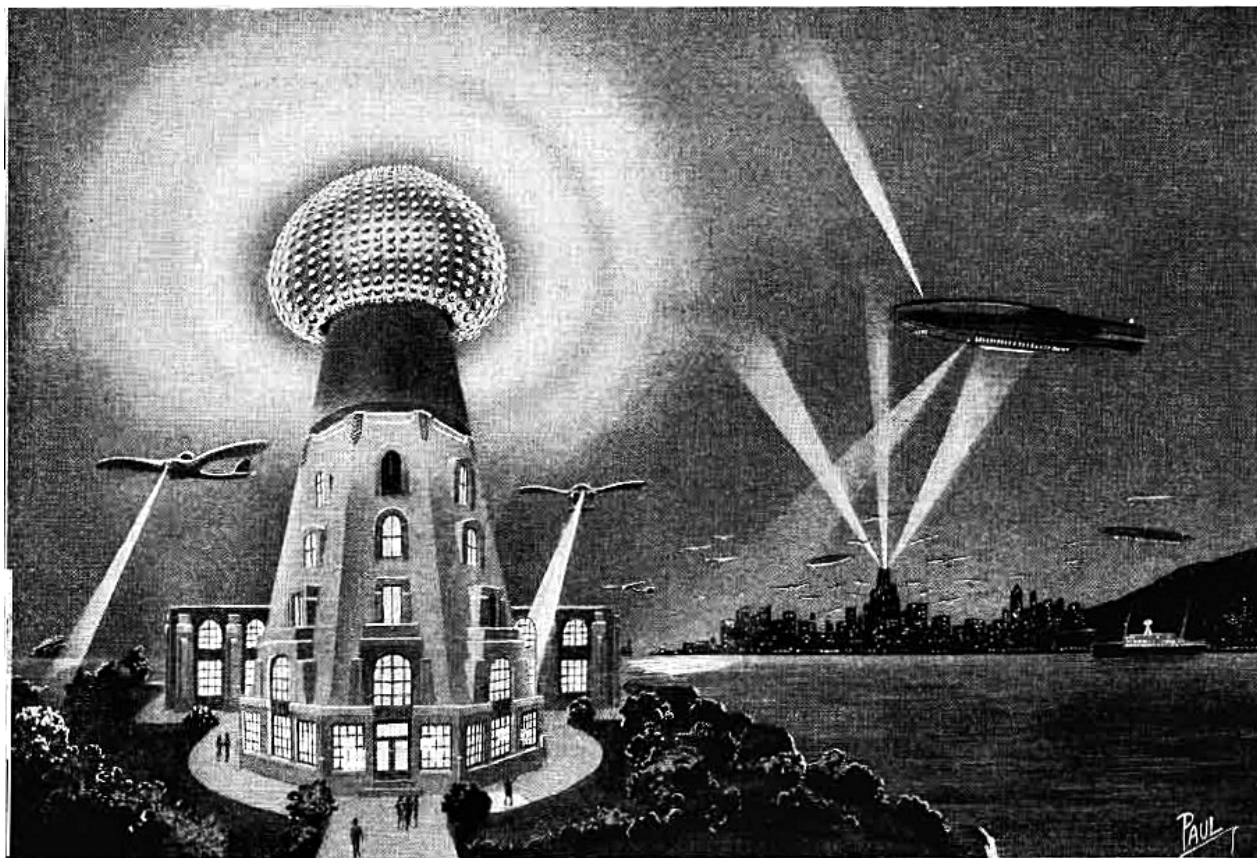


## Tesla's World System 1. (Facebook Notes)



As to the immediate purposes of my enterprise, they were clearly outlined in a technical statement of that period from which I quote, "The 'World-System' has resulted from a combination of several original discoveries made by the inventor in the course of long continued research and experimentation. It makes possible not only the instantaneous and precise wireless transmission of any kind of signals, messages or characters, to all parts of the world, but also the inter-connection of the existing telegraph, telephone, and other signal stations without any change in their present equipment. By its means, for instance, a telephone subscriber here may call up and talk to any other subscriber on the Earth. An inexpensive receiver, not bigger than a watch, will enable him to listen anywhere, on land or sea, to a speech delivered or music played in some other place, however distant."

