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# Low Cost Energy Production Using Wind Belt Technology

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***Abstract:*** ***as the awareness towards generating green energy increases on a global platform, various kinds of renewable energy equipments are seen entering the global market on a daily basis [1]. Wind belt technology is an alternative to the costly and complex wind turbines. Instead of the conventional focus on "rotation", this new wind-based power generator capitalizes on "vibration", making use of a physical effect known as "Aeroelastic Flutter". In aeroelastic flutter when air passing over a thin strip of material creates frequencies that translate into vibrations and in the wind belt case, which convert into energy[2]. Wind belt is one such device that holds a promising future in the renewable energy market. This device converts wind energy to electrical energy by means of a stretched membrane and few magnets located within metal coils [3]. The relative movement causes a change in the strength of the magnetic field applied to the electrical conductor, and the change in the strength of the magnetic field applied to the electrical conductor induces a current flowing in the conductor thus generating electricity [4].***

***Key Words:*** **- Wind belt, Aeroelastic.**

## I. INTRODUCTION

Our team designed a working low cost and a small device to power up small lights radios and possibly a cell phone or even a laptop. The flutter of the membrane creates an iris of motion that is used to oscillate magnets in between magnetic wire coils in order to create a charge. This relatively small amount of energy can hopefully power lights in poor countries with little or no cost to the household. Wind belt design is now being considered to power small sensors in large buildings air ducts in order to regulate the temperature of the building without the use of batteries that will need to be replaced. Currently, the Wind belt technology is new and not widely used. We hope that the Wind belt will become a more feasible generator in the next couple of years after the technology becomes wider known and is augmented to function with greater efficiency. Our hope is that a series of Wind belts can someday be used to power larger things like computers and to charge larger batteries like that of a car or possibly defibrillator for field medics.

## II. CONSTRUCTION

An exemplary electrical generator includes at least one magnetic field generator, at least one electrical conductor, and at least one flexible membrane having at least two fixed ends. The membrane vibrates when subject to a fluid flow. One of the electrical conductor and the magnetic field generator is attached to the membrane and configured to move with the membrane. The vibration of the membrane caused by the fluid flow causes a relative movement between the electrical conductor and the applied magnetic field. The relative movement causes a change in the strength of the magnetic field applied to the electrical conductor, and the change in the strength of the magnetic field applied to the electrical conductor induces a current flowing in the conductor. One or all parts of the generator may be implemented as a MEMS (Micro Electro-Mechanical Systems) device. In one aspect, the direction of the magnetic field may be substantially perpendicular to an area enclosed by the electrical conductor, when the membrane does not vibrate [5].

**Fig 1 Typical Wind Belt model**

## III. POWER GENERATED BY WIND BELT

When calculating the power produced by the Wind belt device two main assumptions must be made about its relation of power to geometry and wind speed.

A.

The amount of power, in watts, generated by the Wind belt is proportional to its area coverage. For example, if a Wind belt of a finite size was replaced by another Wind belt that was twice its size; the new Wind belt would produce twice the amount of power as the original. This is shown in equation 1where A is coverage area and W is power with the respective units.

$$W[W]:A[m^2] \qquad [1]$$

B.

The power produced is proportional to the cube of the wind speed. This would mean that if the wind speed were to double, or increase by a factor of two, the power output would increase by a factor of eight. This can be shown in equation 2with the where v is wind speed with the respective units.

$$W\,[W]:v^3\,[m/s]^3 \qquad [2]$$

The energy the wind produces must be taken into consideration and for simplicity the kinetic energy equation will be used to represent its nominal energy. Equation 3 shows the kinetic energy equation where EK is kinetic energy and m is mass.

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$$E_K\,[J] = \frac{1}{2}\times m\,[kg]\times v^2\left[\frac{m}{s}\right]^2 \qquad [3]$$

The mass of air is written in terms of mass flow to make it easier to measure for practical scenarios and can be elaborated in equation 4 where t is time and ρ is density.

$$\frac{m}{t}\left[\frac{kg}{s}\right] = v\left[\frac{m}{s}\right]\times A\,[m^2]\times\rho\left[\frac{kg}{m^3}\right] \qquad [4]$$

The power produced by the Wind belt can then be equated using equation 5

$$W\,[W] = \frac{1}{2}\times A[m^2]\times\rho\left[\frac{kg}{m^3}\right]\times v^3\left[\frac{m}{s}\right]^3 \qquad [5]$$

The density of air is not usually an ideal value to be measured through a wind turbine so instead the ideal gas equation shown in equations 6 - 9 will be used to replace density with variables such as air temperature, T, and pressure, P, which are more effectively measured. Also note V is volume, R is ideal gas constant, n is moles and M is molar mass. The density of air is not usually an ideal value to be measured through a wind turbine so instead the ideal gas equation shown in equations 6 - 9 will be used to replace density with variables such as air temperature, T, and pressure, P, which are more effectively measured. Also note V is volume, R is ideal gas constant, n is moles and M is molar mass.

