DEVICE WITH VALVES THAT TURNS WIND MOVEMENT INTO MECHANICAL MOVEMENT

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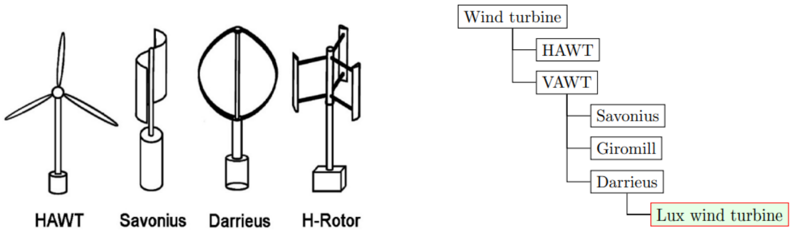
Wind energy can be described as a cheap, clean and renewable source of energy that is completely sustainable. With the growing demand for wind energy, it is productive to investigate the structural and operational factors that undermine the efficiency and performance of a wind turbine. Of paramount importance for the efficient production of wind energy is the aerodynamics of wind turbine blades.

Aerodynamic factors such as drag, airfoil profile, and wake interactions that often reduce the performance of wind turbines can be explored with computational mathematics using computational fluid dynamics (CFD). CFD offers basic methods and tools for simulating physical processes and offers important insights into flow data that are complex and costly to experimentally measure.

The history of wind energy harvesting dates back to the tenth century in Persia using a mechanical device called a windmill [1]. The inhabitants of Eastern Persia, who were predominantly farmers, used windmills to generate mechanical power to grind grain and pump water for agricultural work. However, at the end of the nineteenth century, the mechanical functions of windmills were replaced by wind turbines that generate electricity.

Windmills are similar to wind turbines in that they are both powered by the thrust generated by the wind; however, wind turbines capture the kinetic energy of the wind and convert it into electricity. Understanding wind energy conversion is simple. Uneven heating of the surface of the atmosphere by the sun leads to intermittent wind flow. Wind turbines convert the kinetic energy of the wind flow into mechanical energy, which, through alternating current generators, is converted into environmentally friendly and inexpensive electricity. Thanks to innovative technologies, wind turbines have become an important commercial area for large-scale power generation. Today, the most powerful wind turbines in the world are capable of delivering power up to 9 MW. With continued investment and effective government policies with incentives, the use of wind turbines for wind power seems to be a viable prospect. Over the years, many different wind turbine designs have emerged. However, modern wind turbines can be identified on the basis of shaft orientation and axis of rotation as either horizontal-axis varieties or vertical-axis designs such as the Savonius type, the Darier type, or the Giromile type (Figure 1).

A turbine whose shaft is parallel to the ground is a horizontal axis wind turbine (HAWT). In this design, the axis of rotation is in the same direction as the wind, and the turbine blades provide aerodynamic lift to rotate perpendicular to the direction of the wind. However, the shaft of a vertical axis wind turbine is perpendicular to the ground, as shown in Fig. 2. The two models have a peculiar but different rotor design, each with its own performance and favorable characteristics [2]. While both designs have strengths and weaknesses, HAWT accounts for the majority of utility scale projects to be implemented to their higher efficiency under constant wind conditions [3].



(b) Categories of wind turbines.

Figure 1. Type of wind turbines.

The vertical axis wind turbines (VAWT) shown in fig. 3 have the main rotor shaft assembled perpendicularly and the main components (such as the generator) located near the bottom of the turbine for easy installation and repair. They are built to capture the kinetic energy of the wind independent of the wind.

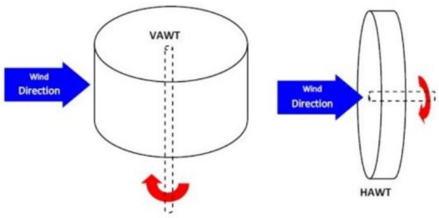


Figure 2: Turbine shaft configuration and rotor orientation [4]

Figure 3: Typical VAWT design example (VAWT Texas A&M)

Orientation, thus eliminating the need to change position with the wind and thus offering great advantages in places where the wind direction is constantly changing.

