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3,208,069

ANTENNA WITH CONTROLLED VOLTAGE DISTRIBUTION

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FIG. 1

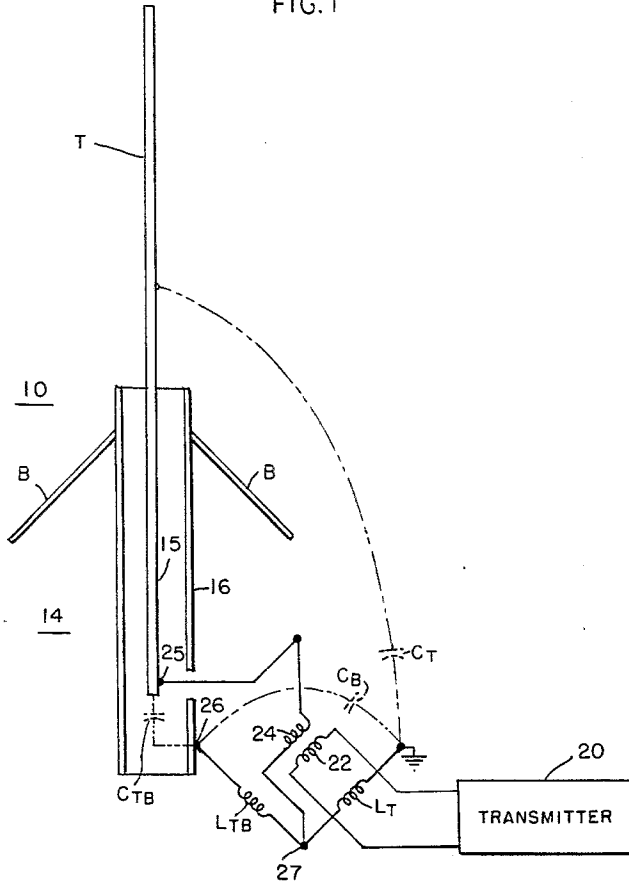


FIG. 2

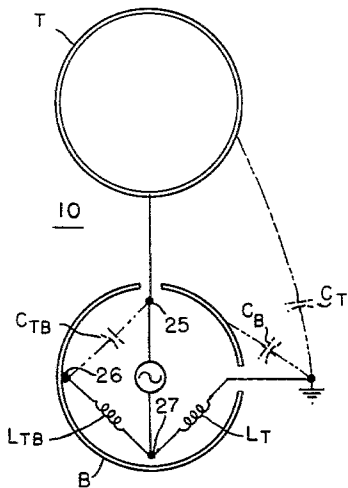
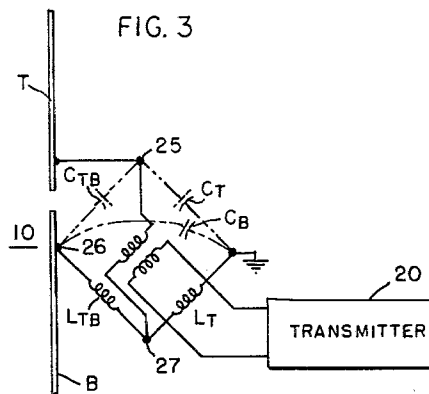


FIG. 3



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FIG. 5

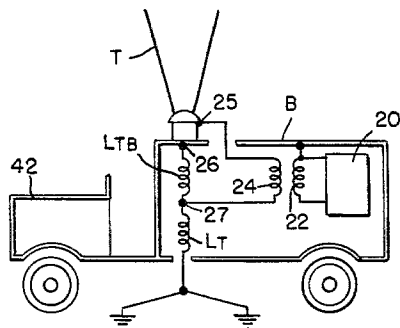
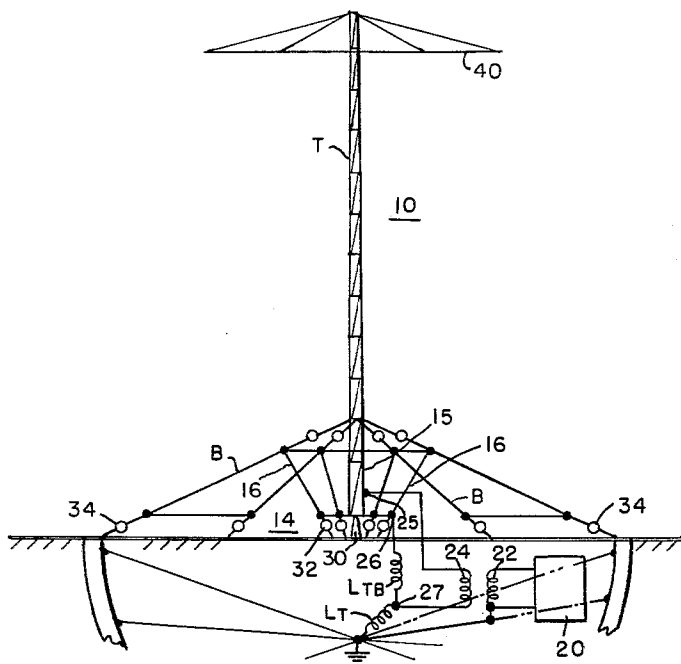


