# Creating Electron Current in Ferromagnetic Wires by Moving Magnetic Gradients

©Cyril Smith, April 2015

## 1. Introduction.

This paper deals with electron bunching in conducting ferromagnetic material created by magnetic gradients. It is shown that these bunches can be moved along a ferromagnetic wire by appropriately phased coils, hence constituting an electric current. If that current flows through a load, power can be extracted but it would appear that there could be no reaction on the drive coils that create the current. This system is worthy of investigation.

## 2. Conduction Electrons in Ferromagnets.

Figure 1 depicts spin-polarized electrons within a Fe wire. A coil around the wire is DC energized thus creating the internal magnetization that aligns the spinning electrons. However with the coil being of limited extent, the field magnitude falls off each side of the coil, thus creating a field gradient. The mobile conduction electrons obtain translatory force from that gradient, and therefore get attracted towards the centre of the coil, creating there an electron bunch.

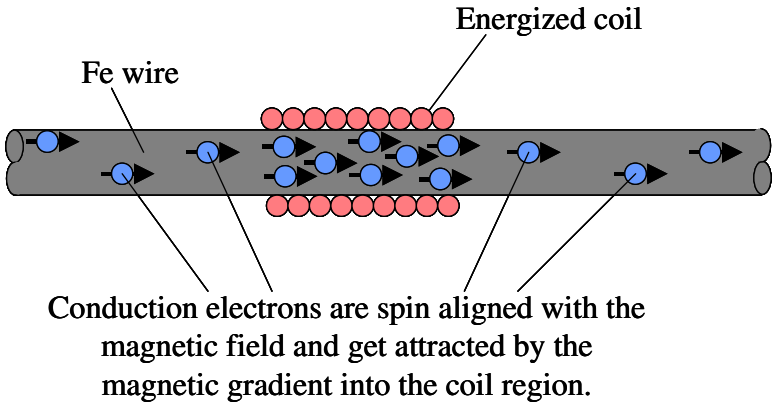


**Figure 1. Electron bunching**

Figure 2 shows the field lines with $B_1$ the field at the centre of the coil and $B_2$ the reduced field some distance away. The field gradient creates forces that can be represented by an effective potential difference $V$ between the $B_1$ and $B_2$ positions of magnitude $|V| = \left(\frac{\mu_B}{e}\right)(B_1 - B_2)$ where $\mu_B$ is the Bohr magneton and $e$ the electron charge.

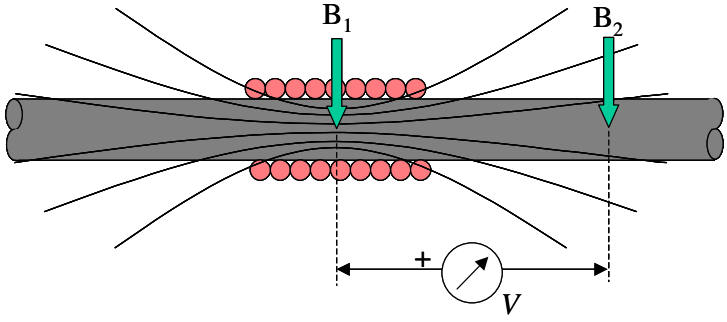


**Figure 2. Field Lines and Effective Potential Difference**

Note that this *V* is the electric potential difference that would be needed to apply an electric force of the same value as that actually applied as a magnetic force, which is why it is called an *effective* potential difference. Electrons are magnetically attracted towards the coil centre, a stable position being reached when the resulting non-uniform charge distribution nulls out the effective potential difference.

### 3. Linear Motor Driven Electrons

The linear motor invented by Prof. Eric Laithwaite is now well known as a propulsion means. That principle can be applied to electron bunches as shown in the next two figures. Figure 3 depicts a series of overlapping coils wound around a ferromagnetic wire such as Fe. Alternate inner coils are energised with alternate magnetization directions, thus creating magnetic nulls between the coils where the flux lines leave the wire. Electrons will bunch within those coils as shown in figure 3.

