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# **Is the Local Energy Conservation Law Valid inside the Electronic Device of Charged Capacitors?**

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## **Abstract**

The energy conservation is one of the most fundamental and well established principles in physics. Emmy Noether extended the energy conservation principle to the quantum field theoretical domain in empty space by relating the time translation invariance of the universe with energy conservation. While this is the case in open empty space, it seems that the local space enclosed by conducting metallic plates has unexpected property suggesting that the energy conservation principle does not necessarily apply to localized bound system of capacitors in electrodynamics. This point of view was raised by noticing the fact that the spherical capacitor has calculable electrostatic self-potential energy in both the inner and outer shells respectively which was not taken into account in the conventional consideration of the total energy stored in the capacitors. It seems like the concept of moving charges one by one into the capacitor plates has helped bypassing the necessary steps to account for the additional repulsive self-potential energy that accumulates simultaneously in both of the capacitor plates in the process of charging the capacitor. We present the dynamics of the repulsive potential energy stored in capacitors and discuss its physical reality in relation to the anomalous energy devices reported in the past.

## **1. Introduction**

The pioneers of the modern physics have developed the concept of energy conservation from thermodynamics where the heat energy is converted into mechanical energy when the adiabatic condition is provided. Repeated testing has provided the evidence that thermal energy conversion from heat energy to kinetic energy is complete as long as there is no heat loss. In the course of the development of the modern physical science, the local energy conservation principle derived from thermodynamics was proven to be accurate that it is believed the same principle must be observed in the case of the theory of electromagnetism. However there are evidences suggesting that the local energy in case of the bound system of capacitors in electrodynamics is not conserved contrary to the general theorem that suggests the energy is conserved in the empty space.

Also, contrary to the case of adiabatic thermodynamic system where the heat transfer can be blocked from entering the system in question by using proper insulation method, it is obvious that the electromagnetic system can not be insulated by the same manner.

The simplest example of this observation is in the fact that the magnetic field can pass through any thermal insulation without any resistance. In effect, it is not possible to insulate a capacitor from the surrounding magnetic field entering the system contrary to the thermodynamic system of insulation. Since magnetic field carries energy, which is a part of the electromagnetic wave, it is possible that the magnetic field could bring in the energy pervading in space into the capacitor without restrictions. The main theoretical cause of this phenomenon is the equipotential boundary condition of the large surface area in the conducting metals. Contrary to the theorem of energy conservation derived from the totally empty space, this must be considered the case of exception because the equipotential boundary condition violates the empty space hypothesis from the beginning. The equipotential boundary condition that imposes on large surface area puts a strong stress in otherwise free space which causes the breaking of the balance of the stored energy in equilibrium.

Detailed analysis shows that the conventional calculation of the stored energy in the capacitors did not include the repulsive electrostatic potential energy from the same charges in the two adjacent metallic plates of the capacitor. When the capacitor is charged by moving individual charges one by one, the repulsive electrostatic potential energy that is created unintentionally inside the metallic plate by the repulsive potential energy was not taken into account as a part of the stored energy. The additional energy that was created in the process of charging the capacitor was not expected and the energy conservation principle looks satisfied without having to take it into account. The physical reason that this happens is because the conducting metallic plate has the work function potential that traps and holds charges together in such a way that the charges can not escape from the body of the conductor. This trap mechanism raises the possibility that the electric charges in the metallic plate develop repulsive electrostatic potential energy among themselves depending on the density of the charges in the capacitor since they can not free themselves from the confined state inside the conductor plate up to a certain level of concentration. As long as there is repulsive electrostatic force among the same charges and the confinement due to the work function potential, the existence of the repulsive electrostatic potential energy stored in each capacitor plates cannot be avoided.

For the purpose of investigating the details of the mechanism of accumulating repulsive potential energy, spherical capacitor has the advantage that the exact amount of repulsive electrostatic potential energy can be calculated due to the uniformity of the distribution of the charges all around the sphere while this is not the case for parallel plate or cylindrical capacitor. The problem is the density of the electric charge can not be expressed in closed mathematical form due to the asymmetric geometrical shape and the subsequent edge effect which depends on the exact thickness of the metal plate and also the corresponding non-uniform distribution of the charges in such cases.

