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.

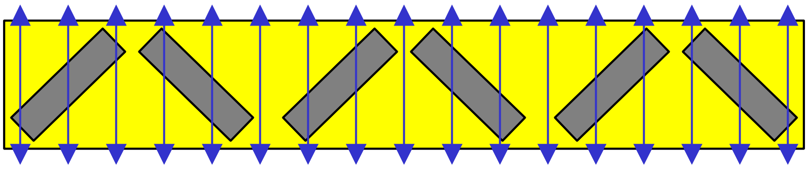

Figure 1. Zig-zag formation of cores.

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.

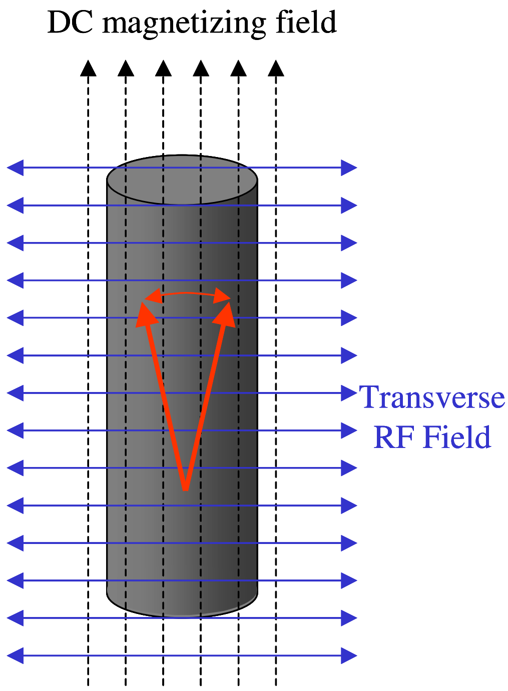

Figure 2. Oscillating Magnetic Vector

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

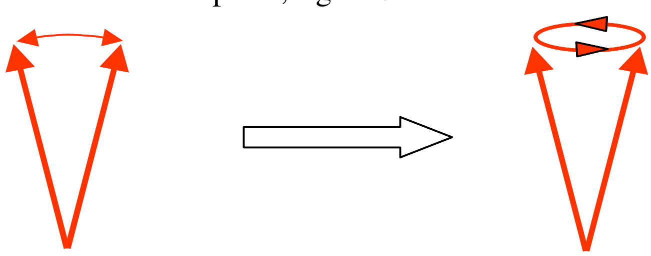

Figure 3. Tendency towards a Precessional Rotation

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

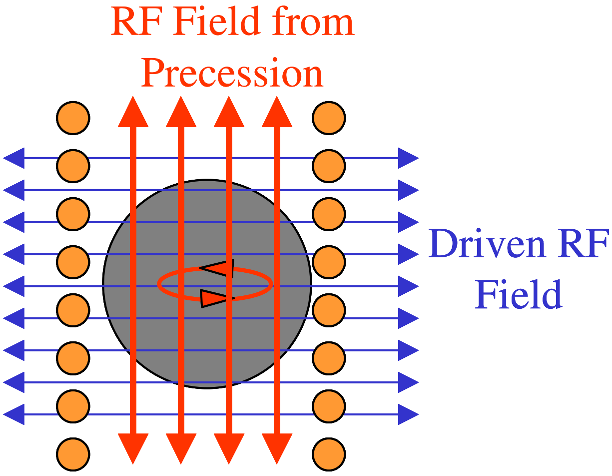

Figure 4. Detecting the Precession using a Coil

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 $V = N\frac{d\Phi}{dt}$ 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 from $\oint \mathbf{E} = \mathbf{v} \times \mathbf{B}$ and since the two precessions are phase linked by a common driving field the series connection adds the two induced voltages, figure 5.

