June 10, 1952 W. SICHAK 2,600,274

ANTENNA

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FIG. 1

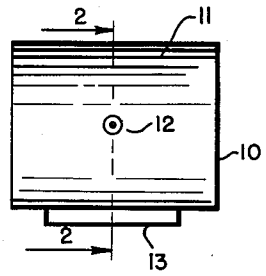


FIG. 2

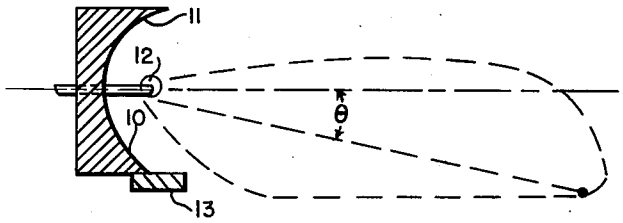
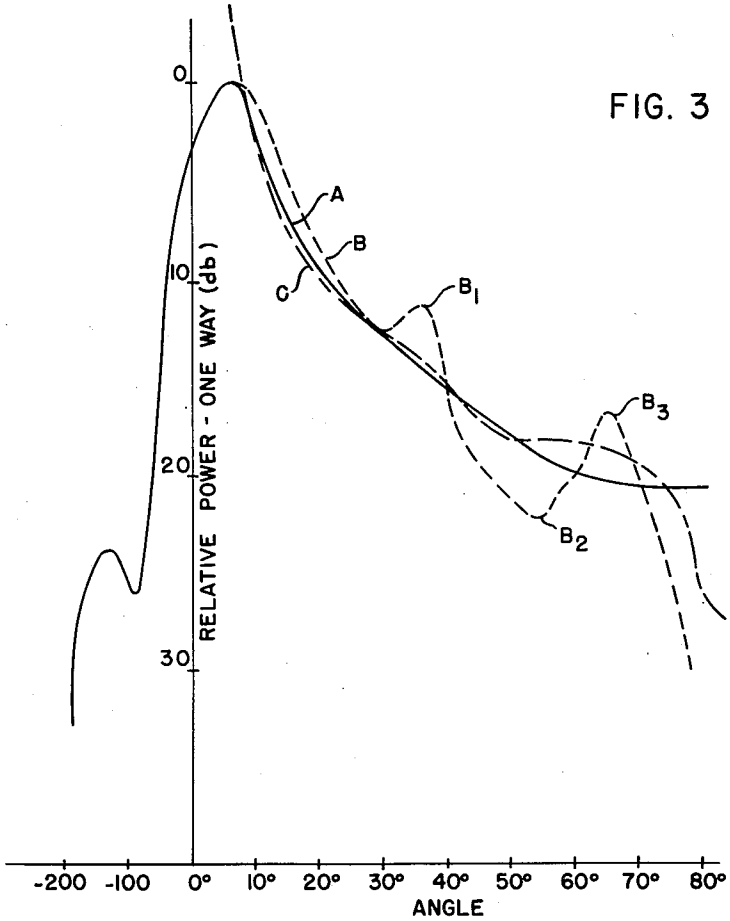


FIG. 3



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6 Claims. (Cl. 250—33.65)

1

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

In certain radio object locating systems, for example, ground search apparatus or low-altitude airborne sets, it is desirable that the distribution of energy 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 elevations 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.

Heretofore several different types of antennas have embodied reflectors shaped in such manner as to produce a $\csc^2\theta$ radiation pattern, such as those disclosed in the copending applications of Ernest A. Martinelli, Serial No. 608,293, entitled "Antenna" and filed August 1, 1945, and Serial No. 608,294, entitled "Antenna" and filed August 1, 1945, Patent No. 2,501,070 granted March 21, 1950, and in my copending application, Serial No. 604,029, entitled "Antenna," and filed July 9, 1945, now abandoned.

With $\csc^2\theta$ antennas as heretofore designed, it is difficult to shape the reflectors to procure a radiation pattern that not only approximates a $\csc^2\theta$ function, but also is free of discontinuities that would appear as bumps on the graph of an experimentally observed curve or on the pattern produced and plotted in either polar or rectangular coordinates. Bumps or discontinuities in the radiation pattern that are 2 db. from maximum to minimum cause objectionable light and dark rings on a cathode ray tube indicator, such as PPI (plan position indication) scope, because of non-uniform ground illumination. Apparently these discontinuities in the $\csc^2\theta$ distribution pattern result from extra radiation from the unmodified portion of the reflector.

The present invention contemplates a means

2

for eliminating the discontinuities in the pattern and thus for smoothing out of the bumps in the plotted curve of the radiation by means of a shelf added to the reflector.

Accordingly, it is one of the objects of the present invention to provide an antenna with means for substantially eliminating discontinuities in the radiation pattern produced thereby.

It is another object of the invention to provide in an antenna having a reflector shaped to produce a $\csc^2\theta$ radiation pattern, means for more closely approximating the $\csc^2\theta$ pattern.

For a better understanding of the invention together with other and further objects thereof, reference is had to the following description, taken in connection with the accompanying drawing.

In the drawing:

Fig. 1 is a front elevation view of an antenna illustrating one embodiment of the invention;

Fig. 2 is a sectional view along the line 2—2 of Fig. 1; and

Fig. 3 is a graph showing the ideal $\csc^2\theta$ and the curves produced by a conventional $\csc^2\theta$ antenna with and without the arrangement according to the present invention, the graph being in rectangular coordinates.

