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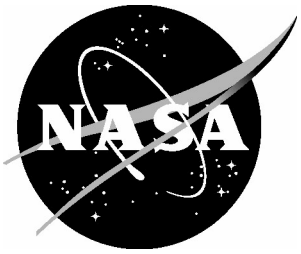

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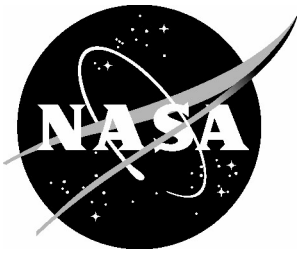

Advanced Energetics for Aeronautical Applications: Volume II

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3. Advanced Electric Concepts

3.1 Introduction and Overview

MSE has presented high-level overviews of on-going research in areas of breakthrough propulsion and energy technologies (Ref. 1, pp. 71-86).

Many of these breakthrough technologies share the common characteristic of being "electric" in nature. Obviously, it would be electric motors powered by fuel cells, which (in turn) drive propulsion fans for the baseline emissionless aircraft concept being developed by MSE and NASA-LaRC. However, "electric" in the context of this report refers to a characteristic of more advanced concepts such as deriving energy from the zero point energy (ZPE) field, present everywhere, and directly propelling an aerospace vehicle (for example) by means of high-voltage electric fields.

The topics included in this section are:

- Dr. Charles P. Steinmetz's theories of electricity;
- longitudinal and transverse electric waves; and
- scalar waves.

Sections 3.1.1 through 3.1.3 briefly introduce these topics and describe some of the ways they are connected.

3.1.1 Dr. Charles P. Steinmetz's Theories of Electricity

Dr. Steinmetz was the Chief Scientist of the GE Corporation approximately a century ago when large-scale alternating current (ac) electric technology was being rapidly developed and applied throughout the civilized world. Dr. Steinmetz also taught advanced courses to graduate electrical engineering students of that time so they could take part in the ongoing development of the electric power industry.

Additionally, those who are currently exploring the potential for accessing ZPE recognize that Steinmetz had valuable insights on electric characteristics and phenomena (not formally taught today) that could potentially help in the discovery and development of such breakthroughs.

One of these advanced topics taught by Steinmetz was electric transients (Section 3.2.2), and another is the characteristics of an electric field in the space surrounding an energized electric conductor (Section 3.2.3).

3.1.2 Longitudinal and Transverse Electric Waves

The traditional teaching on electric waves is actually on ***transverse*** electric waves in which the wave vibration is transverse to the direction of wave propagation. However, contemporary experimenters have found it possible to reproduce the remarkable experiments and results described by Dr. Nikola Tesla more than a century ago on ***longitudinal*** electric waves (in which the wave vibration is in the same direction as wave propagation, provided the experimental apparatus is built exactly according to the principles that Tesla described). Some experimenters have performed side-by-side demonstrations that clearly show that the characteristics of longitudinal and transverse electric waves are quite different.

Section 3.3 will compare the properties of longitudinal and transverse waves and furthermore suggest how the former type will potentially allow ZPE to be accessed and advanced propulsion concepts to be achieved.

3.1.3 Scalar Waves

Scalar waves is the name of a phenomena associated originally with the research of Dr. Nikola Tesla and other pioneering researchers of advanced electric topics. Research into and the recognition of the importance of scalar waves is now significantly growing worldwide.

Section 3.4 will present the topic of scalar waves from the perspective of:

- Dr. Thomas Valone, who has written extensively on ZPE and related phenomena; and
- Dr. Konstantin Meyl, who has written an extensive book on scalar waves in which he uses that phenomena as his basis for describing the properties of matter and energy from a viewpoint that is different from what is commonly accepted.

3.2 Teachings on Electric Phenomena by Dr. Charles P. Steinmetz

3.2.1 Introduction

In the early 1900s, Dr. Charles P. Steinmetz, Past President of the American Institute of Electrical Engineers, was GE Corporation's Chief Scientist for the development of long-distance ac high-voltage power transmission lines.

A series of graduate student university lectures given by Dr. Steinmetz on electric transients was collected and published in book form and was titled *Electric Discharges, Waves and Impulses, and Other Transients* (Ref. 21).

In this book, Dr. Steinmetz teaches what was known at that time regarding what would cause electric transients in electric transmission lines and the consequences of such transients, once formed.

This report includes information from Dr. Steinmetz's first two lectures (i.e., first two chapters of the book). The first chapter is titled *Nature and Origin of Transients*, and the second chapter is titled *The Electric Field*. A brief introduction for each respective chapter will be presented subsequently in this report.

Various claims for advanced energy and propulsion breakthroughs state that transient, high-voltage, or electric discharge phenomena were involved. The intent of this report is not to teach electrical theory but to show that selected electrical phenomena (which in general could be called "electric transients") could ***potentially*** lead to significant breakthroughs in aerospace technology.

3.2.2 Dr. Steinmetz's Teaching on Electric Transients

In the first chapter of the above-referenced book, Steinmetz introduces the question of why electric transients are ***not instantaneous***, with the following quotation (Ref. 21, p. 2):

> *The question then arises, why the effect of a change in the conditions of an electric circuit does not appear instantaneously, but only after a transition period, requiring a finite, though frequently very short time.*

The answer is that electric energy is stored in the electric system (e.g., voltage source, transmission line, and load), and a finite time is required to store energy in (or use energy that has been stored in) the system. With the following quotation, Steinmetz explains that in addition to mechanical energy storage (as in generators and motors) and thermal energy as in light bulb filaments, energy is stored electrically in the space around conductors:

> *While electric power flows over the line, there is a magnetic field surrounding the line conductors, and an electrostatic field issuing from the line conductors. The magnetic field and the electrostatic or "dielectric" field represent stored energy. Thus, during the permanent conditions of the flow of power through the circuit, there is electric energy stored in the space surrounding the line conductors.*

Dr. Steinmetz explained that one type of electric transient consists of one type of stored electric energy changing into another:

> *Thus in electric circuits containing energy stored in the magnetic and in the dielectric field, the change of the amount of stored energy - decrease or increase - frequently occurs by a series of successive changes from magnetic to dielectric and back again from dielectric to magnetic stored energy. This for instance is the case in the charge or discharge of a condenser through an inductive circuit.*

The storage of energy in the dielectric and magnetic fields of an electric circuit is subsequently discussed by Steinmetz in Chapter 2 of his book.

3.2.3 Dr. Steinmetz's Teaching on the Electric Field

In the second chapter of his book, Dr. Steinmetz presents his view on the component parts of the "electric field" surrounding a conductor through which electric power is flowing. Dr. Steinmetz stated that (Ref. 21, p. 10):

> *…in the space surrounding the conductor certain phenomena occur: magnetic and electrostatic forces appear.*

In the following quotation, Steinmetz provides more detailed information regarding the "magnetic field" and "dielectric field," which are the two components of the "electric field":

> *The conductor is surrounded by a magnetic field, or a magnetic flux, which is measured by the number of lines of magnetic force. With a single conductor, the lines of magnetic force are concentric circles, as shown in Figure 8. By the return conductor, the circles are crowded together between the conductors, and the magnetic field consists of eccentric circles surrounding the conductors, as shown by the drawn lines in Figure 9.*
>
> *An electrostatic, or, as more properly called, dielectric field, issues from the conductors, that is, a dielectric flux passes between the conductors, which is measured by the number of lines of dielectric force. With a single conductor, the lines of dielectric force are radial straight lines, as shown dotted in Figure 8. By the return conductor, they are crowded together between the conductors, and form arcs of circles, passing from conductor to return conductor, as shown dotted in Figure 9.*
>
> *The magnetic and the dielectric field of the conductors both are included in the term electric field, and are the two components of the electric field of the conductor.*

Figures 8 and 9 from Dr. Steinmetz's book are shown here as Figures 6 and 7, respectively.

Dr. Steinmetz shows by simple analogous mathematical derivations that:

- the energy stored in the magnetic field surrounding an electrically energized conductor varies as the square of the ***current*** in the circuit; whereas,
- the energy stored in the dielectric field surrounding an electrically energized conductor varies as the square of the ***voltage*** in the circuit.

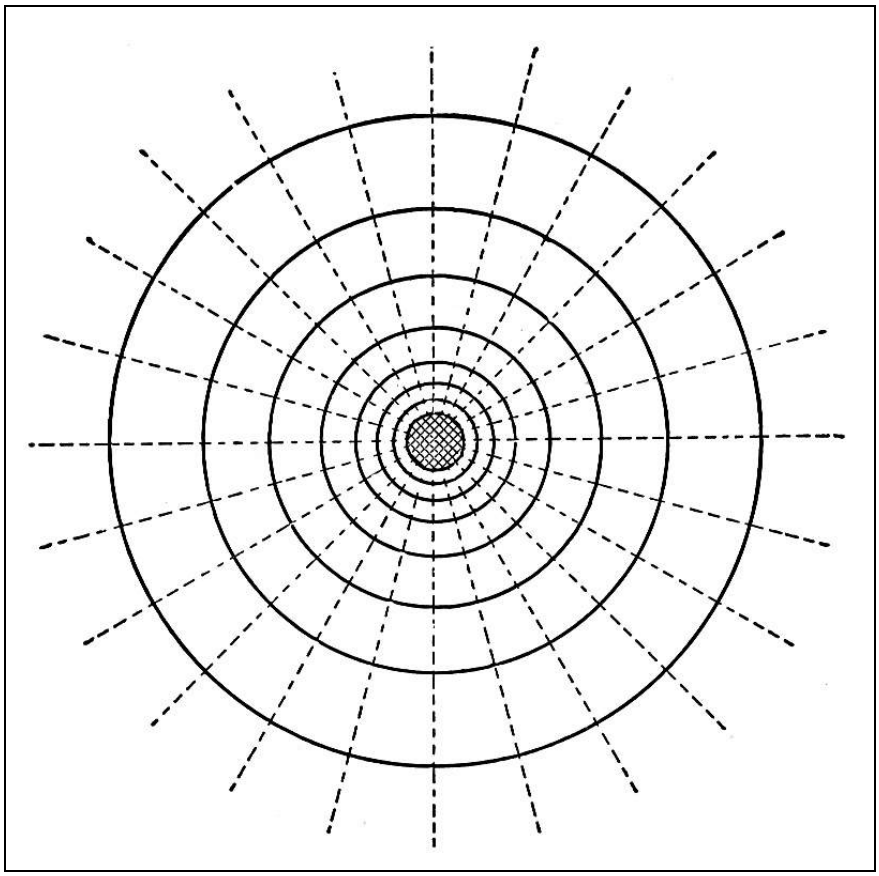

Figure 6. Electric field of conductor. Lines of magnetic force are shown solid; lines of dielectric force are shown dotted.

