Nikola Tesla

THE WIRELESS TRANSMISSION OF POWER,

Resonating Planet Earth

by Toby Grotz

Theoretical Electromagnetic Studies and Learning Association, Inc.
522 West Third Street
Leadville, CO 80461
(719) 486-0133

Abstract

Many researchers have speculated on the meaning of the phrase "non-Hertzian waves" as used by Dr. Nikola Tesla. Dr. Tesla first began to use this term in the mid 1890's in order to explain his proposed system for the wireless transmission of electrical power. In fact, it was not until the distinction between the method that Heinrich Hertz was using and the system Dr. Tesla had designed, that Dr. Tesla was able to receive the endorsement of the renowned physicist, Lord Kelvin.1

To this day, however, there exists a confusion amongs researchers, experimentalists, popular authors and laymen as to the meaning of non-Hertzian waves and the method Dr. Tesla was promoting for the wireless transmission of power. In this paper, the terms pertinent to wireless transmission of power will be explained and the methods being used by present researchers in a recreation of the Tesla's 1899 Colorado Springs experiments will be defined.

Early Theories of Electromagnetic Propagation

In pre-World War I physics, scientists postulated a number of theories to explain the propagation of electromagnetic energy through

the ether. There were three popular theories present in the literature of the late 1800's and early 1900's. They were:

1. Transmission through or along the Earth,
2. Propagation as a result of terrestrial resonances,
3. Coupling to the ionosphere using propagation through electrified gases.

We shall concern our examination at this time to the latter two theories as they were both used by Dr. Tesla at various times to explain his system of wireless transmission of power. It should be noted, however, that the first theory was supported by Fritz Lowenstein, the first vice-president of the Institute of Radio Engineers, a man who had the enviable experience of assisting Dr. Tesla during the Colorado Springs experiments of 1899. Lowenstein presented what came to be known as the "gliding wave" theory of electromagnetic radiation and propagation during a lecture before the IRE in 1915. (Fig. 1)

Dr. Tesla delivered lectures to the Franklin Institute at Philadelphia, in February, 1983, and to the National Electric Light Association in St. Louis, in March, 1983, concerning electromagnetic wave propagation. The theory presented in those lectures proposed that the Earth could be considered as a conducting sphere and that it could support a large electrical charge. Dr. Tesla proposed to disturb the charge distribution on the surface of the Earth and record the period of the resulting oscillations as the charge returned to its state of equilibrium. The problem of a single charged sphere had been analyzed at that time by J.J. Thompson and A.G. Webster in a treatise entitled "The Spherical Oscillator." This was the beginning of an examination of what we may call the science of terrestrial resonances, culminating in the 1950's and 60's with the engineering of VLF radio systems and
Š the research and discoveries of W.O. Schumann and J.R. Waite.

The second method of energy propagation proposed by Dr. Tesla was that of the propagation of electrical energy through electrified gases. Dr. Tesla experimented with the use of high frequency RF currents to examine the properties of gases over a wide range of pressures. It was determined by Dr. Tesla that air under a partial vacuum could conduct high frequency electrical currents as well or better than copper wires. If a transmitter could be elevated to a level where the air pressure was on the order of 75 to 130 millimeters in pressure and an excitation of megavolts was applied, it was theorized that;

"...the air will serve as a conductor for the current produced, and the latter will be transmitted through the air with, it may be, even less resistance than through an ordinary copper wire".2 (Fig. 2)

Resonating Planet Earth

Dr. James T. Corum and Kenneth L. Corum, in chapter two of their soon to be published book, A Tesla Primer, point out a number of statements made by Dr. Tesla which indicate that he was using resonator fields and transmission line modes.

