Considerations on the switched capacitance motor

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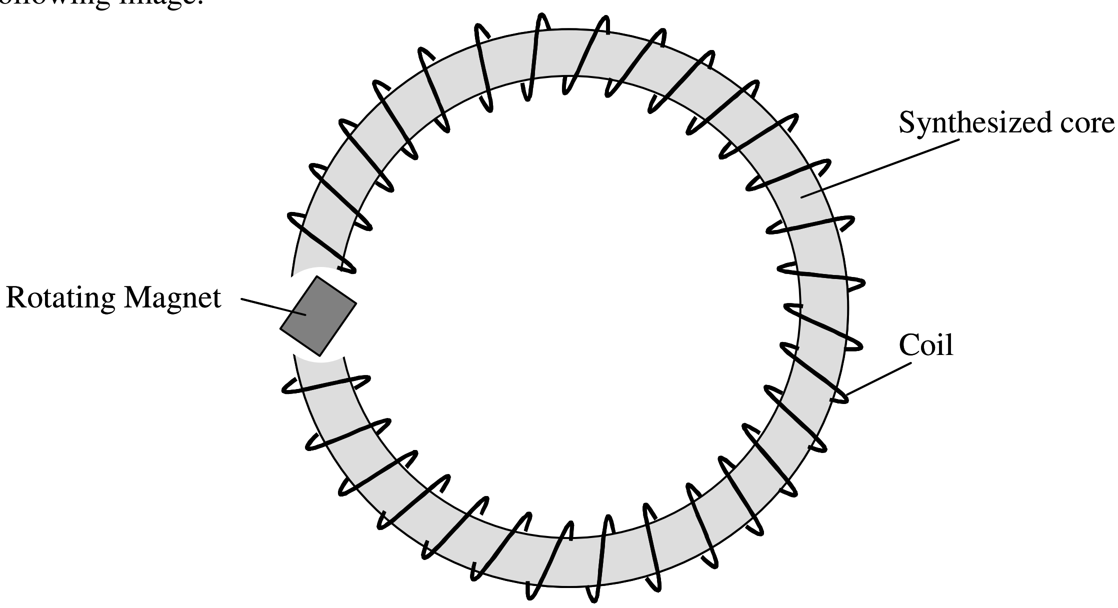
This paper takes a quick look at the switched capacitance motor to see whether it offers any OU potential. Formula are given for the mechanical energy obtained by the magnet being attracted to the synthesized ferromagnetic core, for the energy stored in the pre-charged capacitor before it is connected and finally for the energy obtainable from the coil's discharge when the capacitor is switched out of circuit.

The maximum energy obtained when a magnet is attracted to a keeper is given in my paper "Energy around Coils and Magnets" as

$$W = (1-k)\left(\frac{B_R{}^2 v}{2\mu_0}\right) \quad (1)$$

where k is Nagaoka's geometric factor depending on the length to diameter ratio, B_R is the remanence of the magnet and v is the volume. Note that the magnet is then "shorted" by its keeper, i.e. the reluctance of the keeper is much less than the reluctance of the air space occupied by the magnet. To satisfy this condition the magnet will be assumed to rotate within the air gap of a C shaped synthesized ferromagnetic core, i.e. the coil is wound on a C shaped former as depicted in the following image.



The inductance of such a coil where the air gap is small compared to the length of the coil is given closely by

$$L = \frac{\mu_0 N^2 A}{l} \quad (2)$$

where N is the number of turns, A the cross section area and l the length of the coil. The synthesized core material will start with zero flux through it when the magnet is across the gap, then if the magnet has the same cross section area A as the synthesized core the core will carry the full flux Φ when the magnet is aligned, with Φ given by

$$\Phi = B_R A. \quad (3)$$

Thus the synthesis involves coil current necessary to add flux to that from the magnet in order to create the total flux Φ. Taking the flux from the magnet in the absence of current to be negligible (which will overestimate the current required in practise), and since $\Phi = \frac{Li}{N}$ then from (3) and (2) the necessary current is given by

$$i = \frac{B_R l}{\mu_0 N} \qquad (4)$$

At the point of capacitor disconnection that current flowing through the coil represents inductive energy of value $\frac{Li^2}{2}$ that can be recovered. That energy is from (4) and (2)

$$W_L = \frac{{B_R}^2 A l}{2\mu_0} \qquad (5)$$

To achieve the high current needed for the synthesis the capacitor needs to resonate with the inductance of the coil which requires

$$C = \frac{1}{\omega^2 L} \qquad (6)$$

The peak voltage V at the point where the capacitor is connected, which is also the pre-charged voltage of the capacitor, is $V = \omega N \Phi$ and the energy stored there $\frac{CV^2}{2}$ is from (6), and (3) exactly equal to (5). Thus in theory we regain all the energy initially supplied to the capacitor, the net input is zero. But we have extracted mechanical energy given by (1). Hence the system is theoretically capable of self-running while supplying that energy for each half rotation. However it should be noted that the current i needed is very high and this account takes no heed of energy lost in the resistance of the coil. In practise the coil losses could far outweigh any useful energy gain.