FOOT STEP POWER GENERATION TO RUN A.C. AND D.C. LOADS

A project report submitted in partial fulfillment of the requirement for the degree of

Bachelor of Technology in Mechanical Engineering

By

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CERTIFICATE OF APPROVAL

The forgoing project report is hereby approved as a credible study of an engineering subject carried out and presented in a manner satisfactory to warrant its acceptance as a prerequisite to the degree for which it has been submitted. It is understood that by this approval the undersigned do not endorse or approve any statement made, opinion expressed or conclusion drawn therein but approve the project report only for the purpose for which it has been submitted.

Board of Project Report Examiners:

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SVNU

DEPARTMENT OF MECHANICAL ENGINEERING

We hereby recommend that the project presented under our supervision by **JAYDEEP PANDIT,** entitled **FOOT -STEP POWER GENERATION** be accepted in partial fulfillment of the requirements for the degree of **BACHELOR OF TECHNOLOGY** in Mechanical Engineering.

(PROJECT SUPERVISOR)

DEPARTMENT OF MECHANICAL ENGINEERING

ACKNOWLEDGEMENT

I am using this opportunity to express my gratitude to everyone who supported me throughout the course of this B.Tech final year project. I am thankful for their aspiring guidance, invaluably constructive criticism and friendly advice during the project work. I am sincerely grateful to them for sharing their truthful and illuminating views on a number of issues related to the project. My project has been successful of his guidance.

I express my warm thanks to my teacher **Mr. HIMANGSHU MAJUMDER** and all the people who provided me with the facilities being required and conductive condition for my **FOOTSTEP POWER GENERATION PROJECT**.

We are highly grateful to **Prof. Mr. SUBHAS DEY** and our Dean sir **Mr. S.K. SARANGI** for providing us their valuable suggestion, motivation & ideas during whole project work.

Forwarded by

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CONTENT

ABSTRACT

Need is the mother of all inventions and innovations. Man has improved the standards of everything around him to his comfort, need and desire.

Energy crisis is a major concern in today's world. As the demand of energy is increasing day by day, so the ultimate solution to deal with these sorts of problems is just to implement the renewable sources of energy. The objective of footstep power generation project is to abstract renewable energy. If this project is installed in highly dense areas such as railway stations, clubs, parks etc. then maximum amount of energy can be abstracted from it. By simply walking on footpath, electricity is generated. This project consist rack and pinion assembly as a driving mechanism. In this project, force energy is converted into electrical energy. The control mechanism consists of the rack & pinion, D.C generator, battery and inverter control. We have discussed the various applications and further extension also. So this project is implemented to all foot step, the power generation is very high.

As technology is advancing, the consumption of power is steadily rising. So the challenges of power generation and its cost of production, play an important role in the countries competence in the world economy. Thus "The need of the hour is power". So the problem identified is power generation and means to make it cheaper. The world is growing at a rapid pace. Among many vital sectors of our social life, transportation sector has a key role to play. It is an ever growing sector with the escalating population, growing needs and creeping number of vehicle users. The traffic on the roads becomes doubled or tripled, at alarming rates. If vehicular motion can be put to generate useful power, it can be put to effective use. This idea has mothered the invention of "power generation through speed breakers", inspired by various other existing designs. In this paper an attempt has been made to generate power using speed breakers through rack and pinion mechanism by tapping the energy and utilizing it for various purposes such as lightening the street lights, etc.

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.

In addition to these we have to develop a new methodology of generating power using human energy and name of this alternative is a foot step power generation.

This process involves number of simple setup that is installed under the walking platform. When people walk on this platform their body weight is utilized to rotate pinion through rack. Pinion is connected to dynamo, which ultimately produce electricity.

This work will be great invention if energy wasted through walking is utilized properly. Generally, great amount of such renewable energy is available at highly dense places.

Mechanical energy is converted into electrical energy with the help of rack and pinion assembly. When a person claims the staircase, a force has been acted on the step which has been placed at a certain angle of inclination. When force is applied, rack which is connected to step moves down and rotates the pinion. This rotational speed has been increased using Chain and sprocket drive.

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/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.

