



## [Nikola Tesla slideshow: Images and articles from Tesla's writings](#)

[Steve Taranovich](#) - September 13, 2012

John Ratzlaff compiled 25 years of research on Nikola Tesla in his book, "Tesla Said" (now out of print with one used copy on Amazon last time I looked for \$350). The book is a collection including photocopies of original newspaper and magazine articles and other documents written by Tesla from 1888 to 1939.

In this slideshow, we present a sampling of images and excerpts from this collection, which are all obtainable on the Internet. The image files included here were graciously provided by John Piliounis, a physicist/electronics engineer in Athens, Hellas (Greece).

Some examples of the articles in this book include:

- "On the Dissipation of the Electrical Energy of the Hertz Resonator"
- "Application of Tubes of High Illuminating Power to Photography and Other Purposes"
- "The Transmission of Electrical Energy Without Wire As a Means for Furthering Peace"
- "Nikola Tesla's Plan to Keep 'Wireless Thumb' on Ships at Sea"

For even more Tesla books, see Twenty-First Century (TFC) Books at <http://www.tfcbooks.com/default.htm>.

Gary Peterson, owner/operator of TFC is an avid Tesla enthusiast and has a great background in the Tesla saga in modern times. Gary has been involved with the efforts to save the Wardencllyffe Lab and runs the website <http://www.teslaradio.com/> and has aligned with the Tesla Science Center <http://www.teslasciencecenter.org/>.

**See more about Tesla on EDN:**

[Tesla - Connecting the dots](#)

[Who says Tesla is an unsung hero?](#)

[Save Tesla's lab!](#)

[Nikola Tesla is born, July 10, 1856](#)

**From "The Tesla Alternate Current Motor" in *The Electrical Engineer*, June 22, 1888.**

output, conditions of maximum work, &c., of this machine. Experiment alone can determine its value, and one properly conducted and interpreted set of experiments should enable us to judge both the merit of the invention and its best possible form. I cannot see, however, how, in the form described in the last issue of this journal the motor can work under conditions of a suddenly varying load as satisfactorily as continuous current motors."

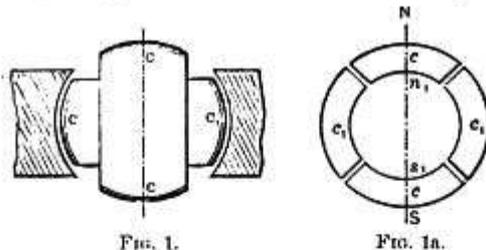
To the above Mr. Tesla replied on June 2 as follows:

"I find in your issue of last week a note of Mr. Duncan referring to my system of alternate current motors.

"As I see that Dr. Duncan has not as yet been made acquainted with the real character of my invention, I cannot consider his article in the light of a serious criticism, and would think it unnecessary to respond; but desiring to express my consideration for him and the importance which I attach to his opinion, I will point out here briefly the characteristic features of my invention, inasmuch as they have a direct bearing on the article above referred to.

"The principle of action of my motor will be well understood from the following: By passing alternate currents in proper manner through independent energising circuits in the motor, a progressive shifting or rotation of the poles of the same is effected. This shifting is more or less continuous according to the construction of the motor and the character and relative phase of the currents which should exist in order to secure the most perfect action.

"If a laminated ring be wound with four coils, and the same be connected in proper order to two independent circuits of an alternate current generator adapted for this purpose, the passage of the currents through the coils produces



theoretically a rotation of the poles of the ring, and in actual practice, in a series of experiments, I have demonstrated the complete analogy between such a ring and a revolving magnet. From the application of this principle to the operation of motors, two forms of motor of a character widely differing have resulted—one designed for constant and the other for variable load. The misunderstanding of Dr. Duncan is due to the fact that the prominent features of each of these two forms have not been specifically stated. In illustration of a representative of the second class, I refer to Fig. 1, given herewith. In this instance, the armature of the motor is provided with two coils at right angles. As it may be believed that a symmetrical arrangement of the coils with respect to the poles is required, I will assume that the armature is provided with a great number of diametrically wound coils or conductors closed upon themselves, and forming as many independent circuits. Let it now be supposed that the ring is permanently magnetized so as to show two poles (N and S) at two points diametrically opposite, and that it is rotated by mechanical power. The armature being stationary, the rotation of the ring magnet will set up currents in the closed armature coils. These currents will be most intense at or near the points of the greatest density of the force, and they will produce poles upon the armature core at right angles to those of the ring. Of course there will be other elements entering into action

### On the Dissipation of the Electrical Energy of the Hertz Resonator

"On the Dissipation of the Electrical Energy of the Hertz Resonator," in *The Electrical Engineer*, December 21, 1892.

THE  
Electrical Engineer.

Vol. XIV.

DECEMBER 21, 1892.

No. 242.

ON THE DISSIPATION OF THE ELECTRICAL ENERGY OF THE HERTZ RESONATOR.

BY

*Nikola Tesla*



ANYONE who, like myself, has had the pleasure of witnessing the beautiful demonstrations with vibrating diaphragms which Prof. Bjerknes, exhibited in person at the Paris Exposition in 1889, must have admired his ability and painstaking care to such a degree, as to have an almost implicit faith in the correctness of observations made by him. His experiments "On the Dissipation of the Electrical Energy of the Hertz Resonator," which are described in the issue of Dec. 14, of THE ELECTRICAL ENGINEER, are prepared in the same ingenious and skillful manner, and the conclusions drawn from them are all the more interesting as they agree with the theories put forth by the most advanced thinkers. There can not be the slightest doubt as to the truth of these conclusions, yet the statements which follow may serve to explain in part the results arrived at in a different manner; and with this object in view I venture to call attention to a condition with which, in investigations such as those of Prof. Bjerknes, the experimenter is confronted.

The apparatus, oscillator and resonator, being immersed in air, or other discontinuous medium, there occurs—as I have pointed out in the description of my recent experiments before the English and French scientific societies—dissipation of energy by what I think might be appropriately called *electric sound waves* or *sound-waves of electrified air*. In Prof. Bjerknes's experiments principally this dissipation in the resonator need be considered, though the sound-waves—if this term be permitted—which emanate from the surfaces at the oscillator may considerably affect the observations made at some distance from the latter. Owing to this dissipation the period of vibration of an air-condenser can not be accurately determined, and I have already drawn attention to this important fact.

These waves are propagated at right angles from the charged surfaces when their charges are alternated, and dissipation occurs, even if the surfaces are covered with thick and excellent insulation. Assuming that the "charge" imparted to a molecule or atom either by direct contact or inductively is proportionate to the electric density of the surface, the dissipation should be proportionate to the square of the density and to the number of waves per second. The above assumption, it should be stated, does not agree with some observations from which it appears that an atom can not take but a certain maximum charge; hence, the charge imparted may be practically independent of the density of the surface, but this is immaterial for the present consideration. This and other points will be decided when accurate quantitative determinations, which are as yet wanting, shall be made. At present it appears certain from experiments with high-frequency currents, that this dissipation of energy from a wire, for instance, is not very far from being proportionate to the frequency of the alter-

nations, and increases very rapidly when the diameter of the wire is made exceedingly small. On the latter point the recently published results of Prof. Ayrton and H. Kilgour on "The Thermal Emissivity of Thin Wires in Air" throw a curious light. Exceedingly thin wires are capable of dissipating a comparatively very great amount of energy by the agitation of the surrounding air, when they are connected to a source of rapidly alternating potential. So in the experiment cited, a thin hot wire is found to be capable of emitting an extraordinarily great amount of heat, especially at elevated temperatures. In the case of a hot wire it must of course be assumed that the increased emissivity is due to the more rapid convection and not, to any appreciable degree, to an increased radiation. Were the latter demonstrated, it would show that a wire, made hot by the application of heat in ordinary ways, behaves in some respects like one, the charge of which is rapidly alternated, the dissipation of energy per unit of surface kept at a certain temperature depending on the curvature of the surface. I do not recall any record of experiments intended to demonstrate this, yet this effect, though probably very small, should certainly be looked for.

A number of observations showing the peculiarity of very thin wires were made in the course of my experiments. I noted, for instance, that in the well-known Crookes instrument the mica vanes are repelled with comparatively greater force when the incandescent platinum wire is exceedingly thin. This observation enabled me to produce the spin of such vanes mounted in a vacuum tube when the latter was placed in an alternating electrostatic field. This however does not prove anything in regard to radiation, as in a highly exhausted vessel the phenomena are principally due to molecular bombardment or convection.

