2009

Regenerative Acceleration

Potential +/- Difference Inc

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"You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete."
— Richard Buckminster Fuller

Introduction

The following technology introduction is an article which is being prepared for the Professional Engineers of Ontario's - Ontario Centre for Engineering and Public Policy. The document is broken down into two parts where the first two pages are for non-engineers who just want an educated overview of the technology and the latter pages are for the more inquisitive reader.

Potential +/- Difference Inc. - Regenerative Acceleration Technology

Displacing Generator Electric Current and the Current Energy Generation Paradigm

In brief, Regenerative Acceleration Technology represents a new energy generation paradigm by displacing traditional seamless electric current in an electric generator with time delayed pulsed current. The result is a 180 degree paradigm shift from conventional generator operation, instead resulting in a generator which accelerates under load in direct violation of Lenz's law and the law of conservation of energy. Lenz's law is a law of physics which explains how magnetic drag or "magnetic friction" is created inside a generator. Lenz's law represents the equivalent of Newton's Third Law of Motion which states that;

"For every action there is an equal and opposite reaction."

This magnetic friction hinges solely on the existence of traditional seamless electric current flow in the generator coils. Lenz's law *and* the law of conservation are built on a traditional electric current foundation, any deviation represents an exception. Regenerative Acceleration technology exploits this exception by producing time delayed current pulses in a boundary region where these laws do not apply.

The "Current" Energy Paradigm

When a Conventional Generator delivers power to a load, the current flowing in the generator sets up a counter electromotive force or magnetic friction which causes the prime mover (whatever is turning the generator such as wind, water or steam) to DECELERATE in accordance with Lenz's law. This armature reaction or counter torque is commonly referred to as Regenerative Braking in an electric vehicle. The more current/power the generator delivers to the load, the greater the rate of deceleration.

New Energy Paradigm

Regenerative Acceleration generator technology, on the other hand, does NOT cause the prime mover to decelerate under load. In fact it causes it to ACCELERATE in violation of Lenz's law. This action occurs because the generator produces a complimentary rather than opposing electromotive torque to that supplied by the prime mover. When applied to electric vehicles the technology has the capacity to not only supply power to the batteries but accelerate the EV as well. The more power the generator delivers the greater the rate of acceleration.

The How and Why

Regenerative Acceleration is accomplished by forcing the primarily inductive generator coils to operate at higher frequencies where the coil's impedance (coil AC resistance + DC resistance) does not allow traditional seamless electric current to flow. Generator Armature Reaction (deceleration as dictated by Lenz's law) is a function of the magnitude of current flowing in the coil. No current flow equals no armature reaction and correctly timed current pulses equals an opposite armature reaction to anything previously known.

Prime mover acceleration is created by increasing and exploiting the generator coils self induced capacitance. Now at desired frequencies the generator coils no longer operate as inductors, storing energy in the Electromagnetic Field around the coil, but instead they operate as capacitors, storing energy in the Electrostatic Field - between the wires inside the coil. Acceleration occurs during the transition period when the generator's rotating magnetic field pole is top dead centre to a generator coil (neither approaching nor receding). At TDC the coil's stored voltage is at a maximum and the frequency is for an infinitesimally small moment, zero. At this exact TDC moment the generator coil's high impedance now drops to the low DC resistance of the coil because the AC resistance portion is a function of frequency which is zero. The large capacitively stored voltage is now able to be dissipated through the low DC coil resistance and a large current and delayed magnetic field is produced which now pushes away on the already receding rotor magnetic pole and simultaneously attracting the next opposite approaching rotor pole - thus accelerating the rotor and prime mover instead of decelerating it as in the conventional generator paradigm. An audible sound of magnetic flux hitting the rotor can be heard when the Regenerative Acceleration coils are engaged.

Next the High Voltage output from the Regenerative Acceleration coils is stepped down through a conventional transformer to the desired level to meet the load requirement.

How does Conventional Generator Current and Regenerative Acceleration Generator Current Differ?

