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Press Kinetic Energy Converter: Revolutionizing Energy Saving with Efficient Power Generation

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***Abstract* – The study explores alternative power source equipment that converts kinetic energy into electric power. It proposes a power-generating tile or step that converts kinetic energy from press into electric power and accumulates it. The device is described as a decentralized source of electrical energy. Experimental research improved the method of converting kinetic energy into electric power. A correlation method was presented for quantitative analysis and calculation. The proposed device can be used in areas with high foot traffic, with small dimensions and easy installation in various types of aisles and stairs. It can also be integrated into LED lighting networks.**

***Keywords* – Kinetic Energy, Press, power, alternative fuel.**

I. INTRODUCTION

The increasing importance of energy saving and efficiency is a pressing issue, necessitating the development and implementation of tools and instruments that can reduce dependence on centralized power sources or electricity expenses. This paper presents studies aimed at solving this problem in institutions, buildings, and places with high foot traffic. The main idea is to develop and implement a low-duty device for generating electricity, converting kinetic energy into electric power. This will generate the required amount of electricity and provide the power supply system with additional, alternative low-duty power sources [1-10].

The Pavegen tile, developed by Laurence Kemball-Cook, is an analogue of the proposed device, which converts kinetic energy from steps into electric power [11-12]. Russian scientists Kh. Abramovich, E. Kharash, and others have proposed similar developments [13], but their disadvantage is that it requires a stationary structure and appropriate assemblage. In the United States, inventors S. Brusaw [16] proposed a device "Solar Roadway Panel" that converts sun energy into electricity, but this requires complete re-equipment of both the road and its entire infrastructure. Piezoelectric DC generators based on the Casimir effect are another example of energy converters operating on piezoceramic materials. However, these devices have drawbacks, such as low reliability and the need for complete re-equipment of both the road and its infrastructure.

Several articles consider the fundamental possibility of obtaining electric energy by converting it from the energy of sound waves and using piezoelectric elements, but do not provide concrete technical solutions for it. Xinyu Xue and Sihong Wang proposed combining the process of conversion of mechanical energy into electrical power with the process of electric energy accumulation in the form of chemical energy, but do not specify the operational and technical characteristics of their development.

Despite the numerous examples of possible conversion of kinetic energy from press into electric power, no specific technical solutions are given for practical implementation. These devices are designed for significant pressing force and can only be installed on motorways.

II. THE DESIGN OF THE DEVICE

An electromechanical device for converting kinetic energy into electric power is being proposed, which converts kinetic energy from people's steps into electric power and accumulates in capacitive storage devices like ultra-capacitors and accumulator batteries. This method is promising and effective, as it can be used as an alternative and decentralized low-duty power source. The device has housing with a pressure plate, where the rotor and stator are co-located and can move relative to one another. The stator windings are connected to an electric rectifier, whose output clamps are connected to a capacitive storage - an ultra-capacitor. The ultra-capacitor recharges the accumulator battery, which is connected to the load via a switch (figs 1 and 2). The rotor of the electric generator rotates about the axis under the action of the drive rail through a cylindrical multiplier, increasing the angular velocity of rotation. The proposed device's small dimensions and weights make it easy to install in places with a large number of pedestrians and a great density of human flow, making the conversion process more effective.

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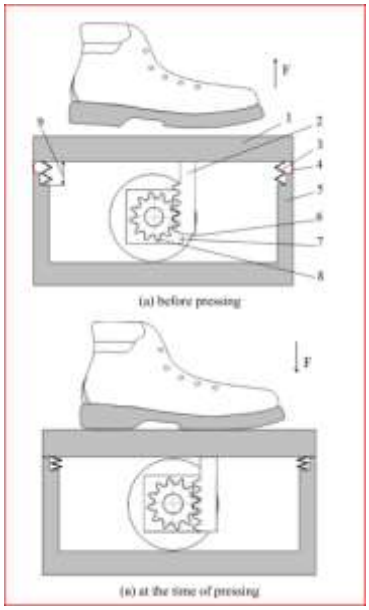