When I first undertook to produce the incandescence of a wire enclosed in a bulb, by connecting it to only one of the terminals of a high tension transformer, I could not succeed for a long time. On one occasion I had mounted in a bulb a thin platinum wire, but my apparatus was not adequate to produce the incandescence. I made other bulbs, reducing the length of the wire to a small fraction; still I did not succeed. It then occurred to me that it would be desirable to have the surface of the wire as large as possible, yet the bulk small, and I provided a bulb with an exceedingly thin wire of a bulk about equal to that of the short but much thicker wire. On turning the current on the bulb the wire was instantly fused. A series of subsequent experiments showed, that when the diameter of the wire was exceedingly small, considerably more energy would be dissipated per unit surface at all degrees of exhaustion than was to be expected, even on the assumption that the energy given off was in proportion to the square of the electric density. There is likewise evidence which, though not possessing the certainty of an accurate quantitative determination, is nevertheless reliable because it is the result of a great many observations, namely, that with the increase of the density the dissipation is more rapid for thin than for thick wires.

The effects noted in exhausted vessels with high-frequency currents are merely diminished in degree when the air is at ordinary pressure, but heating and dissipation occurs, as I have demonstrated, under the ordinary atmospheric conditions. Two very thin wires attached to the

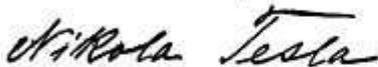
**The Physiological and other Effects of High Frequency Currents**

"The Physiological and other Effects of High Frequency Currents," in *The Electrical Engineer*, December 21, 1892.

## MISCELLANEOUS.

## THE PHYSIOLOGICAL AND OTHER EFFECTS OF HIGH FREQUENCY CURRENTS.

BY



IN THE ELECTRICAL ENGINEER, of January 25, 1893, I note an article by Mr. A. A. C. Swinton, referring to my experiments with high frequency currents. Mr. Swinton uses in these experiments the method of converting described by me in my paper before the American Institute of Electrical Engineers, in May, 1891, and published in THE ELECTRICAL ENGINEER of July 8, 1891, which has since been employed by a number of experimenters; but it has somewhat surprised me to observe that he makes use of an ordinary vibrating contact-breaker, whereas he could have employed the much simpler method of converting continuous currents into alternating currents of any frequency which was shown by me two years ago. This method does not involve the employment of any moving parts, and allows the experimenter to vary the frequency at will by simple adjustments. I had thought that most electricians were at present familiar with this mode of conversion which possesses many beautiful features.

The effects observed by Mr. Swinton are not new to me and they might have been anticipated by those who have carefully read what I have written on the subject. But I cannot agree with some of the views expressed by him.

First of all, in regard to the physiological effects, I have made a clear statement at the beginning of my published studies, and my continued experience with these currents has only further strengthened me in the opinion then expressed. I stated in my paper, before mentioned, that it is an undeniable fact that currents of very high frequency are less injurious than the low frequency currents, but I have also taken care to prevent the idea from gaining ground that these currents are absolutely harmless, as will be evident from the following quotation: "If received directly from a machine or from a secondary of low resistance, they (high frequency currents) produce more or less powerful effects, and may cause serious injury, especially when used in conjunction with condensers." This refers to currents of ordinary potential differences such as are used in general commercial practice.

As regards the currents of very high potential differences, which were employed in my experiments, I have never considered the current's strength, but the energy which the human body was capable of receiving without injury, and I have expressed this quite clearly on more than one occasion. For instance, I stated that "the higher the frequency the greater the amount of electrical energy which may be passed through the body without serious discomfort." And on another occasion when a high tension coil was short-circuited through the body of the experimenter I stated that the immunity was due to the fact that less energy was available externally to the coil when the experimenter's body joined the terminals. This is practically what Mr. Swinton expresses in another way; namely, by saying that with "high frequency currents it is possible to obtain effects with exceedingly small currents," etc.

In regard to the experiments with lamp filaments, I have, I believe, expressed myself with equal clearness. I have pointed out some phenomena of impedance which at that time (1891) were considered very striking, and I have also pointed out the great importance of the rarefied gas surrounding the filament when we have to deal with currents of such high frequency. The heating of the filament by a comparatively small current is not, as Mr. Swinton thinks, due to its impedance or increased ohmic resistance, but principally to the presence of rarefied gas in the bulb. Ample evidence of the truth of this can be obtained in very many experiments, and to cite them would be merely lengthening this communication unduly.

Likewise, observations made when the experimenter's body was included in the path of the discharge, are, in my opinion, not impedance, but capacity, phenomena. The spark between the hands is the shorter, the larger the surface of the body, and no spark whatever would be obtained if the surface of the body were sufficiently large.

I would here point out that one is apt to fall into the error of supposing that the spark which is produced between two points on a conductor, not very distant from each other, is due to the impedance of the conductor. This is certainly the case when the current is of considerable strength, as for instance when, like in the Faraday experiment or some of Dr. Lodge's, a heavily-charged

battery of Leyden jars is discharged through a bent wire. But, when there is a vibration along a wire which is constantly maintained, and the current is inappreciable whereas the potential at the coil terminal is exceedingly high, then lateral dissipation comes into play prominently. There is then, owing to this dissipation, a rapid fall of potential along the wire and high potential differences may exist between points only a short distance apart. This is of course not to be confounded with those differences of potential observed between points when there are fixed waves with ventral and nodal points maintained on a conductor. The lateral dissipation, and not the skin effect, is, I think, the reason why so great an amount of energy may be passed into the body of a person without causing discomfort.

It always affords me great pleasure to note, that something which I have suggested is being employed for some instructive or practical purpose; but I may be pardoned for mentioning that other observations made by Mr. Swinton, and by other experimenters, have recently been brought forward as novel, and arrangements of apparatus which I have suggested have been used repeatedly by some who apparently are in complete ignorance of what I have done in this direction.

## ELECTRICAL RECORDING METERS.—II.

BY CARYL D. HASKINS.

There is another device, or perhaps I had better say there might be another device for accomplishing the object of this last meter in a somewhat similar manner. The actinometer is probably familiar to all who have indulged in amateur photography; it consists of a piece of glass covered with small cubes, each cube of a more intense ruby red than the one beyond it, merging, in fact, from an almost clear glass to an almost perfectly non-actinic medium. Now, it suggested itself to a certain electrician that if a number of these squares were arranged in a piece of glass, one above the other, and a lamp whose light should vary more or less directly with the potential on the lines, be placed before this glass or actinometer, a sensitive film being rotated behind the actinometer at a constant speed, that the varying light of the lamp would draw a curved line, or rather a curved block of light and shade on the paper, which would be measured by a planimeter to get the average voltage, or could be taken at points, to see what the voltage was at certain times; in fact, a recording voltmeter. This device seemed very nice indeed. It had only one fault—it would not work. I might say that the device is my own.

There is almost an endless variety of clock meters. They are not all electricity meters by any means; some are recording voltmeters, others recording ammeters, and others have still different purposes. The familiar recording steam gauge is only a modification of this instrument. A paper is almost invariably rotated over a drum, sometimes being fixed to the drum, and sometimes being drawn from one drum to another, the paper moving at uniform speed, and generally being divided into hours or other fractions of time by abscissa lines.

This clock mechanism can be combined with any indicating device; it is only necessary to supply the connection which shall cause the indicator to mark the paper, and draw a crooked line. First attempts of this kind are generally made with an ordinary solenoid, or sometimes with a simple coil and iron core rising and falling with the current. Whatever the character of the indicator or method of communication between the indicator and paper, it remained necessary to keep the friction of contact low.

First attempts were made with a pencil, bearing directly upon the paper, but the friction introduced by this device was fatal to accuracy. A glass pen has been substituted for the pencil with better results, but even this caused too much friction. The photographic method of line drawing is one of the best systems yet introduced, and is probably more familiar to the majority of us than other methods, because it forms a component part of the Walker meter which has attracted attention at various times.

One of the best methods of accomplishing the registration, perhaps, when all things are considered, the very best, is to attach to the pointer of the indicator, a steel point or needle with an iron armature mounted in the form of a spring, or in some similar manner. By placing an electromagnet behind the paper to be marked, and sending through this magnet an electrical impulse at fixed periods of say, one, two or five minutes, the pointer is drawn sharply down to the paper, puncturing it, and is immediately released by the cessation of energizing current in the electromagnet. Thus, the paper when removed, will have a continuous marking of punctures tantamount to a curved line. This device presents practically no friction, and is more or less simple and easy to carry out. The make-and-break necessary for the electromagnet is easily actuated by the clock movements. But we may say of these forms, as well as of the forms of clock meter which are to follow, that there is one serious objection to them all—they have to be wound up, which is certainly a fault. We may modify this statement by saying that many of these devices have an electrical attachment which makes them self-winding,

## Tesla's Latest Advances in Vacuum-Tube Lighting

From "Tesla's Latest Advances in Vacuum-Tube Lighting," in the *Electrical Review*, January 5, 1898.



PHOTOGRAPHED BY THE LIGHT OF A SINGLE VACUUM TUBE AT A DISTANCE OF FOUR FEET; EXPOSURE TWO SECONDS.



