

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 twelve million volts

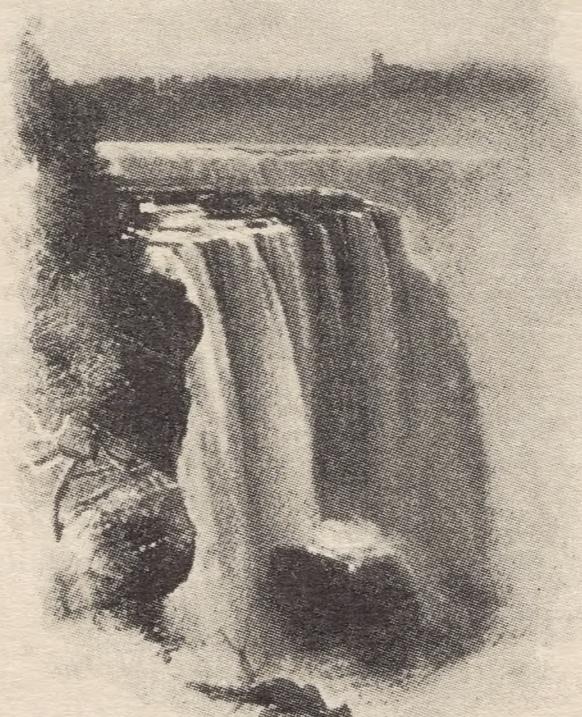
Secret ininterference and multiplicity of messages

"In connection with resonance effects and the * * * transmission of energy over a single conductor, * * * I would say a few words on a subject which constantly fills my thoughts, and which concerns the welfare of all. I mean the transmission of intelligible signals or, perhaps, even power, to any distance without the use of wires. I am becoming daily more convinced of the practicability of the scheme; and though I know full well that the great majority of scientific men will not believe that such results can be practically and immediately realized, yet I think that all consider the developments in recent years by a number of workers to have been such as to encourage thought and experiment in this direction. My conviction has grown so strong that I no longer look upon this plan of energy or intelligence transmission as a mere theoretical possibility, but as a serious problem in electrical engineering, which must be carried out some day. * * * In fact, what is there against the carrying out of such a scheme? We now know that electric vibration may be transmitted through a single conductor. Why, then, not try to avail ourselves of the earth for this purpose? * * * Theoretically, it could not require a great amount of energy to produce a disturbance perceptible at great distance, or even all over the surface of the globe. I think that, beyond doubt, it is possible to operate electrical devices in a city, through the ground or pipe system, by resonance from an electrical oscillator located at a central point. But the practical solution of this problem would be of incomparably smaller benefit to man than the realization of the scheme of transmitting intelligence or, perhaps power, to any distance through the earth or environing medium. Proper apparatus must first be produced, by means of which the problem can be attacked, and I have devoted much thought to this subject. I am firmly convinced that it can be done, and hope that we shall live to see it done."—*Light and Other High-frequency Phenomena.**

*Lecture delivered before the Franklin Institute, Philadelphia, February, 1893, and before the National Electric Light Association, St. Louis, March, 1893.

"Electrical effects of any desired character and of intensities undreamed of before are now easily producible by perfected apparatus of this kind * * *. I have produced electrical discharges, the actual path of which, from end to end, was probably more than one hundred feet long; but it would not be difficult to reach lengths one hundred times as great. I have produced electrical movements occurring at the rate of approximately one hundred thousand horse-power, but rates of one, five, or ten million horse-power are easily practicable. In these experiments effects were developed incomparably greater than any ever produced by human agencies, and yet these results are but an embryo of what is to be. That communication without wires to any point of the globe is practicable with such apparatus would need no demonstration, but through a discovery I made I obtained absolute certitude. Popularly explained, it is exactly this: When we raise the voice and hear an echo in reply, we know that the sound of the voice must have reached a distant wall, or boundary, and must have been reflected from the same. Exactly as the sound, so an electrical wave is reflected, and the same evidence which is afforded by an echo is offered by an electrical phenomenon known as a 'stationary' wave—that is, a wave with fixed nodal and ventral regions. Instead of sending sound vibrations toward a distant wall, I have sent electrical vibrations toward the remote boundaries of the earth, and instead of the wall, the earth has replied. In place of an echo I have obtained a stationary electrical wave * * *.—"The Problem of Increasing Human Energy, *Century*, June, 1900.

