Re-examination of Energy Conservation Principle in Charged Capacitors and the Reported Anomalous Energy Devices

Eue Jin Jeong
Tachyonics Institute of Technology
Austin TX 78741 USA
euejinjeong@utexas.edu

Abstract

Energy conservation is one of the most fundamental and well-established principles of physics. E. 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 an open empty space, it seems that the local space enclosed by conducting metallic plates has an unexpected property, suggesting that the energy conservation principle may not necessarily apply to localized bound systems of capacitors in electrodynamics. This point of view was raised by noting that the spherical capacitor has calculable electrostatic self-potential energy in both the inner and outer shells, which is not considered in the conventional consideration of the total energy stored in the capacitors. It seems that the concept of moving charges one by one into the capacitor plates has helped bypass the necessary steps to account for the additional repulsive self-potential energy that accumulates simultaneously in both capacitor plates in the process of charging the capacitor. We present itemized details of the repulsive potential energy stored in the capacitors and discuss its physical reality in relation to the anomalous energy devices reported in the past.

1. Introduction

The pioneers of modern physics have developed the concept of energy conservation from thermodynamics, where heat energy is converted into mechanical energy under adiabatic conditions. Repeated testing has provided evidence that the 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 modern physical science, the local energy conservation principle derived from thermodynamics [1] has been proven to be accurate, and it is believed that the same principle must be observed in the case of the theory of electromagnetism. However, there is evidence suggesting that the local energy in the case of the bound system of capacitors in electrodynamics is not conserved, contrary to the general theorem that suggests energy is conserved in empty space.

Contrary to the case of an adiabatic thermodynamic system, where the heat can be blocked from entering or exiting the system in question by using a proper insulation method, the electromagnetic system is not energetically isolatable in the same manner.

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

A detailed analysis shows that the conventional estimation of the total energy stored in capacitors does 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 created simultaneously inside the metallic plate by the repulsive force among the same charges was not considered as a part of the stored energy. The additional energy created in the process of charging the capacitor was not expected, and the energy conservation principle was satisfied without taking it into account. The physical reason for this is because the conducting metallic plate has a work function potential that traps and holds charges together in such way that the charges cannot escape from the surface of the metal. This trap mechanism raises the possibility that the electric charges in the metallic plate develop repulsive electrostatic potential energy depending on the density of the charges in the capacitor because they cannot free themselves from the confined state inside the conductor plate up to a certain level of charge concentration. As long as there is a repulsive electrostatic force between the same charges and confinement due to the work function potential in each conductor plate, the incremental accumulation of the repulsive electrostatic potential energy stored in each capacitor plate is inevitable.

For the purpose of investigating the detailed mechanism of accumulating repulsive potential energy, a spherical capacitor has the geometrical advantage that the exact amount of repulsive electrostatic potential energy can be calculated because of the uniformity of the distribution of charges around the sphere, while this is not the case for a parallel plate or cylindrical capacitor. The key issue for the non-spherical form of capacitors is that the density of the electric charge cannot be expressed in a closed mathematical form because it depends on the thickness of the metallic conductor and the exact geometrical configuration, which is unpredictable due to the non-uniform distribution of the charges in such cases. In addition, 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 because the electrons in the metal could be shielded from each other if the charges are stored in predetermined individual bins according to the model.