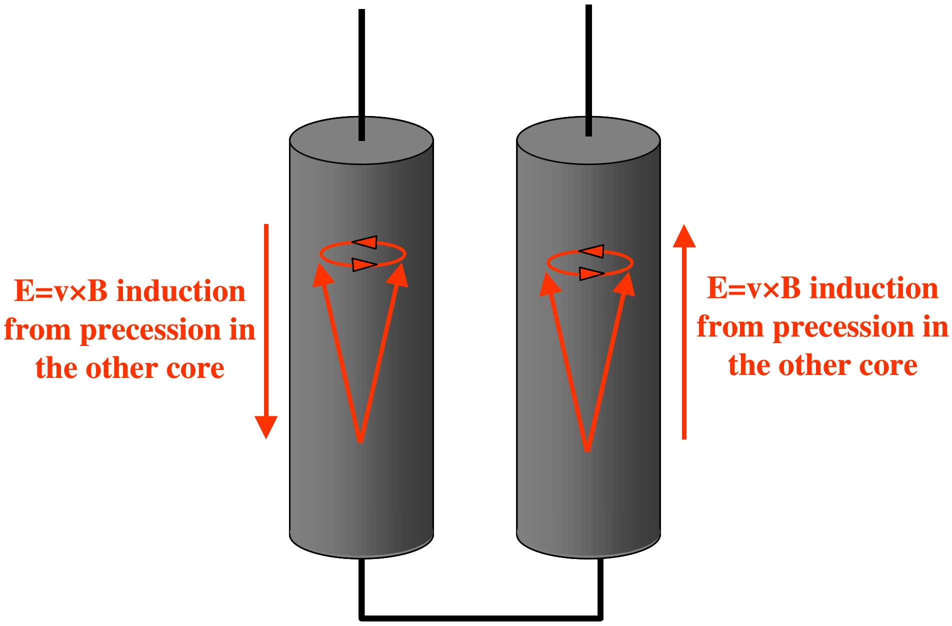

Figure 5. Voltage Inductions in the two cores add.

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? Normally FMR in Fe occurs at microwave frequencies, and this is due to the inherent 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, and this setting could easily be altered requiring careful readjustment. 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 create a uniform static magnetic field in the core which would be a prerequisite for obtaining bulk FMR.

Even at the low frequencies quoted, the skin depth in Fe is very small. Thus it is likely that only the surface region obtains the precession, and not the bulk material. This leads to the possibility of using thin Fe strips instead of rods, and the strip faces could be placed close to each other separated by a thin insulator, thus increasing the magnetic coupling across the gap, figure 6.

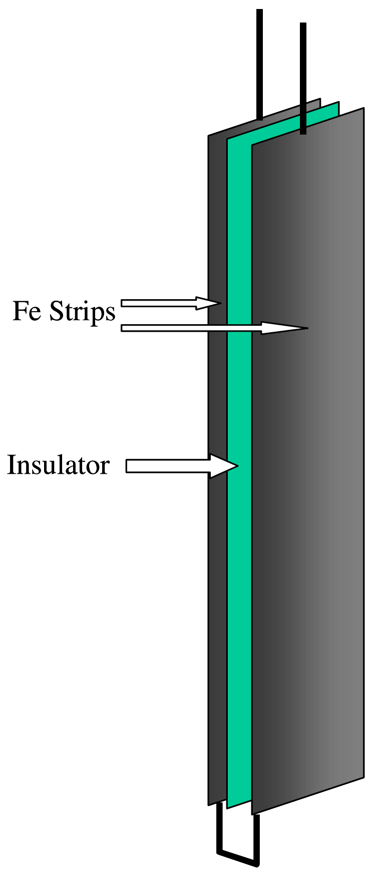

Figure 6. Fe strips in place of rods.

Now to minimise the demagnetizing effects at the ends the bifilar connected strips could be formed into a circle to act like a toroidal core, figure 7.

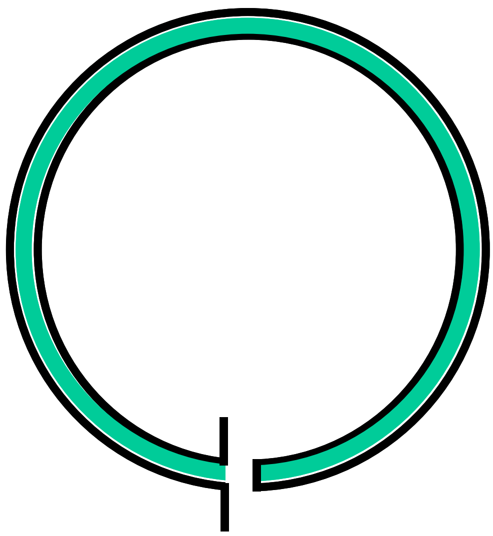

Figure 7. Bifilar strips form a gapped core

A toroidal coil wound on the core would carry DC to longitudinally magnetize the strips and this magnetization should be uniform over the full lengths, figure 8. This will ensure a reasonable line width for the FMR.

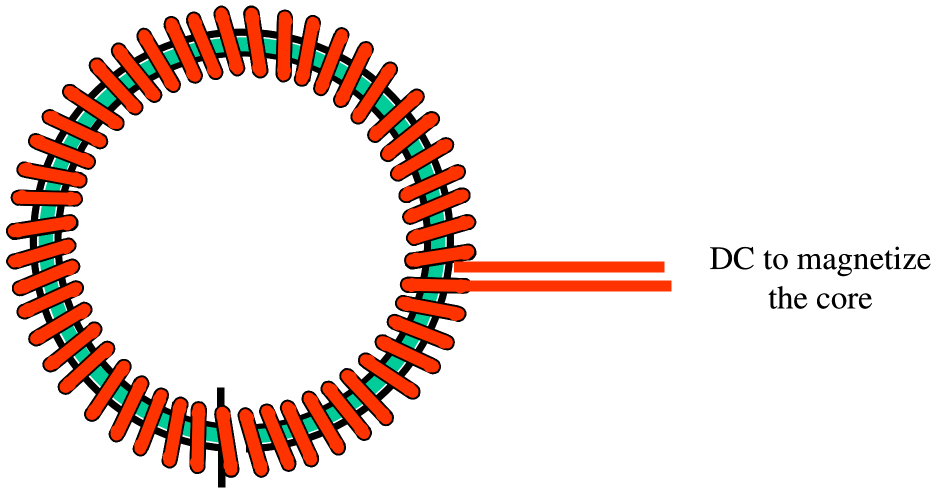

Figure 8. Toroidal magnetizing winding.

