July 3, 1945. C. W. HANSELL 2,379,706

ANTENNA

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Fig. 1.

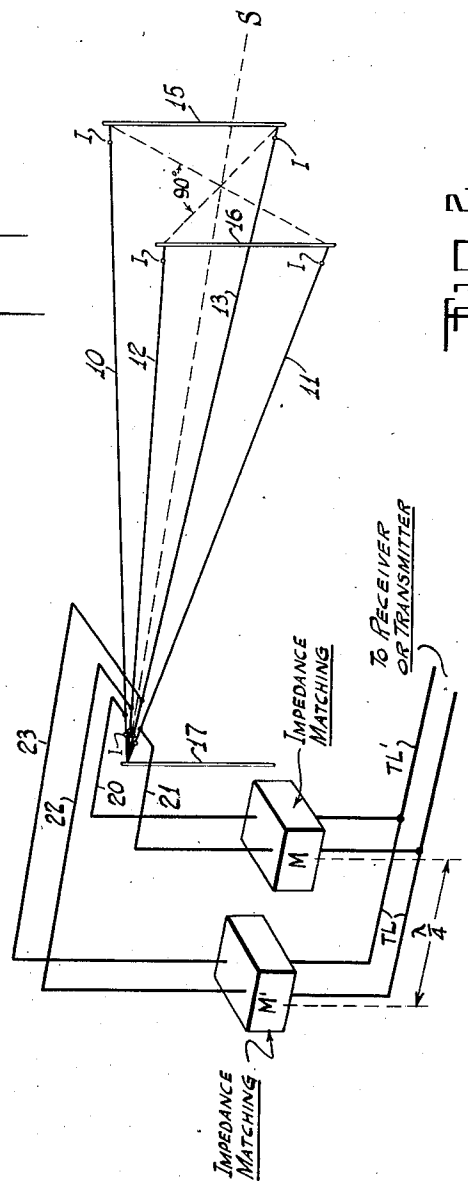
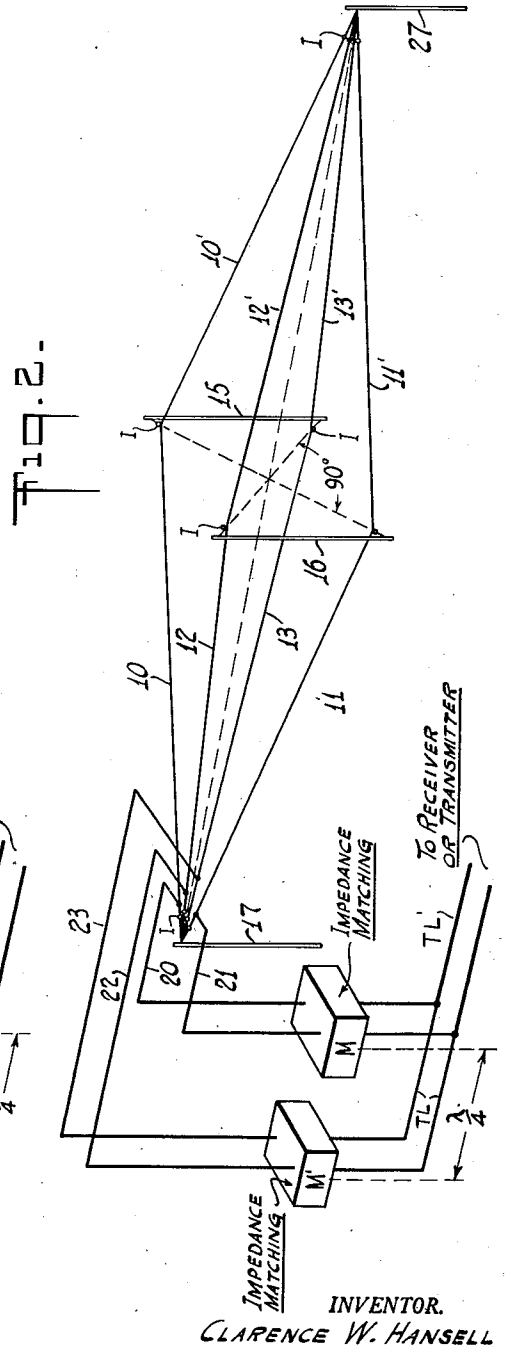


Fig. 2.



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15 Claims. (Cl. 250—33)

The present invention relates to antenna systems and, more particularly, to directive antennas useable over a wide frequency band.

An object of the present invention is the provision of a wide band directive antenna system.

Another object of the present invention is the provision of a directional antenna system which does not require resistance loading.

Still another object of the present invention is the provision of a highly efficient broad band antenna.

A further object of the present invention is the provision of a multi-element antenna in which changes of input impedance of one element counterbalance changes in another element of the antenna.

The foregoing objects, and others which may appear from the following detailed description, are attained by providing an antenna array in the form of two coaxial V or diamond radiators in planes at right angles to one another fed with energy in mutual phase quadrature.

The novel features which, it is believed, are characteristic of the present invention are pointed out with particularity in the appended claims.