2. Drude-Sommerfeld Free Electron Model and Spherical Shell Model Capacitor

According to the photoelectric effect originally proposed by Einstein [3], electrons are confined inside the work-function potential of a particular metallic element. In addition, the standard Solid State physics theories of the Drude-Sommerfeld free electron model [4] on solid-state metals showed that electrons are free to move around inside the conducting metal. If the repulsive electrostatic potential energy becomes greater than the work function potential owing to the high concentration of electrons, the charges jump out of the metal as lightening electricity flying across the space. Because the charges tend to move around inside the conductor in such a way that they can reduce the total energy, they accumulate on the sharp edges of the metallic plate. This is why arcing of the charges typically occurs from the sharp edges of the charged metallic plate. This tendency of electrons makes their distribution inside the metal unpredictable, except in the case of a spherical configuration. As such, electrons will be distributed evenly inside the shell because of the repulsive electrostatic force in the case of a spherical shell, whereas in the case of a parallel plate or cylindrical capacitor, the electrons will tend to move to the corners or to the edges to lower the total energy. To study the detailed distribution of the electrons inside the metallic surface and to investigate the stored energy, a spherical capacitor provides an ideal case because it allows the exact calculation of the self-energy.

3. Orthogonality Condition of the Two Independent Electrostatic Fields

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

Therefore, the repulsive electrostatic force field lines are tangential to the surface of the sphere, while the attractive electrostatic force field lines between the inner and outer shells are radial from the common center of the two spheres. As such, the orthogonality condition is satisfied for the two different electrostatic fields, where one is repulsive and the other attractive, which means that the energies created by these two different fields are not mixed and must be treated independently.

4. Repulsive Electrostatic Self Potential Energy

The concept of repulsive electrostatic potential energy has already been used [5] to calculate the self-energy of an electron in a spherical form to estimate the classical radius of the electron. If electrons can develop self-energy from the repulsive electrostatic force among themselves from their primordial charge distribution, a group of charges distributed in a spherical metallic shell should develop electrostatic self-potential energy due to the repulsive electrostatic forces among themselves as well. However, for some mysterious reasons, this possibility has not been investigated in previous studies on electronic devices. There is no ambiguity that the same electric charges repel each other, and the uniform distribution of charges in the spherical capacitor develops repulsive self-potential energy in both the inner and outer spheres. There is no reason that this principle cannot be applied to both cylindrical and parallel-plate capacitors. The repulsive self-potential energy created in the process of charging the capacitor sustains itself owing to the energy conservation principle until the two opposite charges are recombined and neutralized. The creation of repulsive electrostatic potential energy during capacitor charging is an irreversible process that cannot be undone until the polarized charges are neutralized by recombination.

Therefore, the key question is not whether the repulsive electrostatic self-potential energy exists in various types of capacitors; rather, the question is how the repulsive electrostatic potential energy stored in the capacitors when the capacitor is charged disappears in the circuit theory of conventional electronic devices, and the universal local energy conservation principle in the theory of electrodynamics has prevailed.

The fundamental theoretical cause of the energy imbalance arises from the fact that the large surface area of the capacitor plate is constrained by the equipotential boundary condition owing to the conducting property of the metals, where electrons can move freely. This particular configuration of charge distribution is certainly not under the same configuration generally described by the Poynting vector [6] or Noether's theorem [7], which applies only to the free empty space. The confinement of 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 by Einstein's photoelectric effect [4].

The conventionally calculated energy stored in capacitors using the concept of moving charges one by one was convincing and yet it did not include the repulsive electrostatic potential energy. However, there was no conflict with the energy conservation principle borrowed from thermodynamics when the capacitor was discharged through a load resistor to convert current into heat. As such, it appeared that there was no conflict between the theory and experiment, and there was no need to scrutinize the possible existence of the additional energy stored in the capacitors.

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

To elucidate the key issue of the problem with mathematical clarity, consider a spherical capacitor with an inner spherical shell of radius a and outer shell radius b made of conducting metal. For clarity, let us assume that the charge accumulated in the inner sphere is $-Q_1$ and that accumulated in the outer sphere is Q_2, which is slightly different in magnitude from Q_1. This type of hypothetical charge distribution rarely occurs in reality because of charge invariance in various types of power supplies. However, it is useful for tracing the details of where electrical energy is distributed.