Also the earlier proposition of J. J. Thompson's [2] "plum pudding model" of electrons in solid metal has effectively made it unnecessary to consider the possibility of developing repulsive potential energy since the electrons in the metal could be shielded from each other if the charges are stored in the predetermined individual bins according to the model. However, the standard theories of solid state physics developed by Drude and Sommerfeld [3] have confirmed that electrons are free inside the metal which opened the possibility that the electric charges inside the metal can develop recoverable repulsive self-potential energy.

## **2. Drude-Sommerfeld Free Electron Model**

The Drude free electron model on solid state metals states that the electrons are free to move around inside the conducting metal. As such, the repulsive electrostatic force tends to force the electrons to move as far apart from each other as possible to lower the total energy. According to the photoelectric effect originally proposed by Einstein, electrons are confined inside the work function potential of the particular metallic element's surface. A photonic energy that is greater than the work function potential is required to detach electrons from the surface of the metal. In case of the spherical capacitor, by the same principle, electrons will be spread evenly inside the shell due to the repulsive electrostatic force while in the case of other types of capacitors; the electrons tend to move to the corners or to the edges in the case of parallel plate or cylindrical capacitor to lower the total energy. For the purpose of studying the detailed distribution of the electrons inside the metallic surface and to investigate the stored energy, spherical capacitor provides an ideal case since it allows the exact calculation of the self-energy contrary to other types of capacitors.

The derived result of the calculated energy stored in capacitors by using the concept of moving charges one by one which doesn't include the repulsive potential energy had no conflict with the energy conservation principle borrowed from thermodynamics when the discharged current from the capacitor was converted into heat through a load resistor and as such it looked like there is no conflict between the theory and experiment and there was no need to scrutinize the possible existence of the repulsive self-electrostatic potential energy stored in the capacitors.

## **3. Orthogonality Condition of the Two Independent Electrostatic Fields**

In the theory of electromagnetism, to prove that the two different electric fields are not mixed or partially shared together, it is necessary to prove that the two types of the electrostatic field lines are mutually orthogonal to each other. In the case of spherical capacitor, the charges in the both inner and outer sphere repel each other and tend to spread uniformly in one layer all around the metallic surface to minimize the total energy.

Therefore, the repulsive electrostatic force field lines will be tangential to the surface of the sphere while the attractive electrostatic force field lines between the inner and outer

shell will be radial from the common center of the two spheres. Therefore, the orthogonality condition is naturally satisfied for the two different electrostatic fields, where one is repulsive and the other attractive. Therefore, it proves that the conventionally calculated stored energy in capacitors only included the attractive electrostatic potential energy part.

#### **4. Repulsive Electrostatic Self Potential Energy**

The concept of the repulsive electrostatic potential energy was already used [7] to calculate the self-energy of the electron in spherical form to estimate the classical radius of the electron. As such, there is no ambiguity that the spherical distribution of charges in spherical capacitor does develop repulsive self-potential energy in both the inner and outer spheres respectively. And also, there is no reason this principle cannot be applied to both cylindrical and parallel plate capacitor cases. The once created repulsive self potential energy in the process of charging the capacitor sustains itself due to the energy conservation principle until the two opposite charges are recombined and neutralized. Creation of the repulsive electrostatic potential energy is an irreversible process that can not be undone until the polarized charges are neutralized by recombination.

Therefore, the key question is not if the repulsive electrostatic self potential energy does exist or not in various types of capacitors, the question is rather how the repulsive electrostatic potential energy stored in the capacitors disappears in the conventional electronic devices and the universal local energy conservation principle prevailed.

The fundamental theoretical cause of the energy imbalance comes from the fact that the large surface area of the capacitor plate is under the constraint of the equipotential boundary condition due to the conducting property of the metals where electrons can move around freely. This particular configuration of charge distribution is certainly not under the same configuration generally described by Poynting vector [1] or Noether's theorem [8] that applies only in the free empty space. The reason for the confinement of the electrons in the metallic capacitor plate despite the repulsive force between the charges is due to the work function potential which is the minimum energy required for photons to detach electrons from the surface of the metal as evidenced from Einstein's photo-electric effect [11]. In fact, without the work function potential, electrons cannot stay inside the metal to develop the net repulsive electrostatic potential energy among them.

