

Electrical Energy Harvesting By Using Pendulum Power Generator

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Abstract: - The more power demand has been occurring now a day in India. The main reason of the power demand is due to the lack of improper energy utilization and conservation. The pendulum generator deals with the power generation from the mechanical energy that has been wasted in many day today real time applications. The pendulum setup has been made, that is whenever it has been kicked off the kinetic energy of ball makes the pendulum to oscillate, generates the electrical energy. We can implement the pendulum based power generation system in real time application wherever the vibration produced. We can implement a pendulum based power generation system in such dynamic application we can generate power from it. The pendulum power generator is most efficient & eco friendly power generator. The pendulum power generator is the machine which converts the motion of pendulum i.e. mechanical energy into electrical energy. This is most helpful source or machine for power generation in today

Index Terms: - Pendulum, Magnet, Bob, Crank, Gravity

1. INTRODUCTION

Energy has been universally recognized as one of the most important inputs for economic growth and human development. There is a strong two-way relationship between economic development and energy consumption. On one hand, growth of an economy, with its global competitiveness, hinges on the availability of cost-effective and environmentally benign energy sources, and on the other hand, the level of economic development has been observed to be reliant on the energy demand. In the recent years, India's energy consumption has been increasing at one of the fastest rates in the world due to population growth and economic development.

Man has always been in pursuit of energy to meet his ever increasing demand. In recent times due to effects of pollution and global warming there is a need for generating power from renewable sources. The reason for generating power using gravity is that it is available all over the Earth, abundant and consistent too and it cannot be efficiently converted into electrical energy. In this paper we designed a methodology wherein gravitational

energy is further amplified in terms of its magnitude by using Perpetual Motion Mechanism and hence can be successfully transformed into usable electrical energy. The basic concept of a gravity power generating mechanism is simple. When a body moves down from a higher altitude to a lower one its potential energy is converted into kinetic energy. This motion is converted into circular motion and is then converted into electricity using a generator.

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2. TERMINOLOGY OF PENDULUM POWER GENERATOR

2.1 Newton 1st Law:

This law is really only a definition of force. It says that when a body is acted upon by an external resultant force it will accelerate. If the resultant force is zero, then the body either remains at rest or else it will continue to move at constant velocity (that is with constant speed in a straight line. This law is state that "An object at rest will remain at rest unless acted on by an unbalanced force. An object in motion continues in motion with the same speed and in the same direction unless acted upon by an unbalanced force". This law is called Law of inertia

2.2 Magnetic Field :

A magnetic field is the magnetic effect of electric currents and magnetic materials. The magnetic field at any given point is specified by both a direction and a magnitude as such it is a vector field. The term is used for two distinct but closely related fields denoted by the symbols B and H, where H is measured in units of amperes per meter (A/m) in the SI. B is measured in Teslas (T) and Newton's per meter per ampere in the SI.

2.3 Magnetic Field Strength:

Magnetic field strength is one of two ways that the intensity of a magnetic field can be expressed. Technically, a distinction is made between magnetic field strength H , measured in amperes per meter (A/m), and magnetic flux density B , measured in Newton-meters per ampere also called Teslas (T). The magnetic field can be visualized as magnetic field lines. The field strength corresponds to the density of the field lines. The total number of magnetic field lines penetrating an area is called the magnetic flux. The unit of the magnetic flux is the Tesla meter squared ($T\cdot m^2$) The older units for the magnetic flux, the Maxwell (equivalent to 10^{-8} Wb), and for magnetic flux density, the gauss (equivalent to 10^{-4} T), are obsolete and seldom seen today. Magnetic flux density diminishes with increasing distance from a straight current-carrying wire or a straight line connecting a pair of magnetic poles around which the magnetic field is stable. If a ferromagnetic object such as a piece of iron is brought into a magnetic field, the "magnetic force" exerted on that object is directly proportional to the gradient of the magnetic field strength where the object is located.

