[0029] Although the pitching system shown in Figure 2 includes only one motor-cum-generator 220 for pitching one blade 108, i.e., three motor-cum-generators 220 for pitching three blades 108, there is no specific limit on the number of motor-cum-generators 220 that may required for pitching one blade 108 as per various embodiments of the present subject matter. For example, the pitching system may utilize three smaller capacity motor-cum-generators, synchronized with each other, for pitching one blade 108 of the HAWT 100. The said implementation allows the blade 108, which may be huge in size, to be pitched more easily due to sharing of load between the three smaller capacity motor-cum-generators. In the above example, the three small capacity motor-cum-generators may be attached to a root portion of the blade 108 at an angle of 120 degrees with each other.

[0030] In one example, also shown in Figure 2, the power source may be the intermediated DC output, the motor-cum-generator 220 may be an AC motor that is capable of acting as a generator, and the power converter 212 may be a DC to AC converter, for example, a full bridge inverter, a line regenerative inverter, and the like. Such a regenerative inverter drive enables soft starts and stops for the AC motor and runs the AC motor efficiently. The savings gained by using the regenerative inverter drive with AC motor are both financial and ecological. The regenerative inverter drive not only drives the AC motor that is pitching the blade 108 in the pitch-in mode, but also sheds excess energy when the blade 108 is driving the AC motor in the pitch-out mode. As the generated energy is in the form of electricity, it is conventionally converted and dissipated as heat via braking resistors. However, the present pitching system described herein controls the blade 108 under all conditions and sheds the excess energy by converting the kinetic energy into electricity and injecting the excess energy safely into the power source, such as mains or the intermediate DC output, or sharing the excess energy with other auxiliary loads. Either ways, energy may be saved and electricity costs may be reduced.

[0031] When the power converter 212 is in form of a DC to AC converter, i.e., in form of an inverter drive, it typically includes an input section, a power reservoir section, and an output section. In general, the inverter drive operates in such a way that energy can freely flow in both directions through the output section, but the input section is typically a diode bridge that only permits energy to flow in one direction. In the present pitching system, the power converter 212 may be in form of regenerative inverter drive that includes the above mentioned three sections. However, to operate as a regenerative inverter drive, the power needs to flow in both directions in the input section as well as in the output section. Such a bi-directional flow of power may be achieved by merging two inverters back to back. The additional input inverter allows power to flow from the power source to the power reservoir section when needed, and allows unimpeded reverse flow into the power source, when power in the power reservoir section is above normal operating levels.

[0032] When the motor-cum-generator 220 requires driving, an input inverter section is automatically operated to allow the input power from the power source to pass through and maintain the power reservoir section at the optimum condition. If the blade 108 drives a shaft of the motor-cum-generator 220, then the motor-cum-generator 220 acts as a generator and generated power is passed back through the output inverter section and begins to pump up the power reservoir section. Under these conditions, the regenerative inverter drive switches excess power that is left after pumping the power reservoir section using the input inverter section to return the excess power to the power source. The function of the input inverter section is to synchronize the generated power with the phase rotation of input phases.

[0033] Considering huge size of modern wind turbines and blades, it is very common that local wind conditions may vary for each blade 108. In such cases, a part of the output power generated by the motor-cum-generator 220 in the pitch-out mode for one blade 108 may be provided to the motor-cum-generator 220 of another blade 108 that is in a pitch out mode. In this way, the input power taken from the power source for pitching purposes may be substantially reduced. Furthermore, a part of the output power generated by the motor-cum-generator 220 may be fed to one or more of various auxiliary loads, for example, an excitation circuit 210, the power converter 212, a back-up supply for the pitching system in form of a battery box or a capacitor box, a lighting system, and any system in the HAWT 100 that consumes electricity.

[0034] Figure 3 illustrates a block diagram of a pitching system for a blade(s), such as blade 108, of a HAWT, such as the HAWT 100, according to another embodiment of the present subject matter. In this embodiment, the pitching system includes the motor-cum-generator 220, the power converter 212, and a pitch control system 302.

