FABRICATION AND PERFORMANCE ANALYSIS OF MECHANICAL FOOTSTEP POWER GENERATOR

A

Project Report

Submitted in partial fulfilment of the requirements for the award of the degree of

Bachelor of Technology

in

Mechanical Engineering

Submitted by

Gangeshwar Sharma

Roll No- 1701088, Enrollment no- 170780

Phanendra Maurya

Roll No- 1701029, Enrollment no- 170378

Under the supervision

of

DR. S.K. VERMA

(Professor)

Department of Mechanical Engineering

NIT Patna

DEPARTMENT OF MECHANICAL ENGINEERING

National Institute of technology, Patna

Ashok Rajpath – 800005

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ASHOK RAJPATH PATNA - 800005 (BIHAR)

CERTIFICATE OF APPROVAL

Date: 18.05.2022

This is to certify that the Project report entitled '**FABRICATION AND PERFORMANCE ANALYSIS OF MECHANICAL FOOTSTEP POWER GENERATOR'** submitted by **GANGESHWAR SHARMA,** Roll No. **1701088,** Enrolment No**. 170780** and **PHANENDRA MAURYA,** Roll No. **1701029,** Enrolment No. **170378** to the National Institute of Technology, Patna, is a record of bona-fide research work and is worthy of consideration for the award of degree of B.Tech in Mechanical Engineering of the institute.

_____

Dr. S. K. Verma
(Project Supervisor)
Department of Mechanical Engineering
NIT Patna

_____ _____

(External Examiner)

Dr. Om Prakash
(Head of the Department)
Department of Mechanical Engineering
NIT Patna

CERTIFICATE

This is to certify that the thesis entitled '**FABRICATION AND PERFORMANCE ANALYSIS OF MECHANICAL FOOTSTEP POWER GENERATOR'** submitted by **GANGESHWAR SHARMA,** Roll No. **1701088,** Enrolment No**. 170780** and **PHANENDRA MAURYA,** Roll No. **1701029,** Enrolment No. **170378** to the National Institute of Technology, Patna, is a record of bona-fide research work completed under my supervision and is worthy of consideration for the award of degree of B.Tech in Mechanical Engineering of the institute.

_____

DR. S. K. Verma

(Project Supervisor)

Department of Mechanical Engineering

NIT Patna

Date:

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Gangeshwar Sharma (1701088)

Phanendra Maurya (1701029)

DECLARATION

I certify that

i. The work contained in this thesis is original and has been done by me under the guidance of my supervisor.

ii. The work has not been submitted to any other Institute for any degree or diploma.

iii. I have followed the guidelines provided by the Institute in preparing the thesis

iv. I have conformed to the norms and guidelines given in the Ethical Code of Conduct of the Institute

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Gangeshwar Sharma

Roll No. 1701088

Date:

_____

Phanendra Maurya

Roll No. 1701029

Date:

Dedicated to my Parents

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ABSTRACT

Energy is the main concern of present day. The production of electric current in a huge amount is the need of today world. There are different methods used for the production of energy like conventional and non-conventional methods. Here I will represent the non-conventional method for the production of electric current. This non-conventional method is “Footstep power generation Mechanism” here the energy will be produce by moving the human on a moving plates in which rack and pinion gear are used to convert the physical energy into mechanical energy and further they will have converted into electric energy by using the dynamo. By using this method, we will have produced the energy to light up the bulb. I will also represent the simulation of the footstep power generator using the ansys17.0 software. By the results it’s seen we will produce the 10.925kw power in one hour. 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. It is well known that our planet population is rising continuously, and it is expected to increase dramatically over the coming years. This has led to an
increase in the demand for electric power for the industrial, commercial and living purposes. Currently, fossil fuel has been used as the main source for electricity generation but the amount of these resources is continuously depleting. Besides, renewable technologies are still not quantitively and qualitatively reliable to be considered as the main source of energy. In this study, an alternative power generation method using human footstep was proposed. A new mechanical footstep power generation system using SolidWorks software was designed, fabricated and tested. The stress-strain analysis including the safety factor calculations for the proposed product were conducted in this work. An approximately 34 W per step was generated. All the critical components achieved a minimum safety factor value of 2. In addition, SMART Technology was incorporated into the product to facilitate the monitoring performance of the proposed system. This is also to meet the current technological standards that are globally used.