VAWTs are characterized by lower aerodynamic noise and better fit into the urban environment [5]. Unlike the HAWT, where the gearbox and generator are located at the top of the tower, VAWTs are direct drive, where the alternator and gearbox are usually placed near the base. This arrangement significantly reduces operating costs, increasing durability and reliability [6]. In addition, VAWTs have outstanding performance characteristics such as the ability to operate under uneven wind flow, low turn-on speed and low maintenance costs [7]. Due to these advantages (see Table 1), VAWT can become the mainstream urban wind generation technology due to the slower, more turbulent, multidirectional wind characteristics in most cities [8]. However, there are some limitations to the use of VAWT, namely low power output and fluctuating aerodynamic forces on the turbine blades, which can create a serious fatigue problem for the entire turbine system [9]. However, VAWTs have predominantly been used in small businesses, especially domestic applications, and are attracting growing interest around the world.

Table 1. Difference between HAWT and VAWT. Retrieved from www.windturbinestar.com, wind turbine performance graph

№	efficiency	Horizontal axis design	Vertical axis design
1	Power generation efficiency	50–60 %	Over 70%
2	Electromagnetic	Yes	No
3	interference Steering wind gear	Yes	No
4	Gearbox Over 10 kW:	Yes	No
5	Blade rotation space	Pretty big	Pretty small
6	wind resistance	Weak	strong
7	Noise	5–60 Db	0–10 Db
8	Initial wind speed	high (2,5 m/s– 5 m/s)	Low (1,5 m/s– 3 m/s)
9	The impact of ground projection on humans beings	Dizziness	No effect
10	Failure rate	high	Low
11	Service	Difficult	Comfortable
12	Rotational speed	high	Low
13	Impact on birds	Big	Small
14	cable twist problem	Yes	N o
15	power curve	Depression	Complete

The invention relates to the energy industry, is a design designed to convert wind energy into mechanical energy.

There is a vertical axis device that converts wind energy into mechanical energy (US8,322,035B2). On this device, the aerodynamic blades are attached to the central vertical axis (hereinafter, the word vertical is not used in the text). Such a device has the ability to convert wind energy into mechanical energy and has a low utilization rate of wind energy. The disadvantage of this known device is that it has a small number of blades and the blades on one side of the central axis receive wind energy, and the blades on the opposite side prevent the direction of rotation of the central axis. Due to the difference in the aerodynamic resistance of the blades on one side and the other, we get the resulting torque on the central axis. Since the difference in the aerodynamic resistance of the blades on one side and the other is not very large, the coefficient of wind energy utilization of such a device is very low.

Known valve device, which converts the movement of the wind into mechanical movement (IAP 20190049). The disadvantage of this device is that if one side of the central axis absorbs the force of the wind movement, the opposite side of the central axis cannot use the force of the wind movement. It cannot withstand wind resistance due to the lack of a self-protection system with a sharp increase in wind speed.

The purpose of this invention was to create a device operating in areas where the annual wind speed is not very high (average 3-8 m / s). To solve this problem, the proposed device was created in which the quadrangular blades are attached to the frame at an angle of 90 ° through bearings.

The most important feature of the proposed device is that:

1. Vanes mounted on bearings freely rotating act as valves. 2.Increased number of blades in the same volume of the wind turbine. 3. The blades on the opposite side relative to the central axis, starting from point B to point C (Fig-2), give off useful wind energy to the central axis, starting from point C to point A, the freely rotating blades do not interfere with the direction of the wind. 4. Elimination of emergencies and self-defense when the wind speed increases above the limit level.

The invention is commented with the help of drawings.

Fig-4 side view of the proposed device. Fig-5 top view. Fig-6 protection with increasing wind speed side view. Fig-7 protection with increasing wind speed top view. The device consists of the following main parts: - central axis (shaft) 1: - frame (frame) 2: - elastic stop 3: - reverse stop 4: - blades in working position 5: - blades in open neutral position 6: - mechanism box 7: - wind direction 8.

The upper and lower right sides of the rectangular quadrangular blades 5 are attached to the frame 2 through bearings (D in the drawings) in series with the same gaps. The left corners of the blades 5 should cover the elastic stoppers Z. The elastic stoppers should be adjusted based on the average annual wind speed of the area. The central axis 1 and the blades 5 must be in a perpendicular position relative to the ground (horizon), which allows free movement of the blades.