FIG. 4



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3,208,069 ANTENNA WITH CONTROLLED VOLTAGE DISTRIBUTION

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7 Claims. (Cl. 343-712)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment of any royalty thereon.

This invention relates to antennas and particularly to dipole antennas. More particularly, this invention relates to vertically mounted, electrically short, center-fed dipoles and to systems for their electrical excitation.

Center-fed dipoles are well known. When positioned horizontally, they present no technical problems in achieving effectiveness. In this orientation, the necessary coaxial, or balanced feed lines, can be positioned in the neutral, vertical plane of the dipole so that they will not influence the radiation pattern of the dipole.

Center-feeding can also be applied to vertically mounted dipoles and this is not difficult if the wave length is short enough, or if a self-contained transmitter-receiver radio set is used, and can be mounted high enough to be positioned in the neutral plane of the dipole. However, when the wave length is large compared with the height of the dipole, and the transmitter must be mounted near the ground for practical reasons, several problems become significant.

For example, the R.F. voltage built up between the lower half of the dipole and ground may be high enough to be hazardous to personnel. Also the unavailability of a neutral plane in which to arrange the feed line, the closer proximity of the ground, and the difference in the height of the halves of the dipole above ground causes distortion of the radiation pattern and additional losses in the antenna system. To make matters worse, these losses vary with differing locations, differing installations, and even differing climatic conditions, causing unpredictable variations in the electrical characteristics of the antenna, for example, inconsistency in the radiation pattern.

It is therefore an object of this invention to provide an improved center-fed, vertically-mounted dipole.

It is a further object of this invention to provide an improved, center-fed, vertically-mounted dipole wherein the bottom half of the dipole is kept at a minimum voltage with respect to ground.

It is a further object of this invention to provide a center-fed, vertically-mounted dipole having substantially reduced ground losses.

It is a further object of this invention to provide an improved, dipole-feeding circuit resulting in a better defined and predictable amplitude and phase relationship between the voltages and currents of the various elements of a center-fed, vertically-mounted dipole.

It is a further object of this invention to provide a center-fed, vertically-mounted dipole having an improved and more consistent radiation pattern.

These and other objects are accomplished by maximizing the ratio of the capacity between the top and bottom halves of the dipole, to the capacity between the bottom half of the dipole and ground, and connecting inductors between the bottom half of the dipole and one of the input terminals and between this one terminal and ground.

These inductors, in combination with the capacity of the top half of the dipole with respect to the bottom half and the capacity of the top half of the dipole with respect

to ground form a bridge circuit which is balanced when these inductors are chosen to match these capacities at the operating frequency. The transmission line to the transmitter or receiver is connected across one pair of diagonally opposing corners of this bridge through an isolating transformer, while the bottom half of the dipole and the ground potential point are connected to the other pair of diagonally opposing corners, respectively.

This invention will be better understood and other and further objects of this invention will become apparent from the following specification and the drawings, of which;

FIGURE 1 shows a diagram of a typically, vertical-mounted, center-fed dipole, connected to a transmission line in accordance with the teachings of this invention;

FIGURE 2 shows a more functional representation of the elements of this invention in the same general orientation;

FIGURE 3 shows the elements of this invention in circuit diagram form, positioned to illustrate the bridge concept;

FIGURE 4 shows a physical embodiment of this invention for a fixed installation; and

FIGURE 5 shows a physical embodiment of this invention as applied to a mobile unit.

Referring now more particularly to FIGURE 1, a dipole 10 is vertically mounted. Its top half T and its bottom half B are fed at the electrical center of the dipole through a coaxial feed line 14. The coaxial feed line has a center conductor 15, connected to the top half of the dipole, and an outer conducting shield 16 connected to the bottom half of the dipole.

