

March 10, 1942.

H. O. PETERSON

2,275,646

ANTENNA

Filed July 18, 1939

2 Sheets-Sheet 1

Fig. 1

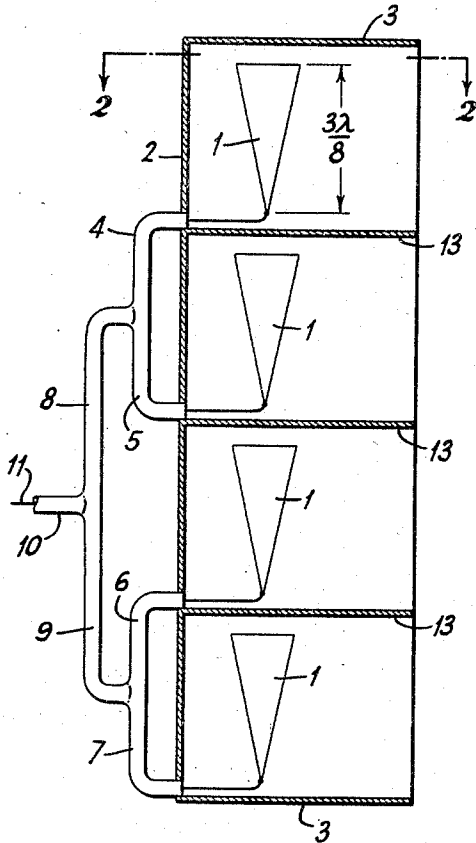


Fig. 3

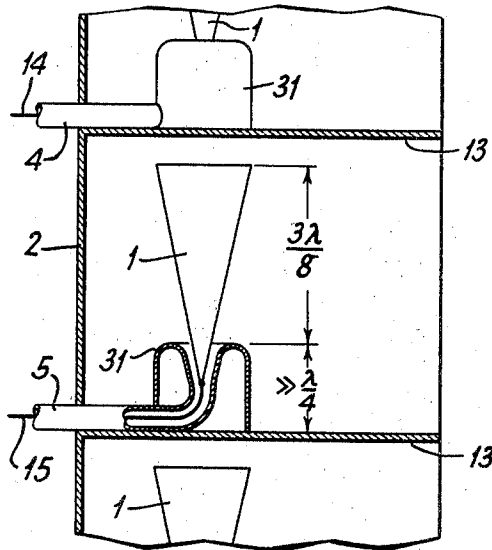
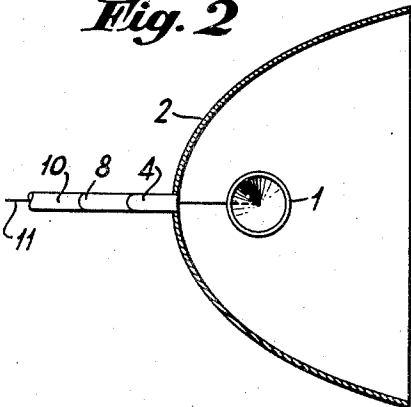