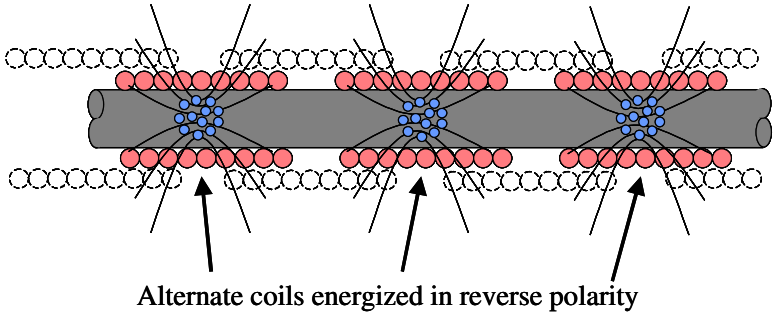


**Figure 3. Sequential Coils creating an Electron Chain**

The outer coils are energised in a similar manner but at a 90 degree phase difference, Figure 4 showing the situation after a quarter cycle. The electron bunches now occur at the centre of the outer displaced coils, all bunches have moved to the right.

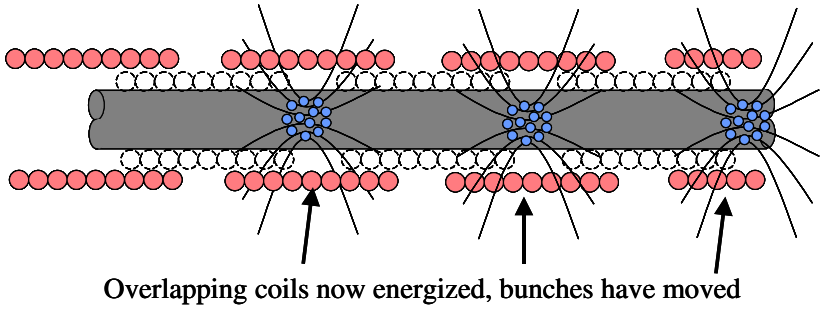


**Figure 4. Displaced Coils Energized**

Thus we have a system for transporting electron bunches along a Fe wire entirely by magnetic means. We could have multiple Fe wires insulated from each other within the coils, and these could be formed as a multiple-turn coil of Fe wire as shown in Figure 5. This depicts in cross section a Fe wire coil wound in the form of a ring-core with the motor windings wound in toroidal form around it. The number of overlapping motor coils shown is not typical, this could be simply two pairs or any even multiple. The motor coils can be driven at a frequency that creates significant electron velocity along the Fe wire so a significant output voltage is to be expected. It would be interesting to see the results of an experiment of this nature, and to see whether power into a load connected across the Fe coil reflects back as power consumed by the drive system.

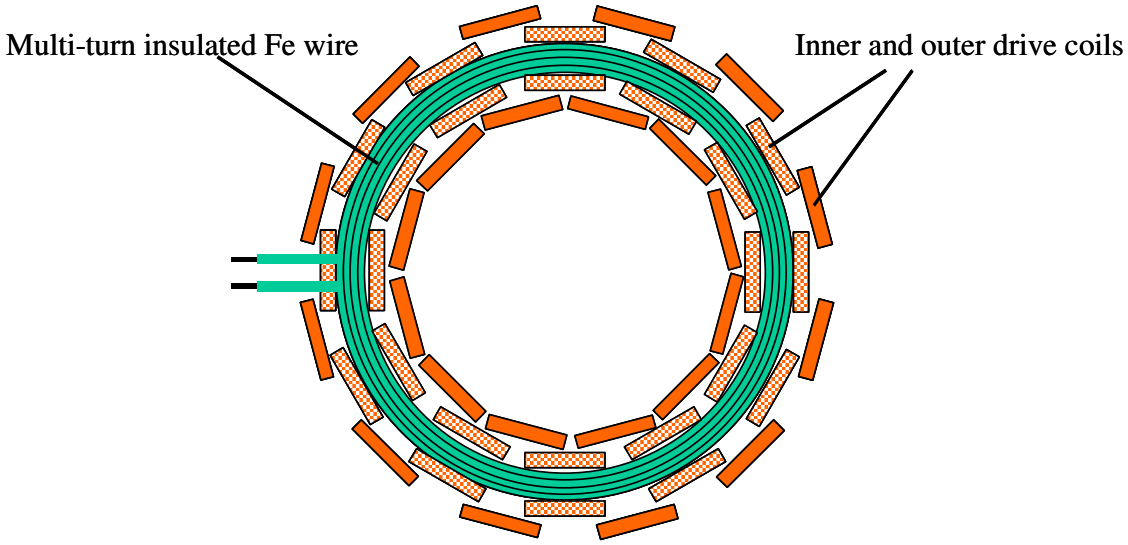


**Figure 5. Suggested Experiment**