E. F. W. ALEXANDERSON.

ANTENNA.

APPLICATION FILED FEB. 15, 1918.

1,360,168. Patented Nov. 23, 1920.

Fig. 1.

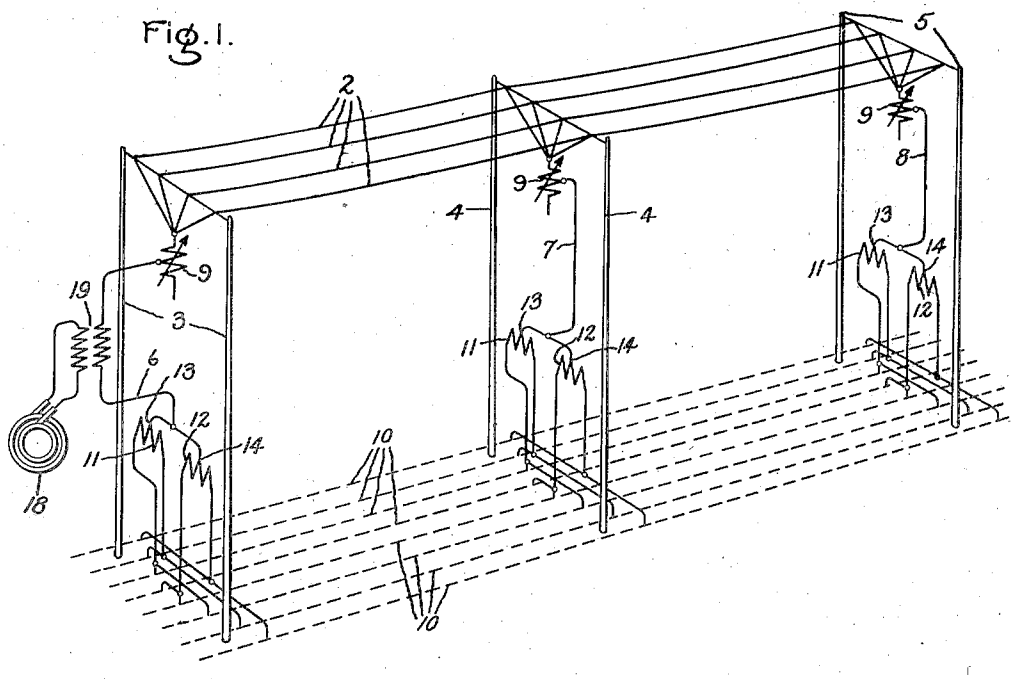
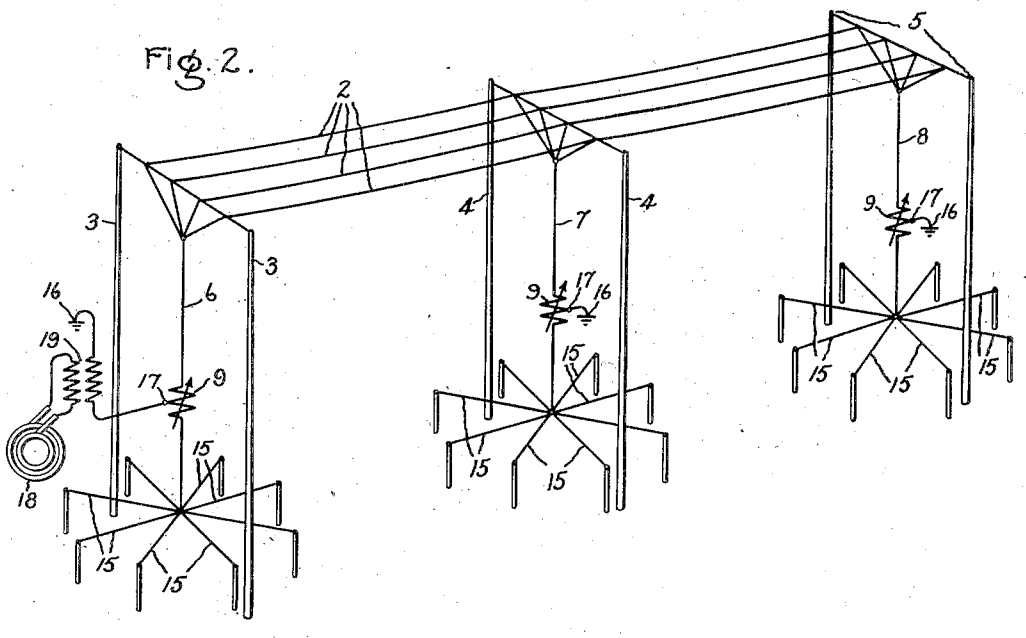