Finally a coil wound around the whole structure would be used as a RF drive coil applying a RF magnetic field in the plane of the Fe strips across their widths, shown in figure 9 as a single turn but in fact a solenoidal coil. When driven at the right frequency this excites the FMR in the Fe where the precessing magnetic vectors induce additive voltage in the bifilar connected strips.

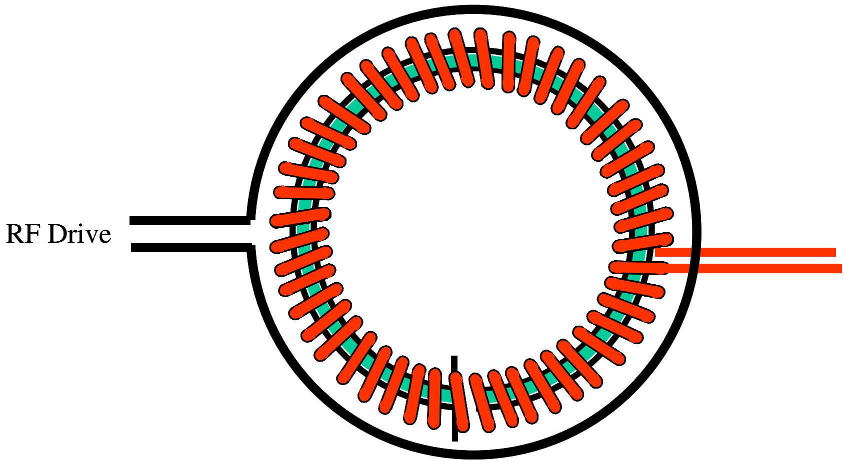

Figure 9. RF drive coil around the toroid

If this induction effect is real and genuinely explains the excess energy in the Stromerzeuger, it should be possible to use the output from the bifilar core to feed back to the RF drive, hence maintaining self-oscillation. This possibility is depicted in the circuit figure 10.

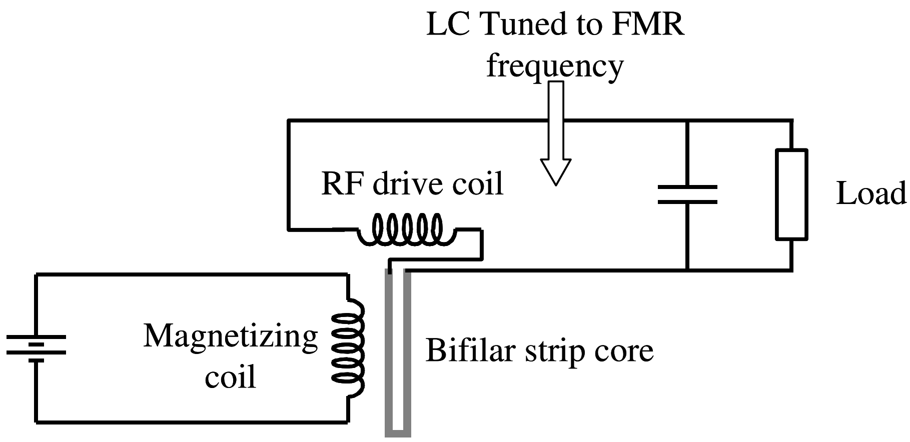

Figure 10. Possible self-oscillating circuit.

To achieve a greater voltage from the bifilar core it could be possible to use a plurality of interconnected strips, or even wires, as shown in figure 11. Fe strip or wire would be wound onto the flexible insulator to form a flat elongated coil. This of course would then be formed into a circle as before and enclosed by a common toroidal magnetizing coil and solenoidal RF coil. Note the Fe flat coil has minimal conventional coil cross-section. It obtains its voltage induction by non-conventional means, i.e. the FMR precessing magnetization of the adjacent Fe conductor on the opposite side of the insulator.

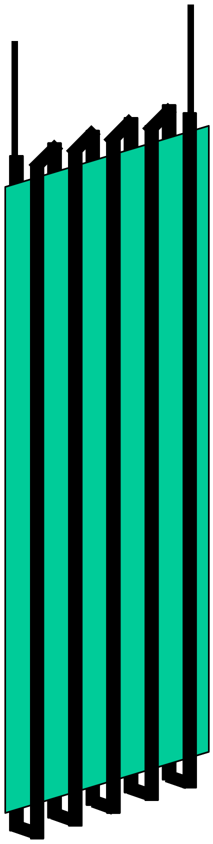

Figure 11. Greater induced voltage from multiple Fe strips