

21. For possibilities - good and bad - posed by scalar EM and TR wave applications see Bearden, "Fer-de-Lance", Tesla Book Co., 1986; "AIDS: Biological Warfare", Tesla Book Co., 1988; "Soviet Phase Conjugate Weapons: Weapons that use time-reversed electromagnetic waves", Bulletin, CRCC, Ft. Collins, CO. Jan. 1988.

## **The distribution of electrical power by means of terrestrial cavity resonator modes**

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The Earth-Ionosphere cavity can be used as a means to distribute electrical energy for industrial purposes at extremely low frequencies. The technology which will permit the wireless distribution of electrical power to or from remote geographical regions is now available for research and development.

It is advanced that the Earth-Ionosphere cavity possesses electrical properties which are appropriate for the wireless distribution of electrical energy to any point on Earth on an industrial scale. Such a remarkable proposition, though seemingly a fanciful concept, is actually no more profound than the notion advanced in the early 1950's to use a cavity resonator to wirelessly distribute microwave power to process food, i.e. - a microwave oven.

Electrical energy at the appropriate frequency may be introduced at one point in a cavity resonator and efficiently collected at another by devices tuned to the same frequency. The resonator itself serves as a two port reactive distribution system. The ELF (extremely low frequency) resonator formed by the cavity between the Earth and the lower E-region of the ionosphere is a nature! resource, that will actually permit the terrestrial distribution of electrical power across a continent, without the necessity of an interconnecting land-line grid of high tension transmission lines.

### **History**

From an historical standpoint, it is significant that Nikola Tesla long ago envisaged such a global power distribution system. A flag of caution should be raised here. It has been common in the past to discard Tesla's far-sighted vision as baseless. We believe that such depreciation has stemmed from critics who were, in fact, uninformed as to Tesla's techniques, measurements and physical observations. After reviewing Tesla's technical disclosures, it is our considered judgement that not only is industrial scale power transmission practical, but that Tesla's actual data is consistent with the very best experimental data available today. It could have only been gotten as a result of authentic terrestrial resonance and power transmission measurements.

Tesla proposed that the Earth itself could be set into a resonant mode at frequencies on the order of 7.5 Hz. From his notes, his private correspondence, his diary and his patent disclosures, it is clear that Tesla's physical explanation and interpretations were erroneous. However, as is often the case, significant explorations or inventions have been made on the basis of faulty physical concepts. Experiments were done, demonstrations performed and data taken. Let us review some of the history behind this early research.

## Tesla's ELF enterprise

In May of 1899, Tesla arrived at Colorado Springs, Colorado with \$100,000. This is the same Tesla whose patented AC power system, purchased by the Westinghouse Corporation which was selected and installed in the original Niagara Falls electric power project of the 1890's. Perhaps it is not unremarkable that almost a century later most of the civilized world still employs a power generation and distribution system in virtually the same form as his early disclosures.

Within three months of his arrival at Colorado Springs, he and his associates constructed a laboratory which housed a prodigious RF signal generator. The primary and secondary were wound on a circular fence 51 feet in diameter and had an input power in excess of 250 KW provided by the Colorado Springs Electric Power Company. The secondary was used to drive a helical resonator, or extra coil, 10 feet high, wound with 100 turns of c6 gauge wire on a coil form about 8 feet in diameter. Emanating from the midst of the extra coil was a tower about 150 feet high, capped with a copper sphere 3 feet in diameter. The resonant frequencies of the driving transmitter have been variously reported as between 50 KHz to 150 KHz. This transmitter, we believe, was used as one component in a recently uncovered process to produce significant currents in the vertical tower and its attachments at pulse frequencies of 7.5 Hz to 15 KHz.

A very colourful account of the first time Tesla fired up his equipment is given in O'Neill's now classic, though somewhat unreliable, biography. Tesla, on various occasions actually said that he had created sparks 150 feet in length. His experiments in Colorado Springs lasted nine months and cost in excess of \$200,000.

Tesla returned to New York on January 21, 1900 and soon received the financial backing of J.P. Morgan, Thomas Fortune Ryan, John Jacob Astor and others. His patent application of January 18, 1902 reveals his intention to construct a massive Tesla coil driven generator for global power distribution.

The installation was subsequently constructed at Wardencllyffe, Long Island in 1902. The tower was 154 feet tall and the cap sphere was 50 feet in diameter. It was never completed, however, and was destroyed during WW 1. Similar towers were to have been built at Niagara Falls, in Australia and in Europe. Tesla, however, had to abandon the Wardencllyffe project when his financial backers withdrew their support.

