Scope & Analysis of an Approach of Electrical Energy Generation

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Abstract **-** This is known that human body contains immense chemical energy, part of which is converted to mechanical energy up to 200W when in motion, so it is ideal to convert the human body kinetic energy to generate electricity. It was experimented that up to 67 Watts of power can be available from human foot strike. In recent years, humans have become increasingly dependent on electronic devices, such as mobile phones, PDAs, and etc. Especially for soldiers in wild area, they need electronic devices for communication and other necessary functions, such as the Land Warrior system of US Army, which provides radio, navigation, computer and other electronics devices . The total power requirement of such necessary devices is more than 20 Watts, and the design goal of such system is to work at least 72 hours. Now- a- days, most of these mobile electronic devices are powered by batteries. Although substantial progresses have been made in reducing the power requirements of the electronic devices and increasing the power densities of batteries, the limited energy storage of battery and its considerable weight hinder the extensive use of electronic devices. Furthermore, discarded battery generates billions of wastes every year, resulting in negative environment impacts. The human body is a tremendous resource of chemical energy. Just one gram of fat can be converted to 9000 calories or 37.7 kJ . Also, an average person of 68kg with 15% body fat stores energy approximately equivalent to 384MJ. Thus, if even a very small fraction of this stored energy could be extracted, a portable device would have a large and renewable resource to draw on. Some researchers have explored to extract energy from body heat , breathing , typing , arm motion and walking . Walking is a main energy consumption activity which also has mechanical power to be exploited. This paper is focused on how to harvest the mechanical energy from human foot strike motion during normal walking. Compared to the existing designs, the proposed harvesting model in this paper will be simpler and stronger, and can harvest not only press-down motion but also the release up motion. In this paper, a new model for converting energy from human foot strike is framed. A spring-slider-crank mechanism is used in the proposed converting method to covert the up-down foot strike motion into unidirectional rotation to drive the alternator. The spring and slider compose an oscillating system to absorb the foot strike motion, and crank and slider make up of the motion conversion mechanism to transfer the bi-directional translation into unidirectional rotation. Gear sets are used to increase the RPM.

Keywords:- Harvesting, Kinetic energy, Strike Motion, Rotation, Mechanical power.

2. INTRODUCTION:-

.The store chemical energy of an average person of 68kg with 15% body fat is approximately equivalent to 384 MJ. Thus, if even a very small fraction of this stored energy could be extracted, a portable device would have a large and renewable resource to draw on.

Some researchers have explored to extract energy from body heat, breathing, typing, arm motion, and walking. Walking is a main energy consumption activity. Which also has mechanical power to be exploited.
It has been calculated that up to 67 W of power are available from heel strike during normal walking for a 68 kg person with the walking frequency at 2 steps

per second. Just one gram of fat can be converted to 9000 calories or 37.7 kJ

There are mainly two methods to harvest the heel strike energy during human walking.

1. Using Piezoelectric Materials :-

The word piezoelectricity means electricity resulting from pressure. A property certain materials have to generate an electric current when they are squeezed or pressed. For example, lead **zirconate titanate** crystals will generate measurable piezoelectricity when their static structure is deformed by about 0.1% of the original dimension.

Conversely, those same crystals will change about 0.1% o their static dimension when an external electric field is applied to the material

2.Using Gears:-

The gears inside the staircase that are used to rotate the generator. The staircase has to be specially designed that can achieve a small displacement when being stepped on. The gears ratio and flywheel are optimized to get the maximum possible power out by driving the micro-generator. Alternatively, we can use a spring action with magnets and coils triggered by the stair case action to generate electricity. However these desigs are very complex with many parts, and can only harvest the pressdown motion, which make these device is fragile, expensive and lower efficiency.