The invention will, however, be more completely understood with reference to the following detailed description which is accompanied by a drawing in which Figure 1 illustrates an embodiment of the invention utilizing a pair of V antennas, while Figure 2 is a modification wherein a pair of diamond antennas are used.

The antenna system shown in Figure 1 includes a pair of V antennas, one of which includes conductors 10 and 11, while the other includes conductors 12 and 13. It will be noted that conductors 12 and 13 of one antenna lie in a plane perpendicular to the plane in which conductors 10 and 11 lie. The line of intersection of the two planes lies along the center line indicated by arrow S which also denotes the direction of maximum response of the antenna system. Antenna wires are supported at their most widely separated ends from poles 15 and 16, suitable insulators I being interposed between the ends of the wires and the antenna poles. The antenna wires are all supported at their more closely adjacent ends from a pole 17, suitable insulators I being, as before, placed between the pole and the ends of the wires. At the more closely adjacent ends of wires 10 and 11 are connected wires 20 and 21 constituting a two wire transmission line leading to an impedance matching network M. Similarly, the more closely adjacent ends of wires 12 and 13 are connected to wires 22 and 23 constituting a two wire transmission line terminating in an impedance matching network M'. Preferably, the lengths of wires 20, 21 and 22, 23 are all equal. If they are not equal then wire 20 or 21 should differ in length from wire 22 or 23 by an integral number of half waves at an intermediate frequency. The impedance matching networks are not essential elements but may be omitted if the lengths of the antennas and connecting lines are adjusted to give substantially non-reactive input impedances at the points where the impedance matching networks are located. The impedance matching networks M and M' are connected together by a two wire transmission line TL having an effective electrical length equal to one quarter of the operating wavelength of the system. To one end of transmission line TL is connected a main transmission line TL', preferably having a characteristic impedance equal to half that of line section TL, to which is connected the receiving or transmitting equipment (not shown) with which the system is to be associated. For the sake of convenience in description the present invention is described primarily from the standpoint of transmission of signals. It should, however, be clearly understood that the present invention is also intended for use in the reception of signals. The characteristic impedances of transmission lines TL and TL' are so adjusted as to assure proper distribution of energy to the impedance matching networks M and M' and the minimizing of reflections. This may be done by varying the spacing between the conductors of the transmission lines and/or their effective diameters. The effective diameters may be increased either by making the physical diameters larger or by using two or more conductors in parallel for each conductor of the transmission line. Now, due to the length of transmission line TL, which is a quarter wavelength for a mean or intermediate frequency and not too far from a quarter wavelength at other frequencies in an operating band of frequencies, any change in input impedance of one V antenna will be counterbalanced, in whole or in part, by a proportional change in input impedance of the other V antenna. The impedance inverting property of the quarter wave line causes the changes in input impedance to cancel each other to a substantial degree over a band of frequencies. Since the two separate V antennas are mounted in planes at right angles to one another there is very low coupling, approaching zero, between them except through the feeder system and each radiates independently in the desired direction, as indicated by arrow S. Consequently,

since the power is equally divided between the antennas the directivity of the system is substantially equal to that of one V antenna or diamond taken alone. Therefore, the addition of the second unit serves the purpose of broadening the frequency band to permit any one of a large band of frequencies to be used with the system without changes in the system or without causing large reflections back into the feeder transmission lines TL'. Because of this broadening an antenna system may be provided which may be employed at any frequency over a broad band without waste of power in terminating resistances. Therefore, the antenna has substantially the same advantages with respect to reduction of input impedance variations as resistance loaded rhombic antennas, wherein however, in order to prevent reflection, approximately half of the power must be wasted in the resistance loading.

The antenna system shown in Figure 2 of the drawing is, as to the left-hand portion of the figure, exactly the same as the antenna system of Figure 1 and the same reference numerals are, therefore, applied to corresponding parts of this figure. However, the V's of Figure 1 are transformed into diamonds by the addition of conductors 10', 12', 11' and 13' connected to the more widely spaced ends of conductors 10, 11, 12 and 13. The conductors bearing the prime numbers again converge toward their ends remote from the feed lines and are supported at the far ends from an antenna pole 27. Each conductor is electrically isolated from every other one at their converging ends by the interposition of insulators I arranged similarly to those at the feeding end of the antenna. However, this insulation of the ends is not essential and, if desired, the wires may be joined together.

The operation of the antenna system of Figure 2 is substantially the same as that of Figure 1 so the operation will not be again gone into, the only substantial distinction being that of the increased directivity due to the use of diamond antennas rather than V antennas.

While I have illustrated a particular embodiment of the present invention, it should be clearly understood that it is not limited thereto since many modifications may be made in the several elements employed and in their arrangement and it is, therefore, contemplated by the appended claims to cover any such modifications as fall within the spirit and scope of the invention.

I claim:

1. A pair of V type directional antenna radiators arranged in planes at right angles and with their bisectors coincident and means for coupling both radiators to a common transmission line, said means comprising a length of transmission line whose characteristic impedance, for a mean operating frequency, is substantially matched at both ends and whose length is substantially equal to a quarter wave at the mean operating frequency of said radiators.