"By the discovery of these facts and perfection of means * * * it becomes possible to transmit * * * electrical energy * * * for industrial uses on a large scale up to practically any amount and, according to all the experimental evidence I have obtained, to any terrestrial distance. * * * The transmitting as well as receiving apparatus may be * * * movable as, when * * * carried by vessels floating in the air or by ships at sea * * *.—"U. S. Patents Nos. 645,576 and 649,621.



New York, April 19th, 1904.

Mr. William B. Rankine,
35 Wall Street,
New York City.

My Dear Rankine:-

Kindly note the following:

The Nikola Tesla Company has no liabilities, and its assets are my patents all duly assigned. I made a personal agreement with Mr. Morgan assigning to him a part of some of these patents, relating specifically to telegraphy and Lighting. Finding, however, that it would be advantageous to have all interests united I proposed to him to join in all my inventions instead of two only, and he accepted. Colonel Astor's interest was also similarly adjusted, so that at present all are in harmony.

Last Summer we undertook to form a manufacturing company under the better name "Tesla Electric & Manufacturing Company", with a capital of \$5,000,000. Unfavorable conditions developed and we thought it better to wait until my plans on Long Island are completed and reaction sets in. The plant at Wardenclyffe, which could now be finished in three to four months will enable me to readily telegraph and telephone to any part of the world, and it can easily be worked up to an earning capacity of ten thousand dollars a day. This is not an exaggerated estimate, for it will have a working capacity of probably more than one hundred Pacific cables put together. You understand, of course, that the receivers will involve expense, but as they are extremely cheap instruments they can be quickly installed in quantities by devoting a part of the earnings to this. No more, therefore, than \$100,000. are necessary, although more money might be used to advantage in order to secure quicker and larger returns.

From enclosed short statement of Kerr, Page & Cooper, relative to some of my patents you will see that they are controlling. These patents have an absolutely assured value of certainly not less than \$5,000,000. They would bring that much even in the event of my death. This means that in the worst possible case those interested with me would get about seven times the sums invested. But if I am properly aided, and my inventions skillfully exploited, I feel quite sure of hundred fold returns. The present company is the third corporation formed in this country under my name. The first two were both very successful, one paying about five times and the other, I think, twenty-five times the original investment.

My enemies have contended that I am a poet and a dreamer but it is nevertheless a fact that more money is going into my inventions than in those of the three greatest electrical inventors

Mr. W. B. R., -2.

of my time put together. Some have told me why I do not get all the capital I need from Mr. Morgan, but you know that this is a foolish argument. Some have expressed a doubt that my machines will perform the work for which they are designed. But as you have seen from the editorial of the leading electrical paper in England, others have used without my permission, the "Tesla Coil", "Tesla Transformer" and Tesla High-potential Methods" in their experiments in which sparks thirty inches long were said to have been used to convey wireless messages across the Atlantic. In 1899 I have produced sparks over one hundred feet long. They are of historical record. I need not say more.

Sincerely yours,

N. Tesla

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Glossary Acme ,

BHE

THE TRANSMISSION OF ELECTRIC ENERGY WITHOUT WIRES



TESLA CENTRAL POWER PLANT AND TRANSMITTING
TOWER FOR "WORLD TELEGRAPHY,"
LONG ISLAND, N. Y.

THE TRANSMISSION OF ELECTRIC ENERGY WITHOUT WIRES.

(Communicated to the Electrical World and Engineer, March 5, 1904.)

BY NIKOLA TESLA.

IT is impossible to resist your courteous request extended on an occasion of such moment in the life of your journal. Your letter has vivified the memory of our beginning friendship, of the first imperfect attempts and undeserved successes, of kindnesses and misunderstandings. It has brought painfully to my mind the greatness of early expectations, the quick flight of time, and alas! the smallness of realizations. The following lines which, but for your initiative, might not have been given to the world for a long time yet, are an offering in the friendly spirit of old, and my best wishes for your future success accompany them.

