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Vertical axis wind turbine generator

Abstract

The present invention relates to a vertical axis wind turbine generator in which a rotor blade (**120**) divided into a fixed blade (**120a**) and movable blades (**120b**, **120c** and **120d**) is connected to a rotor blade rotating shaft (**110**) provided to be vertical, so that backwind power of the rotor blade (**120**) is enhanced to the maximum, and headwind power is minimized to enable high-efficiency power generation.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

(1) This U.S. non-provisional patent application claims priority under 35 U.S.C. § 119 of Korean Patent Application No. 10-2022-0158851, filed on Nov. 24, 2022, the entire contents of which are hereby incorporated by reference.

BACKGROUND

(2) The present invention relates to a wind turbine generator, and more particularly, to a vertical axis wind turbine generator in which a rotary shaft to which a rotor blade is attached to be rotated is vertically provided to generate power.

(3) Most of large-scale installed wind turbine generators are horizontal axis wind turbine generators in which a horizontal shaft is provided and a large-sized blade is mounted on one side of the horizontal shaft. In the horizontal axis wind turbine generators, the blade is attached to one side of the horizontal shaft and is rotated while wind is applied thereto, and thus power generation efficiency is good. However, a rotor blade has a large rotational radius due to a long length thereof, and the long rotor blade rotates to cause the loud noise. Accordingly, the horizontal axis wind turbine generators are not suitable for installation in neighborhood living spaces.

(4) In contrast, vertical axis wind turbine generators may be installed and used on the roofs of buildings or the like on a relatively small scale.

(5) In addition, in the horizontal axis wind turbine generators, only one power generator may be mounted on the horizontal shaft provided in one, but the vertical axis wind turbine generators may be installed as a multi-stage type so that a plurality of power generators are mounted together to produce a relatively large amount of electricity.

(6) However, the vertical axis wind turbine generators have a limitation in which as a rotor blade attached to a vertical shaft rotates around a rotary shaft, a counter-torque wind pressure applied from the wind is generated to reduce torque.

PRIOR ART DOCUMENTS

Patent Documents

(7) Korean Patent Registration No. 10-2448925 Korean Patent Registration No. 10-1498785 Korean Patent Registration No. 10-1483461 Korean Patent Registration No. 10-1554307 Korean

SUMMARY

(8) An object of the present invention for solving the above limitations is to provide to a vertical axis wind turbine generator which minimizes a counter-torque wind pressure that is generated when a rotor blade rotates while moving against a wind, and is structurally stable enough to withstand strong wind even when the wind turbine generator is installed as a multi-stage type.

(9) In order to minimize a counter-torque wind pressure that is unavoidably applied to a rotor blade, which is mounted in a wind turbine generator according to the present invention, while the rotor blade rotates, a rotor blade **120** is divided into a fixed blade **120a**, in which a wind hole **120e** is defined at a center thereof, and movable blades **120b**, **120c** and **120d**, so that when backwind blows, the movable blades close the wind hole **120e** of the fixed blade **120a**, and when headwind blows, the movable blades open the wind hole **120e** of the fixed blade **120a** to minimize a wind pressure of the headwind.

(10) When the wind turbine generator is provided as a multi-stage type, a conical frame **130**, which is provided as a space so that a power generating device M and an accelerating gear **150** may be embedded between multiple stages, and at least three poles **140** are provided in an outer circumference of the conical frame **130** to extend and be fixed to the ground to enable the wind turbine generator to withstand even strong wind.

Description

BRIEF DESCRIPTION OF THE FIGURES

(1) The accompanying drawings are included to provide a further understanding of the inventive concept, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the inventive concept and, together with the description, serve to explain principles of the inventive concept. In the drawings:

(2) FIG. **1** is a side view of four rotor blades **120** connected to a rotor blade rotating shaft **110** according to the present invention;

(3) FIG. **2** illustrates a state in which a rotor blade **120** is separated into one fixed blade **120a** and two movable blades **120b** and **120d** according to the present invention;

(4) FIG. **3** illustrates a state in which a rotor blade **120** is separated into one fixed blade **120a** and three movable blades **120b**, **120c** and **120d** according to the present invention;

(5) FIG. **4** illustrates a state in which a configuration, in which two movable blades **120b** and **120d** are combined to have a bowl shape with a closed wind hole, and a fixed blade **120a** are separated according to the present invention;