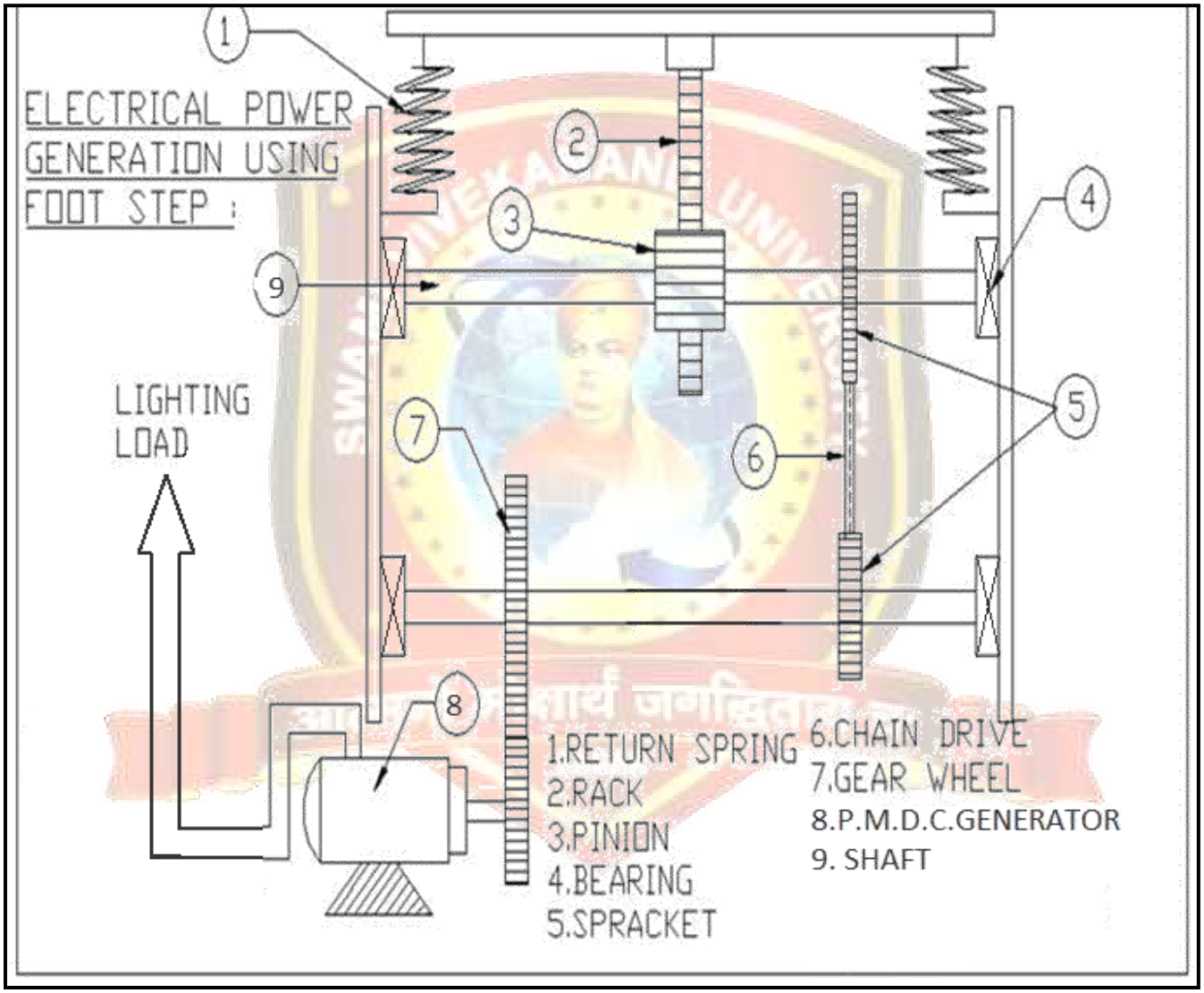


Diagram of Foot Step Power Generation with its basic components

Basic Components with Specification:-

Foot-step power generation system consists of following components……

Serial No.	Name of component	Quantity	Specification
1.	Motor	1	i)Voltage: 10V ii) Type: D.C Generator iii) RPM: 1000
2.	Spur Gear & Pinion	1	i)Mild steel ii) No. of teeth (35 and 18) iii) Pressure angle 20^0full depth iv)Module =2 v)Face width= 4.16mm and 4.3mm
3.	Rack	1	i) Cast Iron (CI) ii)Module=1.5 iii)Max^m. Length =100mm - 120mm iv) width of rack=10mm
4.	Spring	2	i) Mild steel

ii)Wire dia.=5mm
iii)Spring Index=6
iv) Mean coil dia. =30mm
v)No. of Active-Turn=

18,(18=+2)

vi)Load Bearing Capacity=

60kg-100kg

vii)Net Deflection=50mm

5.	Bearing		4i) Type: Ball Bearing

ii) Bearing No= N35

6.	Shaft	2	i) Mild steel

ii)Diameter=15mm-20mm
iii) Length=600mm-800mm

7.	Sprocket	2	i) Mild steel

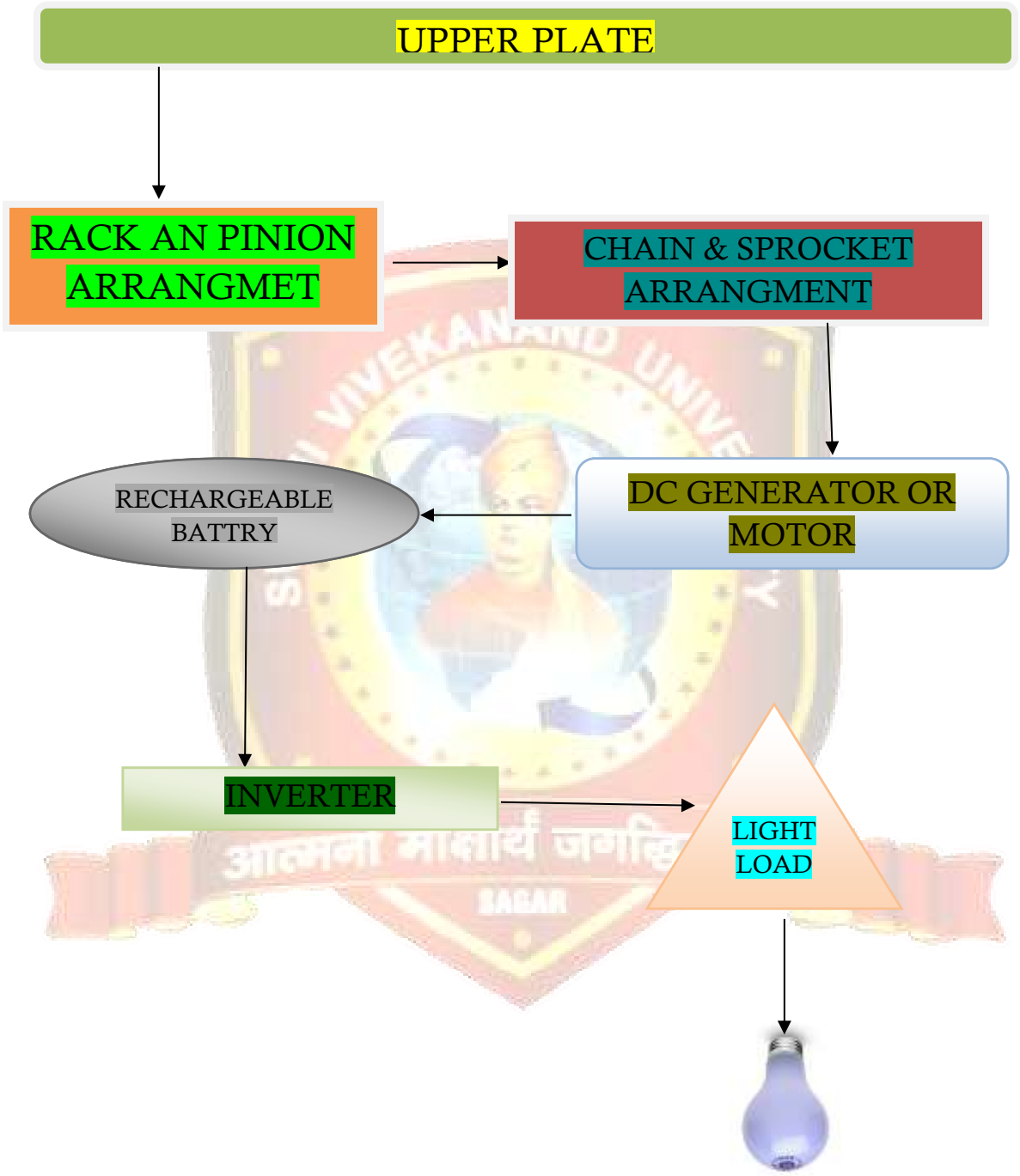
ii) External Dia. =150mm
iii) Internal Dia. =50mm