These examples are cited merely to give an idea of the possibilities of this great scientific advance, which annihilates distance and makes that perfect natural conductor, the Earth, available for all the innumerable purposes which human ingenuity has found for a line-wire. One far-reaching result of this is that any device capable of being operated through one or more wires (at a distance obviously restricted) can likewise be actuated, without artificial conductors and with the same facility and accuracy, at distances to which there are no limits other than those imposed by the physical dimensions of the earth. Thus, not only will entirely new fields for commercial exploitation be opened up by this ideal method of transmission, but the old ones vastly extended.

Nikola Tesla: My Inventions

Photo: Prospective view of Tesla's ultra high voltage (UHV) transmitter station at Wardenclyffe.

## Tesla's World System 2. (Transmission)

"I expect to make a complete announcement of my plans shortly" Mr. Tesla said, "and when I do many persons will be surprised. I have been taking out patents on my inventions on the transmission of electrical energy without wires for the last three years.

By means of the current which will be sent between the different stations I will be able to draw power for almost any purpose. That I will be enabled to get force with which to operate railroads and steamships from currents passing through the air between power houses is an assured fact. All my experiments so far have proved successful and I am now devoting all my time toward getting things on a working basis."



"The current which I will use will be of the familiar alternating type. The energy which is generated in that form will be stored in a condenser, but after its discharge therefrom the intensity of the vibrations will be magnified 10,000 times. These vibrations will be of the kind best calculated for transmission through the earth, which is my real conductor. At the receiving station I will provide means for magnifying the force of the incoming vibrations a quarter of a million times."

Nikola Tesla to send power without wires, The Post-Standard, July 25. 1902.

Nikola Tesla Hard at Work, The Cedar Rapids Evening Gazette, March 15. 1902.

## Tesla's World System 3. (Magnifying transformer)

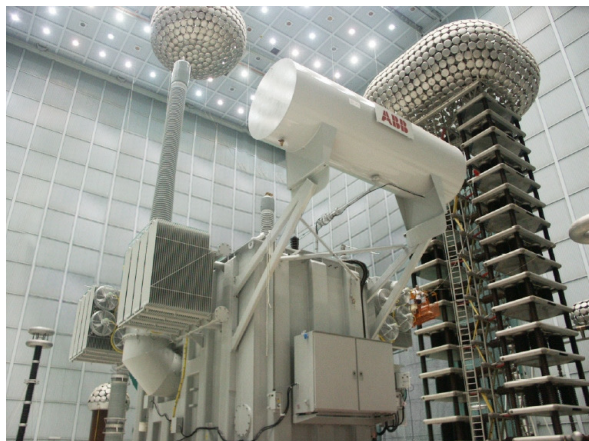




"I will be quite explicit on the subject of my magnifying transformer so that it will be clearly understood. In the first place, it is a resonant transformer, with a secondary in which the parts, charged to a high potential, are of considerable area and arranged in space along ideal enveloping surfaces of very large radii of curvature, and at proper distances from one another, thereby insuring a small electric surface density everywhere, so that no leak can occur even if the conductor is bare. It is suitable for any frequency, from a few to many thousands of cycles per second, and can be used in the production of currents of tremendous volume and moderate pressure, or of smaller amperage and immense electromotive force. The maximum electric tension is merely dependent on the curvature of the surfaces on which the charged elements are situated and the area of the latter. Judging from my past experience there is no limit to the possible voltage developed; any amount is practicable. On the other hand, currents of many thousands of amperes may be obtained in the antenna. A plant of but very moderate dimensions is required for such performances. Theoretically, a terminal of less than 90 feet in diameter is sufficient to develop an electromotive force of that magnitude, while for antenna currents of from 2,000-4,000 amperes at the usual frequencies, it need not be larger than 30 feet in diameter."

Nikola Tesla: My Inventions

Fotos: Nikola Tesla's Wardenclyffe transmitter station, the ultra high voltage test hall of the firm ABB.