CONTENTS

CHAPTER 1. INTRODUCTION

It is important to have a good understanding of the sources of energy, the conversion of energy from one form to another and the ramifications of these conversion. The expanded mindfulness that the world's energy assets are restricted has cause numerous nations to rethink their vitality strategies and take extraordinary measures in killing waste. It has likewise started interest for established researchers to investigate the energy change gadgets and to grow new strategies to more readily use the current restricted assets. Therefore, here we will explain a new technique for electricity generation. This new technique work on the law of conservation of energy “energy neither created or nor destroyed its can changed 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 device is required to have the ability and capacity to store the energy generated 6kw/h.
- The device should be able to support the weight of an average human being which is approximately 137 pounds.
- Once activated the top plate of the device must return to the initial position with displacement not lasting more than 5 seconds.
- The displacement must be compensated appropriately to prevent overshoot in the device. It must be 1 inch.
- The device should measure 50 centimetres in length, 35 centimetres wide and a thickness of 25 centimetres.
- The project must meet all the requisite safety criteria.
- The device developed should also be relatively small and lightweight without compromising its functionality.
- The device should be manufacturable with ease.
- Its construction materials need to be easily accessible and inexpensive so as to minimize the cost of production per unit.
- To be able to generate optimum functionality of the device must be installed in areas where there is a large population density.

CHAPTER 2. LITERATURE SURVEY

T.R. Deshmukh.
According to described along with design International Research Journal of Engineering and Technology Issue: 05 | May 2019 and modeling of parts of the model of the foot step power generation system using 3d modeling software. This process consists number of simple setups that is installed under the walking or standing platform. Project system works on the principle of converting the linear motion because to pressure of footsteps into rotating motion by rack and pinion arrangement. This mechanism fails if there is any occurrence of variable load leads to balancing type problems Power is not generated during return movement of rack

Sasank shekhar Panda.
From the perspective of has described the based on crank shaft; fly wheel, and gear arrangement. This type of footsteps power generation system is eligible to be installed in crowded places and rural areas. Thus, this is a very good technology to provide effective solution to power related problems to affordable extent. This will be the most acceptable means of providing power to the places that involves difficulties of transmission. Maintenance and lubrication is required time to time.

P.Sai Chandu.
In this research paper authors used regulated 5V power, 500mA power supply. Bridge type full wave rectifier is used to rectify the ac output of secondary of 230/12V step down transformer. A rack and pinion is a type of linear actuator including a pair of gears which convert rotational motion into linear motion. The “pinion" engages teeth on the rack. In this paper, since the power generation using foot step get its energy requirements from Non-renewable source of energy.

Ramesh Raja R, Sherin Mathew. et. al.
This research paper attempts to show how energy can be tapped and used at a commonly used floor steps. The usage of steps in every building is increasing day by day, since even every small building has some floors. A large amount of energy is wasted when we are stepping on the floors by the dissipation of heat and friction, every time a man steps up using stairs. There is great possibility of tapping this energy and generating power by making every staircase as a power generation unit. The generated power can be stored by batteries, and it will be used for slighting the building.

CHAPTER 3. OBJECTIVES

To design and develop the model of Mechanical Footstep power generator.

To find the new efficient way of non-conventional energy harvesting via using Rack & pinion approach.

In this project we are converting Mechanical energy into Electrical energy. We are trying to utilize the wasted energy in a useful way.

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 power shortages. `

CHAPTER 4. THEORETICAL BACKGROUND

4.1 Working Principle

The complete fabricated model picture of Foot Step is shown below. The upper plate is mounted on two springs; the weight impact is converted into electrical power with proper control unit. The spring and rack & pinion arrangement is fixed below the foot step which is mounted on base. Spring system is used for return mechanism of upper plate after release of load. The shaft along with pinion is supported by end bearings. A gear is provided there also. A gear is coupled to the shaft. The gear wheel which is provided in shaft is coupled to the Dynamo. The dynamo capacity used here is12V. From the dynamo the wires are taken. These wires are connected to a LEDs, to show the output power. The generator is used here is 12Volt permanent magnet DC generator. The terminal of DC generator is connected to lightning LEDs. In the first step the footsteps is directly connected to the Rack & pinion arrangement. To the pinion shaft dynamo is provided and LEDs are coupled to it. Thus Mechanical energy is converted in to Electrical energy. With the help of block diagram as show in the block diagram the working procedure is explained in step by step manner.

Step 1: When force is applied on the plate by virtue on stamping on the plate the force spring gets compressed.

Step 2: Due to this the rack moves vertically down.

Step 3: The pinion meshed with the rack gear results in circular motion of the pinion gear.

Step 4: For one full compression the pinion Moves one semicircle, when the force applied on the plate released the pinion reverses and moves another semicircle.

Step 5: The intermediate gear with more number of teeth will rotate as a result of motion of pinion. Step 6: The generator attached to the intermediate will obtain the rotating motion, hence results in the sinusoidal waveform (for single Generator).

Step 7: The obtained voltage is passed through Ac neutralizer in order to reduce the ripples that are produced due to uneven motion of generator.

Step 8: From here the power is stored directly in 12v lead acid battery .

Step 9: So the 12v DC is connected to the inverter to convert it into 230AC.

Step 10: Now the voltage obtained is used for small applications.

Step 11: The display unit takes signal from battery and converts it into digital signal by ADC and transfers its data to microcontroller.

Step 12: The voltage signal thus obtained will be displayed in LCD display about how much voltage.

