Jan. 9, 1940. W. I. MATTHEWS 2,186,422

DIVERSITY ANTENNA

Filed June 8, 1938

Fig. 1

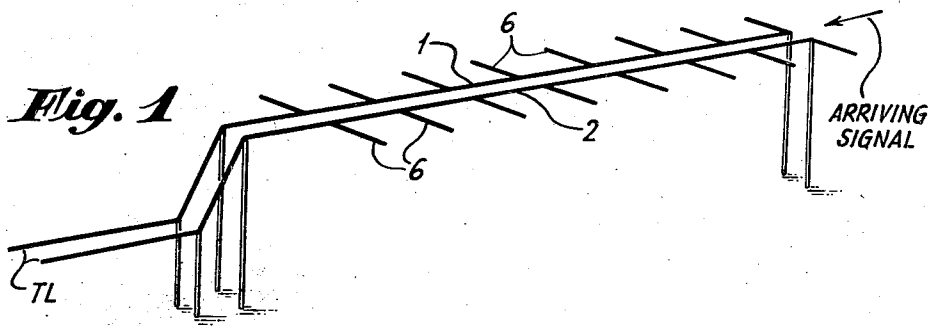


Fig. 2

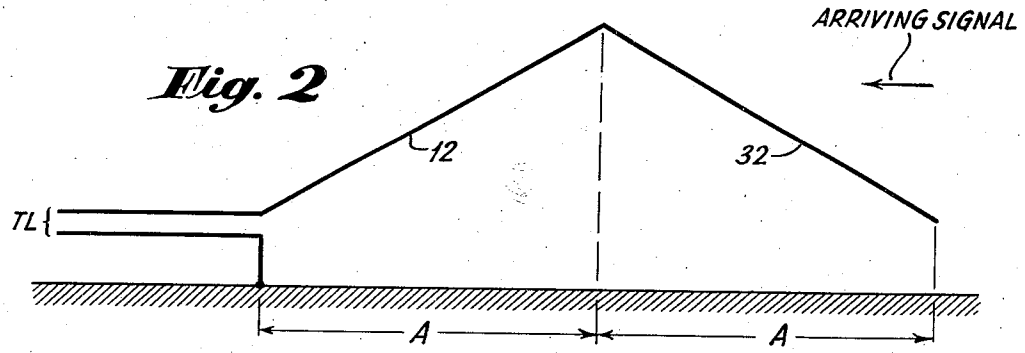
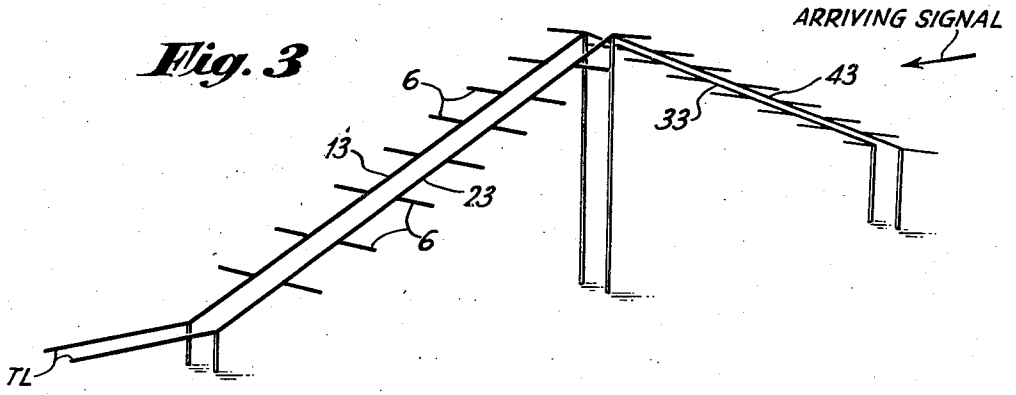


Fig. 3



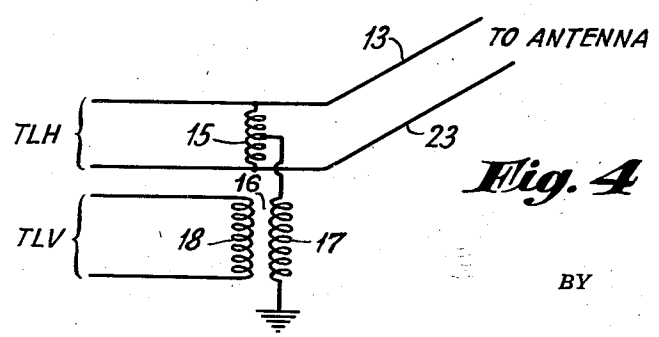


Fig. 4

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DIVERSITY ANTENNA

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Application June 8, 1938, Serial No. 212,410

12 Claims. (Cl. 250—11)

This invention relates to radio receiving antennas and, more specifically, to a single antenna structure for the directive reception of radio waves polarized in horizontal and vertical planes.