(6) FIG. **5** illustrates a completed rotor blade in which a configuration, in which two movable blades are combined to have a bowl shape, and a fixed blade **120a** are combined according to the present invention;

(7) FIG. **6** is a cross-sectional view illustrating a completed rotor blade **120** having a bowl shape according to the present invention;

(8) FIG. **7** illustrates a state in which a configuration, in which three movable blades **120b**, **120c** and **120d** are combined to have a bowl shape with a closed wind hole, and a fixed blade **120a** are separated according to the present invention;

(9) FIG. **8** illustrates a rotor blade **120** having a bowl shape as a whole in which a configuration, in which three movable blades **120b**, **120c** and **120d** combined to have a bowl shape with a closed wind hole, is combined with a fixed blade **120a** to have a shape in which the wind hole of the fixed blade **120a** is closed according to the present invention;

(10) FIG. **9** is a cross-sectional view illustrating a completed rotor blade **120** having a bowl shape according to the present invention;

- (11) FIG. 10 illustrates an opened state of a wind hole **120e** in which two movable blades **120b** and **120d** connected through an elastic band **120f** maintain spacing from each other according to the present invention;
- (12) FIG. 11 illustrates a completed rotor blade **120** in an opened state of a wind hole **120e** in which two movable blades **120b** and **120d** connected to have a shape in which the wind hole **120e** is opened is connected to a fixed blade **120a** according to the present invention;
- (13) FIG. 12 is a cross-sectional view illustrating a completed rotor blade **120** in an opened state of a wind hole **120e** according to the present invention;
- (14) FIG. 13 illustrates an opened state of a wind hole **120e** in which three movable blades **120b**, **120c** and **120d** connected through an elastic band **120f** are connected to each other with maintaining spacing according to the present invention;
- (15) FIG. 14 illustrates a completed rotor blade **120** in an opened state of a wind hole **120e** in which three movable blades **120b**, **120c** and **120d** connected to have a shape in which the wind hole **120e** is opened are connected to a fixed blade **120a** with spacing according to the present invention;
- (16) FIG. 15 is a cross-sectional view illustrating a completed rotor blade **120** in an opened state of a wind hole according to the present invention;
- (17) FIG. 16 is a view illustrating the inside of a conical frame **130**, which is installed in each of multiple stages and provided as a space, in which a power generating device **M** and an accelerating gear **150** are mounted, when a vertical axis wind turbine generator is installed as a multi-stage type according to the present invention;
- (18) FIG. 17 is a cross-sectional view illustrating the inside of a vertical axis wind turbine generator provided as a multi-stage tower type according to the present invention; and
- (19) FIG. 18 illustrates a state in which a vertical axis wind turbine generator is provided as a small-sized one-stage type and is installed on an upper end of a streetlight pole according to the present invention.

DETAILED DESCRIPTION

- (20) Hereinafter, the present invention will be described in detail with reference to the accompanying drawings.
- (21) FIG. 1 is a side view of four rotor blades **120** each having a circular shape, which are connected to a rotor blade rotating shaft **110** provided to be vertical according to the present invention.
- (22) For the sake of convenience of power generation, the rotor blade **120** connected to a vertical shaft is installed to be rotated only in one direction.
- (23) In the rotor blade **120** connected to the vertical shaft, due to the characteristic of the vertical shaft, backwind is applied to the rotor blade **120** disposed at the left on the basis of a direction of wind, and headwind is applied to the rotor blade **120** disposed at the right. This operation is repeated while the rotor blade **120** rotates.
- (24) In the present invention, in order to achieve functions to increase a wind pressure of the backwind, which is applied to the rotor blade when the rotor blade rotates, to the maximum, and minimize a wind pressure of the headwind as described above, the rotor blade **120** is divided into a fixed blade **120a** and movable blades **120b**, **120c** and **120d**.
- (25) A wind hole **120e** having a circular shape is defined at a center of each of the fixed blade **120a** and the movable blades **120b**, **120c** and **120d**. Here, when a plurality of movable blades are combined, the wind hole **120e** is not defined in a movable blade to be combined at the last position.
- (26) The rotor blade **120** is provided by combining the fixed blade **120a** and the movable blades **120b**, **120c** and **120d**. Operations in which the rotor blade **120** is provided through the fixed blade **120a** and the movable blades **120b**, **120c** and **120d** will be described as follows.
- (27) The fixed blade **120a** is connected to a rotor blade rotating shaft **110** through a fixed blade connecting frame **120g**. A first movable blade **120b** is connected to the inside of the fixed blade

120a through four elastic bands **120f**.