#### **5. Detailed Analysis of the Electrostatic Potential Energy Stored in Spherical Capacitor**

To elucidate the key issue of the problem with mathematical clarity, consider the spherical capacitor with inner spherical shell of radius  $a$ , and outer shell radius  $b$  made of conducting metal. For the purpose of clarity, let's assume that the charge accumulated in the inner sphere is  $-Q_1$  and the one accumulated in the outer sphere is  $Q_2$  which is

slightly different in magnitude than  $Q_1$ . This type of hypothetical charge distribution rarely happens in reality because of the charge invariance in various types of power supplies. However it is useful for the purpose of tracing the details on where the electrical energy is distributed.

In general, according to the well established theory of electrodynamics, the capacitance and charge contributes to the energy stored in the capacitor expressed by the following relation.

$$E = \int IVdt = \int_0^Q \frac{dQ}{dt} \frac{Q}{c} dt = \int_0^Q QdQ \frac{1}{c} = \frac{1}{2} \frac{Q^2}{c} \quad (1)$$

where  $c$  represent the capacitance between the two metallic plates that store the opposite charges to each plate, which is given by depending on the material of dielectric constant  $\varepsilon$  in between the two metallic spherical shell,

$$c = \frac{4\pi\varepsilon ab}{b-a} \quad (2)$$

For the given amount of electrostatic charges, according to the equation (1), low capacitance capacitor tends to store more energy than the high capacitance capacitor. And the energy stored in the same capacitor by slightly different magnitude of charges  $-Q_1$  and  $Q_2$  respectively is given by

$$E_{attractive} = \frac{Q_1 Q_2}{4\pi\varepsilon} \frac{b-a}{2ab} \quad (3)$$

It is considered that the physical location of this attractive potential energy is in the space between the two oppositely charged spherical shells where the dielectric material is present.

On the other hand, it is noted that there is also the energy stored in each individual shells because of the repulsive electrostatic potential energy among the same charges that depends on  $Q_1^2$  and  $Q_2^2$ . And the sum of the stored repulsive potential energy in both the inner and outer shell of the capacitor is given by

$$E_{repulsive} = \frac{1}{8\pi\varepsilon_0} \frac{(-Q_1)^2}{a} + \frac{1}{8\pi\varepsilon_0} \frac{(Q_2)^2}{b} \quad (4)$$

The vacuum permittivity  $\varepsilon_0$  inside the metal is employed to calculate the repulsive electrostatic potential energy in between the same charges because the conduction band of the metal, where the electrons move around freely, is considered a vacuum instead of a space filled with dielectric materials. Since the attractive potential energy depends on

$Q_1 \times Q_2$  (3), it is apparent from the functional expression that the repulsive electrostatic potential energy (4) is not included in the conventional stored energy in the capacitor since the repulsive electrostatic potential energy depends on  $Q_1^2$  and  $Q_2^2$ . Also, the physical location of this repulsive potential energy is on the surface of the metallic shells where the force lines are distributed which is orthogonal to the concentric attractive electrostatic force lines which result in the energy given by (3) which is located in space between the two concentric shells. Hence, if  $Q_1 = Q_2 = Q$ , the total repulsive electrostatic potential energy stored in both of the spherical capacitor shells (4) is given by

$$E_{repulsive} = \frac{Q^2}{4\pi\epsilon_0} \frac{b+a}{2ab} \quad (5)$$

The total stored (both the attractive and repulsive) energy in the spherical capacitor of outer radius  $b$  and inner radius  $a$  is given by, which is the sum of (3) and (5)

$$E_{total} = \frac{Q^2}{4\pi\epsilon} \frac{b-a}{2ab} + \frac{Q^2}{4\pi\epsilon_0} \frac{b+a}{2ab} \quad (6)$$

Hence, the ratio between the repulsive potential energy and the attractive potential energy is given by,

$$\frac{E_{repulsive}}{E_{attractive}} = \frac{\epsilon(a+b)}{\epsilon_0(b-a)} \quad (7)$$

In general, the gap distance between the two spherical shells represented by  $(b-a)$  is much smaller than the average radius of the shell  $(a+b)/2$  and also depending on the dielectric substance between the two capacitor plates, the ratio of  $\epsilon/\epsilon_0$  can be substantially large.

