A Possible Means for Extracting Energy from the Earth's Magnetic Vector Potential

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1. Introduction

My paper [1] brought attention to the huge magnetic vector potential of the Earth and dealt with the so-called electro-kinetic potential obtained from movement through that vector field. This present paper deals with movement of conduction electrons at low drift velocities and suggests possible ways that induced potential might give rise to anomalous results. A further paper will deal with electrodes on spinning discs where much greater velocities can be achieved.

2. More on $(\mathbf{v} \cdot \mathbf{A})$ and $\nabla(\mathbf{v} \cdot \mathbf{A})$

We are interested in drift velocity of electrons along a stationary filamentary wire, see section 3 for more details. The spatial variations in electron velocity can come from classical linear acceleration (or deceleration) along the wire or from constant velocity around a curved wire. For a filamentary conductor the electron drift velocity direction is along the wire, hence the potential $\mathbf{v_d} \cdot \mathbf{A}$ at any point is simply the tangential component of **A** as measured along the wire at that point multiplied by the electron drift velocity (to emphasise we are dealing with drift velocity we have added the subscript $_\mathbf{d}$). As its name implies this is a scalar that has the units of volts, it is a scalar electric potential. Equation (5) or (6) of ref. [1] yield the effective **E** field along the wire (whatever contour it follows) and $\mathbf{v_d} \cdot \mathbf{A}$ at any point along the wire is the induced potential. It follows that the voltage induced across a finite length of conductor of uniform cross section is given by the difference in potential $\mathbf{v_d} \cdot \mathbf{A}$ evaluated at the far end from that evaluated at the beginning, and this is independent of the route followed by the wire. It also follows that for a closed loop conductor, where start and end points are the same, the induced voltage is zero, hence there is zero induced current into the loop. However we can deliberately drive current around a closed loop to obtain variations in the EK potential $\mathbf{v_d} \cdot \mathbf{A}$ at different points around the loop. This applies even when **A** is uniform leading to the unusual situation where the drift velocities or currents around the loop may not be uniform. This seemingly is a violation of Kirchoff's Law!

Variation in current and potential along a wire is a well-known phenomenon in standing waves where the effect is produced by em waves propagating in opposite directions. There the potential maxima coincide with current (hence drift velocity) minima, for 100% standing waves the drift velocity is zero at the potential maxima. So we have quasi-static surface electrons at the negative potential maxima that explain the seeming violation of Kirchoff's Law. These can be bled off into a load via connections to the wire. As stated in [1] we cannot do this in our closed loop, we must maintain the electron velocity at the potential maxima. If we deliberately cause the EK potential to be alternating (by deliberately driving alternating current into our loop) it is possible that energy can be extracted via Maxwell's displacement current and that does not involve electron flow away from the conductor. By capacitively coupling to the wire as shown in figure 1, AC current can flow into the load without any alteration to the velocity direction of the electrons in the wire. That extraction of power can result in change of the electron velocity magnitudes in the wire, but this is simply using the induced field as the source of energy whereby the load reacts on that source. In effect the presence of the **A** field supplies additional force to push the moving electrons along one half of the circular trajectory at greater drift velocity, followed by additional reverse force along the other half of the circle to slow down the drift velocity. This variation in drift velocity creates the imbalance of electron density that supplies the electric field driving the displacement current. Whether the presence of the load supplies some reaction to the AC drive remains to be seen, but essentially the AC drive is simply driving current into a short circuit hence a zero power loss.

