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# Foot Step Power Generation by Using Rack and Pinion Mechanism

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**ABSTRACT:**

The demand for electricity is increasing highly due to advancement of present lifestyle of the human being. As the arising technology demand more electricity and the population is also increasing rapidly, so the energy demand is also increasing. This system generates power using a footstep force. This power generation system serves as a medium to generate electricity using non-conventional sources i.e. force, it will be stored and used. This project is useful at public places like railway stations, bridges, at every point of entry and exit. In this mechanical project, the rack is attached to the top plate where a person can press the plate and down. At the top shaft, the pinion is attached which is a mate to rack. When a person presses the plate, the pinion starts rotating at the other end of the shaft. Another gear is attached which is connected to the bottom shaft by chain drive. The chain rotates the freewheel attached to a bottom shaft, In the middle of the shaft the flywheel is attached which stores the energy in it at the other end gear is mate with generator motor which generates the energy. This project will be cost effective and easy to installed in a populated area like railway station, bus stands and in shopping malls. Our project is cost effective and easy to implement.

## 1. INTRODUCTION:

In this project the weight which acts on the foot step is used to generate electrical energy. When a person walks over the foot step, a force acts on the step. One can simply be amazed by knowing how much energy a person can have just by walking on the floor with normal speed. Whenever a person walks, manages to lose energy towards the floor by means excess weight to the floor. Therefore, here we will explain a new technique for electricity generation. This new technique works on the law of conservation of energy "energy neither created or nor destroyed it can change its form". Foot step power generation system is designed to be very useful at public places like railway station, bus stand, shopping malls where lot of people keep walking through all day. This entire human vitality being squandered if can be made workable for usage it will incredible development and group vitality ranches will be extremely helpful vitality sources in packed nations.

## 2. COMPONENT SELECTION:-

### I. FRAME

- Frame is the foremost supportive element in the system. The frame needs to endure all the heaviness of the exploratory setup. The power applied on the framework is conveyed to the four legs.

### II. Rod

- A high carbon alloy steel that is EN8/ AISI 1045 was selected as material for rod.

### III. Spring

- A spring is characterized as a versatile body, whose capacity is to twist when stacked and to recuperate its unique shape when burden is expelled. There are many types of springs but here we used a helical compression spring and there are four springs used as our requirement.

### IV. Rack and pinion

- The gear of a shaft meshes externally and internally with gear in a straight line. Such type of gear is called rack and pinion gear. The straight-line gear is called a rack and the circular wheel is called pinion.

### V. Flywheel

- A flywheel utilized in machines fills in as a repository which stores vitality amid the period when the supply of vitality is more than the necessity and discharges it amid the period when the prerequisite of vitality is more than supply.

**VI. Bearing**

- A bearing is a machine component which bolster another moving machine component (known as diary). It allows a relative movement between the contact surfaces of the individuals, while conveying the heap.

**VII. Battery**

- An electric battery is a device consisting of one or more electromechanical cells that convert stored chemical energy into electrical energy.


**FIG. BATTERY**

## 3. BEARING:-

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.

**FIG. BEARING**

**TYPES OF BEARING**

There are at least 6 common types of bearing, each of which operates on different principles:

I. Plain bearing, consisting of a shaft rotating in a hole. There are several specific styles: bushing, journal bearing, sleeve bearing, rifle bearing, composite bearing;

II. Ball bearing, in which the rolling elements are spherical balls.

III. Roller bearing, in which the rolling elements are cylindrical, taper or spherical rollers.

IV. Fluid bearing, a non-contact bearing in which the load is supported by a gas or liquid (i.e. Air bearing).

V. Magnetic bearing, in which the load is supported by a magnetic field.

VI. Flexure bearing, in which the motion is supported by a load element which bends.

Common motions permitted by bearings are:

VII. Radial rotation e.g. shaft rotation;

VIII. Linear motion e.g. drawer;

IX. Spherical rotation e.g. ball and socket joint;

X. Hinge motion e.g. door, elbow, knee.

## 4. RACK AND PINION MECHANISM:-

The main purpose of rack and pinion is to convert the linear motion into rotary motion. Gear racks are utilized to convert rotating movement into linear motion. A gear rack has straight teeth cut into one surface of a square or round section of rod and operates with a pinion, which is a small cylindrical gear meshing with the gear rack. Generally, gear rack and pinion are collectively called “rack and pinion”. There are many ways to use gears. For example, as shown in the picture, a gear is used with the gear rack to rotate a parallel shaft.

