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INNOVATIVE GENERATION OF RENEWABLE ELECTRIC POWER THROUGH HUMAN KINETIC ENERGY: HARNESSING THE POWER OF CLIMBING STEPS

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ABSTRACT
In this project we are generating 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** needs no input power to generate the output of the electrical power. This project using simple drive mechanism such as rock and pinion assemble and chain drive mechanism. For this project the conversion of the force energy in to electrical energy. The control mechanism carries the rack & pinion, D.C generator, battery and inverter control. Our project deals with the fabrication of a power production unit from the foot steps using the piezoelectric techniques. The concept is to capture the normally lost energy surrounding a system and converting it into electrical energy that can be used to extend the lifetime of that system's power supply or possibly provide an endless supply of energy to an electronic device which has led to power harvesting. One of the most interesting methods of obtaining the energy surrounding a system is to use piezoelectric materials. There exists variety of energy harvesting techniques but mechanical energy harvesting happens to be the most prominent. This technique utilizes piezoelectric components where deformations produced by the foot steps are directly converted to electrical charge via piezoelectric effect. Subsequently the electrical energy can be regulated or stored for further use. The proposed work in this research recommends Piezoelectricity as an alternate energy source. The motive is to obtain a pollution-free energy source and to utilize and optimize the energy being wasted.

I. Introduction
Man has needed and used energy at an increasing rate for his sustenance and well being 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. Subsequently he discovered fire and his energy needs increased as he started to make use of wood and other bio mass to supply the energy needs for cooking as well as for keeping himself warm. 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. Energy harvesting has been a topic of discussion and research since three decades. With the ever increasing and demanding energy needs, unearthing and exploiting more and more energy sources has become a need of the day. Energy harvesting is the process by which energy is derived from external sources and utilized to drive the machines directly, or the energy is captured and stored for future use. With the advent of technology, utilization of energy sources has increased by leaps and bounds. Piezoelectric Energy Harvesting is a new and innovative step in the direction of energy harvesting. Not many researchers have been carried out till now in this field, hence it is a challenging job to extract energy from piezocyrstals. In this research paper, description of the energy harvesting method from the foot steps using the piezoelectric crystal is mentioned. Then later in the paper, the idea of combining energy from a number of piezoelectric crystals to obtain higher voltages is proposed. The stress and the deformation caused in

the foot steps due to the heavy vehicles and the other automobiles are converted into useful electrical energy using the piezo electric energy harvesting methods. The use of various neat as well as clean energy technologies is an important method for achieving environmental sustainability. The majority of individuals spend the greatest of their lives walking. Walking also called as ambulation, and it is a basic and frequent mode of movement for humans in everyday life. Walking creates touch between the human foot and the ground surface. The pressures experienced by human feet as they fall on the ground may macreate kinetic energy, which is a renewable source of energy. Through the use of a footstep power generator, this energy y be turned into electricity. Power may be produced in a variety of ways, and one of them, footstep energy production, can be an efficient way to generate electricity. Given the daily electricity demand and worldwide climate changes, greener power sources are urgently needed before it is too late.

II. Literature

Implementing different renewable energy solutions is a critical step in achieving environmental sustainability. The majority of people walk for the bulk of their lives. Walking, often known as ambulation, is an essential as well as common form of human movement in everyday life. Walking brings the human foot into contact with the earth. The forces that human feet feel when they fall to the earth may provide kinetic energy, which is a sustainable energy source. A footstep power generator may turn this energy into electricity. There are many various types of footstep power generators on the market, but the bulk of them produce energy using a piezoelectric transducer. Choosing the appropriate ferroelectric material, which influences the output of conversion of kinetic energy to electricity, is one of the most difficult problems in constructing footstep power generators using piezoelectric transducers.