Referring now to Figs. 1 and 2 there is shown a reflector 10 which may be of any desired shape to produce a $\csc^2\theta$ radiation pattern. Thus reflector 10 may be shaped according to the manner disclosed in any of the above mentioned copending applications. For simplification of description, the invention will be described herein as directed to a reflector 10 shaped generally as a parabolic cylinder and having a non-parabolic curved portion 11 adjacent the upper edge thereof, the combination of the parabolic and non-parabolic portions being adapted to produce a $\csc^2\theta$ pattern in a downward direction as indicated by the broken line pattern in Fig. 2.

As thus far described, reflector 10 when properly illuminated from a suitable radiation source 12, which may be of the dipole, horn or pillbox types, is adapted to produce a pattern which is shown in rectangular coordinates in Fig. 3 as curve B, the ideal $\csc^2\theta$ being shown as curve A. It will be noted that curve B has prominent bumps due to discontinuities caused by extra radiation from the parabolic lower portion of reflector 10, these bumps being designated B_1, B_2 and B_3. As will be understood, it is desired to eliminate these bumps. This may be achieved according to the present invention by providing a shelf along the lower edge or the unmodified

parabolic side of reflector 10. Thus a shelf 13 is mounted in any suitable manner, such as by screws or welding along the lower edge portion of reflector 10.

Shelf 13 comprises a flat sheet or strip of electrically conductive material disposed along the edge of the parabolic portion of reflector 10. Shelf 13 extends beyond the lower edge of reflector 10 with its plane substantially parallel with the normal focal axis of the parabolic portion of reflector 10. However, if desired, shelf 13 may be slightly tilted in either direction relative to the focal axis to the position giving best results. The dimensions of shelf 13 are not critical: for example, shelf 13 may extend entirely the length of the edge portion of reflector 10 or only part way along the edge. Preferably shelf 13 extends more than half way along the edge of reflector 10 and may extend forwardly away from the reflecting surface of reflector 10 for a distance of from one to three wavelengths of the energy at the desired frequency of operation. It will be understood that when reflector 10 is shaped generally as a parabolic cylinder, shelf 13 will be a straight or flat strip whereas, for a reflector shaped generally as a paraboloid of revolution or having a curved edge, shelf 13 will be curved to conform with the outer edge portion of the reflector.

The effect of shelf 13 upon the radiation pattern is that the bumps that appear on curve B of Fig. 3 are almost entirely eliminated. The curve of the radiation pattern produced with a reflector having a shelf 13 according to the present invention produces a pattern substantially as indicated by curve C of Fig. 3.

While there has been described what is at present considered the preferred embodiment 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. In an antenna for radiating and receiving waves of electromagnetic energy having radiating means and reflector means having a parabolic portion and a non-parabolic portion shaped according to geometric optics to produce a radiation pattern in which the energy distribution varies substantially as the square of the cosecant of the angle measured from the axis of the parabolic portion, means for eliminating irregularities in said pattern, said means comprising a sheet of electrically conductive material mounted along an edge of said reflector and extending forwardly from said reflector in a plane substantially parallel to the normal focal axis of the parabolic portion of said reflector.

2. In an antenna including means for radiating ultra-high frequency radio energy and a reflector adapted to be illuminated by said rediating means, said reflector having a major portion of its reflecting surface of generally parabolic shape to direct radio energy when properly illuminated by said radiating means along a main path in a substantially symmetrical radiation pattern, a portion of the reflecting surface near and along a portion of the length of the edge of said reflector being of non-parabolic shape to direct said energy along a divergent path whereby an unsymmetrical radiation pattern is produced by said reflector that varies generally as the square of the cosecant of an angle measured from the axis of said parabolic portion, and means comprising an electrically conductive strip of material connected to said parabolic portion and extending forwardly thereof to substantially eliminate extra radiation from said parabolic portion and thus substantially eliminate irregularities in the said unsymmetrical radiation pattern.

3. An antenna comprising a reflector and a radiator to illuminate said reflector with ultra-high frequency radio energy, said reflector comprising a parabolic portion and a non-parabolic portion, said portions cooperating to produce a radiation pattern that varies generally as the square of the cosecant of an angle that is measured from the axis of said parabolic portion, and means including an electrically conductive strip of material mounted along the edge of said parabolic portion and extending forwardly substantially parallel to the axis thereof to eliminate irregularities in said cosecant squared pattern.

4. The antenna according to claim 3, wherein said strip extends forwardly of said reflector a distance of from one to three wavelengths of the radio energy at the operating frequency.

5. In an antenna including radiating means and a reflector adapted to be illuminated by said radiating means, said reflector having a major portion of its reflecting surface of generally parabolic shape to direct radiant energy when properly illuminated by said radiating means along a main path in a substantially symmetrical radiation pattern, a portion of the reflecting surface near and along a portion of the length of the edge of said reflector being of non-parabolic shape to direct said energy along a divergent path whereby an unsymmetrical radiation pattern is produced by said reflector that varies as the square of the cosecant of an angle measured from the axis of said parabolic portion, a longitudinal strip of electrically conductive material mounted along the edge of said parabolic portion and extending forwardly of said reflector for a distance of from 1 to 3 wavelengths of the radiant energy at the desired frequency of operation, said strip serving to substantially eliminate extra radiation from said parabolic portion and thus substantially eliminate irregularities in the said unsymmetrical radiation pattern.

6. In an antenna, reflecting means having such shape as to produce a radiation pattern of a configuration that varies generally as the square of the cosecant of an angle measured from the axis of said reflecting means, means for illuminating said reflecting means by ultra-high frequency radio energy, and means including an auxiliary reflector made of electrically conductive material and mounted on one edge of said reflecting means and extending forwardly thereof for eliminating irregularities in the radiation pattern produced by said reflecting means.

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