8.	Metal sheet	1	i) Mild steel

ii) 750x450x5mm

9.	Chain	1	i) Mild steel

BLOCK DIAGRAM



Block Diagram For Foot-Step Power Generation

WORKING PRINCIPLE OF FOOT STEP GENERATOR:

Working principle is based on the law of energy i.e. Mechanical energy is converted in to electrical energy. When the force is applied on the foot step, springs gets compressed and the energy passes vertically through the rack arrangement and the reciprocating movement converted into rotating motion of the pinion when force get released it goes on its initial position. The sprocket arrangement on the same shaft is connect with the other sprocket with the help of chain drive to transfer of energy. The shaft is coupled with the sprocket to regulate in the fluctuation of energy and finally Dynamometer is connected with the shaft which shows the output by converting the Mechanical Energy into Electrical Energy.

WORKING OF FOOT-STEP POWER GENERATION

Diagram of foot-step power generation

WORKING OF FOOT-STEP POWER GENERATION

In this arrangement we are using two steps. The rack & pinion, spring arrangement is fixed below the steps. We are using four springs foe each step. The spring isused to return the step in same position by releasing the load. The rack is coupled to the foot step. In the second step, the Rack is connected to the footsteps. From Rack a shaft is provided in which the largersprocket lies. The larger sprocket is coupled with Rack, so that it is running at the same speed of Rack. The largersprocket is coupled to the smaller sprocket below in the other shaft with the help of chain (cycle). This larger sprocketis used to transfer the rotation force to the smaller sprocket. A gear is provided there also. The smaller sprocket isrunning same direction for the forward and reverse direction of rotational movement of the larger sprocket. It is runningat same speed also.This action locks like a cycle pedaling action. The gear wheel which is provided in smaller sprocket is coupled to the12v DC generator. The DC generator capacity used here is12V. From the generator the wires are taken. These wires are connected to LEDs, to show the output power. Here the chain drive mechanism rotates only in single direction (arrangement is madefor that).

In simple sentence we can understand the working of foot step power generation by following steps like-

Step1: When force is applied on the plate by virtue on stamping on the plate hence the 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 one semicircle.

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).

FRAME STRUCTURE OF FOOT-STEP POWER GENERATION

It is an assemblage of a number of resistant bodies having no relative motion between them. Structures are meant for taking up loads. There is only straining action due to forces acting on them.

No useful energy is transmitted by it. While working, the machine structure is subjected to both static and dynamic forces, therefore it is essential that the structure should not deform or vibrate beyond the permissible limits under the action of these forces.

When a person climbs or get down a step, he pushes a step down, thus producing impact force or thrust force. This impact pressure energy can be utilized to operate the DC motor through bi-directional rack and pinion arrangement. The impact force applied by the human generates Vibration energy which is utilized for to-fro motion of rack. It then converts this linear motion into circular motion of pinion, which rotates the shaft connected to it. DC motor attached to the other side of shaft converts this mechanical energy into electrical energy.

DIAGRAM OF RACK AND PINION MECHANISM

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 involutes profile, 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 tooth details 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 in to linear motion and vice versa. A single gear and pinion meshed with a sliding toothed rank. This combination is converts rotary motion in to back and forth motion. Windshield wipers in cars are powered by rack and pinion mechanism.