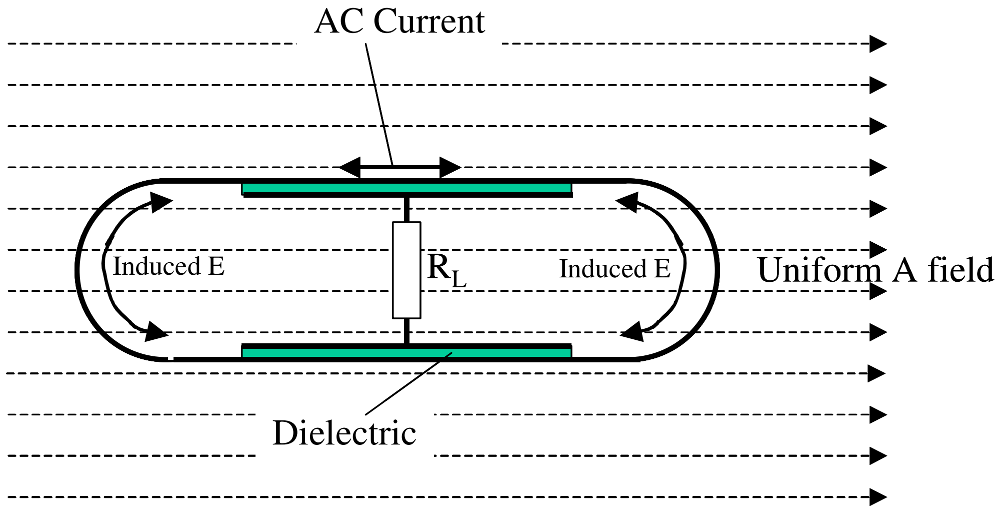

Figure 1. Closed loop experiment.

Here we have a closed loop of current within the **A** field, and the electro-kinetic potentials induced create charge on the straight sections that couple via dielectric to other electrodes. If the current in the loop is alternating then we should see an alternating voltage across the resistor. *Note that we cannot simply connect capacitors to the top and bottom of the loop* because in those capacitors the charge on the plates becomes stationary, and that implies deceleration which negates the induced E field. *We must have current flowing along one electrode of each capacitor*. If we wish to use classical techniques for obtaining high value capacity then we need specially constructed capacitors to allow this situation to occur.

Figure 2 shows the situation at the peak of one half cycle of current with of course reversed polarity for the other half cycle.

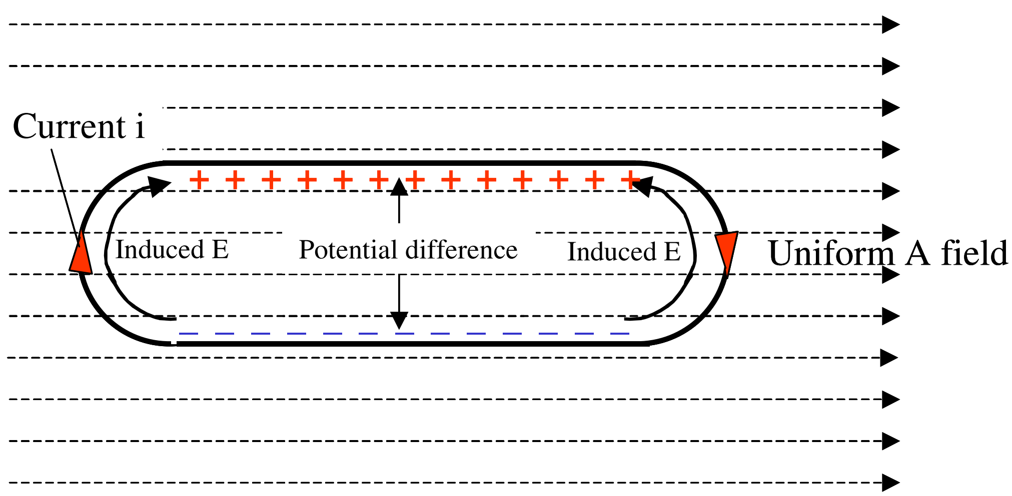

Figure 2. One half cycle peak

A practical realization of this experiment is shown in figure 3. The input has to drive current in the loop that will appear as a short circuit to the source, but we should see the voltage induced from the Earth's **A** field. The straight sections must lie on the E-W axis and reversing the whole system should create a 180° phase reversal of that induced voltage.

