Proceedings of the
International Conference on Mechanical Engineering and Renewable Energy 2015
(ICMERE2015) 26 – 29 November, 2015, Chittagong, Bangladesh

ICMERE2015-PI-254

DESIGN AND FABRICATION OF A GRAVITY POWERED LIGHT

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Abstract- *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. In this project, the gravitational energy of a heavy particle is converted to the electrical energy. When the heavy particle falls down from a higher altitude to a lower one, its potential energy is converted into the kinetic energy. Then this energy is converted to electricity by using a synchronous motor. With the increasing of the altitude of the load, the lighting time increases. If load increases, power production also increases, but the lighting time decreases. Using 1kg of load from the elevation of 145 cm, the generator output is 1.62 J and the lighting time is 42 seconds.*

Keywords: Renewable source, Gravitational energy, Environment friendly.

1. INTRODUCTION

Renewable energy is the energy which comes from natural resources such as sunlight, wind, rain, tides and geothermal heat, which are renewable. In some parts of the world, lighting is provided through expensive and polluting kerosene. Kerosene lamps are hazardous to health and environment and constantly require replenishment. Fumes which are raised from the burning of biomass fuels can cause cataracts and eye infections as well as emitting smoke that is the equivalent to smoking two packets of cigarettes every day [1]. Also, it was estimated that nearly 2.5 million people in India alone suffer severe burns from over turned kerosene lamps every year as well as the vast amounts of carbon dioxide produced. London based designers, Martin Riddiford and Jim Reeves, have spent around four years working on an inexpensive and safe alternative that will be of great benefit to many people across the globe. Unlike solar-powered lamps, the gravity light can be operated all the day and night and under any climatic conditions with zero running costs [2].

2. LITERATURE REVIEW

Sir Issac Newton had discovered the phenomenon of gravity near 400 years ago[3]. London researches Martin Riddiford and Jim Reeves who have spent four years for developing gravity light as an off line project [4]. They are using tried and tested manufacture who has the right knowledge to make gravity light. Gravity light is a revolutionary new approach to storing energy and creating illumination. It takes only three seconds to lift the weight which powers gravity light creating 30 minutes light on its descent [5]. Chun-chao Wang and Yuh-suiang Wang has successfully invents the concept of gravity power generation mechanism. In his concept, more simplified mechanism is used for the generation of the electricity [6]. The primary objective of his invention is to provide gravity power generation mechanism which can provide a continuous and stable operation to continuously convert the gravity potential energy into the kinetic energy and then to convert the kinetic energy into electrical energy, so as to perform a long time, effective and stable energy output. Russian Inventor Mikhail Dmitriev to know about his gravity motor [7]. He has apparently devised a mechanism whereby static gravitational pull can be harness to generate useful energy. He has worked for many years developing and testing gravity powered devices and he has been very successful in his work. His various designs is based on the principle of having weights attached to a wheel and arranging for those weights to be offset outwards when falling and offset inwards when rising. Because of the different lever arms involved, that gives a force imbalance which causes the wheel to rotate continuously and if the weights are of a considerable size, then the rotation is powerful and can be used to generate electrical energy.

3. TYPES OF ENERGY USED

Energy comes in two basic forms: potential and kinetic. Potential Energy is any type of stored energy. It can be chemical, nuclear, gravitational, or mechanical. Kinetic Energy is found in movement. Even the tiniest things have kinetic energy, like atoms vibrating when they are hot or when they transmit sound waves. Renewable gravitational Energy is used in this setup.

3.1 Renewable Energy:

Renewable energy is natural energy which does not have a limited supply. It can be used again and again, and

will never be run out. Renewable energy is the energy which comes from natural resources such as sunlight, wind, rain, tides and geothermal heat, which are renewable (naturally replenished). Renewable is an alternative to fossil fuels and nuclear power and was commonly called alternative energy. This energy is easily abundant and environmental pollution free. In future, the world will entirely depend on the renewable energy. Renewable energy replaces conventional fuels in four distinct areas:

Power generation, hot water heating, transport fuels and rural (off grid) energy services [8].

3.2 Gravitational Energy:

Gravitational energy is the energy where an object possesses downward movement because of its weight in a gravitational field. The most common use of gravitational potential energy is for an object near the surface of the Earth where the gravitational acceleration can be assumed to be constant at about 9.8 m/s. Since the zero of gravitational potential energy can be chosen at any point(like the choice of the zero of a coordinate system), the potential energy at a height h above that point is equal to the work which would be required to lift the object to that height with no net change in kinetic energy . Since the force required to lift it is equal to its weight, it follows that the gravitational potential energy is equal to its weight times the height to which it is lifted [9].

