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EXAMINER.

No. 782,181. PATENTED FEB. 7, 1905.

G. O. SQUIER.

WIRELESS TELEGRAPHY.

APPLICATION FILED NOV. 10, 1904.

2 SHEETS—SHEET 1.

Fig. 1.

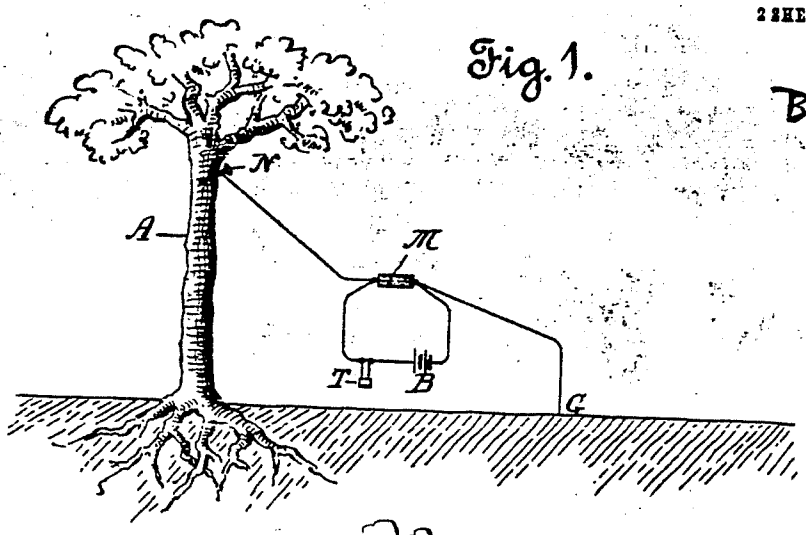


Fig. 2.

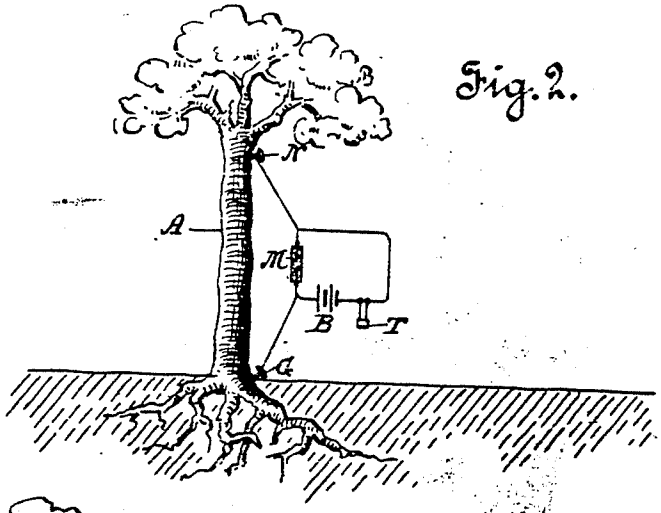
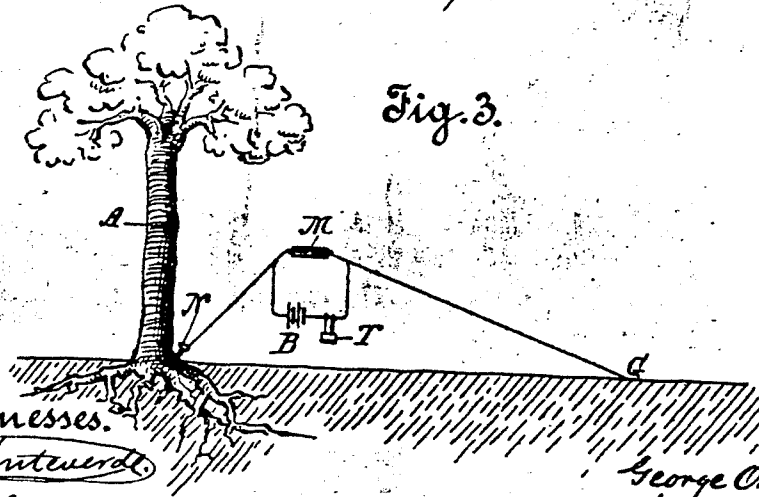


Fig. 3.



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No references cited.

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2 SHEETS—SHEET 2.

Fig. 4.

