

Construction of Piezo electric shoes and a Design to Increase it's efficiency

Alexander Thennis.A¹, Kaviyarasan.M², Tamizselvan. S³, Gokul.B⁴, Dr.Maria Jayaprakash.A⁵

¹Department of Mechanical Engineering, Rajiv Gandhi College of Engineering and Technology

² Department of Mechanical Engineering, Rajiv Gandhi College of Engineering and Technology

³Department of Mechanical Engineering, Rajiv Gandhi College of Engineering and Technology

⁴Department of Mechanical Engineering, Rajiv Gandhi College of Engineering and Technology

⁵Professor, Department of Mechanical Engineering, Rajiv Gandhi College of Engineering and Technology

Abstract - As per first law of thermodynamics, energy can neither be created nor be destroyed. But, it can be transferred from one form to the other form. While we walk, we generate a small amount of energy in the form of pressure. But this energy is not used anywhere. It just gets transferred to the ground in vain. When this form of energy can be used in the production of electricity, we can get a considerable amount of renewable energy. The main component used here is piezo plates. These piezo plates produce a small amount of electric charge when deformed. So, it will be fitted at the bottom of the shoes and because of the pressure generated during walking, it tends to bend. Because of this deformation, electric charges will be produced. The electric charges thus produced will be purely in Alternating current(AC). To convert it into Direct Current(DC), a bridge rectifier is used. The current thus produced will be stored in Lithium ion battery and can be used for charging electronic applications such as Mobile phones, Bluetooth etc., We also have additional features like Solar sheets and GPS module.

Key Words: Piezo plates, Lithium ion Battery, Bridge rectifier, Direct Current, Detachable Batteries.

1.INTRODUCTION

In our modern world, energy is the main core component for sustainability of life. Without energy, carrying on our day to day life is literally impossible. But unfortunately, most of the resources we are using to provide energy are a Non-Renewable one like burning of fossil fuels. Since, nowadays demand is more than the production, at some point, these Non-renewable sources will exhaust. So, we are in imminent need to look forward to an alternate source of energy, a renewable one. Our project is a step towards the production of energy through a renewable source. Using these piezo plates, we can generate a considerable amount of energy.

2. Body of Paper

i) PRINCIPLE

The main principle behind this project is Piezo electric effect. Piezo electric effect states that “ When certain materials are

subjected to mechanical stress, it tends to generate electric charge in response to the applied mechanical stress”.

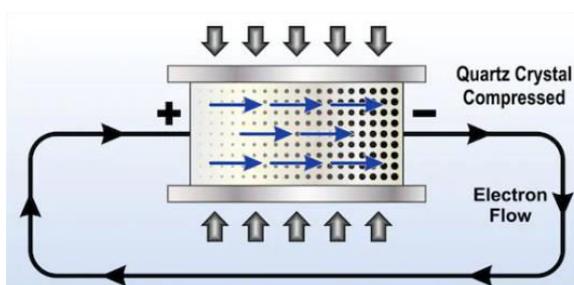


Fig -1 : Piezo electric effect

ii) COMPONENTS USED

- Piezo plates
- IN4007 diode
- Solar sheet
- Neo 6M GPS Module
- Lithium ion battery
- Printed Circuit Board
- Metal piece
- Connecting wires

iii) PIEZO PLATES

A piezoelectric sensor is a device that uses the piezoelectric effect, to measure the changes in pressure, acceleration, temperature, strain or force by converting them to an electrical charge. The prefix piezo is derived from Greek for “press” or “squeeze”. Piezoelectric sensors are versatile tools for the measurement of various processes. Pierre curie discovered the piezo electric effect in 1880. The piezo plates made of quartz crystal is one of the material that obeys piezo electric effect. It is the main component of our project. These piezo plates when applied mechanical load, will generate electric charge.

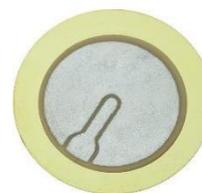


Fig-2: Piezo Disc

Examples of piezo materials are

- Quartz • PZT • PbTiO3 • PLZT • PVDF • BaTiO3 • PhZrO3

iv) IN4007 DIODE

It is a semi-conductor device with two terminals. It allows the flow of current in one direction only. It typically acts as a one-way switch which allows current to flow freely in one direction but strictly restricts it's flow in the other direction. It is made from a semi-conductor silicon. Since the electric charge produced by the piezo plates will be purely Alternating current(AC) which can't be used, We need to convert it into Direct current(DC), we need to construct a bridge rectifier. So, we are using four IN4007 diodes to construct the bridge rectifier.

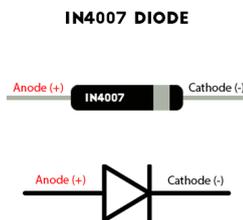


Fig-3: IN4007 Diode

PIN CONFIGURATION

Pin No	Pin Name	Description
1	Anode	Current always enters through anode
2	Cathode	Current always exits through cathode

Features:

- Average forward current is 1A
- Non-repetitive Peak current is 30A
- Reverse current is 5uA
- Peak repetitive Reverse voltage is 1000V
- Power dissipation 3W
- Available in DO-41 Package 1.4.2.3

IN4007 Equivalent Diodes

IN4148, IN4733A. IN5408, INS822. Zener Diodes

v) SOLAR SHEETS

One of the main objective of our project is to produce as much as renewable energy as possible. So, we are attaching solar sheets on the top of the shoes. These solar sheets are bendable.

