July 29, 1941. C. W. HANSELL 2,250,531

ANTENNA

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Fig. 1

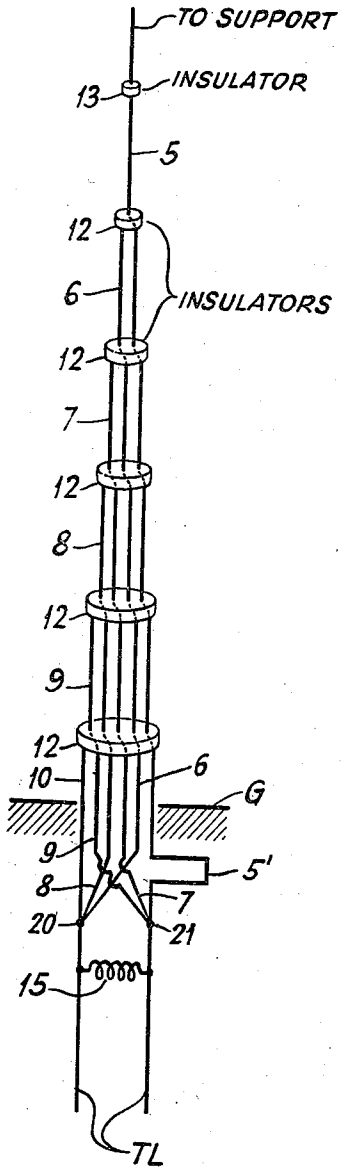
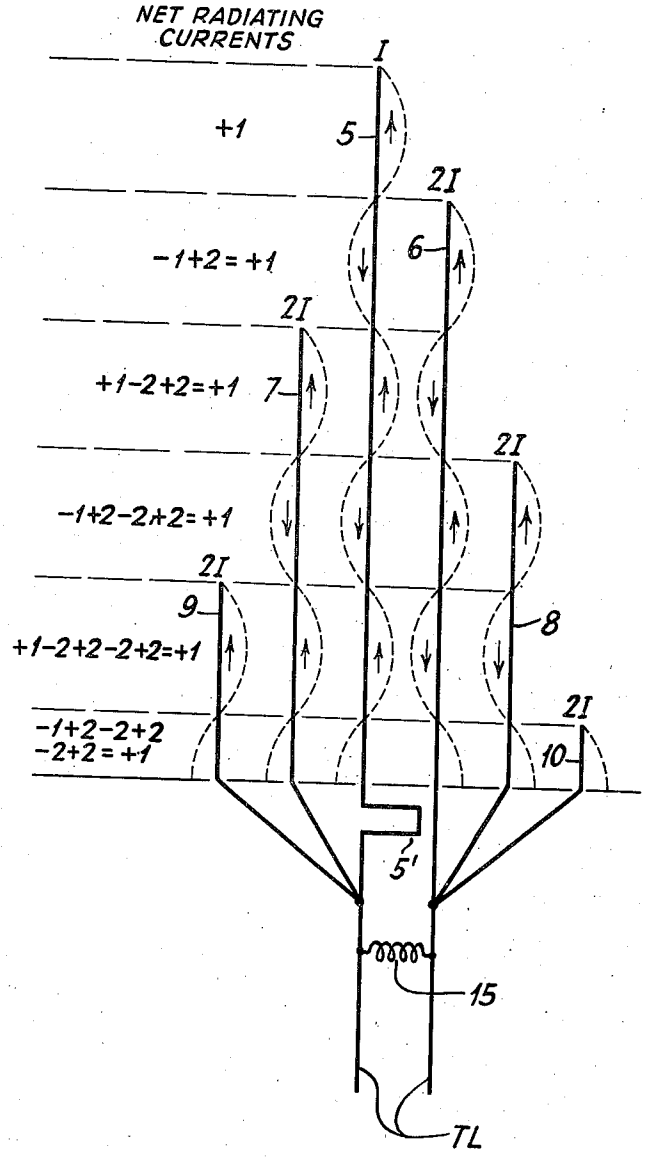


Fig. 2



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14 Claims. (Cl. 250—33)

This invention relates to antennas and, more particularly, to antennas for the transmission of short radio waves with a substantial vertical directivity and with little or no horizontal directivity but at the same time giving uniform and maximum radiation in the horizontal plane.

An object of the present invention is to provide a simple mechanical antenna arrangement for use with short waves which is equivalent in its effect to a series of co-linear dipoles energized in the same phase with respect to one another.

