V 2.2

QEG
A Mechanically Pumped Parametric Transformer

Preliminary Conditional Reverse Engineering Analysis
Prior to Examination of an Operational Device:

In this device all coils share the same toroidal core; therefore, they form a toroidal transformer. The two series resonating coils form the primary, and the two output coils (tapped by the Neutral) form the secondary. The core has four equally spaced pole pieces. This allows the non-magnetized rotor to modulate the core reluctance thereby modulating the inductance of the resonating coils. This modulation can be considered to be a parametric coupling of mechanical energy of the rotor to electrical energy in the resonating coils.

The following equations govern this energy transfer relationship:

$$E = \frac{d}{dt}(Li) = \underbrace{L\frac{di}{dt}}_{\text{Flux Coupling Term}} + \underbrace{i\frac{dL}{dt}}_{\text{Parametric Coupling Term}}$$

Normal transformers are governed by the flux coupling term, and are based upon constant reluctance and inductance values with time variant current (and voltages). This device, on the other hand utilizes a parametrically varied reluctance and inductance in order to induce oscillating current and voltages. This operation is additionally governed by the parametric coupling term in the above equation. Parametric coupling of an oscillating circuit requires that the pumping frequency be twice the oscillating frequency. The reluctance is modulated four times per armature revolution occurring when the rotor and the pole pieces align. Since the oscillating (resonant) frequency should be one-half the pumping frequency we can determine the driving RPM in relation to the resonant frequency.

For example: assuming a driving speed of 1,800 RPM or 30 Revolutions per Second, a production of 30 x 4 = 120 pumps per second is realized. Given that resonant frequency is one-half of pump frequency, the resonant oscillations should occur at 120/2 = 60 cycles per second (or 60 Hertz). Similarly, a 1500 driving RPM infers a 50 Hz output. (Where 1500/60 = 25, 25 x 4 = 100, 100/2 = 50 Hz.)

Since we are told that the QEG is typically driven into resonance at approximately 1450 RPM, and that the resonant frequency is about 400 Hz, a disparity emerges. At 1450 RPM we would expect a resonant frequency of approximately 48.33 Hz to exist, however, apparently the Parallel LC Resonant Circuit is designed to resonate at something close to or slightly over 400 Hz. This implies that the QEG is actually being operated at something like the 9th Harmonic of the design frequency. Usually the most efficient coupling should occur at the design frequency. Operation in this manner necessitates a critical tuning procedure before effective phase lock occurs.

The design of this machine appears to achieve much of its efficiency from its ability to reduce back MMF to the rotor in comparison to what a traditional generator rotor experiences. The back MMF experienced by the rotor is proportional to the core magnetic field strength near the times of the pole/rotor alignment which is when parametric pumping occurs in this device. Since this occurs near the zero-crossing points when the magnetic field is in the process of reversing itself, little energy is needed to drive this device as compared to a traditional generator. When a near synchronization in time of the pole/rotor alignments occur with the zero crossing points of the resonating coil current sine wave, then this condition is met, so long as phase lock is maintained.

As the rotor approaches, aligns, and leaves a given pair of poles, a magnetic shunt is formed which alters the effective shape of the core as well as the magnetic path length. This produces the desired parametric change in both Reluctance and Inductance which is "parametric pumping". As these magnetic shunts form and subsequently disconnect, magnetic snap-back occurs as magnetic flux loops are broken and forced to reform within the cyclically altering core geometry. Interesting and novel energy effects are thought to exist when magnetic snap-back occurs.

An examination of the parametric coupling term from the equation ($i\frac{dL}{dt}$) allows for a closer look at the parametric pumping and the reduced back MMF. The magnetic field strength (and Flux Density) corresponds to the sine wave current in the parallel LC resonant circuit. As the current becomes smaller, crosses zero, and then begins to reverse direction so does the magnetic field. In phase lock, this happens as the rotor approaches, aligns, and leaves each pair of poles, which is when parametric pumping and Inductance pulses occur. (See Fig. 1)

As the rotor passes each pole/rotor alignment, the rate of change in Inductance $\frac{dL}{dt}$ reaches a positive maximum as alignment begins, traverses its own zero-point as exact alignment occurs, and reaches a negative maximum as the rotor begins to misalign. Once the rotor is fully disengaged from the pole-pair the rate of change in Inductance returns to zero where $\frac{dL}{dt} = 0$ until the next pole/rotor alignment occurs. (See Fig. 2)

While the current (i) is relatively small during these events, it is exactly zero for only the briefest time at the exact moment of pole/rotor alignment. The rate of change in Inductance $\frac{dL}{dt}$ is significant (at a maximum) during the same period. All of this works together to allow the rotor to move past each pole-pair with minimal back-MMF while parametrically pumping energy into the system. When the rotor is between poles, the flux coupling term describes the operation of the QEG as a toroidal transformer; the energy stored in the resonant LC circuit supplies power to the output coils and load by transformer action.