(1) Attractive electrostatic potential energy stored in a spherical capacitor

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

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

where c represents the capacitance between the two metallic plates that store the opposite charges on each plate, which depends on the material of the dielectric constant ε between the two metallic spherical shells,

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

For the same amount of electrostatic charge, according to Equation (1), a low-capacitance capacitor tends to store more energy than a high-capacitance capacitor. The energy stored in the same capacitor by slightly different magnitudes of charges $-Q_1$ and Q_2 in the inner and outer spherical shell is given by

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

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.

(2) Repulsive electrostatic potential energy stored in a spherical capacitor

On the other hand, there is also additional energy stored in the conduction band of each individual shell because of the repulsive electrostatic force among the same charges that depend on Q_1^2 and Q_2^2. The sum of the stored repulsive potential energy in both the inner and outer shells of the capacitor is given by

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

Note that the repulsive electrostatic potential energy stored in each of the two spherical shells in (4) has the same mathematical expression as that of the self-energy of the electron employed to estimate the classical electron radius in classical electrodynamics [5]. The vacuum permittivity ε_0 inside the metal is utilized to calculate the repulsive electrostatic potential energy between the same charges because the conduction band of the metal, where the electrons move freely, is considered a vacuum instead of a space filled with dielectric material. Because the attractive potential energy depends on (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. In addition, the physical location of this repulsive potential energy is on the surface of the metallic spherical shells where the repulsive electrostatic force lines are tangential to the surface of the shell. This is orthogonal to the attractive concentric electrostatic force lines that 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 spherical capacitor shells (4) is given by:

$$E_{repulsive} = \frac{Q^2}{4\pi\varepsilon_0}\frac{b+a}{2ab} \qquad (5)$$

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

$$E_{total} = \frac{Q^2}{4\pi\varepsilon}\frac{b-a}{2ab} + \frac{Q^2}{4\pi\varepsilon_0}\frac{b+a}{2ab} \qquad (6)$$

(3) Ratio of the repulsive vs. attractive potential energy stored in the spherical capacitor

The ratio between the repulsive potential energy and attractive potential energy is given by

$$\frac{E_{repulsive}}{E_{attractive}} = \frac{\varepsilon(a+b)}{\varepsilon_0(b-a)} \qquad (7)$$

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 additionally, depending on the dielectric substance between the two capacitor plates, the ratio of $\varepsilon/\varepsilon_0$ can be substantially large.

Material	$k = \varepsilon/\varepsilon_0$
PbMgNbO3+PbTiO3	22600:
PbLaZrTiO3	1000:
BaSrTiO3	300:
H2O	80:

Table 1: Samples of the High Dielectric Constant Materials

Table 1 lists several materials with high dielectric constants. For example, according to Equation (7), for a spherical capacitor with a radius of 5 cm and a gap distance of 1 mm between the two conducting spheres, where the gap is filled with the dielectric material PbLaZrTiO3, which has a dielectric constant of 1000, the stored repulsive electrostatic potential energy is 100,000 times the attractive potential energy. If the dielectric material between the same double spherical shell is pure water, which has a dielectric constant of 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 required to charge the capacitor.
Even in the case where the dielectric material is a vacuum, the stored repulsive energy is still larger than the attractive one by a factor of the diameter of the sphere divided by the gap distance between the two metallic shells forming the capacitor, as can be seen from equation (7), which is still much larger than 1. When a commercially available capacitor made for an electronic circuit is labeled as $10uF$ 100 V, it represents the attractive potential energy capacitance in (2). Information about the capacitance represented by the repulsive potential energy (5) is not provided because such information is not required in standard electronic circuit theory. Electronic circuits operate without such information in most low-voltage circuit applications. However, because the stored energy depends on the square of the applied voltage, grounding becomes a serious issue in high-voltage applications because the circuit needs to drain excess energy to the ground to prevent damage to other electronic components and/or to the unwitting handlers.

