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Harvesting Waste Kinetic Energy Through Footwear for Therapeutic Use

There is a growing need for physical therapy, yet the expense and inconvenience of achieving a lasting benefit is its drawback. The effectiveness of physical therapy depends on the frequency of application and can only be achieved through continual treatment. Electrical muscle stimulation (EMS) is a form of electrotherapy that uses electrical impulse to elicit muscle contraction. It is used to relax muscle spasms, prevent and decrease disuse atrophy, increase local blood circulation, re-educate muscles, maintain and increase range of motion, and for rehabilitation purposes with muscle injury. Massive amounts of kinetic energy from walking go to waste. The potential of harnessing this waste energy has widespread benefits. The goal of this experimentation was to use piezoelectric materials placed on the bottom of the foot to directly power EMS to aid in muscle rehabilitation. When pressure is applied to piezoelectric materials, electricity is produced. Extremely high yet transient voltages and little current are properties that render piezoelectric materials difficult to use to store energy. A spring system that applies substantial force on the piezoelectric crystal from a grill lighter produces ~50 kV when measuring its air gap. To regulate the amount of energy delivered, two circuit designs were created to create multiple levels of intensity. The first used two transformers, and the second involved the use of diodes to drop the voltage to different levels. Quantitatively measuring the voltage at different settings was difficult due to technical limitations, but the proportionality between different intensities was confirmed qualitatively and with an oscilloscope. The device timed the EMS pulses with the walking cycle so as to maximize muscle strengthening and rehabilitation in an efficient, pragmatic, and green method.