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ТЕЛО ЧЕЛОВЕКА КАК БИОМЕХАНИЧЕСКАЯ СИСТЕМА ДЛЯ ПОЛУЧЕНИЯ ЭНЕРГИИ

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Аннотация

Данная статья рассматривает тело человека как альтернативный источник получения энергии. Проанализированы различные способы получения энергии с помощью биомеханической системы. Сделан вывод о перспективности их использования в будущем.

Ключевые слова: альтернативные источники энергии, тело человека, портативная электроника, беспроводные зарядные устройства, метод Зеебека, элемент Пельтье.

THE HUMAN BODY AS A BIOMECHANICAL SYSTEM FOR ENERGY OBTAINING

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ABSTRACT

This article considers the human body as an alternative source of energy. Various ways of energy obtaining using a biomechanical system are analyzed. The conclusion is made about the prospects of their use in the future.

Keywords: alternative energy sources, human body, portable electronics, wireless chargers, Seebeck method, Peltier element.

At the moment, there is a fairly large number of energy sources that converts natural energy resources into electricity using special installations which operate on different principles. Thermal power plants became the main type. They generate over 70% of the world's electricity. A thermal power plant generates electrical energy by converting the chemical energy of the fuel into thermal energy during combustion, and then into mechanical energy of the rotation of the electric generator shaft. This type of electric energy production causes colossal harm to the environment and depletes natural resources [1].

Alternative energy sources are gaining momentum, which, in comparison with traditional ones, are harmless and use renewable energy sources such as wind speed and solar radiation. For this purpose, huge complexes are involved.

But at the moment, humanity is facing an increasingly acute issue of energy obtaining in small volumes with instant delivery to the user. Technological progress does not stand still, a huge number of various wearable devices for personal use is produced in the world, and the problem of charging portable electronics is more relevant than ever. The person himself comes to the rescue in solving this problem.

The human body can be viewed as a biomechanical machine that processes organic compounds in the course of its life. The food consumed is decomposed into simpler substances, some of which are used as building materials for the body, and another part serves as fuel. A person consumes per day an amount of food equal to approximately 2500-3000 kcal, which in terms of kilowatt-hours is equal to 2.9-3.5 kW*h. But far from all the energy consumed by the body is fully utilized by it, since the efficiency of our body is below 100%. Much of it is emitted as heat.

People have long found out how to use part of the mechanical energy of the body, and as an example of this - a wristwatch with an automatic winding, but very little energy is spent on it, there is not enough for something more demanding, users are interested in the opportunity to receive much more useful from the body energy, and it is much more difficult. It is irrational to hang a large flywheel on a person, it will bring discomfort, extra heaviness, and there will be a need for miniature generators that convert mechanical energy into electrical energy. So far, it is problematic to use excess of mechanical energy of body movement. The only real source of this energy is walking. When walking, a lot of energy is released by touching the feet of the ground and transferring body weight to it. Moving at a moderate speed a person makes about 120 steps per minute. At the moment of touching the ground, he exerts pressure on it, mechanical work is performed.

A piezoelectric element (Fig. 1) applied in lighters can be considered to use the foot pressure on the surface. Its area is 0.25 cm², the area of the shoe sole is 150 cm², which means that about 600 such elements can be placed in the shoe sole. Pressing the piezoelectric element of the lighter with a frequency of moderate steps of a person of 0.5 seconds, 0.5 mW is received on average, which is 0.3 W for 600 elements. It will be generated 0.3 W*h during an hour of walking.

Figure 1. *Piezoelectric element*

0.3 W*h is not enough, even without taking into account the following nuance: an effort of about 3 kg is required to activate the piezoelectric element of the lighter. 600 elements will require an effort of 1800 kg. When walking, a person creates an effort of approximately 120% of his mass. With a body weight of 70 kg, this is about 85 kg. This is only enough to activate 28 elements, and 28 × 0.5 = 14 mW, only 0.014 W*h of energy will be generated per hour of walking, which is absolutely negligible. So far, it is problematic to convert the mechanical energy of the body into electrical energy without creating inconvenience for a person. It is possible to equip shoes with piezoelectric elements, but using sufficient power to meet basic human needs is not.