Chun Kit Ang explained the growth of a foot steps power generator in changing kinetic energy into electricity [10]. Kinetic energy is one of the non-conventional energy sources. A significant amount of study was done to see if it was possible to transform kinetic energy into electricity. Nonetheless, the majority of prior studies focussed on the selections of appropriate materials as well as the intricate design of power generators. By putting mechanical footsteps power generators on the rearmost foot area, this study proposes a simple and low-cost method to improve the performance and efficiency of kinetic energy to electricity energy conversions. M. Aman explained the Power Generation from Piezoelectric Footstep Technique. The major subject of this article is the generation of electric power from people's footsteps and the pressure applied when walking, which is frittered away. The primary issue of the energy crisis is the demand and supply mismatch. The "Foot step power production system is a system that converts mechanical energy into electrical energy utilizing transducers and the pressure produced by the footstep. The power producing floor generates power, which is essentially the conversion of kinetic energy into electrical energy. Today's electricity demand is rising, and existing power generation sources are unable to meet this worldwide challenge [9). Sarat Kumar Sah0o discussed about the foot step power generation. Creating electrical energy in this project using a non-traditional Sarat Kumar Sahoo discussed about the foot step power generation. Creating electrical energy in this project using a non-traditional way of just stepping on the footprints. At this time, non-conventional energy systems are desperately needed. Steps-based energy generating does not require any fuel input to create power. In this study, we just use a rack and pinion arrangement, as well as an alternator and a chain drive mechanism, to generate power. The mechanism consists of rack as well as pinion, chain drives, alternator, and battery for proper operation in converting Force into electrical energy. We've spoken about how can be used in a variety of different ways. B. Swetha, et al. discussed in their study on footstep power generation system. In today's world, the need for non conventional energy has risen in tandem with the rise in power demand. Renewable-energy source, like solar as well as wind, are employed to meet this human need for electricity. However, these sources are insufficient, and energy waste is growing via a variety of ways. To solve this problem, we plan to harness the energy generated by human mobility by installing piezoelectric sensors in the flooring,

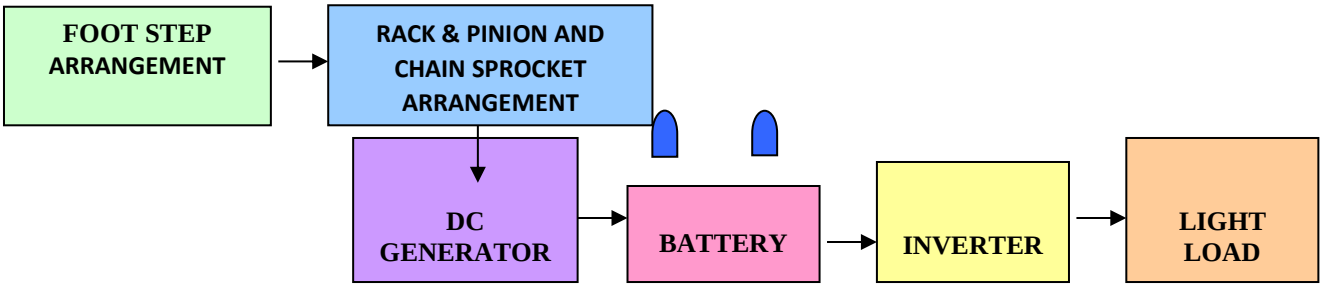
particularly in densely inhabited regions. These sensors detect and transform the pressure of footfall into electrical energy. This will not pollute the environment, and changes in climatic circumstances will have no impact.

2.1 Instruments

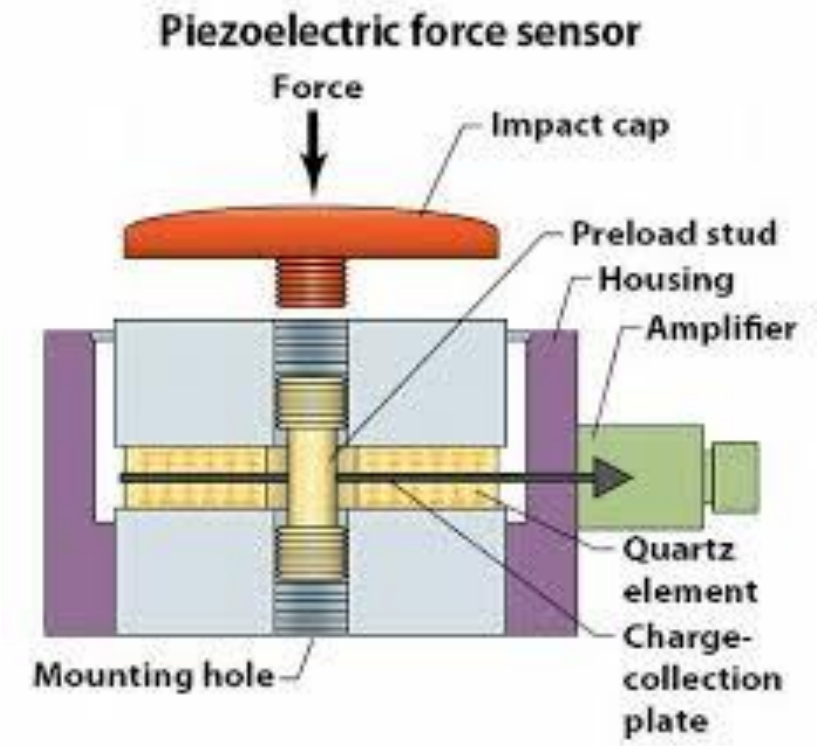
The block diagram of the foot step power generation is shown in figure. The main components of this project are,

