

July 9, 1935.

P. S. CARTER

2,007,640

ANTENNA

Filed Jan. 13, 1934

Fig. 1

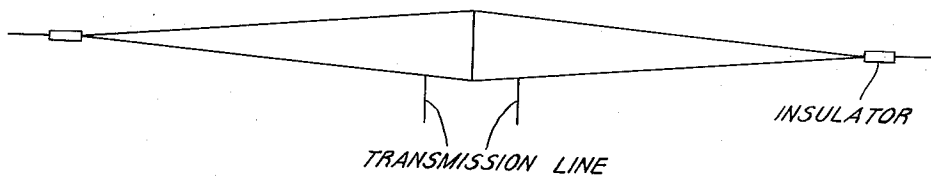


Fig. 2

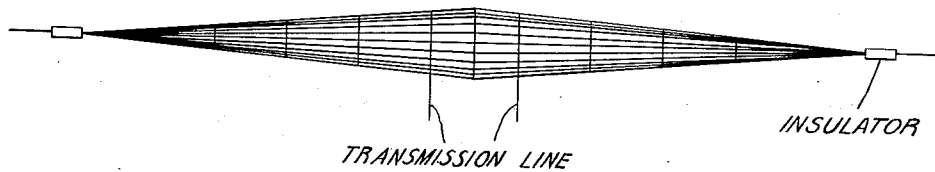


Fig. 3

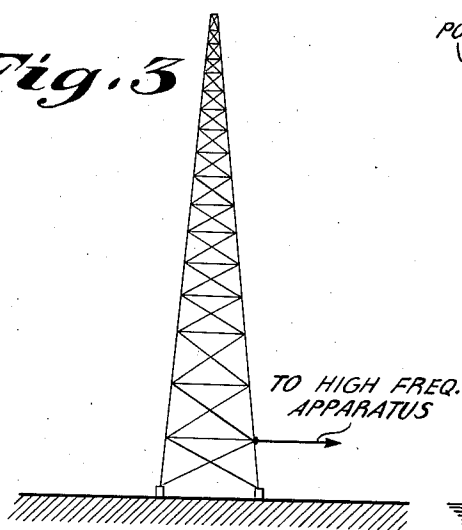
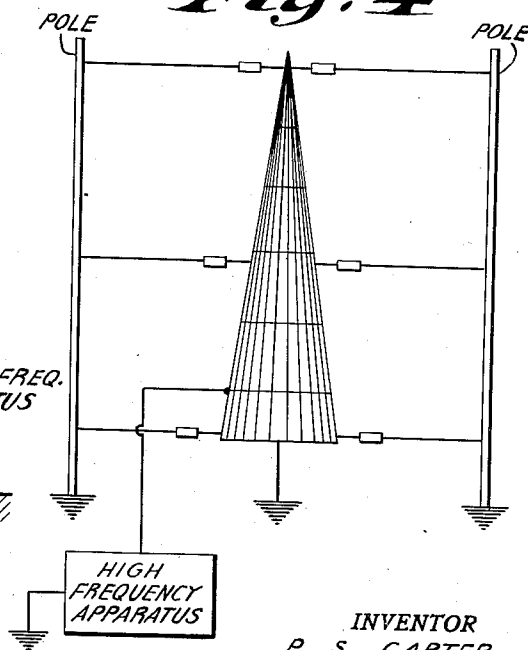


Fig. 4



INVENTOR
P. S. CARTER
BY *H. S. Grover*
ATTORNEY

UNITED STATES PATENT OFFICE

2,007,640

ANTENNA

Philip S. Carter, Port Jefferson, N. Y., assignor to
Radio Corporation of America, a corporation
of Delaware

Application January 13, 1934, Serial No. 706,530

2 Claims. (Cl. 250—33)

This invention relates to improvements in antenna, and one of its objects is to obtain from a radiating system an increase in concentration of radiation in the direction perpendicular to the antenna and, simultaneously therewith, an increase in radiation efficiency. A further object is to provide a system whose natural wave length of oscillation is less than that of the ordinary type of antenna customarily employed for communication purposes.

Both of these objects are accomplished, in accordance with the invention, by providing a radiating antenna with a variable cross-section constructed in such manner that the diameter varies approximately logarithmically.