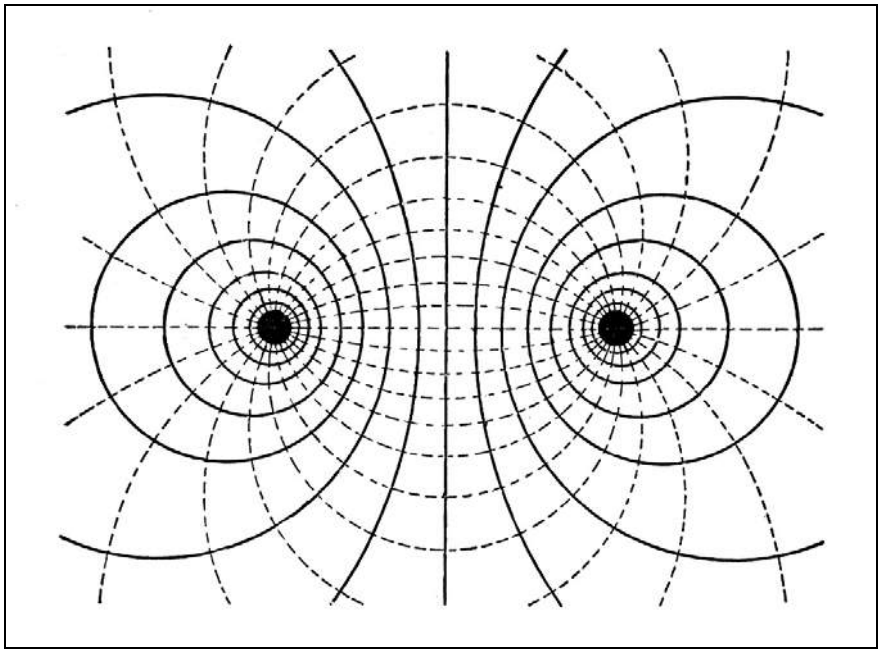

Figure 7. Electric field of circuit. Lines of magnetic force are shown solid; lines of dielectric force are shown dotted.

In the following quotation, Steinmetz teaches that the dielectric field surrounding an electrically energized conductor is not on the ***surface*** of the conductor but is in the space ***outside*** the conductor (Ref. 21, pp. 13-14):

> *Unfortunately, to a large extent in dealing with the dielectric fields the prehistoric conception of the electrostatic charge on the conductor still exists, and by its use destroys the analogy between the two components of the electric field, the magnetic and the dielectric, and makes the consideration of dielectric fields unnecessarily complicated.*
>
> *There obviously is no more sense in thinking of the capacity current as current which charges the conductor with a quantity of electricity, than there is of speaking of the inductance voltage as charging the conductor with a quantity of magnetism. But while the latter conception, together with the notion of a quantity of magnetism, etc., has vanished since Faraday's representation of the magnetic field by the lines of magnetic force, the terminology of electrostatics of many textbooks still speaks of electric charges on the conductor, and the energy stored by them, without considering that* ***the dielectric energy is not on the surface of the conductor, but in the space outside of the conductor, just as the magnetic energy*** *(emphasis added).*
>
> *All the lines of magnetic force are closed upon themselves, all the lines of dielectric force terminate at conductors, as seen in Figure 8, and the magnetic field and the dielectric field thus can be considered as a* ***magnetic circuit*** *and a* ***dielectric circuit****.*

As depicted in Figure 6 (Steinmetz's Figure 8), where there is a single conductor, an important difference between the magnetic field and the dielectric field is that the lines of magnetic force are ***finite***, whereas, the lines of dielectric force are ***infinite***.

3.3 Differences Between Longitudinal and Transverse Electric Waves

3.3.1 Introduction

The fundamental differences between "longitudinal electric waves" and what are commonly referred to as "electromagnetic waves" were first described by the inventor Dr. Nikola Tesla and the mathematician Dr. Charles P. Steinmetz approximately 100 years ago (Refs. 21 and 22).

Dr. Nikola Tesla invented the ac electric transmission system and its major components during the 1880s. At approximately 1890, Dr. Tesla began to investigate, write about, and demonstrate electric and electric transmission phenomena, which appeared unusual at that time and are very difficult to theoretically describe now based upon contemporary electric theory (Ref. 23). Over the years, investigators have ***claimed*** that Dr. Tesla was using a type of electric transmission referred to as longitudinal electric waves. It is to be understood that this claim (longitudinal electric waves) is applicable for the Tesla experimental phenomena replicated in the 1980s by a group of researchers in southern California who call themselves the Borderland Sciences Research Foundation (BSRF) (Refs. 17 and 24). These replications are described subsequently.

3.3.2 Definitions

Exact definitions of these two types of electric waves (from approximately 100 years ago) are as follows:

- Electromagnetic Waves = Transverse Electromagnetic Waves (TEM waves); for which the energy-related vibration is ***perpendicular*** to the wave propagation direction; and
- Longitudinal Electric Waves = Longitudinal Magneto-Dielectric Waves (LMD waves) for which the energy-related vibration is in the ***same*** direction as the wave propagation direction.

3.3.3 Wave Propagation Velocity Differences

The BSRF researchers claimed that they have demonstrated that the wave propagation velocities of transverse waves and longitudinal waves are significantly different, even when they are produced by the same signal source.

The wave velocity of transverse waves was determined by measuring the frequency for which low-power radio waves directly coupled to the end of a conductor of known length produced a resonance condition that resulted in a maximum voltage measured at the "far" (nonsource) end of the conductor. Wave velocity was calculated as (resonant) frequency times wave length, which was equal to frequency times conductor length times four. (The factor of four is included because reflected energy and input energy result in a maximum output when the conductor length is one-quarter of the full [electric] wave length.)

The wave velocity of longitudinal waves was determined in a very similar manner; however, the radio waves were ***capacitively*** (i.e., not directly) coupled to one end of a conductor equal in length to the conductor used for the transverse wave velocity measurement. As was done for transverse waves, wave velocity was calculated as (resonant) frequency times conductor length times four.

The results of these determinations were as follows:

- transverse wave velocity = 2.44×10^8 m/s = 0.81 x c; and
- longitudinal wave velocity = 3.74×10^8 m/s = 1.25 x c.

The velocity of transverse waves in "free space" (i.e., not confined to a conductor or other physical material) has been measured to be 3.00×10^8 m/s, and this value is commonly referred to as "the velocity of light, c" (Ref. 25).

The following points should be noted.

- Dr. Nikola Tesla described the propagation of some of the electric waves from his "Tesla Coils" as being "many" times the speed of light. [A Tesla Coil built ***as described by Tesla*** generates ***both*** transverse waves ***and*** longitudinal waves (Ref. 22)].

- Dr. James Clerk Maxwell's ***original*** electric wave equations (which he published in 1865, see Section 3.4.3.3 of this report) were written in a form of mathematics known as "quaternions" that predicted ***both*** transverse waves and longitudinal waves. Other researchers modified Maxwell's original equations to the vector form, as commonly taught in universities today, and in so doing ***arbitrarily*** discarded longitudinal waves. Nevertheless, longitudinal waves are believed to be a part of nature (Ref. 26).

3.3.4 Transverse Waves vs. Longitudinal Waves: Transmission Line Characteristics

The BSRF researchers demonstrated that the distribution of field strength and energy level along the length of a transmission line is fundamentally different when comparing transverse waves vs. longitudinal waves.

All electric transmission lines have electric properties referred to as "inductance" (associated primarily with coils) and "capacitance" (associated primarily with capacitors).

To illustrate the transverse configuration, a physical model of a two-element (two-wire) transmission line was demonstrated in which ***coils were connected in series*** in each wire and ***capacitors were connected in "shunt"*** from one wire to the other. Each coil had an inductance of 10 millihenry (mH), and each capacitor had a capacitance of 0.047 microfarad (μF). This model was several feet long. The analysis and understanding of this configuration is a well-accepted part of contemporary electric science and engineering.

The longitudinal configuration was illustrated with the identical coils and capacitors (in a model of equal length as for the transverse configuration); however, in this instance, the ***capacitors were connected in series*** in each wire, and the ***coils were connected in "shunt"*** from one wire to the other. Such a configuration would be considered "unconventional" according to contemporary electric science and engineering.

High frequency power from an audio oscillator was introduced to the "source" end of the model transmission lines; the other end will be referred to as the "far" end. The input power at the source end was stated to be essentially the same for both the transverse and longitudinal configurations.

The BSRF researchers showed that the distribution of magnetic field, dielectric field, capacitor temperature, and coil temperature along the length of the transmission lines was different for the two respective configurations. More importantly, it was shown that the electric energy transmitted to the far end of the transmission line was significantly more for the longitudinal configuration than for the (conventional) transverse configuration.

3.3.5 Unique Characteristics of Longitudinal Electricity

The BSRF researchers claim they have not only demonstrated fundamental differences between transverse and longitudinal waves but also refer to a number of phenomena they believe are unique to longitudinal waves.

It is important to understand that after Dr. Nikola Tesla invented the ac electric power distribution system and many of its essential components (e.g., alternators and motors), he began a lengthy series of experiments in which he perfected a power transmission system whose capabilities far exceeded that of alternating current. The key is believed to be that Tesla used ***longitudinal waves that he produced with high-voltage impulses of direct current (dc) electricity.*** The pulses were always of one polarity; therefore, they are defined as direct current, ***not*** alternating current (Ref. 23).

The BSRF experimenters built a transmitter coil and a receiver coil ***according to the information and specifications in Tesla's 1900 patent*** (Ref. 27). These coils were technically described as air-core transformers of an approximately 18-in-diameter flat spiral configuration. The coils (which will be subsequently described in more detail) are referred to as "pancake" coils due to their flat shape.

The major components of the longitudinal wave transmitting system were:

- a dc electric impulse generator (which was actually a small antique Tesla Coil manufactured in the 1920s);
- two "spark-gap" tubes as used in radar technology, which are now available in the electronic surplus market; and
- one of the pancake coils.

Initially, the BSRF researchers showed that with longitudinal waves, a standard incandescent electric light bulb is readily lit to normal brightness using ***only a single wire connection*** to energize the bulb.

The next demonstrations were based upon effects produced by small standard incandescent-type electric light bulbs (designed for household ac operation), which were powered instead by ***longitudinal electric impulses*** (Figure 8).

The light emitted by these bulbs (powered by longitudinal electric impulses) was described by the BSRF researchers as the color of natural daylight or "bluish" compared to identical adjacent bulbs powered by standard 120-volt (V) ac, 60-hertz (Hz) electric power, for which the emitted light was described as "reddish."

The BSRF experimenters placed their fingers approximately 1 in. from the bulbs lit by longitudinal electric impulses and claimed they could feel a ***mechanical force*** radiating from the bulbs and pushing against their fingers. However, when a piece of copper foil was hung from a piece of masking tape and brought to within approximately one-half inch of the same impulse-powered bulb, the copper foil was pulled ***toward*** the bulb. The BSRF researchers believe that this was not a mere high-voltage charge effect, as the copper foil was ***not*** pulled toward other high-voltage parts of the circuit.