These appear to be the primary factors involved from what we can determine, with the information we have so far, on this interesting power generation design. Critical comments from James Robitaille or other members of the QEG community are welcomed.

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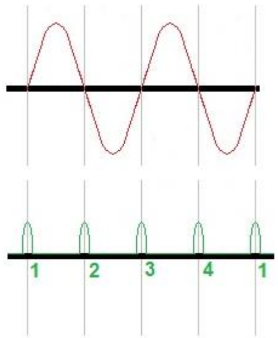
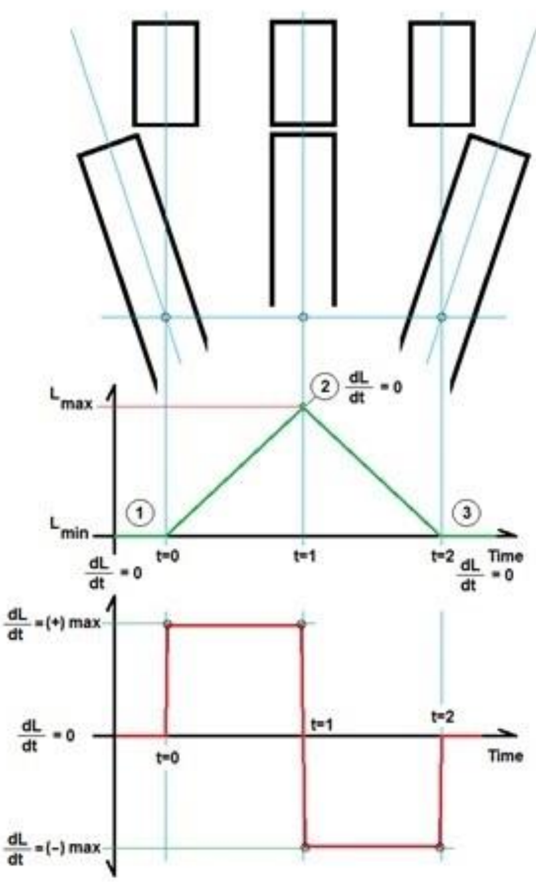


Sine wave current
in parallel LC resonant circuit

Parametrically pumped inductance
pulses at current zero crossings

Fig.1



Pole/Rotor alignment
progression

Corresponding change
in Inductance over time

Corresponding Rate of Change of
Inductance over time

Fig. 2

$$E = \frac{d}{dt}(Li) = \underbrace{L\frac{di}{dt}}_{\text{Flux Coupling Term}} + \underbrace{i\frac{dL}{dt}}_{\text{Parametric Coupling Term}}$$

Parametric Energy Equation

Other observations:

James Robitaille stated that the exciter is not necessary for the basic operation of the QEG; therefore, we omitted it from this analysis.

The resonant coil capacitor combination should have a spark-gap across it to limit the peak voltage to a safe value. In addition, if capacitor failures occur, high value voltage balancing resistors should be added across each capacitor.

It should be determined whether the specified electronic motor drive circuit will operate at 400 Hz since it is a SCR phase controlled device and may be sensitive to input frequency. If this is the case, a controller that rectifies the incoming line to DC and provides a pulse width modulated output should be used. Voltage feedback to this controller could be used to regulate the output voltage of the device.

If the output of the QEG is rectified and filtered to DC, the ideal inverter to use to produce 60 Hz AC and possible co-generation to the power line is the type of inverter designed for solar photo-voltaic systems. They usually require from 250-600 volts DC and can easily self-adjust within that range.

A redrawn schematic needs to be provided to address the issue of the missing bridge rectifier and the inconsistent use of 240V power line and 120V Feedback simultaneously.

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