electronics can be realized by a variable load circuit operably coupled to the output of the at least one piezoelectric element.

[0013a] In view of the above, according to a first aspect of the present invention, there is provided a system for converting environmental vibrational energy into electrical energy for storage in at least one electrical power storage device, the system comprising: a transducer that undergoes oscillating movement in response to the environmental vibrational energy, the transducer producing an oscillating electrical signal in response to the oscillating movement; power electronics, operably coupled between the transducer and the at least one electrical power storage device, the power electronics processing the oscillating electrical signal produced by the transducer, wherein the power electronics includes at least one control element having a configuration that provides variable dampening of the oscillating movement of the transducer in response to at least one control signal supplied thereto; at least one sensor for measuring properties of the oscillations of the transducer over time; and control electronics operably coupled to the at least one control element of the power electronics and to the at least one sensor, the control electronics carrying out a control scheme that generates and supplies the at least one control signal to the at least one control element over time in a manner that controls the at least one control element to dynamically vary the dampening of the oscillating movement of the transducer over time, wherein the control scheme is based upon a predetermined parametric relation involving a plurality of variables derived from the properties measured by the at least one sensor, wherein the plurality of variables include a first variable representing excitation frequency of the transducer.

[0013b] According to a second aspect of the present invention, there is provided a system for converting environmental vibrational energy into electrical energy for storage in at least one electrical power storage device, the system comprising: a transducer that undergoes oscillating movement in response to the environmental vibrational energy, the transducer producing an oscillating electrical signal in response to the oscillating movement of the transducer; power electronics, operably coupled between the transducer and the at least one electrical power storage device, the power electronics processing the oscillating electrical signal produced by the transducer, wherein the power electronics includes at least one control element having a configuration that provides variable dampening of the oscillating movement of the transducer in response to at least one control signal supplied thereto; at least one sensor for measuring properties of the oscillations of the transducer over time; and control electronics operably coupled to the at least one control element of the power electronics and to the at least one sensor, the control electronics carrying out a control scheme that generates and supplies the at least one control signal to the at least one control element over time in a manner that controls the at least one control element to dynamically vary the dampening of oscillations of the transducer over time, wherein the control scheme is based upon a predetermined parametric relation representing relative phase between two variables derived from the properties measured by the at least one sensor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Fig. 1 is a functional block diagram of an exemplary system that converts environmental vibrational energy into electrical energy for storage in at least one electrical power storage device in accordance with embodiments described herein,

[0015] Fig. 2 is a schematic representation of a mechanical model of the electromagnetic vibrational energy harvester of Fig. 1;

[0016] Fig. 3 is a schematic representation of an electrical model of the electromagnetic vibrational energy harvester of Fig. 1;

[0017] Fig. 4 is a graph of the simulation results showing the power harvested by the system of Fig. 1 as a function of excitation frequency, where the system employs a control scheme having a constant electrical damping factor; the different curves have different constant electrical damping factors as shown;

[0018] Figs. 5(A), 5(B) and 5(C) are graphs of the simulation results showing the transducer excitation, transducer response (relative velocity), and the time varying electrical damping factor of the system of Fig. 1 in the time domain, where the system employs a control scheme referred to herein as a simulated spring control scheme; Fig. 5(A) is a graph of the simulation results of the system for a subcritical excitation. Fig. 5(B) is a graph of the simulation results of the system for resonant excitation. Fig. 5(C) is a graph of the simulation results of the system for a