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MECHANICAL DESIGN OF SMALL VERTICAL AXIS WIND TURBINE

Abstract. *A new type of vertical shaft wind generator has a mechanical structure design, which can adjust the installation Angle of the wind blade according to the wind speed. When the wind force is large, the speed of the generator is higher than the rated speed. The blade Angle is adjusted by controlling the front and back movement of the electric push rod, so that the speed of the vertical shaft wind generator can be reduced to the rated speed. In this way, the stopping and fault of the wind generator caused by excessive speed can be avoided. At the same time, the braking system of the vertical shaft wind generator is designed, and the mechanical braking system is adopted.*

Keywords: vertical axis wind turbine; Structural design; Mechanical braking

Introduction

In recent years, horizontal axis wind turbine are widely used. Vertical axis wind turbine has low start wind speed, high wind energy utilization rate, Can receive wind in any direction, low noise, and low manufacturing and maintenance costs, has a broad market prospect in the small and medium-sized wind turbine. However, the drawback of the vertical axis wind turbine is that the structure is complex. And the cost of manufacturing and maintenance is high [1; 2].

Vertical axis wind turbine technology has developed rapidly and has gradually developed for commercial production since 1970s. All developed countries today, such as Canada, the United States and the Netherlands, have used vertical axis wind turbines for deployment.

In 1975, the San Diego laboratory produced a 17m-high vertical axis wind turbine in good condition [3].

In the 1980s. China has developed the small vertical axis wind turbines, single machine capacity of thousands of Watts, such as China aerodynamic research and development center in 1984, designed a 6 m in diameter, rated power 2 kw test unit, and a wind tunnel test was carried out. In 2005, the state council three gorges office of Harbin engineering university, Chinese academy of machinery science joint and Harbin electric group, more than a dozen units, such as the successful development of our country's first with independent intellectual property rights completely 50 kw vertical axis wind turbines small testing machine. The prototype has been tested and installed in huade county of Inner Mongolia and successfully connected to the network, which has played a significant role in promoting the development of China's vertical axis wind turbine. At present, the main problems of small and medium sized non-grid-connected vertical axis wind turbines are low power generation efficiency, high starting wind speed, long stopping time, and the blade speed can only change with the wind speed.

The research and development of small and medium-sized (5kw-20kw) vertical axis wind turbines has provided green energy for promoting the construction of new energy industrial base and protecting the ecological environment.The research and development of small and medium-sized (5kw-20kw) vertical axis wind turbines has provided green energy for promoting the construction of new energy industrial base and protecting the ecological environment.

Overall mechanical structure design

The existing vertical axis wind turbine is directly driven by the wind leaf generator spindle rotation (rotor) and power generation [4; 5], the deficiency of this method is the speed of the generator main shaft (the rotor) is determined by wind speed. In extreme weather conditions, wind speed too fast, the speed of the generator main shaft far more than the rated speed of wind turbine, such as not brake in time, will cause serious consequences.

This design provides a vertical axis wind turbine mechanical structure, the wind leaf Angle can be adjusted according to the wind speed, when the generator speed is lower than the rated speed, the wind leaf in the wind Angle, when the generator speed is higher than the rated speed, adjust the Angle of the blades to make vertical axis wind turbine speed has been rated speed.

As shown in Fig. 1, it is a schematic diagram of the overall structure of the vertical axis wind turbine. The lower end of the generator is equipped with braking device, speed detection and control device.The upper end cover of the generator is equipped with a carbon brush and a carbon brush holder, and the main shaft of the generator is equipped with a connecting disk with a connecting post, which turns with the main shaft [6].

Vertical axis wind turbines overall structure by the horizontal connecting rod, nut, flange, the blades, the connecting rod, electric putter, connecting rod, under the wind turbine unit, braking and detection device, stents, brake handle, such as carbon brush components.

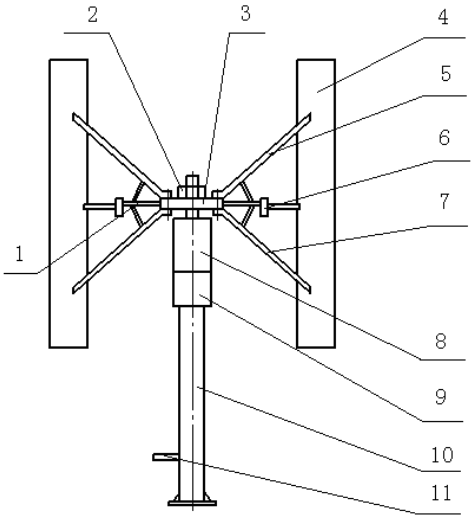

Figure 1 – Structure diagram: 1 – The level of connecting rod; 2 – nut; 3 – flange; 4 – The blades; 5 – The connecting rod above; 6 – Electric putter; 7 – The connecting rod below; 8 – Generating set; 9 – Braking and testing equipment; 10 – stents; 11 – The brake handle

One end of the upper connecting rod and the lower connecting rod is installed on the flange plate, and the other end is connected with the air blade, which ACTS as the fixing of the air blade.The horizontal link is mainly used to adjust the Angle of the air blade. One end of the horizontal link is connected to the flange plate and the other end is connected to the electric push rod. The flange plate is mounted on the main shaft (rotor) of the wind turbine through the tapered hole and drives the main shaft of the wind turbine to rotate together [7].