$$P\left[\frac{N}{m^2}\right]\times V\,[m^3] = n\,[mol]\times R\left[\frac{J}{K\cdot mol}\right]\times T\,[K] \qquad [6]$$

$$P\left[\frac{N}{m^2}\right]\times\left(\frac{m\,[kg]}{\rho\left[\frac{kg}{m^3}\right]}\right) = n\,[mol]\times R\left[\frac{J}{K\cdot mol}\right]\times T\,[K] \qquad [7]$$

$$\rho\left[\frac{kg}{m^3}\right] = \frac{M_{Air}\left[\frac{kg}{mol}\right]\times P\left[\frac{N}{m^2}\right]}{R\left[\frac{J}{K\cdot mol}\right]\times T\,[K]}\ \text{Where}\ M_{Air} = 0.0287\left[\frac{kg}{mol}\right]\ \text{and}\ R = 8.314\left[\frac{J}{K\cdot mol}\right] \qquad [8]$$

$$\rho\left[\frac{kg}{m^3}\right] = 0.003484\left[\frac{kg\cdot K}{J}\right]\times\frac{P\left[\frac{N}{m^2}\right]}{T\,[K]} \qquad [9]$$

The new power equation is shown in equation 10 where power can now be derived given any air pressure and temperature, wind speed and Wind belt size measurements.

$$W\,[W] = 0.001742\left[\frac{kg\cdot K}{J}\right]\times A[m^2]\times\frac{P\left[\frac{N}{m^2}\right]}{T\,[K]}\times v^3\left[\frac{m}{s}\right]^3 \qquad [10]$$

## IV. DETAIL MODEL DRAWING

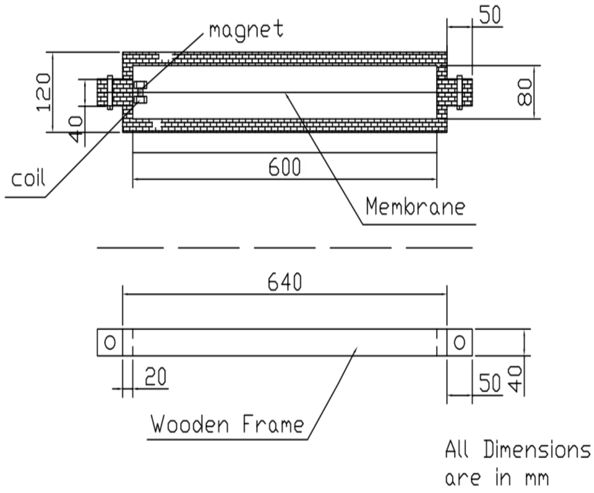


Fig 2 Wind Belt Specification

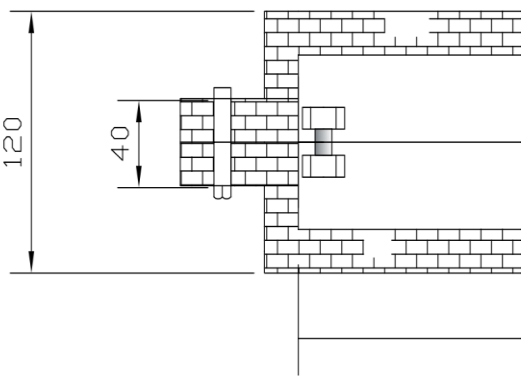


Fig 3 Wind Belt Magnet and Coil Arrangement

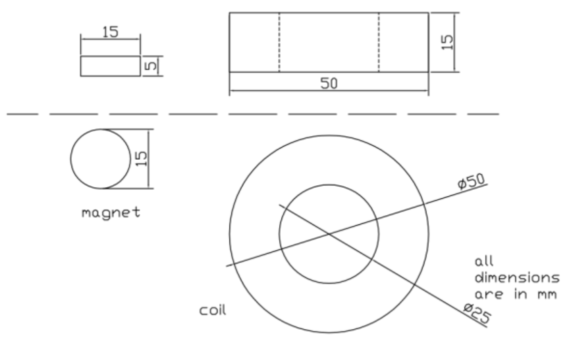


Fig 4 Magnets and Coil Specification

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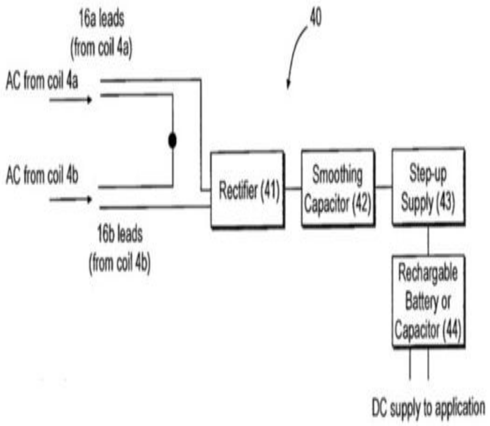


