

Energy Harvesting Using Rack and Pinion Mechanism

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Abstract: The project deals with usage of "Human locomotion" to generate electricity. The whole bio energy is being wasted but with a possible technical implementation this energy can be harnessed, which will be of optimum use in a densely populated region. A non-conventional method by simple walking in the staircase. The mechanical setup used is "Rack and pinion mechanism"

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I. Introduction

Man has needed and used energy at an increasing rate for his sustenance and wellbeing ever since he came on the earth a few million years ago. Primitive man required energy primarily in the form of food. He derived this by eating plants or animals, which he hunted. With the passage of time, man started to cultivate land for agriculture. He added a new dimension to the use of energy by domesticating and training animals to work for him. With further demand for energy, man began to use the wind for sailing ships and for driving windmills, and the force of falling water to turn water for sailing ships and for driving windmills, and the force of falling water to turn water wheels. Till this time, it would not be wrong to say that the sun was supplying all the energy needs of man either directly or indirectly and that man was using only renewable sources of energy. This whole human/bio-energy being wasted if can be made possible for utilization it will be great invention and crowd energy farms will be very useful energy sources in crowded countries. In this paper described about generation electrical power as non-conventional method by simply walking or running on the foot step. Non-conventional energy system is very essential at this time to our nation. Non-conventional energy using foot step is converting mechanical energy into the electrical energy. Here in this project a mechanical arrangement is made. That is rack and pinion gear mechanism (chain and sprocket used here). In this project the force produced by humans while walking is converted into electrical energy using proper mechanical setup and a generator. The out put being a variable current due to difference in the type of motion therefore a full wave rectifier is used to convert the current which is alternating in nature to unidirectional D.C current which can be stored and used in multiple ways (this stored energy can be converted to A.C current using a setup of inverter along with a transformer).

II. Existing System

Other people have developed piezo-electric (mechanical-to-electrical) surfaces in the past, but the Crowd Farm has the potential to redefine urban space by adding a sense of fluidity and encouraging people to activate spaces with their movement. The Crowd Farm floor is composed of standard parts that are easily replicated but it is expensive to produce at this stage. This technology would facilitate the future creation of new urban landscapes athletic fields with a spectator area, music halls, theatres, nightclubs and a large gathering space for rallies, demonstrations and celebrations, railway stations, bus stands, subways, airports etc. Like Capable Of Harnessing Human Locomotion For Electricity Generation.

III. Proposed System

Proposal for the utilization of waste energy of foot power with human locomotion is very much relevant and important for highly populated countries like India and China where the roads, railway stations, bus stands, temples, etc. are all over crowded and millions of people move around the clock. This whole human/bioenergy being wasted if can be made possible for utilization it will be great invention and crowd energy farms will be very useful energy sources in crowded countries. Walking across a "Crowd Farm," floor, then, will be a fun for idle people who can improve their health by exercising in such farms with earning. The electrical energy generated at such farms will be useful for nearby applications.

