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Foot Step Power Generation for Rural Energy Application to Run A.C. and D.C. Loads

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***Abstract* - This paper is all about generating electricity when people walk on the Floor. Think about the forces you exert which is wasted when a person walks. The idea is to convert the weight energy to electrical energy The Power Generating floor intends to trans-late the kinetic energy to the electrical power. Energy Crisis is the main issue of world these days. The motto of this research work is to face this crisis somehow. Though it won’t meet the requirement of electricity but as a matter of fact if we are able to design a power generating floor that can produce 100W on just 12 steps, then for 120 steps we can produce 1000 Watt and if we install such type of 100 floors with this system then it can produce 1MegaWatt. Which itself is an achievement to make it significant.**

Key words - Foot Step, D.C. Generator, Rack & Pinion, Chain Drive Arrangement, LEDs

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.

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.

II. PROJECT OVERVIEW

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.

FOOT STEP POWER GENERATION MODEL

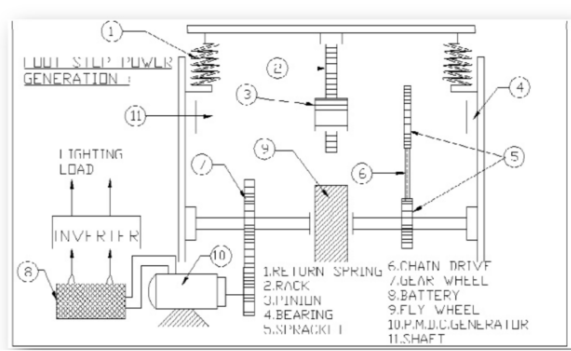


Fig : Foot step power generation model

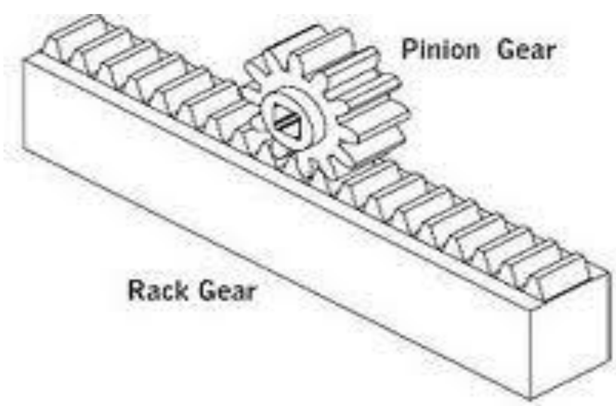
III. Hardware Description

3.1 Foot step arrangement

WORKING OF FOOT STEP 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)

3.2 Rack And Pinion and chain sprocket arrangement



DESCRIPTION:
Spring design:

FL=215
O/d=Φ40
W/d=Φ5

Spring constant:

The spring constant *k* is function of the spring geometry and the spring material's shear modulus *G*,a

$$k = \frac{Gd^4}{8D^3 n_a}$$

Where *G* is found from the material's elastic modulus *E* and Poisson ratio n,

$$G = \frac{E}{2(1+\nu)}$$

And *D* is the mean diameter of the spring (measured from the centers of the wire cross-sections),

$$D = D_{outer} - d$$

The distance between adjacent spring coils (defined as the *coil pitch*) is found by dividing the spring free length by the number of active coils,

$$coil_{pitch} = \frac{L_{free}}{n_a}$$

The rise angle of the spring coils (the angle between the coils and the base of the spring) is found from the arctangent of the coil-pitch divided by the spring circumference,

$$\theta = \operatorname{atan}\left(\frac{coil_{pitch}}{\pi D}\right)$$

The solid height of the spring is found by summing the widths of all the spring coils. The total number of spring coils is equal to the active coils in the spring interior plus the 2 coils at the spring ends

$$L_{solid} = n_t d \quad n_t = n_a + 2$$

The length of wire needed to make the spring is found from,

$$L_{wire} = \pi D\left(\frac{n_a}{\cos(\theta)} + 2\right)$$

Spring Force and Stress:The maximum force the spring can take occurs when the spring is deformed all the way to its solid height,

$$F_{max} = k\left(L_{free} - L_{solid}\right)$$

The maximum shear stress in the spring associated with the maximum force is given by,

$$\tau_{max} = \frac{8WD}{\pi d^3} F_{max}$$

Where W is the Wahl correction factor (accounting for spring curvature stress) and C is the spring index (essentially an aspect ratio of the spring cross-section),

$$W = \frac{4C-1}{4C-4} + \frac{0.615}{C} \quad C = \frac{D}{d}$$

Spring Resonance Finally, the lowest resonant frequency (in Hz) of the spring is found from the simple equation,