- Foot step arrangement
- Rack and pinion arrangement
- Chain sprocket
- Fly wheel
- D.C generator
- Battery
- Inverter Circuit and
- Light Arrangement

BLOCK DIAGRAM



2.2 Fundamentals of piezoelectrics



Piezoelectricity is the ability of some materials (notably crystals and certain ceramics) to generate an electrical potential in response to applied mechanical stress. This may take the form of a separation of electric charge across the crystal lattice. If the material is not short circuited, the applied charge induces a voltage across the material. The word is derived from the Greek word piezien, which means to

squeeze or press. The conversion of mechanical energy into electrical one is generally achieved by converters alternator type or commonly known dynamo. But there are other physical phenomena including piezoelectricity that can also convert mechanical movements into electricity. The phenomenon that produces an electric charge when a force is applied to piezoelectric material is known as the piezoelectric effect.

The piezoelectric effect exists in two domains, the first is the direct piezoelectric effect that describes the material's ability to transform mechanical strain into electrical charge, the second form is the converse effect, which is the ability to convert an applied electrical potential into mechanical strain energy. The direct piezoelectric effect is responsible for the materials ability to function as a sensor and the converse piezoelectric effect is accountable for its ability to function as an actuator. A material is deemed piezoelectric when it has this ability to transform electrical energy into mechanical strain energy, and likewise transform mechanical strain energy into electrical charge. The piezoelectric materials that exist naturally as quartz were not interesting properties for the production of electricity, however artificial piezoelectric materials such as PZT (Lead, Zirconate, Titanate) present advantageous characteristics. Piezoelectric materials belong to a larger class of materials called ferroelectrics. One of the defining traits of a ferroelectric material is that the molecular structure is oriented such that the material exhibits a local charge separation, known as an electric dipole.

Throughout the artificial piezoelectric material composition the electric dipoles are orientated randomly, but when a very strong electric field is applied, the electric dipoles reorient themselves relative to the electric field; this process is termed poling. Once the electric field is extinguished, the dipoles maintain their orientation and the material is then said to be poled. After the poling process is completed, the material will exhibit the piezoelectric effect. The mechanical and electrical behavior of a piezoelectric material can be modeled by two linearized constitutive equations. These equations contain two mechanical and two electrical variables. The direct effect and the converse effect may be modeled by the following matrix equations:

Direct Piezoelectric Effect: $\mathbf{D = d \cdot T + \varepsilon T \cdot E}$ **(1)**

Converse Piezoelectric Effect: $\mathbf{S = sE \cdot T + dt \cdot E}$ **(2)**

Where D is the electric displacement vector,
T is the stress vector,
εT is the dielectric permittivity matrix at constant mechanical stress,
sE is the matrix of compliance coefficients at constant electric field strength,
S is the strain vector,
d is the piezoelectric constant matrix,
E is the electric field vector.

The subscript t stands for transposition of a matrix. When the material is deformed or stressed an electric voltage can be recovered along any surface of the material (via electrodes). Therefore, the piezoelectric properties must contain a sign convention to facilitate this ability to recover electric potential.

The way a piezoelectric material is cut produces three main operational modes:

- Transverse
- Longitudinal
- Shear.