Electric current flows continuously and seamlessly in a conventional generator when the generator is delivering power to a load. The magnitude of electric current also dictates the magnitude of the repelling counter electromotive force (magnetic friction) which operates in concert with current flow and is also seamless and continuous. The generator coil produces a constant repelling magnetic field as the magnet pole approaches the coil and then an attracting magnetic field as the pole attempts to move away. **The result is <u>additional</u> energy must be supplied to the prime mover to overcome this magnetic drag to maintain power to the load – or, quite literally the "lights go out".**

The Regenerative Acceleration Generator on the other hand produces a delayed (non seamless) current pulse and a delayed magnetic field pulse. This delayed magnetic field pulse (electromotive force) is produced at just the right time (TDC) to reverse the effects of magnetic

drag and create a magnetic dividend which attracts the approaching magnetic field pole (instead of repelling it) and repels the receding pole (instead of attracting it.) **The result is reduced energy must be supplied to the prime mover while at the same time power to the load increases to the point where the lights get brighter and eventually "blow out" due to too much power.**

In the following slightly technical discussion on Lenz's Law and the law of conservation of energy (from Wikipedia) we can see just how utterly dependant these two well established laws of physics are on current flowing in a generator coil. If we removed the word "current" (as underlined) from the text below, both of these laws of physics cease to have any relevance to this particular system of electricity generation.

Lenz's law

Lenz's law is an extension of the law of conservation of energy to the non-conservative forces in electromagnetic induction. It can be used to give the direction of the induced electromotive force (EMF) and current resulting from electromagnetic induction. Heinrich Lenz postulated in 1834 the following law;

"An induced current is always in such a direction as to oppose the motion or change causing it."

The law provides a physical interpretation of the choice of sign in Faraday's law of induction, indicating that the induced EMF and the change in flux have opposite signs.

Explanation of Lenz's law

If the magnetic field associated with the current in a conductor were in the same direction as the change in magnetic field that created it, these two magnetic fields would combine to give a net magnetic field which would in turn induce a current with twice the magnitude. This process would continue creating infinite current from just moving a magnet: this would be a violation of the law of conservation of energy.

Connection with law of conservation of energy

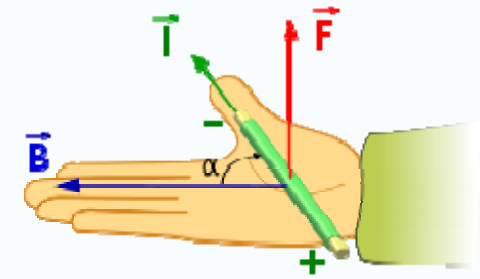
The law of conservation of energy relates exclusively to irrotational (conservative) forces. Lenz's Law extends the principles of energy conservation to situations that involve non-conservative forces in electromagnetism. To see an example, move a magnet towards the face of a closed loop of wire (eg. a coil or solenoid). An electric current is induced in the wire, because the electrons within it are subjected to an increasing magnetic field as the magnet approaches. This produces an EMF (electro-motive force) that acts upon them. The direction of the induced current depends on whether the north or south pole of the magnet is approaching: an approaching north pole will produce a counter-clockwise current (from the perspective of the magnet), and south pole approaching the coil will produce a clockwise current.

To understand the implications for conservation of energy, suppose that the induced currents' directions were opposite to those just described. Then the north pole of an approaching magnet would induce a south pole in the near face of the loop. The attractive force between these poles

would accelerate the magnet's approach. This would make the magnetic field increase more quickly, which in turn would increase the loop's current, strengthening the magnetic field, increasing the attraction and acceleration, and so on. Both the kinetic energy of the magnet and the rate of energy dissipation in the loop (due to Joule heating) would increase. A small energy input would produce a large energy output, violating the law of conservation of energy. [*This is actually what occurs during Regenerative Acceleration operation].*

This scenario is only one example of electromagnetic induction. Lenz's Law states that the magnetic field of any induced current opposes the change that induces it.

