United States Patent

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[73] Assignee The United States of America, as represented by the Secretary of the Army

[54] **FORESHORTENED LOG-PERIODIC ANTENNA EMPLOYING INDUCTIVELY LOADED AND FOLDED DIPOLES**
6 Claims, 3 Drawing Figs.

[52] U.S. Cl. 343/792.5, 343/802, 343/814, 343/895
[51] Int. Cl. H01q 11/10
[50] Field of Search 343/749, 751, 792.5, 803, 802, 814, 895

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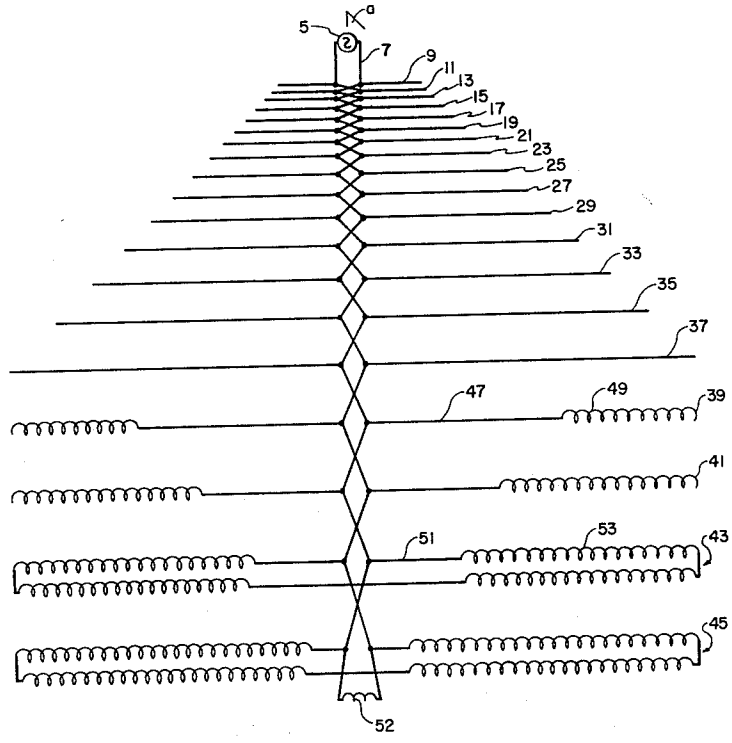
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ABSTRACT: Some of the lower frequency elements of this planar dipole log periodic antenna are inductively loaded to reduce the size thereof and others of said lower frequency elements are both loaded and folded, and in addition the dipoles are provided with a mounting and supporting boom which also functions as a balanced low impedance transmission line.