2.3 Working Principle

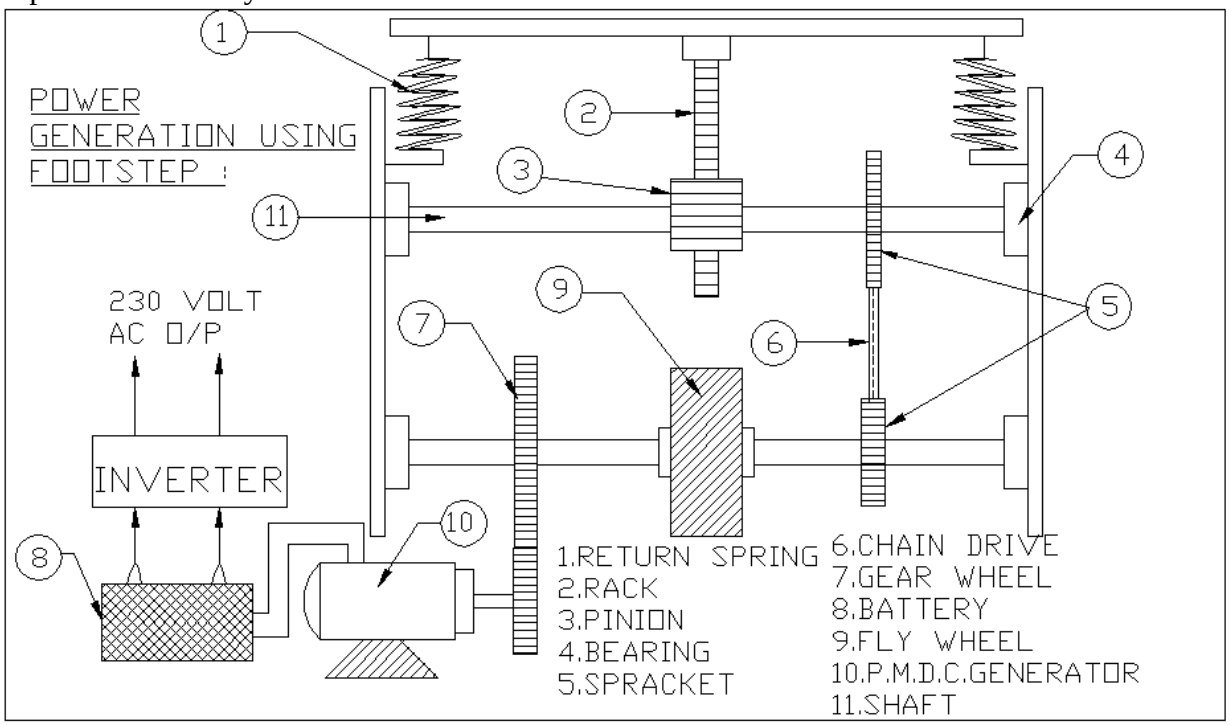
The complete diagram of the foot step power generation is given below. Only one step is inclined in certain small angle which is used to generate the power. The pushing power is converted into electrical energy by proper driving arrangement.

The rack & pinion, spring arrangement is fixed at the inclined step. The spring is used to return the inclined step in same position by releasing the load. The pinion shaft is connected to the supporter by end bearings as shown in fig. 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.The fly wheel and gear wheel is also coupled to the smaller sprocket shaft. The flywheel is used to increase the rpm of the smaller sprocket shaft. The gear wheel is coupled to the generator shaft with the help of another gear wheel.

The generator is used here, is permanent magnet D.C generator. The generated voltage is 12Volt D.C. This D.C voltage is stored to the Lead-acid 12 Volt battery. The battery is connected to the inverter. This inverter is used to convert the 12 Volt D.C to the 230 Volt A.C. This working principle is already explained the above chapter. This 230 Volt A.C voltage is used to activate the light, fan and etc.

By increasing the capacity of battery and inverter circuit, the power rating is increased. This arrangement is fitted in shopping complex, college and wherever the large people walking on the foot steps simultaneously.



A piezoelectric material is made up of both positively and negatively charged particles arranged in such a way that all the positively-charged particles and all the negatively-charged particles are grouped about the same central point. If two opposite faces of a crystal are placed under the foot steps, the crystal can be slightly flattened and distorted, and the charged particles making up the crystals are pushed together and spread out sideways. The change is such that the average position of the negatively-charged particles shifts slightly with respect to the average position of the positively-charged particles. This means there is, in effect, a separation of positive and negative charges and a potential difference is therefore created between two faces of the crystal.

Output voltage and power is directly proportional to the pressure applied or in other words the weight of the vehicle passing on it and the time the vehicle applies load. The output voltage obtained from a single piezoelectric crystal is in millivolts range, which is different for different crystals. And the wattage is in microwatt range. So in order to achieve higher voltages, the piezoelectric crystals can be arranged in cascading manner, that is, in series. The energy thus obtained is stored in lithium batteries or capacitors.