[0035] The pitch control system 302 may control the power converter 212 and the motor-cum-generator 220. In one implementation, the pitch control system 302 may be in-built to the power converter 212. In another implementation, the pitch control system 302 may be provided outside the power converter 212 as a separate unit. The pitch control system 302 may receive various inputs, such as a blade angle input 304 from a blade angle encoder (not shown in figure 3), a control input 306 from a main control system (not shown in figure 3) of the HAWT 100, and other input(s) 308, such as an input from an end limit switch for blade angle or pitch angle. The blade angle encoder continuously provides the blade angle input 304 to the power converter 212 based on measurement of instantaneous wind speed, for example, via an anemometer. Accordingly, the power converter 212 provides necessary input power to the motor-cum-generator 220 to adjust a blade angle or a pitch angle. Further, the control input 306 ensures synchronization between the pitch control system 302 of the pitching system and the main control system of the HAWT 100. Further, the end limit switch for the blade angle is a safety feature that defines tolerance limits beyond a pitching range of 0 degrees and 90 degrees. In case the blade 108 is going be pitched beyond the tolerance limits, e.g., -2 degrees or 92 degrees, due to some fault, then the end limit switch disconnects the blade 108 from the pitching system to ensure safety of the blade 108.

[0036] In one example, also shown in Figure 3, the power source may be the intermediated DC output, the motor-cum-generator 220 may be a DC motor that is capable of acting as a generator, and the power converter 212 may be a DC to DC converter, for example, a MOSFET or IGBT based power converter.

[0037] The different implementations provided above are not limiting and are only illustrative examples of the different scope of the present subject matter. Other implementations apparent to a person skilled in the art are also included within the scope of the present subject matter.

I/We claim:

1. A pitching system for at least one blade (108) of a horizontal axis wind turbine (100), the pitching system comprising:

a motor-cum-generator (220) coupled to the at least one blade (108) to adjust a pitch of the at least one blade (108) during a pitch-in mode, the at least one blade (108) being adjusted against wind force during the pitch-in mode, and to generate an output power during a pitch-out mode, the at least one blade (108) being pitched by wind force during the pitch-out mode and acting as a prime mover for the motor-cum-generator (220) during the pitch-out mode; and

a power converter (212) provides an input power to the motor-cum-generator (220) to adjust the pitch of the at least one blade (108) during the pitch-in mode from a power source and provides a part of the output power generated by the motor-cum-generator (220) during the pitch-out mode back to the power source.

2. The pitching system as claimed in claim 1, wherein the power source is one of an intermediate DC output obtained from the horizontal axis wind turbine (100) and a power grid.

3. The pitching system as claimed in claim 2, wherein the intermediate DC output is an output of a rectifier connected downstream to a generator of the horizontal axis wind turbine (100), the output being fed to an inverter connected downstream to the rectifier.

4. The pitching system as claimed in claim 2, wherein the motor-cum-generator (220) is an AC machine, wherein the power converter (212) is a DC to AC converter when the power

source is the intermediate DC output, and wherein the power converter (212) is an AC to AC converter when the power source is the power grid.

5. The pitching system as claimed in claim 2, wherein the motor-cum-generator (220) is a DC machine, wherein the power converter (212) is a DC to DC converter when the power source is the intermediate DC output, and wherein the power converter (212) is an AC to DC converter when the power source is the power grid.

6. The pitching system as claimed in claim 1, wherein the motor-cum-generator (220) is active during entire operation of the horizontal axis wind turbine (100).

7. The pitching system as claimed in claim 1, wherein the motor-cum-generator (220) is coupled directly to the at least one blade (108) in a gearless manner.

8. The pitching system as claimed in claim 1, wherein the power converter (212) is one of an inverter and a combination of two inverters coupled back to back.

9. The pitching system as claimed in claim 1 further comprising:

a pitch control system (302) to control the power converter (212) and the motor-cum-generator (220).

10. The pitching system as claimed in claim 9, wherein the pitch control system (302) is communicatively coupled to at least one of a main control system of the horizontal axis wind turbine (100) and a blade angle encoder.

