To all whom it may concern:

Do it known that I, NIKOLA TESLA, a citizen of the United States, residing at the borough of Manhattan, in the city of New York, county and State of New York, have invented certain new and useful Improvements in Apparatus for the Transmission of Electrical Energy, of which the following is a specification, reference being had to the drawing accompanying and forming a part of the same.

This application is a division of an application filed by me on September 2, 1897, Serial No. 650,343, entitled "Systems of transmissions of electrical energy," and is based upon new and useful features and advantages of the apparatus shown and described in said application for carrying out the method therein disclosed and claimed.

The invention which forms the subject of my present application comprises a transmitting coil or conductor in which electrical currents or oscillations are produced and which is arranged to cause such currents or oscillations to be propagated by conduction through the natural medium from one point to another remote therefrom and a receiving coil or conductor at such distant point adapted to be excited by the oscillations or currents propagated from the transmitter.

This apparatus is shown in the accompanying drawing, which is a diagrammatic illustration of the same.

A is a coil, generally of many turns and of a very large diameter, wound in spiral form either about a magnetic core or not, as may be desired. C is a second coil formed by a conductor of much larger size and smaller length wound around and in proximity to the coil A.

The apparatus at one point is used as a transmitter, the coil A in this case constituting a high-tension, secondary, and the coil C the primary, of much lower tension, of a transformer. In the circuit of the primary C is included a suitable source of current G. One terminal of the secondary A is at the center of the spiral coil and from this terminal the current is led by a conductor B to a terminal D, preferably of large surface, formed or maintained by such means as a balloon at an elevation suitable for the purposes of transmission. The other terminal of the secondary A is connected to earth, and, if desired, to the primary also, in order that the latter may be at substantially the same potential as the adjacent portions of the secondary, thus insuring safety. At the receiving station a transformer of similar construction is employed; but in this case the longer coil A constitutes the primary, and the shorter coil C the secondary, of the transformer. In the circuit of the latter are connected lamps L, motors M, or other devices for utilizing the current. The elevated terminal D connects with the center of the coil A, and the other terminal of said coil is connected to earth and preferably, also, to the coil C for the reasons above stated.

The length of the thin wire coil in each transformer should be approximately one-quarter of the wave length of the electric disturbance in the circuit, this estimate being based on the velocity of propagation of the disturbance through the coil itself and the circuit with which it is designed to be used. By way of illustration, if the rate at which the current traverses the circuit including the coil be one hundred and eighty-five thousand miles per second then a frequency of nine hundred and twenty-five per second would maintain nine hundred and twenty-five stationary moves in a circuit one hundred and eighty-five thousand miles long and each wave would be two hundred miles in length.

For such a low frequency, which would be resorted to only when it is indispensable for the operation of motors of the ordinary kind under the conditions above assumed, I would use a secondary of fifty miles in length. By such an adjustment or proportioning of the length of the secondary coil or coils the points of highest potential are made to coincide with the elevated terminals D D', and it should be understood that whatever length be given to the wires this requirement should be complied with in order to obtain the best results.

It will be readily understood that when the above-prescribed relations exist the best conditions for resonance between the transmitters.
ting and receiving circuits are attained, and
to the fact that the points of highest po-
tential in the coils or conductors A A' are
identical with the same points in the
maximum flow of current will take place in
the two coils, and this, further, necessarily
implies that the capacity and inductance in
each of the circuits have such values as to
secure the most perfect condition of synchro-
nism with the impressed oscillations.

When the source of current G is in opera-
tion and produces rapidly pulsating or oscil-
lating currents in the circuit of coil C, cor-
responding induced currents of very much
higher potential are generated in the second-
ary coil A, and since the potential in the same
gradually increases with the number of turns
from the center and the difference of poten-
tial between the adjacent turns is compar-
tively small a very high potential impractica-
ble with ordinary coils may be successively
obtained.

As the main object for which the apparatus
is designed is to produce a current of excess-
ively-high potential, this object is facilitated
by using a primary current of very consid-
erable frequency; but the frequency of the
currents is in a large measure arbitrary, for
if the potential be sufficiently high and the
terminals of the coils be maintained at the
proper elevation where the atmosphere is
rarefied the stratum of air will serve as a con-
ducting medium for the current produced
and the latter will be transmitted through the
air, with, it may be, even less resistance than
through an ordinary conductor.

As to the elevation of the terminals D D', it is
obvious that this is a matter which will be
determined by a number of things, as by the
amount and quality of the work to be per-
formed, by the condition of the atmosphere,
and also by the character of the surrounding
country. Thus if there be high mountains
in the vicinity the terminals should be at a
greater height, and generally they should al-
ways be at an altitude much greater than that
of the highest objects near them. Since by
the means described practically any potential
that is desired may be produced, the currents
through the air strata may be very small, thus
reducing the loss in the air.