<b>Material</b>	$\kappa = \frac{\epsilon}{\epsilon_0}$
PbMgNbO <sub>3</sub> +PbTiO <sub>3</sub>	22600:
PbLaZrTiO <sub>3</sub>	1000:
BaSrTiO <sub>3</sub>	300:
H <sub>2</sub> O	80:

**Table 1: Examples of High Dielectric Constant Materials**

Table 1 is a list of some of the high dielectric constant materials. For example, according to the relation (7), the spherical capacitor of 5 cm radius and the gap distance 1 mm between the two conducting spheres where the gap is filled with the dielectric material PbLaZrTiO<sub>3</sub> which has the dielectric constant 1000, the stored repulsive electrostatic potential energy is 100,000 times the attractive potential energy.

If the dielectric material in between the same double spherical shell is pure water which has the dielectric constant 80 as shown in Table 1, the repulsive electrostatic potential energy is 8000 times larger than the attractive potential energy (3) which is the same as the input energy needed to charge the capacitor. If a commercially available capacitor made for electronic circuit is labeled as  $10\mu F$  100V, it represents the capacitance in (2). The information about the capacitance represented by the repulsive potential energy (5) is not provided because such information is not required in the standard electronic circuit theory. Electronic circuit works without such information in most of the low voltage circuit applications. However, since the stored energy depends on the square of the applied voltage at high voltage applications, the grounding becomes a serious issue because the circuit needs to drain the excess energy to the ground not to cause damage to other electronic components.

What is evident from the above consideration is that the repulsive potential energy stored in the capacitor is very large (5) compared to the attractive potential energy when high dielectric constant material is placed in between the two conducting metallic plates of the capacitor. Also, even though the exact mathematical calculation of the repulsive self-potential energy is not possible in case of parallel plate and cylindrical capacitors due to the edge effect that obscures the analytic expression of the field configuration, it is expected that this is a general phenomenon that applies to all other types of the capacitors.

## **6. Property of the Repulsive Electrostatic Potential Energy Stored in the Capacitors**

According to the general equation of motion of a particle under the influence of an external potential function, the kinetic energy of the particle is gained only when the particle travels following the force lines created by the potential function. This is the reason potential energy is designated as "potential" that may not materialize unless the particle is allowed to act upon it. This is exactly what happens inside the closed electronic circuit that has a capacitor. In most cases, charges flow through the wire and meet the opposite charges to release energy and neutralize the polarization without having the chance to convert the repulsive potential energy into kinetic energy. Since charges can not act upon the repulsive potential energy inside the tightly closed electronic circuit by wire, conversion of the repulsive potential energy into kinetic energy doesn't happen and the stored repulsive potential energy simply disappears. It is noted that the repulsive and attractive potential energy exist as "potential" energy until the charges are recombined and the charge polarization disappears.

This is the reason it has been considered the energy released by discharge from a capacitor through a resistor according to the conventionally known laws of physics is expressed by the relation (3) which reflects only the attractive part of the stored energy. The conversion of the repulsive potential energy into electrical current happens only when there is a discharge device in the circuit that allows the charges to travel following the repulsive electrostatic force lines through space like spark gap, cold cathode tube, and vacuum tubes which are the examples of the devices that allow the charges to jump out of

the conductor into space so that the stored repulsive electrostatic potential energy can be materialized into the kinetic energy and consequently into electrical current of usable form.

Therefore, first there was the omission of the repulsive electrostatic potential energy in the theoretical calculation of the stored energy in the capacitors and second, the incomplete experimental verification by releasing the electric charge through a resistive load thereby unintentionally blocking the repulsive potential energy from manifesting itself into kinetic energy. These were the two fundamental errors that resulted in the conventional physical law of the local energy conservation in charged capacitors. However, two errors both in theory and experiment that mutually confirming each other don't necessarily prove the involved scientific principle correct.

