MULTIFREQUENCY ANTENNA SYSTEM INCLUDING AN ISOLATION SECTION OPEN CIRCUITED AT BOTH ENDS

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ABSTRACT

A multifrequency antenna system including a center fed dipole element one-half wavelength long at the lowest frequency of operation is described. This dipole element has circuit elements at appropriate positions along the element on each side of the center feed such that the center section of the dipole is effectively "cut" to form higher frequency dipoles one-half wavelength long at the higher harmonic frequencies of the lowest frequency of operation. Mutual coupling between the center section associated with a higher frequency dipole and the adjacent section is essentially zero by the adjacent sections including a quarter wave section at the higher frequency open circuited at each end.

6 Claims, 5 Drawing Figures
Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Distance (D) Between Dipole Centers in Waves Lengths

Mutual Resistance Ohms

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MULTIFREQUENCY ANTENNA SYSTEM INCLUDING AN ISOLATION SECTION OPEN CIRCUITED AT BOTH ENDS

This invention relates to radio frequency antenna systems in general, and more particularly, this invention relates to a multifrequency antenna, wherein the antenna operates as a resonant structure at one frequency and wherein the antenna has effective "cuts" or open circuits therein so as to form an antenna that also operates at higher frequencies.

These "cuts" may be achieved in one example by separating the antenna conductor into sections with these sections spaced by a dielectric. An effective "cut" may be achieved by providing a section a quarter wavelength long with one end short circuited and the opposite end presenting an open impedance. In the prior art, attempts have been made to produce a multifrequency antenna using a single "cut" or open circuit on either side of the center feed points of a dipole. This, however, does not isolate the adjacent sections associated with the lower frequency dipoles from coupling with the higher frequency dipole sections and causing changes in the pattern shape associated with the higher frequency dipoles.

In accordance with this invention, there is provided a multifrequency antenna that may be used for reception and transmission of radio frequency signals. The antenna may be employed in the field of amateur radio as well as in the field of commercial radio or television and across other fields in which it may be desirable to process different frequency radio signals from the same antenna without employing various switching arrangements or other devices for changing antennas or their effective length each time it is desired to transmit or receive different frequency signals.

For example, this invention consists of a center fed dipole. This center fed dipole has a length between the remote tips approximately equal to one-half a wavelength at the lowest frequency of operation. A first pair of open circuits is placed along the dipole with an open circuit located a quarter wavelength away from both sides of the center feed at the highest frequency of operation of said antenna. A second pair of open circuits is placed along the dipole with an open circuit located a half wavelength away from both sides of the center feed at the highest frequency of operation of said antenna.

The invention is described in detail in the following specification and illustrated in the following drawings wherein:

FIG. 1 illustrates the mutual resistance in ohms versus the distance between the centers of two collinear dipoles in wavelengths.

FIG. 2 is a line drawing of a center fed dipole having symmetrical dipole halves.

FIG. 3 is a series of line drawings of a dipole half showing pictorially the optimum "cut" positions for a multifrequency antenna as shown in FIG. 2.

FIG. 4 shows an arrangement in accordance with an embodiment of the present invention for achieving a multifrequency center fed dipole using quarter wave coaxial line sections wherein only one-half of the dipole is drawn.

FIG. 5 is a view showing the application of this invention to a quarter wave type of antenna.
and a second cut 31 located a quarter wavelength away at 8 MHz from the first cut 29. At a frequency of about 8 MHz, a quarter wave conductor 30 is located between cuts 29 and 31. Again in the case of a center fed half wavelength resonant antenna a symmetrically placed pair of cuts would be placed in dipole half 15'.

Turning to portion D of FIG. 3, a multifrequency antenna at 4 MHz and 2 MHz is provided by a single cut 33 a quarter wavelength at 4 MHz from the center feed point 13 leaving a quarter wave conductor 34 at 4 MHz open circuit at each end. Again the case of a center fed antenna a symmetrically placed cut would be in dipole half 15'. Referring to portion E and operating only at 2 MHz, there are no cuts.

Next to be considered is the means to provide "cuts" or open circuits in the dipole halves 15' and 15" at the positions indicated in FIG. 3 for all of the above harmonic frequencies in one antenna. One approach is that illustrated in FIG. 4 employing quarter wave coaxial line sections. As mentioned previously only the dipole half 15 of the center fed dipole is illustrated in FIG. 4. The dipole half 15' is a mirror image of dipole half portion 15. To complete a center fed antenna structure a symmetrical structure is located on the other side of the feed point 13 as shown in FIG. 2.

Referring to FIG. 4, there is illustrated dipole half 15 of a center fed multifrequency dipole employing the quarter wavelength coaxial sections or traps. Each quarter wave line section or trap is short circuited at one end and open circuited at the opposite end. Two of these sections or traps are placed side by side, but reversed in direction to present a quarter wave section open circuited at each end. A first conductor 35 is a quarter wavelength long at 32 MHz from the center feed point 13 to end 41 of the first and shortest pair of adjacent coaxial sections 37 and 39. The coaxial section 37 has an inner conductor 37A and an outer conductor 37B. The coaxial section 39 has an inner conductor 39A and an outer conductor 39B. The inner conductor 37A is coupled to conductor 35 at an open circuited end 41 and the opposite end of conductor 37A is shorted to the outer conductor 37B by a conductive plate across end 42. The first section 37 is thereby open circuited at the end 41 nearest the center feed point 35 and short circuited at end 42 a quarter wavelength away at 32 MHz from the open circuited end 41. The outer conductor 37B of the first section 37 is adjacent to and connected to the outer conductor 39B of the second section 39. The second section 39 is open circuited at its far end 43 from the feed point 13 and is short circuited by a conductive plate across the near end 45 (shunting inner conductor 39A to outer conductor 39B) a quarter wavelength away at 32 MHz.

