How FMR could explain the Coler Stromerzeuger

The Hudson letter in the UK National Archives mentions cores "arranged in zig-zag formation". This suggests a layout like that shown in figure 1.

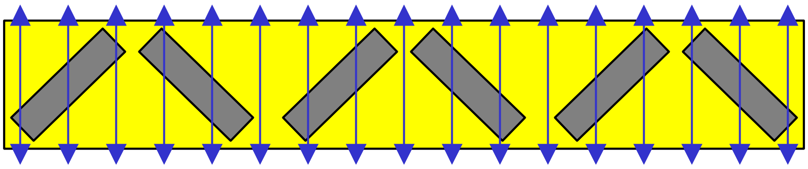

Figure 1. Zig-zag formation of cores.

That is unlike the cores shown in the Norrby patent where they are all vertical. Being within the vertical RF magnetic field (shown by the blue vectors in figure 1) of the large flat coils it is clear that each core sees a transverse component of RF field. That transverse RF field, along with the longitudinal static magnetizing field, will create a transverse oscillation of the magnetic vector as shown in figure 2.

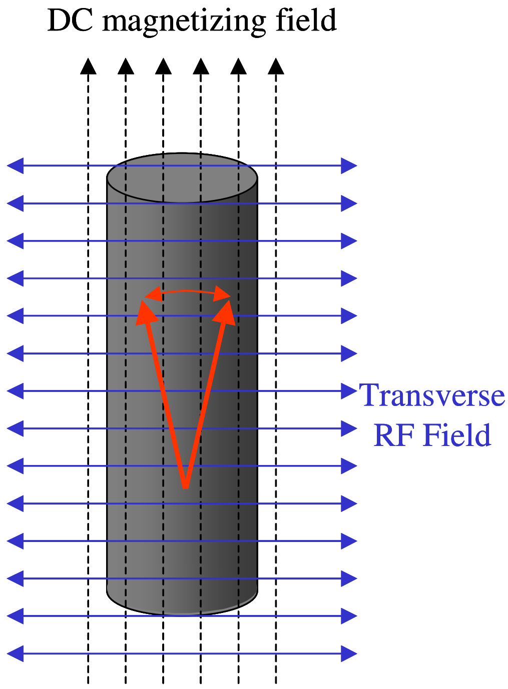

Figure 2. Oscillating Magnetic Vector

This transverse oscillation of the vector will tend towards a precessional rotation due to the natural precession of the dipoles, figure 3.

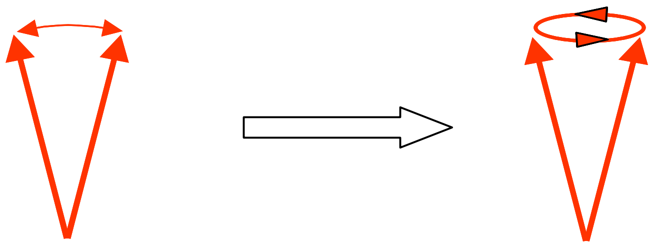

Figure 3. Tendency towards a Precessional Rotation

A suitably mounted coil around the core could detect cross-coupling due to the magnetization precession while at the same time rejecting direct induction from the driving field, figure 4.

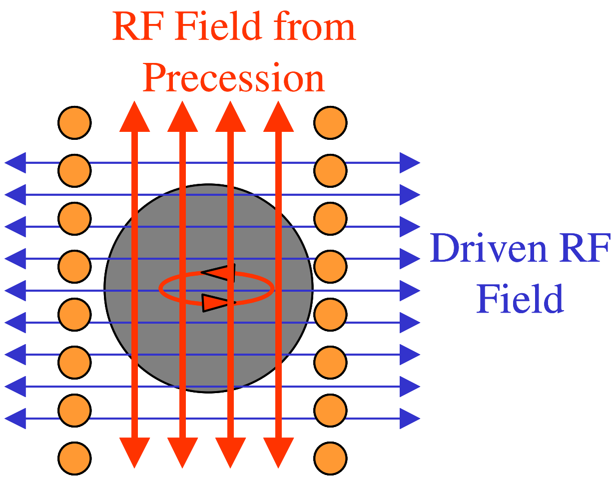

Figure 4. Detecting the Precession using a Coil

This could be the basis of an experiment for observing and tuning the effect. Note that the induction into the coils can be obtained from either $V = N\dfrac{d\Phi}{dt}$ where Φ is the flux and N the number of turns, or the line integral $\oint \mathbf{E} = \mathbf{v} \times \mathbf{B}$ along the conductor where **B** is the local field and **v** the effective velocity of that field , both give the same result.