4. METHODOLOGY

The gravity light consists of an LED bulb fixed to an adjustable lamp that can be hooked up on a wall or hung from a ceiling. It also comprises a pulley mechanism and a ballast bag (weight) hanging from the lamp. The gravity light works on the principle similar to that of pendulum clocks that are operated with the help of weights. The potential energy is represented by the ballast material. When the ballast bag is suspended, the potential energy in the ballast is converted by gravity with a slow descent of the bag. The converted energy then generates light. The gravity light can be operated for 30 minutes continuously before the ballast bag needs to be refilled. The strength of the light can be adjusted from strong lighting to long-lasting low-level lighting. The two terminals present at the front of the gravity light can be used as a generator.

Fig.1: Fabricated gravity light

The main components used in this project are:

1. Synchronous motor
2. Bicycle wheel
3. Ball bearing
4. Pulley
5. Belt
6. Load
7. Steel flat bar
8. LED light
9. Resistor
10. Pipe and Stand

4.1 Synchronous motor:

A synchronous electric motor is an AC motor in which, at steady state, the rotation of the shaft is synchronized with the frequency of the supply current; the rotation period is exactly equal to an integral number of AC cycles. Synchronous motors contain multiphase AC electromagnets on the stator of the motor that create a magnetic field which rotates in time with the oscillations of the line current. The rotor with permanent magnets or electromagnets turns in step with the stator field at the same rate and as a result, provides the second synchronized rotating magnet field of any AC motor. A synchronous motor is only considered doubly-fed if is supplied with independently excited multiphase AC electromagnets on both the rotor and stator [10].

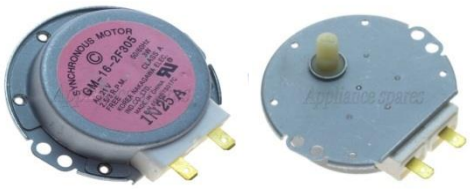

Fig.2: A typical synchronous motor

4.2 Wheel:

A bicycle wheel is a wheel, most commonly a wire wheel, designed for a bicycle. A pair is often called a wheel set, especially in the context of ready built "off the shelf" performance-oriented wheels. Bicycle wheels are typically designed to fit into the frame and fork via drop outs, and hold bicycle tires. A typical modern wheel has a metal hub, wire tension spokes and a metal or carbon fiber rim which holds a pneumatic rubber tire.

Fig.3: Bicycle wheel

4.3 LED:

A light-emitting diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices and are increasingly used for other lighting. Appearing as practical electronic components in 1962, early LEDs emitted low intensity red light, but modern versions are available across the visible, ultraviolet, and infrared wavelengths, with very high brightness. When a

light-emitting diode is switched on, electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor.

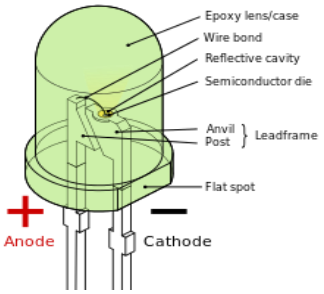

Fig.4: LED Light

4.4 Electrical polarity of LED:

As with all diodes, current flows easily from p-type to n-type material. However, no current flows and no light is emitted if a small voltage is applied in the reverse direction. If the reverse voltage grows large enough to exceed the breakdown voltage, a large current flows and the LED may be damaged. If the reverse current is sufficiently limited to avoid damage, the reverse-conducting LED is a useful diode [11].

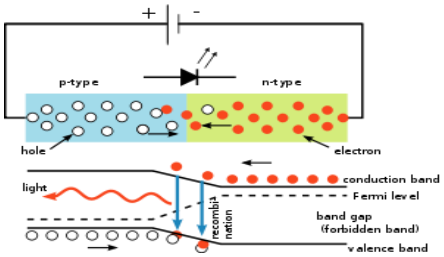

Fig.5: Electrical polarity of LED light

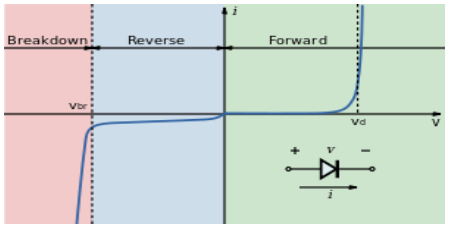

Fig.6: Diode IV Diagram

4.5 Resistor:

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. In electronic circuits resistors are used to limit current flow, to adjust signal levels, bias active elements, terminate transmission lines among other uses. High-power resistors that can dissipate many watts of electrical power as heat may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity. Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in electronic equipment. Practical resistors as discrete components can be composed of various compounds and forms. Resistors are also implemented within integrated circuits. The electrical function of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than nine orders of magnitude. The nominal value of the resistance will fall within a manufacturing tolerance.