CHAPTER 5. DESIGN & ANALYSIS

5.1 DESIGN DESCRIPTION:

The design for whole device comes with top plate, base plate, 3 gears, 1 rack with pinion, rod supports, left/right side support and generator.

5.2 BENCHMARK:

Wind turbines are one of the sources of green energy as depend on wind currents to turn the turbines and generate electricity and also inexpensive to maintain since propulsion is natural. Similarly, the device is seek to develop would have zero negative impact on the environment and would be inexpensive to maintain since it depends on human moment to produce electricity, also; not be affected by shifts in weather patterns; unlike wind turbines whose productivity solely depends on the natural wind direction. This new device would be fully dependent on human motion which is entirely under people control to operate.

5.3 PERFORMANCE PREDICTION:

The performance of the project will be as described below:
The footstep power generator electricity provided by human motion.
The displacement must be compensated appropriately to prevent overshoot in the device. It must be 1 inch.
Once activated the top plate of the device must return to the initial position with displacement not lasting more than 5 seconds.

5.4 DESCRIPTION OF ANALYSIS:

• A1: Finding the maximum permissible torque for a shaft of known dimensions, trying to calculate the max. Permissible for the shaft and knowing the whole dimensions can use for shaft.
• A2: Measuring one force on the beam to try how the average human weight 137 lb. will be on the device.
• A3: Measuring the two forces on the beam for human motion, just example if two humans' motion be on the steel beam how will be good for steel and nothing will happen for the steel such as broken.
• A4: trying to get exact measure for top plate that will work in device, and if trying to make it bigger can change the volume to higher to be good.
• A5: trying to get exact measure for base plate that will work in device, and if trying to make it bigger can change the volume to higher to be good. But in the base plate the length should be bigger than the top plate.

• A6: L-bracket measure it and want to know how can bending the bracket by 90 degree to get the exact measure and be work in device to hold the Rod Support with base plate.
• A7: Measuring the Left/right side support to know how can support the load for one force on the top side support.
• A8: Measuring the punch hole for top plate and base plate, Shear stress and strain for punch hole to Top plate and Base plate and avoid the extra space.
• A9: calculating the shear stress for top plate that help the device to know how and will be good for human.
• A10: Calculating the shear force and bending moment Diagram to know if the steel of top plate will be bending for 137 lb. for human motion or not.
• A11: Calculating the Spring's constant and how far the stretched or compressed and using the Hooke's Law to measure constant and compressed. F = - kx.
• A12: Box measuring, trying to measure how can making a box for the device to be in good condition and how can use size for the box.

5.5 COMPONENTS

S.No.	Components	Details	Specification	Quantity
1.	Top Plate	15.75cm × 7.87cm	10mm Thick Iron late	1
2.	Rod Support	3.04cm × 1.89cm	10mm Thick Iron Plate	2
3.	Base Plate	15.75cm × 9.84cm	10mm Thick Iron Plate	1
4.	L-Bracket	1.57cm × 1.57cm	10mm Thick Iron Plate	2
5.	R/L Side Support	11.81cm × 3.94cm	10mm Thick Iron Plate	2
6.	Shaft	8.11cm long	Diameter 1cm	1
7.	Spring	Diameter 0.5cm	Iron	1
8.	DC Motor	12 Volt		1

Fig 1: Rack & Pinion

Fig 2: R/L Side Support

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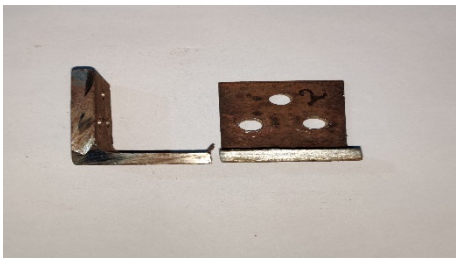