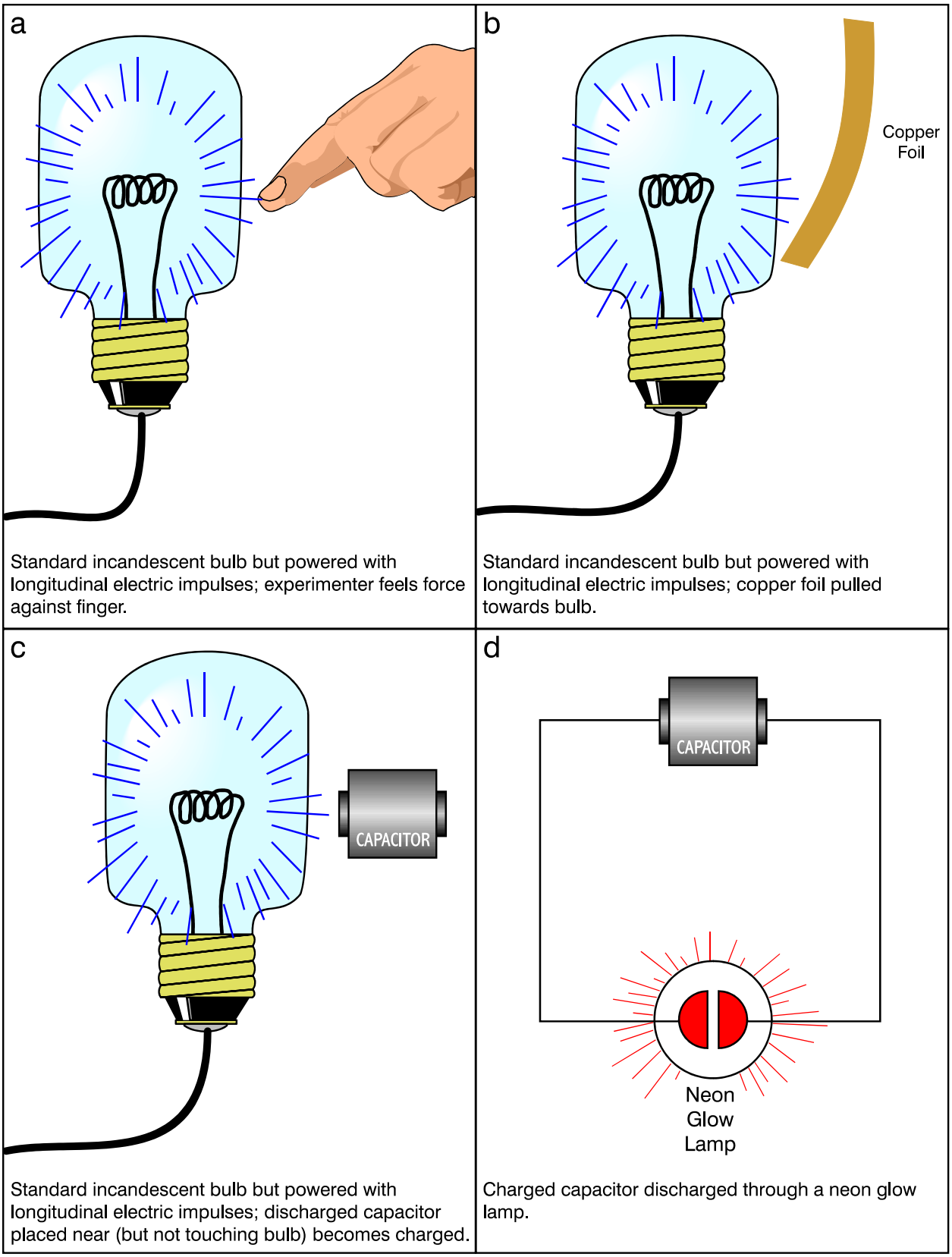

Figure 8 (a-d). Experiments with standard incandescent bulbs powered by longitudinal electric impulses.

The BSRF experimenters claimed that they were demonstrating what Tesla had described in patents and articles approximately 100 years ago, namely that dc electric impulses can produce not only visible light but also "rays" that exhibit mechanical action at a distance.

3.3.6 Demonstration of Tesla's Radiant Energy Patents

Next, the BSRF experimenters referred to the cover page of one of Dr. Tesla's "Radiant Energy" patents that described a form of rays that could charge a capacitor at a distance with no direct connection to the capacitor (Refs. 28 and 29).

This was followed with a demonstration of what the patents described. An electric device referred to as a "doorknob capacitor" (with a capacitance value of 500 picofarad, a voltage rating of 20 kilovolts (kV), and dimensions of approximately 1-in. diameter and 1 in. in length) was first shown to be discharged by momentarily shorting it out by means of a wire touching both terminals. Then, for a few seconds, this capacitor was brought near (***but not touching***) one of the incandescent electric bulbs operating on electric impulse energy. The capacitor was rapidly charged as shown by discharging it through a neon glow lamp (the neon glow lamp emitted a bright flash of light, and the spark where the connection was made was very audible as it made a "snapping" sound). When the capacitor was held near a high-voltage wire in the circuit (rather than the bulb operating on electric impulse energy), only a ***very small*** amount of charge was received.

This demonstrated capability of storing energy in a capacitor ***at a distance without using conventional electromagnetic technology*** is significant.

One of the BSRF experimenters gave some detailed information about the construction of the transmitter and receiver coils and the principles of construction (based upon information originally presented by Dr. Tesla) (Figure 9):

- The coil primary consists of two turns of bronze strap made from three layers of 1-in-wide by 0.010-in-thick metal.
- The ODs of the primary turns are 18 in.
- The coil secondary consists of 20 turns of Teflon-coated silver-plated coaxial cable (the inside conductor of the coaxial cable is not used; the outer sheath conductor is used).
- The secondary turns start inside the primary turns and spiral inward to a diameter of 13-1/2 in. (Coil turns are immobilized by placing them in notches cut in spoke-like wooden strips.)
- The secondary turns are actually ***double turns*** with one wire on top of another (when viewing the flat face of the coil). This is done to obtain the correct amount of capacitance in the coil to allow it to function as Tesla originally designed.
- The receiving coil is constructed identically to the transmitting coil but with its respective windings wound in a complementary direction.

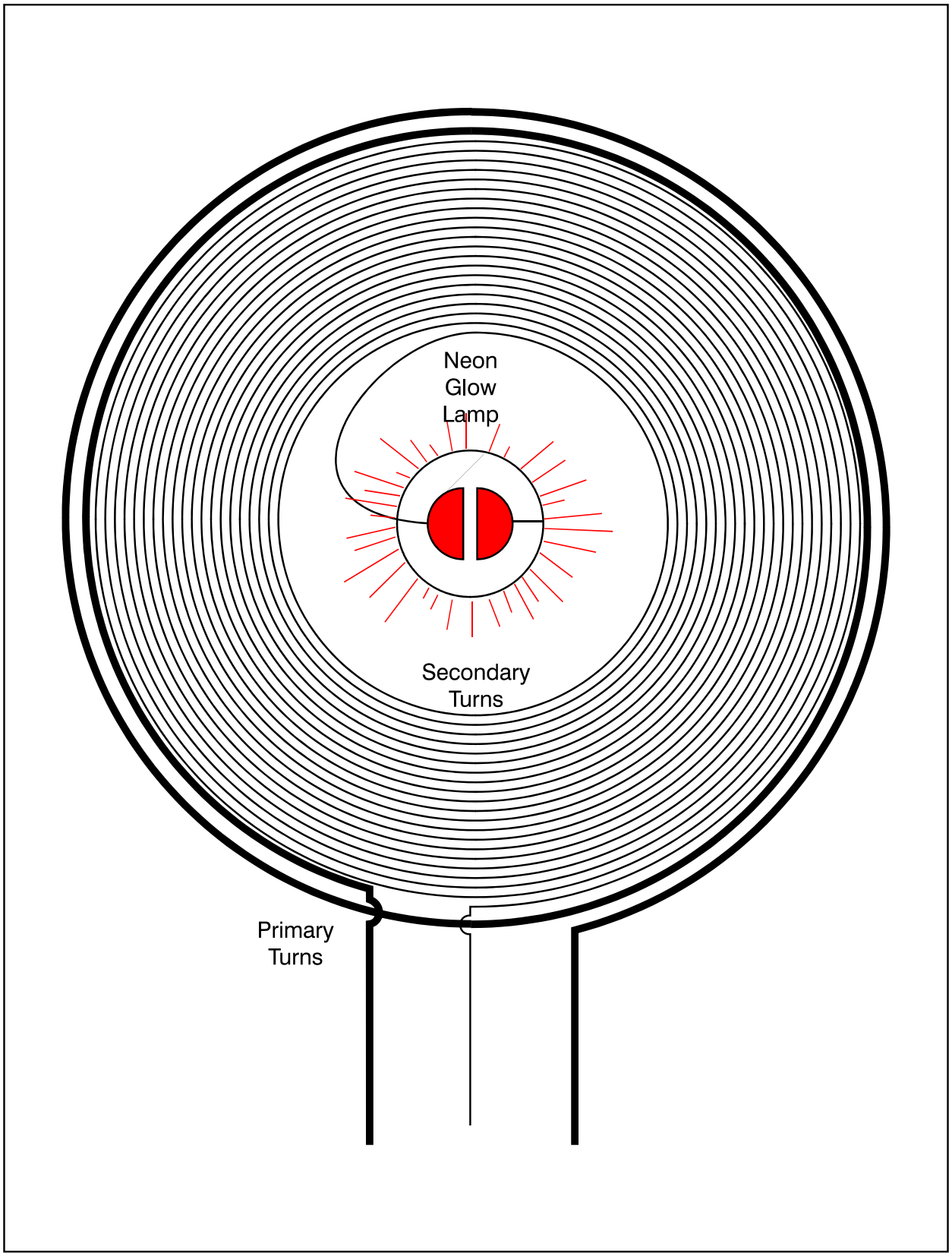

Figure 9. Flat spiral coil for transmitting/receiving longitudinal electric waves (not to scale).

- The coils are designed and built such that the total ***volume*** of metal material in the primary is equal to the total ***volume*** of metal material in the secondary. (Note that according to contemporary electric construction practice, such a requirement would appear to be strange; however, Dr. Tesla was researching different phenomena, and he precisely described what he found.)
- For both the transmitter and receiver coils, the interior end of the secondary winding terminates (with a one-wire connection) to a neon glow lamp (approximately 2 in. in diameter) that is located adjacent to the plane of the coil on the central coil axis. (The BSRF experimenters substituted an argon glow lamp rather than the neon type; the characteristics are very similar). For a very high-power system (such as the ones Dr. Tesla built), the experimenters stated that the interior coil termination should be a metal sphere.