Fig.7: A typical resistor

4.6 Pulley:

A pulley is a wheel on an axle or shaft that is designed to support movement and change of direction of a cable or belt along its circumference. Pulleys are used in a variety of ways to lift loads, apply forces, and to transmit power. In nautical contexts, the assembly of wheel, axle, and supporting shell is referred to as a "block. "A pulley may also be called a sheave or drum and may have a groove between two flanges around its circumference. The drive element of a pulley system can be a rope, cable, belt, or chain that runs over the pulley inside the groove. Pulleys are assembled to form a block and tackle in order to provide mechanical advantage to apply large forces. Pulleys are also assembled as part of belt and chain drives in order to transmit power from one rotating shaft to another. A wooden pulley of 16.5 cm circumference is used to transmit power. It has a high co-efficient of friction.

Fig.8: Pulley and Bearing assembly

5. DESIGN AND FABRICATION

Gravity Light is designed to be a replacement for a kerosene lamp. Gravity Light's output is better than a kerosene lamp.

5.1 Working procedure of the Gravity Light:

The gravity light consists of a synchronous motor as the generator, a bicycle wheel as the larger pulley, a wooden pulley as the smaller one and a belt which is attached with larger to smaller pulley. When a heavy load applied to the one end of the larger pulley, due to gravity the load starts to move downward. Hence the larger pulley starts to rotate. With the rotation of the larger pulley the belt transmits power to smaller pulley where a synchronous motor is fitted. As the synchronous motor rotates with a low rpm (4-5 rpm), it produces enough electricity to light the LEDs.

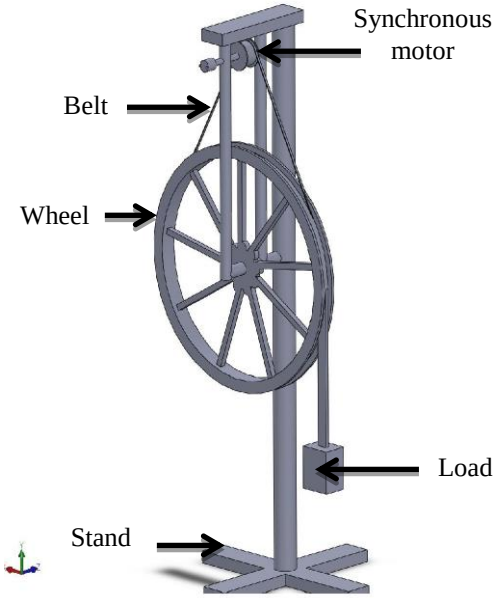

Fig.9: Designed Gravity Light (SolidWorks Design)

5.2 Calculations:

The diagram above has Ar, Br and Cr are:
Ar = rotational speed of the small pulley A with the generator attached, (4)
Br= rotational speed of the large pulley B,(3)
Cr= rotational speed Cr of the small sprocket C that's attached to the large pulley (2).

By starting with the generator, in this case a synchronous motor is used. When it is turned the shaft of a motor, the motor acts like a generator, producing electricity. There is a small pulley that is attached to the generator shaft and its diameter is 5.25 cm. and circumference is 16.5 cm.
Now there needs a rotational speed for the small pulley of 5-6 RPM to find some combination of large pulley with attached small pulley (or sprocket in this case), and possibly more than one of them that would cause a mass to fall at a reasonably slow speed for long enough to light the LED for a reasonably long time.

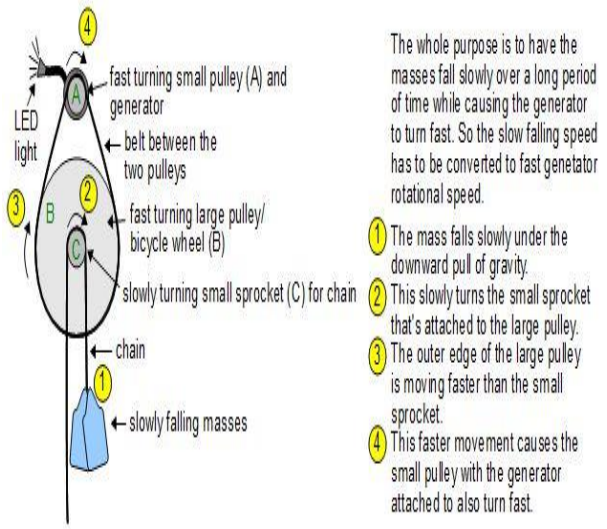

Fig.10: Schematic diagram of gravity powered light

Using 1 kg of load, the potential energy of the load for an altitude of 145 cm, *Ep*= mass × gravity constant × height of the load = *mgh* = 1kg × 9.81 ms^{-2} × 1.45m =14.23 J
This potential energy is converted to the electrical energy by the generator. Hence,
Generator output =Voltage × Current flow × time of load landing= *VIt* =3.2 V× 12 mA × 42 s = 1.62 J
The height from where the load is falling by the gravity is, *h* = 145cm.
Time required to fall the load, *t* = 42 s.
Hence, velocity of the falling mass, *v* = 3.45 cm per second.
Efficiency= (Output energy /Input Energy)*100%
= (1.62J/14.23J)*100% =11.23%