PHOTOGRAPH OF THE EXPERIMENTER'S HAND MADE BY THE LIGHT OF A SINGLE IMPROVED VACUUM TUBE OF 1,000 CANDLES. EXPOSURE TWO SECONDS; DISTANCE FROM THE TUBE FOUR FEET.



PHOTOGRAPH MADE BY THE LIGHT OF A SINGLE VACUUM TUBE, AT A DISTANCE OF FIVE FEET; EXPOSURE, FIVE SECONDS.

### **Evolution of a high-tension transformer**

**An illustration of the evolution of a high-tension transformer from "Some Experiments in Tesla's Laboratory with Currents of High Potential and High Frequency" in the *Electrical Review*, March 29, 1899.**

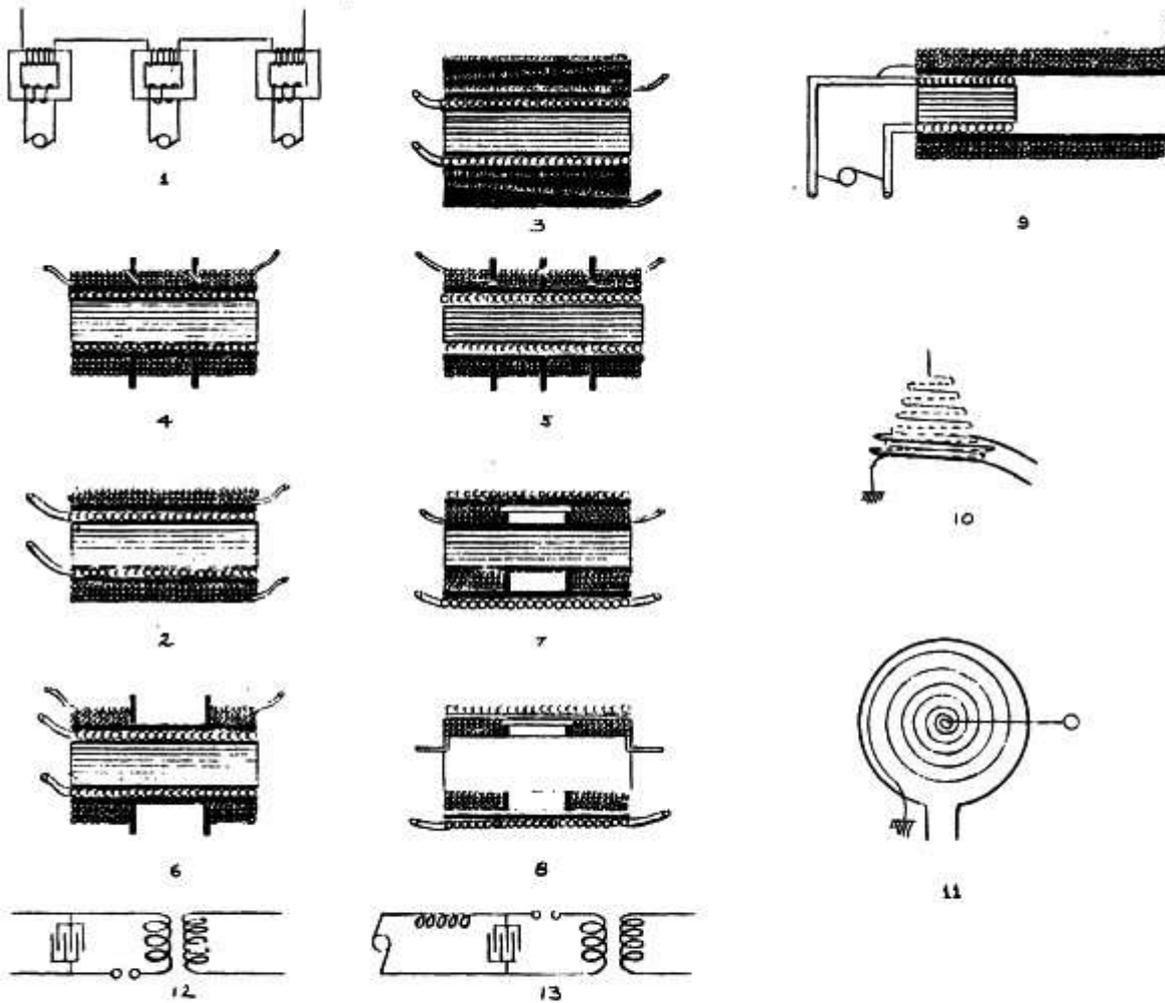


FIG. 2 - TABLE OF DIAGRAMS ILLUSTRATING THE EVOLUTION OF A HIGH-TENSION TRANSFORMER ENABLING THE PRODUCTION OF ELECTRO-MOTIVE FORCES OF MANY MILLIONS OF VOLTS.

### Some Experiments in Tesla's Laboratory

Also from "Some Experiments in Tesla's Laboratory with Currents of High Potential and High Frequency" in the *Electrical Review*, March 29, 1899.

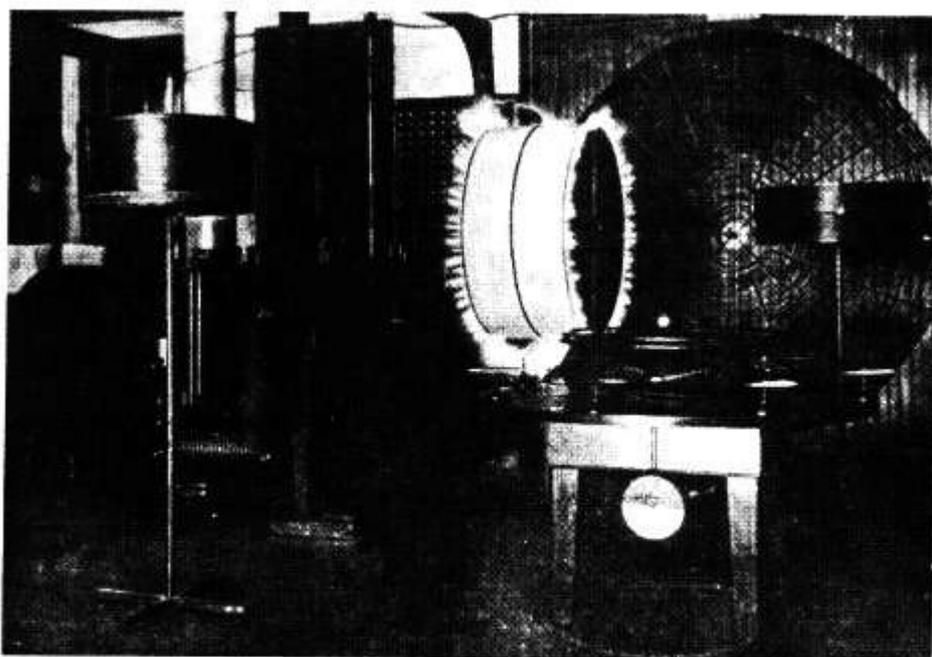


FIG. 3 - PHOTOGRAPH SHOWING A PART OF THE LABORATORY, WITH A DISCONNECTED RESONATING COIL SUPPORTED ON AN INSULATING STAND, AND ILLUMINATED BY THE STREAMERS PRODUCED, OTHER COILS REMAINING UNAFFECTED - THE PRESSURE DEVELOPED IN THE RESONATING COIL IS OVER HALF A MILLION VOLTS.



FIG. 4 - PHOTOGRAPH SHOWING AN INCANDESCENT LAMP LIGHTED BY A SYNCHRONIZED CIRCUIT COMPOSED OF A WIRE LOOP AND CONDENSER, AND ENERGIZED BY WAVES TRANSMITTED FROM A DISTANCE.

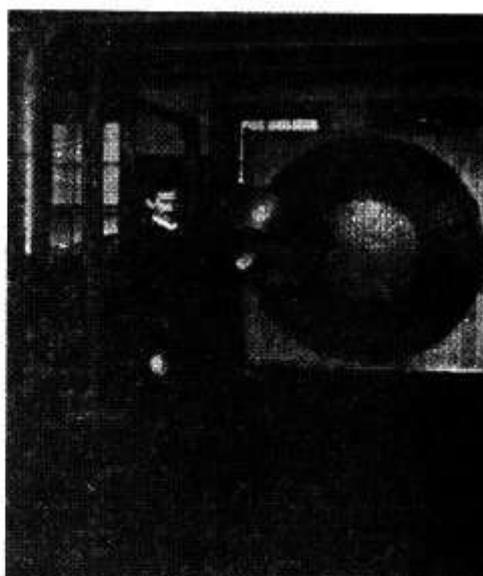


FIG. 5 - PHOTOGRAPH SHOWING AN INCANDESCENT LAMP LIGHTED BY MEANS OF WAVES TRANSMITTED THROUGH SPACE TO A COIL WITHOUT A CONDENSER.

