The Alternate Wind Generator

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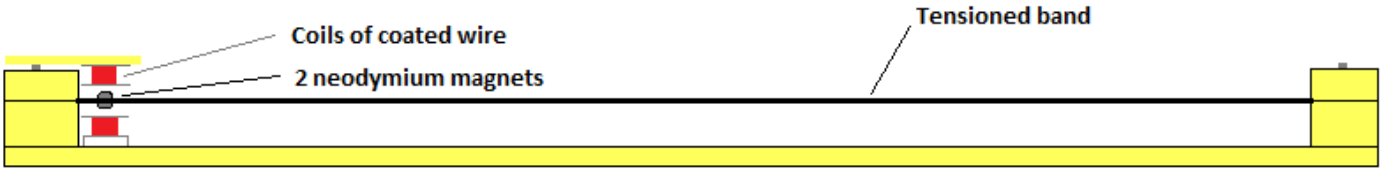
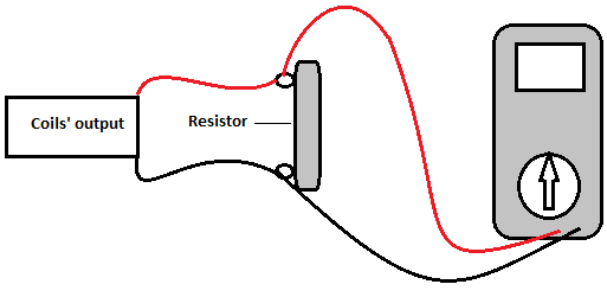
The most widely accepted, recognized and employed device for generating electrical power from wind energy is the wind turbine. These turbines' effectiveness is evident when they are hundreds of feet tall and placed in extremely windy locations but their ability to produce power greatly diminishes when these two factors are taken away. Turbines are unable to efficiently produce power when scaled down due to friction in their moving components which is not possible to overcome with the smaller blades catching a lesser amount of wind(Ward, 2007). To solve this problem, a 28 year old inventor named Shawn Frayne, invented what he calls the Windbelt (Ward, 2007). Frayne says that his Windbelt idea was sparked by watching a film of the Tacoma Narrows Bridge collapse in high school(Ward, 2007). The bridge was torn apart by aeroelastic flutter and the Windbelt employs this same phenomenon to create electricity ("Windbelt Innovation" 2010). Shawn Frayne's invention consists of a membrane tensioned across a housing, two neodymium magnets fitted to the membrane and two coils of coated wire which interact with the magnets to induce electricity (Ward, 2007). This set up is extremely simple and has been tested to produce up to 40 milliwats in only a ten mile per hour wind stream (Ward, 2007). This shows the Windbelt to be anywhere from 10 to 30 times as efficient as the most advanced micro turbines (Ward, 2007). Additionally and perhaps most importantly, the Windbelt is extremely inexpensive to create and maintain ("Windbelt - Reinventing wind power"). The simplicity and availability of the materials allow these generators to be used in developing countries or other areas where solar or conventional electricity is either too expensive or inaccessible ("Windbelt Innovation" 2010). Furthermore, the Windbelt is quite rugged and easily fixed or repaired by even essentially totally unskilled individuals; further lending itself to application in developing countries ("Windbelt - Reinventing wind power"). Still further, the Windbelt has very few moving parts which translates into simplicity but also, unlike turbines,

safety from spinning blades for bats, birds and even people in the vicinity of the generator ("Windbelt Innovation" 2010). This invention of a new breed of wind powered electric generator has opened portals to new safer, cheaper, more accessible and simple power options for people worldwide.

I constructed my own Windbelt and have observed very favorable results during testing. I used wood as the primary construction material instead of the more professional aluminum housing that Frayne's company uses. I first cut a 1x4 board to about a meter long and then fastened a 2 inch long 2x4 and a 2 inch long 1x4 atop one another on either side of the main board with two bolts through each stack. I then broke a VHS tape and scavenged the film from it to use as a membrane or belt. This belt was placed between the short 2x4 and the 2x6 and the bolts were then fastened down and the belt was held in place. I then placed one neodymium button magnet on either side of the belt (top and bottom) so they would hold one another in place and essentially create a single magnet. The magnets were positioned about two inches along the belt from where it was held in place by the short boards. The coils which would be interacting with the magnets to produce an electrical current were then placed. The coils I used are varnished copper "magnet wire" spools that I bought. Instead of taking the wire off and rewrapping it into another coil, I decided to simply leave the wire on the plastic spools that it came on and utilize the coils that were already present. I positioned these two coils above and below the magnets at slight angles (they were slightly farther apart on the side that faces down the band) to ensure that the coils could be as close to the oscillating magnets as possible without interfering with the band's motion. As described, construction was very simple which holds consistent with the Frayne's generators.