1. When he speaks of tuning his apparatus until Hertzian radiations have been eliminated, he is referring to using ELF vibrations: "...the Hertzian effect has gradually been reduced through the lowering of frequency."3

2. "...the energy received does not diminish with the square of the distance, as it should, since the Hertzian radiation propagates in a hemisphere."3

3. He apparently detected resonator or standing wave modes: "...my discovery of the wonderful law governing the movement of electricity through the globe...the projection of the wavelengths (measured along the surface) on the earth's diameter or axis of symmetry...are all equal."3

4. "We are living on a conducting globe surrounded by a thin layer of insulating air, above which is a rarefied and conducting atmosphere...The Hertz waves represent energy which is radiated and unrecoverable. The current energy, on the other hand, is preserved and can be recovered, theoretically at least, in its entirety."4

As Dr. Corum points out, "The last sentence seems to indicate that Tesla's Colorado Springs experiments could be properly interpreted as characteristic of a wave-guide probe in a cavity resonator."5 This was in fact what led Dr. Tesla to report a measurement which to this day is not understood and has led many to erroneously assume that he was dealing with faster than light velocities.

The Controversial Measurement;

It does not indicate faster than light velocity

The mathematical models and experimental data used by Schumann and Waite to describe ELF transmission and propagation are complex and beyond the scope of this paper. Dr. James F. Corum, Kenneth L. Corum and Dr. A-Hamid Aidinejad have, however, in a series of papers presented at the 1984 Tesla Centennial Symposium and the 1986 International Tesla Symposium, applied the experimental values obtained by Dr. Tesla during his Colorado Springs experiments to the models and equations used by Schumann and Waite. The results of this exercise have proved that the Earth and the surrounding atmosphere can be used as a cavity resonator for the wireless transmission of electrical power. (Fig. 3)

Dr. Tesla reported that .08484 seconds was the time that a pulse emitted from his laboratory took to propagate to the opposite side of the planet and to return. From this statement many have assumed that
Š his transmissions exceeded the speed of light and many esoteric and fallacious theories and publications have been generated. As Corum and Aidinejad point out, in their 1986 paper, "The Transient Propagation of ELF Pulses in the Earth Ionosphere Cavity", this measurement represents the coherence time of the Earth cavity resonator system. This is also known to students of radar systems as a determination of the range dependent parameter. The accompanying diagrams from Corum's and Aidinejad's paper graphically illustrate the point. (Fig. 3 & Fig. 4)

We now turn to a description of the methods to be used to build, as Dr. Tesla did in 1899, a cavity resonator for the wireless transmission of electrical power.

PROJECT TESLA:

The Wireless Transmission of Electrical Energy Using Schumann Resonance

It has been proven that electrical energy can be propagated around the world between the surface of the Earth and the ionosphere at extreme low frequencies in what is known as the Schumann Cavity. The Schumann cavity surrounds the Earth between ground level and extends upward to a maximum 80 kilometers. Experiments to date have shown that electromagnetic waves of extreme low frequencies in the range of 8 Hz, the fundamental Schumann Resonance frequency, propagate with little attenuation around the planet within the Schumann Cavity.

Knowing that a resonant cavity can be excited and that power can be delivered to that cavity similar to the methods used in microwave ovens for home use, it should be possible to resonate and deliver power via the Schumann Cavity to any point on Earth. This will result in practical wireless transmission of electrical power.

Background

Although it was not until 1954-1959 when experimental measurements were made of the frequency that is propagated in the resonant cavity surrounding the Earth, recent analysis shows that it was Nikola Tesla who, in 1899, first noticed the existence of stationary waves in the Schumann cavity. Tesla's experimental measurements of the wave length and frequency involved closely match Schumann's theoretical calculations. Some of these observations were made in 1899 while Tesla was monitoring the electromagnetic radiations due to lightning discharges in a thunderstorm which passed over his Colorado Springs laboratory and then moved more than 200 miles eastward across the plains. In his Colorado Springs Notes, Tesla noted that these stationary waves "... can be produced with an oscillator," and added in parenthesis, "This is of immense importance."6 The importance of his observations is due to the support they lend to the prime objective of the Colorado Springs laboratory. The intent of the experiments and the laboratory Tesla had constructed was to prove that wireless transmission of electrical power was possible.

