

May 5, 1970

YOSHIHIRO TAKEICHI ET AL
PYRAMIDAL HORN REFLECTOR ANTENNA

3,510,874

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Fig. 1.

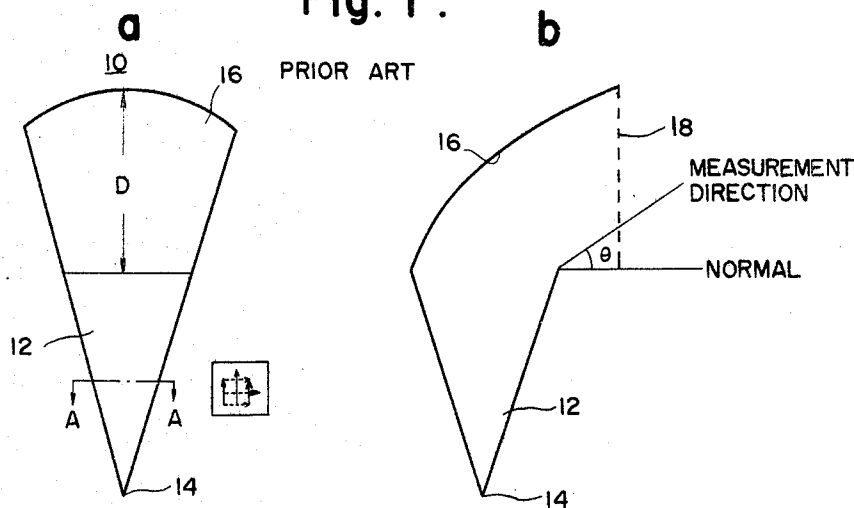
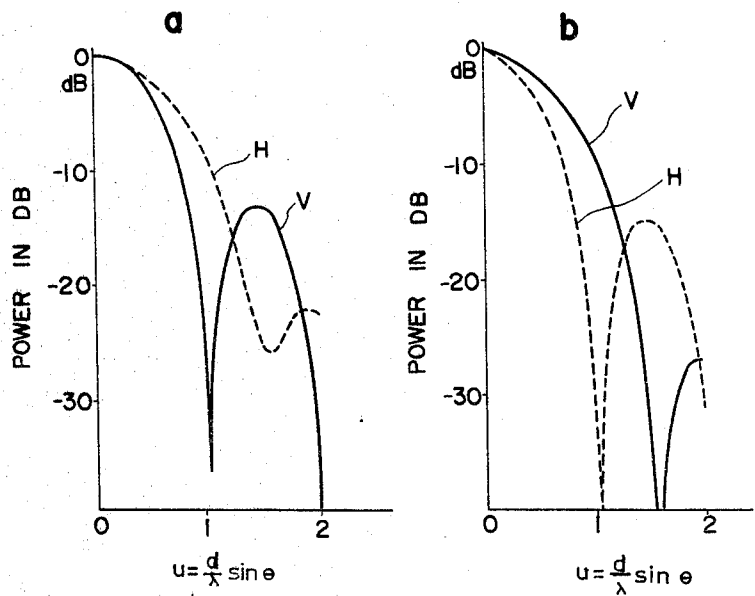


Fig. 2.



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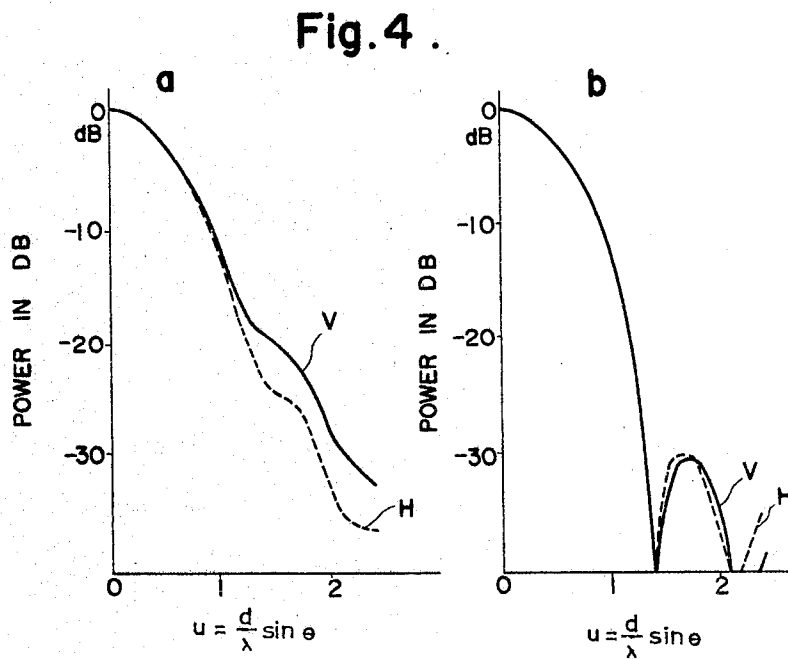
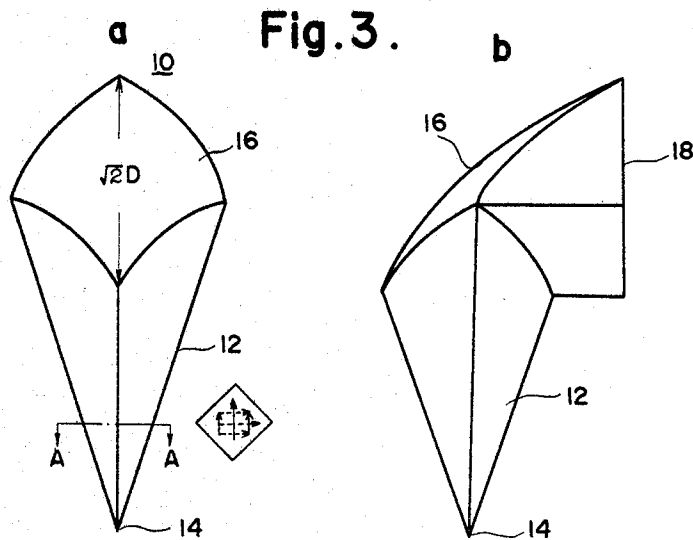
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PYRAMIDAL HORN REFLECTOR ANTENNA
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Int. Cl. H01q 13/00