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

6. Casimir Effect and Zero Point Energy

The capacitor configuration of two conducting metallic plates facing each other has a quantum field theoretical effect of mutual attraction known as the Casimir effect [8], from which the zero-point energy concept has been developed [9]. Considering the fact that the pursuit of zero-point energy is basically the same as extracting vacuum energy, there are certain similarities in the two different approaches, although the concept of the repulsive potential energy stored in the capacitor does not require the quantum field theory, but only the standard theory of electrodynamics to prove its existence. However, the idea of zero-point energy and the Casimir effect due to vacuum polarization originating from quantum field theory provide a conceptual background for the mysterious origin of the repulsive electrostatic potential energy stored in capacitors.

While the theory of electrodynamics has never failed experimental tests and as such, the presence of the repulsive electrostatic potential energy in charged capacitors is certain, the theory does not elaborate where this extra energy comes from other than the fact that it simply demonstrates it. The reason this is so baffling is because we are accustomed to the concept of the balance of energy on where it comes from and how much of it is utilized and/or wasted because energy is a limited valuable life source.

The concept of extra energy represented by the repulsive electrostatic potential energy stored in the capacitors, which can be created as much and as freely as possible, will introduce a widely open end on the supply side of the equation in our long-held perception of the limited energy source.

7. Property of the Repulsive Electrostatic Potential Energy Stored in the Capacitors

According to the general equation of motion for a particle under the influence of an external potential function, the kinetic energy of the particle is obtained 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 or may not materialize unless the particle is allowed to act upon the force generated by the potential. This is what occurs inside a closed electronic circuit with 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 converting the repulsive potential energy into kinetic energy. Because charges cannot act upon the repulsive potential energy inside the tightly closed electronic circuit by the wire, conversion of the repulsive potential energy into kinetic energy does not occur, and the stored repulsive potential energy simply disappears. It is noted that the repulsive and attractive potential energy exist as “potential” energy until the charge polarization is neutralized.

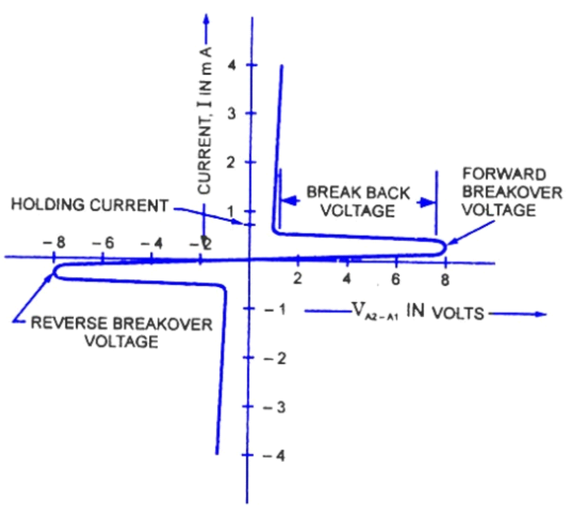
This is the reason it has been proven and verified that the energy stored and released by the discharge of the capacitor through the resistor is equal according to the conventionally known laws of physics, which is expressed by the capacitor energy (1), which reflects only the attractive part of the 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/or 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 kinetic energy and consequently into the electrical current of the usable form.

Therefore, there was an omission of the repulsive electrostatic potential energy in the theoretical calculation of the stored energy in the capacitors, and 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 two fundamental misconceptions that resulted in the conventional physical law of local energy conservation in charged capacitors in electrodynamics. However, two errors, both theoretical and experimental, that mutually confirm each other to be accurate, do not necessarily prove that the involved scientific principle is valid.

The earlier cases of unusual energy-producing devices reported by Nikola Tesla [10], T. H. Moray [11], and others have consistently used discharge circuit elements such as spark gaps, cold cathode tubes, and vacuum tubes in their devices, which confirms the space-discharge to electrical-current-gain mechanism, which contributed to the workings of their devices, whether the engineers performing the experiment recognized the anomalous excess energy creation effect or not at the time.