11. The pitching system as claimed in claim 1, wherein the power converter (212) provides the input power to the motor-cum-generator (220) during a braking mode, the at least one blade (108) being held still about a pitch axis in the braking mode.

12. The pitching system as claimed in claim 1, wherein a part of the output power generated in the pitch-out mode by the motor-cum-generator (220) coupled to the at least one blade (108) is fed to another motor-cum-generator (220) coupled to another blade (108) of the horizontal axis wind turbine (100), the another blade (108) being in one of the pitch-in mode and a braking mode, the another blade (108) being held still about a pitch axis in the braking mode.

13. The pitching system as claimed in claim 1, wherein a part of the output power generated in the pitch-out mode by the motor-cum-generator (220) is fed to an auxiliary load of the horizontal axis wind turbine (100).

14. The pitching system as claimed in claim 13, wherein the auxiliary load is one of an excitation system, a back-up supply for the pitching system, and a lighting system of the horizontal axis wind turbine (100).

15. The pitching system as claimed in claim 1, wherein the motor-cum-generator (220) includes a permanent magnet rotor, and wherein stator terminals of the motor-cum-generator (220) are short-circuited together during a braking mode, the at least one blade (108) being held still about a pitch axis in the braking mode.

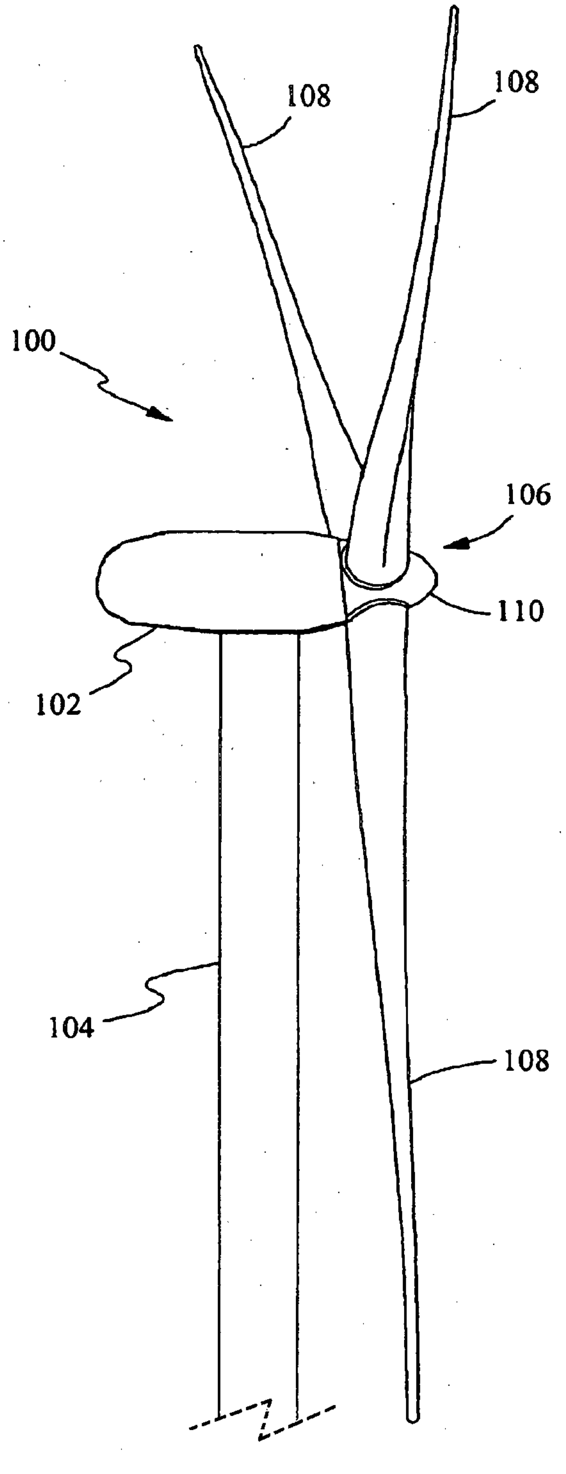

Figure 1

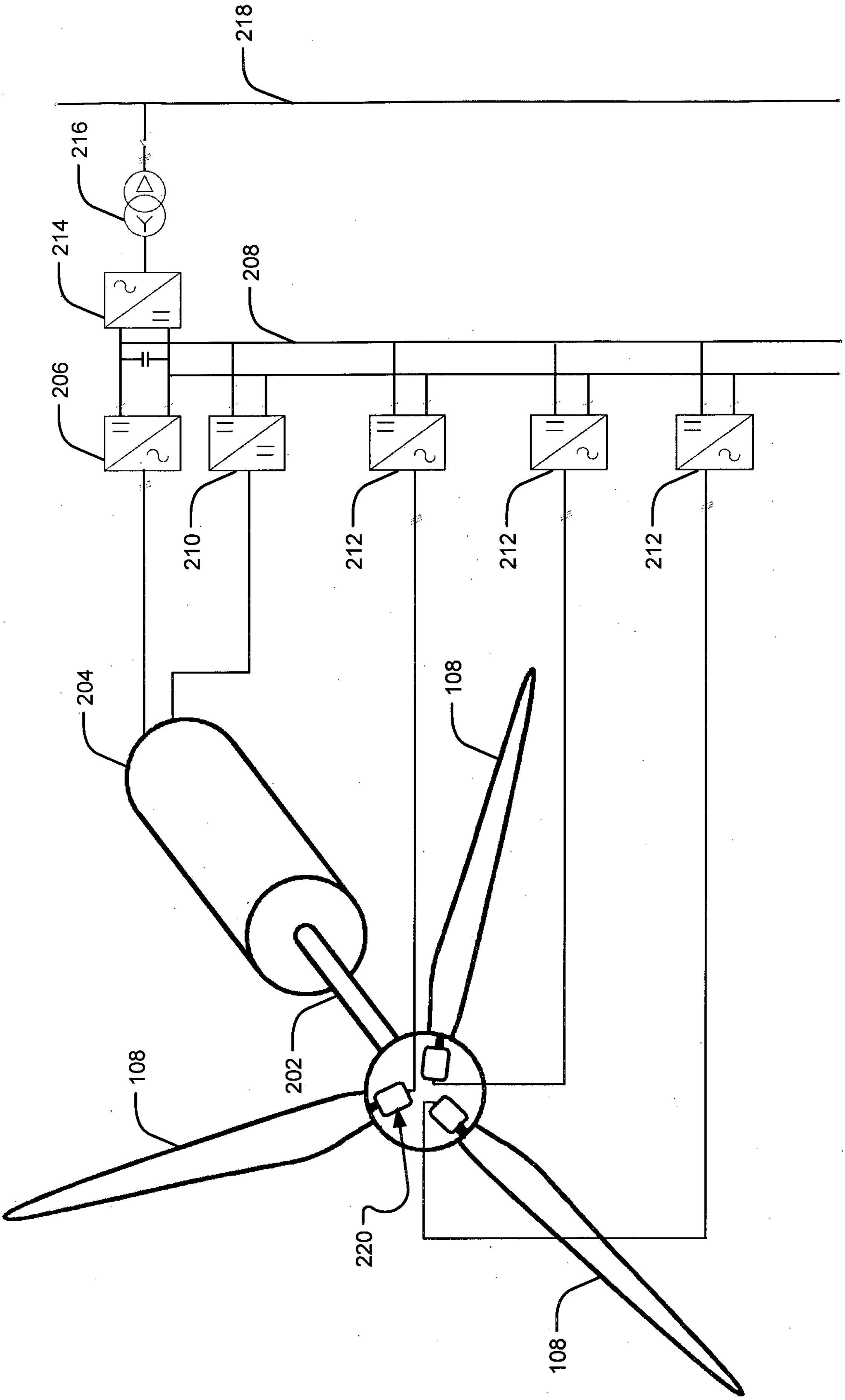

Figure 2