A vertical axis wind generator is equipped with three wind blades, NACA0016 airfoil was used in the wind blade [8; 9], the connecting rod above and the connecting rod below is connected with the wind blade, which can fix and support the wind blade. Electric push rod end connected to the central wind leaf, the other end connected to the level of connecting rod, electric putter work can promote the blades around the connecting rod, link rod under the above points of attachment as the axis of rotation, realize the wind leaf Angle adjustment, as shown in Fig. 2 [10; 11] .

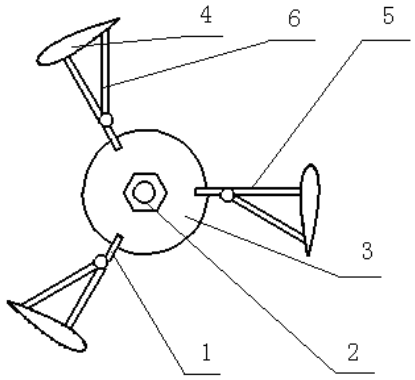

Figure 2 – Vertical view: 1 – The level of connecting rod; 2 – nut; 3 – flange; 4 – The blades; 5 – Connecting rod; 6 – Electric putter

The lower end of the vertical axis wind turbine unit is equipped with braking device, speed detection and control device, which can control whether the electric push rod works according to whether the speed of the generator exceeds the rated speed. The speed of the generator is always lower than or equal to the rated speed, avoiding the stop and failure caused by the excessive speed of the wind turbine, and improving the efficiency and safety of the wind turbine.

The speed sensor installed at the lower end of the wind turbine detects the speed of the vertical axis wind turbine. If the speed is less than the rated speed, the wind blade is at the maximum windward Angle. When speed is greater than the rated speed, sensors to transmit signals to PLC, through the PLC instruction, through adjusting the vertical axis wind turbine wind electric draw stem and leaf of the wind Angle, so that the speed of the vertical axis wind turbines can still maintain within the rated speed, the vertical axis wind turbines can still work, improve the efficiency of power generation.

The upper end cover of the vertical axis wind generator is equipped with a carbon brush and a carbon brush bracket, and the main shaft of the generator is equipped with a connecting disk with a terminal post, and turns with the main shaft of the generator, as shown in figure 3 [12; 14] .

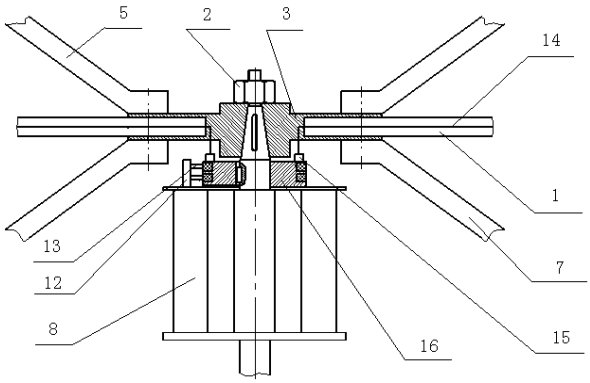

Figure 3 – Carbon brush installation structure diagram: 1 – The level of connecting rod; 2 – nut; 3 – flange; 4 – The blades; 5 – The connecting rod above; 6 – Electric putter; 7 – The connecting rod below; 8 – Wind turbine; 9 – Braking and testing equipment; 10 – stents; 11 – The brake handle; 12 – Carbon brush holder; 13 – Carbon brush; 14 – Electric push rod power cord; 15 – terminal; 16 – Connection plate;

Braking system structure design

In the use of vertical axis wind turbines, some braking (braking) measures should be taken to prevent bad weather and excessive wind force from affecting the units. Existing in the process of using vertical axis wind turbines in the brake and the main use of electromagnetic brake and hydraulic device, the deficiency of this approach is the need to certain external supply of energy (electricity). In extreme cases, if there is no external

energy (electricity), wind turbines will not be able to brake and brake in time, causing serious consequences.

The mechanical brake device of the vertical axis wind turbine designed in this paper does not need power, hydraulic or other power devices in the process of braking, but USES the mechanical brake structure, as shown in figure 4. Brake by generator shaft under the flange, flange on the generator main shaft, generator shaft, brake disc, pin, pin plate, pull on the rope, spline shaft, fork, fork control handle element composition and so on. The flange plate under the generator shaft and the upper flange plate of the generator shaft are fixed on the main shaft of the generator and rotate with the main shaft of the generator. Brake disc to the spindle rotation axis symmetric distribution of the generator, together with the generator shaft rotation, pin shaft axis and generator spindle axis coaxial, pin dish can slip on spline shaft, fork control handle with fork fixed.