Schumann Resonance is analogous to pushing a pendulum. The intent of Project Tesla is to create pulses or electrical disturbances that would travel in all directions around the Earth in the thin membrane of non-conductive air between the ground and the ionosphere. The pulses or waves would follow the surface of the Earth in all directions expanding outward to the maximum circumference of the Earth and contracting inward until meeting at a point opposite to that of the transmitter. This point is called the anti-pode. The traveling waves would be reflected back from the anti-pode to the transmitter to be reinforced and sent out again.

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At the time of his measurements Tesla was experimenting with and researching methods for "...power transmission and transmission of intelligible messages to any point on the globe." Although Tesla was

not able to commercially market a system to transmit power around the globe, modern scientific theory and mathematical calculations support his contention that the wireless propagation of electrical power is possible and a feasible alternative to the extensive and costly grid of electrical transmission lines used today for electrical power distribution.

The Need for a Wireless System of Energy Transmission

A great concern has been voiced in recent years over the extensive use of energy, the limited supply of resources, and the pollution of the environment from the use of present energy conversion systems. Electrical power accounts for much of the energy consumed. Much of this power is wasted during transmission from power plant generators to the consumer. The resistance of the wire used in the electrical grid distribution system causes a loss of 26-30% of the energy generated. This loss implies that our present system of electrical distribution is only 70-74% efficient.

A system of power distribution with little or no loss would conserve energy. It would reduce pollution and expenses resulting from the need to generate power to overcome and compensate for losses in the present grid system.

The proposed project would demonstrate a method of energy distribution calculated to be 90-94% efficient. An electrical distribution system, based on this method would eliminate the need for an inefficient, costly, and capital intensive grid of cables, towers, and substations. The system would reduce the cost of electrical energy used by the consumer and rid the landscape of wires, cables, and transmission towers.

There are areas of the world where the need for electrical power exists, yet there is no method for delivering power. Africa is in need of power to run pumps to tap into the vast resources of water under the Sahara Desert. Rural areas, such as those in China, require the electrical power necessary to bring them into the 20th century and to equal standing with western nations.

As first proposed by Buckminster Fuller, wireless transmission of power would enable world wide distribution of off peak demand capacity.

This concept is based on the fact that some nations, especially the United States, have the capacity to generate much more power than is needed. This situation is accentuated at night. The greatest amount of power used, the peak demand, is during the day. The extra power available during the night could be sold to the side of the planet where it is day time. Considering the huge capacity of power plants in the United States, this system would provide a saleable product which could do much to aid our balance of payments.

MARKET ANALYSIS

Of the 56 billion dollars spent for research by the the U.S government in 1987, 64% was for military purposes, only 8% was spent on energy related research. More efficient energy distribution systems and sources are needed by both developed and under developed nations. In regards to Project Tesla, the market for wireless power transmission systems is enormous. It has the potential to become a multi-billion dollar per year market.

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Market Size

The increasing demand for electrical energy in industrial nations is well documented. If we include the demand of third world nations, pushed by their increasing rate of growth, we could expect an even faster rise in the demand for electrical power in the near future.

In 1971, nine industrialized nations, (with 25 percent of the world's population), used 690 million kilowatts, 76 percent of all power generated. The rest of the world used only 218 million kilowatts. By comparison, China generated only 17 million kilowatts and India generated only 15 million kilowatts (less than two percent each).7 If a conservative assumption was made that the three-quarters of the world which is only using one-quarter of the current power production were to eventually consume as much as the first quarter, then an additional 908 million kilowatts will be needed. The demand for electrical power will continue to increase with the industrialization of the world.

Market Projections

The Energy Information Agency (EIA), based in Washington, D.C., reported the 1985 net generation of electric power to be 2,489 billion kilowatt hours. At a conservative sale price of $.04 per kilowatt hour that results in a yearly income of 100 billion dollars. The EIA also reported that the 1985 capacity according to generator name plates to be 656,118 million watts. This would result in a yearly output of 5,740 billion kilowatt hours at 100% utilization. What this means is that we use only about 40% of the power we can generate (an excess capability of 3,251 billion kilowatt hours).