It has heretofore been the practice, in order to mitigate fading of short wave signals, to receive either horizontally or vertically polarized signals on two or more geographically spaced antennas. The resultant output from each antenna is then combined at the receiving station so that even though the signal received from one of the antennas is at a very low level due to a fading of the signal, the signal from the other antenna may still be of usable strength. This principle has been called the diversity principle and is ordinarily applicable to antennas of like kind separated in space.

For successful operation of this system the antennas must be spaced a number of wavelengths apart and, hence, requires the use of considerable area of ground.

Tests have shown that a marked diversity effect exists between vertical and horizontal arrays located at approximately the same geographical location.

An object, therefore, of the present invention is the application of this polarization diversity effect to a single antenna structure.

Another object of my invention is to provide a single antenna structure which is selectively responsive to both horizontally and vertically polarized radio waves.

As a further object, the present invention involves the simultaneous transmission of both horizontally and vertically polarized waves.

Still another object of the present invention is to accomplish simultaneous transmission and reception on the same frequency band, using a single antenna structure and without mutual interference.

My present invention relates to a single array which responds to both vertical and horizontal polarized waves and, briefly, consists of a pair of wires arranged in a vertical half diamond and extending in the direction of desired reception. To each of the wires of the half diamond is attached a plurality of horizontal half wave antennae arranged transversely to the half diamond. The vertical half diamond construction enables the antenna to receive vertically polarized signals while the horizontal dipoles attached thereto respond to the horizontally polarized wave. By means of a suitable coupling arrangement between the antenna and the transmission line, the two components of the received signal wave are separated and separately transmitted to the receiving apparatus.

Referring, now, for a more complete disclosure of my invention, to the following detailed description, which is accompanied by drawing, in which

Figures 1 and 2 illustrate diagrammatically the separate components of my antenna while Figure 3 illustrates an embodiment of my invention and Figure 4 illustrates a coupling means for coupling transmission lines to the antenna.

Referring to Figure 1 it will be seen that there is a pair of linear conductors 1 and 2 to which are coupled transverse pick-up wires 6. The two conductors, 1 and 2, are parallel to one another and extend from transmission line TL in the direction of the desired reception. The pick-up wires 6 are arranged in a horizontal plane and at right angles to the conductors 1 and 2. The pick-up wires 6 may be either directly connected to wires 1 and 2 or may be coupled thereto through limiting impedances which may take the form of small series condensers, or they may be coupled thereto in any other known fashion. The antenna, as shown in this figure, responds best to horizontally polarized waves. An antenna of this general type is more completely described in a patent to H. O. Petersen, No. 1,821,402, granted September 1, 1931.

The antenna shown in Figure 2 consists of conductors 12 and 32 connected in series and arranged in a common vertical plane. They are arranged in such a manner as to describe a vertical half diamond with respect to the earth. In determining the physical dimensions of such an array, wires 12 and 32 should, preferably, each be a number of wavelengths long and each of the wires should be a half wavelength longer than their projected distance A on the ground. This type of antenna responds best to vertically polarized waves.

My invention, as shown in Figure 3, involves the combination of a vertical array of Figure 2 with the horizontal array of Figure 1. The single wire normally used as a vertical half diamond is replaced by the two sets of wires 13, 33 and 23, 43. These wires are relatively closely spaced so as to produce a transmission line for the horizontally polarized waves picked up by pick-up wires 6. The dipole pick-up wires 6, as described with respect to Figure 1, are connected across the transmission line and disposed in planes parallel to the earth. These doublets respond primarily to the horizontally polarized waves. At the end of the array remote from the

direction of the arriving signal a transducer for separating the vertical and horizontal components for transfer to the transmission line leading to the radio receivers is provided. This transducer is shown diagrammatically in Figure 4.

The transducer comprises a center tapped coil 15 and a transformer 16. The two ends of coil 15 are connected to the transmission wires 13 and 23. From the center tap of coil 15 to ground is connected primary 17 of transformer 16. The ends of coil 15 are connected to transmission line TLH which carries the horizontally polarized waves to the receiver while the secondary 18 of the transformer 16 is connected to the transmission line TLV for a vertical component of the received signal waves. It will be apparent that for horizontally polarized signal waves the end terminals of coil 15 will experience voltages of opposite polarity thus transferring signal energy to the transmission line TLH, while no difference of potential will exist between the center tap and ground and, therefore, none of the energy due to the horizontally polarized signal waves will appear across the secondary 18 of the transformer. For vertically polarized waves the end terminals of coil 15 receive voltages of like polarity thus resulting in no energy transferring to transmission line TLH. These like voltages, however, give rise to a potential difference across coil 17 and thus result in a transfer of energy to the transmission line TLV. If desired, in order to prevent reflections in the transmission line or to increase discrimination against signals arriving to the array from the direction apposite to that shown by the arrow in the figures, terminating impedances may be provided across the ends of the conductors 33 and 43 remote from the transmission line. Also, it should be apparent that my invention is equally adapted to the use of transmission, it then being merely necessary to connect the proper transmission apparatus to transmission lines TLH and TLV.