### Some Experiments in Tesla's Laboratory (cont.)

Also from "Some Experiments in Tesla's Laboratory with Currents of High Potential and High Frequency" in the *Electrical Review*, March 29, 1899.



FIG. 6 - EXPERIMENT ILLUSTRATING THE ACTION OF A SYNCHRONIZED CIRCUIT ENERGIZED BY WAVES TRANSMITTED FROM A DISTANT OSCILLATOR - THE ENERGY RECEIVED IS TRANSFERRED UPON ANOTHER UNRESPONSIVE CIRCUIT, LIGHTING THE INCANDESCENT LAMP ATTACHED TO THE SAME.

FIG. 7 - EXPERIMENT SHOWING A COIL ENERGIZED BY THE WAVES OF A DISTANT OSCILLATOR AND ADJUSTED TO THE CAPACITY OF THE BODY OF THE OPERATOR, WHO PRESERVES HIMSELF FROM INJURY BY MAINTAINING A POSITION AT THE NODAL POINT, WHERE THE INTENSE VIBRATION IS LITTLE FELT - THE PRESSURE ON THE END OF THE COIL TOWARDS THE READER, WHICH IS ILLUMINATED BY THE POWERFUL STREAMERS, IS NEARLY HALF A MILLION VOLTS.



FIG. 8 - PHOTOGRAPH OF THE EXPERIMENTER STANDING IN THE MIDDLE OF THE LABORATORY AND LIGHTING A VACUUM BULB BY WAVES FROM A DISTANT OSCILLATOR - HIS BODY IS, IN THIS CASE, SUBJECTED TO GREAT ELECTRICAL PRESSURE.



Some Experiments in Tesla's Laboratory (cont. 2)

Also from "Some Experiments in Tesla's Laboratory with Currents of High Potential and High Frequency" in the *Electrical Review*, March 29, 1899.

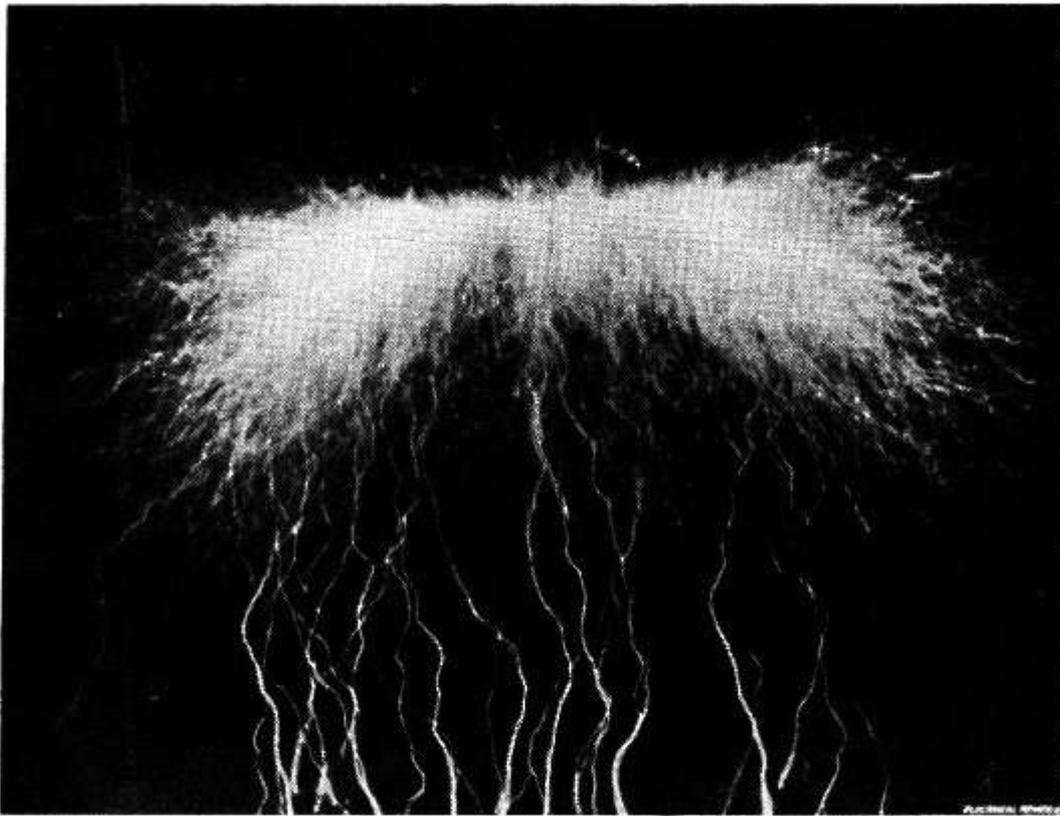
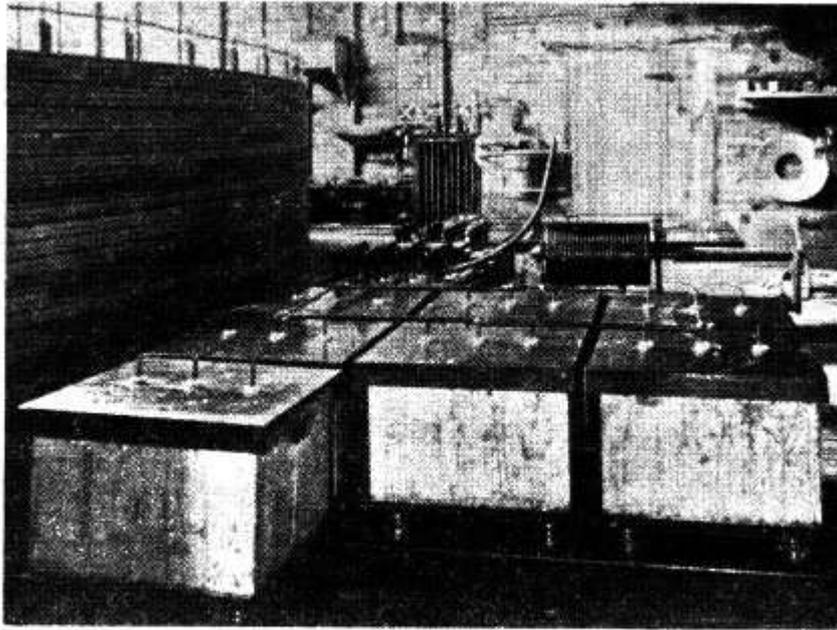


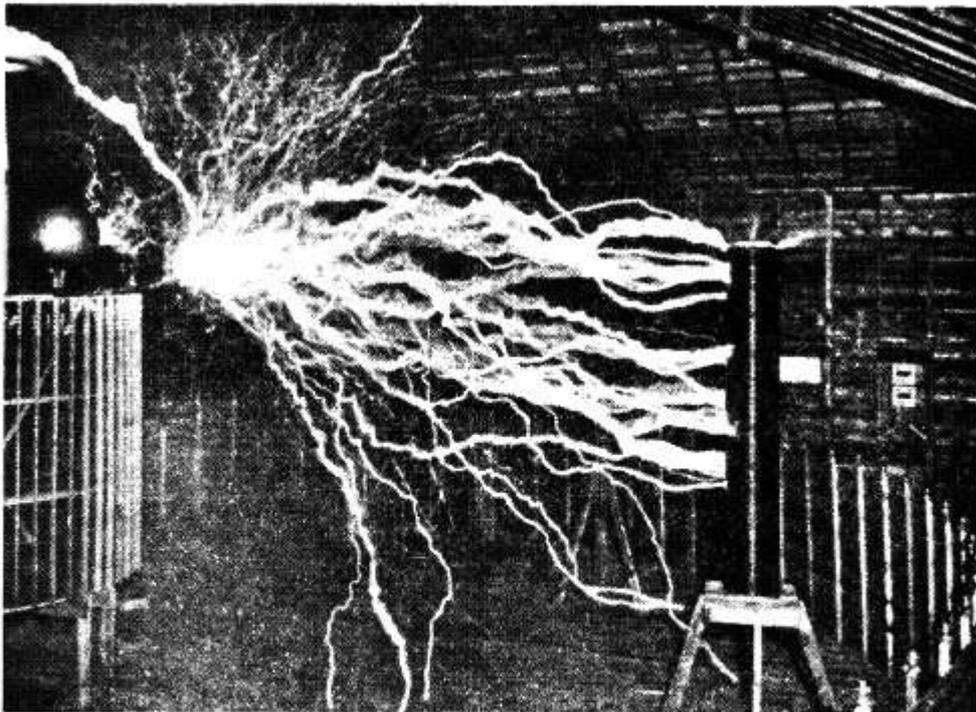
FIG. 11 - PHOTOGRAPH OF AN ACTIVE TERMINAL OF AN IMPROVED OSCILLATOR, USED IN TESLA'S EXPERIMENTS FOR TRANSMITTING ELECTRICAL ENERGY TO GREAT DISTANCES WITHOUT WIRES - WIDTH OF ILLUMINATED SPACE IS 18 FEET- THE PRESSURE ON THE TERMINAL IS ABOUT EIGHT MILLION VOLTS.