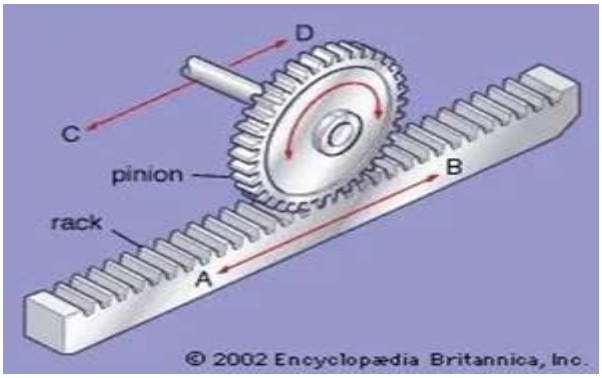


**FIG.RACK AND PINION**

**CHARACTERISTICS OF RACK AND PINION**

The characteristics of rack and pinion systems in steering are as follows:-

1) Simple structure

2) High rigidity

3) Small and lightweight

4) Excellent responsiveness

## 5. SPRINGS

Springs can store energy when compressed. In everyday use the term often refers to coil springs, but there are many different spring designs. Modern springs are typically manufactured from spring steel. An example of a non-metallic spring is the bow, made traditionally of flexible yew wood, which when drawn stores energy to propel an arrow. Springs are made from a variety of elastic materials, the most common being spring steel. Small springs can be wound from pre-hardened stock, while larger ones are made from annealed steel and hardened after manufacture. Some non-ferrous metals are also used, including phosphor bronze and titanium for parts requiring corrosion resistance, and low-resistance beryllium copper for springs carrying electrical current.

**FIG . SPRINGS**

**CLASSIFICATIONS OF SPRINGS**

**a) Tension/extension spring**

The spring is designed to operate with a tension load, so the spring stretches as the load is applied to it.

**b) Compression spring**

Designed to operate with a compression load, so the spring gets shorter as the load is applied to it.

**c) Torsion spring**

Unlike the above types in which the load is an axial force, the load applied to a torsion spring is a torque or twisting force, and the end of the spring rotates through an angle as the load is applied.

**d) Constant spring**

Supported load remains the same throughout deflection cycle.

**e) Variable spring**

Resistance of the coil to load varies during compression.

**f) Variable stiffness spring**

Resistance of the coil to load can be dynamically varied for example by the control system, some types of these springs also vary their length thereby providing actuation capability as well. They can also be classified based on their shape.

**g) Flat spring**

Made of a flat spring steel.

**h) Machined spring**

Manufactured by machining bar stock with a lathe and/or milling operation rather than a coiling operation. Since it is machined, the spring may incorporate features in addition to the elastic element. Machined springs can be made in the typical load cases of compression/extension, torsion, etc.

**i) Serpentine spring**

A zig-zag of thick wire, often used in modern upholstery/furniture.

**j) Garter spring**

A coiled steel spring that is connected at each end to create a circular shape.

## 6. MULTI-METER:-

A digital multimeter is an instrument that provides functionality for making basic measurements of electric circuits, from current to voltage and resistance**.**

A multimeter (also known as a volt-ohm-milliammeter, volt-ohmmeter or VOM) is a measuring instrument that can measure multiple electrical properties. A typical multimeter can measure voltage, resistance, and current, in which case can be used as a voltmeter, ammeter, and ohmmeter.

