Design and Analysis of Door Harvesting Energy
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ABSTRACT

Our aim is to create a device which can harvest the power expended whenever anyone open or close the door. This device should be relatively non-obstructive, and would be able to store electrical energy for further use or introduction into the power grid. The harvester would consist of a system of weights or gears connected to a dynamo motor. A battery / capacitor with the capacity to store energy generated in a typical day would be required. So the energy can be returned to the grid or stored in a central energy bank at the end of the day.

Keywords: Spur and pinion gear, 6V DC dynamo motor, IN4007 PN Junction Diode

INTRODUCTION

Energy is one of the major concerns facing our society. Economic and environmental reasons both press engineers to develop cleaner, more renewable ways to harvest power. Our group wishes to contribute to the effort to harvest human power. Although our project would use simple technology and is relatively small in scope, it possesses potential to harness the ubiquitous energy expended by people in their daily lives. Our door-opening harvester harnesses the energy people expend in opening and closing and stores this electrical power for future use. It will be a simple, cheap device which could save a lot of energy in the long run, especially in big buildings. It lets us explore our interests in power and circuit design as well as making something to harness cheap, renewable energy which is beneficial for both the economy and the environment.

2. Description of Components:

The major parts of "Design and Fabrication of Door Harvesting Energy" are described below:

- Wooden Door
- Door closer
- Spur and Pinion gear
- 6V DC dynamo motor
- IN 4007 PN junction diode

3. Wooden door:
A door is a moving structure used to block off, and allow access to, an entrance to or within an enclosed space, such as a building or vehicle. Similar exterior structures are called gates. Typically doors have an interior side that faces the inside of a space and an exterior side that faces the outside of that space. While in some cases the interior side of a door may match its exterior side, in other cases there are sharp contrasts between the two sides, such as in the case of the vehicle door.

4. Door closer:
A door closer is a mechanical device that closes a door, in general after someone opens it, or after it was automatically opened. Choosing a door closer can involve the consideration of a variety of criteria. In addition to the closer's performance in fire situations, other criteria may include resistance to
opening forces (for use by disabled or infirm), control over the rate of closing, safety, durability, risk of vandalism, anti-ligature and aesthetics. Door closer are broadly classified into:
They are
• Manual
• Automatic

4.1 Manual door closer:
A manual door closer stores the energy used in the opening of the door in a compression or torsion spring and releases it to close the door. Some closers allow for adjustment of the strength of the spring, making it easier or more difficult to push the door open.

4.2 Automatic door closer:
An automatic door closer (more often called a "door opener") opens the door itself, typically under the control of a push button, motion detector or other device, and then closes it as well, typically employing a motion or proximity detector to determine when it is safe to close the door.

5. Spur gears:
Spur gears have been used since ancient times. The two-man drive system that Leonardo Davinci designed to power a vision of a helicopter like device. The device never flew, but the gear system works. Modern gears are a refinement of the wheel and axle. Gear wheels have projections called teeth that are designed to intersect the teeth of another gear. When gear teeth fit together or interlock in this manner they are said to be in mesh. Gears in mesh are capable of transmitting force and motion alternately from one gear to another. The gear transmitting the force or motion is called the drive gear and the gear connected to the drive gear is called the driven gear.

Advantages of Spur Gear:
• Spur gears have high power transmission efficiency.
• They are compact and easy to install.
• They offer constant velocity ratio.
• Unlike belt drives, spur gear drives have no slip.
• Spur gears are highly reliable.
• They can be used to transmit large amount of power (of the order of 50,000 kW).

Disadvantages of Spur Gear:
• Spur gear drives are costly when compared to belt drives.
• They cannot be used for long distance power transmission.
• Gear teeth experience a large amount of stress.