Fig 3: L-Bracket

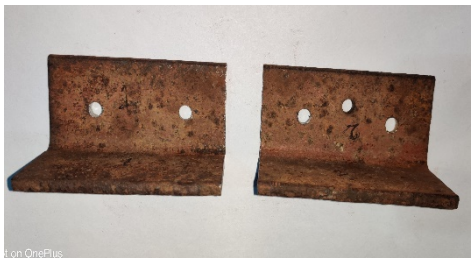


Fig 4: Side Support Stud Rods

Fig 5: Top Plate

Fig 6: Base Plate

Fig 7: Stud Rods & Spring

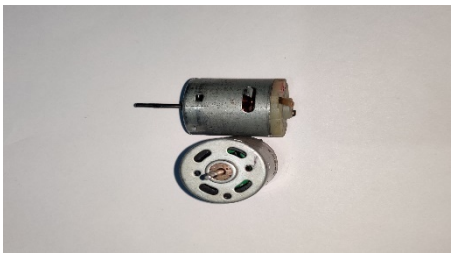
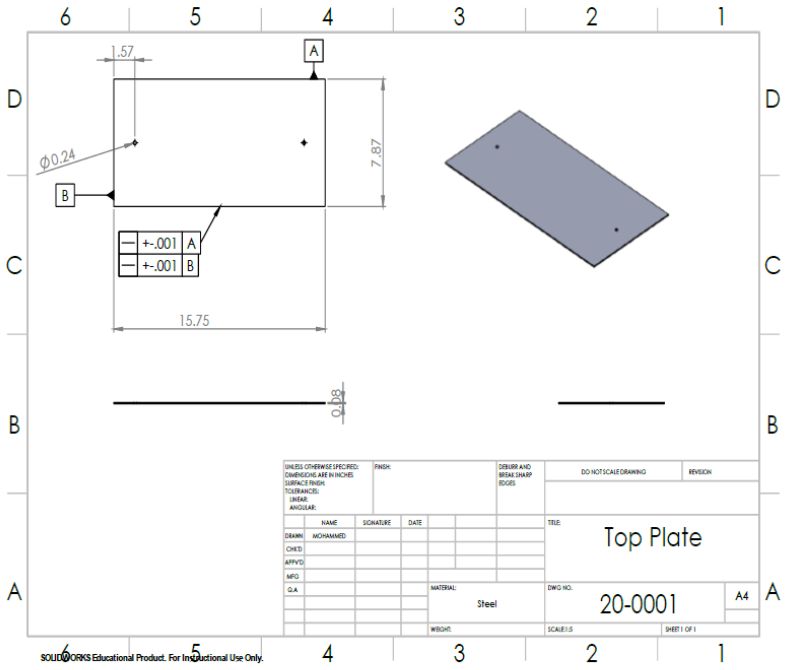


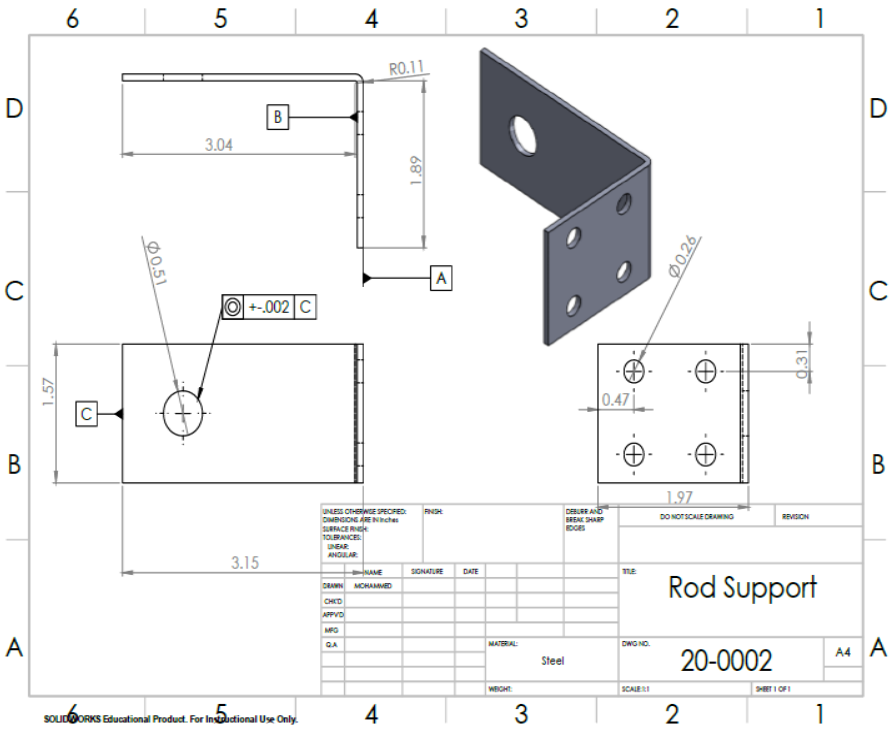
Fig 8: DC Motor

APPENDIX – DESIGN

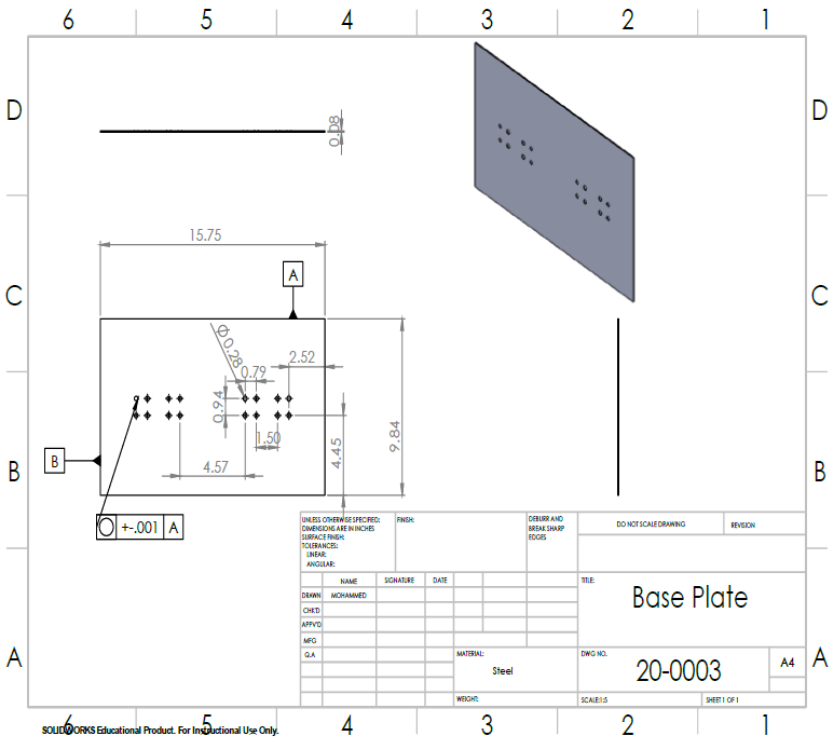
1: (TOP PLATE)