## Physical Operation

Tesla had proposed that the Earth itself could be set into resonant electrical oscillations which he experimentally determined to be no lower than 6 Hz and no greater than 20 KHz. He claimed to have resonated the Earth in this frequency range by using a huge spark gap transmitter energized by the standard secondary of his monstrous Tesla Coil. His patent application of February 19, 1900, entitled "Apparatus for Transmission of Electrical Energy" is probably the closest description available of the equipment used at Colorado Springs the previous summer. Assuming Tesla's claimed demonstration of distant power transmission without wires as a working hypothesis, then a plausible physical explanation is that the discharges from the electrode at the top of his giant tower would have significant spectral components at the Schumann resonance frequencies and excite a standing wave mode in the Earth-Ionosphere cavity. These physical issues have been addressed in recently presented technical publications. The overwhelming documented technical evidence clearly substantiates the above position.

## Schumann Resonances

In 1952, the German physicist, W. O. Schumann recognized the possibility that a somewhat unusual example of a resonant cavity might be provided by the Earth itself as one boundary surface, and the ionosphere as the other. These two concentric spheres could then form the boundaries of a resonant electromagnetic cavity. (Sea water has a conductivity of 4 Siemens/meter while the ionosphere has an effective conductivity on the order of 1 milli-Siemen/m. Evidently, the structure can easily support damped oscillations.)

Determination of the cavity resonant frequencies follows from a solution of Maxwell's Equations subject to the given boundary conditions. At extremely low frequencies (ELF), where the wavelength is large compared to the effective height of the ionosphere, the electric field is essentially radial, and its amplitude distribution varies as the cosine of the polar angle measured from the position of the source antenna. Amplitude distributions for the first and second modes of oscillation of the Schumann cavity are as shown in Figure 1, when the Earth-Ionosphere cavity is excited by a source which launches vertically polarized electromagnetic waves from the North Pole.

## Measured Electrical Properties

There are a variety of electrical properties of the Earth-Ionosphere cavity which have been experimentally determined over the past twenty years and are now well documented in scientific literature.

### (a) Spectral Response

The resonant frequencies of the cavity have been predicted and observed. One would expect natural phenomena to excite cavity oscillations. This, indeed, does happen. The cavity is set into oscillation by solar flares, for example. But, by far the dominant natural phenomenon exciting cavity resonances is thunderstorm activity occurring world-wide. The power density spectrum of a lightning stroke is very broad, containing a wide band of frequencies. Electrically, the Earth-Ionosphere cavity behaves like a multiply tuned LC network driven by an impulse generator, and oscillations are excited at the natural resonant frequencies of the network. Thunderstorm activity is more or less continuously present on Earth, with the main centers of activity being Southeast Asia, the Congo and the Amazon Basin. Consequently, experimental measurements of the atmospheric noise power density spectrum would be expected to reveal peaks at the cavity resonant frequencies, should Schumann's hypothesis be correct. Figure 2 is a typical measurement of the atmospheric noise spectral density vs. frequency. The first few cavity resonances reported above are quite evident. This is how the measured values were determined.

These sorts of measurements have been reported by many observers over the past 20 years. The spectra are frequently skewed about the center frequency and may undergo variations up to about 1 Hz in periods on the order of a minute or so.