From these examples, we conclude that the key mechanism for utilizing 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 space before allowing them to recombine and let the total energy manifest at the power load.

Certain solid-state electronic devices with multiple layers of semiconductor junctions, for example, Sidac [12], among others, were developed in the 1950s and have a negative resistance property in their I-V discharge curves, as shown in Fig. 1. This is similar to the cold cathode tube, which is known to exhibit a negative resistance slope in the I-V discharge curves, as shown in Fig. 2. It is a mystery why there is a negative slope in the I-V discharge curve from these electronic components in the first place, because it indicates that there is an electrical current gain effect from somewhere in the circuit, according to the well-established circuit theory of electronic devices.



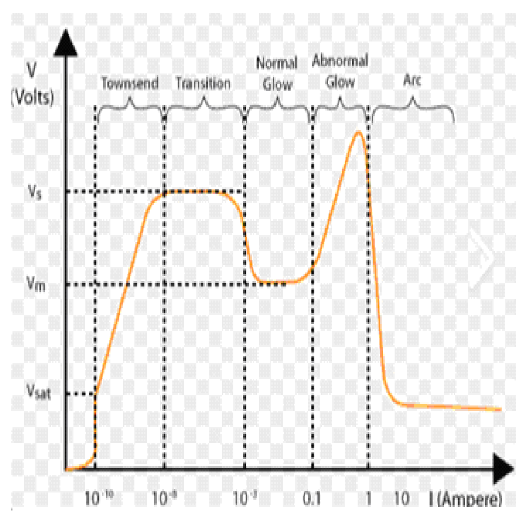


Fig 1. **Sidac V-I Discharge Curve** **Fig. 2**. **Cold Cathode Tube I-V Discharge Curve**

The reason for the manifestation of the negative slope in the I-V curve from these devices is that the DC power supplies used by the labs to test the I-V discharge property are made by stepping up or down the line voltage by transformers and rectifying the AC voltage using rectifiers and sending the unregulated DC voltage through the parallel array of regulating capacitors, which becomes the source of the repulsive electrostatic potential energy that provides the current gain effect in the I-V discharge curves for both the cold cathode tube and Sidac cases. This also indicates that the Solid State Sidac device can perform the same task of energy conversion inside the semiconductor junction without having to let the charges pass through the process of open space discharge.

8. Reported Experiments on Repulsive Potential Energy Harvested by Capacitor Discharge

Nikola Tesla, Thomas Henry Moray, and others in the early 20th century patented and demonstrated devices that mysteriously produced more energy than was put in. These devices are not supposed to generate more energy than the input energy from the perspective of the known physical principle of energy conservation. In the case of Nikola Tesla's patented device, he claimed that the device is collecting "radiant energy from the Sun"; however, the amount of radiant energy from the sun received by the antenna is not close enough to run any power device. The practical conversion of repulsive electrostatic potential energy into useful electrical current was achieved 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.

(1) Nikola Tesla radiant energy device

The original diagram in Fig. 3 of Tesla's radiant energy device contains a capacitor, rotary spark gap discharge element, transformer, and antenna that collects 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.

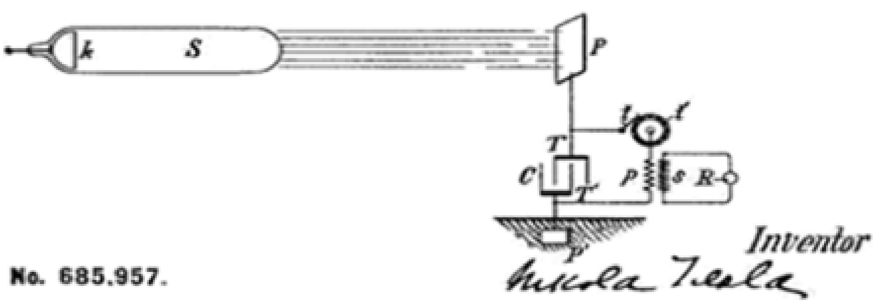


Fig 3: Nikola Tesla Radiant Energy Device Schematic Diagram

If the capacitor has a large ratio of repulsive electrostatic potential energy to attractive energy, the device can generate sufficient power to operate a power load when an efficient energy conversion device is utilized. As has been extensively discussed in the book “The Inventions, Researches and Writings of Nikola Tesla” [13], the technical problem Tesla has faced with his circuit is that the spark gap becomes a conductor because of the plasma produced by high-voltage arcing through the air, which contains