Force on a current-carrying wire



Right hand rule for a current-carrying wire in a magnetic field B

When a wire carrying an electrical current is placed in a magnetic field, each of the moving charges, which comprise the current, experiences the Lorentz force, and together they can create a macroscopic force on the wire (sometimes called the **Laplace force**). By combining the Lorentz force law above with the definition of electrical current, the following equation results, in the case of a straight, stationary wire:

$$\mathbf{F} = I\mathbf{L} \times \mathbf{B}$$

where

F = Force, measured in newtons
I = current in wire, measured in amperes
B = magnetic field vector, measured in teslas
×= vector cross product
L = a vector, whose magnitude is the length of wire (measured in metres), and whose direction is along the wire, aligned with the direction of conventional current flow.

Alternatively, some authors write

$$\mathbf{F} = L\mathbf{I} \times \mathbf{B}$$

where the vector direction is now associated with the current variable, instead of the length variable. The two forms are equivalent.

If the wire is not straight but curved, the force on it can be computed by applying this formula to each infinitesimal segment of wire d$\boldsymbol{\ell}$, then adding up all these forces via integration. Formally, the net force on a stationary, rigid wire carrying a current I is

$$\mathbf{F} = I \oint d\boldsymbol{\ell} \times \mathbf{B}(\boldsymbol{\ell})$$

(This is the net force. In addition, there will usually be torque, plus other effects if the wire is not perfectly rigid.)

One application of this is Ampère's force law, which describes how two current-carrying wires can attract or repel each other, since each experiences a Lorentz force from the other's magnetic field. For more information, see the article: Ampère's force law.

EMF

The magnetic force (q **v** × **B**) component of the Lorentz force is responsible for **motional** electromotive force (or motional EMF), the phenomenon underlying many electrical generators. When a conductor is moved through a magnetic field, the magnetic force tries to push electrons through the wire, and this creates the EMF. The term "motional EMF" is applied to this phenomenon, since the EMF is due to the motion of the wire.

In other electrical generators, the magnets move, while the conductors do not. In this case, the EMF is due to the electric force (q**E**) term in the Lorentz Force equation. The electric field in question is created by the changing magnetic field, resulting in an **induced** EMF, as described by the Maxwell-Faraday equation (one of the four modern Maxwell's equations).[20]

Both of these EMF's, despite their different origins, can be described by the same equation, namely, the EMF is the rate of change of magnetic flux through the wire. (This is Faraday's law of induction, see above.) Einstein's theory of special relativity was partially motivated by the desire to better understand this link between the two effects.[20] In fact, the electric and magnetic fields are different faces of the same electromagnetic field, and in moving from one inertial frame to another, the solenoidal vector field portion of the E-field can change in whole or in part to a B-field or vice versa.[21]

Electrical generator

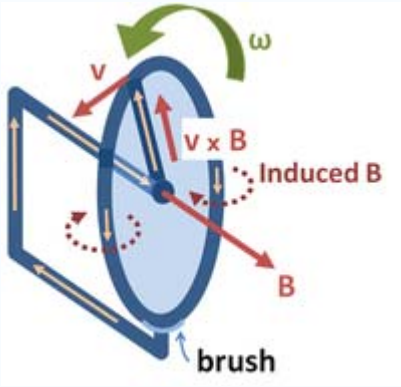


Figure 8: Faraday's disc electric generator. The disc rotates with angular rate ω, sweeping the conducting radius circularly in the static magnetic field **B**. The magnetic Lorentz force **v** × **B** drives the current along the conducting radius to the conducting rim, and from there the circuit completes through the lower brush and the axle supporting the disc. Thus, current is generated from mechanical motion.

The EMF generated by Faraday's law of induction due to relative movement of a circuit and a magnetic field is the phenomenon underlying electrical generators. When a permanent magnet is moved relative to a conductor, or vice versa, an electromotive force is created. If the wire is connected through an electrical load, current will flow, and thus electrical energy is generated, converting the mechanical energy of motion to electrical energy.

