

April 8, 1941.

P. S. CARTER

2,237,779

WIDE BAND ANTENNA ARRAY

Filed May 24, 1938

Fig. 1

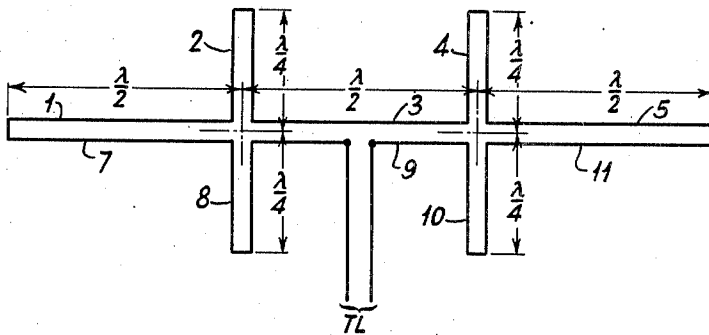


Fig. 2

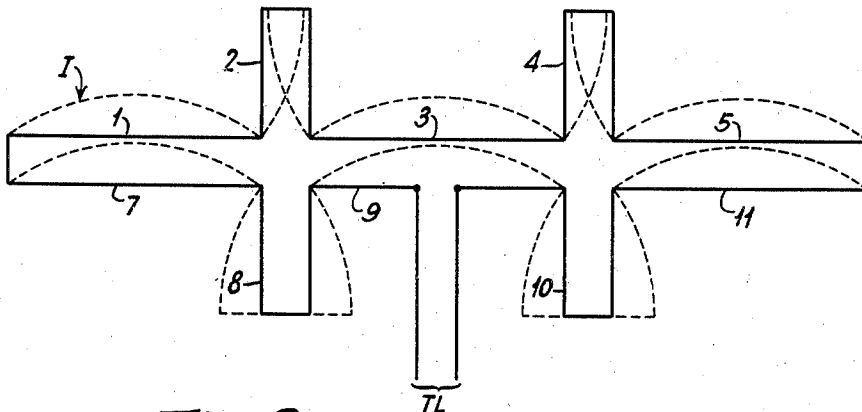
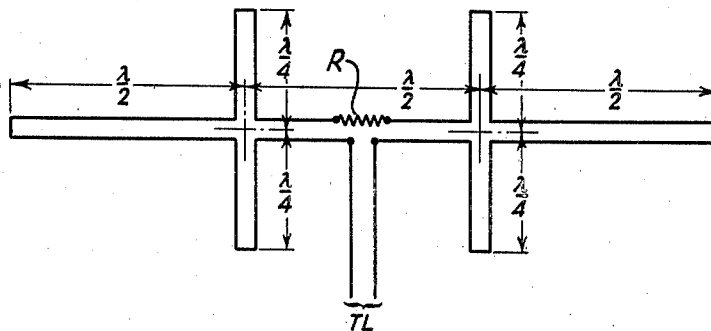


Fig. 3



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UNITED STATES PATENT OFFICE

2,237,779

WIDE BAND ANTENNA ARRAY

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Application May 24, 1938, Serial No. 209,658

11 Claims. (Cl. 250—11)

The present invention relates to antennas and, more particularly, to an antenna equivalent in its radiation effects to a horizontal half wave dipole array of the broadside type.

The primary object of the present invention is to provide an antenna array which will have an extremely broad tuning range when directly connected to a transmission line of ordinary impedance characteristic. In other words, it is desired to provide an antenna array which when directly connected to a transmission line has a flat impedance versus frequency characteristic over a broad range as seen looking toward the antenna from the transmitter or receiver terminals.

A secondary object is to provide an antenna array which requires no special impedance matching circuit between the antenna and the feeder in order to match the surge impedance of the line to the impedance of the antenna array. Although the horizontal half wave dipole array of the broadside type, as heretofore known, has in itself a sufficiently broad tuning characteristic to give satisfactory transmission and reception over a band of frequencies such as may be used in television, it has been found that when this type of array is matched to a transmission line in any of the known ordinary ways the tuning characteristic of the array is made very much narrower and is insufficient for the band of frequencies now generally used for television purposes.

The above mentioned difficulty is overcome and the foregoing objects achieved in accordance with the present invention generally by providing for each element of the dipole array a multiple dipole system, the component elements of which are effectively arranged in parallel. Although it has just been stated that the component elements of the dipole array are effectively in parallel, it should be understood that by the term "effectively" it is deemed that all of the dipole elements radiate in parallel or receive in parallel depending upon whether the antenna is used for transmission or reception, while in practice from a direct current standpoint the dipole elements may be actually connected in series.

The present invention differs in one respect from the usual broadside array in that radiator and feed wires are provided which are so arranged as to present an impedance to the transmission line not greatly different from the characteristic impedance of the transmission line.

The principle by which this is obtained is similar to that disclosed in my prior co-pending ap-

plication, Serial No. 155,335, filed July 24, 1937 (RCA docket #13,081).

A better understanding of the invention will be had by referring to the following detailed description, which is accompanied by drawing, wherein Figure 1 illustrates an embodiment of the present invention, Figure 2 is a diagrammatic representation of an antenna similar to that shown in Figure 1 with the current distribution of the antenna system shown thereon in dotted lines and Figure 3 illustrates a modification of my invention.

