Piezo Electric Energy Harvesting System

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Technology description

Background

Pacemakers and other similar implantable medical devices suffer from the shortcoming of limited battery life. When the useful life of the batteries powering these devices has expired, surgical procedures are usually necessary to replace them. Like all surgeries, these procedures involve undesirable risk to the patient, patient discomfort, and utilization of healthcare resources that could be put to other uses. Therefore reducing or eliminating the need for performing these replacement procedures is desirable.

Invention

This system allows for the harvesting of the body’ s mechanical energy (e.g. from the heart cycle of contraction-relaxation) and subsequent conversion into electrical energy using piezeoelectric materials. The piezoelectric materials are monolithically integrated with rectifiers and millimeter-scale batteries, allowing for concurrent power generation and storage of harvested electrical energy. The components of this system are coated in a biocompatible material with superior mechanical properties that allow for a uninhibited organ motion while avoiding delamination of the system. These Mechanical Energy Harvesting (MEH) units are arranged in the body with other, identical units in order to increase the power generation capability of the entire system. Results from bovine and ovine models indicate that such a system is easily capable of generating enough power to operate a cardiac pacemaker.

Application area

Application:This invention is capable of being used to power not only pacemakers, but also other implantable microelectronic devices such as heart rate monitors, cardioverter-defibrilators, neurostimulators, etc. The market and number of potential applications for this invention is expected to grow as advances in the field of implantable microelectronic devices increase the prevalence and types of said devices. Additionally, this invention may also be adapted for skin-mounted configurations, capable of producing power for not only health and wellness devices, but potentially non-biomedical devices, eliminating or reducing the need to replace the batteries of these devices as well.

This invention has been shown to be superior to the state of the art in in vivo experiments in bovine and ovine models.

•Output open-circuit voltages and short-circuit currents are 3 and 5 orders of magnitude greater, respectively, than those achieved in previous in vivo experiments
•Piezoelectric material monolithically integrated with rectifiers and millimeter scale batteries for simultaneous power generation and storage.
•Results indicate power production levels that are easily enough to power a cardiac pacemaker.
•Utilizes biocompatible materials with superior mechanical properties; also induces negligible constraints on motion of organs on which it is implanted – no detectable changes in cardiac conduction/epicardial motion even when affixed to the epicardium in in vivo results.
•Mechanically and electrically stable device behavior over 20 million cycles of bending/unbending in moist hydrogel environment.
•Maintains conformal contact with the heart, without delamination of the device, during the entire cycle of cardiac motion (contraction to relaxation).

Institution

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