$$f_{res} = \frac{1}{2}\sqrt{\frac{k}{M}}$$

Where k is the spring constant from above and M is the spring mass. The spring mass M can be found by weighing the spring, or by finding the spring volume and multiplying by its material density,

$$M = \rho \cdot Vol = \rho\left(L_{wire}\frac{\pi}{4}d^2\right)$$

We can express the spring's lowest resonance in terms of basic spring geometry if we substitute for k and M in the equation for f_{res} (and then eliminate L_{wire}). Doing so gives,

$$f_{res} = \frac{1}{2}\sqrt{\frac{\frac{Gd^4}{8D^3 n_a}}{\rho\pi D\left(\frac{n_a}{\cos(\theta)}+2\right)\frac{\pi}{4}d^2}} = \frac{d}{2\pi D^2}\sqrt{\frac{G}{2\rho n_a\left(\frac{n_a}{\cos(\theta)}+2\right)}}$$

For springs with small rise angles and several active coils we can make the approximation,

$$n_a\left(\frac{n_a}{\cos(\theta)}+2\right) \approx n_a n_t \approx n_t^2$$

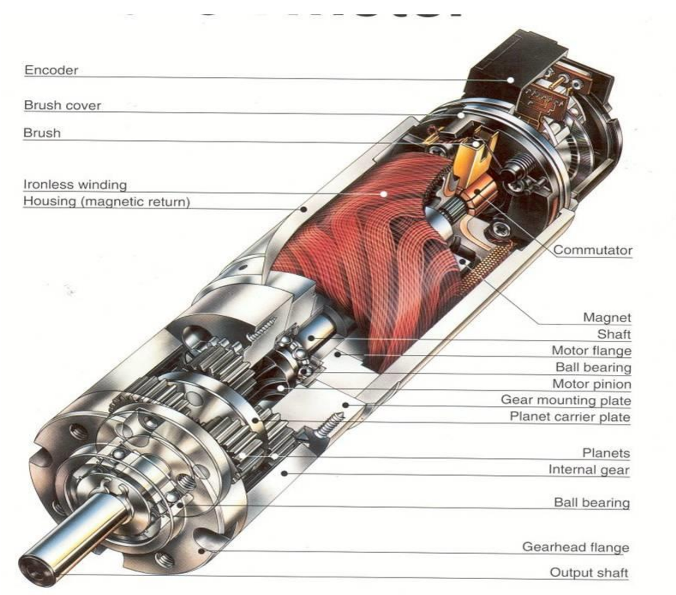
If we also allow the approximation,

$$2\pi\sqrt{2} \approx 9$$

We can then simplify the resonant frequency formula to a form that can be found in several reference books,

$$f_{res} = \frac{d}{9D^2 n_t}\sqrt{\frac{G}{\rho}}$$

3.3. PMDC Generator



Generator Construction:
Simple loop generator is having a single-turn rectangular copper coil rotating about its own axis in a magnetic field provided by either permanent magnet or electro magnets. In case of without commutator the two ends of the coil are joined to slip rings which are insulated from each other and from the central shaft.Two collecting brushes (of carbon or copper) press against the slip rings.Their function is to collect the current induced in the coil. In this case the current waveform we obtain is alternating current . In case of with commutator the slip rings are replaced by split rings.In this case the current is unidirectional.

Components of a generator:

Rotor: In its simplest form, the rotor consists of a single loop of wire made to rotate within a magnetic field. In practice, the rotor usually consists of several coils of wire wound on an armature.

Armature: The armature is a cylinder of laminated iron mounted on an axle. The axle is carried in bearings mounted in the external structure of the generator. Torque is applied to the axle to make the rotor spin.

Coil: Each coil usually consists of many turns of copper wire wound on the armature. The two ends of each coil are connected either to two slip rings (AC) or two opposite bars of a split-ring commutator (DC).

Stator: The stator is the fixed part of the generator that supplies the magnetic field in which the coils rotate. It may consist of two permanent magnets with opposite poles facing and shaped to fit around the rotor. Alternatively, the magnetic field may be provided by two electromagnets.

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Field electromagnets: Each electromagnet consists of a coil of many turns of copper wire wound on a soft iron core. The electromagnets are wound, mounted and shaped in such a way that opposite poles face each other and wrap around the rotor.

Brushes: The brushes are carbon blocks that maintain contact with the ends of the coils via the slip rings (AC) or the split-ring commutator (DC), and conduct electric current from the coils to the external circuit.