Allowing for down time and maintenance and the fact that the night time off peak load is available, it is possible that half of the excess power generation capability could be utilized. If 1,625 billion kilowatt hours were sold yearly at $.06/kilowatt, income would total 9.7 billion dollars.

Project Tesla: Objectives

The objectives of Project Tesla are divided into three areas of investigation.

1. Demonstration that the Schumann Cavity can be resonated with an open air, vertical dipole antenna;
2. Measurement of power insertion losses;
3. Measurement of power retrieval losses, locally and at a distance.

Methods

A full size, 51 foot diameter, air core, radio frequency resonating coil and a unique 130 foot tower, insulated 30 feet above ground, have been constructed and are operational at an elevation of approximately 11,000 feet. This system was originally built by Robert Golka in 1973-1974 and used until 1982 by the United States Air Force at Wendover AFB in Wendover, Utah. The USAF used the coil for simulating natural lightning for testing and hardening fighter aircraft. The system has a capacity of over 600 kilowatts. The coil, which is the largest part of the system, has already been built, tested, and is operational.

A location at a high altitude is initially advantageous for reducing

atmospheric losses which work against an efficient coupling to the Schumann Cavity. The high frequency, high voltage output of the coil will be half wave rectified using a uniquely designed single electrode X-ray tube. The X-ray tube will be used to charge a 130 ft. tall, Š vertical tower which will function to provide a vertical current moment. The mast is topped by a metal sphere 30 inches in diameter. X-rays emitted from the tube will ionize the atmosphere between the Tesla coil and the tower. This will result in a low resistance path causing all discharges to flow from the coil to the tower. A circulating current of 1,000 amperes in the system will create an ionization and corona causing a large virtual electrical capacitance in the medium surrounding the sphere. The total charge around the tower will be in the range of between 200-600 coulombs. Discharging the tower 7-8 times per second through a fixed or rotary spark gap will create electrical disturbances, which will resonantly excite the Schumann Cavity, and propagate around the entire Earth.

The propagated wave front will be reflected from the antipode back to the transmitter site. The reflected wave will be reinforced and again radiated when it returns to the transmitter. As a result, an oscillation will be established and maintained in the Schumann Cavity. The loss of power in the cavity has been estimated to be about 6% per round trip. If the same amount of power is delivered to the cavity on each cycle of oscillation of the transmitter, there will be a net energy gain which will result in a net voltage, or amplitude increase. This will result in reactive energy storage in the cavity. As long as energy is delivered to the cavity, the process will continue until the energy is removed by heating, lightning discharges, or as is proposed by this project, loading by tuned circuits at distant locations for power distribution.

The resonating cavity field will be detected by stations both in the United States and overseas. These will be staffed by engineers and scientists who have agreed to participate in the experiment.

Measurement of power insertion and retrieval losses will be made at the transmitter site and at distant receiving locations. Equipment constructed especially for measurement of low frequency electromagnetic waves will be employed to measure the effectiveness of using the Schumann Cavity as a means of electrical power distribution. The detection equipment used by project personnel will consist of a pick up coil and industry standard low noise, high gain operational amplifiers and active band pass filters.

In addition to project detection there will be a record of the experiment recorded by a network of monitoring stations that have been set up specifically to monitor electromagnetic activity in the Schumann Cavity.

Evaluation Procedure

The project will be evaluated by an analysis of the data provided by local and distant measurement stations. The output of the transmitter will produce a 7-8 Hz sine wave as a result of the discharges from the antenna. The recordings made by distant stations will be time synchronized to ensure that the data received is a result of the operation of the transmitter.

Power insertion and retrieval losses will be analyzed after the measurements taken during the transmission are recorded. Attenuation, field strength, and cavity Q will be calculated using the equations presented in Dr. Corum's papers. These papers are noted in the references. If recorded results indicate power can be efficiently coupled into or transmitted in the Schumann Cavity, a second phase of research involving power reception will be initiated.

