Generation of Electrical Power From Stimulated Muscle Contractions Evaluated

This project is a collaborative effort between NASA Glenn Research Center's Revolutionary Aeropropulsion Concepts (RAC) Project, part of the NASA Aerospace Propulsion and Power Program of the Aerospace Technology Enterprise, and Case Western Reserve University's Cleveland Functional Electrical Stimulation (FES) Center. The RAC Project foresees implantable power requirements for future applications such as organically based sensor platforms and robotics that can interface with the human senses. One of the goals of the FES Center is to develop a totally implantable neural prosthesis. This goal is based on feedback from patients who would prefer a system with an internal power source over the currently used system with an external power source.

The conversion system under investigation would transform the energy produced from a stimulated muscle contraction into electrical energy. We hypothesize that the output power of the system will be greater than the input power necessary to initiate, sustain, and control the electrical conversion system because of the stored potential energy of the muscle. If the system can be made biocompatible, durable, and with the potential for sustained use, then the biological power source will be a viable solution.

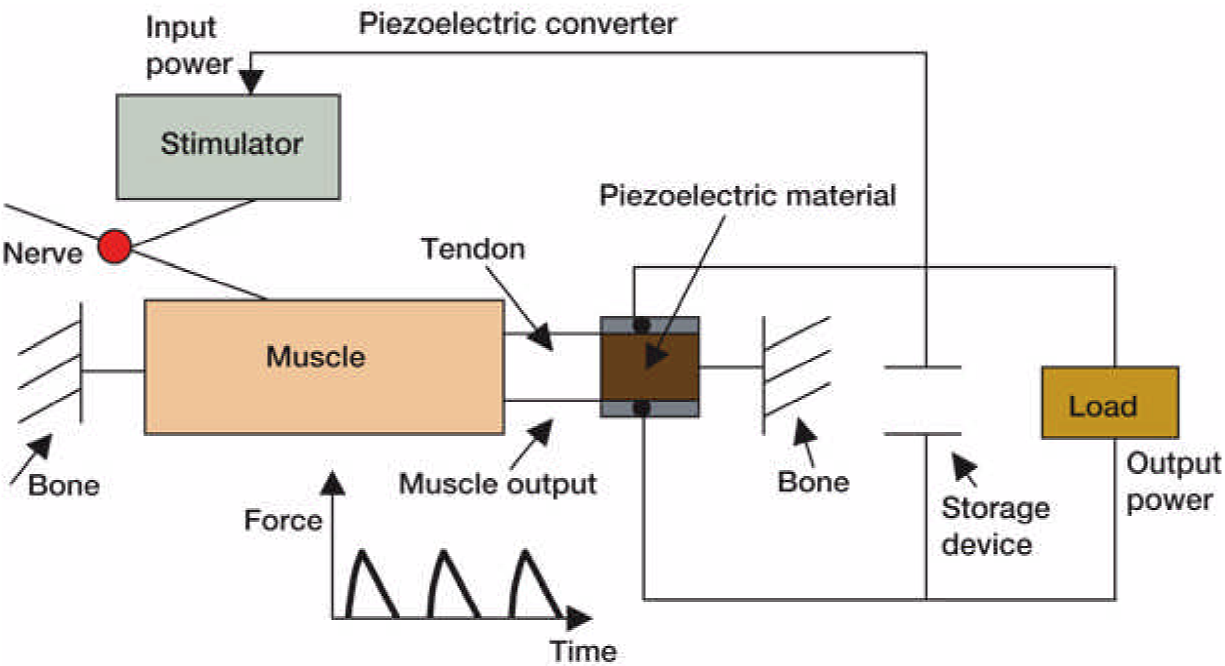

Diagram of the piezoelectric converter idea. A piece of piezoelectric material is attached between a tendon and bone. The muscle contraction stretches the piezoelectric material, causing a charge to build up on it. A capacitor or battery is used to store the generated electricity. Some of the generated power is used to stimulate the muscle to cause the *contraction.*