Fig. 1 The design of the device: 1 - the pressure plate; 2 - the electric generator drive rail; 3 - the spring; 4 - the airtight connection of the plate with the housing; 5 - the body; 6 - the electric machine (electric drive); 7 - multiplier; 8 - the electric generator drive gear; 9 - the pressure plate working stroke; F - the pressing force

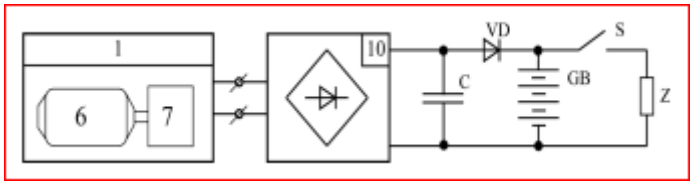

Fig. 2 The device principal electrical scheme: 1 - the pressure plate; 6 - the electric machine (electric generator); 7 - the multiplier; 10 - the electric rectifier; C - the capacitive storage; VD - the diode; GB - the rechargeable battery; S - the switch; Z - the load

III. Principle of Action

The proposed device aims to convert kinetic energy into electric power using an electromechanical energy converter based on an electric machine. The device's operation is explained by schematic drawings, Figs. 1 and 2, which show that when pressing on the device, the press plate moves downward under the action of the pressing force, causing the generator drive rail to move downward. This causes the electric generator to turn, increasing the angular rotational speed of the electric machine rotor. The electric generator rotor then directs the electromotive force in the windings of the electric machine stator. When the foot is removed, the pressure plate is turned back to its original position, and the electric generator rotor rotates in the opposite direction, directing the EMF in the stator windings with a negative value. The stator windings are connected to the electric rectifier, which charges the capacitive storage C-ultra-capacitor and a storage battery GB. The switch S switches the power supply to load Z. This electromechanical device increases the efficiency of converting energy from pressing into electric power, while maintaining the overall dimensions of the device.

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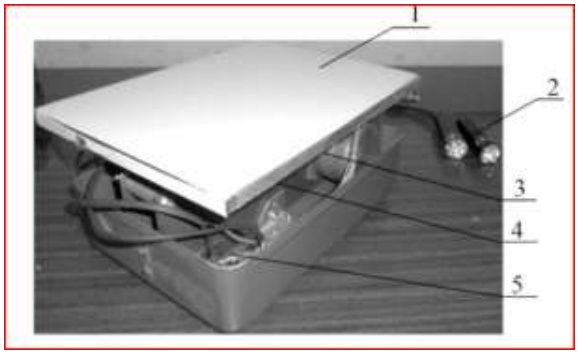

Fig. 3 The element of the experimental sample of the device for converting kinetic energy of press into electric power: 1 - the pressure plate; 2 - the external load (LED lamps); 3 - the electric machine (electric generator); 4 - the multiplier; 5 - the electric rectifier.

IV. Experimental Research

The proposed device converts kinetic energy of pressing into electric power through an experimental sample. The device can have multiple elements, and a series of studies have been conducted on the conversion, accumulation, and subsequent use of this power. The prototype features two electric generators (DS-200-1), a 1:2 gear ratio multiplier, a 10mm working stroke pressure plate, two 60 lumen LED lantern lamps, and two ICR 18650 Li-ion accumulator batteries. The geometric dimensions of the device are 150mm in height, 200mm in width, and 250mm in length. The device's efficiency has been confirmed through these studies.

The experiment aims to investigate the potential of a device converting kinetic energy into electric power as an alternative renewable source of energy. The device can consist of several elements, and measurements are taken on one electric generator to eliminate errors. A series of measurements of 100 presses are conducted, and graphs of the generated capacity's dependence on time are built. The integration of these graphs is then performed to determine the quantitative value of the generated power.

The results show that one pressure generates two impulses of electricity due to the reverse stroke of the pressure plate, which also results in the generation of electricity. The top value of generated voltage per step is 5 V, with the rotor rotation frequency being up to 360 rpm.

