

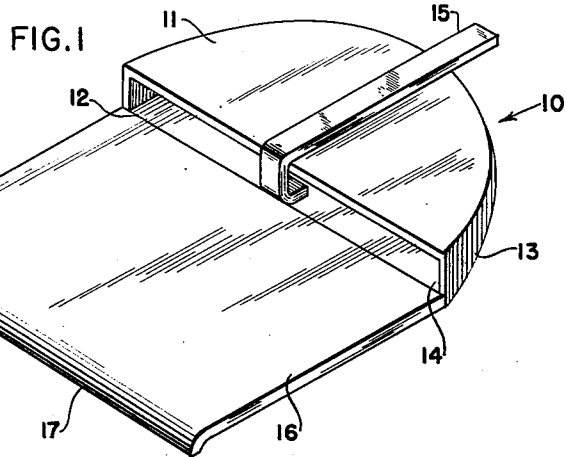
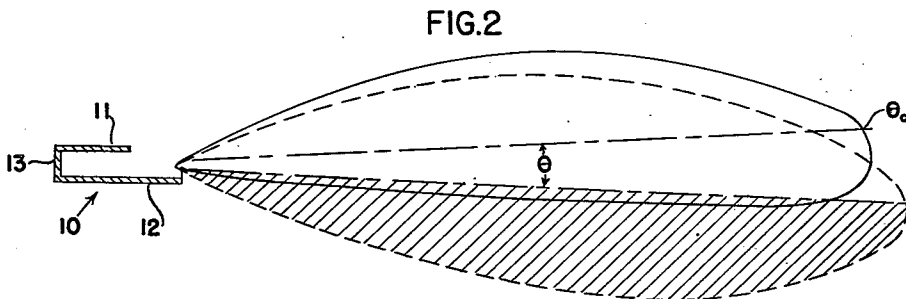
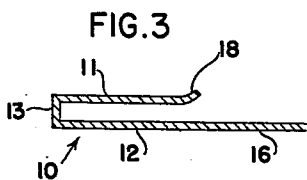
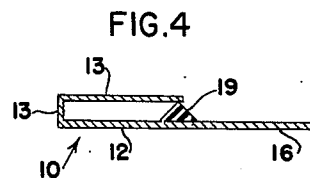
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This invention relates to antennas for communication systems and particularly to means for obtaining an unsymmetrical radiation pattern. More specifically, the invention is directed to a radiating means modified to produce a radiation pattern in which the energy distribution approximates the relationship $\csc^2\theta$ in one plane, generally the vertical plane, where θ is the angle measured from the axis of the radiating means or of the undistorted or symmetrical beam patterns; i. e., with an undistorted or conventionally shaped radiator.

In certain radio object-locating systems, for example ground search apparatus or low-altitude airborne apparatus, it is desirable that the energy distribution in a vertical plane be such that the variation of energy density versus the radiation angle approximates a cosecant-squared function. This distribution provides generally uniform echo strength for targets disposed at substantially equal elevation with respect to the antenna regardless of whether the target is close in or distant, and it eliminates to a great degree, the need for tilting the antenna to obtain satisfactory coverage of the area under observation.

One of the essentials in generating the so-called $\csc^2\theta$ pattern is the obtaining of a sharp cut-off in beam intensity from a point designated θ_0 (Fig. 2) in the negative direction (in this instance in the downward direction) and a $\csc^2\theta$ distribution in the positive direction with the antenna arranged so the point θ_0 corresponds to the maximum slant range of the antenna.

The present invention contemplates a means of modifying a usual type of antenna radiating means such as one shaped as a pillbox to obtain a different type of energy distribution pattern than that normally produced, including a pattern of $\csc^2\theta$ configuration.

Accordingly, one of the objects of the invention is to provide an antenna having means for affording an unsymmetrical distribution pattern of radiating energy, for example, a $\csc^2\theta$ pattern.

Another object of the invention is to provide a line source type of radiating element with means for eliminating a portion of the radiation pattern normally produced by the radiating element.

Another object of the invention is to provide a line source type of radiating element with means for preventing radiation of substantially half the normal radiation pattern produced by the radiating means and to obtain a sharp drop in beam intensity from the peak power.

Other objects, features, and advantages of the invention will become apparent from the follow-

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ing description taken in connection with the accompanying drawing, in which:

Fig. 1 is a perspective view of an antenna according to one embodiment of the invention;

Fig. 2 is a diagrammatic view of the antenna shown in Fig. 1 and illustrating the radiation patterns produced;

Fig. 3 is a side sectional view of the antenna of Fig. 1 showing a modification thereof; and

Fig. 4 is a side sectional view of the antenna of Fig. 1 showing another modification thereof.

In general, the antenna, according to this invention, comprises a radiating source which may be a linear array type, a pillbox type or more generally, a line source type of radiating means. The linear array type may be such as those described in the co-pending applications of Luis W. Alvarez, Serial No. 542,287, filed June 27, 1944 and issued as Patent No. 2,480,208 on August 30, 1949 and Serial No. 509,790, filed November 10, 1943 and of Jack Steinberger, Serial No. 585,227, filed March 22, 1945 which latter application has become abandoned. The pillbox type radiator comprises a parabolic cylindrical reflecting surface of small axial dimension mounted between plane parallel plates which serve to inclose the ends of the cylinder.

By way of example and to simplify the illustration, the invention is herein described, according to a preferred embodiment, as applied to an antenna having a pillbox type feed or radiating element. However, it is to be understood that the invention is not limited to the pillbox type radiator as it is contemplated to use any suitable source for radiating energy in a pattern which is relatively narrow in one, and preferably a horizontal, plane.