3.3.7 Long-Range Longitudinal Wave Transmission

Finally, the BSRF researchers demonstrated longitudinal waves being transmitted and then received several thousand feet away.

Inside the BSRF laboratory building a conventional continuous wave (CW) radio transmitter was connected to the pancake transmitter coil. Outside (on the seashore beach 3,000 ft away), a conventional (shortwave) portable radio receiver was connected to the pancake receiver coil, which in turn was connected to a copper screen immersed in the ocean as an "antenna" for the longitudinal waves. The signal reception [at a frequency of 2.94 megahertz (MHz)] was shown. It was not demonstrated to what extent the screen immersed in the ocean was augmenting the reception process; however, it should be noted that there was no "line of sight" from the transmitter to the receiver and the transmission distance was too short to use reflecting the signal from the ionosphere. It was also stated that the transmitter location was not only 3,000 ft away but was behind a mountain. Therefore, the point of the BSRF demonstration was to show that longitudinal waves (at this frequency) can more readily penetrate matter than can transverse waves.

In their concluding comments, one of the BSRF experimenters pointed out that all the demonstrations they showed were done on a very low budget with "surplus" equipment or equipment fabricated from available materials and that anyone could reproduce the experiments. He went on to state that the key is that anyone attempting to replicate Dr. Tesla's experiments will be successful when they realize that Tesla ***did*** know what he was doing and his discoveries were ***not*** confined to generally accepted electric principles.

3.4 Scalar Waves

3.4.1 Introduction

Advanced energy researchers believe a phenomenon known as "scalar waves" may be an important key for accessing ZPE (Section 4) and achieving advanced propellantless propulsion. The following sections present information on this topic.

3.4.2 Dr. Thomas Valone's Writings on Scalar Waves

Dr. Thomas Valone has investigated, lectured on, and written about breakthrough energy, breakthrough propulsion, and advanced physics topics for nearly 25 years.

Dr. Valone defines the following terms in the glossary of one of his books (Ref. 30):

Comments are provided beneath some of these quoted definitions.

> *Longitudinal Wave—A pressure type of wave, similar to sound, in which the vibrations are along the direction of travel, a sequence of compressions and rarefractions...Scalar waves are longitudinal, as contrasted with EM 'Hertzian' waves which have transverse oscillations. Longitudinal waves are non-Hertzian as a result, as Tesla said many times, regarding his magnifying transmitter.*

"EM" is an abbreviation for electromagnetic. One may suggest the sound-like waves are propagated in the "aether." E.Y. Webb carefully explains in his book (as presented in Section 5.3.4) that the experiments done in the 1880s, which caused many physicists to conclude that there was no aether, were faulty, being based on a false premise (Ref. 31).

> *Scalar Field—In physics, each point in space for a particular potential is assigned a magnitude but no direction. The scalar potential is just the Coulomb potential due to a charge density...While EM (electromagnetic) waves travel at light speed, 'the scalar potential propagates instantaneously everywhere in space'.*

The concept of "instantaneous" propagation is supported mathematically, as explained in Section 3.4.2.4.

> *Scalar Wave—(see Longitudinal Wave.) Also Tesla Wave. An oscillating field of pure potential without E and B (electric and magnetic) fields. X is a scalar wave varying harmonically in time but only longitudinal fields exist...In quantum mechanics (e.g., Aharonov-Bohm experiment) it has real effects on the electron wave function. Because no energy or momentum transfer occurs, X fields can penetrate all objects and in fact can traverse the whole universe. Scalar waves thus may in fact, travel faster than light speed c, since no c-limited fields are involved.*

Even though scalar waves can "penetrate all objects," they can nevertheless sometimes interact with matter in certain specific situations, explained subsequently in this report.

> *Transverse Wave – A standard Hertzian EM vector wave which oscillates laterally, as contrasted with a Tesla electrostatic scalar wave which vibrates longitudinally.*

To date, almost all of the world's electric and electromagnetic (EM) technology is based upon transverse EM waves. Longitudinal wave technology and its unique proven capabilities are not as widely known or used.

3.4.2.1 Scalar Potentials, Fields and Waves – Their Scientific Basis

Dr. Valone has also published a report on scalar waves and related phenomena, which is a collection of articles and patents by researchers of this topic (Ref. 32). The remainder of Section 3.4.2 consists of material quoted from Valone's report with explanations added.

The first (overview) article of this report is by Dr. Valone. Selected excerpts from this article follow; comments are provided after some of the selected excerpts:

> *A scalar field can be defined as a physical influence pervading an area, analogous to a voltage field, but without a direction. Scalar fields are everywhere.*
>
> *Without showing the physics, which can be found in the references, we start with the famous Aharonov-Bohm experiment which brought the Vector Potential into prominence. (A "vector potential" is analogous to a voltage or electric field that has direction.) Up until this experiment, the Vector Potential was relegated to electromagnetic textbooks as a mathematical concept without physical effects. Once Aharonov and Bohm set up a long coil with no leaking magnetic field outside the coil, they found that they could change the interference pattern of an electron beam source which went **around** the coil. This was unexplainable except that the Vector Potential was outside the coil.*

The physics concepts underlying the Aharonov-Bohm experiment are the basis of patented communications systems, which cannot be shielded and are described subsequently.

> *By using special coils to create internal magnetic fields, scientists have suggested that we can create scalars. Toroids (e.g., Coil #69370 from PICO Electronics, Mt. Vernon, NY) have the unique geometry of being a long coil that touches both ends together, like a donut. This ensures that the magnetic field does not stray outside the coil. In my paper to the 1992 Tesla Symposium, I tested the PICO coil in a backwound or caduceus mode, since it has two layers which can be backwound, for scalar generation.*

As an example, Valone is referring to the manner in which half of a (continuous) length of wire wound into the shape of a coil may be wound (on the same coil form) in a direction opposite that of the first half. Another way to describe this is to visualize a ***pair*** of wires connected together at one end. The ***pair*** is then wound in the shape of a coil. The magnetic field produced by electric current flowing ***to*** the connected end ***cancels*** the magnetic field produced by the return current ***from*** the connected end (because the respective currents are flowing in opposite directions). This method of winding is often referred to as "***bifilar***." Such a coil cannot generate a net magnetic field; however, the more subtle scalar fields may be generated.

Dr. Jack Dea, from the Arizona State University, writes in 1985 that...the (longitudinal) "phase field" (of scalar waves) has a l/r dependence and that more intriguing is their property of passing right through matter since information is carried rather than energy. He predicts that (scalar waves)...can penetrate all objects and in fact can traverse the whole universe.

The term "l/r dependence" means that the magnitude of the scalar wave varies inversely as the distance from the transmission source. In contrast to this, the magnitude of the better known transverse wave varies inversely as the ***square*** of the distance from the transmission source.

3.4.2.2 Dr. Hal Puthoff's U.S. Patent for a Potential-Based Communication System

One of the leading proponents of ZPE is Dr. Harold E. Puthoff of the Institute for Advanced Studies at Austin, located in Austin, Texas. Dr. Puthoff has published a number of papers and articles on the theoretical physics supporting ZPE.

Additionally, Dr. Puthoff obtained a U.S. Patent on a ***nonelectromagnetic*** communication system that cannot be shielded. The cover page of Puthoff's U.S. Patent (5,845,220) is included in Valone's report. The title of this patent is *Communication Method and Apparatus with Signals Comprising Scalar and Vector Potentials without Electromagnetic Fields*. MSE spoke with Dr. Puthoff about his invention and briefly described it in the prior work (Ref. 1, pp. 85-86):

It is important to note that the Aharonov-Bohm effect is the basis of a unique communication system patented by Dr. Harold E. Puthoff of the Institute for Advanced Studies at Austin, located in Austin, Texas.…The patent abstract reads, "Information that changes as a function of time is communicated from a transmitting site to a receiving site by transmitting a signal comprising scalar and vector potentials without including any electromagnetic field...The patent diagrams depict alternating voltage from a signal generator coupled to two essentially square metal plates at right angles to each other and alternating current from the same signal generator coupled to an electric coil located where the two metal plates would intersect.

*The receiver is **electromagnetically shielded** and uses a cryogenic superconductor device known as a "Josephson Junction." The Josephson Junction converts the electrostatic scalar and magnetic vector potentials that **do** penetrate the shielding into conventional electromagnetic waves that can then be subsequently detected by an ordinary radio receiver.*

The importance of this invention is that it is a nonelectromagnetic communication system and cannot be shielded.

In response to specific questions from MSE, Dr. Puthoff stated the following:

- *as the patent states, only **potential** is being transmitted and received;*
- ***no energy** is transferred from the transmitter to the receiver. (Energy would be the sum of the squares of the individual electrostatic and magnetic fields, and these fields cannot be transferred, as they are shielded); and*
- *the system has been built and tested "as part of a classified project."*

Raymond C. Gelinas received U.S. Patent 4,429,288 for a nonshieldable communication technology that is apparently very similar to that invented by Dr. Puthoff.

3.4.2.3 An Excerpt from One of Dr. David Bohm's Quantum Mechanics Lectures

Dr. David Bohm was one of the two scientists who predicted that there would be an effect from potentials (when fields are shielded), which has become known as the Aharanov-Bohm Effect (briefly described in Section 3.4.2.1).

Valone included a brief excerpt from one of Dr. Bohm's books, *Lectures on Quantum Mechanics*, in which Bohm points out that elementary particles may have ***scalar interactions***, as well as the (classical) ***electromagnetic interactions***.

3.4.2.4 Excerpt from "Classical Electrodynamics"

Valone includes several pages on vector and scalar potentials excerpted from the textbook, *Classical Electrodynamics*, by Jackson.

It is noted that in his final comments on this topic, Jackson points out that even though "electromagnetic disturbances propagate with finite speed," (one of the equations he presents) "indicates that the scalar potential 'propagates' instantaneously everywhere in space." Jackson states that this characteristic is "puzzling."

3.4.3 Dr. Konstantin Meyl's Teachings on Scalar Waves

3.4.3.1 Introduction

Professor Dr.-Ing. Konstantin Meyl began to lecture on scalar waves in Germany in 1996. Dr. Meyl published a book compiled from a series of lectures on scalar waves and related topics that he gave from 1996 to 2003. This book has subsequently been translated from German to English (Ref. 33). Dr. Meyl was also one of the speakers at the Extraordinary Technology Conference held in Salt Lake City, Utah, in August of 2004, and he presented experimental demonstrations of scalar wave phenomena as part of his lecture on that topic.

3.4.3.2 Scalar Wave Concepts from Dr. Meyl's Book

Dr. Meyl's book is comprehensive and lengthy as it attempts to explain (by means of a scalar wave approach) a very wide spectrum of topics that include physics, electric phenomena, cosmology, biology, and Earth history.

