Introducing the Practice of Asymmetrical Regauging to Increase the Coefficient of Performance of Electromechanical Systems

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***Abstract*--This paper introduces an asymmetrical regauging physics used to increase the coefficient of performance of a specially designed electric motor. The coefficient of performance terminology, a review of gauge theory, and an examination of discarding the Lorentz condition to achieve asymmetrical regauging are presented.**

I. INTRODUCTION

A project is underway to investigate a process referenced in recent permanent magnet (PM) motor patents [1].[1] These specially designed PM motors claim to capture and use environmental energy as an additional energy input. The term coefficient of performance (COP) is introduced to adequately describe the energy transfer of these motors. The technique that allows this energy transfer to occur is called asymmetrical regauging (ASR). The physics behind the ASR process will be examined by reviewing gauge theory, the Lorentz gauge, and the effect of discarding the Lorentz gauge to include the vacuum current density.

II. COEFFICIENT OF PERFORMANCE

The energy transfer of electrical machinery is generally described using the term "efficiency". Efficiency is defined as the power output divided by the total power input from all sources. The underlying assumption when defining the energy of any system is that all the energy input is from an identifiable and measurable energy sources(s). In an ideal system the efficiency would be one. The equation for efficiency (η) is normally stated [2] as

$$\eta = \frac{P_{Out}}{P_{In}} \text{ [Watts].} \quad (1)$$

Coefficient of performance is a broader energy transfer term that defines the measure of energy output divided by the operator's energy input. COP is used to describe any machinery that has additional energy input from the environment. For example, COP is commonly used to describe the energy exchange of heat pumps[3] or solar collectors. Unlike the term "efficiency", the COP can be greater than one. See Fig. 1 for the energy flow diagram. The following equation defines COP mathematically.

$$COP \equiv \frac{P_{Out}}{P_{In(Operator)}} \text{ [Watts]} \quad (2)$$

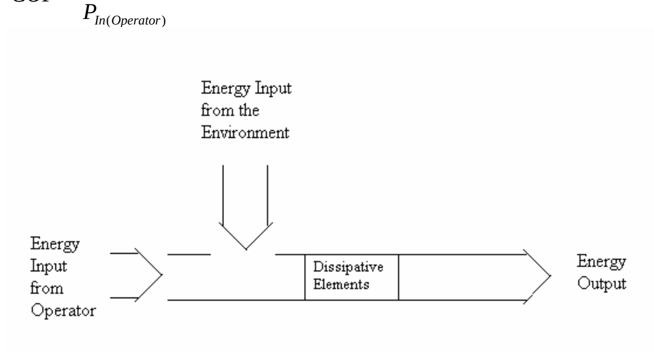

Fig. 1. Energy flow for machines described by COP.

III. REVIEW OF THE LORENTZ GAUGE

To understand how environmental energy may be utilized in a motor, to theoretically gain a COP >1, a review of the Lorentz gauge is first presented. The equations used in standard practice to design motors are derived from Maxwell's equations. It has been accepted practice, to apply the Lorentz gauge to these equations to make them simpler. In abbreviated steps, we start with Maxwell's equations [4]:

$$\nabla \bullet \vec{E} = \frac{1}{\varepsilon_0}\rho \quad \text{(Gauss's law)} \quad (3)$$

$$\nabla \bullet \vec{B} = 0 \quad (4)$$

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad \text{(Faraday's law)} \quad (5)$$

$$\nabla \times \vec{B} = \mu_0 \vec{J} + \mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial t} \quad \text{(Ampere's law \& displacement current)} \quad (6)$$

All the information in Maxwell's four equations can be reduced to the following equation [4]:

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$$\left(\nabla^2\vec{A}-\mu_0\varepsilon_0\frac{\partial^2\vec{A}}{\partial t^2}\right)-\nabla\left(\nabla\bullet\vec{A}+\mu_0\varepsilon_0\frac{\partial V}{\partial t}\right)=-\mu_0\varepsilon_0\vec{J} \tag{7}$$

The Lorentz gauge is then applied to reduce the complexity of these two equations. Mathematically, applying any gauge, is represented by (9,10) where gamma is an arbitrary, differentiable scalar function called the *gauge function* [5] .

$$V(t,x)\mapsto V'(t,x)=V(t,x)-\frac{\partial\Gamma(t,x)}{\partial t} \tag{8}$$

$$\vec{A}(t,x)\mapsto\vec{A}'(t,x)=\vec{A}(t,x)+\nabla\Gamma(t,x) \tag{9}$$

To specifically apply the Lorentz gauge, the "Lorentz Condition" is imposed by choosing a set of potentials (A, V) such that

$$\nabla\bullet\vec{A}=\mu_0\varepsilon_0\frac{\partial V}{\partial t}\,. \tag{10}$$