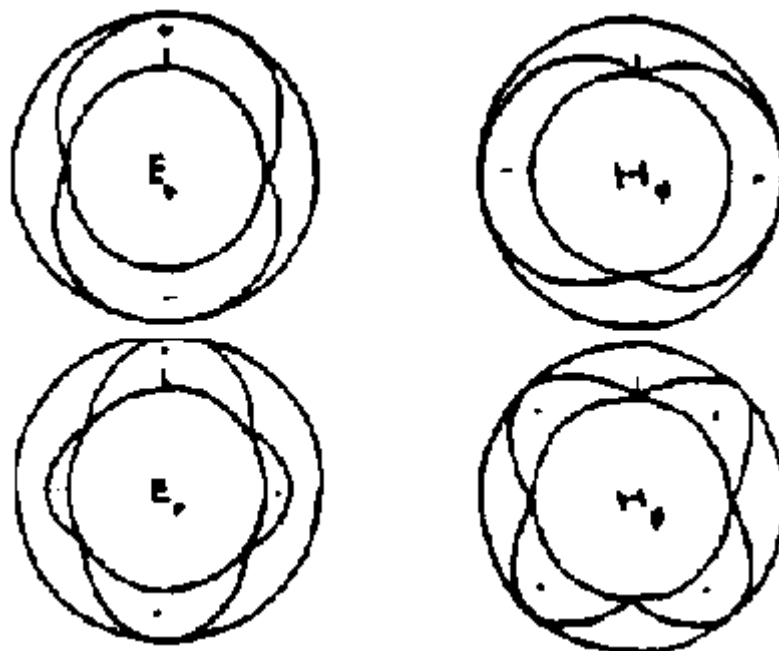


Figure 1. Radial electric field  $E_r$  and azimuthal magnetic field intensity  $H_\phi$ , for the first two cavity resonator modes of the Earth-Ionosphere shell.

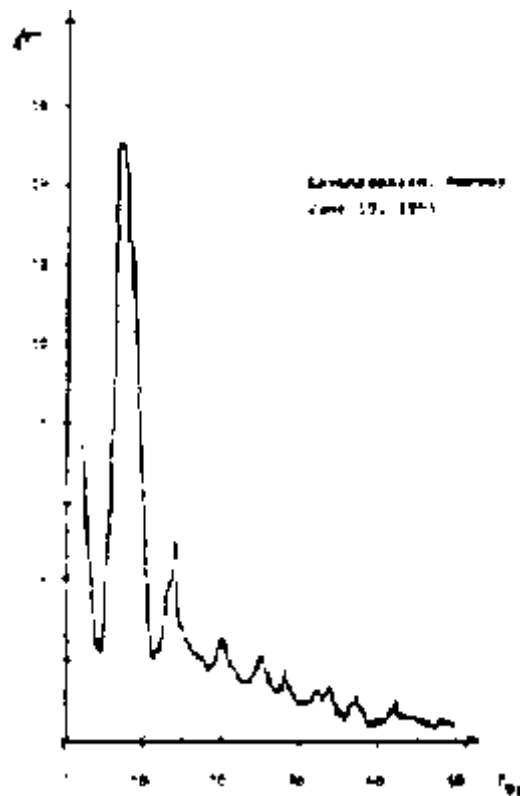


Figure 2. Typical spectrum of cavity noise. Prominent Schumann resonances at 8, 14, 20 and 26 Hz are visible. Peaks at 32, 37 and 43 Hz are apparent.

### (b) Cavity Q

An important practical question associated with the Earth-Ionosphere cavity is its ability to store or contain energy without dissipating it by heating up the Earth or the ionosphere boundaries. In electrical and microwave circuit theory, a quantity called the Q of the resonant cavity is determined as a ratio between the stored energy and the energy loss per cycle in the cavity,

$$Q = \omega_0 \frac{\text{stored energy}}{\text{power lost}}$$

where  $\omega_0$  is the resonant angular frequency assuming no losses. The Earth-Ionosphere cavity Q has been measured and documented experimental data places it in the range between 3.8 to 7.8.

### (c) Propagation Attenuation Constant

While the above Q is relatively low for a tuned circuit, it does indicate that the waveguide propagation losses are surprisingly small. For electromagnetic propagation on a transmission line or in a waveguide, a forward traveling wave attenuates as

$$E(\ell) = E_0 e^{-\alpha \ell}$$

where  $\alpha$  is the attenuation constant in nepers per meter. The measured value of the attenuation constant for ELF waves propagating in the Earth-Ionosphere cavity has been experimentally determined to be on the order of one quarter of a dB per thousand kilometers. By way of comparison, single circuit 200 KV 60 Hz overhead power transmission lines have attenuation constants on the order of 1.15 dB per thousand kilometers. Experimentally established transmission and distribution losses are 23% less for the Schumann Cavity than for conventional power transmission lines.

The issue of the practicality of the proposed distribution system does not rest upon the efficiency of the transmission medium. Rather, the technical issue to be faced concerns the electromagnetic coupling mechanism to be used. This issue, we believe, was addressed by Tesla and the experimental results which he disclosed testify to his conspicuous success

The Earth-Ionosphere cavity is, indeed, capable of being artificially excited into oscillation and the cavity can be employed as a medium for the global distribution of electrical power.

What is required is the creation of a practical engineering capability to efficiently launch electrical power into the cavity and to couple energy from the cavity.

It is absolutely astonishing that Tesla's public disclosures and technical publications match the electrical properties of the Schumann Cavity fifty years before there was even a theoretical model to predict rough values.

