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A Review on Mechanisms and Challenges of Mechanical Footstep Power Generators

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ABSTRACT
As human population is increasing, so is the demand for electricity. Human locomotion is a potential source of renewable energy. A mechanical footstep power generator is used to tap waste energy from human locomotion and convert it into usable form such as electricity. Research shows that large amount of power is generated from non-renewable energy resource compared to that of renewable energy resource. The conventional methods of generating power are greatly inadequate and tend not to be eco-friendly. This review is aimed at analyzing the various methods of generating electricity through mechanical footstep power generator. Data from previous and trending works were collected through the review of relevant literatures. The mechanisms highlighted in this paper include picso-electric mechanism, rack and pinion mechanism, fuel-piston mechanism. The selection of suitable transducers and low power capacity are challenges present in the use of picso-electric mechanism. Rack and pinion mechanism also suffers from low power output and high maintenance cost. The fuel-piston mechanism with pulley arrangement is more efficient and requires less maintenance. This mechanism can be further improved upon to achieve greater efficiency by adopting a crankshaft flywheel mechanism with multiple pulley arrangement.

Keywords: ***eco-friendly, footstep generator, human locomotion, population, renewable energy.***

1 INTRODUCTION

In this current era of globalization, human population has increased exponentially around the globe. It was reported that the world's population reached approximately 8 billion as at October 2022 (worldometer, 2022). Energy crisis is due to two reasons; firstly, continues and rapid increase in the world's population and secondly, increase in the standard of living of human beings (Jamagade *et al.*, 2017). Walking is the most common activity in human life. When a person walks, he loses energy to the earth surface in the form of impact, vibration, sound, friction, etc. (Rajeev *et al.*, 2019). The force exerted by human feet upon landing on the ground generates a renewable energy known as kinetic energy. This energy can be converted into electricity through a footstep power generator. Such a system is highly effective for installation in places that expect frequent mobility of a large population, such as educational institutions, market, motor parks, sport facilities, etc.

2 FOOTSTEP POWER GENERATION MECHANISMS

A footstep power generator basically converts the pressure from footsteps into electricity. To achieve this, it employs three main mechanisms. This paper concentrates on the different mechanisms used for footstep power generation.

2.1 Piezoelectric Mechanism

Briscoe and Dunn (2014), defined piezoelectricity as "electric charge that accumulates in response to applied mechanical stress in materials that have non-centrosymmetric crystal structure". "Piezoelectricity" is a Greek originated word, which means "squeeze or press". It refers to the property of the piezoelectric materials to generate an electric field when a mechanical force is applied, a phenomenon called the direct piezoelectric effect. Different types of footstep power generators are available and majority of these devices use piezoelectric transducer to generate power. One of the greatest challenges in designing footstep power generators with piezoelectric transducer is the selection of suitable ferroelectric material because it governs the efficiency of converting kinetic energy to electricity (Nayan, 2015). Conventionally, the piezoelectric footstep power generator uses ferroelectric materials made up of crystal such as Lead (II) titanate ($PbTiO_3$), Lead (II) Zirconate ($PbZrO_3$), Polyvinylidene Difluoridoer Polyvinylidene Fluoride (PVDF) and Lead Zirconate titivate (PZT). While both of the PZT and Polyvinylidene Difluoridoer (PVF) are commonly used as piezoelectric, the former material is the best candidate of piezoelectric because it produces better output voltage compare to other ferroelectric materials (Mohanty *et al.*, 2014). Despite its popularity, piezoelectric footstep power generator suffers with some drawbacks such as the infeasibility of this technology under static condition and the limitation of power capacity (Muthane *et al.*, 2015).