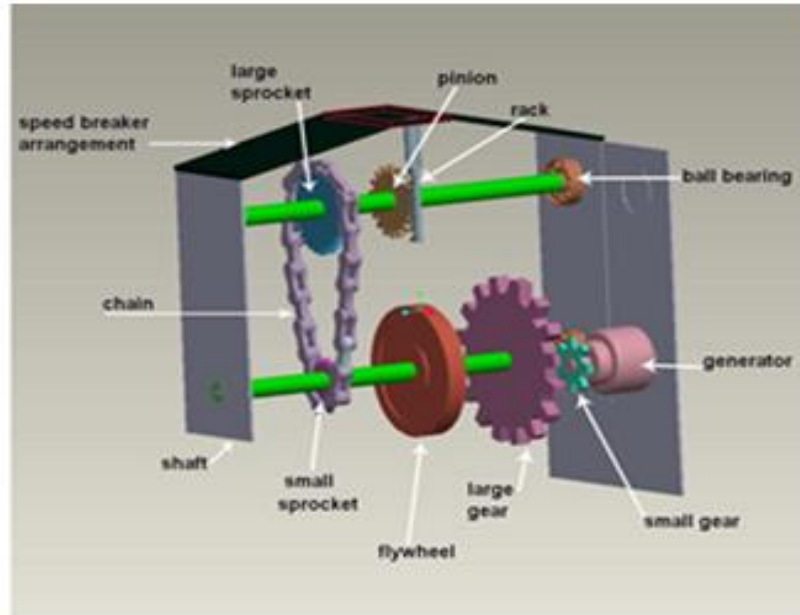


Fig 1: Schematic diagram of proposed system

The creation of new source of perennial environmentally acceptable, low cost electrical energy as a replacement for energy from rapidly depleting resources of fossil fuels is the fundamental need for the survival of mankind. We have only about 25 years of oil reserves and 75 – 100 years of coal reserves. Resort to measure beginning of coal in thermal electric stations to serve the population would result in global elementic change in leading to worldwide drought and decertification. The buzzards of nuclear electric-stations are only too will. Now electric power beamed directly by micro-wave for orbiting satellite. Solar power stations (S.P.S) provide a cost-effective solution even though work on solar photo voltaic and solar thermo electric energy sources has been extensively pursued by many countries. Earth based solar stations suffer certain basic limitations

IV. Working of Footstep Generator

Step1: When force is applied on the plate by virtue on stamping on the plate the force spring gets compressed

Step2: The rack here moves vertically down

Step3: The pinion meshed with the rack gear results in circular motion of the pinion gear

Step4: For one full compression the pinion Moves 1semicircle

Step5: When the force applied on the plate released the pinion reverses and moves another semi-circle **Step6:** The generator attached to the pinion hence results in the sinusoidal waveform (for single Generator)

4.2.Operating Procedure:

Whenever force is applied on the plate that force is converted to Electrical energy is used to drive DC loads. And that minute voltage which is stored in the Lead Acid battery. The battery is connected to the inverter. This 230 Volt A.C voltage is used to activate the conveyor belt. We are using conventional battery charging unit also for giving supply to the circuitry. Here the amount of battery gets charged whenever we place our foot on plate. Here we are using an inverter to convert dc to ac voltage by placing a load or a bulb. We can check the voltage values of particular load how much it is consuming with the help of LED or multi meter.

4.3.Rack And Pinion Mechanism:

A rack and pinion is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion. A circular gear called "the pinion" engages teeth on a linear "gear" bar called "the rack"; rotational motion applied to the pinion causes the rack to move relative to the pinion, thereby translating the rotational motion of the pinion into linear motion. For example, in a rack railway, the rotation of a pinion mounted on a locomotive or a railcar engages a rack between the rails and forces a train up a steep slope. For every pair of conjugate involutesProfile, there is a basic rack. This basic rack is the profile of the conjugate gear of infinite pitch radius. A generating rack, is a rack outline used to indicate toothdetails and dimensions for the design of a generating tool, such as a hob or a gear shaper cutter. Rack and pinion combinations are often used as part of a simple linear actuator, where the rotation of a shaft powered by hand or by a motor is converted to linear motion. The rack carries the full load of the actuator directly and so the driving pinion is usually small, so

that the gear ratio reduces the torque required. This force, thus torque, may still be substantial and so it is common for there to be a reduction gear immediately before this by either a gear or worm gear reduction. Rack gears have a higher ratio, thus require a greater driving torque, than screw actuators. A rack and pinion mechanism is used to transform the rotary motion into linear motion and vice versa. A single gear, and pinion meshed with a sliding toothed rack. This combination converts rotary motion into back and forth motion. Windshield wipers in cars are powered by rack and pinion mechanism.