## 7. DIGITAL MULTI-METER:-

Digital instruments, which necessarily incorporate amplifiers, use the same principles as analog instruments for resistance readings. For resistance measurements, usually a small constant current is passed through the device under test and the digital multimeter reads the resultant voltage drop; this eliminates the scale compression found in analog meters, but requires a source of precise current. An auto ranging digital multimeter can automatically adjust the scaling network so the measurement circuits use the full precision of the A/D converter.

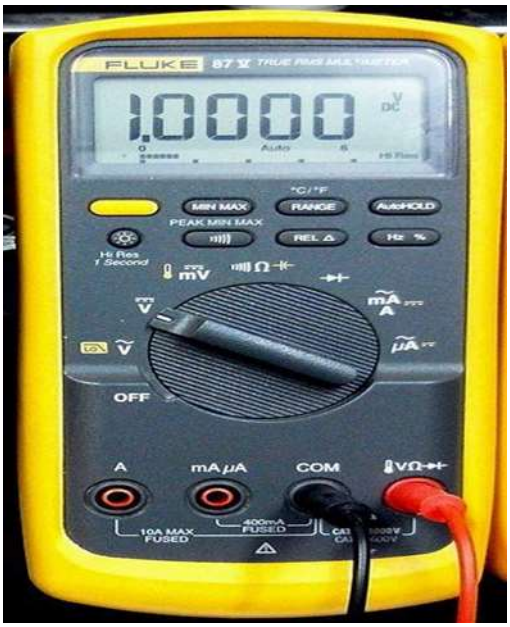


**FIG. DIGITAL MULTI-METER**

## 8. AMMETER:-

An **ammeter** (abbreviation of *Ampere meter*) is an instrument used to measure the current in a circuit. Electric currents are measured in amperes (A), hence the name. For direct measurement, the ammeter is connected in series with the circuit in which the current is to be measured. An ammeter usually has low resistance so that it does not cause a significant voltage drop in the circuit being measured.

## 9. Moving magnet:-

Moving magnet ammeters operate on essentially the same principle as moving coil, except that the coil is mounted in the meter case, and a permanent magnet moves the needle. Moving magnet Ammeters are able to carry larger currents than moving coil instruments, often several tens of Amperes, because the coil can be made of thicker wire and the current does not have to be carried by the hairsprings. Indeed, some Ammeters of this type do not have hairsprings at all, instead using a fixed permanent magnet to provide the restoring force.

## 10. Electrodynamic:-

An electrodynamic ammeter uses an electromagnet instead of the permanent magnet of the arsenal movement. This instrument can respond to both alternating and direct current and also indicates true RMS for AC. See Wattmeter for an alternative use for this instrument.

## 11. WORKING PROCESS OF FOOTSTEP POWER GENERATION:-

A. When a person moves from a foot step power generation system the plates move downward direction due to force is applied on the plate by virtue of impressing on the plate the force spring gets compressed.

B. The rack here moves vertically downward.

**C.** When the rack moves pinion will have engaged with the rack gear results in circular motion of the pinion gear.

D. For one full compression the pinion moves 1 half circle.

E. When the force will have removed on the plate the pinion reverses and moves another half circle.

F. The dynamo attached to the pinion hence result in the sinusoidal wave form (for single dynamo).

G. Then, in this result energy produced will stored on battery for used.

H. There is a small led light placed near the base.

I. There are two terminals connected to the led light.

J. The two terminals are connected to a tachometer which shows how much power is produced.

K. The purpose of flywheel is to store the energy produced and send it to the battery.

L. It produces more noise. It consists many mechanical moving parts.

## 12. ADVANTAGES OF FOOT-STEP POWER GENERATION:-

[1] Non-conventional system.

[2] No need of fuel.

[3] Power generation is simply walking on the steps.

[4] Long life.

[5] Compact in size.

[6] High sensitivity.

[7] No external power required.

[8] Self-generating.

**[9]** Flywheel stores the electricity.

## 13. DIS-ADVANTAGES OF FOOT-STEP POWER GENERATION:-

**[1]** More noise.

**[2]** High maintenance.

[3] High initial cost.