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3 Claims

ABSTRACT OF THE DISCLOSURE

The disclosed horn reflector antenna includes a parabolic reflector having an axis of revolution parallel to one of diagonals of a cross section of the horn involved. Its vertical and horizontal radiation patterns each have a beam width scarcely affected by the polarization direction and include considerably low side lobes.

This invention relates to improvements in horn reflector antennas used with microwave communication.

It is well known that as the horn reflector type of antennas include a reflecting mirror surface composed of one portion of a paraboloid of revolution whose focus is at a feeding point to the antenna, that a beam of electromagnetic energy radiated by the antenna has a common phase angle on the aperture or mouth surface of the electromagnetic horn involved resulting in a sharp directivity. On the other hand, such an antenna has radiation patterns both having a beam width and a shape dependent upon the polarization direction. Further such a radiation pattern includes a relatively high side lobe or lobes.

It is, accordingly, an object of the invention to provide a new and improved horn reflector antenna for radiating a beam of electromagnetic energy having a beam width substantially unaffected by the polarization direction.

It is another object of the invention to provide a new and improved horn reflector antenna having a vertical and horizontal radiation pattern including considerably low side lobes.

It is a more special object of the invention to provide an improved diagonal horn reflector antenna including a reflecting mirror having an inner surface shaped by the revolution of a parabola about a line substantially parallel to one of diagonals of a cross section of the electromagnetic horn involved.

It is still another object of the invention to provide a new and improved horn reflector antenna capable of substantially reducing the effect of ground reflection upon communication.

It is a further object of the invention to provide a new and improved horn reflector antenna capable of providing an information channel less affected by any other intelligence channel.

Briefly, the invention accomplishes the above cited objects by the provision of a horn reflector antenna including an electromagnetic horn in the form of a hollow square pyramid and a parabolic reflector operatively connected to the horn, characterized in that the parabolic reflector comprises a reflecting surface of revolution type having its axis of revolution substantially parallel to one of diagonals of a square cross section of the horn.

The electromagnetic horn may be preferably energized in the mode of operation of a diagonal horn.

The horn reflector antenna of the invention may be advantageously disposed such that the longitudinal axis of the electromagnetic horn is in the vertical direction with respect to the ground while the aperture surface of

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the antenna has two diagonals substantially parallel and normal to the horizontal plane respectively.

The invention will become more readily apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIGS. 1a and b are respectively a front and a side elevational view of a horn reflector antenna according to the prior art practice;

FIGS. 2a and b are respectively a vertical and a horizontal radiation pattern for the antenna illustrated in FIG. 1;

FIGS. 3a and b are views similar to FIGS. 1a and b but illustrating one embodiment of the invention; and

FIGS. 4a and b are respectively a vertical and a horizontal radiation pattern for the antenna illustrated in FIG. 3.

Referring now to the drawings and FIGS. 1a and b in particular, there is illustrated a horn reflector antenna according to the prior art practice. The antenna generally designated by the reference numeral 10 comprises an electromagnetic horn 12 in the form of a hollow square pyramid electrically connected at the reduced end 14 to a feeding waveguide (not shown) and a parabolic reflector 16 electrically connected to the enlarged open end of the horn 12. The parabolic reflector 16 has an inner surface composed of a portion of paraboloid of revolution substantially parallel to one side of the cross section of the horn 12 and its focus at the reduced horn end 14.