**Fig 5 Line Diagram of Wind Belt**

### IV A) PHOTOGRAPHIC VIEW OF THE MODEL

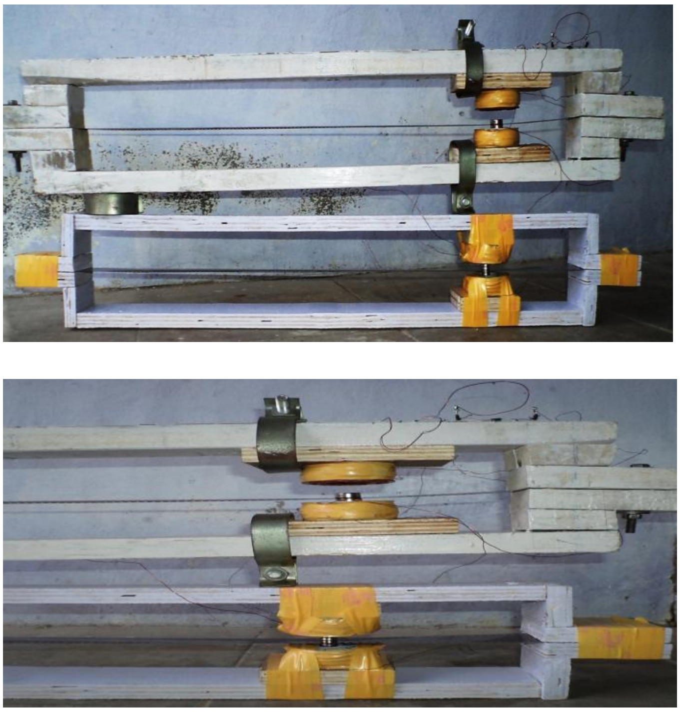

**Fig 6 Photographic View of the Model**

### V. COST ANALYSIS

The cost of these materials can be cut to a minimum if recycled materials are used.

**Table 1 Cost Analysis**

| **Item** | **Our Cost (in Rs )** |
|---|---|
| Wood | 400 |
| NdFeB Magnet | 1200 |
| Ribbon(Camera Film) | 150 |
| Soldering Rod | 200 |
| Multimeter | 300 |
| Insulated Tape | 40 |
| Nails | 20 |
| 28 SWG Insulated Copper Wire | 500 |
| Screw Driver Set | 200 |
| Scissor, Pliers | 100 |
| Hammer, Hacksaw, Handsaw | 200 |
| LED | 10 |
| Nuts, bolts, and washers | 40 |
| **TOTAL** | **3360** |

### VI. RESULT AND DISCUSSIONS

To test the Wind belt, blow a large fan across the belt if there is no wind available.

**Fig 7 Two Wind Belt Connected In Series**

| Wind Speed (m/sec) | Current(mA) |
|---|---|
| 3 | 2 |
| 3.4 | 2.2 |
| 3.8 | 2.3 |
| 4.2 | 2.5 |
| 4.4 | 2.7 |
| 4.8 | 2.9 |
| 5.2 | 2.9 |
| 5.4 | 2.9 |

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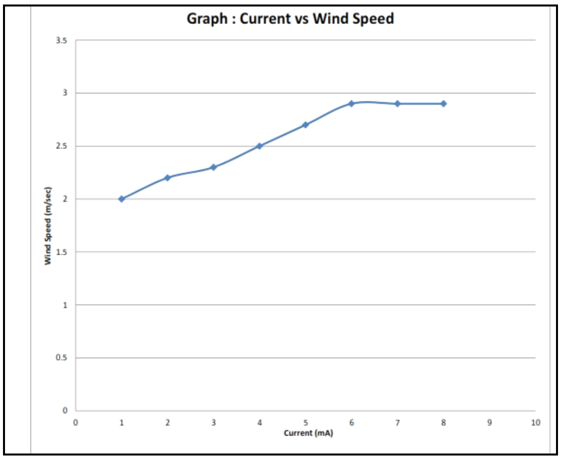


## VII. CONCLUSION

The Wind belt has no gears or bearings, making it much more efficient than scaled down wind turbines which have to contend with friction. This makes Wind belt preferable for smaller scale applications such as powering LED lights in rural communities. In addition, due to the nature of Aeroelastic flutter, Wind belt can be tuned to optimize their output at different wind speeds and theory is not dependent on high wind speeds. Wind belts are cheap to produce, the smaller versions costing not more than three to four thousand INR with an expected lifespan of 20 years, and can be easily manufactured in developing countries. Perhaps the most significant barrier to the current use of Wind belt is the relative newness of the technology. Wind belts in any size are not yet being widely manufactured and so each one must be designed and constructed individually. The construction of a wind belt is much simpler to that of a conventional wind turbine. In a wind turbine, gears and other mechanical systems help in moving the turbine and generate electricity, whereas a wind belt is just a very simple mechanism which can be made easily with just few thousand INR. Moreover, wind belt uses even the lightest of the winds for vibrating the membrane. In a recent experiment, a prototype of wind belt was found to be ten to thirty times more efficient than micro turbines. Moreover, as the constructing a wind belt is cheap, it can be an excellent alternative especially in rural areas where kerosene is used for lesser amount of power. As kerosene produces smoke that is known to create health problems, a wind belt seems to be an effective alternative device in the rural areas.

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