6. RESULTS

For 1kg of load from a height of 1.45m the input energy is 14.23 J and the output by the generator is 1.62J. Hence the efficiency of gravity powered light is 11.23%. Some observations are made from the gravity light are given below:

Table 1: Observations of lighting time for different heights of 1 kg mass:

Observations	Weight (Kg)	Height (feet)	Lighting Time (seconds)
1	1 kg	3.5	42
2	1 kg	4.0	49
3	1 kg	4.5	56
4	1 kg	5.0	64
5	1 kg	5.5	75

Plotting for lighting time:

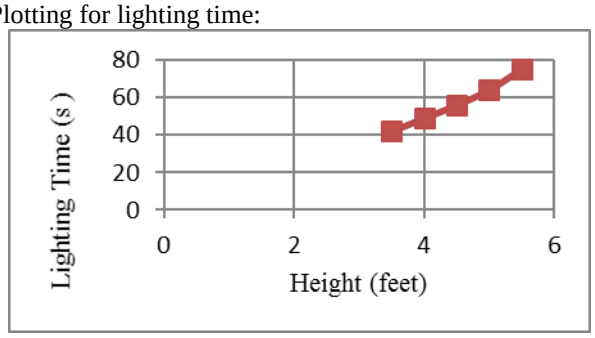

Fig.11: Graph for lighting time (s) vs. height (feet)

Table 2: Observations of Voltage and current for different masses from a fixed height (3.5 feet):

Observations	Weight (kg)	Voltage (V)	Current (mA)	Lighting Time (seconds)
1	1.0 kg	3.2	12	42
2	1.5 kg	3.6	15	38
3	2.0 kg	3.9	17	34
4	2.5 kg	4.3	19	29
5	3.0 kg	4.7	22	26

Plotting for voltage and weight from 3.5 feet:

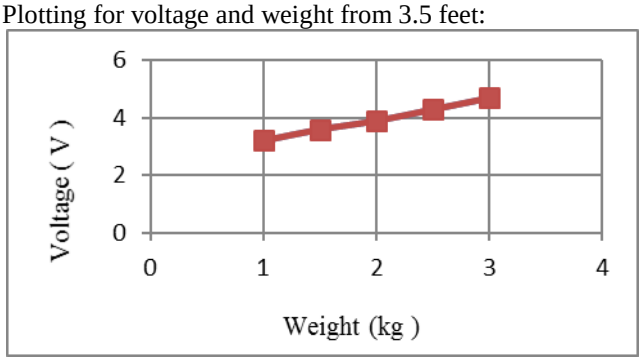

Fig.12: Graph for voltage (V) vs. weight (kg)

Plotting for current and weight from 3.5 feet:

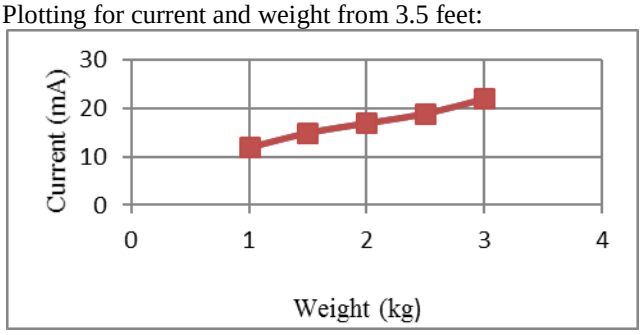

Fig.13: Graph for current (mA) vs. weight (kg)

7. CONCLUSION

Generation of gravity power can be increased by applying much heavier load at the end of bicycle wheel. Though heavy load increases the voltage and current of synchronous motor but it decreases the lighting time of LED. Applying heavy load, it may cause bending to the pipe stand. So a suitable mass must be used to fall it as much long time as possible. If we use 2.5-3 rpm synchronous motor, the lighting time will increase. Due to friction of the pulley and belt, there is a power loss in a great extent. Gravity light needs no operating cost, so it can be operated as the demand of the light. In the remote areas, it may play a great important rule for the education as well as fulfilling the demand of the power. Moreover, the power can be stored in the battery so that it may give a great advantage to emergency situation.

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9. NOMENCLATURE

Symbol	Meaning	Unit
V	Voltage	v
I	Current	amp
W	Weight	kg
v	Velocity	(m/s)
t	Time	(s)