**Talking With the Planets**

From "Talking With the Planets," in *Collier's Weekly*, February 9, 1901.



VIEW OF THE ESSENTIAL PARTS OF THE ELECTRICAL  
OSCILLATOR USED IN THE EXPERIMENTS DESCRIBED.



EXPERIMENT TO ILLUSTRATE THE CAPACITY OF THE OSCILLATOR  
FOR PRODUCING ELECTRICAL EXPLOSIONS OF GREAT POWER.

**Tesla announces a consulting engineership**

Tesla announces a consulting engineership, from the *Electrical World and Engineer*,  
February 6, 1904.



*Electrical oscillator activity ten million horsepower*

*Power transmission without wires*

New York, January 1, 1904

I wish to announce that in connection with the commercial introduction of my inventions I shall render professional services in the general capacity of consulting electrician and engineer.

The near future, I expect with confidence, will be a witness of revolutionary departures in the production, transformation and transmission of energy, transportation, lighting, manufacture of chemical compounds, telegraphy, telephony and other arts and industries.

In my opinion, these advances are certain to follow from the universal adoption of high-potential and high-frequency currents and novel regenerative processes of refrigeration to very low temperatures.

Much of the old apparatus will have to be improved, and much of the new developed, and I believe that while furthering my own inventions, I shall be more helpful in this evolution by placing at the disposal of others the knowledge and experience I have gained.

Special attention will be given by me to the solution of problems requiring both expert information and inventive resource--work coming within the sphere of my constant training and predilection.

I shall undertake the experimental investigation and perfection of ideas, methods and appliances, the devising of useful expedients and, in particular, the design and construction of machinery for the attainment of desired results.

Any task submitted to and accepted by me, will be carried out thoroughly and conscientiously.

Laboratory, Long Island, N. Y.  
Residence, Waldorf, New York City.

*Nikola Tesla*

*Burning atmospheric nitrogen by high frequency discharge develop millions volts*

*Source of energy for multiplicity of purposes*

**Tesla wireless plant on Long Island**  
The Tesla wireless plant on Long Island, circa early 1900s.



**A comparison of the Hertz and Tesla wireless transmission systems from "The Disturbing Influence of Solar Radiation on the Wireless Transmission of Energy" in the *Electrical Review and Western Electrician*, July 6, 1912.**