DIAGRAM OF CHAIN AND SPROCKET MECHANISM

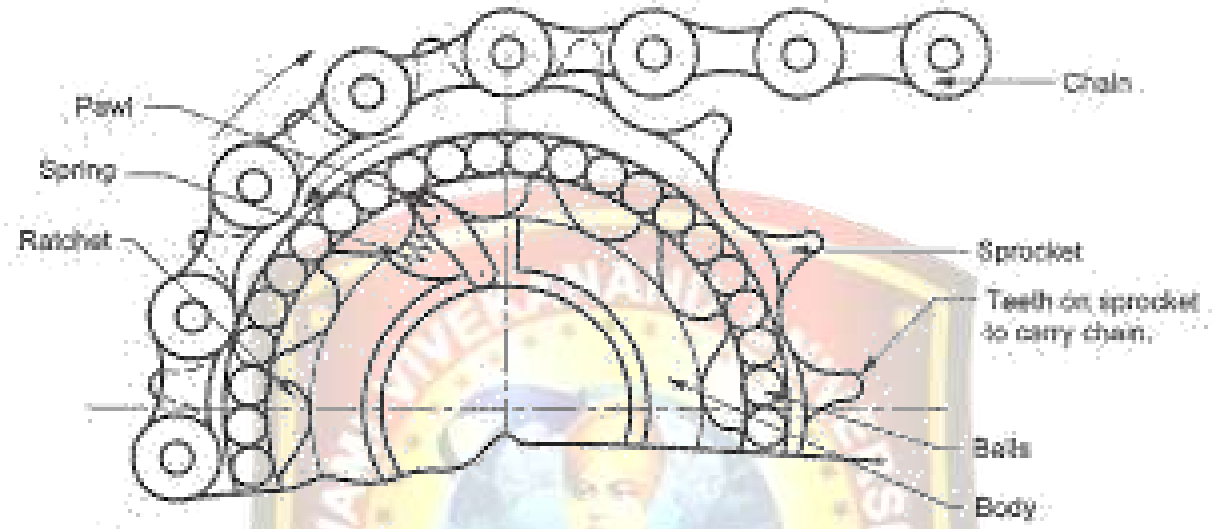


Fig. 1.25 : Rear wheel arrangement with pawl and rachet

CHAIN AND SPROCKET MECHANISM

Chain and Sprocket-

A sprocket is a toothed wheel that fits onto a shaft. It is prevented from rotating on the shaft by a key that fits into keyways in the sprocket and shaft.

A chain is used to connect two sprockets. One sprocket is the driver sprocket. The other sprocket is the driven sprocket. Motion and force can be transmitted via. the chain from one sprocket to another, therefore from one shaft to another. Chains that are used to transmit motion and force from one sprocket to another are called **power transmission chains.**

There are 6 major groups of power transmission chains:-

- Standard general purpose roller chains, widely used in industry.
- High performance roller chains, these roller chains are stronger than general purpose roller chains.
- Lube-free chains, these chains can be used without lubrication.
- Environmentally resistant chains with special corrosion resistance.
- Specialty chains, **Type 1**. Used as bicycle chains, motor cycle chains, automotive chains.
- Specialty chains, **Type 2**. Including miniature chains, leaf chains and inverted tooth chain, i.e. silent chains.

Most of these chains are the roller type, i.e. they are composed of link plates, pins that join the link plates and also rollers and bushes.

The size of the chain links must match precisely the size and spacing of the sprocket teeth.

Advantage of chain drives:-

An advantage of chain drives over most belt drives is that the chain cannot slip on the sprocket, so the chain and sprocket provides a positive, non-slip drive, i.e. the chain cannot slip on the sprocket because the sprocket teeth prevent the chain from slipping.
Some belt and pulley drives also have teeth. These toothed belt and pulley drives are used in applications where it is important that the belt does not slide on the pulley, e.g. timing belts in internal combustion engines and the drive belts that replace the chain on some motorcycles.

Disadvantage of chain drives:-

The disadvantage of the chain and sprocket drive is that it can be noisy and more expensive than a belt and pulley drive system. Chain and sprocket drives are not used on some applications such as drilling machines and lathes precisely because the chain and sprocket drive does not allow slip. For safety reasons, belt and pulley drives are used on many machines so that in the event of something jamming in the machine, under great pressure, the belt can slip on the pulley rather than damaging the machine as would happen with a no-slip chain and sprocket drive.

Chain and sprocket drive are used in applications where slipping should not occur-

- Bi-cycles and motor-cycles.
- Cam shaft drive in internal combustion engine.
- Fork lifts trucks.
- Elevator escalator.

AIM OF THE PROJECT

The conventional sources of energy are generally non-renewable sources of energy, which are being used since a long time. To improve the power generation technologies and to make them more sustainable, non –conventional technologies have been discovered. Energy generated by using wind, tides, solar, geothermal heat, and biomass including farm and animal waste is known as non-conventional energy. All these sources are natural, renewable or inexhaustible and do not cause environmental pollution and are eco-friendly. More over them do not require heavy expenditure. The non-conventional sources of energy are abundant in nature. Most of the non –conventional sources have been boons at hand only to the well developed countries. The developing countries that lag behind in technical assets and financial limitations are striving to install the technologies of the latest trends and advanced versions. With the vast development of the technologies and understanding them, many other creative techniques of power generation have been emerged. The newly developed techniques are aimed at cost effectiveness.Thus they become more affordable to the countries like India, where installation cost and space occupancy is serious issues. One such creative technique is power generation through speed breakers and Foot-Step. It is achieved in three possible ways.

The ways are……..

- Use of lever mechanism
- Use of roller mechanism and
- Use of rack and pinion mechanism

The rack and pinion mechanism has advantages over the other two. When compared with roller mechanism. Now our project is to completely utilize the technique of using rack and pinion mechanism for power generation.

This system can embedded at any public places due to small structure like Railway Platform, Malls and busy Foot Path etc.

OBJECTIVE OF THE PROJECT

The objective of this project is to design a setup that leads to generatingelectricity .the energy which is going waste when human climb the stairs. This human energy is utilized and convertedinto electrical energy. This generated energy is cost effective and nonhazardous for human. Power can be generatedthrough stepping on the stairs; the generated power will be stored and can be used for domestic purpose. To obtain the above purpose, the experimental setup is designed which contains the structure, dome, rack, spur gear, bearings,flywheel, shaft, springs, chain drive and dynamo. The working principle is based on law of energy i.e. mechanicalenergy is converted into electrical energy. When force is applied on footstep rack and spring get compressed thereforethe pinion is rotated. This rotates the chain drive arrangement. The flywheel is coupled with chain drive to regulate thefluctuation and finally the dynamo is connected with the shaft. Thus reciprocating energy is converted into rotatingenergy and mechanical energy is converted into electrical energy. The energy generated is risk free and pollution free.
The way of energy generation is eco friendly and nonhazardous to human. The output of energy increases as weightincreases. The weight range is from 10 to 15kg. The LED bulb blow is of 9 watt and the range of voltage obtained is from 8 to 35V as per the changes in weight. The electricity is produced in low budget when mass production andinstallation is done. The required area is low, no obstructions in traffic, easy maintenance and construction.