It has been the practice in the past, in communication by radio, to employ as radiating elements one or more wires of constant diameter. When these are used for broadcasting purposes, it has been usual to suspend these radiating wires between two tall towers. By means of the present invention, however, and according to one embodiment thereof, the tower itself is used as a radiator and its effective diameter made to vary in a substantially logarithmic manner so as to obtain an increase in radiation resistance, as a consequence of which there is obtained an increase in the radiation efficiency and a decrease in high angle radiation, a result which reduces fading at the receiver due to causes such as interference between the waves radiated at high angles and ground waves. In the short wave field, however, where there are used wires of constant diameter having lengths approximately equal to half the length of the communication wave, the principal advantage of the invention lies in the increase in directivity obtained, as compared with the ordinary half wave length dipole radiator.

One important advantage of the present invention resides in the existence of a continual change in the characteristic impedance of the radiating line which results in a desirable current distribution therein. To illustrate, if the ordinary antenna of constant diameter having a length equal to half that of the communication wave were lengthened, the current therein would reverse, whereas by utilizing an antenna of variable cross-section in accordance with the invention, the current distribution is made to be very much like that in a half wave length line.

Referring to the drawing, Figure 1 illustrates, schematically, an antenna of the dipole type built according to the principles underlying the

present invention, and Figure 2 illustrates one of the embodiments which the structure of Figure 1 might take; Figure 3 illustrates an antenna where the tower itself comprises the radiating element, and Figure 4 shows an antenna utilizing only one half of the system of Figure 2.

A general outline of the theory of the operation of the invention follows: It is well known that the coefficients of inductance and capacity for a radiator having a constant diameter are very nearly equally distributed along its line, and that such a distribution of these constants can be shown mathematically to result in a sine wave distribution of the current. When the diameter of a radiator is made to vary logarithmically, the coefficient of inductance varies in a linear manner with the distance, but the coefficient of capacity varies in an inverse manner to that of inductance, so that the square root of the product of the two always remains equal to the reciprocal of the velocity of light. The resulting differential equation for the variation of the current along the wire is of the Bessel type. The general form of the current distribution is given by the sum of two zero order Bessel functions of the first and second kind, each multiplied by constants determined by the particular conditions. The argument in these functions is a factor depending upon the ratio of the maximum to minimum value of inductance and the distance from the ends. For the resonance condition the natural wave length will lie within the limits of $1.25L$ and $2L$, where L is the length, depending upon the particular logarithmic law of variation in the diameter. In the ordinary radiator the natural wave length, disregarding end effects, is $2L$. The current distribution for the radiator described in this invention, although theoretically given in terms of Bessel functions is of approximately a sine wave form wherein the velocity of propagation is assumed to be greater than light by the ratio of $2L$ to its natural wave length. Such a velocity is, of course, impossible but in the steady state the current distribution is approximately the same as though it actually existed.

By integration of or summing up the energy flow over an imaginary sphere surrounding this radiator, we find a considerable increase in radiation resistance as compared to that for the ordinary type of radiator.

One particular arrangement for practicing the invention is illustrated in Figure 1 wherein there is shown a dipole radiator which may be a solid or consist of a cage of wires as shown in Figure 2. If desired, the arrangements of Figures 1 and 2

may be cut at the center and one half used above ground, the second half being considered as the image below ground of the actual radiator used. Such an arrangement is illustrated in Figure 4.

5 A further embodiment is illustrated in Figure 3 which discloses the usual type of tower so shaped as to have a substantially logarithmic variation in diameter, the lattice work forming, in effect, a cage of wires without straying from the limitations of good structural engineering practice.

10 It is to be understood, of course, that the invention is not limited to the modifications shown, since there are any number of modifications varying considerably in structural details which will fall within the spirit and scope of the invention.

15 I claim:

1. An antenna comprising a horizontal dipole, said dipole having an over-all diameter which is greatest at its center and which decreases from the center toward both ends, and a two wire transmission line connected to said dipole at points 5 symmetrically disposed with respect to the center of said dipole.

2. An antenna comprising a horizontal dipole composed of an interconnected plurality of conductors, said dipole having an over-all diameter 10 which is greatest at the center and which decreases from the center toward both ends, and a two wire transmission line connected to said dipole at points symmetrically disposed with the center of said dipole.

15 PHILIP S. CARTER.