Work process. The wind flow sets in motion closed blades 5 which abut against the bearings on the right side and elastic stoppers on the left side and are located on the right side of the central axis, as a result, the frame 2 rotates around the central axis 1. The blades 5 located on the left side of the central axis 1 resting on reverse stops starting from point B at a distance to point C drive the frame 2 around the central axis.

As a result, the blades on both sides transfer wind energy to the central axis. At a distance from point C to point A, the blades on bearings, freely rotating, do not interfere with the wind flow and perform the function of a spontaneously opening valve.

The self-protection system at high wind speeds is adjusted using elastic stoppers based on the average annual wind speed of the area. As a result, with an increase in wind speed, the blades, bending the elastic stopper, move to a neutral position that does not interfere with the wind flow. Thus, the blades go into protection mode one by one.

When the wind speed decreases below the critical value, the blades switch to the original operating mode. Reverse stoppers 4 in the protection mode allow the blades to pass in the opposite direction and ensure unhindered rotation of the blades in the opposite direction.

Because of these factors, it is possible to increase the number of blades for the full use of wind energy.

Depending on the required initial data (nominal wind speed and electric power), it is possible to change the number of blades and the volume of the wind wheel.

Scope: The invention relates to the renewable energy industry, is a design designed to convert wind energy into mechanical energy.

Purpose: The purpose of this invention was to create a device that operates in areas where the annual wind speed is not very high (average 3 to 8 m/s)

The essence of the invention: A device that converts wind energy into mechanical energy consists of quadrangular blades. The right angles of the blades are mounted on the frames at an angle of 90° through bearings, which allows the blades to move freely. As a result, the blades open and close depending on the direction of the wind, acting as valves.

The wind flow, closing the blades (valves) on one side of the vertical axis, transmits wind energy to the vertical axis, the blades on the opposite side of the vertical axis, starting from point B to point C, resting on the back stoppers, transmit wind energy to the vertical axis, starting from point C to point A blades moving freely do not interfere with the flow of wind (see Fig. 5). A large number of blades make it possible to use wind energy more efficiently.

Depending on the required power, you can change the number and area of the blades, the distance between the blades and the vertical axis.

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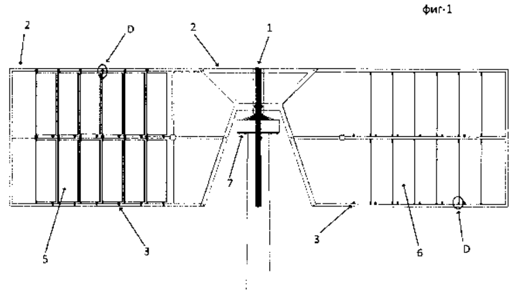

Fig. 4. General view of the wind turbine

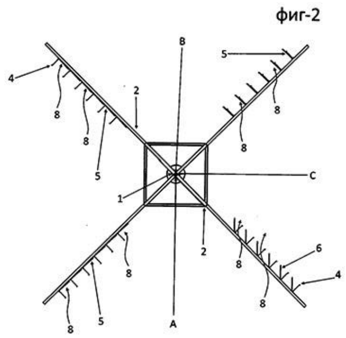

Fig.5. Right view of the device

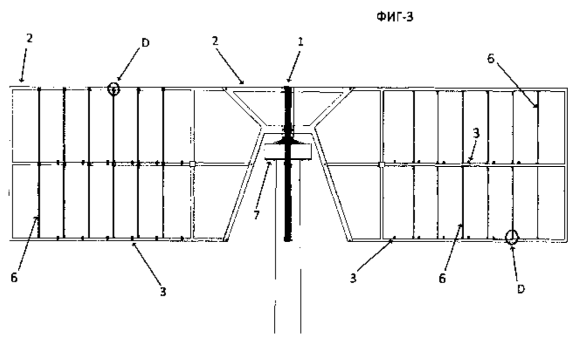

Fig-6 protection with increasing wind speed side view.

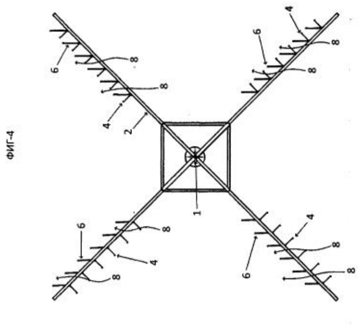

Fig-7 protection with increasing wind speed top view.

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