In the following sections, this report will focus on those topics in Dr. Meyl's book related to the properties of scalar waves and how they may potentially be used for both advanced energy and advanced propulsion applications. As additional disclaimers, it is to be understood that:

- it is Dr. Meyl's ***personal hypotheses*** or ***postulates*** that are being reported and they may not agree with those of other researchers nor are they necessarily endorsed by NASA-LaRC/MSE; and
- Dr. Meyl's original book has been translated from German to English, and the resulting translation may not be communicating precisely what Dr. Meyl intended.

3.4.3.3 Longitudinal Electric Waves

In the late 19th century, scientists were trying to understand the electric wave phenomena discovered by Dr. Heinrich Hertz. The properties of electric wave phenomena claimed by Dr. Nikola Tesla were totally different than the properties of the electric wave phenomena claimed by Dr. Hertz, and this lead to contention between the competing viewpoints (Ref. 33, p. 191).

Because of the controversy, the eminent scientist, Professor William Thomson of Glasgow University, Scotland (also known as Lord Kelvin) traveled to New York in 1897 to see Tesla's experiments and, as a result, he concluded that ***both*** Tesla and Hertz were correct. The explanation is that Hertz experimented with ***transverse*** waves, whereas Tesla's waves were ***longitudinal***.

Hertz claimed that the transverse electric waves he discovered could be calculated with Dr. James Clerk Maxwell's electrodynamic equations, and scientists of that time accepted the experimental agreement with mathematical calculations as proof Hertz was correct.

However, as explained in a recent NASA CR, almost no scientists or engineers today have even ***seen*** (much less understood) Dr. James Clerk Maxwell's ***original*** electrodynamic equations, published in 1865, which ***did*** predict longitudinal waves, transverse waves, and much more (Ref. 1, p. 81). What scientists and engineers today refer to as "Maxwell's Equations" is an extremely simplified set of electrodynamic equations that is quite different than what Maxwell published. A more correct name for what is taught today would be Maxwell-Heaviside equations, as Oliver Heaviside was the major adversary of Maxwell who removed the capability to calculate ***longitudinal*** electric waves and electric ***potentials*** from Maxwell's ***original*** equations.

However, Tesla's claims were backed up with documented experimental demonstrations rather than mathematical equations. In the following quotation, Meyl describes one of Tesla's demonstrations and states that Hertz's technology could ***not*** have accomplished such a demonstration:

> *In Colorado Springs he had built a 10 kW transmitting installation and lighted 200 fluorescent lamps of 50 Watt each on a mountain in the Rocky Mountains in a distance of 25 miles. With that he had completely transmitted the transmission power of 10 kW, as can be inferred from the press reports at that time. With Hertzian waves, which propagate spatially, this experiment even today, after over 100 years, wouldn't be realizable technologically. According to the law of the square of the distance one isn't even able to let glow a tiny little lamp in such a distance.*

Meyl helps resolve the controversy between longitudinal and transverse waves by explaining that the high-voltage "spark" transmitters used in the early days of radio actually transmitted ***both*** longitudinal ***and*** transverse waves (Ref. 33, p. 459). The characterization of the type of radio technology employed was in the ***receiver***, not the transmitter. Tesla's equipment would only receive longitudinal waves, whereas the equipment of Hertz and other pioneer radio inventors (such as Marconi) were designed to receive only transverse waves. Because both types of waves (longitudinal and transverse) were being transmitted, ***both*** viewpoints of how the technology functioned were correct.

3.4.3.4 Dr. Meyl's Personal Tesla Coil Experiments

Dr. Meyl describes how he personally constructed and experimented with a small-scale version of a Tesla flat ("pancake") coil in 1995 (Ref. 33, pp. 405-407). By adding:

- a spherical electrode (approximately 6 in. in diameter);
- a spirally wound flat Tesla Coil (approximately 4 in. in diameter);
- a two-turn coil to electrically couple to the outer turns of the flat coil; and
- an old interleaved metal plate variable capacitor (formerly used in broadcast radio receivers)

to the input of an oscilloscope, Meyl could readily receive, detect, and analyze scalar wave signals originating from (unspecified) sources of interferences and distant thunderstorms. Compared to what he had learned in his prior training and expertise in electrical engineering, Meyl stated that he was totally surprised at the large magnitude of the scalar wave signals displayed on the oscilloscope screen. Meryl also stated that he and his colleagues had to repair their oscilloscope several times due to scalar wave energy spikes that had entered the equipment but were too brief to be visually observed on the oscilloscope screen.

3.4.3.5 Differences Between the Near-Field and Far-Field of a Transmitted Signal

Meyl explains that the properties of waves in the "near-field" and "far-field" with respect to the transmission source are quite different (Ref. 33, p. 463).

According to Meyl, Hertz used relatively short waves that were only a few meters in length, whereas Tesla typically used frequencies of approximately 100 kilohertz (kHz) and wave lengths of several kilometers and, in some cases, Tesla used frequencies as low as 6 Hz with a wave length as large as the entire Earth. Meyl states that the characteristic distance that distinguishes near-field from far-field is the wave length divided by 2 π. According to this definition, the Tesla experiments were near-field (characterized by longitudinal waves) and those of Hertz were far-field (characterized by transverse waves).

Meyl adds the insight that ***scalar*** wave technology is by no means obscure but is in widespread commercial use in the anti-theft system in the doorways of stores. Unless a small passive coil (in a package wrapper) has been deactivated at the point of sale, that coil will be a scalar wave receiver and couple energy back to the scalar wave transmitter at the door, be detected, and thereby activate a security alarm.

3.4.3.6 Variable Velocity of Scalar Waves

Meyl states that unlike transverse waves moving through a given medium, scalar (longitudinal) waves have a nonconstant velocity (Ref. 33, p. 469). The velocity of propagation of a scalar wave oscillates at double the frequency of the wave and with opposite phase to the corresponding field. This means that when the field is maximum, the wave velocity is minimum, and vice versa. However, an ***average*** velocity of propagation of a scalar wave may be determined and stated.

3.4.3.7 Potential Efficiency of Scalar Waves for Communications

Meyl points out the wastefulness of Hertzian wave technology for communicating point to point (Ref. 33, pp. 482-485). With conventional Hertzian waves, only a very small fraction of transmitted energy arrives at the intended point of reception. In contrast to this, scalar wave communication, where the energy couples to the receiver (at resonance), could (according to Meyl) allow one to "carry out a telephone call right through the Earth" with the power expenditure of only a few ***microwatts***.

3.4.3.8 Comparison of Scalar Wave Propagation with Nerve Conduction

The final information chosen from Meyl's book, which is related to the preceding section, is on the biophysical process of nerve conduction (Ref. 33, pp. 519-521). Meyl states that nerve conduction is a form of "single-wire transmission," and the segmented (interrupted) geometry of the insulation sheath surrounding nerves (which makes nerve signal transmission efficient and selective) was very similar to one of the single-wire transmission concepts described by Dr. Tesla approximately a century ago.

3.4.3.9 Vortices as a Link Between Scalar and Transverse Waves

Dr. Meyl postulated in his talk given at the August 2004 Extraordinary Technology Conference that conventional linear (i.e., nonspherical) transmitting antennas emit scalar waves ***at the surface of the antenna***. A vortex shape energy flow then transforms the longitudinal scalar waves into conventional (Hertzian) transverse waves as the energy traverses the "critical" distance from the near-field to the far-field, which is the wave length divided by 2 π.

Note: For this reason, Dr. Meyl is deeply concerned that cell phone users are directly coupling scalar waves from the phone's near-field directly into their brains, potentially causing brain damage. Many researchers and engineers are not even aware of the existence of scalar waves. ***Conventional*** measuring techniques and measurements at greater than the critical distance, where only transverse waves occur, do ***not*** indicate the presence of scalar waves.

At the receiving antenna, another set of energy vortices forms and transforms the transverse waves back into scalar waves that enter the antenna, (i.e., essentially the inverse of what happens at the transmitter). However, when spherical antennas are used for the transmitter and receiver (Tesla's method), the scalar waves do not transform into transverse waves.

3.4.3.10 Dr. Meyl's Scalar Wave Demonstration Device

Dr. Meyl and his university students built a miniature transmitter and receiver to demonstrate (within a distance of approximately 20 ft between these two units):

- properties of scalar waves; and
- a comparison between the properties of scalar waves and transverse waves in the same environment.

These researchers used principles (except for those related to voltage and size) from the writings of Dr. Nikola Tesla in the design of this equipment. For affordability and portability, the miniature transmitter and receiver "towers" have a maximum dimension of approximately 1 ft. Each tower has a horizontal flat Tesla "pancake" coil in the base (with an approximate diameter of 6 in) and a "Tesla" sphere on top (with an approximate diameter of 4 in). For the purpose of making accurate frequency measurements, the researchers incorporated up-to-date technology, namely a digital frequency readout display. Because of the relatively small size of the equipment, a frequency range of approximately 4 to 8 MHz was used rather than the very low frequencies Tesla used with his relatively large systems. Additionally, Meyl stated that these small-scale demonstration devices operated at an electric potential of 2 V, in contrast to potentials in the range of 60 kV as Tesla used in his large equipment.

3.4.3.11 A Demonstration of (Average) Scalar Wave Velocity

As explained in Section 3.4.3.6, even though the velocity of scalar waves can vary, the ***average*** velocity of these waves may be determined.

If wave length is considered constant, velocity is proportional to frequency. With his transmitter and receiver spaced approximately 20 ft apart, Meyl demonstrated that the (digitally read) resonant frequencies for reception were:

- transverse waves: 4.6 MHz; and
- scalar waves: 7.1 MHz.

Meyl claimed that the ratio of the scalar to transverse resonance frequencies (7.1 MHz/4.6 MHz), which is 1.54, is the ratio of the respective velocities. That is, for the conditions of the demonstration, the average velocity of the scalar waves was 1.54 times the velocity of the transverse waves, or 1.54 times the (commonly understood) "speed of light."

3.4.4 The Polarization Synchrotron

3.4.4.1 Introduction

Apparently, the functioning of a recently described device ***cannot*** be explained by EM theory as presently taught. However, it is suggested that scalar wave concepts may allow this technology to be more readily understood.