Towards the close of 1898 a systematic research, carried on for a number of years with the object of perfecting a method of transmission of electrical energy through the natural medium, led me to recognize three important necessities: First, to develop a transmitter of great power; second, to perfect means for individualizing and isolating the energy transmitted; and, third, to ascertain the laws of propagation of currents through the earth and the atmosphere. Various reasons, not the least of which was the help proffered by my friend Leonard E. Curtis and the Colorado Springs Electric Company, determined me to select for my experimental investigations the large plateau, two thousand meters above sea level, in the vicinity of that delightful resort, which I reached late in May, 1899. I had not been there but a few days when I congratulated myself on the happy choice and I began the task, for which I had long trained myself, with a grateful sense and full of inspiring hope. The perfect purity of the air, the unequaled beauty of the sky, the imposing sight of a high mountain range, the quiet and restfulness of the place—all around contributed to make the conditions for scientific observation ideal. To this was added the exhilarating influence of a glorious climate and a singular sharpening of the senses. In those regions the organs undergo perceptible physical changes. The eyes assume an extraordinary limpidity, improving vision; the ears dry out and become more susceptible to sound. Objects can be clearly distinguished there at distances such that I prefer to have them told by someone else, and I have heard—this I can venture to vouch for—the claps of thunder seven or eight hundred kilometers away. I might have done better still, had it not been tedious to wait for the sounds to arrive, in definite intervals, as heralded precisely by an electrical indicating apparatus—nearly an hour before.

In the middle of June, while preparations for other work were going on, I arranged one of my receiving transformers with the view of determining in a novel manner, experimentally, the electric potential of the globe and studying its periodic and casual fluctuations. This formed part of a plan carefully mapped out in advance. A highly sensitive, self-restorative device, controlling a recording instrument, was included in the secondary circuit, while the primary was connected to the ground and an elevated terminal of adjustable capacity. The variations of potential gave rise to electric surgings in the primary; these generated secondary currents, which in turn affected the sensitive device and recorder in proportion to their intensity. The earth was found to be, literally, alive with electrical vibrations, and soon I was deeply absorbed in this interesting investigation. No better opportunities for such observations as I intended to make could be found anywhere. Colorado is a country famous for the natural displays of electric force. In that dry and rarefied atmosphere the sun's rays beat the objects with fierce intensity. I raised steam, to a dangerous pressure, in barrels filled with

concentrated salt solution, and the tinfoil coatings of some of my elevated terminals shriveled up in the fiery blaze. An experimental high-tension transformer, carelessly exposed to the rays of the setting sun, had most of its insulating compound melted out and was rendered useless. Aided by the dryness and rarefaction of the air, the water evaporates as in a boiler, and static electricity is developed in abundance. Lightning discharges are, accordingly, very frequent and sometimes of inconceivable violence. On one occasion approximately twelve thousand discharges occurred in two hours, and all in a radius of certainly less than fifty kilometers from the laboratory. Many of them resembled gigantic trees of fire with the trunks up or down. I never saw fire balls, but as a compensation for my disappointment I succeeded later in determining the mode of their formation and producing them artificially.

In the latter part of the same month I noticed several times that my instruments were affected stronger by discharges taking place at great distances than by those near by. This puzzled me very much. What was the cause? A number of observations proved that it could not be due to the differences in the intensity of the individual discharges, and I readily ascertained that the phenomenon was not the result of a varying relation between the periods of my receiving circuits and those of the terrestrial disturbances. One night, as I was walking home with an assistant, meditating over these experiences, I was suddenly staggered by a thought. Years ago, when I wrote a chapter of my lecture before the Franklin Institute and the National Electric Light Association, it had presented itself to me, but I had dismissed it as absurd and impossible. I banished it again. Nevertheless, my instinct was aroused and somehow I felt that I was nearing a great revelation.

