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Electricity Generation Using Air Borne Wind Turbine

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Abstract: ***This paper presents a novel Air Borne Wind Generator. Magenn Air Rotor System (M.A.R.S), a type of Air Borne Wind Generator that is used to generate electricity. It rotates around a horizontal axis in response to the wind and the electricity is sent down with the help of tether which can be stored in batteries or can be used instantly. It generates clean renewable energy and is economical compared to the other conventional methods. The paper briefly presents the design and construction features. Advantage and disadvantages of the design Implemented are presented.***

Keywords: ***Magenn Air Rotor System, Airborne Wind Generator.***

I. INTRODUCTION

Renewable energy production is where the world is moving towards to meet the increasing power demands. There are many renewable sources available, solar, wind and hydro. Construction of these energy production methods requires a larger area and can become quite impossible to construct them in an inhospitable region where no traditional infrastructure exists. The kinetic energy of wind can be either converted into mechanical or electrical energy. As far as wind energy is concerned, towering wind turbines have a huge disadvantage because they are restricted to a particular location and fixed altitude. When the wind is slow or absent, the power produced is almost zero. Therefore we have to reach higher altitudes in order to use the wind energy to its full potential. This is where airborne wind energy is playing a crucial role.

AIRBORNE WIND TURBINE

An airborne wind turbine is a design concept for a wind turbine supported without a tower. The airborne turbine is supported by a tripod stand on both the sides of the turbine. Two motors are used instead of a generator which is placed at the two ends of the turbine. The generated electricity is transferred down the cable which can be stored in batteries or can be used immediately. This will avoid the expense of tower construction or the need of slip rings. The basic airborne wind turbine is shown in fig .1

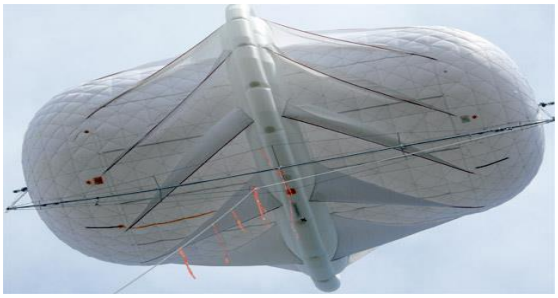

Fig 1: General airborne wind turbine

II. COMPONENTS

The components used for this concept is new and inexpensive compared to the traditional wind turbines. Nylon cloth is a family of synthetic polymers, widely used for textiles. It has great strength, toughness, and elasticity. It has a density of 1.15g/cm3.

It has an electrical conductivity of 10-12s/m and thermal conductivity of 0.25w. The melting point of the cloth is 463-624k.Any DC motor with a permanent magnet can be easily used as a generator. They are two types, brushed and brushless DC motor. Any of these can be used as a generator. We are using brushed DC motor because it gives DC output. If we use brushless, the output is AC because of the absence of commutator and brushes. We have to use rectifiers in order to convert them into DC. An axle is a central shaft for rotating wheel or gear. It is made up of aluminum and when the air is blown, it rotates and makes the wheel or gear to rotate as it is connected to it.

Two gears are used at both the end of the turbine. This is to increase the speed of the motor if the rotation speed of the turbine is low. Pinions are used to control the speed of the turbine if the wind speed is high.

III. CONSTRUCTION AND DESIGN

The turbine is designed with aluminum strips for easy rotation. It consists of two rings, the inner ring, and the outer ring. The turbine at the ends is connected with plastic caps in which the aluminum rods are placed.

The shaft is connected to both ends of the aluminum rods so, when the turbine rotates, the shaft also rotates. Plastic sticks are screwed to the inner ring and the plastic caps for mechanical support to the cloth. The other end of the cap is connected with the gear and pinion which in turn is connected to the motor for rotation. The turbine now is covered with nylon cloth completely excluding the end part of the caps.

The internal structure of the turbine is shown in fig.2. These components are chosen such that they are inexpensive compared to other wind turbines. They are also chosen because of lightweight. The entire turbine with the motors weighs around 1.5kg.

It is designed and constructed in such a way that, it has a free rotation. So when the wind blows it rotates freely.

