

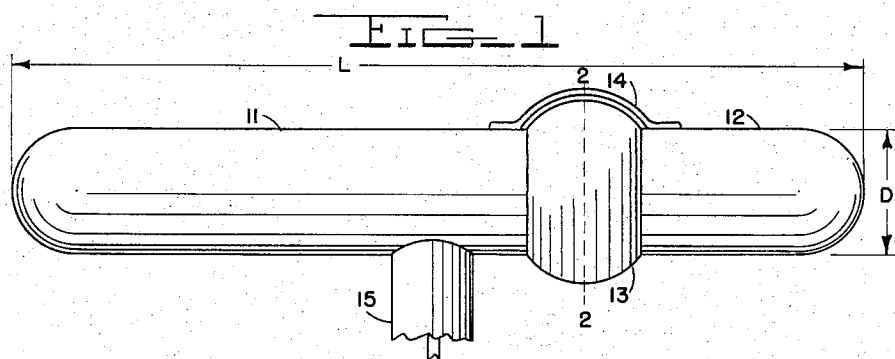
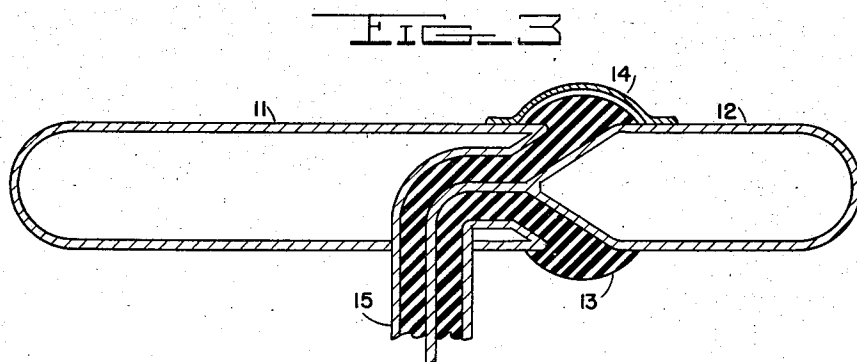
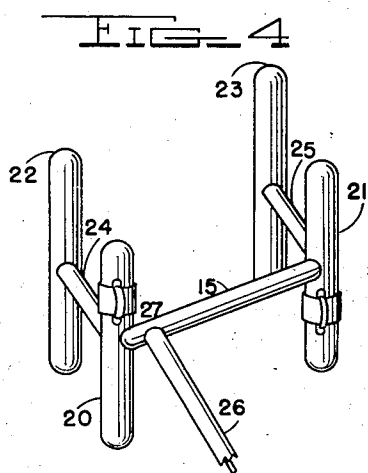
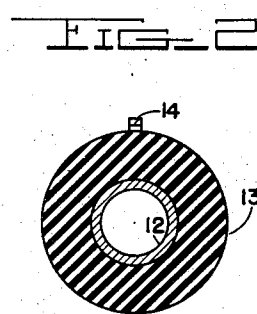
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This invention relates to wide-band antennas.

An object of the invention is to provide a wide-band antenna operative at substantially half-wave resonance including means effecting an impedance match between said antenna and a coaxial transmission line without the use of an external balance-to-unbalance transformer or a physical ground plane.

Another object of the invention is to provide a novel wide-band directional antenna array.

In accordance with the invention, the wide-band antenna comprises an elongated member divided asymmetrically into two sections and a coaxial transmission line entrant into said member at the longitudinal center thereof. The conductors of the line are expanded to intersect the surface of the elongated member in planes perpendicular to the longitudinal axis thereof at a distance less than one-quarter wavelength from one end of said member. A metallic link connecting the ends of the two sections provides mechanical rigidity. The effective shunt capacitive reactance between the expanding portions of the line is made anti-resonant with the inductive reactance of the link, thereby providing a substantially non-reactive termination for the line, the impedance of the termination being equal to the input resistance of the antenna and to the characteristic impedance of the line.

Additionally, the invention provides a directional antenna array comprising a plurality of antennas as hereinbefore described and a plurality of parasitic antennas of similar shape.

A more complete understanding of the invention may be had by reference to the following detailed description of an exemplary embodiment and the accompanying drawings in which:

Fig. 1 is a side view of a dipole antenna in accordance with the invention,

Fig. 2 is a sectional view in the plane 2—2 of Fig. 1,

Fig. 3 is a vertical section of Fig. 1, and

Fig. 4 is an isometric view of a directional antenna array in accordance with the invention.