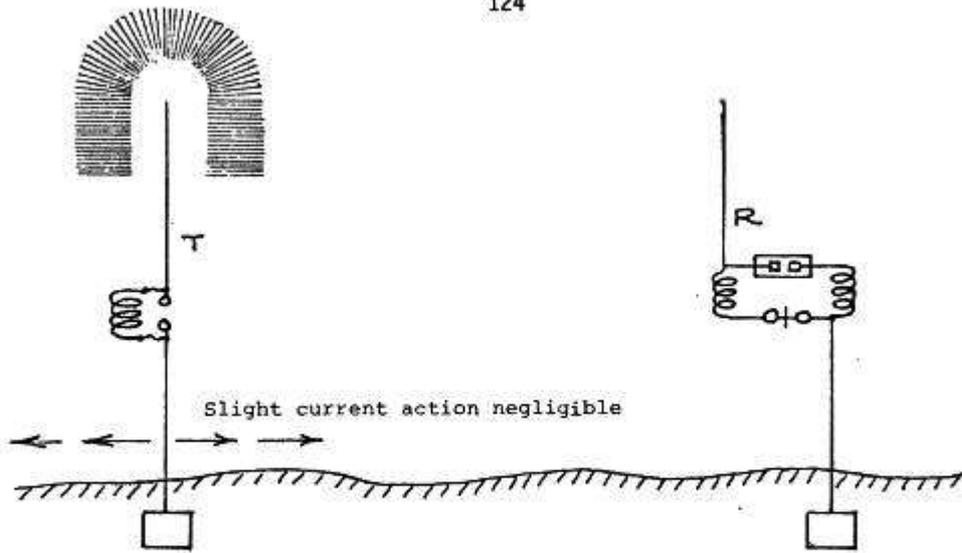


Fig. 1 - Hertz Wave System

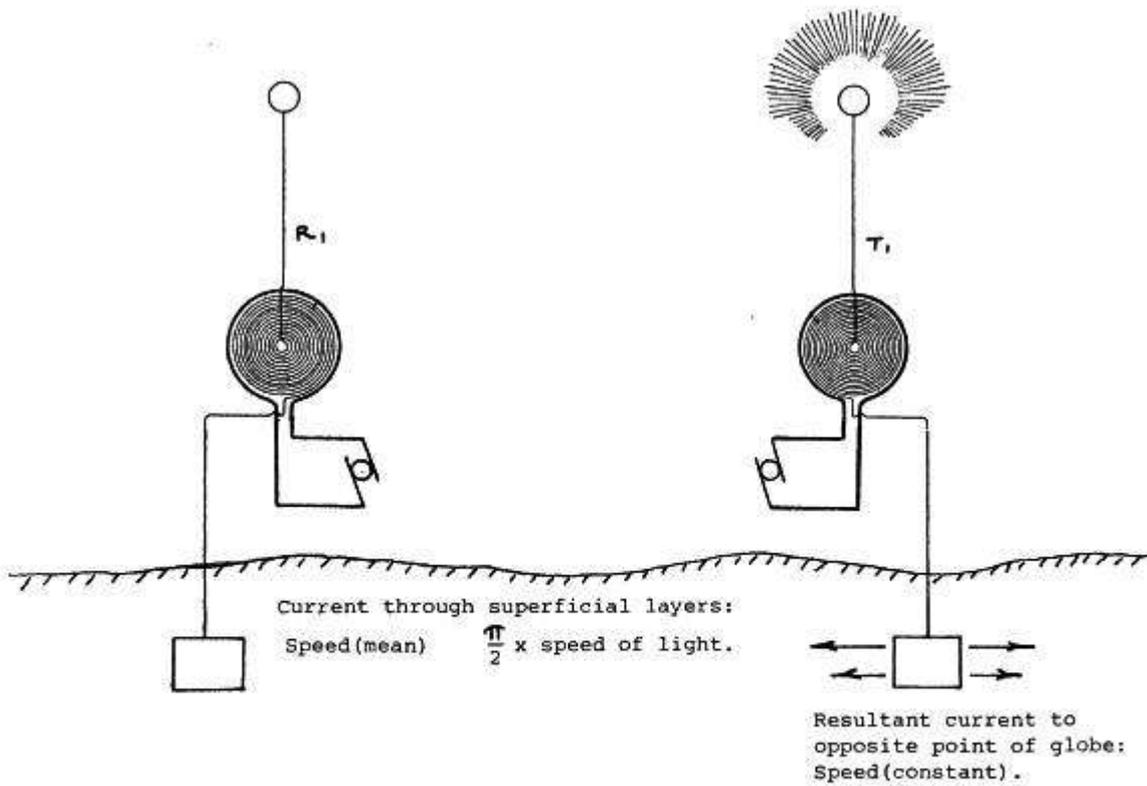


Fig. 2 - System Devised by Tesla

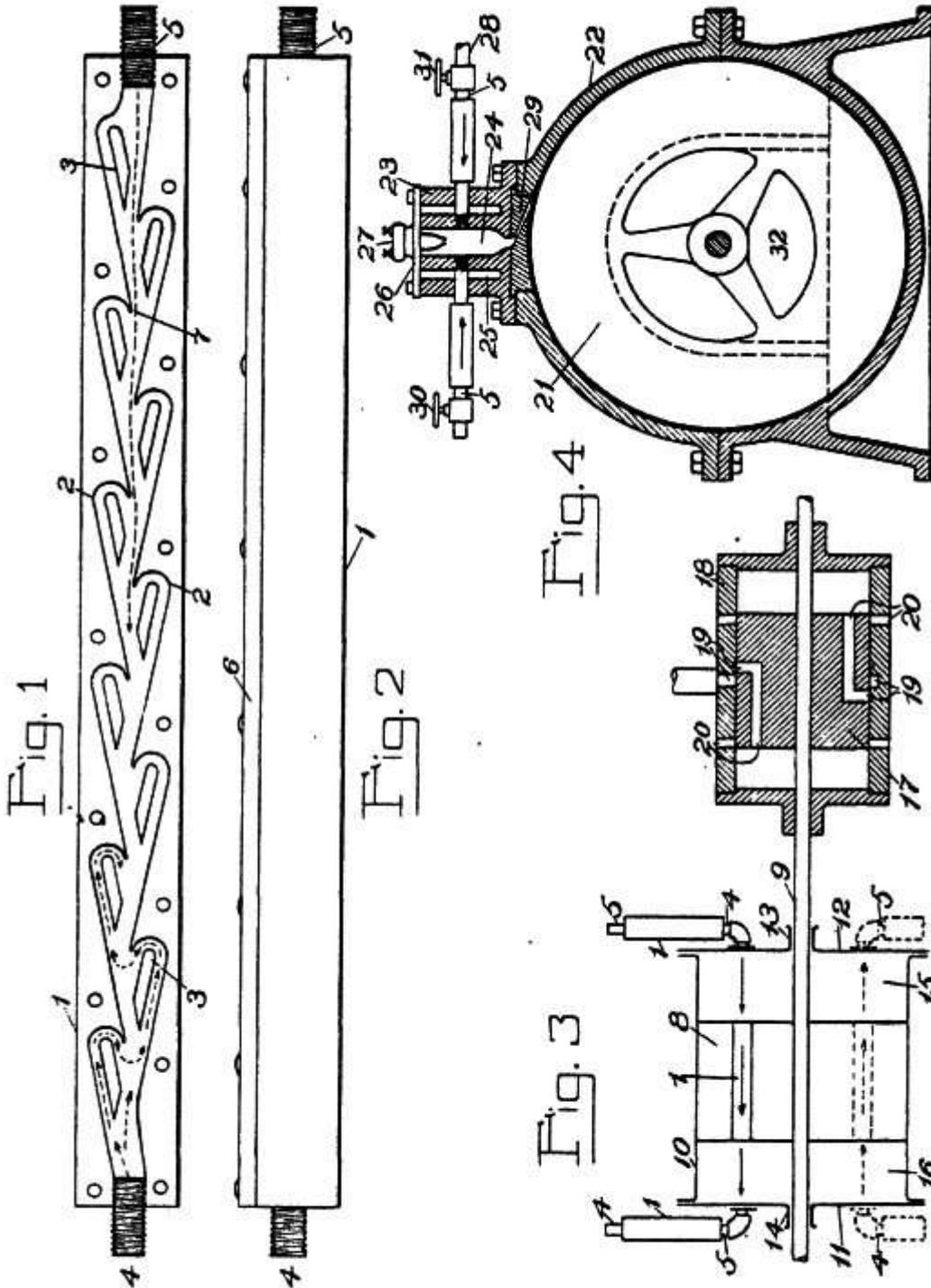
**Tesla's Valvular Conduit**  
**Tesla's Valvular Conduit, patented February 3, 1920.**

N. TESLA.  
VALVULAR CONDUIT.

APPLICATION FILED FEB. 21, 1916. RENEWED JULY 8, 1919.

1,329,559.

Patented Feb. 3, 1920.



INVENTOR  
*Nikola Tesla*  
BY  
*Spur, Page, Cooper & Reynolds*  
ATTORNEY..

Famous Scientific Illusions  
From the article "Famous Scientific Illusions" in the *Electrical Experimenter*, February 1919.

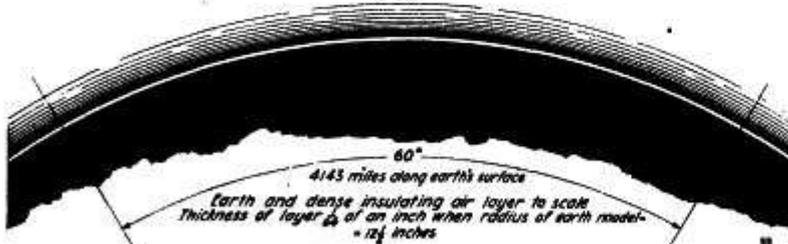
energy of motion. The moon is not posses of such *vis viva*. If it were the case then a revolving body as M<sub>1</sub> would contain mechanical energy other than that of which

tion of the latter immediately stiffens, being at the same time deformed by gravitational pull. The shape becomes permanent upon cooling and solidification and the smaller

Fig. 5  
Highly rarefied medium (insulating)...



Fig. 6



A Section of the Earth and its Atmospheric Envelope Drawn to Scale. It is Obvious That the Hertzian Rays Cannot Traverse So Thin a Crack Between Two Conducting Surfaces For Any Considerable Distance. Without Being Absorbed, Says Dr. Tesla, in Discussing the Ether Space Wave Theory.

we have experimental evidence. Irrespective of this so exact a coincidence between the axial and orbital periods is, in itself, immensely improbable for this is not the permanent condition towards which the system is tending. Any axial rotation of a mass left to itself, retarded by forces external or internal, must cease. Even admitting its perfect control by tides the coincidence would still be miraculous. But when we remember that most of the satellites exhibit this peculiarity, the probability becomes infinitesimal.

Three theories have been advanced for the origin of the moon. According to the oldest suggested by the great German philosopher Kant, and developed by Laplace in his monumental treatise "Mécanique Céleste", the planets have been thrown off from larger central masses by centrifugal force. Nearly forty years ago Prof. George H. Darwin in a masterful essay on tidal friction furnished mathematical proofs, deemed unrefutable, that the moon had separated from the earth. Recently this established theory has been attacked by Prof. T. J. J. See in a remarkable work on the "Evolution of the Stellar Systems", in which he propounds the view that centrifugal force was altogether inadequate to bring about the separation and that all planets, including the moon, have come from the depths of space and have been captured. Still a third hypothesis of unknown origin exists which has been examined and commented upon by Prof. W. H. Pickering in "Popular Astronomy of 1907", and according to which the moon was torn from the earth when the later was partially solidified, this accounting for the continents which might not have been formed otherwise.

Undoubtedly planets and satellites have originated in both ways and, in my opinion, it is not difficult to ascertain the character of their birth. The following conclusions can be safely drawn:

1. A heavenly body thrown off from a larger one cannot rotate on its axis. The mass, rendered fluid by the combined action of heat and pressure, upon the reduc-

mass continues to move about the larger one as tho it were rigidly connected to it except for pendular swings or librations due to varying orbital velocity. Such motion precludes the possibility of axial rotation in the strictly physical sense. The moon has never spun around as is well demonstrated by the fact that the most precise measurements have failed to

show any measurable flattening in form.

2. If a planetary body in its orbital movement turns the same side towards the central mass this is a positive proof that it has been separated from the latter and is a true satellite.

3. A planet revolving on its axis in its passage around another cannot have been thrown off from the same but must have been captured.

II. The Fallacy of Franklin's Pointed Lightning-Rod.

The display of atmospheric electricity has since ages been one of the most marvelous spectacles afforded to the sight of man. Its grandeur and power filled him with fear and superstition. For centuries he attributed lightning to agents god-like and supernatural and its purpose in the scheme of this universe remained unknown to him. Now we have learned that the waters of the ocean are raised by the sun and maintained in the atmosphere delicately suspended, that they are wafted to distant regions of the globe where electric forces assert themselves in upsetting the sensitive balance and causing precipitation, thus sustaining all organic life. There is every reason to hope that man will soon be able to control this life-giving flow of water and thereby solve many pressing problems of his existence.

Atmospheric electricity became of special scientific interest in Franklin's time. Faraday had not yet announced his epochal discoveries in magnetic induction but static frictional machines were already generally used in physical laboratories. Franklin's powerful mind at once leaped to the conclusion that frictional and atmospheric electricity were identical. To our present view this inference appears obvious, but in his time the mere thought of it was little short of blasphemy. He investigated the phenomena and argued that if they were of the same nature then the clouds could be drained of their charge exactly as the ball of a static machine, and in 1749 he indicated in a published memoir how this could be done by the use of pointed metal rods. (Continued on page 728)

MODE OF PROPAGATION OF THE CURRENT FROM THE TRANSMITTER THRU THE EARTH

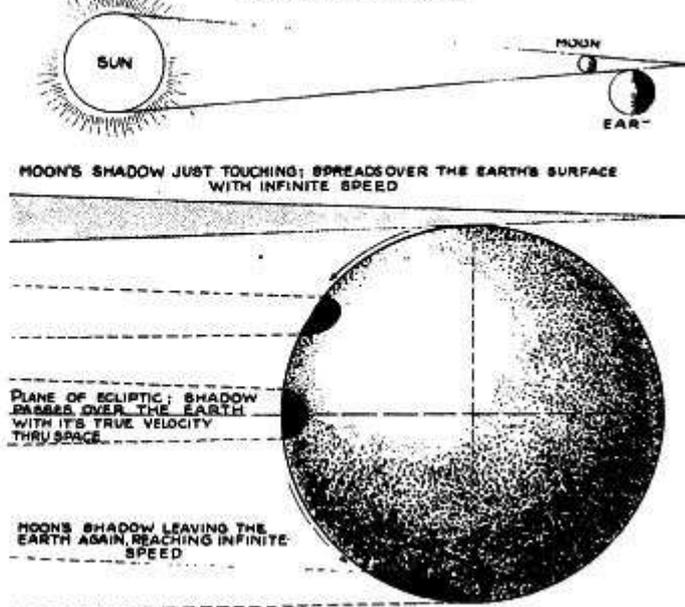


Fig. 8.—This Diagram Illustrates How, During a Solar Eclipse, the Moon's Shadow Passes Over the Earth With Changing Velocity, and Should Be Studied in Connection With Fig. 9. The Shadow Moves Downward With Infinite Velocity at First, Then With its True Velocity Thru Space, and Finally With Infinite Velocity Again.