Integration of the received graphs showed that 100 presses (corresponding to 100 steps) generated 16.89 W/h. An element of the device for converting kinetic energy into electric power with two electric generators generates 33.78 W/h with 100 steps performed on it. If the power generating tile or step consists of 2 elements, it generates 67.56 W/h, and if it consists of 4, it generates 135.12 W/h.

The number of items in one such device depends on the technical conditions of its installation and location. For example, if the average number of presses per step in front of an educational institution is approximately 10,000 per day, one device with 2 elements will generate 6.76 kWh, and a device with 4 elements will generate 13.5 kWh on it. The number of items in one such device is determined by the technical conditions of its installation and location.

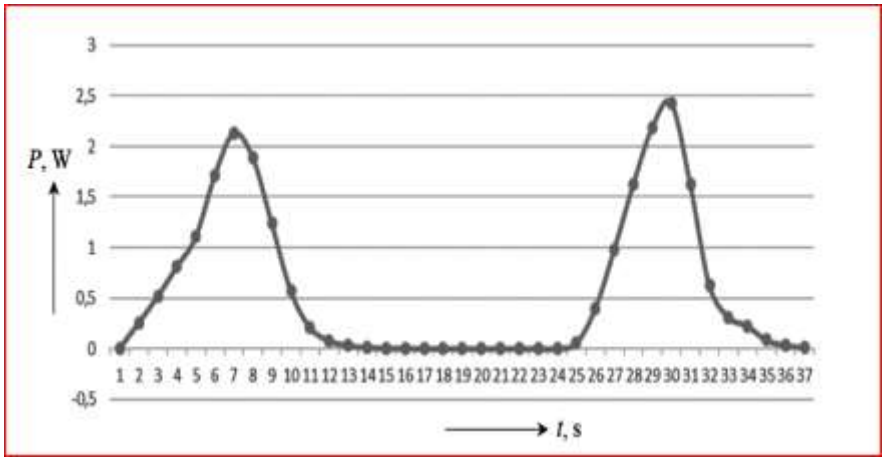

Fig. 4 The graph of measurement of the generated power resulted from two presses on the device (sampling rate is 100 Hz)

V. DISCUSSIONS

The study focuses on the installation of a device at the entrance to any educational institution, which can meet the requirements for electric lighting using LED technology during a dark day. If several devices are installed, it is possible to partially or completely abandon the centralized illumination of general use areas, such as corridors, halls, and lobbies, resulting in reduced electrical supply expenses and cost savings.

The proposed converter has been tested and found to be simple and efficient, generating 13.5 kWh of power during 10,000 presses. However, further improvements are needed for wide-range use, both inside buildings and outside in places with heavy traffic. The step engine can be used to return the pressure plate to its initial position, working as an electric motor.

The device's design and software for the step engine need to be improved, and the algorithm of work for raising the pressure plate should be suggested. Electric current, supplied by Li-ion accumulator batteries, may decrease the generated energy value. Future research will focus on this topic.

The value of the generated energy from one step on the device depends more on the tempo of walk, as the harsher the steps, the more energy is generated. The location of the device should be considered when calculating its location, as it significantly influences the energy generation process.

In conclusion, the proposed device transforms kinetic energy into electric energy, making it an efficient way to save energy and improve the energy economy in densely populated areas.

VI. CONCLUSIONS

The study analyzed alternative power source equipment for converting various types of energy into electric power. A technical solution for a power generating tile or step was proposed, which converts kinetic energy of press into electric power and accumulates it for future use. The operating principle of the power-generating tile is described as an alternative and decentralized source of electrical energy. Experimental research on the developed element of the power generating device was conducted, resulting in improved conversion methods and a correlation method for quantitative analysis and calculation of generated electricity. The results showed that the potential of the device as a source of electric energy varies depending on its structural peculiarities. For instance, a single generator with 10,000 steps could generate 1.7 kWh, while a system with four generators could generate 13.5 kWh. The experimental research data allowed for the evaluation of the device's potential as an alternative renewable energy source, allowing for the determination of the number of devices needed for specific objects, such as LED lighting.

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