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FOOT STEP POWER GENERATION

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ABSTRACT

The Footstep power generation system is designed to capture energy that would normally be wasted around the system and convert it into electrical energy. Piezoelectric materials are used in technology to generate energy. This method uses piezoelectric components that convert deformations generated in various ways directly into electrical charges via the piezoelectric effect. The electrical energy can then be regulated or stored for further use. This project uses simple walking or running as an input source to generate electricity in an unconventional way. A piezoelectric sensor then sends a signal to the Arduino Uno to convert it into electrical energy. This system creates tension through the power of pedaling. The system serves as a medium for generating, storing and using electricity from unconventional sources (electricity). This project aims to be used in public places such as train stations where many people come and go throughout the day. In such locations, these systems are placed at every access point where people pass through an entrance or exit and must step on this device to pass. These devices are capable of producing a voltage at each step, and when connected in series produce large amounts of current. For this purpose, we use piezoelectric sensors, which utilize the piezoelectric effect to convert acceleration, force, and pressure into electrical signals for measurement. Here we will connect a voltmeter to measure the output power and a small LED light for demonstration purposes. We also use a battery and a weighing unit to demonstrate the system more effectively.

INTRODUCTION

This system creates voltage through the force of footsteps while moving. It utilizes a non-conventional power source that is stored energy and used later. This electricity generation method can be implemented in places with frequent foot traffic like hospitals, railway stations, airports, offices and vegetable centers. When someone steps onto the system, which has piezo electric sensors installed, a small output voltage is generated with each step when connected in series; this adds up to produce a good amount of electricity. A voltmeter is used to measure the output, and it can be demonstrated by using small LED lights.

METHODOLOGY: MODEL OF FOOT STEP GENERATION

The diagram in Figure 1 illustrates how the foot step converter works: on the right side, it shows no load being applied, and on the left, we can see that the person's weight is causing a pressure on the top plate.

Fig. 1. Storing Device for Foot Step Electric Energy

The bulbs of 12 V and 6 V are linked to the generator's output, which will activate when a foot load is applied. The power from the generator is then directed towards a 12-lead acid battery with the help of an AC-DC bridge converter. At first, this battery was totally depleted. Then, by stepping on the pressure plate, the energy generated was stored in said battery. A 100 W bulb connected to the battery through an inverter allowed us to monitor how long it stayed lit. A table shows us how many footsteps were taken, as well as how much energy was stored per stride.

Table 1: Energy storing table

No. of footsteps	Duration of lighting a 100 watt 230 Volt bulb (s)	Total energy (J)	Energy /step (J)
250	6	600	2.4
500	12	1200	2.4
750	18	1800	2.4
1000	25	2500	2.5

PRINCIPLE

Our project functions on the basis of piezoelectric sensors. We adjust the wooden plates and springs above and below them to make them moveable. This non-conventional energy source is converting mechanical energy from a foot step into electricity. The footstep board comprises sixteen piezo electric sensors connected in parallel. When pressure is applied to these sensors, they transform this mechanical energy into electrical energy, which is then stored in a 12V rechargeable battery attached to an inverter. For regular supply to the circuitry, we employ a conventional battery charging device. This inverter changes 12V DC voltage to 230V AC voltage, allowing us to run AC loads with it.