The requirements for this project have been identified and include (1) the system must be completely implantable, (2) the system must have a maximum power-output-to-volume ratio, and (3) the system must have long-term durability and life expectancy. Two concepts have been developed and are under investigation: (1) attach piezoelectric material to a tendon and generate electricity by deforming the material with the force produced during muscle contractions, as shown in the preceding figure, and (2) attach a magnet to a tendon and have the motion produced during muscle contraction cause the magnet to move through a coil to produce electricity, as shown in the following figure. Preliminary theoretical output power calculations for these two options have been made, and further analysis will be done to determine which option to investigate fully. Workbench studies will investigate the experimental power characteristics of one or more power-conversion systems, and animal studies will investigate the ability to generate power when driven by the physiological process.

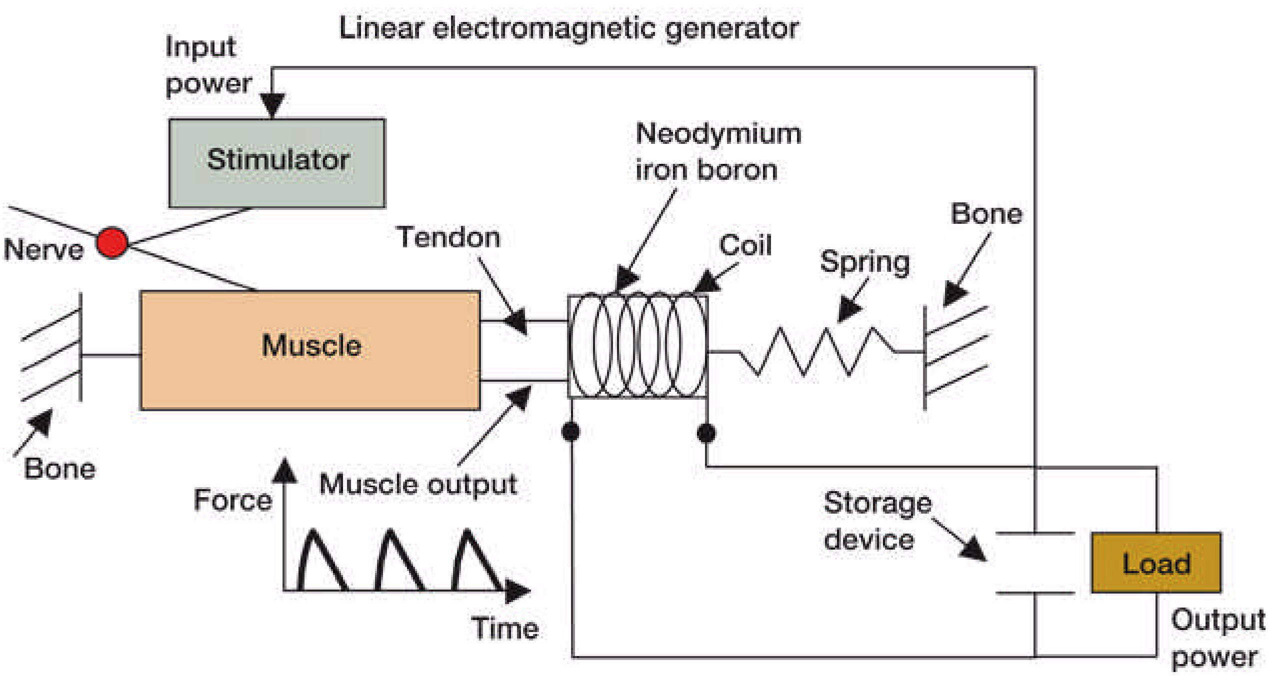

Diagram of the linear electromagnetic generator idea. A magnet and spring are attached between a tendon and bone. A coil is wound around the magnet and tendon leaving room for the magnet to slide in and out of the coil. The muscle contraction causes the magnet to move, causing voltage induction across the coils. A capacitor or battery is used to store the generated electricity. Some of the generated power is used to stimulate the muscle to cause the contraction.

Find out more about this research:
http://www.grc.nasa.gov/WWW/AERO/base/rac.htm

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