It was on the third of July—the date I shall never forget—when I obtained the first decisive experimental evidence of a truth of overwhelming importance for the advancement of humanity. A dense mass of strongly charged clouds gathered in the west and towards the evening a violent storm broke loose which, after spending much of its fury in the mountains, was driven away with great velocity over the plains. Heavy and long persisting arcs formed almost in regular time intervals. My observations were now greatly facilitated and rendered more accurate by the experiences already gained. I was able to handle my instruments quickly and I was prepared. The recording apparatus being properly adjusted, its indications became fainter and fainter with the increasing distance of the storm, until they ceased altogether. I was watching in eager expectation. Surely enough, in a little while the indications again began, grew stronger and stronger and, after passing through a maximum, gradually decreased and ceased once more. Many times, in regularly recurring intervals, the same actions were repeated until the storm which, as evident from simple computations, was moving with nearly constant speed, had retreated to a distance of about three hundred kilometers. Nor did these strange actions stop then, but continued to manifest themselves with undiminished force. Subsequently, similar observations were also made by my assistant, Mr. Fritz Lowenstein, and shortly afterward several admirable opportunities presented themselves which brought out, still more forcibly, and unmistakably, the true nature of the wonderful phenomenon. No doubt whatever remained: I was observing stationary waves.

As the source of disturbances moved away the receiving circuit came successively upon their nodes and loops. Impossible as it

seemed, this planet, despite its vast extent, behaved like a conductor of limited dimensions. The tremendous significance of this fact in the transmission of energy by my system had already become quite clear to me. Not only was it practicable to send telegraphic messages to any distance without wires, as I recognized long ago, but also to impress upon the entire globe the faint modulations of the human voice, far more still, to transmit power, in unlimited amounts, to any terrestrial distance and almost without any loss.

With these stupendous possibilities in sight, with the experimental evidence before me that their realization was henceforth merely a question of expert knowledge, patience and skill, I attacked vigorously the development of my magnifying transmitter, now, however, not so much with the original intention of producing one of great power, as with the object of learning how to construct the best one. This is, essentially, a circuit of very high self-induction and small resistance which in its arrangement, mode of excitation and action, may be said to be the diametrically opposite of a transmitting circuit typical of telegraphy by Hertzian or electromagnetic radiations. It is difficult to form an adequate idea of the marvelous power of this unique appliance, by the aid of which the globe will be transformed. The electromagnetic radiations being reduced to an insignificant quantity, and proper conditions of resonance maintained, the circuit acts like an immense pendulum, storing indefinitely the energy of the primary exciting impulses and impressing upon the earth and its conducting atmosphere uniform harmonic oscillations of intensities which, as actual tests have shown, may be pushed so far as to surpass those attained in the natural displays of static electricity.

Simultaneously with these endeavors, the means of individualization and isolation were gradually improved. Great importance was attached to this, for it was found that simple tuning was not sufficient to meet the rigorous practical requirements. The fundamental idea of employing a number of distinctive elements, co-operatively associated, for the purpose of isolating energy transmitted, I trace directly to my perusal of Spencer's clear and suggestive exposition of the human nerve mechanism. The influence of this principle on the transmission of intelligence, and electrical energy in general, cannot as yet be estimated, for the art is still in the embryonic stage; but many thousands of simultaneous telegraphic and telephonic messages, through one single conducting channel, natural or artificial, and without serious mutual interference, are certainly practicable, while millions are possible. On the other hand, any desired degree of individualization may be secured by the use of a great number of co-operative elements and arbitrary variation of their distinctive features and order of succession. For obvious reasons, the principle will also be valuable in the extension of the distance of transmission.

Progress though of necessity slow was steady and sure, for the objects aimed at were in a direction of my constant study and exercise. It is, therefore, not astonishing that before the end of 1899 I completed the task undertaken and reached the results which I have announced in my article in the *Century Magazine* of June, 1900, every word of which was carefully weighed.