2.4 Pendulum:

A pendulum is a weight suspended from a pivot so that it can swing freely. When a pendulum is displaced sideways from its resting, equilibrium position, it is subject to a restoring force due to gravity that will accelerate it back toward the equilibrium position. When released, the restoring force combined with the pendulum's mass causes it to oscillate about the equilibrium position, swinging back and forth. The time for one complete cycle, a left swing and a right swing, is called the period. The period depends on the length of the pendulum, and also to a slight degree on the amplitude, the width of the pendulum's swing. The simple gravity pendulum is an idealized mathematical model of a pendulum. This is a weight (or bob) on the end of a mass less cord suspended from a pivot, without friction. When given an initial push, it will swing back and forth at constant amplitude

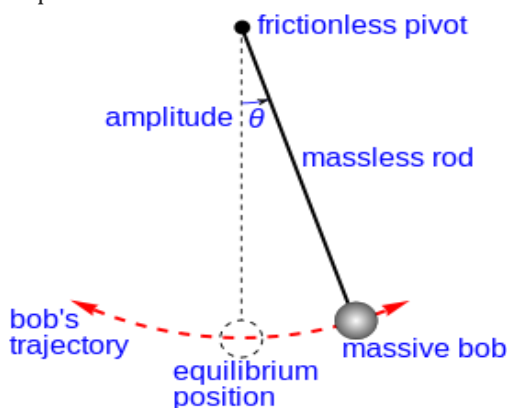


Figure 1: Simple Pendulum

2.5 Pendulum Time Period:

The period of swing of a simple gravity pendulum depends on its length, the local strength, and to a small extent on the maximum angle that the pendulum swings away from vertical, θ_0 , called the amplitude. It is independent of the mass of the bob. If the amplitude is limited to small swings the period T of a simple pendulum, the time taken for a complete cycle, is

$$T = 2\pi \sqrt{\frac{L}{g}}$$

Where L is the length of the pendulum and g is the local acceleration of gravity.

2.6 Force Generated by Pendulum:

When a simple pendulum is displaced from its equilibrium position, there will be a restoring force that moves the pendulum back towards its equilibrium position. As the motion of the pendulum carries it past the equilibrium position, the restoring force changes its direction so that it is still directed towards the equilibrium position. If the restoring force F is opposite and directly proportional to the displacement x from the equilibrium position, so that it satisfies the relationship where a mass m is suspended by a string of length l and is displaced from its equilibrium position by an angle θ and a distance x along the arc through which the mass moves

There are two dominant forces acting upon a pendulum bob at all times during the course of its motion. There is the force of gravity that acts downward upon the bob. It results from the Earth's mass attracting the mass of the bob. And there is a tension force acting upward and towards the pivot point of the pendulum. The tension force results from the string pulling upon the bob of the pendulum. In our discussion, we will ignore the influence of air resistance - a third force that always opposes the motion of the bob as it swings to and fro

The gravitational force can be resolved into two components, one along the radian direction, away from the point of suspension, and one along the arc in the direction that the mass moves. The component of the gravitational force along the arc provides the force F and is given by

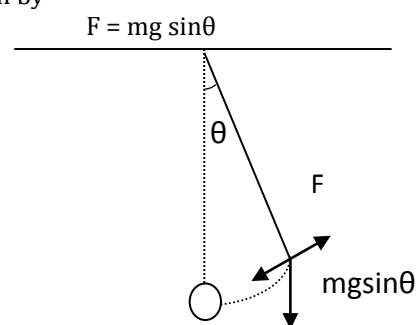


Figure 2: Force Generated by Pendulum

The pendulum is attached on a horizontal body frame connected at the point in which it moves freely over the surface. Both sides of the supporting frame are attached by the fixed magnet & both side of the pendulum is attached by the magnet. An arrangement is so that the magnets of similar polarity are attached, thus, the pendulum moves between the magnets of similar polarity. Once the pendulum is displaced from its equilibrium position it swings to and fro. The connecting rod is attached to the rotating crank type disc which convert the pro and fro movement of pendulum into rotation. Generator is attached to the crank disc through the shaft

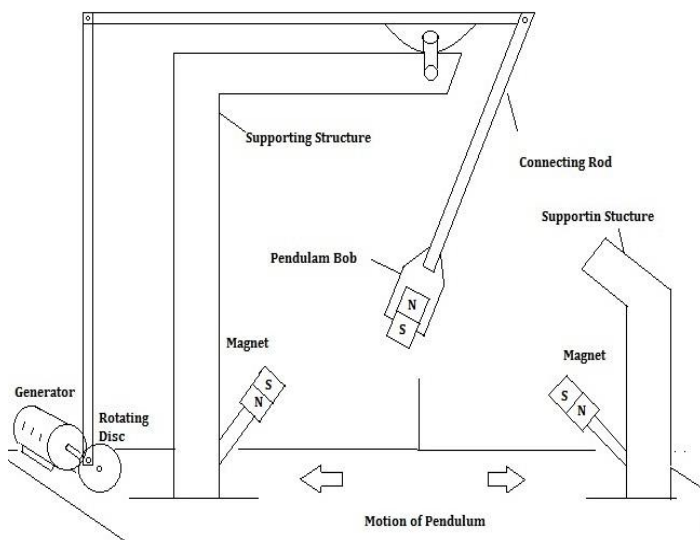


Figure 3: Construction of the Pendulum Power Generator

Components of the Pendulum Power Generator are:

3.1 Permanent Magnet:

A permanent magnet produces a high magnetic field. It consist three permanent magnet one fixed on the bob and remaining fixed on both left and right side at equal distance from centre position. The magnet is fixed in such way that they have same polarity. The property of repulsion of like polarity of magnet is use in this pendulum power generator. The magnetic strength is decided from standard physical chart of magnet and the magnet have high strength to repel the pendulum bob.

3.2 Pendulum Bob:

The simple gravity pendulum is an idealized mathematical model of a pendulum. This is a weight on the end of a mass less cord suspended from a pivot, without friction. When given an initial push it will swing back and forth at constant amplitude. It connected on the supporting frame and the pendulum bob is made up of non magnetic material and has good tensile strength to sustain the weight continuously. The time for one complete cycle is called the period. The period depends on the length of the pendulum.

3.3 Supporting Frame:

It is a non magnetic material to support the generator and the electric circuit assembly. At the center of the supporting frame pendulum is attached. Magnets are fixed on both side of the frame. The one side of supporting frame is look like 'L' shape where the bob and connecting rod is attached.

3.4 Crank Disc:

A crank is simply an off-center connection that provides energy or takes energy from a rotating wheel. Crank system is used to convert the circular motion into reciprocating motion . The end of the rod attached to the crank moves in circular motion while the other end is usually constrained to move in linear sliding motion. As the crank pushes back and forth the wheel rotates.

3.5 Low RPM Generator:

Low rpm generator produce power at low revolution per minute. Low rpm generators once employed provides years of usage. These generators not only provides higher efficiency but also have low cost, low rpm generator are used because they give a highly reliable power output as they work at less speed which leads to less wear and tear of the various part of generators. The rpm of the generator is about 50-100 rpm at small size , the speed of the generator can increase bigger size of unit by gear system, like wind turbine.

4. OPERATION OF PENDULUM GENERATOR

The pendulum power generator is the machine which converts the motion of pendulum i.e. mechanical energy into electrical energy. In this generator the pendulum is attached on a horizontal body frame connected at the point in which it moves freely over the surface. The pendulum moves between the fix magnets with similar polarity.

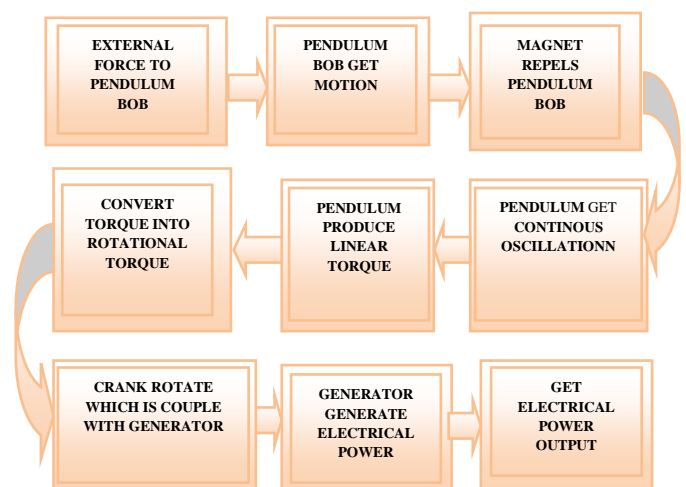


Figure 4: Operational Sequence of Pendulum Power Generator

There are two dominant forces acting upon a pendulum bob at all times during the course of its motion. There is a force of gravity which act on the pendulum bob, It results from the Earth's mass attracting the mass of the bob. And there is a tension force acting upward and towards the pivot point of the pendulum. The tension force results from the string pulling upon the bob of the pendulum.