The conclusion should be obvious: Tesla could have only obtained these numbers by successfully stimulating the cavity. Tesla had to have solved the problem of launching energy into the Earth-Ionosphere waveguide and coupling energy from the cavity. We believe that the technical aspects of his apparatus have been sufficiently disclosed, in his patents, to be able to replicate his cavity stimulation and power transmission experiments. This experimental investigation should be carried out immediately. Clearly, whoever executes a sound and careful program of research along these lines will develop a technology capable of distributing electrical energy on a vast scale without the necessity of a land-line network.

It is evident that we are advocating one of the most visionary energy distribution systems ever conceived. And yet we maintain that it is technically sound and can be swiftly inaugurated at a fraction of the capital investment required by the only other alternative electrical power distribution system - high voltage overhead power transmission lines.

Tesla was aware of this and could clearly see through to the logical conclusion. When he returned to New York City in 1900, he wrote:

"Men could settle down everywhere, fertilize and irrigate the soil with little effort, and convert barren deserts into gardens, and thus the entire globe could be transformed and made fitter abode for mankind."

This program will inevitably have an even broader impact upon all the civilized world. The electrical power industry will experience a major innovation. The global economics of today, which is so petroleum dominated, would be transformed overnight to reflect the importance of those nations which are happily endowed with natural resources appropriate for the generation of electrical energy.

Such research will not only revolutionize the areas of energy, transportation, agriculture and commerce, but, in all probability, could even inspire significant alterations in the present structure of world governing bodies. We are referring to the consequences initiated by a global diffusion of energy. International society could perhaps be on the verge of a metamorphosis comparable in magnitude to the great agitation, evolution and achievement which so characterized the European Renaissance and the forward progress of civilization to which it gave birth.

During the last century, natural science seemed, for all intents and purposes, to have reached its maturity. From our vantage point today, that period is called 'the Golden Age of Classical Physics'. Yet, almost a hundred years ago, remarkable discoveries began to be made which would engender profound modifications of classical physics. It was the experimental science of the 1890's which would soon give birth to what, today, we call modern physics. It was a renaissance no less than the transition which had occurred several centuries earlier in art, literature and natural philosophy.

It has been observed that, standing on the threshold of the 1890's, only a writer of science fiction could have dreamed of the revolution on physical thought which was to occur over the next few years. And even the poets and writers of that day were unable to grasp the impact which the new science would soon have on industry, the military and the political life of the entire planet, which we have observed during the twentieth century.

Today, we stand on a similar threshold. But now it is technology which is experiencing such radical growth. We submit that the "high tech" society which we enjoy today may be but a destitute and

primitive shadow of the flourishing civilization which could soon emerge across the threshold of the 21st century.

The power distribution system which we are proposing will surely require careful and considered investigation. There are no simple engineering answers.

Engineering has been called "that profession which utilizes the resources of the Earth for the benefit of mankind". We are proposing the initial step in what eventually will be an engineering project the scale of which civilization has never endeavored to attain before. But never since the days of Columbus, could so much be gotten for so small a financial investment. Never before in recorded history has it been within the grasp of the technical community to so dynamically influence the advancement of civilization.

### The engineering challenge

There is a need for a practical waveguide probe capable of exciting the Earth-Ionosphere cavity at 8Hz where the wavelength is about 37.5 million meters. Poor radiation efficiency and physical size limitations for such probes in previously known technology have been overcome with our inventions, patented in the U.S. and other nations. (Nos. 4,751,515 and 4,622,558). With these, a contrawound structure waveguide probe of reasonable size can be built which can excite the Earth-Ionosphere cavity. It employs the earth as an image current source and has a maximum dimension of 0.001 free space wavelengths (with much smaller sizes possible), designed to launch vertically polarized, omnidirectional energy efficiently into the cavity at its primary resonant frequency, or sufficiently close to a resonance frequency so as to be within the resonance frequency bandwidth. Because propagation losses are so low at the primary Schumann resonance frequency, signals at that frequency may be transmitted to any point of the earth without significant attenuation.

An important element of the inventions is that the path inhibit propagation, thereby creating slow waves, and provide an electromagnetically closed path so that a standing inhibited-velocity wave, or resonant operation, can be established in response to the flow of electrical current through the path.