We are using solar sheets instead of solar panels because solar sheets can be bend into a considerable amount and it will be easy to adapt with the design of the shoes.



Fig-4: Bendable Solar sheet

vi) NEO 6M GPS MODULE

It is a GPS receiver which is used to locate the accurate location of the GPS holder. It contains a ceramic antenna which enables to send and receive signal in a wide range. The module supports baud rate from 4800bps to 230400bps with default baud of 9600.

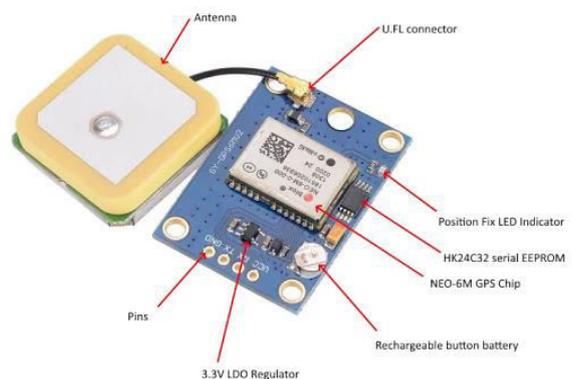


Fig-5: Neo 6M GPS Module

FEATURES

- A complete GPS module with an active antenna integrated, and a built-in EEPROM to save configuration parameter data.
- Built-in 25 x 25 x 4mm ceramic active antenna provides strong satellite search capability.
- Equipped with power and signal indicator lights and data backup battery.
- Power supply: 3-5V;
- Default baud rate: 9600bps.
- Interface: RS232 TTL

vii) LITHIUM ION BATTERY

It is a device used to store the generated electric current. It also acts as a device to discharge electric current to the electronic devices. We are using Lithium ion batteries instead of Lithium polymer batteries because Lithium Polymer batteries have large memory effect when compared to Lithium

ion batteries, Which means it can be used for a large number of cycles with high efficiency.



Fig-6: Lithium ion Battttery

viii) PRINTED CIRCUIT BOARD

It mechanically supports and electrically connects the electronic devices with the required connection. It greatly helps to reduce space of connecting wires. It is a base for attaching all the components with required connection. It uses conductive tracks, pads and other features etched from one or more sheet layers of copper laminated onto and/or between sheet layers of a non-conductive substrate. Components are generally soldered onto the PCB to both electrically connect and mechanically fasten them to it. Printed circuit boards are used in all but the simplest electronic products. They are also used in some electrical products, such as passive switch boxes.



Fig-7: Printed Circuit Board

ix) OBJECTIVES

- To make use of the unused energy produced while walking.
- To save the energy from going unused.
- To deliver as much energy as possible.
- To increase the efficiency of piezo crystal.

x) WORK PLAN

- While we walk, some amount of energy will be generated.
- These piezo plates are attached to the bottom of the shoes.
- While walking, due to the pressure generated, these piezo plates tend to bend.

- Due to this deformation, electric energy will be produced.
- This electric energy produced will be purely AC (Alternating Current).
- To convert this into DC (Direct Current), a bridge rectifier is used.
- The current thus generated will be stored in Lithium-ion batteries
- It can be further used to charge electronic devices such as mobile phones, Bluetooth, iPads, etc.,
- The project is designed with two piezo plates attached on the top and bottom of a cylindrical material piece.
- It enhances more deformity and also doubles up the number of piezo plates used.
- Because of this, the amount of current generated will also increase.

xi) EXISTING TECHNIQUES

From the researches I had done, I have found the previous ideas of projects related to our project.

Some of them are

- Piezo plates were fitted on the platform or pathway where people walk. By the movement of people, current is generated and use for powering street lights.
- Piezo material were fitted at the bottom of the tiles in crowded places to generate electricity.
- A small rack and pinion arrangement is designed at the bottom of the shoes to generate electricity.
- Piezo discs were fitted at the entrances of crowded places to generate electricity.

xii) BRIDGE RECTIFIER

A bridge rectifier is an arrangement of components used to convert Alternating current(AC) to Direct current(DC). This arrangement consists of four diodes D1, D2, D3 & D4 and a load resistor. These diodes are arranged in a closed loop.

Once the input signal is applied across the two terminals like A & B then the o/p DC signal can be attained across the RL. Here load resistor is connected in between two terminals like C & D. The arrangement of two diodes can be made in such a way that the electricity will be conducted by two diodes throughout every half cycle. The pairs of diodes like D1& D3 will conduct electric current throughout the positive half cycle. Similarly, D2 & D4 diodes will conduct electric current throughout a negative half cycle.