3.4.4.2 Background Information

A recently published article titled, "Table-Top Synchrotron Defies Convention," (which has been accepted for publication in *The Journal of Applied Physics*) is quoted in its entirety, as follows (Ref. 34):

> *A group of physicists in the UK and US has built a device which they claim generates radiation that circumvents the inverse square law. John Singleton of the Los Alamos National Laboratory in New Mexico and colleagues say that their table-top machine works by rotating a pattern of polarization at faster than the speed of light, and that it could be used as a new type of low-power or long-range radio transmitter. But other researchers believe that they have got their physics wrong.*
>
> *The device, dubbed a polarization synchrotron by its inventors, consists of a 2 metre-long gently curving arc of alumina (a dielectric material), with a series of electrodes fitted at regular intervals along its length. Applying a sinusoidal voltage across each electrode and displacing the phase of the voltage very slightly from one electrode to the next generates a sinusoidally-varying polarization pattern that propagates along the device. By carefully adjusting the frequency of the voltage and the phase displacement the researchers say they can make the wave travel at greater than the speed of light (even though no physical quantity of charge travels superluminally).*
>
> *This principle is based on a model of pulsars—rapidly spinning neutron stars—developed by one of the group, Houshang Ardavan of Cambridge University. Ardavan believes that the well-defined pulses of radio waves emitted by these astronomical objects are caused by the pulsar's rotating magnetic field polarizing the surrounding plasma. As the magnetic field sweeps round so too does the region of polarized plasma, and far enough away from the pulsar this region will sweep round at faster than the speed of light.*

Singleton's group—which includes Ardavan's son, Arzhang Ardavan (of Oxford University)—believes that its polarization synchrotron, like a pulsar, emits radiation in a well-defined beam. They argue that the electromagnetic wavefronts generated by each point within the polarization pattern build up behind that point like sound waves from a supersonic aircraft. Interference between these wavefronts then reinforces the radiation along a spiral trajectory—the beam—that travels away from the source.

The researchers claim that the intensity of this beam is proportional to 1/r, where r is the distance from the transmitter, rather than the $1/r^2$ associated with spherically decaying radiation. They carried out tests on their device at the Turweston Aerodrome in Northamptonshire between May 2003 and February 2004, measuring the intensity of the emitted radiation at a range of distances up to 900 metres and mapping the three-dimensional shape of the emission.

According to Singleton, the polarization synchrotron could transmit radio messages with very little power or over vast distances. A scaled-down version of the device could be used in mobile phones to allow direct communication with satellites, rather than having to rely on relay stations. He says the device could also be used in radar systems, since the beam's unusual shape would make it difficult to trace the beam back to its source.

However, other researchers are skeptical. John Hannay, a theoretical physicist at Bristol University points out that conventional radio sources can generate slowly decaying radiation over limited distances. He has previously said that Singleton and co-workers must test their device over tens of kilometres rather than hundreds of metres.

3.4.4.3 Unusual or Anomalous Features of the Polarization Synchrotron

The unusual or anomalous features of the polarization synchrotron, as described in the above article, are listed as follows:

- the beam intensity is proportional to 1/r, (not $1/r^2$, as for more conventionally known forms of radiation), where r is the distance from the transmitter;
- the beam is generated by a "polarization pattern," and one may suggest that this is describing a "wave of potential";
- the wave can be made to travel at greater than the speed of light; and
- there is a capability to transmit messages with very little power or over vast distances.

3.4.4.4 Possible Explanation of the Unusual or Anomalous Features of the Polarization Synchrotron by Means of a Scalar Wave Approach

The unusual or anomalous features of the polarization synchrotron are not readily explainable by conventional EM theory as presently taught; therefore, the claims were perceived by some as controversial. However, each of the unusual features matches exactly (at a qualitative level) with the respective described properties of scalar waves, as described in this report, namely:

- beam intensity varying as 1/r;
- beam as a "wave of potential";
- wave velocity greater than the speed of light; and
- capability to transmit messages with very little power or over vast distances.

Therefore, because the unusual features of the polarization synchrotron qualitatively match the properties of a scalar wave generator, it is possible to suggest that the operation of this device is based upon scalar wave principles and not conventional EM technology.

3.4.4.5 Astronomical Implications of the Polarization Synchrotron

It is stated in the article quoted above that the operating principle of the polarization synchrotron is based on a model of pulsars.

If the suggestion in the preceding section is correct, namely that the operation of this technology is based upon scalar wave principles, it is possible to further suggest that pulsars emit scalar waves (in addition to conventional transverse waves).

4. Breakthrough Energetics—Zero Point Energy

4.1 Introduction and Overview

MSE published information on ZPE that included the following quotation (Ref. 1, p. 79):

> *According to the principles of quantum mechanics, the seemingly empty vacuum between atoms, when considered at small enough dimensions (orders of magnitude smaller than atoms), contains an exceedingly high energy density (as large as 10^{94} ergs/cm^3). This energy is referred to as zero-point energy because it is believed to exist even at a temperature of absolute zero. This energy can be thought of as electromagnetic radiation of all frequencies or even as fluctuations of spacetime itself. Because of the totally random characteristic of this energy, it paradoxically appears to cancel itself out or not exist. Most physicists believe that the randomness of this energy does not allow any of it to be tapped for any practical use (one exception is a recent acknowledgment by developers of nanoscale microelectromechanical systems that the zero-point energy (which has been conclusively proven to exert the measurable Casimir Force when micromechanical parts are within 1 micron or less of each other) can prevent such devices from functioning, unless means are introduced to overcome this phenomenon).*

The existence of this type of energy is not immediately obvious, and it is difficult to detect because it is incoherent. The energy is everywhere–its detection requires measuring an energy ***difference***, and the extremely high frequencies of this energy do not readily interact with matter (Ref. 1, p. 79).

4.2 Accessing or "Tapping" Energy from Zero Point Energy

4.2.1 Specific Disclaimer Regarding ZPE Plausibility

For more than 100 years, a number of people have claimed to have invented energy conversion technologies that would deliver an output energy greater than the input energy. Of course, it is not considered controversial that the common "heat pump" does this routinely; one unit of electrical energy is used to transfer approximately three units of heat into a selected location (i.e., within a building). The heat (of course) is simply being transferred either from the air or the ground.

However, when it appears that one unit of electrical energy has been put into a device that delivers more than one unit of electrical output, many scientists and engineers consider this to be an example of measurement error, fraud, or an accomplishment that goes against the accepted Laws of Thermodynamics.

It should be noted that the science of thermodynamics originated nearly 200 years ago in an attempt to compare quantities of heat with an equivalent quantity of mechanical work. As (classical) thermodynamics is generally taught today, a (conceptual) "boundary" is drawn around a system being investigated, and (by ***definition***), if the boundary is drawn large enough, the energy within the system is ***conserved*** (i.e., ***constant***). However, if nuclear reactions are involved, then the term "mass-energy" (based upon Dr. Albert Einstein's equation $E = mc^2$) must be used rather than "energy."[2] Dr. Ilya Prigogine won the Nobel Prize in Chemistry in 1977 for describing an "open" form of thermodynamics that predicts nonclassical behavior when a source of energy is available to continue flowing through a system (Ref. 35). According to Prigogine's theory, outputs and inputs do not need to be equal.

One can put forth the hypothesis that ZPE is potentially such an energy source that can possibly explain the "excess output" inventors have claimed to observe. The calculated spatial density of ZPE is incomprehensibly large (as described in Section 4.1). If these calculated values are correct and a ***very small fraction*** of ZPE could be obtained in a system output, then this output could readily exceed the conventional types of energy entering the system. The working hypothesis in this report is that (excluding claims associated with poor measurements and intentional fraud) ZPE has been demonstrated a number of times, and that an examination of what is common or similar between claimed technologies could lead to a theoretical understanding of the science involved. Once the underlying scientific theory is understood, it may be possible to derive a short-list of "principles" that could be used to develop ZPE technology.

4.2.2 ZPE Credibility Breakthrough

The concept of accessing a significant amount of useful energy from the ZPE gained much credibility when a major article on this topic was recently published in *Aviation Week & Space Technology*, a leading aerospace industry magazine (Ref. 36).

4.2.3 ZPE Access Principles Stated by Moray King

According to Mr. Moray King, who has been studying and lecturing on ZPE for more than 30 years and has published two books on this topic, there are a few basic principles that do allow ZPE to be tapped, and these principles have been incorporated in technology that inventors have ***claimed*** achieved this result (Refs. 37 and 38).

One of the principles that Mr. King claims may allow ZPE to be tapped is that of the nonequilibrium thermodynamics advanced by Ilya Prigogine who won the Nobel Prize in Chemistry for this work in 1977. Mr. King explains Prigogine's work and its importance in the following (Ref. 1, pp. 79-80):

- The standard scientific belief is that the Second Law of Thermodynamics must cause systems to become more random and disordered; however, nonlinear systems (e.g., ionized plasma) are not restricted to this "law."

[2] Mr. Gloyd Simmons, Staff Engineer, U.S. Air Force Programs Manager, MSE Technology Applications, Inc., April 1, 2003.

- The addition of energy to a plasma can sometimes form a metastable vortex ring called a plasmoid. According to Mr. King, "such a structure cannot be predicted by a linear thermodynamic model, but it can be predicted by a nonlinear magnetohydrodynamic model. The nonlinear interactions produce macroscopic coherence from random turbulence."
- The persistence of "ball lightning," which has been modeled as a vortex ring plasmoid, is cited by Mr. King as evidence that such structures are cohering some ZPE (which maintains the stability of the structure) and then radiating excess energy as light and heat.

Mr. King has stated that many inventors who have claimed to build devices that produce "anomalous" excess energy have been doing the following:[3]

1. *Use ions in a plasma to 'tap' ZPE, because the electric field lines are highly concentrated where they enter the nucleus of an atom.*
2. *Induce a shock-wave into the plasma to cause a sudden motion of ions.*
3. *Tap ZPE via what could be called a 'rebound effect'.*

Mr. King has shown many connections between advanced physics concepts and ZPE claims; however, his views (like that of other ZPE researchers) should be considered as a "work in progress."

4.2.4 Dr. Thomas Valone's Overview of ZPE Approaches

4.2.4.1 Introduction

Dr. Thomas Valone has been researching and teaching advanced energy concepts (mostly related to tapping ZPE) since 1980. Valone founded the Integrity Research Institute (IRI) in Washington, DC in order to provide a focus for his publishing, research, and teaching activities.

Dr. Valone has released a sample chapter of his forthcoming book, which included the following excerpts (Ref. 39):

> *With the discovery of ZPE, scientists find that space is rich with activity from* ***virtual particles*** *and full of energy. Therefore, physicists like to call it the "physical vacuum" when they want to talk about ZPE. Furthermore, the vacuum also vibrates and "fluctuates." In fact, that is the essence of ZPE. Vacuum fluctuations are even predicted by a branch of physics, started by Albert Einstein, Neils Bohr, and Werner Heisenberg, called quantum mechanics.*

[3] Moray B. King, "Advanced Work of Dr. T. Henry Moray," Presentation at the Institute of New Energy Symposium, September 2003.

Even the energy density of the limited zero point field is amazing. It is much more than we humans normally can comprehend. For example, if we presume that the minimum possible wavelength is limited to the size of the proton, the famous Nobel Prize winning physicist, Richard Feynman, calculated that the energy density of ZPE would be ten raised to the 108^{th} power joules per cubic centimeter (10^{108} J/cc).