BACKGROUND OF THE PROJECT

The use of fossil fuels and other non-reusable sources of energy must be reduced in order to keep emissions lowand alleviate the use of diminishing resources. The idea of human powered generation has been implemented inmany different situations. Some examples include hand-crank radios, shaking flashlights, and receiving powerfrom gym equipment. The use of exercise equipment for a clean source of energywould turn out to be an even more fun experience for participants; it would provide them a means to exercise whileindirectly generating power.

Using human powered generation gives a power source that is not directly derived from natural sources.An example is that a human powered generator can be operated if there is no sun for solar generation, no wind forwind generation, and no water for hydro generation. The power generated from pedal is perfect for remote areas,hilly regions, strategic location, Islands etc., where electricity generation is scanty if not nil. In these situations, asmall portable power generating unit would be of great help to provide power supply to charge battery-operatedgadgets like mobile phones, lamps, radio, communication devices, etc. It is important to visualize new ways tobring power to the people as population continues to grow and power shortages continue to occur. Much of thepower that is provided to people today is done in very un-sustainable ways; new ideas are needed to transit into apost cheap-petroleum era. This design relates to very compact and easily portable power-generating unit, whichbesides being used as a power generator can also be used as cycle exerciser. It serves dual purpose of powergeneration and helping the person to maintain physical fitness through exercise of muscles of legs. It can be pedaledor cranked by hand/foot to charge 12 volt batteries and run small appliances.

The main aim of this project is to develop much cleaner cost effective way of power generation method, which in turns helps to bring down the global warming as well as reduce the powershortages. In this project the conversion of the force energy in to electrical energy by Foot-Step System.

GENERAL CONSIDERATIONS

The footstep arrangement is used to generate the electric power. Now a day's power demand is increased, so thefootstep arrangement is used to generate the electrical power in order to compensate the electric power demand. In thisarrangement the mechanical energy is converted into electrical energy.

This section is constructed by of rubber or other material which is placed within the surface areas. This section ismainly placed in the crowed areas. This footstep arrangement is attached with spring section. Footstep section consists with following arrangement such as-

- Metal plate
- Springs
- Ball Bearing
- Gearwheel arrangement
- Rack and Pinion Section
- Chain drive Mechanism
- Coupling section
- LEDs

The rack & pinion, spring arrangement is fixed at the inclined step. The spring issued to return the inclined step insame position by releasing the load. The pinion shaft is connected to the support at the end by Ball Bearing. Thelarger sprocket also coupled with the pinion shaft, so that it is running at the same speed of Gear Wheel arrangement. The largersprocket is coupled to the small cycle sprocket with the help of chain to transfer torque to the Motor through coupling section. Now the Motor convert this mechanical energy to the Electrical energy and the electrical energy is stored in Inverter. Finally this store energy can be use at the time of requirement.

FABRICATION DETAILS

The frame structure for the total unit is fabricated using L-Angle frames and ordinary frames. These frames are made of mild steel. They are held to proper dimensions are attached to form a unit with the help of welding. Then the bearings which are of standard make are kept in place with their respective shafts through them and are welded to the frame structure. The shafts are also made of mild steel. Hinges are used to move the arrangements by welding it to the frame structure. These hinges are responsible for the movement of the plates in an up and down motion. A rack which is made up of mild steel and has 35 teeth is welded to the plate arrangements. A pinion which is also made up of mild steel and which has 18 teeth is fitted on the shaft initially, and welded. This pinion tooth is exactly made to mate with the teeth of the rack. A bicycle sprocket and chain arrangement of standard make is fitted with the larger sprocket on the top shaft and its smaller sprocket on the bottom shaft. The sprocket wheels are welded to the shaft. A special stand arrangement is made to seat the 10V DC generator using frames. A 10V DC generator is placed within the seat and is held firm using bolts and nuts. Wires are connected to the terminals of the DC generator and its other ends are connected to the light.

RESULT OF THIS PROJECT

This section presents the result of the input and output data. The results were obtained base on both the evaluationof the models presented in section three and the fabricated design. The input and output data are tabulated forclarity, also, graphs were used when necessary to show the dependence of some parameters on the others.

When human climb the stairs that human energy isconverted in to electrical energy by using the experimentalsetup.