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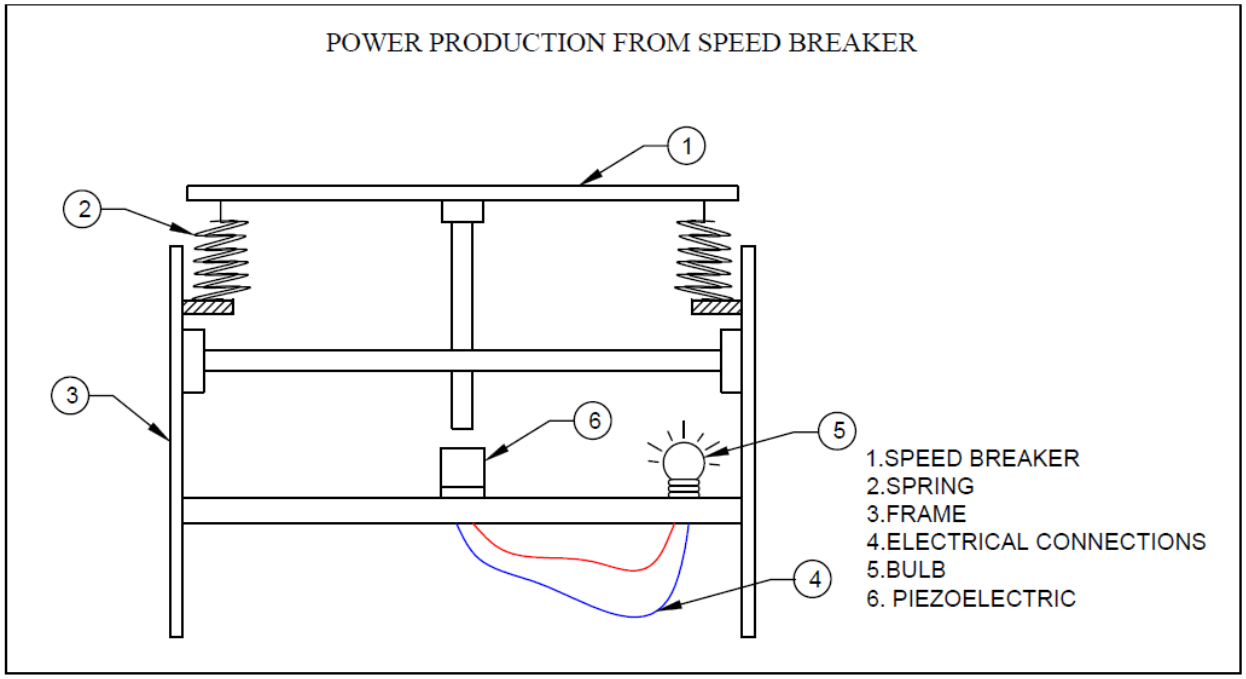

2.4 Advantages and Disadvantages

The power generation using foot step has various advantages by implementing for the usage whereas it may have a few disadvantages which does not affect or make major drawbacks.

2.4.1 Advantages

- Power generation is simply walking on the step
- Power also generated by running or exercising on the step.
- No need fuel input
- This is a Non-conventional system
- Battery is used to store the generated power
- An efficient alternative energy harvesting system.
- The power generated by this method can be used for lighting up the roads.
- The cost of the project is less.
- Maintenance free system.
- It is one of the unconventional, non polluting forms of energy harvesting methods.

2.4.2 Disadvantages

- Only applicable for the particular place.
- Mechanical moving parts is high
- Initial cost of this arrangement is high.
- Care should be taken for batteries

Conclusion

In concluding the words of our project, since the foot step power generation 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 to the places like college, railway station, shopping complex and etc. It is able to extend this project by using same arrangement in all the steps so that increase the power production rate. This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between the institution and the industries. We are proud that we have completed the work with the limited time successfully. The **"FABRICATION OF POWER**

PRODUCTION FROM FOOT STEP" system is working with satisfactory conditions. We can able to understand the difficulties in maintaining the tolerances and also the quality. We have done to our ability and skill making maximum use of available facilities.Thus we have developed a **"POWER PRODUCTION FROM FOOT STEP"** which helps to generate power from the foot steps using piezo electric techniques. Also we gathered knowledge about the energy harvesting methods and the piezo electric techniques associated with it. By using more techniques, they can be modified and developed according to the applications.

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