Referring now to Fig. 1, there is shown an antenna in accordance with the invention comprising two colinear metallic sections 11, 12 of unequal lengths, an insulator 13 between sections 11, 12 and a metallic link 14 conductively attached at each end to sections 11 and 12, respectively.

A coaxial transmission line 15 is joined to section 11 at a position midway between the extreme ends of the antenna, the diameter of said line 15 being less than the diameter of the sections 11, 12. The ends of the antenna may be rounded off in hemispherical form as shown.

The electrical properties of an antenna are dependent on its physical dimensions and shape. Consequently, it is desirable that the antenna be sufficiently rigid to resist deformation by externally applied forces due to shock, vibration, or other causes. From a consideration of the properties of insulating materials known to the art, it will be found that the mechanical strength of said materials is, in general, relatively low. The metallic link 14 therefore provides additional mechanical rigidity in addition to that provided by insulator 13 in order that the element 12 may not be displaced appreciably from its position relative to element 11 by external forces. The dimensions of the link 14 are determined primarily in accordance with the magnitude of the external forces which it is contemplated may be applied to the antenna.

The electrical properties of the antenna of Fig. 1 will now be considered. It was found that an optimum ratio of diameter D to length L in a preferred embodiment of the antenna is of the order of 0.15 and that an antenna constructed in accordance with said ratio functioned to radiate energy with relatively constant efficiency over a wide band of frequencies. The length L of the antenna is such that half-wave resonance obtains at the center of the band of frequencies for which it is designed. Due to the end effect of radiation and the relative thickness of the antenna, it was found that half-wave resonance occurs when the length L is 0.46 of the wavelength of the applied energy.

Referring now to Fig. 3 there is shown a sectional view of Fig. 1. The interior of cylindrical sections 11, 12 may be hollow as shown in order to reduce the weight of the antenna. Radio frequency energy applied to the transmission line 15 induces currents which flow through said line on the inner surface of the outer conductor and in the opposite direction on the outer surface of the inner conductor of line 15. The outer surface of the outer conductor of line 15 remains at zero potential because the radio frequency

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currents in the line 15 are concentrated on the interior thereof, due to skin effect. The line 15 enters the antenna section 11 at a position of zero potential, midway between the extreme ends of the antenna. Consequently no radio frequency current flows through the junction of section 11 and the outer surface of line 15, and said junction produces no effect on the radiating properties of the antenna. The line 15 is bent within the interior of the antenna so that its axis coincides with the longitudinal axis of said antenna. The outer and inner conductors of line 15 then expand until they intersect the surfaces of sections 11 and 12 respectively. The linear rates of expansion of the two conductors are experimentally determined in order that the expanding portions thereof provide effectively a capacitive reactance equal to and in parallel with the inductive reactance of the link 14, so that a parallel resonant circuit is formed which has impedance equal to the resistive component of the antenna impedance. The insulating material 13 of the line 15 divides the antenna into two sections 11, 12 of unequal lengths. The relative lengths of sections 11 and 12 determine the antenna impedance at the termination of line 15 with the surface of sections 11, 12. Preferably, the relative lengths of sections 11 and 12 are adjusted so that the resistive component of the antenna impedance is equal to the characteristic impedance of the line 15. When the reactive components of the termination impedance of line 15, including the inductive reactance of link 14, are resonant as hereinbefore specified, the effective Q of the resonant circuit is low because the circuit is effectively in parallel with the resistive component of the antenna impedance. Thus, the termination impedance of line 15 remains predominantly resistive and relatively constant over a wide band of frequencies, thereby enabling the antenna to absorb a relatively constant amount of energy. Due to the shape of the antenna, and particularly to its large diameter, said antenna functions with relatively constant efficiency to radiate said energy over a wide band of frequencies.