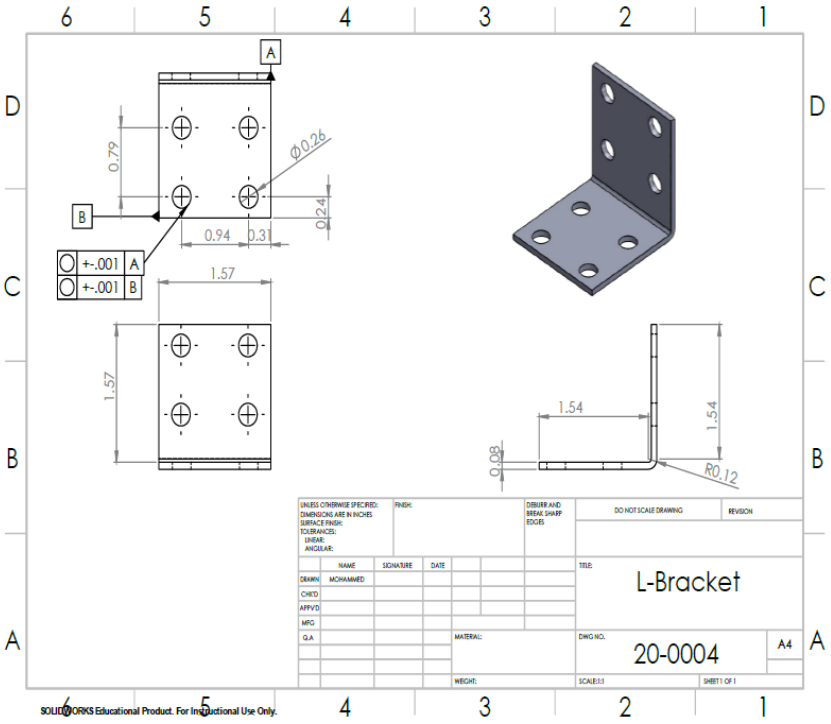
2: (ROD SUPPORT)



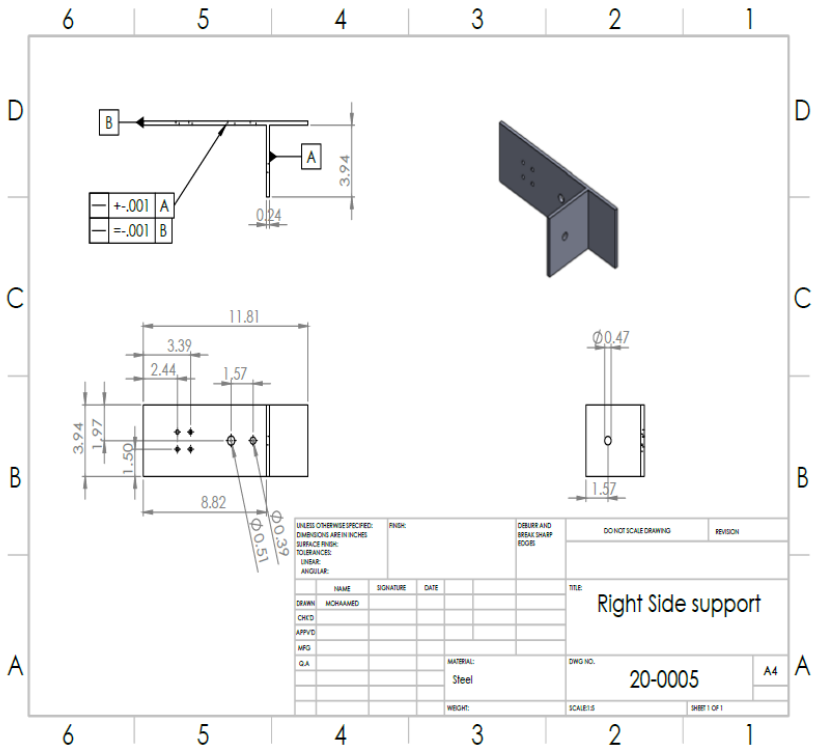
3: (BASE PLATE)