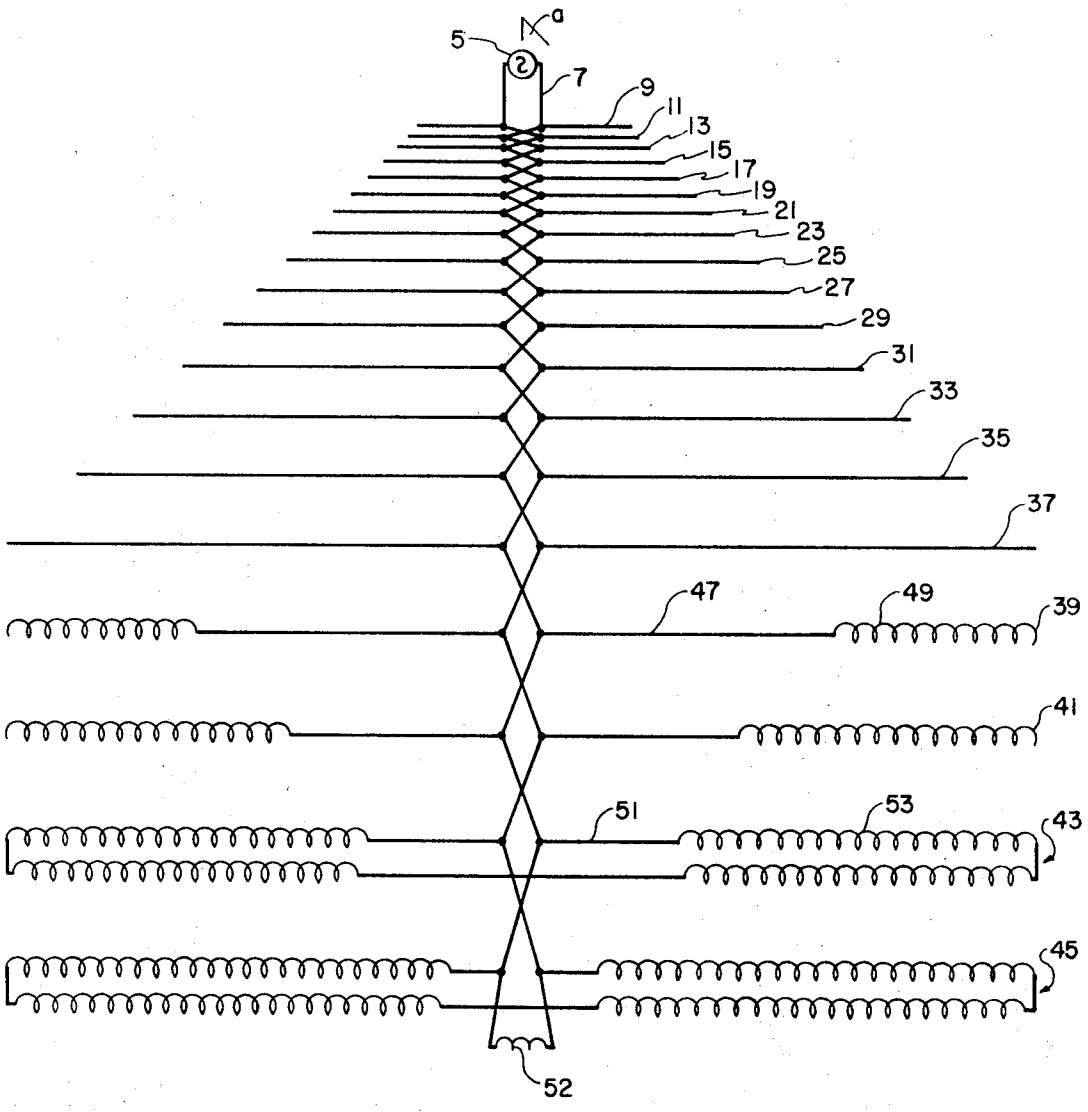


FIG. 1

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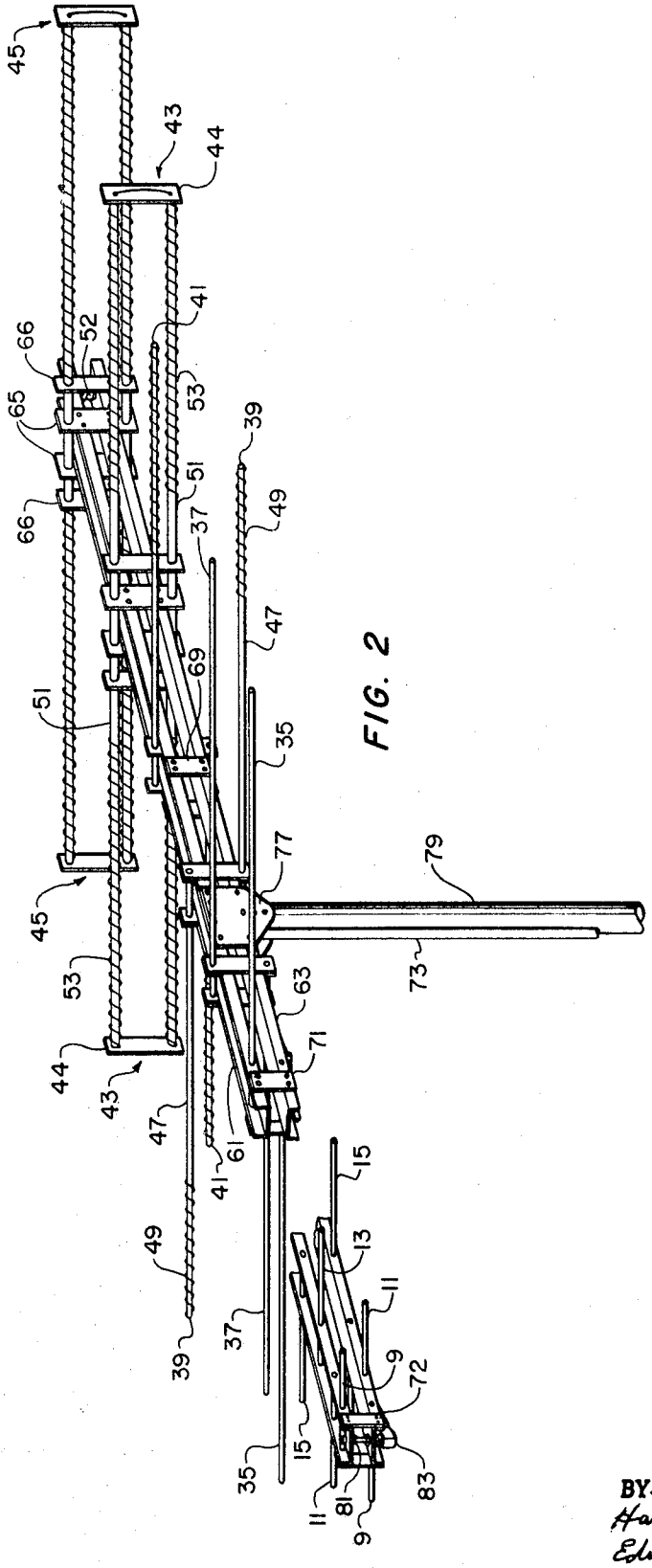