Using the Lorentz gauge, (7, 8) can be reduced to (11,12) [5]. Equations (11,12) are the ones on which all the equations for motor design are currently based. Since the magnetic vector field and the voltage scalar field are both changed at the same time, this is an example of what can be referred to as symmetrical gauging.

$$\nabla^2\vec{A}-\mu_0\varepsilon_0\frac{\partial^2\vec{A}}{\partial t^2}=-\mu_0\vec{J} \tag{11}$$

$$\nabla^2 V-\mu_0\varepsilon_0\frac{\partial^2 V}{\partial t^2}=-\frac{1}{\varepsilon_0}\rho \tag{12}$$

Notice that (11) is (7) with the middle term, (13), eliminated.

$$-\nabla\left(\nabla\bullet\vec{A}\right)+\mu_0\varepsilon_0\frac{\partial V}{\partial t} \tag{13}$$

IV. Asymmetrical Regauging

Invoking the Lorentz condition in classical electromagnetics discards the vacuum polarization component that exists in quantum electrodynamics [6] since

$$-\nabla\left(\nabla\bullet\vec{A}\right)+\mu_0\varepsilon_0\frac{\partial V}{\partial t}=\mu_0\vec{j}_A \tag{14}$$

and $\vec{j}_A=\sigma\vec{E}_A$ (15)

Asymmetrical regauging is the equivalent of discarding the Lorentz condition. Further ASR is any process that changes the potential energy of a system and also produces a net force in the process [6].

Understanding the vacuum and its polarization are essential steps to utilizing energy from the environment. According to Noble Laureate T.D. Lee, quantum physicists define the vacuum state as the lowest energy state of the system [7]. Hence, the vacuum is considered to be the worst case model of the environment. Maxwell's equations must be modified, in the vacuum, since ρ and $\vec{J}$ vanish. Classically, this causes the Ampere-Maxwell law to be revised.

$$\nabla\times\vec{B}=\mu_0\varepsilon_0\frac{\partial\vec{E}}{\partial t} \tag{16}$$

In [6, 8], the authors show that if the vacuum current density factor is included, the above equation changes to

$$\nabla\times\vec{H}=\vec{j}_A+\frac{\partial\vec{D}}{\partial t} \tag{17}$$

where $\vec{D}=\varepsilon_0\vec{E}+\vec{P}_A$ and $\vec{H}=\frac{1}{\mu_0}\vec{B}-\vec{M}$. (18)

This leads to the result that

$$\frac{\partial\vec{P}_A}{\partial t}=\vec{j}_A\,. \tag{19}$$

Hence, discarding the Lorentz condition in classical electrodynamics leads to new equations that include the effect of the vacuum polarization.

It has already been shown in quantum electrodynamics that the vacuum behaves like a dielectric [9]. The vacuum sprouts positron-electron pairs as shown in the Feynman diagram in Fig. 2.

Fig. 2. Feynman diagram of positron-electron pair.

V. Future Work

It has been shown that by discarding the Lorentz gauge, the Ampere-Maxwell law equation evolves to include the current density of the vacuum. Also, the task remains to develop the equation and determine the process to apply it to magnetic motors. The predecessor to this patented motor appears to be a motor previously called the "Wankel motor" [10]. Future work is planned to study the Wankel motor to ascertain the exact mechanism involved that allows this motor to exchange energy with the vacuum.

VI. Conclusion

It has been suggested in at least one recent patent that it is possible to make use of energy from the environment as an extra source in permanent magnet motors. This paper presents a new term “coefficient of performance’ which may be used to more adequately describe the energy transfer of such an electromechanical system. This paper also shows the physics behind one possible explanation for this phenomenon.

The physics is explained by first considering how the Lorentz gauge is used to give us the design equations used today. The Lorentz gauge is then discarded to show how the current density of the vacuum may be included in the Maxwell-Ampere equation. They term asymmetrical regauging is introduced for this procedure. The particle physics explaining the vacuum polarity is introduced. A thorough investigation for practical application of this new equation is encouraged by suggestion that further study be applied to the “Wankel motor”.

NOMENCLATURE

∇	Vector operator “del”= $\hat{x}\frac{\partial}{\partial t} + \hat{y}\frac{\partial}{\partial t} + \hat{z}\frac{\partial}{\partial t}$.
$\vec{A}$	Magnetic vector potential
$\vec{B}$	Magnetic field
ε_0	Permitivity of free space
$\vec{E}$	Electric field strength
$\vec{J}$	Electric current density (volume)
$\vec{j}_A$	Vacuum current density
$\vec{M}$	Magnetic dipole moment
μ_0	Permeability of free space
$\vec{P}_A$	Classical vacuum polarization (Dipole moment per unit volume)
ρ	Charge density
σ	Vacuum conductivity
V	Electric potential

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