Fig. 2



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Fig. 5

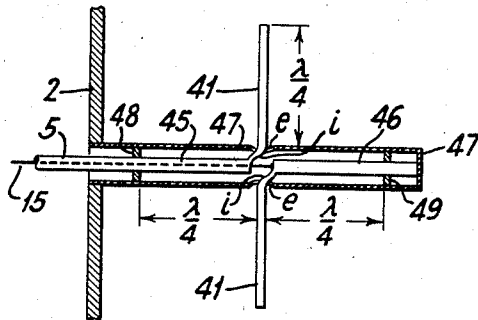


Fig. 4

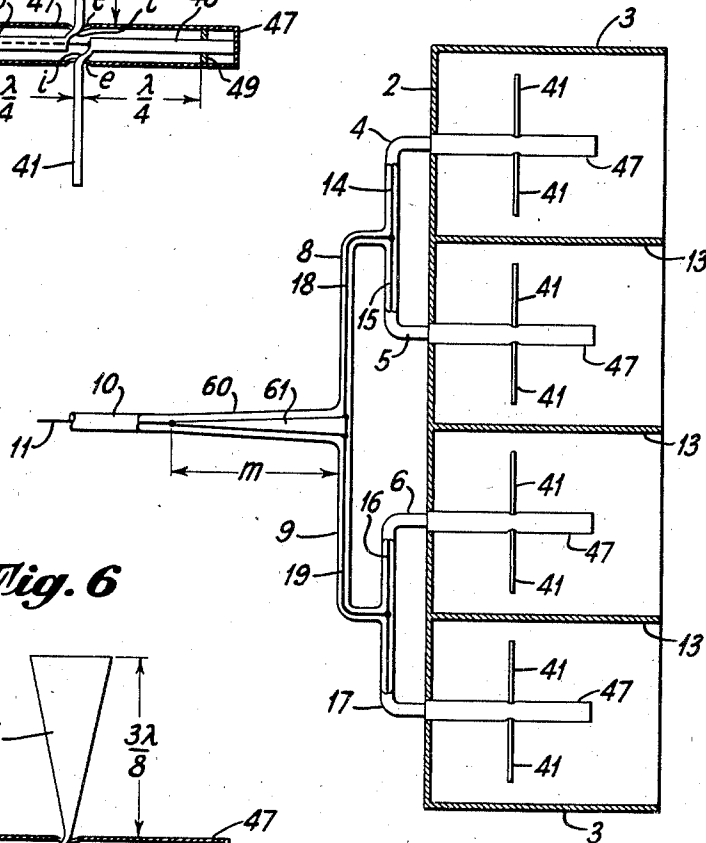
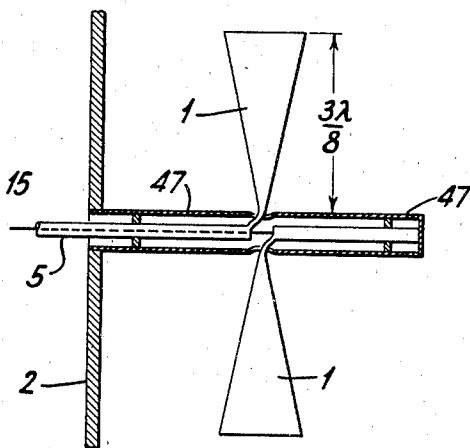


Fig. 6



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UNITED STATES PATENT OFFICE

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3 Claims. (Cl. 250—11.53)

The present invention deals with antennas and, more particularly, with ultra short wave directive antennas.

An object of the present invention is to obtain improved directivity in an ultra short wave antenna system.

Another object of the present invention is to provide a directive antenna having a symmetrical radiating system and which may be energized from a single sided coaxial feeder.

Another object of the present invention is to provide an antenna system which does not require transformers for coupling between a coaxial transmission line and a symmetrical radiating system.

Still another object of the present invention is the provision of an antenna structure which is mechanically secure and is safeguarded against lightning strokes.

The present invention features an antenna array within a parabolic reflector in order to obtain a directional radiation pattern. In order to further increase directivity by reducing random phase relationship between the signals radiated from the various antennae of the array metallic partitions are provided within the reflector between the antennae.

As another feature of the invention in order to obtain as wide a frequency band as possible I may use conical radiating elements. The elements of the array are each energized by transmission lines of equal length thereby assuring proper phase relationship for any frequency within the band. Furthermore, by a proper proportioning of the dimensions I avoid the use of conventional frequency-discriminatory impedance matching circuits between the elements of the antenna and the transmission line connected thereto.

As still a further feature of the invention I provide a mechanically strong and electrically efficient means for transforming from a single sided coaxial cable to a symmetrical radiating circuit.