FIG. 2

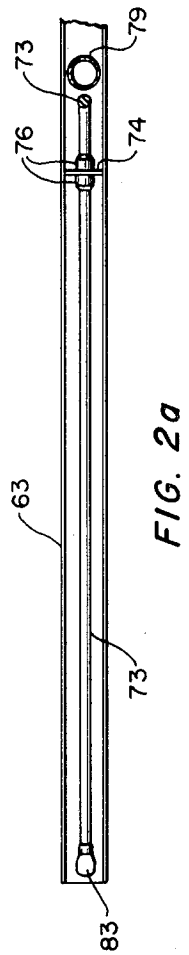


FIG. 2a

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FORESHORTENED LOG-PERIODIC ANTENNA EMPLOYING INDUCTIVELY LOADED AND FOLDED DIPOLES

This invention relates to a novel and useful log periodic antenna, and more particularly to such an antenna in which size reduction has been achieved without appreciable degradation in antenna performance. The invention is illustrated herein in connection with a planar dipole-type log periodic structure in which slow-wave structures are used to load and hence to foreshorten the lower frequency elements of the antenna. To counteract the tendency of a loaded dipole to lower its impedance, one or more of the heavier loaded dipoles are folded. In addition, the horizontal boom which supports the dipoles comprises a pair of back-to-back channels which form a balanced transmission line of low characteristic impedance. The coaxial feed cable is connected to the boom in such a way that the required unbalance-to-balance transformation is effected.

It is thus an object of this invention to provide a planar dipole-type log periodic antenna of compact construction with uniform electrical characteristics over its entire frequency range.

Another object of the invention is to provide a compact and easily portable planar log periodic antenna in which a plurality of the lower frequency elements are inductively loaded to reduce the physical length thereof and in addition some of said elements are folded.

A further object of this invention is to provide a log periodic antenna in which some of the elements are unloaded, unfolded dipoles and the remainder are loaded dipoles and in addition at least one of said remainder of said dipoles is folded to increase the impedance thereof.

A further object of the invention is to provide a compact planar dipole-type log periodic antenna in which some of the lower frequency elements thereof are loaded and others of said lower frequency elements are both loaded and folded, and in addition said antenna is provided with a mounting and supporting boom which also functions as a balanced low impedance transmission line.

These and other objects and advantages of the invention will become apparent from the following detailed description and drawings, in which:

FIG. 1 is a schematic diagram showing the electrical features of the antenna itself; and

FIG. 2 is an isometric pictorial view of the same antenna.

FIG. 2*a* is a bottom view of the boom.

Referring first to FIG. 1, this drawing is a top view of a particular antenna embodying the principles of the invention and designed to operate over a 3½octave range from 20 to 230 megahertz. The unloaded, unfolded dipoles 9 through 37 are tapered in length and spaced according to the well-known design principles of log periodic antennas. The half apex angle, a, was chosen as 45°, T=0.85 and σ=0.0375. With these design parameters, the unloaded, unfolded dipoles 9 through 37 cover the frequency range from 230 to 40 megahertz, the total span of the shortest dipole 9 being approximately 17 inches and that of dipole 37 approximately 160 inches. The lowest octave of the frequency range (20—40 megahertz) is covered by the four inductively loaded dipoles 39 through 45. All of these four dipoles are the same physical length as the dipole 37, but all have progressively longer electrical lengths due to different amounts of inductive loading. Each half of dipole 39 comprises an inner tubular portion 47 and an outer portion 49 comprising a helical wire which provides the inductive loading or slow-wave structure. The next dipole 41 is similar but the helical portion is longer to provide the required longer electrical length for this element. The two lowest frequency dipoles 43 and 45 are folded, dipole 45 being more heavily loaded than 43. FIG. 1 shows the two parallel parts of the folded dipoles side-by-side for easy visualization, however these parts are actually one above the other, as shown in the pictorial view of FIG. 2. The spacing between the foreshortened dipoles is the same as it would be with full-sized dipoles. An inductive termination 52 at the low-frequency end of the antenna improves the VSWR. As stated above, the loading of dipoles decreases the impedance thereof below the 72 ohms of an unloaded, unfolded dipole. An unloaded, folded dipole however has an impedance of approximately four times an unfolded dipole. Thus the rather heavy loading of the two folded dipoles will decrease the impedance thereof to the vicinity of that of the unloaded, unfolded dipoles. Also, the folded dipole has a lower Q and hence has a wider bandwidth than an unfolded dipole. The result is a more nearly optimum impedance bandwidth for the foreshortened elements and better VSWR for the antenna as a whole, while achieving a substantial size reduction. The impedance bandwidth is defined as the frequency interval about resonance for which the input reactance does not exceed the resonant input resistance. Also, the folded dipoles provide more space for the winding of the loading helices. The antenna of FIG. 1 is shown as having its feed line 7 connected to a signal source 5 which may be a transmitter. The feed is transposed between each dipole so that the proper phase relations will obtain between the different dipoles. The antenna of course may also be connected to a receiver.