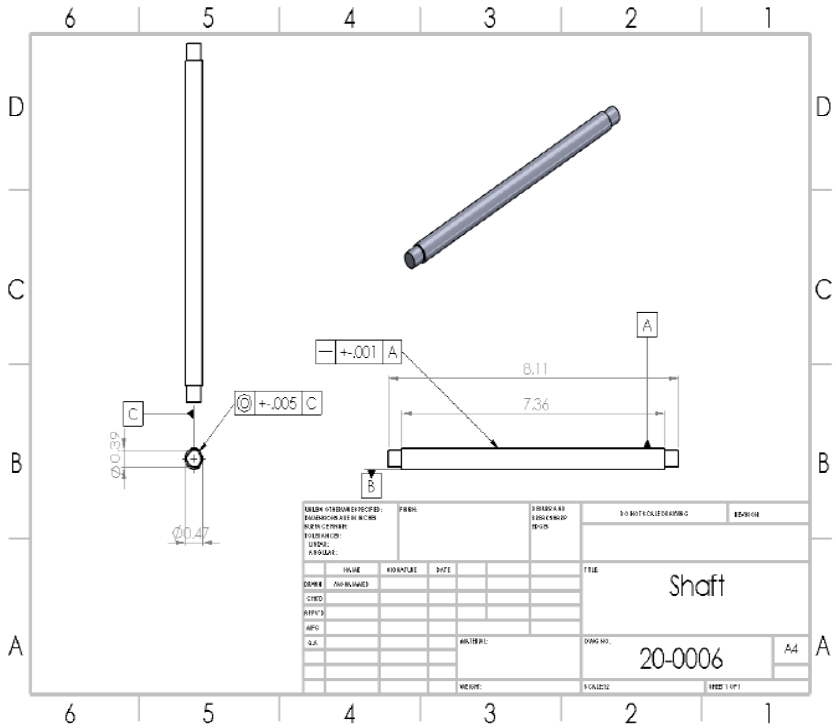
4: (L-BRACKET)



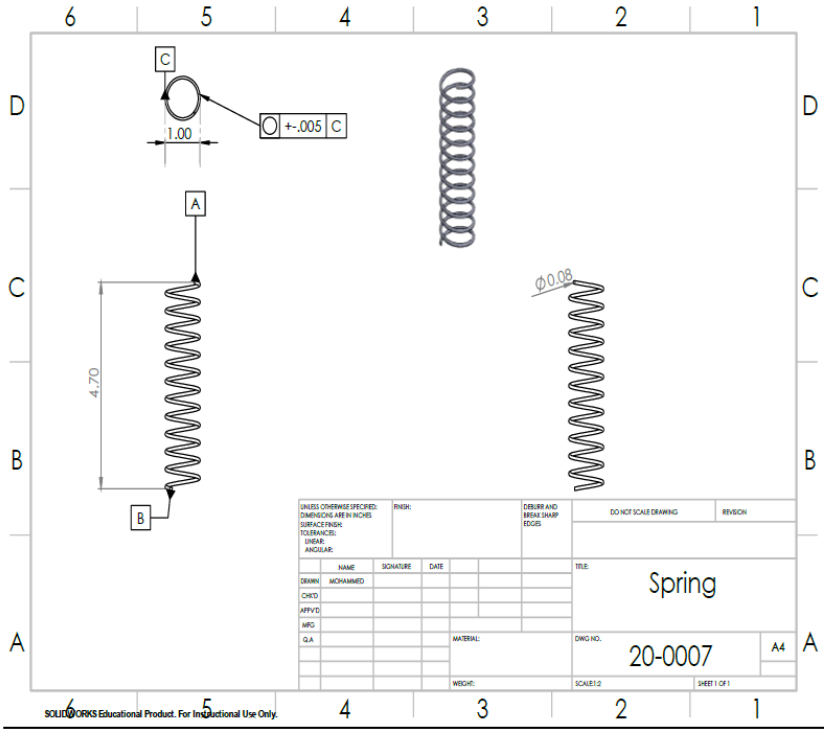
5: (RIGHT/ LEFT SIDE SUPPORT)