Applications of Spur Gear:
Spur gears have a wide range of applications. They are used in:
• Metal cutting machines
• Power plants
• Marine engines
• Mechanical clocks and watches
• Fuel pumps

6. Pinion gear:
Pinion gear or driven gear in which connected to the driving gear and gets rotated by the driving gear.

6 Volt dc dynamometer:

Dynamo motor:
It is an electrical generator that produces direct current with use of commutator. It is capable of delivering power to the industry and the foundation upon which many other later electric-power conversion device were based, including electric motor, the alternating-current alternator and rotary converter. The simple alternator dominates large scale power generation for efficiency, reliability and cost reasons. A dynamo has the disadvantages of mechanical commutator. Also converting alternating to direct current using power rectification devices is effective and usually economic.

The main advantage of 6V dynamo is versatility of the electric system, such as the ability to charge the cell phone battery with a cigar lighter receptable as cell phones are now becoming more and more needed for users. Though 6V dynamos watt rating is underpowered for medium to high watt application.

Specifications:
• Continuous current (max): 6 Amps.
• wire lengths: 180mm (approx.) from casing
• fixing: One M5 stud, with spring washer & fixing nut
• case size: 56mm x 33mm x 18mm deep
• TOTAL WEIGHT (INC. WIRES): 75gms. (approx.)

In 4007 pn junction diode:

Diode:
A diode is a two terminal electronic component with asymmetric conductance. It has low resistance to current in one direction and high resistance to the other. A semiconductor diode is a crystalline piece of semiconductor material with a p-n junction connected to two terminals. Diode part are different for current and voltage.

IN4007 DIODE:
IN4007 is a simple, very common for silicon rectifier diode commonly used for AC adapters for common household appliances. Often used for reverse voltage protection, the IN4007 is a staple for many powers, DC to DC setup and breadboard projects.In4007 is rated for up to 1A/1000V,these diode are used up to 3A and comes in larger DO-201 axial package.
7. Design of Components:

Wooden Door:

A door which is designed with the material of plywood about height of 79m and width is about 36.5m, thickness is 20mm and it is placed on the floor of height about 86m and width of 43m, thickness is 50mm.

Spur And Pinion Gear:

Specification:

Number of teeth in driving wheel : 72
Number of teeth in pinion wheel : 12
Pressure angle α : [°]: 20 [°]: 0
Head height fact for driving and pinion wheel [Parts of normal module] : 1
Foot height factor for driving and pinion wheel [Parts of normal module] : 1.25
Profile shift coefficient for driving wheel : 0.52
Profile shift coefficient for pinion wheel : 0.57

Calculation:

Driving & Driven Gear:

Pitch Diameter (D):
Driving gear:
\[ d = \frac{\text{teeth (n)}}{\text{diametrical pitch (dp)}} \]
\[ = \frac{72}{48} = 1.5 \]
Driven gear:
\[ d = 0.25 \]
Circular pitch (cp):
Driving gear:
\[ \text{cp} = \frac{\pi}{\text{diametrical pitch (dp)}} \]
\[ = \frac{\pi}{48} = 0.06545 \]
driven gear:
\[ \text{cp} = 0.06545 \]
Centre distance (cd):
\[ \text{cd} = \frac{(\text{teeth on pinion + teeth on gear})}{(2 \times \text{diametrical pitch})} \]
\[ = \frac{(12+72)}{(2\times48)} = 0.875 \]
base circle diameter (bc):
Driving gear:
\[ \text{bc} = \text{pitch diameter} \times \cos (\text{pressure angle, (α)}) \]
\[ = 1.5 \times \cos \text{(20)} \]
\[ = 1.4095 \]
driven gear:
\[ \text{bc} = 0.2349 \]
addendum (a):
Driving gear:
\[ a = 1 \div \text{diametrical pitch (dp)} \]
\[ = 0.020833 \]
driven gear:
\[ a = 0.020833 \]
dedendum (b):
Driving gear:
\[ b = 1.157 \div \text{diametrical pitch (dp)} \]
\[ = 0.024104 \]
Driven gear:
\[ b = 0.024104 \]