2. A pair of rhombic directional antenna radiators arranged in planes at right angles and with their longitudinal bisectors coincident and means for coupling both radiators to a common transmission line, said means comprising a length of transmission line whose characteristic impedance, for a means operating frequency, is substantially matched at both ends and whose length is substantially equal to a quarter wave at the mean operating frequency of said radiators.

3. A pair of V type directional antenna radiators arranged in planes at right angles and with their bisectors coincident and coupling means for coupling each radiator to the end of a transmission line, said coupling means comprising impedance matched line sections which differ in length by a quarter wavelength at a chosen frequency.

4. A pair of rhombic directional antenna radiators arranged in planes at right angles and with their longitudinal bisectors coincident and coupling means for coupling each radiator to the end of a transmission line, said coupling means comprising impedance matched line sections which differ in length by a quarter wavelength at a chosen frequency.

5. An antenna system including a pair of directional radiating units arranged in planes at right angles to one another with their directions of maximum response in alignment, and means for connecting said units to transducer equipment, the electrical length of the connections between each of said units and said means differing by a quarter of the operating wavelength.

6. An antenna system including a pair of directional radiating units arranged in planes at right angles to one another with their directions of maximum response in alignment, a transmission line connected at one end to transducer equipment connections from each of said units to points on said transmission line, said points being spaced one quarter of the operating wavelength.

7. An antenna system including a pair of directional radiating units arranged in planes at right angles to one another with their directions of maximum response in alignment, a tranmission line connected at one end to transducer equipment, connections from each of said units to points on said transmission line, said points being spaced one quarter of the operating wavelength and the length of said connections so differing by one half of the operating wavelength that energy from said transmission line arrives at said units in quadrature phase relationship.

8. An antenna system including a pair of directional radiating units arranged in planes at right angles to one another with their directions of maximum response in alignment, a transmission line connected at one end to transducer equipment, connections from each of said units to points on said transmission line, said points being spaced one quarter of the operating wavelength and the length of said connections so differing by one half of the operating wavelength that energy from said transmission line arrives at said units in quadrature phase relationship, and impedance matching networks in each connection from said transmission line to said units.

9. An antenna system including a pair of directional radiating units arranged in planes at right angles to one another with their directions of maximum response in alignment, and means for connecting said units to transducer equipment, the electrical length of the connections between each of said units and said means differing by a quarter of the operating wavelength, each directional radiating unit including a pair of conductors, the spacing of said conductors in said planes varying along their length.

10. An antenna system including a pair of directonal radiating units arranged in planes at right angles to one another with their directions of maximum response in alignment, a transmission line connected at one end to transducer equipment, connections from each of said units to points on said transmission line, said points

being spaced one quarter of the operating wavelength, each directional radiating unit including a pair of conductors, the spacing of said conductors in said planes varying along their length.

11. An antenna system including a pair of directional radiating units arranged in planes at right angles to one another with their directions of maximum response in alignment, a transmission line connected at one end to transducer equipment, connections from each of said units to points on said transmission line, said points being spaced one quarter of a wavelength within the operating band of wavelengths and the length of said connections being equal or differing by integral half waves of an operating wavelength so that in phase energy in said transmission line has a phase quadrature relationship in said units, each directional radiating unit including a pair of conductors, the spacing of said conductors in said planes varying along their length.

12. An antenna system including a pair of directional radiating units arranged in planes at right angles to one another with their directions of maximum response in alignment, and means for connecting said units to transducer equipment, the electrical length of the connections between each of said units and said means differing by a quarter of the operating wavelength, each directional radiating unit including a pair of conductors diverging along their length with increasing distance from said connections.

13. An antenna system including a pair of directional radiating units arranged in planes at right angles to one another with their directions of maximum response in alignment, a transmission line connected at one end to transducer equipment, connections from each of said units to points on said transmission line, said points being spaced one quarter of the operating wavelength, each directional radiating unit including a pair of conductors diverging along their length with increasing distance from said connections.

14. An antenna system including a pair of directional radiating units arranged in planes at right angles to one another with their directions of maximum response in alignment, a transmission line connected at one end to transducer equipment, connections from each of said units to points on said transmission line, said points being spaced one quarter of the operating wavelength and the length of said connections being equal, or differing by integral half waves of the operating wavelength, so that energy from said transmission line arrives at said units in the same phase relationship, each directional radiating unit including a pair of conductors diverging along their length with increasing distance from said connections.

15. An antenna system including a pair of directional radiating units arranged in planes at right angles to one another with their directions of maximum response in alignment, a transmission line connected at one end to transducer equipment, connections from each of said units to points on said tranmission line, said points being spaced one quarter of the operating wavelength, and the length of said connections being alike or so differing that energy from said transmission line arrives at said units in 90 degree phase relationship, each directional radiating unit including a pair of conductors, the spacing of said conductors diverging and then converging in a diamond configuration in said plane.

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