The human body releases about 100 W of thermal energy into the environment. It can be converted into electric using the Seebeck effect: the appearance of an electromotive force in thermoelectric materials, parts of which are exposed to different temperatures. By placing a plate on the body that is in contact with the environment on the other side, electricity can be generated due to the temperature difference. The greater the temperature difference, the higher the generated power, which is why such generators are especially effective outdoors in winter.

The efficiency of modern thermoelectric materials does not exceed 10%, that is, up to 10 W of electricity will be generated from 100 W of heat. But in this case, it will be necessary to cover 100% of the body with thermoelectric material [2].

So far, the maximum that Seebeck's elements are capable of is powering small wearables, like "smart" watches.

Matrix PowerWatch is a “smart” watch that uses the heat of the human body and temperature differences with the environment for charging. The positioning of the project is associated with efficient energy distribution and “green” technologies. Inside the device are all the main functions of a modern smart watch: counting heart rate and steps, monitoring sleep patterns, interchangeable dials, calorie counter and training modes. Also, this watch is water and shock resistant. The device weighs 50-70 grams, display dimensions - from 46 to 50 mm [3].

Battery life is based on the Seebeck effect. The energy that arises with a difference of degrees is quite enough to power a low-power Ambiq processor, and thus no one experiences any problems with autonomy and current performance characteristics. The thermocouple itself is not that small and takes up almost all the space under the display and the board [4].

A similar technology was taken as a basis by the inventor Ann Makosinski, who invented a flashlight that charges from the temperature difference between the air and the human body. The effect is explained by the use of four Peltier elements (Fig. 2). As a result, Anne's flashlight produces quite bright light, but does not require rechargeable batteries [5].

The assembly sequence of the innovative flashlight was as follows: Ann took a hollow aluminum tube, Peltier elements were mounted in it. Then the young woman placed the tube with the elements in another, now polyvinylchloride tube with a small hole. This allowed air to circulate and cool the device. And everything worked: the flashlight began to shine brightly when a certain temperature difference was reached.

Using four Peltier elements and the temperature difference between the palm and the surrounding air, the flashlight is powered, and ultimately gives a bright light without batteries or moving parts. The flashlight is easy to use and requires only five degrees in temperature difference for the device to deliver power up to 5.4 mW and can illuminate a space within a radius of 1.5 m with the brightness of a candle.

With a usable palm area of 10 cm^2, using a Peltier element (efficiency 10%), up to 57 mW of power can be obtained. The main part, without which it does not work, is the converter for raising the voltage. At such a slight temperature difference of 30 degrees, the element does not produce more than 0.5 volts. The converter raises the voltage to 3-5 volts.

After a long search, Ann decided to complicate the design of the flashlight and added a power converter - an integrated circuit with an efficiency of 50% at 100 mV. As a result, the flashlight consists of only 4 components: a step-up transformer, a microcircuit, a capacitor and an LED.

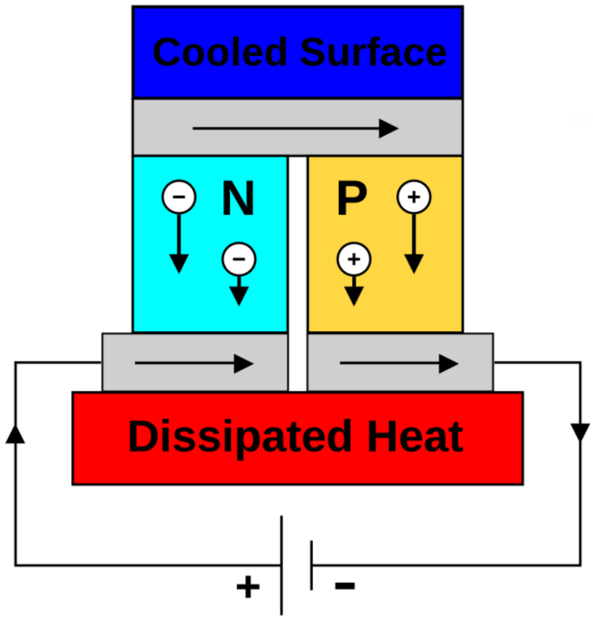

Figure 2. Peltier element

The inventor made 2 flashlights with Peltier elements of different sizes: 16 sq. cm. and 5.4 sq. cm accordingly. Both flashlights are 25 mm in diameter and 125 mm in length and represent the simplest but most effective design. With a temperature difference of 5 degrees, the first one gives light with a brightness of 32 lumens per sq. m, and the second - 43 lumens per sq. m. Naturally, the higher the temperature difference, the brighter the light.