Another object of the present invention is to provide a mechanically simple antenna structure which is adapted to be readily mounted on the top of a high building or tower or, alternatively, which may be supported from a single tall mast.

These, and other objects which may appear from a reading of the specification, are achieved, according to the invention, by providing an antenna consisting of a group of closely spaced parallel vertical conductors of varying length. The shortest of these conductors has an effective length of radiating portion equal to approximately a quarter of the length of the operating wave and the other conductors are progressively longer by multiples of a half the length of the operating wave. The conductors are so energized that the currents in the other upper half wave portions of the longer conductors are in phase with the current in the quarter wave length conductor, the intensity of energization of the longest conductor being preferably half of that of each of the others.

With such an arrangement there is obtained the equivalent of a co-linear series of vertical dipole antennas each of which carry current in the same direction at any instant of time.

The antenna of the present invention may be constructed of wires suspended from a mast or other support or it may be constructed of rods of sufficient size to be self-supporting. Furthermore, as an alternative form of construction the antenna may consist of a nested series of tubes of progressively increasing diameters, the largest tube being a quarter of the length of the operating wave in length and the other tubes being progressively longer by multiples of a half the length of the operating wave. Each of the tubes is insulated from the others throughout its entire length and so energized that the currents in the outer exposed and radiating half wave portions are all in the same phase relationship.

A more complete understanding of the invention may be had by reference to the following detailed description, which is accompanied by a drawing in which Figure 1 shows an embodiment of the present invention, while Figure 2 shows the antenna of Figure 1 in an exploded form with the current relationships diagrammatically indicated along each wire.

Referring to Figure 1, letter G denotes a metallic ground plate or other effective neutral plane for the antenna. In the antenna conductor 5 is the longest of the antenna conductors 5, 6, 7, 8, 9 and 10, each being progressively a half wave length shorter than the preceding wire. Conductor 10 is a quarter of a length of the operating wave in length. The antenna wires are supported in position by insulators 12 and 13. Insulator 13 is connected by any suitable means to a support which is not shown. Alternate wires of the antenna are connected together so as to be fed in the same phase relationship and connected to opposite sides of the transmission line TL. A suitable impedance matching coil 15 may be provided in order to properly match the impedance of the antenna to the impedance of the transmission line.

The current fed to conductor 5 must have an intensity of half of that supplied to each of the other wires. This may be obtained by either making the longest wire smaller than the others so that the logarithms of their diameters differ by about 2 to 1, or it may be done by so arranging the length of the feed connection that a reactance, either inductive or capacitive, may be inserted in series with the long wire as indicated by loop 5'. In practice, substantially correct relative currents and phase relations may be obtained by adjusting the relative lengths of connections to each antenna conductor. Considering the standing electrical waves on each wire, due to reflections from the upper ends, it is desirable that the connection points 20, 21 be at a point on each conductor not too near a maximum or minimum of potential or current in order that correct phase relations may result automatically. Also, conductor 5 should connect at a point on the standing wave different from that of the other conductors, i. e. at a higher percentage potential point, in order that correct current may be obtained.

As a modification of this second form appropriate reactances may be inserted in series with all of the wires of the antenna, provided the overall length of each wire is not too close to a multiple of one-quarter wave electrically.

As another means of feeding the antenna each wire may be fed by tapping a tank circuit, the tops being so disposed as to force the desired current distribution and phase relationship in the wires.

In practice, the wires of the antenna will ordinarily be made with physical dimensions slightly less than indicated in order to allow for the end effect. Preferably, the wires should differ in length by half waves electrically rather than physically, although in most cases the difference will be small.

In Figure 2, the antenna is shown in an exploded form so that the connections of the transmission line to the wires and the phase relationship of the currents may be more readily seen. The current in the long wire **5** is indicated by I and in order to indicate that the intensity of the current in the wires **6**, **7**, **8**, **9** and **10** is twice that of the current in the wire **5**, the currents in these wires are indicated by **2I**. As shown by the chart on the side of Figure 2, the effective current in the top half wave section of wire **5** may be taken at a given instant as having an intensity and polarity +1. At the same instant in the next lower section the current will be of the same intensity and negative in polarity, while in conductor **6** a current of the same polarity as that in the top section of wire **5** exists but of twice the intensity. The resultant intensity in this section is therefore also +1. Similarly, as shown by the chart at the side of Figure 2, the resultant effective radiating current in each of the lower sections also is +1.