Fig. 2.

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# UNITED STATES PATENT OFFICE.

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## ANTENNA.

1,360,168. Specification of Letters Patent. Patented Nov. 23, 1920.

Application filed February 15, 1918. Serial No. 217,379.

*To all whom it may concern:*

Be it known that I, ERNST F. W. ALEXANDERSON, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Antennæ, of which the following is a specification.

My present invention relates to antennæ for radio signaling systems and more particularly to ground connections for a radiating antenna system.

One method which has heretofore been employed for grounding an antenna consists in burying a network of ground conductors beneath the antenna, covering an area of about the same order of magnitude as that covered by the elevated conductors and connecting the antenna to a single point in this network. With such an arrangement there is a tendency for the conductors or the portion of the network nearest the ground connection to collect nearly all of the ground current while those portions located farthest from the ground connection collect but very little current. As a result the ground resistance of the system is much greater than it would be if the ground current were equally divided among all of the conductors.

One of the objects of my invention is to secure a system of connections to the ground conductors which is arranged in such a way that the current in the ground will be divided substantially equally among all of the buried conductors, and the ground resistance will be a minimum.

In attaining this object I provide a plurality of connections between the antenna and the ground conductors at points distributed as uniformly as possible over the area covered by the overhead system. This may conveniently be done by arranging a system of conductors which are elevated a short distance above the earth and which extend in multiple, from the lower end of the usual vertical conductor coming down from the aerial, to each of the points chosen in the buried system. By a suitable arrangement of balancing coils the connections may be made to the vertical conductor in such a way as to cause equal current to flow in all of the ground connections.

A further object of my invention is to provide means for reducing the ground resistance of the system to a value lower than that which can be obtained with the grounding system described above and at the same time retain all of the advantages of a system having a direct ground connection.

In attaining this object of my invention I provide a capacity ground constructed in a similar manner to an insulated counterpoise and operate this capacity ground in multiple with the buried network. This capacity ground is connected to the aerial through a greater impedance than the impedance connecting the aerial to the buried network so that in effect the potential impressed thereon is ultranegative with respect to that impressed upon the buried network.

The novel features which I believe to be charactertistic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation together with further objects and advantages thereof will best be understood by reference to the following description taken in connection with the accompanying drawing in which Figure 1 shows diagrammatically a method of connecting the antenna to the grounding system and Fig. 2 shows the application of capacity grounds to the antenna.

As indicated in Fig. 1 the radiating antenna comprises a plurality of horizontal wires 2 supported by the towers 3, 3; 4, 4; and 5, 5. Vertical conductors 6, 7 and 8 are provided for connecting the antenna to ground at each pair of supporting towers. This method of providing multiple grounds for an antenna is described and claimed in my co-pending application, Serial No. 191,110, filed Sept. 13, 1917, which is a continuation of my application, Serial No. 123,276 filed October 2, 1916. Each of these vertical conductors includes the usual loading coil 9. A ground for the system is obtained by means of a plurality of conductors 10 buried in the earth beneath the antenna and extending over an area as large as or somewhat greater than that covered by the antenna. In employing a ground of this type it has been customary to connect all of the buried conductors together by underground conductors and to connect a single point in the network to the lower end of the vertical con-