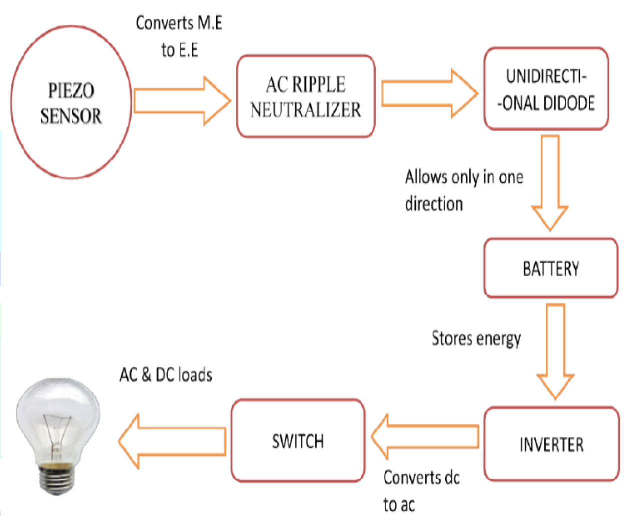

Fig 2: Block diagram

The piezoelectric material transforms pressure into electrical energy. The pressure can come from the weight of either vehicles passing over it or pedestrians walking on top of it. To make the output of this material smooth, a bridge circuit is used to convert its variable voltage into a linear one. An AC ripple filter is then used to take out additional fluctuations in the output. This DC voltage is then stored in a rechargeable battery. Since an individual Piezo film does not generate a lot of power, several were tested together with both parallel and series connections. Combining in parallel did not produce a noticeable rise in voltage, however connecting them in series caused an increase but not in direct proportion. Therefore, both parallel and series links were combined to produce a 40V voltage with a high current density. There are also provisions for either DC or AC loads; the LCD displays the voltage generated across each tile.

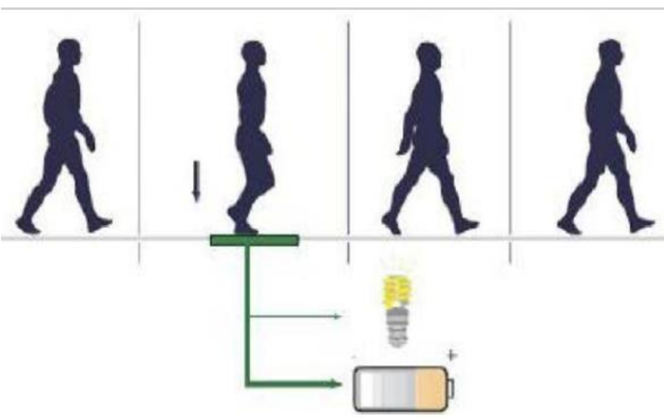

Fig 3: Schematic representation of working model

MAXIMUM THEORETICAL VOLTAGE GENERATED

When pressure is applied to a piezoelectric material, electricity is generated. As such, it is comparable to an ideal capacitor and can be treated as such. For each tile, three piezo are set up in series, and after 10 of these series connections are arranged, they are linked together in parallel. Therefore, when all the circuits have been completed and 3 piezoelectric discs are connected in series, the equivalent capacitance is:

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

We know,

$$Q = C * V$$

So,

$$C = \frac{Q}{V}$$

Hence,

$$\frac{V_{eq}}{Q} = \frac{V_1}{Q} + \frac{V_2}{Q} + \frac{V_3}{Q}$$

Thus,

$$V_{eq} = V_1 + V_2 + V_3$$

Thus, the net voltage produced in a series connection can be found by adding all of the voltages from each piezoelectric disc. 13V is the output obtained from one piezo disc

$$V_{eq} = V_1 + V_2 + V_3$$

$$= 13 + 13 + 13 = 39V$$

Therefore, the piezo tile's output voltage in this experiment is 39V. To test the Piezo tile’s voltage-generating ability, we had people who weighed between 40kg and 75kg walk on it. Figure 8 displays the relationship between weight of the person and generated power. It appears that maximum voltage is produced when higher weights or pressures are applied.