Can Radio Ignite Balloons?

From the article "Can Radio Ignite Balloons?" in the *Electrical Experimenter*, October 1919.

# Can Radio Ignite Balloons?

As a result of the newest theory, that powerful induced currents emanating from the Naval Radio Station in Chicago produced the spark that ignited the Goodyear dirigible airship which plunged in flames thru the roof of a bank building in that city, resulting in death for thirteen persons and injury to

## The Opinions of Nikola Tesla and Other Radio Experts

Station. The building thru the skylight of which the blazing dirigible fell was the Illinois Trust and Savings Bank.

head of a large engineering corporation and foreman of the coroner's jury of technical men, said experts had suggested the radio theory to him.

Col. J. C. Morrow, chief air officer of the central department of the army, the principal witness at the inquest, was a passenger in the dirigible on a trip preceding

**LEROY'S RADIO APPARATUS FOR DEMONSTRATING IGNITION BY WIRELESS.**

HEAVY WIRE LOOP  
TRANSMITTING LOOP  
SPARK GAP  
25-20 SPARKCOIL  
MERCURY INTERRUPTER  
DISTANCE OF SEVERAL YARDS  
AIR TIGHT GLASS VESSEL  
MICROMETER SPARK GAP  
GLASS PLATE AND TIN FOIL CONDENSER  
ADJ. MICA TABLE ON WHICH SUBSTANCES TO BE IGNITED ARE PLACED

SPARKS WILL OCCUR IN BREAKS OR LOOSE WIRE JOINTS IN BALLOON WIRE

HERTZ RESONATOR

CURRENT INDUCED IN SEVERAL BALES, DISCHARGING FROM ONE BALE TO ANOTHER.

WIRE OR METAL HOOPS IN CLOSE PROXIMITY TO EACH OTHER MAY CAUSE SPARKS TO OCCUR

LABORATORY TEST WITH RADIO FREQUENCY CURRENTS SHOW THAT METAL OBJECTS SHOULD HAVE TO BE COLLIDED - BUT CAN BE 5' APART AND SPARKS WILL JUMP AS SHOWN BETWEEN ADJACENT METAL RODS OR WIRES DUE TO UNIPOLAR INDUCTION

NOTE CURRENTS INDUCED BY RADIO WAVES IN METAL GIRDER FRAMING OF DIRIGIBLE A SPARK MAY OCCUR AT A LOOSE JOINT, BOLT OR RIVET, BURNING THE BAG FABRIC AND IGNITING THE GAS. LABORATORY TESTS WITH A SMALL TESLA COIL AND WIRE CAGES, ETC. CETERA, PROVE THIS.

— HOW RADIO MAY INDUCE CURRENTS IN AIRSHIPS —

NON RIGID GAS DIRIGIBLE  
METAL WIRE

HOW RADIO INDUCED CURRENTS MAY BE SET UP IN METAL GONDOLAS, GUY WIRES ETC. AND CAUSE SPARKS TO JUMP

INSULATORS  
TO BREAK UP "RESONANCE" AND PREVENT THE BALLOON WIRES FROM BECOMING HIGHLY CHARGED THEY SHOULD BE BROKEN UP INTO SHORT LENGTHS BY INSULATORS

INDUCTIVE LOOP, CONDENSER AND LAMPS CONNECTED THUS.

LAMPS → LOOP CONDENSERS

NIKOLA TESLA HIGH FREQUENCY TRANSMITTER

Copyright, 1919, by K. P. O.

Herewith Are Shown Some of the Plausible Reasons Why the Recent Chicago "Blimp" Disaster Might Have Been Caused By a Spark Induced By An Adjacent Radio Station. The Photo in the Lower Right-hand Corner Shows Three Incandescent Lamps Lighted to Full Candlepower, At a Distance of 100 Feet from Dr. Nikola Tesla's Colorado High Frequency Power Plant. The Oscillator Was Worked at Less Than Five Per Cent of Its Total Capacity.

twenty-seven others, naval communication officers will aid the authorities in fixing responsibility for the disaster. It was ascertained that technical experts had suggested this theory, because the big ship sailed over or near the Transportation building, from the roof of which are projected the antennae of the Naval Radio

Lieut. F. S. Mason, of the Great Lakes Naval Training Station, district communication service officer, while refraining from agreeing with the theory, said he would cooperate with the investigating officials. Pilot John Bostner, of the ill-fated dirigible, said he had not been aware of the location of the naval radio station. H. M. Byllesby,

the fatal one. At that time he said the ship was in safe condition. The pilot he considered competent. He thought the possibility of sparks from the exhaust igniting the gas bag very remote, but said he had not formed an opinion as to the cause of the accident.

(Continued on page 591)

## Our Future Motive Power

From "Our Future Motive Power" in *Everyday Science and Mechanics*, December 1931.

# • Our Future

By NIKOLA

**I**N this instructive article, the great scientist and inventor who revolutionized industry and communication with his alternating current motors and distributing system, and opened the way for radio with his high-frequency researches, analyzes the problem of obtaining power to replace our wasted fuel, and indicates the method of tapping the earth's hidden resources which will support the industry of future generations.

**T**HE material as well as intellectual progress of Man is becoming ever more dependent on the natural forces and energies he is putting to his service. While not exactly a true measure of well being and enlightenment, the amount of power used is a reliable indication of the degree of safety, comfort and convenience, without which the human race would be subject to increasing suffering and want and civilization might perish.

Virtually all our energies are derived from the sun, and the greatest triumph we have achieved in the utilization of its undying fire is the harnessing of waterfalls. The hydro-electric process, now universally employed, enables us to obtain as much as eighty-five per cent of the solar energy with machines of elementary simplicity which, by resorting to the latest improvements in the technical arts, might be made capable of enduring for centuries. These advantages are entirely exceptional, very serious handicaps and great, unavoidable losses confronting us in all other transformations of the forces of nature. It is, therefore, desirable in the interest of the world as a whole, that this precious resource should be exploited to the limit. Judging from the average height of the water discharged annually from the clouds, and the mean fall over the aggregate land surface, the total terrestrial water power may be theoretically estimated at ten billions of horse power. Of course, only a part of that is suited for practical development and relatively little is actually utilized—twenty-five per cent, perhaps, in the most advanced countries, less in others, and there are some in which not even the ground has been broken. Great waterfalls exist in many inaccessible regions of the globe and new ones are being discovered, all of which will be eventually harnessed when the wireless transmission of energy is commercialized. There is foundation for hope, however, that our present limitations in the amount of the available power may be removed in the future. Three-quarters of the earth's surface are covered by the oceans and the rainfall over all this vast area is useless



Above and at the right, the arrangement of one of the great terrestrial-heat power plants of the future. Water is circulated to the bottom of the shaft, returning as steam to drive the turbine, and then returned to liquid form in the condenser, in an unending cycle.

for our purpose. Much thought has been given to artificial production of rain, but none of the means proposed offers the slightest chance of success. Besides, so far only the precipitation in a limited region was contemplated, leaving the total quantity of moisture for the entire land unchanged except as modified through the natural tendency of the oceans to divert more and more water from the continents. The real and important problem for us to solve is not to bring about precipitation in any chosen locality, but to reverse this natural process, draw the vapors from the seas and thereby increase, at will, the rainfall on the land. Can this be done?