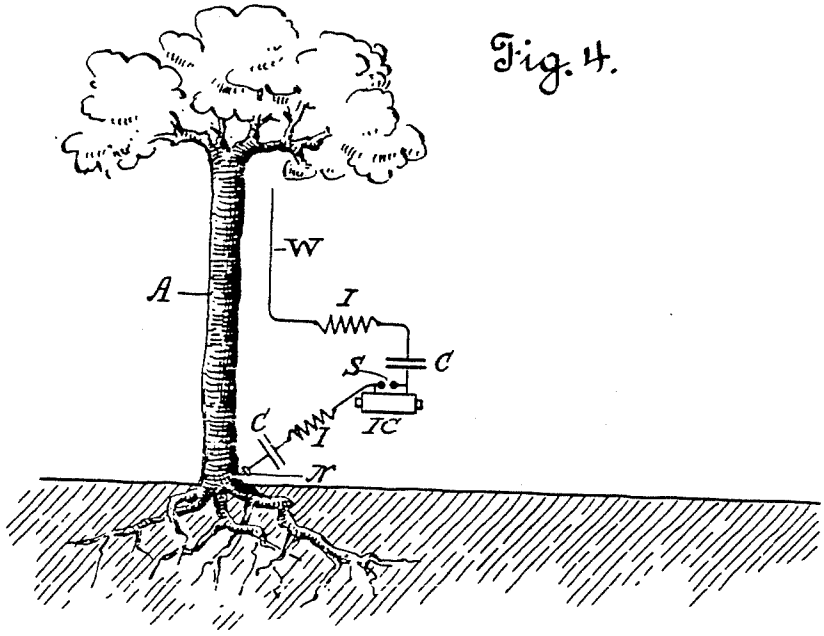
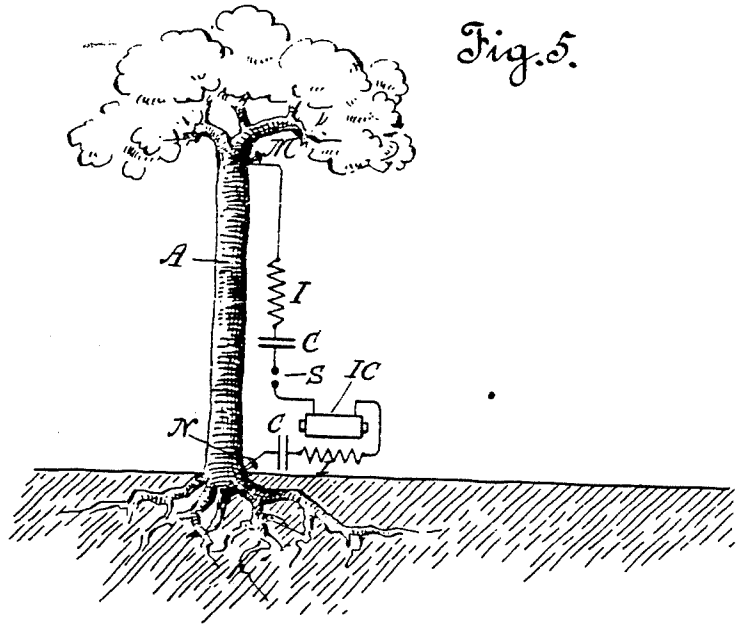


Fig. 5.



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UNITED STATES PATENT OFFICE.

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WIRELESS TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 782,181, dated February 7, 1905.

Application filed November 10, 1904. Serial No. 232,083.

To all whom it may concern:

Be it known that I, GEORGE OWEN SQUIER, of the Signal Corps, United States Army, a citizen of the United States, residing in the city and county of San Francisco, State of California, have invented certain new and useful Improvements in Wireless Telegraphy, of which the following is a specification.

My invention relates to the transmission of intelligence without intervening wires, commonly known as "wireless telegraphy" or "space telegraphy," or "Hertzian-wave telegraphy" &c., in which as at present universally practiced the transmitting and receiving stations for the operation thereof must be provided with some form of vertical antenna supported from an insulating mast or framework. This vertical insulated electrical conductor at the transmitting and receiving stations may assume a large variety of forms and shapes, involving multiple conducting-wires joined together in various ways to increase the electrostatic capacity of the aerial or joined or attached to conducting plates, cylinders, or cages in various forms for the general purpose of increasing the said electrostatic capacity of the vertical aerial, thereby facilitating the transmission and reception of signals by such systems. In other words, in all successful known forms of wireless telegraph apparatus as at present practiced some form of vertical metallic conducting aerial is required whenever appreciable distances are to be spanned by this method. These aerials in whatever form are at present a principal item in the expense and maintenance of installations of all wireless telegraph systems and are the most serious engineering construction involved in the operation of wireless telegraphy. From a military standpoint the ability to use wireless telegraphy without the cumbersome masts and accessories which at present must be transported in the field is of great advantage.

I have discovered that for at least moderate distances all such forms of aerial conductors, plates, or surfaces or other means of absorbing electromagnetic waves above referred to can be entirely dispensed with, using in place thereof living vegetable organisms, particularly in the form of growing trees, preferably covered with foliage.