Working:

The commutator rotates with the loop of wire just as the slip rings do with the rotor of an AC generator. Each half of the commutator ring is called a commutator segment and is insulated from the other half. Each end of the rotating loop of wire is connected to a commutator segment. Two carbon brushes connected to the outside circuit rest against the rotating commutator. One brush conducts the current out of the generator, and the other brush feeds it in. The commutator is designed so that, no matter how the current in the loop alternates, the commutator segment containing the outward-going current is always against the "out" brush at the proper time. The armature in a large DC generator has many coils of wire and commutator segments. Because of the commutator, engineers have found it necessary to have the armature serve as the rotor(the rotating part of an apparatus) and the field structure as the stator (a stationary portion enclosing rotating parts).

fig : pmdc generator

3.4. Battery

RECHARGEBLE BATTERIES:

A rechargeable battery or storage battery is a group of one or more electrochemical cells. They are known as secondary cells because their electrochemical reactions are electrically reversible. Rechargeable batteries come in many different shapes and sizes, ranging anything from a button cell to megawatt systems connected to stabilize an electrical distribution network. Several different combinations of chemicals are commonly used, including: lead-acid, nickel cadmium(NiCad), nickel metal hydride (Nigh), lithium ion (Li-ion), and lithium ion polymer (Li-ion polymer).

Fig: Rechargeable Batteries

Rechargeable batteries have lower total cost of use and environmental impact than disposable batteries. Some rechargeable battery types are available in the same sizes as disposable types. Rechargeable batteries have higher initial cost, but can be recharged very cheaply and used many times.

Rechargeable batteries are used for automobile starters, portable consumer devices, light vehicles (such as motorized wheelchairs, golf carts, electric bicycles, and electric forklifts), tools, and uninterruptible power supplies. Emerging applications in hybrid electric vehicles and electric vehicles are driving the technology to reduce cost and weight and increase lifetime. Normally, new rechargeable batteries have to be charged before use; newer low self-discharge batteries hold their charge for many months, and are supplied charged to about 70% of their rated capacity.

Grid energy storage applications use rechargeable batteries for load leveling, where they store electric energy for use during peak load periods, and for renewable uses, such as storing power generated from photovoltaic arrays during the day to be used at night. By charging batteries during periods of low demand and returning energy to the grid during periods of high electrical demand, load-leveling helps eliminate the need for expensive peaking power plants and helps amortize the cost of generators over more hours of operation.

The US National Electrical Manufacturers Association has estimated that U.S. demand for rechargeable batteries is growing twice as fast as demand for non -rechargeable.

3.5. Inverter

An inverter is an electrical device that converts direct current (DC) to alternating current (AC); the converted AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits. Solid-state inverters have no moving parts and are used in a wide range of applications, from small switching power supplies in computers, to large electric utility high-voltage direct current applications that transport bulk power. Inverters are commonly used to supply AC power from DC sources such as solar panels or batteries.

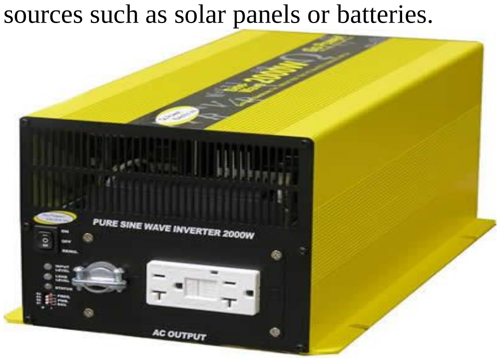

Fig : Inverter

There are two main types of inverter. The output of a modified sine wave inverter is similar to a square wave output except that the output goes to zero volts for a time before switching positive or negative. It is simple and low cost (~$0.10USD/Watt) and is compatible with most electronic devices, except for sensitive or specialized equipment, for example certain laser printers. A pure sine wave inverter produces a nearly perfect sine wave output (<3% total harmonic distortion) that is essentially the same as utility-supplied grid power. Thus it is compatible with all AC electronic devices. This is the type used in grid-tie inverters. Its design is more complex, and costs 5 or 10 times more per unit power (~$0.50 to $1.00USD/Watt).[1] The electrical inverter is a high-power electronic oscillator. It is so named because early mechanical AC to DC converters were made to work in reverse, and thus were "inverted", to convert DC to AC. The inverter performs the opposite function of a rectifier

3.6. Light Loads

Fig : Bulb

Do not support leaves, but contain food reserves to enable the plant to survive adverse conditions. The leaf bases may resemble scales, or they may overlap and surround the center of the bulb as with the onion. A modified stem forms the base of the bulb, and plant growth occurs from this basal plate. Roots emerge from the underside of the base, and new stems and leaves from the upper side.

Other types of storage organs (such as corms, rhizomes, and tubers) are sometimes erroneously referred to as bulbs. The correct term for plants that form 0underground storage organs, including bulbs as well as tubers and corms, is **geophytes**. Some epiphytic orchids (family Orchidaceous) form above-ground storage organs called **pseudo bulbs** that superficially resemble bulbs.