Much has already been done towards making my system commercially available, in the transmission of energy in small amounts for specific purposes, as well as on an industrial scale. The results attained by me have made my scheme of intelligence transmission, for which the name of "World Telegraphy" has been suggested, easily realizable. It constitutes, I believe, in its principle of operation, means employed and capacities of application, a radical and fruitful departure from what has been done heretofore. I have no doubt that it will prove very efficient in enlightening the masses, particularly in still uncivilized countries and less accessible regions, and that it will add materially to general safety, comfort and convenience, and maintenance of peaceful relations. It involves the employment of a number of plants, all of which are capable of transmitting individualized signals to the uttermost confines of the earth. Each of them will be preferably located near some important center of civilization and the news it receives through any channel will be flashed to all points of the globe. A cheap and simple device, which might be carried in one's pocket may then be set up anywhere on sea or land, and it will record the world's news

or such special messages as may be intended for it. Thus the entire earth will be converted into a huge brain, as it were, capable of response in every one of its parts. Since a single plant of but one hundred horse-power can operate hundreds of millions of instruments, the system will have a virtually infinite working capacity, and it must needs immensely facilitate and cheapen the transmission of intelligence.

The first of these central plants would have been already completed had it not been for unforeseen delays which, fortunately, have nothing to do with its purely technical features. But this loss of time, while vexatious, may, after all, prove to be a blessing in disguise. The best design of which I knew has been adopted, and the transmitter will emit a wave complex of a total maximum activity of ten million horse-power, one per cent. of which is amply sufficient to "girdle the globe." This enormous rate of energy delivery, approximately twice that of the combined falls of Niagara, is obtainable only by the use of certain artifices, which I shall make known in due course.

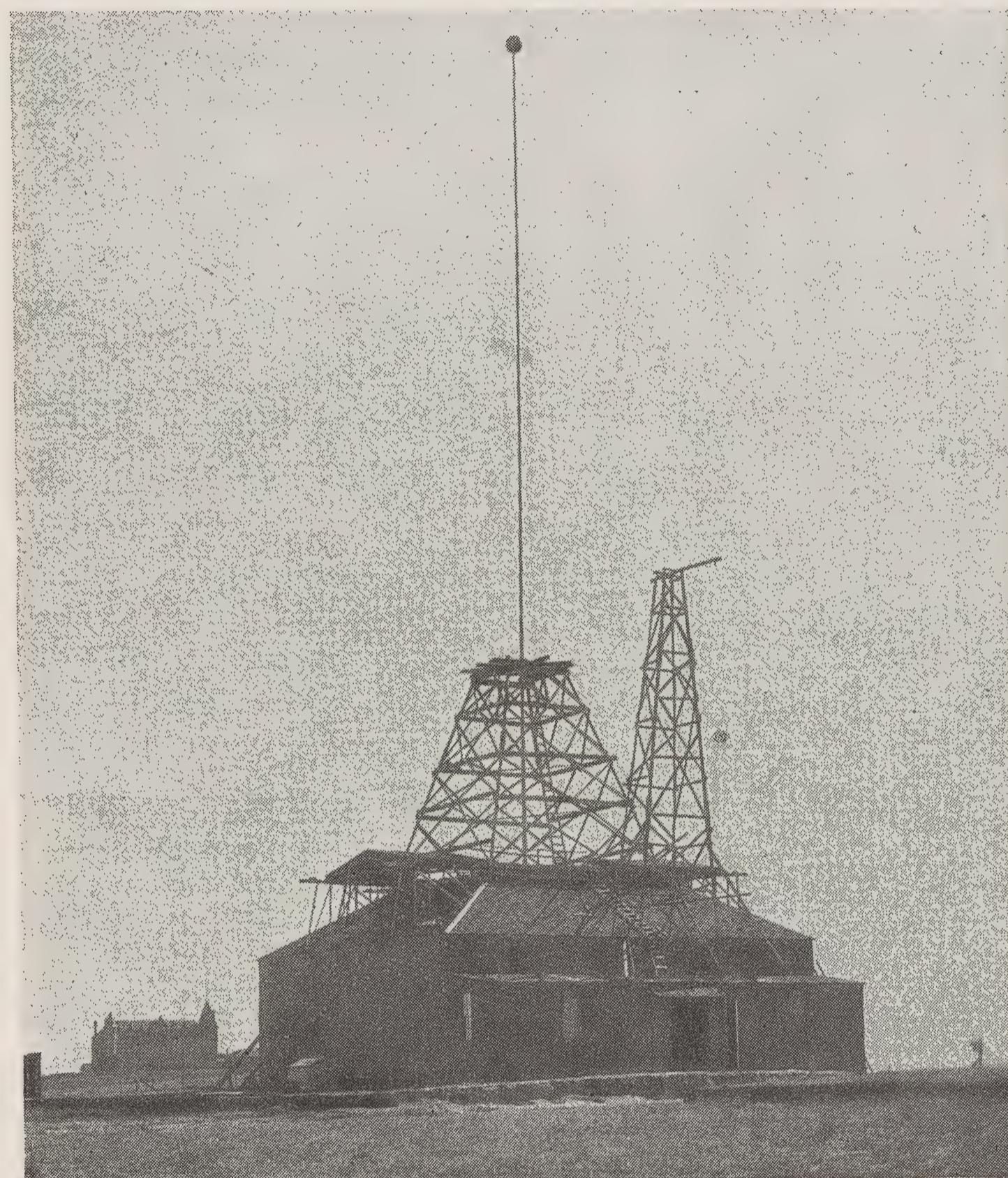
For a large part of the work which I have done so far I am indebted to the noble generosity of Mr. J. Pierpont Morgan, which was all the more welcome and stimulating, as it was extended at a time when those, who have since promised most, were the greatest of doubters. I have also to thank my friend, Stanford White, for much unselfish and valuable assistance. This work is now far advanced, and though the results may be tardy, they are sure to come.