It is well established in the art of wireless telegraphy that it is several times more difficult to practice the system over land than over the surface of sea-water. It is also known that this is largely due to the absorption of the electromagnetic waves by the surface of the earth, intervening hills, mountains, &c., and by objects on the surface of the earth, such as buildings and foliage in general. I have discovered that growing vegetation, particularly in the form of tall trees covered with foliage, absorb the electromagnetic waves passing through them to a remarkable degree, to such an extent that instead of becoming an obstacle to wireless telegraphy they themselves may be used for efficient antennæ, absorbing the Hertzian radiation sufficiently to enable the ordinary forms of electric-wave detectors to be used for the reception and transmission of messages, as described below. A living vegetable organism in the form of a growing tree, preferably covered with foliage, has been proved, by experiments which I have conducted, to possess many qualities which admirably adapt it for use in wireless telegraphy.

Experience has shown the great importance attached to a good "earth" or "ground" connecting the transmitting and receiving antennæ with the earth, and various expedients are resorted to to secure this. Among these may be mentioned the burying of large conducting-plates in water deep in the earth, or surrounded by coke or other material, or the insertion of metal strips in the surface of the earth or beneath it in the vicinity of the foot of the transmitting and receiving antennæ. Experience has also shown the importance of a good electrical conducting area on the surface of the ground in the vicinity of the foot of the antenna, particularly to a distance at least equal to a quarter of a wave length of the radiations used, and numerous suggestions have been made for increasing this surface conductivity of the earth by spreading metallic nets or other devices at the foot of

the antenna, either surrounding it entirely or in the direction of the distant station or stations.

I have discovered that a living vegetable antenna as presented in a growing tree, with its large number of roots generally extending out radially from the trunk and often to great depths and distances, conducts electromagnetic waves with great facility, affording an excellent ground or earth for intimately joining electrically the vertical antenna to the earth.

As is well known, the roots of a tree are organized cells filled with saps or juices composed of water, starch, cellulose, protoplasm, various vegetable acids, and mineral substances of various kinds, depending upon many conditions well known to the botanist. This sap has been found to possess electrical conductivity, and it, as existing in the living cells of growing vegetable organisms, is well adapted for the transmission of electromagnetic waves. It is also well known that there is no more intimate connection between earth and air, both of which are essentially involved in wireless telegraphy, than is found in growing vegetation, which, in fact, lives and grows from the constituents of both. The main roots of a tree are covered by innumerable microscopic organized hair roots and rootlets, through the surfaces of which the tree obtains its nutrition from the soil and the general vegetable circulation is maintained, and the fluids thus involved in this circulation in the organized cells have been found to be good conductors for electromagnetic waves. Again, it is a general object in wireless telegraphy to increase the capacity of the vertical antenna by adding extra wires or conducting metallic plates or surfaces attached thereto. In the vegetable antenna here proposed the great aggregate surface of the growing leaves elevated from the surface of the earth acts as the capacity areas above referred to and greatly increases the electrostatic capacity of the whole. These leaves act in much the same manner as conducting-plates for electromagnetic waves and can be charged and discharged in the same general way through the conducting-cells and juices throughout their structure. In general this large surface of growing leaves serves as a large plate of a condenser, whose other plate is the earth, the stem or trunk of the tree connecting the root system below. This root system also seems to insure a good conducting space or area of earth around the base or foot of such an antenna to a considerable radial distance and conduces to keeping the surrounding earth bed in a moist and therefore good conducting state for electric waves. The trunk or stem is composed in general of an outer cambium layer filled with juices containing vegetable acids, minerals in solution, and vegetable compounds, composing [illegible]. This cambium layer thus filled with juices may be regarded from an electrical standpoint as a conducting-cylinder, joined to the earth most intimately by the entire root system of the tree and to the elevated capacity through its branches and leaves. We thus have, as I have found by experiments, a very efficient absorber or emitter of electromagnetic waves.

In illustrating my invention with the accompanying drawings only simple methods of transmitting and receiving by my system are indicated, although I wish to be distinctly understood as not limiting myself to any particular arrangement of circuits for this purpose, as it is well known these can be varied in a very large number of ways, depending upon the particular type of detector employed, whether operating by potential or by energy and whether syntony is an object or otherwise, &c. These drawings indicate diagrammatically two or three of the simplest arrangements which I have found in practice to be successful, it being distinctly understood, as above stated, that a very large number of combinations of ohmic resistances, inductances, and capacities may be used in a variety of ways to produce successful results. The figures, therefore, merely indicate direct electrical connections without such transformers, inductances, or condensers.

Figures 1, 2, and 3 indicate diagrammatically three simple forms of receiving wireless telegraphic waves by my invention. Figs. 4 and 5 indicate diagrammatically two simple forms of transmitting said waves.

