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VARIABLE POLARIZATION ANTENNA SYSTEM

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FIG. 1

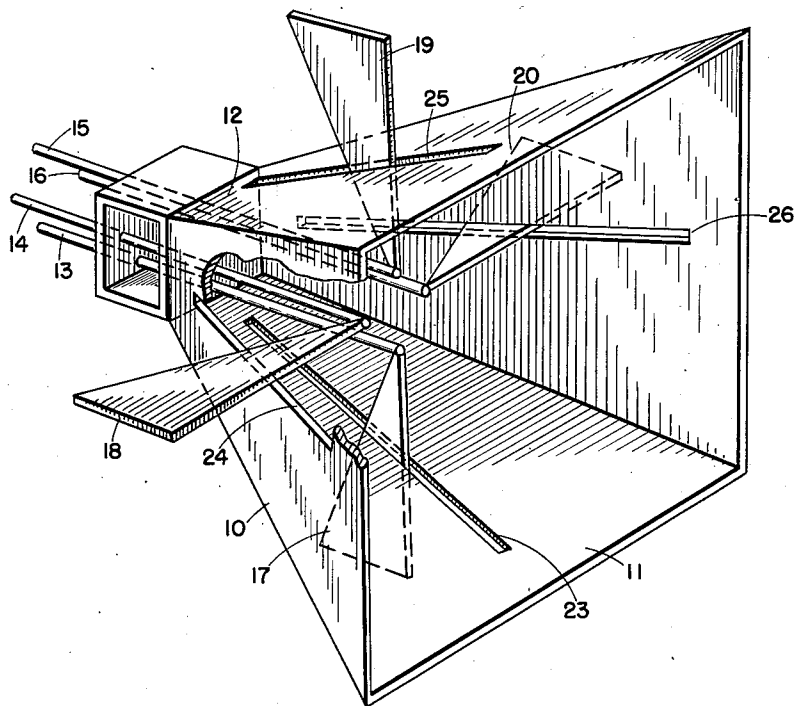


FIG. 3

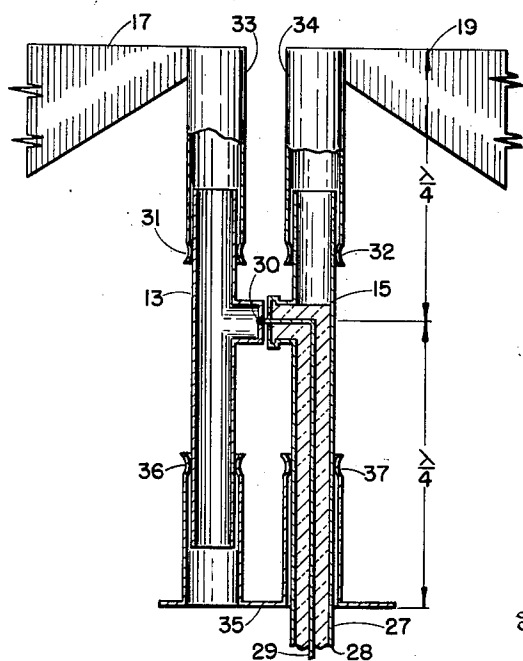
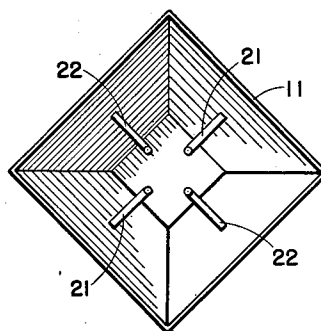


FIG. 2



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VARIABLE POLARIZATION ANTENNA
SYSTEM

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This invention relates to radio antennas and, in particular, to a variable polarization antenna system for ultra high frequency radiation and reception.

One object of the invention is to provide an antenna which is tunable over a wide range of frequencies.

Another object of the invention is to provide an antenna which is capable of producing three types of polarization; namely, horizontal, vertical or circular polarization.

Another object of the invention is to provide an antenna which is of adjustable wave length and having two dipole radiators set in a reflecting structure.

A further object of the invention is to provide an antenna which can be adjusted through a range of radiant wave lengths while keeping a constant input impedance.

A still further object of the invention is to provide an antenna having a substantially constant field strength pattern as it is tuned throughout its operating frequency range.