Case 1: At 50 kg load the voltage generated is 35.5 V

Case 2: At 35 kg load the voltage generated is 21.43 V

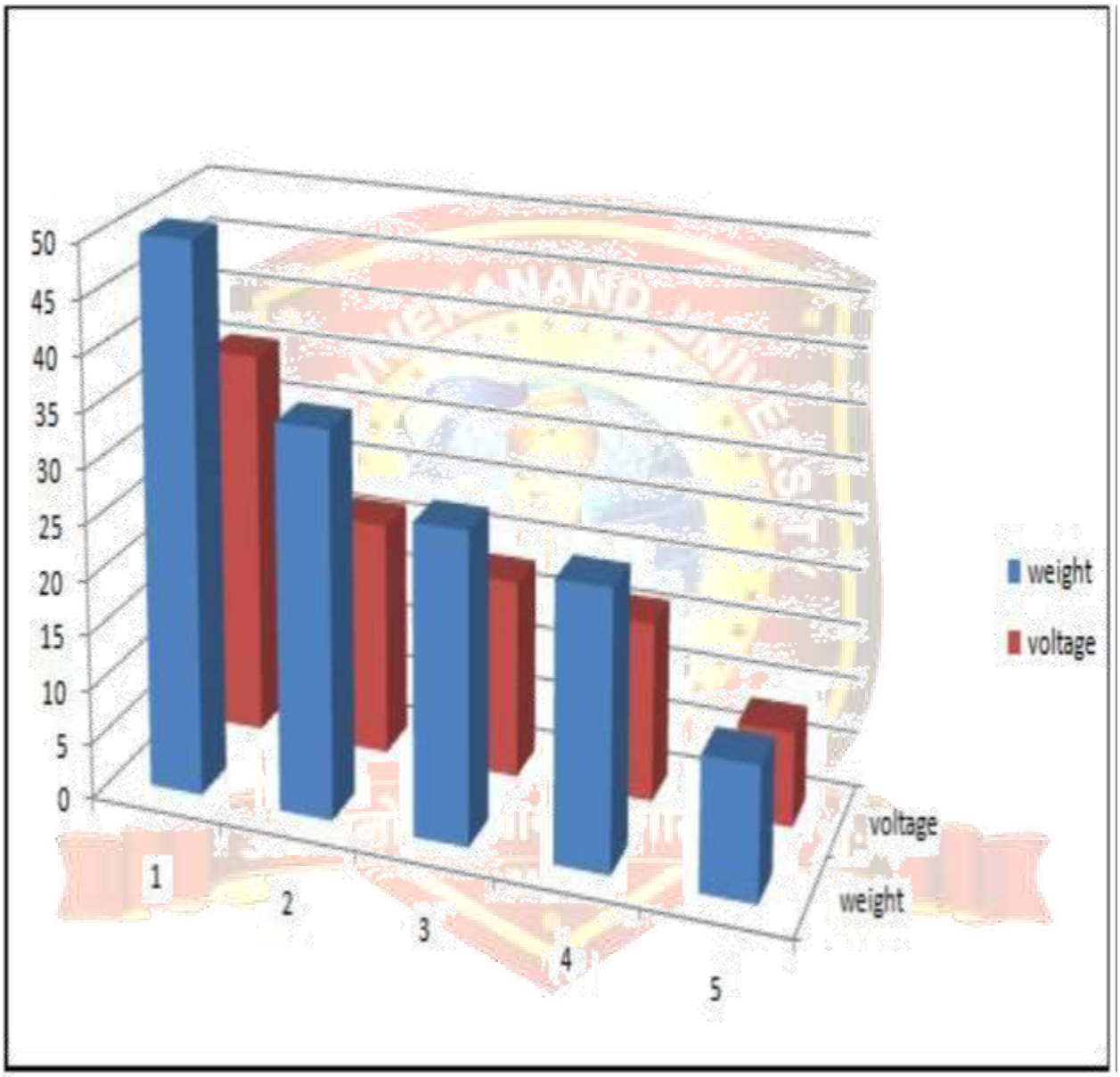
Case 3: At 28 kg load the voltage generated is 18.05 V

Case 4: At 25 kg load the voltage generated is 16.28 V

Case 5: At 12 kg load the voltage generated is 8.59 V

- The experimental setup is not hazardous for human.

- It is cost effective when continuously used.



Graphical Representation of Weight (W) vs. Voltage (V)

DESIGNING CALCULATION FOR FOOT-STEP POWER GENERATION

A. Spring Calculation:-

Specification :(standard values are considered)
∂=190-11=75mm
Material=steel wire
Ultimate tensile strength=1090 N/mm2
Modulus of rigidity=81370 N/mm2
Permissible shear stress (ι) for spring wire should be50% of ultimate tensile strength.

We are finding the following values:

- Wire diameter. (d)
- Mean coil diameter. (D)
- Number of active coil. (N)
- Total number of coils.
- Free length of spring.
- Pitch of the coil.

Now,

P=63….. (Assume 65kg)
∂=75 mm
C=6.
G=81370 N/mm^2
$T=0.5\ S_{ut}$

1) Wire Diameter:-

The permissible shear stress is;
ι= 0.5×Sut
S_{ut}=1090 N/mm2
= 0.5×1090
ι = 545 N/mm2

$$K = \frac{4c-1}{4c+4} + \frac{0.615}{c}$$
$$= \frac{4\times6-1}{4\times6+4} + \frac{0.615}{6}$$

K=1.2525

$$T = k \times \frac{9\times P\times c}{\pi\times d^{\wedge}2}$$
$$545 = 1.2525 \times \frac{8\times638\times6}{\pi\times d^{\wedge}2}$$

d =4.546=5mm

Where,

d=wire diameter

Di=inside diameter

Do=outside diameter

D=mean coil diameter

2) Mean Coil Diameter:-

D=C×d

=6×5

D=30 mm

3) Number of Active Coil:-

$$\delta = \frac{8\times P\times D^3\times N}{G\times d^{\wedge}4}$$
$$50 = \frac{8\times638\times30^3\times N}{81370\times5^{\wedge}4}$$

N=18

4) Total Number of Turns:-

It is assumed that the spring to spur and gear end. The number of inactive coils is 2.

N_1=N+2=18+2=20

5) Free Length of spring:-

The actual deflection of spring is:

$$\delta = \frac{8\times P\times D^3\times N}{G\times d^{\wedge}4}$$
$$\delta = \frac{8\times638\times30^3\times18}{81370\times5^{\wedge}4}$$
$$\delta = 48.78 \text{ mm}$$

6) Solid Length of spring:-

It is assumed that here will be gap of between Consecutive coils which spring is subjected to Maximum force.

Total number of coils is 18.