#### Tesla's World System 4. (Inventions and discoveries)



Thus, not only will entirely new fields for commercial exploitation be opened up by this ideal method of transmission, but the old ones vastly extended. The World System is based on the application of the following inventions and discoveries:

1. The Tesla Transformer: This apparatus is in the production of electrical vibrations as revolutionary as gunpowder was in warfare. Currents many times stronger than any ever generated in the usual ways and sparks over one hundred feet long, have been produced by the inventor with an instrument of this kind.
2. The Magnifying Transmitter: This is Tesla's best invention, a peculiar transformer specially adapted to excite the earth, which is in the transmission of electrical energy when the telescope is in astronomical observation. By the use of this marvelous device, he has already set up electrical movements of greater intensity than those of lightening and passed a current, sufficient to light more than two hundred incandescent lamps, around the Earth.
3. The Tesla Wireless System: This system comprises a number of improvements and is the only means known for transmitting economically electrical energy to a distance without wires. Careful tests and measurements in connection with an experimental station of great activity, erected by the inventor in Colorado, have demonstrated that power in any desired amount can be conveyed, clear across the globe if necessary, with a loss not exceeding a few per cent.



4. The Art of Individualization: This invention of Tesla is to primitive tuning, what refined language is to unarticulated expression. It makes possible the transmission of signals or messages absolutely secret and exclusive both in the active and passive aspect, that is, non-interfering as well as non-interferable. Each signal is like an individual of unmistakable identity and there is virtually no limit to the number of stations or instruments which can be simultaneously operated without the slightest mutual disturbance.





5. The Terrestrial Stationary Waves: This wonderful discovery, popularly explained, means that the Earth is responsive to electrical vibrations of definite pitch, just as a tuning fork to certain waves of sound. These particular electrical vibrations, capable of powerfully exciting the globe, lend themselves to innumerable uses of great importance commercially and in many other respects. The first "World System" power plant can be put in operation in nine months. With this power plant, it will be practicable to attain electrical activities up to ten million horse-power and it is designed to serve for as many technical achievements as are possible without due expense.

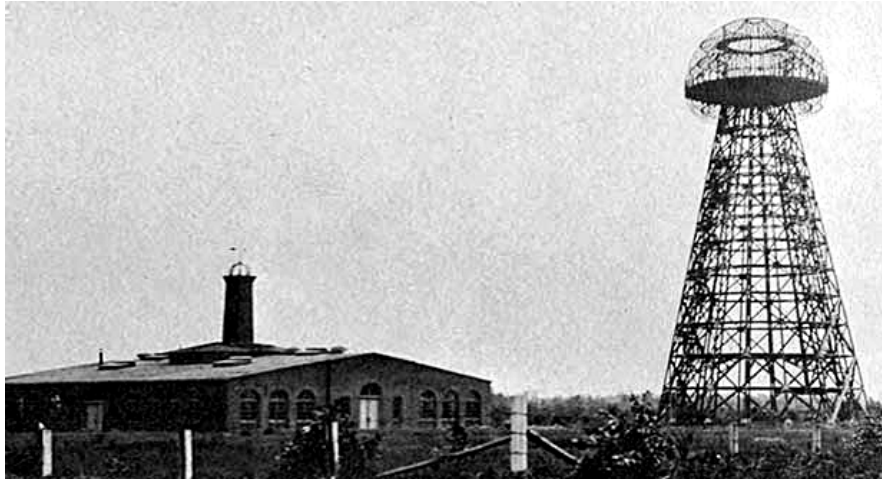
Nikola Tesla: My Inventions

Photos: Nikola Tesla's laboratories at Colorado Springs and Wardenclyffe, CG's 1600 KV Ultra High Voltage Research Centre in Nashik, India.

### **Tesla's World System 5. (One wire transmission)**

"It is difficult for a layman to grasp how an electric current can be propagated to distances of thousands of miles without diminution of intensity. But it is simple after all. Distance is only a relative conception, a reflection in the mind of physical limitation. A view of electrical phenomena must be free of this delusive impression. However surprising, it is a fact that a sphere of the size of a little marble offers a greater impediment to the passage of a current than the whole earth. Every experiment, then, which can be performed with such a small sphere can likewise be carried out, and much more perfectly, with the immense globe on which we live. This is not merely a theory, but a truth established in numerous and carefully conducted experiments. By impressing upon it current waves of certain lengths, definitely related to its diameter, the globe is thrown into resonant vibration like a wire, stationary waves forming, the nodal and ventral regions of which can be located with mathematical precision.





