

Tree Radio Telephony and Telegraphy

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IN 1904 the author conducted some experiments with a view to utilizing growing trees as antenna for radio telegraphy and discovering the efficacy, in a general way, of using a direct metallic contact to certain trees (principally eucalyptus) to increase the audibility of radio signals.

It was found that the regular Army buzzer telephone and telegraph sets were inoperative with any ordinary ground or earth, but became operative when connected to a metallic nail driven in the trunk or roots of a tree. This incident led the author to pursue the subject experimentally in the autumn of 1904.

Living vegetation plays a more important part in electrical phenomena than has been generally supposed. We have seen that living vegetable organisms absorb and conduct electromagnetic oscillations over a wide range of the electromagnetic spectrum, beginning with sunlight, whose electrical action in the plant cell is at present little understood, and extending to waves of identical character, but of immensely greater lengths, such as Hertzian radiation, telephonic waves, and oscillations of the ordinary low frequencies used in commercial electric transmission lines. Disruptive discharges between vegetable electrodes and electrostatic effects between vegetable surfaces are easily produced.

If, as indicated above in these experiments, the earth's surface is already generously provided with efficient antennae, which we have but to utilize for such communication, even over short distances, it is a fascinating thought to dwell upon in connection with the future development of the transmission of intelligence.

A growing tree, covered with foliage, is influenced inductively by electrical disturbances outside of itself, and in fact becomes generally responsive to induced electrical oscillations.

It is believed that vegetation should be studied more systematically, from a distinctly physical standpoint, than has been done in the past. Physics has been said to be the mother of all sciences, and more the physical method of studying all science is proving to be the true one, as is evidenced by the great advance in recent years, in comparatively new branches of scientific work, such as Astrophysics and Physical Chemistry. Has not the time arrived for a more systematic study of Physical Botany, in the light of the new electrical theory of matter?"

Tree Antenna

In connection with the organization and development of Transatlantic radio reception, which was carried out during the period of the war to provide against the possibility of the interruption of the submarine cable system, the Signal Corps established a chain of special receiving stations in different parts of the United States to copy and record enemy and allied radio messages from European stations for the information of our Army General Staff.

It was immediately discovered that with the sensitive amplifiers now in use it was possible to receive signals from the principal European stations by simply laying a small wire netting on the ground beneath the tree and connecting an insulated wire to a nail driven in the tree well within the outline of the tree top.

One of the best receiving arrangements was found to be an elevated tree earth-terminal in the upper part of the tree top

as described later, and an earth consisting practically of several short pieces of insulated wire sealed at the outer ends radiating out from a common centre, and buried a few inches beneath the surface of the ground in the neighborhood of the tree.

It was soon found that a tree-antenna could be used efficiently as a multiple receiving set over widely different wave lengths, receiving either from separate terminals at the same or different heights of the tree or in series from the same terminal.

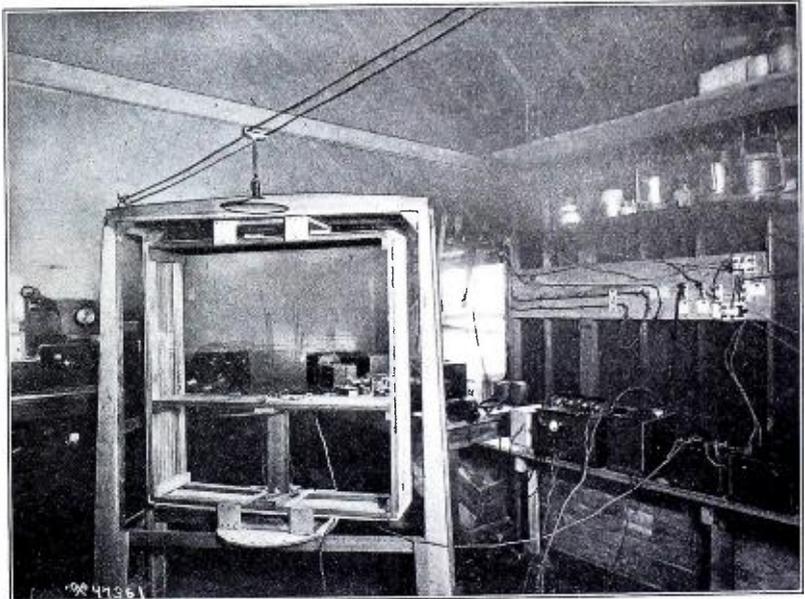
This same type of circuit was employed in an inverse manner for telephonic transmitting purposes, and although the experiments thus far have been limited to short distances, it was found that 2-way telephonic communication was easily estab-

ity effects, this resistance was much smaller.

Using the substitution method, measurements of the apparent series capacity and resistance of the lead alone and of the lead attached to nails driven into the tree at various heights were made at different frequencies. In all cases the lead was of just sufficient length to reach to the point of contact, whether connected electrically to the nail or tree.

The original data are given in Tables I and II.

The small change in the electrostatic capacity occasioned by making electrical contact with the tree, while all other conditions remain unaltered, is to be remarked and also the large increase in resistance under the same conditions. The increase in re-



Floraphone Long Wave Receiving Apparatus, with Direction Finder and "Barrage" Receiver.

lished with remarkably low values of transmitting antenna current.

The flexibility of this arrangement is very striking. The linking up of wire and wireless methods was found to be convenient and efficient. Radio telephonic messages from airplanes were readily received by the tree-antenna arrangement and transferred thence to the wire system of the City of Washington and finally received at any point desired.

Furthermore, telephonic transmission thru the tree-antenna was received by another tree-antenna, and automatically returned to the sender on a wire system, thus making the complete circuit. Long distance reception on any wave length from all the larger European stations and from our ships at sea was easily accomplished and traffic copied on a twenty-four hour schedule by the regular enlisted operators of the Signal Corps.

Tree contact was made through copper nails driven three inches into the tree. Ground contact was made thru a bundle of copper wire buried three feet deep in moist soil. Three grounds were installed so that the individual resistances could be determined. An average value for this resistance with direct current was 150 ohms.

At radio frequencies, on account of capac-

istance is particularly pronounced for small heights and long wave length.

It is interesting to note that no correspondence is to be observed between the resistance curves when plotted from curves I and II, as determined by these measurements, and the curves representing the radiation resistance of a simple vertical wire.

The explanation of such large resistance values in case of tree antennae is probably to be found in the effect of the immediate proximity of partially conducting media to the conducting lead.

Referring to the general theory of alternating current systems, it can be shown that the receiver constants for which a maximum energy extraction from the antenna is obtained are: (1) The receiver inductance should be such as to resonate with the apparent antenna capacity at the frequency in question, (2) An effective receiver resistance equal to the apparent resistance of the antenna at the frequency in question.

An inspection of the foregoing shows that, in general, the effective antenna resistance is many times the apparent resistance of antenna as ordinarily used, and that,

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