In the Stromerzeuger the cores are arranged in pairs, one on each side of the vertical board, and the electrical connections of the two cores are in series. Magnetization precession in one core will induce a longitudinal voltage in the other and since the two precessions are phase linked by a common driving field the series connection adds the two induced voltages, figure 5.

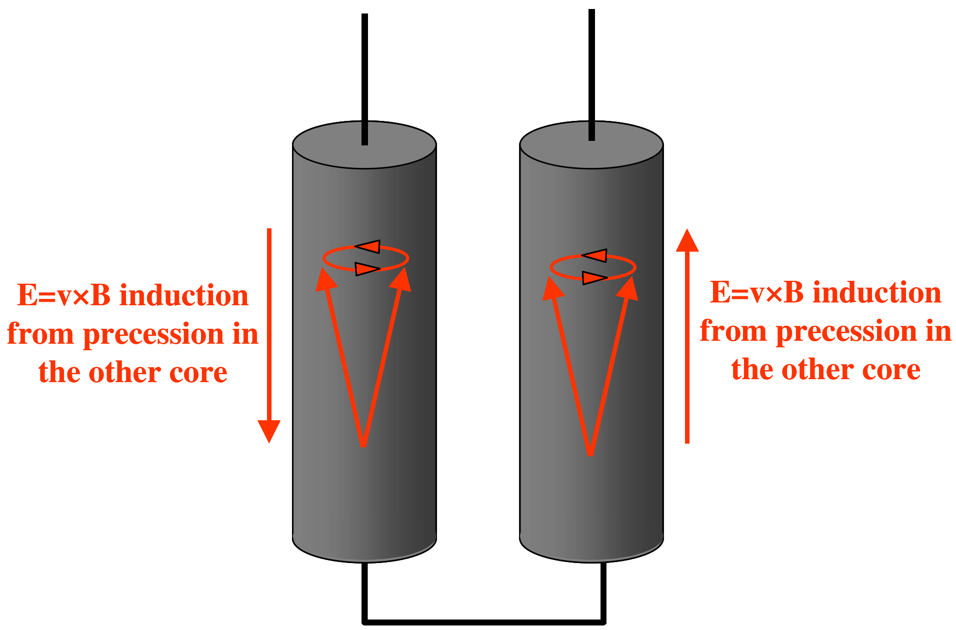

Figure 5. Voltage Inductions in the two cores add.

This can be partially modelled in FEMM as a 2D model. Thus we can model two long Fe rods parallel to the z direction (into or out of the paper). We can take account of skin depth by modelling the inner portion as diamagnetic thus expelling magnetic fields (this is easily done by setting the relative permeability to be greater than 0 but less than 1). The outer skin can be modelled as Fe with known permeability and conductivity, then a transverse component of the precessing longitudinal magnetization vector can be applied by giving the Fe some coercivity. Figure 6 shows the FEMM model where the skin depth is deliberately made large for illustration purposes, and the magnetization angle is 0 (pointing to the right).

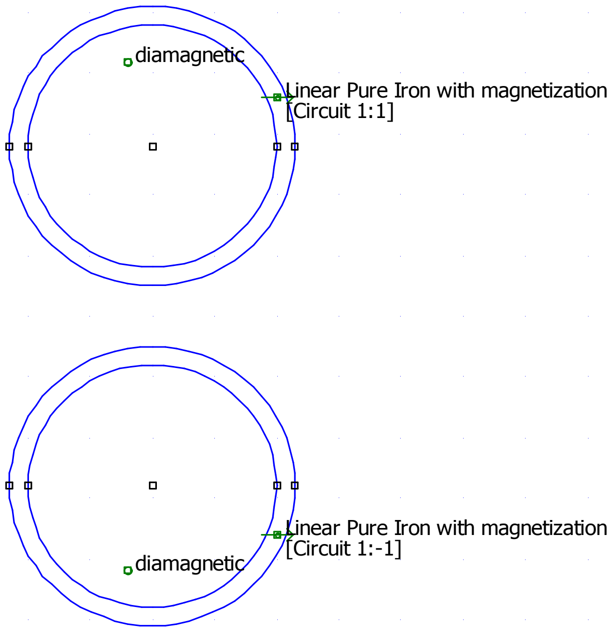

Figure 6. FEMM model of two Fe rods

Figure 7 shows the magnetic field lines where it is seen that there exists some flux passing between the rods. FEMM has the facility to treat the rods as conductors forming a single turn around that flux and will give the flux linkage. Since the transverse magnetization vector is rotating at precession frequency creating alternating flux linkage, FEMM allows the voltage induction to be assessed. This can be done quite simply by assuming the induction to be sinusoidal, or more accurately by a series of FEMM runs with the magnetization angle stepped between runs. It clearly demonstrates that the internal precessing magnetization induces voltage into the two rods connected in series. Until recently consideration has only been given to possible anomalous induction within the rods due to their own internal magnetic features, treating the rods in isolation. It is now shown that magnetic inter-coupling between pairs of rods is a more likely source of anomalous voltage. Note that the series connection shown in figure 5 is exactly that of the Norrby patent on which the Stromerzeuger is based, and explains why there are two rods in series for each branch connection.

