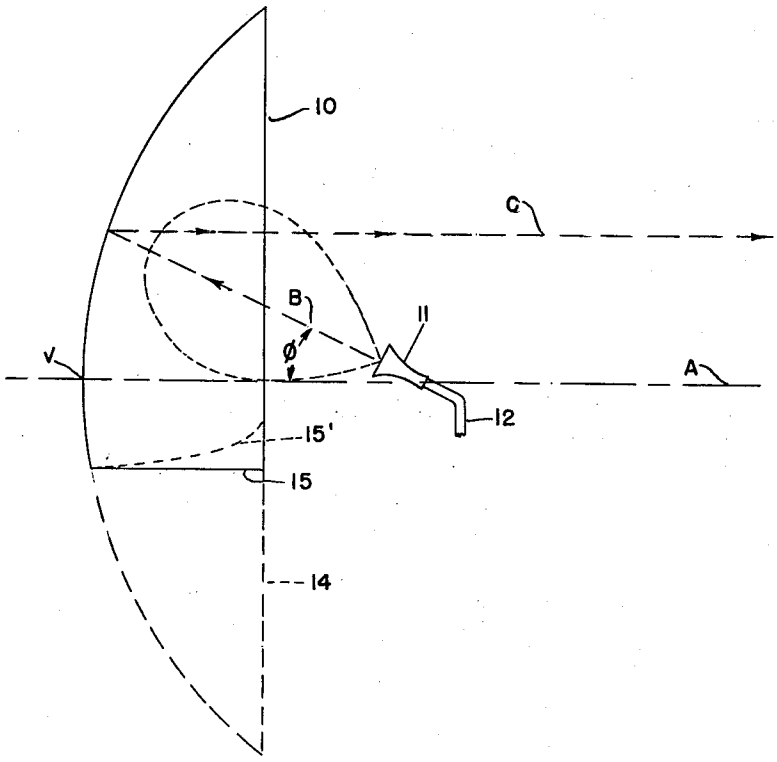
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This invention relates to the provision of antenna systems for transmission or reception of high-frequency radio waves and particularly to antenna systems for operation at frequencies in the so-called microwave range, corresponding to wave lengths of the order of centimeters, which antenna systems are adapted to provide desirable energy transfer characteristics over a range of frequencies. More particularly, the invention relates to arrangements for reducing the frequency sensitivity of such antenna systems.

The term "energy transfer characteristics" is used to refer to the fact that the antenna serves to transfer energy from a conductor system such as a transmission line or other form of wave guide to free space either directly or with the help of a system of reflectors or to transfer energy vice versa. In general, the energy transfer is not perfect, which is to say that there are some losses and, more important, that some energy is reflected, in the case of transmission, back into the transmission line.

In a radio object-locating system, it is desirable that an antenna feed be matched to free space or to the load of the antenna, in order to reduce the possibility of high standing wave ratios in the R. F. components of the system. However, a matched R. F. line is sometimes difficult to achieve if an appreciable amount of the radiant energy is reflected back into the feed from a reflector, as such returning energy sets up large standing waves in the feed line and R. F. components.

It is the principal object of this invention to provide an antenna with means for reducing the amount of radiant energy returning to the feed line.

It is a further object of the invention to provide a novel antenna arrangement having improved energy transfer characteristics and which minimizes the setting up of standing waves in the feed line therefor.

It is a still further object of the invention to provide a novel antenna arrangement adapted to reduce the frequency sensitivity of the antenna.

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 which is a diagrammatic side sectional view of a parabolic reflector with a radiating element for illuminating the same in accordance with this invention.

In the drawing, 10 designates a reflector having a parabolic reflecting surface. Reflector 10 may

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be shaped generally as a paraboloid of revolution or as a parabolic cylinder. For simplification of illustration and description, the invention will be described herein with reference to a reflector formed as a paraboloid of revolution.