The pictorial view of FIG. 2 shows the physical as well as the electrical features of the antenna. The dipoles are supported by a pair of parallel channels 61 and 63 mounted back-to-back with one above the other and held in position by insulated spacers. The channel spacing is such that the space therebetween forms a balanced low impedance transmission line. The insulated spacers 69, 71 and 72 position the channels and in addition the larger spacer 77 provides a support for the antenna mast 79. The coaxial feed cable 73 runs up the mast and along the lower channel 63 to the high frequency or rear end of the boom. FIG. 2*a* illustrates the connection of the insulated coaxial line 73 to the boom. FIG. 2*a* is a bottom view looking up the mast at the underside of lower channel 63, with the dipoles omitted. The outer conductor 73 is conductively connected to the lower channel at two points, one at 74 near the mast and the second at the high-frequency end of the same channel. The channel 63 includes a conductive wall 74 on which a pair of feedthrough threaded studs, 76, are mounted, so that when the coax 73 is connected to these studs, the outer conductor thereof makes contact with the lower channel. The coax then runs along the lower channel to another feedthrough threaded stud 83 at the high-frequency end of the lower channel. The coax center conductor projects through stud 83 and is conductively connected to the upper channel 61 at 81. The coaxial line is insulated so that the outer conductor does not contact the channel except at the described studs. The described arrangement couples the balanced line comprising the two channels to the unbalanced coax and hence is a form of balun.

The boom of FIG. 2 is shown broken two parts with dipoles 17 through 35 omitted to save space and permit clear illustration of the distinctive features. In an actual antenna built by the present inventor, each unloaded dipole consisted of a pair of hollow aluminum tubes which were mounted by means of threaded studs on the sides of the aluminum channels 61 and 63. Each half of the same dipole is mounted on a different one of the channels and the mounting of the next adjacent dipole is transposed or reversed, as shown in FIG. 2, to achieve the required crisscross connection of adjacent dipoles. Each half of the loaded, unfolded dipoles 39 and 41 comprise a hollow aluminum tube 47 threaded onto the channel with a fiberglass tube 49 attached to the outer end thereof. The loading helix is wound of aluminum wire on the surface of the fiberglass tube. Each half of the two folded dipoles 43 and 45 comprise fiberglass tubes 51 attached to a pair of fiberglass plates 65 which also serve as spacers for the two channels. The two folded dipoles are formed entirely of aluminum wire 53 on the surface of the supporting fiberglass tubes. The tubes are spaced at their outer ends by a rectangular insulator 44. A second pair of insulated spacers 66 may be used with each folded dipole.

It should be understood that the invention should not be limited to the exact details of construction shown and described, since obvious modifications will occur to a person skilled in the art.

I claim:

1. A compact and easily portable planar dipole-type log periodic antenna comprising a plurality of spaced dipole elements which are tapered in electrical length and in spacing between adjacent elements and a feedline for said elements in which some of the lower frequency elements thereof are inductively loaded linear dipoles and in addition one or more of the more heavily loaded dipole elements are inductively loaded and folded dipoles.

2. The antenna of claim 1 in which said loaded dipole elements are loaded by an electrically conductive helix.

3. The antenna of claim 1 wherein all of said lower frequency elements are the same physical length but are tapered in electrical length according to the log periodic relationship.

4. The antenna of claim 1, wherein said loaded dipole elements each consist of a single tubular member having at least a portion thereof formed of an electrically insulating material surrounded by a helical slow-wave structure.

5. The antenna of claim 4 in which all of said dipole elements are supported on a pair of back-to-back metal channels mounted one above the other, the space between said channels forming a low impedance transmission line, said feedline being a coaxial feedline connected to said pair of channels to form an unbalanced-to-balanced transformation.

6. The antenna of claim 1 wherein said loaded dipole elements are each of substantially uniform cross section throughout the length thereof and said portion is the major portion of said dipole element.