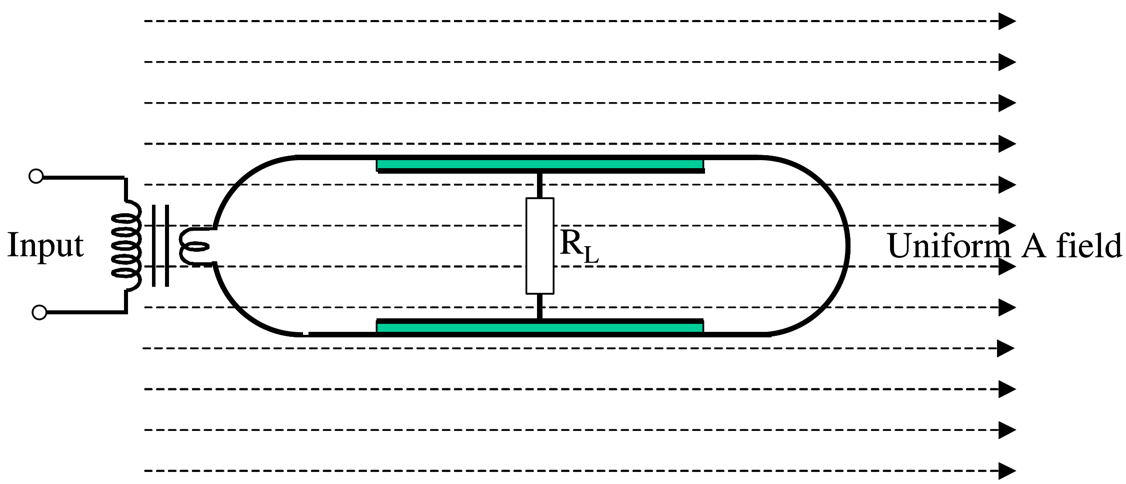

Figure 3. Practical experiment

If this experiment gives a positive result it will be the first conclusive evidence that energy can be extracted via the vector magnetic potential. Also it provides the first ever instrument for measuring that vector potential. And it offers potential as a means of creating an electronic compass.

3. Drift velocity considerations

The volumetric number density N_D of atoms in a material is given by

$$N_D = \frac{N_A \rho}{W_A} \text{ per cm}^3 \tag{1}$$

where N_A is Avagrado's number, ρ is the density and W_A the atomic weight. For copper ρ is 8.92 g/cm^3, W_A is 63.54 and Avagrado's number is 6.025×10^{23}. Thus 1 cm^3 of copper contains 8.46×10^{22} atoms. With one conduction electron per atom that same number applies to the electron density. For a wire of diameter d mm carrying a current i the drift velocity v_d is given by

$$v_d = \frac{4000i}{\pi e N_D d^2} \text{ mm/s} \tag{2}$$

where e is the electron charge 1.602×10^{-19} Coulombs.
Thus a copper wire 1mm diameter carrying 1 amp has a drift velocity of 9.39×10^{-2} mm/s, or 9.39×10^{-5} m/s in SI units. Using that SI value against typical laboratory vector potential differences we get trivial induced potentials of only fractions of a micro-volt. Such tiny voltage is unlikely to be of any use. However in the Earth's equatorial vector field varying tangentially from +200 to –200 Weber/m a U shaped wire would have an induced potential of 37.6 milli-volts which is much more respectable. Since that voltage is for a current of 1 amp the induction can be represented by a negative resistor of magnitude 37.6 milliohms but note this value applies to our 1mm diameter wire. In view of the simplicity of denoting the induction by a resistor value, enabling equivalent circuits to be created and solved, a useful formula for the induced resistance R_{ind} in U shaped copper wires of diameter d mm undergoing a 180 degree change from parallel to anti-parallel within a uniform vector potential field is

$$R_{ind} = \pm \frac{9\cdot4\times10^{-5} A}{d^2} \text{ Ohms} \tag{3}$$

where R_{ind} can be positive or negative depending on the initial parallel current direction relative to the **A** field. Note that this value may not apply to HF alternating current where skin effect will increase the drift velocity (for a given current) and therefore increase the value of R_{ind}. Figure 4 shows the equivalent circuit for the proposed experiment.