(28) Two of the four elastic bands **120f** are connected to upper left and right portions of the inside of the fixed blade **120a** and upper left and right side surfaces of the first movable blade **120b**, and the other two elastic bands **120f** are connected to lower left and right portions in the same method.

(29) After the fixed blade **120a** is connected to the first movable blade **120b** as above, when a wind pressure is generated by the backwind, a portion, which has a small diameter, of the first movable blade **120b** is inserted to protrude into the wind hole of the fixed blade **120a**, and a portion having a large diameter is in a state of being hooked with the wind hole of the fixed blade **120a**.

(30) Continuously, a second movable blade **120c** is connected to the inside of the first movable blade **120b** through four elastic bands **120f** in the same method as the fixed blade **120a** and the first movable blade **120b**. When a wind pressure is generated by the backwind, a portion, which has a small diameter, of the second movable blade **120c** is inserted and protrudes from the wind hole of the first movable blade **120b**, and a portion having a large diameter is in a state of being blocked by the wind hole of the first movable blade **120b**.

(31) A third movable blade **120d** is connected to the inside of the second movable blade **120c** through four elastic bands **120f** in the same method as above. When a wind pressure is generated by the backwind, a portion, which has a small diameter, of the third movable blade **120d** is inserted and protrudes from the wind hole of the second movable blade **120c**, and a portion having a large diameter is in a state of being blocked by the wind hole of the second movable blade **120c** so that the rotor blade is completed. As described above, when the wind pressure of the backwind is applied, the entire configuration of the rotor blade **120** is provided as a bowl shape to generate the wind pressure of the backwind to the maximum.

(32) FIGS. 2 and 3 are views illustrating a configuration in which the fixed blade **120a** and the first, second, and third movable blades **120b**, **120c** and **120d** are separated from each other.

(33) The rotor blade **120** is provided by being divided into one for a large-sized multi-stage tower type, in which three movable blades are mounted, and one for a small-sized one-stage type for neighborhood living spaces, in which one or two movable blades are mounted.

(34) When only one movable blade is mounted, a movable blade in the form of the third movable blade **120d** in which a wind hole is not defined is mounted.

(35) FIG. 4 illustrates a configuration, in which two movable blades are combined to have a bowl shape, and a configuration in which a fixed blade **120a** is separated.

(36) FIG. 5 is a view illustrating a completed rotor blade **120** having a bowl shape with a closed wind hole, in which the two movable blades combined to have a bowl shape are combined with the fixed blade **120a**.

(37) FIG. 6 is a cross-sectional view of a bowl shape of the rotor blade **120** completed as above.

(38) FIGS. 7 and 8 illustrate a configuration, in which three movable blades **120b**, **120c** and **120d** are combined to have a bowl shape, and a configuration in which the fixed blade **120a** is separated, and illustrate a completed rotor blade **120** having a bowl shape with a closed wind hole, in which the three movable blades combined to have a bowl shape are combined with the fixed blade **120a**.

(39) FIG. 9 is a cross-sectional view of a bowl shape of the rotor blade **120** completed as above.

(40) FIGS. 10 and 11 illustrate two movable blades, which are connected to each other in a state in which the two movable blades to which a headwind pressure has been applied maintain spacing from each other so that the wind hole **120e** is opened, and a completed rotor blade **120** with the opened wind hole, in which the two movable blades are connected to a fixed blade **120a**.

(41) FIG. 12 is a cross-sectional view of the rotor blade **120** completed in the state in which the wind hole is opened as above.

(42) FIGS. 13 and 14 illustrate three movable blades **120b**, **120c** and **120d**, which are connected to each other in a state in which the three movable blades to which a headwind pressure has been applied maintain spacing from each other so that the wind hole **120e** is opened, and illustrate a completed rotor blade **120** with the opened wind hole in a state in which the three movable blades

120b, 120c and 120d are connected to a fixed blade **120a**.

(43) FIG. **15** is a cross-sectional view of a bowl shape of the rotor blade **120** completed as above.