In the Faraday's disc example, the disc is rotated in a uniform magnetic field perpendicular to the disc, causing a current to flow in the radial arm due to the Lorentz force. It is interesting to understand how it arises that mechanical work is necessary to drive this current. When the generated current flows through the conducting rim, a magnetic field is generated by this current through Ampere's circuital law (labeled "induced B" in Figure 8). The rim thus becomes an electromagnet that resists rotation of the disc (an example of Lenz's law). On the far side of the figure, the return current flows from the rotating arm through the far side of the rim to the bottom brush. The B-field induced by this return current opposes the applied B-field, tending to decrease the flux through that side of the circuit, opposing the increase in flux due to rotation. On the near side of the figure, the return current flows from the rotating arm through the near side of the rim to the bottom brush. The induced B-field increases the flux on this side of the circuit, opposing the decrease in flux due to rotation. Thus, both sides of the circuit generate an EMF opposing the rotation. The energy required to keep the disc moving, despite this reactive force, is exactly equal to the electrical energy generated (plus energy wasted due to friction, Joule heating, and other inefficiencies). This behavior is common to all generators converting mechanical energy to electrical energy.

The following is a business plan questionnaire presented to Potential Difference Inc by Jim Roche, CEO of Stratford Managers.

Jim Roche is President & CEO of Stratford Managers, a company he founded in 2006..Stratford works with fast-growing businesses around the world involved in service delivery, high technology, clean technology and manufacturing as well as non-profit companies like CMC where Jim acted as interim President and CEO in early 2007.

Prior to starting Stratford, Jim was President & CEO of Tundra Semiconductor, a company he co-founded in 1995.

Prior to starting Tundra, Jim was a founding member in 1986 of Newbridge Networks Corporation, a manufacturer of data and voice communications products. He helped Newbridge grow to over 5,000 employees and earn revenues of over $1B. Newbridge was acquired by Alcatel in 2000.

Jim has served on numerous public, private and non-profit boards including Stratford, Tundra, Fidus, CANARIE, CMC, Precarn, OCRI and others.

The Business Problem You're Solving

What is the business (not technical) problem? How is it solved now? Who is affected?

At the present time electric vehicle acceptance and integration into the marketplace is hampered by poor range, long recharge times not to mention nonexistent EV recharge infrastructures. These issues are addressed and eliminated with the employment of EV Regenerative Acceleration Technology because now “plug in recharging” can be made virtually obsolete.

Car manufacturers – struggling with battery weight and range limitations, governments – footing the bill for recharge stations, consumer inconvenience and the environment will all be positively affected by the integration of Regenerative Acceleration Technology.

The Business Solution

What is your business solution (not technical) and how/why is it a better solution?

Currently electric vehicles have only two modes of recharging their mass of up to 1000 lb batteries; 1) plugging them into the grid, 2) regenerative braking (which recharges the batteries while slowing down, “breaking” the EV at the same time). As the name implies – Regenerative Acceleration is the exact opposite of regenerative braking in that the generator now recharges the batteries while accelerating the vehicle. Now EV batteries can be recharged during both braking, acceleration and coasting.

Regenerative Acceleration Technology has the capacity to dramatically increase EV range and performance while at the same time reducing battery size and weight and completely eliminating grid “plug ins” because battery recharging can occur during more than 100% of the EV operation if an additional flywheel is employed while the EV is stationary.

Market Opportunity / Strategy

How many people/companies are affected by this problem, what are they spending today to overcome it, how much will they spend for your solution?

Regenerative Acceleration Technology has viable solution applications in every single energy sector worldwide – basically anywhere energy is produced and used from Nuclear power, hydroelectric plants to home emergency generators and everything and everywhere in between.

Power generation based on Regenerative Acceleration Technology would result in virtually none of the environmental damage currently caused by traditional power sources, and could ultimately replace these traditional sources in many contexts. Therefore, there is virtually unlimited financial potential for the application of Regenerative Acceleration Technology.

Products / Technology

What is your technology solution, what is your unfair technical advantage - your "secret sauce"?

Generator technologies which ACCELERATE under load in rather than decelerate and outperform current generator technology at this early stage by over 4000%