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ПЕРСПЕКТИВИ ВИКОРИСТАННЯ НОВИХ МЕТОДІВ БЕЗДРОТОВОЇ ПЕРЕДАЧІ ЕЛЕКТРОЕНЕРГІЇ

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THE UNTAPPED POTENTIAL OF WIRELESS POWER TRANSMISSION

The problem of wireless power transmission over distances hasn’t stop being of great interest for scientists and still causes them to perform endless researches in this area, carried on for more than a hundred years. The objective of this paper is to describe a new system of transmitting the power which is called wireless transmission of electricity.

Wireless transmission of electricity is based upon the coupled resonant objects to transfer electrical energy without interconnecting wires between the objects. The system consists of a wireless electricity transmitter (a power source) and devices which act as receivers (an electrical load). The operation is based on the principle of resonant coupling and microwave energy transfers. The action of an electrical transformer is the simplest instance of wireless energy transfer. Wireless transmission would be ideal in the cases when instantaneous or continuous energy transfer is required, but interconnecting wires are inconvenient or impossible to provide.

Maxwell's theory of electromagnetism, published in 1865, mentions electromagnetic waves moving at the speed of light, making the conclusion that light itself was a form of such waves. In 1886 Hertz performed a successful experiment with pulsed wireless energy transfer. He constructed an apparatus that produced and detected microwaves in the ultra-high frequency region [2; 7]. Nikola Tesla is assumed to be the founder of the study of methods of transferring energy to a distance without any wires. In 1893 he demonstrated the lighting project with fluorescent lamps, without using conductors of electricity at the World Exhibition in Chicago. A year later, the same Tesla lit an incandescent lamp in his hands. He also created the Wardenclyffe Tower, or the first wireless telecommunications tower in the world intended for commercial trans-Atlantic telephony, broadcasting, and to demonstrate the wireless transmission of electricity. Tesla wanted to transmit electricity from this Tower to the whole globe without wires using the Ionosphere. The source of the transmitted electricity was to be the Niagara Falls power plant [3; 5].

Let us consider some methods of wireless transmission of electrical power.

The principle of mutual induction between two coils can be used for the transfer of electrical power without any physical contact in between. The simplest example of how mutual induction works is the transformer, where there is no physical contact between the primary and the secondary coils. The transfer of energy takes place due to electromagnetic coupling between the two coils [6].

Electrodynamic Induction. Also known as "resonant inductive coupling", electrodynamic induction resolves the main problem associated with non-resonant inductive coupling for wireless energy transfer; specifically, the dependence of efficiency on transmission distance. When resonant coupling is used, the transmitter and receiver inductors are tuned to a mutual frequency and the drive current is modified from a sinusoidal to a non-sinusoidal transient waveform. Pulse power transfer occurs over multiple cycles. In this manner significant power may be transmitted over a distance of up to a few times the size of the transmitter.

Electrostatic Induction. Also known as "capacitive coupling" is an electric field gradient or differential capacitance between two elevated electrodes over a conducting ground plane for wireless energy transmission, involving high frequency alternating current potential differences transmitted between two plates or nodes.

Electromagnetic Transmission. Electromagnetic waves can also be used to transfer power without wires. By converting electricity into light, such as a laser beam, and then firing this beam at

a receiving target, such as a solar cell on a small aircraft, power can be beamed to a single target [1; 4].

Laser and microwave power transmission methods are also used.

In 2007 scientists at Massachusetts Institute of Technology demonstrated a wireless transmission of electricity, powering a 60-watt bulb through the air (at a distance of 2.13 m). The new system uses two copper coils (transmitter and receiver), tuned to the same resonant frequency. In this case, the first coil emits an evanescent magnetic field oscillated at a frequency of a few MHz. Magnetic coupling of the two coils leads to the efficient transfer of energy, while all other items in the room practically do not feel the effects of the magnetic field. For people and electronics, the system is completely safe and the influence it exerts on them is even weaker than that of the Earth's magnetic field.

In 2010 a completely wireless TV was presented at the world exhibition CES 2010.

In spring 2012, the company Dengyo and Volvo Technology Japan successfully tested a wireless power transmission system. They have developed the technology in the microwave range of 2.45 GHz, a high-efficiency "rectenna." This device combines the antenna and rectifier to convert electromagnetic waves into direct current. In the experiments, each of eight rectennas provided an output power of 1.3 kW. Working in conjunction, they showed the efficiency of up to 84%. It was possible to transmit 10 kW at a distance of 4-6 meters.

The main disadvantages of wireless transmission are very high initial cost, limited power and distance. On the other hand, the advantages of wireless power transmission include the absence of wires and e-waste, or need for the battery. It is harmless, if field strengths are below safety levels. It is a more efficient energy distribution system, the maintenance costs being less. The system reduces the cost of electrical energy used by the consumer, eliminating wires, cables, and transmission towers. The electrical energy can be economically transmitted without wires to any terrestrial distance, so that there would be no transmission and distribution loss. The efficiency of the transmission can be as high as 96 or 97 per cent, and there are practically no losses [3]. Experiments claim that wireless electricity transmission using microwaves and laser is safe for human health and the environment.

It is clear that the wireless systems in the range from 100 W to 100 kW cannot compete with conventional systems, because of the enormous costs involved. Nevertheless, wherever economic competition is not the prime consideration, it can be an option. Microwave wireless power transmission can supply power to places that are difficult to reach. Especially small communities in rural areas could be supplied with power using wireless transmission of electrical energy. There is every reason to believe that further investigations could make the development and utilization of this technology more efficient.

References

1. A. Kurs, A.Karalis, R. Moffatt, J. D., P. Fisher and M. Soljačić, “Wireless Power Transfer via Strongly Coupled Magnetic Resonances”, Science, June 2007.

2. Leonardo Energy official website http://www.leonardo-energy.org

3. S. K. Singh, T. S. Hasarmani, and R. M. Holmukhe “Wireless Transmission of Electrical Power Overview of Recent Research & Development” IJCEE, Vol.4, No.2, April 2012.

4. Nikola Tesla, Colorado Springs Notes, Beograd, Yugoslavia, 1978.

5. Nikola Tesla, My Inventions, Ben Johnston, Ed., Austin, Hart Brothers, 1982.

6. Tesla Memorial Society of New York official website http://www.teslasociety.com

7. Elihu Thomson Wireless Transmission of Energy, UK, 1991.