Furthermore, it is also possible to utilize one transmission line to take received signals of one polarization to a receiver, while the other transmission line can be used to take energy from a transmitter to the antenna to radiate waves of the other polarization at the same time, the receiving and transmission operations occurring without mutual interference due to the lack of interaction between the two channels.

While I have particularly illustrated and described one form of my invention, it is to be understood that my invention is not limited to the form illustrated and that modifications may be made within the scope of the invention.

I claim:

1. A directive antenna comprising a pair of relatively closely spaced conductors and a plurality of transverse pick-up wires coupled thereto at intervals along said conductors, said conductors being arranged in a vertical half diamond configuration with respect to the earth.

2. A directive antenna comprising a pair of relatively closely spaced conductors and a plurality of transverse horizontal pick-up wires coupled thereto at intervals along said conductors, said conductors being arranged in a vertical half diamond configuration with respect to the earth.

3. A directive antenna comprising a pair of relatively closely spaced conductors and a plurality of transverse pick-up wires coupled thereto at intervals along said conductors, said conductors being arranged in a vertical half diamond configuration with respect to the earth and signalling means connected to one end of said conductors.

4. A directive antenna comprising a pair of relatively closely spaced conductors, a plurality of transverse pick-up wires coupled thereto at intervals along said conductors, signal responsive means connected to one end of said conductors, said conductors being arranged in a vertical half diamond configuration with respect to the earth with the end of said conductors remote from said means directed toward the source of said signals.

5. A directive antenna comprising a pair of relatively closely spaced conductors, the ends of said conductors being supported comparatively near the earth and their midpoints substantially elevated thereabove, a plurality of transverse pick-up wires coupled with said conductors at spaced intervals along said conductors and signal responsive means connected to one end of said conductors.

6. A directive antenna comprising a pair of relatively closely spaced conductors, the ends of said conductors being supported comparatively near the earth and their midpoints substantially elevated thereabove, a plurality of transverse horizontal pick-up wires coupled to said conductors at spaced intervals along said conductors and signal responsive means connected to one end of said conductors.

7. In combination, a source of radio signals, a directive antenna comprising a pair of relatively closely spaced conductors, the ends of said conductors being supported comparatively near the earth and their midpoints substantially elevated thereabove, a plurality of transverse pick-up wires coupled to said conductors at spaced points along said conductors, one end of said conductors being directed toward said source and signal responsive means connected to the other end of said conductors.

8. In combination, a source of radio signals, a directive antenna comprising a pair of relatively closely spaced conductors, said conductors being arranged in a vertical half diamond configuration with respect to the earth, a plurality of transverse horizontal pick-up wires coupled thereto along the length of said conductors, one end of said conductors being directed toward said source of radio signals and signal responsive means connected to the other end of said conductors.

9. A directive antenna comprising a pair of relatively closely spaced conductors, the ends of said conductors being supported comparatively near the earth and their midpoints substantially elevated thereabove, a plurality of transverse horizontal pick-up wires coupled thereto at spaced intervals along the length of said conductors, a center tapped coil connected to one end of said conductors, a transmission line also connected thereto, a transformer having its primary connected from said center tap to ground and its secondary connected to a second transmission line.

10. A directive antenna comprising a pair of relatively closely spaced conductors, the ends of said conductors being supported comparatively near the earth and their midpoints substantially elevated thereabove, a plurality of transverse horizontal pick-up wires coupled thereto at spaced intervals along the length of said conductors, a center tapped coil connected to one end of said conductors, a transmission line also connected thereto, a transformer having its pri-

mary connected from said center tap to ground and its secondary connected to a second transmission line and signal responsive means connected to each of said transmission lines.

11. In combination, a source of radio signals, a directive receiving antenna comprising a pair of relatively closely spaced conductors, said conductors being arranged in a vertical half diamond configuration with respect to the earth, one end of said conductors being directed toward said source, a plurality of transverse horizontal pick-up wires coupled to said conductors, a center tapped coil connected to the end of said conductors remote from said source, a transmission line also connected thereto, a transformer having its primary connected from said center tap to ground and its secondary connected to a second transmission line.

12. In combination, a source of radio signals, a directive receiving antenna comprising a pair of relatively closely spaced conductors, said conductors being arranged in a vertical half diamond configuration with respect to the earth, one end of said conductors being directed toward said source, a plurality of transverse horizontal pick-up wires coupled to said conductors, a center tapped coil connected to the end of said conductors remote from said source, a transmission line also connected thereto, a transformer having its primary connected from said center tap to ground and its secondary connected to a second transmission line, and signal responsive means connected to each of said transmission lines.

WALTER I. MATTHEWS.