This mode of conveying electrical energy to a distance is not 'wireless' in the popular sense, but a transmission through a conductor, and one which is incomparably more perfect than any artificial one. All impediments of conduction arise from confinement of the electric and magnetic fluxes to narrow channels. The globe is free of such cramping and hinderment. It is an ideal conductor because of its immensity, isolation in space, and geometrical form. Its singleness is only an apparent limitation, for by impressing upon it numerous non-interfering vibrations, the flow of energy may be directed through any number of paths which, though bodily connected, are yet perfectly distinct and separate like ever so many cables. Any apparatus, then, which can be operated through one or more wires, at distances obviously limited, can likewise be worked without artificial conductors, and with the same facility and precision, at distances without limit other than that imposed by the physical dimensions of the globe."

Nikola Tesla: Wireless Telegraphy & Telephony, 1908.

Fotos: Nikola Tesla laboratory at Wardenclyffe, UHV test line in Japan and China.



## Tesla's World System 6. (The Singular Misconception of the Wireless.)

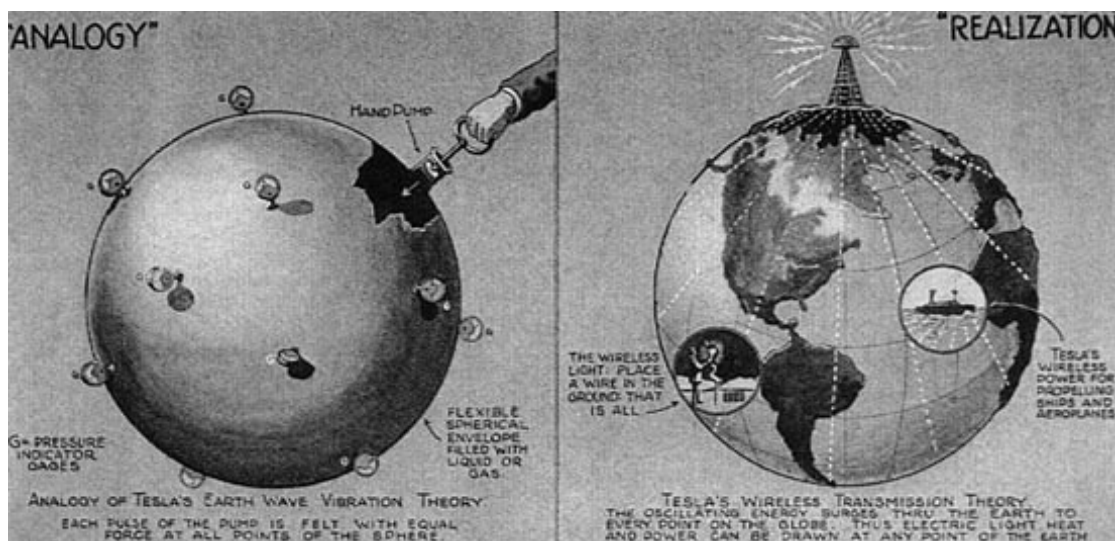
To the popular mind this sensational advance conveys the impression of a single invention but in reality it is an art, the successful practise of which involves the employment of a great many discoveries and improvements. I viewed it as such when I undertook to solve wireless problems and it is due to this fact that my insight into its underlying principles was clear from their very inception.

In the course of development of my induction motors it became desirable to operate them at high speeds and for this purpose I constructed alternators of relatively high frequencies. The striking behavior of the currents soon captivated my attention and in 1889 I started a systematic investigation of their properties and the possibilities of practical application. The first gratifying result of my efforts in this direction was the transmission of electrical energy thru *one wire* without return, of which I gave demonstrations in my lectures and addresses before several scientific bodies here and abroad in 1891 and 1892.