(44) As described above, the rotor blade **120** is provided by being divided into the fixed blade **120a** and the movable blades **120b, 120c and 120d**. When the rotor blade **120** is disposed at the left on the basis of the direction of the wind while rotating, the backwind is applied to the rotor blade **120**, and when the rotor blade **120** is disposed at the right, the headwind is applied to the rotor blade **120**. In the rotor blade **120** to which the backwind is applied, the movable blades **120b, 120c and 120d** are combined to each other in a state of closing the wind hole **120e** inside the fixed blade **120a** so that the rotor blade **120** as a whole has a bowl shape, and in the rotor blade **120** to which the headwind is applied, the movable blades are connected to each other with maintaining spacing inside the fixed blade **120a** so that the rotor blade **120** has a shape in which the wind hole **120e** is opened.

(45) The vertical axis wind turbine generator according to the present invention is based on a fundamental principle that at least three rotor blades **120** are connected to the rotor blade rotating shaft **110**, which is provided to be vertical, at fixed intervals and rotate to generate power.

(46) Here, the rotor blade **120** rotates by being connected to the rotor blade rotating shaft **110** provided to be vertical. Thus, when being at a position of the backwind on the basis of a direction of wind, the rotor blades **120** rotates while backwind is applied thereto, and when being at a position of the headwind, the rotor blades **120** rotates while the headwind is applied. This rotation is repeated.

(47) Therefore, in order to maintain high-efficiency power generation, the vertical axis wind turbine generator according to the present invention needs to maintain the wind pressure of the backwind, which is applied to the rotor blade **120**, to be the maximum, and minimize the wind pressure of the headwind.

(48) In order that the wind pressure is applied to the rotor blade **120** to the maximum, as described above, the rotor blade **120** has a bowl shape, which has an inlet that is wide as the movable blades **120b, 120c and 120d** are continuously in contact with each other inside the fixed blade **120a**, and which is sealed as the wind hole **120e** is closed. Accordingly, when the wind is concentrated into the bowl without escaping, the wind pressure is generated to the maximum. In order to minimize the wind pressure of the headwind applied to the rotor blade **120**, the movable blades are in a state of maintaining spacing from the fixed blade **120a**, and also the movable blades are made maintain spacing from each other. Accordingly, the wind hole **120e** is opened so that when the wind escapes with the minimum resistance, the wind pressure is generated to the minimum.

(49) Each of the movable blade may be made of a light material, so that even due to a small wind pressure, the movable blade rapidly moves to close or open the wind hole, and the fixed blade may be made of a firm material so that the fixed blade withstands even strong wind.

(50) As described above, when the backwind blows, the maximum wind pressure is applied to the rotor blade **120**, and when the headwind blows, the minimum wind pressure is applied to the rotor blade **120**. Accordingly, the maximum torque is generated to enable the maximum power generation.

(51) FIG. **16** is a view illustrating a conical frame **130**, which is installed between multiple stages and provides a space in which a power generating device **M** and an accelerating gear **150** are mounted, when the vertical axis wind turbine generator according to the present invention is provided as a multi-stage tower type, and which has an outer circumference in which a pole hole **130a** is defined and through which at least three poles **140** vertically passes to extend and be fixed to the ground so as to maintain safety even against strong wind.

(52) FIG. **17** is a cross-sectional view illustrating the inside of a vertical axis wind turbine generator provided in a multi-stage tower type according to the present invention.

(53) In the vertical axis wind turbine generator provided in a tower type, a conical frame **130** is provided between multiple stages, two generating devices **M** and an accelerating gear **150** are

mounted in the conical frame **130**, and four poles **140** vertically pass through an outer circumference of the conical frame **130** to extend and be fixed to the ground.

(54) FIG. **18** is a side view of a state in which a vertical axis wind turbine generator is provided as a small-sized one-stage type and is installed on an upper end of a streetlight pole according to the present invention.

(55) As provided as a small-sized one-stage type, the vertical axis wind turbine generator may be installed in neighborhood areas, and may be installed in the suburban houses or on rooftops of neighborhood buildings, in addition to streetlights, so that electricity necessary in lives is produced. When the vertical axis wind turbine generator is on a streetlight, a solar panel **160** may be installed on an upper portion of a power generator.

(56) In the vertical axis wind turbine generator according to the present invention, the power generating device is mounted on each of upper and lower ends of the rotor blade rotating shaft **110**. However, the power generating device M installed on the upper end of the streetlight pole as in FIG. **18** is mounted only on the lower end.