abundant amounts of nitrogen and oxygen. His painstaking attempt to maintain the spark gap by performing constant optimum discharge is visible at a certain point in his attempt 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 the complex conduction process, as shown in Fig 2, because the negative resistance effect occurs only in a particular range of conducting electric currents.
The actual role of the antenna in the circuit is to collect and save the electrostatic charge floating in atmospheric space into the capacitor, where the opposite electrode is connected to the ground. Tesla maintained that the source of energy comes from the sun day and night, in the form of radiant energy. This was the main part that baffled scientists at the time; 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 operates 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 because of the excessively high voltage and current built up in the circuit, which is one of the main technical challenges in achieving successful completion of the operating device. Engineering a new electronic device that defies the conventional principle of physics cannot be completed unless the underlying physical mechanism that causes such an anomaly is fully accounted for in detail at the fundamental theoretical level.

(2) T. H. Moray radiant energy device

The schematic diagram in Fig. 4. was drawn by an eyewitness who had a chance to look inside the T H Moray's device, which provides another case of an excess energy device experimented by the inventor. Moray was able to produce 50 kWh of energy in a time span of a week [11]. The main parts of the circuit are capacitors, cold cathode tubes, and a transformer that controls the output voltage of the power load. The circuit component U in the diagram is composed of two different metal bars in contact, where one is lead and the other is steel. The contact point of metals with different work-function potentials is known to produce a nonzero contact potential.

The antenna was 200 feet long and 80 feet above the ground, and the wire was a copper cable approximately a fourth inch in diameter, according to the record. Before starting the device, it took 10-20 minutes to charge the capacitor from the antenna. The circuit component switch S is used to start the device to oscillate because the abrupt change in the inductance in the LC resonance circuit by tapping the switch in the presence of non-zero voltage across capacitors C4 and C5 creates a current spike in the circuit that can start the oscillation once the capacitors are fully charged. To dispel the suspicion that he may be tapping the electricity from the household power line, he performed the experiment in a remote area miles away from the city, where there are no nearby power lines. In one experiment, Moray ran his device for 157 h, without any connection to an external power source. It is noted that the capacitor and discharge elements are the essential circuit components that comprise the energy-producing electronic circuit in both

Tesla and Moray. The other common feature of both circuits is that they use either a 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.