One half of the electrically conducting path may be eliminated in embodiments of the structure by employing the image theory technique. Thus, a conducting image surface electrically supplies the missing portion of the path. The image surface may be a conducting sheet, a screen or wires arranged to act electrically as a conducting sheet, or may be the earth, in accordance with the improvement disclosed in the patents of the known electromagnetic theory.

### COMPARISON OF PHYSICAL PARAMETERS

Physical Parameter	Accepted Experimental Values	Predicted from Tesla's Disclosures
Attenuation Constant (dB/Mm)	$.20 \leq \alpha \leq .30$	.26
Resonant Frequency (Hz)	$6.8 \leq f_n \leq 7.8$	6
Cavity Q	$3.8 \leq Q \leq 7.8$	$3.2 \leq Q \leq 6.4$

Coherence Time (sec.)	no data available	0.08484
Phase Velocity	$.71 \leq V_r \leq .83$	0.8
Cavity Mode Structure	$P_n(\cos\theta)$	"Projections of all the stationary nodes onto the earth's diameter are equal."
Cavity Thickness (Km)	$35 \leq h \leq 80$	"greater than 8 Km" "about 20 Km"

**Table 1.** Documented numerical evidence that Tesla excited terrestrial resonances in 1899. Additionally there is a host of descriptive evidence.

## Wireless transmission of power - resonating planet Earth

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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 of wireless transmission of 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 amongst 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 method to be used by present researchers in a recreation of the Colorado Springs experiment 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 1915 IRE lecture.

Dr. Tesla delivered lectures to the Franklin Institute at Philadelphia in February, 1903, and to the National Electric Light Association St. Louis in March 1903. 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 "The Spherical Oscillator." This was the beginning of the science of terrestrial resonances, culminating in the 1950's and 60's with VLF radio engineering 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)

### **Resonating Planet Earth**

Dr. James T. Corum, in chapter two of his soon to be published book, "A Tesla Primer", points 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 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.



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 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.

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. Experiments to date have shown that the electromagnetic waves of extreme low frequencies in the range of 8Hz, the fundamental Schumann resonance frequency, propagate with little attenuation around the planet within the Schumann resonance 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 wavelength 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 of 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 antipode. The traveling waves would be reflected back from the anti-pode to the transmitter to be reinforced and sent out again.

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 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. Based on the 1971 world-wide power generation of 908 million kilowatts, approximately 207 million kilowatts are being produced to make up losses. This results in a cost of 454 billion U.S. dollars at 5 cents a kilowatt. The power wasted in transmission now costs over 100 billion dollars a year. Wireless transmission of power, if fully utilized, could save over 90 billion dollars per year. Any technology that can reduce these losses and the corresponding costs is of extreme importance.

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 U.S. this system would provide a saleable product which could much to aid our balance of payments.

In 1971, nine industrialized nations, (with 25% of the world's population), used 690 million kilowatts, 76% 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). 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.

A system of wireless transmission of power would make electrical energy available to people and nations which are not now privileged with the access to power developed nations take for granted.

### **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 120 foot tower have been constructed and are operational at an elevation of approximately 11,000 feet (3350 meters) for the experiment. This system is centered around a very powerful resonating Tesla coil. It was originally built 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 150 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 electrostatically charge a 120 ft. (37 m) tall, vertical mast which will function to provide a vertical current moment. The mast is topped by a metal sphere 30 inches (75 cm) in diameter. 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. Discharging the antenna 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 and reflected 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 put into 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. This effort is headed by Dr. D.D. Sentman who is with the Institute of Geophysics and Planetary Physics at the University of California at Los Angeles. Dr. Sentman's project is funded by Los Alamos National Laboratory, the Lawrence Livermore Laboratory, and the National Aeronautics and Space Administration. Dr. Sentman has agreed to participate in verification of the goal of this proposal.

## 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. 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.

## Regulating Agencies

The Radio Regulations of the International Telecommunications Union (ITU), Article 2, Section 11, Geneva; 1959, list world-wide frequency allocations from 10 kilohertz to 275 gigahertz. Frequencies below 10 kilohertz and above 275 gigahertz are not allocated. In the United States the Federal Communications Commission has allocated frequencies in accordance with ITU regulations. In effect, there is no governmental agency in the world that has jurisdiction over the frequency of operation of Project Tesla.

## 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.

Exposure to man-made sources of ELF can be up to 1 billion (1000 million) 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. Project Tesla will use a 150 kw generator to excite the Schumann cavity. Dr. Corum's calculations predict that the field strength due to this excitation at 7.8 Hz will be on the order of 46 picoteslas.

## References

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