Working depth:
Driving gear:
\[ w = \frac{2}{\text{diametrical pitch (dp)}} \]
\[ = 0.04167 \]
Driven gear:
\[ w = 0.04167 \]
Whole depth
Driving gear:
\[ \text{wd} = \frac{2.157}{\text{diametrical pitch (dp)}} \]
\[ = 0.04494 \text{ driven gear:} \]
\[ \text{wd} = 0.04494 \]
clearance:
Driving gear:
\[ c = \frac{0.157}{\text{diametrical pitch (dp)}} \]
\[ = 0.00327 \text{ driven gear:} \]
\[ c = 0.00327 \]
Outside diameter:
Driving gear:
\[ \text{od} = (\text{teeth + 2}) \div \text{diametrical pitch} \]
\[ = \frac{(72+2)}{48} = 1.54167 \]
Driven gear:
\[ \text{od} = 0.29167 \]
Module:
Driving gear:
\[ m = \frac{25.4}{\text{diametrical pitch (dp)}} \]
\[ = 0.52916 \]
Driven gear:
\[ m = 0.52916 \]
Gear ratio:
\[ i = \frac{\text{Number of teeth in driving gear}}{\text{Number of teeth in driven gear}} \]
\[ i = 72/12 \]
\[ i = 6 \div 1 \]
\[ i = 6:1 \]

Design Of Assembly:

The assembly unit which consists of wooden door, door closer, 6Volt dynamo motor, IN4007 PN junction diode, LED bulb. Wooden door which is connected to that of floor, where the door closer is placed on top of the door. The another end which is connected to that spur gear(driving gear) by means of a cylindrical shaft. The pinion gear which is meshed with that of driving gear. From the pinion gear which is connected to the 6 Volt dynamo motor by means of cylindrical shaft. Where IN4007 PN junction diode are connected in series as a bridge rectifier connection with that of dynamo motor and a resistor 1k in a parallel connection. which is connected to that of LED bulb light

8 Working principle:

When the door is manually opened the door closer placed at the top are used to return the door automatically to its original position, hence the sliding motion of the door is converted into rotary motion in door closer device. The spur gear (driving gear) which is connected to that of door closer, are rotated and the pinion (driven gear) which is meshed
with the driving gear are also rotated. Pinion gear connected to dynamo motor, due to rotation, where excitation of the electromagnet produce electric field around the rotor, the diode connected as a bridge rectifier circuit, which is worked on the principle When the diode is reverse-biased, a very small drift current due to thermal excitation flows across the junction. This current (reverse saturation current, $I_0$) is given, according to the Boltzmann equation, by the formula $I_0 = K_0 e^{-eV_0/KT}$. When the diode is Forward-biased through a voltage $V$, a small drift current flows again across the junction, there is an additional component, the diffusion current $V_d$, given by the formula $I_d = K_0 e^{e(V-V_0)/KT}$.

**Advantages and disadvantages:**

**Advantages:**
1. Cheap, renewable source of energy.
2. Low investment, capable of great long-term savings in large buildings.
3. Virtually no maintenance costs.
4. An un-obstructive device.
5. An unused energy can be used for various purposes.

**Disadvantages:**
1. Only less amount of energy is produced.
2. Velocity should be more while opening the door.

**Applications:**
1. A battery / capacitor with the capacity to store energy generated in a typical day would be required so the energy can be returned to the grid or stored in a central energy bank at the end of the day. Hence the energy can be used for charging a cell phone.
2. ATM door is equipped with a card-sweep electronic entry system, so the power supply for that electronic device is provided by this door harvesting energy system.
3. While door is equipped with attendance electronic machine in companies, for providing energy to that electronic device are provided by this door harvesting energy system.

**Results and Discussion**

Thus our project design and fabrication of door harvesting energy is provided successfully with our project member and my guide with his important points and instruction. In our project by manually opening door of wasted energy is converted into a useful energy source by our gear and dynamo setup.

**Conclusion:**

Thus we have developed a “DESIGN AND FABRICATION OF DOOR HARVESTING ENERGY” which helps to know how to convert a unused energy into a usable energy source. The application of our energy to charge a cell phone battery and some low energy appliances.

This would be the less cost production of conversion of wasted energy into a useful energy.

**Features:**
- Collects power from all door swinging movement
- May be installed on almost all hinged doors
- Easy installation and set up
- Power storage up to a day
- Power is given to electronic swiping machine which is kept in the door.

**References**