Once construction was finished, the testing and adjusting of the generator was performed. The objective of testing the generator is to optimize its electrical energy output through slight changes and improvements to it. As a test, I used a common household fan to cause a wind-like effect on the generator. To test my generator's output, I hooked up a 50ohm resistor directly in a circuit with the pair of coils. Then, to measure the change in voltage across the resistor, I added a voltmeter in series with the resistor. This configuration (see figure below) gives me a voltage amount which I could then in turn use to calculate the power output of my generator. When I started out, I had my coils poorly positioned and my band was not stretched to the optimum tautness. During testing this initial setup resulted in a recorded voltage of approximately 20millivolts. Once I experimented with the band and adjusted it to have the oscillation and wave with the highest recorded voltage, approximately 30 millivolts were created. I then positioned the two coils directly in line with one another and the magnets and also as close to the vibrating band as possible. After the coils were aligned there was a slight increase in voltage; however with the distance between the magnets and the coils decreasing, the voltage increased exponentially as shown in the below equation.



$$\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi}\frac{3\hat{r}(\vec{m}*\hat{r})-\vec{m}}{r^3}$$ (Stewart et al. 2011)

Once tuned and adjusted, my generator is capable of consistently producing between 60 and 100 millivolts but will jumps as high as 170mV at the tested wind speed.

Now, computing the power output of the Generator while producing an average of 80mV:

$$\Delta V = I * R \qquad \frac{\Delta V}{R} = I \qquad \frac{80x10^{-3}V}{50\Omega} = .0016\ A$$

$$P = I^2 * R \qquad (.0016A)^2 * 50\Omega = 1.28x10^{-4}W$$

The reason for the production of electricity in the generator in physics terms is really quite simple; as is the rest of the generator. The whole basis for the creation of electrical energy is Faraday's law (Stewart et al. 2011). Faraday's law solves for electromotive force (voltage for our purposes) given magnetic field, magnetic flux and/or electric field as shown in the below equation.

$$emf = \oint_C \vec{E} * d\vec{l} = -\frac{d\emptyset_m}{dt} = -\frac{d}{dt}\int_S \left(\vec{B} * \hat{n}\right)dA$$ (Stewart et al. 2011)

Simply put, Faraday's law states that an electrical current will be observed if a magnet and a loop of wire are moved relative to one another. This is the physical principle for basically all generators of electricity. As also stated in Faraday's law, since my generator has multiple loops, (a coil of wire) the effect of the magnets' field induces a greater emf and therefore more voltage ("Electromagnetic Induction"). To this point, I added the secondary coil above the first coil in order to utilize the other side of the magnetic field. The tuning of the belt was important in order to maximize oscillation speed because: "If the same coil of wire passed through the same magnetic field but its speed or velocity is increased, the wire will cut the lines of flux at a faster

rate so more induced emf would be produced" ("Electromagnetic Induction"). I used two of the three methods (more loops of wire and faster change in magnetic field) available within Faraday's law to increase the induced emf but the last method did not benefit my generator's performance. The last way to induce a greater emf is to increase the magnetic field("Electromagnetic Induction"). I attempted this by adding another button magnet to the bottom magnet on the band; this caused an unbalanced twisting motion of the band and magnets and actually decreased effectiveness so I removed the magnet. The induced current from the generator was alternating current (AC). This is because as the magnet moves relatively closer to or even inside the coil, the change in magnetic field will be positive; however in the opposite direction the change in magnetic field will be negative ("Electricity and Magnetism"). This switching of changing magnetic field direction will induce a current that is also switching accordingly and is aptly named Alternating Current ("Electricity and Magnetism").

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