During that period, while working with my oscillation transformers and dynamos of frequencies up to 200,000 cycles per second, the idea gradually took hold of me that the earth might be used in place of the wire, thus dispensing with artificial conductors altogether. The immensity of the globe seemed an unsurmountable obstacle but after a prolonged study of the subject I became satisfied that the undertaking was rational, and in my lectures before the Franklin Institute and National Electric Light Association early in 1893 I gave the outline of the system I had conceived.

In my exposition to him (Lord Kelvin) I resorted to the following mechanical analogues of my own and the Hertz wave system: Imagine the earth to be a bag of rubber filled with water, a small quantity of which is periodically forced in and out of the same by means of a reciprocating pump, as illustrated. If the strokes of the latter are effected in intervals of more than one hour and forty-eight minutes, sufficient for the transmission of the impulse thru the whole mass, the entire bag will expand and contract and corresponding movements will be imparted to pressure gauges or movable pistons with the same intensity, irrespective of distance. By working the pump faster, shorter waves will be produced which, on reaching the opposite end of the bag, may be reflected and give rise to stationary nodes and loops, but in any case, the fluid being incompressible, its inclosure perfectly elastic, and the frequency of oscillations not very high, the energy will be economically transmitted and very little power consumed so long as no work is done in the receivers. This is a crude but correct representation of my wireless system in which, however, I resort to various refinements. Thus, for instance, the pump is made part of a resonant system of great inertia, enormously magnifying the force of the impress impulses. The receiving devices are similarly conditioned and in this manner the amount of energy collected in them vastly increased.



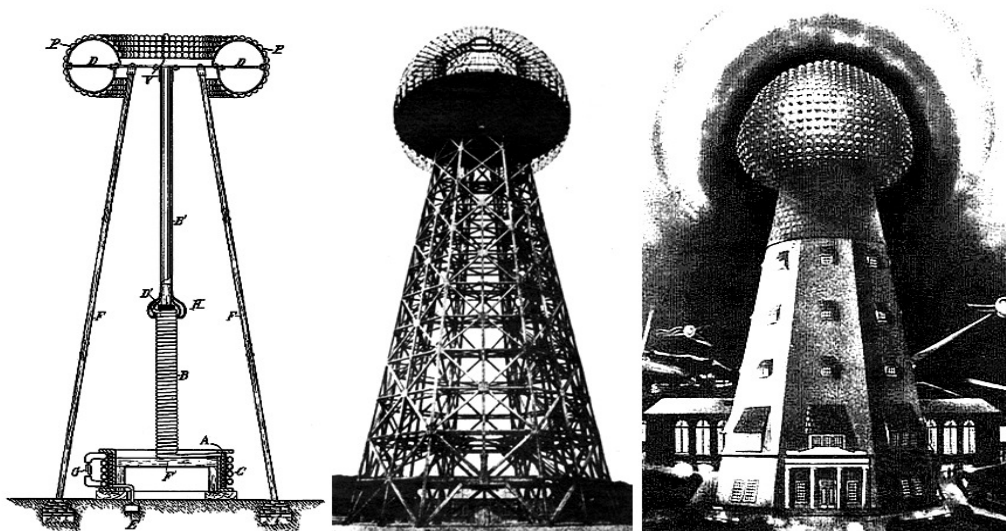
The Hertz wave system is in many respects the very opposite of this. To explain it by analogy, the piston of the pump is assumed to vibrate to and fro at a terrific rate and the orifice thru which the fluid passes in and out of the cylinder is reduced to a small hole. There is scarcely any movement of the fluid and almost the whole work performed results in the production of radiant heat, of which an infinitesimal part is recovered in a remote locality.

Some experts, whom I have credited with better knowledge, have for years contended that my proposals to transmit power without wires are sheer nonsense but I note that they are growing more cautious every day. These men labor under the impression that the energy flows in all directions and that, therefore, only a minute amount can be recovered in any individual receiver. But this is far from being so. The power is conveyed in only one direction, from the transmitter to the receiver, and none of it is lost elsewhere. It is perfectly practicable to recover at any point of the globe energy enough for driving an airplane, or a pleasure boat or for lighting a dwelling. I am especially sanguine in regard to the lighting of isolated places and believe that a more economical and convenient method can hardly be devised. The future will show whether my foresight is as accurate now as it has proved heretofore.