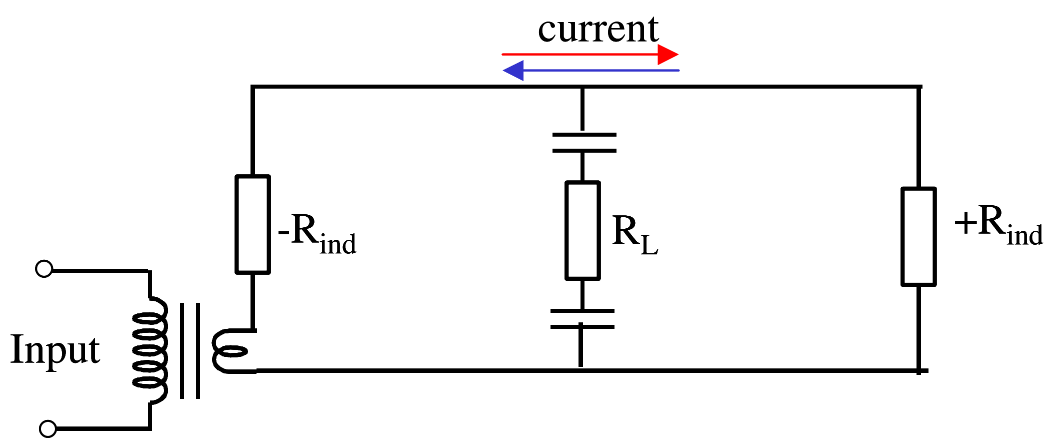

Figure 4. Equivalent Circuit

(Note that in this circuit we show capacitors as components connected by wires to the loop, and therefore current flows along these wires into the load R_L. However in the real circuit no electrons actually leave the loop, the current flow there is Maxwell's displacement current.)

The driver sees induced $+R_{ind}$ and $-R_{ind}$ in series hence sees only a short circuit that does not consume any power (we have ignored actual wire resistance here). Solving this circuit gives some indication of how the system can obtain power in its load R_L. If energy is gained from the **A** field then we should see OU with regard to the input power and the power dissipated in R_L.

4. Increasing Drift velocity

The drift velocity v_d is known to be proportional to the E field in the wire, the fermi velocity v_f of the electrons and the electron mean-free-path λ as given by

$$v_d = \frac{e}{m}\frac{E\lambda}{v_f}. \tag{4}$$

where *e/m* is the electron charge to mass ratio. For a Maxwellian distribution of velocities the mean-free-path is given by

$$\lambda = \frac{1}{\left(\sqrt{2}\right)N_D\sigma} \tag{5}$$

where N_D is the number density of atoms and σ is the collision cross section area of the electron against those atoms. Putting (5) into (4) yields

$$v_d = \frac{e}{m}\frac{E}{\left(\sqrt{2}\right)v_f N_D\sigma} \tag{6}$$

Note that v_d is inversely proportional to the number density of atoms. Generally the number density N_D is given by (1), but if we could create a conduction path that had a lower value then we could achieve higher drift velocity. Such a conduction path can occur on the surface of a conductor if there is a static electric field present pulling electrons to the surface, i.e. the conductor is the negative plate of a capacitor that has a high DC potential applied to it. Clearly those surface electrons can exist slightly above the surface of the ion lattice, held there by Coulomb attraction to the ions, where they can more freely travel across the surface without colliding with ions. Surface texture would play its part in this. There is some evidence of this effect being present in experiments that have shown anomalous effects, such as Russion inventor Sergy Alexeew's device [2].

5. Conclusions

For typical drift velocity of electrons in a copper wire their electro-kinetic (EK) potential in the Earth's magnetic vector potential **A** field is not trivial. This paper suggests how that EK potential could be measured. If the experiment proves successful it could provide the first ever instrument for measuring a static magnetic vector potential. It would also offer possibilities as a magnetic compass since the Earth's **A** field points E-W. There would also be the possibility of extracting energy from the Earth's field.

References.

[1] Electro-kinetic Potential in the Earth's A Field
http://www.overunityresearch.com/index.php?action=dlattach;topic=3395.0;attach=23796

[2] Considerations on Sergy Alexeew's TPU Scheme
http://www.overunityresearch.com/index.php?action=dlattach;topic=3248.0;attach=21262