The earlier cases of the unusual energy producing devices reported by Nikola Tesla, T. H. Moray and others have consistently used discharge circuit element such as spark gap, cold cathode tube, and vacuum tube in their devices which confirms the space-discharge  $\Rightarrow$  electrical-current-gain mechanism which contributed to the workings of their devices whether the engineers performing the experiment realized the anomalous excess energy creation effect or not at the time.

From these examples, we summarize that the key mechanism to utilize the additional electrostatic potential energy stored in the capacitor is by converting the repulsive potential energy into electrical current by letting the accumulated charges in the capacitor discharge through the space first before allowing them to recombine and manifest the total energy at the power load.

It needs to be mentioned that certain solid state electronic device like Sidac has the negative resistance property in its I-V discharge curves (Fig. 1) just like the cold cathode tube which is known to have the negative resistance slope at certain region of the I-V discharge curves (Fig. 2).

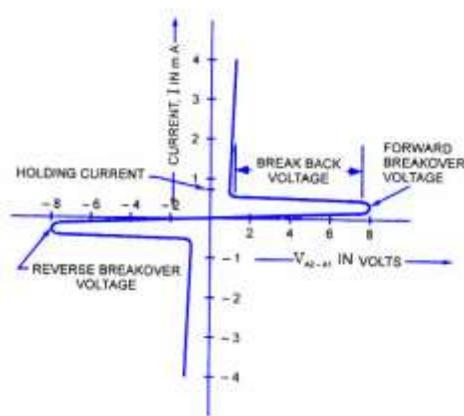


Fig 1. Sidac I-V Discharge Curve

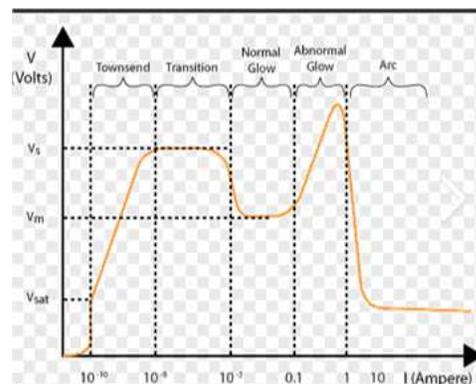


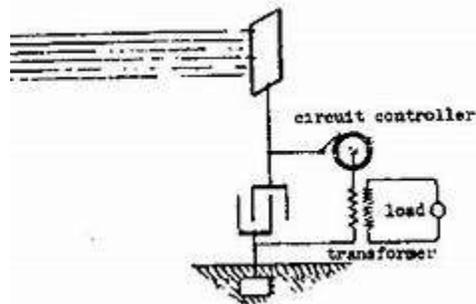
Fig 2. Cold Cathode Tube I-V Discharge Curve

The fact that there is negative slope in the I-V discharge curve from these devices was a mystery, because it indicates there is electrical current gain effect from somewhere in the circuit according to the circuit theory of the electronic devices. This also indicates the solid state device Sidac can perform the same task of energy conversion from inside the semiconductor junction without having to go through the process of the open space discharge.

The reason for the negative slope in the I-V curve of these device is because most of the DC power supplies used by Labs to test the I-V discharge property are made by stepping up or down of the line voltage by transformers and rectifying the AC voltage using diodes and send the unregulated DC voltage through the parallel array of regulating capacitors and this becomes the source of the repulsive electrostatic potential energy that provides the current gain effect in I-V discharge curves for both cold cathode tube and Sidac cases.

## 7. Reported Experimental Manifestations of Excess Energy Phenomena

Nikola Tesla, Thomas Henry Moray and others in the early 20th century have patented and demonstrated devices that mysteriously produced more energy than put in. These devices were not supposed to generate more energy than the energy put in from the perspective of the known physical principle of energy conservation. In case of Nikola Tesla's patented device, he claimed the device is collecting "radiant energy from the Sun", however, the amount of radiant energy from the Sun received by the antenna is not anywhere close to be enough to run any power device.