While I have particularly shown and described an embodiment of my invention, it is to be distinctly understood that my invention is not limited thereto but modifications within the scope of the invention may be made.

I claim:

1. An antenna comprising a plurality of closely spaced parallel conductors of lengths varying by a half the length of the operating wave and means for energizing said conductors so that the current in the end half wave portions are in phase, the intensity of energization of the longest of said conductors being a half that of each of the others.

2. An antenna comprising a plurality of closely spaced parallel vertical conductors of lengths varying by a half the length of the operating wave and means for energizing said conductors so that the currents in the upper half wave portions are in phase, the intensity of energization of the longest conductor being one half that of each of the others.

3. An antenna comprising a conductor which is long in terms of the length of the operating wave and having insulators attached thereto at points one half the length of the operating wave apart, a plurality of other conductors parallel to said first conductor, each conductor having one of its ends attached to a different insulator and means for so energizing all of said conductors that the currents in their end half wave portions are in phase, the current in said first conductor being one half the intensity of that in the remaining conductors.

4. An antenna comprising a conductor an odd multiple of a quarter the length of the operating wave in length and having insulators attached thereto at points one half the length of the operating wave apart, a plurality of other conductors parallel to said first conductor, each conductor terminating at a different insulator and means for so energizing all of said conductors that the currents in their end half wave portions are in phase, the current in said first conductor having an intensity one half of that in the remaining conductors.

5. An antenna comprising a conductor which is long in terms of the length of the operating wave and having insulators attached thereto at points one half the length of the operating wave apart, a transmission line connected to one end of said conductor, a plurality of other conductors also connected to said transmission line and parallel to said first conductor, each of said other conductors terminating at a different insulator, said conductors being so connected to said transmission line that the currents in their end one half wave portions are in phase, the current in said first conductor being adjusted to have an intensity of one half of that in the remaining conductors.

6. A short wave antenna comprising a plurality of closely spaced parallel conductors of varying length, the shortest of said conductors having a length equal to one quarter of the operating wave and the other conductors being progressively longer by multiples of a half the length of the operating wave and means for energizing said conductors so that the currents in the end half wave portions of said conductors are in phase, the intensity of energization of the longest conductor being one half that of each of the others.

7. A short wave antenna comprising a plurality of closely spaced parallel vertical conductors of varying length, the shortest of said conductors having a length equal to a quarter of the length of the operating wave and the other conductors being progressively longer by multiples of one half the length of the operating wave and means for energizing said conductors so that the currents in the upper half wave portions of said conductors are in phase, the intensity of energization of the longest conductor being one half that of each of the others.

8. An antenna comprising a plurality of closely spaced parallel conductors of lengths varying by a half the length of the operating wave and means for so energizing said conductors that the net effective radiation from all of the end half wave portions of said conductors is of equal intensity and in phase.

9. An antenna comprising a plurality of straight parallel conductors of lengths each varying by a half the length of the operating wave from the length of every other conductor, said conductors being so energized that the net effective radiation from all of the end half wave portions is of equal intensity and in phase.

10. An antenna comprising a plurality of straight closely spaced parallel conductors of lengths each varying by a half the length of the operating wave from the length of every other conductor and means for energizing said conductors so that the current in the end half wave portions are in phase.

11. An antenna comprising a plurality of closely spaced parallel vertical conductors of lengths varying by a half the length of the operating wave and means for so energizing said conductors that the net effective radiation from all of the upper half wave portions of said conductors is of equal intensity and in phase.

12. An antenna comprising a plurality of straight parallel vertical conductors of lengths each varying by a half the length of the operat-

ing wave from the length of every other conductor, said conductors being so energized that the net effective radiation from all of the upper half wave portions is of equal intensity and in phase.

13. An antenna comprising a plurality of straight closely spaced parallel vertical conductors of lengths each varying by a half the length of the operating wave from the length of every other conductor and means for energizing said conductors so that the current in the upper half wave portions are in phase.

14. A short wave antenna comprising a plurality of straight parallel conductors of varying length, the shortest of said conductors having a length equal to one-quarter of the operating wave and the other conductors being progressively longer by multiples of a half the length of the operating wave, and means for so energizing said conductors that the currents in the end portions of said conductors are in phase and the net effective radiation from all of the end portions is of equal intensity.

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