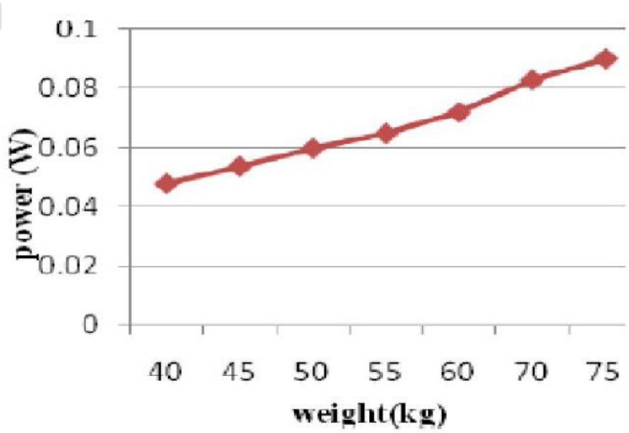

Fig 4: Power vs weight graph of Piezo tile

CIRCUIT

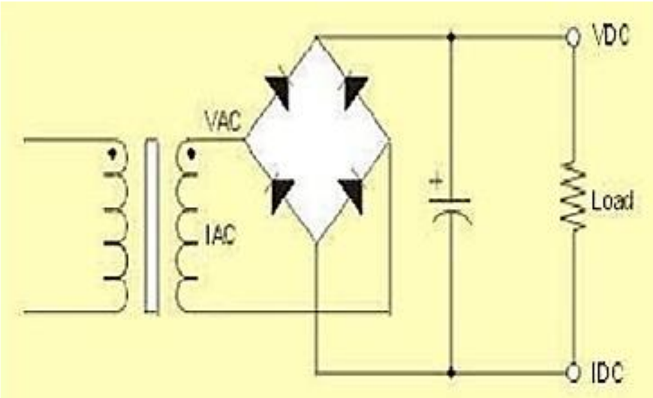

Fig 5 : Circuit

The transformer's output is sent to the rectifier, which changes alternating current (A.C.) into direct current (D.C) of a non-stable type. In this project, a bridge rectifier is appropriate due to its merits like stability and full wave rectification. The bridge rectifier circuit consists of four diodes connected to form a bridge-like figure. The alternating voltage input is applied across two diagonal corners of the bridge and the load resistance is connected between the other two ends. As seen in the diagram, the bridge rectifier can be used to convert A.C. to D.C.

The two diodes, D1 and D3, conduct during the positive half of the input AC voltage waveform. This places them in series with the load resistance (RL). The current then flows through RL. Inversely, during the negative cycle of the AC voltage, the remaining two diodes, D2 and D4, are conducting in series with the load resistance. Consequently, the same direction of current flows through RL as it did during the positive half cycle. As a result, a bi-directional wave is inverted into a unidirectional wave.

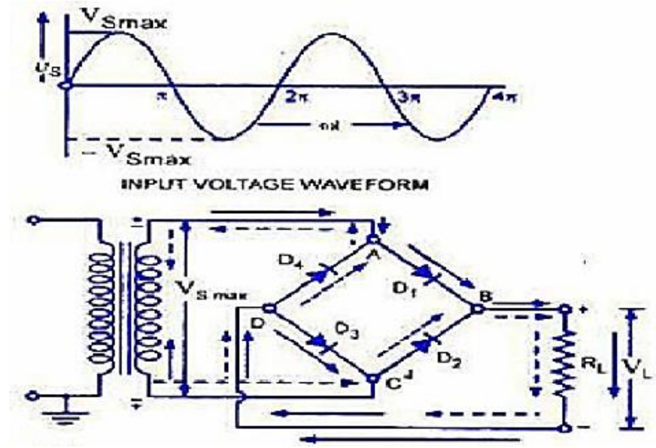

Fig 6: Bridge Rectifier

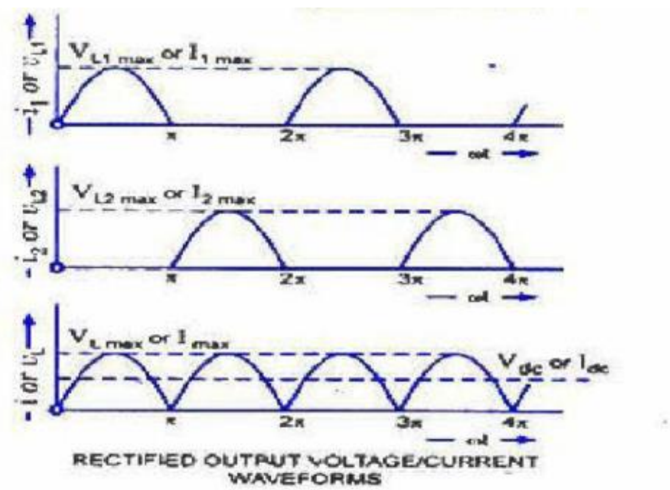

Fig 7: Bridge Rectifier Output

APPLICATION OF SYSTEM

- The energy trapped in footsteps can be tapped to provide power for street lighting, agricultural purposes, and household needs.
- This energy production can be harnessed in the event of a power outage.
- Metros, Rural Applications etc.
- This device can be tapped for both alternating current and direct current purposes.

CONCLUSION

This energy solution is economical and accessible. It can be found in rural areas where little or no power is available. Tests showed that PZT was the most effective material for this type of setup, and that a series-parallel connection was more efficient. Experimentation proved that there is a linear relationship between the weight placed on the tile and the resulting voltage. This technology is suitable for crowded areas as it eliminates the need to lay out long power lines for street lighting. It can also be used to power roadside buildings and charge ports. With only 11% of our primary energy being renewable, this project could help reduce the energy crisis and create a healthier global environment.

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