Environmental Considerations

The extreme low frequencies (ELF), present in the environment have several origins. The time varying magnetic fields produced as a result of solar and lunar influences on ionospheric currents are on the order of 30 nanoteslas. The largest time varying fields are those generated by solar activity and thunderstorms. These magnetic fields reach a maximum of 0.5 microteslas (uT) The magnetic fields produced as a result of lightning discharges in the Schumann Cavity peak at 7, 14, 20 and 26 Hz. The magnetic flux densities associated with these resonant frequencies vary from 0.25 to 3.6 picoteslas. per root hertz (pT/Hz1/2).

Exposure to man made sources of ELF can be up to 1 billion (1000 million or 1 x 109) times stronger than that of naturally occurring fields. Household appliances operated at 60 Hz can produce fields as

high as 2.5 mT. The field under a 765 kV, 60 Hz power line carrying 1 amp per phase is 15 uT. ELF antennae systems that are used for submarine communication produce fields of 20 uT. Video display terminals produce fields of 2 uT, 1,000,000 times the strength of the Schumann Resonance frequencies.9

Project Tesla will use a 150 kw generator to excite the Schumann cavity. Calculations predict that the field strength due to this excitation at 7.8 Hz will be on the order of 46 picoteslas.

Future Objectives

The successful resonating of the Schumann Cavity and wireless transmission of power on a small scale resulting in proof of principle will require a second phase of engineering, the design of receiving stations. On completion of the second phase, the third and fourth phases of the project involving further tests and improvements and a large scale demonstration project will be pursued to prove commercial feasibility. Total cost from proof of principle to commercial prototype is expected to total $3 million. Interest in participation in this project may be directed to the author.

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FOOTNOTES

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FURTHER INFORMATION ABOUT TESLA

The Tesla Memorial Society
% Nicholas Kosanovich
453 Martin Road
Lackawanna, NY 14218
(716) 822-0281

The Tesla Coil Builders Association
% Harry Goldman
RD #6 Box 181
Glenns Falls, NY 12801\
(518 792-1003

The Tesla Book Company
PO Box 1649
Greenville, TX 75401

High Voltage Press
PO Box 532
Claremont, CA 91711

ABOUT THE AUTHOR

Mr. Grotz, is an electrical engineer and has 15 years experience in the field of geophysics, aerospace and industrial research and design. While working for the Geophysical Services Division of Texas Instruments and at the University of Texas at Dallas, Mr. Grotz was introduced to and worked with the geophysical concepts which are of importance to the proposed project. As a Senior Engineer at Martin Marietta, Mr. Grotz designed and supervised the construction of industrial process control systems and designed and built devices and equipment for use in research and development and for testing space flight hardware. Mr. Grotz organized and chaired the 1984 Tesla Centennial Symposium and the 1986 International Tesla Symposium and was President of the International Tesla Society, a not for profit corporation formed as a result the first symposium. As Project Manager for Project Tesla, Mr. Grotz aided in the design and construction of a recreation of the equipment Nikola Tesla used for wireless transmission of power experiments in 1899 in Colorado Springs. Mr. Grotz received his B.S.E.E. from the University of Connecticut in 1973.

Wireless Transmission of Power now Possible. B Thomas. B.Thomas W., Wireless Transmission of Power now Possible. Apr 2014. 978-979.Â Abstract Wireless power,transmission,is an underdeveloped,field of study. There are many promising,applications for the ability to transport powerover,great distances and boundaries,without the need,for transmission,lines. Current technology,employs the use of microwaves,because,of the economic,and energy,efficiency that can be leveraged,by products already in production. Wireless power transfer explained with types- inductive coupling, microwave transmission and LASER. Also find a working example using HF transformer.Â Traditional wired power transmission systems usually require lying of transmission wires between the distributed units and the consumer units. This produces a lot of constraints as the cost of the system- the cost of the cables, the losses incurred in the transmission as well as in distribution. Just imagine, only the resistance of the transmission line results in loss of about 20-30% of the generated energy. If you talk about the DC power transmission system, even that is not feasible as it requires a connector between the DC power supply and the device.