Meanwhile, the transmission of energy on an industrial scale is not being neglected. The Canadian Niagara Power Company have offered me a splendid inducement, and next to achieving success for the sake of the art, it will give me the greatest satisfaction to make their concession financially profitable to them. In this first power plant, which I have been designing since a long time, I propose to distribute ten thousand horse-power under a tension of one hundred million volts, which I am now able to produce and handle with safety.

This energy will be collected all over the globe preferably in small amounts, ranging from a fraction of one to a few horse-power. One of its chief uses will be the illumination of isolated homes. It takes very little power to light a dwelling with vacuum tubes operated by high-frequency currents and in each instance a terminal a little above the roof will be sufficient. Another valuable application will be the driving of clocks and other such apparatus. These clocks will be exceedingly simple, will require absolutely no attention and will indicate rigorously correct time. The idea of impressing upon the earth American time is fascinating and very likely to become popular. There are innumerable devices of all kinds which are either now employed or can be supplied, and by operating them in this manner I may be able to offer a great convenience to the whole world with a plant of no more than ten thousand horse-power. The introduction of this system will give opportunities for invention and manufacture such as have never presented themselves before.

Knowing the far-reaching importance of this first attempt and its effect upon future development, I shall proceed slowly and carefully. Experience has taught me not to assign a term to enterprises the consummation of which is not wholly dependent on my own abilities and exertions. But I am hopeful that these great realizations are not far off, and I know that when this first work is completed they will follow with mathematical certitude.

When the great truth accidentally revealed and experimentally confirmed is fully recognized, that this planet, with all its appalling immensity, is to electric currents virtually no more than a small metal ball and that by this fact many possibilities, each baffling imagination and of incalculable consequence, are rendered absolutely sure of accomplishment; when the first plant is inaugurated and it is shown that a telegraphic message, almost as secret and non-interferable as a thought, can be transmitted to any terrestrial distance, the sound of the human voice, with all its intonations and inflections, faithfully and instantly reproduced at any other point of the globe, the energy of a waterfall made available for supplying light, heat or motive power, anywhere—on sea, or land, or high in the air—humanity will be like an antheap stirred up with a stick: See the excitement coming!



EXPERIMENTAL LABORATORY, COLORADO,
ERECTED SUMMER OF 1899.

(DISCOVERY BY MR. TESLA OF THE STATIONARY WAVES OF THE EARTH
WAS MADE HERE.)