[4] Less efficiency.

[5] Extra care should be taken for batteries.

[6] Rust can be easily taken place.

**[7]** Only applicable for particular places.

## 14. APPLICATIONS OF FOOT-STEP POWER GENERATION:-

[1] School.

**[2]** College.

**[3]** Cinema halls.

**[4]** Railway stations.

**[5]** Bus stands.

**[6]** Shopping complex.

[7] Airports.

**[8]** Lifts.

## 15. POWER GENERATION BY FOOT STEPS USING RACK AND PINION ARRANGEMENT:-

This process involves number of simple setups that is installed under the walking platform. When People walk on this platform their body weight compresses the setup which rotates a dynamo and current is produced. Greater movement of people will generate more power. This whole human energy being wasted if can be made possible for utilization it will be great invention and power producing platform will be very useful energy sources in crowed countries. Proposal for the utilization of waste energy of foot power with human locomotion is very much important. The generated power can be stored by batteries, and it will be used for slighting the building.

**FIG. POWER GENERATION BY USING RACK AND PINION MECHANISM**

## 16. OUTPUT POWER CALCULATION:-

Let us consider,

The mass of a body = 65 kg(Approximately)

Height of spring = 8 cm

Therefore, Work done =Force x Distance

Here, Force = Weight of the body

= 65 kg x 9.81

= 637.65N

Distance travelled by the body = Height of the spring

= 8 cm

= 0.08 m

Therefore, Output power = Work done/Sec

= (637.65 x 0.08)/60

= 0.8502 Watts

(For One pushing force)

## 17. FUTURE SCOPE:-

**a)** **Staircases:-** Piezo electric tiles can be places under the staircases to generate power that could be stored in rechargeable batteries and this could be used to charge phones in the buses. These sensors can be placed in those regions where lots of footsteps are involved such as airports, railways stations, cricket and football grounds, large public gathering meet ups etc., and the energy generated by them can be used to power various electronic gadgets. Above mentioned were the few ways to say energy using piezo electric concept.

**b)** **Sidewalks:-** In population dense countries such as China, India etc., where sidewalks are always crowded can be potential place to use piezoelectric tiles as lot of footsteps would produce vibration that could generate power/energy. This generated energy can be used to power up various appliances for public use such as street lights, traffic signals etc. This can turn out be the most efficient way to generate huge amount of renewable energy with minimal cost and least human efforts.

**c)** **Escalators:-** The concept of placing piezoelectric sensors can also be applied to escalators of various crowded places such as malls, metro stations, theaters, airports etc.

**d)** **Dance floors:-** This is the place where many people continuously produce vibrations by dancing that could generate power which can be used to power that particular dance studio at bare minimum.

## 18. CONCLUSION:-

This project can be handled in various ways to make the best use of it. There are many more extensions that can be made to this project. Generators of more load capacity can be used to get more power. Although the power generation is little less in this project. It tries to make use of the energy wasted to generate electricity. The power generation using footsteps get its energy requirements from the Non-renewable source of energy. There is no need of power from the mains and there is less pollution in this source of energy. It is very useful in the places like railway stations, shopping complex etc.

This is also an eco-friendly method for energy production, there is no huge required to install the as like other energy plants. There is no pollution, no sound, no smoke so this is a best method to install this in public place area. There is no maintenance cost and installation cost are also less as compared to other.

We will also make the energy production greater than 10.925KW (hr.) by increasing the size of power generation system. We can further design it for a different size as requirement of energy to full fill. It's also installs on parks to light up the lights. Executing this system, we can easily reduce the dependence on the other conventional sources of energy, thus can be considered valuable from that point of view.

In energy crises facing countries where the load shading of electricity is due to the shortage of energy, this foot step power generation system is best method to produce energy and the output of electricity production is increased by increasing the size of foot step power generation system. As compare to other energy producing system the cost of this system is less.

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