The present invention features an antenna array comprising two dipoles within a reflecting structure which is built with a square mouth and having a square throat. According to this arrangement two dipoles are set in the same plane, but mutually perpendicular and at 45° from the horizontal. By varying the phase of excitation voltage of one or both dipoles, three types of polarization may be produced; viz., horizontal, vertical, or circular. Elliptical polarization also is attainable at intermediate phase settings. As another feature of the invention, in order to obtain as wide a frequency band as possible triangular flat sheet radiators are employed as the dipole radiating elements.

Other objects and features of the invention will become apparent upon the reading of the following description taken in conjunction with the drawings, in which:

Fig. 1 is a perspective view of an antenna embodying the principles of the invention, one side of the reflector being broken away in order to show details of the dipole arrangement within the reflector;

Fig. 2 shows an end view of the reflecting structure of Fig. 1 in its intended operating position;

Fig. 3 is a partially sectioned view of an exemplary matching section for the coaxial dipole feeders.

For radio transmission operations at ultra-high frequencies, that is to say, at frequencies

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of the order of 100 to 1000 megacycles per second, it is desirable to have a radiating or receiving antenna which can be tuned to any frequency within a considerable range and retain substantially constant directive properties within this range in order to yield a desired power gain.

In order to tune such an antenna to different wave lengths, it is obviously necessary to be able to vary at will over a considerable range the length of each dipole within the reflecting structure. In the arrangement about to be described, means for effecting this result is described.

Referring particularly to Fig. 1 there is shown a reflecting structure 10 having a square mouth 11 and a throat 12 of smaller size than the mouth 11 and which is preferably, though not necessarily, square. The sides of the reflecting structure 10 connecting the mouth with the throat thus flare outwardly from the throat making an acute angle with the axis of the reflecting structure. Rearwardly introduced through the throat 12 and positioned within the reflecting structure 10 are the parallel reciprocally adjustable tubular feeders 13, 14, 15 and 16, which are connected at their respective forward ends to the apex of the triangular radiators 17, 18, 19 and 20, respectively which form the dipoles generally designated by the reference numerals 21 and 22 which are energized in the case of a transmitting structure to radiate the energy into space or, in the case of a receiving structure, are used for conveying the received energy to suitable translating apparatus.

As shown in Fig. 1, the triangular plate radiators 17, 18, 19, and 20 of the dipole antennas 21 and 22 are of similar dimensions, and the effective length of these radiators is adjustable by the provision of slots 23, 24, 25, and 26 in the sides of the reflector 10 through which the triangular plate radiators pass exteriorly of the radiating structure 10. The slots are of a width to provide a sliding fit for the plate radiators and are of a length sufficient to permit maximum forward and rearward longitudinal movement of the radiators relative to the slots. Thus these slots may be made of various lengths to control the range of frequencies through which the antenna may be tuned as the radiators are moved axially along the reflecting structure, since the effective length of the dipole elements and thus the frequency to which they are tuned is that which is enclosed within the sides of the reflecting structure and which length, due to the angle these sides subtend with the axis of the

reflector, increases as the radiators are shifted axially toward the mouth of the reflector.

To provide for tuning of the radiators means such as a motor connected through suitable gearing to a feed screw is employed to adjust the feeders 13, 14, 15, and 16 simultaneously in order to cause them to enter further or be retracted from the reflecting structure.

This may be accomplished by fixedly mounting the reflector and shifting the dipole elements relative thereto or vice versa. Also, a suitable impedance matching section must be tuned in accordance with the tuning of the dipoles since the matching section is highly frequency sensitive. A matching section, such as shown in Fig. 3, may be provided in which the pairs of feeder elements 13, 15, and 14, 16 to the dipoles 21 and 22 respectively are fixedly mounted with respect to a fixed reference. The energy to be radiated or picked up by the dipoles is coupled through the coaxial line 27 to the fixed feeder element 15. The outer conductor 28 of the coax 27 is connected to the tubular element 15 and the inner coax conductor 29 is connected at 30 to the feeder 13. Since the feed point 30 must always be an odd number of quarter-wave lengths from the apex of the dipole elements 17 and 19 regardless of the frequency of the energy fed thereto tubular feeder members 13 and 15 are coupled to the dipole elements 17 and 19 through telescopic connections 31, 32 where the tubular members 33 and 34 on which the dipole elements 17, 19 are mounted slidably surround the feeders 13 and 15. Likewise, the shorting member 35 is adjustably positioned with respect to the feed point 30 by means of telescoping elements 36 and 37 slidably connected to feeders 13 and 15. Since the feeders 13, 15 are fixedly positioned relative to the reflector 10, movement of the reflector relative to the radiating elements to tune the dipoles will also vary the distance from the feed point 30 between the feeder 13 and 15 and the apex of the radiating elements. A suitable linkage may be coupled between the telescoping elements 33, 34 and the shorting member 35 to move the member 35 by an equal amount and in a direction opposing the movement of the telescoping elements. It will be apparent that the slope of the sides of the reflector 10 and thus the rate of change of effective length of the dipoles for a given axial movement of the reflector can be so proportioned to the longitudinal movement of the feed point 30 relative to the radiating elements that the matching section will be tuned continuously to the same frequency as the dipoles.