The apparatus at the receiving-station re-
sponds to the currents propagated from the
transmitter in a manner which will be well
understood from the foregoing description.
The primary circuit of the receiver—that is,
the thin wire coil A'—is excited by the cur-
rents propagated by conduction through the
intervening natural medium from the trans-
mitter, and these currents induce in the sec-
ondary coil C' other currents which are util-
ized for operating the devices included in the
circuit thereof.

Obviously the receiving-coils, transfor-
ers, or other apparatus may be movable—as,
for instance, when they are carried by a ves-
sel floating in the air or by a ship at sea. In
the former case the connection of one termi-
nal of the receiving apparatus to the ground
might not be permanent, but might be inter-
mitently or inductively established without
departing from the spirit of my invention.

It is to be noted that the phenomena here
involved in the transmission of electrical en-
ergy is one of true conduction and is not to
be confounded with the phenomena of elec-
trical radiation which have heretofore been
observed and which from the very nature and
mode of propagation would render practically
impossible the transmission of any appreci-
able amount of energy to such distances as
are of practical importance.

What I now claim as my invention is—
1. The combination with a transmitting coil
or conductor connected to ground and to an
5 elevated terminal respectively, and means for
producing therein electrical currents or oscil-
lations, of a receiving coil or conductor simi-
larly connected to ground and to an elevated
terminal, at a distance from the transmiss-
ting-coil and adapted to be excited by cur-
rents caused to be propagated from the same
by conduction through the intervening nat-
ural medium, a secondary conductor in in-
ductive relation to the receiving-conductor
and devices for utilizing the current in the
circuit of said secondary conductor, as set
forth.

2. The combination with a transmitting coil
or conductor having its ends connected to
ground and to an elevated terminal respec-
tively, a primary coil in inductive relation
thereto and a source of electrical oscillations
in said primary circuit, of a receiving conduc-
tor or coil having its ends connected to ground
and to an elevated terminal respectively and
adapted to be excited by currents caused to
be propagated from the transmitter through
the natural medium and a secondary circuit
in inductive relation to the receiving-circuit
and receiving devices connected therewith, as
set forth.

3. The combination with a transmitting in-
strument comprising a transformer having its
secondary connected to ground and to an ele-
vated terminal respectively, and means for
impressing electrical oscillations upon its pri-
mary, of a receiving instrument comprising
a transformer having its primary similarly
connected to ground and to an elevated ter-
minal, and a translating device connected
with its secondary, the capacity and induc-
tance of the two transformers having such
values as to secure synchronism with the im-
pressed oscillations, as set forth.

4. The combination with a transmitting in-
strument comprising an electrical transfor-
meter having its secondary connected to
ground and to an elevated terminal respec-
tively, and means for impressing electrical
oscillations upon its primary, of a receiving
instrument comprising a transformer having
its primary similarly connected to ground
and to an elevated terminal, and a translat-
ing device connected with its secondary, the capacity and inductance of the secondary of the transmitting and primary of the receiving instruments having such values as to secure synchronism with the impressed oscillations, as set forth.

5. The combination with a transmitting coil or conductor connected to ground and an elevated terminal respectively, and means for producing electrical currents or oscillations in the same, of a receiving coil or conductor similarly connected to ground and to an elevated terminal and synchronized with the transmitting coil or conductor, as set forth.

6. The combination with a transmitting instrument comprising an electrical transformer, having its secondary connected to ground and to an elevated terminal respectively, of a receiving instrument comprising a transformer, having its primary similarly connected to ground and to an elevated terminal, the receiving-coil being synchronized with that of the transmitter, as set forth.

7. The combination with a transmitting coil or conductor connected to ground and to an elevated terminal respectively, and means for producing electrical currents or oscillations in the same, of a receiving coil or conductor similarly connected to ground and to an elevated terminal, the said coil or coils having a length equal to one-quarter of the wave length of the disturbance propagated, as set forth.

8. The combination with a transmitting coil or conductor connected to ground and to an elevated terminal respectively, and adapted to cause the propagation of currents or oscillations by conduction through the natural medium, of a receiving-circuit similarly connected to ground and to an elevated terminal, and of a capacity and inductance such that its period of vibration is the same as that of the transmitter, as set forth.

9. The transmitting or receiving circuit herein described, connected to ground and an elevated terminal respectively, and arranged in such manner that the elevated terminal is charged to the maximum potential developed in the circuit, as set forth.

10. The combination with a transmitting coil or conductor connected to ground and to an elevated terminal respectively of a receiving-circuit having a period of vibration corresponding to that of the transmitting-circuit and similarly connected to ground and to an elevated terminal and so arranged that the elevated terminal is charged to the highest potential developed in the circuit, as set forth.

NIKOLA TESLA.

Witnesses:
PARKER W. PAGE,
MARCELLUS BAILEY.