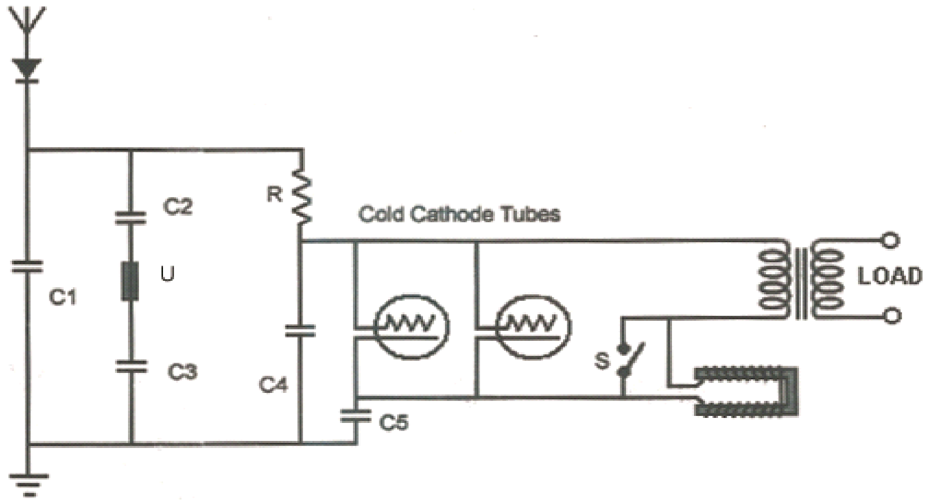


Fig 4: T. H. Moray Radiant Energy Device Schematic Diagram

Moray struggled with his switching device because the cold cathode discharge tube did not last long before it broke down to become a nondischarging tube. What happened is that the repeated discharge on the metallic surface of the electrodes caused the conductor to corrode and oxidize in time, which turned the cold cathode tube into an insulator that no longer functioned as a discharge device altogether. This was the fundamental technical challenge that inventors had to deal with in the early 20th century to develop a device that produces energy in mysterious circumstances, and the main circuit component was the energy conversion element that converts the repulsive potential energy into an electrical current. Although they may not have recognized the fact that the key source of the excess energy was from the electrostatic repulsive potential energy stored in the capacitors, it is certain that they were convinced there was extra energy coming from somewhere into the circuit from their hands-on experience of repeated experimental tests.

(3) Stanley Meyer water-fuel cells

To present another seemingly irrelevant yet deeply related case of an excess energy device, an interesting experiment was conducted on a hydrogen gas–water fuel cell applied to automotive fuel patented by Stanley Meyer in the late 1980s [14]. Because water is an insulator in its pure form, it can be used as a dielectric material between two concentric conducting metal plates in cylindrical form immersed in water. By using an external inductor in series or parallel in the circuit that includes the capacitor formed by the two metallic plates in a concentric cylinder immersed in pure water, a resonant electronic circuit configuration can be developed. By supplying 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 subjected to an oscillating high-voltage electrical source. In addition, water, as a dielectric material between the two conducting metal plates, can be excited to ionize and generate hydrogen and oxygen with a sufficiently high supplied voltage. The repulsive potential energy stored in the capacitor was converted to the ionization energy required to dissociate water molecules into hydrogen and oxygen. In electronic circuit theory, there is infinite impedance in a parallel resonance circuit in resonance, therefore, the energy released through the water fuel cell can be made to originate mostly from the electrostatic repulsive potential energy, which is 8000 times larger than the attractive potential energy stored in the capacitor in the case of a 5 cm radius and a 1 mm gap between the two spherical shells. In practical cases, the surface area of the fuel cell plates could be 10 times larger than 80 square centimeters, and the gap distance could be 10 times wider; however, it is reasonable to consider that there are still a few thousand amplification factors that are available for the operation of energy conversion. Even if there is a substantial amount of energy loss in the process of operation of the device by heat and other Ohmic losses in the power driver, the prospect is still optimistic. It is reported that Stanley Meyer demonstrated his fuel gas generator 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 a detailed theoretical enumeration of the additional energy stored in the capacitor, Stanley Myer's water fuel cell was considered an accident and was found to be fraudulent by an Ohio court in 1996 because the energy required to produce 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 clarification of the physical mechanism inside the electromechanical device or in sophisticated construction can be a risky adventure. As a result, his patent did not receive full support from the contemporary scientific community.

9. Conclusion

We re-examined the details of the stored energy distribution in charged capacitors using the simplest case of a spherical capacitor from a theoretical perspective in relation to past experimental tests of energy devices performed by scientists and engineers. The advantage of using a 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 a surprising conclusion that was not possible in the past. This result is in stark contrast to the conventional energy conservation law in charged capacitors, and the prospect of using the repulsive electrostatic potential energy stored in the capacitors to generate clean energy for the environment and for the benefit of humanity does not seem too far out of reach.

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