**Fig 3: Nikola Tesla Radiant Energy Device Schematic**

However, the conversion of the repulsive electrostatic potential energy into useful electrical current can be seen in the early invention of Nikola Tesla's radiant energy device where he used the open air spark gap as a discharge device as shown in Fig 3.

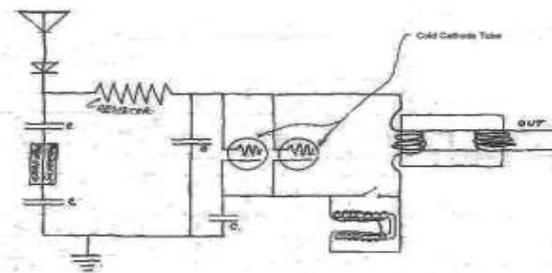
The diagram in Fig 3 of Tesla's radiant energy device contains a capacitor, rotary spark gap discharge element, transformer and antenna that collect atmospheric electrostatic charge. The "circuit controller" in the diagram is a rotating spark gap where the frequency

of the spark discharge is controlled by the rotational speed of the rotor where the spark gap terminal is mounted. It is noted that the radiant energy coming from the sun is not enough to run any electrical power load.

However if the capacitor has a large ratio of the repulsive electrostatic potential energy and the attractive one, the device can certainly generate enough power to operate a power load when the efficient energy conversion device is utilized. As has been extensively discussed in the book “The Inventions, Researches and Writings of Nikola Tesla” [9], the technical problem Tesla has faced with his circuit was that the spark gap becomes a conductor because of the plasma produced by high voltage arcing through the air which contains abundant amount of nitrogen and oxygen. His painstaking attempt to maintain the spark gap perform constant discharge is visible at certain point by his attempt to try to use an external fan to blow off the plasma to prevent it from becoming a conductor by arcing. Evidently arcing and discharge are two different modes of complex conduction process as shown in Fig 2 because the negative resistance effect occurs only in particular range of the conducting electric currents.

The actual role of the antenna in the circuit is to collect and save the electrostatic charge floating in the atmospheric space into the capacitor where the opposite electrode is connected to the ground. Tesla claimed the source of energy is coming from the Sun day and night in the form of radiant energy. This was the main part that baffled the scientists at the time and consequently they did not approve Tesla's theory of radiant energy and the entire subject of the radiant energy device itself became a non-issue.

When the device works in steady mode, the repeated discharge of the capacitor through the spark gap in each cycle of oscillation accumulates electrical energy in the resonance circuit. Theoretically this energy can grow exponentially in time unless the power is tapped and extracted by the load, otherwise certain elements in the circuit can break down due to the excessively high voltage and current built up in the circuit, which was one of the main technical challenges the pioneers had to overcome to achieve the successful completion of the operating device.



**Fig 4: T. H. Moray Radiant Energy Device Schematic**

In fact, engineering of a completely new electronic device that defies the conventional principle of physics cannot be completed unless the underlying physical mechanism that causes such anomaly is fully accounted for in detail in the fundamental theoretical level.

The schematic diagram Fig 4 shows another case of the energy device experimented by T. H. Moray. It was reported that he was able to produce 50 kWh of energy in a time span of a week. The main part of the circuit is the capacitors, cold cathode tubes and the transformer that controls the output voltage to the power load. The antenna was 200 feet long and 80 feet above the ground, the wire is a copper cable approximately a fourth inch in diameter according to the record. Before starting the device, it took 10-20 minutes of charging time of the capacitor from the antenna. To dispel the suspicion that he may be tapping the electricity from the household power line, he performed the experiment in remote area miles away from the city where there are no nearby power lines. In one experiment, it was reported that Moray ran his device for 157 hours without any connection to external power source. It is noted that the capacitor and the cold cathode tube are the essential circuit components that comprise the energy producing electronic circuit in both cases of Tesla and Moray. The other common feature of both of the circuit is that they use either series or parallel LC resonance circuit where the discharge element is connected in such a way that the discharges occur at the peak voltage of the oscillation in the capacitor. Moray struggled with his switching device because the cold cathode discharge tube didn't last long before it breaks down to become a non-discharging tube. It is possible that the repeated discharge on the metallic surface of the electrodes caused the conductor to corrode and oxidized in time which turned the conductor surface inside the cold cathode tube into insulator which prevented the discharge mechanism altogether. This was the fundamental technical challenge that the pioneers dealt with in the early 20<sup>th</sup> century to develop the devices that produce energy in mysterious circumstances. Although they may not have noticed the fact that the key source of the excess energy was in the capacitors, it is certain that they were convinced there was extra energy coming from somewhere into the circuit that needed to be developed