Reflector 10 is illuminated by a radiating element 11 located at the approximate focal point of reflector 10. Radiating element 11 is preferably a wave guide aperture type of feed or a horn type feed as shown, although it may also be any other conventional type of radiator such as a dipole, or, for a parabolic cylindrical reflector, a linear array type radiating element, said dipole or linear array preferably being provided with a conventional secondary reflector whereby energy radiated by said dipole or array may be directed toward, and concentrated upon, a preselected portion of paraboloid 10. Energy is fed to radiating element 11 by means of a transmission line 12 which may be of the hollow pipe wave guide or coaxial conductor type.

According to this invention, radiating element 11 is so disposed that the axis of directivity of the primary beam pattern of radiant energy as designated by line B is not coincidental with that of the normal focal axis, designated by line A, of reflector 10, but is disposed at an angle ϕ thereto. This may be achieved by tilting the feed or radiating element 11.

By tilting the radiating element 11 the possibility of energy being reflected by reflector 10 directly back into the feed is greatly reduced. This is due to the fact that the line of maximum radiation (line C) is moved off center with respect to the normal axis of reflector 10 (line A) so that it does not pass through the feed element, as would be the case if radiating element 11 were not tilted and a symmetrical paraboloid reflector were used. Also, the large amount of energy ordinarily reflected back to the radiator 11 from the portion of reflector 10 near the vertex V thereof is almost entirely eliminated because the reflector 11 is an inefficient radiator in this direction due to the tilted directivity of the primary pattern.

It will thus be understood that with the axis of the primary pattern tilted at an angle ϕ toward one edge of reflector 10, very little energy impinges on the portion of the reflecting surface near the opposite edge or, as shown in the drawing, the lower edge of reflector 10. To eliminate inefficient reflection of this minor portion of the radiant energy, the lower portion 14 of reflector 11, and preferably less than half of the reflecting surface of reflector 10, is removed. Reflector

10 may be cut along a straight line 15 across the width thereof or it may be cut in a curved line 15', which may, if desired, follow the curvature of the surface, depending on the primary pattern radiated by element 11. Thus reflector 10 may be cut along a line 15 substantially coinciding with the line of intersection with reflector 10 of a plane spaced from axis A and perpendicular to the plane through the periphery of reflector 10. As shown, reflector 10 is cut along a horizontal line 15 across the width of reflector 10 and spaced from the vertex V of reflector 10, thus removing the portion 14 shown in dotted lines in the drawing. This removed portion 14 is less than half of the total reflecting surface of the complete paraboloid configuration.

The combination of the tilted axis of the directivity of the antenna feed 11 and the use of a cut paraboloid as described, results in a highly satisfactory antenna from the standpoint of feed match and antenna gain inasmuch as the feed matching does not depend on a cancellation of feed energy. As the possibility of loss due to reflection back to the feed is minimized, the antenna is less frequency sensitive and therefore may be utilized over a greater band of frequencies.

What is claimed is:

1. An antenna comprising, in combination, a reflector having a reflecting surface solely of paraboloidal shape with an edge portion removed, said portion being less than half of the normal paraboloidal reflecting surface, and means for producing an antenna pattern having a principal axis parallel to the center axis of said reflector comprising, a directional radiating element located in a fixed position at the focal point of said reflector, said element being tilted so that its axis of directivity is disposed at an angle to the normal focal axis of said reflector on the opposite side of said focal axis from said cut-off portion, whereby the line of maximum radiation of said antenna is spaced from and parallel to the focal axis of said reflector.

2. A microwave antenna comprising a paraboloidal reflector having a portion comprising less than half of the reflecting surface thereof cut off approximately along the line of intersection with said reflecting surface of a plane perpendicular to the plane through the periphery of said reflector and spaced from the axis of said reflector, the reflecting surface of said reflector being solely of paraboloidal shape, and means for producing an antenna radiation pattern having a principal axis parallel to said axis of said reflector comprising, a directional radiating element positioned at the focal point of said reflector and having an axis of directivity which is tilted with respect to said axis of said reflector toward the edge of said reflector opposite to said cut-off portion.

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