Nikola Tesla: Famous Scientific Illusions, Electrical Experimenter, February, 1919.

## Tesla's World System 7. (Wireless transmission)

The transmission of power without wires is not a theory or a mere possibility, as it appears to most people, but a fact demonstrated by me in experiments which have extended for years. Nor did the idea present itself to me all of a sudden, but was the result of a very slow and gradual development and a logical consequence of my investigations which were earnestly undertaken in 1893 when I gave the world the first outline of my system of broadcasting wireless energy for all purposes. In several demonstrative lectures before scientific societies during the preceding three years, I showed that it was not necessary to use two wires in transmitting electrical energy, but that one only might be employed equally well. My experiments with currents of high frequencies were the first ever performed in public and elicited the keenest interest on account of the possibilities they opened up and striking character of the phenomena. Few of the experts familiar with the up-to-date appliances will appreciate the difficulty of my task with the elementary devices I had then at command, as accurate adjustments for resonance had to be made in every experiment.



The transmission of energy through a single conductor without return having been found practicable it occurred to me that possibly even that one wire might be dispensed with and the earth used to convey the energy from the transmitter to the receiver.

Nikola Tesla: World System of Wireless Transmission of Energy, Telegraph and Telegraph Age, October 16, 1927.

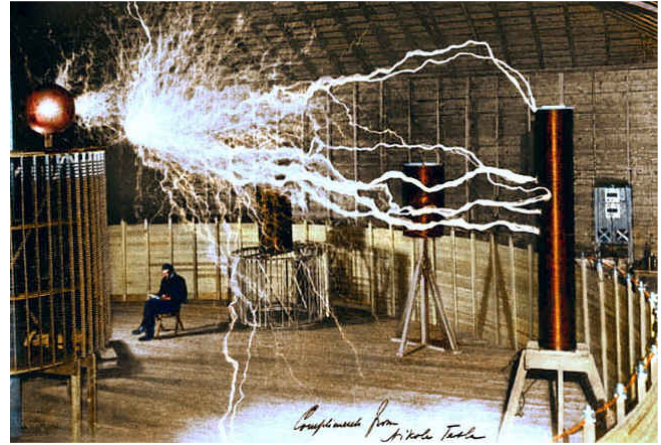
Photos: Patent figure, construction and prospective view of Tesla's wireless transmitter at Wardenclyffe.

## Tesla's World System 8. (Efficiency)

"The chief discovery, which satisfied me thoroughly as to the practicability of my plan, was made in 1899 at Colorado Springs, where I carried on tests with a generator of fifteen hundred kilowatt capacity and ascertained that under certain conditions the current was capable of passing across the entire globe and returning from the antipodes to its origin with undiminished strength. It was a result so unbelievable that the revelation at first almost stunned me. I saw in a flash that by properly organized apparatus at sending and receiving stations, power virtually in unlimited amounts could be conveyed through the earth at any distance, limited only by the physical dimensions of the globe, with an efficiency as high as ninety-nine and one-half per cent.

The mode of propagation of the currents from my transmitter through the terrestrial globe is most extraordinary considering the spread of the electrification of the surface. The wave starts with a theoretically infinite speed, slowing down first very quickly and afterward at a lesser rate until the distance is about six thousand miles, when it proceeds with the speed of light. From there on it again increases in speed, slowly at first, and then more rapidly, reaching the antipode with approximately infinite velocity.