ductor. With such an arrangement however, the part of the network, nearest the point of connection will collect the greater part of the current and as a result the ground resistance is greater than it would be if all equal portions of the network collected equal currents. I have overcome this disadvantage by providing connections above the earth between the lower ends of vertical conductors 7 and each of the buried conductors 10. In order to make these connections in such a way that the current will divide equally among all of the conductors I have, in the system illustrated, provided balancing coils 11 and 12 and connected the vertical conductors 6, 7 and 8 to points 13 and 14 between the ends of these coils as indicated. One end of balancing coil 12 is connected to the two outer conductors of the buried system and the other end is connected to the two central conductors. One end of balancing coil 11 is connected to the two conductors immediately adjacent the outer conductors and the other end is connected to the two conductors immediately adjacent the central pair of conductors. By properly choosing the points of connection 13 and 14 the potentials in the grounding system may be so balanced that the ground current will be equally divided among all of the conductors and under these conditions the multiple resistance will be a minimum.

I have found that the ground resistance may be reduced still more by employing capacity grounds in multiple with the system of buried conductors as indicated in Fig. 2. In the present case the capacity grounds consist of a plurality of horiontal conductors 15 radiating from the foot of the vertical conductors 6, 7 and 8 and insulated from earth. The conductors 15 are all connected to the lower ends of the loading coils 9 and the ground conductors 16 which may be of the form shown in Fig. 1 or any other desired form are connected to the points 17 which are located between the two ends of the loading coils. By connecting the capacity ground to the loading coils in this way the potential impressed thereon will be ultra negative with respect to that on the ground conductors.

Capacity grounds, or radial counterpoises have been used heretofore without any direct connection to earth. The object of the counterpose in such a case is to prevent the electrostatic lines from passing through the ground, the counterpoise acting as a screen between ground and antenna in such a way that the electrostatic lines go directly to the counterpoise. Such a counterpoise has an indefinite or floating electrostatic potential and is not grounded at all. In the arrangement which I have described, however, the capacity ground does not function in the same manner as the usual counterpoise as its principal function is to draw current from the ground. Hence the contact between the antenna and ground includes not only the contact surface of the buried wires but also the capacity connection between the conductors 15 and ground.

I have found that by using the two methods of grounding in conjunction with each other the ground resistance of the antenna is reduced to a value lower than can be obtained with either one separately. The use of a grounded system instead of a floating counterpoise also has several practical advantages. The alternator 18 which supplies current to the antenna through the transformer 19 is connected to a ground circuit and is therefore protected from static potentials. The antenna itself is also protected from atmospheric disturbances by being permanently grounded at several points through the different loading coils.

While I have shown and described only one way in which each of the two features of my invention may be carried into effect it will be apparent that many modifications in the specific application of my invention may be made without departing from the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. A grounding system for a radiating antenna comprising a plurality of paths to ground of unequal length from the lower end of a vertical conductor extending downwardly from the antenna, and inductive means for distributing the current through the several paths in such a way as to obtain a minimum multiple resistance.

2. A grounding system for a radiating antenna comprising a plurality of paths to ground of unequal length from the base of a vertical conductor extending downwardly from the antenna, and inductive means for distributing the current in substantially equal parts among the different paths.

3. A radiating antenna system comprising an elevated network extending over a considerable area and supplied with radio frequency current, a system of conductors buried in the ground beneath said network, a plurality of connecting wires carrying the charging current of the network to points in the system of ground conductors located at unequal distances from the lower end of a vertical conductor extending downwardly from the network, and inductive means for distributing the current in substantially equal parts between the different points in the ground system.

4. A radiating antenna system comprising a plurality of elevated conductors extending over a considerable area and supplied with radio frequency current, a system of conductors buried in the earth beneath said elevated conductors, a vertical

conductor extending downwardly from said elevated network and connecting conductors from the lower end of said vertical conductor to a plurality of points in said system of buried conductors which are located at unequal distances from the lower end of said vertical conductor, all of said connecting conductors being elevated above the earth and being connected to the system of buried conductors in such a way that the current in the system will be divided substantially equally among all of said connecting conductors.