April 8th, 1904.

Nikola Tesla, Esq.,
New York, N.Y.

Dear Sir:

Relying to your letter of April 8th in which you request us to express briefly our opinion in regard to the validity and scope of a number of patents granted to you, we would say that while we have the greatest confidence in the practical value of the inventions to which the patents relate, which confidence has been confirmed by the developments in the art subsequent to their grant, and by the evident appreciation of some of the earlier inventions on the part of the public by their enforced adoption, we do not feel qualified as experts to pass upon this question, and therefore limit our answer to a consideration of the legal effect of the patents themselves.

The group of patents first mentioned by you comprises the following:

- No. 454,622, dated April 25, 1891.
- No. 462,418, dated Nov. 3, 1891.
- No. 568,176, dated Sept. 22, 1896.
- No. 568,178, dated Sept. 22, 1896.
- No. 568,179, dated Sept. 22, 1896.
- No. 568,180, dated Sept. 22, 1896.
- No. 577,670, dated FEB. 23, 1897.

These patents all refer to methods of producing, regulating and distributing electric energy in a form suited for application to systems of which wireless telegraphy may be taken as the type, or in general where high frequency or a much higher potential than is possible by previously known means, is to be attained. As you were not only the first, to our knowledge, in this field of invention, but were the first to succeed in producing the desired results, by the use of the methods and apparatus of these patents, and as no other successful plan has been proposed by others, so far as we know, these patents must be regarded as controlling of the art, if their claims properly define and cover the inventions to which they relate. This we believe is the fact. The claims were drawn with great care, and with a practically clear field before us, and we know of no instance in the practical plans proposed in a large number of patents which have been taken out by others subsequently to yours, in which the more important claims have been avoided.

We know of nothing to anticipate the claims and are of opinion that they are valid.

The next group of patents to which you refer comprises:

- No. 645,576, Mar. 20, 1900.
- No. 649,621, May 16, 1900.

These two patents cover fully the method and arrangement

of apparatus which we understand is indispensable to the practical operation of systems for the transmission of energy without wires. We are of opinion that the validity of these patents is beyond question, and we believe that their effect is controlling.

Of the other patents mentioned by you Nos. 685,953 dated Nov. 5, 1901 and 685,954 of the same date, cover in the broadest terms the storage and transmitted energy, and its periodical discharge for use, which, of course, is not fundamental, nor in all cases indispensable, but nevertheless, we should think, a feature of great practical value. We know of nothing that would invalidate the claims of these patents.

Patents 723,188, dated Mar. 17, 1903 and 725,605 dated April 14, 1903 cover the only practical means of isolating the energy transmitted, as for example in securing secrecy and non-interference in the transmission of signals that has been called to our attention. The patents, we believe, fully and broadly cover the special methods or plan to which they relate, so that their value as a controlling factor in the art could only be impaired by the discovery of some radically different method.

The value of your Reissued patent No. 11,865 dated Oct. 23, 1900 depends entirely upon the commercial value of the plan of insulating conductors to which it refers, but this is a matter upon which we are not competent to pass an opinion. The patent, we believe, is valid, and the subject matter so far as we have been able to ascertain, is wholly new.

Patent No. 613,809 dated Nov. 8, 1898 for controlling the operation of self propelled vessels or vehicles by electrical impulses transmitted without the use of wires, relates, as you say, to a subject which has been discussed to such an extent in the scientific journals and public press, as to call for no comment from us. Your priority in this line of work, in this country, at least, enabled us to secure very broad and controlling claims in this patent for the invention. We know of nothing that would defeat the claims, nor that could be used to accomplish the same result without infringing them.

The other patents referred to by you, are for subordinate features which enter as details in your proposed system or are designed to increase its efficiency, and so far as we know, are valid.

In the above, we have endeavored to comply closely with your request for brevity of expression, and have not attempted to state in detail the grounds upon which our views are based. Should you desire it we shall be glad to go in greater detail into the considerations which have led us to the conclusions above expressed.

Yours very truly,

(Signed) Kerr, Page & Coopers.