Referring, now, to Figure 1 there are shown a plurality of half wave radiating elements 1, 7; 3, 9 and 5, 11. The conductors of each of these pairs are very closely spaced from one another, perhaps a distance of one-hundredths of a wave length, and conductors 1, 7 and 5, 11 are electrically connected at their ends. Conductor 1 is connected to conductor 3 by means of a half wave phasing loop 2 which has no effective radiation. Similarly, conductors 3 and 5 are connected together by loop 4, 7 and 9 by loop 8, and conductors 9 and 11 by loop 10. Conductor 9 is electrically discontinuous at the center and the transmission line TL is connected at that point. The currents flowing in each of the pairs of conductors 1, 7; 3, 9 and 5, 11 will be in the same direction in space. Consequently, the arrangement will be almost identical in the radiation characteristic of each pair with that of a single wire half wave dipole antenna and the array as a whole to that of a horizontal half wave dipole array of the broadside type. With the close spacing, as heretofore mentioned, the mutual impedance, that is, the coupling between each of the pairs of conductors, is almost equal to the impedance of one wire.

Since the total current in the two wires of the double wire array of Figure 1 is substantially the same as for a corresponding single wire array the power radiated per total ampere squared, i. e. the radiation resistance, is also substantially the same. Since each wire of the pair carries half the current the effective radiation resistance with respect to the loop current in one wire alone is increased by the factor 4. If we neglect the attenuation due to radiation the effective resistance presented to the transmission line would be four times that for a corresponding single wire array. However, in such an antenna the attenuation due to radiation is sufficiently high to result in a nearly pure traveling wave of current in the half wave dipole "9" joining the transmission line. For this reason little or no impedance transformation is necessary for matching the antenna im-

phasing loops between said radiating portions, another conductor likewise having an odd number of co-linear half wave radiating portions and non-radiating phasing loops connecting said radiating portions arranged with said co-linear portions parallel to those of said first conductor and closely spaced thereto, said spacing being so close that the mutual impedance between the parallel portions of said conductors is substantially equal to the impedance of a single one of said conductors means for connecting the extreme ends of said conductors together, said first mentioned conductor being electrically discontinuous at its center and a transmission line connected across said discontinuity whereby said conductors are energized in a series relationship from said transmission line.

7. An antenna system comprising a conductor having an odd number of co-linear radiating portions and non-radiating phasing loops between said radiating portions, another conductor likewise having an odd number of co-linear radiating portions and non-radiating phasing loops arranged with said co-linear portions parallel to those of said first conductor and closely spaced thereto, said spacing being so close that the mutual impedance between the parallel portions of said conductors is substantially equal to the impedance of a single one of said conductors means for connecting the ends of said conductors together, the central radiating portion of each conductor having a gap at its center, a resistance connected across one of said gaps and a transmission line connected across the other of said gaps whereby said conductors are energized in a series relationship from said transmission line.

8. An antenna system comprising a conductor having an odd number of co-linear half wave radiating portions and non-radiating phasing loops between said radiating portions, another conductor likewise having an odd number of co-linear radiating portions and non-radiating phasing loops arranged with said co-linear portions parallel to those of said first conductor and closely spaced thereto, said other conductor being electrically discontinuous at its center and a transmission line connected across said discontinuity, said spacing being of the order of $\frac{1}{100}$ of the length of the operating wave whereby the impedance of said antenna is multiplied, means for connecting the ends of said conductors together, said conductors thereby being all connected in a series circuit across said transmission line, said first conductor having a different effective cross section than said other conductor, whereby the ratio of said multiplication is an odd value.

9. An antenna system comprising a conductor

having an odd number of co-linear half wave radiating portions and non-radiating phasing loops between said radiating portions, another conductor likewise having an odd number of co-linear radiating portions and non-radiating phasing loops arranged with said co-linear portions parallel to those of said first conductor and closely spaced thereto, said other conductor being electrically discontinuous at its center and a transmission line connected across said discontinuity, said spacing being of the order of $\frac{1}{100}$ of the length of the operating wave whereby the impedance of said antenna is increased, means for connecting the ends of said conductors together, said conductors thereby being all connected in a series circuit across said transmission line, said first conductor having a larger cross section than said other conductor, whereby said increase in impedance is transformed into an odd value.

10. An antenna system comprising a conductor having an odd number of co-linear half wave radiating portions and non-radiating phasing loops between said radiating portions, another conductor likewise having an odd number of co-linear radiating portions and non-radiating phasing loops arranged with said co-linear portions parallel to those of said first conductor and closely spaced thereto, said spacing being of the order of $\frac{1}{100}$ of the length of the operating wave means for connecting the ends of said conductors together, said first conductor having a smaller cross section than said other conductor, said other conductor being electrically discontinuous at its center and a transmission line connected across said discontinuity said conductors being energized in series from said transmission line and radiating in a parallel relationship.

11. An antenna system comprising a conductor having an odd number of co-linear half wave radiating portions and non-radiating phasing loops between said radiating portions, another conductor likewise having an odd number of co-linear radiating portions and non-radiating phasing loops arranged with said co-linear portions parallel to those of said first conductor and closely spaced thereto, said spacing being of the order of $\frac{1}{100}$ of the length of the operating wave means for connecting the ends of said conductors together, one of said conductors being composed of a plurality of wires connected in parallel, said other conductor being electrically discontinuous at its center and a transmission line connected across said discontinuity said conductors being energized in series from said transmission line and radiating in a parallel relationship.

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