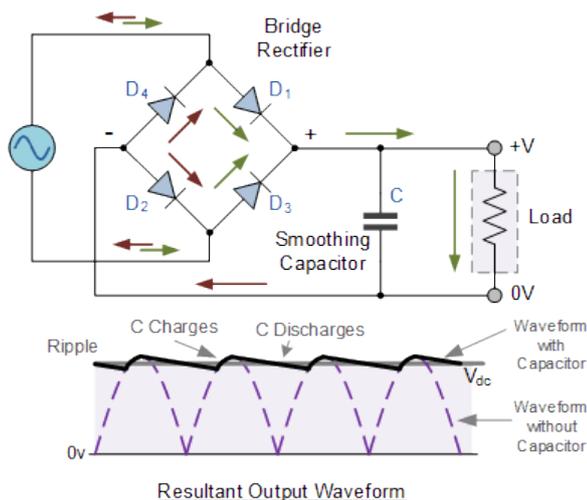


Fig-8: Bridge Rectifier

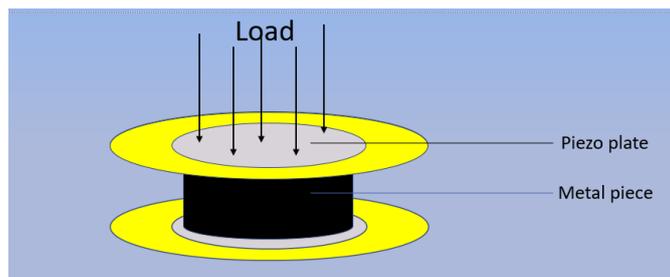


Fig-9: New Design

Material properties

For this design, we need an apt material for the cylindrical object.

- The material selected should be of low weight so that the weight of the shoes are not over increases which will cause more discomfort while walking.
- The material selected should be of low cost, so that the project will be cost efficient.
- The material selected should not damage the piezoelectric discs.
- The material selected should have less wear and tear.

So, we chose aluminium metal for the small cylindrical metal piece.

xvi) CIRCUIT CONNECTIONS

By our analysis, we found that, in a series connection the voltage is good but the current is poor. While, it was exactly opposite in the case of parallel connection i.e. the current is good, but the voltage is poor. But in the series connection, the voltage does not increase in linear fashion maybe owing to the non-linearity of the system’s total internal impedance. When connected in series, the equivalent capacitance of three piezoelectric discs are $1/C_{eq} = (1/C1) + (1/C2) + (1/C3)$

We know that

$$Q = C \cdot V$$

Therefore,

$$V_{eq}/Q = (V1/Q) + (V2/Q) + (V3/Q)$$

Which results in

$$V_{eq} = V1 + V2 + V3$$

So, to improve the total output, we connected the piezo plate circuit connections in both series and parallel connection as combined. This improves the overall output and efficiency.

xiii) DETACHABLE BATTERIES

Since we are attaching this piezoelectric discs into shoes, we need detachable batteries. This is because, we are having two shoes. So, by our concept, once the Lithium-ion battery is charged, the set of battery can be detached and attached to a power bank and electronic devices can be charged further. While this set of battery is used for charging, another set of batteries can be replaced to be charged. This ensures continuous charging.

xiv) ADDITIONAL FEATURES

As we have discussed, the main aim of the project is to generate as much energy as possible. To achieve this, we are planning to add a solar sheet on the top of the shoes. It will definitely increase the amount of power generated in tremendous amount. We are also planning on attaching a NEO 6M GPS module inside the shoe. It will be used to locate the exact location of the person, We are attaching this for safety purposes to locate a person.

xv) DESIGN TO INCREASE THE EFFICIENCY

From so far we have studies, we found that, by increasing the number of piezoelectric discs, the amount of current generated will increase. Adding to that, the current generated is directly proportional to the deformity. So, when we can deform the piezoelectric discs more, we could provide high current. For that, we created a design with two piezo plates attached to the top and bottom of a small cylindrical material. So, when pressure is applied, the cylindrical material will increase the amount of pressure concentrated at the center and also it bends the piezoelectric discs more. There are two advantages by using this. One is the more deforming of the piezoelectric discs and other is the increase in the total number of discs used. The number of piezoelectric discs will double up.

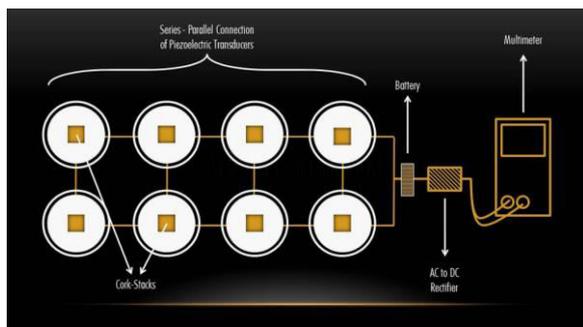


Fig-10: Circuit Connection

3. CONCLUSIONS

By connecting in combination (both series and parallel) connection, the overall power about is noticed to be increased. By placing a cylindrical metal piece between the piezo plates, the number of piezo plates used is doubled and also the deformation. Because of this, the overall power output is increased. Using these technique in a large amount will definitely produce a considerable part of energy production.

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