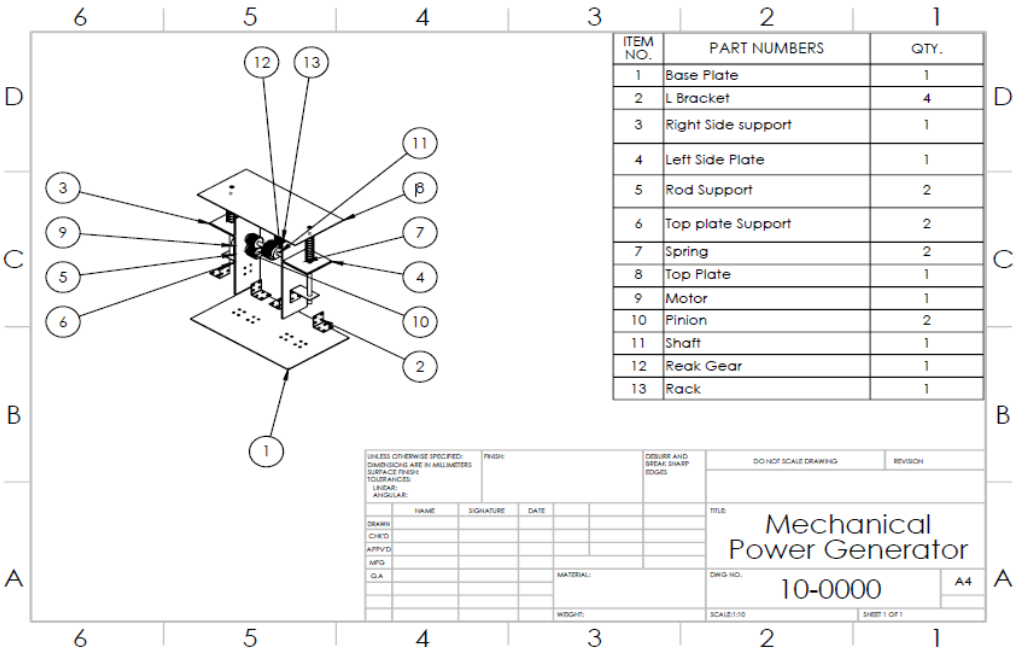
6: (SHAFT)



7: SPRING



8: Assembly Drawing



ITEM NO.	PART NUMBERS	QTY.
1	Base Plate	1
2	L Bracket	4
3	Right Side support	1
4	Left Side Plate	1
5	Rod Support	2
6	Top plate Support	2
7	Spring	2
8	Top Plate	1
9	Motor	1
10	Pinion	2
11	Shaft	1
12	Reak Gear	1
13	Rack	1

CHAPTER 6. CONSTRUCTION

A. METHOD:

The complete diagram of the power generation using footsteps. L-shapes window is inclined in certain small angle which is used to generate the power. The pushing power is converted into electrical energy by proper driving arrangement.

The rack & pinion, spring arrangement is fixed at the footsteps which are mounded bellow the L-shapes window. The spring is used to return the inclined L-shapes window in same position by releasing the load. The pinion shaft is connected to the supporter by end bearings. The larger sprocket also coupled with the pinion shaft, so that it is running the same speed of pinion. The larger sprocket is coupled to the small cycle sprocket with the help of chain cycle.

This larger sprocket is used to transfer the rotation force to the smaller sprocket. The smaller sprocket is running same direction for the forward and reverse direction of rotational movement of the larger sprocket. This action locks like a cycle pedaling action.

6.1 METHOD OF CONSTRUCTION:

One of the major factors that determined the nature of the generation system was environmental issues. constructing a device that generated power while conserving the environment was the most critical factor that motivated the idea of coming up with this generation system. The system is designed in a way that the people movement will be utilized to generate electricity. The footstep power generator basically translates the oscillatory motion to circular and later to electricity. The construction of the system includes measurement, manual cutting, drilling and welding.

Fig 9: Model Construction

6.2 MANUFACTURING ISSUES:

Most of the material purchased did not conform to the measurement of the parts of the generator. Getting materials with similar measurements was impossible. In addition, some materials are not locally available. The last problem is the cost of the material. For instance, the price of steel is relatively high.

6.3 METHODS USED IN TO SOLVE THE PROBLEM:

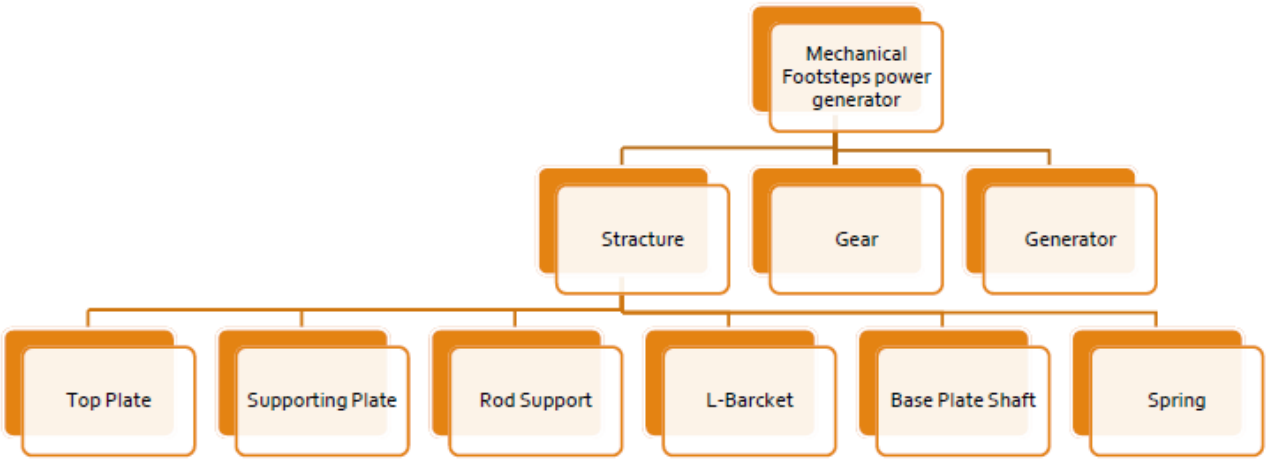
In order to get the correct measurement, measurement and manual cutting of the materials were done. Where the screws were needed, drilling was done to ensure that the bolts were fitted correctly. Other methods used in connecting different parts include welding. Welding was done were permanent attachment was needed. To ensure that enough time to make the cutting and measurement was available; all the materials were ordered in time.