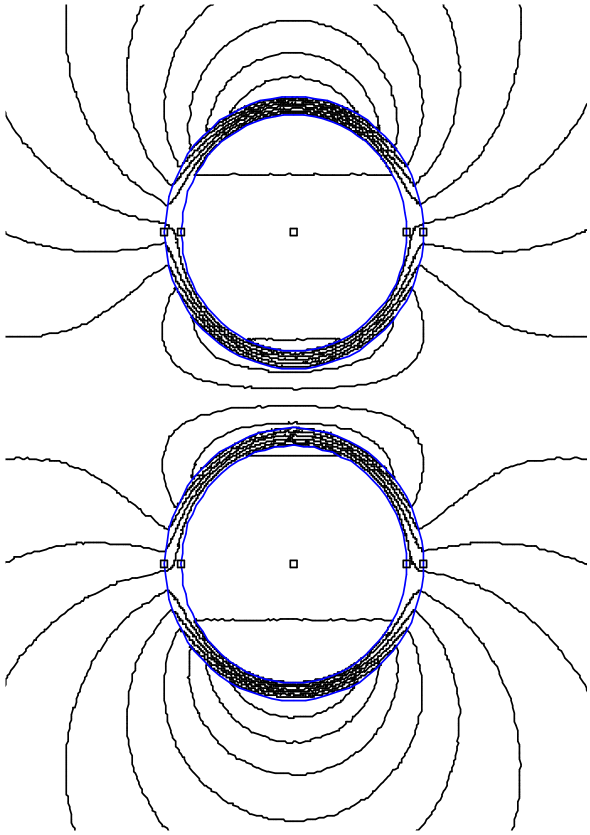

Figure 7. FEMM result showing flux linkage between the two rods

Clearly the voltage induction would be a maximum at Ferromagnetic resonance, and the question remains can FMR in Fe occur at the low frequencies purported to occur? And perhaps more importantly can FMR be more than just an absorption phenomenon, can it be used to extract energy from the precessions? It is known that individual electron precessions obey quantum rules, their precession is a form of perpetual motion. Only when those precessions are cohered spatially and temporally do we observe a precession of the bulk magnetization. Is it possible that having achieved that coherence we can extract energy that actually comes from the quantum forces driving the electrons? Only by experimentation will we find that answer.

Normally FMR in Fe occurs at microwave frequencies, and this is due primarily to the remanent (spontaneous) magnetization. In fact most FMR experiments deliberately saturate the Fe so that magnetization is at a known level. There doesn't appear to be any work done on *partially* magnetized Fe where the FMR frequency could be much lower. Perhaps this is because FMR is used mainly as an investigative tool to examine other characteristics of the sample. It is known that Coler had to adjust the magnetization of his cores: this setting was unstable and could easily be disturbed, then requiring careful readjustment to get back to working condition. He even resorted to heating the cores to above their Curie temperature to remove any inherent magnetization before starting the readjustment. This suggests that partial magnetization was a necessary and critical feature.

It is known from the Hudson letter that the cores obtained static magnetization from three windings, the central one being wound in opposition to the two outer ones. Also the electrical connection to the end of the core came via magnetized piano wire through a tapered section like a lathe collet. All these features could be an attempt to eliminate geometric demagnetisation so as to create a highly uniform low value static magnetic field in the core, which would be a prerequisite for obtaining bulk or surface FMR.

It is known that Coler used a high purity iron (Armco) in his attempted 1946 replication of the Stromerzeuger. The earlier 1926 demonstration probably used Swedish iron, which was the best quality iron available at that time. Any attempted work would have to do the same, and would have to have access to heating and annealing facilities in order to eliminate magnetic anisotropy and spontaneous magnetization. Also the static magnetization coils and the tapered section to PM's at each end (Coler used magnetized piano wire) would need to be designed using 3D simulation techniques in order to create the maximum uniformity of magnetization along the rod.