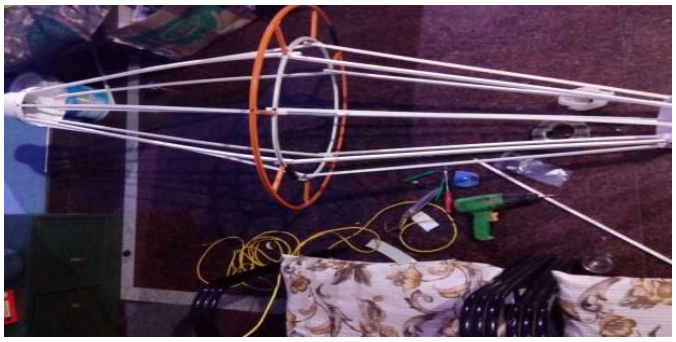

Fig 2: Internal structure of the turbine

The blades which are made of paper plates is cut to give a duct shape so as to trap maximum wind. A number of paper plates are equal to the number of plastic sticks inside the turbine. The paper plates are stuck on top of the nylon cloth with a tape. This makes the blades light weight and easy for rotation. The basic construction of the turbine is shown in fig.3

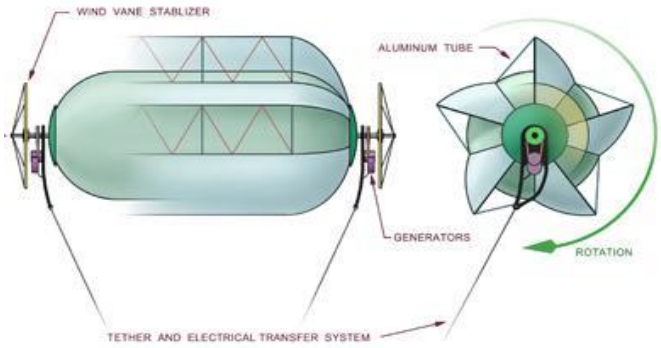

Fig 3: Basic design of the airborne wind turbine

IV. MEASUREMENTS

The total width of the model is 6.1 feet. The length of the shaft is 5.7 feet. The outer ring diameter is 29.5 inch. The diameter of the inner ring is 21 inch. The gap between the inner and outer ring is 4.5 inch. The gap between each plastic stick at the ends is 2 inch. There is a 6.5-inch gap between each plastic stick at the center.

V. WORKING

When the wind is blowing, the blades trap the wind and starts spinning due to light weight. The blades change the wind's energy into rotational shaft energy. The turbine rotates in the horizontal direction. The shaft inside it also rotates along with the turbine. The shaft uses the rotation of the blades to spin the magnets in the motor to produce mechanical energy. The other end of the shaft is connected to the gear box. This gearbox transfers the energy to a secondary shaft. The step up gear causes higher rotations in the secondary shaft and consequently lower torque. Now the motor rotates at higher speed than the turbine thus producing more energy. The complete picture of the turbine after completion is shown in fig.4

Fig 4: The complete airborne wind turbine

The motor converts this mechanical energy into electrical energy using the principle of electromagnetic induction. This electrical energy is transferred down by transmission cables. This energy is used to glow a 3W LED bulb which is connected to the transmission cable. The relationship between the wind speed and power output is shown below.

$$\text{Power} = k\, C_p\, 1/2\, \rho\, A V^3$$

Where,

P= power output in volts
Cp= maximum power coefficient
ρ = Air Density, lb/ft3
A= Rotor swept area, π D2/4 (D is the rotor diameter in ft, π = 3.1416)
V = Wind speed, mph
k = 0.000133, A constant to yield power in kilowatts, since we are measuring in volts, this constant is neglected.

VI. OUTPUT

We have concentrated much about the designing part. As the wind speed increases, the power output also increases. For about 10 rotations, the output in terms of volts is 15 volts. The
Wind speed recorded to get 15 volts is 12 m/s.

VII. ADVANTAGES AND DISADVANTAGES

- ADVANTAGES

1. Can be installed even in remote areas where no traditional infrastructure exists.
2. Can be raised to higher altitudes without a tower.
3. Installation cost is low and not hard to implement.
4. Does not require a huge mass of land.
5. The energy it produces does not cause any pollutants.
6. Can operate in wind speed from 2 to 28 meters/second
7. Less noise pollution

- DISADVANTAGES

1. The system must be shutdown in case of bad weather like thunder and lightning strikes.
2. Safety precautions must be taken if the cables get detached.

CONCLUSION

The demand for energy is increasing day by day and so are the alternative methods to reach the demand. Wind energy can be utilized to its full potential if we can suspend the turbine to higher altitudes. This paper has proposed a method for electricity generation which has low-cost installation and very easy to deploy. Every technology has its own pros and cons and so is the airborne wind turbine. Efforts can be made to modify this turbine to reach higher altitudes and to generate more electricity. The turbine can be filled with helium gas and can be freely suspended in the air. Dacron cloth can be used instead of nylon cloth to prevent the leakage of helium gas. The system which has the above specification is shown in fig.1. The output of our airborne wind turbine can be increased by using generators instead of motors. We have used motors instead of generators because it is cheap compared to generators. In the future; rapid development in the sector of airborne wind energy systems is expected.

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