Incandescent

These are the standard bulbs that most people are familiar with. Incandescent bulbs work by using electricity to heat a tungsten filament in the bulb until it glows. The filament is either in a vacuum or in a mixture of argon/nitrogen gas. Most of the energy consumed by the bulb is given off as heat, causing its Lumens per Watt performance to be low. Because of the filament's high temperature, the tungsten tends to evaporate and collect on the sides of the bulb. The inherent imperfections in the filament causes it to become thinner unevenly. When a bulb is turned on, the sudden surge of energy can cause the thin areas to heat up much faster than the rest of the filament, which in turn causes the filament to break and the bulb to burn out.

Incandescent bulbs produce a steady warm, light that is good for most household applications. A standard incandescent bulb can last for 700-1000 hours, and can be used with a dimmer. Soft white bulbs use a special coating inside the glass bulb to better diffuse the light; but the light color is not changed

.

Halogen

Halogen bulbs are a variation of incandescent bulb technology. These bulbs work by passing electricity through a tungsten filament, which is enclosed in a tube containing halogen gas. This halogen gas causes a chemical reaction to take place which removes the tungsten from the wall of the glass and deposits it back onto the filament. This extends the life of the bulb. In order for the chemical reaction to take place, the filament needs to be hotter than what is needed for incandescent bulbs. The good news is that a hotter filament produces a brilliant white light and is more efficient (more lumens per watt).

The bad news is that a hotter filament means that the tungsten is evaporating that much faster. Therefore a denser, more expensive fill gas (krypton), and a higher pressure, are used to slow down the evaporation. This means that a thicker, but smaller glass bulb (envelope) is needed, which translates to a higher cost. Due to the smaller glass envelope (bulb), the halogen bulb gets much hotter than other bulbs. A 300 watt bulb can reach over 300 degrees C. Therefore attention must be paid to where halogen bulbs are used, so that they don't accidentally come in contact with flammable materials, or burn those passing by.

Care must be taken not to touch the glass part of the bulb with our fingers. The oils from our fingers will weaken the glass and shorten the bulb’s life. Many times this causes the bulb to burst when the filament finally burns out.

To summarize, the halogen has the advantage of being more efficient (although not by much) and having longer life than the incandescent bulb. They are relatively small in size and are dimmable. The disadvantages are that they are more expensive, and burn at a much higher temperature, which could possibly be a fire hazard in certain areas.

temperature, which could possibly be a fire hazard in certain areas.

Fluorescent

These bulbs work by passing a current through a tube filled with argon gas and mercury. This produces ultraviolet radiation that bombards the phosphorous coating causing it to emit light (see: “How Fluorescents Work”). Bulb life is very long - 10,000 to 20,000 hours. Fluorescent bulbs are also very efficient, producing very little heat. A common misconception is that all fluorescent lamps are neutral or cool in color appearance and do not have very good color-rendering ability. This is largely due to the fact that historically the "cool white" fluorescent lamp was the industry standard. It had a very cool color appearance (4200K) and poor CRI rating. This is simply no longer the case. Regarding color, a wide variety of fluorescent lamps , using rare-earth tri-phosphor technology, offer superior color rendition and a wide range of color temperature choices (from 2700K to 5000K and higher). Fluorescent bulbs are ideal for lighting large areas where little detail work will be done (e.g. basements, storage lockers, etc.). With the new type bulbs, and style of fixtures coming out, fluorescents can be used in most places around the home. Most fluorescent bulb cannot be used with dimmers.

That fluorescent bulb need components called ballasts to provide the right amount of voltage. There are primarily two types - magnetic and electronic. Electronic ballasts solve some of the flickering and humming problems associated with magnetic ballast, and are more efficient, but cost more to purchase. Some ballasts need a “starter” to work along with it. Starters are sort of small mechanical timers, needed to cause a stream of electrons to flow across the tube and ionize the mercury vapor

On tube type fluorescent bulbs, the letter T designates that the bulb is tubular in shape. The number after it expresses the diameter of the bulb in eighths of an inch.

IV. Advantages And Applications

Advantages

- Reliable
- Economical
- Eco-Friendly
- Less consumption of Non- renewable energies.

Applications

- Foot step generated power can be used for agricultural, home applications, street-1lightening.
- Foot step power generation can be used in emergency power failure situations.

V. Conclusion

the project **“foot step power generation for rural energy application to run a.c. and d.c. loads”** is successfully tested and implemented which is the best economical, affordable energy solution to common people. this can be used for many applications in rural areas where power availability is less or totally absence. as india is a developing country where energy management is a big challenge for huge population. by using this project we can drive both ac as well as d.c loads according to the force.

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