Axial gap (N11) = N-1 = (18-1)×1 = 17 mm

Free length = solid length + axial gap+∂

(Solid length = N1×d=20×5=100)

= 100+17+49

Free length = 166 mm

7) Pitch of Coil:-

$$P = \frac{\text{freelength}}{N1-1}$$

$$= \frac{166}{18-1}$$

$$P = 9.76 \text{ mm}$$

B. Rack and Pinion:-

Nomenclature:

F_t=Transmitted force

F_n= Normal force

F_r= Resultant force

θ = Pressure angle

Pressure angle = 20^0

1) Fr = Ft tan θ……. (1)

F_t = tangential force (weight of human = 65kg)

F_t = 65 x 9.81

F_t = 637.65 N

F_r = 637.65 x tan20.....using equation (1)

F_r = 232.02 N

2) $F_n = \frac{f_t}{\cos\theta}$ .....(2)

$= \frac{637.65}{\cos 20}$

$F_n = 678.57$ N

3) Power

$P = \frac{\text{Work}}{\text{time}}$ .....(3)

$P = \frac{\text{Forcexdisplacement}}{\text{time}}$

$P = \frac{637.65 \times 0.050}{1}$

$P = 31.88$ watt

4) Power

$P = \frac{2\pi NT}{60}$ .....(4)

$T = \frac{P \times 60}{2\pi \times N}$

$T = \frac{31.88 \times 60}{2 \times 3.142 \times 30}$

$T = 9.3$ N.m

5) $T = f_t \times r$ .....(5)

$r = \frac{T}{f_t}$

$= \frac{9.3}{637.65}$

$r = 0.015$

$r = 15$ mm So $D = 30$ mm

6) Using Lewis form factor:-

$$\sigma_t = \frac{f_t x P_d}{y.b} \ldots\ldots(6)$$

Let,

P_d = diametrical pitch

$$P_d = \frac{T}{D} \ldots\ldots(7)$$

$$= \frac{18}{30}$$

$$= 0.6 \text{ mm}^{-1}$$

Then,

$$\sigma_t = \frac{f_t x P_d}{y.b} \quad \ldots \text{using equation(6)}$$

$$= \frac{588.6 \text{ X } 0.6}{30 \text{ X } 0.308}$$

$$\sigma_t = 38.22 \text{ N/mm}^2$$

7) $$\sigma_{allow} = \frac{S_{ut}}{fos} \ldots\ldots(8)$$

$$= \frac{210}{2}$$

$$\sigma_{allow} = 105 \text{N/mm}^2$$

So $\sigma_t << \sigma_{allow}$

So design is safe.

8) $$m = \frac{D}{T} \ldots\ldots(9)$$

$$= \frac{30}{18}$$

m= 1.66

Then the module of pinion = 1.66

Also The module of rack = 1.66

9) Pinion Dimension:-

Outer Dia. = $d_0 = 2m + D$ ….. (10)

= 2 x 1.66 + 30

d_0= 33.32 mm

10) Root Dia. (d_r):-

d_r= D-(2m+2C) …… (11)

= 30 – (2 x 1.66 + 2 x 0.25)

d_r= 26.18 mm

11) Addendum:-

A_d = m …… (12)

A_d = 1.66

12) Dedendum:-

D_d = m + c …… (13)

D_d= 1.66 + 0.25

D_d = 1.91 = 2 mm

13) Linear displacement of rack for one rotation of piston:-

L = (πm) x T ……. (14)

= π x 1.66 x 18

= 94.44

L = 100 mm

Maximum length of rack is 100 mm.

Width of rack is 10

C. Chain Drive Selection:-

In order to select a chain drive, the following essential information must be known:

- The power to be transmitted;
- The speed of the driving and driven pulleys;

To calculate the-

Pitch of the chain:-

$$P = \frac{2\pi(R+r)}{T_1+T_2}$$

Centre distance:-

$$X = \frac{D+d}{2} + 30$$

Length of chain:-

$$L = \frac{P}{2}(T_1 + T_2) + 2X + \frac{(\frac{P}{2}\text{cosec}\frac{180}{T_1} - \frac{P}{2}\text{cosec}\frac{180}{T_2})}{X}$$

This can further be simplified as:

$$L = Y + 2X + Z$$

Where:

T_1 = Number of teeth on the driver sprocket

T_2 = Number of teeth on the driven sprocket

P = Pitch of the chain

X = Center distance

R = Radius of bigger sprocket.

r = Radius of smaller sprocket.

$$Y = \frac{P}{2}(T_1 + T_2)$$

$$Z = \frac{(\frac{P}{2}\text{cosec}\frac{180}{T_1} - \frac{P}{2}\text{cosec}\frac{180}{T_2})}{X}$$

D. Shaft Design:-

The shaft used for this design was designed based on a shaft subjected under combined bending and twistingmoment. The following parameters were assumed for the design: Maximum allowable working stress = 63Mpa;
Maximum shear stress = 42Mpa.
Torque on the flywheel is equal to that on the small sprocket.

Let T_1 = maximum tension on the flywheel (pulley C)

T_2 = tension on the slack side of the flywheel

Vertical load on the flywheel $Wc = T_1 + T_2$

Vertical load on compound sprocket $W_D = T_3 + T_4$

Torque acting on the flywheel $T = [T_1 - T_2] R_C$

Let ,
T3 = Tension on the tight side of the chain on sprocket D
T4 = Tension on the slack side of the chain
Since the torque on both flywheel and sprocket (C and D) is same,

