A Permanent Magnet Self-Running Motor

I had originally wrote under this heading in 2003. Having reviewed the original paper I realized I had got some things wrong so here it is again in amended form.

Ken Wasson wrote "Cogging torque is shaft torque vs. angular position sensed relative to the generator frame when no current is applied.....

1. The sum of cogging torque through one revolution is exactly zero. That fact provides a check of the zero torque output of the torque sensor and associated scope settings at any speed. (*The sum must be zero or else we would have a perpetual motion machine without the need for current* [my italics])."

I took that *current* to mean applied current as stated in the first sentence, and I was prepared to challenge the view that a PM perpetual motion machine using self-generated current is impossible. While formulating my argument I found I was effectively inventing a self-running PM motor, so here is the argument for all to shoot down.

Lenz's Law states that "the induced current in a circuit is always in such a direction as to produce flux that will *oppose* the *change* in the flux field which produces the current". While many people incorrectly assume this to be an *absolute* opposition (i.e. flux of positive value creates a Lenz reaction of negative value), it is in reality expressing a tendency, there has to be a changing flux ($d\Phi/dt$) present, the reaction current and its flux is opposing the *change*. In AC waveforms that $d\Phi/dt$ is a 90 degree phase shift, *the reaction current is shifted 90 degrees from the applied flux*. This is perhaps more readily understood when the coil is part of a magnetic circuit having sinusoidal flux Φ driven through it. When connected to a resistor the coil appears in the magnetic circuit as a "magnetic inductance L_m" obeying $mmf=-L_m d\Phi/dt$, that mmf of course coming from the coil current flowing into the load resistor. The value of L_m is N^2/R where N is the number of turns and R is the load resistor. This consideration is easily derived from the fact that the voltage induced into the coil is proportional to $d\Phi/dt$ hence the current in the coil also follows $d\Phi/dt$. The magnetic inductance L_m is in series with the normal reluctance of the coil that for coils wound on air is the reluctance of the air space occupied by the coil.

Lenz's Law considered only a conductive circuit, i.e. a resistive load where the current is in phase with the induced voltage. When you load a coil with a capacitor or an inductor you now have to consider the extra phase shift. If that extra phase reaches 90 degrees, *you do now have Lenz's Law as an absolute*. What is more, in one case (inductive load) the reaction current is in genuine opposition to the applied flux, the reluctance of the coil increases in value by N^2/L. This creates the unusual situation where in the magnetic circuit the air space occupied by the coil effectively increases in length, or it appears to have a relative permeability less than unity as would be the case if the core were diamagnetic. *The simple act of connecting an inductor across the coil has given the appearance of a diamagnetic core inserted into the coil*.

In the other case (capacitive load) the reaction current is in support of the applied flux, the reluctance of the coil *decreases* in value by ω^2N^2C. This creates the situation where the coil appears to have a core whose relative permeability is greater than unity, t*he simple act of connecting a capacitor across the coil has given the appearance of a ferromagnetic core inserted into the coil.*

Now take an air coil connected across an external capacitor, then imagine a PM rotating or moving towards the air coil. *The air coil will pull flux from the moving PM, it will act like a lump of permeable material, the magnet will be attracted to the coil*. Conceptually you can imagine the dielectric of the capacitor "transported" by the electrical connection so as to be placed physically inside the air coil, converted into a magnetic dielectric where it receives its energy directly from the flux of the PM. But it is not physically transported, *we can break the electrical connection anytime we like*. If we break that connection after the magnet has been attracted, the attraction disappears, we can remove the magnet back to its starting position at no expenditure of energy.

So the machine looks something like the following figure. Simple isn't it? Of course the reality is somewhat different, we have to take account of the practical ohmic resistance of the coils, and that obscures the wanted effect. Maybe the use of room-temperature super-conductors would make such a scheme practical. I intend to examine this in more detail to see whether it offers anything useful using copper coils.