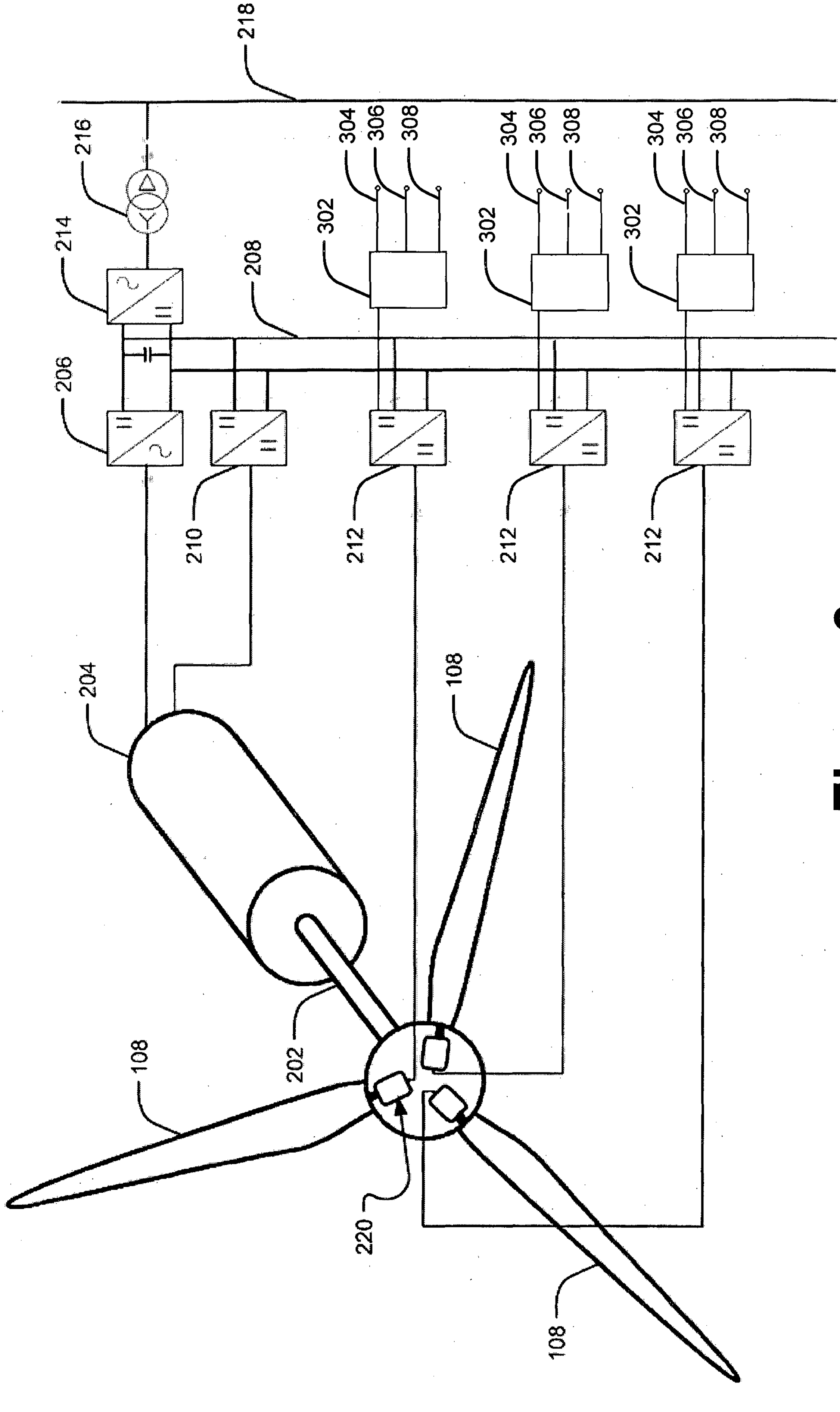
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Figure 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2014/001108

A. CLASSIFICATION OF SUBJECT MATTER
INV. F03D7/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F03D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	EP 2 080 902 A2 (GEN ELECTRIC [US]) 22 July 2009 (2009-07-22) abstract paragraph [0011] - paragraph [0035] figures -----	1,2,4, 6-14 3,5,15
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
26 September 2014	02/10/2014

Name and mailing address of the ISA/
European Patent Office, P.B. 5818 Patentlaan 2
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INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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