Let’s consider the reason why the Peltier element was chosen. It is much more logical to purchase a flashlight with a muscle drive, solar panels, or build a wind turbine.

It is quite possible to get by with a muscle drive, but there are a lot of moving parts in it, and one breakdown is enough to be left without electricity. There are no moving parts in solar panels, but sunlight is not easy to find in winter conditions or under a two-meter concrete roof of a shelter. The wind farm occupies a large area, there are moving parts, it is more suitable for a stationary installation when equipping a long-term shelter. Despite the low efficiency of the Peltier element in the generation mode, when connected to the output of the converter of a portable battery with a declared charge current of 1000 mA, the generator was able to give a current of about 600 mA. This current is enough to charge most gadgets [6].

A positive example is the experience of Samsung, one of the largest top portable electronics manufacturers today, that uses this method for new designs. It has been looking for new types of wireless charger and has been improving the charging process itself. In the modern world, accessories are given the same close attention as smartphones themselves. Against this background, Samsung's invention, which was recently patented, no longer looks unrealistic.

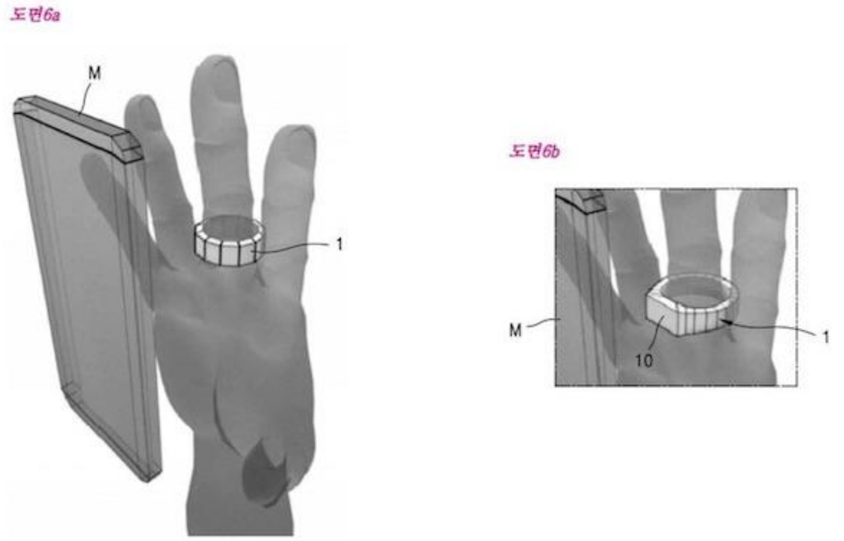

Figure 3. *Ring designed by Samsung*

We are talking about a special ring that is designed to charge your smartphone every time you pick it up (Fig. 3). The small device itself can generate electricity from the kinetic energy obtained by the movement of the hands, like a mechanical self-winding watch. Movement alone will not be enough to charge the battery. Samsung engineers have foreseen this and taught the device to use body heat as an additional source of energy. However, it is already clear that the volume of the battery built into the ring cannot be the ultimate, primarily due to the miniature size of this gadget. According to experts, it is definitely not worth waiting for more than 300-500 mAh, which automatically makes the use of the ring relevant only in emergency cases. Samsung representatives also noted that the implementation of this type of charging will not be limited to just a ring. Soon the company plans to implement similar technologies in bracelets, glasses and even ordinary wallets, because while their owner is moving, they are storing energy [7].

Based on the above, one can confidently say that the Seebeck method is successfully applied today and is promising for the development of new technologies based on it in the future. It is already planned to create flexible sheet thermoelectric materials suitable for use in clothing. A jacket and pants made from such fabric will be able to generate several watts of energy, sufficient to charge a smartphone and small wearables.

Today, the fundamental challenge for scientists is to increase the efficiency of the Peltier element. If this problem is solved, huge prospects can be achieved in using this method completely replacing power banks and wired chargers [8].

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