Referring now to Fig. 1, there is shown a pillbox type radiating element 10 comprising parallel plates 12 closing the ends of a parabolic reflecting cylinder 13 and affording a substantially rectangular opening, aperture or mouth 14. Energy for exciting pillbox 10 may be fed thereto by any desired means such as by wave guide 15 entering mouth 14. Pillbox 10 may be supported in any suitable manner so that the planes of plates 11 and 12 are preferably horizontal. As thus far described, pillbox 10 is adapted to radiate energy in a pencil type beam pattern. A pencil beam is characteristically relatively narrow both in elevation and azimuth, and has a configuration in the vertical plane similar to that shown in dotted lines in Fig. 2.

It is desired to obtain an unsymmetrical radiation pattern, preferably one in which the pattern

is directed toward one side of the axis of the normal undistorted beam, and, if desired, one having a $\text{csc}^2\theta$ configuration. This may be achieved, according to this invention, by providing a means for effectively removing or cutting off approximately half of the normal pencil beam pattern. The means generally comprises a plate or plane member extending in front of and forwardly of the radiating source in the horizontal plane. As shown in Fig. 1, the plane member 16 is a continuation or extension of one of the parallel plates 11 or 12, in this instance plate 12. When it is desired that the energy distribution pattern be directed upwardly, plate 16 is an extension of the lower plate 12, as shown, and if it is desired to direct the pattern downwardly, the plane member or plate 16 may be an extension of upper parallel plate 11. Plate 16 may be of any desired electrically conductive material, but is adapted to act neither as a reflector nor as a radiator. Plate 16 may be of any desired shape but preferably is generally rectangular as shown, and may, if desired, be slightly bent along its free end as at 17 preferably to afford an exponentially curved surface portion for smoothing out the radiation pattern produced. Plate 16 in the position shown is effective to confine the radiation to the upper half portion of the normal pencil beam by eliminating substantially the lower half of the normal pencil beam pattern as indicated by the shaded area of Fig. 2. Thus, the energy density is directed upwardly with the arrangement as shown in Fig. 1.

The parabolic curvature of cylindrical reflecting surface 13 of pillbox 10, or the characteristics of any other type of line source, is sufficient to give the necessary high degree of azimuth resolution while the effect of the plate 16 is that half of the radiation pattern is simply cut off and thrown away resulting in a sharp drop in beam intensity from the peak power.

In order to get a beam pattern of $\text{csc}^2\theta$ configuration or of other desired pattern for that part of the distribution pattern remaining, any suitable means may be provided for controlling the energy distribution. For example, the geometry of the primary feed may be controlled by such means as flaring of the mouth 14 as shown in Fig. 3 or of providing a lens (described more fully hereinafter) as generally indicated in Fig. 4 or both. The flared portion 18 of Fig. 3 may be shaped in any desired manner so that the energy radiated from the pillbox, or a linear array antenna element may be radiated in any desired beam pattern such as that indicated by the solid line configuration of Fig. 2. By suitably shaping flared portion 18, a radiating pattern of $\text{csc}^2\theta$ configuration may be obtained. Similar results may be obtained by inserting a wave refracting element, such as a prism, 19 of suitable characteristics in the mouth portion 14 of pillbox 10 or in any other suitable manner in front of a linear array. Lens 19 may be shaped also to get a $\text{csc}^2\theta$ or other desired pattern. Preferably, lens 19 is made of a dielectric material, such as polystyrene, which has characteristically low radiation losses.

One advantage of the antenna as described herein is that it permits the antenna to be mounted on an aircraft in such a manner that the antenna will not protrude appreciably from the actual skin of the aircraft.

While there has been described what is at present considered preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention.

What is claimed is:

1. An antenna comprising a pillbox type radiating element adapted to radiate energy in a pencil type radiation pattern, means for feeding electromagnetic energy to said pillbox, said pillbox comprising a parabolic cylindrical reflecting surface of small axial dimension and a pair of parallel plane plate members enclosing the ends of said surface, and means for eliminating substantially half of said radiation pattern, said last mentioned means comprising a single plane member extending forwardly of said pillbox in the same plane as one only of said plates.

2. An antenna as claimed in claim 1 wherein the other of said plates of said pillbox is flared at its end adjacent said plane member whereby a predetermined desired shape of radiation pattern is adapted to be produced.

3. An antenna as claimed in claim 1 wherein said plane member is an extension of one of said plates and has a substantially rectangular shape.

4. An antenna as claimed in claim 1 wherein the edge portion of said plane member distant from said pillbox is bent to afford an exponentially curved portion.

5. An antenna as claimed in claim 1 wherein the edge portion of said plane member distant from said pillbox is bent along its length, whereby a predetermined desired shaping of radiation pattern is produced.

6. A directive antenna, with means for distorting the radiation pattern from said antenna substantially into $\text{csc}^2\theta$ pattern in one plane, where θ is the angle measured from the axis of directivity of said undistorted pattern, comprising a directive reflector, a pair of parallel conductive end plates coupled to said reflector and forming therewith a radiating aperture, radiating means positioned to illuminate said directive reflector, and a single conductive plane member positioned adjacent said radiating aperture and in the plane of one only of said end plates.

7. An antenna according to claim 6 further including a wave refracting element of dielectric material positioned in said radiating aperture and shaped to reinforce radiation on the side of the axis of directivity of said directive reflector remote from said single plane member.

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