

IET Innovation Awards June 2022

Summary of entry

Entry in category: Most cutting edge solution in power and energy

Title: Electrostatic Power Generator

Long title: An alternative dynamo application, using electrostatics instead of electromagnetics

Overview:

Since the early 19th century, when Michael Faraday formulated his theory of electromagnetics, the production of electricity has been dominated by generators built on this principle. But these contain magnetic materials, sometimes requiring expensive elements such as Rare Earths, and they require sometimes complex windings that dissipate heat and waste source energy. There has to be a better way.

A whole branch of physics, Electrostatics, seems to have been confined to studying flashy spectacles and getting shocks from nylon carpets. But the possibility of using this phenomenon for mainstream useful purposes has been neglected, and this omission has inspired a ground-up review of possibilities.

When reviewing the basic theory of Electrostatics, and coupling this with Newtonian Mechanics, both of which are core parts of a scientific education, new possibilities emerge. Both subjects study work and energy: one relates energy to electrostatic charge distribution, and the other relates work to mechanical movement.

Two questions then arise. Firstly, can mechanical work/energy be efficiently converted to electrostatic energy/work. Secondly, can the electrostatic energy, in the form of stationary charges, be converted into a form that can be used for common applications.

This has led to the development of a device that, while appearing similar overall to conventional generators, operates on very different principles. Being electrostatic it requires no magnets or coil windings, which are costly in materials and construction. It can be made from any inexpensive, conductive material, such as aluminium, which would also save weight. And without coils of wire generating resistive heat, the prospect of greater inherent conversion efficiency is clear.

The other question is answered by a simple electronic circuit that delivers electrostatic energy in the form of controlled pulses into batteries that are capable of powering anything from small, portable devices to the new generation of motor vehicles.

How does it work?

Electrostatic theory shows that, when two plates separated by a dielectric are charged, a force exists between them. If they are then electrically isolated and separated, mechanical force and work is required. At the same time, as the charge remains unchanged, it is shown that the voltage existing between the plates increases.

The resulting combination of charge and voltage represents energy, and this exactly matches the mechanical work done.

The device, which consists simply of an inner and outer conductive tube, each castellated at their matching surface, operates simply by rotating one relative to the other and thereby changing the capacitance between them. By charging the cylinders from a battery when the castellations match (maximum capacitance between them), and rotating to a point where they do not match, the voltage increases, potentially many times that of the battery.

The charge/discharge process is completely automatic, without any form of mechanical synchronism, by a simple threshold switch that discharges the capacitance back into the battery. The process is repeated as the next castellations match, and as many times per revolution as there are castellations. The energy harvested per discharge is proportional to the square of the battery voltage.

How does your innovation make a difference?

Society depends extensively on electrical power, and this is expected to remain so. Some of that power is provided by rechargeable batteries, and this proportion can be expected to increase with the anticipated adoption of electrically powered vehicles. Also, as greater use is being made of ephemeral sources such as wind, sun, tide and waves, batteries are being developed that can store this energy and deliver it throughout the demand cycle.

Therefore a means of charging batteries directly from a device that harvests environmental energy, bypassing the high voltage alternating current supply and the AC to DC converters, has to be given serious consideration.

The Electrostatic Power Generator addresses this issue directly. It can be configured as a hub in a wind turbine or water turbine, or attached to any rotating machinery to provide auxiliary power through batteries.

Conceptually, this device is cheaper, lighter and more efficient than conventional electromagnetic devices. It can be scaled for many applications, and could serve for local micro-generation in houses and other buildings, which could save costs in using distributed (grid) power. It can charge batteries of any voltage, but is most productive with high voltage batteries, such as those used in motor vehicles.

50 word summary

The Electrostatic Power Generator provides electrical power for the purposes of charging batteries. It is inexpensive to produce and can take energy from natural resources such as wind and tide. It can be scaled for use in domestic or industrial contexts and could be used for charging vehicles.

Concept model

The following images were taken from a simple concept model constructed from 3-D printed plastic and conductive paint.