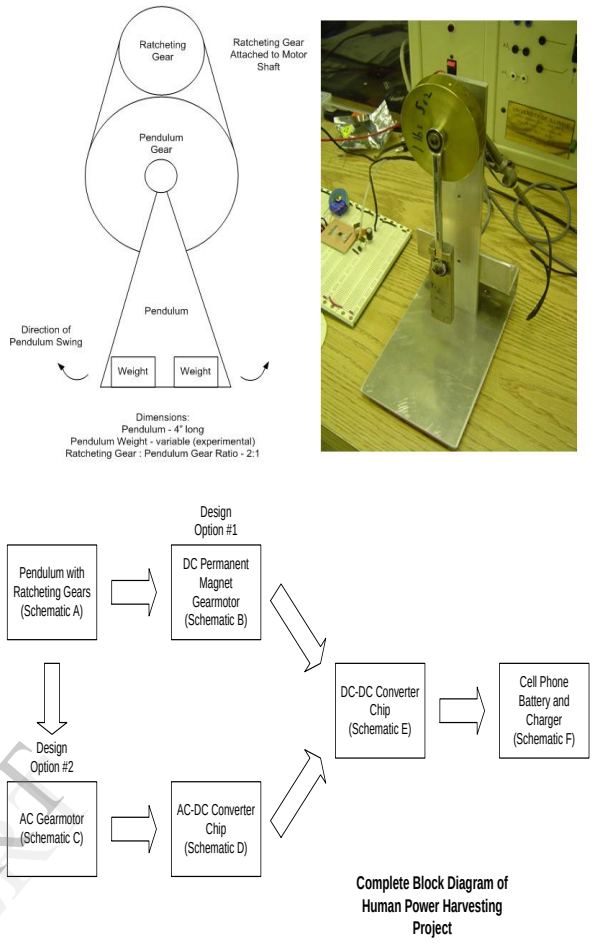

Fig.1.2 Block Diagram shows Working Principle

3. Working for Pendulum Type Harvesting System (Using Gear):-

1. Takes movement from walking and turns it into mechanical power.
2. Attached to a ratcheting gear system, designed much like a ratcheting wrench.
3. Second gear in system will be directly connected to the shaft of the gearmotor. Piezoelectric devices are implements that use materials exhibiting piezoelectric effects. "Piezo," in Greek, means "pressure," which explains that when you apply pressure to piezoelectric materials, you get a charge separation within a crystal and a voltage across the crystal that is sometimes extremely high (How Stuff Works, 2000).

4. Working of Piezoelectric Harvesting System:

Piezoelectric Material & Devices:-

Quartz, Rochelle salt, and certain ceramics all exhibit piezoelectric behaviors.

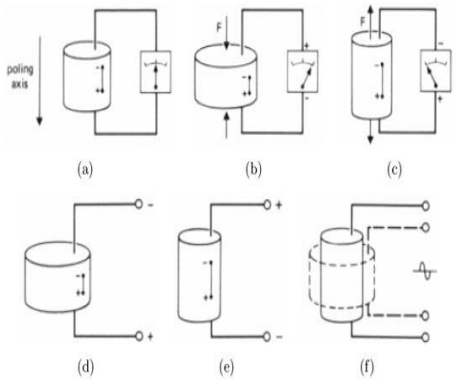

Figure 1 The Piezoelectric effect in a cylindrical body of piezoelectric ceramic (a) no load, (b) compressed, (c) stretched, (d) shorten, (e) lengthen, and (f) grow and shrink [61].

Placing piezoelectric devices that are used to capture energy from foot traffic underneath airport terminals can effectively capture electrical energy and send it back to the power grid through inverters, which are needed in order to convert the DC power, from the piezoelectric, into AC power used by terminal lighting systems (Inverters for solar panel installations work just as well for piezoelectric devices).

The crystal's voltage can generate a nice spark that lights the gas in the grill. shoes striking a piezoelectric pad underneath a floor tile act like a hammer hitting the crystal material inside the pad. This energy from the shoe then creates a voltage that can be used to power lighting systems. Hundreds or even thousands of these piezoelectric devices would be installed underneath flooring to capture the kinetic energy from walking.