An electromagnetic energy introduced into the horn 12 through the abovementioned waveguide is reflected from the inner parabolic surface of the reflector 16 to turn its direction of propagation and then emitted in the form of a beam to the exterior through an aperture surface indicated at dotted line 18 in FIG. 1b. Since the inner reflector surface has its focus at the reduced end 14 of the electromagnetic horn 12 the aperture surface 18 coincides with an equi-phase surface of the beam of electromagnetic energy and therefore has a sharp directivity.

Referring now to FIGS. 2a and b there are illustrated respectively a vertical and a horizontal radiation pattern exhibited by a horn reflector antenna such as the antenna 10 shown in FIGS. 1a and b. In FIGS. 2a and b the axis of ordinates represents a radiated electromagnetic power in decibels and the axis of abscissas represents a function

$$\mu = \frac{D}{\alpha} \sin \theta$$

where D is a longitudinal length of the aperture surface 18 (see FIG. 1b), α is an exciting wavelength, and θ is an angle formed between the normal to the aperture surface and a measurement direction (see FIG. 1b). Also solid line V depicts a radiation pattern exhibited by an antenna such as 10 excited with a vertically polarized wave while dotted line H depicts a radiation pattern exhibited by the antenna excited with a horizontally polarized wave.

From FIGS. 2a and b it will be seen that the beam width for the vertically polarized wave is different from that for horizontally polarized wave and also that each of the vertical and horizontal radiation patterns includes a relatively high side lobe.

Also the horn 12 has a distribution of electric field as shown in a cross sectional view depicted adjacent to the right of the horn 12 and taken along the line A—A in FIG. 1a. In the sectional view solid line corresponds to the vertically polarized wave and dotted line corresponds to the horizontally polarized wave.

The invention contemplates to eliminate the abovementioned disadvantages of the prior art horn reflector antennas. In other words, it provides a horn reflector antenna

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having a vertical and horizontal radiation pattern having a beam width substantially unaffected by the polarization direction and a considerably low side lobe or lobes.

Referring now to FIGS. 3a and b wherein the same reference numerals designate the components corresponding to those shown in FIGS. 1a and b, there is illustrated a horn reflector antenna according to the invention. As shown, a parabolic reflector 16 has its inner reflecting surface provided through revolution of one portion of a parabola about a line substantially parallel to one of diagonals of a square cross section of an electromagnetic horn 12. The antenna has an aperture surface having a maximum length of $\sqrt{2}D$ where D represents a length of each side thereof that illustrated in FIG. 2a. Therefore the horn 12 is operated as a diagonal horn.

The horn reflector antenna shown in FIG. 3 has a vertical and a horizontal radiation pattern as illustrated in FIGS. 4a and b respectively wherein both the coordinate axes and the reference characters have the same meaning as in FIGS. 2a and b.

The horn 12 shown in FIG. 3 has a distribution of electric field as illustrated in a cross section view depicted adjacent the right of the same and taken along the line A—A, in FIG. 3a. Again solid line V corresponds to the vertically polarized wave and dotted line H corresponds to the horizontal polarized wave.

From FIGS. 4a and b it will be seen that the present antenna has a vertical and horizontal radiation pattern each having a beam width substantially unaffected by the polarization direction and a considerably low side lobe.

From the foregoing it will be appreciated that the horn reflector antenna including a parabolic reflector surface having its axis of revolution substantially parallel to one of diagonals of a cross section of the associated electromagnetic horn can be effectively used in the case it is desired to provide a predetermined fixed magnitude of a beam width for each of the vertically and horizontally polarized waves in consideration of the effect of ground reflection for the purpose of selectively operating the antenna with the vertically and horizontally polarized waves.

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The considerably low side lobe decrease the effect of ground reflection due to the lobe. In addition, the use of the present antenna with a desired radio station having another radio station or stations disposed at an angular position or positions close to the desired station, can reduce interference with the undesired station or stations.

While the invention has been illustrated and described with reference to a single preferred embodiment thereof it is to be understood that various changes in the details of constructions and the arrangement and combination of parts may be resorted to without departing from the spirit and scope of the invention.

What we claim is:

1. A horn reflector antenna including an electromagnetic horn in the form of a hollow square pyramid and a parabolic reflector integrally connected to the horn, said parabolic reflector comprising a reflecting surface of revolution having an axis of revolution substantially parallel to one of two diagonals of a cross section of said horn.

2. A horn reflector antenna as claimed in claim 1 wherein said horn operates as a diagonal horn.

3. A horn reflector antenna as claimed in claim 1, wherein the longitudinal axis of said horn is disposed vertically with respect to a horizontal plane, the aperture surface of the antenna has a pair of diagonals substantially parallel and normal with respect to the horizontal plane respectively.

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ELI LIEBERMAN, Primary Examiner

U.C. Cl. X.R.

343—840, 914