In practice, it was found necessary to limit the maximum distance between feeders 13 and 15 to a value less than a quarter-wave length at the highest frequency to be employed to maintain the directivity and gain of the antenna approximately constant throughout the frequency range. With such distances exceeding this limit, the unit displays a tendency to radiate from the feed point 30 rather than the dipoles for the frequencies whose quarter-wave length exceed this distance. Matching of the feeders 14 and 16 may be accomplished by a similar device.

When the antenna structure is positioned as shown in Fig. 2, the various types of polarization may be achieved as follows.

In the first condition, the two pairs of feeders 13, 15 and 14, 16 are excited in the same R. F. phase. This produces a radiation which is horizontally polarized.

In the second condition, the phase difference

of R. F. excitation through each of the feeders is made to be ninety degrees by suitable means. One means for accomplishing the phase quadrature is the introduction of additional feed line to an electrical length of $\frac{1}{4}$ wavelength. The dipoles are thereby fed in quadrature, producing a circular polarized wave.

In the third condition the relative phase difference of the R.-F. excitation through each of the feeders is made 180 degrees. This produces a vertically polarized wave.

Under all the above conditions the amplitude of R.-F. excitation is maintained constant. Special angles of polarization or elliptical polarization may be obtained by adjusting both phase and amplitude of the feeder excitation current.

While I have particularly shown and described one particular embodiment of the invention, it is distinctly understood that the invention is not limited thereto but that modifications may be made within the scope of the invention and such variations are covered by the scope of the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. A pyramidal reflecting antenna horn structure having a longitudinal axis and rectangular mouth and throat apertures, said mouth being of greater dimensions than said throat whereby the sides of said structure subtend an acute angle with the axis of said structure, longitudinal slots each located along a median line of each of said sides, and dipole radiators comprising triangular plate members extending radially from a position near the axis of said structure through said slots and externally of said structure and axially movable with said structure whereby adjustment of said dipoles varies the tuning of the latter over a wide frequency band.

2. An antenna comprising an elongated horn type reflecting structure having four longitudinal slots cut in the surface thereof, said slots being positioned so that the plane which intersects two of the slots lies at right angles to the plane which intersects the other two slots, and a pair of mutually perpendicular dipole radiators axially and movably disposed within the horn structure, said dipoles being positioned so that the ends of the dipoles extend through the slots in said horn structure.

3. An antenna comprising a pyramidal reflecting horn structure having a longitudinal axis and rectangular mouth and throat apertures, said structure having a predetermined taper in its vertical and horizontal dimensions, a longitudinal slot formed in each side of said horn along the median line thereof, a pair of dipole radiators disposed within the horn, the individual radiator elements of said dipoles extending radially from a position near the axis of the horn through said slots externally of said horn, whereby axial movement of said radiators relative to horn varies the tuning of the radiators.

4. An antenna comprising an elongated horn type reflecting structure, a plurality of longitudinal slots formed in the surface of said horn, and dipole radiator means movably disposed within the horn for energizing the same, the individual radiator elements of said dipole means extending through said slots whereby axial movement of

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said radiator means varies the tuning of the dipole radiator means.

5. An antenna comprising an elongated horn type reflector having four longitudinal slots formed in the surface thereof, said slots being positioned so that the plane that intersects two of the slots lies at right angles to the plane which intersects the other two, a pair of mutually perpendicularly disposed dipole radiators movably located within the horn, the individual elements of said dipoles being arranged so that the ends thereof extend through the slots in said horn,

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and means interconnecting said dipoles in a predetermined phase relation.

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