$[T_3-T_4]R_D = T$

And

$T_3/T_4 = T_1/T_2$

Horizontal load on shaft due to flywheel = 0
Horizontal load due to sprocket = 0
Reaction on the bearing support
Considering the vertical load on flywheel

$$R_{AV} + R_{BV} = [T_1 + T_2]$$
$$R_{BV} \; x \; 0.15 = [T_1 + T_2] \; x \; 0.075$$

Bending moment at A and B

$$M_{CV} = R_{AV} \; x \; 0.075$$
$$M_{DV} = R_{BV} \; x \; 0.038$$

Maximum bending moment

$M = M_C$

Let d = diameter of shaft
Equivalent twisting moment

$$T_e = \sqrt{M^2 + T^2}$$

And

$$T_e = \frac{\pi}{16} x \; \tau \; x \; d^3$$

Equivalent bending moment

$$M_e = \frac{1}{2}\left[M + \sqrt{M^2 + T^2}\right] = \frac{1}{2}[M + T_e]$$

And

$$M_e = \frac{\pi}{32} x \; \sigma_b \; x \; d^3$$

COST ESTIMATION

Money is important factor in any project. While installing any project, its cost has to be estimated. If cost of project is less, thenultimately its cost of electricity generation is reduced. Operation cost of footstep power generation system is nearly equal to zero. Life of this system is approximately equal to 10^6 load cycles (for 65 Kg work load). Only operational and maintenance isassociated with this system. Cost of electricity generated per unit watt is very low.

Per Unit Cost Estimation:-

Min^{m}.average life of components=10 Lakh cycles. (By Assumption)
Power generated in each cycle = 30….. (From calculations)
Efficiency of the Model = 50%
Total cost of model = Rs.6250
Therefore,

$$\text{Steps required to generate 1MW Power} = \frac{1\times10^{6}}{\text{each step power generation}\times\text{effiency}}$$

$$= \frac{1\times10^{6}}{30\times0.5}$$

$$= 66{,}666.67 \text{ steps}$$

2) Power Generated by Each Model

$$= \frac{\text{Number of cycles before failure}}{\text{cycles required for 1MW power generaation}}$$

$$= \frac{1\times10^{6}}{66666.67}$$

$$= 15\text{MW}$$

$$\text{Cost required per unit kilo-Watt} = \frac{6250}{15\times1000}$$

$$= 0.41667 \text{ Rs/KW}$$

COST ESTIMATION

SR.NO.	COMPONENT & DETAILS	COST IN (Rs.)
1.	Base plate and upper plate Mild steel -300×300 mm (300×2) ……..1000.00	
2.	Fixed Cylindrical pipes MS pipes, 30mmdia.-100mm length (100×4) ……...400.00	
3.	Moving pipes MS pipes, 20 mm dia. 100 mm length (100×4) ……400.00	
4.	Springs Alloy Steel Wire (100×4)……..500.00	
5.	Stair frame MS l angle frame……1000.00	
6.	Rack and pinion Cast iron, module 1.5…….1100.00	
7.	DC motor 12 volt, 60 rpm…… 250.00	
8.	Fabrication Cutting, welding etc……..600.00	
9.	Miscellaneous……1000.00	
Total cost of assemble of foot-step power generation…….6250.00		

❖ ADVANTAGES OF FOOT-STEP POWER GENERATION-

- Pollution free power generation.
- Simple construction, mature technology and easy maintenance.
- No manual work necessary during power generation.
- Energy available all year round.
- No fuel transportation problem.
- No consumption of any fossil fuel which is non-renewable source of energy.
- Uninterrupted power generation during day and night.
- Maximum utilization of energy.
- Load to the piston cylinder arrangement is freely got by movements of vehicles or man load.
- No fuel storage is required.
- It will work with both light weight load and heavy weight load.
- Highly efficient in heavy crowded place.
- This arrangement required very less maintenance cost.

❖ DISADVANTAGESOF FOOT-STEP POWER GENERATION-

- ❖ We have to check mechanism from time to time.
- ❖ It can get rusted in rainy season.
- ❖ Initial cost of this arrangement is high.
- ❖ Less electricity will produce.
- ❖ Only applicable in particular space.
- ❖ Mechanical moving part is more.
- ❖ Care should be taken for Batteries.
- ❖ To get required R.P.M. for the Generator shaft.
- ❖ Skill operators are required.

APPLICATION OF THIS PROJECT

- 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
- This can be actualized on Railroad stations, Transport stops, airplane terminals, Temple, Bus terminal, Music Hall, Market to produce electric power by human Physical action.
- Additionally can be actualized in parking garages, electric elevators.
- This system can be executed on Gymming instruments like cardio machine for control age and the power age rate is high.
- We can utilize this instrument in vehicle suspension framework.
- In provincial zones etc. High Initial Cost.
- Also can be implemented in parking lots, electric escalators.
- We can use this mechanism in automobile suspension system.

FUTURE SCOPE OF THIS PROJECT

Small changes in construction and design of the power generation set up can help to make the following future application.In future aspects we can use this principal in the speed breakers at high ways where are rushes of the vehicles too much thus increase input torque and ultimate output of generator. If we are used this principle for the utilization of waste energy of foot power with human locomotion is very much relevant and important for highly populated countries like India 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 or palace then we produce efficient useful electrical for large purposes. Walking across a crowd farm, floor, will be a fun for idle people who can improve their health by exercising is such farms with earning. Thus electrical power generated from there will be of many uses.

- The gear transmission can be replaced by a series of chain drives for more power production
- A provision can be made for storing the generated power in a battery and utilizing in future.
- Stress analysis can be carried out on the speed breaker. Speed breaker can be designed in a more compact manner in order to resist the heavy load.

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. 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.

This project can be handled in various ways to make the best use of it. There is many more extension 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. It is able to extend this project by using same arrangement and construct in the foot-steps/speed breaker so that increase in the power production rate by fixing it in school, colleges, highways etc.The output power generated is 3V.Our final conclusion in this project is creative way to make use of the energy wasted in various ways. By storing output power in batteries we can utilize this for further use. By making to rotate rack and pinion arrangement in either direction the output power can be increased. When we implement this project in large scale the overall cost of the project reduces.

Implementing this system, we can easily reduce our dependency on the conventional sources of energy, thus can be considered beneficial from that point of view.