Quantum electrodynamics (QED) predicts that the vacuum spawns particles that spontaneously pop in and out of existence. Their time of existence is strictly limited by the ***uncertainty principle*** *but they create some havoc while they bounce around during their brief lifespan, from virtual existence to real existence and back. The churning 'quantum foam,' as it is popularly called, is believed to extend throughout the universe even filling the empty space within the atoms in human bodies.*

4.2.4.2 Dr. Valone's Concepts for Accessing ZPE

The following ZPE access concepts are described in two of Dr. Valone's books published on this topic (Refs. 39 and 40).

Nonconservation

Zero point energy consists of random EM waves of all possible frequencies or can be considered to be random fluctuations of the vacuum itself. Researchers believe that ZPE is ***not*** conserved. If correct, so-called "conservation laws" do ***not*** apply to ZPE. Experiments have been performed that readily show that small amounts of ZPE are being tapped, and these experiments have been replicated. Other researchers are developing concepts to access appreciably larger power levels (e.g., kilowatts) of ZPE, and key ideas of some of these were presented by Valone.

The Lamoreaux Experiment

In 1997, Dr. Lamoreaux accurately measured the force (caused by ZPE) between two conducting objects separated by a short distance (on the order of microns) (Ref. 41). The force (known as the Casimir Force because it was predicted by the physicist Casimir approximately 50 years earlier) occurs because random ZPE EM waves larger than the distance between the conducting objects are essentially "shorted out" and cannot exist within that small space. Therefore, the ZPE in the vacuum ***outside*** the two close objects, which has a very slightly greater energy density, will have an effective pressure ***slightly*** higher than between the objects and produce an attractive force between these objects. The force Lamoreaux measured agreed with the theoretically predicted value within 5%.

Laboratory ZPE Measurement

Valone described a recent technical report that claimed to detect ZPE in a laboratory experiment. The spectral density of energy across a superconducting "Josephson Junction" was stated to match the spectral density predicted by Planck's second radiation law, thereby measuring the effect of ZPE (Ref. 42).

Solid-State Diode ZPE Converter

Finally, Valone referred to the pioneering concepts for producing electric power by rectifying thermal noise (derivable from ZPE), which were developed by Joseph Yater (Ref. 43). Yater "theorized that a Schottky diode, formed between a semiconductor and a metal, with nonlinear rectifying characteristics and fast switching speeds, could be the diode of choice for rectifying thermal noise." Yater states in the above-referenced patent that "for the long range design goals, submicron circuit sizes are required if all the high power goals of megawatts per square meter are to be achieved."

4.3 Zero Point Energy Principles in the Similar Technologies of Nikola Tesla and E.V. Gray

4.3.1 Dr. Peter Lindemann

Dr. Peter Lindemann has been researching, writing about, and lecturing on advanced electric and ZPE principles for approximately 25 years. Lindemann was the first to recognize that the technology ***principles*** used to achieve what Dr. Nikola Tesla ***claimed*** in the 1890s were the same as those used by E.V. Gray to achieve the accomplishments Gray ***claimed*** in the 1970s and 1980s. However, the hardware used by the respective inventors was different, as will be described in subsequent sections (Ref. 23).

4.3.2 ZPE Principles Suggested in E.V. Gray's Technology

E.V. Gray, Sr. announced an electric engine using capacitor discharges and electromagnets in 1973 (Ref. 23). Gray claimed the engine running on batteries could produce 100 horsepower (hp) and recharge the batteries. Gray claimed that this was possible because he had discovered a new "cold" form of electricity, and he received a patent for this technology in 1975 titled, *Pulsed Capacitor Discharge Electric Engine* (Ref. 44). In 1978, it was evident to advanced energy researcher Dr. Peter Lindemann that though the patent protected the design of the motor, it did not reveal the ***technique*** of its operation.

In 1999, Dr. Lindemann learned that Gray had received two other patents for his capacitor discharge technology in the late 1980s (Refs. 45 and 46). Dr. Lindemann contends that these two patents describe the core secret of what Gray had discovered, essentially the same technology (but accomplished in a different manner) that Dr. Nikola Tesla had discovered in 1890. Even though the wording of these patents described energy derived from electric impulses and suggested that the circuit diagram shown could generate far more output energy than the energy put into it, the operating principles were not explained.

4.3.3 The Energy Science of Dr. Nikola Tesla

Dr. Lindemann claims that information from Chapter 1 of a book recently written by Gerry Vassilatos enabled him to understand the similarities between the discoveries of E.V. Gray and those of Tesla (Ref. 47). This section presents the important points of what Lindemann wrote, which in turn was based on the studies of Vassilatos.

In 1889, Dr. Nikola Tesla began a series of experiments in an attempt to produce EM waves, which were theoretically predicted years earlier by Dr. James Clerk Maxwell. Tesla used what he called "disruptive discharges" obtained by charging a powerful capacitor bank, then discharging through copper bus bars, thereby explosively vaporizing the copper.

Tesla noted that these explosive discharges produced shock waves that could be felt as stinging sensations in his body. He further realized that these effects were similar to shock wave or "surge" effects that occurred during an extremely brief time interval when technicians would close an electrical circuit energized by a ***dc*** dynamo. Dynamos rated at a few thousand volts produced electrical impulses (or shock waves) as high as ***millions*** of volts for the brief interval when they were switched into load circuits.

Tesla learned how to intensify this effect by keeping the electrical surge ***unidirectional (i.e., preventing any back-oscillations)***. He also found that something like "rays" emanating from the discharges could easily penetrate insulators like glass or metals (like copper). Then Tesla searched the scientific literature and learned that such phenomena had only been previously described on two occasions.

By experimentation, Tesla learned that the parameters related to this phenomenon that produced penetrating rays from electrical discharges were:

- abruptness—the instantaneous switch closure was important;
- impulse time—which had to be brief;
- a single direction of current—there could be no reversal or "backflow"; and
- a considerable enhancement was achieved by placing an electrical capacitor between the disrupter and the dynamo.

Tesla initially used motor-driven, high-speed rotating contact switches to produce his unidirectional impulses. Later he used an automatic magnetic quench method (that he invented) to continually (i.e., repetitively) "blow out" (i.e., disrupt or terminate) an electric arc almost immediately after it would reestablish itself.

Tesla realized he had discovered a previously unknown electrical phenomenon: "radiant electricity," and furthermore, that this transmitted energy consisted of ***longitudinal waves (not alternating waves)***.

By experimenting, Tesla learned how to either project electrical charge into or withdraw electrical charge from objects that were ***not*** physically in contact with the rest of the apparatus. A modern demonstration of this phenomena, charging a capacitor at a distance, is described in Section 3.3.6. Tesla additionally discovered (and publicly demonstrated) the information given below.

- Peculiar lighting and heating effects could be obtained from radiant electricity by choosing appropriate pulse durations.
- "Radiant shock waves actually auto-intensified when encountering segmented objects," (e.g., the turns of an air-core coil).

- The electrical discharges traversed coils in the manner of gases moving over surfaces rather than behaving according to the "normal" EM laws.
- When the discharge stream was directed at a distant metal plate, electronic charges would be produced in the metal.
- Tesla measured zero current in the secondaries of his coils; however, he did measure a voltage rise along the length of the coil. His system was dynamic, yet it behaved like an electrostatic field, producing voltage without current.
- It was possible to illuminate incandescent lamps connected to the circuit disrupter producing the electrical discharges even when these lamps were electrically shorted out by means of a heavy U-shaped copper bus bar. Tesla showed that there was another type of energy flowing in the circuit that took the path of highest resistance (not lowest resistance) to light the bulbs.
- His high-voltage coils were inadvertently "fractionating" electrons (which could not leave the metal of the coil from "something else") that traveled like a gas ***over the surface of the coil***. Thus, "electrical discharges" were "composed of several simultaneous mobile species."
- ***Abrupt unidirectional impulses*** were the key to releasing this second type of energy inherent in electricity. Merely alternating the current direction would ***not*** be sufficient to do this.

Tesla realized that the nonelectron part of electricity released by abrupt impulses, which was capable of penetrating many forms of matter, would be a key to tapping into immense amounts of energy. One can hypothesize that the controlled release of this nonelectron component of electricity was the means used by Tesla to access practical quantities of ZPE.

Tesla's experiments guided him to understand that the nonelectron energy flow he was researching ***exhibited characteristics of a gas*** (though it was not a gas). Tesla's coils ***(built and operated as he described)*** are best understood from a fluid dynamics (not electrical) perspective.

Tesla experimented with ways in which to transmit power from his coils while at the same time minimizing the electrical arcs projected from them.

The important points of Tesla's research on electrical impulse phenomena (as described by Dr. Lindemann) can be summarized as follows:

1) What we call electricity consists of the flow of charged particles (generally electrons) that have mass and "something else" (an energetic or "neutral component"), which is normally associated with (somehow bound to) the charged particles, and therefore not normally detected.
2) If dc electricity at a sufficiently high voltage undergoes an abrupt explosion-like event such as a discharge (spark), the charged and neutral components of electricity are momentarily separated.
3) The separation process must be completed by forcing the electrons "out of the way" (such as by using a magnetic arc quench technique like the one invented and used by Tesla).

4) A radiant form of energy (termed by Tesla as "Radiant Energy") then proceeds on a straight line trajectory (at superluminal velocity, according to Tesla) and penetrates many (but not all) forms of matter.
5) Radiant Energy then releases electrons (i.e., reconstitutes "normal" electricity when it impacts a metallic conductor).
6) Tesla stated that this overall process was ***magnifying energy***; he assigned the name "magnifying transmitter" to the system that he designed, built, and tested and that he ***claimed*** accomplished this goal (Ref. 23).
7) It should be noted that according to classical "closed-system thermodynamic theory," energy in a system can never be "magnified." However, it should also be noted that with an "open thermodynamic system" with sufficient energy available from the ZPE field, which according to accepted principles of physics exists everywhere in the universe, it would be ***possible*** to have a measured energy output greater than the measured energy input, ***provided that*** the unidirectional electric impulse and longitudinal electric wave phenomena used by Tesla was converting merely an ***extremely small*** fraction of (unobservable) ZPE to observable energy.
8) One hypothesis is that Tesla experimentally discovered a way to separate a neutral "mass-free" component from the charged "mass-bound" component of electricity, thereby allowing this mass-free component to magnify or grow as it traversed space (which contains the incomprehensibly large amount of ZPE) then (when intercepting a metallic conductor) forming a greater amount of electric energy than was used to initiate the process. This statement will be explained in increasing detail in subsequent sections.