B. FOOTSTEP ARRANGEMENT:

This is made up of mild steel. The complete set up is fixed in this model footstep. The two L-shapes frame is fixed in the above two ends of the track. Bellow this L-shapes window, the actual power generation arrangement is constructed.

Fig 10: Working Model

C. DRAWING TREE



CHAPTER 7. RESULTS & DISCUSSION

7.1 CALCULATION & OBSERVATION

Subsequent to testing the Device, we noticed. Whenever the Device was worked, we estimated the voltage of 5 to 10 volts with the help of multimeter.

- Voltage Generated (V)= 10 volt
- Current Generated (I)= 1.5A
- As Electrical power (p)= 10×1.5 = 15 Watt.

7.2 THEORETICAL RESULTS

S.No.	Weight	Displacement	Power Output
1.	**65 × 9.8**	**0.05**	**31.88**
2.	**75 × 9.8**	**0.05**	**36.78**
3.	**85 × 9.8**	**0.05**	**41.69**
4.	**95 × 9.8**	**0.05**	**46.59**

The Power output mentioned above is for one press. According to survey an average of 100 person per hour will passes over the unit at Patna railway station. So, 7.356 KW Can be generated per hour. And 176.544 KW can be generated per day from this unit.

7.3 PROJECT RISK ANALYSIS

The system is risk free. Non-performance or faulty of the system does not have any risk. The effect of faulty on the system is only failure to generate power. The system is environmentally friendly and safe to use. The system is dependent on human movement. Therefore, the system depends on human movement which is renewable and implies that the system is only limited to work only on places with significant movement of people. Therefore, there are areas where the system can be installed. Lack of movement implies no power generation. Therefore, depending on this system only is risky due to irregular production. For instance, when the system is installed in school, the system will only be functional during school days. During holidays, the possibility of getting power from the insignificant.
For security purposes during the construction of the system the following protective gadgets will be necessary: gloves, Dust mask, eye protection, the welding mask, footwear, hearing protection and protective cloths.

7.5 SUCCESS

To ensure that the purchase of the construction material is ready, different calculations were necessary. For instance, finding the spring constant; these will determine the type of spring that need to be purchased, the material tensile stress and strain also needed to be calculated. Such calculation facilitated determination of the type of materials that are best for the system. So far, all calculations have been done and materials required with every material specification identified.

7.6 ADVANTAGES

- Produces electricity efficiently.
- It is an inexpensive source of all known forms of energy.
- It does not pollute the environment.
- Automatically operates the street light when the sun falls.
- It can be easily maintained.
- Simple construction, mature technology.
- No manual work necessary during generation.
- Energy available all year round.
- No fuel transportation problem.
- No consumption of any fossil fuel which is non-renewable source of energy.
- Reliable, Economical, Eco-Friendly.
- No need of fuel input.
- This is a non-conventional system.
- Battery is used to store the generated power.

7.7 DISADVANTAGES

- The system is only applicable in particular places
- High initial Cost.

CHAPTER 8. CONCLUSIONS

Mechanical Footsteps Power Generator is a risk-free electricity generation system. Much of the energy that is wasted when people are moving is well utilized and transformed to electrical energy which can be used in schools and other institutions. This method of power generation is cost effective when used continually. Basically, the cost efficiency is realized in the long term. This method of power generation can be installed in areas such as malls, schools, colleges, at the railway stations or any other areas where people movement is intensive.

The production of electricity using this method is environmental conservative because power is produces without polluting the environment. Also, the power that is wasted by human while working is utilized by this system to produce electricity. Therefore, the system ensures maximum utilization of available energy. The energy source is renewable and is available continuously. Therefore, the method is very convenient than other methods of power generation. The power generated by this system can be used in the rural areas. The method is also very eco-friendly; the production does not require fueling, that produce smoke and other pollutants. The tests that have been done so far have confirmed that the system is best because being provides affordable energy solution to people.

Although the method seems advantageous in most aspects, the amount of power that can be generated by this system may not be used in places where mass electricity is needed. The system is constructed to generate 6kw/h. Therefore, the system can only generate power for lighting and powering simple electricity gadgets. However, more improvement can be done to increase its production such as coming up with a method of stepping up the generated power.

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