(57) In the vertical axis wind turbine generator according to the present invention, the rotor blade **120** is divided into the fixed blade **120a** and the movable blade, and the movable blade moving due to the wind pressure is connected to the inside of the fixed blade **120a** so that the wind hole **120e** defined at the center of the fixed blade **120a** is closed or opened. Accordingly, when the backwind blows, the wind pressure of the blade is generated to the maximum, and when the headwind blows, the wind pressure of the blade is minimized to enhance the torque of the rotor blade **120**.

(58) In addition, when provided as the small-sized one-stage type, the vertical axis wind turbine generator may be possible to install in small areas, and thus be installed in the suburban houses, the rooftops of the buildings, or upper ends of streetlights to produce electricity necessary in neighborhood lives.

(59) Moreover, when the vertical axis wind turbine generator is provided as a multi-stage type, a plurality of power generating devices M may be possible to install in one power generation facility to increase space utilization.

(60) Furthermore, when the vertical axis wind turbine generator is provided as a multi-stage tower type, the conical frame **130** in which the space is defined may be provided between multiple stages in layers, and the at least three poles **140** may pass through the outer circumference of the conical frame **130** to extend and be fixed to the ground so that the wind turbine generator sufficiently withstands even the strong wind.

(61) Although the embodiments of the present invention have been described, it is understood that the present invention should not be limited to these embodiments but various changes and modifications can be made by one ordinary skilled in the art within the spirit and scope of the present invention as hereinafter claimed.

Claims

1. A vertical axis wind turbine generator in which a rotary shaft is provided to be perpendicular to the ground, the vertical axis wind turbine generator comprising: at least two conical frames (**130**) which are provided in layers and each of which has an inner space; at least three poles (**140**) vertically passing through an outer circumference of the conical frame (**130**) to be fixed to the ground; a rotor blade rotating shaft (**110**) installed vertically and configured to rotate between the conical frame (**130**) and the conical frame (**130**); at least three rotor blades (**120**), each of which is divided into a fixed blade (**120a**) and movable blades (**120b**, **120c** and **120d**) and has a center in which a wind hole having a circular shape is defined, and which are connected to the rotor blade rotating shaft (**110**) at the same interval; wherein the fixed blade (**120a**) is connected to the rotor blade rotating shaft (**110**) through a fixed blade connecting frame (**120g**); wherein a first movable blade (**120b**) is connected to the inside of the fixed blade (**120a**) through four elastic bands (**120f**),

wherein two of the four elastic bands (120f) are connected to upper left and right portions of the inside of the fixed blade (120a) and upper left and right side surfaces of the first movable blade (120b), and the other two elastic bands (120f) are connected to lower left and right portions in the same method, wherein with the fixed blade (120a) connected to the first movable blade (120b) as above, when a wind pressure is generated by a backwind, a portion, which has a small diameter, of the first movable blade (120b) is inserted to protrude into the wind hole of the fixed blade (120a), and a portion having a large diameter is in a state of being hooked with the wind hole of the fixed blade (120a); wherein a second movable blade (120c) is connected to the inside of the first movable blade (120b) through four elastic bands (120f) in the same method as the fixed blade (120a) and the first movable blade (120b), wherein when a wind pressure is generated by the backwind, a portion, which has a small diameter, of the second movable blade (120c) is inserted and protrudes from a wind hole of the first movable blade (120b), and a portion having a large diameter is in a state of being blocked by the wind hole of the first movable blade (120b); wherein a third movable blade (120d) is connected to the inside of the second movable blade (120c) through four elastic bands (120f) in the same method as above, wherein when a wind pressure is generated by the backwind, a portion, which has a small diameter, of the third movable blade (120d) is inserted and protrudes from the wind hole of the second movable blade (120c), and a portion having a large diameter is in a state of being blocked by a wind hole of the second movable blade (120c) so that the rotor blade is completed, wherein when the wind pressure of the backwind is applied, the entire configuration of the rotor blade (120) is provided as a bowl shape to generate the wind pressure of the backwind to the maximum; wherein the rotor blade (120) to which a headwind is applied, the movable blades (120b, 120c, 120d) are connected to each other with maintaining spacing inside the fixed blade (120a) so that the rotor blade (120) has a shape in which the wind hole is opened; an accelerating gear (150) installed in the conical frame (130) and connected to each of upper and lower ends of the rotor blade rotating shaft (110); and a power generating device (M) connected to the accelerating gear (150) and configured to produce electricity.