4.3.4 Dr. Lindemann's Definition of "The Electro-Radiant Event"

Dr. Lindemann refers to the process discovered, developed, and used by Tesla in his magnifying transmitter as "The Electro-Radiant Event," and he summarizes its characteristics as follows (in Dr. Lindemann's words) (Ref. 23, p. 44):

> *The Electro-Radiant Event is produced when a high-voltage, direct current is discharged across a spark-gap and interrupted abruptly before any reversals of current can occur.*
>
> *This effect is greatly increased when the source of direct current is a charged capacitor.*
>
> *The Electro-Radiant Event leaves wires and other circuit components perpendicular to the flow of current.*
>
> *The Electro-Radiant Event produces a spatially distributed voltage that can be thousands of times higher than the initial spark discharge voltage.*
>
> *It propagates instantaneously as a longitudinal, electrostatic "light-like ray" that behaves similarly to an incompressible gas under pressure.*

Electro-Radiant effects are solely characterized by impulse duration and voltage drop in the spark-gap.

Electro-Radiant effects penetrate all materials and create "electronic responses" in metals like copper and silver. In this case, "electronic responses" means that an electrical charge will build up on copper surfaces exposed to Electro-Radiant emissions.

Electro-Radiant impulses shorter than 100 microseconds are completely safe to handle and will not cause shock or harm.

Electro-Radiant impulses shorter than 100 nanoseconds are cold and easily cause lighting effects in vacuum globes.

Dr. Lindemann claims the Electro-Radiant Event is the "gain mechanism" that Tesla discovered and then used in his magnifying transmitter. According to Dr. Lindemann, "it is the foundation of his claim that he was able to create more energy in his output than it took to initiate it in his input" (Ref. 23, p. 43).

4.3.5 Comparing E.V. Gray's Technology with that of Tesla

Dr. Lindemann states that the energy magnification results E.V. Gray demonstrated and claimed to achieve in the 1970s were based upon the same principles used by Tesla (making similar claims) in the 1890s. However, each inventor used a somewhat different approach. Fundamentally important principles can be learned by examining what is ***common*** to both approaches.

Dr. Lindemann lists the important common features between the technology of Tesla and Gray as follows (Figure 10) (Ref. 23, pp. 47-53):

- They both start with a source of high-voltage direct current.
  - Tesla used a high-voltage dc generator (dynamo); and
  - Gray used the sequence of a battery, multivibrator, transformer, and rectifier to obtain high-voltage direct current.
- Both inventors used their respective high-voltage direct current sources to charge a capacitor repeatedly.
- In both circuits, the next component is a spark-gap.
- The spark in the gap must be ***unidirectional***.
  - Tesla's circuit had the continuous voltage from the dynamo to ensure the unidirectional discharge of his capacitor; and
  - Gray used an electronic vacuum tube to ensure there would be no current reversal.

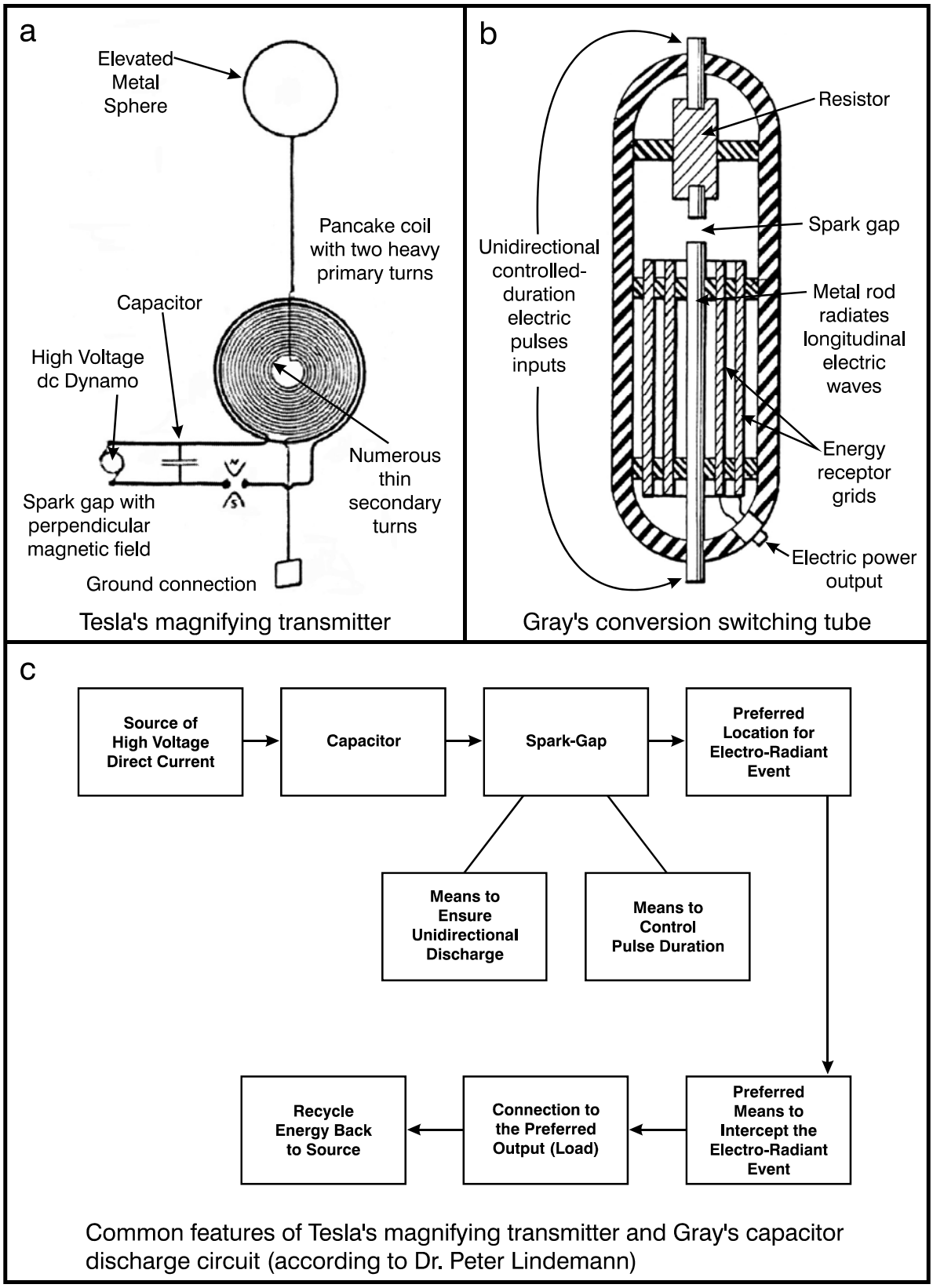

Figure 10 (a-c). Technologies of Tesla and Gray and common features of both.

- The spark duration must be controlled.

  – Tesla used a magnetic field to quench the arc in his spark-gap. He could determine the time before quench by adjusting the magnetic field strength (and capacitance of his capacitor); and
  – Gray used a resistor to limit discharge current, and the discharge duration was controlled by means of the same electronic vacuum tube referred to above.

- The respective circuits then have what Dr. Lindemann calls the "preferred location for the Electro-Radiant Event."

  – Tesla used two turns of very heavy (thick) copper wire as the "primary" of his magnifying transmitter. (It is to be understood this transformer (a small working model is described in Section 3.3.6) is not a normal transformer primary based upon conventional EM induction); and
  – Gray used what he called a "conversion switching element tube." As described in his patent, this device is essentially a metal can "specifically designed to have an explosive, electrostatic event radiate away from its central chamber."

- The next element common to the two technologies being compared in Dr. Lindemann's analysis is the "preferred means to intercept the Electro-Radiant Event."

  – Tesla used the "secondary" coil located within the outer thick primary turns as in his magnifying transmitter; and
  – Gray used charge-receiving grids within his "conversion switching element tube."

Dr. Lindemann points out that there is no direct connection in either technology between the source of energy and the "receiver element."

- Next in the sequence is what Dr. Lindemann calls the "connection to the preferred output."

  – Tesla used a ground connection at one end and an elevated metal sphere connected to the other end of his magnifying transmitter secondary. His intention was to transmit electrical power to the world; Tesla did demonstrate the transmission of 10 kW of electric power (which lit a bank of 200 lamps) with no wires at a distance of 26 miles during his experiments conducted in Colorado Springs, Colorado, in 1899 (Ref. 30, p. 123); and
  – Gray connected his charge-receiving grids to an inductive load (i.e., an output circuit that performed useful work and also served to recharge the batteries).

(It should be noted that Tesla's long-distance transmission of 10 kW was efficiently accomplished by using resonance principles rather than by a high-power EM energy "beam" such as engineers would consider using at this time.)

Dr. Lindemann explains (and Gray's patent drawings indicate) that Gray's conversion switching element tube contained concentric metal cylinders surrounding one of the two high-voltage electrodes that formed a spark-gap in the interior of the device. Dr. Lindemann refers to Gray's conversion switching element tube as an "electro-radiant transceiver" because it both broadcasts and receives the "Electro-Radiant Event."

Based upon statements made by Gray in the 1970s, as well as photographs of his technology also from that time, Dr Lindemann presents more technical details of Gray's work (Ref. 23, pp. 55-59).

- Three conversion switching element tubes were used with each being approximately 3 in. in diameter, and (according to patent drawings) the length of each is several times the diameter.
- Each conversion switching element tube was fed by discharges from a single large capacitor. The labels on the capacitors stated their rating was a capacitance of 2 μF and a voltage rating of 4,000 V dc. (Dr. Lindemann states that Gray had claimed in newspaper articles from the 1970s that the electric discharges in his system were from a potential of 3,000 V.)
- The output pulses from the switching tubes were fed into the primary turns of an air-core transformer (wound on a 4-in-diameter polyvinyl chloride pipe), and electrical power from the secondary turns was then available to be used. An air-core (not iron-core) transformer was used because of the high operating frequency.
- Pulse durations used by Gray were in the 10- to 50-microsecond range. This is ***postulated*** by Dr. Lindemann; however, he bases this upon statements made by both Tesla and Gray concerning their respective technologies.
- The charge-receiving grids in Gray's conversion tubes are copper. (As previously stated, Tesla had learned in his experiments that when "radiant electricity" is intercepted by a metallic conductor, "normal" electricity is produced.)

Dr. Lindemann summarizes Gray's cold electricity circuit as follows:

> *It starts with power out of the battery; he raises it to 3,000 volts DC that he stores in a very large capacitor. He then discharges impulses through a spark-gap, clipped by a vacuum tube, such that the impulse duration is less than 50 microseconds. This staccato of impulses flows through the Electro-Radiant Transceiver, which creates a series of radiant, electrostatic fields of spatially-distributed voltage that is picked up by the charge-receiving grids. As soon as the Electro-Radiant Event ceases, these charged grids discharge to ground through the primary of the "inductive load." The output recovery system is inductively coupled to this discharge primary with a voltage step-down to run light bulbs and other medium voltage appliances, as well as another step-down transformer to recharge the secondary battery. By switching the batteries back and forth periodically, Gray could keep the system going indefinitely, and still produce a sizable output* (Ref. 23, p. 59).