As shown in Fig. 4, when the brakes are required, pull on the rope through the pulley for applying pressure lever, brake disc diameter enlarges, and flange on the generator shaft contact, friction, realization of wind turbine deceleration and braking. At the same time, through the fork fork control handle control, make the pin plate move up, and then make the pin slides up into the generator shaft under the flange hole, loosen rope, implement vertical axis wind turbine mechanical brake. When the generator to kick in, as long as through the fork fork down motion control lever control, make the pin plate and pin down, and then from pin shaft generator shaft under the flange hole. The braking avoids the use of power and other energy sources, and improves the braking reliability of wind turbines. Fig. 5 is a schematic diagram of the top view of brake disc structure, and FIG. 6 is a schematic diagram of the part controlled by the fork [15].

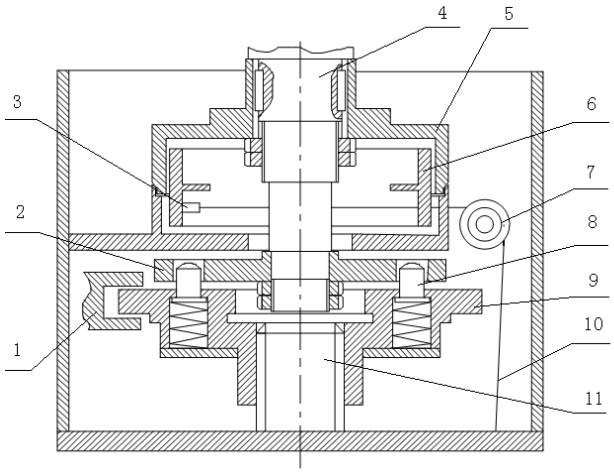

Figure 4 – Diagram of brake structure: 1 – fork; 2 – Generator shaft under the flange plate; 3 – leverage; 4 – Generator spindle; 5 – Generator shaft top flange; 6 – The brake disc; 7 – The pulley; 8 – pin; 9 – Pin plate; 10 – Pull on the rope; 11 – Spline shaft; 12 – Fork handle; 13 – Handle positioning element

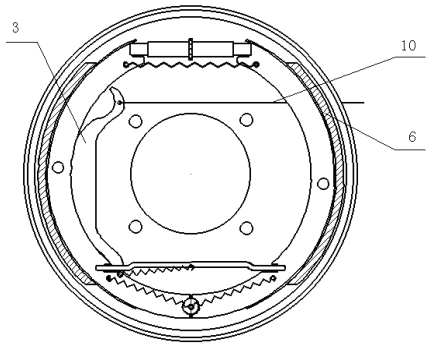

Figure 5 – Diagram of brake disc structure: 3 – leverage; 6 – The brake disc; 10 – Pull on the rope

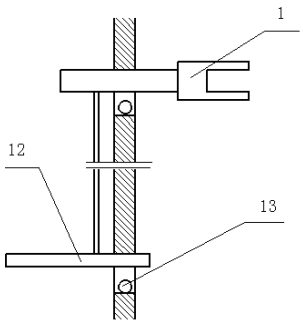

Figure 6 – A schematic diagram of the dial-fork control structure: 1 – fork; 12 – Fork handle; 13 – Handle positioning element

Figure 7 – Vertical axis wind generator physical drawing

Conclusion

Through the mechanical structure design and braking system design of vertical axis wind generator, the installation Angle of vertical axis wind turbine blade can be adjusted according to the wind speed. When the wind is strong, keep the rated speed of wind turbines constant, so as not to damage the units. At the same time, the use of a rise in brake disc and bolt linkage to realize reliable mechanical braking, the vertical axis wind turbine prototype has been successfully trial-produced, as shown in figure 7, fully realize the design requirements, received good results.

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МЕХАНІЧНИЙ ДИЗАЙН МАЛОЇ ВЕРТИКАЛЬНОЇ ОСІ ВІТРОВОЇ ТУРБІНИ

***Анотація**. Новий тип вертикального валу вітрового генератора має конструкцію, яка може регулювати встановлення кута вітрової лопасті відповідно до швидкості вітру. Коли сила вітру велика, швидкість генератора вище, ніж номінальна швидкість. Кут нахилу леза регулюється шляхом регулювання переднього та заднього руху електричного стрижня, так що швидкість вітрогенератора з вертикальним валом може бути зменшена до номінальної швидкості. Таким чином, можна уникнути зупинки та несправності вітрогенератора, викликаного надмірною швидкістю. Одночасно розроблена гальмівна система вітрогенератора з вертикальним валом, а також застосована механічна система гальмування.*

Ключові слова: вертикальна вісь турбіни; Конструктивний дизайн; Механічне гальмування

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