Dipole antennas constructed in accordance with the invention are well adapted to be used as elements of a directional antenna array, particularly when said array is required to operate effectively over a wide band of frequencies. For example, Fig. 4 shows an isometric view of a four-element directional antenna array comprising two coplanar parallel dipole antennas 20, 21 and two coplanar parallel parasitic antennas 22, 23 supported in parallel spaced relationship to antennas 20 and 21, respectively, by rods 24 and 25 of equal length. The distance between the planes of the dipole antennas 20, 21 and the parasitic antennas 22, 23 may be of the order of 0.22 wavelength. The dipole antennas 20 and 21 are spaced one-half wavelength apart by transmission line 15, and are oppositely oriented in space. Consequently, in order to excite antennas 20 and 21 in phase, a 180 degree phase shift must be introduced in the line 15 connecting said antennas. This phase shift is accomplished conveniently by effecting a junction 27 between line 25 and line 15 at a position such that the phase of the voltage applied through said junction 27 to antenna 21 lags the voltage applied to antenna 20 by 180 degrees. When the dielectric constant of the line is greater than unity, the physical displacement of the junction 27 from the center of line 15 is less than one-

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quarter wavelength, as is indicated qualitatively in Fig. 4. When the dielectric constant is unity, as with air insulation, the junction 27 should coincide with the junction of the line 15 with antenna 20. The radiation field of the array of Fig. 4 has two intensity maxima along a line perpendicular to the plane of the dipole antennas 20, 21. The opposite orientation of dipole antennas 20, 21 minimizes the effect of any residual phase difference between currents flowing in the two portions of each dipole antenna 20, 21 which might otherwise result in an asymmetrical radiation pattern.

An outstanding advantage of the invention lies in the fact that, although an unbalanced concentric transmission line is used to feed energy to the antenna, no frequency-selective elements commonly known as "bazookas" are required to convert the unbalanced feed to a balanced feed, the conversion being accomplished within the antenna itself which has minimum frequency selectivity.

It should be understood that the practice of the invention is not restricted to the embodiments illustrated and described but is circumscribed only by the scope and limitations of the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. An antenna comprising an elongated hollow member divided asymmetrically into two sections, a coaxial transmission line entrant into the member at the longitudinal center thereof, and means coupling each conductor of the coaxial line to a respective antenna section.

2. An antenna comprising an elongated hollow member divided asymmetrically into two sections, a coaxial transmission line entrant into the member at the longitudinal center thereof and terminating in a line portion coaxial with the longitudinal axis of the antenna, and means connecting each conductor of the line portion to a respective antenna section.

3. An antenna comprising an elongated hollow member divided asymmetrically into two sections, a coaxial transmission line entrant into the member at the longitudinal center thereof and terminating in a line portion coaxial with the longitudinal axis of the antenna, and expanded conductor means connecting the line to the adjacent ends of the sections.

4. An antenna comprising an elongated hollow cylindrical member divided asymmetrically into two sections, a coaxial transmission line entrant into one section at the longitudinal center of the member and terminating in a line portion coaxial with the cylindrical member, a pair of conical conductors connecting the adjacent section ends to the line, and a dielectric member interposed between the conical conductors.

5. An antenna comprising an elongated hollow cylindrical member divided asymmetrically into two sections, a coaxial transmission line entrant into one section at the longitudinal center of the member and terminating in a line portion coaxial with the cylindrical member, a pair of conical conductors connecting the adjacent section ends to the line, a dielectric member interposed between the conical conductors, and an inductive metallic member externally connecting the antenna sections.

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6. A dipole antenna comprising a cylinder having a radius of the order of 0.035 of the mean operating wavelength and a length of the order of 0.5 of said wavelength, a coaxial transmission line entrant into the interior of said cylinder at the longitudinal center thereof, the inner and outer conductors of said transmission line being expanded to intersect the surface of said cylinder asymmetrically of its length in planes perpendicular to the longitudinal axis of said cylinder, and a metallic link connecting said portions, the inductance of said link being resonant with the effective capacitance between the expanded portions of said conductors to provide a substantially non-reactive termination impedance for said line.

7. A directional antenna array comprising a plurality of coaxial parallel elements, each of said elements comprising a dipole antenna in accordance with claim 4, the shorter portion of adjacent elements being oriented in opposite directions relative to the common axis of said elements, and a plurality of cylindrical parasitic elements having substantially the same radii as the dipole elements and coupled thereto by the radiated field of said dipole elements.

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8. An antenna array comprising a plurality of parallel asymmetrical dipole antennas substantially as described in claim 4, the adjacent dipoles of the array being inverted one from the other and spaced apart by one half wave length.

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