5. A radiating antenna system comprising a plurality of horizontal elevated conductors extending over a considerable area and supplied with radio frequency current through a ground connection, a plurality of separate ground conductors buried in the earth extending from said ground connection parallel with the elevated conductors, and a plurality of connecting conductors between the lower end of a vertical conductor extending downwardly from the elevated conductors and said ground conductors, all of said connecting conductors being elevated above the earth and being connected to said ground conductors in such a way that the current in the system will be divided substantially equally among all of said connecting conductors.

6. A radiating antenna system comprising an elevated conducting network extending over a considerable area and supplied with radio frequency current, a plurality of vertical conductors extending downwardly from said network at points substantially uniformly distributed in said network, a system of ground conductors buried in the ground beneath said network, a plurality of connecting wires extending from the lower end of each vertical conductor to points in the system of ground conductors located at unequal distances therefrom, and means for distributing the antenna current in substantially equal parts between the different points in the ground system.

7. A radiating antenna system comprising a plurality of substantially horizontal elevated conductors extending over a considerable area and supplied with radio frequency current, a system of ground conductors buried in the earth and extending parallel with said elevated conductors, a plurality of vertical conductors extending downwardly from said elevated conductors, and a plurality of connecting conductors extending from the lower end of each vertical conductor to points in the system of ground conductors located at unequal distances therefrom, and inductive means for distributing the antenna current in substantially equal parts between the different points in the ground system.

8. A grounding system for a radiating antenna system comprising both a conductive and a capacity path to ground from a vertical conductor leading downwardly from the antenna, said ground path comprising connections to a plurality of ground points located at unequal distances from the base of the vertical conductors, and inductive means for distributing the current to the several ground points in such a way as to obtain a minimum multiple resistance.

9. A radiating antenna system comprising an elevated conducting network extending over a considerable area and supplied with radio frequency current, a plurality of ground connections for said elevated system, a second system of conductors insulated from earth extending over the area between said network and earth, and connections between the elevated network and said second system of conductors including means whereby a potential is impressed thereon which is ultranegative with respect to the earth potential of the system.

10. A grounding system for a radiating antenna comprising a ground conductor buried in the earth and extending over an area of the same order of magnitude as that covered by the antenna and a system of conductors insulated from the ground and connected to the antenna in such a way that the antenna current will divide between the ground conductor and the insulated system.

11. A radiating antenna system comprising an elevated conducting network extending over a considerable area and supplied with radio frequency current, a system of ground conductors buried in the earth beneath said network and extending over an area of the same order of magnitude as said network and a system of conductors elevated above the earth and insulated therefrom, and connected to said network in such a way that the antenna current will divide between the ground conductors and the insulated system.

12. A radiating antenna system comprising a plurality of substantially horizontal elevated conductors supplied with radio frequency current, a ground connection for said elevated conductors, a horizontal conducting network insulated from earth and connections from said elevated conductors to said conducting network whereby a potential is impressed on said conducting network which is ultra-negative with respect to the earth potential of the system.

13. A radiating antenna system comprising an elevated conducting network supplied with radio frequency current, an inductance having one terminal connected to said elevated network and its other terminal connected to a second system of conductors which is insulated from earth and extends over the area between the elevated network and earth, and a ground connection to an intermediate point in said inductance.

14. A radiating antenna system comprising an elevated conducting network extending over a considerable area, a plurality of vertical conductors extending downwardly from said network, a ground connection for each of said vertical conductors, a second system of conductors insulated from the earth and extending over the area between said network and earth, and connections between each of said vertical conductors and said second system of conductors whereby a potential is impressed thereon which is ultra-negative with respect to the earth potential of the system.

In witness whereof, I have hereunto set my hand this 14th day of February, 1918.

ERNST F. W. ALEXANDERSON.