The dipole antenna is electrically excited by a transmitter 20 connected through inductively coupled coils 22 and 24 representing an example of an isolating transformer and compensating coil L_{TB} to the terminals 25 and 26 of the coaxial feed line. An additional compensating coil L_T is connected between ground and the junction 27, of the coils L_{TB} and 24. The capacities between the top and bottom halves of the dipole, and ground are shown in dotted lines and labeled C_T and C_B respectively. The capacity between the halves of the dipole is labeled C_{TB} .

The interaction of the elements of the dipole and ground, and the excitation system may be more clearly seen in FIGURE 2, in which the capacitive spheres T and B represent the top and bottom halves of the dipole 10, respectively, and are labeled—as are the other elements of all the figures in these drawings—to relate to the corresponding elements of FIGURE 1.

The source of energy across the terminals 25 and 27 is represented by the symbol for an alternating current generator, instead of including all of the elements 20, 22, and 24 of FIGURE 1. The capacity C_{TB} between the top and bottom halves of the dipole is compensated for by the inductor L_{TB} connected between the terminal 26 of the bottom half of the dipole and the terminal 27. The capacity C_T between the top half of the dipole and ground is compensated for by the inductor L_T connected between the terminal 27 and ground.

The bridge circuit formed by this interconnection of elements is more clearly seen in FIGURE 3 where all of the elements of the system are represented by their circuit diagram symbols. The capacities C_{TB} and C_T , connected between the bottom half of the dipole and ground, form one path between a first pair of the diagonally opposing corners of the bridge and the inductors L_{TB} and L_T form the other path of the bridge between the same diagonally opposing corners.

The bridge input terminals 25 and 27 are connected to a second pair of the diagonally opposing corners of the

bridge and, as in FIGURE 1, these are fed through the inductively coupled coils 22 and 24.

In operation, the electrical excitation is applied across the second pair of diagonally opposing corners of the bridge, whose arms are balanced so that no signal appears across the first pair.

This holds the bottom half of the dipole at ground potential, which reduces or eliminates the R.F. voltage and current between the bottom half of the dipole and ground, or electrically neutralizes the bottom half of the dipole with respect to ground.

The reduction of the ground currents reduces the ground losses usually encountered and the discontinuities and inconsistent operation resulting from the facts that the effectiveness of the ground connection depends to a large degree on the skill of the man who constructed the grounding elements; that the effective ground will vary from location to location, and with different types of soil and terrain; and that the effective ground will even vary with seasonal and daily changes in the moisture in the ground.

The electrically neutralizing of the bottom half of the dipole with respect to the voltage to ground also reduces the hazard to the personnel who have to operate the transmitter, which should be—and, in mobile operation, must be—situated close to the dipole.

If the bottom half of the dipole is held substantially at ground potential, while the dipole is being electrically excited, it is obvious that the other elements of the antenna and certain parts of the connecting lines must be free to vary in potential with respect to ground and to carry higher voltages, in some cases, than they would normally carry.

For example, the dipoles must be fed from a "floating" source; either an ungrounded transmitter, or, more practically, through an inductively-coupled, ungrounded coil, such as 24 of FIGURES 1 and 3, or by using a coaxial cable for the winding of inductor L_T which serves as transmission line. Other means for "isolating" the input terminals from ground are readily apparent to those skilled in the art. In this case, the transmitter itself may be grounded for safe and effective operation.

A practical example of this invention is seen in FIGURE 4. The top half of the dipole T is the extension of the tower structure that continues as the center conductor 15 of the coaxial feed line 14 whose outer shield is provided by the wires 16. The bottom half of the dipole is provided by the wires B and has a "skirt" configuration.

This configuration serves to maximize the ratio of the capacity between the top and bottom halves of the dipole, to the capacity between the bottom half of the dipole and ground, which minimizes the ground losses of the system.

The transmitter 20 supplies the electrical excitation through the inductively coupled coils 22 and 24, to the terminals 25 and 27 as in FIGURE 1 and the compensating inductors L_{TB} and L_T are connected as before.

The center element 15 is insulated from ground by the insulator 30; the outer shielding wires 16 of the coaxial feed lines 14 are insulated from ground by the inductors 32; and the wires B of the bottom half of the dipole are insulated from ground by the insulators 34.

An "umbrella" 40 of a well-known type is positioned at the upper extremity of the top half of the dipole to increase the effective capacitive loading of the antenna.

FIGURE 5 illustrates another practical embodiment of this invention. In this figure the dipole is incorporated in a mobile unit, with the top half T of the dipole projecting through the body of the vehicle, which serves as the bottom half B of the dipole. The coaxial connecting cable is not necessary, in this embodiment of the invention, since the transmitter 20 and inductively coupled coils 22 and 24 are adjacent to the top half of the dipole and all of these elements, as well as the coils compensat-

ing for the various capacities of the dipoles are all within the vehicle.