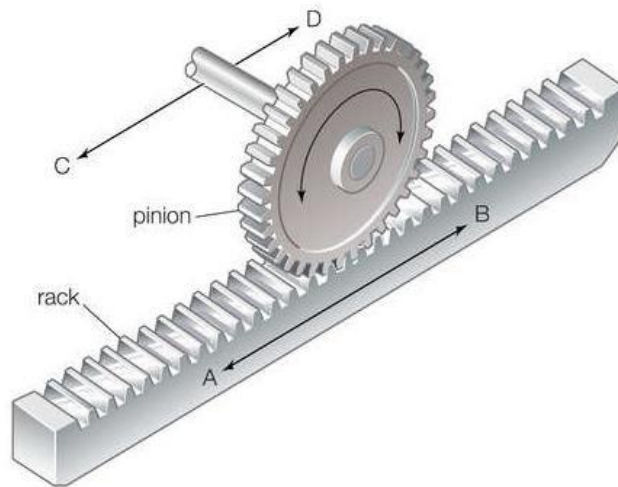


Fig 2: Schematic diagram of rack and pinion tool

V. Different Types of Mechanisms

- Levers
- Gears
- Wheels
- Chain & Sprocket
- Cams
- Rack & pinion

This Mechanisms require some type of Motion (movement)

VI. There Are Four Types of Motion

- Linear
- Rotary
- Reciprocating
- Oscillating

VII. The Different Types of Forces Are

- Static- no movement (still force)
- Dynamic - moving forces
- Compression- squashing force
- Tension- pulling force
- Bending - compression and tension
- Torsion - turning or twisting
- Shear- cutting
- Equilibrium- all forces are balanced

VIII. Rectifier Used

Rectifier is a circuit used to convert polarity changing current (A.C) to an unidirectional current. Hence a full wave rectifier is used in the circuit.

The basic component of the rectifier is the diode. It is a semiconductor device that allows the current to flow in a single direction. When placed correctly it converts varying current to a proper D.C current.