In Fig. 1, N represents a point of electrical connection with the tree A, formed in any suitable manner, such as driving a metallic nail into the tree, preferably through the living portion thereof. M represents a suitable detector for electric waves, such as a coherer or microphone. G represents the electrical connection with the earth by any suitable means, such as driving a metallic pin into the surface thereof. T is a telephone or other suitable device used to interpret the effects caused in the receiver or detector by the electrical waves. B is a source of electromotive force. Obviously the detector M may be connected to the circuit through a suitable oscillation-transformer.

In the variations indicated in Figs. 2 and 3 corresponding letters represent similar apparatus to that in Fig. 1.

For the electrical waves absorbed by a growing tree, as indicated in Figs. 1, 2, and 3, I have found, as theory indicates, that there is a general potential node for the electric waves in a region at or near the base of the tree where the earth-line intersects its trunk or stem. It has been found by experiment that a vertical wire or antenna earthed at its lower extremity possesses a potential node at the point of contact with the earth for electric waves sent or received. This potential

node region has been found by experiment to be one of the advantageous points of connection for the receiving-circuit.

The arrangements indicated in Figs. 1, 2, and 3 give good results and have been operated over distances of several miles with complete success. Investigation has shown that the point N in Figs. 1 and 2 may be a point of electrical connection with the tree through its main trunk or stem, its branches, buds, or leaves. The point G in Fig. 2 and the point N in Fig. 3 may be at any point in the potential node region previously referred to near the base of the tree. This point may be either in the tree itself or in the earth itself adjacent thereto. The point G in Fig. 1 and point G in Fig. 3 may be at various distances from the base of the tree. Manifestly the electrical connections designated by M N and M G in Figs. 1, 2, and 3 may be one conductor or many conductors arranged in a variety of ways, and the actual electrical connection to the tree may be a single metallic pin or several pins or a metallic ring or collar surrounding the whole or part of the tree, making contacts at various points therewith. The point G in Figs. 1 and 3 may be any good earth connection with metallic pins, nets, strips, or other devices.

Figs. 4 and 5, as already stated, show simple methods of transmitting electric waves by my invention. As stated above in the case of Figs. 1, 2, and 3 I do not wish to limit myself to these particular arrangements for transmitting, as no claims are made for any particular arrangement of electrical apparatus. In these Figs. 4 and 5, I C represents an ordinary inductance-coil; C, capacity; I, inductance. Electrical connections with the tree (indicated at N in Fig. 4 and at M and N in Fig. 5) may be substantially of the same kind and subject to the same conditions as stated in describing Figs. 1, 2, and 3 above.

Manifestly the electrical waves may be impressed upon the aerial through the medium of an oscillation-transformer or in any other suitable manner, as particular forms of apparatus are not claimed in this specification. Since the capacity of an aerial wire is increased by the presence near it of another conductor, the aerial wire W (indicated in Fig. 4) may be placed at various distances from the trunk or stem of the tree and parallel thereto to produce changes in the efficiency of transmission.

S in Figs. 4 and 5 is a spark-gap.

My invention or discovery is obviously applicable to systems wherein the transmitting and receiving appliances and devices are arranged in many different forms and combinations.

The one feature common to all systems at present existing is some form of aerial antenna for both transmitting and receiving stations. There are a large number of different forms of wave-detectors at present used in wireless telegraphy, such as those depending for their action upon difference of potential or pressure and those depending for their action upon energy or current, and I wish to state explicitly that I do not limit myself to any particular form of arrangement of circuits for transmitting or receiving or any particular form or class of receivers or other appliances for interpreting the signals: but since the one common feature of all systems is some form of aerial the vegetable aerial here proposed can be used with many of such systems.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In wireless telegraphy, means for shunting a portion of the electromagnetic waves absorbed by living vegetable organisms, through a branch electrical circuit, and a suitable receiving device operated by the waves thus shunted.

2. In wireless telegraphy a "ground" or "earth" for transmitting or receiving electromagnetic waves, comprising the living vegetable organisms of the roots and rootlets of growing vegetation.

3. In wireless telegraphy, the means for increasing the electrostatic capacity of vertical antennæ or aerials comprising living vegetable leaf systems elevated from the earth.

4. In wireless telegraphy an antenna or aerial containing, as a part of its electrical circuit for conducting electromagnetic waves, living vegetable matter.

5. In wireless telegraphy an antenna or aerial containing, as a part of its electrical circuit for conducting electromagnetic waves, the stem or trunk of living vegetable matter.

6. In wireless telegraphy an aerial or antenna composed of a "ground" or "earth" connection through the root system of living organic vegetation, a vertical conductor consisting of the stem or trunk of living organic vegetation, and the branch and leaf system attached thereto as an elevated capacity area.

7. In wireless telegraphy an antenna or aerial containing, as a part of its electric circuit for absorbing, emitting, and conducting electromagnetic waves, the branch and leaf system of living vegetable matter.

In witness whereof I have hereunto set my hand.

GEORGE OWEN SQUIER.

Witnesses:
J. COMPTON,
D. B. RICHARDS.