Other objects and features of the invention will become apparent by reference to the following detailed description which is accompanied by drawings in which Figure 1 shows in section an elevation of my improved antenna system; Figure 2 shows a horizontal sectional view of the form of my invention shown in Figure 1; Figure 3 shows a modification of the form of my invention shown in Figure 1 in which impedance matching means are employed between the radiating element and the transmission line energizing the radiating element; in Figure 4 I have shown a further modification of my invention in which a single sided transmission line is coupled to a symmetrical radiating system; Figure 5 shows in enlarged section a portion of Figure 4,

while Figure 6 shows a modification of the form shown in Figure 5.

Referring, now, to Figure 1 reference numerals 1, 1 indicate radiating elements of my antenna array. These radiating elements are placed at the focus of parabolic reflector 2. The parabolic reflector is closed at the ends by plates 3, 3. To successive ones of the radiating elements 1 are connected transmission lines 4, 5, 6 and 7. These line sections are of equal length and at their points of junction are connected to transmission line 10 through line sections 8 and 9 which are also of equal length. It will, therefore, be seen that the total length of connections between transmission line 10 and each of the radiating elements is the same. Therefore, the phase relationships are maintained constant no matter what frequency is applied to the transmission line. Between each of the radiating elements 1 have placed metallic partitions 13. These metallic partitions confine the signal radiated from each of the radiating elements into a definite area and thus a uniform phase relationship is obtained in the area immediately beyond the open side of the reflector. Due to this uniform phase relationship an improvement in directivity is obtained. In other words, less response is obtained for directions away from the main lobe of the directive diagram.

Figure 2 shows more clearly the relationship between the parabolic reflector 2 and the radiating element 1.

In Figure 3 I have shown a modification of a portion of the embodiment shown in Figure 1. The same form of radiating element 1 is utilized as described with reference to Figure 1. Also, the radiating elements are each confined between partitions 13, 13 as before described. In this modification the radiating element 1, having a length approximately equal to three-eighths of the length of the operating wave at its apex, is connected to central conductor 15 of transmission line 5 within pedestal 31. The height of this pedestal 31 is considerably less than a quarter of the length of the operating wave. The impedance of the transmission line is smoothly transformed to a value equal to that of the radiator without affecting the band width by gradually tapering the central conductor 15 into radiator 1. The diameter of the inner surface of pedestal 31 is likewise tapered. By arranging a constant change of ratio of the diameter of the central conductor and inner surface of the pedestal, a smooth transformation of impedance is obtained. While Figure 3 shows only one radiating element, of course, any desired number may be used and the transmission lines are preferably connected together in the same way as described with reference to Figure 1. With this form of connection and utilizing this

shape of radiating element an extremely broad frequency band may be covered with substantially uniform response.

In Figures 4 and 5 I have shown a balanced or symmetrical radiating system substituted for the single sided radiating elements shown in Figure 1. The radiating system within each compartment of the reflector comprises a pair of quarter wave rods 41, 41. These are energized in an opposing phase relationship at their adjacent ends by a phase inverting circuit within cylinder 47. This coupling and inverting circuit includes two cylindrical members 45 and 46 having equal diameters and being somewhat greater than a quarter of the operating wave-length in length. The cylinder 45 may conveniently be an extension of the outer casing 5 of the concentric cable transmission line. The inner conductor 15 of the coaxial transmission line is connected to the end of cylinder 46 and the two radiating elements 41, 41 are directly connected to the adjacent ends of cylinders 45 and 46. Within outer cylinder 47 are also located two shorting plates 43 and 49 making contact between the inner surface of cylinder 47 and the outer surfaces of cylinders 45 and 46. These shorting plates are adjustable in their position and are adjusted to a position a quarter of the length of the operating wave distant from the adjacent ends of cylinders 45 and 46. Adjusted to this position the impedance of the outer shell at points *e, e* to the operating frequency may be made very high compared with the impedance of the concentric feeder line 5, 15 and the impedance of the antenna elements 41 at those points. By a proper choice of the ratio of diameters of cylinder 47 and cylinders 45, 46, the concentric line and the coupling circuit may be made to have the same impedance as the antenna elements as viewed at points *i, i*. Each of the plurality of balanced radiating systems just described with reference to Figure 5 is, as shown in Figure 4, connected to transmission line 10, 11 by uniform length connections. Thus, as previously described, a uniform phase relationship is maintained throughout. The final impedance at the junction of connection lines 8 and 9 may or may not exactly agree with the impedance of the transmission line 10, 11. If not, an additional section of transmission line 60, 61 may, therefore, be interposed between these two lines. By a choice of proper dimensions of the taper of inner conductor 61 with respect to the diameter of the outer conductor 60, the impedance may be made to match perfectly. The distance *m* is ordinarily fixed at several quarter wavelengths of the operating wave. With this form of impedance matching structure no restriction in the band width of the antenna itself is obtained.