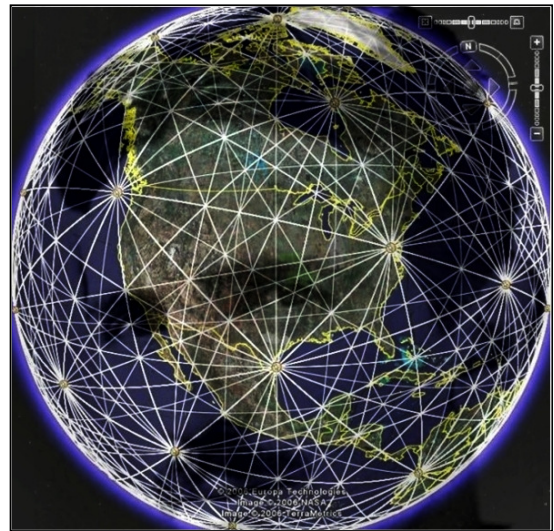


The law of motion can be expressed by stating that the waves on the terrestrial surface sweep in equal intervals of time over equal area, but it must be understood that the current penetrates deep into the earth and the effects produced on the receivers are the same as if the whole flow was confined to the earth's axis joining the transmitter with the antipode. The mean surface speed is thus about 471,200 kilometers per second – fifty-seven per cent. greater than that of the so-called Hertz waves – which should propagate with the velocity of light if they exist. The same constant was found by the noted American astronomer, Capt. J.T.T. See, in his mathematical investigations, for the smallest particles of the ether which he fittingly designates as "etherons." But while in the light of his theory this speed is a physical reality, the spread of the currents at the terrestrial surface is much like the passage of the moon's shadow over the globe."

Nikola Tesla: World System of Wireless Transmission of Energy, Telegraph and Telegraph Age, October 16, 1927.

### Tesla's World System 9. (Ley-lines)

"Since I began the construction of the first power plant in 1899 I have expressed myself repeatedly in regard to it and the plans I had previously formed through the medium of the Electrical Review, Electrical World, Electrical Experimenter, Science and Invention and other periodicals, notably the Century Magazine of June, 1900, to which I contributed a lengthy article on the "Problem of Increasing Human Energy"; but certain facts must still be told. In the first place the fundamental difference between the broadcasting system as now practiced and the one I expect to inaugurate is that at present the transmitter emits energy in all directions, while in the system I have devised only force is conveyed to all points of the earth, the energy itself traveling in definite paths determined beforehand.



Perhaps the most wonderful feature is that the energy travels chiefly along an orthodromic line, that is, the shortest distance between two points at the surface of the globe, and reaches the receiver without the slightest dispersion, so that an incomparably greater amount is collected than is possible by radiations. I have thus provided a perfect means for transmitting power in any desired direction far more economically and without any such qualitative and quantitative limitations as the use of reflectors would necessarily involve."

Nikola Tesla: World System of Wireless Transmission of Energy, Telegraph and Telegraph Age, October 16, 1927.

## Tesla's World System 10. (Utilization)

By impressing upon it current waves of certain lengths, definitely related to its diameter, the globe is thrown into resonant vibration like a wire, stationary waves forming, the nodal and ventral regions of which can be located with mathematical precision. Owing to this fact and the spheroidal shape of the earth, numerous geodetical and other data, very accurate and of the greatest scientific and practical value, can be readily secured. Through the observation of these astonishing phenomena we shall soon be able to determine the exact diameter of the planet, its configuration and volume, the extent of its elevations and depressions, and to measure, with great precision and with nothing more than an electrical device, all terrestrial distances. In the densest fog or darkness of night, without a compass or other instruments of orientation, or a timepiece, it will be possible to guide a vessel along the shortest or orthodromic path, to instantly read the latitude and longitude, the hour, the distance from any point, and the true speed and direction of movement. By proper use of such disturbances a wave may be made to travel over the earth's surface with any velocity desired, and an electrical effect produced at any spot which can be selected at will and the geographical position of which can be closely ascertained from simple rules of trigonometry.



One of the most important uses of wireless energy will be undoubtedly for the propulsion of flying machines to which power can be readily supplied without ground connection, for although the flow of the currents is confined to the earth an electro magnetic field is created in the atmosphere surrounding it. If conductors or circuits accurately attuned and properly positioned are carried by the plane, energy is drawn into these circuits much the same as a fluid will pass through a hole created in the container. With an industrial plant of great capacity sufficient power can be derived in this manner to propel any kind of aerial machine. This I have always considered as the best and permanent solution of the problems of flight. No fuel of any kind will be required as the propulsion will be accomplished by light electric motors operated at great speed.

Nikola Tesla: The Future Of The Wireless Art, Wireless Telegraphy & Telephony, 1908.

Nikola Tesla: World System of Wireless Transmission of Energy, Telegraph and Telegraph Age, October 16, 1927.