To present another seemingly irrelevant yet deeply related case of excess energy device, there was an interesting experiment of hydrogen gas water fuel cell applied to automotive fuel patented by Stanley Meyer in the late 1980s [12]. Since water is an insulator in pure form, water can be used as a dielectric material in between the two concentric conducting metal plates in cylindrical form immersed in the water. By using the external inductor in series or parallel in the circuit that includes the capacitor formed by the two metallic plates in concentric cylinder immersed in pure water, a resonance electronic circuit configuration can be developed. By supplying the AC electricity that has the same frequency as the LC resonance circuit where C is the capacitance created by water and the two metal conductors, the water is subject to an oscillating high voltage source. And the water as a dielectric material in between the two conducting metal plates can be excited to ionize and generate hydrogen and oxygen with enough high supplied voltage. The repulsive potential energy stored in the capacitor is converted to the ionization energy needed to dissociate the water molecule into hydrogen and oxygen. Since there is infinite impedance in the circuit at parallel resonance, the energy released through the water fuel cell can be made to originate mostly from the electrostatic repulsive potential energy that is 8000 times larger than the attractive potential energy stored in the capacitor in case of 5 cm radius and 1 mm gap between the two spherical shells. In practical cases, the surface area of the fuel cell plates can be much larger than 80 square centimeters, and the gap distance could be much wider than 1 mm, yet it is reasonable to consider that

there still is a few thousand of amplification factor that is available for the operation of the energy conversion. Even if there could be substantial energy loss in the process of the operation of the device by heat and other ohmic losses in the power driver, the prospect is certainly more than sufficient. It is reported that Stanley Meyer demonstrated his device by driving the car installed with his water fuel cell at 38 miles per gallon of water for thousands of miles without using gasoline or extended batteries.

However, without the detailed theoretical enumeration of the additional energy stored in the capacitor, Stanley Myer's water fuel cell was considered an accident and it has been found to be fraudulent by an Ohio court in 1996, since the energy required to produce the hydrogen and oxygen must have come from the energy supplied by the external battery source that is used to dissociate the water molecule into oxygen and hydrogen according to the known physical laws of the time. As in most cases, engineering without a detailed mathematical understanding of the physical mechanism that is going on inside the electro-mechanical device or in a sophisticated construction can be a risky adventure. As a result, his patent didn't receive full support from the contemporary scientific community of the time.

## **8. Conclusion**

We reexamined the details of the stored energy distribution in charged capacitors using the simplest case of spherical capacitor from the theoretical perspective in relation to the past experimental trials of energy devices experimented by scientists and engineers. The advantage of using the spherical capacitor is that the exact mathematical form of the repulsive electrostatic potential energy can be calculated and it can be generalized to other types of capacitors to bring out the surprising conclusion that was not possible in the past. The result is in stark contrast to the conventional energy conservation law in charged capacitors and the prospect of using the phenomenon to generate clean energy for the future of humanity seems not too far out of the reach.

## **9. Acknowledgement**

We noticed the stored energy anomaly in capacitors in 1999 by gedanken experiment tracing all the energy stored in the capacitors. It was not an easy task to challenge the centuries old doctrine that the early pioneers have established as a corner stone of the modern science. However, we as scientists must have faith on the principles of mathematics and the experimental testing no matter how absurd the result may sound. It is our best assessment that the local energy conservation principle in electrodynamics was flawed from the beginning and humanity can be better off by revising it. I'm grateful to my mentors who taught me the wonders of mathematics and physics that are the tools to investigate the hidden scientific truths to explore the deeper mysteries of the universe for the advancement of human civilization.

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