In Figure 6 is shown the adaptation of the conical radiating elements to the structure shown in Figure 5 for transforming from a single sided cable to a symmetrical circuit. It is not believed necessary to describe this figure in any detail since the distinction between this and Figure 5 is the use of the conical radiators having a length equal to three-eighths of the operating wavelength, as described with reference to Figures 1 and 2, instead of the quarter wave radiating rods. This balanced radiating system may, of course, be substituted for the system shown in Figure 4.

While I have particularly shown and described several embodiments of my invention it is distinctly understood that my invention is not lim-

ited thereto but that modifications may be made within the scope of the invention.

I claim:

1. A directive antenna system comprising a cylindrical reflector divided longitudinally into a series of separate chambers and a radiating element within each of said chambers, each of said radiating elements comprising a dipole antenna having a pair of adjacent ends and means for energizing said dipole from a coaxial transmission line having an outer sheath and an inner conductor comprising a supporting shell surrounding a portion of said transmission line and attached at one end to said reflector, said shell having a length greater than half the length of the operating wave, an auxiliary conductor within said shell connected to the inner conductor of said transmission line, and having a diameter equal to the diameter of the outer sheath of said transmission line, the adjacent ends of said dipole passing through apertures in said supporting shell and connected to the adjacent ends of said sheath and said auxiliary conductor, and means for connecting the inner surface of said supporting shell to the outer surface of said sheath and auxiliary conductor at points a distance equal to a quarter of the length of the operating wave from said adjacent ends.

2. A directive antenna system comprising a cylindrical reflector divided longitudinally into a series of separate chambers and a radiating element within each of said chambers, each of said radiating elements comprising a dipole antenna parallel to the axis of said reflector having a pair of adjacent ends, and means for energizing said dipole from a coaxial transmission line having an outer sheath and an inner conductor comprising a supporting shell surrounding a portion of said transmission line, and attached at one end to said reflector, said shell having a length greater than half the length of the operating wave, an auxiliary conductor within said shell connected to the inner conductor of said transmission line and having a diameter equal to the diameter of the outer sheath of said transmission line, the adjacent ends of said dipole passing through apertures in said supporting shell and connected to the adjacent ends of said sheath and said auxiliary conductor, and means for connecting the inner surface of said supporting shell to the outer surface of said sheath and auxiliary conductor at points a distance equal to a quarter of the length of the operating wave from said adjacent ends.

3. Means for feeding energy to a pair of adjacent ends of a dipole antenna from a coaxial transmission line having an outer sheath and an inner conductor comprising a supporting shell surrounding a portion of said transmission line, said shell having a length greater than half the length of the operating wave, an auxiliary conductor within said shell connected to the inner conductor of said transmission line and having a diameter equal to the diameter of the outer sheath of said transmission line, the adjacent ends of said dipole passing through apertures in said supporting shell and connected to the adjacent ends of said sheath and said auxiliary conductor, and means for connecting the inner surface of said supporting shell to the outer surface of said sheath and auxiliary conductor at points a distance equal to a quarter of the length of the operating wave from said adjacent ends.

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