We will make arrangement in such a way that pendulum get repel and get into motion and moves continuous. The connecting rod is attached to the rotating crank type disc which convert the pro and fro movement of pendulum into rotation. In our discussion, we will ignore the influence of air resistance - a third force that always opposes the motion of the bob as it swings to and fro Generated is attached to the crank disc and hence electrical power is generated.

The frame will be in such a way that it can hold the weight of whole assembly. The magnet on both sides of frame are fixed, because magnets have tendency that, it always tries to attract each other. A low RPM generator will be used to convert mechanical energy to electrical energy. This low RPM generator can be achieved by gear system. A spring action will be there to ensure the continuous motion of pendulum.

5. SAMPLE CALCULATION OF PENDULUM POWER GENERATOR:

All the calculation done below is the sample calculation for pendulum power generator, which consists all assume value.

5.1 Magnetic Strength:

$$B = \frac{B_r}{\pi} \left\{ \left[\arctan \frac{LW}{2z\sqrt{4z^2 + L^2 + W^2}} \right] - \left[\arctan \frac{LW}{2(D+z)\sqrt{4(D+z)^2 + L^2 + W^2}} \right] \right\}$$

Where,

B_r = Remanence Field Independent of Magnet's Geometry (According To Standard Physical Chart)

Z = Thickness of Magnet Coating

L = Length of the Block

W =Width of the Block

D =Thickness of the Block

Assume the Value

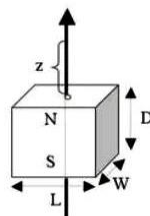
$$Z = 0.00065 \text{ m}$$

$$L = 0.08 \text{ m}$$

$$W = 0.03 \text{ m}$$

$$D = 0.02 \text{ m}$$

$$B_r = 1.32 \text{ (According To Standard Physical Chart)}$$



$$B = \frac{1.32}{\pi} \left\{ \left[\tan^{-1} \left(\frac{0.08 \times 0.03}{2 \times 0.00065 \sqrt{4(0.00065)^2 + 0.08^2 + 0.03^2}} \right) \right] - \left[\tan^{-1} \left(\frac{0.08 \times 0.03}{2(0.02 + 0.00065) \sqrt{4(0.02 + 0.00065)^2 + 0.08^2 + 0.03^2}} \right) \right] \right\}$$

$$B = 0.41 \text{ Tesla}$$

Tesla is the magnetic strength measuring unit of magnet which repels the Pendulum bob.

For The Calculation of Electrical Power Generation

m = Mass of the Pendulum Bob

L = Length of Pendulum Bob

D = Distance of Pendulum Oscillation

θ = Angle between Centre position to oscillation

Assume the Value

$$m = 1.5 \text{ M}$$

$$g = 9.8 \text{ m/s (Acceleration due to Gravity)}$$

$$L = 0.35 \text{ M}$$

$$D = 0.40 \text{ M}$$

$$\theta = 30$$

5.2 Force Produce by Pendulum

$$F = mg \sin \theta$$

$$= 1.5 \times 9.8 \times \sin 30$$

$$= 7.35 \text{ N}$$

5.3 Torque Produce by Pendulum

$$Tq = F \times D$$

$$= 7.35 \times 0.4$$

$$= 2.94 \text{ N-m}$$

5.4 Time Period of Pendulum

$$T = 2\pi \sqrt{\frac{L}{g}}$$

$$= 2\pi \sqrt{\frac{0.35}{9.8}}$$

$$= 1.19 \text{ sec}$$

5.5 Electrical Power Produce by Pendulum

$$P = Tq \times \frac{2\pi N}{60}$$

$$= 2.94 \times \frac{2\pi \times 50}{60}$$

$$= 15.39 \text{ W}$$

5. ADVANTAGES OF PENDULUM GENERATOR

- i) It can be used in remote areas where power supply is not available.
- ii) It does not require no running cost because it does not required any fuel.
- iii) It can installed in any place quickly as compare to solar, wind and other type of plant
- iv) It is portable; it can be use as portable power generator.
- v) It is simple in construction like other conventional part.
- vi) It required small area for installation
- vii) It required less maintains than other power plant.

6. CONCLUSION

With the demand for energy requirements increasing tremendously, it can be met by alternative energy resources such as Gravity. Particularly, it can generate more power compared to the other type of non-conventional energy.

In addition, this alternative energy source offers benefits such as easy deploying, low installation cost and maintenance systems, and less operating cost. In terms of operational lifetime, installation cost and reliability, so a Pendulum Power Generator is considered as a promising alternate for traditional power sources.

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