A ground connection is shown below the vehicle. It will be noted that the ground connection carries only the current through C_T . In order to present low ohmic resistance to this current it is advisable to provide for a ground system, outside the confines of the skirt or its equivalent, which collects as great a portion as possible, or economically feasible, of the total electric displacement between antenna top and ground.

This embodiment is particularly well suited to the advantages of this invention, since the high voltages that might be developed between the bottom half of the dipole and ground would be more serious in mobile, or vehicular, applications due to the proximity of personnel and the difficulty of isolating and shielding the antenna elements, or taking other safety precautions that are much easier in fixed applications.

The advantage of minimizing the effect of ground is also valuable in that mobile units have to operate under varied terrain conditions where the effective ground must inevitably vary with each condition.

What is claimed is:

1. An antenna feed system comprising a vertically mounted dipole having a first capacity, between its top and bottom halves, and a second capacity, between its top half and ground, said capacities having a given ratio; a first and second input terminals; said first input terminal connected to said top half; a first inductor connected between said second input terminal and said bottom half; a second inductor connected between said second input terminal and a ground terminal; and a transmitter connected between said first and second input terminals, the inductances of said first and second inductors having said given ratio.

2. An antenna feed system comprising a vertically mounted dipole having a first capacity, between its top and bottom halves, and a second capacity, between its top half and ground, said capacities having a given ratio; a first and second input terminals; a coaxial cable having its center conductor connected between said first terminal and the top half of said dipole and its outer shield connected to the bottom half of said dipole; a first inductor connected between said second input terminal and said coaxial cable shield; a second inductor connected between said second input terminal and a ground terminal; and means for connecting a transmitter between said first and second input terminals, the inductances of said first and second inductors having said given ratio.

3. An antenna feed system as in claim 2 wherein the top half of said dipole comprises a vertical projection of said center conductor beyond one end of said coaxial cable, and the bottom half of said dipole comprises a series of conductors connected to and projecting downwardly from said outer shield near said one end of said coaxial cable.

4. An antenna system as in claim 2 wherein the top half of said dipole and the center conductor of said coaxial cable comprise a vertically mounted metallic tower; and the lower half of said dipole comprises a plurality of radial guy wires connected to the lower half of said tower but electrically insulated from ground and from said tower; and the outer shield of said coaxial cable comprises a plurality of wires connected between said guy wires and ground, but electrically insulated from ground, and extending a substantial distance along the length of said tower.

5. A bridge circuit for feeding a dipole antenna comprising a first and second diagonally opposing terminals; a third and fourth diagonally opposing terminals; the top half of a vertically mounted dipole connected to said first terminal; the bottom half of said dipole connected to said third terminal; a first inductor connected between said second and third terminals; a second inductor connected between said second and fourth terminals; said

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fourth terminal connected to ground; and means for connecting a transmitter between said first and second terminals, the ratio of the capacity between the top and bottom halves of said dipole to the capacity between the top half of said dipole and ground being equal to the ratio of the inductance of said first inductor to the inductance of said second inductor.

6. A bridge circuit for feeding a dipole antenna comprising a first and second diagonally opposing terminals; a third and fourth diagonally opposing terminals; a coaxial cable having its center conductor connecting the top half of a vertically mounted dipole to said first terminal, and its outer shield connecting the bottom half of said dipole to said third terminal; a first inductor connected between said second and third terminals; a second inductor connected between said second and fourth terminals; said fourth terminal connected to ground; and a transmitter connected to the primary of a transformer; the secondary of said transformer connected between said first and said second terminals, the ratio of the capacity between the top and bottom halves of said dipole to the capacity between the top half of said dipole and ground being equal to the ratio of the inductance of said first inductor to the inductance of said second inductor.

7. A feed system for a vehicular mounted dipole wherein the body of the vehicle is the bottom half of said dipole and a vertically mounted conductor, projecting

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from the roof of said vehicle, is the top half of said dipole comprising a transmitter connected to the primary of a transformer; one terminal of the secondary of said transformer connected to said vertically mounted conductor; a first inductor connected between the other terminal of said secondary and the body of said vehicle; and a second inductor connected between said other terminal of said secondary and the ground beneath said vehicle; the ratio of the inductance of said first inductor to the inductance of said second inductor being equal to the ratio of the capacity between the top and bottom halves of said dipole to the capacity between the top half of said dipole and the ground beneath said vehicle.

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