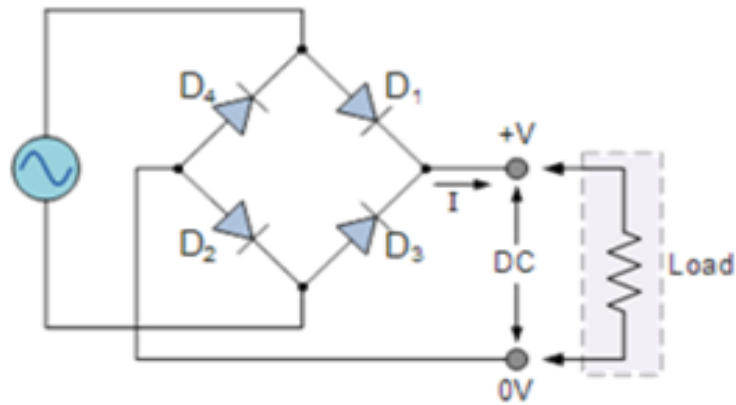


Fig 3 : Schematic diagram of a full wave rectifier

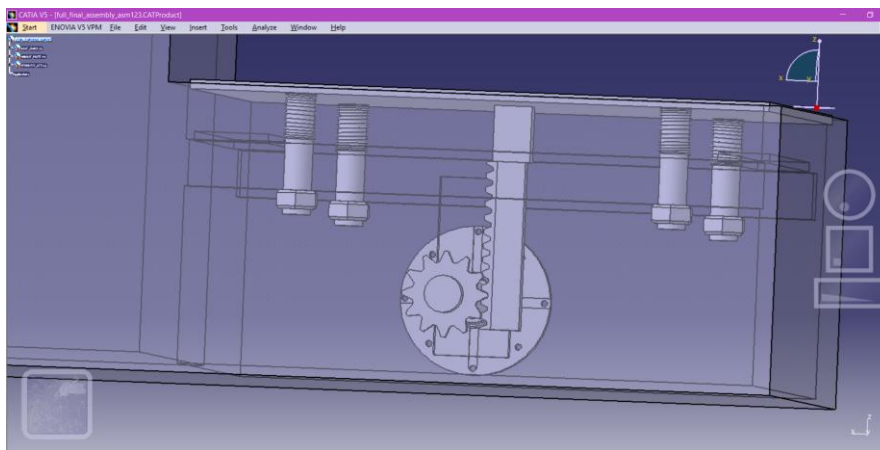


Fig 4 : Schematic diagram of a full wave rectifier

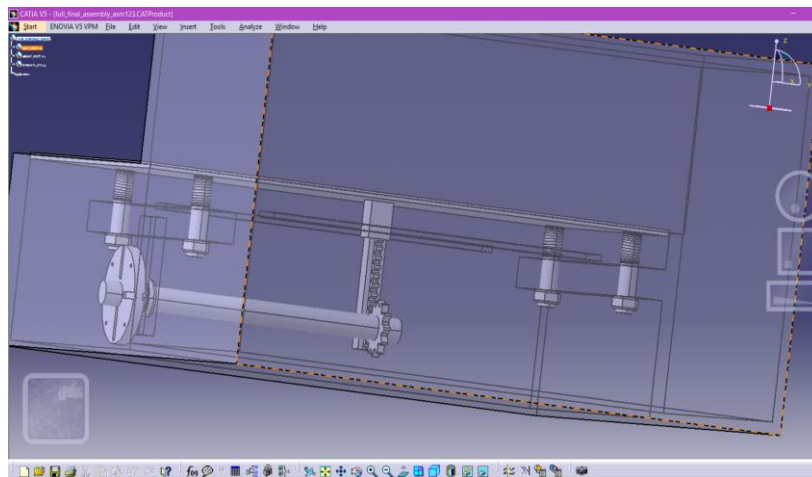


Fig 5 : Schematic diagram of a full wave rectifier

IX. Design and Calculation

Material: cast-iron

Outside diameter: 25mm

Circular pitch: $3.14/25 = 0.1256\text{mm}$

Pressure angle: 21

Pitch diameter: $D=N/P = 0.8\text{mm}$

Addendum: $1/25 = 0.04\text{mm}$

Dedendum: $1.157/25 = 0.04628\text{mm}$

Circular tooth Thickness: $1.57/25 = 0.628\text{mm}$

X. Design of Rack

Pitch circle diameter of the gear is =25 Circumference of the gear is = 3.14 Pitch circle diameter=
 $3.14 \times 25 = 78.5\text{mm}$

Specification of Rack Width:1.5mm Height:130mm

Generator Speed: 300RPM Type: DC geared motor

Battery Capacity: 12V

Output Power Calculation Let us consider,
The mass of a body = 60 Kg (Approximately)

Height after step = 13 cm

∴ Work done = Force x Distance Here,

Force = Weight of the Body

$$= 60 \text{ Kg} \times 9.81$$

$$= 588.6 \text{ N}$$

∴ Output power = Work done/Sec

$$= (588.6 \times 0.13)/60$$

$$= 1.27 \text{ Watts}$$

10.1. Advantage

- Simple technology and easy maintenance.
- No labor required.
- No fuel required.
- Pollution free power generation.
- This system does not depend on the weather like solar, wind and hydro power for generation.
- This unit has minimum cost of installation

10.2. Advantage over previous model:

One of the advantage over the previous piezo electric crystal model is that, here when a damage occurs it can be repaired as the setup is built mechanically . Where as in piezo electric crystal model repair and rework is not possible the piezo electric crystal should be completely replaced.

XI. Applications

- Foot step generated power can be used for agricultural, home applications, street-lightening.
- Foot step power generation can be used in emergency power failure situations.

XII. Conclusion

In concluding the words of this paper, since the power generation using foot step gets 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 to the places all roads and as well as all kind of foot step

which is used to generate the non-conventional energy like electricity. It is able to extend this project by using same arrangement and construct in the footsteps so that increase the power production rate by fixing school and colleges, highways etc.

XIII. Future Scope

Small changes in construction and design of the power generation set up can help to make the following future applications. Proposal for the utilization of waste energy of foot power with human locomotion is very much relevant and important for highly populated countries like India and China where the roads, railway stations, bus stands, temples, etc. are all over crowded and millions of people move around the clock. This whole human/bio energy being wasted if can be made possible for utilization it will be great invention and crowd energy farms will be very useful energy sources in crowded countries. Walking across a "Crowd Farm," floor, then, will be a fun for idle people who can improve their health by exercising in such farms with earning. The electrical energy generated at such farms will be useful for nearby applications.

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