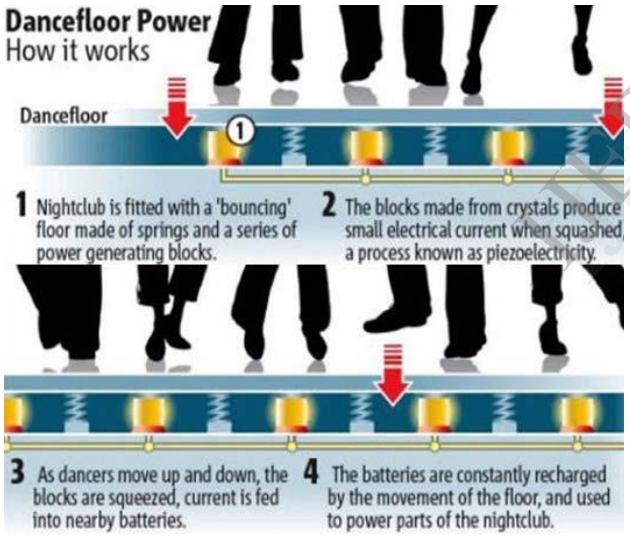

Figure 1.9

How a piezoelectric flooring system generater electricity through kinetic energy. This example of piezo electricity would be similar to one installed at airports except that springs would not be needed, thin, piezoelectric pads would be installed underneath the floor material. The pressure placed upon the pads as people walk will generate the needed force to create an electrical charge; the charge will be sent to an inverter and then directly to the airports main power grid thus avoiding the need for batteries.

5. Working Of Piezoelectric Material :-

Piezoelectric generators are electricity generation device based on piezoelectric effect. The piezoelectric current is generated when a mechanical force applied on a body is converted to electric potential. In simple words, it means that whenever a piezoelectric material is deformed it generates electric current that can be harnessed by the means of capacitors and electrical circuitry. Many piezoelectric materials are already in use in transformers and various electrical components. It finds extensive use in motor manufacturing, motion sensors and even land mine devices used as weaponry all over the world. There are numerous other applications of piezoelectric effect. It can be used to make piezoelectric generator for charging smaller appliances or even running your watch. If it is fitted in your shoe then it can power your gadgets with every step you take.

6. Piezoelectric Generator Principle :-

The vibrations energy harvesting principle using piezoelectric materials is illustrated in figure. The conversion chain starts with a mechanical energy source bike. Bike vibrations are converted into electricity via piezoelectric element. The electricity produced is thereafter formated by a static converter before supplying a storage system or the load (electrical device).

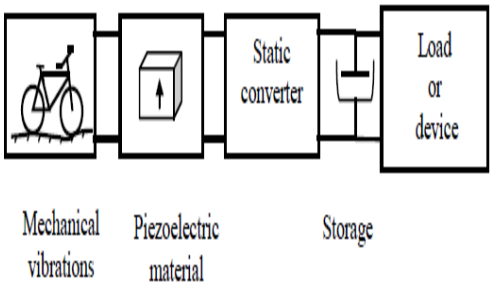

Fig.1.10 General diagram of generator based vibrations energy

7. Harvesting using piezoelectric material

TABLE I. - Typical piezoelectric materials coefficients

Material	$d_{33}(10^{-12}$ C/N)
Quartz	2.3
$BaTiO_3$	90
$PbTiO_3$	120
PZT	560
PZN-9PT	2500

For the PZT, d_{33} = 560 (10-12 C / N) means that 1 N applied strain produces 560 10-12 C electrical charge.

8. Conclusion

Electromagnetic and kinematical analyses are conducted to study the harvester's performance. Analysis shows that the dual oscillating mechanism can more effectively amplify the vibration which contributes to higher power output.

A novel mechanism for energy harvesting from human footstep motion is presented. It adopts the dual oscillating mode to harness acceleration from footstep, including the mass spring oscillating sub mechanism absorb external excitation and the cantilever beam with tip mass to amplify the vibration, and the electromagnetic induction to convert kinetic energy to electricity.

9. References

[1] U. K. Singh and R. H. Middleton, "Piezoelectric power scavenging of mechanical vibration energy", Australian Mining Technology Conference.
[2] Roundy S., Wright P. K. and Rabaye J., "A. study of low-level vibrations as a power source for wireless sensor nodes", Computer Communications .
[3] Steven R. Anton and Henry A. Sodano, A review of power harvesting using piezoelectric materials Smart Materials and Structures .
[4] www.ecofriend.com
[5] www.wikipedia.com