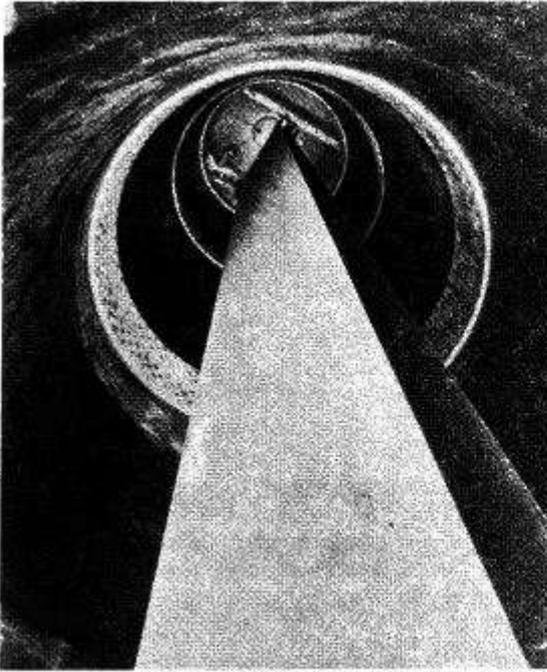
The sun raises the water to a height where it remains in a state of delicate suspension until a disturbance, of relatively insignificant energy, causes condensation at a place where the balance is most easily disturbed. The action, once started, spreads like a conflagration for a vacuum is formed and the air rushing in, being cooled by expansion, enhances further condensation in the surrounding masses of cloud. All life on the globe is absolutely dependent on this gigantic trigger mechanism of nature and my extended observations have shown that the complex effects of lightning are, in most cases, the chief controlling agents. This theory, formulated by me in 1892, was borne out in some later experiments I made with artificial lightning bolts over 100 feet long, according to which it appears possible, by great power plants suitably distributed and operated at the

Internal heat of the earth is great and, in comparison with the demands which man can make upon it, is practically inexhaustible; since the heated contents of the earth are sextillions of tons.

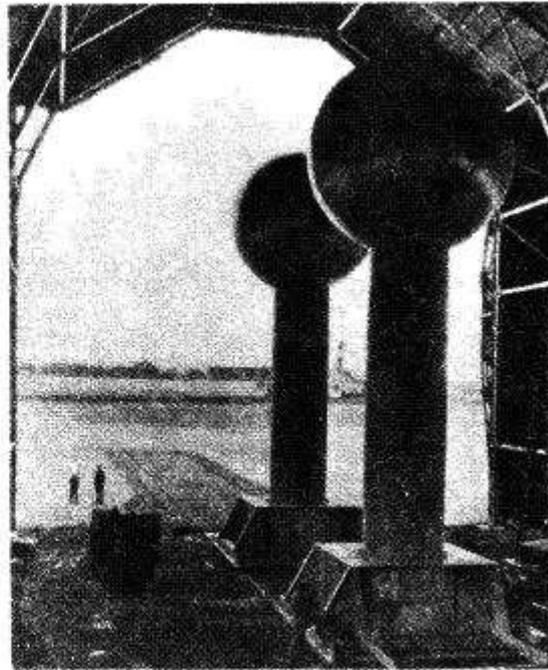
proper times, to draw unlimited quantities of water from the oceans to the continents. The machines being driven by waterfalls, all the work would be performed by the sun, while we would have merely to release the trigger. In this manner we might obtain sufficient energy from falling water to provide for all our

## Possibilities of Electro-Static Generators

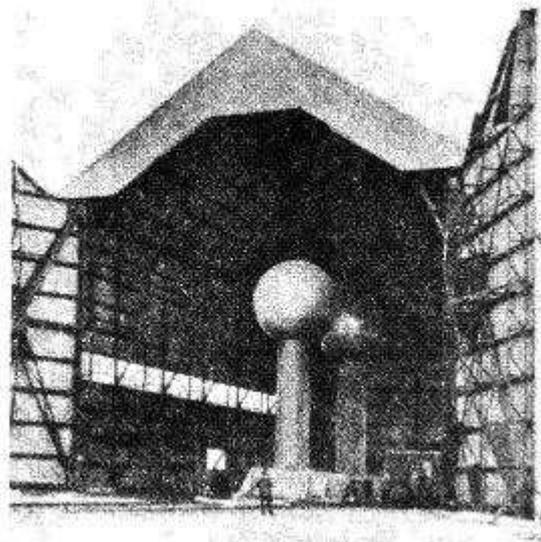
From "Possibilities of Electro-Static Generators" in the *Scientific American*, March 1934.



Looking up through one of the insulating columns of the Van de Graaff generator, showing the endless paper belt



Another view of the high-voltage generator. Tracks are provided so that the equipment may be rolled into the open



The Van de Graaff generator, shown housed in an aircraft hangar, is discussed by Dr. Tesla in the accompanying article

### Radio Power Will Revolutionize the World

From "Radio Power Will Revolutionize the World" in *Modern Mechanics and Inventions*, July, 1934.

# Radio Power will Revolutionize

## Tesla's World of Tomorrow

"We are on the threshold of a gigantic revolution, based on the commercialization of the wireless transmission of power.

"Motion pictures will be flashed across limitless spaces . . .

"The same energy (wireless transmission of power) will drive airplanes and dirigibles from one central base.

". . . In rocket-propelled machines . . . it will be practicable to attain speeds of nearly a mile a second (3600 m.p.h.) through the rarefied medium above the stratosphere.

". . . We will be enabled to illuminate the whole sky at night . . . Eventually we will flash power in virtually unlimited amounts to planets."

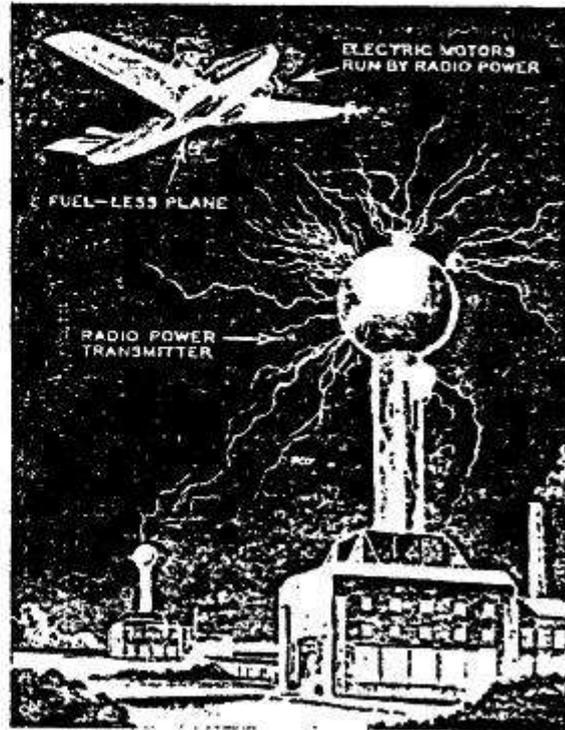
—Nikola Tesla.

**T**HE world will soon enjoy the benefits of electricity transmitted by radio. Huge and expensive transmission lines will be unnecessary. Bulky and unsightly distribution systems will be done away with. A little receiving device in your home will give you all the power you can use—and for only a fraction of present-day costs.

We will soon be communicating with other planets, where it is entirely possible that there is civilization far ahead of ours.

Tomorrow we will see rocket planes flying through stratosphere at a speed of a mile a second or 3600 miles an hour.

Fanciful dreams? No! Just conclusions based upon knowledge of what has been done, what is being done and what can be done in the future. I speak along practi-



Nikola Tesla, electrical wizard, foresees the day when airplanes will be operated by radio-transmitted power supplied by ground stations, as shown in the drawing above.

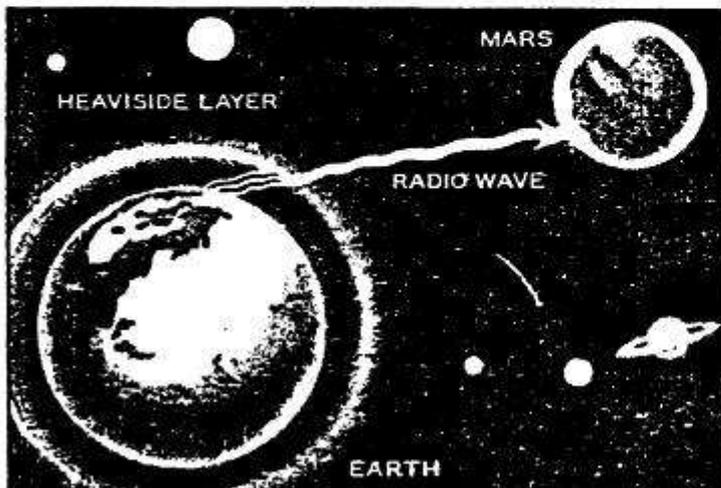
cal lines and with a practical knowledge of what I am talking about.

Power transmission by radio is going to change our present civilization materially. The transmission of energy to another planet is now only a matter of engineering. I have solved the problem so well I no longer regard it as doubtful. I am also

certain there are creatures on other planets whose ways are like ours. The new era will see amazing developments in interplanetary relations.

Every other planet has to pass through the same phase of existence this earth did, and life is started on them during that favorable phase by the rays of some sun. It develops in the presence of moisture, heat and light in much the same manner as life does here. We know that light propagates in straight lines, and consequently our perceptions of the forms through the images projected on the retina must be true.

Therefore, it should not be hard to establish intelligent exchange of ideas between two



By using ultra-short waves, science expects to penetrate the heaviside layer, or gaseous medium surrounding the earth, and establish radio communication with Mars and other distant planets, as shown in drawing above.

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