A second and longer pair of coaxial sections 47 and 49 is spaced from the first pair of coaxial sections 37, 39. The inner conductor 39A of the section 39 of the first pair of coaxial sections or traps is coupled at open end 51 to the inner conductor 47A of the first section 47 of the second longer pair of coaxial sections. Each of the second longer pair of coaxial sections 47 and 49 are a quarter wavelength long at the next lower frequency of 16 MHz. The outer conductors 47B and 49B of sections 47 and 49 respectively are directly connected to each other. The first coaxial section 47 of the second longer pair of coaxial sections is short circuited by a conductive plate across the end 53 (shunting inner conductor 47A to outer conductor 47B) a quarter wavelength away at 16 MHz from the open circuited end 51 of the coaxial section 47. The second coaxial section 49 is short circuited by a conductive plate across the end 55 (shunting inner conductor 49A to outer conductor 49B) and open circuited at the end 57 a quarter wavelength away at 16 MHz.

A third still longer pair of coaxial sections 59 and 61 is provided. Each of the sections 59 and 61 is a quarter wavelength long at 8 MHz. The inner conductor 49A of the coaxial section 49 is connected to the inner conductor 59A of the longer coaxial section 59 of the third pair of coaxial sections. The inner conductor 59A is short circuited at the far end 65 by a conductive plate connecting the inner conductor 59A to the outer conductor 59B. The outer conductor 61B of second coaxial section 61 is adjacent to the outer conductor 59B of section 59. The section 61 is short circuited at the end 67 by a conductive plate connecting the inner conductor 61A to outer conductor 61B. This section 61 is open circuited at the opposite end 69 a quarter wavelength away at 8 MHz.

A single quarter wave coaxial section 71 has its inner conductor 71A connected to the inner conductor 61A of the coaxial section 61. This coaxial section 71 is a quarter wavelength long at the next lowest frequency of 4 MHz. The inner conductor 71A is short circuited at the end 77 of the antenna furtherest from the feed point 35 by the conductive plate connecting inner conductor 71A to outer conductor 71B.

A quarter wavelength long section 15 at 2 MHz is provided between feed point 13 and end 77. A quarter wavelength long section at 4 MHz is provided between feed point 13 and the open circuited end 69. A quarter wavelength long section at 8 MHz is provided between the feed point 13 and open circuited end 57 with a second quarter wavelength section at 8 MHz open circuited at both ends being provided by sections 59 and 61. A quarter wavelength half dipole section at 16 MHz is provided between feed point 13 and open circuited end 43. A quarter wave section at 16 MHz open circuited at both ends is provided by sections 47 and 49. A quarter wavelength section 35 at 32 MHz is provided between feed point 13 and open circuited end 41.

An antenna constructed in accordance with this invention may also take the form of the antenna illustrated in FIG. 5 in which a quarter wave antenna 81 at 2 MHz is provided. One side 83 of a transmission line 82 is connected to a transmitter or receiver and the other side 80 of the transmission line is grounded. The one-quarter wave section 81 may be divided up as dipole half portion 15 in FIG. 4. In this arrangement a first pair of the coaxial trap sections 87, 88 each about a quarter wavelength long at 32 MHz begin at a point 85 a quarter wavelength at 32 MHz from the feed point 84. A second pair 89, 90 of coaxial trap sections each a quarter wavelength long at 16 MHz is provided. The second pair is located about a quarter wavelength at 16 MHz from the center feed point 84. A third pair of coaxial sections 91, 92 each a quarter wavelength long at 8 MHz begin at a point 93 a quarter wavelength at 8 MHz from center feed point 84. A coaxial line section 94 a quarter wavelength long at 4 MHz is provided. This section 94 is open circuited at end 95 which is a quarter wavelength away at 4 MHz from feed point 84. The entire dipole half 81 from feed point 84 to shorted end 96 is approximately a quarter wavelength long at 2 MHz. The coaxial sections 87, 88, 89, 90, 91, 92 and
3,735,413

3. An antenna system for operating at a multiplicity of frequencies comprising:
   a center fed low frequency dipole element having a length between the extreme ends of the dipole halves approximately equal to one-half wavelength at the lowest frequency of said multiplicity of frequencies, each of said dipole halves including a first quarter wavelength conductive section open circuited at each end at the highest frequency of said multiplicity of frequencies, each of said first conductive sections beginning a quarter wavelength away at said highest frequency from the center feed point of said dipole to form a center fed high frequency dipole decoupled from said low frequency dipole.

4. The antenna system as claimed in claim 3 wherein each of said low frequency dipole halves include a second quarter wavelength conductive section open circuited at each end at an intermediate frequency of said multiplicity of frequencies, each of said second conductive sections beginning a quarter wavelength away at said intermediate frequency from said center feed point.

5. The combination as claimed in claim 3 wherein said conductive sections each include a pair of coaxial transmission line sections having their outer conductors adjacent to each other with the inner conductor of the first coaxial section short circuited to its outer conductor at only one first end of the conductive section and the inner conductor of the second coaxial section short circuited to the outer conductor of the second coaxial section at only the second or opposite end of the conductive section.

6. An antenna system for operating at a multiplicity of frequencies comprising:
   a first antenna element including a pair of feed terminals with said element adapted to resonate at the lowest frequency of said multiplicity of frequencies, said antenna element including at least one section a quarter wavelength long at the highest of said multiplicity of frequencies from said feed terminals, said section being open circuited at opposite ends with the open circuited end nearest said feed terminals being located a quarter wavelength at said highest frequency from said feed terminals.

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